EVA-Link – Long Range Tracking and Communication at MDRS

Presented by Kent Nebergall

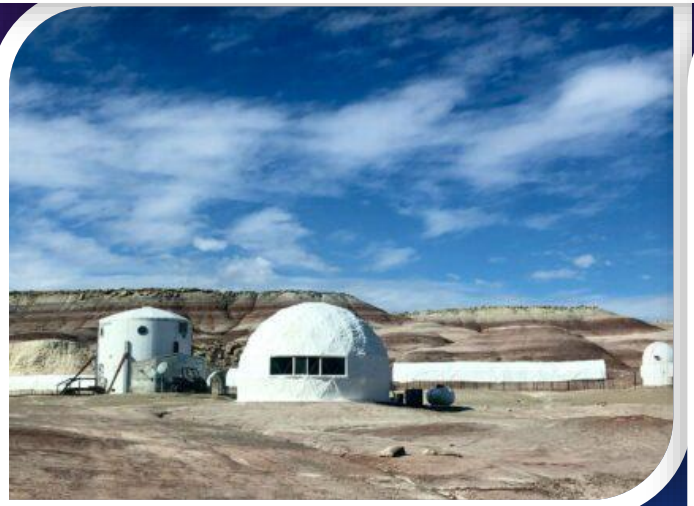
Developed by Mars Society Chicago Chapter/ Archipelago Space Research

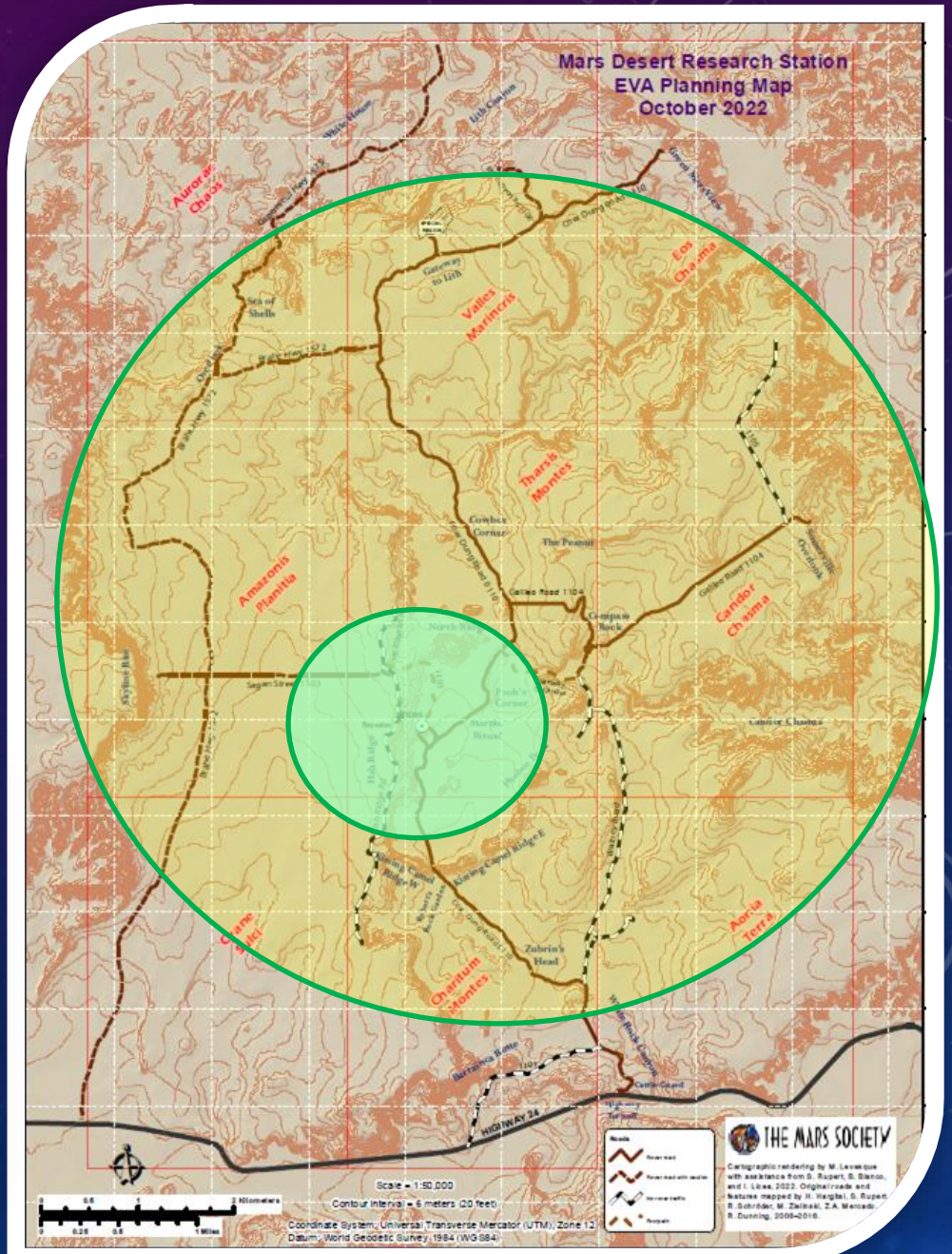
Mars Society Conference – August 2024. Seattle.

Overview

- What is EVA-Link?
- How Does it Help Analog Crews?
- 2023/4 Prototype Field Tests
- Lessons Applied to Baseline System
- Plans for the Next Field Season
- Volunteers Needed

Mars Desert Research Station





EVA-Link Features

- GPS Tracking
- Texting
- Location Tags
- Voice Links
- VR Integration

Why EVA-Link?
MDRS Core Principles

Safety – Simulation – Science

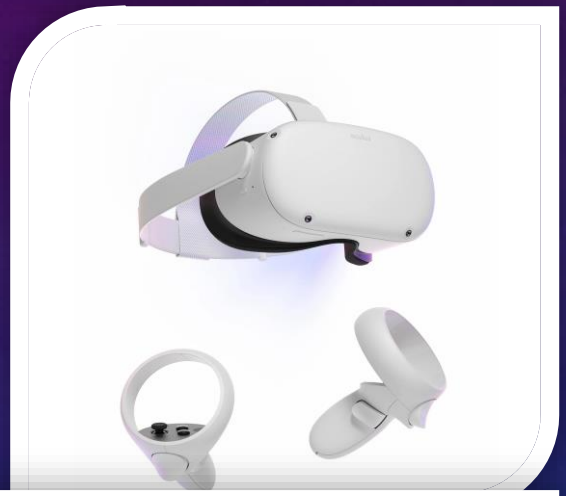
To improve EVA safety for analog astronauts

To improve the situational awareness of analog astronauts on EVA and in hab

To extend the scientific reach of space analogs

Who Participates?

EVA Crew

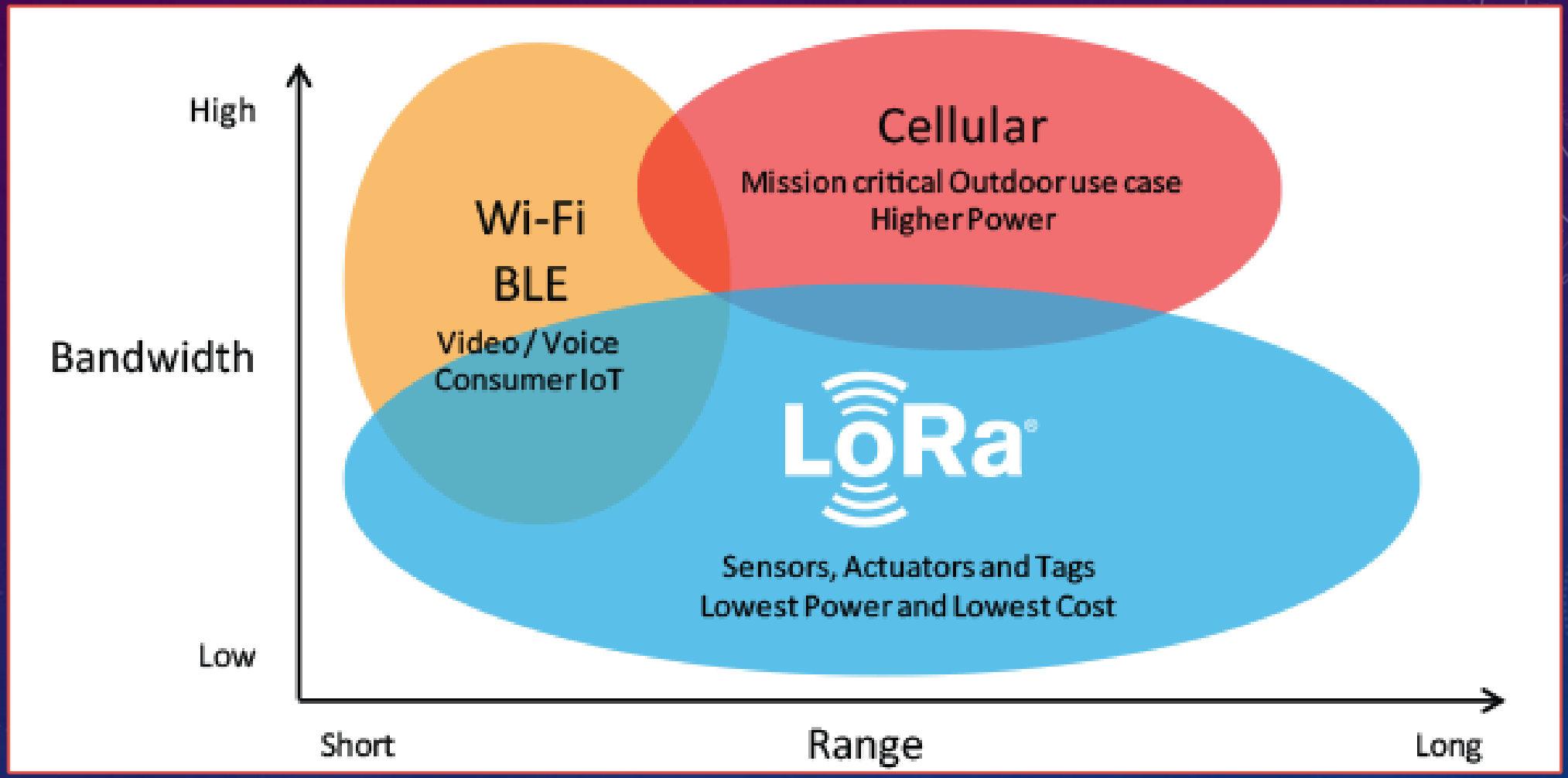


VR Participants

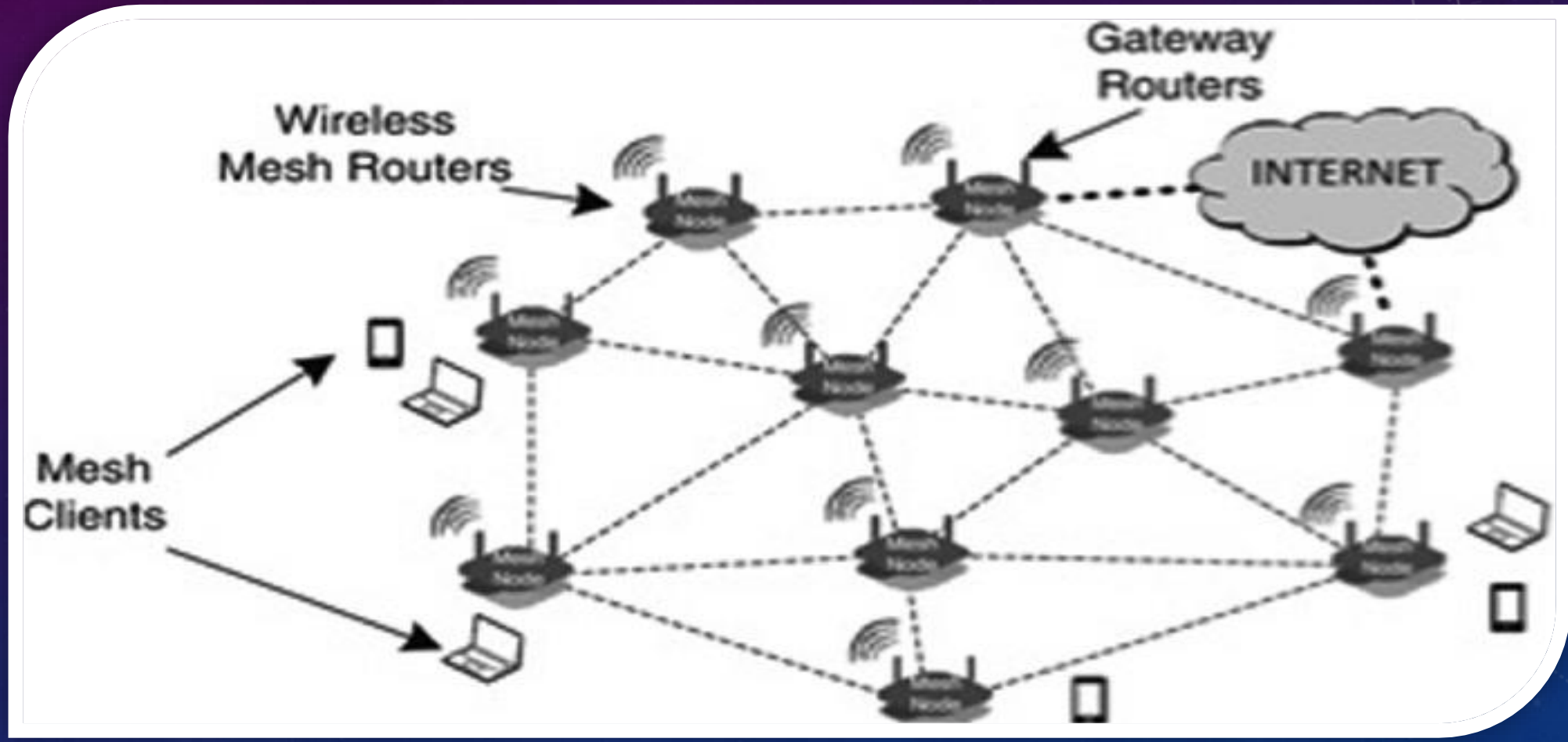
Hab Crew

Mission Support

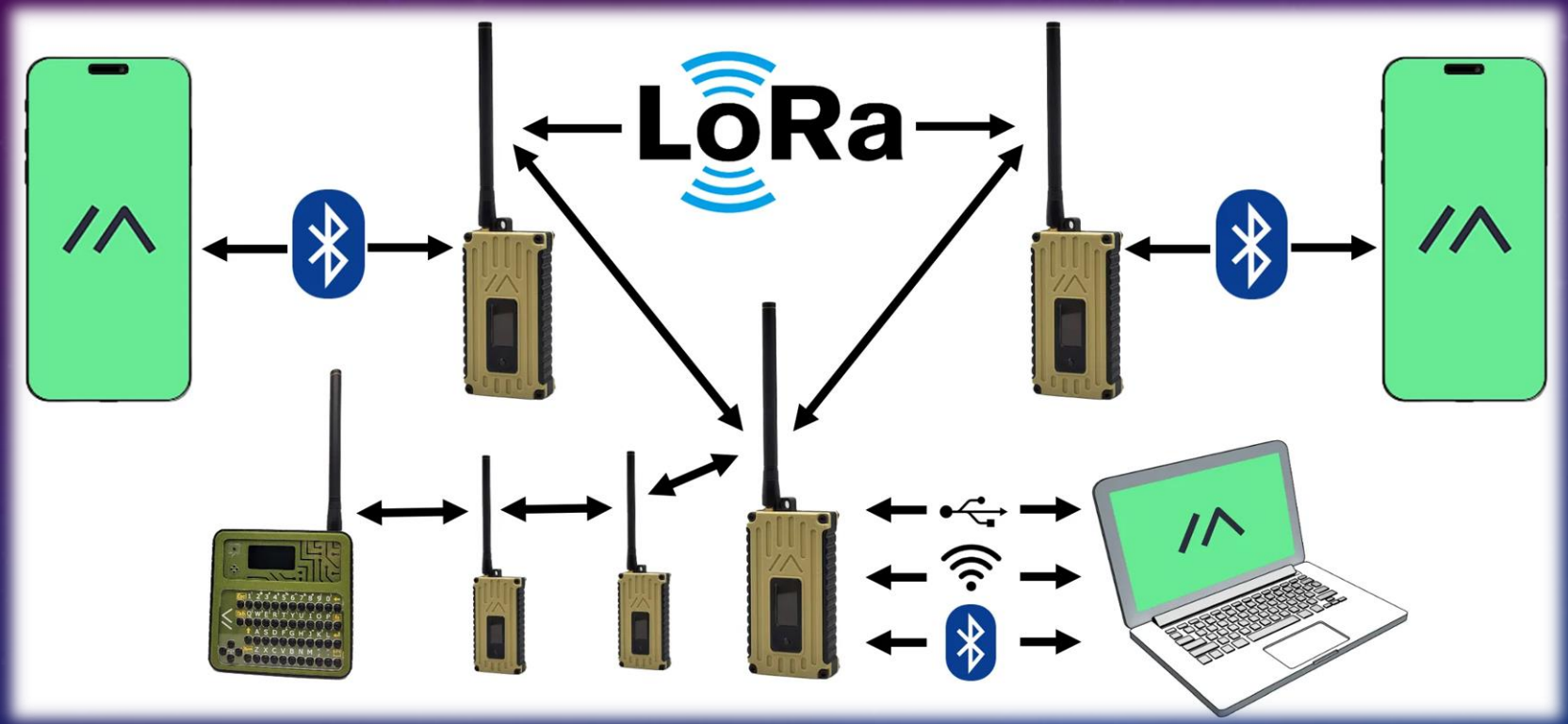
Definitions: LoRa – (Long Range)



Definitions: Mesh Network



Definitions: Meshtastic

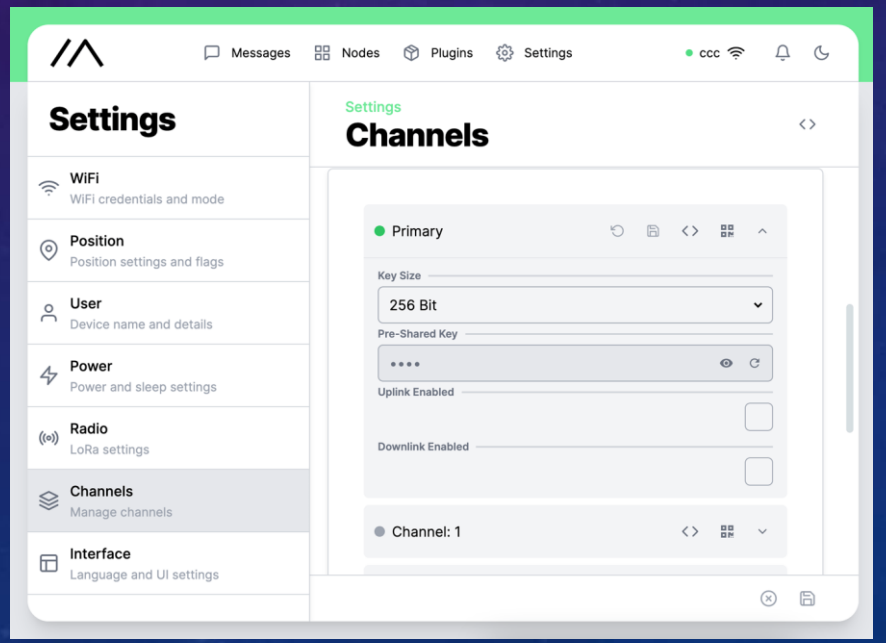


Meshtastic


EVA-Link Hardware

Suit Module

- Currently a LILYGO Meshtastic Device.
- Comes with Bluetooth, LORA communications, and GPS receiver.
- Can communicate with Meshtastic software on a cell phone or tablet to communicate and show maps in the field.

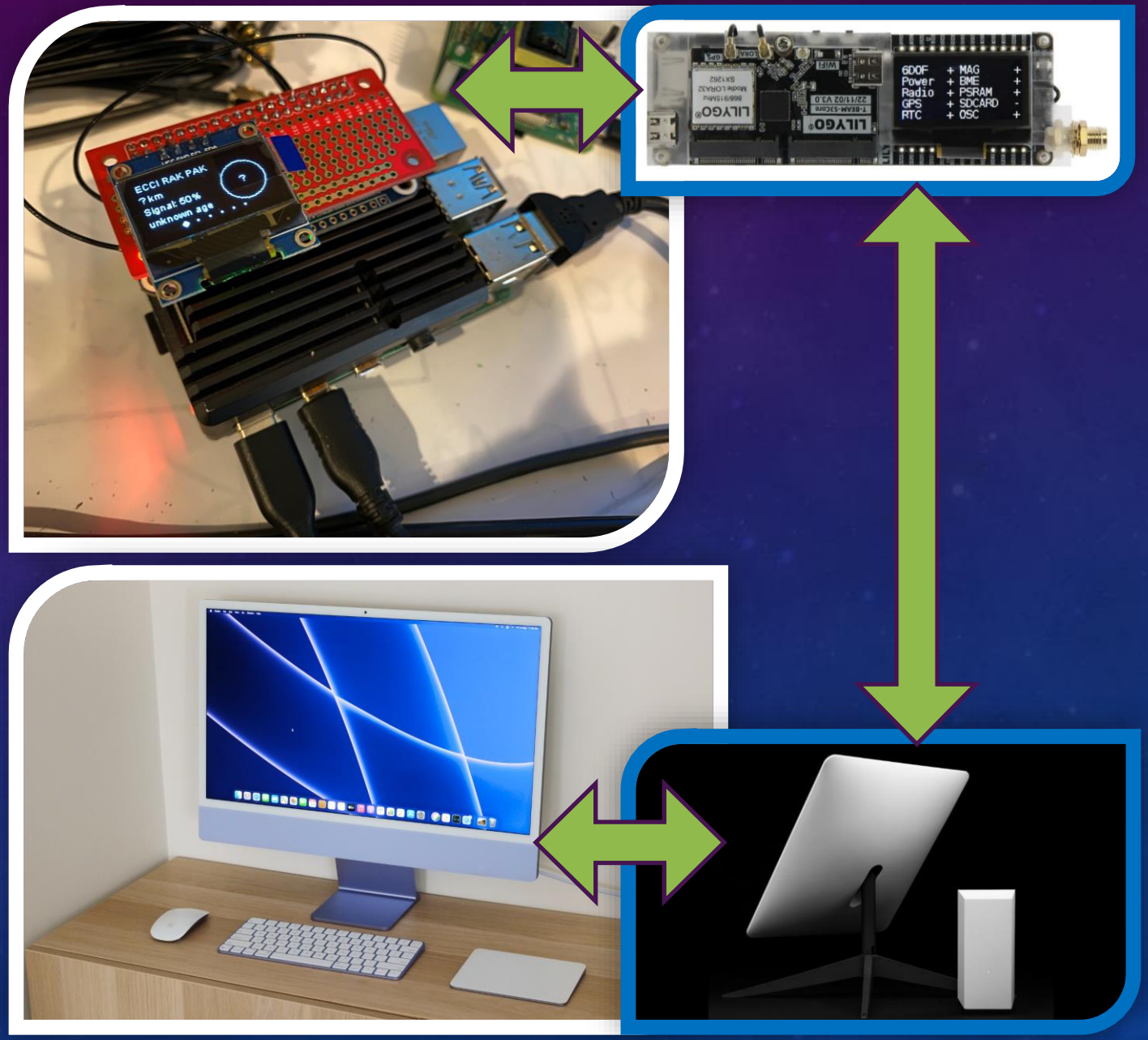


Hilltop Relays

- Positioned on hilltops around MDRS to cover any areas without line of sight on the Hab.
- Solar powered and self-monitoring for temperature, battery health.
- Installed last field season, ready for re-deploy each season from now on.

Hab Base Station

- Links the outside long range network with wi-fi in the hab and the internet/cloud.
- Real time maps on the Mac for every tag.
- Tablets/phones on network can send and receive messages in or outside of hab.
- Database of tracks for each EVA and crew being built up, along with text messages sent, battery data, etc.



OPERATIONAL VIEW – System Core

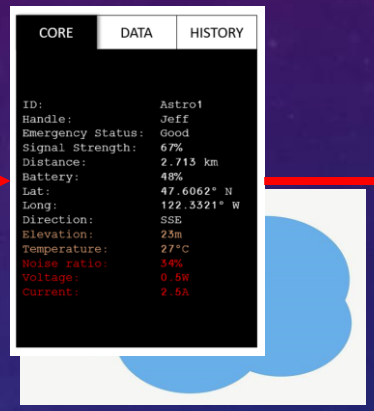
GMRS Radio

T-Beam

Voice

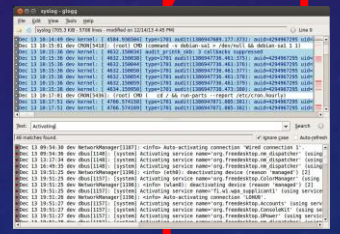
GMRS Radio

iMac

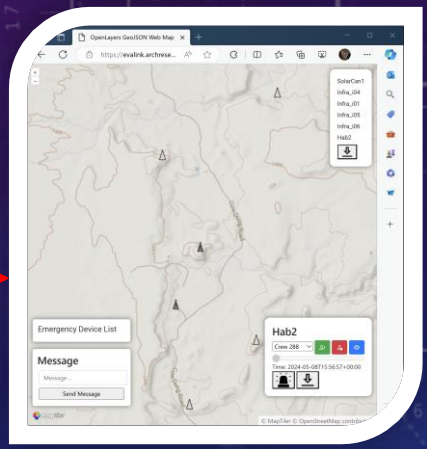


MQTT Broker in Azure

Telemetry

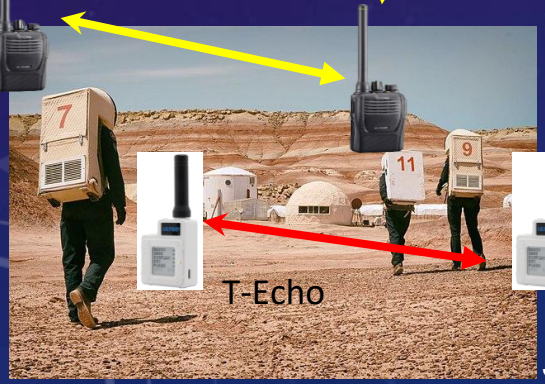


GPS Logging



GIS Status Map

MarsComms VR



T-Echo

See also Jeff Rayner's Presentation on Mars VR

Discord Server

Technology Stacks: Hybrid to Simplified

Capability	As Tested	2024/5 Season	Planned
GPS Tracking	EVA LINK	EVA LINK	EVA LINK
Texting	Meshtastic Phone App	Hab: EVA-Link Field – Phone App	EVA LINK
Location Tags	Meshtastic App plus Data Logs	Use Location Data with other systems	EVA LINK
Voice Links	Discord MDRS to VR Only	Discord MDRS to VR Only	Discord Logged and Bidirectional
VR Integration	JSON Data File, Quest 2 Headset	JSON Data File, Quest 2/3 Headset	EVA LINK + Mars VR + Discord

Updates

Timeline

2022-3 Team build/Design

- Workbench Prototypes
- Virtual Office Setup for Dev Team (Discord, etc.)

2023-4 Prototype Field Tests

- Secondary Systems to Boost Feature Set
- Gap Analysis and Fixes
- Relay Field Tests

2024-5 Live System Launch

- User interface Features
- Cell Phone Text Relay

Crew 261 - Lessons Learned

Subset of Prototype hardware/software

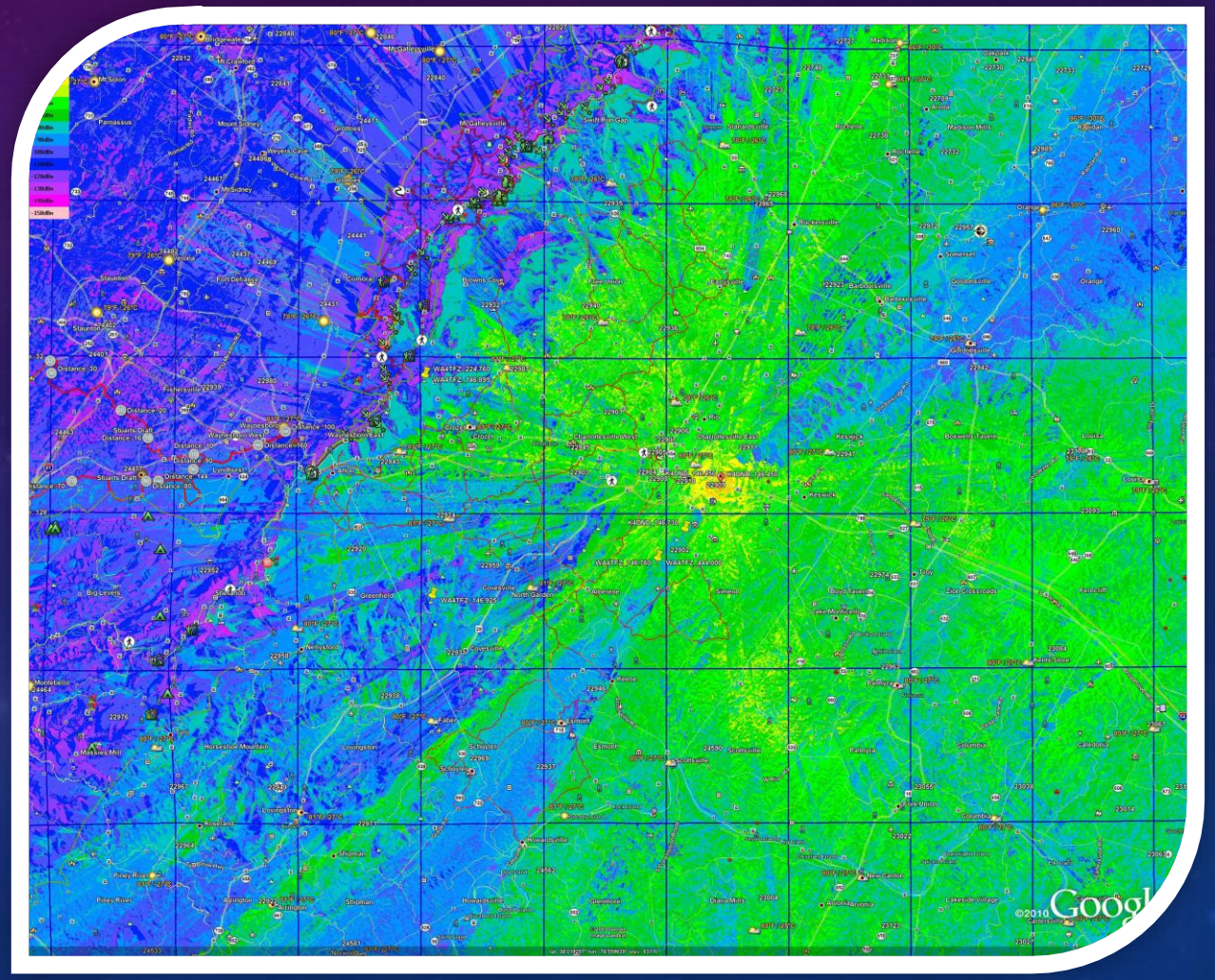
See also James Burk's Presentation on Crew 261, 2023 Mars Society Conf.

Crew 261 – Findings and Solutions

Prototype System Tested	Issue Found	Solution Found	Result or Plan
• Basic T-Beams used as Repeaters • Manually placed on Hilltops	• Shadows where no signal in field	• Used software to simulate tower placement and optimized locations. • Better electronics and antennas	Field testing with Sergei shows issue resolved.
• T-Beam Basic used in field • Positions verified with Garmin backup system	• “Jumpy” GPS reporting with spikes in unexpected directions	• Software rejects noise. • Radios standardized. • Much better radios for relays, Hab.	Initial field tests (Sergei jogging) are clean and reliable.
• Minimal “Breadboard” systems with “alpha” software, draft procedures	• Processes too complex for setup. • Documentation poor. • Field support limited	• Software improved • User Interfaces simplified • Documentation, Versions standardized	In development Summer 2024. Promising results so far. Better documentation will help a lot with support.

Radio Shadow Study Tools

- Used an online Radio Propagation Simulation to find the best hilltops for the relays
- Able to use Mars VR and the extended map to plan routes up and down the hills to put the equipment in place.

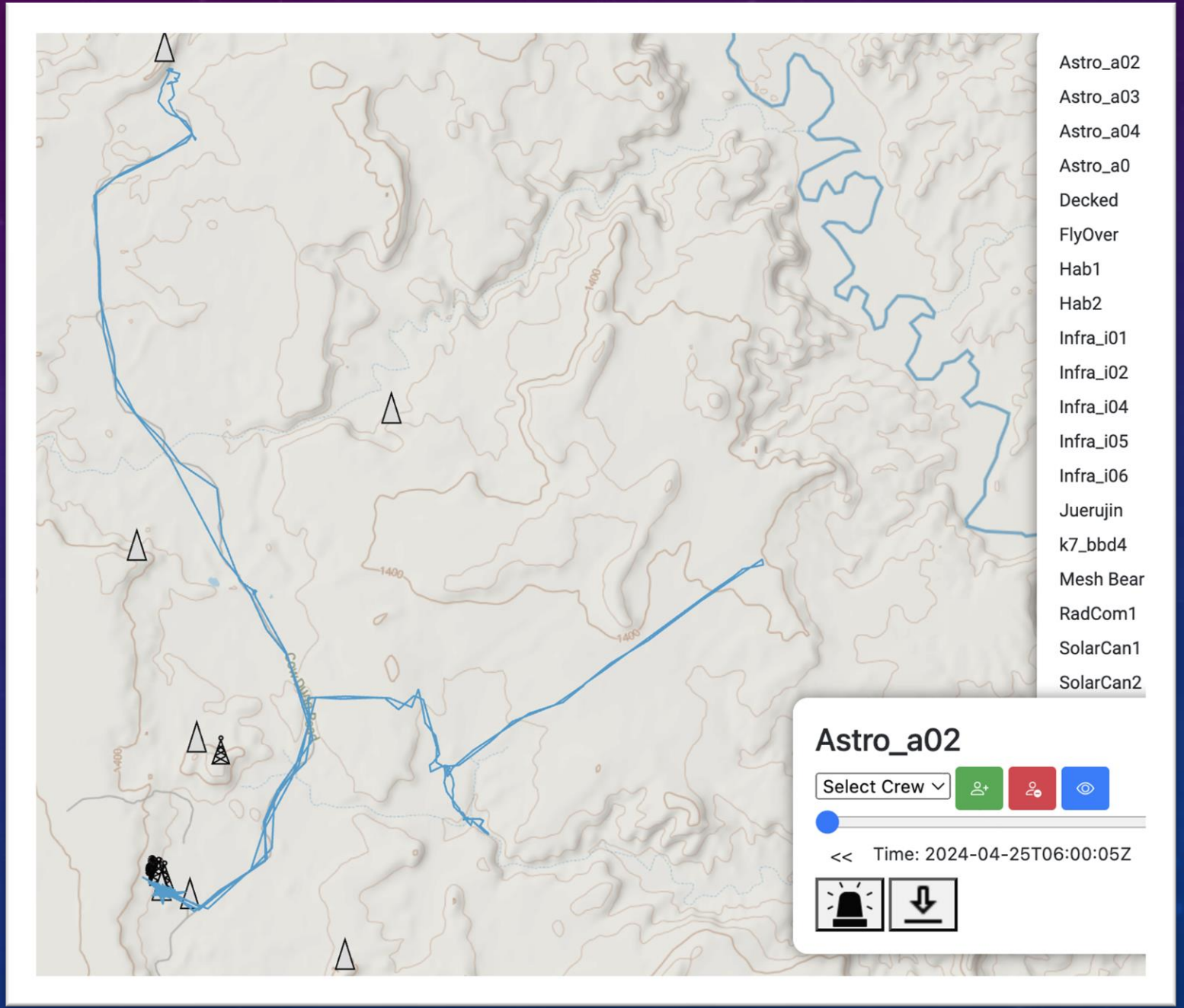


Relay Upgrades

- Better Electronics
- Better Batteries
- Solar powered
- Insulated
  - Warm batteries at night
  - Cool electronics in daylight

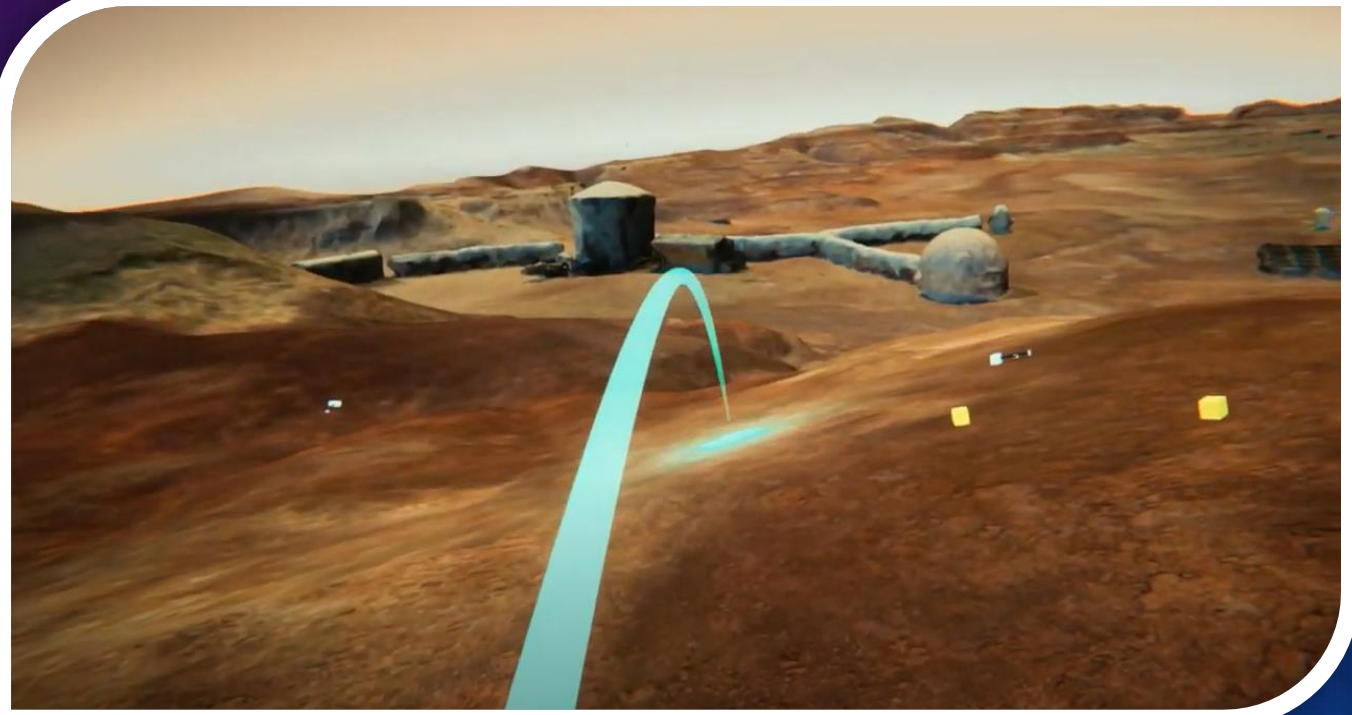
Dashboard Map Advances

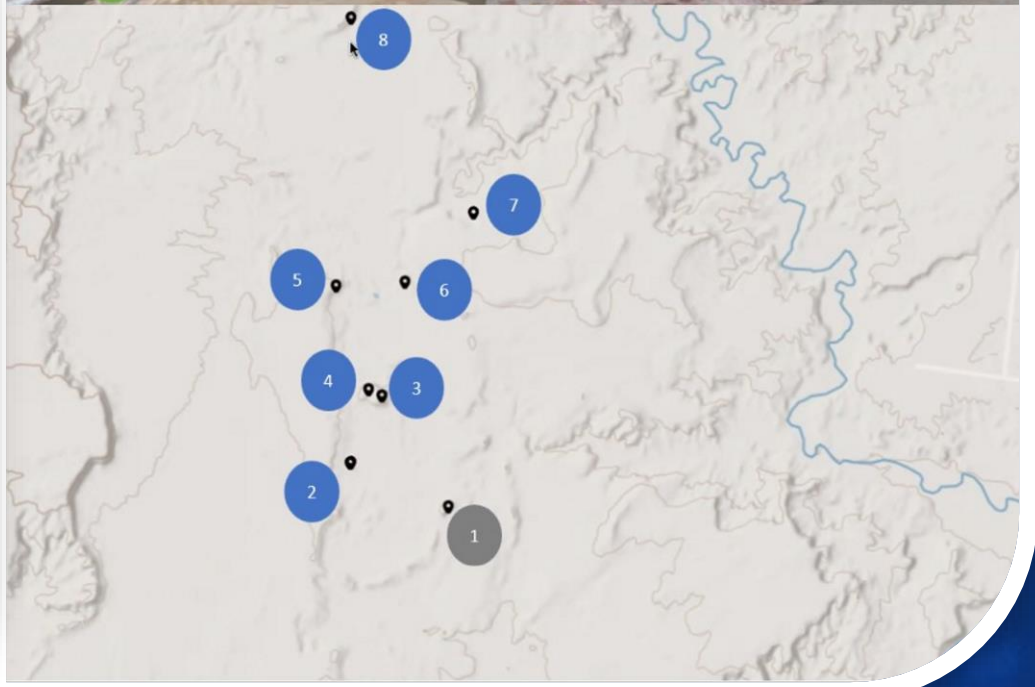
- Added Messaging Window
- Can assign a crew/name to a beacon so map shows names, not numbers
- Can click on a beacon to see status.
- Ground Track Records Visible



VR Maps Include Relays, Crews

- Mars VR map combined with satellite map to give view all the way to the horizon. VR views in browser possible





We are Go for Launch!

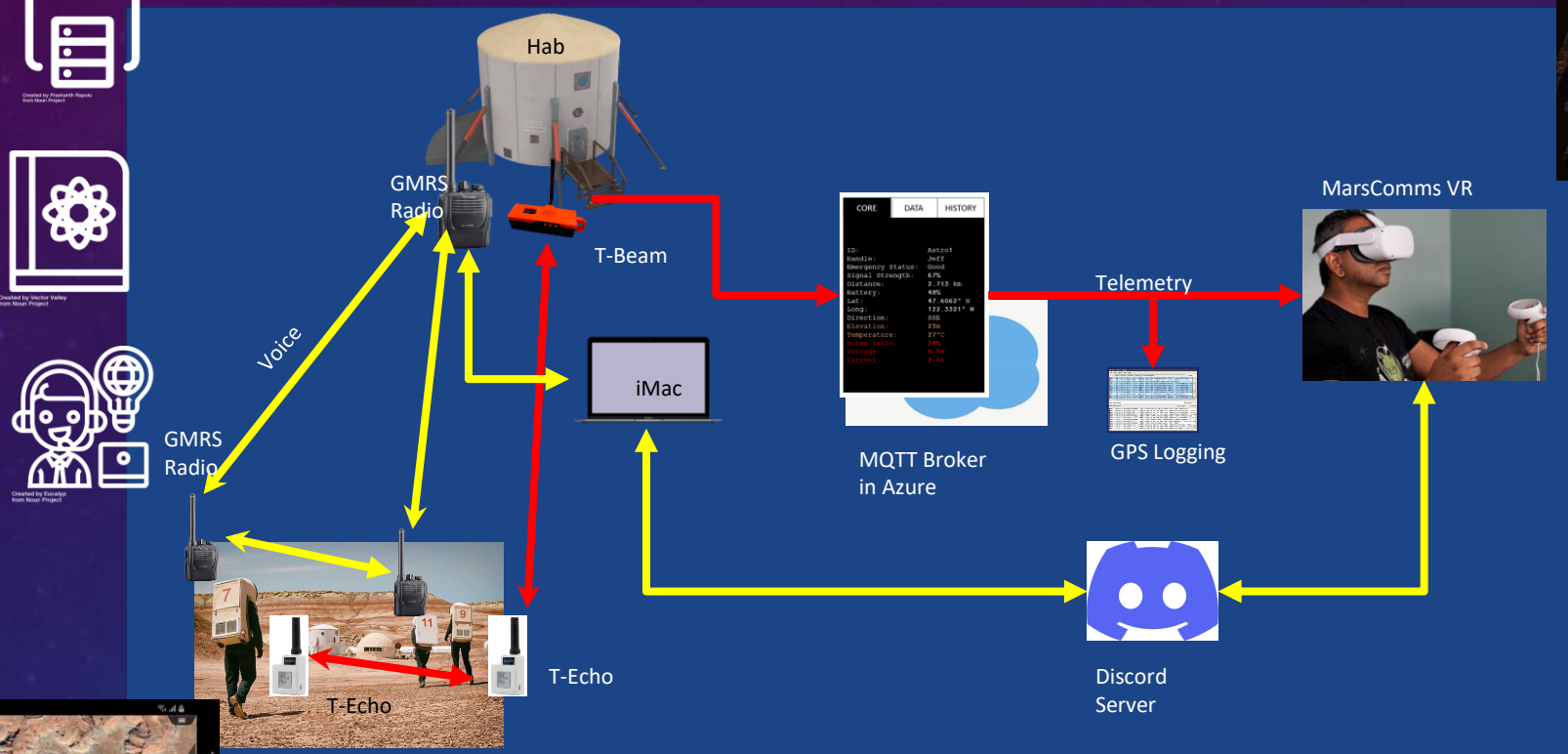
Next Steps

Extended and Future Capabilities

Local Compute & Storage

Electronic Lab Notebook

Operations Knowledgebase



God Mode ✓

Mobile EVA Terminal

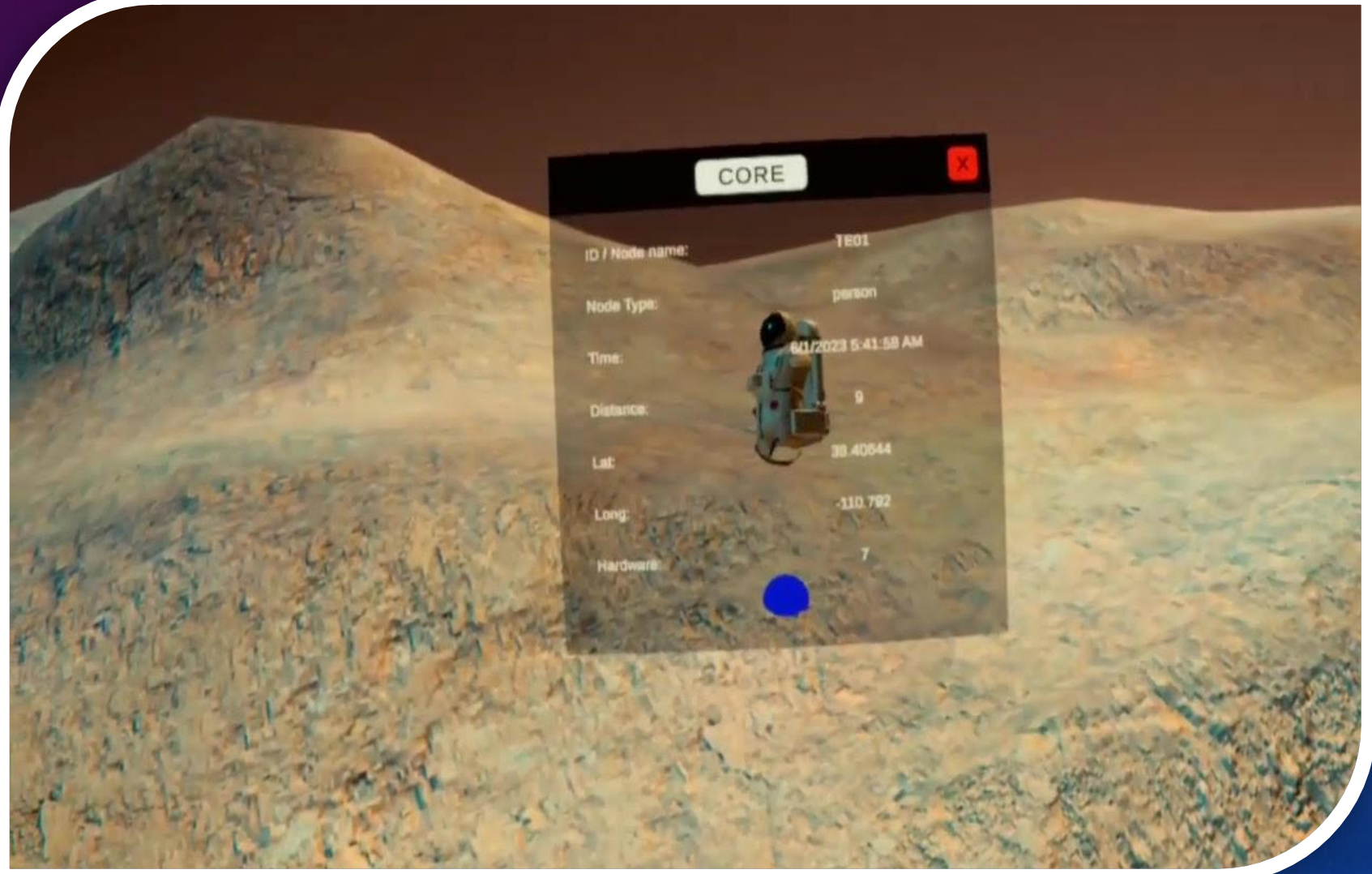
EVA Recordings ✓

GIS Analytics

Ops Dashboard

VR Surface Integration

- Data Streams from Crew and Relays can be overlayed on the crew member as an information box.



In Development/Must Haves

Current Work	Important Next Work	Operational Improvements	Nice to Have Items
Map Improvements • Astronauts named • Logs kept by Crew, EVA and labeled • Ability to display past EVA tracks.	**Lab Notebook** • Settle on an open-source software package • Incorporate EVA logs into “paper trail”.	• Preset protocols for sample collection tags. • Operational knowledgebase of EVA-Link and all station hardware/software, expanded over time	• Meshtastic Weather station that can be prompted for data • Heads-up display in helmet • Unified software with simplified user experience.
Documentation • Standard install guides • Troubleshooting guides • Operation guides	**Field Comms** • New crew devices with two-way text onboard	• ESP32 Suit devices with display in helmet or on wrist • Mobile EVA Terminal	• Long range digital voice radio with synchronized logging of speech. • Text to Speech in suit for messages sent.
VR Improvements • Crew data overlap	**GIS analytics** • See where on map past crews found rock types	• Wall terminals (tablets) around base for local point-to-point use • Echo/ equivalent in hab	• Open Platform for crew-specific equipment

EVA Link Team

CORE TEAM:

Brad Midgley

Patrick Selby

Kent Nebergall

Chris Kozlov

Lily MacFaydian

Mark Midgley

Jeff Rayner + MXTreality

Peter Dekluyver

James Burke

Eric Kristoff

Ashton Zeth

Taylor Anhalt

SPECIAL THANKS TO:

Sergii Iakymov

Mike Stoltz

Louis Dekluyver

Jason Simpson

YOU CAN HELP TOO !

To the right are just a few of skills that could make a big impact.

How?

- eric.kristoff@gmail.com
- Sign up at https://forms.gle/YAupewVJw4CPTg3v6

Or find Kent, Peter or Aston around Convention

GitHub Repo

https://github.com/marssociety/EVALink

Technical writing

Web Development

MDRS crews

Blogging

Video editing

Graphic design

Information management

Science advisory (geology, biology, etc.)

Python coding

Mobile/Android development

Rich Web App Client

Database, Edge computing, Hardware Integration.

One more thing…

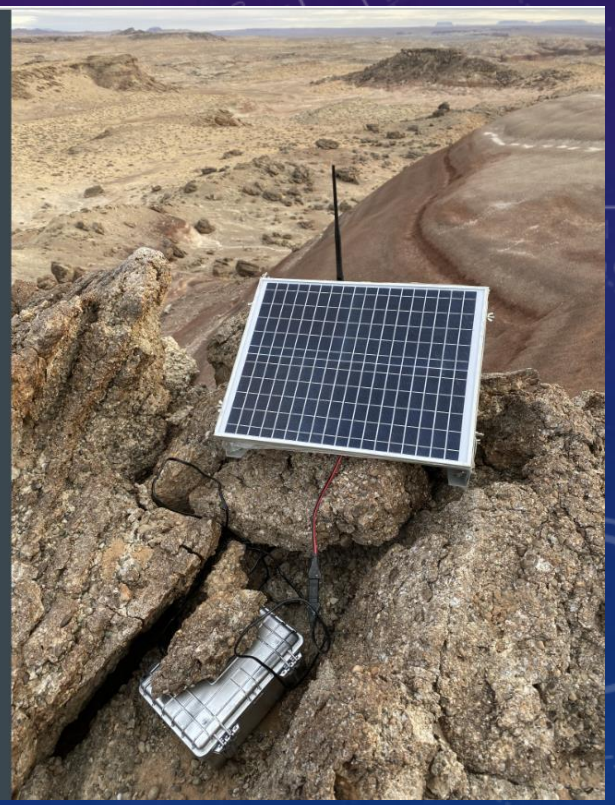
NASA at MDRS 2006

- ✓ Satellite Navigation
- ❑ Digital Panorama Pictures
- ✓ Digital Relay
- ❑ Voice Recognition
- ❑ Follow Me AI/Autonomy
- ✓ Network over entire area

- ❖ Digital Voice Comms
- ✓ Tag sample data (GIS)
- ✓ Email info from field to SMEs directly

Three box trucks of equipment

EVA-Link – Compact tracking/Data Links



NASA at EAA Airventure 2024…

- For Wildfires, an ATC for the field to track and guide in drones.
- Off the shelf, mesh network

Thank you!
Questions?

- archresearch.net
- MacroInvent.com