Urban Propagation

Urban Propagation at 915 MHz

Dense urban environments present some of the most complex RF propagation conditions for mesh networks. Understanding these effects helps planners place nodes effectively and set realistic range expectations.

Street Canyon Effect

Buildings create RF corridors along streets and dead zones perpendicular to them. A node at street level may have excellent range in one direction and very poor range 90 degrees away. This directional bias is caused by reflections off building facades channeling energy down the street while absorbing or blocking energy crossing between streets.

When planning urban coverage, orient your mental model around street grids — as a rough illustration, a single node may cover several blocks along a street axis but only one or two blocks across it. These block counts are illustrative of the canyon anisotropy, not measured figures; actual coverage depends on building height, street width, and node placement.

Building Penetration Losses at 915 MHz

Material	Typical Loss
Concrete / brick exterior walls	10 - 20 dB
Interior walls (drywall)	3 - 5 dB
Windows (plain glass)	2 - 5 dB

These figures are consistent with commonly cited material-attenuation tables (e.g. ITU-R P.2040 and vendor RF references). Note an important exception: **low-emissivity (low-E) or metal-coated glass**, common in modern energy-efficient buildings, attenuates far more than plain glass — often **10–30+ dB** — because the metallic coating reflects RF. Don't assume the 2–5 dB plain-glass figure for coated windows.

Elevator shafts and stairwells can sometimes act as opportunistic waveguides, occasionally propagating signal across multiple floors or between building sections — though this is anecdotal

and not reliable. In practice, metal-lined elevator shafts are more often RF-blocking than waveguiding. Where it does occur, it can be exploited (placing a node near a stairwell to reach upper floors) or can cause unexpected interference between nodes, but do not count on it in a link budget.

Rooftop Advantage

Nodes above the building line communicate freely across the urban environment. The **roofline is the critical breakpoint** — it acts as a diffraction edge, so crossing from just below to just above the parapet wall can change a link dramatically. The figure of "1 meter below vs 1 meter above the parapet" is illustrative of how sensitive this diffraction edge is, not a precise threshold.

Getting above the building line converts an urban node from a neighborhood-scale device into a metro-scale relay. A single well-placed rooftop node can serve an entire neighborhood that would otherwise require dozens of street-level nodes.

Reflections and Multipath

Urban environments create multipath propagation — signals arrive at the receiver via multiple reflected paths with different time delays and phase offsets. This causes constructive and destructive interference that varies by location, creating "dead spots" (fade nulls) spaced roughly every half wavelength — about **16 cm (~6 inches) at 915 MHz**, not a few feet. Because the nulls recur on this fine spatial scale, moving a node even a few inches can move it into or out of a null, and this can degrade narrow-band radio performance.

LoRa's chirp spread spectrum handles multipath well compared to conventional narrowband radios. The chirp encoding is largely immune to moderate multipath delay spread, making LoRa a good choice for urban mesh deployment where multipath is unavoidable.

Underground Infrastructure

Subway stations, underground parking garages, and utility tunnels are essentially RF-opaque at 915 MHz. Plan for coverage gaps in underground infrastructure — nodes above ground do not penetrate reliably. Underground coverage requires dedicated nodes installed within the underground space itself.

Practical Urban Planning Guidelines

1. **Establish a rooftop backbone first.** Prioritize 3 - 5 high-rise or rooftop nodes to establish a "backbone" visible across the metro area. These nodes handle the long-haul mesh connectivity.

2. **Fill in with lower nodes as the network grows.** Street-level and mid-rise nodes fill gaps in the backbone coverage for pedestrian and in-building use.
3. **One well-placed rooftop node can serve an entire neighborhood.** Resist the urge to densely deploy at street level before establishing rooftop coverage - the rooftop node will outperform 10 street nodes.
4. **Account for building penetration in link budgets.** If a link must pass through walls, add the appropriate dB loss to your budget before assuming the link will work — and use the higher coated-glass figure if the building has low-E windows.

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