

Setting Up Trail Relay Nodes

Extending Mesh Coverage with Fixed Relay Nodes

Valleys, forest canopy, and steep ridgelines all attenuate LoRa signals. A solar-powered relay node placed at a trailhead, ridge saddle, or summit can extend the useful range of a hiking group, helping bridge the gap between a party in a canyon and a vehicle-mounted node at the parking area. Coverage extension is best-effort and depends on siting and line of sight; a relay is not a guaranteed emergency link.

Siting Principles

- **Elevation:** A ridge saddle or summit node can see both sides of a mountain, relaying between two groups that have no direct line of sight.
- **Solar exposure:** South-facing orientation (northern hemisphere). Avoid positions shaded by rock faces in the afternoon.
- **Wind:** Exposed summits require robust enclosures. Low-profile nodes strapped to cairns survive better than tall masts on windswept passes.
- **Drainage:** Avoid topographic low points where condensation pools. Enclosure drain holes should face downward.

Recommended Hardware

For unattended outdoor relay use, a **RAK WisBlock** or **Heltec V3** in an IP67-rated enclosure is a practical choice. As an approximate starting point, a 6W solar panel with a 3.7V 2000-4000 mAh LiPo can sustain a low-power relay through the day in many US latitudes from roughly April through October - but actual sizing depends on node duty cycle, current draw, insolation, and shading, so build a power budget for your specific load rather than treating these figures as guaranteed. In winter, battery sizing must account for short day length and reduced panel efficiency. Use a Hammond 1554 polycarbonate box with a cable gland for the antenna feedthrough; apply conformal coating to the PCB.

Case Study: Mount Whitney Corridor

The Mount Whitney Trail in California presents a classic coverage challenge. The trailhead at Whitney Portal has cell coverage; the upper mountain does not. A relay node on Trail Crest (~4,160 m / 13,645 ft) can extend coverage across much of the upper mountain, though a single relay will not reliably cover the entire upper mountain given the intervening ridges and complex high-alpine terrain. If it relays to a MQTT-connected node at the portal parking area, summit parties may gain a best-effort path to reach emergency contacts via the internet - this is not guaranteed and must not be relied upon for emergencies (carry a PLB/satellite messenger). Community members have discussed similar deployments on PCT sections in the Sierra Nevada and Cascades, but documentation of specific maintained installations is limited; treat such reports as anecdotal unless a firm source is available.

Permissions and Leave No Trace

Fixed installations on public land require coordination with the land management agency:

- **National Forest:** Fixed installs generally require a Special Use authorization under 36 CFR 251 Subpart B. There is no general exemption for leaving unattended infrastructure on federal land - requirements vary by forest and district, so contact the local district ranger before deploying anything.
- **National Parks:** Written authorization from the Superintendent is required, and Parks are stricter. SAR coordinator endorsement significantly helps the application.
- **LNT:** Use existing structures where possible. Do not drive stakes or anchors into rock. Remove all hardware at the end of the season unless a multi-year authorization is in place.

Mounting to Existing Infrastructure

With ranger permission, trail sign posts, trail register boxes, and established marker posts are ideal mounting points. Use stainless steel hose clamps or ratchet straps - no permanent fasteners. Paint enclosures brown or forest green to reduce visual impact. Photograph the installation for permit documentation and end-of-season removal verification.

Node Configuration: Relay Role

For a dedicated relay, use the **ROUTER_LATE** role on current firmware (the ROUTER role has been deprecated as of firmware 2.7.11 because misuse caused rebroadcast collisions and premature hop consumption). The role changes the node's rebroadcast and priority behavior - it does not change transmit power. TX power is configured separately under LoRa config, so set it explicitly there. Disable Bluetooth unless local configuration access is needed. Set the hop limit to 3 or 4 to allow messages to traverse the relay without flooding the mesh.

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