

Edge-Dry Telemetry Gateway: Proof of Concept & BOM

Project: Big Shoulders Restoration Site Telemetry Gateway

A rugged field gateway for restoration and structural-drying jobs. It gathers LoRaWAN environmental and material-moisture telemetry, performs local calculations and caching, captures visible and thermal images, and sends records to the company backend over cellular service.

Hardware Bill of Materials & Component Sourcing

Component Name & Details	Operational Function & Specifications	Sourcing Link
Raspberry Pi 5 (8GB RAM)	Central compute engine. Runs edge data structures, local SQLite logging, and audio/image processing.	Buy Raspberry Pi 5 [cite: 1]
Industrial M.2 NVMe SSD + M.2 HAT+	High-speed storage layer preventing file system corruption during sudden on-site power cuts.	Buy Raspberry Pi M.2 HAT+ [cite: 1]
Sixfab 4G/LTE Cellular Modem Kit (Telit LE910C1)	Establishes persistent connection over cellular towers to push real-time logs to the manager app API.	Buy Sixfab LTE Modem Kit [cite: 1]
Seeed Studio SenseCAP LoRaWAN HAT (915 MHz)	Wireless interface that listens to ambient room nodes (S2101) and structural pin nodes (S2100) across the building.	Buy Seeed Studio SenseCAP [cite: 1]
Raspberry Pi Camera Module 3 Wide (12MP, HDR)	Captures high-contrast site visual documentation inside	Buy Pi Camera Module 3 Wide [cite: 1]

Component Name & Details	Operational Function & Specifications	Sourcing Link
	dark basements, attics, and drying chambers.	
MLX90640 Thermal Infrared Camera Breakout	Reads surface temperature anomalies on structural elements to track hidden evaporative cooling and moisture.	Buy MLX90640 Thermal Breakout [cite: 1]
12V-to-5V Step-Down Buck + LiFePO4 UPS	Power management system providing clean internal battery backup ensuring 10+ minutes of continuous standby time during sudden site power cuts.	Industrial Power Distributor
Polycase ML Series Opaque Black Enclosure	Heavy-duty, solid-wall matte black polycarbonate enclosure with zero hinges or moving doors. Secured via corner machine screws into brass inserts for a true IP65 waterproof seal.	Buy Polycase ML Series

Physical Layout & Design Specifications

- **Hinge-Free Construction:** It will be built like a professional commercial console (similar to a PS5 core chassis), utilizing a solid-wall screw-cover box with zero doors or latches to eliminate weak points, dust gaps, or water intrusion.
- **Standby Power Requirement:** The integrated LiFePO4 UPS module guarantees a minimum of **10 minutes of active standby power**, allowing the Raspberry Pi 5 to safely flush active database transactions and log unexpected power outages before its shutdown.
- **External Interfaces:** Faceplate-mounted master toggle switch, green/red systemd status indicator LEDs, and waterproof aviation connectors (GX16) for external structural probes.

Compute and Storage

Raspberry Pi 5 with active thermal management and NVMe storage. The enclosure must provide a credible sealed-system thermal path; no unsupported claim of IP65 or thermal adequacy will be made before testing.

Local 915 MHz LoRaWAN reception.

Cellular uplink with externally serviceable antenna connections or sealed antenna pigtails.

Antennas separated from noisy switching-power electronics and metal mounting hardware.

Imaging

Camera Module 3 Wide behind a flush protective optical window.

MLX90640 behind a dedicated IR-compatible window; ordinary acrylic is not assumed suitable for long-wave infrared.

Power

Protected external DC input, power- path/UPS controller, LiFePO4 battery pack, regulated 5 V rail sized for Pi 5 plus modem transients, input-power-loss detection, and orderly shutdown control.

Human Interface

One guarded or recessed master power control.

Restrained status light pipe or small indicator band: normal, connecting/fault, and backup-power/shutdown state.

No exposed internal wiring or stacked-module appearance.

Interfaces and Connections

External DC input through a sealed connector or cable gland.

LTE and LoRa antennas through sealed bulkhead interfaces or internal antennas if RF testing supports them.

Camera and thermal windows on the user-facing panel.

Internal CSI, I2C, USB/PCIe, GPIO, and power harnesses secured and strain-relieved.

Power and Runtime Expectations

Continuous external power during normal field use.

Minimum backup runtime: 10 minutes at the actual worst- case operating load.

Preferred behavior: stay online briefly, record and report the outage, then shut down cleanly before battery undervoltage.

Battery chemistry: LiFePO₄ for durability and reduced thermal- runaway risk relative to common Li-ion packs.

Power Tree and Power Budget

The exact module variants must be verified before final component selection. For concept sizing, reserve a 25 W peak 5 V load envelope for the Pi 5, NVMe, radios, imaging, indicators, and modem transients.

Assumptions

Black exterior is a UV-stable, impact-resistant polymer or coated production enclosure; exact process is not yet selected.

Commercial module sizes, antenna types, and the final UPS pack remain provisional until sourced and measured.

The thermal sensor requires a material specifically transmissive at its operating infrared wavelength.

The first concept may use estimated internal massing because no PCB/module assembly has yet been placed in the project.

Change Notes

Added minimum 10-minute backup runtime and controlled- shutdown behavior.

Added premium matte-black product styling while retaining rugged field requirements.

Explicitly prohibited exposed module stacks, loose wiring, and utility-box appearance

Physical Design Expectations

Sophisticated matte-black exterior with concealed fasteners where practical, controlled seam lines, and no visible internal components or

loose wiring.

Soft rounded-rectangle body with a slightly raised or recessed sensor face.

IP65 design intent; qualification pending.

Magnetic base and integrated strap channel/bracket retained from the blueprint.

Flush visible-camera window and separate thermal-sensor window.

Antenna and power interfaces concentrated on a protected rear/lower service face. Internal partitions or shields should visually and mechanically organize compute, RF, and battery regions.

Firmware-Relevant Hardware Requirements

Detect loss and restoration of external power.

Expose battery voltage/state telemetry where supported.

Log power events locally before shutdown.

Controlled shutdown timer with a target near 8 minutes, retaining margin to complete shutdown before the 10-minute minimum expires.

Watchdog and automatic service recovery on reboot.