

SkyMesh



Aerial-Ground Mesh Networking for
Wilderness Search & Rescue

Restoring communications when terrain breaks rescue teams apart

The Problem



Terrain breaks links

Forest and mountain teams lose line-of-sight, splitting mesh networks into disconnected partitions.



Coordination collapses

Partitioned teams lose voice, routing, and command visibility — rescue becomes slower and riskier.



Existing options fall short

Current solutions are costly, proprietary, or require cellular/satellite infrastructure unavailable in the field.

When teams cannot communicate, rescue becomes slower, riskier, and less coordinated.

Our Solution

An offline communication kit that detects mesh partitions and automatically restores connectivity via an autonomous UAV aerial relay.

- 1 Ground nodes form a Wi-Fi offline mesh (Mumble)
- 2 Command node hosts voice (Murmur), maps, and monitoring
- 3 Telemetry & probes detect a network partition
- 4 UAV relay autonomously joins and repositions to restore links
- 5 Connectivity recovers; system logs the result

Open Architecture

Reproducible, no vendor lock-in

Integrated Services

Voice · Chat · Network monitoring

UAV-Assisted Repair

Autonomous relay, not static

Measurable KPIs

Concrete acceptance criteria

Target Audience

PRIMARY USERS

- Firefighters
- Police & SAR Units
- Field teams in disconnected terrain
- Command post operators

Reliable field comms without cellular

STAKEHOLDERS

- Civil protection organizations
- Public safety & emergency agencies
- Air operation coordinators
- UAV payload / technical partners

Institutional procurement path

Competitors & Our Edge

Dimension	SkyMesh	ResponDrone	Persistent Sys.	Rajant	goTenna
Offline mesh operation	✓	Partial	Partial	Partial	✓
UAV relay support	✓	Partial	✗	✗	✗
Autonomous repair	✓	✗	✗	✗	✗
Integrated voice + chat	✓	✗	Partial	✗	✗
Open / reproducible	✓	✗	✗	✗	Partial

Our system is the only open, offline kit with UAV-assisted autonomous repair and integrated voice + monitoring — no proprietary lock-in.

The Team



Pedro Gonçalves

Networking & Integration



Henrique Ferreira

Voice & User Workflow



Dylan Félix

Monitoring & Guidance SW



Eduardo Curião

Power & Autonomy



Leonardo Catarino

UAV Payload & Flight Ops



Vicente Ferreira

Field Hardware & Deploy

Scientific Advisor: Prof. Ayman M. Radwan · Co-advisor: Mariana Santana

Results Achieved

1

Simulation-first Architecture

OpenWrt mesh simulator with telemetry & real-time route adaptation (802.11s + Babel)

2

Interactive Visualizer

Controllable mesh simulator; change link quality in real time; loss and recovery testing

3

BOM Simplified

~€180 prototype path (3 GL-AR300M16 nodes + power banks). Low-cost, reusable hardware.

4

Stakeholder Feedback

Air Force feedback collected; concept seen as promising; However, too difficult to test in their facilities due to bureaucracies.

Key targets: Recovery ≤ 30 s · Boot-to-mesh ≤ 60 s · Setup ≤ 10 min · Ground autonomy ≥ 8 h · PTT restore ≤ 10 s

Results Achieved

Simulation

Initially no drone or ground node is deployed

The screenshot displays a simulation interface for a mission. At the top, a status bar shows: **Command Console**, **SAR-LAB - MESH SAR MISSION**, **DRONES 0/0**, **GROUND 1/1**, **CONTACT Connected**, **VOICE All up**, **HQ LINK Live**, **ALERTS 0 crit - 0 warn**, **Live Map**, **Alerts**, **00:00:13**, and **End Mission**.

The left sidebar contains the following sections:

- VOICE (MUMBLE)**: **Murmur server - HQ** (Running), **Teams with voice access** (1/1).
- AVAILABLE MISSION CAPACITY**: **ACTIVE UAV RELAYS** (None).
- ACTIVE GROUND TEAMS**: **ground_node1** (100% battery, Withdraw button).
- AVAILABLE UAV RELAYS**: **uav_relay1** through **uav_relay6**, each with a **+ Deploy from HQ** button.
- AVAILABLE GROUND TEAMS**: **ground_node2** and **ground_node3**, each with a **+ Deploy** button.
- SELECT AN ASSET**: **MUMBLE STRESS TEST** (Expand button).

The main map area shows a topographic terrain with a blue **HQ** icon, a green **ground_node1** icon, and a blue **Search area** rectangle. A **GUIDANCE HOLD - OK** message states: "Mesh predicted healthy — no UAV repositioning needed." A speed control bar shows **SPEED 1x** with options for 2x, 4x, 8x, 16x, and 32x. A **Legend** in the bottom-left of the map identifies: **HQ** (blue house), **Ground team** (green circle), **Radio range** (green circle), **Search area** (blue rectangle), **UAV relay** (blue square), **Mesh link** (blue line), and **Planned spot** (blue circle).

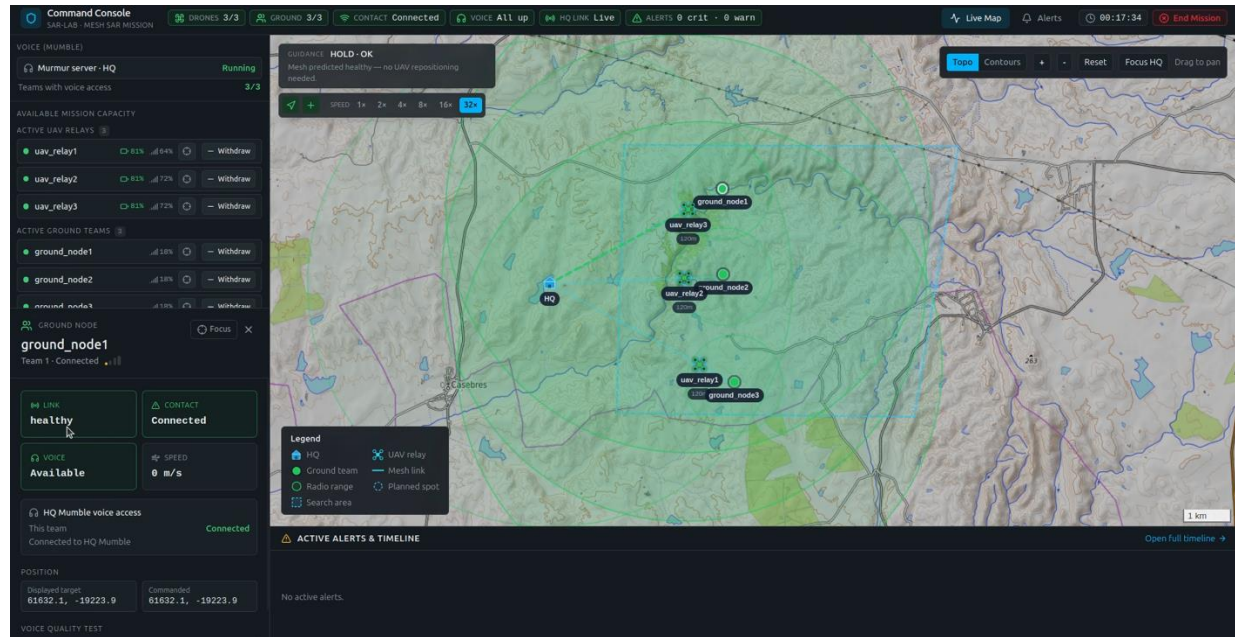
The bottom of the interface features an **ACTIVE ALERTS & TIMELINE** section with the text "No active alerts." and a link to **Open full timeline**.

Results Achieved

Simulation

Then, ground nodes are deployed and are followed by the relay UAVs.

These are responsible for maintaining connection between the nodes and command.

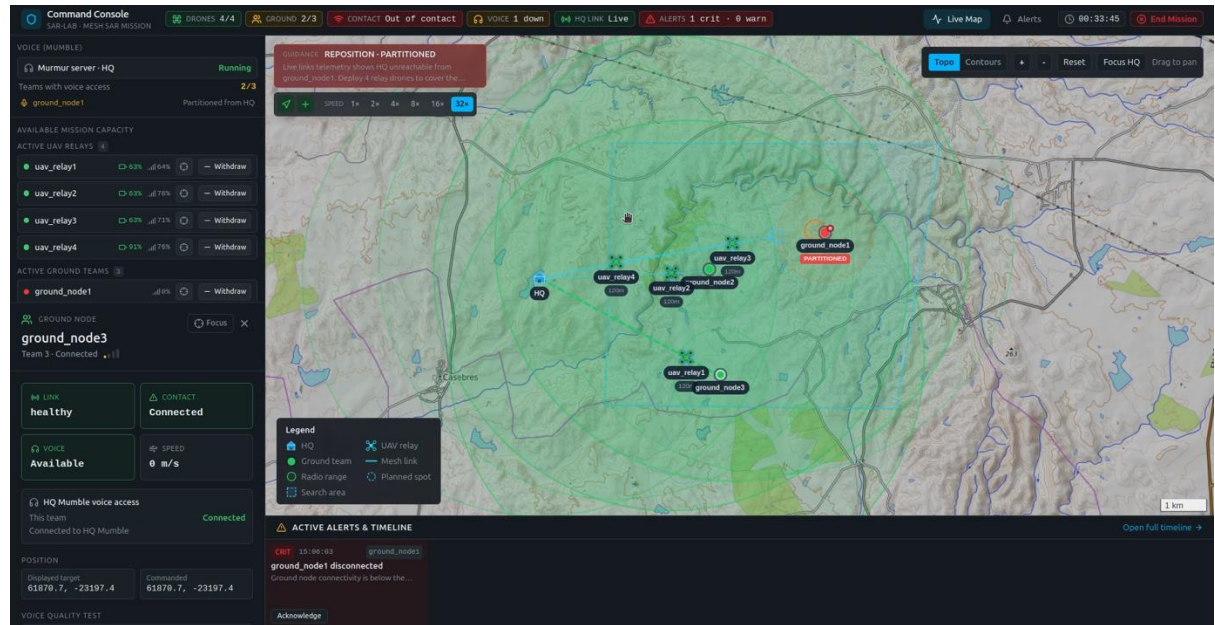


Results Achieved

Simulation

At some point, breaks may happen and the mesh is partitioned.

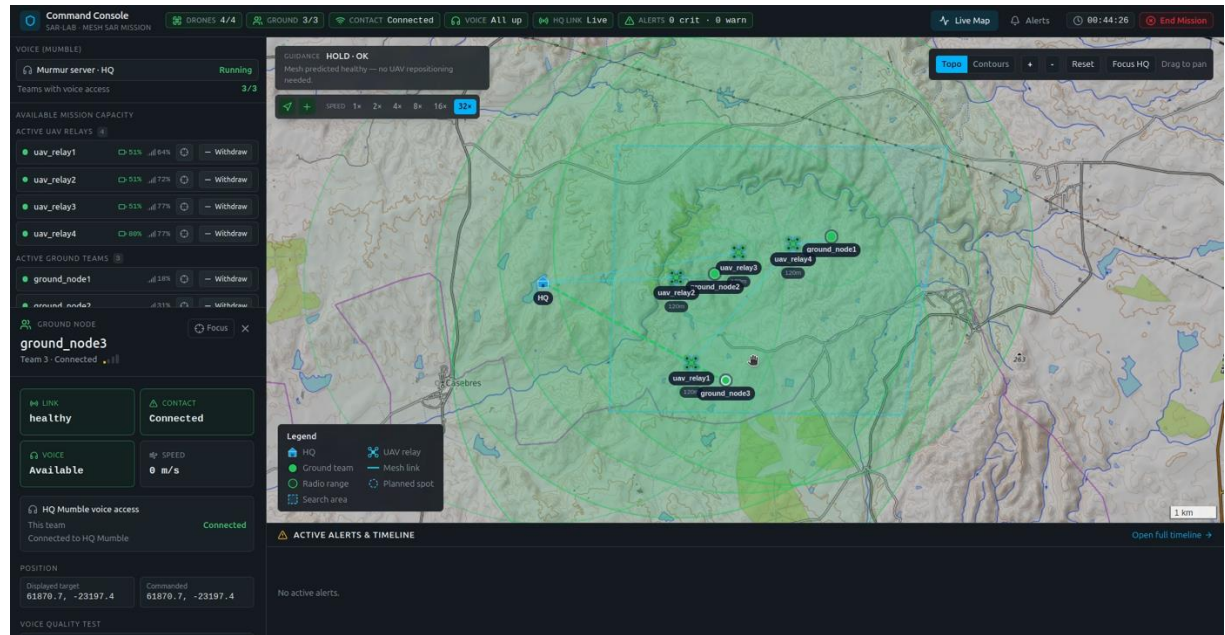
In that case, a UAV is automatically deployed to re-establish connection



Results Achieved

Simulation

Finally, the UAV arrives and connection is re-established between ground nodes and command.



Solution Architecture



SERVICES OVER MESH

- PTT: Phones ↔ Murmur (Mumble)
- Monitoring: Telemetry → Command
- Map: HTTP GPS → Command
- Autonomy: Partition detect + UAV reposition

Team Contributions

Pedro Gonçalves

Networking & Integration

- Mesh bring-up scripts
- Partition detection & logging
- Integration test plan

Henrique Ferreira

Voice & User Workflow

- PTT server/client deploy
- User onboarding workflow
- Voice quality test procedure

Dylan Félix

Monitoring & Guidance SW

- Telemetry agent & dashboard
- UAV positioning engine
- Acceptance test harness

Eduardo Curião

Power & Autonomy

- Power budget model
- ≥ 8 h autonomy tests
- Payload safety guidelines

Leonardo Catarino

UAV Payload & Flight Ops

- Payload mechanical integration
- Flight checklist & safety
- Link characterization logs

Vicente Ferreira

Field Hardware & Deploy

- Ground node ruggedization
- Deployment kit assembly
- Setup timing validation

Costs & Benefits

PROTOTYPE COSTS

~€180

total BOM

- 3× GL-AR300M16-Ext nodes — ~€120
- 3× power banks (≥20 Ah) — ~€60
- External 2.4 GHz omni antennas (shipped with routers)
- 3D printed casings printed at iStart lab, with no cost

EXPECTED BENEFITS

Low-cost iteration

Prove viability before heavier RF upgrades

Open stack

Reproducible, auditable, no lock-in

Operational safety

Faster team coordination → safer rescues

Scalable path

Prototype today → operational kit later

Find Us Online



Landing Page

Project overview & updates

icquackson.github.io/PIC-Website



Project Blog

Weekly progress posts & insights

<https://icquackson.github.io/PIC-Website/#blog>



Demo Video

System walkthrough & field tests

<https://youtu.be/qrV37HpGoxU>