

Marine and Aviation

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Recreational Boating and Marina Networks

Marine environments are ideal for LoRa mesh propagation - water has near-zero signal attenuation, low horizon clutter, and antenna elevation on a mast provides exceptional range. A modest 6 dBi antenna at 10m above waterline can achieve 20-40 km range to similarly-equipped vessels.

Marina-to-Vessel Communications

Marina operators have adopted mesh networking for dock communications where VHF radio is too public and cellular is unreliable when boats are in covered slips or channels.

- **Slip status boards** - Sensor nodes on dock pedestals reporting power usage or water connections
- **Fuel dock coordination** - Fuel dock attendant to harbormaster messaging without shouting or VHF
- **Guest notification** - Message guests in slips about marina events or maintenance shutdowns
- **Pump-out requests** - Environmental dock coordination

Vessel-to-Vessel Applications

Cruising fleets, sailing clubs, and buddy-boat passages use mesh for fleet coordination:

- **Buddy boat position sharing** - Real-time GPS position of all fleet vessels on a shared map, without AIS equipment costs
- **Anchorage coordination** - Communicate with other vessels in an anchorage when cell service is absent
- **Race committee communications** - Start line to mark boats without dedicated radio infrastructure
- **Float plan check-ins** - Automated position broadcasts allow shore-based contacts to verify safe progress

Antenna Installation on Vessels

Marine mesh antenna installation differs from land installations:

- **Masthead mount** - Ideal for sailboats: 15-20m height, 360-degree view, potentially 30-50 km range in open water. Use marine-grade stainless mounts and UV-stable cable ties. Route coax inside the mast where possible.
- **T-top or hard top** - Powerboats typically mount antennas on T-tops at 3-4m height; still provides 10-15 km range over calm water.
- **Pushpit or stern rail** - Lower but easy to access; use vertical polarization and ensure clear view forward and aft.
- **Connector weatherproofing** - Marine environment is extremely corrosive. Use only marine-rated N-type or sealed SMA connectors; apply self-amalgamating tape over all outdoor connections; inspect annually.

Integration with Existing Marine Electronics

Meshtastic's serial interface can be integrated with NMEA 0183 networks on boats, allowing the node to report GPS position from the boat's chartplotter GPS rather than relying on a separate GPS module. This keeps position data synchronized with the boat's navigation system.

Search and Rescue Applications

Search and rescue (SAR) operations are one of the most compelling real-world applications for LoRa mesh networking. The combination of off-grid operation, long range, GPS position sharing, and low cost addresses several critical gaps in existing SAR communications infrastructure.

Current SAR Communications Gaps

Existing SAR communications rely primarily on VHF/UHF amateur and commercial radio, which has well-known limitations in complex terrain:

- **Shadow zones** - VHF requires line-of-sight; a searcher in a valley cannot communicate with team members on the opposite ridge.
- **Simplex range limits** - Portable VHF has 1-5 km range in terrain; repeaters extend this but require fixed infrastructure.
- **No position reporting** - Standard radio doesn't transmit GPS coordinates; operators must report verbally.
- **Licensing requirements** - Most SAR volunteers are licensed, but this restricts equipment use by citizen responders and ad-hoc volunteers.

How Mesh Addresses These Gaps

A LoRa mesh deployed for a SAR operation provides:

- **Automatic GPS position sharing** - Every searcher with a mesh node appears on the operations map in real time. No verbal position reports needed.
- **Multi-hop relay through terrain** - Mesh relays through intermediate nodes, bypassing terrain shadows that block direct radio. A searcher in a canyon relays through nodes on the ridge above to reach incident command.
- **No license required for ISM band operation** - Civilian volunteers can carry nodes without licensing.
- **Days of battery life** - An nRF52840 node runs 3-5 days on a small LiPo; searchers don't need to manage charging during a multi-day operation.
- **Redundant network** - If any node is lost or damaged, the mesh reroutes automatically.

SAR Deployment Architecture

1. **Incident Command (IC) node** - Laptop or tablet running [Meshtastic app](#); receives all position reports and messages from field teams. May connect via MQTT to a cloud map for remote monitoring by county OES.
2. **Hilltop relay nodes** - 2-4 battery-powered repeater nodes placed on high terrain at the search area perimeter, creating mesh backbone coverage. Carried by support personnel or cached at ridge lines.
3. **Team leader nodes** - Each search team leader carries a dedicated mesh node for position reporting and messaging. Phone app is acceptable for team leaders with smartphones.
4. **Subject detection consideration** - A mesh node left at the last known point (LKP) can serve as a reference beacon visible to all searchers on their maps.

Coordination with Existing SAR Infrastructure

Mesh networking complements rather than replaces existing SAR radio systems. Plan for:

- Primary VHF/UHF team radio continues for voice coordination
- Mesh supplements with position data and text messaging
- Interoperability: IC node can have both mesh and VHF capability
- Pre-incident training: all team members should practice with mesh before an actual deployment

Mountain and Wilderness SAR Specifics

For wilderness SAR in mountainous terrain, pre-deploy mesh infrastructure by caching solar repeater nodes at known high points (trailheads, summit areas, saddles). These permanent installations provide instant mesh coverage when a SAR operation is activated, without requiring field teams to carry and place temporary infrastructure during the first critical hours.