Hardware Guide

Boards, radios, antennas, enclosures — what to buy and why.

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□□ Start Here — Hardware Guide

This book helps you choose the right hardware for your specific use case - whether you're buying your first node, kitting out a field team, or specifying infrastructure for a community network.

□□ Just Want a Quick Answer?

- **First node, just want something to try:** Best Hardware for Beginners
- **Portable / hiking / field use:** Best Hardware for Portable and Handheld Use
- **Fixed outdoor repeater:** Best Hardware for Fixed Repeaters
- **Room server / gateway:** Fixed Infrastructure Node Hardware Selection
- **Side-by-side comparison table:** Popular Board Comparison Table

□□ What's In This Book

Platform Choice: ESP32 vs nRF52840

- ESP32 vs nRF52840: Which Platform? - Power, performance, and compatibility differences
- nRF52840 vs ESP32: Architecture Comparison for Mesh Operators

Radio Chip Selection

- LoRa Radio Chips Explained: SX1262 vs SX1276 vs LR1110
- SX1262 vs SX1276: Why It Matters

Device Categories

- Budget Devices - Under $30
- Mid-Range Devices - $30 - 80
- Premium & Feature-Rich Devices
- T-Deck as a Standalone Communicator
- T114 and T3-S3: New Hardware for 2025 - 2026

Infrastructure Hardware

- Fixed Infrastructure Node Hardware Selection
- Prebuilt Solar Repeater Units
- Base Station Nodes

Accessories

- GPS Modules for LoRa Nodes
- Displays for LoRa Nodes
- PCB Trace vs External Antenna

Software / Apps

- MeshCore App (Official)
- Meshtastic App
- MeshOS (Standalone Device Firmware)

➡ Related Books

- DIY Build Guides - Device-specific setup and enclosure builds
- Antennas & RF - Choosing and installing antennas
- Solar & Power Systems - Powering your nodes

Choosing the Right Hardware

Hardware Overview & Buying Guide

Hardware Overview & Buying Guide

Choosing hardware for a LoRa mesh node comes down to three factors: what role the device will play (handheld communicator, portable node, or fixed repeater), what firmware you intend to run (MeshCore or Meshtastic), and your budget. This guide organises current community-vetted options into tiers. (Prices below are approximate and volatile, as of 2026-06-08.)

Role-Based Recommendations

Role	Best Choices	Why
First node / learning	Heltec V3, LilyGo T-Beam	Cheap, widely documented, easy to flash
Everyday carry	Heltec Wireless Paper, SenseCAP T1000-E, LilyGo T-Echo	Small form factor, long battery life
Field communicator with keyboard	LilyGo T-Deck, LilyGo T-Deck Plus	Full QWERTY, touchscreen, standalone use
Fixed solar repeater (DIY)	Heltec V3, Heltec V4, RAK4631	Low cost, well-supported, solar-ready
Fixed solar repeater (prebuilt)	RAK WisMesh Repeater, SenseCAP P1-Pro	IP-rated, pre-flashed, minimal setup
Base station / high-power node	Station G2	ESP32-S3 + SX1262 with 35 dBm PA + LNA; rated to 36.5 dBm (~4.46 W) US915 output. NOTE: 36.5 dBm exceeds the 30 dBm conducted limit for unlicensed Part 15.247 use - legal only under an amateur (Part 97) licence with no encryption and station ID. Built for infrastructure

Price Tiers at a Glance

Prices approximate and volatile (as of 2026-06-08); check the manufacturer store for current figures.

Tier	Price Range	Devices
Budget	~$15 - $30	Heltec Capsule Sensor (~$26+), Heltec Wireless Paper (~$20-25), Heltec V3 (~$15-20)
Mid-range	$25 - $50	Heltec V4, LilyGo T-Beam, Heltec T114, Wio Tracker L1/L1 Lite, SenseCAP T1000-E
Premium	$43 - $109	LilyGo T-Deck/T-Deck Plus, LilyGo T-Echo, Wio Tracker L1 Pro, Atlavox M1, Nano G2 Ultra, RAK WisMesh Pocket, Station G2 (~$109)

Key Specifications to Compare

- **LoRa chip:** Most devices use the Semtech SX1262. Verify your device targets the right frequency band for your region (915 MHz in North America).
- **MCU:** ESP32 boards are more common and easier to flash via USB. nRF52840 boards (T-Echo, T114, RAK4631) use DFU flashing but draw significantly less power.
- **TX power:** Most boards built around a bare SX1262 top out at ~22 dBm (the chip's maximum). Boards with an external PA can go higher. The Station G2 reaches 36.5 dBm (~4.46 W) via its onboard PA - useful for infrastructure but exceeds the unlicensed Part 15.247 conducted limit (legal only under a Part 97 amateur licence) and requires proper RF planning.
- **Display:** OLED (V3, V4, T-Beam) is bright but draws more power. E-ink (Wireless Paper, T-Echo) is nearly zero power between updates. TFT (T114) is full-colour.
- **GPS:** Built-in on T-Beam, T-Echo, T-Deck Plus, Wio L1, SenseCAP T1000-E, and the L1 Pro (per the individual Meshtastic device pages, as of 2026-06-08). Add-on or absent on most Heltec boards.
- **Battery:** Many boards require you to supply your own 18650 or LiPo. Check connector type before ordering a battery.

Where to Buy

As general purchasing guidance (as of 2026-06-08), most devices are available on AliExpress (typically cheapest, ~2 - 4 week shipping), Amazon (faster, usually slightly more expensive), and directly from manufacturer stores. For RAK WisBlock modules, shop at store.rakwireless.com. For SenseCAP devices, use the Seeed Studio store.

Common Pitfalls

- Check connector type before buying antennas. SMA and RP-SMA look nearly identical but are not interchangeable, and the LoRa connector varies by board (and sometimes by board revision) - many small dev boards (including the Heltec V3) actually expose a U.FL/IPEX connector that needs a U.FL-to-SMA pigtail rather than a direct SMA jack. Always check your specific board's spec before ordering an antenna.
- Do not run any LoRa device without an antenna connected. Transmitting without a load can damage the PA.
- Many marketplace 18650 cells are counterfeit or overrated on capacity. Buy from reputable cell brands/sellers (see the Battery Chemistry Guide).

MeshCore Device Compatibility

MeshCore Device Compatibility

MeshCore is a lightweight mesh firmware optimised for LoRa networks. The following devices are supported as of early 2026 (the supported list changes - always check flasher.meshcore.io for the latest list before purchasing hardware specifically for MeshCore).

Supported Devices

Device	MCU	Notes
Heltec V3	ESP32-S3	Most popular beginner choice; stock BT antenna issue (see Budget Devices page)
Heltec V4	ESP32-S3	~22 dBm (confirm against Heltec's current spec - some sources cite 28 dBm via an integrated PA, others ~22 dBm); solar charging interface
Heltec T114	nRF52840	Lower power than ESP32; DFU (double-tap) flashing
Heltec Wireless Paper	ESP32-S3	E-ink display (250×122); ~20 µA deep sleep (figure quoted for Heltec's V4; verify against the Wireless Paper datasheet)
LilyGo T-Beam	ESP32	GPS built-in; 18650 holder
LilyGo T-Deck	ESP32-S3	QWERTY + touchscreen standalone node
LilyGo T-Echo	nRF52840	E-ink + GPS + NFC; ~850 mAh internal battery (~5 - 7 day runtime)
RAK4631 (WisBlock)	nRF52840	Modular platform; DFU flashing
Wio Tracker L1	nRF52840	OLED + GPS; bare board

Device	MCU	Notes
Wio Tracker L1 Lite	nRF52840	Most affordable Wio option; includes L76K GPS (drops the OLED screen vs the standard L1, not GPS)
Wio Tracker L1 Pro	nRF52840	Rugged enclosed, GPS, built-in battery
SenseCAP T1000-E	nRF52840	Credit-card size, IP65, GPS; LR1110 radio
Station G2	ESP32-S3	High-power base station (SX1262 + 35 dBm PA + LNA, ~36.5 dBm US915 output). Note: 36.5 dBm conducted exceeds the US FCC Part 15.247 30 dBm conducted limit; full-power US use requires amateur Part 97. See Base Station Nodes.

Firmware Variants

When flashing MeshCore you choose a firmware variant:

- **Companion:** Personal device that pairs with a phone app over BLE or USB.
- **Repeater:** Autonomous mesh relay node; no user interaction needed after setup.
- **Room Server:** Acts as a message store-and-forward hub for a channel.

nRF52 vs ESP32 Considerations

nRF52840-based devices (T-Echo, T114, RAK4631, Wio series, SenseCAP T1000-E) draw significantly less power than ESP32 equivalents, making them better suited for battery-critical deployments. The trade-off is a different flashing workflow: nRF52 devices typically use USB DFU with a double-tap reset (the UF2/USB DFU bootloader) rather than the BOOT-button (esptool) bootloader used on ESP32 boards. See the Meshtastic nRF52 flashing docs.

Meshtastic Device Compatibility

Meshtastic Device Compatibility

Meshtastic is the other major firmware option for LoRa mesh nodes. Hardware compatibility overlaps significantly with MeshCore. Always verify at flasher.meshtastic.org before purchasing.

Widely Used Meshtastic Devices

Device	MCU	Price Range	Notes
Heltec V3	ESP32-S3 + SX1262	$20 - $30	Very common; large community
Heltec V4	ESP32-S3 + SX1262	$25 - $35	~22 dBm TX (confirm against Heltec's current spec; some sources cite a higher-power variant). Both V3 and V4 use the SX1262 - any difference is not a clear datasheet-supported power increase.
LilyGo T-Beam	ESP32	$35 - $45	GPS; popular for mobile nodes
LilyGo T-Deck	ESP32-S3	$43 - $53	Standalone keyboard device
LilyGo T-Echo	nRF52840	$50 - $65	Long battery life
RAK4631 (WisBlock)	nRF52840 + SX1262	Varies	Modular; add GPS/sensor modules
SenseCAP T1000-E	nRF52840 + LR1110	$35 - $45	GPS, IP65, compact (radio is Semtech LR1110, not SX1262)
Heltec T114	nRF52840 + SX1262	$30 - $45	TFT display; lower power

Prices are approximate retail ranges as of 2026-06-08 and are volatile; check a current retailer (e.g. the manufacturer's store, Rokland, or Seeed Studio) before buying.

Choosing Between MeshCore and Meshtastic

Factor	MeshCore	Meshtastic
Community size	Smaller, growing	Very large, well-documented
Room server support	Yes (built-in variant)	Via MQTT bridge
App ecosystem	MeshCore app (Android/iOS)	Meshtastic app (Android/iOS/web)
Repeater setup	Simple, dedicated variant	Router role in settings
Firmware updates	OTA via app or web flasher	OTA via app or web flasher

Both firmware options run on the same hardware. You can re-flash between them at any time without permanent consequences - choose based on the network you are joining or building.

LoRa Radio Chips Explained: SX1262 vs SX1276 vs LR1110

When buying LoRa hardware, listings frequently mention specific radio chip models. Understanding what these chips are and how they differ prevents costly purchasing mistakes.

Why the chip matters

The LoRa transceiver chip is the core radio hardware. It determines the radio's maximum transmit power, receiver sensitivity, supported frequency bands, and power consumption. The board that surrounds it (the MCU, display, GPS, etc.) matters too - and two boards using the same LoRa chip will have a similar baseline radio performance, unless one board adds a power amplifier, LNA, or different RF front-end (antenna matching, filtering), which can change output power and sensitivity significantly.

The three chip families you'll encounter

SX1262 (current standard)

The most common LoRa chip in new hardware as of 2024 - 2026, and the dominant chip across current Meshtastic and MeshCore supported-hardware lists. An evolution of the SX1276 with significant improvements.

Spec	Value
Max TX power	+22 dBm (158 mW) max; some boards add an external PA to reach higher power

Spec	Value
Frequency range	150 MHz - 960 MHz (covers both 868 MHz EU and 915 MHz US)
Receiver sensitivity	~−137 dBm at SF12 / 125 kHz BW (the headline −148 dBm figure is at the narrowest bandwidth, not BW125)
RX current	~4.6 mA
Sleep current	0.6 µA
Interface	SPI

Used in: Heltec V3, V4, T096 (with PA), RAK4630/4631, T-Echo, T-Deck, T-Deck Plus, Station G2, most recent LilyGo boards, Nano G2 Ultra.

Buy this if: You're buying any new hardware. The SX1262 is the current generation chip and has no meaningful disadvantages compared to older alternatives. Its real advantages over the SX1276 are lower RX current, TCXO stability, and a slightly better link budget.

SX1276 (older generation, still common)

The predecessor to the SX1262. Widely used in older boards (T-Beam v0.7 - v1.1, early Heltec boards) and still found in some current products. Fully compatible with SX1262-based nodes - they use the same LoRa protocol.

Spec	Value
Max TX power	up to +20 dBm (100 mW) via PA_BOOST on 868/915 MHz boards (+17 dBm is the RFO-path limit)
Frequency range	137 MHz - 1020 MHz
Receiver sensitivity	~−137 dBm at SF12 / 125 kHz BW (headline −148 dBm is at the narrowest bandwidth) - within ~1-3 dB of the SX1262 at the same SF/BW
RX current	~9.9 mA - significantly higher than SX1262
Sleep current	0.2 µA
Interface	SPI

Used in: Original T-Beam (before Supreme), some budget LoRa modules, SX1278/SX1279 are frequency variants of the same family.

Key limitation: Lower max TX power (+20 dBm via PA_BOOST vs +22 dBm on the SX1262) and higher RX current. At the same SF/BW the two chips' sensitivity is within ~1-3 dB - so the SX1262's edge is mainly its lower RX current and TCXO stability, not a dramatic range difference. For battery-powered use, the SX1262 is preferable.

Buy this if: You have existing SX1276 hardware that still works. Don't specifically seek it out for new purchases.

LR1110 / LR1120 (multi-band, advanced)

Semtech's newest transceiver family, adding GNSS/Wi-Fi geolocation scanning and (on the LR1120) multi-band capability beyond standard sub-GHz LoRa. Note the two chips differ: the **LR1110** does LoRa on sub-GHz only (150-960 MHz), while the **LR1120** adds 2.4 GHz LoRa and an S-band.

Spec	Value
Max TX power	+22 dBm sub-GHz LoRa (LR1110 & LR1120); +15 dBm 2.4 GHz LoRa (LR1120 only)
Frequency range	LR1110: 150-960 MHz LoRa (sub-GHz only). LR1120: adds 2.4 GHz LoRa and S-band. The LR1110's extended receive coverage applies to its passive Wi-Fi/GNSS geolocation scanner, not to LoRa.
Additional features	Wi-Fi passive scanning, GNSS scanning (geolocation without a GPS chip)
RX current	~5.3 mA (LoRa RX; verify against the Semtech LR1110 datasheet)

Used in: Seeed Wio Tracker 1110, some newer development boards.

Key advantage: GNSS scanning for geolocation without a dedicated GPS module. (2.4 GHz LoRa for short-range high-throughput applications is an LR1120-only feature, not available on the LR1110.)

For mesh use: Meshtastic supports LR1110 on the Wio Tracker 1110 for standard 915 MHz operation. MeshCore LR1110 support status is unclear - check the MeshCore supported-hardware docs. The 2.4 GHz LoRa band is not used by standard mesh protocols.

What about SX1278 and SX1268?

You may see these variants in search results:

- **SX1278:** Lower-frequency variant of the SX1276 family, covering roughly 137-525 MHz (e.g. 433/470 MHz). Not used for 915 MHz mesh.
- **SX1268:** The 433/470 MHz (China) sibling of the SX1262 family, supporting up to +22 dBm in a similar package. Functionally equivalent to the SX1262 for LoRa mesh purposes, but on the lower bands.

- **LLCC68:** Budget SX1262-compatible chip used in some low-cost boards. Supports SF5 - SF11 only (not SF12). Fine for community mesh presets but lacks the maximum sensitivity of SF12.

Power amplifiers: getting to 1W and beyond

The stock SX1262 outputs +22 dBm (158 mW). Some boards add an external RF power amplifier (PA) to reach higher power levels:

TX power	In mW	How achieved	Example hardware
22 dBm	158 mW	SX1262 native	Most standard boards
28 dBm	630 mW	SX1262 + PA (contested - verify against heltec.org)	Heltec T096 (28 dBm-PA claim is contested/NEEDS-EXPERT)
30 dBm	1000 mW	SX1262 + 1W PA (e.g. E22-900M30S module)	Ikoka Stick 1W variant
33 dBm	2000 mW	SX1262 + 2W PA	Ikoka Stick 2W variant (existence of a turnkey 2W variant is unverified)

Important - FCC limits: Under 47 CFR 15.247 the US 902-928 MHz limit is **1 W (30 dBm) conducted** referenced to an antenna of ≤6 dBi; antennas above 6 dBi require a dB-for-dB conducted-power reduction. The 36 dBm (4 W) EIRP figure is the *derived* ceiling (30 dBm + 6 dBi), not a flat standalone limit. The 33 dBm conducted figure above **exceeds the 30 dBm conducted limit** and is not legal for unlicensed US (Part 15) use - it would only be operable under an amateur (Part 97) license (no encryption, station identification required). See the FCC Regulations page in the Antennas & RF section.

Summary: what to buy

Use case	Chip recommendation	Example board
Portable companion node (low power priority)	SX1262, nRF52840 board	T-Echo, T1000-E
Fixed repeater (solar/mains)	SX1262 on nRF52 or ESP32	RAK4631, Heltec V4
High-power infrastructure repeater	SX1262 + PA (Ikoka 1W)	Ikoka Stick 1W
GPS-tracking node (ultra-long battery)	SX1262, nRF52840, T096	Heltec T096

Use case	Chip recommendation	Example board
Budget/experimental	LLCC68 or SX1276	Various eBay modules

Portable & Personal Devices

Budget Devices

Budget Devices

Budget-tier devices generally cost under ~$30 (as of 2026-06-08) and can be a reasonable entry point, but they come with trade-offs: most bare boards ship without GPS, an enclosure, or a battery. Users who want a turnkey experience may be better served by a kit. They support both MeshCore and Meshtastic, are widely available, and have extensive community documentation.

Heltec V3 - $20 - $30 (as of 2026-06-08)

The Heltec V3 is the most popular beginner device in the community. It runs an ESP32-S3 paired with an SX1262 LoRa radio, includes a small OLED display, and ships with an external LoRa antenna that connects via an on-board U.FL/IPEX (IPEX1.0) connector.

- **MCU:** ESP32-S3
- **LoRa chip:** SX1262
- **Display:** 0.96" OLED
- **Antenna:** External LoRa antenna via on-board U.FL/IPEX (IPEX1.0) connector (many resellers add a U.FL-to-SMA pigtail; the bare board is U.FL/IPEX)
- **USB:** USB-C
- **Battery:** JST connector for LiPo (not included)

Known issue - Bluetooth/WiFi antenna instability (community-reported): Some users report BLE instability on the V3. Heltec attributes reboots/instability to the 2.4 GHz spring antenna being compressed by an enclosure rather than to a PCB antenna - if you case the board, make sure no part of the enclosure presses against or covers the antenna area. The V3's 2.4 GHz antenna is a spring antenna with no separate PCB-antenna pad to desolder, so older "desolder the PCB antenna and solder on a 31 mm wire" community fixes do not match the V3's actual hardware. Treat such mods as unverified community lore.

Heltec Wireless Paper - ~$16 from Heltec direct, up to ~$25 via resellers (as of 2026-06-08)

A unique budget option built around a 2.13" e-ink display. The e-ink panel draws essentially no power between refreshes, giving the Wireless Paper exceptional battery life.

- **MCU:** ESP32-S3
- **Display:** 2.13" e-ink (250 × 122)
- **Deep sleep current:** ~20 µA - among the lowest of any supported device
- **Use case:** Ultra-low-power fixed node or infrequently checked carry device

Heltec Capsule Sensor V3 - ~$26+ (as of 2026-06-08)

An ultra-compact cylindrical telemetry/sensor node (23 g, IP65). Note this is a LoRa/LoRaWAN sensor device, not a general-purpose chat node - confirm it runs the Meshtastic/MeshCore messaging firmware you intend before buying, so it isn't mistaken for a beginner messaging device. It is fully integrated: a built-in LoRa antenna, a built-in 250 mAh rechargeable battery, and a magnetic charging port. Sensors attach via a solderless BTB (board-to-board) connector - no soldering of antenna or battery is required.

Summary Comparison

Device	Price (as of 2026-06-08)	Display	GPS	Beginner-friendly
Heltec V3	$20 - $30	OLED	No	Yes
Heltec Wireless Paper	~$16 - $25	E-ink 2.13" (250 × 122)	No	Yes
Heltec Capsule Sensor V3	~$26+	None	No	Yes (built-in antenna & battery, solderless BTB for sensors; telemetry-oriented)

Mid-Range Devices

Mid-Range Devices

Mid-range devices ($25 - $50) add useful features: GPS, better displays, higher transmit power, lower power consumption, or more robust form factors. (Prices below are as of 2026-06-08 and shift over time.)

Heltec V4 - $25 - $35 (as of 2026-06-08)

A direct upgrade over the V3. The V4 adds a solar charging interface, making it well-suited for small solar-powered repeater builds. It uses the same ESP32-S3 family + SX1262 as the V3, though the V4 differs in memory (V3 = ESP32-S3FN8 with 8 MB integrated flash; V4 = ESP32-S3R2 with 2 MB PSRAM + 16 MB external flash). Its LoRa output is the SX1262's native level (~21-22 dBm) unless an integrated PA is confirmed on Heltec's spec sheet.

- **TX power:** ~22 dBm (SX1262 native; confirm against Heltec's current spec - the often-repeated "28 dBm" figure is not documented in Heltec's datasheet and would require an external PA)
- **Solar input:** Yes (dedicated solar charging circuit)
- **Display:** OLED

LilyGo T-Beam - $35 - $45 (as of 2026-06-08)

A full-featured ESP32 board with GPS built in and an 18650 battery holder. The T-Beam is one of the most popular mobile nodes because position reporting works out of the box. The 18650 form factor means you can use widely available rechargeable cells.

- **MCU:** ESP32
- **GPS:** Built-in (the older v1.1 uses a u-blox NEO-6M; current revisions ship newer u-blox modules such as the M8N/M10) - specify by revision when it matters
- **Battery:** 18650 holder (cell not included)
- **Connector:** SMA antenna

Heltec T114 - $30 - $45 (as of 2026-06-08)

Uses an nRF52840 rather than ESP32, which draws significantly less power. The 1.14" TFT colour display is a step up from OLED. Solar-ready. Best choice for a low-power personal node that also has a decent screen.

- **MCU:** nRF52840
- **GPS:** Optional (offered with or without an onboard GPS module depending on variant)
- **Display:** 1.14" TFT colour
- **Power:** Lower than ESP32 equivalents
- **Flashing:** DFU (double-tap reset)

Wio Tracker L1 - $29.90 (as of 2026-06-08)

Bare board with a 1.3" OLED display and GPS (L76K). nRF52840-based. Good value if you plan to build it into a custom enclosure.

Wio Tracker L1 Lite - $27.90 (as of 2026-06-08)

The most affordable Wio option. A bare board with LoRa **and an onboard L76K GPS** - the difference versus the standard L1 is that the Lite drops the OLED screen (and ships without a case or battery), not GPS. Good choice if you want position reporting at the lowest price and don't need the built-in screen.

SenseCAP T1000-E - $35 - $45 (as of 2026-06-08)

Credit-card sized device with IP65 weather resistance, GPS, and nRF52840. One of the most compact GPS-capable options available. Ships pre-assembled in a rugged housing - no enclosure work needed.

- **Form factor:** 85 × 55 × 6.5mm (credit card size)
- **IP rating:** IP65
- **GPS:** Yes
- **MCU:** nRF52840

Mid-Range Summary

Device	Price	MCU	GPS	Display	Solar
Heltec V4	$25 - $35	ESP32-S3	No	OLED	Yes
LilyGo T-Beam	$35 - $45	ESP32	Yes	OLED	No
Heltec T114	$30 - $45	nRF52840	Optional	TFT 1.14"	Yes
Wio Tracker L1	$29.90	nRF52840	Yes	OLED	No
Wio Tracker L1 Lite	$27.90	nRF52840	Yes	-	No
SenseCAP T1000-E	$35 - $45	nRF52840	Yes	None	No

Prices in this table are as of 2026-06-08.

Premium & Feature-Rich Devices

Premium & Feature-Rich Devices

Premium devices (roughly $43 - $109, as of 2026-06-08) target users who want a self-contained communicator, maximum battery life, infrastructure-grade performance, or specialised capabilities like NFC. Prices are volatile and vary by vendor and region.

LilyGo T-Deck - $43 - $53 (as of 2026-06-08)

A standalone LoRa communicator with a full QWERTY keyboard and 2.8" touchscreen. Can be used without a phone - type and read messages directly on the device. Best choice for field use where you want a dedicated communicator rather than pairing with a phone. Note: the base T-Deck ships with no battery; only the T-Deck Plus includes a built-in cell (see below).

- **MCU:** ESP32-S3
- **Display:** 2.8" IPS touchscreen
- **Input:** QWERTY keyboard + trackball
- **Battery:** Not included (standard LiPo)

LilyGo T-Deck Plus - $65 - $85 (as of 2026-06-08)

The T-Deck Plus adds GPS and a built-in 2000 mAh battery to the base T-Deck. The GPS makes it useful for position-aware mesh communications without any external modules. (The 2000 mAh cell is specific to the Plus; the base T-Deck has no built-in battery.)

LilyGo T-Echo - $50 - $65 (as of 2026-06-08)

E-ink display, nRF52840, GPS, and NFC in one device. The nRF52840 + e-ink combination can deliver multi-day battery life on a single charge, but real-world runtime varies widely with configuration (device role, channel utilisation, GPS on/off) and is often considerably shorter under active routing. The manufacturer does not state a fixed "7-14 day" figure - treat any runtime claim as configuration-dependent. The NFC functionality is available for app pairing workflows.

- **MCU:** nRF52840
- **Display:** E-ink
- **Battery life:** Multi-day, highly configuration-dependent (no fixed manufacturer figure)
- **GPS:** Yes
- **NFC:** Yes

Wio Tracker L1 Pro - $46.99 (Seeed Studio, as of 2026-06-08)

Rugged enclosed version of the Wio Tracker L1. Built on a bare nRF52840 + Wio-SX1262 (not a RAK4630 module). Includes GPS, a 128×64 OLED, and a built-in battery. Good choice for outdoor carry or vehicle mounting where a bare board is not practical.

Nano G2 Ultra - ~$86 (Unit Engineering direct) to ~$99 (Rokland) (as of 2026-06-08)

Uses nRF52840 and a wideband LoRa antenna that covers roughly 815 - 940 MHz, making it compatible with multiple regional frequency plans (the matching network still constrains real performance at the band edges). Has a 1.3" OLED screen. Rated battery life of ~3.5 days. Good choice for travellers who operate on different regional networks.

RAK WisMesh Pocket - $99 (WisMesh Pocket V2, as of 2026-06-08)

A polished handheld device with a 3200 mAh battery, 1.3" OLED display, and GPS. The large battery and GPS make it well-suited as a primary communicator for extended outdoor use. (The earlier $89 figure reflected the V1; the current V2 is $99.)

Station G2 - ~$109 (as of 2026-06-08)

The infrastructure workhorse. Built on an ESP32-S3 (WROOM-1) + SX1262 with a 35 dBm power amplifier and LNA. Its rated 36.5 dBm (4.46 W) US915 output is the highest of any standard supported device - but note this exceeds the FCC 30 dBm (1 W) conducted limit for unlicensed Part 15.247 use; operating at full output is only lawful under an amateur license (Part 97, which prohibits encryption and requires station ID). Includes a low-noise amplifier (LNA) for improved receive sensitivity. Designed to sit at a high point and serve as a backbone node. Requires 15 V USB-C Power Delivery - a standard USB charger will not work.

- **TX power:** 36.5 dBm (4.46 W) - exceeds the FCC 30 dBm conducted limit; full output is Part 97 (licensed) only
- **LNA:** Yes
- **Power input:** 15 V USB-C PD
- **Use case:** Fixed base station / high-site repeater

Premium Device Summary

Prices below are as of 2026-06-08 and are volatile.

Device	Price	MCU	Display	GPS	Battery	Standout Feature
T-Deck	$43 - $53	ESP32-S3	2.8" touch	No	External LiPo (none built-in)	QWERTY keyboard
T-Deck Plus	$65 - $85	ESP32-S3	2.8" touch	Yes	2000mAh (built-in)	QWERTY + GPS included
T-Echo	$50 - $65	nRF52840	E-ink	Yes	Multi-day (config-dependent)	Long battery + NFC
Wio L1 Pro	$46.99	nRF52840	OLED 128×64	Yes	Built-in	Rugged enclosed
Nano G2 Ultra	~$86 - $99	nRF52840	1.3" OLED	No	~3.5 days	815 - 940 MHz wideband
RAK WisMesh Pocket	$99 (V2)	nRF52840	OLED 1.3"	Yes	3200mAh	Large battery + GPS
Station G2	~$109	ESP32-S3	-	No	External	36.5 dBm (Part 97 only), LNA

Infrastructure & Solar Nodes

Prebuilt Solar Repeater Units

Prebuilt Solar Repeater Units

Prebuilt solar nodes take the complexity out of outdoor deployments. They arrive weather-rated, often pre-flashed, and ready to mount. The trade-off is higher cost compared to a DIY build. Prices below are as of 2026-06-08 and vary by retailer.

RAK WisMesh Repeater - $129 (as of 2026-06-08)

IP67-rated enclosure with 5.2Ah battery and pre-flashed MeshCore repeater firmware. Designed specifically for unattended outdoor deployment. Mount it, point the solar panel, and it runs.

- **IP rating:** IP67
- **Battery:** 5.2Ah
- **Firmware:** MeshCore (pre-flashed)
- **Solar:** External panel required (sold separately); RAKwireless also lists a bundled solar-panel version

RAK WisMesh Repeater Mini - $69 (as of 2026-06-08)

A smaller, lower-cost version of the WisMesh Repeater. IP65 rated with a 2000mAh battery. Good starting point for a solar site where you want a prebuilt option without the full Repeater cost.

SenseCAP Solar Node P1 - $69.90 (as of 2026-06-08)

Integrated solar panel in the housing. No external battery included - you add your own 18650 cells. Low entry cost if you already have cells.

SenseCAP Solar Node P1-Pro - $89.90 (as of 2026-06-08)

A popular choice for outdoor repeaters. Includes built-in GPS, capacity for 4x 18650 cells, and an integrated solar panel. Ships with Meshtastic firmware. The GPS enables position reporting from the repeater itself.

- **GPS:** Yes
- **Battery capacity:** 4x 18650 (cells not included)
- **Solar:** Integrated
- **Firmware:** Meshtastic (pre-flashed)

Atlavox Beacon - $235.99 (as of 2026-06-08)

Premium solar repeater with a 5W ETFE solar panel, 5000mAh battery, and IP67 rating. ETFE panels are more durable and efficient than standard PET-laminated panels, making this a good long-term investment for critical sites.

Atlavox Beacon Outpost - $269.99 (as of 2026-06-08)

Same hardware as the Beacon but comes pre-flashed and pre-configured, with an ALFA antenna included. Zero-setup deployment - unbox, mount, done.

PEAKmesh Solar Nodes - ~$99+ (as of 2026-06-08)

Community-built nodes (sold via Etsy) with vendor-claimed runtimes of up to a month without sun, using large 21700 lithium-ion cells. Available in birdhouse and tree-hang form factors - useful for natural environments where a standard enclosure would look out of place or draw attention.

Yeti Wurks Base Station - ~$99+ (as of 2026-06-08)

IP65-rated, pre-configured. Yeti Wurks also offers a solar kit (~$150) that bundles the base station with a 5.5W solar panel - a convenient all-in-one purchase for a new solar site.

Seeed MeshCore Starter Kit - ~$132.80 (as of 2026-06-08)

Bundles a SenseCAP P1-Pro (solar node/repeater) with a Wio Tracker L1 Pro (handheld/carry device), both pre-flashed with MeshCore. The most convenient way to get both an infrastructure node and a personal device in one purchase.

Prebuilt Solar Node Comparison

Prices and specs as of 2026-06-08; confirm against the vendor listing before purchase.

Device	Price	Battery	IP Rating	Solar Included	Pre-flashed	GPS
RAK WisMesh Repeater	$129	5.2Ah	IP67	No	Yes	No
RAK WisMesh Repeater Mini	$69	2000mAh	IP65	No	No	No
SenseCAP P1	$69.90	18650 (DIY)	Yes	Yes	No	No
SenseCAP P1-Pro	$89.90	4x 18650 (DIY)	Yes	Yes	Yes	Yes
Atlavox Beacon	$235.99	5000mAh	IP67	5W ETFE	Yes	No
Atlavox Beacon Outpost	$269.99	5000mAh	IP67	5W ETFE	Yes (configured)	No
PEAKmesh Solar Nodes	~$99+	30+ day rated (vendor-claimed)	Yes	Yes	Yes	Varies
Yeti Wurks Base Station	~$99+	-	IP65	Optional (~$150 kit)	Yes	No

Base Station Nodes

Base Station Nodes

Base station nodes are designed for fixed high-site installations where maximum transmit power, receive sensitivity, and continuous power availability matter more than portability or battery life.

Station G2 - ~$109 (as of 2026-06-08)

The Station G2 is the benchmark base station for MeshCore and Meshtastic networks. It delivers 36.5 dBm (approximately 4.46W) of TX power - substantially more than the 22 - 28 dBm typical of portable devices. A built-in LNA improves receive sensitivity, extending the effective range on both transmit and receive. Price is volatile; check the current listing on the official B&Q Consulting shop (shop.uniteng.com) or Tindie before buying.

Station G2 Key Specs

- **TX power:** 36.5 dBm (4.46W) via integrated 35 dBm PA - **note: this conducted level exceeds the FCC Part 15.247 1 W / 30 dBm conducted limit;** lawful at full power in the US only under an amateur Part 97 license (with encryption off) - see FCC compliance note below
- **LNA:** Yes - improves receive sensitivity
- **Power input:** 15V USB-C Power Delivery (PD) - standard USB-A/5V chargers will not work
- **MCU:** ESP32-S3 (WROOM-1)
- **Radio:** SX1262
- **Display:** 1.3" OLED
- **Antenna:** SMA connector; use a high-quality outdoor antenna
- **Enclosure:** Open board; requires weatherproof enclosure for outdoor deployment

FCC Part 15 Note: In the US 902-928 MHz ISM band, FCC Part 15.247 limits **conducted** output to 1 W (30 dBm) referenced to an antenna of up to 6 dBi; with a 6 dBi antenna this works out to a derived 36 dBm (4 W) EIRP ceiling. The 36 dBm figure is a *derived* EIRP limit, not a flat standalone conducted limit. Antennas above 6 dBi require a dB-for-dB reduction in conducted power. The Station G2's 36.5 dBm **conducted** TX power already exceeds the 30 dBm conducted limit on its own, before any antenna gain - so it is not legal for unlicensed Part 15 operation at full power. Amateur radio operators using Part 97 authority may run higher power (up to 1500 W PEP under 47 CFR 97.313, subject to conditions), but Part 97 prohibits messages encoded to obscure their

meaning - which conflicts with Meshtastic's default channel encryption - and requires a licensed control operator and station identification. Consult Part 15.247 and Part 97 rules and your antenna's gain specification before deploying.

Deployment Considerations

- Mount at the highest practical point. Line-of-sight dominates range at 915 MHz - elevation matters far more than TX power.
- Use low-loss coax (LMR-400 or equivalent) for the feedline. At 36.5 dBm output, cable loss becomes significant. Every 3 dB of cable loss halves your effective radiated power.
- Pair with a 5 - 8 dBi omni antenna for broad coverage, or a Yagi for point-to-point backbone links. Remember that any antenna above 6 dBi requires reducing conducted power dB-for-dB under Part 15.247.
- The 15V PD requirement means you need a USB-C PD charger or power supply. Many laptop chargers work. For solar-powered base stations, you will need a 15V solar charge controller output, which is non-standard - most builders use a boost converter from a 12V battery.

RAK WisBlock Base Station Approach

An alternative base station can be built using a RAK4631 (nRF52840 + SX1262) on a RAK19007 base board, mounted in a weatherproof enclosure. This approach costs more upfront but offers modularity: you can add GPS modules, environmental sensors, or additional radios on the WisBlock connector system. The RAK4631 draws far less sleep power than the Station G2 (2.0 µA module sleep vs the ESP32-S3's milliamp-range sleep), making it more practical for solar-powered base stations without a boost converter. Note the RAK4631's bare SX1262 tops out at ~22 dBm, well below the Station G2's PA-boosted output.

Siting a Base Station

Consideration	Guidance
Height	Greater height extends the radio horizon and clears terrain and Fresnel-zone obstructions, which is usually the dominant range factor - the benefit is not a fixed amount per height doubling. (Separately, in free space doubling the link *distance* costs ~6 dB of path loss.) Rooftop > hilltop > pole-mounted > ground level.
Obstructions	Buildings and trees absorb 915 MHz. Clear line of sight to the horizon is ideal.
Antenna choice	5 - 8 dBi for omnidirectional coverage. Higher gain focuses the beam - avoid if terrain varies in elevation around the site. Antennas above 6 dBi also require a dB-for-dB conducted-power reduction under FCC Part 15.247.

Consideration	Guidance
Lightning protection	Use a DC-grounded gas-discharge lightning arrestor on the feedline. Ground the mast. 915 MHz / sub-GHz arrestors are inexpensive (often under ~$30, as of 2026-06-08).
Power	Mains power is preferred. Solar requires careful sizing for winter minimums.

Fixed Infrastructure Node Hardware Selection

Fixed infrastructure nodes - backbone repeaters, room server hosts, and long-term outdoor installations - have different hardware requirements than portable client nodes. Reliability, power efficiency, and maintainability are the priorities.

Primary Hardware Candidates

RAK4631 (nRF52840 + SX1262)

The RAK4631 WisBlock core is the most popular choice for fixed infrastructure in 2025-2026:

- **Current draw:** ~17 mA in continuous LoRa receive (RAK datasheet), ~125 mA transmit at 22 dBm (SX1262 ~118 mA per Semtech, plus MCU). Sleep is ~2.0 µA. A ~3 mA figure would be a duty-cycled/averaged idle value, not steady receive.
- **Average power:** ~8-15 mA in typical repeater operation (estimate; actual average depends on RX duty cycle and traffic - mostly RX at ~17 mA with brief TX bursts and low-power sleep between)
- **Advantages:** Modular WisBlock system allows easy sensor/GPS/display add-ons; nRF52840 has excellent power management; SX1262 supports all required frequencies
- **Form factor:** Small enough to fit in an IP67 enclosure with a 18650 battery pack
- **Firmware:** MeshCore (REPEATER or Companion), Meshtastic

LILYGO T-Beam Supreme (ESP32-S3 + SX1262)

Good choice when WiFi/MQTT gateway capability is needed at a fixed site:

- **Current draw:** ~80-120 mA approximate whole-board current with ESP32 WiFi active, ~30 mA (WiFi off, LoRa only; depends on GPS on/off and CPU activity). Both are board-level estimates, not single datasheet values.

- **Advantages:** Built-in GPS, WiFi for MQTT bridge, USB-C, relatively large community
- **Disadvantages:** Higher power draw than nRF52 makes solar budget larger; ESP32 requires periodic watchdog resets in some deployments
- **Best for:** Gateway nodes with internet connectivity, sites with reliable grid or large solar panels

Heltec HT-n5262 / HT-n5262M (nRF52840 + SX1262)

Ultra-compact option for space-constrained installations:

- **Current draw:** Comparable to the RAK4631 (both are nRF52840 + SX1262): expect ~17 mA continuous LoRa RX, ~125 mA TX at 22 dBm, microamp-range sleep. Verify against Heltec's datasheet for the specific variant.
- **Advantages:** Extremely small form factor (the HT-n5262M is a 1.27 mm stamp-hole solder-down module for integration onto your own PCB). Note: the bare module does not include a LiPo/JST connector; a built-in battery connector applies only to a dev-board variant - confirm the variant you are buying.
- **Best for:** Discreet indoor deployments, installations with severe space constraints

Hardware Selection Matrix

Use Case	Recommended Hardware	Reason
Solar outdoor repeater	RAK4631	Lowest power, weatherproof WisBlock ecosystem
Indoor backbone with internet gateway	T-Beam Supreme	WiFi for MQTT bridge (GPS is largely unusable indoors without sky view, so position tracking applies only to an outdoor/rooftop gateway)
High-altitude remote repeater	RAK4631	Low power essential for limited solar; reliable firmware
Room Server host: RAK4631 or Heltec V3 running MeshCore Room Server firmware	RAK4631 via USB serial	Pi handles room server; RAK handles LoRa radio. Verify the supported host hardware and architecture against docs.meshcore.io Room Server requirements before deploying.

Antenna Considerations for Fixed Sites

Infrastructure nodes should use external antennas rather than the stub antennas included with most development boards:

- **Omnidirectional (5-8 dBi fiberglass):** Best for covering 360 degrees; mount at highest practical point
- **Yagi/directional (10-15 dBi):** Best for point-to-point backbone links over long distances; requires careful alignment. Note for unlicensed US (Part 15.247) operation: antenna gain above 6 dBi requires a dB-for-dB reduction in conducted transmitter power, so high-gain Yagis above 6 dBi must be paired with a correspondingly lower TX power setting.
- **Antenna cable:** LMR-195 or LMR-400 (minimize cable length to reduce loss). LMR-400 has ~1.3 dB/10 m (12.8 dB/100 m, 3.9 dB/100 ft) loss at 900 MHz per the Times Microwave datasheet.

Emerging & Specialty Hardware

Heltec Mesh Node T096

Overview

The **Heltec Mesh Node T096** (Heltec's nRF52 part naming follows the HT-n5262 / HT-n5262M family) combines an nRF52840 MCU with an SX1262 radio and an *integrated power amplifier*. Heltec rates its maximum TX power at **28±1 dBm** via that PA — well above the SX1262's bare native +22 dBm — which it pairs with on-board GPS and an ultra-low sleep current, making it purpose-built for solar and remote deployments. *(TX-power figures for Heltec PA boards are contested across third-party sources; the 28±1 dBm here reflects Heltec's own current spec — verify against heltec.org before relying on it.)*

Specifications

Attribute	Value
Price	~$30 (Heltec lists ~$29.90-$33.90 depending on date/variant; as of 2026-06-08)
MCU	nRF52840
Radio	SX1262 + integrated power amplifier
TX Power	28±1 dBm (per Heltec, via integrated PA; verify against heltec.org)
GNSS	UC6580 - L1+L5, 6 constellations (GPS, GLONASS, BeiDou, Galileo, QZSS, NavIC)
Display	0.96″ color TFT (commonly 160×80 panels; confirm resolution against Heltec datasheet)
Sleep Current	12 µA
Bluetooth	BLE 5 + Bluetooth Mesh
Battery Connector	1.25 mm lithium
Solar Input	1.25 mm solar connector
MeshCore Support	Yes (compatible with Meshtastic and MeshCore per Heltec)

T096 vs. Heltec V4

Feature	T096	V4
TX Power	28±1 dBm (Heltec, via PA)	~22 dBm stock (contested; some sources cite up to ~27-28 dBm on PA variants — verify against heltec.org)
Price	~$30 (as of 2026-06-08)	~$17 - 20 (as of 2026-06-08)
GPS	Yes (UC6580, L1+L5)	No
Wi-Fi	No	Yes
Sleep Current	12 µA	Higher
Best Role	Solar / remote / field	Indoor / USB-powered nodes

RF output is **not** identical between the two: the T096 reaches 28±1 dBm via its integrated PA, whereas the Heltec V4's stock output is around 22 dBm (higher on some PA variants — the exact figure is contested, so verify against heltec.org). Beyond raw output, the T096's 12 µA sleep current and built-in GPS make it far more suitable for long-term solar-powered deployments, where the V4's Wi-Fi integration goes unused.

Target Use Cases

- Solar-powered relay nodes
- Remote repeaters (mountain tops, rural infrastructure)
- Portable field kits requiring GPS without an external module

Ikoka Stick

Overview

The **Ikoka Stick** is a community DIY design (by **ndoo**) for an ultra-compact stick-format LoRa node built on the **Seeed Studio XIAO nRF52840** paired with an **EBYTE E22-900M**-series LoRa module. It is a hobbyist build rather than a productized multi-MCU node. The compact stick form factor is suited to use as a pocket companion; higher-power builds (see below) require a larger enclosure and should not be confused with the pocketable stick.

Variants & Power Options

The base E22-900M module (SX1262) outputs up to **+22 dBm**. Higher-power "variants" are separate enclosure-based builds that use a higher-power EBYTE E22 module (e.g. E22-900M30S at 30 dBm) or add an external power-amplifier stage downstream of the module — these are not the compact pocket stick.

Variant	TX Power	Typical Use
Standard (compact stick)	22 dBm (~158 mW)	Personal carry / compact node
1 W (box build)	30 dBm	Infrastructure repeater

FCC caveat: The 1 W variant sits at the FCC Part 15.247 conducted limit of 30 dBm (1 W) and is only legal under Part 15 with an antenna of ≤6 dBi (higher-gain antennas require a dB-for-dB conducted-power reduction). A 2 W / 33 dBm build (using EBYTE's large E22-900M33S UART module) **exceeds the FCC Part 15 conducted limit and is not legal for unlicensed US use** — high-power tower use of such a variant generally requires an amateur Part 97 license (no encryption, station identification). Confirm conducted power plus antenna gain against 47 CFR 15.247 before deploying under Part 15. Note also that a 33 dBm module is a large, high-current part (drawing on the order of 1-2 A peak with significant heat dissipation needs) and cannot fit a pocketable stick form factor.

Key Specifications

- **MCU:** Seeed Studio XIAO nRF52840
- **Radio:** EBYTE E22-900M series (built on the SX1262, rated up to +22 dBm). The 1 W build uses a higher-power E22 module (e.g. E22-900M30S) or an external PA stage added after the base module.
- **Form factor:** Compact stick (the standard 22 dBm build). Higher-power builds require a larger enclosure and heatsinking and are not pocketable.

Community Deployments

The Ikoka Stick is the basis of CascadiaMesh's "*1 Watt Ikoka Box*" build - one of the most replicated community deployment designs, used for high-density urban and suburban coverage nodes. As an enclosure-based 1 W build, it is distinct from the pocketable standard stick.

RF Filtering

In electrically noisy environments (near industrial equipment, dense urban RF, tower-share sites), a LoRa cavity filter can suppress out-of-band interference and protect the receiver, improving effective range in difficult RF environments. The Baymesh (Nullrouten) cavity filter is one option; verify the exact SKU, center frequency (US-band LoRa filters are tuned near 906-915 MHz, not a single "910 MHz" point), and current price before purchasing.

Target Use Cases

- High-power infrastructure repeaters (enclosure-based 1 W box build, not the pocket stick)
- Tower mount and rooftop deployments
- Community mesh backbone nodes

Harbor Breeze Solar Node (~$10 enclosure, ~$65 total build)

Overview

The **Harbor Breeze Solar Node** converts a $10 - 15 Harbor Breeze 60-lumen solar LED floodlight (Lowe's item #SL1832) into a weatherproof, solar-powered mesh node. The floodlight already includes a small solar panel (rated ~0.6 W per the Lowe's listing; a rough estimate of ~90 mA at 5 V), an 18650 cell (the listing includes a 3.7 V ~1500 mAh 18650), a charge circuit, and a weatherproof enclosure - the hard parts are done for you. (Prices and specs as of 2026-06-08.)

Total cost including radio: approximately **$60 - 70** (as of 2026-06-08; the total tracks the volatile RAK4631 street price). Enclosure + solar hardware alone: $10 - 15.

Bill of Materials

All prices are commodity/street prices as of 2026-06-08 and will vary; recompute the total if the RAK4631 price changes.

Item	Cost
Harbor Breeze 60LM Solar LED Light (Lowe's #SL1832; includes a ~1500 mAh 18650)	$10 - 15
RAK4631 WisBlock Core (nRF52840 + SX1262)	$18 - 24 (street price, varies)
RAK19007 WisBlock Base Board (USB-C + JST) - $9.99 per store.rakwireless.com	$9.99
915 MHz LoRa Antenna 2 dBi SMA whip (typical commodity price)	$5 - 10

Item	Cost
u.FL to SMA Bulkhead Pigtail (~10 cm; typical commodity price)	~$5
18650 cell (optional - a ~1500 mAh cell is already included; only needed for a higher-capacity replacement or if depleted)	$5 - 10
Misc: heat-shrink, silicone sealant	~$5
Total (approx., as of 2026-06-08)	**~$60 - 70**

Assembly Overview

1. Remove the back cover of the floodlight housing.
2. Remove the LED assembly and cut existing wires near the board.
3. Drill a 1/4″ hole through the housing for the SMA bulkhead connector.
4. Install the RAK WisBlock base board and core module inside the housing.
5. Wire the battery: red = positive (+).
6. Wire the solar panel to the RAK19007 solar charge input header - **verify the exact header label and polarity against the RAK19007 datasheet before connecting**.
7. Weatherproof all cable entry points and the SMA hole with silicone sealant.
8. Reinstall the back cover.

Critical Warnings

- **Keep the solar input within the RAK19007's rated charge-input limit.** Confirm the exact maximum solar/charge input voltage against the current RAK19007 datasheet before connecting; as a conservative ceiling, do not feed more than ~6 V into the solar input. The Harbor Breeze panel is rated ~0.6 W trickle charge. Do not substitute a higher-voltage panel.
- Verify solar wire polarity *before* connecting to the charge-input header. Reverse polarity will damage the charge circuit.
- This panel provides trickle charge only - not suitable for high-duty-cycle backbone repeaters. Nodes that transmit frequently will discharge the battery faster than the panel can recharge it.

Best For

- Fence lines and yard boundary sensors
- Low-traffic area coverage (parking lots, fields, trails)

- Budget-conscious deployments where AC power is unavailable

Not recommended for high-traffic backbone repeaters or nodes that need continuous uptime.

Best Portable Nodes: Ranked

Overview

This ranked guide is based on community testing and field deployments. All devices listed support **Meshtastic** (with one caveat: the SenseCAP T1000-E uses an LR1110 radio, which per Meshtastic docs currently cannot receive packets from older SX127x nodes). MeshCore compatibility varies - notes are included where support differs by operating mode. Prices are volatile and shown as of 2026-06-08.

Rankings

#1 - LilyGo T-Echo ($65 - 75, as of 2026-06-08) - Best All-Around

- **Display:** 1.54″ e-ink (sunlight-readable, zero power when static)
- **GPS:** Yes (Quectel L76K)
- **Battery:** ~850 mAh internal LiPo (not user-swappable; requires disassembly) - roughly 5 - 7 day runtime depending on duty cycle
- **Antenna:** U.FL/IPEX connector (verify against LILYGO spec)
- **Size:** ~90×40×15 mm (approximate; LILYGO does not publish exact case dimensions)
- **Why #1:** The e-ink display is the standout feature for outdoor use - readable in direct sunlight with no backlight drain. Best balance of size, runtime, and usability.

#2 - SenseCAP T1000-E (~$40, as of 2026-06-08) - Best Budget Portable

- **Display:** None (phone-dependent)
- **GPS:** Yes
- **Radio:** LR1110 (note: currently cannot receive Meshtastic packets from older SX127x nodes, per Meshtastic docs)

- **Battery:** 700 mAh
- **Rating:** IP65 weatherproof
- **Size:** Credit card
- **Why #2:** The most pocketable GPS-equipped node available. IP65 rating handles rain and dust. No display means you need a phone, but at ~$40 it's the entry point for serious portable use.

#3 - RAK WisMesh Tag (~$50, as of 2026-06-08) - Best Wearable (editorial)

- **Display:** LED indicators only
- **GPS:** Yes (onboard AT6558R GNSS; triple-press to enable/disable on demand; all antennas built into housing)
- **Battery:** 1000 mAh
- **Rating:** IP66
- **Runtime:** 2 - 3 days
- **Why #3:** IP66 is the highest IP rating among the devices in this list (IP ratings extend to IP68/IP69 elsewhere). Badge/clip form factor designed for events and SAR operations. LED-only feedback keeps it simple and robust.

#4 - LilyGo T-Deck Plus ($85 - 100, as of 2026-06-08) - Best Standalone

- **Display:** 2.8″ color touchscreen (IPS)
- **Input:** Physical QWERTY keyboard + trackball
- **GPS:** Yes
- **Battery:** 2000 mAh
- **MeshCore:** Widely used as a standalone MeshCore companion device; confirm specific mode support against docs.meshcore.io
- **Why #4:** The only device here with a full keyboard for free-text composition standalone, so it's the most capable for extended messaging with no phone. (The T-Echo can also operate without a phone but only for limited interaction such as canned messages.) Best choice if you want a standalone communicator rather than a companion node.

#5 - LilyGo T-Beam Supreme ($55 - 70, as of 2026-06-08) - Most Versatile

- **Display:** 1.3″ OLED
- **Radio:** SX1262
- **GPS:** Yes (u-blox MAX-M10S high-sensitivity module)
- **Battery:** Replaceable 18650 (holder fits only unprotected flat-top cells)
- **MeshCore:** Plausible complete mode support; confirm against docs.meshcore.io
- **Why #5:** The only device here with a user-replaceable 18650 - carry spares to extend field time (subject to cell availability and recharging). Can also be configured as a portable repeater. High-sensitivity GPS performs better in urban canyons and dense canopy.

Quick Comparison

Device	Price	Battery	GPS	Display	IP Rating	Phone Needed?
T-Echo	$65 - 75	~850 mAh internal	Yes	E-ink	-	Optional
T1000-E	~$40	700 mAh	Yes	None	IP65	Yes
WisMesh Tag	~$50	1000 mAh	Yes	LED	IP66	Optional
T-Deck Plus	$85 - 100	2000 mAh	Yes	2.8″ touch	-	No
T-Beam Supreme	$55 - 70	18650 replaceable	Yes	1.3″ OLED	-	Optional

Prices above are volatile and shown as of 2026-06-08.

MeshCore Compatibility Note

All five devices support Meshtastic (with the T1000-E LR1110 RX caveat noted above). For MeshCore, the **T-Deck Plus** and **T-Beam Supreme** are widely used and likely offer broad operating mode support - confirm specific modes against the MeshCore supported-hardware docs (docs.meshcore.io). Other devices may have limited mode availability - check the MeshCore compatibility list before purchasing if MeshCore is your primary firmware.

Apps & Software

Apps & Software

MeshCore App (Official)

Overview

The **MeshCore App** is the official companion application for MeshCore devices, developed by Liam Cottle, who builds the official MeshCore client apps. The MeshCore protocol itself was created by Scott (Ripple Radios / ripplebiz). It is the recognized standard for device setup across the CascadiaMesh and RegionMesh communities.

Platforms & Availability

- **iOS:** App Store (free)
- **Android:** Google Play (free)

Connection Methods

- BLE (primary - most common)
- USB serial

Features

- Direct messaging with end-to-end encryption (E2EE)
- Public channel messaging
- Node management and status monitoring
- Radio configuration (TX power, frequency, spreading factor)
- **Choose Preset wizard** - guided setup for USA/Canada regional presets
- Repeater administration (clock sync, stats, adverts)
- Room server administration

Required For

- Initial setup of any MeshCore companion device
- Setting the USA/Canada regional preset on a new node
- Configuring radio settings

Cost

Free. The app offers an optional **Premium** in-app purchase for cosmetic extras (e.g. ad removal, dark theme, and other personalization options); the core device-setup and administration features, including repeater and room server administration, are not paywalled. See MeshCore Open below for a fully open-source alternative.

Notes

This is the "official" app as recognized by the CascadiaMesh and RegionMesh communities. If you are setting up a MeshCore device for the first time, start here.

MeshCore Open (Free & Open Source)

Overview

MeshCore Open is a free, open-source companion app for MeshCore devices, developed by zjs81 and a community of contributors (25+ as of 2026-06-08) under the MIT license. It is not affiliated with the MeshCore core team but is widely used as a full-featured alternative - particularly for users who need offline maps, advanced CLI access, or multi-platform support without paywalls.

Project Stats

- **Source:** github.com/zjs81/meshcore-open
- **License:** MIT
- 383+ GitHub stars, 7 alpha releases (latest Alpha7, Mar 2026). Star and contributor counts are volatile - figures are as of 2026-06-08; see the GitHub repo for current numbers.

Platforms & Installation

Platform	Availability	Install Method
Android (API 21+)	Stable	APK from GitHub releases, or Obtainium for auto-updates
iOS (12+)	Beta	TestFlight (see TESTFLIGHT_GUIDE.md in the repo; confirm current distribution channel)
Linux	Stable	Prebuilt binaries on releases page
Windows	Supported	Flutter - check the releases page for a prebuilt binary; build from source if none is available

Platform	Availability	Install Method
macOS	Supported	Flutter - check the releases page for a prebuilt binary; build from source if none is available
Web (Chrome)	Beta	WebSocket bridge required

Connection Methods

- BLE
- USB
- TCP

Key Features vs. Official App

Feature	MeshCore Open	Official App
Repeater / room server CLI access	Full, no paywall	Some features paywalled
Offline maps	Yes (tile downloads, deep zoom)	No
MGRS coordinates	Yes	No
Path visualization / route management	Yes	No
Emoji reactions & threaded replies	Yes	No
Auto-retry with path clearing	Yes	No
TX power / radio settings control	Yes	Yes
SNR tracking per contact	Yes	Limited
3-level debug logging	Yes	No
Languages	15	1 - 2
Off-Grid Repeat mode	Yes	No
Platforms	Android, iOS, Linux, Win, Mac, Web	Android, iOS

Note: GPX export and explicit line-of-sight terrain analysis are not confirmed in the current MeshCore Open documentation as of 2026-06-08; the app provides path visualization and route management. Verify against the app's current feature list before relying on a specific capability.

Off-Grid Repeat Mode

Off-Grid Repeat is described as enabling a connected companion device to forward mesh packets while your phone is connected - turning a standard companion node into a temporary repeater without reflashing firmware. This named feature and its exact behavior are not confirmed in a primary source as of 2026-06-08; verify against the MeshCore Open documentation before relying on it for emergency communications.

How to Enable

1. Go to **Settings > Node Settings > Radio Settings** (menu path may differ in the current build - verify in-app)
2. Select an **Off-Grid preset**: Off-Grid 433 MHz, Off-Grid 869 MHz, or Off-Grid 918 MHz
3. Toggle **Off-Grid Repeat ON**

Region/legality warning: For unlicensed US/Canada use, choose the **918 MHz** preset (inside the 902-928 MHz Part 15 ISM band). The **433 MHz** preset falls in the US 70 cm amateur band (Part 97 license required, no encryption, station ID) and **869 MHz** is an EU SRD band (863-870 MHz) outside the US 902-928 MHz Part 15 band - neither is legal for unlicensed US operation. Operators must select the preset legal for their region.

Limitations

- Only 3 preset frequencies available (433, 869, 918 MHz) - these span three different regulatory regimes, so pick the band legal for your region (918 MHz for unlicensed US; 869 MHz is EU SRD; 433 MHz overlaps amateur allocations)
- Phone battery drains faster while active
- Phone must remain awake with the app open
- BLE/USB/TCP connection must stay active throughout

Use Cases

- Emergency response - instant temporary repeater anywhere
- Events - supplement fixed infrastructure
- Bootstrapping a new mesh area
- Temporary coverage extension

MeshOS (Standalone Device Firmware)

Overview

MeshOS is standalone device firmware for keyboard-equipped MeshCore devices, developed by Andy Kirby. (Note: Andy Kirby is the developer of MeshOS, not the founder of MeshCore - MeshCore was created by Scott of Ripple Radios. The MeshCore companion app is developed by Liam Cottle.) MeshOS is maintained at meshcore.co.uk, separate from the core team's canonical firmware at github.com/meshcore-dev/MeshCore.

MeshOS is purpose-built for T-Deck class devices and phone-independent operation.

Target Devices

- LilyGo T-Deck
- LilyGo T-Deck Plus
- LilyGo T-Lora Pager (T-Pager)

Pricing

- **Base features:** Free
- **Full license:** ~£8 one-time, tied to device serial number (as of 2026-06-08; price/availability via meshcore.co.uk)

Features

Feature	Free	Paid (£8)

Direct messaging with E2EE	Yes	Yes
Channel / group messaging	Yes	Yes
Repeater Scanner with whitelist management	Yes	Yes
Last Heard list (signal strength + distance)	Yes	Yes
Mesh Signal Meter	Yes	Yes
Noise Floor Monitor (live RF background graph)	Yes	Yes
Trace Route	Yes	Yes
QR code display for URLs	Yes	Yes
Lock screen (time, battery, mesh signal)	Yes	Yes
Terminal access with packet logging	Yes	Yes
Repeater Admin (clock sync, stats, adverts)	No	Yes
Offline world maps (T-Deck Plus only)	Limited zoom	Full zoom

When to Choose MeshOS

- You own a T-Deck or T-Deck Plus and want fully phone-independent operation
- You are a repeater operator who needs on-device diagnostics (Noise Floor Monitor, Trace Route, Repeater Admin)
- You want go-bag / emergency deployments with no phone dependency

When NOT to Choose MeshOS

- You need GPS-based maps but only have a standard T-Deck (not the Plus) - GPS is required for mapping features
- You need firmware for hardware outside the T-Deck family - use the core team firmware

Governance Note

MeshOS is Andy Kirby's separate firmware product, distributed via meshcore.co.uk; it is distinct from the canonical MeshCore firmware at github.com/meshcore-dev/MeshCore maintained by the

MeshCore core team (the project was founded by Scott of Ripple Radios). There has been a dispute between Andy Kirby and the MeshCore core team over direction and naming; both MeshOS and the core-team firmware are actively maintained choices. MeshOS is optimized for standalone keyboard devices; the core-team firmware covers the full hardware range and is the reference implementation for new device support.

Meshtastic App

Overview

The **Meshtastic App** is the official companion application for Meshtastic devices, developed and maintained by the Meshtastic open-source project (meshtastic.org). It is required for initial setup of any Meshtastic-firmware device.

Platforms & Availability

- **iOS:** App Store (free)
- **Android:** Google Play (free)
- **Web:** client.meshtastic.org - browser-based, connects via USB serial (Chrome/Edge)

Connection Methods

- BLE (most common for mobile)
- Wi-Fi (for nodes with Wi-Fi capability, e.g. ESP32 devices)
- USB serial (web app via Chrome/Edge)

Features

- Node list with signal, battery, and last-seen status
- Direct and channel messaging
- Map view with node positions
- Full device configuration: region, modem preset, channels, power settings
- Channel management (import/export via QR code or URL)
- Telemetry display (battery, environment sensors if equipped)
- MQTT configuration for internet backhaul

Required For

- All initial Meshtastic device setup
- Setting region (e.g. US, EU_868)
- Setting modem preset (LongFast, MediumSlow, etc.)
- Configuring channels and channel keys

Web App

The web app at **client.meshtastic.org** provides full configuration capability from a desktop browser via USB serial - useful when a mobile device is unavailable or when doing detailed configuration with a keyboard. Requires Chrome or Edge (WebSerial API).

Cost

Free and open source.

Hardware Comparison & Selection

Side-by-side board comparison table and use-case decision guide for LoRa mesh hardware.

Popular Board Comparison Table

Board Comparison Table

The table below covers the most widely deployed boards for LoRa mesh networking as of 2025 - 2026, across both Meshtastic and MeshCore platforms. All TX power figures are nominal maximum; actual radiated power depends on antenna gain and any regulatory caps applied in firmware.

Board	MCU	Radio	TX Power	RX Current	Sleep	Battery	GPS	Screen	Platform	Notes
T-Beam v1.1	ESP32	SX1262	22 dBm	~40 mA	~10 mA	18650 holder	NEO-6M	Optional OLED	Meshtastic / MeshCore	Classic all-in-one. AXP192 PMIC.
T-Beam Supreme	ESP32-S3	SX1262	22 dBm	~45 mA	~8 mA	18650 holder	MAX-M10S	Optional OLED	Meshtastic	Newer variant; better GPS. (The SX1268 is only the 433/470 MHz China sibling; US/915 MHz units use the SX1262.)

Board	MCU	Radio	TX Power	RX Current	Sleep	Battery	GPS	Screen	Platform	Notes
Heltec LoRa 32 V3	ESP32-S3	SX1262	22 dBm	~40 mA	~800 µA	JST LiPo	No	0.96" OLED	Meshtastic / MeshCore	Cheap, OLED display useful for debug. USB-C.
RAK4631	nRF52840	SX1262	22 dBm	~8 mA	~2 µA	JST LiPo	Optional RAK1910/1920	No (separate module)	Meshtastic / MeshCore	Modular WisBlock system. Best power efficiency for ESP32-free builds.
LilyGO T-Echo	nRF52840	SX1262	22 dBm	~8 mA	~12 µA	JST LiPo	L76K GNSS	1.54" ePaper	Meshtastic	Excellent battery life. ePaper shows info with no power draw. Popular for hiking.

Board	MCU	Radio	TX Power	RX Current	Sleep	Battery	GPS	Screen	Platform	Notes
Heltec T114	nRF52840	SX1262	21 dBm	~8 mA	~12 µA	JST LiPo	Optional	1.14" TFT	MeshCore primary	Heltec Mesh Node T114 (a Heltec product, not LILYGO). Pairs an nRF52840 with a bare SX1262 (no external PA), so TX tops out near the SX1262's ~21 dBm ceiling. nRF52840 efficiency makes it a common MeshCore repeater choice.
Seeed XIAO S3 + LoRa	ESP32-S3	SX1262	22 dBm	~40 mA	~14 µA	JST LiPo	No	No	Meshtastic / MeshCore	Tiny form factor. Good for compact builds.

Board	MCU	Radio	TX Power	RX Current	Sleep	Battery	GPS	Screen	Platform	Notes
ZebraHat 1W	ESP32	SX1262 +PA	30 dBm	~45 mA active	~10 mA	External	No	No	Meshtastic	1W transmitter. For mountain-top infrastructure where extra power matters. Requires heat management.

Board	MCU	Radio	TX Power	RX Current	Sleep	Battery	GPS	Screen	Platform	Notes
Ikoka 2W Module	-	SX1262 +PA	33 dBm	~80 mA TX	-	External	No	No	Meshtastic / MeshCore	External power amplifier add-on. 2W output. 33 dBm conducted exceeds the FCC Part 15.247 1 W (30 dBm) conducted limit, so it is NOT legal for unlicensed US operation; using it lawfully requires an amateur (Part 97) license, which prohibits encryption and requires station identification.

Per-Platform Notes

ESP32 Boards (T-Beam, Heltec LoRa 32)

Easy to source, wide support, larger community. Higher power consumption limits battery life. Built-in USB serial is convenient for development. Not ideal for solar-only deployments where current draw matters.

nRF52840 Boards (RAK4631, T-Echo, T114)

Dramatically lower power consumption. RAK4631 is modular - add sensors, GPS, cellular as needed. T-Echo has excellent all-in-one form factor with ePaper. Preferred for long-term battery or solar deployment.

High-Power Options (ZebraHat, Ikoka)

In the US, 902-928 MHz operation is limited by FCC Part 15.247 to 1 W (30 dBm) *conducted* output referenced to a ≤6 dBi antenna (with dB-for-dB reduction above 6 dBi). A 30 dBm board like the ZebraHat is at that ceiling; a 33 dBm module like the Ikoka exceeds it and is not legal for unlicensed Part 15 use. Higher TX power is not always better - it increases interference with nearby nodes and draws more power. Use only for specific long-range requirements after confirming conducted-power and antenna-gain compliance (or operating under an appropriate amateur license).

Board Selection by Use Case

Board Selection by Use Case

Use this guide to narrow down board options based on your deployment scenario. Every use case has a different set of priorities - power consumption, form factor, display needs, and software support all vary. Start with your primary use case and cross-reference the comparison table for spec details.

Personal Handheld / Hiking Node

Battery life and portability are the dominant concerns. You want GPS for position tracking and a display you can read outdoors.

- **Top pick: LilyGO T-Echo** - best battery life, ePaper screen doesn't drain battery, built-in GPS and nRF52840.
- **Budget pick: Heltec LoRa 32 V3** - cheap, OLED shows status, but its ESP32-S3 draws far more than an nRF52840. Real runtime depends entirely on the attached cell and OLED usage: with a small battery and the screen on, expect only a handful of hours (roughly 4-12 hours), stretching toward a day or two on a larger cell with the display dimmed.
- **Runner-up: RAK4631 WisBlock** - very low power, modular, but no screen.

Permanent Home Node (Window / Balcony)

Always-on, plugged in, no battery concern. Prioritize ease of setup and reliability over power efficiency.

- **Top pick: RAK4631** - plug into USB or small LiPo, stays on 24/7 on minimal power, no display needed.
- **Alternative: Heltec LoRa 32 V3** - fine on USB power since it's indoors and plugged in.
- **Not recommended: T-Beam** - bulkier, designed for mobile.

Solar-Powered Outdoor Repeater

Power budget is everything. The node must survive cloudy days on battery reserves. nRF52840 platforms are strongly preferred.

- **Top pick: Heltec T114 (MeshCore) or RAK4631 (Meshtastic)** - nRF52840 low power is essential. A small 5W panel can run these indefinitely.
- **Budget alternative: T-Beam with external LiFePO4 and proper charge controller** - works but needs a bigger panel due to ESP32 power draw.
- **High-power repeater: ZebraHat or Ikoka PA module** - for mountaintop/long-distance links, but requires larger solar/battery due to TX current draw. **Legal note:** 1 W (30 dBm) PA options sit at the FCC Part 15.247 conducted limit (and only with antennas ≤6 dBi; higher-gain antennas require a dB-for-dB conducted-power reduction). The Ikoka 2 W (33 dBm) variant *exceeds* the Part 15 conducted limit and is not legal for unlicensed US operation — it requires an amateur Part 97 license (no encryption, station identification). Confirm conducted power plus antenna gain against 47 CFR 15.247 before deploying.

Vehicle / Mobile

Reliable 12V power supply and physical durability matter more than ultra-low sleep current. Roof antenna mounting is a major range multiplier in this scenario.

- **Top pick: T-Beam v1.1 or Supreme** - tough, battery holder, can run from 12V car USB. The larger size is fine in a vehicle.
- **With external antenna:** use a T-Beam or Heltec with a magnetic-mount NMO antenna adapter. Roof antenna dramatically improves range over internal.

Fixed Infrastructure / Gateway with Internet

Internet backhaul lets your node bridge the mesh to MQTT or other services. The LoRa radio is a peripheral here; the compute platform matters more.

- **Top pick: Any board + Raspberry Pi** - use a cheap Heltec or T-Beam as the LoRa radio connected to a Pi Zero 2W running Meshtastic or MeshCore gateway software.
- **All-in-one option: T-Beam with WiFi enabled** - running Meshtastic's built-in MQTT client (no Pi needed for simple setups).

Developer / Experimenter

GPIO availability, modular expansion, and good toolchain documentation are the priorities. You're likely to change the hardware configuration frequently.

- **Top pick: RAK WisBlock** - modular system lets you add/remove GPS, sensors, displays. Clean Arduino/PlatformIO support. Good documentation.
- **Alternative: T-Beam Supreme** - ESP32-S3, more GPIO, good for prototyping.

T-Deck as a Standalone Communicator

T-Deck as a Standalone Communicator

The LILYGO T-Deck is one of the most distinctive devices in the mesh radio ecosystem. Unlike the vast majority of mesh nodes, which function as radio bridges and depend on a paired smartphone for any human interface, the T-Deck is a fully self-contained communicator. It integrates an ESP32-S3 microcontroller, an SX1262 LoRa radio, a 2.8" 320x240 colour IPS display, a miniature QWERTY keyboard, and a trackball pointer into a single handheld package roughly the size of a vintage BlackBerry.

Hardware Overview

- **MCU:** ESP32-S3 dual-core at 240 MHz, 16 MB flash, 8 MB PSRAM
- **Radio:** SX1262 -- required for MeshCore; also works with Meshtastic
- **Display:** 2.8" 320x240 IPS TFT (commonly reported as an ST7789-class controller), readable in mixed lighting
- **Input:** integrated QWERTY chiclet keyboard (managed by a secondary ESP32-C3) plus a mini trackball
- **Battery:** the base T-Deck ships with no battery -- it has an onboard LiPo charge circuit and a JST connector, but you must supply your own cell. Only the T-Deck Plus includes a built-in battery (2,000 mAh). Runtime depends on the cell fitted and on whether the device is actively transmitting or passively listening.
- **GPS:** no GPS on the base mainboard; the T-Deck Plus adds an onboard GPS, and on the base unit an optional GPS module can be added via the expansion header -- recommended for mobile deployments

Firmware Options

MeshCore T-Deck build is the most feature-complete option for operators who want a phone-free experience. The firmware ships with a dedicated T-Deck UI that uses the keyboard for direct message composition, a scrollable node list, and channel/frequency selection via the trackball. Refer to the current MeshCore T-Deck documentation for the exact key bindings, as these change between firmware releases.

Meshtastic also runs on the T-Deck and takes advantage of the keyboard for text input. The Meshtastic UI is somewhat simpler but familiar to operators already embedded in the Meshtastic ecosystem.

Use Cases

The T-Deck shines in scenarios where carrying and depending on a personal smartphone is undesirable or impractical:

- **Emergency Operations Centre (EOC) operator:** An EOC station can run on a T-Deck permanently plugged into USB power, avoiding the privacy and policy concerns of using a personal phone on an official channel.
- **Search and Rescue (SAR) command post:** A command post T-Deck provides a dedicated mesh terminal that field teams can talk to without requiring any app install or Bluetooth pairing on their end.
- **Fixed infrastructure station:** Repeater sites or unattended relay nodes can pair a T-Deck as a local diagnostic terminal -- check node health, send test messages, or update configs without needing a laptop.

Limitations

- **Size and weight:** At roughly 130 x 75 x 20 mm and approximately 200 g with battery, it is heavier and bulkier than a T-Beam or RAK module. Not ideal for belt-carry on long hikes.
- **No built-in GPS (base unit):** On the base T-Deck the optional GPS module must be purchased and installed separately, adding cost and complexity. Without it (or without a T-Deck Plus), the device cannot broadcast its own position.
- **Screen resolution:** The 320x240 display, while colour and readable, is constrained. Long messages wrap to many lines and require scrolling; dense node lists can feel cramped. Operators relying on the T-Deck for heavy text work should set shorter message conventions.

Overall, the T-Deck is one of the most operator-friendly devices for anyone who wants a true standalone mesh communicator. Its keyboard and display combination removes the smartphone dependency that most nodes carry, making it a compelling choice for fixed stations, EOC deployments, and SAR command posts.

nRF52840 vs ESP32: Architecture Comparison for Mesh Operators

nRF52840 vs ESP32: Architecture Comparison for Mesh Operators

When selecting hardware for a mesh deployment, the choice of microcontroller architecture is often the single most consequential decision you will make. Two families dominate the mesh radio space: Nordic Semiconductor's nRF52840 and Espressif's ESP32 line. Each makes very different trade-offs, and understanding them will inform whether you reach for a RAK4631 or a T-Beam.

nRF52840 -- The Power-Sipping Workhorse

Attribute	Value
Core	ARM Cortex-M4F at 64 MHz (single core)
Flash	1 MB internal
RAM	256 KB SRAM
Radio	Bluetooth 5 / 802.15.4 (Thread, Zigbee) / ANT / 2.4 GHz proprietary -- no WiFi
Operating voltage	1.7-5.5 V native; 3.3-3.7 V typical
Deep-sleep current	approximately 0.5 uA (System OFF), approximately 2 uA (System ON)
Hardware AES	Yes -- AES-128/256 in hardware

The nRF52840's headline feature is its power envelope. A node built around this chip, such as the RAK4631 WisBlock or the Heltec Mesh Node T114, can run for weeks or months on a modest LiPo battery or small solar panel. The integrated hardware AES engine handles Meshtastic/MeshCore

packet encryption without burning CPU cycles.

ESP32 -- The Feature-Rich Generalist

Attribute	Value
Core	Dual-core Xtensa LX6/LX7 at 240 MHz
Flash	4-16 MB (external)
RAM	520 KB SRAM (original ESP32) / 512 KB SRAM (ESP32-S3), plus optional PSRAM
Radio	WiFi 802.11 b/g/n plus BLE 4.2/5.0
Operating voltage	3.3 V (LDO required from LiPo)
Minimum sleep current	10-20 mA (WiFi stack overhead; modem-sleep)

The ESP32's dual-core design and WiFi radio make it vastly more capable at network-layer tasks. It can run an MQTT broker client to bridge LoRa packets to the internet, host a local web configuration interface, and handle more complex packet routing logic -- the WiFi bridging and web-portal tasks in particular are out of reach for the nRF52840, which lacks WiFi entirely.

Power Budget Implications

In solar or battery-only deployments where average current draw matters more than peak performance, the nRF52840 wins decisively. As an approximate, configuration-dependent figure, a typical RAK4631 deployment draws on the order of 5-8 mA average in active receive mode. A T-Beam (ESP32 + always-on GPS + LoRa RX) in the same role draws roughly 40-80 mA average, with the GPS module a large contributor to that current. These are board-level estimates, not chip specs, and vary with duty cycle and configuration. At 100 mAh of daily budget (a small 2W panel in winter), that difference means the RAK4631 runs indefinitely while the T-Beam is power-constrained.

Firmware Support Matrix

- **Meshtastic:** supports both nRF52840 (RAK4631, T114) and ESP32 (T-Beam, Heltec, T3-S3)
- **MeshCore:** supports nRF52840 (RAK4631, T114) and ESP32-S3 (T-Deck, T3-S3); does not support the original ESP32

Decision Framework

- Need WiFi for MQTT internet bridging? -- **ESP32 required**

- Need a web-based config portal? -- **ESP32 required**
- Deploying a solar or battery node for months unattended? -- **nRF52840 strongly preferred**
- Running at a fixed AC-powered location with internet access? -- Either works; ESP32 adds more flexibility
- Maximising range per milliwatt? -- Both chips drive the SX1262 identically; chip choice does not affect RF performance

Buyer's Guide by Use Case

Opinionated hardware recommendations for every scenario: beginner nodes, portable handheld, fixed repeaters, and room server gateways.

Buyer's Guide by Use Case

Best Hardware for Beginners

Choosing your first LoRa mesh node is one of the most important decisions you will make as a new mesh networking enthusiast. The wrong board can mean weeks of frustration with driver problems, dead-on-arrival USB chips, or - most painfully - discovering that your freshly flashed device operates on 868 MHz and cannot talk to any of the 915 MHz nodes in your region. This guide cuts through the noise.

Top Recommended Boards for First-Time Buyers

Board	MCU	Radio	Screen	GPS	Approx Price (USD)	Best For
LilyGO T-Beam Supreme	ESP32-S3	SX1262	Yes (1.3" OLED, built-in)	Yes (u-blox MAX-M10S / NEO-M10S)	$30 - $40 (as of 2026-06-08)	Best all-rounder first node
Heltec WiFi LoRa 32 V3	ESP32-S3	SX1262	Yes (0.96" OLED)	No	$18 - $24 (as of 2026-06-08)	Budget-friendly first node
RAK WisBlock Starter Kit	nRF52840	SX1262 (RAK4631)	No (optional add-on)	Optional module	$35 - $50 (as of 2026-06-08)	Low-power & modular builds

First Choice: LilyGO T-Beam Supreme

The **T-Beam Supreme** (based on ESP32-S3 + SX1262) is the most complete out-of-the-box experience for a beginner. It includes:

- Integrated GPS (u-blox MAX-M10S / NEO-M10S - significantly better than the older NEO-6M in earlier T-Beams)
- Built-in 1.3" OLED display

- 18650 battery holder with integrated charge/BMS circuit and USB-C charging
- SMA antenna connector - you can immediately attach any standard 915 MHz antenna
- Full Meshtastic and MeshCore firmware support
- Active community support and extensive documentation

You will need to supply an 18650 cell (any protected 18650 works; Samsung 30Q and Sanyo NCR18650GA are popular choices) and a 915 MHz antenna.

Budget Pick: Heltec WiFi LoRa 32 V3

The **Heltec V3** is the cheapest reliable entry point. Its on-board 0.96" OLED display gives you immediate feedback without needing a phone. The V3 has a U.FL/IPEX LoRa connector and ships with a small whip antenna; for any real deployment, use a proper outdoor 915 MHz antenna via a U.FL-to-SMA pigtail. (Note: the small spring antenna on the board is for WiFi/Bluetooth only, not LoRa.) The V3 uses the SX1262 radio (a significant upgrade over the V1/V2 SX1276) and the ESP32-S3 MCU.

Caution: The Heltec V3 uses a CP2102 USB-serial chip. If the device is not recognized on Windows, install the Silicon Labs CP210x VCP driver.

Modular Pick: RAK WisBlock Starter Kit

The **RAK WisBlock Starter Kit** pairs the RAK19007 base board with the RAK4631 core module. This gives you an nRF52840 MCU and SX1262 radio. The modular system means you can add GPS, sensors, displays, and other peripherals by plugging in additional WisBlock modules. Battery life is dramatically better than ESP32 boards - see the Fixed Repeater page for power draw numbers. The tradeoff is that it has no built-in display and the ecosystem requires slightly more research to assemble.

What to Avoid as a Beginner

Board / Issue	Why to Avoid for Beginners

T-Beam v1.1 (older revisions)	Uses SX1276 radio (slightly lower RX current/sensitivity margins than SX1262), older GPS module, USB issues
Heltec V1 / V2	SX1276 radio; less active firmware support. (Some users also report OLED reliability complaints on these older revisions.)
No-name "LoRa32" clones from AliExpress	Often fake SX1278 chips, wrong frequency band (see below), poor QC
TTGO LoRa32 V1	SX1276 chip; an older board with comparatively limited current community support (as of 2026-06-08)
Any board labeled "433 MHz" or "868 MHz"	Wrong band for North America - will not communicate with 915 MHz network

Where to Buy Reliably

Official / Recommended Sources

- **LilyGO official store** on AliExpress - LilyGO operates a verified flagship store; this is safe
- **RAK Wireless official store** (store.rakwireless.com) - direct from manufacturer
- **Heltec official store** on AliExpress - Heltec's own storefront is reliable
- **Rokland.com** - US-based reseller carrying T-Beams, Heltec, and antennas; faster US shipping
- **Amazon** - only buy from the brand's own Amazon storefront (e.g., "Sold by LilyGO"), not third-party resellers

AliExpress Cautions

- AliExpress is fine when buying from verified brand storefronts (LilyGO, Heltec, RAK). Generic sellers on AliExpress frequently sell 868 MHz boards to US buyers, misrepresent chip versions, or ship counterfeit radios.
- Always confirm the frequency band in the product title or description before purchasing. Look for "915M" or "915MHz" explicitly - not just "LoRa".
- Check seller feedback specifically mentioning "915" and "US shipping".

Understanding "915 MHz": What It Means and How to Verify

LoRa radios operate in license-free ISM (Industrial, Scientific, and Medical) frequency bands. The correct band depends on where you are:

Region	Correct Band	Notes
United States, Canada, Mexico, Brazil	**902 - 928 MHz** (commonly "915 MHz")	FCC Part 15 (US), ISED RSS-210 (Canada), IFT (Mexico), ANATEL (Brazil). Meshtastic BR_902 covers 902.0 - 907.5 MHz in Brazil.
European Union, UK, Switzerland	**868 MHz**	ETSI EN 300 220, 863 - 870 MHz
Japan	**920 - 923 MHz** (AS923)	ARIB STD-T108 (920 MHz band) - not 433 MHz
China	**470 - 510 MHz** (CN470) / 779 - 787 MHz	Not 433 MHz for mesh use
433 MHz (various regions)	**433 MHz**	A separate low-power ISM option used in some regions; different antenna requirements entirely
Australia, New Zealand	**915 MHz**	Same band as North America

How to Verify Before Buying

1. **Product title:** Should explicitly say "915MHz" or "915M". "868MHz" or "433MHz" means it will NOT work on the US network.
2. **Hardware marking:** Once received, look at the SX1262 module's silkscreen or the PCB itself. Most modules have a small label or PCB trace indicating the matching network (e.g., "915" on the antenna matching network).
3. **Firmware check:** When flashing Meshtastic, select the correct region during setup (US/AU for 915 MHz). If the firmware was previously flashed, check the region in Meshtastic app under Radio Config → LoRa → Region.
4. **SX1262 vs SX1276 note:** The SX1262 chip itself is wideband and can be tuned to any frequency in software - the limiting factor is the matching network and antenna on the board, which is fixed at manufacture time. Buying the wrong frequency band is a hardware problem, not a software one.

First Node Checklist

- Board verified as 915 MHz band
- 915 MHz antenna - at minimum a simple whip; ideally a tuned 915 MHz fiberglass antenna
- USB-C cable (data-capable, not charge-only) for flashing firmware
- 18650 cell if using T-Beam (or LiPo battery if using WisBlock)
- Meshtastic or MeshCore firmware downloaded for your specific board variant
- Meshtastic app (Android/iOS) or serial terminal to configure the device

Best Hardware for Portable and Handheld Use

A portable LoRa mesh node needs to fit in your pocket, run for a full day on battery, display incoming messages without requiring your phone, and work reliably in the field. This page compares the top portable options and helps you match hardware to your specific use case.

Comparison Table: Top Portable Nodes

Device	MCU	Display	GPS	Antenna	Battery Life*	Weight	Price (USD)
LilyGO T-Echo	nRF52840	1.54" e-ink	Yes (L76K)	U.FL/IPEX (verify) + stub antenna	**5 - 7 days**	~38g w/ battery + case	$40 - $55 (as of 2026-06-08)
LilyGO T-Beam Supreme	ESP32-S3	Optional OLED	Yes (u-blox MAX-M10S)	External SMA	1 - 2 days	~55g w/battery	$30 - $40 (as of 2026-06-08)
Heltec WiFi LoRa 32 V3	ESP32-S3	0.96" OLED	No	U.FL (LoRa) + spring antenna (WiFi/BT)	4 - 12 hours	~9g (bare board)	$18 - $24 (as of 2026-06-08)
RAK WisBlock + RAK1910 GPS	nRF52840	Optional	Yes (optional module)	External via IPEX/SMA	3 - 5 days	~30g base	$45 - $65 (as of 2026-06-08)

**Battery life estimates assume standard mesh operation with the screen used as needed and no continuous GPS fix unless noted. Actual runtime depends on each device's own battery capacity (e.g. the T-Echo's built-in ~850 mAh cell vs. an external 18650 on the Heltec/RAK boards), so treat these as rough comparisons rather than absolute figures.*

Note: the Station G2 was previously listed here but has been removed. It is an ESP32-S3 high-power base station (SX1262 + power amplifier, SMA, USB-C PD), not an nRF52840 portable handheld, so it does not belong in a pocket-carry comparison.

Top Pick for Portable Use: LilyGO T-Echo

The **T-Echo** is the best portable LoRa mesh device available today. Its advantages are significant and not easily replicated by other boards:

E-Ink Display: The Killer Feature

The 1.54-inch e-ink display is bistable, so the panel itself draws near-zero current while showing a static message and only consumes power when it refreshes. (The rest of the device - MCU and radio - still draws current, so total device draw is not near-zero.) Compare the panel to the Heltec's OLED, which draws roughly 20 - 30 mA (approximate; content- and brightness-dependent) whenever the screen is on. In a field scenario where you glance at the device every few minutes, the e-ink display's power savings are meaningful. The display also remains readable in direct sunlight - an OLED is almost unreadable outdoors in bright conditions.

Integrated GPS

The T-Echo includes a Quectel L76K GPS module, giving it position reporting for mesh mapping and position-sharing features. The GNSS antenna is integrated within the device housing - no external GPS patch antenna required. Cold start is typically on the order of 45 - 90 seconds outdoors with a clear sky view (a typical observed range; actual time-to-first-fix depends on almanac state and sky view).

Battery Life

Powered by a built-in 3.7V LiPo (~850 mAh, not designed for user removal) and running on the nRF52840's ultra-low-power sleep modes, the T-Echo achieves several days of real-world field use. This is several times longer than equivalent ESP32-based boards, whose deep-sleep current is far higher than the nRF52840's (sub-microamp-class sleep). See the Fixed Repeater page for a detailed power-draw breakdown.

Antenna Connector

The T-Echo ships with a stub antenna tuned for either 868 MHz or 915 MHz (verify your purchase). Sources conflict on the connector type across hardware revisions - it is most commonly a U.FL/IPEX connector rather than a full SMA, so verify against the LilyGO product page/board photos for the revision you buy before ordering an antenna or pigtail. Either way the antenna is replaceable, and you can fit a higher-gain antenna for improved range when needed. This is better than relying on a bare PCB-trace antenna.

Heltec V3 for Ultra-Compact Use

If extreme compactness is the priority and battery life is less critical (for example, a day-hike where you will charge each night), the **Heltec WiFi LoRa 32 V3** is one of the most pocketable options. The bare board is tiny (52 x 26 x 10 mm, ~9g) and fits an Altoids-tin footprint; it has no on-board 18650 holder, so running on a single 18650 requires an external holder and wiring. The OLED display is small but readable indoors. The primary limitations are battery life and the inadequate on-board antenna for serious outdoor use.

Enhancement tip: The Heltec V3 has a U.FL connector for the LoRa radio (the spring antenna on the board is for WiFi/BT only). Adding a U.FL-to-SMA pigtail and a proper 915 MHz antenna can significantly improve effective range.

Phone-as-Display Option

Many users prefer running a headless node (no display on the hardware) and connecting via BLE to the Meshtastic or MeshCore app on their phone. This approach has real advantages:

- Larger, more readable screen
- Full message history and thread view
- Map view with other node positions
- Notification push even when the app is in background (Android)

Boards suitable for phone-as-display use - all three expose BLE for phone pairing: RAK WisBlock with RAK4631 (nRF52840, BLE built in), T-Beam Supreme (ESP32-S3, BLE), and Heltec V3 (ESP32-S3, BLE). The phone approach works well when hiking with a phone anyway - the node can be clipped to a pack strap while the phone stays in a pocket.

Practical Use Case Recommendations

Scenario	Best Choice	Why
Multi-day backpacking trip	T-Echo	5 - 7 day battery, sunlight-readable display, GPS built in
Day hikes / weekend trips	T-Beam Supreme or T-Echo	T-Beam for GPS accuracy; T-Echo for battery
Urban carry (city EDC)	Heltec V3 or T-Echo	Heltec is smallest; T-Echo for longer between charges
SAR / emergency comms team	T-Echo	Reliable multi-day battery, no charging anxiety in the field
Tech-forward user, always has phone	RAK WisBlock (headless)	Best battery life, modular, phone app provides UI
Fixed portable (camping base camp)	T-Beam Supreme	Best GPS, good display options, widely documented

Accessories Worth Having

- **915 MHz stubby antenna:** Often better than a generic included whip on devices with a poor stock antenna. Stubby antennas are typically low-gain (around 0 - 2 dBi), so don't expect a large range boost. Compact options include the Taoglas FXP73 or a Molex flexible 915 MHz antenna (confirm 915 MHz coverage and that the gain figure is for your mounting - FXP-series gain is mounting-dependent).
- **Weatherproof case:** LilyGO sells an optional case for the T-Echo. Pelican 1010 micro cases work well for T-Beam.
- **Carabiner clip:** Attach to pack strap for hands-free carry.
- **External battery for 18650-based boards:** On boards like the Heltec V3 that take an external cell, a higher-capacity 18650 or LiPo extends runtime. (The T-Echo's battery is internal and not designed for user replacement, so plan to charge it via USB rather than swap cells.)

Best Hardware for Fixed Repeaters

A fixed repeater node has one job: forward mesh packets reliably, indefinitely, with as little power consumption as possible. This page covers the hardware decisions that matter most for solar-powered or battery-backed repeater deployments.

The Core Decision: nRF52840 vs ESP32

For repeater use, the MCU platform is the single most important hardware choice. The nRF52840 (used in the RAK4631 and T-Echo) consumes roughly **3 orders of magnitude less sleep power** than the ESP32-S3, which is the state a repeater spends most of its time in. (Note: the Station G2 is an ESP32-S3 high-power base station, not an nRF52840 board - it is covered separately under base stations, not here.)

Power Draw Comparison by Board (Repeater Mode)

The figures below are **estimates**, not manufacturer-datasheet power tables. They assume a 5% active duty cycle and typical regulator/peripheral quiescent draw; real-world results vary with baseboard, firmware, mesh traffic, and radio settings. Datasheet anchor points are cited where available.

Board	MCU	Active Current (mA)	Sleep Current (mA)	Avg Draw @ 1 tx/min (mA)	18650 Runtime (hrs)*
RAK4631 (WisBlock)	nRF52840	~15 (RX; datasheet RX ~17, TX ~125 at 20 dBm)	**0.002** (module datasheet 2.0 µA; higher on a populated baseboard)	**~2.5** (est.)	**~800+** (est.)

Board	MCU	Active Current (mA)	Sleep Current (mA)	Avg Draw @ 1 tx/min (mA)	18650 Runtime (hrs)*
T-Echo	nRF52840	~18 (est.)	~0.012 (est.; LILYGO publishes no power table)	~3.0 (est.)	~660 (est.)
T-Beam Supreme	ESP32-S3	~80 - 120 (est.; GPS + PMIC dominate)	~1.0 - 2.5 (est.)	~12 - 18 (est.)	~110 - 165 (est.)
Heltec WiFi LoRa 32 V3	ESP32-S3	~70 - 100 (est.)	~1.5 - 3.0 (est.; regulator/OLED leakage)	~14 - 20 (est.)	~100 - 140 (est.)
ESP32 generic LoRa	ESP32	~100 - 160 (est.; varies by regulator)	~2.0 - 5.0 (est.)	~18 - 28 (est.)	~70 - 110 (est.)

**18650 capacity assumed at 2500 mAh (a conservative, realistic usable-capacity planning figure; cells are commonly 2500-3500 mAh). Active time assumed at 5% duty cycle. Runtime values are derived estimates, not datasheet specs - real-world results will vary based on mesh traffic, firmware version, and radio settings. (The Station G2 is omitted from this repeater table: it is an ESP32-S3 mains/PD-powered high-power base station, not a low-power solar-repeater candidate.)*

Gold Standard: RAK4631 (RAK WisBlock)

The **RAK4631** is the best board available for fixed repeater deployments. Its key advantages for repeater use:

- **2.0 µA module sleep current (datasheet)** - the radio and MCU together draw less than most voltage regulators leak; expect somewhat higher on a populated baseboard due to the baseboard regulator's quiescent current
- **Modular design** - base board, core module, and optional IO modules are separate. The base board includes the battery management and charging circuit; you supply the battery.
- **Industrial temperature range:** -40°C to +85°C. (Standard ESP32 / ESP32-S3 parts are also rated -40°C to +85°C, so the MCU silicon is not the limiting factor; in practice the LiPo battery - typically rated ~0°C to +45°C for charging - sets the real-world thermal envelope for either platform.)
- **SX1262 radio** with excellent receiver sensitivity: ~-137 dBm at SF12 / 125 kHz bandwidth (the headline -148 dBm figure applies only at the narrowest bandwidth, not BW125)

- **Hardware cryptographic acceleration** via the Arm TrustZone CryptoCell-310 accelerator - useful for secure mesh deployments. (Note: this is a crypto accelerator, not Cortex-M33 TrustZone-M memory isolation; the nRF52840 is a Cortex-M4F.)
- **Excellent Meshtastic and MeshCore support** - actively maintained firmware targets

RAK WisBlock Solar Repeater BOM

All prices below are approximate commodity / store prices as of 2026-06-08 and are volatile; verify against the RAK store and vendor listings before ordering. Present the total as an estimate range, not a fixed quote.

Component	Part	Est. Cost (as of 2026-06-08)
Core module	RAK4631 (nRF52840 + SX1262)	~$25 - $30 (verify RAK store; often listed near $25-30)
Base board	RAK19007 ($9.99) or RAK19003 (mini)	$10 - $18 (verify RAK store SKUs)
Solar charge module	CN3791-based MPPT board (verify the correct RAK solar SKU - RAK12007 is a WisBlock sensor module, not a solar charger)	$8 - $15
LiPo battery	3.7V 3000 - 5000 mAh flat pack	$8 - $15
Solar panel	5V 1W - 2W panel (60mm × 110mm typical; size for worst-case winter insolation)	$5 - $12
Antenna	915 MHz fiberglass or tuned whip	$8 - $25
Enclosure	IP67 ABS box (100×68×50mm)	$6 - $12 (approximate commodity price)
Total		**~$70 - $125 (estimate range, as of 2026-06-08)**

Alternative: T-Echo as a Repeater

The **T-Echo** makes an excellent fixed repeater when you want a complete ready-to-flash unit without assembly. It uses the same nRF52840 platform as the RAK4631 and achieves similar sleep power. Tradeoffs versus the WisBlock approach:

- The T-Echo includes a 1.54" e-paper display (useful for diagnostics; wastes a tiny amount of power even off)
- Battery capacity is limited to the small internal flat LiPo (the bundled cell is commonly cited around ~850 mAh and is not user-removable; an optional ~2400 mAh expansion accessory exists), vs the large external packs usable with WisBlock. Verify the bundled

cell capacity against the current LILYGO listing.
- GPS can be disabled in firmware to save the current the Quectel L76K draws when active (~10 mA active; see the L76K datasheet) - important for pure repeater duty
- The antenna uses a U.FL/IPEX connector (sources conflict on SMA vs U.FL - verify against your unit) and is easily replaced with a higher-gain antenna for elevated installs

Why Not Just Use an ESP32 Board?

ESP32 boards like the T-Beam Supreme are perfectly capable of repeater duty with AC power (plugged in). If you have mains power at the repeater site, the ESP32's higher power draw is irrelevant and its better WiFi connectivity can be useful for firmware OTA updates and gateway bridging. However:

- A solar system sized for an ESP32 repeater costs 3 - 4x more than one for a WisBlock, because the panel and battery must be larger
- For a given small panel/battery, an ESP32 repeater is more likely to run out of charge in cloudy or short-day conditions than an nRF52840 system. (A properly sized ESP32 system can survive winter, and an undersized nRF52840 one can fail - the deciding variable is panel/battery sizing, not the MCU alone.)
- The practical indoor/mains-powered exception: T-Beam Supreme repeaters work well in building deployments where power is available and WiFi/BLE features are useful

Antenna Recommendations for Fixed Repeaters

A fixed repeater benefits more from antenna quality than almost any other hardware upgrade. Typical improvements from the standard rubber duck to a quality fiberglass antenna range from +3 dB to +6 dB gain, which roughly doubles to quadruples effective range in ideal (free-space) conditions. In real-world obstructed paths (path-loss exponent ~2.7-4) the improvement is typically less.

Antenna Type	Gain	Use Case	Notes
Rubber duck (included)	1 - 2 dBi (nominal)	Basic testing only	Adequate for indoor, room-scale use
Tuned whip (λ/4 over a ground plane)	~5.15 dBi ideal (2 - 5 dBi real-world)	Outdoor mounted, no cable run	DIY option; cheap and effective. (Note: ~2.15 dBi is the half-wave dipole figure, not the monopole-over-groundplane value.)

Antenna Type	Gain	Use Case	Notes
Fiberglass 3 dBi (e.g., Taoglas OMB.8912 - verify band/gain on datasheet)	3 dBi	Pole-mounted outdoor repeater	Good all-around choice
Fiberglass 5 - 6 dBi collinear (verify example part against datasheet - the Linx ANT-916-CW-RCS is a near-unity-gain quarter-wave whip and does not match this 5-6 dBi class)	5 - 6 dBi	Hilltop / elevated repeater	Narrower vertical beam; best at elevation
Yagi directional (verify gain on datasheet)	10 - 14 dBi	Point-to-point links	Only useful for specific directional paths

FCC note: Antennas above 6 dBi gain require reducing conducted power dB-for-dB under FCC Part 15.247(b)(4) (subject to the fixed point-to-point provisions of 15.247(c)). Plan your link budget as EIRP = conducted power + antenna gain - feedline loss, and keep within the applicable limits for your operating authority.

Understanding LoRa Hardware

Deep-dive technical reference on MCU platforms, frequency bands, antenna types, and GPS integration for LoRa mesh nodes.

ESP32 vs nRF52840: Which Platform?

Two microcontroller platforms dominate the LoRa mesh hardware landscape: Espressif's **ESP32** family and Nordic Semiconductor's **nRF52840**. Both are capable, both are well-supported by Meshtastic and MeshCore firmware, and both commonly pair with the SX1262 (and related Semtech LoRa transceivers such as the SX1276/SX1268/LLCC68). But they are optimized for fundamentally different use cases, and choosing the wrong one has real consequences.

Platform Comparison at a Glance

Feature	ESP32 / ESP32-S3	nRF52840
Manufacturer	Espressif Systems	Nordic Semiconductor
CPU cores	Dual-core Xtensa LX6/LX7 (ESP32-S3)	Single-core ARM Cortex-M4F
CPU speed	240 MHz	64 MHz
RAM	512 KB SRAM on ESP32-S3 (classic ESP32 has 520 KB); + external PSRAM on some boards	256 KB SRAM
Flash	Typically 4 - 16 MB (external)	1 MB internal (+ optional external)
WiFi	**Yes (2.4 GHz 802.11 b/g/n)**	No
Bluetooth	BLE 5.0	BLE 5.0 + Bluetooth Mesh
Active current (typical, approximate)	80 - 240 mA	10 - 20 mA
Deep sleep current	10 - 150 µA (varies by variant)	**~0.4 µA (System OFF, no RAM retention) up to ~8 µA (with RAM retention / wake sources)**
Supply voltage	3.0 - 3.6V	1.7 - 5.5V (natively tolerant)
Operating temp range	-40°C to +85°C	-40°C to +85°C
Hardware crypto	AES accelerator, SHA accelerator	CryptoCell-310 crypto accelerator (not Cortex-M33 TrustZone-M)
USB native	Yes (ESP32-S3, -S2, -C3)	Yes

Figures above are approximate typical ranges, not single datasheet values; cite per-mode datasheet figures where precision matters. Per Nordic, the nRF52840 draws ~4.8 mA peak in TX (0 dBm), ~4.6 mA peak in RX, and ~52 µA/MHz running from flash; its System OFF floor is ~0.4 µA (no RAM retention) and ~1.5 µA in System ON with wake-on-RTC. The ESP32-S3 and nRF52840 are both rated -40 to +85 °C per their respective datasheets.

Power Consumption: The Real Numbers

For battery-powered mesh nodes, power consumption is frequently the deciding factor. Here are approximate figures for a LoRa mesh node in active listening mode (radio on, MCU active, no WiFi). Exact values depend heavily on board design and firmware sleep strategy:

Condition	ESP32-S3	nRF52840	Factor Difference
Active (CPU + radio RX)	80 - 120 mA	15 - 20 mA	nRF52840 uses ~5 - 6x less
Light sleep (radio on)	2 - 5 mA (approx., firmware-dependent)	0.5 - 1 mA (approx., firmware-dependent)	nRF52840 uses ~4x less
Deep sleep (radio off)	10 - 100 µA	~0.4 - 8 µA	nRF52840 uses ~10 - 50x less
Transmit (100 mW / +20 dBm)	~120 - 160 mA peak	~120 - 150 mA peak	Similar (dominated by SX1262 PA current)

Note on transmit current: LoRa TX draw is dominated by the SX1262 power amplifier, which draws ~118 mA at +22 dBm and ~45 mA at +14 dBm per the Semtech datasheet (the RAK4631 module measures ~125 mA at +20 dBm). With MCU overhead, a node transmitting at +20-22 dBm draws roughly 120-160 mA total — not the 350-500 mA sometimes quoted, which reflect WiFi TX bursts rather than LoRa.

Practical implication (illustrative estimate): A node that spends 95% of its time in light sleep will consume roughly 3 - 5 mA on ESP32-S3 vs 0.6 - 1 mA on nRF52840. On a 2000 mAh 18650 cell, that is approximately:

- ESP32-S3: ~400 - 650 hours (~17 - 27 days)
- nRF52840: ~2000 - 3300 hours (~83 - 137 days)

This 4 - 5x difference is why nRF52840 is the correct choice for battery-powered or solar nodes, and the ESP32 is acceptable only when AC power is available.

Sleep Modes Explained

ESP32 Sleep Modes

- **Active:** Full operation, both cores running, radio on
- **Modem sleep:** WiFi/BT radio off, CPU running - not useful for mesh nodes since the LoRa radio is external
- **Light sleep:** CPUs paused, memory retained, peripheral clocks gated. ~0.8 mA total system is achievable (board/firmware dependent) for an ESP32-S3 with the LoRa radio in sleep
- **Deep sleep:** Most of chip off, only RTC domain active. ~10 - 150 µA depending on which RTC peripherals/ULP are enabled
- **Minimal deep sleep (RTC timer only):** ~5 µA but loses non-RTC GPIO state. This is the lowest-current deep-sleep configuration rather than a separately named mode

Key limitation: the ESP32's sleep modes interact poorly with external peripherals. Bringing WiFi up from deep sleep takes 200 - 400 ms - during which messages can be missed.

nRF52840 Sleep Modes

- **System On (active):** Full operation, up to 64 MHz CPU
- **System On (idle):** CPU halted, peripherals running - ~1 - 3 mA (config-dependent)
- **System On (low power):** Aggressive clock gating via automated low-current modes - ~0.5 - 1 mA (config-dependent)
- **System Off:** Only GPIO wakeup retained - ~0.4 µA with no RAM retention, rising to ~1.5 - 2 µA with RAM retention / wake sources enabled

The nRF52840's architecture allows the BLE radio and application code to be active simultaneously in time-division, with very efficient power management built into the SoftDevice BLE stack.

WiFi: ESP32's Biggest Advantage

The ESP32's integrated 802.11 WiFi is a genuine capability that the nRF52840 lacks entirely. This matters for:

- **MQTT bridging:** An ESP32 node can connect directly to a WiFi network and forward mesh messages to an MQTT broker without any additional hardware
- **OTA firmware updates:** WiFi-based OTA is reliable and convenient; no cable required
- **Web configuration interface:** Meshtastic's web UI is served over WiFi from the node itself

- **NTP time sync:** WiFi-enabled nodes can sync accurate time without GPS

If your deployment scenario requires WiFi connectivity from the node itself - for example, a Meshtastic MQTT gateway or a node that serves as both a mesh device and a WiFi access point - the ESP32 is the better choice.

BLE Capabilities

Both platforms support BLE 5.0 and use it for phone-to-node configuration and message viewing via the Meshtastic and MeshCore apps. In practice, BLE performance is similar between the platforms. The nRF52840 additionally supports Bluetooth Mesh natively, but this is not used in current Meshtastic/MeshCore deployments.

Community and Software Support

Criterion	ESP32	nRF52840
Meshtastic support	Excellent - most boards are ESP32	Excellent - RAK4631, T-Echo, Station G2 all supported
MeshCore support	Good - T-Beam Supreme, Heltec V3 supported	Excellent - RAK4631 is the primary MeshCore platform
Community size	Larger overall (ESP32 dominates maker ecosystem)	Smaller but highly technical
Documentation quality	Extensive (Arduino, ESP-IDF, PlatformIO)	Good (Zephyr RTOS, Nordic SDK, Arduino)
Custom firmware development	Easier (Arduino IDE widely used)	Requires more expertise (Zephyr preferred)

Decision Guide

Use Case	Recommended Platform	Reason
Solar or battery repeater	**nRF52840**	4 - 5x better battery life is decisive
Portable handheld (multi-day)	**nRF52840**	Extended field battery life
WiFi-connected gateway	**ESP32**	Only platform with integrated WiFi
Mains-powered room server	**ESP32 or Pi**	Power draw irrelevant; WiFi useful
First node / beginner	**ESP32**	More tutorials, more community support, cheaper

Use Case	Recommended Platform	Reason
Secure or production mesh	**nRF52840**	Stronger dedicated security hardware (CryptoCell-310 accelerator, secure boot). Note: current Meshtastic/MeshCore firmware use software crypto and do not yet leverage the CryptoCell, so this is a potential rather than currently-realized advantage

Frequency Bands Explained

Frequency Bands Explained: 915 MHz vs 868 MHz vs 433 MHz

The single most common source of frustration for new LoRa mesh users - and the most easily avoided - is buying hardware on the wrong frequency band. A 868 MHz device purchased on AliExpress will not communicate with any 915 MHz nodes in a North American mesh network. This page explains the regulatory framework, how to identify what band your hardware is on, and why the problem occurs so frequently.

Regional Frequency Band Reference

Note on the power column: for the US/Canada 902-928 MHz band the figures are **conducted** output power (referenced to an antenna of ≤6 dBi gain), not EIRP. For the EU/UK they are **ERP**. These are not the same as EIRP. See the notes below the table for the antenna-gain rules.

Region	Correct Band	Frequency Range	Regulatory Body	Max Power (conducted / ERP - see notes)
United States	**915 MHz**	902 - 928 MHz	FCC (Part 15, Subpart C)	30 dBm (1 W) conducted, ref. ≤6 dBi antenna
Canada	**915 MHz**	902 - 928 MHz	ISED (RSS-210)	30 dBm conducted, ref. ≤6 dBi antenna
Mexico	**915 MHz**	902 - 928 MHz	IFT	30 dBm conducted, ref. ≤6 dBi antenna

Region	Correct Band	Frequency Range	Regulatory Body	Max Power (conducted / ERP - see notes)
Brazil	**915 MHz**	902 - 907.5 MHz (Meshtastic BR_902)	ANATEL	30 dBm conducted, ref. ≤6 dBi antenna
Australia / New Zealand	**915 MHz**	915 - 928 MHz	ACMA / RSM	30 dBm conducted, ref. ≤6 dBi antenna
European Union	**868 MHz**	863 - 870 MHz	ETSI (EN 300 220)	Most of band: 25 mW (14 dBm) ERP with duty-cycle limits. 500 mW (27 dBm) ERP only in the 869.4 - 869.65 MHz sub-band (10% duty cycle)
United Kingdom	**868 MHz**	863 - 870 MHz	Ofcom (IR 2030)	Mirrors ETSI: mostly 25 mW (14 dBm) ERP, duty-cycle limited; 500 mW (27 dBm) only in the 869.4 - 869.65 MHz sub-band
India	**865 MHz**	865 - 867 MHz	DoT / WPC	License-exempt SRD band (WPC GSR notification); up to ~1 W ERP with a spectral-density cap - verify the current WPC limit before deploying
China (mainland)	**470 MHz or 779 MHz**	470 - 510 MHz / 779 - 787 MHz	MIIT	Micro-power SRD limits per MIIT (Meshtastic CN uses ~19 dBm / ~79 mW) - verify against the current MIIT regulation
Japan	**920 MHz**	~920.8 - 927.8 MHz (AS923 / ARIB STD-T108)	MIC	Per ARIB STD-T108 (Meshtastic JP uses 16 dBm / ~40 mW) - verify the channel-specific limit
Korea	**920 MHz**	920 - 923 MHz	KCC / RRA	10 mW (verify against the current Korean RF-device standard)

Conducted power vs EIRP (US/Canada): Under 47 CFR 15.247, the 902-928 MHz limit is 1 W (30 dBm) *peak conducted* output power, referenced to an antenna with directional gain of ≤6 dBi. With a ≤6 dBi antenna this yields roughly a 36 dBm EIRP ceiling, but 36 dBm is a *derived* figure,

not a flat standalone limit. If the antenna gain exceeds 6 dBi, the conducted output power must be reduced dB-for-dB above 6 dBi. So a high-gain directional antenna (e.g. a 10-15 dBi Yagi) does not let you radiate more - it requires you to turn the transmitter down accordingly. The EU/UK figures above are ERP, which is a different reference again. 868 MHz is an EU band and is **not** a US unlicensed ISM band.

Why You CANNOT Use EU Hardware on a US Network

This is not a software restriction - it is a physical hardware limitation. Here is what happens:

1. The SX1262 radio chip itself can technically tune to a very wide frequency range. However, the matching network (a set of inductors and capacitors) on the PCB between the chip and the antenna is designed and tuned at manufacture for a specific frequency band.
2. A board built for 868 MHz has its antenna matching network optimized for 868 MHz. If you configure the firmware to transmit at 915 MHz, the mismatch between the matching network and the actual operating frequency results in:
   - Reduced transmit power (some energy is reflected back rather than radiated because of the impedance mismatch)
   - Reduced receiver sensitivity, because the front-end matching (and filtering, on boards that have it) is tuned for 868 MHz and attenuates the wanted 915 MHz signal
   - At these sub-watt power levels, a band offset of this size is far more likely to reduce performance than to damage the radio. A severe mismatch (e.g. transmitting with no antenna at all) can stress the PA, but the modest VSWR from a ~5% frequency offset is generally within the SX1262's load tolerance
3. In practice, a 868 MHz board configured for 915 MHz operation transmits at reduced power and receives with reduced sensitivity. The exact degradation depends on the board's matching network (often a few dB to several dB, dominated by the antenna mismatch), and in a real mesh it typically will not communicate reliably with other nodes.

Additionally: Transmitting on a frequency outside your regional allocation is a regulatory violation. US unlicensed sub-GHz ISM operation under Part 15.247 is the 902-928 MHz band; 868 MHz is not an unlicensed ISM band in the US, so operating a standard LoRa node on 868 MHz there is not authorized. Conversely, reconfiguring a CE-marked 868 MHz device to 915 MHz operates it outside the band its CE/RED conformity (Directive 2014/53/EU) was declared for, voiding that conformity.

Why AliExpress Listings Default to 868 MHz

Most LoRa hardware manufacturers are based in China. 868 MHz is the standard band for the large EU/UK market. When a generic AliExpress seller lists "LoRa32 development board" without a clear frequency specification, it is very often 868 MHz because:

- 868 MHz is a common export configuration for the European market
- Many sellers do not understand the regional band requirements and list boards without specifying frequency
- Products are often labeled simply "LoRa" with no frequency mentioned - defaulting to whatever batch was ordered (often 868 MHz)
- The price difference between 868 and 915 MHz versions is typically zero, so sellers don't bother distinguishing (as of 2026-06-08; pricing varies by vendor and is not guaranteed)

The rule: If the listing does not explicitly say "915MHz" or "915M", assume it is 868 MHz and do not buy it for North American use.

How to Identify Your Hardware's Frequency Band

Before Buying

- Check the product title for "915MHz", "915M", "US915", or "AU915"
- Check the product description for frequency specification
- Look at photos of the PCB - many boards have the frequency printed on the silkscreen near the antenna connector
- Check the seller's other listings - if they sell both 868 and 915 versions, make sure you selected the right one

After Receiving

- **PCB silkscreen:** Look near the SMA/U.FL connector or on the module itself. Common markings: "915", "868", "433", or a product code like "SX1262-915".

- **Module label / SKU:** On RAK WisBlock modules, frequency is set by the region-specific variant ordered (e.g. a US915 SKU), not by a letter suffix. Note that the "-R" suffix (as in RAK4631-R) denotes the RUI3 firmware build - it does **not** indicate a frequency band. Always check the SKU/listing for the band.
- **Firmware frequency:** If the device has already been flashed, connect via serial or BLE and check the configured region. In Meshtastic: Radio Config → LoRa → Region. The configured region should be US (or AU for Australia) for 915 MHz operation.
- **RF spectrum verification (advanced):** Using an RTL-SDR or similar receiver, you can observe the actual transmit frequency when the node sends a packet. This is the definitive test.

The 433 MHz Band

A third band - 433 MHz - is a defined, legitimate region option in several jurisdictions (Meshtastic has EU_433, ANZ_433, UA_433, MY_433, PH_433, and others), where it is a valid if lower-bandwidth mesh band. For North American community mesh networking, 433 MHz is not used. If you accidentally purchase a 433 MHz board for a 915 MHz network, it is completely unusable in that network - not just degraded, but transmitting and receiving on an entirely different part of the spectrum. Additionally, 433 MHz requires a physically larger antenna (a quarter-wave whip is approximately 17 cm at 433 MHz vs about 8 cm at 915 MHz).

Frequency Band Identification Quick Reference

What You See	Interpretation	US/Canada Compatible?
"915MHz", "915M", "US915", "AU915"	Correct band for North America/Australia	Yes
"868MHz", "868M", "EU868"	European 863-870 MHz band - wrong for North America	No
"IN865"	India's 865-867 MHz band - a separate allocation from EU868, also wrong for North America	No
"433MHz", "433M"	433 MHz - a valid band in some regions (EU_433, ANZ_433, etc.) but not used for North American mesh	No
No frequency mentioned	Assume 868 MHz unless confirmed otherwise	Assume No - verify first

What You See	Interpretation	US/Canada Compatible?
RAK4631-R	The "-R" suffix means the RUI3 firmware build, NOT a frequency. Band is set by the region SKU - check the listing	Depends on SKU - verify
RAK4631 (no suffix)	No suffix does not imply a band. The RAK4631 ships in region-specific SKUs (US915, EU868, etc.) - check the listing	Depends on SKU - verify

PCB Trace vs External Antenna

The antenna is one of the most important factors in the range and reliability of a LoRa mesh node, alongside spreading factor and transmit power. (Spreading factor in particular changes the link budget by 15-20+ dB across SF7-SF12, which often outweighs the few-dB difference between a poor and a good antenna.) Even so, the antenna is the most commonly overlooked hardware detail, especially by beginners who assume the built-in PCB trace antenna is adequate for outdoor use.

PCB Trace Antennas: What They Are

A PCB trace antenna (also called a PCB antenna or on-board antenna) is a specific pattern etched directly into the copper layers of the circuit board. No separate component - it is part of the PCB itself. You can identify one by looking at a corner of the board where the copper traces form a meandered or serpentine pattern, often with a small keepout area around it where no other copper is present.

PCB trace antennas are used because they cost essentially nothing to add during PCB manufacturing, they take up minimal volume, and they eliminate the need for an SMA/U.FL connector and cable. For products designed to be small and cheap - like many ESP32 dev boards - they make sense as a baseline.

Why PCB Antennas Are Inadequate for Outdoor Use

A well-designed, well-matched PCB trace antenna at 915 MHz can reach roughly 0 - 2 dBi, but the small or detuned implementations found on typical dev boards are frequently negative-gain (commonly -3 to -6 dBi, sometimes worse) once electrical size, lossy FR4, ground-plane coupling, and proximity to a hand or case are accounted for. Treat a dev-board PCB antenna as significantly

worse than a quarter-wave whip. In practice, PCB antennas on development boards suffer from several additional problems:

- **Proximity effects:** A PCB trace antenna's tuning is affected by everything near it - your hand, a battery, the case material, the board itself. Moving the device changes the antenna's effective frequency and radiation pattern.
- **Orientation sensitivity:** PCB trace antennas are non-omnidirectional, with pronounced nulls in their radiation pattern. In a pocket or on a table, a null direction may be exactly toward the nodes you want to reach.
- **No replaceable component:** If the PCB trace antenna design is suboptimal (common on cheap dev boards), there is nothing to improve without adding an external connector.
- **Body shielding:** When carried in a pocket, the human body absorbs several dB of the already-weak signal from a PCB antenna. An external antenna on a cable can be positioned to avoid this.

Gain Comparison

Antenna Type	Typical Gain	Effective Range vs PCB	Notes
PCB trace antenna (dev board)	-4 to +2 dBi (often negative when detuned)	Baseline	Subject to proximity detuning
Small rubber duck (included)	1 - 2 dBi	~1.1 - 1.3x	Better than PCB in most orientations
Quality 915 MHz rubber duck	2 - 3 dBi	~1.3 - 1.5x	Taoglas, Linx brand options
Quarter-wave whip + ground plane	~5.15 dBi (ideal ground plane; ~2-5 dBi on a small/finite ground plane)	~1.3 - 2x	Omnidirectional; DIY-constructable. Note 2.15 dBi is the half-wave dipole figure, not the monopole's
Fiberglass 3 dBi (915 MHz)	3 dBi	~1.5 - 2x	Best for outdoor fixed nodes
Fiberglass 5 dBi	5 dBi	~2.5 - 3x	Narrower beam; use at elevation
Fiberglass 8 dBi	8 dBi	~4 - 5x	Very narrow beam; hilltop/tower only. Can shoot over nearby/low nodes
Yagi 10 dBi	10 dBi	~6 - 8x	Highly directional; point-to-point only. Gain depends on element count

Range multipliers are approximate in ideal line-of-sight conditions. Real-world gains depend on terrain, obstruction, and link margin. Antenna gain figures for commercial products are

nominal/marketing values and vary by sample.

Connector Types: SMA vs U.FL

SMA (SubMiniature version A)

SMA is a threaded RF connector found on most external antennas. Boards with an SMA connector (T-Beam, RAK WisBlock base boards) can directly accept standard SMA-terminated antennas. There are two variants:

- **SMA:** Female connector on the antenna (outer thread, inner pin) plugs into the board's male SMA jack (inner socket, outer thread)
- **RP-SMA (Reverse Polarity SMA):** Used on WiFi routers and many US-market devices. The genders of the center conductor are swapped. A standard SMA antenna will NOT fit an RP-SMA connector without an adapter. Make sure your antenna matches your board's connector type.

U.FL (also called IPEX or MHF1)

U.FL is a tiny snap-fit coaxial connector used internally on boards when the antenna connector needs to be on a cable or module rather than soldered to the main PCB. The Heltec V3 LoRa output, some WisBlock modules, and many radio modules use U.FL.

A U.FL connector board requires a **U.FL to SMA pigtail cable** (typically 10 - 15 cm) to adapt to a standard SMA antenna. Over such a short run of thin (1.13 mm / RG-178-class) coax, this cable introduces only a small fractional-dB insertion loss at 915 MHz (on the order of 0.3 - 0.5 dB), which is a worthwhile tradeoff for a proper external antenna.

When Is a PCB Antenna Acceptable?

PCB antennas are adequate in these specific scenarios:

- **Indoor testing at short range:** Verifying that firmware flashed correctly, testing basic connectivity between nodes in the same room
- **High-density indoor mesh:** In a building with many nodes at close range (under 50 meters), PCB antenna limitations are less relevant

- **Ultra-compact wearable or embedded device:** If physical size constraints prevent any external component, a PCB antenna may be the only option - but accept the range limitation

For any outdoor deployment, fixed repeater, or range-critical use, an external antenna is non-negotiable.

Antenna Selection for Common Boards

Board	Built-in Antenna	External Connector	Recommended Upgrade
Heltec WiFi LoRa 32 V3	U.FL LoRa output with included external antenna (the on-board metal spring antenna is for WiFi/BT only, not LoRa)	U.FL / IPEX (LoRa)	U.FL - SMA pigtail + 3 dBi rubber duck
LilyGO T-Beam Supreme	None (SMA only)	SMA male	Quality 915 MHz 3 dBi rubber duck; fiberglass for fixed
LilyGO T-Echo	None	U.FL / IPEX (verify; sources conflict SMA vs U.FL)	Included rubber duck is adequate; upgrade for repeater use
RAK4631 (WisBlock)	None	IPEX (U.FL) on module	RAK base board provides SMA passthrough; use 3 - 5 dBi fiberglass for fixed nodes
Station G2	None	SMA male	3 dBi stubby for portable; fiberglass for fixed

Cable Loss Warning

If your antenna requires a coaxial cable run (for example, mounting an antenna on a roof while the radio is indoors), cable loss must be accounted for. At 915 MHz:

- RG-58: approximately 0.7 - 0.8 dB/meter - avoid runs over 3 meters
- RG-8X: approximately 0.27 - 0.30 dB/meter - usable up to ~10 meters
- LMR-400: approximately 0.13 dB/meter (~3.9 dB per 100 ft) - suitable for long runs
- LMR-200: approximately 0.23 - 0.25 dB/meter - good for medium runs

A 10-meter run of RG-58 costs you roughly 7 - 8 dB at 915 MHz - more than a 5x reduction in power, completely erasing any gain advantage from a high-gain antenna. Use the lowest-loss cable practical for your installation.

GPS Integration in LoRa Nodes

GPS in a LoRa mesh node serves two primary purposes: precise location sharing with other mesh users (visible on the Meshtastic map or MeshCore position view), and network topology visualization. Whether you need GPS depends heavily on your use case - and whether you have it, you need to manage its substantial power draw carefully.

Why GPS Matters for Mesh Networking

- **Position sharing:** Nodes with GPS broadcast their coordinates at regular intervals. Other mesh users can see your location on the map, which is critical for field teams, SAR operations, and event coordination.
- **Network mapping:** Community mesh maps (like Meshmap.net for Meshtastic) aggregate node positions to show coverage areas and network topology. GPS-equipped nodes contribute to this.
- **Time synchronization:** GPS provides a highly accurate time signal (UTC). Meshtastic uses a listen-before-talk (CSMA-style) channel access scheme, not strict time-slotting/TDMA, so a node does not need network-wide time sync to communicate. Clock drift on a node without GPS (and without a phone/RTC time source) mainly affects message timestamps and position freshness, not the ability to send and receive messages.
- **Range testing:** Knowing the exact GPS coordinates of both ends of a link allows accurate range measurement for antenna and placement experiments.

Boards with Integrated GPS

Board	GPS Module	Constellations	Cold Start	GPS Antenna	Notes

LilyGO T-Beam Supreme	u-blox NEO-M10S / MAX-M10S (Quectel L76K option)	GPS, GLONASS, Galileo, BeiDou	~30 - 45s (open sky)	External patch antenna included	Best GPS performance of common boards
LilyGO T-Echo	Quectel L76K	GPS, GLONASS, BeiDou	~45 - 90s (open sky)	Integrated ceramic patch	Compact, adequate for field use
LilyGO T-Beam v1.1 (older)	NEO-6M / NEO-M8N	GPS only (NEO-6M) or GPS+GLONASS (M8N)	45 - 120s	External patch antenna	Older; M8N variant is better
RAK WisBlock + RAK1910	u-blox MAX-7Q	GPS, GLONASS	~60s	Requires external patch antenna	Module adds GPS to any WisBlock base
RAK WisBlock + RAK12500	u-blox ZOE-M8Q	GPS, GLONASS, Galileo, BeiDou	~26s	Integrated ceramic patch	Better performance than RAK1910

Adding GPS to Boards Without

Boards like the Heltec WiFi LoRa 32 V3, Station G2, or basic ESP32 LoRa boards do not include GPS. You can add it via UART:

Common Add-On GPS Modules

Module	Chip	Interface	Cost (as of 2026-06-08)	Notes
GT-U7 / Neo-6M clone	u-blox NEO-6M (often clone)	UART (9600 baud default)	$4 - $8	Ubiquitous, adequate for basic use; GPS only, no GLONASS
Beitian BN-220	u-blox UBX-M8030	UART	$12 - $18	Concurrent GPS + GLONASS (or GPS + BeiDou); compact; popular in FPV community
Beitian BN-880	u-blox UBX-M8030 + compass (HMC5883L or QMC5883L depending on revision)	UART + I2C	$15 - $22	GPS + GLONASS + compass
Grove GPS (Seeed)	Air530 or u-blox	UART via Grove connector	$10 - $15	Plug-and-play with Grove system boards

Module	Chip	Interface	Cost (as of 2026-06-08)	Notes
PA1010D (Adafruit)	MediaTek MT3333	UART or I2C	$14 - $20	Very small (25×25mm); good sensitivity

UART Wiring for External GPS

Connecting an external GPS module via UART to an ESP32 or nRF52840 board requires four wires:

GPS Module Pin	Connects To (MCU)	Notes
VCC	3.3V or 5V (check module specs)	Most modern GPS modules are 3.3V; some accept 5V
GND	GND	Common ground reference
TX (GPS transmits)	RX pin on MCU (e.g., GPIO 34 on T-Beam)	GPS sends NMEA sentences to MCU
RX (GPS receives)	TX pin on MCU	MCU sends configuration commands to GPS; not strictly required for basic operation

In Meshtastic firmware, configure the GPS UART pins via the serial module settings or by editing the platformio.ini defines for your board variant. The default baud rate for most GPS modules is 9600; some support higher speeds (38400, 115200) for reduced latency.

GPS Power Consumption

GPS is one of the highest-power peripherals in a LoRa mesh node. Understanding its power draw is essential for battery life calculations:

GPS Module	Acquisition Current	Tracking Current	Standby / Sleep
u-blox NEO-6M (clone)	~50 mA	~45 mA	~4 mA (power save mode)
u-blox MAX-M10S (T-Beam Supreme)	~18 mA	~12 mA	**~28 µA (hardware backup mode)**
Quectel L76K (T-Echo)	~29 mA	~20 mA	~0.5 mA (standby)
u-blox ZOE-M8Q (RAK12500)	~22 mA	~18 mA	~15 µA (backup)
Beitian BN-220	~40 mA	~35 mA	~1 mA

A GPS module drawing 20 mA continuously on an nRF52840 node that otherwise draws only a few milliamps (depending on sleep and BLE settings) completely changes the power budget. With GPS always on, the effective battery life drops by an order of magnitude on an already efficient node.

Disabling GPS to Save Power

For nodes where GPS is not needed - fixed repeaters, indoor nodes, nodes operated by users who are not location-sharing - GPS should be disabled:

In Meshtastic

- Open Meshtastic app → Radio Config → Position
- Set **GPS Mode** to "Disabled" or "Not Present"
- Set **Position Broadcast Interval** to 0 (disable position broadcasting)
- The firmware will stop initializing the GPS UART and power-gate the GPS module if the board supports it

In MeshCore

- GPS can be disabled in the node configuration. Boards without GPS will automatically operate without position features.

Hardware Power Gating

The T-Beam Supreme provides software-controllable GPS power - on the Supreme, GPS power is gated through the AXP2101 PMIC. When GPS is disabled in Meshtastic firmware, cutting power to the GPS eliminates its standby draw entirely (the MAX-M10S otherwise draws ~28 µA in hardware backup mode). This is the correct way to save GPS power on the T-Beam.

On boards without hardware GPS power gating (many DIY builds), you may need to add a P-channel MOSFET or a load switch IC between the 3.3V rail and the GPS module's VCC to enable software-controlled power off.

GPS Accuracy and Placement Tips

- **Sky view is everything:** GPS requires line-of-sight to satellites. A node in a metal enclosure, inside a building, or under a dense tree canopy will have poor GPS accuracy or

fail to acquire a fix. For outdoor fixed nodes, ensure the GPS antenna has clear sky view.

- **Active vs passive antenna:** The MAX-M10S on the T-Beam Supreme supports active antennas (it includes an antenna supervisor / LNA_EN for active-antenna control), and the T-Beam Supreme exposes an external GPS antenna connector. Active antennas include a built-in LNA and provide better sensitivity in marginal conditions. The T-Beam's included antenna is typically a passive ceramic patch - an active upgrade (check connector compatibility) can improve indoor fix times.
- **Almanac reuse (warm start):** Meshtastic saves almanac data received from satellites to flash and reloads it on boot, enabling a faster warm start. It does **not** download AGPS almanac/ephemeris data over WiFi or the internet. (General-purpose u-blox AssistNow AGPS, where supported by a host application, can reduce cold-start time to roughly 1 - 5 seconds under good sky-view conditions, but Meshtastic's mechanism is local flash reuse, not an online download.)
- **Backup battery:** GPS modules with a small backup coin cell retain almanac data between power cycles, reducing cold start to a faster "warm start" (older modules typically 5 - 15 seconds; the MAX-M10S hot start is ~1 s). The T-Beam Supreme includes this backup battery circuit.

SX1262 vs SX1276: Why It Matters

SX1262 vs SX1276: Why It Matters

The two most common LoRa radio ICs from Semtech in mesh nodes today are the older SX1276 (SX127x family) and the newer SX1262, though newer boards may instead use the LR1110/LR1121 or the 2.4 GHz SX1280. Both the SX1276 and SX1262 implement LoRa spread-spectrum modulation and are outwardly similar, but their performance characteristics and firmware support differ in ways that matter to operators making purchasing decisions.

SX1276 -- The Legacy Chip

The SX1276 was Semtech's main LoRa transceiver through most of the 2010s and became the default radio in the first wave of Meshtastic hardware. It supports 433, 868, and 915 MHz bands via separate variants. Key specs:

- Receive sensitivity: ~-137 dBm at SF12, BW125 (the headline ~-148 dBm figure applies only at the narrowest bandwidth)
- Max output power: +20 dBm via the PA_BOOST path (+17 dBm on the RFO path); most 868/915 MHz Meshtastic boards use the +20 dBm PA_BOOST output
- No dedicated hardware Channel Activity Detection (CAD) of the kind the SX126x family added
- Wider support across early Meshtastic board designs

Boards using SX1276: T-Beam v0.7, v1.0, v1.1; Heltec LoRa 32 V1 and V2; original TTGO LoRa boards.

SX1262 -- The Current Standard

The SX1262 is Semtech's second-generation LoRa transceiver and is now the standard chip in nearly all modern mesh hardware. Improvements over SX1276:

- Receive sensitivity: ~-137 dBm at SF12, BW125 -- essentially the same as the SX1276 at the same SF/BW (both datasheets quote ~-148 dBm only at their narrowest bandwidth). At a given SF/BW the two chips are within roughly 1-3 dB of each other
- Max output power: +22 dBm (vs +20 dBm)
- Hardware Channel Activity Detection (CAD) -- the chip can listen for LoRa preambles and avoid transmitting when the channel is busy, reducing packet collisions
- Lower RX current draw and TCXO-based frequency stability, giving a slightly better overall link budget

Boards using SX1262: T-Beam v1.2 and Supreme; RAK4631 WisBlock (all variants); Heltec LoRa 32 V3; LILYGO T-Deck; Heltec Mesh Node T114; T3-S3.

MeshCore Chip Support

In practice, MeshCore targets SX126x-class radios and the great majority of MeshCore hardware uses the SX1262. MeshCore does, however, support SX1276/SX127x variants as well, so an SX1262 is not a hard requirement. If you are buying hardware specifically for MeshCore, SX1262-equipped boards are the most widely supported choice; check the MeshCore supported-hardware list for the specific board you intend to use.

Meshtastic supports both chips, though official guidance now flags the older SX127x boards as phased out and not recommended for new purchases.

Practical Range Impact

At the same spreading factor and bandwidth, the SX1262 and SX1276 have very similar receive sensitivity (within about 1-3 dB), so swapping chips does not by itself produce a large range increase. The SX1262's real advantages are its lower RX current draw, TCXO stability, hardware CAD, and a slightly better overall link budget. Real-world range in any deployment is dominated by antenna gain, height, line of sight, and local noise -- not by the choice between these two chips.

Quick Reference: Which Board Has Which Chip

Board	Chip	MeshCore Compatible
T-Beam v0.7 / 1.0 / 1.1	SX1276	Yes (SX127x supported)
T-Beam v1.2 / Supreme	SX1262	Yes
RAK4631 (all)	SX1262	Yes
Heltec V1 / V2	SX1276	Yes (SX127x supported)

Heltec V3	SX1262	Yes
T-Deck	SX1262	Yes
T114	SX1262	Yes
T3-S3	SX1262 variant (also sold with SX1276 / LR1121 / SX1280)	Yes

When purchasing used or surplus hardware, always verify the board version before assuming SX1262. Many T-Beams sold on secondary markets are pre-v1.2 and carry the SX1276. Check the silkscreen on the radio module or the board revision printed near the USB port.

T114 and T3-S3: New Hardware for 2025-2026

T114 and T3-S3: New Hardware for 2025-2026

The 2024-2025 product refresh introduced two boards that are quickly becoming community favourites: the **Heltec** Mesh Node T114 and the **LILYGO** T3-S3. (Note: the T114 is a Heltec board, not a LILYGO board.) Both pair an SX1262 LoRa radio with a modern microcontroller, but they target distinctly different use cases and operator needs.

T114 -- Compact Infrastructure Node

The Heltec Mesh Node T114 combines Nordic Semiconductor's nRF52840 with the SX1262 in a compact form factor with a small 1.14″ TFT. It is well suited to infrastructure deployments as well as light handheld use:

- **MCU:** nRF52840 (ARM Cortex-M4F at 64 MHz)
- **Radio:** SX1262 -- MeshCore and Meshtastic compatible; ~21±1 dBm TX (bare SX1262, no external PA)
- **Display:** 1.14″ TFT
- **Connectivity:** USB-C for power and programming; BLE for phone pairing
- **Power:** Leverages the nRF52840's exceptional sleep current (sub-25 µA) -- suitable for solar deployments on very small panels; includes a solar charge connector
- **Form factor:** Smaller than a T-Beam; easy to fit in weatherproof enclosures

The T114 is a strong choice for infrastructure roles thanks to its low sleep current and small footprint. For a repeater node on a rooftop or inside a pelican case, the compact board fits easily. Community feedback has been overwhelmingly positive: operators report clean BLE pairing, reliable SX1262 performance, and excellent battery life. Firmware is entered via a DFU double-tap reset. The one common complaint is that the small PCB can be finicky to solder antenna connectors to, so purchasing the version with a pre-soldered U.FL connector is recommended.

Firmware support: Meshtastic ships official T114 firmware. MeshCore also supports the T114 with its nRF52840 build.

T3-S3 -- The WiFi-Capable LoRa Node

The LILYGO T3-S3 pairs Espressif's ESP32-S3 with an SX1262 and is positioned as a direct competitor to the T-Beam Supreme in the WiFi-capable segment:

- **MCU:** ESP32-S3 (ESP32-S3FH4R2) dual-core at 240 MHz, 4 MB flash, 2 MB PSRAM
- **Radio:** SX1262
- **GPS:** No onboard GPS; optional external GPS module via header (Meshtastic docs list the T3-S3 as "No GPS")
- **WiFi:** 802.11 b/g/n via ESP32-S3 -- enables MQTT bridging and web config
- **USB-C:** Yes, with native USB on ESP32-S3 (faster flashing, serial CDC without external chip)
- **Form factor:** Slightly more compact than T-Beam Supreme; no integrated keyboard

The T3-S3 is a useful WiFi MQTT gateway option for existing T-Beam deployments. Where the original T-Beam uses an older ESP32, the T3-S3's ESP32-S3 offers native USB and handles concurrent WiFi and LoRa tasks more reliably. With 4 MB flash and 2 MB PSRAM it has enough headroom for Meshtastic's typical WiFi/MQTT workload, though it is not a large-memory board (2 MB PSRAM, not the 8 MB found on the T-Deck), so running every feature simultaneously should not be assumed.

Availability and Pricing (as of 2026-06-08)

- The T3-S3 is available directly from **lilygo.cc**; the T114 from Heltec and resellers, typically with 2-3 week shipping from Shenzhen
- Amazon listings exist for both boards (US warehouse stock, faster shipping, approximately 15-20% price premium)
- AliExpress offers the lowest prices but longest lead times
- T114: approximately $18-34 USD depending on variant/GPS option (as of 2026-06-08) -- prices are volatile; see the Mid-Range Devices page for the same board
- T3-S3: approximately $25-32 USD without GPS module (as of 2026-06-08) -- verify against the lilygo.cc listing

Community Verdict

Both boards have earned strong reputations in the mesh community since their wider availability in mid-2024. The T114 is now a popular recommendation for solar repeater builds in the RAK4631's price range, particularly where MeshCore compatibility is required. The T3-S3 is a recommended ESP32 platform for new WiFi gateway deployments, preferred over the ageing T-Beam for its

updated silicon and USB-C convenience. Operators upgrading from T-Beam v1.1 hardware should consider the T3-S3 as a modern replacement.

Accessories and Peripherals

Displays for LoRa Nodes

Adding a display to a LoRa node provides visual feedback on mesh status, incoming messages, and GPS coordinates - without requiring a phone connection. Different display types make different tradeoffs between power consumption, visibility, and cost.

Built-in Display Options

Many popular LoRa boards ship with or can be fitted with a display:

Board	Display Type	Size	Power Draw	Sunlight Readable
Heltec WiFi LoRa 32 V3	OLED (SSD1306)	0.96" 128x64	+15-20 mA when on	Poor
T-Beam (most versions)	OLED (SSD1306, commonly an add-on module)	0.96" 128x64	+15-20 mA when on	Poor
T-Echo	E-Ink (1.54")	1.54" 200x200	~0 mA when static	Excellent
RAK WisBlock + RAK14000	E-Ink (2.13")	2.13" 250x122	~0 mA when static	Excellent

Note: the 0.96" SSD1306 OLED is commonly a separate add-on module rather than present on every T-Beam revision - some T-Beam versions ship without a screen.

OLED Displays

SSD1306-based 0.96" OLED displays are inexpensive and common. They connect via I2C (SDA/SCL pins) and the SSD1306 is a natively supported (selectable) driver in Meshtastic firmware.

- **Advantages** - High contrast, works in complete darkness, fast refresh
- **Disadvantages** - Poor in direct sunlight; draws roughly 15-20 mA when on (current varies with displayed content - typically under 15 mA - and is significant for battery nodes); OLED panels can also dim or burn in over thousands of hours of continuous use
- **Power tip** - Set a short screen timeout to minimize power draw, e.g. `meshtastic --set display.screen_on_secs 30`. Note: a value of **0 does NOT disable the screen** - in Meshtastic, 0 maps to 10 minutes (the default). To minimize screen-on power, set a small

positive value (e.g. 1); screen-off behavior on solar/battery nodes is governed by the device's power-saving settings, not by `screen_on_secs 0`.
- **Adding to a bare board** - Many ESP32 boards have I2C headers that accept standard 0.96" OLED modules. On the original (classic) ESP32 the common I2C defaults are SDA = GPIO 21 and SCL = GPIO 22; ESP32-S3 boards (e.g. Heltec V3) use different and remappable I2C pins, so always check your board's pinout.

E-Ink Displays

Electronic ink displays consume power only when the display content changes. Once updated, the image is held with zero power consumption - ideal for battery-operated nodes.

- **Advantages** - Zero standby power, excellent sunlight readability, long battery life, full image visible even when battery is critically low
- **Disadvantages** - Slow refresh (1-2 seconds), ghosting artifacts after many refreshes, limited to black/white (no grayscale on basic modules), higher cost than OLED
- **Best use cases** - Handheld nodes where you need to read position and messages in direct sunlight; any node where battery life is the priority

TFT Color Displays

Color TFT displays (ST7789, ILI9341) provide higher resolution and color, but draw significantly more power (30-80 mA with the backlight on). Generally not recommended for battery-powered LoRa nodes but suitable for always-powered room server displays or status panels. T-Deck devices (a complete LoRa device with keyboard and color display) use a ST7789 TFT touchscreen.

Adding an External Display to an Existing Node

Most ESP32 and nRF52840 LoRa boards support adding an external I2C OLED. Steps:

1. Identify I2C pins on your board (SDA, SCL, 3.3V, GND) from the board's pinout documentation
2. Connect a 0.96" SSD1306 OLED module: VCC to 3.3V, GND to GND, SDA to SDA, SCL to SCL
3. In Meshtastic: the OLED is auto-detected on boot, so no manual "enable" is usually needed. If auto-detect fails, set Config → Display → OLED Definition to the correct

controller (SSD1306/SH1106/SH1107) and save
4. The display should activate after reboot

GPS Modules for LoRa Nodes

GPS provides automatic position reporting for mesh mapping and navigation. Many boards include an integrated GPS; for those that don't, external GPS modules can be added via UART or I2C.

Integrated GPS vs External Module

Approach	Boards	Pros	Cons
Integrated GPS	T-Beam, T-Echo, some RAK boards	All-in-one, no wiring	Higher cost; disabling GPS to save power depends on whether the board provides GPS power gating (some integrated boards switch GPS power via the PMIC/GPIO, others do not)
External UART GPS	Any board with UART pins	Flexible, replaceable, can be positioned for best sky view	Wiring required, adds bulk
GPS from phone via BLE	Any (Meshtastic only)	No hardware needed	Requires active phone connection; phone must remain near node

Popular External GPS Modules

Module	Interface	TTFF (cold)	Current Draw	Notes
u-blox NEO-M8N	UART	26s	23 mA	Excellent sensitivity; widely supported
Quectel L76K	UART	30s	~29 mA (acquisition/tracking)	Used on the LilyGO T-Echo (and some Wio Tracker L1 boards); compact. The T-Beam Supreme uses a u-blox M10-series module, not the L76K
u-blox MAX-M8Q	UART	26s	15 mA	Compact form factor; patch antenna

Module	Interface	TTFF (cold)	Current Draw	Notes
ATGM336H	UART	~35s	~20 mA	Inexpensive Chinese alternative; adequate for most uses (figures approximate)
GT-U7 (NEO-6M clone)	UART	60s+	~45 mA	Very inexpensive; poor sensitivity; not recommended (figures approximate)

TTFF = Time To First Fix from a cold start in open sky conditions.

Wiring an External UART GPS

Most GPS modules use 3.3V logic and UART at 9600 baud. Connect:

- GPS VCC → 3.3V on LoRa board
- GPS GND → GND on LoRa board
- GPS TX → UART RX pin on LoRa board
- GPS RX → UART TX pin on LoRa board (needed only if sending commands to GPS)

Configure in Meshtastic: Config → Position → GPS Mode = Enabled; GPS RX pin = RX pin number from your board's pinout.

GPS Power Management

GPS is one of the largest power consumers on a LoRa node. For battery-powered nodes:

- **Disable GPS if fixed position is configured** - A repeater at a known location doesn't need active GPS
- **Increase GPS update interval** - For slow-moving applications, a 60-300 second GPS update interval with smart beaconing works well
- **GPS power gating** - Some boards route GPS power through a GPIO-controlled switch. Meshtastic can be configured to power-cycle the GPS between fixes, which can substantially reduce average GPS current; the exact average depends on the module and update interval
- **Almanac caching** - After a successful fix, Meshtastic caches almanac data to flash and reloads it on boot, enabling faster warm starts on subsequent power-ups. Meshtastic has no internet/app-based AGPS preload feature; it does not download almanac or ephemeris over WiFi/internet

Keyboards, Buttons, and Input Devices

Adding physical input to a LoRa node enables sending messages and navigating menus without a phone. Input options range from simple push buttons to full QWERTY keyboards.

Canned Messages with a Rotary Encoder

The Meshtastic Canned Messages module supports a rotary encoder for scrolling through preset messages and a push button for sending. This is the most practical hardware UI upgrade for a fixed node.

Rotary Encoder Wiring (typical)

```
Encoder CLK (A) → choose a free GPIO per your board's schematic
Encoder DT (B) → choose a free GPIO per your board's schematic
Encoder SW (button) → choose a free GPIO per your board's schematic
Encoder VCC → 3.3V
Encoder GND → GND
```

GPIO assignment is board-specific and must be chosen from your board's schematic. Do not copy fixed pin numbers from another board: on many boards some GPIOs are input-only or do not exist, and the official Meshtastic docs warn that "GPIO access is fundamentally dangerous because invalid options can physically damage or destroy your hardware." Valid encoder port-A/B pins are in the range 1-39 on ESP32-class boards. Pick free, output-capable GPIOs for the pins you use, and verify against your board's pinout before wiring. The KY-040 rotary encoder module (~$1-2) is the most common choice.

Configuration

```
meshtastic --set canned_message.enabled true
meshtastic --set canned_message.inputbroker_pin_a <your encoder A GPIO>
meshtastic --set canned_message.inputbroker_pin_b <your encoder B GPIO>
meshtastic --set canned_message.inputbroker_event_press SELECT
meshtastic --set-canned-message "OK|On my way|At destination|Need help|ETA 5 min"
```

Note the message list is set with the standalone `--set-canned-message` flag, not a `--set canned_message.messages` key, and the press event value is `SELECT` (an input-event character), not the protobuf enum name.

T-Deck: Integrated QWERTY Device

The LilyGO T-Deck is a complete Meshtastic/LoRa device with an integrated small QWERTY keyboard, color TFT touchscreen, trackball, LoRa radio, and optional GPS. It's the closest thing to a dedicated LoRa messenger device:

- Native keyboard input for typing full messages without a phone
- Color display shows message history, node list, and map
- Runs Meshtastic firmware with full touchscreen UI
- Battery: the base T-Deck ships with **no battery** (you add your own cell). Only the T-Deck Plus has a built-in 2000 mAh battery, giving roughly 8-12 hours of active use
- Price: approximately $50-70 (as of 2026-06-08; the base T-Deck is often found nearer $45 — verify with a current retailer listing)
- Limitation: higher power consumption than OLED nodes; not ideal for solar/battery long-term deployment

WisBlock Input Modules (RAK14001 / RAK14004)

For WisBlock-based nodes, RAKwireless offers two distinct input/output modules that mount directly to the WisBlock base board without wiring. These are separate modules, not one combined unit: the **RAK14001** is an RGB LED module (no buttons), and the **RAK14004** is a matrix-scan keypad controller (no LEDs). The RAK14004 uses a matrix-scanning technique supporting up to 8x8 = 64 buttons and is paired with separate RAK keypad modules (such as the RAK14009/14010/14011); it is not itself a fixed 4x4 keypad.

Simple Button for Alert Sending

A momentary push button connected to a user-accessible GPIO pin can be used with the Meshtastic canned-message input to send a message from the node - useful for panic buttons, check-in buttons, or man-down alerts in safety applications.

```
meshtastic --set canned_message.send_bell true
```

Note: `send_bell` only appends a bell character (ASCII BEL) to a message so receiving nodes can beep on arrival — it does not by itself send a message on a button press. To send with a single press, use a `scanAndSelect` input source (a long press sends the highlighted message) or configure a single-item canned-message list so the one available message is sent immediately.