

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 pair with the SX1262 radio. 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 (+ 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)	80 - 240 mA	10 - 20 mA
Deep sleep current	10 - 150 μ A (varies by variant)	1.9 - 8 μA
Supply voltage	3.0 - 3.6V	1.7 - 5.5V (natively tolerant)
Operating temp range	-40°C to +85°C (commercial grade varies)	-40°C to +85°C
Hardware crypto	AES accelerator, SHA accelerator	ARM TrustZone + hardware crypto engine
USB native	Yes (ESP32-S3, -S2, -C3)	Yes

Power Consumption: The Real Numbers

For battery-powered mesh nodes, power consumption is frequently the deciding factor. Here are measured averages for a LoRa mesh node in active listening mode (radio on, MCU active, no WiFi):

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	0.5 - 1 mA	nRF52840 uses ~4x less
Deep sleep (radio off)	10 - 100 μ A	1.9 - 8 μ A	nRF52840 uses ~5 - 50x less
Transmit (100 mW / +20 dBm)	~400 - 500 mA peak	~350 - 400 mA peak	Similar (dominated by PA current)

Practical implication: 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:

- 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 (good for ESP32-S3 with LoRa radio in sleep)
- **Deep sleep:** Most of chip off, only RTC domain active. ~10 - 150 μ A depending on wakeup configuration
- **Hibernation:** Only RTC timer active. ~5 μ A but loses GPIO state

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
- **System On (low power):** Aggressive clock gating - ~0.5 - 1 mA
- **System Off:** Only GPIO wakeup retained - ~1.9 μ A typical

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
Secure or production mesh	nRF52840	ARM TrustZone hardware security

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