

Understanding the Technology

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What Is LoRa? (For Beginners)

LoRa stands for "Long Range." It is a radio modulation technique from Semtech that enables very long range wireless communication at very low power, at the cost of low data rates - the physical layer beneath Meshtastic and MeshCore.

How it works

LoRa uses **chirp spread spectrum** - the signal is spread across a wide frequency band using a continuously sweeping chirp tone. This spreading gives LoRa extraordinary resilience to noise. A receiver can decode a packet even when the signal is far below the background noise floor - a capability few low-cost radio systems offer. (Other spread-spectrum schemes, such as GPS, also operate below the noise floor.)

Key characteristics

- **Range:** 1 - 15 km typical; 30 - 50+ km achievable with elevated antennas
- **Data rate:** 0.2 - 22 kbps depending on preset - slower than a 1990s modem, but sufficient for text and GPS
- **Power:** Nodes run days to weeks on a small battery; active current is roughly 10 - 30 mA for nRF52-based boards and 40 - 100+ mA for ESP32-based boards. Days-to-weeks battery life applies mainly to nRF52-class hardware; size your battery for your specific board.
- **No subscription:** Operates in the unlicensed 902 - 928 MHz ISM band in North America. No SIM, no carrier fees.
- **License-free:** Standard operation under FCC Part 15.247 requires no amateur radio license

What LoRa is NOT

- **Not WiFi:** Far slower, far longer range. No web browsing or streaming.

- **Not cellular:** No towers, no coverage maps, no subscription. Works anywhere two nodes are within radio range of each other.
- **Not LoRaWAN:** LoRaWAN is a specific hub-and-spoke IoT architecture. Meshtastic and MeshCore are peer-to-peer mesh networks. Same radio hardware, completely different protocols. See the [LoRa Mesh vs. LoRaWAN](#) page for the full comparison.
- **Not Bluetooth or Zigbee:** Those are short-range (meters). LoRa is long-range (kilometers).

Why 915 MHz?

The 902 - 928 MHz ISM band is the North American LoRa mesh standard because it is unlicensed under FCC Part 15, has better building and vegetation penetration than 2.4 GHz, and yields practical antenna sizes (~8 cm quarter-wave).

The fundamental tradeoff

LoRa's extreme range comes at the cost of speed. A 50-byte text packet takes several hundred milliseconds to transmit. This is fine for messaging and GPS tracking - and impossible for voice, video, or large files. Design your use case around this constraint and LoRa delivers remarkable results.

LoRa Mesh vs. LoRaWAN

Both use the same LoRa radio chips but operate completely differently. This is the most common source of newcomer confusion.

LoRaWAN

A **hub-and-spoke** network designed for IoT sensors reporting to the cloud. End devices transmit to fixed gateways; gateways forward over the internet to a server. No direct device-to-device communication. No gateway in range = no connectivity. Examples: The Things Network, Helium.

LoRa Mesh (Meshtastic, MeshCore)

A **peer-to-peer** network where nodes communicate directly and relay each other's messages. Works completely offline - no internet required. Messages hop: A → B (relay) → C → D. Adding nodes usually extends coverage and adds redundant paths, though very large or chatty meshes can congest the shared channel. Examples: Meshtastic, MeshCore.

Comparison table

Feature	LoRaWAN	LoRa Mesh
Architecture	Hub-and-spoke	Peer-to-peer
Network server required	Yes (usually internet-hosted; private offline servers are possible but uncommon)	No
Direct messaging	No	Yes
Multi-hop relay	No	Yes
Works without infrastructure	No	Yes
Typical use case	Sensor data to cloud	Off-grid comms, group coordination

They cannot communicate with each other. Different packet formats, addressing, and network stacks - they share hardware but speak different protocols.

Important: LoRaWAN gateways won't build a mesh

LoRaWAN gateways (\$100 - \$300) are internet-backhaul radios, not mesh relays - they pass traffic between devices and a network server (in both directions, including downlinks to devices) but never peer-to-peer. To build a LoRa mesh network you need Meshtastic- or MeshCore-compatible devices, not LoRaWAN gateways.

How Mesh Routing Works

When two nodes are too far apart to communicate directly, intermediate nodes relay the message. Meshtastic and MeshCore solve this differently.

Flooding (Meshtastic)

When a node receives a new packet it rebroadcasts it once - unless it first hears another node relay the same packet, in which case it stays quiet (managed flooding). Duplicate detection prevents loops. The message floods outward until it reaches its destination or exhausts its hop count (default 3, configurable up to 7).

- **Simple and robust:** No routing tables. New nodes work immediately. Self-healing if relay fails. (Since Meshtastic 2.6, direct messages additionally use a learned next-hop relay, with automatic fallback to flooding, so some routing state does exist for DMs.)
- **Limitation:** In a dense mesh, a single message can trigger dozens of rebroadcasts. This is why faster presets such as MediumFast are preferred in dense networks.

Path-based routing (MeshCore)

MeshCore discovers explicit routes before sending data:

1. Node A's first message is flood-routed; each repeater that relays it appends its ID to the packet's path
 2. Destination D sends back a **delivery report** listing the repeaters the message traversed; this report is flood-routed back to A and becomes the basis for the future direct path
 3. Node A caches the route $A \rightarrow B \rightarrow C \rightarrow D$ and uses it for all subsequent messages to D
- **More efficient at scale:** Messages travel only the established path - much less airtime than flooding in large networks
 - **Limitation:** The first message to a new contact is flooded (using more airtime); the efficient direct path only kicks in from the second message onward. Topology changes require re-discovery.

Which is better?

Both work well in practice. Flooding is simpler and more resilient for small-to-medium networks. Path-based routing scales better for large infrastructure deployments. In practice, your choice is determined by which protocol your local community uses.

The mesh advantage

In Meshtastic, every node is a potential relay; in MeshCore, only nodes flashed as repeaters relay - client nodes deliberately do not. A hilltop repeater that can hear both a valley and a distant mountaintop effectively bridges those two coverage zones for all messages. A few well-placed infrastructure nodes have outsized impact on total network reach.