

Building the Off-Grid Grid: Meshtastic and MeshCore

Unpacking LoRa Mesh Networks, North American
Configurations, and Infrastructure Deployment

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Introduction to LoRa

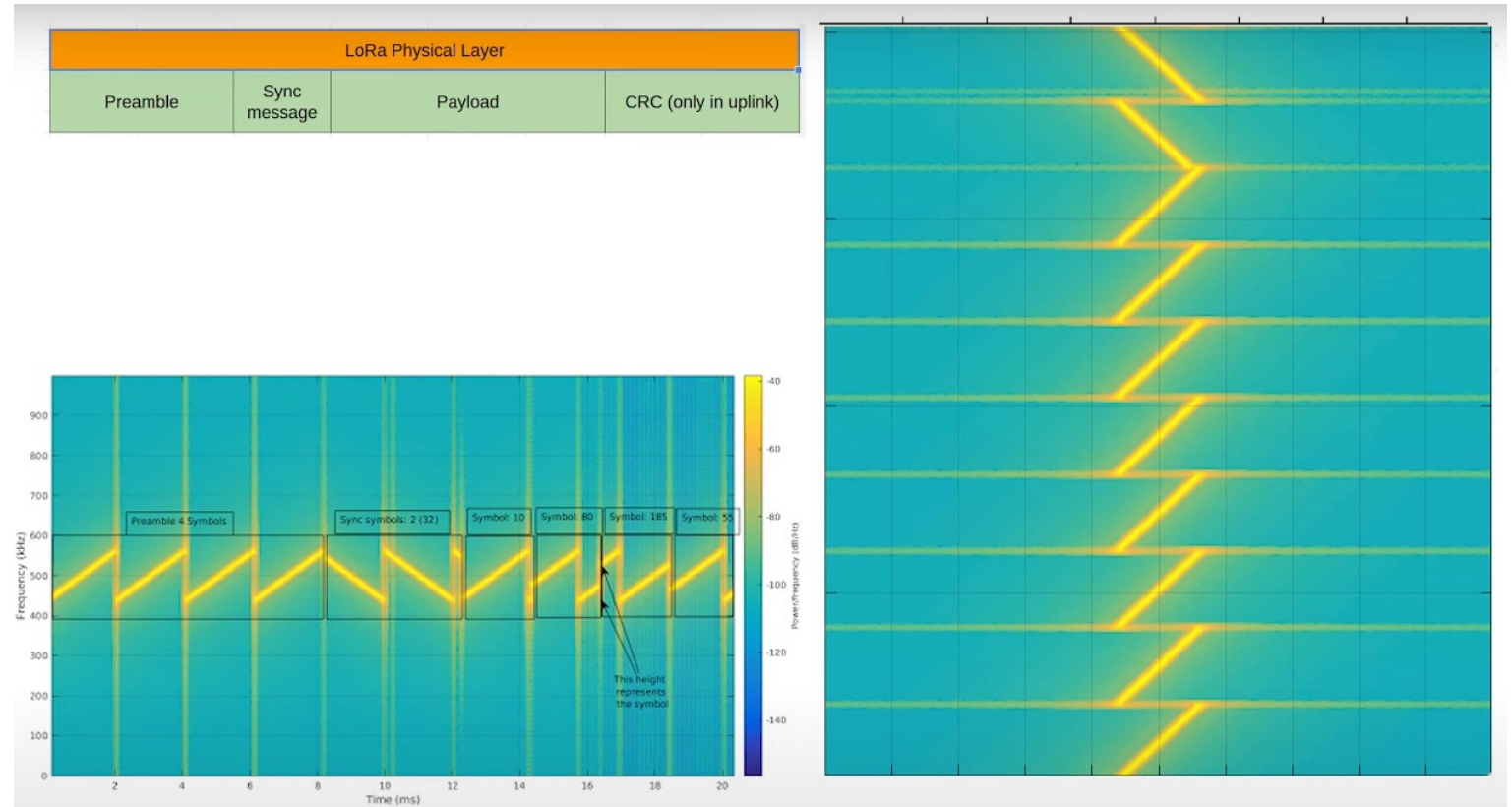
What is LoRa? Stands for Long Range.

- It is a low-power, chirp spread spectrum (CSS) radio modulation technology.
- Designed for small data packets (text messages, GPS coordinates, telemetry) sent over “long distances.”

Key Characteristics:

- **High Link Budget:** Can decode signals weaker than the background noise floor. +150dB Link Budget.
- **Low Power Consumption:** Devices can run for days on a small battery or indefinitely on a small solar panel.
- **Line-of-Sight Dependent:** Performs phenomenally across flat terrain or from high elevations but is attenuated by buildings and dense foliage.

LoRa Chirp



Parameters

- **Center Frequency** – It's the middle of the bandwidth.
- **Spreading Factor (SF)** - How much we "spread" our data over time.
 - Each step up in Spreading Factor doubles the airtime to transmit.
 - Each step up in Spreading Factor adds about 2.5db extra link budget.
 - **Note:** Spreading Factors 5 and 6 are only supported on 2nd generation LoRa chips (SX126x, LR11xx, SX128x). 1st generation chips (SX127x / RF95) are limited to SF7-SF12. If you select SF5/6 on an unsupported device, the firmware will automatically clamp it to SF11.
- **Bandwidth** - How big of a slice of the spectrum we use.
 - Each doubling of the bandwidth is almost 3db less link budget.
 - Bandwidths less than 31 may be unstable unless you have a high-quality Crystal Oscillator.
- **Coding Rate** - How much redundancy we encode to resist noise.
 - Increasing coding rate increases reliability while decreasing data-rate.
 - 4/5 - 1.25x overhead
 - 4/6 - 1.5x overhead
 - 4/7 - 1.75x overhead
 - 4/8 - 2x overhead

For RF Engineers

LoRa Data Rate (Rb) Formula : -

$$R_b = SF * \frac{\left[\frac{4}{4+CR} \right]}{\left[\frac{2^{SF}}{BW} \right]} * 1000$$

SF = Spreading Factor (6,7,8,9,10,11,12)

CR = Code Rate (1,2,3,4)

BW = Bandwidth in KHz
(10.4,15.6,20.8,31.25,41.7,62.5,125,250,500)

Rb = Data rate or Bit Rate in bps

Numerical Equation:-

$$FSPL = (44\pi d/\lambda)^2 = (44\pi df/c)^2$$

Where,

FSPL = Free Space Path Loss

d = distance between Tx and Rx in meters

f = Frequency in Hertz

Logarithmic Equation:-

$$FSPL \text{ (dB)} = 20\log_{10}(d) + 20\log_{10}(f) - 147.55$$

Meshtastic vs. MeshCore: The Architectural Split

The Shared Core:

- Both platforms run on the exact same hardware (e.g., Heltec V3/V4, RAK WisBlock, Seeed Studio devices, Lilygo devices) and operate completely independently of the cellular grid or internet.

<https://meshcore.io/#hardware>

The Divergent Philosophies:

- **Meshtastic (The Ad Hoc Network):** * Uses a **Managed Flood** routing protocol. Every device in the network acts as a peer and relays messages for everyone else.
- Perfect for highly mobile groups (hiking, tactical teams, emergency response) with zero setup required.

MeshCore (The Managed Grid):

- Uses **Source/Structured Routing**. Only designated "Fixed Repeaters" relay traffic; handheld user devices ("Companions") remain quiet.
- Perfect for building permanent, high-capacity urban backbones with less radio congestion and optimized battery life for handhelds.

MeshCore Network Architecture

Why Repeaters Matter in MeshCore: Because MeshCore companion devices do not rebroadcast*, the entire network relies on stationary, permanent Repeaters to serve as the backbone.

Advantages over standard flooding:

- **Scalability:** Supports up to **64 hops** (compared to Meshtastic's standard cap of 3 to 7 hops).
- **Efficiency:** Drastically reduces "radio noise" because random handhelds aren't stepping on each other's signals to repeat packets.

Hardware Requirements:

- **Core Chipsets:** Typically built on ultra-low-power RAK4631 (nRF52-based) or Heltec V3/V4 (ESP32).
- **Antenna Selection:** High-quality 5.8 dBi to 8 dBi fiberglass omnidirectional antennas mounted high (roofs, towers, masts) for optimum Line-of-Sight.

North American Configuration & Frequency Allocations

The ISM Band: In North America (US and Canada), both platforms operate in the unlicensed **915 MHz ISM band**.

Meshtastic North America Settings:

- **Region Preset:** US (915 MHz).
- **Frequency Slots:** Dynamically spreads across frequencies between 902 MHz and 928 MHz (using FHSS).
- **Default Channel:** Long Fast (provides the best balance of range and speed for general use).

MeshCore North America Settings:

- **Region Preset:** USA/Canada (Recommended)
- **Primary Center Frequency:** Set to **910.525 MHz**.
- **Bandwidth:** 62.5 kHz.
- **Spreading Factor:** SF 7 (Default standard for balanced local throughput).
- **Coding Rate:** 5.

MeshCore Companion Configuration

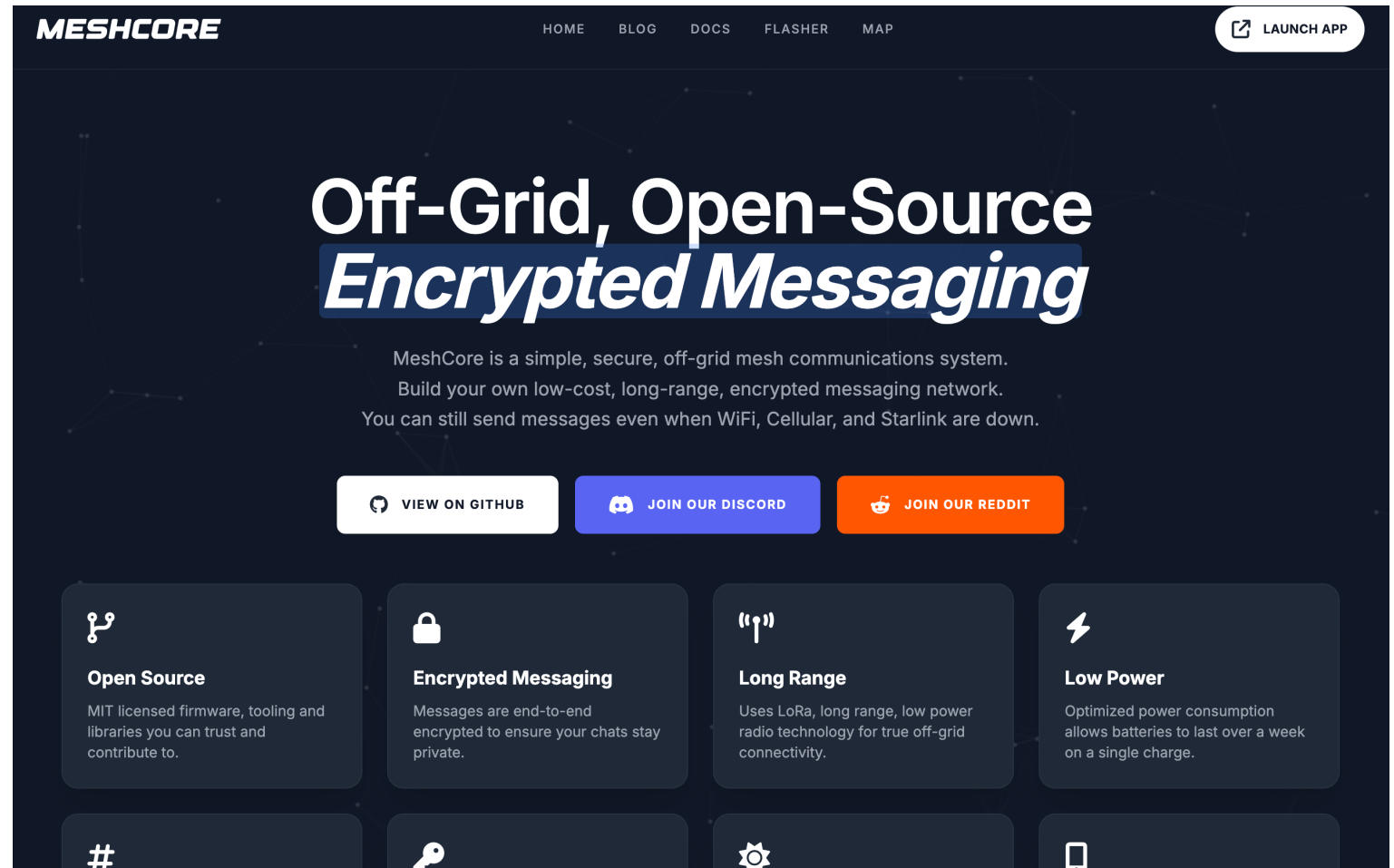
Step 1: Flashing the Firmware

- Connect the device via USB using a Chromium browser (Chrome/Edge and now Firefox) to the MeshCore Web Flasher.
- <https://meshcore.io/flasher/>
- Select the exact hardware target and flash the "**Companion**" firmware variant.

Step 2: Basic Configuration via Bluetooth

- Name, Frequency, Bandwidth, Spreading Factor, Coding Rate

Meshcore.io Webpage



Step-by-Step MeshCore Repeater Configuration

- **Step 1: Flashing the Firmware**
 - Connect the device via USB using a Chromium browser (Chrome/Edge and now Firefox) to the MeshCore Web Flasher.
 - Select the exact hardware target and flash the "**Repeater**" firmware variant (not Companion).
- **Step 2: Basic Configuration (Via Web Config/USB)**
 - *Note: Unlike Meshtastic, MeshCore repeaters are configured via USB/Web client (config.meshcore.io), not over Bluetooth.*
 - **Name:** Give it a descriptive location-based name (e.g., West-Nokomis-Repeater).
 - **Location:** Manually set decimal Latitude and Longitude coordinates. *(Tip: Use static coordinates over map selection rather than an active GPS module to conserve power). (Tip 2: Set the coordinates near your QTH and not exactly at your QTH for privacy).*

Step-by-Step MeshCore Repeater Configuration (cont.)

- **Step 3: Advanced Network Settings**
 - **Transmit (TX) Power:** Typically set between 17 and 22 dBm (must remain under the legal 1W / 30 dBm limit including antenna gain).
 - **Advert Interval:** Recommended settings for a new mesh are a *Zero Hop* interval of 120 minutes and *Flood Advert* of 6 to 12 hours to prevent network bloat.
 - **Admin Password:** Set a strong password; this allows you to remotely manage the node over the air later using a Companion device.

Powering and Deploying the Infrastructure

- **Off-Grid Enclosures:** Waterproof, IP67-rated enclosures placed as high as safely possible.
- **Power Configurations:**
 - *Wall Power:* Best for indoor/attic setups near an outlet.
 - *Solar Setup (Gold Standard):* A 5W–6W solar panel paired with a weather-resilient battery pack (e.g., 6,000–10,000mAh LiFePO4 for superior performance in sub-freezing winter temperatures).
- **Verification:** Use the MeshExplorer tools or local map telemetry to ensure the node is successfully mapped and routing packets for the community.

Room Servers

- **Acts like a Bulletin Board system**
 - Stores messages for later retrieval
 - Three access levels, Admin, Guest, and Read-only
 - Use the same frequency, bandwidth, SF, and CR, as Companion Devices and Repeaters.
 - Room Servers can be configured to repeat messages but only provide a basic subset of Repeater functionality.
 - Best when paired with a Repeater.
 - Best when mains powered.

Channels vs. Rooms

- Channels
 - Broadcast only and flood routed
 - Companion must be on-line to receive
- Rooms
 - Messages are stored for later retrieval
 - Companions must have a path to a room server
- Hash Channel
 - Companions must subscribe to that #channel
 - Messages exist in the moment
- Private Channels/Rooms
 - Encrypted with shared keys
- Direct Message
 - Encrypted messages between two companions

Another Split

[Meshcore.io](#) vs. [Meshcore.co.uk](#)

Statement from the Developers (Scott & Liam)

- <https://blog.meshcore.io/2026/04/23/the-split>

Response from Andy Kirby

- <https://nodakmesh.org/blog/meshcore-split-andy-kirby-response>

Official Code Repository

- <https://github.com/meshcore-dev/MeshCore>

Conclusion & Summary

Meshtastic remains the king of immediate, decentralized, "pop-up" communication for tactical scenarios and recreational groups on the move.

MeshCore provides an engineered, corporate or municipal grade solution for predictable, wide-area, fixed-infrastructure grids.

The Future: As both ecosystems grow rapidly, a hybrid approach deploying fixed MeshCore backbones alongside nimble Meshtastic mobile nodes will shape the future of alternative communications.

Q&A Session