

Building a Mesh Weather Station Network

Building a Mesh Weather Station Network

A neighbourhood weather monitoring grid built on mesh radio nodes provides hyper-local environmental data at a fraction of the cost of commercial weather station networks. This page presents a deployment blueprint: hardware selection, node placement strategy, data aggregation, and community value proposition.

A note on telemetry capture. The realistic data path for an automated mesh weather grid today is **Meshtastic**, whose Telemetry module reports environment metrics (temperature, humidity, barometric pressure, gas resistance/IAQ, voltage, current) that an ESP32 gateway can publish to MQTT and into a database. MeshCore sensor support exists but is build-time and request/response only (see the [MeshCore Sensor Data Integration](#) page); it has no scheduled-broadcast sensor packets and no room-server sensor log to scrape. The hardware list below works for either firmware, but choose your aggregation method (below) to match the firmware you actually flash.

Use Case and Goals

The target deployment is a 5-node network covering a suburban neighbourhood approximately 2 km in diameter, providing temperature, humidity, barometric pressure, and rainfall (with optional tipping-bucket rain gauge) at 15-minute intervals. The base station node aggregates data and pushes to a local dashboard and optionally to Weather Underground as a Personal Weather Station (PWS) network contribution.

Hardware List (5-Node Network)

Item	Qty	Notes
RAK19007 Base Board	5	One per node

Item	Qty	Notes
RAK4631 Core Module	5	nRF52840 + SX1262
RAK1906 BME680 Sensor	5	Temp/humidity/pressure/IAQ
0.5 W solar panel	4	Remote nodes; base station uses mains power. 0.5 W is marginal in low-sun regions — size to local insolation and duty cycle (see note below).
3000 mAh LiPo battery	4	Remote node backup power. Add an in-line fuse on the positive lead and a charge controller with low-temperature charge cutoff (see safety note below).
Weatherproof enclosure (e.g. RAK Unify or equivalent IP-rated box)	5	Use an outdoor-rated enclosure with mounting bracket; verify the exact SKU's IP rating against the manufacturer datasheet before buying.
915 MHz fiberglass antenna (3 dBi)	5	~3 dBi over isotropic — a modest gain over a true half-wave dipole (~2.15 dBi), but a worthwhile upgrade over a stock rubber-duck whip.
Raspberry Pi 4 (base station)	1	Runs the data pipeline (MQTT broker / collector + database + dashboard)

The RAK4631/RAK19007 is configured over its onboard USB-C connector, which already provides a serial console — no separate USB-C-to-UART adapter cable is required for normal setup.

Battery safety (outdoor LiPo): outdoor nodes need an in-line fuse (or polyfuse) on the battery positive lead, and a charge controller/PMIC with a **low-temperature charge cutoff** so the pack is never charged below 0 °C (32 °F). Charging a lithium cell below freezing causes lithium plating — permanent capacity loss and a fire risk. A bare TP4056 has no such cutoff. This applies to LiFePO4 as well.

Solar sizing: a 0.5 W panel may be insufficient in low-sun months or cloudy climates. Size the panel and battery to your worst-month insolation and the node's actual duty cycle rather than assuming a fixed wattage carries a node year-round.

Node Placement Strategy

LoRa range depends heavily on terrain and obstructions. For a neighbourhood grid targeting 1 - 2 km node spacing:

- **Hilltops and ridge lines** - Priority placement. Raising an antenna extends the radio horizon: the line-of-sight distance to the horizon is roughly $4.12 \times \sqrt{h}$ km for antenna

height h in metres (about 13 km at 10 m, 16 km at 15 m for a flat earth), and the usable link is the sum of both ends' horizons. A rooftop-mounted node on a two-storey building often outperforms a ground-level hilltop node.

- **Open areas** - Parks, schoolyards, and sports fields with no obstructions in the LoRa Fresnel zone are ideal secondary sites.
- **Avoid dense urban canyons** - Buildings attenuate 868/915 MHz signals significantly, from a few dB for a single drywall partition to 20+ dB for reinforced concrete per wall. Place nodes at building edges or on roof parapet walls rather than interior courtyards.
- **1 - 2 km spacing** - With omnidirectional 3 dBi antennas and SF10 spreading factor, links around 1.5 km are achievable in favourable suburban line-of-sight conditions; obstructions, foliage, and terrain reduce this. Test with field RSSI measurements before finalising locations.

Use RF planning tools such as HeyWhatsThat or Radio Mobile to model coverage before physically deploying hardware.

Data Aggregation at the Base Station

The aggregation method depends on the firmware you flash:

- **Meshtastic (recommended for automated weather telemetry):** an ESP32 gateway node publishes telemetry to an MQTT broker (JSON output is supported on ESP32 gateways, not on nRF52). A collector subscribes to the broker and writes the readings to InfluxDB. Note the RAK4631 is an nRF52 board, so it cannot itself emit JSON-MQTT — pair it with an ESP32 gateway or a host-side bridge for the base-station role.
- **MeshCore:** there is no room-server sensor log to parse. Use the [MeshCore Sensor Data Integration](#) path — a host running `meshcore_py` requests telemetry from each node (CayenneLPP response) and writes the decoded values to InfluxDB.

A Grafana instance on the same Raspberry Pi can provide the neighbourhood dashboard, accessible via a local web browser or optionally published to the internet via a Cloudflare Tunnel for remote access without port-forwarding.

Sample Grafana panels for the weather station dashboard:

- Map panel showing node locations with colour-coded current temperature
- Time-series panel with all 5 node temperatures overlaid (last 24 hours)
- Humidity and pressure time-series with storm-front detection annotation
- Battery voltage panel to flag nodes needing maintenance
- Uptime table showing last-seen timestamp per node

Comparison with Weather Underground PWS Network

Weather Underground's Personal Weather Station programme allows individuals to contribute data to a public map. A mesh weather station network is complementary rather than competing:

- **Mesh advantage** - No internet connectivity required per node; data flows over radio. A single internet-connected base station is sufficient for the whole neighbourhood.
- **PWS contribution** - Optionally forward base station data to Weather Underground using the WU API to contribute to the public network and gain access to WU dashboard tools.
- **NOAA CoCoRaHS comparison** - CoCoRaHS focuses on manual rain gauge readings reported daily. An automated mesh network provides sub-hourly data and adds temperature, humidity, and pressure. The two approaches are complementary; mesh data can supplement manual CoCoRaHS reports for the same location.

Community Value Proposition

A neighbourhood mesh weather station network provides tangible community benefits beyond individual weather curiosity:

- **Urban heat island mapping** - Identify which streets or parks run significantly hotter in summer, informing tree-planting and shade-structure decisions.
- **Frost and freeze alerts** - Gardeners and small farmers can get a useful hyperlocal indication of frost or freeze from the nearest sensor node, which may differ from official forecasts based on airport weather stations kilometres away. Treat a single uncalibrated node as supplementary — cross-check against the National Weather Service forecast before acting on it.
- **Flood and drainage monitoring** - Nodes near drainage channels can trigger alerts on rapid barometric pressure drops correlated with heavy rain events.
- **Resilience during grid outages** - Solar-powered mesh nodes continue operating when mains power fails, providing situational awareness during severe weather events precisely when it is most needed.
- **Educational resource** - Open data from a neighbourhood sensor grid makes a compelling school science project, with real local data available for analysis.

Revision #5

Created 2026-05-03 06:11:42 UTC by Mesh America Admin

Updated 2026-06-10 03:17:45 UTC by Mesh America Admin