Hardware Comparison & Selection

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

- Popular Board Comparison Table
- Board Selection by Use Case
- T-Deck as a Standalone Communicator
- nRF52840 vs ESP32: Architecture Comparison for Mesh Operators

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