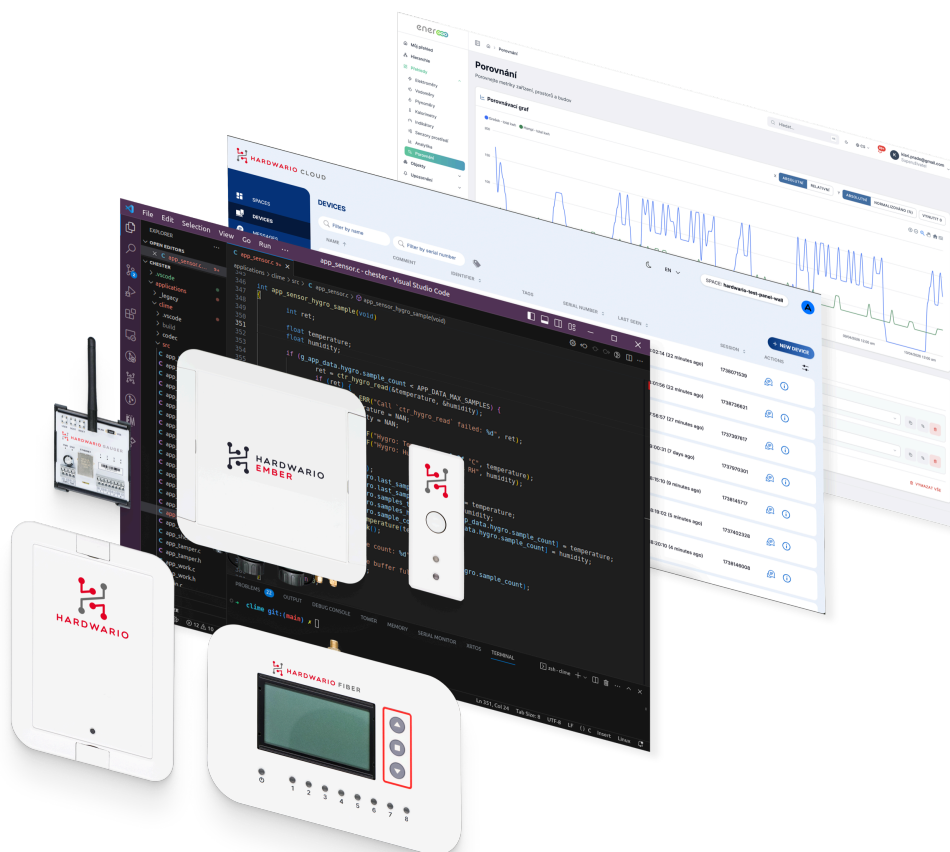


Reference Architectures for Six Industries

Field-proven monitoring blueprints — from the factory floor to the pharmacy fridge



Contents

1. How to use this book	2
2. One pattern, four layers	3
3. The hardware, one piece at a time	3
4. Manufacturing	5
5. Energy & utilities	7
6. Agriculture	8
7. Healthcare	9
8. Construction & real estate	11
9. Retail	12
10. Choosing your first architecture	13

1. How to use this book

Most industrial-IoT projects don't fail on the sensor. They fail in the gaps between layers: the meter that speaks a protocol the receiver doesn't, the network the customer can't own, the cloud that won't hand data to the system where decisions are made.

This book closes those gaps in advance. It holds six monitoring blueprints — manufacturing, energy, agriculture, healthcare, construction and real estate, retail — and every one of them follows the same pattern. Learn the pattern once, in the next chapter, and each industry becomes a short read: the problem, the picture, what gets installed, what the customer sees, and the proof.

Find your customer's industry. Take the blueprint as the starting point of the proposal. Change only what the site survey forces you to change.

TERMS YOU'LL MEET

Eight terms carry most of this book. Everything else is explained where it first appears.

LPWAN

Low-power wide-area network: radio designed to carry small messages over long distances, for years on a battery.

LoRaWAN

An LPWAN you can run yourself, on your own receivers, with no mobile operator involved.

Network server

The software that runs a LoRaWAN network: it knows which devices belong and hands their data onward.

Modbus

A decades-old industrial protocol that PLCs and control systems use to read values from devices.

NB-IoT / LTE-M

Cellular flavors of LPWAN. The device uses the mobile network, like a phone does, but sips power.

Gateway

The box that receives radio messages from nearby sensors and passes them on over the internet.

PLC

The rugged computer that controls a machine on a factory floor.

FOTA

Firmware over the air: updating a device's built-in software remotely, with no site visit.

2. One pattern, four layers

Every blueprint in this book is the same picture with different labels. Four layers, each chosen independently:



Figure 1 — The four-layer pattern behind all six blueprints.

Devices do the measuring: temperature, humidity, electrical pulses, weight, movement. They run on batteries or the site's own power.

Connectivity is how readings travel. Either each device carries its own cellular connection (NB-IoT or LTE-M), or the devices share a private LoRaWAN network built on a gateway the customer owns. Choose per site; both paths can serve one fleet.

Collection is where the fleet is managed. Cellular devices report to HARDWARIO Cloud, which handles device health, firmware updates over the air, and a remote diagnostic shell (99.9 % availability SLA, EU-hosted, GDPR-compliant). Private LoRaWAN networks run a network server — ChirpStack or The Things Stack — self-hosted or operated by HARDWARIO as a service.

Customer systems are the destination. Data leaves through open interfaces (REST API and webhooks from the Cloud, MQTT and webhooks from the network server) and lands in ThingsBoard or a purpose-built application, then flows onward into the ERP, MES, or BI systems the customer already runs. Analytics live there, in the customer's world. The platform moves data; it does not trap it.

The white-label thread runs through all four layers: your logo printed on the devices, a radio network the customer owns, a multi-tenant dashboard under your brand, and your application on top. The end customer sees your product.

3. The hardware, one piece at a time

Five devices populate all six blueprints. Meet them here; the industry chapters use their names freely.


BUILDING BLOCK 1

CHESTER

The all-rounder. A modular monitoring platform in a rugged box: plug-in expansion modules decide what it measures, and it reports over the mobile network or LoRaWAN.

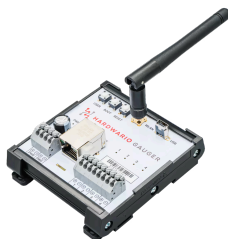
- 3+ years on one primary lithium battery; solar, 24 V DC, and 230 V AC options
- IP67 enclosure, rated -20 to +60 °C
- 15+ ready-made applications — no firmware development needed


BUILDING BLOCK 2

STICKER

The volume sensor. A palm-sized LoRaWAN device that watches temperature and humidity wherever you put it — plus external probes, voltage inputs, and a motion option.

- 2+ years on two standard AA cells
- Configured by tapping a phone against it (NFC), even with the batteries out
- Mounts with two screws or double-sided tape


BUILDING BLOCK 3

GAUGER

The production counter. It sits on the DIN rail, counts electrical pulses from machines, and lets the factory's own systems read the totals straight from it.

- 4 galvanically separated pulse inputs for 24 V industrial signals (PNP)
- Built-in Modbus TCP server and REST API, over WiFi or Ethernet
- Powered from 9–28 V DC; no changes to existing PLC programs


BUILDING BLOCK 4
EMBER

The network builder. A LoRaWAN gateway: one unit receives from hundreds of nearby sensors and forwards everything over LTE or Ethernet.

- 8-channel LoRaWAN concentrator (EU868 / US915)
- IP67 enclosure, mounts indoors or outdoors; 11–28 V DC
- Builds a network the customer owns — no per-device network fees


THE RADIO HEART OF EMBER

An 8-channel LoRaWAN concentrator card. One gateway listens to hundreds of sensors at once.


BUILDING BLOCK 5
FIBER

The edge computer. An embedded Linux device with eight wired temperature inputs and an on-site display. It runs your own software, right where the measurement happens.

- 8× 1-Wire inputs, backlit LCD with per-channel LEDs
- PoE powered (IEEE 802.3af) with Li-Ion battery backup
- Delivers data over MQTT with TLS; open platform with root access

4. Manufacturing

THE PROBLEM

In a Vanson Bourne study for ServiceMax, 82 % of companies reported at least one episode of unplanned downtime over three years. On most factory floors the losses start earlier: short stops and slow changeovers never reach the manual report, and machine effectiveness is debated instead of measured.

The hardest constraint is the equipment itself. Decades of machines, many without a PLC, and none of them may be rewired or stopped for a monitoring project.

THE PICTURE



Figure 2 — Manufacturing: machine counts and states flow into the systems the plant already runs.

WHAT GETS INSTALLED

Device	What it does
GAUGER	Counts machine cycles from 24 V pulse signals, with or without a PLC; the plant's MES or SCADA reads the totals straight from its built-in Modbus TCP server and REST API
CHESTER Current	Clamp-on current transformers read machine load from existing cables — up to 4 machines per battery-powered device, with no electrician and no rewiring
CHESTER Push	A wireless help button for the line — up to 4 buttons per device for timestamped worker escalation, reported over the mobile network

GAUGER mounts on the DIN rail in the existing cabinet; the CHESTER devices run on battery. No PLC program changes, no rewiring, no production downtime. A first line is live in days.



GAUGER UP CLOSE

Power terminals on the left, Ethernet in the middle, four pulse inputs on the right, WiFi antenna on top. The plant reads its counts over Modbus TCP — straight from the DIN rail, with no PLC program changes.

WHAT THE CUSTOMER SEES

True counts and machine states per shift, in the MES and SCADA screens the plant already uses, or in a dashboard under your brand. The pilot question is usually one number: hidden idle time, a specific failure mode, or real availability per shift.

PROOF
KSB — from pilot to certified series production

Global pump manufacturer KSB partnered with HARDWARIO to monitor industrial pump systems. The jointly developed second-generation system is certified — CE, RED, EMC, Safety, IP67, EN 18031 — and in series production. The platform that answered the pilot's question carried an OEM product through certification into manufacturing.

5. Energy & utilities

THE PROBLEM

The EU Energy Efficiency Directive requires remote meter reading, and the deadlines are not moving. Meanwhile manual reading rounds keep compounding across buildings and boiler rooms, and waste surfaces only when the invoice arrives. Per U.S. EPA / ENERGY STAR figures, about 30 % of the energy used in commercial buildings is wasted.

The constraint is the meter estate. Thousands of installed meters, and none of them will be replaced for a monitoring project.

THE PICTURE


Figure 3 — Energy: the existing meter estate becomes remotely readable, without replacing a single meter.

WHAT GETS INSTALLED

Device	What it does
CHESTER wM-Bus	Listens to wireless M-Bus — the radio most utility meters already speak (T1/C1) — and collects up to 128 meters per unit, running 7+ years on battery at a daily readout
CHESTER Energy	Polls Modbus electricity meters over an RS-485 wire — up to 8 meters per bus — and reports the readings over NB-IoT / LTE-M
GAUGER	Counts the pulse outputs of wired meters in utility rooms; totals served over its built-in Modbus TCP server and REST API

No meter replacement and no site wiring: the wM-Bus reader is battery-powered, install-and-forget. Readings reach NB-IoT even in basements and metering rooms.

WHAT THE CUSTOMER SEES

Every reading lands in the billing, ESG, or BI system where their analytics already live, fed by the Cloud's REST API and webhooks, with an exportable audit trail behind it. Group the estate by meter protocol and pilot on the lowest-risk group of 50–100 meters.

PROOF

E.ON and Surun Services — two utility deployments

For E.ON, battery-powered CHESTER units monitor temperature and humidity inside cable cabinets over NB-IoT, reporting daily for years. In Western Australia, Surun Services launched an energy-metering service on CHESTER: an RS-485 extension reads a SATEC industrial power meter over Modbus and reports over LoRaWAN — in an enclosure carrying Surun's own logo.

6. Agriculture

THE PROBLEM

Stored grain is capital sitting in a steel cylinder. Without control of temperature and humidity, mold and moisture migration can destroy it; entire silos have been emptied and discarded after undetected degradation.

The sites are the hard part. Bins, barns, and fields with no grid power, no WiFi, extreme cold, and inspection routines that cannot keep pace with seasonal windows.

THE PICTURE



Figure 4 — Agriculture: monitoring that survives the sites where it is installed.

WHAT GETS INSTALLED

Device	What it does
CHESTER GrainLink	Instruments silos with multi-point temperature cables, humidity, and fill tracking; solar or battery powered
CHESTER Meteo	A weather station — wind, rain, temperature, pressure — feeding frost and irrigation decisions
STICKER Clime / Input	Covers barns and storage rooms on AA batteries; soil-moisture and leak-detection variants watch fields and water lines
EMBER	Builds private LoRaWAN coverage for farms and storage campuses — a network the customer owns, with no per-device network fees

The hardware is IP67 and rated -20 to $+60$ °C — and field-proven far below that rating in Canadian winters. A farmer mounts a unit on a silo or pole in minutes and configures it from a phone.

THE BOX THAT SURVIVED -48.8 °C

CHESTER with the lid off: one primary lithium battery, a cellular modem, and terminal blocks for whatever the site needs.



WHAT THE CUSTOMER SEES

Alerts before spoilage, not reports after it: hotspot warnings, frost alarms, and trends in a purpose-built application. Pilot on the highest-risk asset before the season that matters, then replicate the same configuration across bins and sites.

PROOF

GrainLink — 1,000+ systems across North America

GrainLink builds its grain-storage monitoring product on CHESTER. Over 1,000 systems track temperature and humidity in silos across Canada and the USA, and the same technology is expanding to Brazil, Europe, and Australia. In the words of Axilera's CTO: "Whether it's -40 degrees or $+40$ degrees, exposed to scorching heat or blanketed in ice, the device continues to operate without fail."

7. Healthcare

THE PROBLEM

Good Distribution Practice requires documented, unbroken temperature control for pharmaceuticals, vaccines, and blood products. Manual logs are exactly what fails an audit: hard to verify, easy to miss, blind between rounds.

An excursion in a pharmacy fridge can compromise stock before the next scheduled check. Every additional ward and cold room multiplies the workload on clinical staff.

THE PICTURE



Figure 5 — Healthcare: audit-ready records, with readings visible right at the point of care.

WHAT GETS INSTALLED

Device	What it does
STICKER Clime	Watches fridges, freezers, and medication storage — compact, provisioned from a phone over NFC, 2+ years on AA cells
CHESTER Clime	Covers cold rooms and blood banks with up to 32 external wired temperature probes per device
CHESTER Display	Adds an on-site readout at the point of care: a 400 × 240 LCD with OK/alarm states and a buzzer
FIBER	Handles wired precision zones — 8 probe inputs, PoE power with Li-Ion battery backup so monitoring rides through outages

Everything on this list is wireless or PoE. No conduits through clinical areas, and pilots install without disturbing operations.



AT THE POINT OF CARE

A CHESTER-based unit with display and buzzer: staff see conditions and alarms without opening an app — here printed with the deploying partner's own brand.

WHAT THE CUSTOMER SEES

Continuous logs, event history, and exportable audit trails replace transcription; calibration certificates support compliance. Alerts route to dashboards, SMS, e-mail, or push in the application layer. Start at the highest-risk storage point and validate the alarm workflow with the quality team before rolling out by department.

PROOF

O.K. SERVIS BioPro — hospital networks in production

Through its partner O.K. SERVIS BioPro, HARDWARIO monitoring runs in renowned hospitals: STICKER sensors watch vaccine refrigerators in the Prague Central Military Hospital, the Canadian Medical clinic network in the Czech Republic, and Agel facilities in Slovakia. BioPro also deploys the display units across multiple hospitals, putting readings and alarms directly in front of clinical staff.

8. Construction & real estate

THE PROBLEM

Infrastructure safety and building performance are both inspection problems. Quarterly visual checks leave long blind periods in which tilt, vibration, settlement, or a radon concentration goes unmeasured. ESG reporting without instrumented data degrades into spreadsheet assembly.

And every proposed fix meets the same resistance: nobody wants a monitoring project that means rewiring an occupied building or trenching a live site.

THE PICTURE



Figure 6 — Construction & real estate: continuous data where there used to be quarterly inspections.

WHAT GETS INSTALLED

Device	What it does
CHESTER Structure	Reads displacement, strain, tilt, and vibration sensors on bridges, retaining walls, and buildings; battery, DC, or solar powered
CHESTER Radon / Clime IAQ	Continuous radon measurement (up to 32 probes) and indoor air quality — CO ₂ , VOC, temperature, humidity
CHESTER Current + GAUGER	Tenant sub-metering from clamp-on current transformers and existing meters' pulse outputs — no rewiring, no construction work
EMBER	Covers the site or campus with private LoRaWAN, including temporary construction-phase networks

Wireless sensors, clamp-on transformers, and pulse taps mean installation in occupied buildings without construction work. On remote structures, battery and solar power remove the electrician from the critical path.

WHAT THE CUSTOMER SEES

An early-warning system instead of an archive: alert thresholds on movement and air quality, plus instrumented data feeding LEED/BREEAM submissions and ESG workflows from day one.

PROOF

Statotest and Skanska — infrastructure in production

Statotest builds its structural-monitoring solution on CHESTER: bridges, retaining walls, and buildings monitored continuously for movement, with automated alerts — including three units watching cracks and column movement at the Liberec swimming pool ahead of reconstruction. Skanska piloted remote water-level measurement in garages and rainwater tanks with CHESTER units and ultrasonic sensors over NB-IoT, integrated into the Sharpy building platform its managers already use.

9. Retail

THE PROBLEM

Store operations leak margin in three quiet places. Cold-chain excursions turn chilled goods into write-offs before anyone notices. Shelves run empty while safety stock over-orders elsewhere. Layouts and staffing get tuned by instinct, because foot traffic was never actually counted.

Multiply by a store estate, and manual checking is a payroll line, not a process.

THE PICTURE



Figure 7 — Retail: shelf, cooler, and traffic signals from every store, on one platform.

WHAT GETS INSTALLED

Device	What it does
CHESTER Scale	Weighs shelf and pallet inventory on strain-gauge load cells, with remote tare and calibration
STICKER Clime	Watches coolers, display cases, and stockrooms, running 2+ years on AA batteries
CHESTER Motion	Counts foot traffic with dual motion sensors that distinguish direction of movement
EMBER	One private LoRaWAN network per store — a repeatable kit for chain-wide rollout, with no per-device network fees

Everything is battery-powered and wireless, so pilots install during opening hours. The per-store network kit is what makes a chain deployment quotable: the same bill of materials, repeated.



THREE FACES OF STICKER

The same palm-sized sensor, with variants for climate, inputs, and motion. Two screws or a strip of tape, and it's installed.

WHAT THE CUSTOMER SEES

Refrigeration alerts before the write-off, shelf-weight trends, and counted (not guessed) foot traffic, consolidated across the estate and handed to operations and supply-chain platforms over the REST API. Start with the loss that is easiest to measure and validate against the store's manual routine.

PROOF

ADASTRA — a strategic retail partnership

After successful joint IoT pilots with leading retail players in the Czech Republic and abroad, ADASTRA and HARDWARIO agreed to continue their strategic cooperation in retail digitalization: ADASTRA Lab develops IoT solutions for retail and the wider supply chain, with HARDWARIO as its key supplier — particularly for smart shelving and scales.

10. Choosing your first architecture

Across six industries, the pattern held: the same four layers, the same five devices, different catalog applications. That regularity is the commercial point. An integrator who deploys the manufacturing blueprint has already learned most of the energy one; a per-store retail kit is a per-site agriculture kit with different sensors.

Three rules carry across every chapter:

1. **Start where the loss is measurable.** Every blueprint begins with one number the customer already believes: downtime, spoilage, an audit finding, the cost of a reading round. The pilot exists to move that number.
2. **Decide connectivity per site, not per fleet.** Cellular for dispersed and fast; a private LoRaWAN network for dense and owned. Both paths end in the same integration layer, so the choice never forks your product.
3. **Keep the data's destination in the customer's world.** ThingsBoard or a purpose-built application, then the systems where decisions happen. The platform's job is to make that hand-off boring.

A HARDWARIO deployment typically goes from the first call to live data in 2–4 weeks. What happens after the pilot works — provisioning at fleet scale, operations, and the partner economics — is the subject of the companion booklet, *The Integrator's Guide: from PoC to 1,000 Devices* (HWP.260705.01).

Pick the blueprint. We'll help you quote it.

Bring us the site: the machines, the meter estate, the silo, the cold room, the store.
HARDWARIO's engineers will map it to one of these six blueprints, flag what the site survey must confirm, and help you scope a pilot that goes live in 2–4 weeks.

Start at www.hardwario.com or write to ask@hardwario.com.

- [Book a 30-minute call](#)
- [Read the documentation](#)
- [Explore the industry solutions](#)

ABOUT HARDWARIO

HARDWARIO a.s. designs and manufactures industrial IoT devices in Liberec, Czech Republic. Founded in 2016 and listed on the Prague Stock Exchange, the company does more than 80 % of its business through its partners.

HARDWARIO a.s.

HEADQUARTERS

U Jezu 525/4
460 01 Liberec
Czech Republic

HARDWARIO LTD

LONDON OFFICE

10 John Street
London WC1N 2EB
United Kingdom

HARDWARIO LLC

HOUSTON OFFICE

2500 Wilcrest Dr, Suite 624
Houston, Texas 77042
USA