

The logo consists of the word "RESQ" in a bold, white, sans-serif font, centered within a dark blue circle. The circle is set against a solid dark blue background.

RESQ

Ishaan Verma, Raghav Srinivasan, Mehaan Shah

Problem & Use Case

Critical challenges in search and rescue operations that compromise safety and response speed



Information Void

Responders enter dangerous, unpredictable conditions with minimal situational awareness.

- Exact victim count is unknown
- Precise victim location is missing



Communication Gap

Complete communication blackouts between victims and rescue teams.

- No way for victims to call for help
- Responders cannot transmit status



Unmapped Path Hazards

Hidden obstacles and dangerous structural conditions along the rescue path.

- Unknown environmental risks
- Unmapped interior layouts

CUMULATIVE IMPACT ON OPERATIONS

Elevated Risk to Responders Extended Search & Rescue Times Lack of real-time telemetry significantly reduces survival rates.

Scope

A proof-of-concept system that surveys a controlled indoor floor, deploys temporary relay nodes, and reports one cooperating victim device to a responder.



In scope

- One autonomous rover
- Single floor, up to 100 m²
- Multiple rooms and hallways
- Level, dry floor with static obstacles
- Three relay nodes for the MVP
- One cooperating phone or beacon
- One responder base station



Out of scope

- Active flame, extreme heat, dense smoke, or water
- Structural collapse, stairs, rubble, or moving obstacles
- Multiple victims or uncooperative devices
- Certified deployment in an active emergency



Robotics & Software

SLAM, exploration, navigation



Embedded Systems & Circuits

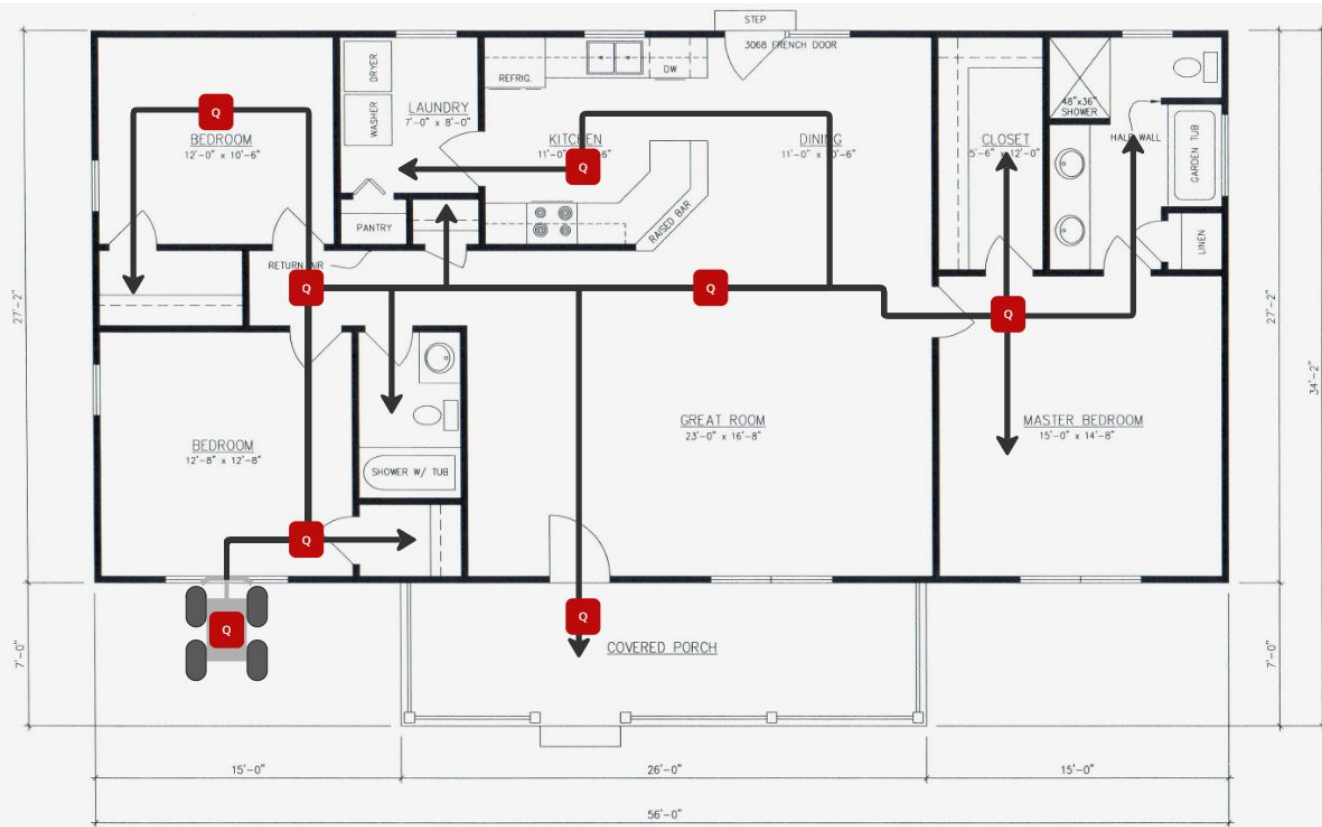
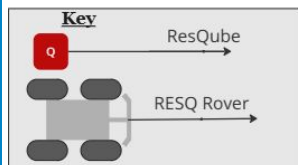
Control, sensing, power, deployment



Signals & Networking

RSSI localization, Multi-hop links

Example System Deployment Map



Use-Case Requirements I

User-Level Measure	Pass Condition	Basis for Target
$\geq 90\%$ in ≤ 10 minutes	Map at least 90% of the reachable floor area in the 100m ² course after one start command	Ten minutes preserves most of a 30-minute minimum SCBA test interval for responder action.
$\leq 0.5\text{m}$ error	Mean absolute position error for walls and major obstacles. Detect every traversable opening at least 0.815 m wide.	0.815 m is the U.S. Access Board minimum clear door width. The 0.5 m target is well within that.
0 contacts	Complete 10 full-course trials without touching a wall or obstacle. A responder may stop the rover at any time.	Safety requirement. Zero-contact acceptance prevents the robot from adding hazards or blocking a path.
≥ 30 minutes	Operate continuously on one charge while driving, sensing, computing, and communicating.	Aligned with a documented 30-minute NIOSH SCBA test duration.

Use-Case Requirements II

User-Level Measure	Pass Condition	Basis for Target
$\geq 90\%$ availability	The responder receives rover status and map updates for at least 95% of mission time. No communication outage exceeds 5 seconds.	NIST treats coverage and availability as paramount. The 95% and 5-second limits are our acceptance thresholds.
$\leq 10\text{s}$ detection	Detect one cooperating victim phone in at least 9 of 10 placements after it enters node range.	A responder needs prompt confirmation. Ten seconds and 9 of 10 are our testable thresholds pending phone and radio feasibility tests.
$\leq 1\text{m}$ localization	Report the victim device within 1 m at least 8 of 10 placements, with a visible confidence region.	Fire-service research identifies 1 m and sustained accuracy as key needs. RSSI literature shows this target might be technically aggressive.

Technical Challenges & Risks

RF & Mesh Networking

- RSSI Localizations through walls
- Multi-hop RF propagation
- Ensuring integrity of the mesh network system between nodes
- Ensuring accurate localization of:
 - Victims
 - RESQUBES
 - RESQ Rover

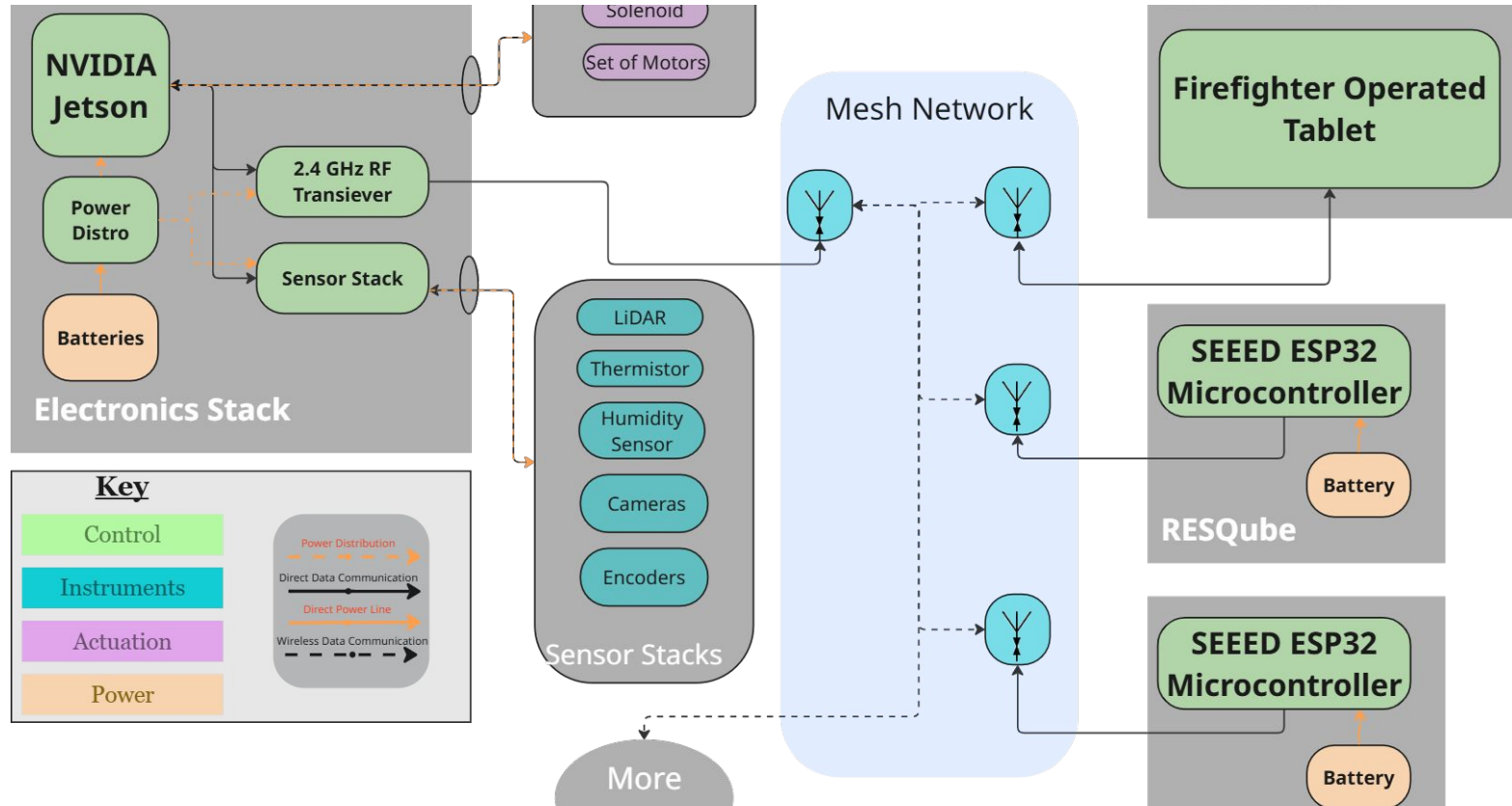
Navigation & Autonomy

- Autonomous Navigation with limited information
- Path planning
- Obstacle Detection
- Localization + exploration

System & Environment

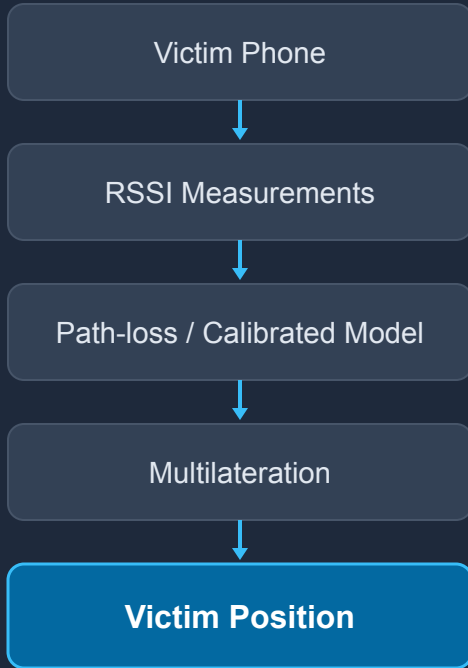
- Hazardous conditions
- Power Constraints on the RESQUBES
- Sensor Fusion
- Ease of use for victims

Proposed System Approach

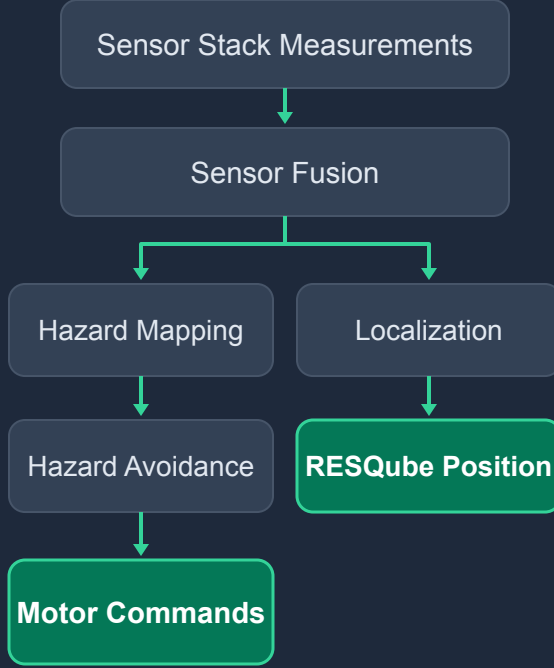


Subsystems

RF Localization Subsystem



Sensor Stack Subsystem



Traversal Subsystem



Testing & Verification

Victim localization

TEST PROCEDURE

Place phone at known coordinates

VERIFICATION METRIC

Measure error in estimated location and actual location

Network

TEST PROCEDURE

Vary node spacing and number of walls

VERIFICATION METRIC

Measure connectivity time compared to operation time

Navigation

TEST PROCEDURE

Run multiple environments w/ different victim locations

VERIFICATION METRIC

Success Rate; Search Time; Collisions

Mapping

TEST PROCEDURE

Run multiple environments

VERIFICATION METRIC

Wall position error; Hazard position error

Durability

TEST PROCEDURE

Stress testing on structural mock components

VERIFICATION METRIC

Component level heat & impact resistance

Schedule & Division of Labor

