Site Planning

Choosing locations, antennas, and using network maps.

Choosing a Repeater Location

Placement determines performance. A well-placed repeater with modest hardware will consistently outperform a poorly placed repeater with expensive equipment.

The primacy of line-of-sight

LoRa signals travel best when there is a clear, unobstructed path between transmitter and receiver. Any obstruction - a building, a ridge, a dense stand of trees - attenuates the signal. The higher your repeater, the more of the surrounding terrain is in line-of-sight.

Location types

Hilltops and ridgelines

The best possible placement. A repeater on a hilltop with 360-degree unobstructed views can serve an area many times larger than the same hardware at ground level. As a rule of thumb, even modest height gains above the surrounding obstructions can noticeably improve coverage; how much depends on the local terrain. The underlying mechanism is the radio horizon, which grows with the square root of antenna height - roughly $3.57\times\sqrt{h_m}$ km (or about $1.23\times\sqrt{h_{ft}}$ miles) - so the first few tens of feet above ground level deliver the largest gains.

Rooftops

The most practical option for urban deployments. The highest accessible rooftop in a neighborhood, with the antenna mounted on a short mast, gives excellent urban coverage. Flat commercial rooftops are ideal.

Towers and elevated structures

Communications towers, water towers, and fire lookout towers are excellent platforms. Many communities with amateur radio infrastructure already have tower access - connecting with local ham radio clubs is a good path to shared hosting arrangements.

When co-locating on a registered antenna structure or shared tower, coordinate with the structure owner. RF-exposure (MPE) evaluation and antenna-structure-registration obligations rest with the tower owner, and your Part 15 unlicensed device must not interfere with the licensed services already on the structure.

Mast installations

A 15 - 30 foot mast in a yard or field dramatically improves line-of-sight over the surrounding area. Particularly effective in flat terrain where even modest height above obstructions makes a large difference.

Common placement mistakes

- **Hop gobbling:** A poorly placed repeater that is only marginally better than other nodes can consume hop budget without meaningfully extending range. Every hop used by a marginal relay is a hop unavailable for a more distant leg. Place repeaters where they add significant coverage, not just incremental reach.
- **Too many repeaters too close together:** Dense clusters of repeaters can flood the network with redundant retransmissions. Space repeaters to provide overlapping but not excessively redundant coverage.
- **Ignoring the coverage below:** Very high-gain antennas on tall structures can create dead zones directly beneath them. Size antenna gain to match your deployment height.

Coverage planning tools

- Meshtastic Site Planner - the official Meshtastic tool; estimates theoretical coverage from a given location
- HeyWhatsThat - third-party tool for radio horizon visualization based on terrain elevation
- meshmap.net - third-party community map showing existing Meshtastic nodes near you (only shows nodes reporting to the public MQTT server, so it is incomplete)

Always validate coverage estimates with real-world testing - planning tools do not account for buildings, vegetation, or local RF environment.

Antenna and Signal Range Factors

What determines your repeater's range

Several factors interact to determine how far your repeater can reach. Understanding them helps you make better placement and hardware decisions.

Antenna height and line-of-sight (most important)

This is the dominant factor by a wide margin. Higher placement gives more line-of-sight coverage. Even a few meters of additional height can meaningfully extend coverage. Use terrain analysis tools to identify locations with the best natural line-of-sight before committing to a deployment.

Antenna type and gain

Omnidirectional antennas

Standard for general-purpose repeaters. Higher gain concentrates the signal horizontally, increasing range but reducing coverage of areas directly below. As a common community rule of thumb, many repeater deployments use 3 - 6 dBi omnidirectional antennas as a reasonable balance between reach and overhead coverage; this is not an official Meshtastic specification, so consider your own terrain and coverage goals. Note also that antenna gain counts toward your EIRP limit (see Transmit power below): an antenna over 6 dBi requires a corresponding reduction in conducted power under FCC rules.

Directional antennas (Yagi)

Best for linking two specific points across a long distance. Directional antennas can achieve dramatically longer range in one direction but provide no coverage off-axis. Useful for point-to-point relay links, not general area coverage.

Antenna and cable quality

Upgrading from a stock antenna to a quality external antenna is often one of the highest-return improvements available. Use short, low-loss coaxial cable (LMR-200 or LMR-400) between the radio and antenna. Long cable runs with cheap coax can negate antenna gain improvements.

LoRa modem presets

Meshtastic provides eight primary preset modem configurations (plus a deprecated ninth, Very Long Slow / `VERY_LONG_SLOW`, which is not recommended and is being phased out). Each preset is a named combination of Spreading Factor (SF), Bandwidth (BW), and Coding Rate (CR) that determines the tradeoff between range, data rate, and airtime. The official preset names are: `SHORT_TURBO`, `SHORT_FAST`, `SHORT_SLOW`, `MEDIUM_FAST`, `MEDIUM_SLOW`, `LONG_FAST`, `LONG_MODERATE`, `LONG_SLOW`, and the deprecated `VERY_LONG_SLOW`.

Preset	SF	BW	CR	Data Rate	Link Budget	Notes
Short Turbo	7	500 kHz	4/5	21.9 kbps	140 dB	500 kHz: legal in the US 902-928 MHz band; restricted in some narrower regional bands
Short Fast	7	250 kHz	4/5	10.9 kbps	143 dB	
Short Slow	8	250 kHz	4/5	6.25 kbps	145.5 dB	
Medium Fast	9	250 kHz	4/5	3.52 kbps	148 dB	
Medium Slow	10	250 kHz	4/5	1.95 kbps	150.5 dB	Recommended for dense networks
Long Fast	11	250 kHz	4/5	1.07 kbps	153 dB	Firmware default

Preset	SF	BW	CR	Data Rate	Link Budget	Notes
Long Moderate	11	125 kHz	4/8	0.34 kbps	156 dB	
Long Slow	12	125 kHz	4/8	0.18 kbps	158.5 dB	Maximum range; very low throughput

Higher link budget = more range. Higher data rate = more network capacity and less airtime per message. Note: these link-budget figures assume a 22 dBm TX power and 0 dBi antennas (the Meshtastic reference conditions); adjust for your actual TX power and antenna gain (e.g. with the Semtech LoRa calculator). They are relative comparisons between presets, not absolute path-loss budgets.

Choosing a preset for your network

The most important rule: match whatever preset the rest of your local network uses. Nodes on different presets cannot hear each other, even on the same channel name. A preset sets SF, bandwidth and coding rate; nodes must match SF and bandwidth to demodulate each other, and because bandwidth also determines the frequency-slot grid, mismatched presets generally also transmit on different center frequencies.

- **Check with your local community first.** Many regional networks have standardized on a specific preset. Check local Discord servers, forums, or network maps before deploying.
- **Long Fast** (firmware default) - widely used, works well for sparse networks and rural deployments. Good starting point if no local standard exists.
- **Medium Slow / Medium Fast** - increasingly common in larger networks (60+ nodes). Faster data rate reduces airtime collisions in dense areas while still covering similar distances.
- **Long Slow** - maximum range, but much lower throughput. Can cause network congestion at scale. Not recommended for regular deployment. (The even slower `VERY_LONG_SLOW` preset is deprecated.)
- **Short Turbo** - highest throughput. It uses 500 kHz bandwidth, which is legal in the US 902-928 MHz band but restricted or prohibited in some narrower regional bands (e.g. EU 868 MHz). US operators may use it; verify compliance for your region first.

Transmit power

More transmit power increases range up to the legal limit. In the US, FCC Part 15 (47 CFR 15.247) caps conducted power at 1 W (30 dBm) in the 902-928 MHz band. Antenna gain up to 6 dBi is allowed at full power. For every dB of antenna gain above 6 dBi, you must reduce conducted power by the same amount (47 CFR 15.247(b)(4)). The frequently quoted 36 dBm (4 W) EIRP figure is simply what 30 dBm + 6 dBi works out to - it is a derived ceiling, not a flat license to radiate 36 dBm with any antenna. The region setting in your firmware is the master control that enforces the legal power cap, so set it correctly. Meshtastic's defaults are compliant with standard antennas, but you remain responsible for EIRP compliance with any non-standard or high-gain antenna - custom setups require the gain-reduction calculation above.

Interference

The 902 - 928 MHz ISM band is a shared, unlicensed band, so other devices operating in it (Wi-Fi extenders, cordless phones, industrial telemetry, and other LoRa networks) can reduce effective range. If you suspect interference, try changing the channel frequency slot within the band and comparing performance.

Using the Meshtastic Network Map

Before deploying a repeater, check a network map to understand where existing coverage exists and where gaps are most significant. This helps you choose a placement that adds the most value to the network. Note that these maps are third-party tools and only show nodes reporting to the public MQTT server, so they are an incomplete, not authoritative, picture of the mesh.

Available map tools

- **meshmap.net** - community-run map showing nodes that report to the public MQTT server. Third-party and unofficial; coverage is incomplete because it only includes nodes with an internet-connected MQTT gateway.
- **Meshtastic Site Planner** - a coverage-prediction tool for estimating signal reach from candidate locations using terrain data.
- **HeyWhatsThat** - a line-of-sight / viewshed tool useful for checking what a high point can "see" before you commit to a repeater site.

What the maps show

Nodes appear on the map if they have GPS enabled, are configured to share their location, and their data has reached the internet via an MQTT gateway node. Clicking a node shows its ID, name, hardware, and last activity time. Some maps display estimated coverage radius or known links between nodes.

The network map depends on nodes reaching the internet via an MQTT gateway. During internet or grid outages - i.e. during the very emergencies you would most want it - the map can be stale or blank and does **not** reflect live mesh state. Do not rely on it for real-time situational awareness during an incident; verify coverage on the radios themselves rather than trusting the map.

How to use the map for planning

1. Find your area and identify where existing nodes and repeaters are concentrated
2. Identify gaps in coverage - areas with no nearby nodes, or areas that would benefit from a relay between two clusters
3. Look for natural high points near the gap that could serve as a relay location
4. Check whether your planned location already has a node - placing a repeater very close to an existing one adds little value and increases network traffic

Making your repeater appear on the map

A REPEATER-role node suppresses all of its own broadcasts (NodeInfo, position, and telemetry) and is hidden from node lists, so it will not appear on the map. A ROUTER-role node does broadcast its NodeInfo and position by default and will appear on map services that collect MQTT data. If map visibility matters, you can use ROUTER role instead of REPEATER - but choose ROUTER only for genuinely well-positioned infrastructure nodes, and do not switch to ROUTER merely for map visibility, since it also changes power behavior (ROUTER forces power-saving sleep), turns BLE/WiFi/Serial off by default, and affects routing.