Backcountry Skiing and Avalanche Country

> **Mesh is a coordination tool, not a rescue system.** It is best-effort - messages may not get through, and positions can be stale or missing. It is NOT a substitute for a PLB/satellite messenger, a 457 kHz avalanche beacon, or 911. Search and rescue does NOT monitor Meshtastic. Carry dedicated safety gear; use mesh only as a supplement.

Group Position Awareness in Avalanche Terrain

Standard avalanche-terrain travel doctrine (taught by AIARE and avalanche.org) is to know where everyone is *before* entering a slide path. The fundamental rule - one person in the exposure at a time, rest watching from a safe zone - requires that the group knows who is where at all times. In a touring party of four or more spread across a large alpine cirque, verbal communication is often impossible above the noise of wind and terrain.

Mesh can help here, with an important caveat: every member's LAST-REPORTED GPS position is visible on the Meshtastic app map, typically updated only every few minutes, and positions can be stale or missing over a lossy, best-effort mesh. A member could have moved out of the safe zone since their last beacon. Confirm the group is clear visually or by voice before committing to a slide path - never authorize a couloir drop on the map alone.

Mesh Is a Supplement, Not a Replacement for Avalanche Transceivers

> **Critical Safety Note:** Meshtastic mesh networking operates at 915 MHz LoRa. Avalanche transceivers (ARVA/beacons) operate at 457 kHz. They are fundamentally different technologies with no operational overlap. A LoRa device *cannot* detect a buried beacon signal, and a beacon receiver *cannot* locate a LoRa transmitter, and mesh does nothing to narrow a burial search. A 457 kHz transceiver, probe, and shovel are REQUIRED, non-negotiable gear that every person entering avalanche terrain must carry and know how to use. Meshtastic is NOT an avalanche safety device; it only adds situational awareness on top of this baseline - it does not replace any element of it.

With that foundation clear: mesh can add value in backcountry avalanche terrain as a coordination aid. Beacons only help after a burial. Mesh can aid group coordination and travel discipline throughout the day, but avalanche avoidance still depends on terrain and snowpack assessment and travel protocol, not on position-sharing - mesh does not *prevent* a burial.

Route Logging and Safe Exit Documentation

Meshtastic devices broadcast GPS position, which can be ingested by a gateway node running MQTT back to a server. For a backcountry party, positions that reach a gateway are logged automatically; coverage gaps occur wherever the mesh cannot reach the gateway, so in deep terrain with no gateway in range the recorded track will have gaps and is not guaranteed complete. If a party fails to return, any last-known positions that were uploaded to a gateway with internet before contact was lost may help - but SAR does NOT monitor the mesh, so a written/registered trip plan and a satellite PLB remain the primary safeguards, not the mesh log.

For a reliable record of your own route, use a dedicated GPS track app on your phone. Meshtastic primarily caches the recent positions of *other* nodes it has heard rather than a continuous, rescuer-readable breadcrumb track of your own route, so do not rely on reading a complete route history off the device.

Communication in Terrain Traps and Narrow Canyons

All line-of-sight radio - VHF, UHF, and LoRa alike - struggles in narrow creek drainages, cliff-walled couloirs, and dense tree zones. It is a myth that LoRa "penetrates terrain better" because of frequency: 915 MHz is a *higher* frequency than VHF (30-300 MHz) and actually attenuates more through terrain and foliage and diffracts *less* well around obstacles. LoRa's real robustness comes

from spreading-factor processing gain at very low data rates (it can decode signals far below the noise floor), not from superior propagation. In informal field trials, LoRa at SF12 (the most robust spreading factor) has held a link in some corridors where a 5 W VHF handheld was unreliable - this is anecdotal, not a published, reproducible test, and results vary widely with terrain, antenna, and conditions.

Approximate field estimates, highly dependent on spreading factor, antenna, and canopy (treat as rough, not guaranteed): in dense conifer forest, roughly 0.5 - 1.5 km node-to-node. In open alpine terrain with clear line of sight and elevation, roughly 3 - 8 km. In a narrow canyon, often only 0.3 - 0.8 km, sometimes only line-of-sight up the canyon.

Battery Management in Extreme Cold

Backcountry skiers typically skin uphill for several hours before skiing down. During the uphill, the body generates significant heat. This is the time to keep batteries warm inside a chest layer. On summit stops and in rest zones, temperature drops rapidly - pull the device out only when needed and return it to the warm layer immediately after. Expect roughly 50% capacity loss at -20 C (it recovers when the cell warms).

> **Never charge a lithium cell below 0 C (32 F).** Charging a Li-ion/LiPo cell below freezing causes lithium plating, permanent capacity loss, and a latent internal-short fire/venting risk. Discharging in the cold is fine, but charging is not. Do NOT run a "USB cable from a warm pack to a device in a cold hip-belt pocket all day" - that charges the cell while it is sub-freezing, exactly the prohibited condition. Use the warm pack only to keep an idle device warm, or bring the device fully into the warm layer before charging it.

Hardware Option: T-Echo for Avalanche Terrain

The LILYGO T-Echo is a suitable low-power option for backcountry use - though it is not avalanche safety equipment and must never be treated as such - for three reasons:

1. **E-ink display:** Readable in direct sunlight on bright alpine days without requiring backlight power. Checking group positions on a sunny ridge is instant and uses minimal battery.
2. **Integrated GPS:** No separate GPS puck required; the device is self-contained.

3. **Low standby power:** The T-Echo has an internal ~850 mAh Li-ion cell (USB-C charged, no AAA cells) and weighs ~120-130 g cased with battery. Expect roughly a day of active-GPS runtime from a single charge (more at low duty), and substantially less in cold - adequate for a long backcountry day if you start fully charged.

Carry the T-Echo in a chest pocket of your soft-shell, with the GPS antenna positioned upward. Avoid deep burial in a pack unless the device is in sleep mode.

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