Forest and Vegetation Propagation

Forest and Vegetation Propagation at 915 MHz

Vegetation is one of the most significant impairments to 915 MHz propagation. Forested terrain requires a fundamentally different planning approach from open or urban environments.

Foliage Attenuation

915 MHz is significantly absorbed by vegetation. Specific attenuation through dense in-leaf woodland near 900 MHz is roughly **0.2 - 0.5 dB per meter** (ITU-R P.833 / Weissberger), i.e. about **20 - 50 dB per 100 m** of traversal. Importantly, the loss does *not* grow linearly without bound - it saturates beyond roughly 14 m of foliage depth, so very deep canopy adds less than a simple per-meter multiplication would predict. Typical losses:

Vegetation Type	Loss per 100 m of Traversal
Dense deciduous forest (summer, full leaf)	~20 - 50 dB
Coniferous forest (pine, fir)	Comparable - needle vs. broadleaf differences at 915 MHz are not well-characterized and depend on density and moisture; do not assume conifers are reliably lower (year-round dense, high-moisture canopy can be similar or higher)

Even a few hundred meters of dense forest can consume the entire link margin of a typical LoRa deployment. As a result, ground-level range in dense forest is often only 200 - 500 meters even with the longest LoRa spreading factors - this figure is derived from the loss budget and consistent with field reports, not a fixed measured constant, and actual range varies with antenna height, modem preset, and forest density.

Seasonal Variation

Deciduous forests have dramatically different propagation in summer (full leaf) versus winter (bare branches). A link that works reliably in December may fail completely in July when the leaves are out.

Always plan coverage for worst-case summer leafed-out conditions. Links that are marginal in winter will likely fail in summer. If your network must work year-round, design for July.

Elevation Above Canopy

The single most effective technique for improving range in forested terrain is getting the antenna above the tree canopy.

A node mounted at canopy level or just above it has near-line-of-sight to distant nodes that are also above the trees. Even clearing the canopy by roughly 5 - 10 meters dramatically improves range in forested areas (an approximate guideline - the benefit depends on canopy height and link geometry).

Node Position	Typical Range (derived / site-dependent)
Ground level in dense forest	~200 - 500 m (typical, derived from loss budget)
At or above canopy (~20 m elevation)	~5 - 10 km to other elevated nodes (typical example; clear-LOS LoRa links can far exceed this, dense conditions fall short)

This is a dramatic difference - illustrative of the order-of-magnitude benefit, the same hardware can perform roughly 10 - 20× better simply by being above the canopy. The exact multiplier is an illustration, not a precise measured figure.

Trail Corridor Effect

Trails create linear openings in the forest canopy. Range along a trail is significantly better than off-trail in the same forest. The open sky corridor above the trail allows near-LOS propagation along the trail axis.

This is useful for planning hiking or trail mesh coverage - nodes near trail intersections or high points along trails will have better coverage than nodes placed arbitrarily in the forest interior.

Mixed Terrain Path Budgets

When a link crosses both open and forested terrain, **plan for the worst-case segment**. A 10 km link that crosses 3 km of dense forest needs to be designed for the forest loss, not the open segments.

Use a simple approach: calculate the total forest path length in your link, apply a conservative **~40 - 50 dB/100m** for dense summer deciduous canopy (the high end of the 20 - 50 dB/100m range is the conservative worst-case planning value; note the loss saturates beyond ~14 m depth), and verify the total loss fits within your link budget. If it doesn't, raise antenna height or use a higher-gain antenna. (Transmit power is already at the radio's ~22 dBm chip maximum on standard mesh hardware; FCC Part 15.247 caps conducted power at 30 dBm and EIRP at 36 dBm, and antennas above 6 dBi require a dB-for-dB power reduction - so there is little legal headroom to simply "turn up the power.")

Summary for Forest Deployments

- Mount antennas as high as practical - at or above canopy height
- Test and plan for summer worst-case conditions
- Use trail corridors for coverage where possible
- Account for every meter of forest in your path budget
- Consider tower or tall-tree mounting for backbone nodes

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