RUBINLAKE



PRODUCT SECURITY

Connected Products DACH 2027

Security is cheap. Waiting costs markets.

RUBINLAKE GmbH

Version 1.2

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Executive summary

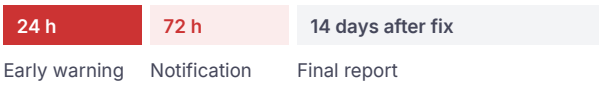
In machinery and equipment, it is no longer only the factory that is connected but also the product that leaves it. The large majority of surveyed German makers of products with digital elements (94 %) already sell devices that can be updated in the field. Each of these devices extends the manufacturer's responsibility beyond the factory gate and is a potential point of attack. The European Commission puts the damage its Cyber Resilience Act (CRA) could spare EU businesses at €180-290 billion a year.

Europe has answered with five acts: the CRA, the Data Act, the Machinery Regulation, the cybersecurity rules of the Radio Equipment Directive and the Batteries Regulation. Between August 2025 and December 2027 they make security, updates and data access a condition of market access. The first duty already applies. Since 11 September 2026, manufacturers must report actively exploited vulnerabilities within 24 hours through ENISA's single reporting platform.

The hardware of products launching in 2027 has to be fixed now. Yet no harmonised standard under the CRA or the Machinery Regulation is in the Official Journal, and no notified body has yet been designated under the CRA. Reliable cost figures are scarce, and few of the surveyed makers are ready. Whether security belongs in the product is no longer the manufacturer's decision but the law's.

DEADLINE

24 hours to the early warning on an actively exploited vulnerability



READINESS

3 % of surveyed makers consider themselves fully CRA-compliant



STANDARDS

0 of 41 requested CRA standards cited in the Official Journal



COST

< €0.50 security premium per device and month at 10,000 units



This report examines which design secures a connected product most cheaply over its life. It answers the question for manufacturers with 100 to 4,999 staff in Germany, Austria and Switzerland, using four typical devices: a battery tool, a machine with a gateway, a controllable building device such as a heat pump, and a logistics tracker. For these devices our cost model prices the base cost of radio and cloud and the security premium at list prices, in the base case for 10,000 units per product over five years. The security premium is small per device and about the same for every product. Unit volume, radio and backend decide the bill, and these choices are made before the standards arrive.

Main findings

F1 The obligations reach the installed base, not only new products.

86 million M2M SIM profiles in German networks, +17 % in one year

Active SIM profiles in Germany, end of 2025, million

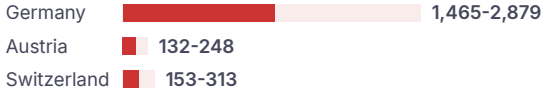


CRA vulnerability reporting has applied to installed devices since 11 September 2026.

F2 The Mittelstand is affected across the board, and readiness lags far behind.

1,750-3,440 makers in DACH, estimated

Makers of connected products, estimated range



Only half of the surveyed German makers have started implementing the CRA.

F3 A gateway sold on its own has no route to conformity yet.

0 notified bodies under the CRA so far

Conformity assessment under the CRA

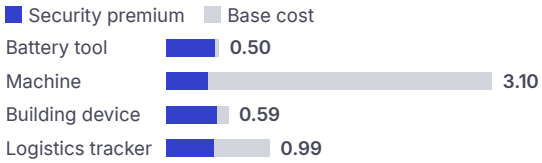
Battery tool	Self-assessment
Machine	Self-assessment
Building device	Self-assessment
Logistics tracker	Self-assessment
Gateway, class I	**Notified body, none yet**

A class I gateway needs a notified body as long as no harmonised standard exists.

F4 Compliance is not what makes a connected product expensive.

€0.50-3.10 base cost and security premium per device and month

Cost per device and month, EUR

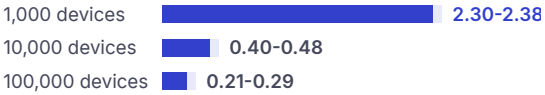


The radio and the backend decide the total, not security.

F5 Unit volume matters more than any component.

€2.30 security premium per device and month at 1,000 units

Security premium per device and month, EUR



Fixed costs spread over all devices. The secure element is the smallest item.

F6 Tracker designs need a new battery concept and cellular without 2G.

2028 Germany's 2G networks close

Deadlines for new trackers



Most portable batteries must be removable by the user from 18 February 2027.

Manufacturers that settle architecture and backend now spread the cost of security over their whole fleet. Those that wait for the standards will design under deadline pressure, with fewer choices left. Chapters 1 to 7 set out the evidence, and Section 8 turns it into recommendations for the different roles in a company.

1 Deadlines and scope

Connected tools, machines, building devices and trackers developed today will reach a single market whose rules change fundamentally by December 2027. Five EU acts cover every one of these products by then, and the vulnerability reporting duty has applied since September 2026, also to devices in the field. Harmonised standards are still missing. We estimate that 1,750 to 3,440 makers in DACH are affected, and few of the surveyed firms are ready. The chapter sets out the dates and the scope of each act and shows where the standards and the manufacturers stand.

1.1 Connected devices in DACH

Germany's mobile networks carried 86.1 million machine-to-machine (M2M) SIM profiles at the end of 2025, 17 % more than a year earlier.[78] That is about four fifths of the 106.4 million other active SIM profiles.[78] Austria counted 27.5 million M2M SIM cards at the end of 2025, twice the 13.8 million other SIM cards in use and more than three times the 8.4 million of the end of 2021. Some of them work in devices abroad.[337, 338] In Switzerland, M2M subscriptions rose by 14.3 % to 5.2 million in 2024, while mobile subscriptions overall grew by 2.5 %.[48]

These counts cover only devices on mobile networks. Tools and building devices that connect over BLE or Wi-Fi come on top. Worldwide, Ericsson counts 22.3 billion Internet of Things (IoT) connections at the end of 2025, of which 4.5 billion, about a fifth, are cellular.[134] Ericsson expects the total to more than double to 47.1 billion by 2031.[134]

1.2 From reporting duties to full application

Vulnerability reporting under the Cyber Resilience Act (CRA) has applied since 11 September 2026, the Machinery Regulation applies from 20 January 2027 and the full CRA from 11 December 2027.[167, 168, 171] Five legal acts set the pace: the CRA,[171] the Data Act,[170] the Machinery Regulation,[168] the cybersecurity delegated act under the Radio Equipment Directive (RED)[141] and the Batteries Regulation with its battery passport.[169] All five are regulations. They apply directly in Germany and Austria without national transposition, and to products from Switzerland as soon as those are placed on the EU market. Three of the six deadlines already apply, and the full CRA comes last (Figure 1). A product whose development starts now and which ships in 2028 has to meet all five acts at once.

A corrigendum moved the Machinery Regulation date from the original 14 January.[167] After an amendment, the RED delegated act has applied from 1 August 2025, one year later than first adopted.[145] Five of the eight application dates have passed, and the full CRA comes last (Table 1).

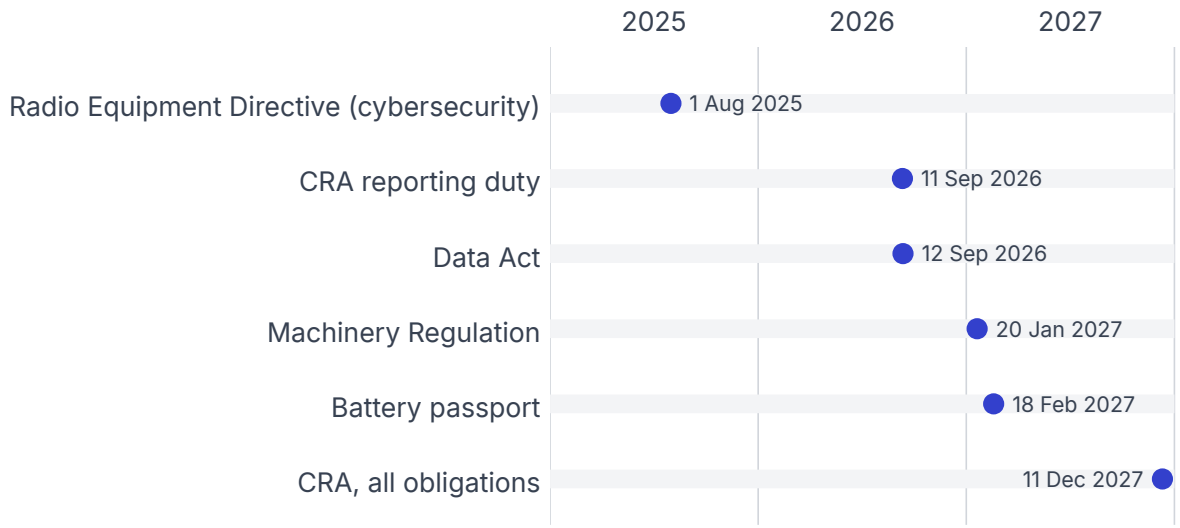


Figure 1: **Application dates of the EU acts**

DATE	ACT	OBLIGATIONS THAT APPLY	PRODUCTS IN SCOPE
1 Aug 2025	RED Delegated Reg. 2022/30	Essential requirements on network protection, personal data and fraud	Radio equipment placed on the market from this date
12 Sep 2025	Data Act	General application: pre-contract information, user and third-party access rights, contract rules	Connected products and related services in the EU
11 Jun 2026	CRA	Rules for notifying conformity assessment bodies	Notified bodies and authorities
11 Sep 2026	CRA	Reporting of actively exploited vulnerabilities and severe incidents	All products with digital elements on the market, including those placed before 2027
12 Sep 2026	Data Act	Access by design and by default	Connected products placed on the market after this date
20 Jan 2027	Machinery Regulation	Full application; Machinery Directive 2006/42/EC repealed	Machinery and related products placed on the market from this date
18 Feb 2027	Batteries Regulation	Battery passport, QR code on all batteries, end-user removability of portable batteries	Batteries and products incorporating them placed on the market from this date
11 Dec 2027	CRA	Essential requirements, conformity assessment, CE marking	Products with digital elements placed on the market from this date

Table 1: **Application dates and products in scope**
Sources: [141, 145, 167, 168, 169, 170, 171].

11 September 2026, CRA reporting. Article 14 applies fifteen months before the rest of the regulation.[171] An actively exploited vulnerability or a severe incident requires an early warning within 24 hours and a notification within 72 hours.[171] Both go through ENISA's Single Reporting Platform, which has run since 11 September 2026.[133, 156] The final report is due 14 days after a fix or mitigation is available, or for a severe incident one month after the notification.[171] Reports go to the CSIRT acting as coordinator in the Member State of the main establishment, and ENISA receives

them at the same time.[171] Impacted users must be informed, where appropriate in a structured, machine-readable format.[171] Open-source software stewards report only from 11 December 2027.[156]

The duty also covers products placed on the market before 11 December 2027.[171] It applies today to a tool sold in 2023 that is still in the field.

12 September 2025 and 12 September 2026, Data Act. Access by design and by default covers only products placed on the market after 12 September 2026.[170] The user's rights to obtain data and to have it shared with a third party, by contrast, have applied since 12 September 2025 without a cut-off date for placing on the market. They therefore reach the installed base as well.[170]

11 June 2026, CRA notified bodies. Member States have been able to notify conformity assessment bodies under the CRA since 11 June 2026.[171] No body has been notified under the CRA so far.[161] Germany has registered the BSI as its notifying authority, Austria has registered none.[161]

20 January 2027, Machinery Regulation. The Machinery Regulation replaces the Machinery Directive 2006/42/EC on this date.[167, 168] Machinery placed on the market under the Directive before that date may still be made available afterwards.[168] The essential requirements on protection against corruption and on the safety and reliability of control systems are new for connected machinery.[168]

18 February 2027, batteries. Batteries for light means of transport (LMT), industrial batteries above 2 kWh and electric-vehicle batteries placed on the market from this date need a battery passport with data on the individual battery, including data from its use.[169] All batteries need a QR code, and products with portable batteries must let the end-user remove and replace them.[169]

1.3 Scope and exemptions

None of the exemptions takes a typical tool, machine, building device or tracker out of scope. The CRA excludes medical devices, vehicles, aviation, marine equipment and defence.[171] The differences between products lie in the detail of each act.

CRA. The CRA covers products with digital elements whose intended or reasonably foreseeable use includes a direct or indirect data connection to a device or network.[171] Apart from the reporting duty, legacy products fall under the CRA only if they are substantially modified once it applies in full.[171] EU type-examination certificates issued for cybersecurity requirements under other Union harmonisation legislation remain valid until 11 June 2028.[171]

RED delegated act. Since 1 August 2025, radio equipment that can reach the internet must protect the network.[141] It must also protect personal, traffic and location data where it processes them.[141] The act counts communication "via any other equipment", so a Bluetooth tool that reaches the cloud through a smartphone app is covered.[141] Medical and IVD devices are excluded from all requirements, and products under the aviation, vehicle type-approval and road-toll legislation only from data protection and fraud protection, not from network protection.[141] Delegated Regulation 2026/339 repeals the act with effect from the day the CRA applies in full.[154] From then on a radio product answers to one cybersecurity regime, the CRA, instead of two.[154] Radio equipment placed on the market up to 10 December 2027 remains subject to market surveillance against the requirements of the delegated act.[154]

Data Act. A connected product is an item that "obtains, generates or collects data concerning its use or environment" and can communicate them, and "whose primary function is not the storing, processing or transmission of data on behalf of any party other than the user".[170] The access obligations of Chapter II do not apply to micro and small enterprises without large partner or linked

enterprises. They reach medium-sized enterprises one year after they qualify as such or one year after placing a product on the market.[170] A small enterprise employs fewer than 50 persons, a medium-sized one fewer than 250.[138] Makers with 100 or more staff therefore gain at most one year's grace per product.[170] The Commission's Digital Omnibus proposal of 19 November 2025 would amend the Data Act. At the time of publication it is at first reading and not adopted.[153, 174] The text in force applies.

Machinery Regulation. Cordless power tools and stationary machines meet the definition of machinery: an assembly with a drive system other than human or animal effort and at least one moving part.[168] Mandatory third-party assessment applies to six categories, among them safety components and embedded systems with self-evolving behaviour that use machine learning for safety functions.[168] Household appliances for domestic use, audio, video and IT equipment, office machinery and low-voltage switchgear are excluded insofar as they fall under the Low Voltage Directive or the RED.[168]

Batteries Regulation. A portable battery is sealed, weighs 5 kg or less and is "not designed specifically for industrial use".[169] Any battery above 5 kg that is not an electric-vehicle, LMT or starting, lighting and ignition (SLI) battery is an industrial battery.[169] Typical power-tool packs and tracker cells are therefore portable batteries and need no passport. A stationary home storage battery, by contrast, is an industrial battery and needs a passport above 2 kWh.

1.4 Status of harmonised standards

Of the five acts, only the RED has harmonised standards in the Official Journal, while none has been cited yet for the CRA or the Machinery Regulation (Table 2).[136, 148, 151, 159] The CRA standardisation request asks for 41 standards, the first of them due on 30 August 2026.[147] ETSI has had 17 vertical CRA drafts in public enquiry since August 2026.[136] Depending on the product category, the enquiry closes between mid-September and mid-November 2026.[136]

ACT	STATUS	STANDING
RED 2022/30	EN 18031-1, −2 and −3:2024 cited in the Official Journal on 30 Jan 2025, with restrictions (no presumption if users may skip passwords; for −2 parental control; for −3 clause 6.3.2.4)	Official
CRA	Standardisation request M/606 (C(2025) 618, 3 Feb 2025): 41 standards. Original deadlines: 2 core horizontal standards 30 Aug 2026, 26 vertical standards 30 Oct 2026, 13 further horizontal standards 30 Oct 2027	Official request
CRA	ETSI: 17 vertical drafts in public enquiry since 13 Aug 2026; CEN/CENELEC horizontal standards scheduled for the end of 2026	Draft
Machinery Regulation	No list of harmonised standards under Regulation 2023/1230 published; the Commission expects the first list before the end of 2026	Draft
Machinery Directive	List updated by Implementing Decision 2026/2015 of 4 Sep 2026; repealed with effect from 20 Jan 2027	Official, expiring
Guidance	BSI TR-03183 Parts 1, 2, 3 and H: non-binding, no presumption of conformity	Guidance

Table 2: **Harmonised standards by act**
Sources: [54, 82, 136, 147, 148, 151, 155, 159].

CRITICAL

No presumption of conformity yet for the CRA

Once the Directive is repealed in January 2027, its list of harmonised standards lapses with it, and no list under the Machinery Regulation or the CRA has replaced it yet. Until the first list appears, new machinery reaches the market without a presumption of conformity from harmonised standards.

Class I products under the CRA may self-assess only if they apply harmonised standards, common specifications or a European certification scheme in full.[171] Without them they need a notified body, which does not yet exist under the CRA. The gap therefore weighs most on these products.

1.5 Affected manufacturers and readiness

Of the 4,410 manufacturers in DACH with 100 to 4,999 staff, we estimate that between 1,750 and 3,440 make connected products, more than four fifths of them in Germany (Figure 2).[37, 56, 175, 190, 367] Preparation for the CRA lags behind. Only 3 % of the surveyed German industrial firms consider themselves fully compliant.[330]

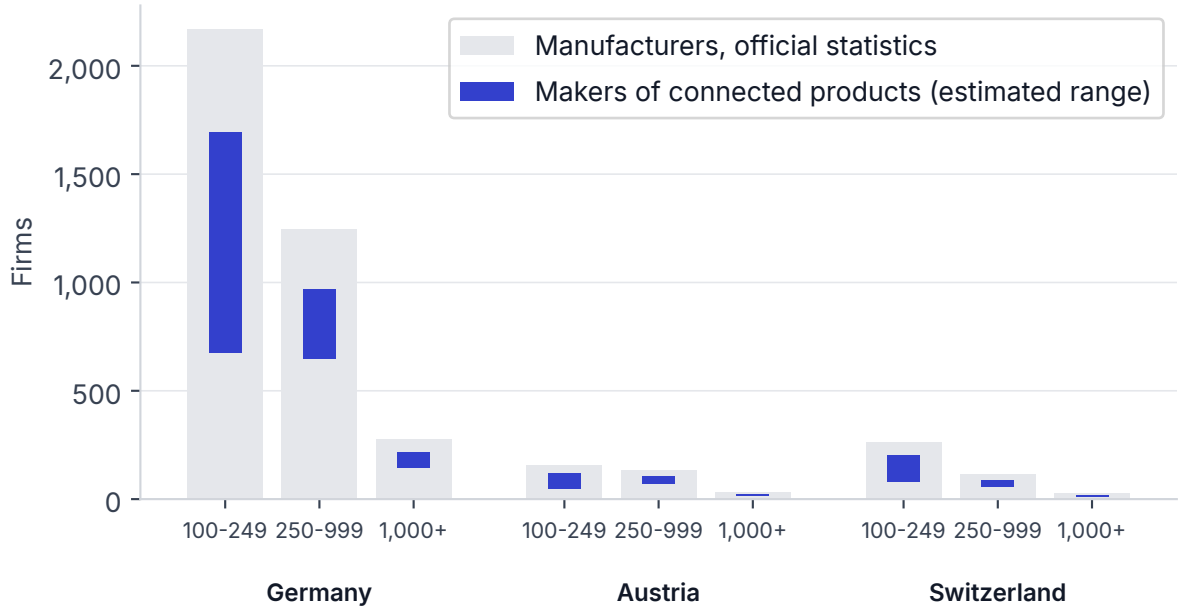


Figure 2: **Manufacturers by country and size band**
Note: Switzerland 2024, otherwise 2023. Sources: [37, 56, 175, 190, 367].

The population is small and concentrated. In Germany the 3,692 firms with 100 or more employees in electronics, electrical equipment, machinery and medical technology (WZ 26, 27, 28 and 32.5) make up about a third of the 11,359 legal units in these industries with 20 or more staff. Yet they employ 1.77 million of the 2.11 million people working there, or 84 %.[367] The 100-249 band holds most firms but the lowest share of makers of connected products. Our estimate is least certain there, with a range of 673 to 1,692 German makers of connected products (Section A.3).[37, 190, 367]

- **Connected functions are standard in larger firms.** The large majority of the 100 surveyed German industrial companies with products with digital elements (94 %) already offer updatable products.[331] Of 555 surveyed manufacturers with 100 or more employees, 45 % use IoT platforms and another 33 % plan to.[37]
- **Implementation depends on company size.** Half of the surveyed firms have started active CRA implementation, 59 % of those with 500 or more employees and 37 % of the smaller ones. As

many have no dedicated external reporting channel for vulnerabilities, although the reporting duty already applies.[330, 331]

- **Software bills of materials are mostly missing.** Of 200 surveyed German industrial companies, 18 % have a software bill of materials (SBOM) for all affected products, 39 % have at least partially inventoried their software and 24 % have done nothing.[307] Only 46 % are familiar with the CRA.[307]
- **Awareness is low across the economy.** Of 1,003 surveyed German companies with 10 or more employees, 29 % know what the CRA means for them.[36] More than a quarter (28 %) have never heard of it.[36]

IN SUMMARY

Connected-product regulation is not a project for December 2027 but already demands a working reporting process for devices that have been sold. Design decisions for products entering development now are made without standards to guide them. The next chapter shows what the five acts require of the device itself.

2 Device requirements

A root of trust and a device identity cannot be added after shipment. The security functions of a connected device therefore have to be fixed before design freeze. The five acts translate into eight such device functions, and the Cyber Resilience Act (CRA) asks for all eight. All four example devices, from the battery tool to the logistics tracker, fall into the CRA default class and may assess their own conformity. Only a gateway sold on its own can become an important product as a router or firewall, and it then needs a notified body that does not yet exist under the CRA. The chapter introduces these four archetypes, derives the functions from the legal texts and shows where classification depends on a design choice.

2.1 Four device archetypes

We examine obligations, cost and architecture on four device archetypes. An archetype is a typical device that stands for a whole product group and brings that group's usual combination of radio, path to the cloud and applicable acts. The four archetypes are a battery tool with BLE tracker, a machine with gateway, a building device under § 14a EnWG and a logistics tracker for assets, containers and trailers.

1. Battery tool with BLE tracker. A cordless drill, impact wrench, grinder or saw with a removable battery pack and a Bluetooth Low Energy (BLE) radio. The radio serves configuration and diagnostics through a smartphone app and lets the owner locate the tool. The app relays data to the manufacturer's cloud. The tool is machinery within the meaning of the Machinery Regulation, a power-driven assembly with moving parts.[168] The pack is a portable battery if it is sealed, weighs 5 kg or less and is not designed specifically for industrial use.[169]

2. Machine with gateway. A stationary machine (machine tool, packaging, process or handling machine) whose controller connects through an edge gateway to the operator's network or a cloud service, via Ethernet, Wi-Fi or a cellular modem. The gateway may be built into the machine and

placed on the market with it, or sold separately as a retrofit product. That distinction decides its CRA class.

3. Building device under § 14a EnWG. A heat pump, wallbox, air-conditioning unit or stationary storage battery that the distribution system operator may throttle under § 14a of the German Energy Industry Act.[61] The Bundesnetzagentur's determination BK6-22-300 of 27 November 2023 governs this grid-oriented control from 1 January 2024.[74] A throttled device must still be able to draw at least 4.2 kW under direct control.[74] The device receives a control signal and may report energy data. Some models also connect to an app via Wi-Fi or Ethernet.

4. Logistics tracker for assets, containers and trailers. A battery-powered, sealed device with satellite positioning (GNSS), a cellular radio (LTE-M, NB-IoT or 2G/4G) and often Bluetooth, mounted on equipment, containers or trailers. It reports location and sensor data such as temperature, shock or door state to a platform used by the fleet or asset owner. It is not machinery and carries a small portable battery.

2.2 Eight device functions

None of the five acts prescribes a component or uses the words "secure boot". They describe outcomes that an engineering team has to translate into eight functions. The CRA asks for all eight, the Machinery Regulation for six (Figure 3).[168, 171] Firmware integrity, authentication and the update mechanism shape the hardware. The SBOM, vulnerability handling and logging are processes as much as hardware. Data export and product identification concern data leaving the device.



Figure 3: **Device functions by act**
Note: articles and annex points by act in Table 22. Sources: [141, 148, 168, 169, 170, 171].

Firmware integrity. The CRA requires products to protect stored, transmitted and processed data, commands, programs and configuration against unauthorised manipulation, to report on corruptions and to mitigate the effects of attacks.[171] The Machinery Regulation requires that software and data critical for compliance with the safety requirements are "identified as such" and "adequately protected against accidental or intentional corruption".[168] Neither text prescribes a mechanism. The term secure boot appears only in Implementing Regulation 2025/2392, in the description of microcontrollers and microprocessors whose security functions protect "other

products … such as secure boot chain".[149] The established engineering answer is a verified boot chain anchored in a hardware root of trust.

Update mechanism and support period. Vulnerabilities must be fixable through security updates, by default automatic, with an opt-out and the option to postpone.[171] The manufacturer distributes updates securely, without delay and free of charge, and, where technically feasible, separately from functionality updates.[171] The support period must reflect the time the product is expected to be in use and must be at least five years, unless the product is expected to be in use for less.[171] Each security update must remain available for at least ten years after its release or for the rest of the support period, whichever is longer.[171] The end date of the support period must be stated to the user.[171] The maker of a machine that runs fifteen years therefore plans support for its expected use time, not for the minimum of five years.

Software bill of materials (SBOM). Manufacturers must draw up an SBOM "in a commonly used and machine-readable format covering at the very least the top-level dependencies".[171] The Commission may specify format and elements by implementing act.[171] Until then, technical guideline TR-03183 Part 2 (version 2.1.0) of the German Federal Office for Information Security (BSI) gives formal and technical SBOM requirements, as non-binding guidance without a presumption of conformity.[54] The Machinery Regulation adds its own inventory duty. The machine must identify the software necessary for safe operation and "be able to provide that information at all times in an easily accessible form".[168]

Vulnerability handling and reporting. Only the CRA asks for this function. It requires remediation without delay, regular security tests, public disclosure of fixed vulnerabilities, a coordinated vulnerability disclosure policy and a contact address for reports.[171] The user information must name a single point of contact.[171] Since 11 September 2026, the reporting chain of Article 14 applies on top.[171] BSI TR-03183 Part 3 covers the handling of incoming vulnerability reports, again as non-binding guidance.[54]

Authentication. Four of the five acts require authentication. The CRA demands a secure-by-default configuration and protection from unauthorised access.[171] Under the RED, none of the three parts of EN 18031 confers a presumption of conformity "if, when applying its clauses 6.2.5.1 and 6.2.5.2, the user is allowed not to set and use any password".[148] A setup flow that lets the user skip the password is therefore outside the standard. The Data Act and the Machinery Regulation also presuppose protected access.[168, 170]

Data export interface. The Data Act requires access by design for all products placed on the market after 12 September 2026.[170] Product data and related service data, including the metadata needed to interpret them, must be accessible to the user "by default, easily, securely, free of charge, in a comprehensive, structured, commonly used and machine-readable format, and, where relevant and technically feasible, directly".[170] Before the sale, the seller states the type, format and estimated volume of data, whether the product generates data continuously and in real time, where it stores data and how the user can access it.[170] The data holder makes readily available data accessible when the user cannot access them directly on the device, where relevant and technically feasible "continuously and in real-time".[170] At the user's request, it shares them with a third party.[170] Typical implementations are a Bluetooth service, an OPC UA or Modbus endpoint or an authenticated cloud API, each with a data catalogue that matches the pre-contract information. Under the CRA the device has to secure the transfer.[171] For batteries in its scope, the Batteries Regulation requires a passport that combines model data with data specific to the individual battery, including data "resulting from the use of that battery".[169] The path from device to passport backend becomes a compliance path when the battery management system is the only source of use data.

Logging. The CRA requires products to record and monitor relevant internal activity, including access to or modification of data, services or functions, with an opt-out for the user, and to report possible unauthorised access.[171] The Machinery Regulation goes furthest. The machine "shall collect evidence of a legitimate or illegitimate intervention" in safety-relevant hardware, in the software and in its configuration.[168] Its control system keeps a tracing log of intervention data and of the versions of safety software uploaded after placing on the market, "enabled for five years after such upload", for use on reasoned request of a national authority.[168] Control systems with self-evolving behaviour also keep data on safety-related decisions for one year.[168]

Product identification. The product or its software must be identifiable unambiguously under four of the five acts: the CRA in the user information,[171] the Data Act in the pre-contract information,[170] the Machinery Regulation for safety-relevant software[168] and the Batteries Regulation with the QR code that every battery carries from 18 February 2027 and, for industrial batteries above 2 kWh, with the battery passport.[169]

2.3 A common security baseline

Four of the five acts ask for the same small set of device capabilities, and the CRA says so itself. Its essential requirements "include all the elements" of the RED cybersecurity requirements.[171] By its own account, the CRA "could facilitate" compliance with the cybersecurity requirements of the Machinery Regulation, provided the manufacturer demonstrates the overlap through harmonised standards and a risk assessment that covers those risks.[171] The Data Act, often read as the opposite of security, requires access "securely" and lets the data holder restrict sharing that could undermine the product's security.[170] Six capabilities make up this common baseline (Table 3).

CAPABILITY	MEETS REQUIREMENTS OF	PURPOSE
Hardware root of trust and verified boot	CRA, RED, Machinery Regulation	Protects firmware and safety software against tampering
Unique device identity, no shared default password	CRA, RED, Data Act	Needed for authenticated data export and for the RED standard EN 18031
Signed over-the-air updates with rollback protection	CRA, Machinery Regulation	Security updates for at least five years, each kept available for ten
Tamper-evident event log with software version history	CRA, Machinery Regulation	Machines must keep evidence of interventions and a five-year log of safety software
Authenticated, documented data export, local or cloud	Data Act, CRA	Uses the same identity and access model as the service channel
SBOM per firmware release, vulnerability intake, reporting runbook	CRA	Required since 11 Sep 2026, also for products already in the field

Table 3: **Capabilities of the common security baseline**

A product with a shared default password and unsigned firmware therefore fails four acts at once. Even a simple logistics tracker needs this baseline. Its user, typically the fleet operator, has a Data Act right to the position and sensor data.[170] Trackers in the field are also exactly the installed base for which the CRA reporting duty already applies.[171] A device without unique credentials, signed updates and an SBOM can neither be patched nor reported on within 24 hours.

2.4 Obligations by archetype

Every archetype falls under the CRA and the Data Act, and each has one obligation that is easy to miss (Table 4).[170, 171] Several classifications depend on the design or on a reading the texts do not settle. In these cases the manufacturer has to document its classification explicitly.

ACT AND REQUIREMENT	BATTERY TOOL	MACHINE	BUILDING DEVICE	LOGISTICS TRACKER
CRA: scope, reporting from 11 Sep 2026, full from 11 Dec 2027	Yes	Yes, machine and gateway	Yes	Yes
CRA: class	Default, the Bluetooth module does not raise the class	Machine: default. Gateway sold on its own: conditional Class I (router) or Class II (firewall)	Default, not a smart home security product	Default, not a wearable
CRA: conformity route	Module A	Machine: Module A. Class I gateway: Module A only with harmonised standards applied in full, else B+C or H. Class II: B+C, H or EUCC	Module A	Module A
CRA: support period	≥ 5 years or expected use	Expected use time of the machine, if longer than 5 years	≥ 5 years or expected use	≥ 5 years or expected use
RED (Reg. 2022/30), Art. 3(3)(d)	Yes, also when connected via the app	Conditional: gateway or controller with radio	Conditional: models with Wi-Fi or cellular	Yes
RED (Reg. 2022/30), Art. 3(3)(e)	Yes if location or user data processed	Conditional: personal data on the HMI or gateway	Conditional: personal data, e.g. consumption profiles	Yes: location data
Data Act, Art. 3(1) access by design	Yes: usage, battery and location data	Yes: machine operating data	Yes: operating and energy data	Yes: position and sensor data
Machinery Regulation, Annex III 1.1.9 / 1.2.1	Yes	Yes, Annex I Part A only for ML-based safety functions	Conditional: check the household-appliance exclusion	No
Batteries Regulation: battery passport (Art. 77)	No, as long as the pack is a portable battery	Only if an industrial battery > 2 kWh is built in	Storage > 2 kWh: yes	No: portable battery
Batteries Regulation: QR code (Art. 13(6))	Yes	If batteries are incorporated	Yes, for the storage battery	Yes
Batteries Regulation: end-user removable battery (Art. 11)	Yes, packs are removable by design	-	-	Yes, derogation only where needed for safety

Table 4: **Requirements of the five acts by archetype**
Note: our classification for the typical design, “Conditional” where the design or an open reading decides. Sources: [141, 149, 168, 169, 170, 171].

Battery tool. Three regimes meet in one housing. As machinery, the tool falls under the cybersecurity sections of the Machinery Regulation from 20 January 2027. The app channel must not create a hazard if it can change safety-relevant parameters such as speed, torque or kickback detection, and the safety firmware must be protected and identifiable.[168] The BLE radio brings in

the RED. A tool that reaches the internet only through the user's phone is internet-connected radio equipment, because the text includes communication via other equipment.[141] Location or user data add the privacy requirement.[141] The built-in Bluetooth module is itself a Class I network interface, but it does not raise the tool's CRA class.[149, 171] Access by design under the Data Act covers usage, battery and location data.[170] The pack gets a QR code, but no passport as long as it is a portable battery.[169] A pack marketed only for professional or industrial use, by contrast, may count as an industrial battery. Its classification therefore has to be documented explicitly.

Machine with gateway. The machine itself stays in the CRA default class, because the core function of a machine tool falls into no category of important or critical products.[171] The gateway is where classification becomes delicate. A gateway placed on the market on its own whose core function is to route traffic between the plant network and the internet matches the description of a router and is then a Class I product.[149] A gateway sold only as an integral part of the machine is assessed with the machine, which stays default. The same hardware sold both ways needs two classifications. If the gateway is marketed with the core function of protecting the plant network by monitoring and restricting traffic, it fits the firewall description instead. It is Class II, with a mandatory notified body or certification.[149] In our reading, a routing gateway that merely integrates firewall rules remains a router. For the installed base of long-lived machines, the Data Act's Article 4 access right matters more than access by design, which only covers newly placed machines.[170] The machine needs a notified body under the Machinery Regulation only if it embeds self-evolving, machine-learning safety functions.[168]

Building device. A heat pump or wallbox is not a smart home product with security functions that protect the physical security of consumers, so it stays in the CRA default class.[149, 171] A home energy manager that routes between home network and internet may itself be a router. A smart meter gateway in the § 14a control path is a critical product.[171] It belongs to the metering point operator, not to the device maker, and does not change the class of the device.[171] The manufacturer also has to classify and document whether a domestic heat pump falls under the Machinery Regulation or under its household-appliance exclusion.[168] A stationary storage battery above 5 kg counts as an industrial battery and needs a passport above 2 kWh.[169] The battery passport therefore hits this archetype hardest.

Logistics tracker. The tracker is a default CRA product and internet-connected radio equipment that processes location data. Both RED points therefore apply, and with them EN 18031-1 and −2.[141, 148] It is not a Class I wearable, because it is mounted on goods, not worn on the body.[149] The Commission reads that class as products that collect health data.[149] A badge that only reports position is outside it. A lone-worker badge with fall detection needs checking. The tracker remains a connected product under the Data Act, because it transmits data on behalf of its user, not of third parties.[170] The least noticed obligation is in the Batteries Regulation. From 18 February 2027 a portable battery in a product must be "readily removable and replaceable by the end-user" with commercially available tools, and removal instructions must be published online.[169] A potted, glued or welded tracker does not meet this. The exemption for devices used mainly around water applies only where it is needed for safety.[169] An IP67 tracker on a trailer therefore qualifies only with that justification. Without it, the battery compartment must open with commercially available tools.

2.5 Conformity assessment routes

The CRA classifies a product by its core function, not by the components it contains. A product whose core function matches a category in Annex III is important (Class I or II), one matching Annex IV is critical, everything else is in the default class.[171] Implementing Regulation 2025/2392 has described each category since 21 December 2025. It confirms that the product "as a whole"

decides. A component with the core function of an important product does not by itself make the host product important.[149] A product that can perform the functions of a category but whose core function is different is not in that category, just as a smartphone is not an operating system.[149] Only the default class can always assess itself, the other classes only under conditions or not at all (Table 5).[171]

CLASS	RELEVANT ANNEX ENTRIES	CONFORMITY ASSESSMENT
Default	Everything not listed in Annex III or IV, including tools, machines, heat pumps, wallboxes and trackers	Module A (internal control); B+C, H or a certification scheme voluntary
Important, Class I	III-I.8 boot managers; III-I.10 physical and virtual network interfaces (incl. Bluetooth, Wi-Fi, Ethernet, fieldbus adapters); III-I.11 operating systems (incl. real-time OS); III-I.12 routers, modems intended for connection to the internet (incl. cellular modems), switches; III-I.14 microcontrollers with security-related functionalities; III-I.17 smart home products with security functionalities	Module A only if harmonised standards, common specifications or a European certification scheme at level “substantial” are applied in full; otherwise B+C or H with a notified body
Important, Class II	III-II.2 firewalls, intrusion detection and prevention systems; III-II.4 tamper-resistant microcontrollers (AVA_VAN 2 or 3)	B+C, H, or a European certification scheme at level “substantial”
Critical	IV.2 smart meter gateways and other devices for advanced security purposes; IV.3 smartcards and similar devices, including secure elements	European certificate where a delegated act under Art. 8(1) requires it; otherwise the Class II routes

Table 5: **CRA product classes and conformity assessment**
Sources: [149, 171].

The components inside the four archetypes are full of important and critical products: the Bluetooth or cellular module, the real-time operating system and the microcontroller with secure boot in Class I, the secure element as a critical product. Their makers need their own conformity assessment for them. The tool, machine, heat pump and tracker nonetheless stay in the default class.[149, 171] Buying CRA-compliant components therefore reduces the work but does not replace the manufacturer’s own assessment of the whole product.

The classification of a gateway is the most expensive. A Class I gateway cannot assess itself and needs a notified body as long as no CRA harmonised standard is cited in the Official Journal.[171] No body is yet notified under the CRA.[161] The Commission’s standardisation request M/606 schedules the standards for routers, modems and switches and for firewalls, including those specifically intended for industrial use, for 30 October 2026.[147] Citation in the Official Journal follows only after that. BSI TR-03183 Part H describes how a manufacturer can use an ISO/IEC 27001-conformant management system for a Module H assessment.[54] For a gateway launching in 2028, a notified body is therefore the planning case. A standard cited in the Official Journal by then would be an upside, not a basis for planning.

IN SUMMARY

For most manufacturers, compliance is therefore an engineering task, not an approval process. Only selling a gateway on its own makes them depend on standards and notified bodies that are still missing. The next chapter shows what the eight functions cost per device and month.

3 Cost per device

A maker of connected products pays for radio, cloud and security month after month for the whole life of its fleet, and has to build that cost into its price. In the base case, the connectivity and security layer costs €0.50-3.10 per device per month, not counting the host product. Security accounts for €0.40-0.48 of it in every archetype, and only fleet size moves that amount by much. The chapter looks in detail at the base cost and the security premium, puts the cost of the Cyber Resilience Act (CRA) and the Data Act in proportion, and shows how fleet size, radio choice and product class change the premium.

3.1 Monthly running cost

For this report we built a cost model of our own. It calculates four archetypes: a battery tool with a BLE tracker, a machine with a cellular gateway, a building device under § 14a EnWG and a logistics tracker. The model covers the connectivity and security layer from the radio chip to the conformity assessment at published list prices, but not the host product's motor, battery, enclosure and main controller. We spread one-off costs per device, such as chips, SIM packages and certificates, over 60 months. We spread one-off costs per product, such as secure development, documentation and conformity assessment, over all devices of the fleet and over 60 months, and monthly fees at fleet level, such as a certificate authority (CA) or a tooling subscription, over all devices of the fleet. The base case is 10,000 units over five years (line items, assumptions and sensitivity in Appendix C).

In our model a compliant battery tool costs €0.50 a month in the base case and the machine €3.10. The building device lies in between at €0.59, the logistics tracker at €0.99. For the machine, the cellular tariff and the always-on cloud traffic together make up almost four fifths of the total (€2.44 of €3.10). The radio therefore sets the total (Figure 4).

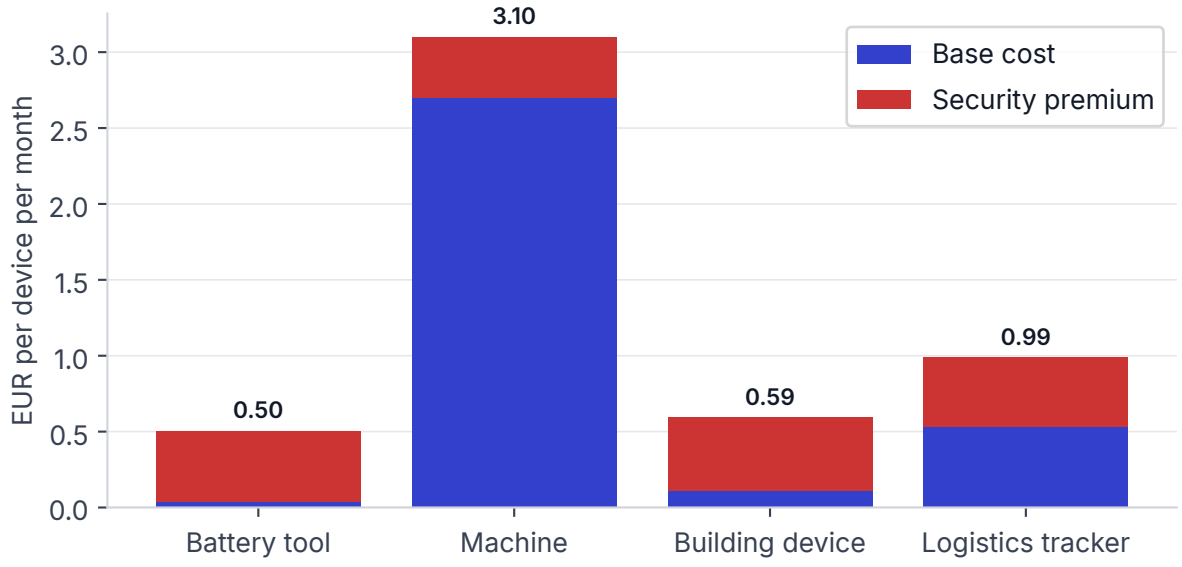


Figure 4: **Cost per device per month by archetype**
Source: RUBINLAKE cost model.

The security premium, by contrast, costs almost the same for every archetype, €0.40-0.48 per device per month. It covers the secure element, the public key infrastructure (PKI), signed over-the-air (OTA) updates, software bill of materials (SBOM) and vulnerability tooling, secure development, documentation and conformity assessment. Because the premium barely varies, its weight depends on the base. It is 13 % of the machine's monthly cost but 93 % of the battery tool's (Table 6). For devices without a SIM, compliance costs more than connectivity; for devices with one, the tariff matters more than the law.

ARCHETYPE	BASE COST (EUR/ MONTH)	SECURITY PRE-MIUM (EUR/ MONTH)	TOTAL (EUR/ MONTH)	PREMIUM OVER 5 YEARS PER UNIT (EUR)	PREMIUM SHARE (%)
Battery tool with BLE tracker	0.04	0.47	0.50	28.06	93
Machine with gateway	2.70	0.40	3.10	24.09	13
Building device under § 14a EnWG	0.11	0.48	0.59	28.92	81
Logistics tracker	0.53	0.46	0.99	27.49	46

Table 6: **Base cost and premium by archetype**
Note: rows may not add up because of rounding. Source: RUBINLAKE cost model.

3.2 The CRA compliance share

In our model the per-product compliance block for the CRA adds €0.175 per device per month in the base case, about two fifths of the premium (36-44 %). For it we take the Commission's per-product estimates, the only published figures of their kind. On an average development cost of €140,000, the Commission adds 30.5 % for secure development (€42,700), 9 % for documentation and reporting (€12,600) and €18,400 for self-assessment.[144] It puts third-party assessment at €25,000 and recurring testing at €3,000-5,000 per product.[144]

We have costed this block deliberately on the cautious side and apply all figures in full, as if the manufacturer had no comprehensive security measures today. Yet the Commission itself counts about half of the secure-development cost as business as usual. It calls its own documentation figure unverified and probably too high.[144]

Across the EU the Commission expects compliance costs of up to about €29 billion. Against this stand €180-290 billion a year in avoided incident costs for businesses, extrapolated from Bitkom's damage estimate for Germany.[142, 144] The German government's implementation bill states no compliance cost of its own for business.[100]

Fees of notified bodies are the least transparent item. Few bodies publish their prices. Serma offers an EU-type examination under the Radio Equipment Directive (RED) by LCIE (notified body 0081) from €3,900.[359] For the RED, the Commission puts third-party testing at €5,000-15,000 per model for simple products and €50,000 or more for software-heavy equipment.[140]

3.3 Data Act cost at company level

The Data Act adds cost per company, not per device. The Commission caps the cost of making product data accessible at €300,000 a year per small or medium-sized enterprise (SME) and €1 million per large company.[143] For the whole IoT market it estimates €410 million one-off and €88 million a year, and it gives no cost per product.[143]

Spread over a fleet, the cap can exceed the whole security premium. An SME at the €300,000 ceiling would carry €2.50 per device per month at 10,000 units. A large company spreading €1 million over 100,000 devices would carry €0.83.[143] Where a product already exports its data through a documented cloud API, the cost per device should be a fraction of these bounds.

3.4 Security cost over the lifecycle

Over five years the security premium in our model comes to €24-29 per unit, from €24.09 for the machine to €28.92 for the building device. It has four parts:

- **Signed OTA:** about half the premium. Golioth's USD 0.25 per device per month is €0.22, or 48 % of the battery tool's premium.[199] On AWS IoT Device Management the machine's OTA costs €0.15 a month, most of it for secure tunnels rather than update jobs.[16]
- **CRA compliance per product:** €0.175 a month.
- **PKI:** €0.04 a month. The USD 400 monthly fee of AWS Private CA is shared across the fleet. Certificates cost USD 0.35-0.75 each up to 10,000.[19]
- **Secure hardware:** under €0.05 a month, or €1.13-2.56 per unit once.[112, 114]

The secure element is the smallest item. At reel prices the ATECC608B costs USD 0.725 at 3,000 units, the STSAFE-A110 USD 1.27 at 5,000 and the SE050C2 USD 2.87 at 3,000.[108, 112, 114] The pre-provisioned Trust&GO variant costs USD 1.91, more than twice the bare part. The difference pays for factory key injection.[108] Saving on the chip saves a few cents a month. The running services decide the lifetime cost.

3.5 Fleet size as the main cost driver

Fleet size matters more than any component. In our model the security premium rises to about €2.30 per device per month at 1,000 units (€2.30-2.38), about five times the base case. At 100,000 units it falls below €0.30 (€0.21-0.29). In the small fleet, the per-product compliance block is spread over a tenth of the devices. The USD 400 monthly CA fee alone then comes to €0.36 per

device.[19] Two measures cut the PKI part: AWS's short-lived certificate mode at USD 50 a month,[19] or one CA shared across all of a manufacturer's product lines.

At 100,000 units OTA becomes the largest part of the premium. The choice of update service then matters more than any other line. Azure Device Update costs USD 0.07 per device per month,[266] nRF Cloud from USD 0.10[285] and Golioth USD 0.25.[199] balena charges USD 2.00 per additional device, almost thirty times Azure's rate.[28]

Radio choice changes the base, not the premium. For the machine, Swisscom's CMP Mobile Lite at CHF 1.00 lowers the base from €2.70 to €1.70, but includes no roaming.[376] For the building device, LTE-M instead of the customer's Wi-Fi raises the base from €0.11 to €0.57, with an nRF9151 and Telekom's LPWA package at €14.50.[96] For the tracker, LoRaWAN on The Things Stack costs about the same per month as LTE-M (€0.52 against €0.53) but needs its own GNSS chip (MAX-M10S, USD 9.33 at 500).[115, 385] LoRaWAN reaches trailers and containers only within range of own or roaming gateways.[385] A Myriota satellite plan on top of LTE-M raises the base to €1.41 before the satellite modem, for which Myriota publishes no price.[274]

Product class changes little per device. Third-party assessment at the Commission's average of €25,000 adds €0.011 a month to the premium in the base case.[144] At €50,000, the Commission's estimate for software-heavy radio equipment, it adds €0.053.[140] The premium falls by €0.036 if half of the secure-development cost is already business as usual.[144] The product class is a question of lead time, not of cost per device.

IN SUMMARY

It is not the security the law requires that makes a connected product expensive, but a small fleet, a cellular tariff and a separate backend for each product line. Product planning and purchasing fix these items before any harmonised standard exists. The next chapter shows which components and which architecture lie behind these costs.

4 Technology and architecture

A connected product meets the device requirements of the five acts in six technical layers between the radio chip and the ERP system, and no single layer covers a whole act. Most components are available certified, among them secure elements, microcontrollers with one of 316 PSA certifications, and update and certificate services. The gaps are processes no vendor sells, namely factory provisioning, a security team that meets the 24-hour reporting clock and an update mechanism that lasts the whole support period. The chapter takes the layers from the radio up, maps the obligations of the acts onto them and combines them into one reference architecture per archetype.

4.1 Connectivity

The radio decides how long a product can be reached for updates. The last 2G networks in Germany and Austria close in 2028, inside the support period of a product launched in 2027.[6, 77] Telekom aims for 30 June 2028, Vodafone for September 2028 with some critical IoT use until 2030, and Telefónica for the end of 2028.[77] A1 in Austria plans for 31 May 2028.[6] 3G is already off in all three countries, and Switzerland has closed 2G as well.[47, 373, 413] The Cyber Resilience Act (CRA) asks for updates over the whole support period.[171] A radio that disappears before then becomes a compliance risk. New designs need no 2G fallback; fleets with 2G modules need a migration plan.

LTE-M and NB-IoT are the low-power cellular options with national coverage and no announced end date. Telekom completed nationwide LTE-M in July 2020.[94] At the end of 2020 Vodafone's LTE-M covered more than 90 % and its NB-IoT more than 97 % of Germany's land area.[408] LTE-M handles mobility and firmware images, while NB-IoT reaches deeper indoors. A system-in-package such as the Nordic nRF9151 sleeps at 2.7 µA in power saving mode (PSM).[284] 5G RedCap (3GPP Release 17)[5] is the successor for devices that need more bandwidth. Its market is young, as Germany's first commercial RedCap product was a smartwatch in September 2025.[95] For 2027 RedCap is therefore an option for the machine gateway, not a default.

Three further networks belong to the customer or the utility, not to the device maker. The Federal Network Agency (BNetzA) has assigned 3.7-3.8 GHz for local 5G campus networks since November 2019, from a base fee of €1,000.[80] By November 2025 it had issued 484 assignments in that band,[75] against 27 in the 26 GHz band.[76] The 450 MHz band went to 450connect in 2021 for energy and water,[73] assigned until 31 December 2040,[72] and carries smart meter traffic. LoRaWAN (ITU-T Y.4480)[254] runs below a 1 % duty cycle at 868 MHz.[84] Firmware updates are therefore limited to small deltas. Germany has no nationwide public LoRaWAN network. Netze BW alone runs up to 3,000 gateways.[255]

At short range the law shapes pairing more than the radio. Bluetooth Low Energy (BLE) offers LE Secure Connections[41] and, since Core 6.0, Channel Sounding for ranging.[42] EN 18031-1 gives no presumption of conformity where the user may choose not to set any password.[148] "Just Works" pairing therefore cannot be the only protection for a tool that accepts commands. New Wi-Fi CERTIFIED devices have required WPA3 since 2020.[411] Galileo's navigation message authentication (OSNMA) has been in service since 24 July 2025 and lets a tracker detect spoofed positions.[176]

4.2 Device security layer

The device security layer carries most of the security properties the CRA requires of the product.[171] Access protection, confidentiality, integrity and exploit mitigation all depend on it. It is also the layer most fully available as certified parts. It further carries the Machinery Regulation's duty to protect safety-relevant software against corruption and to collect evidence of intervention.[168]

Keys sit either in a discrete secure element or trusted platform module (TPM), or in an isolated region of the main microcontroller. Five of seven common parts carry a Common Criteria (CC) certificate (Table 7). NIST has listed FIPS 140-2 certificates as historical since September 2026. They still cover deployed modules. New procurement that asks for FIPS, however, needs FIPS 140-3, which the TA100's successor TA101 holds at Level 2.[261, 276, 277, 278] The ATECC608B has no certificate, and Microchip lists one of its variants as not recommended for new designs.[263] A TPM 2.0[394] suits a Linux gateway with measured boot, a secure element a microcontroller device.

COMPONENT	VENDOR	CERTIFICATION	PROVISIONING OPTION
EdgeLock SE050	NXP	CC EAL6+ up to OS level; FIPS 140-2 level 3 for the SE050F variant (historical since September 2026)	EdgeLock 2GO
EdgeLock SE051	NXP	CC EAL6+ with AVA_VAN.5; IEC 62443-4-2 certified for applicable requirements	EdgeLock 2GO
OPTIGA Trust M	Infineon	CC EAL6+	Trust M Express, pre-registered for AWS IoT and Azure IoT Hub
ATECC608B	Microchip	No CC or FIPS certificate	Trust&GO (pre-provisioned, MOQ 10), TrustFLEX, TrustCUSTOM
TA100	Microchip	FIPS 140-2 level 2 (historical since September 2026; successor TA101: FIPS 140-3 level 2); AEC-Q100 grade 1	TrustFLEX / custom
STSAFE-A110	ST	CC EAL5+ AVA_VAN.5	ST personalisation service
OPTIGA TPM SLB9672	Infineon	TPM 2.0; CC EAL4+ AVA_VAN.4 (BSI-DSZ-CC-1277-2026); FIPS 140-2 level 2 (historical since September 2026)	Pre-installed endorsement key

Table 7: Certification of common secure elements and TPMs
Sources: [51, 217, 218, 297, 298, 368].

The PSA Certified level is the evidence that counts where keys stay on the microcontroller. The PSA Certified database holds 316 certifications from 123 companies, among them Level 3 for the STM32U585, NXP MCX N94x/N54x and Silicon Labs EFR32MG21B.[326] On Armv8-M parts, TrustZone isolates a secure partition. Trusted Firmware-M is the reference implementation.[395] Level 2 shows in a 25-day lab evaluation that the root of trust resists software attacks; Level 3 extends that to substantial hardware attacks.[325] Both build on the SESIP method of GlobalPlatform, which took over PSA Certified in September 2025.[194] SESIP is published as EN 17927:2023.[83] The Nordic nRF54L15, which Nordic markets as designed for Level 3, was certified at Level 1 in January 2026.[326] The certificate pays off as reuse. NXP shows how a manufacturer can carry a chip's security target into EN 18031 and IEC 62443-4-2 evidence.[295]

A design built to IEC 62443 and EN 18031 yields such reusable evidence, but not yet a presumption of conformity under the CRA. The CRA's 41 harmonised standards are still being written under

standardisation request M/606, and none is cited in the Official Journal.[151] The EN 18031 series under the Radio Equipment Directive (RED), by contrast, has been cited with restrictions since January 2025.[145, 148] IEC 62443-4-1 sets the development process,[208] IEC 62443-4-2 the component requirements,[117, 209] and ETSI EN 303 645 the consumer IoT baseline.[135]

Secure boot closes the layer. MCUboot is the common open-source bootloader for 32-bit microcontrollers.[258] Linux gateways use U-Boot verified boot with a TPM-measured chain. Updates follow the architecture of RFC 9019[214] with a signed manifest per RFC 9124.[215] The bootloader checks the signature against a key in the root of trust, refuses a downgrade and falls back to the old slot if the new image fails. This meets two CRA duties, the secure distribution of updates and automatic security updates by default.[171]

4.3 Device management and PKI

Update services are easy to buy, but each device's identity is not. It has to be in place before the device leaves the factory. Five services carry most DACH projects in 2026: Mender for embedded Linux and microcontrollers,[292] Memfault with crash reporting,[260] Golioth billed per active device,[199] AWS IoT Device Management with signed FreeRTOS jobs[20] and Azure Device Update, which stays generally available while Microsoft previews a successor.[267] Microsoft's edge platform, Azure IoT Operations, brings its own MQTT broker.[269] Prices and owners of these services changed in 2025 and 2026. Memfault is now part of Nordic, and Golioth part of Canonical.[198, 286] The update service therefore belongs behind an abstraction, and an open on-device format such as MCUboot images keeps the vendor replaceable.

Every device needs a unique credential, because the CRA asks for secure-by-default configuration[171] and EN 18031 rules out universal default passwords.[148] There are three routes:

1. **Pre-provisioned secure elements.** The chip vendor signs the birth certificate: Microchip Trust&GO from 10 units,[263] Infineon Trust M Express,[218] NXP EdgeLock 2GO.[296]
2. **In-line provisioning at end-of-line test.** A station with a hardware security module signs each device's request with the manufacturer's own issuing CA, using services such as DigiCert, Keyfactor EJBCA or GlobalSign.[105, 195, 232]
3. **First-connect provisioning.** AWS fleet provisioning by claim[21] or the Azure Device Provisioning Service.[268] It is the cheapest route. Its weakest link is the shared claim credential.

Certificate lifetime is a design decision. A birth certificate for the product life plus short-lived operational certificates renewed over EST[212] limits the damage of a stolen key. BRSKI adds zero-touch bootstrap.[213] Short lifetimes are also cheaper. AWS Private CA costs USD 50 a month in short-lived mode against USD 400 in general-purpose mode.[19]

4.4 SBOM and PSIRT tooling

Tools cover three of the CRA's eight vulnerability-handling duties, namely the software bill of materials (SBOM), testing and disclosure.[171] The update service covers two more. Only a product security incident response team (PSIRT) can do the rest. Since 11 September 2026 that team must send an early warning within 24 hours of an actively exploited vulnerability, a notification within 72 hours and a final report within 14 days of a fix, also for products already on the market.[171] ENISA's Single Reporting Platform opened the same day and sends each report to the coordinating CSIRT and ENISA at once.[133]

The formats are settled. CycloneDX is ECMA-424[120] and SPDX is ISO/IEC 5962.[253] Technical Guideline TR-03183-2 of the Federal Office for Information Security (BSI), dated August 2025, is the most specific profile: CycloneDX 1.6 or SPDX 3.0.1 or later, a SHA-512 hash per component, and

no vulnerability information in the SBOM itself.[50] Advisories go out separately as CSAF 2.0, whose VEX profile states whether a product is affected.[302] Version 2.1 was in draft in September 2026.[303] BSI's CERT-Bund itself publishes as a CSAF trusted provider.[52] CSAF advisories therefore reach German customers through a channel they already read.

OWASP Dependency-Track is free and matches SBOMs against vulnerability feeds continuously.[321] Bought-in firmware without source, such as radio modules, needs binary analysis, offered for example by ONEKEY in Düsseldorf.[308] No tool supplies the other parts of a PSIRT: a named team, a published contact, triage with VEX statements and a release path into the update service.

4.5 Data interfaces for the Data Act

The Data Act asks for access by design but names no protocol. For device makers the hard part is therefore authorisation, not format. Products placed on the market since 12 September 2026 must make readily available data accessible to the user "by default, easily, securely, free of charge, in a comprehensive, structured, commonly used and machine-readable format".[170] Articles 4 and 5 add access on request and access for third parties the user names.[170] The Commission's FAQ of January 2026 counts data stored even temporarily as readily available, but does not require direct access in every situation.[158]

Four open interfaces meet the test in DACH industry. OPC UA (IEC 62541)[211] can publish over MQTT,[312] and umati builds on the VDMA's machinery specification for it.[398] MQTT 5.0 is an OASIS Standard.[301] The Asset Administration Shell (IEC 63278-1),[210] at version 3.2 in IDTA Release 26-01,[216] holds static product data and points to live data. A documented REST API serves users and third parties in the cloud.

Third-party access must be scoped to one user's products and revocable. The manufacturer reuses the identity layer for this. The device certificate identifies the product, and an OAuth-style grant ties it to the user. The data leaving the product falls under the CRA's confidentiality and data minimisation duties.[171]

4.6 Obligations by layer

The secure device and the PKI carry more of the law than any other layer. They are also the two that a firmware update cannot add later. The CRA, the RED, the Machinery Regulation and the Data Act each need at least five of the six layers (Table 8).

LAYER	CRA, PROPERTIES (ANNEX I PART I)	CRA, PROCESSES (ANNEX I PART II)	RED	MACHINERY REGULATION	DATA ACT
Connectivity	(2)(h) availability, (2)(i) impact on networks; reachability for (2)(c)	(7) update channel over the support period	Art. 3(3)(d) network protection; secure pairing	1.2.1(a) resistance to malicious attempts on the link	Transport of data to user and third party
Secure device	(2)(d) access, (2)(e) confidentiality, (2)(f) integrity, (2)(k) exploit mitigation	(7) signature check of updates	Art. 3(3)(d), (e), (f): authentication, secure storage	1.1.9 protection against corruption, evidence of intervention	Device identity behind each data set
Device management and OTA	(2)(c) automatic security updates, (2)(l) logging	(2) remediation, (7) secure distribution, (8) free updates	Update mechanism, logging	1.1.9 evidence of software intervention	Remote configuration of data access

LAYER	CRA, PROPERTIES (ANNEX I PART I)	CRA, PROCESSES (ANNEX I PART II)	RED	MACHINERY REGULATION	DATA ACT
Certificates and PKI	(2)(b) secure by default, (2)(d) authentication	(7) code-signing keys	No universal default passwords; credential management	1.2.1(a) authenticated control commands	Authorisation of third parties
SBOM and PSIRT	(2)(a) no known exploitable vulnerabilities	(1) SBOM, (3) tests, (4) disclosure, (5) CVD, (6) contact; Art. 14 24 h / 72 h / 14 days	Vulnerability handling for radio stacks	Supplier software evidence	n/a
Data interfaces	(2)(e) confidentiality, (2)(g) data minimisation, (2)(m) deletion	n/a	Art. 3(3)(e) privacy	n/a	Art. 3(1) access by design, Art. 4 access on request, Art. 5 third parties

Table 8: **Legal requirements by layer**
Note: An entry means the layer carries the technical measure, not that buying the layer produces conformity. Sources: [141, 148, 168, 170, 171].

Vulnerability handling under the CRA is mostly process. Without a PSIRT the reporting clock cannot be met, whatever tools are in place.[133, 171] The Data Act, by contrast, needs neither a new radio nor a new chip. It adds an authorisation layer on top of the device identity the CRA already demands.

4.7 Four reference architectures

The four archetypes share one backbone and differ only where physics or regulation forces them to. The backbone has five elements:

- Every device holds a unique key in a root of trust and a factory-issued certificate.
- Every image is signed and checked before it runs.
- One update service serves all product lines.
- One PSIRT serves all products and reports through ENISA's Single Reporting Platform.[133]
- Every product exposes its data through a documented interface.[170]

4.7.1 Battery tool with BLE tracker

The battery tool carries no cellular modem and reaches the cloud only through the user's phone or a site gateway. Its security therefore sits in the BLE chip, and its updates travel through a courier it does not trust (Figure 5).

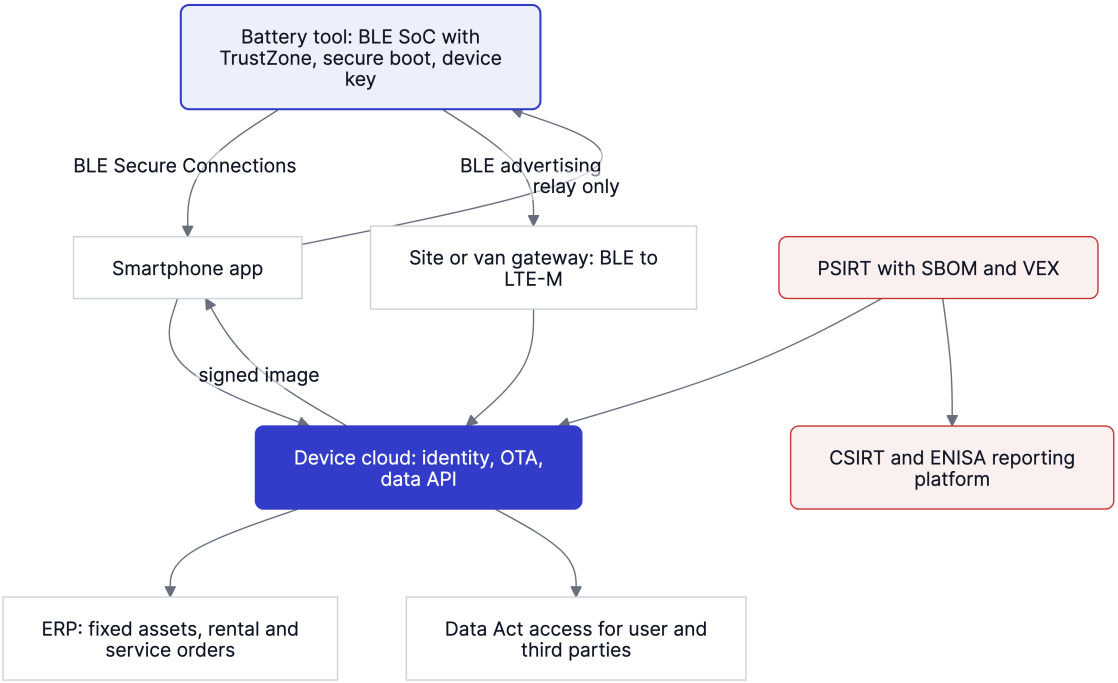


Figure 5: **Reference architecture: battery tool with BLE tracker**

RADIO	Bluetooth LE with LE Secure Connections. Lock, unlock and torque commands come only from an authenticated app session.
GATEWAY	The user's phone, or a BLE-to-LTE-M gateway in the van, site container or tool crib. Every advertising packet carries a rotating, encrypted identifier.
PLATFORM	A device cloud for microcontroller fleets that registers identities from the factory manifest, keeps the ownership record and serves the data API.
ERP	Event-driven posting of last-seen location, usage hours, charge cycles and fault codes. The ERP never polls tools.
UPDATE MECHANISM	Signed image relayed by the app. The bootloader checks signature and version and keeps the old image until the new one boots.
REPORTING PATH	SBOM of BLE stack and application from the build, with the radio vendor's SDK as a third-party component, and a CSAF advisory with VEX.

Cost. In our cost model the battery tool comes to €0.50 per device per month in the base case, the lowest of the four archetypes. Of this, €0.47, or 93 %, is the security premium. Signed OTA on Golioth is about half of that premium.[199]

What to watch. Pairing must make the user set a credential, as the password rule of EN 18031 requires.[148] PSA Level 3 evidence has to be checked in the certification registry, not in the datasheet.[326] For the battery tool, automatic security updates by default depend on an app the user opens.[171] The update service must therefore track which tools have not been in range. The site gateway is a radio product with CRA and RED duties of its own.

4.7.2 Machine with gateway

The machine's gateway reads the control system but has no write path to the safety controller (Figure 6). That separation carries the protection the Machinery Regulation requires against "reasonably foreseeable malicious attempts from third parties leading to a hazardous situation".[168]

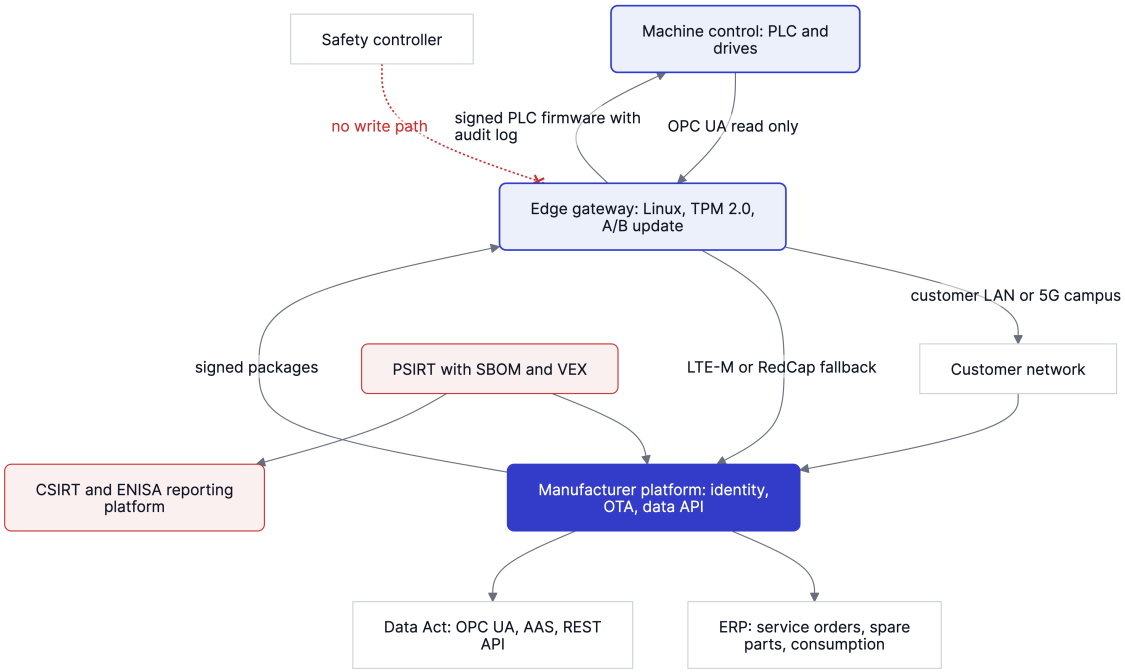


Figure 6: **Reference architecture: machine with gateway**

RADIO	The customer's network first (Ethernet, Wi-Fi with WPA3 or a 5G campus network). Cellular with an eSIM as the fallback, over LTE-M, or RedCap for video and large logs. No 2G or 3G.
GATEWAY	Linux edge gateway with TPM 2.0, measured boot and an A/B root file system. It reads the control system over OPC UA and signs an audit log of every change.
PLATFORM	Azure IoT Hub with Device Update, AWS IoT Core with Device Management jobs, or self-hosted Mender.
ERP	Condition events become service orders, consumption data spare-part proposals or usage-based billing. The customer's ERP receives the same events through the Data Act interface.
UPDATE MECHANISM	Gateway packages and PLC firmware are signed separately. PLC firmware waits for a maintenance window, and security fixes travel on their own channel.
REPORTING PATH	SBOM to BSI TR-03183-2 for several hundred Linux packages, binary analysis of supplier firmware and CSAF advisories pushed to customers.

Cost. For the machine we calculate €3.10 per device per month in the base case, the highest of the four archetypes. The cellular tariff and always-on cloud traffic drive the total. The security premium of €0.40 is 13 % of it.

What to watch. The audit log on device and platform supplies the evidence of intervention in the software that the Machinery Regulation requires.[168] PLC firmware is a safety-relevant change. The CRA asks for security updates to be separated from functionality updates where technically feasible.[171] The customer can then accept fixes without requalifying the process. A Class I gateway sold on its own needs a notified body as long as no CRA harmonised standard is cited in the Official Journal.[171] It should be designed to IEC 62443-4-2.[209] Certified parts for it exist, such as the NXP SE051[298] or the SLB9672 TPM, certified until 2031.[51]

4.7.3 Building device under § 14a

The building device takes grid control through the metering point operator's smart meter gateway and control box, never through the manufacturer's cloud.[74, 403] The maker therefore designs an EEBUS interface and keeps the cloud path separate from it (Figure 7).

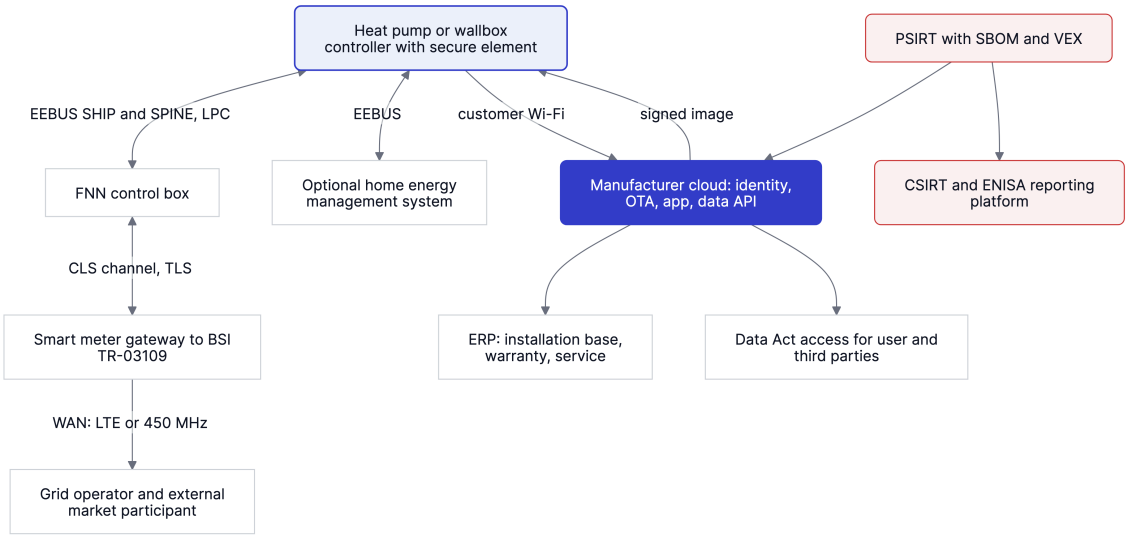


Figure 7: **Reference architecture: building device under § 14a EnWG**

RADIO	Not the maker's choice on the grid side, where the smart meter gateway uses public mobile networks or 450 MHz. The device's own link is the customer's Wi-Fi.
GATEWAY	Smart meter gateway to BSI TR-03109 and an FNN control box. The device accepts EEBUS where available and has a relay input as the fallback.
PLATFORM	Manufacturer cloud over the customer's Wi-Fi for app, diagnosis, updates and Data Act access. It carries no grid control.
ERP	Commissioning creates the installation-base record that anchors warranty, recalls and security updates. Service events post as service orders.
UPDATE MECHANISM	Signed images, automatic by default with an opt-out, never during an active control period. Minimum power and response time are checked after every update.

REPORTING PATH	As for the other archetypes, plus coordinated disclosure with the EEBus Initiative and control-box vendors, since a flaw in the EEBUS stack reaches other makers' devices.

Cost. For the building device we arrive at €0.59 per device per month in the base case. Of this, €0.48, or 81 %, is the security premium.

What to watch. A throttled device keeps at least 4.2 kW under BNetzA determination BK6-22-300, in force since 1 January 2024.[74] A control signal must take effect within five minutes, and devices under old agreements move to the new regime by 1 January 2029.[74] The customer gets a reduced grid fee in return,[61] with a time-variable option since 1 April 2025.[79] The control chain is not in the maker's hands. It consists of the smart meter gateway,[53] its WAN[73] and a control box to the FNN specification of August 2025, covered by BSI TR-03109-5.[49, 403] Control boxes offer EEBUS and relay contacts.[93] The rollout target for these metering points is 90 % only by the end of 2032.[60] The relay fallback therefore stays necessary for years. EEBUS (VDE-AR-E 2829-6)[402] pairs devices by their certificate's key identifier, confirmed by a person.[123] The device therefore keeps its EEBUS key in protected storage and shows the identifier on display or label.

4.7.4 Logistics tracker

The logistics tracker is a battery budget with a radio attached. LTE-M with power saving carries it on the road, a BLE site gateway on site, and one tracker identity links both paths (Figure 8). The radio transmission, not sleep or GNSS, decides how long the cell lasts.

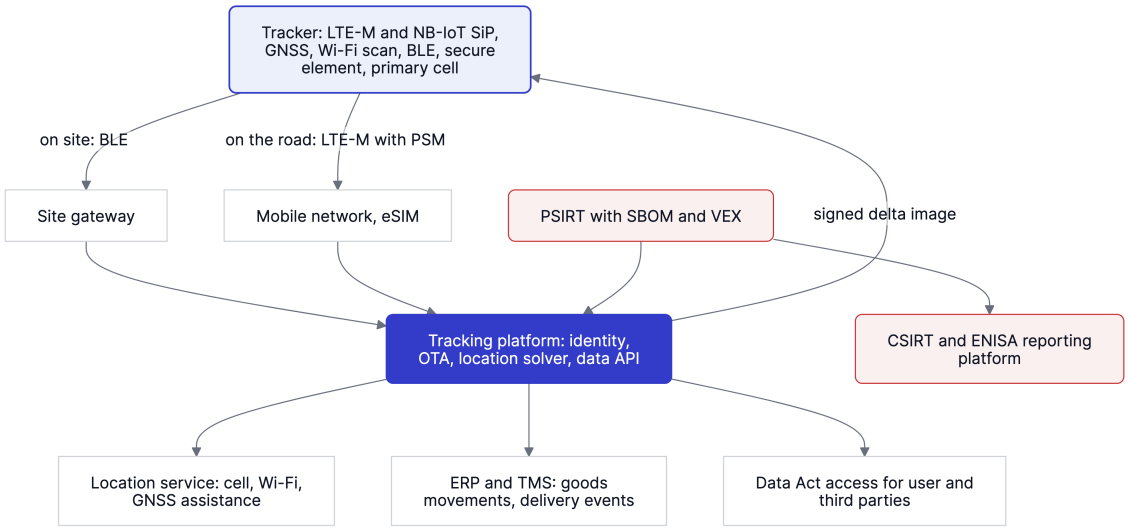


Figure 8: **Reference architecture: logistics tracker**

RADIO	LTE-M as the primary bearer for mobility and handover, NB-IoT as the deep-indoor fallback. An eSIM whose operator profile can be changed in the field.
GATEWAY	None on the road, and on site the BLE gateway of the battery tool. The track stays continuous because it is keyed on the tracker's certificate, not on the bearer.
PLATFORM	The common backbone plus geofences and a location solver behind an interface the manufacturer controls.

ERP	Geofence entries and exits post as goods-movement or delivery events to the ERP or transport management system. Raw positions stay in the platform.
UPDATE MECHANISM	Signed delta images over LTE-M, only when stationary, in good coverage and above a battery threshold.
REPORTING PATH	As for the other archetypes, plus the cellular modem firmware as a separate SBOM component that can be updated on its own.

Cost. For the tracker we calculate €0.99 per device per month in the base case, of which €0.46, or 46 %, is the security premium.

What to watch. The positioning chain decides the battery. A motion sensor decides whether a fix is needed. The cloud solves a Wi-Fi scan to under 100 m and a cell scan to under 700-1,000 m.[287] GNSS at about 25 mW[397] runs only when the asset moves. The nRF9151 draws 18 µA in LTE-M with extended discontinuous reception (eDRX).[288] An eSIM under GSMA SGP.32 lets a trailer change operator without opening a sealed housing.[202] Sleep and hourly GNSS fixes use about 3 % of a D-size cell of 17 Ah a year (Table 9). An A-size cell, by contrast, holds only 3.6 Ah.[340]

ITEM	CALCULATION	CHARGE PER YEAR (MAH)
Sleep in PSM	2.7 µA × 8,760 h	24
GNSS, one fix per hour	25 mW × 30 s assumed per fix = 0.75 J; at 3.6 V about 0.058 mAh per fix × 8,760 fixes	507
LTE-M report, one per hour	Charge per transmission depends on network and coverage	measure in the field
Capacity of an LS 33600	17 Ah nominal	17,000

Table 9: **Annual charge budget of the logistics tracker**
Sources: [284, 341, 397].

No datasheet gives the charge per LTE-M report. It depends on coverage and on how long the modem stays connected before it returns to PSM. It therefore has to be measured on the target network, in good and in poor coverage. The cell loses less than 1 % a year to self-discharge in storage at +20 °C.[341] Its 17 Ah are rated at 5 mA, +20 °C and a 2.0 V cut-off, and at low temperature and higher current it delivers less.[341] The manufacturer therefore sizes the cell with Saft for the coldest operating temperature and the real pulse profile, not for the nominal figure.

From 18 February 2027 the Battery Regulation requires portable batteries to be removable by the end user.[150, 169] The manufacturer therefore checks whether an exception applies before designing a sealed housing. Semtech closed its LoRa Cloud geolocation service on 31 July 2025.[355] The location solver therefore belongs behind the manufacturer's own interface. Galileo OSNMA authenticates the position where it serves as evidence for customs or insurance.[176]

IN SUMMARY

Taken together, the bottleneck is not the technology but the manufacturer's own organisation. A manufacturer that fixes the root of trust and the backbone once for all product lines runs the PSIRT and the update mechanism only once and builds every further product on them. The next chapter shows where logistics tracking departs from this design.

5 Spotlight: logistics tracking

Logistics trackers are the fourth archetype and, for makers of tools and machines, a service business that is only beginning on trailers, containers and machines. From 18 February 2027 most portable batteries must be removable by the user, and Germany's 2G networks close in 2028. These two dates decide which tracker a maker can still build. Six radio classes compete for the same assets, about tenfold apart in unit price and more than a hundredfold in battery life. The chapter compares the classes, sets out the rules for trackers and vehicles and places vendors, market and demand.

5.1 Tracker and tag classes

A tracker is defined by how it finds its position and how it reports it. Six classes combine the two, and each trades battery life against coverage and accuracy.

- **Bluetooth Low Energy (BLE) tags** advertise an identifier and borrow the position of the phone or gateway that hears them. Milwaukee runs a community network through its free ONE-KEY app,[270] and Apple's AirTag runs more than a year on a coin cell.[22]
- **LoRaWAN trackers** last up to seven years on three AA cells[8] but depend on gateway coverage, which Germany lacks nationwide. Semtech shut down LoRa Cloud, the geolocation service many of them used, on 31 July 2025.[355]
- **LTE-M and NB-IoT trackers** report straight over the mobile network and are the default for load carriers and containers. Sensolus specifies up to eight years on replaceable batteries.[358]
- **GNSS plus cellular** gives trailers and unpowered equipment a satellite position to a few metres outdoors, from Digital Matter's Oyster3 on three replaceable AA cells[116] to Tive's rechargeable Solo 5G at 50 days or more.[389]
- **Ultra-wideband (UWB)** locates to 10-30 cm against fixed anchors in hospitals, plants and warehouses.[272]
- **Satellite IoT** reaches containers at sea. Myriota specifies its UltraLite for ten years on two AA cells,[275] and o2 Telefónica has offered NB-IoT with Skylo satellite fallback in Germany since March 2025.[300, 362]

5.2 Price and battery life by class

A BLE tag sells for €7.14, less than a third of any other tracker class, and a GNSS tracker with cellular from €42.01 net, €84.03 with a rechargeable battery[271, 322] (Figure 9). Battery life runs from 20 days to about ten years.[116, 322]



Figure 9: **List price by tracker class**
Note: No public price exists for satellite trackers. Sources: [22, 271, 322, 354].

Most B2B vendors sell on quotation only. Digital Matter, Tive, Trackunit, Hilti, Bosch and Myriota publish no list price.[43, 116, 207, 275, 389, 392] Public prices are therefore mostly single-unit web-shop prices.

Sensolus sells its trackers as a service at a flat fee, €1 per month for the BLE-based location tag at 1,000 assets and €6 per month for the cellular Track 1115 at 500 assets.[357, 358] Otherwise running costs arise mainly from network and connectivity, on LoRaWAN for instance from a network server such as The Things Stack Standard.[385] A 1NCE SIM costs from €12 for ten years and 500 MB, and o2 charges €0.70 per kB for satellite IoT via Skylo.[3, 362] BLE and UWB tags carry no network fee but need an app, a gateway or anchors on site (Table 10).

CLASS	EXAMPLE PRODUCTS	UNIT PRICE, NET (€)	COST PER MONTH (€)	BATTERY LIFE (YEARS)
BLE tag	Minew E8 and MTB07 (pallet tag), Apple AirTag	7.14-29.41	0	1-8
LoRaWAN	RAKwireless RAK2270 (no GNSS), Seeed T1000-A (GNSS, Wi-Fi, BLE), Minew LTB01-G, Abeeway Compact	13.29-40.15	0.19	1-7
LTE-M / NB-IoT	Minew MTB04 (shipping label), Sensolus Track 1115, Bosch sensors	25.87	from 0.10	up to 8
GNSS + cellular	PAJ COMPACT and POWER Finder 4G, Digital Matter Oyster3	42.01-84.03	5-12	up to 10
UWB	Apple AirTag (BLE + UWB), Minew MBM01/MBS02	29.41	0	over 1
Satellite	Myriota UltraLite (2 AA cells), o2 NB-IoT with Skylo	n/a	from 0.88	10

Table 10: **Cost and battery life by tracker class**
Note: Net prices, USD converted at the ECB reference rate, n/a where prices are on request only (as also for Oyster3 and Minew's UWB tags), PAJ trackers 20 and 90 days per charge, RAK2270 at hourly uplinks. Sources: [3, 8, 22, 43, 116, 137, 271, 272, 274, 322, 333, 354, 358, 362, 385].

Shop prices understate the spread for industrial devices. Berg Insight puts typical device costs at €100-300 for dry containers, €50-150 for pallets and €20-100 for cargo.[311] Devices last 5-10 years on dry containers, 1-10 years on pallets and 20-100 days per charge on cargo.[311]

Battery life follows the reporting schedule, not the device. The same Oyster3 lasts about ten years at one update a day and 3.5 years at one an hour.[116] A datasheet figure without a reporting interval is no basis for a business case.

Price is moving from hardware to service. Sensolus charges one recurring fee per asset for hardware, connectivity, platform and support, and Hilti gives its BLE tags to fleet customers free of charge.[207, 357] A maker that wants tracking revenue competes with these models, not with the tag's bill of materials.

5.3 Regulatory dates and tracker design

From 18 February 2027 the Batteries Regulation requires a product's portable battery to be "readily removable and replaceable by the end-user" with commercially available tools.[169] The exceptions are narrow, such as washable appliances for wet environments. A potted or glued tracker fails this test, and most of Bosch's sensor models are sealed.[43]

The end of Germany's 2G networks catches the fallback radio. Telekom aims to switch 2G off on 30 June 2028, Vodafone in September 2028 with some critical IoT uses until the end of 2030, and Telefónica at the end of 2028.[77] Tive's Solo 5G and Bosch's Sense I still keep a 2G fallback,[43, 389] while cellular trackers are specified for up to eight years.[358] A device mounted in 2027 thus outlives its fallback. Replaceable cells and LTE-M or NB-IoT without 2G, as in Oyster3, Abeeway and Sensolus, meet both dates.[8, 116, 358] In Austria A1 switches off its 2G network on 31 May 2028, and Switzerland has already closed 2G.[6, 47]

Security follows the rules of every connected product. As radio equipment that processes location data, a tracker has had to meet the RED's requirements on network protection and personal data since 1 August 2025.[141, 145] Without a user interface it needs a unique credential from the factory instead of a shared default password.[148] It reports location data only as often as the purpose requires.[171] In our assessment, a broadcasting BLE tag also needs rotating, non-linkable identifiers, so that strangers cannot follow it.

Vehicles run on a separate clock. The smart tachograph version 2 (G2V2) has applied to vans above 2.5 t in international transport since 1 July 2026, and from 1 January 2027 new cars and vans need packet-switched eCall[146, 172] (Table 11).

DATE	OBLIGATION	LEGAL BASIS
21 August 2023	Smart tachograph version 2 (G2V2) in newly registered vehicles	Implementing Reg. (EU) 2021/1228, Art. 2
31 December 2024	Vehicles with analogue or digital tachographs operating outside their Member State of registration retrofitted with G2V2	Reg. (EU) 165/2014, Art. 3(4), as amended by Reg. (EU) 2020/1054
18 August 2025	Vehicles with smart tachograph version 1 in international transport retrofitted with G2V2	Reg. (EU) 165/2014, Art. 3(4a)
1 January 2026	New type approvals of eCall systems and vehicles only to the packet-switched standards CEN/TS 17184:2022 and CEN/TS 17240:2018	Delegated Reg. (EU) 2024/1180, Art. 2(2)
1 July 2026	Vans above 2.5 t in international transport or cabotage: driving and rest time rules and G2V2	Reg. (EC) 561/2006, Art. 2(1)(aa), as amended by Reg. (EU) 2020/1054

DATE	OBLIGATION	LEGAL BASIS
1 January 2027	Certificates of conformity of new vehicles without packet-switched eCall no longer valid	Delegated Reg. (EU) 2024/1180, Art. 2(3)

Table 11: **Tachograph and eCall obligations**
Sources: [139, 146, 172, 173].

Domestic van transport is exempt from the tachograph duties.[163, 164] G2V2 records positions with a receiver tested for Galileo's authenticated navigation messages (OSNMA), in service since July 2025.[139, 176] An aftermarket tracker on such a van therefore duplicates that record unless it covers the trailer, the load or the tools. The Commission bases the eCall change on the phase-out of 2G and 3G networks in all Member States between 2025 and 2030.[146] None of these rules reaches trailers, containers, tools or machines.

5.4 Vendors and products in DACH

The market splits by asset rather than by radio. In every segment the network or the service, not the tag, is the product (Table 36).

Tools and equipment. Hilti's ON!Track combines BLE tags, a GPS tracker for machines and trailers, and site and vehicle gateways.[207] Trackunit splits the same job into machine telematics, trackers for unpowered equipment, small tags and site gateways.[391] A BLE tool is found by the contractor's van gateway, which is the logic of the first archetype. Würth sells its W-CONNECT Bluetooth tag, which shows the last known position in its ORSY online app, to trade customers without public prices.[10] At IAA Transportation in September 2026 Würth also showed a van gateway with LTE and eSIM that checks whether the assigned tools are on board.[186] Bosch Professional sells no stand-alone tag in Germany, only the GCY 42 Bluetooth module for its own tools, at €35 before VAT.[336]

Load carriers, containers and trailers. Bosch's Sense I and Minew's MTB07 BLE pallet tag serve load carriers and pallets.[43, 271] Among the providers of disposable smart labels Berg Insight names BOX ID and Giesecke+Devrient in Germany and Truvami in Switzerland.[31] For container tracking it names Giesecke+Devrient and Sensolus, and for trailers the German makers Schmitz Cargobull and Krone.[32]

Vendor churn. A tracker fleet outlives its vendors. Kizy's domain is now parked for sale, Roambee trades as Decklar and Teltonika lists its TAT141 tracker as end of life.[92, 240, 382] Device identity, update keys and location solver must therefore stay under the maker's control.

5.5 Installed base and growth to 2028

Berg Insight expects the installed base of trackers on cargo-carrying units to double, from 11.1 million at the end of 2023 to 22.4 million in 2028, at 15.0 % a year.[32] That is faster than fleet management systems in Europe at 11.0 % a year to 2029[30] (Table 12). Disposable smart labels grow fastest, from 400,000 shipped worldwide in 2024 to a forecast 31.8 million a year by 2029.[31]

SEGMENT AND METRIC	REGION	BASE YEAR	BASE VALUE	FORECAST YEAR	FORECAST VALUE	ANNUAL GROWTH (CAGR)
Cargo-carrying units: tracking device shipments	Worldwide	2023	4.0m	2028	6.6m	10.2 %
Cargo-carrying units: installed base	Worldwide	2023	11.1m	2028	22.4m	15.0 %

SEGMENT AND METRIC	REGION	BASE YEAR	BASE VALUE	FORECAST YEAR	FORECAST VALUE	ANNUAL GROWTH (CAGR)
Cargo-carrying units and cargo: revenue, 12th edition	Worldwide	2023	€2.1bn	2028	€3.5bn	10.2 %
Cargo-carrying units and cargo: revenue, 13th edition	Worldwide	2024	€2.7bn	2029	€4.5bn	10.8 %
Active devices on trailers	Worldwide	2024	5.8m	-	-	-
Active devices on intermodal containers	Worldwide	2024	5.3m	-	-	-
Active devices for general cargo	Worldwide	2024	3.2m	-	-	-
Smart labels: shipments	Worldwide	2024	0.4m	2029	31.8m	140 %
Smart labels: market value	Worldwide	2024	€11.2m	2029	€181.6m	75 %
Fleet management: active systems	Europe	2024	18.1m	2029	30.5m	11.0 %
Fleet management: share of non-private commercial vehicles and cars	Europe	2024	26.7 %	2029	42.8 %	-

Table 12: **Tracking market size by segment**
Note: None of the forecasts reports DACH separately. Sources: [30, 31, 32, 33, 311].

The headroom is large. Only about a fifth (20 %) of some 30 million intermodal containers, 15.7 million trailers and 5.5 million rail freight wagons carry a tracking device.[32] Trailers account for 45.8 % of the installed base of trackers on cargo-carrying units and intermodal containers for 40.6 %.[32] Maersk has fitted all 360,000 of its reefer containers with tracking devices.[32]

5.6 Factory fit and retrofit

Trucks leave the factory with telematics fitted, but trailers, containers and machines do not. That is where the retrofit market lies.[30] Daimler Truck fits Fleetboard in all medium and heavy trucks and MAN fits RIO in new ones.[30] By active subscribers in Europe at the end of 2024, Targa Telematics with 900,000, Webfleet with 752,000 and CalAmp with 600,000 lead the aftermarket providers, and Scania with 461,000, Daimler Truck with 382,000, Volvo with 364,000 and MAN with 264,000 the truck makers.[30] Geotab has taken over Verizon Connect's remaining European operations, Germany included, and Berg Insight counts 11 mergers and acquisitions in the market in 2025 up to November.[30]

German fleets leave room. In a Dataforce survey of more than 530 fleet operators from September to December 2024, about a fifth (21 %) of fleets with five or more vehicles used telematics, about 40 % of fleets with 16 or more commercial vehicles and 60 % in transport and warehousing.[407]

GPS location is the most used function, at 84 % for vans. Among the surveyed fleets with telematics, the share that also covers its vans rose from 51 % in 2018 to 78 % in 2024.[407]

5.7 The demand side

Defence, hospitals and building sites all need to find assets, but none of them has a budget line for tracking. The Federal Ministry of Defence lists more than €108 billion for 2026, without a breakdown by logistics or materiel tracking.[65]

Defence supply chains. No Bundeswehr tender published since January 2025 asks for asset, container or vehicle tracking.[329] In our assessment, two design requirements follow from the technology instead. Position evidence needs authenticated GNSS, which Galileo OSNMA offers,[176] and a tracker that can be told to stop transmitting needs a signed command channel.

Hospitals. The Krankenhauszukunftsgesetz funded digitisation with up to €4.3 billion, but applications closed on 31 December 2021 and none of its eleven project types names tracking.[64, 69] Since 1 January 2025 a hospital without the required digital services faces a deduction of up to 2 % per inpatient case.[63] Tracking therefore enters hospitals inside those processes, as UWB or BLE.

Building sites. Theft drives the demand. In Austria, police-recorded losses from building-site theft peaked at €18.7 million in 2017 and ran at about €17 million in 2018 and 2019.[324] Almost nine in ten (88 %) of 150 construction and plant hire firms surveyed in June 2021 had been robbed.[324] The vendors converge on a site gateway that listens for BLE tags, plus GNSS trackers on large items.[207, 391] For a tool or machine maker the task is therefore integration. A tool with a rotating BLE identifier is found by any contractor gateway, and its data must be accessible to the user.[170]

IN SUMMARY

Taken together, a tracker sold from 2027 needs a replaceable battery sized to its reporting schedule and a network that still runs after 2028. For makers of tools and machines the business lies in the service around the device, not in the device itself. The next chapter shows what changes for makers in Austria and Switzerland.

6 Spotlight: Austria and Switzerland

Austria and Switzerland hold 718 of the 4,410 manufacturers in the DACH population. A maker that sells into all three countries meets two more grid regimes and, at the Swiss border, the EU's third-country rules. Austria shares EU product law with Germany, but its new Electricity Act makes only generators controllable and leaves heat pumps to contracts. Swiss makers are third-country manufacturers under the Cyber Resilience Act (CRA) and need a legal representative in the EU under the Data Act, whatever becomes of the mutual recognition agreement (MRA) with the EU. For machinery, an EU economic operator is added from 2027 for as long as the MRA machinery chapter is not updated. The chapter sets out both countries in the same order, from what is different through the key dates to what they mean for makers, and closes with the rules for Swiss makers on the EU market.

6.1 Austria

6.1.1 Differences from Germany

Austria applies the same EU product law as Germany but has no counterpart to § 14a EnWG. Its new Electricity Act (ElWG) obliges generators, not consumption devices, to be controllable.[335] A heat pump sold in Austria therefore needs no grid operator control interface by law. Consumption devices become controllable through contracts on flexible grid access, through aggregators or through market-based procurement of flexibility.[335] Germany's § 14a EnWG, by contrast, lets the grid operator dim new heat pumps and wallboxes.[61]

The meter is almost everywhere, the data are not. At the end of 2024, 96.9 % of Austria's 6.74 million metering points had a smart meter, but only one in eight of these meters (12.6 %) ran the opt-in configuration that transmits 15-minute values.[132]

Of the population's manufacturers, 318 are Austrian, and we estimate that 132 to 248 of them make connected products.[175] Machine building is the core of the Austrian population. Division 28 has more employees than divisions 26 and 27 together[175] (Table 13).

ÖNACE	PRODUCTS	ENTERPRISES	OF WHICH 50-249	OF WHICH 250+	EMPLOYEES
26	Electronic and optical products	704	54	19	34,888
27	Electrical equipment	625	71	42	52,050
28	Machinery and equipment	1,426	192	98	104,506
32.5	Medical and dental instruments	877	13	4	9,121

Table 13: **Manufacturers in Austria by division, 2023**
Source: [175].

The metal technology industry (FMTI) exported 79.0 % of its preliminary 2025 production value of €47.0 bn.[182] The electrical and electronics industry sold €23.6 bn of production in 2025, about half the metal technology figure, with 71,932 staff.[181]

Austrian makers also face a second cybersecurity law. The NIS 2 Directive covers the manufacture of electronic and optical products, electrical equipment and machinery (NACE C26, C27 and C28) for medium-sized and large entities.[166] Every firm in the Austrian population has at least 100 employees.

6.1.2 Key dates

Three Austrian dates fall inside the life of a product launched in 2027: controllable generators since 1 June 2026, the new NIS law since 1 October 2026 and the end of A1's 2G network on 31 May 2028.[6, 334, 335] The Nationalrat passed the ElWG on 12 December 2025 by 116 votes to 47, the two-thirds majority it needed.[323] Most of its provisions on meters and flexibility are already in force, and some apply from later dates[335] (Table 14).

PROVISION	RULE	APPLIES FROM
§ 49	Smart meters at all metering points; on request within two months	in force
§ 50 (2)	Minimum functions: 15-minute values stored at least 60 days; daily remote reading over a bidirectional interface; remote disconnection; a unidirectional interface that gives the customer the measured values	in force
§ 54 (2)	Households may refuse 15-minute values, except at metering points with a heat pump, charging point, storage or generation unit	in force
§ 63	Customers and generators may sell load and feed-in control on all electricity markets, alone or through aggregators	in force
§ 76	New or substantially modified generation units from 3.68 kW need a control device with a standardised interface; operator control by 1 June 2028 (> 25 kW), 1 June 2029 (3.68-25 kW), 1 January 2030 (0.8-3.68 kW, on request)	1 June 2026
§ 101	Peak capping: PV feed-in not limited below 70 % of module peak power; wind at most 1 % of annual energy	PV in force; wind 1 January 2027
§ 103	Flexible grid access: the operator may cap grid-effective power while capacity is lacking; consumption and storage units may opt in	in force
§ 139	Market-based procurement of flexibility where cheaper than grid expansion; joint proposal to the regulator within nine months	in force

Table 14: **ElWG provisions for connected building devices**
Source: [335].

The Network and Information Systems Security Act 2026 (NISG 2026) transposes NIS 2 and creates the Federal Office for Cybersecurity as supervisory authority. Its substantive provisions apply from 1 October 2026.[334] All Austrian operators had closed their 3G networks by 2025, and the Austrian Economic Chamber expects the other operators to follow A1 and close 2G by 2028.[413]

6.1.3 Implications for makers

A building device sold in Germany and Austria needs one hardware platform with two control paths: a § 14a interface for Germany and an aggregator or energy management interface for Austria.[335] A hybrid system with PV or a battery from 3.68 kW also needs the § 76 control device from 1 June 2026.[335] The grid operator signals only the power at the connection point, and optimisation behind the meter stays with the owner.[335]

The standardised interface is set in the technical and organisational rules (TOR) of the regulator E-Control, not in the act.[335] The TOR for type A generation units have applied since 1 June 2026. They require a digital interface that the grid operator reaches over the owner's internet connection with an OpenADR protocol based on IEC 62746-10-1, rule out third-party systems in between and require the setpoint to be met within one minute.[121] A maker's cloud therefore cannot carry the grid

operator's signal. The grid operators are to specify the Austrian OpenADR profile by 31 October 2026 and publish it by 31 December 2026.[121]

The smart meter supplies the data. It must offer the customer a unidirectional interface with the measured values, and at metering points with a heat pump or charging point its 15-minute values cannot be switched off.[335] For security, NIS 2 governs the firm's own networks, including the development and update infrastructure the CRA relies on, while the CRA governs the product.[166, 171] One incident process can serve both if it routes product vulnerabilities to the CRA reporting platform and incidents in the firm's own systems to the national authority.

6.2 Switzerland

6.2.1 Differences from Germany

Switzerland is the opposite of Germany on grid control. Since 1 January 2026 the owners of installations hold their flexibility, and anyone who wants to use it, the grid operator included, needs a contract.[344]

The Electricity Supply Ordinance (StromVV) sets out the details. Contracts state the control system, scope, remuneration and term, and grid operators publish their rates every year.[345] Without consent or pay, the grid operator may only curtail feed-in at the connection point, by at most 3 % of the energy generated there per year, and act in an immediate threat to grid security.[345] Ripple control of heat pumps used before 2026 continues unless the owner objects.[345]

Of the population's manufacturers, 400 are Swiss, and we estimate that 153 to 313 of them make connected products.[56] Electronics, watches included, and machinery employ most of the staff in the Swiss divisions[56] (Table 15). Watch-making accounts for almost half of division 26's employment.[55] Medical technology, about 1,400 firms with about 72,000 employees, trades more than half of its exports and imports with the EU, and 43 % of the surveyed firms plan no investment, the highest share since the survey began.[371]

NOGA	PRODUCTS	ENTERPRISES	OF WHICH 50-249	OF WHICH 250+	EMPLOYEES
26	Electronic and optical products, watches	1,920	260	82	124,075
27	Electrical equipment	816	90	24	27,831
28	Machinery and equipment	1,850	292	58	81,810
32	Other manufacturing, incl. medical devices	3,647	62	20	30,813

Table 15: **Manufacturers in Switzerland by division, 2024**
Source: [56].

The Swiss tech industry (machinery, electrical and metal industries) grew its exports by 0.7 % to CHF 68.1 bn in 2025, with exports to the EU up 3.5 % and to the United States down 7.6 %.[378] Its capacity utilisation stayed below the long-term average of 85.6 %, at 81.5 % in the fourth quarter of 2025[378] and 81.1 % in the second quarter of 2026.[377]

6.2.2 Key dates

The Swiss dates that matter to makers fall between January 2026 and December 2027:

- **Already passed.** 2G is off, and Swisscom ended 3G service at the end of 2025. Sunrise scheduled its 3G shutdown for the same date.[47, 373]
- **1 January 2026.** The flexibility rules of the StromVG and StromVV apply.[344]
- **31 January 2026.** Grid operators' guidelines on smart meter data formats due.[345]

- **20 January 2027.** The EU Machinery Regulation applies.[168]
- **End of 2027.** 80 % of the meters in each grid area must be smart.[345]
- **11 December 2027.** The main CRA obligations apply to Swiss products sold in the EU.[171]

6.2.3 Implications for makers

A device for the Swiss market needs an interface that a grid operator or a third party can use under contract, but no prescribed one.[344, 345] A heat pump maker therefore designs for voluntary, paid control with an owner's veto in Switzerland, not for dimming by the grid operator under § 14a EnWG.

The meter becomes the device's data source. Art. 8a[decies] StromVV requires a customer interface that delivers measured values at the moment of capture in an internationally common data format, with updatable meter software.[345] From 2028 most Swiss households and businesses will therefore have a meter that an energy manager, heat pump or wallbox can read without a meter of its own.[345] At the end of 2024, 2.94 million smart meters were in operation, half (50.2 %) of all meters, against 26.1 % in 2021.[46]

6.3 Swiss manufacturers on the EU market

The five acts apply to every product placed on the EU market, wherever its manufacturer is based. The Data Act says so expressly for manufacturers of connected products "irrespective of the place of establishment".[170, 171] What changes for a Swiss manufacturer is who else carries duties, which authority it deals with and whether the mutual recognition agreement (MRA) still recognises its machinery assessments once the Machinery Regulation applies.

Importer. The EU importer of a Swiss product may place it on the market only after ensuring that the CRA conformity assessment was carried out and the technical documentation exists. The product must also bear the CE marking and come with the EU declaration of conformity and the required user information.[171] The importer adds its own name and contact details to the product, packaging or accompanying document and informs the manufacturer of any vulnerability it becomes aware of. It keeps the declaration for at least ten years or the support period, whichever is longer.[171]

Authorised representative. Under the CRA the appointment is optional, by written mandate. The mandate must at least cover keeping the declaration and documentation available, answering authorities and cooperating on corrective action. It cannot take over the manufacturer's design and vulnerability-handling obligations.[171] For radio equipment, electrical equipment and machinery, Article 4 of the Market Surveillance Regulation requires an economic operator established in the Union, which is the importer, an authorised representative or a fulfilment service provider, whose name appears on the product.[165] The Machinery Regulation keeps this duty for machinery.[167, 168] The MRA chapters for radio equipment and for electrical equipment refer to the directives in force and accept a manufacturer or importer established in Switzerland for labelling and for keeping the documentation.[343] A Swiss maker therefore needs neither a contract with an EU economic operator nor its contact details on the product, as long as the MRA chapter for its product is up to date.[125] The Data Act adds its own requirement, independent of the MRA. An entity not established in the Union that makes connected products available in the Union must designate a legal representative in a Member State, and falls under that Member State's competence.[170]

Reporting. The reporting obligations of Art. 14, which have applied since 11 September 2026, bind the Swiss manufacturer directly.[171] A manufacturer without a main establishment in the Union reports to the CSIRT of the Member State where its authorised representative is established. Failing that, the Member State of the importer placing the most of its products is responsible, then

that of the distributor, then the Member State with the most users.[171] Appointing an authorised representative in Germany or Austria therefore fixes which CSIRT a Swiss manufacturer deals with.

Swiss law at home. Switzerland has no act in force equivalent to the CRA or the Data Act. On 25 September 2026 the Federal Council moved the drafting of a Cybersecurity Act from the Federal Office for Cybersecurity (BACS), mandated in August 2025, to the Federal Department of Defence, Civil Protection and Sport (DDPS), with a draft due by June 2027. The act is to follow the CRA, bind manufacturers, importers and distributors and allow a sales ban on insecure products.[45, 351] Consultation, parliament and a possible referendum still lie ahead. We therefore do not expect it to apply before 11 December 2027.

Two sector rules mirror EU cybersecurity requirements, one planned and one in force. For machinery, the revised Swiss Machinery Ordinance (MaschV) would take over the EU Machinery Regulation's requirements on protection against corruption and on the safety and reliability of control systems, together with the presumption of conformity for machines certified under an EU cybersecurity scheme.[125, 168] No Swiss certificates of that kind exist.[125] For radio equipment, the Telecommunications Installations Ordinance (FAV), read with the BAKOM ordinance on telecommunications installations (VFAV), takes over the three requirements of Delegated Regulation 2022/30.[125, 346] Since 1 August 2025, the same date as in the EU, radio equipment that does not meet them may no longer be placed on the Swiss market.[346] CE marking is generally not required in Switzerland.[365] A Swiss maker selling into DACH thus builds to EU law for Germany and Austria and uses the same design at home.

6.3.1 The MRA question

The MRA covers 20 product sectors, including machinery (chapter 1), medical devices, electrical equipment and radio and telecommunications terminal equipment (chapter 7), and thus 73 % of Swiss industrial exports to the EU.[349, 365] Its core is that conformity is assessed once, in Switzerland or in the EU.[349] The CRA is not among its chapters. A CRA conformity assessment by a Swiss body is therefore not recognised through the MRA, and where a Class I or II product needs a notified body, it must be one notified in the EU.[365] Since 26 May 2021 the EU has refused to update the agreement while institutional questions were open. The medical devices chapter has therefore stayed as it was, and medical device makers have lived with third-country status since then.[349]

The EU-Swiss package (Bilaterals III) is meant to end that blockage by adding institutional elements to the MRA, so that it follows EU law regularly.[349] The agreements were signed on 2 March 2026 and sent to parliament the same month, without an entry-into-force date.[124] The amending protocol to the MRA rewrites the agreement's institutional articles and chapters 4, 5, 11 and 15 of its annex, not the machinery chapter. It enters into force only together with the other agreements of the package.[85, 124]

For machine builders the test comes on 20 January 2027.[168] The MRA machinery chapter, in its version of 22 December 2017, still refers to the Machinery Directive and the MaschV of 2 April 2008.[343] Updating it to Regulation 2023/1230 requires an equivalent Swiss ordinance and the consent of both parties in the Joint Committee.[125] The totally revised MaschV takes over the Regulation by reference and is to enter into force on the same day.[125] The consultation ran from 19 September to 19 December 2025.[342, 350] The explanatory report expects the MRA chapter to be updated in time and has the economics ministry (WBF) examine the consequences if it is not.[125]

So far, the Federal Council has not adopted the revised ordinance and the Joint Committee has not updated the chapter. The MaschV in force is the version of 20 January 2024, and SECO's designation of machinery standards of 9 October 2026 still refers to the 2008 ordinance and the

standards cited under the Directive.[343, 347, 364] The Federal Council can still adopt the ordinance in time, but the update of the chapter also needs the EU's consent. Until then, a Swiss machine builder exporting to the EU needs an EU economic operator named on the product and, for Annex I machinery, an EU notified body[349] (Table 16).

AREA	MRA UPDATED	MACHINERY CHAPTER NOT UPDATED
Machinery conformity assessment	once, in Switzerland, recognised in the EU	EU conformity assessment needed
EU economic operator, labelling	not needed for machinery	importer or authorised representative in the EU; relabelling
CRA (cybersecurity)	outside the MRA: EU rules apply in full, importer duties apply	same
Medical devices	update possible after entry into force	third-country status continues, as since 2021

Table 16: **Effects of the two MRA outcomes for Swiss makers**
Note: "MRA updated" assumes the EU-Swiss package in force. Sources: [349, 365].

IN SUMMARY

Taken together, one product built to EU law serves all three countries, but each grid needs its own control path and every Swiss maker needs an EU partner with duties of its own. Neither depends on the MRA or on a future Swiss cybersecurity act. The next chapter shows who can supply the stack that meets these rules.

7 Vendor landscape

A maker of connected products buys most layers of its stack, from the secure element through the update service to the IoT platform, and needs these vendors for the whole support period of its products. Every layer can be bought from named vendors, but the market behind it changed owners in 2025 and 2026, and the three large US clouds cut IoT services. Not one body is notified under the CRA yet. A gateway that needs one therefore has no route to conformity. The chapter describes the consolidation by layer, the cloud providers' retirements and the status of notified bodies.

7.1 Market consolidation 2025-2026

The vendor market consolidated in four layers of the stack between 2024 and 2026. Device management moved to chip and OS vendors, capital flowed to firmware security, PKI vendors went to financial investors, and independent platforms changed owners (vendors by layer in Appendix D).

A vendor chosen in 2026 may therefore have a different owner, product line or price list before a product sold in 2027 reaches the end of its support period.

7.1.1 Device management and OTA

Three of the five OTA products that carry most DACH projects changed owners between June 2025 and March 2026. Nordic Semiconductor acquired Memfault on 24 June 2025 and is integrating it into nRF Cloud. Nordic has committed to keep serving device makers on other vendors' hardware.[286] Golioth became part of Canonical on 3 March 2026,[198] and Canonical's Zephyr 26.04 LTS has shipped with Golioth OTA since September 2026.[200] The OTA choice is therefore tied more closely than before to a chip or operating-system vendor.

Two vendors focus on compliance for the German-speaking market. qdCloud maps its functions to CRA requirements and states that this does not replace the conformity assessment of the product.[332] Kontron in Linz sells the operating system and the update service together[241] and has had Ennoconn as anchor shareholder since 2026.[243]

7.1.2 SBOM, vulnerability management and PSIRT

The binary-analysis vendors, which read compiled firmware and so cover bought-in radio modules and supplier boards, raised more capital than any other vendor group in the stack. Exein in Rome alone raised €70 million in July 2025, €100 million in December 2025 and USD 270 million at a USD 1.7 billion valuation in September 2026.[177, 178, 180] Dragos bought NetRise, and Keysight sells Cybeats' SBOM platform under its own name.[89, 118]

No tooling vendor sells the PSIRT team, the disclosure policy or the 24-hour reporting path. Engineering firms offer them as services. Ginzinger electronic systems and its partner LIMES Security, for example, sell secure updates and the matching CVE process as part of a lifecycle service.[192] The tooling can be bought, the process stays with the maker or its service partner.

7.1.3 Secure element and PKI

Four listed chip makers supply the common secure elements and their provisioning services, among them NXP EdgeLock 2GO, Infineon Trust M Express and Microchip Trust&GO.[218, 263, 296] The issuing-CA vendors consolidated under financial investors. Keyfactor bought InfoSec Global,

DigiCert bought Vercara and Valimail, and Sectigo took over Entrust's public certificate business.[103, 104, 231, 352] Keyfactor also took a growth investment above USD 1 billion in 2026.[233] The DACH-based PKI and HSM vendors are smaller, and several are owned by private equity or the state.

7.1.4 IoT connectivity

Two Germany-based MVNOs compete with the national operators. 1NCE in Cologne reports more than 40 million SIM connections,[4] emnify in Berlin more than 23 million.[130] Both are investor-funded. 1NCE raised USD 60 million in April 2025, with Deutsche Telekom among its investors.[1] Both offer SGP.32 eSIM, the standard for changing profiles in the field.[129]

7.1.5 IoT platforms

The independent platforms changed owners, while the German industrial platforms stayed with their groups. Cumulocity was bought back from Software AG by its management in January 2025,[86] and PTC sold ThingWorx and Kepware to TPG, closing on 13 March 2026.[327] Siemens renamed MindSphere to Insights Hub,[361] Bosch IoT Suite shows no end-of-life notice,[44] and Device Insight has been a wholly owned KUKA subsidiary since 2019.[102]

7.1.6 Trackers and telematics

Two of the main tracker and telematics suppliers came under financial owners in 2025. Advent International completed its acquisition of u-blox, the Swiss GNSS and cellular module maker, on 26 November 2025.[11] Trackunit, the construction-equipment telematics vendor, has had Goldman Sachs Alternatives as majority investor since June 2025.[390]

7.1.7 Engineering service providers

The two listed engineering service providers with large German operations, Bertrandt and EDAG, reported revenue falls of 18 % and 13 % for their financial years ending in 2025.[34, 122] The specialist embedded firms in Austria and Switzerland are smaller and work closer to the device.

7.2 Discontinued IoT services as a platform risk

All three large US clouds have retired IoT services or closed them to new customers since 2023. Google retired IoT Core in 2023, and AWS and Microsoft followed with several services from 2024, six changes in four years[14, 201, 264] (Table 17). For a product with a support period of at least five years, each one is a platform risk.[171]

SERVICE	PROVIDER	CHANGE	DATE
Google Cloud IoT Core	Google	Retired	August 2023
AWS IoT Analytics	AWS	Closed to new customers 24 Jul 2024; end of support	15 Dec 2025
AWS IoT Events	AWS	Closed to new customers 20 May 2025; end of support	20 May 2026
AWS IoT FleetWise	AWS	Closed to new customers; end of support not announced	30 Apr 2026
Azure IoT Central	Microsoft	No new applications; applications unavailable after 20 Sep 2029	23 Sep 2026
Azure IoT Edge 1.5 LTS	Microsoft	End of support; no successor LTS listed	11 Nov 2026
Azure Device Update for IoT Hub	Microsoft	Remains generally available; Azure Device Registry updates in preview	October 2026

Table 17: **Cloud IoT service retirements since 2023**
Sources: [14, 17, 18, 201, 264, 265, 267].

The core services are not affected. AWS IoT Core and Azure IoT Hub have no retirement announced, and Microsoft names IoT Hub, the Device Provisioning Service and Fabric as the migration path from IoT Central.[264] The risk lies in the services built on top. The update service therefore belongs behind an abstraction.

7.3 Notified bodies under the CRA

NANDO currently lists no body notified under Regulation (EU) 2024/2847, in any status.[161] Chapter IV of the CRA has applied since 11 June 2026, and the Commission publishes each body in NANDO once it is notified.[157]

The authorities are not complete either. Fourteen notifying authorities in 13 Member States are registered for the CRA, in Germany the BSI.[161] Austria has registered none. The Federal Chancellery states that it will take on the role.[59] Germany's CRA implementation act has yet to complete the parliamentary procedure.[100, 220] Swiss bodies have no route to notification, because the CRA is not covered by the EU-Swiss MRA.[365]

Two bodies have said in public that they are on the way. SGS Brightsight in the Netherlands holds ISO/IEC 17065 accreditation for CRA Module B and will seek notification through the Dutch notifying authority.[360] TÜV NORD will apply to the BSI for designation under the CRA.[396]

A Class I product such as a stand-alone gateway therefore needs a notified body that does not yet exist, as long as no CRA harmonised standard is cited. RED assessments under EN 18031, by contrast, can be booked today, with 55 active bodies, 12 of them in Germany.[160]

IN SUMMARY

A maker buys the stack but must build it so that it can switch update service, PKI and cloud without touching a device in the field. Standardisation and notification, not the maker, decide market access for gateways sold on their own. The last chapter turns the analysis into actions by role, a twelve-month plan and five guiding questions.

8 Recommendations

A maker of connected products has less than a year before the CRA applies in full on 11 December 2027. The reporting duty for vulnerabilities applies already. By the end of March 2027 it should be able to report an actively exploited vulnerability within 24 hours and know the CRA class of each product. The architecture follows by mid-year, a pilot on one product line by autumn, and the conformity assessment before the deadline. The chapter assigns the actions to three roles, sets them out in a twelve-month plan, names the funding that can carry part of the cost and closes with five guiding questions.

8.1 Management

Management decides on the fleet over which security is spread and on the backend that carries it. Both set the cost (F4, F5).

- Make one shared device backend the rule for all product lines, with one update service, one PKI and one vulnerability process. In our cost model the security premium falls from about €2.30 a month per device at 1,000 units to under €0.30 at 100,000 (F5).
- Budget security as a running cost of about half a euro per device and month, priced into the product and its service contracts, not as a one-off project (F4). Budget the Data Act once for the whole company, as one export interface and one data-sharing process.[143]
- Give one person the responsibility for product security and the authority to file a report without further sign-off (F1).
- Fund the twelve-month plan below from January 2027 and review it every quarter. The deadlines do not move when the standards are late (F1, F2).
- Choose the OTA service and the cellular tariff by their cost over five years, not by the price of the chip (F4). Ask every platform and OTA vendor for a written commitment that covers your products' support period, and for a documented export path.
- Decide whether tracking is sold as a service, and price it against all-in fees per asset, not against the tag's bill of materials.[357] Plan tool tracking as integration with the contractors' site gateways, not as a gateway network of your own.[207, 391]

8.2 Product and engineering

Engineering fixes the design choices that cannot be changed after shipment (F3, F4, F6).

- Fix secure boot, a hardware root of trust, a unique device identity and the factory provisioning route before the board layout of every product launched in 2027. None of them can be added by a firmware update, and in our cost model the secure element is the smallest cost item (F4, F5).
- Design gateways as part of the machine, sold and documented with it, and describe their core function as machine connectivity, not network protection, so that they stay in the CRA default class[149] (F3).
- Keep the gateway's write path to safety functions closed by design, and sign PLC firmware separately from the gateway's own packages, so that customers can install security fixes without requalifying their process.[168, 171]
- Release no firmware without an SBOM in the format of BSI TR-03183 and a check against known vulnerabilities,[54] and route every match to a named product security team that can report to ENISA within 24 hours (F1).

- Run device identities, update keys, the update service and the location solver behind an interface of your own that survives a vendor sale or a cloud retirement.
- Remove 2G fallbacks from tracker and gateway designs, and make batteries removable by the user or document the exemption, before the designs freeze[77, 169] (F6).

8.3 Compliance

Compliance owns the duty that applies today and the classification that sets every later cost (F1, F3).

- Own the reporting path through ENISA's single reporting platform and test it in a drill before a real case arrives[133, 171] (F1). Run one reporting process for the CRA and NIS 2 where the company also falls under NIS 2. It sends product vulnerabilities to the platform and incidents in the company's own systems to the national authority.[166]
- Bring the installed base into the reporting duty, not only current production (F1).
- Own the CRA classification of every product, measured against the Commission's implementing regulation on product categories[149] (F3).
- Assess conformity against the essential requirements of Annex I now, instead of waiting for harmonised standards, and keep the evidence for each requirement (F3). Certified radio modules and secure elements save work but do not replace the assessment of the whole product.[171]
- For any important product, contact early the bodies that have announced a CRA notification (F3).
- For Swiss products, designate the legal representative under the Data Act and write the CRA duties into every contract with an EU importer: documentation, contact details on the product, cooperation on vulnerabilities.[170, 171] For Swiss machinery, also name an EU importer or authorised representative and keep an EU notified body in reserve for Annex I machinery, as long as the machinery chapter of the mutual recognition agreement has not been brought into line with the new Machinery Regulation.[343, 349]

8.4 The twelve-month plan

The obligations set the order of the plan. The reporting duty, which already applies, comes first, and the conformity assessment for products placed on the market after 11 December 2027 comes last[171] (Table 18). The plan starts in January 2027 and is written for a manufacturer with one to five connected product lines and one engineering organisation.

MONTH FROM PUBLICATION	PHASE	OUTCOME	RELATED DEADLINE	RESTS ON
1-3	Reporting and classification	A working CRA reporting process; every product placed in a CRA class and a Machinery Regulation category	CRA reporting, in force since 11 Sep 2026; Machinery Regulation, 20 Jan 2027	F1, F3
4-6	Assessment and architecture	A gap list per product against the requirement matrix; a target architecture and a costed bill of materials	Data Act design duty for new products, in force since 12 Sep 2026	F4, F5

MONTH FROM PUBLICATION	PHASE	OUTCOME	RELATED DEADLINE	RESTS ON
7-9	Pilot	One product line on the target stack: secure element, signed OTA, SBOM per release, data interface	Battery Regulation, 18 Feb 2027; 2G shutdown, 2028	F6
10-12	Assessment and CE marking	Technical documentation, conformity assessment and EU declaration of conformity for each product placed on the market after 11 Dec 2027	CRA in full, 11 Dec 2027	F3

Table 18: **Action plan for the first twelve months**

8.4.1 Months 1-3: reporting and classification

The first quarter deals with the obligation that already applies. An actively exploited vulnerability or a severe incident requires an early warning within 24 hours, a notification within 72 hours and then a final report, through ENISA's single reporting platform and for products already on the market too.[133, 156, 171]

A1	Name the owner of product security incidents and a deputy, and make sure one of them can decide on a report within 24 hours.
A2	Register on ENISA's single reporting platform and establish which CSIRT is competent. For a Swiss maker, this follows from the EU economic operator it works with.
A3	Publish a vulnerability disclosure policy and a contact address for security reports on the company website.
A4	Build an inventory of every product with digital elements on the market, with its firmware versions in the field.
A5	Place each product in a CRA class (default, important class I or II, critical) and, for machinery, check whether it falls under Annex I of the Machinery Regulation.
A6	Record every classification that is a judgement call, such as a gateway sold on its own, with its reasoning.

The classification decides the cost of everything that follows. A default-class product can be self-assessed under module A, while an important product needs a harmonised standard or a notified body.[171] The Commission's implementing regulation on categories has applied since 21 December 2025 and settles borderline cases.[149]

8.4.2 Months 4-6: assessment and architecture

The second quarter measures each product against the requirement matrix of the five acts and decides the target design. The CRA's Annex I sets the yardstick, with secure default configuration, integrity and confidentiality, a declared support period and vulnerability handling with an SBOM,[171] in the format of BSI TR-03183.[54]

A7	Run a gap assessment per product line against the matrix, one row per requirement, with the evidence that exists today.
A8	Decide the support period per product and publish it, as the CRA requires it to be stated at the time of purchase.
A9	Choose the target stack: radio, secure element or TPM, device identity and PKI, OTA service, SBOM tool, data interface.
A10	Cost the target stack for the planned fleet size, including the security premium.
A11	Check the radio choice against the 2G shutdown.
A12	Design the Data Act interface for products placed on the market from now on, covering the product data generated, the user's access path and the format.

These decisions cannot be revised later. Germany's 2G networks close between 30 June 2028 and the end of 2028, while a product sold in 2027 with a five-year life is still in the field.[77] The device security layer cannot be added after shipment. The Data Act's access-by-design duty applies to connected products placed on the market after 12 September 2026.[170]

8.4.3 Months 7-9: pilot

The third quarter proves the design on one product line, from factory provisioning to a signed field update and a test report through the reporting process of the first quarter.

A13	Provision device identities in the factory and enrol them in the PKI, for one production batch.
A14	Ship one signed and, where needed, encrypted firmware update to the pilot fleet, and roll one back.
A15	Automate SBOM generation in the build pipeline of the pilot line.
A16	Run a reporting drill with a simulated actively exploited vulnerability, from detection to the 24-hour early warning.
A17	Test the Data Act interface with a user and, if relevant, a third party nominated by the user.
A18	For battery-powered products, check that portable batteries can be removed and replaced by the end user and that industrial batteries above 2 kWh have a battery passport, both due from 18 February 2027.

The battery rule matters most for tools and trackers. Many trackers are potted or sealed, which conflicts with the removability rule unless an exemption applies[169] (F6).

8.4.4 Months 10-12: assessment and CE marking

The last quarter completes the documentation and the conformity assessment, so that every product can carry the CE marking on the day the CRA applies in full.[171] New machines already follow the Machinery Regulation, which applies from 20 January 2027.[168]

A19	Compile the technical documentation per product: risk assessment, the requirement matrix with evidence, SBOM, support period, test reports.
A20	For default-class products, carry out the internal control under module A and draw up the EU declaration of conformity.
A21	For important products without a cited harmonised standard, book a notified body as soon as the first one is notified.
A22	Update the user information: support period, security contact, secure decommissioning, data access.
A23	Brief sales and service on what changes for products in the field and for spare parts.
A24	Plan the first annual review. Harmonised standards may simplify the next assessment once the first ones are cited.

The standardisation request schedules the CRA harmonised standards for routers, modems, switches and firewalls for 30 October 2026.[147] Citation in the Official Journal follows only after that. A plan for 2027 therefore cannot count on them. Swiss manufacturers follow the same plan, with an EU economic operator added in the first quarter.

8.5 Funding for CRA compliance

No national grant pays for CRA compliance in Germany, Austria or Switzerland (Appendix E). The two open calls that name the CRA are European. SECURE pays SMEs up to €30,000 at a 50 % funding rate,[353] and a Digital Europe topic funds the implementation of EU cyber legislation.[280]

The year 2026 narrowed the choice further. ZIM has accepted no new applications since 7 July 2026,[387] KMU.DIGITAL will not return in 2027,[414] and the state digitalisation grants ended in Baden-Württemberg, Lower Saxony and Thuringia.[250, 282, 386] The successors of the KfW ERP-Digitalisierungs- und Innovationskredit pay a grant of 3 or 5 % only from Stage 2.[235, 237]

Few programmes still have a dated window. MID-Digitale Prozesse opened on 19 October 2026.[294] SECURE closes on 11 December 2026,[353] the FFG Basisprogramm's 2026 call on 31 December 2026,[313] KIRAS on 26 February 2027[317] and Digitalbonus.Bayern at the end of 2027.[29] The other programmes are closed or rolling. A maker can, for example, request the KfW ERP-Förderzuschuss at any time with the loan through its house bank,[237, 238] and L-Bank, the aws erp-Kredit, Innosuisse and the tax credits have no deadline either.

A German maker will therefore realistically finance CRA work with a KfW Stage 2 or 3 loan and its grant plus the Forschungszulage, whose assessment base rose to €12 million a year.[35, 62] An Austrian maker uses the FFG Basisprogramm and the Forschungsprämie, a Swiss maker an Innosuisse project with a research partner.

8.6 Five guiding questions

Five questions show whether a company is ready. Each should be answered with yes.

1. Would an early warning on an exploited vulnerability reach ENISA within a day today, including for a product sold years ago?

2. Could you justify the CRA class of every gateway and every other borderline case to a market surveillance authority today?
3. Is security anchored in hardware in every product you launch in 2027, from boot to device identity?
4. Does a single backend carry the updates, certificates and vulnerability reports of all your product lines?
5. Will every tracker and gateway you sell in 2027 still work after the 2G shutdown, and can the user replace its battery where no exemption applies?

A no to the first question means that a duty already in force is not met. A no to any of the others is a cost or a market risk for products launched in 2027.

IN SUMMARY

The deadlines set the order of the work, not the state of the standards. A maker that waits for cited standards starts the conformity assessment too late for its 2027 products. It carries the work largely on its own budget. Loans and R&D tax credits ease the burden only at the margin.

Appendix

A Method

Every number in the report rests on published sources or on assumptions marked as such. No survey of our own and no negotiated prices are used. Our cost model and our estimate of the number of makers of connected products (Section 1.5) rest partly on assumptions.

A.1 Sources

The evidence falls into six kinds:

- **Legal texts.** Dates and obligations are taken from the application articles of the legal texts, as corrected.[141, 167, 168, 169, 170, 171] The status of harmonised standards and of notified bodies is taken from the Official Journal, the Commission's NANDO database and the European standardisation organisations.
- **Official statistics.** Enterprise counts come from the German cost structure survey for 2023, Eurostat's structural business statistics for Austria (2023) and the Swiss enterprise census STATENT (2024).[56, 175, 367]
- **Surveys.** The share of firms that offer connected functions and the readiness signals come from published surveys of 100 to 1,003 firms, run by research institutes, associations, consultancies and vendors.[36, 37, 190, 307, 330] Each reflects how firms assess themselves.
- **Prices.** All prices are list prices currently published by vendors and distributors. We leave vendors that publish no price out of our cost model, and we do not estimate a price for them.
- **Compliance cost estimates.** The per-product cost of the CRA and the cost of third-party testing come from the Commission's impact assessments and support study.[140, 143, 144, 410]
- **Market events.** Acquisitions, product launches and service closures come from the companies' own announcements and from the business and legal press.

A.2 Measured and assumed

We calculate the cost per device with a cost model of our own for the four archetypes (Appendix C). Its only assumptions are the radio, data traffic, security hardware and update service per archetype, and every other number in the model is a list price with its source.

Our population estimate starts from official enterprise counts. The assumptions are the share of firms that make connected products, the split of the German 100-499 band by the 2017 ratio, the size structure for Austria and Switzerland, and two employment-weighted approximations for Switzerland.

A.3 Population estimate

No statistical office counts "manufacturers of connected products". We therefore estimate 1,750-3,440 such manufacturers. To get there, we multiply official enterprise counts by industry and size band[56, 175, 367] by a low and a high survey-based share. The connected share rests on surveys, not registers, and is therefore the weakest step. In a later edition we plan to replace it with signals from the RUBINLAKE platform.

A.3.1 Method in four steps

Step 1: industry classes. We count enterprises in four classes of WZ 2008 (Germany), ÖNACE 2008 (Austria) and NOGA 2008 (Switzerland), which match NACE Rev. 2 at this level: division 26

(computer, electronic and optical products, including measuring, control and navigation instruments), division 27 (electrical equipment, including motors, switchgear, wiring devices and household appliances), division 28 (machinery and equipment n.e.c., including power tools, heat pumps and machine tools) and group 32.5 (medical and dental instruments). We leave out divisions 29 and 30 (vehicles) because vehicles under EU type approval fall outside the CRA.[171] We keep groups 26.1 (components and boards) and 27.3 (cables and wiring devices) in the base, since their parts can themselves be products with digital elements under the CRA.[171]

Step 2: size bands. The German cost structure survey (Kostenstrukturerhebung, KSE) counts legal units with 20 or more persons employed in the bands 20-49, 50-99, 100-499, 500-999 and 1,000 and more.[367] We split 100-499 into 100-249 and 250-499 with the ratio of the last KSE edition that published both bands (reference year 2017). Then, 73 % of the 100-499 firms in division 26 had fewer than 250 employees, 71 % each in divisions 27 and 28, and 74 % across manufacturing.[366] We use the manufacturing value for group 32.5. Austria and Switzerland publish only the bands 50-249 and 250 or more.[56, 175] We apply the German structure to both. In the four classes, 47 % of German firms with 50-249 employees have 100 or more, and 18 % of those with 250 or more have 1,000 or more.[367] This is an assumption. Austrian and Swiss firms in the 250+ band are smaller on average. Our 1,000+ cells for both countries are therefore more likely too high than too low.

Step 3: national adjustments. Swiss division 26 includes watch-making (NOGA 26.52), which accounts for 47.7 % of the division's 117,217 employees.[55] We remove that share from the Swiss division-26 counts. Switzerland does not publish group 32.5 by size band. We therefore scale division 32 by the 66.8 % of its employment that falls in group 32.5.[55] Both are employment-weighted approximations.

Step 4: connected share. The connected share sets the width of the range. We apply a low and a high share of firms that make connected products:

- **Low:** the share of establishments that used, or planned by 2021 to use, IoT service platforms to offer digital services, from Fraunhofer ISI's German Manufacturing Survey 2018, 17 % plus 14 % for 50-249 employees and 37 % plus 15 % for 250 or more.[190] We use 31 % for the 100-249 band and 52 % above. The share is old and measures platform use rather than product features. We therefore treat it as the floor.
- **High:** the share of German manufacturers with 100 or more employees that use IoT platforms (45 %) or plan to (33 %), Bitkom 2026, n = 555.[37] That gives 78 %, which we apply to all bands. The question covers IoT platforms in production as well as in products, so it marks the ceiling.

Each estimate per country and size band is the base count times the share. The 277 German legal units with 1,000 or more employees give 144 makers at 52 % and 216 at 78 %.[37, 190, 367]

Top band. No official source breaks at 5,000 employees. The top band of 1,000-4,999 therefore also contains firms with 5,000 or more. The KSE's 1,000+ class has 277 German legal units in the four classes with 867,062 persons, an average of 3,130.[367] The KSE counts legal units. The subsidiaries of large groups therefore appear separately, and most of them fall below 5,000. We deduct no 5,000+ class and so overstate the top band slightly.

A.3.2 By country and size band

Germany holds more than four fifths of the population, 3,692 of the 4,410 firms in the base and 1,465-2,879 of the 1,750-3,440 estimated makers. Austria adds 132-248 and Switzerland 153-313 (Table 19).

COUNTRY	FIRMS	100-249	250-999	1,000-4,999	TOTAL
Germany	in the base	2,170	1,245	277	*3,692*
	of which connected	673-1,692	648-971	144-216	*1,465-2,879*
Austria	in the base	155	133	30	*318*
	of which connected	48-121	69-104	15-23	*132-248*
Switzerland	in the base	262	113	25	*400*
	of which connected	81-205	59-88	13-20	*153-313*

Table 19: **Population and range by country and size band**
Note: Size bands by employees, base year 2023 for Germany and Austria and 2024 for Switzerland, Germany in legal units, rows may not add up because of rounding. Sources: [37, 56, 175, 190, 367].

The 159 Austrian enterprises with 250 or more employees in divisions 26 to 28 employ 136,695 people.[175] Switzerland has 82 enterprises with more than 249 employees in division 26 (including watch-makers), 24 in division 27 and 58 in division 28.[56]

A.3.3 By sector

Machinery (WZ 28) accounts for 2,075 of the 3,692 German manufacturers with 100 or more employees, more than half, and supplies three of the four archetypes.[367] Only Germany publishes size bands below division level. The breakdown therefore covers Germany alone (Table 20).

WZ 2008	PRODUCTS	100-499	500-999	1,000+	TOTAL 100+	ARCHETYPE SUPPLIED
26	Electronic and optical products	533	64	52	649	Logistics tracker
26.5	of which measuring, control, navigation	262	29	22	313	Machine, logistics tracker
27	Electrical equipment	568	94	58	720	Building device
27.1	of which motors, transformers, switchgear	238	29	25	292	Machine, building device
27.5	of which household appliances	27	6	8	41	Building device
28	Machinery and equipment	1,724	207	144	2,075	Battery tool, machine, building device
28.1	of which general-purpose machinery (pumps, valves, drives, hydraulics)	381	58	45	484	Machine
28.2	of which other general-purpose machinery	533	50	46	629	Battery tool, machine, building device
28.24	of which power-driven hand tools	13	0	4	17	Battery tool
28.25	of which cooling and ventilation, incl. heat pumps	108	n/p	n/p	n/p	Building device
28.4	of which machine tools	192	27	12	231	Machine
28.9	of which special-purpose machinery	558	64	32	654	Machine
32.5	Medical and dental instruments	201	24	23	248	Machine
	Total	**3,026**	**389**	**277**	**3,692**	

Table 20: **German manufacturers by WZ group, 2023**
Note: "n/p" marks cells suppressed for confidentiality. Source: [367].

Battery tool with BLE tracker. WZ 28.24 is a narrow class of large firms. It has 31 legal units with 20 or more employees, and the four with 1,000 or more account for 11,841 of the class's 16,054 persons.[367] Firms classified elsewhere also sell battery tools with trackers, for instance in metal products (division 25). The class therefore undercounts the archetype.

Machine with gateway. Division 28 alone has 2,075 legal units with 100 or more employees and 1.10 million persons in all units with 20 or more.[367] Machine builders also show the highest connected share. In 2018, 24 % of them used IoT service platforms and a further 20 % planned to.[190]

Building device under § 14a EnWG. The archetype sits mainly in 28.25 (395 legal units with 20 or more employees, of which 108 with 100-499), in 28.21 (furnaces and burners, 127) and in division 27.[367] Heat pump sales in Germany rose 55 % to 299,000 units in 2025, more than gas condensing boilers (229,000).[81] Each heat pump that a grid operator can control under § 14a EnWG has a communication interface and is therefore a product with digital elements.[171]

Logistics tracker. Makers of equipment and trackers are spread across divisions 26 and 27. Specialist tracker makers are often below the 100-employee threshold. The large buyers of trackers are the tool and machine makers in this population.

A.3.4 Cross-check with the associations

The associations define their industries differently from official statistics. Their counts therefore confirm the order of magnitude of the official base but not its cells (Table 21).

ASSOCIATION	ASSOCIATION FIGURE	OFFICIAL COMPARISON FIGURE
VDMA (Germany, machinery)	6,459 enterprises, average 178.9 employees (2016); 6,653 enterprises, average 182.8 (2018)	WZ 28: 5,688 legal units with 20+ employees, 1,102,436 persons, average 194 (2023)
ZVEI (Germany, electrical and digital industry)	872,700 employees end of 2025; turnover €226.8 bn in 2025	WZ 26 + 27: 858,294 persons in legal units with 20+ employees (2023)
FEEI (Austria, electrical and electronics industry)	71,932 employees, production €23.6 bn (2025)	ÖNACE 26 + 27: 86,938 employees (2023)
FMTI (Austria, metal technology industry)	130,694 employees (December 2025), production €47.0 bn	ÖNACE 28: 104,506 employees (2023)
Swissmem (Switzerland, tech industry)	322,900 employees in Q4 2025; exports CHF 68.1 bn in 2025	NOGA 26-28: 233,716 employees (2024)
Swiss Medtech (Switzerland, medical technology)	about 1,400 firms, about 72,000 employees	NOGA 32.5: 1,472 institutional units, 19,990 employees (2022)

Table 21: **Association figures and the official base**
Sources: [55, 56, 175, 181, 182, 367, 371, 378, 404, 405, 416].

VDMA. The official count for 2023 is lower than the VDMA's, but the series are not comparable. The KSE covers only legal units with 20 or more persons, each classified by its main activity.[367] The VDMA combines Destatis data with its own.[404] It represents about 3,500 German and European member companies itself.[406] On either count, about 2,000 German machine builders have 100 or more employees.[367]

ZVEI. Official employment in divisions 26 and 27 is of the same size as the ZVEI's figure.[367] The electrical and digital industry employed 1.9 % fewer people at the end of 2025 than a year

before.[416] The ZVEI expects real production to grow 2 % in 2026, with capacity utilisation at 78 % against a long-term average of 83 %.[417]

FEEI, FMTI and Swissmem. Swissmem and the FMTI define their industries more widely than the classes used here. Swissmem includes metal processing, the FMTI metal products. The FEEI's count is lower than the ÖNACE 26 and 27 total because its membership does not cover every firm classified there.[175, 181]

B Legal basis

Each of the eight device functions in Section 2 is set out in specific articles or annex points of up to four acts (Table 22).

DEVICE FUNCTION	ACT	PROVISION
Firmware integrity (secure boot)	CRA	Annex I Part I (2)(f), (k)
	RED (Reg. 2022/30)	Art. 3(3)(d) via EN 18031-1
	Machinery Regulation	Annex III 1.1.9
Update mechanism and support period	CRA	Annex I Part I (2)(c); Part II (7), (8); Art. 13(8), (9)
	Machinery Regulation	Annex III 1.2.1(f): log of safety-software versions
Software bill of materials (SBOM)	CRA	Annex I Part II (1)
	Machinery Regulation	Annex III 1.1.9: list of safety-relevant software
Vulnerability handling and reporting	CRA	Annex I Part II (2)-(6); Art. 14
Authentication, no blank passwords	CRA	Annex I Part I (2)(b), (d)
	RED (Reg. 2022/30)	EN 18031 restriction on clauses 6.2.5.1/6.2.5.2
	Data Act	Access "securely" (Art. 3(1))
	Machinery Regulation	Annex III 1.1.9
Data export interface	CRA	Annex I Part I (2)(m): secure transfer
	Data Act	Art. 3(1), 3(2), 4, 5
	Batteries Regulation	Art. 77: passport data
Logging of interventions and access	CRA	Annex I Part I (2)(d), (l)
	Machinery Regulation	Annex III 1.1.9; 1.2.1(f): 5-year tracing log
Product identification	CRA	Annex II (3), (7)
	Data Act	Art. 3(2)
	Machinery Regulation	Annex III 1.1.9
	Batteries Regulation	Art. 13(6): QR code

Table 22: Legal basis of each device function
Sources: [141, 148, 168, 169, 170, 171].

C Cost model

We built our own cost model for the cost per device in Section 3. It uses only the public list prices valid at the time of publication, plus a few assumptions.

C.1 Model assumptions

We set the radio, data traffic, security hardware and update service per archetype by design rather than measuring them (Table 23). The base case assumes 10,000 units over 60 months. We convert prices in USD and CHF at the ECB reference rates of 15 October 2026, €1 = USD 1.1208 = CHF 0.9305.[137] Prices exclude VAT where the vendor says so. Most B2B price lists do not say.

For components we take the highest quantity break that DigiKey publishes (500 to 5,000 units), not from a negotiated price for 10,000 units. Contract prices for an order of that size are usually lower. The hardware lines are therefore an upper bound. We neither discount nor inflate, count staff time only inside the Commission's per-product estimates, and cost the Data Act per company rather than per device.

ARCHETYPE	RADIO AND PATH TO THE CLOUD	DATA TRAFFIC PER DEVICE	SECURITY HARDWARE	UPDATE SERVICE
Battery tool with BLE tracker	BLE SoC, relayed by the user's app or a site gateway	20 messages a day, 60 minutes a day connected	ATECC608B Trust&GO, pre-provisioned	Golioth
Machine with gateway	LTE Cat-1, IoT SIM with 100 MB a month	one message every 10 s, always connected	TPM 2.0 SLB9672	AWS IoT Device Management, 12 jobs a year
Building device under § 14a EnWG	Wi-Fi via the customer's network	one message a minute, always connected	SE050	Golioth
Logistics tracker for assets, containers and trailers	LTE-M/NB-IoT with GNSS, power saving mode	24 messages a day, 30 cloud location fixes a month	STSAFE-A110	Golioth

Table 23: **Model assumptions by archetype**
Note: messages of at most 5 KB. Source: RUBINLAKE cost model.

C.2 Measured list prices

Cellular tariffs span the widest range of any input, from €10 per SIM for ten years with o2 to €2.07 per SIM and month with Telekom.[97, 381]

Connectivity tariffs. DACH IoT tariffs follow three pricing models:

- **One-off packages for the device's life.** 1NCE IoT Lifetime Flat: €12 per SIM for 500 MB and 250 SMS over ten years. A top-up of the same size also costs €12 net.[3] o2 Business Easy IoT (Telefónica): €10 net per SIM for ten years with 750 MB (world), 1,000 MB (Europe) or 1,500 MB (Germany), no minimum order, business customers based in Germany only.[381] Telekom IoT Business LPWA: €14.50 one-off per SIM for ten years with 6.5 MB a month in Europe over NB-IoT and LTE-M.[96] Magenta (Austria): IoT Tarif 5 at €9.99 for 60 months (6.5 MB) and IoT Tarif 10 at €18.99 for 120 months (8.33 MB), minimum 10 SIMs.[256]

- **Monthly fees per SIM.** Telekom IoT Business Classic: €2.07 a month per SIM with 100 MB, minimum 10 SIMs and 12 months.[97] The tariff family starts at €1.43.[96] Swisscom CMP Mobile Lite: from CHF 1.00 per SIM, CHF 69 activation, no roaming.[376] Sunrise IoT Starter Services, at their launch in June 2022: CHF 1.50 to 9.00 per SIM per month for 2 MB to 5 GB, plus CHF 205 one-off, minimum 12 months.[370]
- **Usage-based pricing.** Onomondo: data from €0.0025 per MB, plan fees on request.[310]

LPWAN and satellite.

- **The Things Stack Cloud:** Standard plan €190 a month including a licence for 1,000 end devices, or €0.19 per device. The plan covers the network server only, without gateways or roaming.[385]
- **Swisscom LPN:** LoRaWAN connectivity at CHF 1.00 per device on the Lite plan, or from CHF 0.45 on the Smart plan with a CHF 49 monthly platform fee.[376]
- **Myriota:** satellite plans from USD 0.99 per device per month.[274]

Cloud. AWS IoT Core in Frankfurt:[15]

- USD 0.096 per million connection minutes
- USD 1.20 per million messages for the first billion a month, metered in 5 KB increments
- USD 0.18 per million rules triggered and the same again per million actions
- USD 1.50 per million shadow and registry operations
- USD 0.001 per location fix

Azure IoT Hub, per unit and month, messages metered in 4 KB blocks on paid tiers:[266]

- S1: USD 25 for 400,000 messages a day
- S2: USD 250 for 6 million messages a day
- S3: USD 2,500 for 300 million messages a day

At 8,640 messages per machine and day, 10,000 machines fit in one S3 unit. That is USD 0.25 per device per month against USD 0.41 on AWS.[15, 266] For the other three archetypes both clouds cost under €0.07 a month.

Device management and OTA.

- **Golioth:** USD 0.25 per active device per month, no platform tiers.[199]
- **AWS IoT Device Management:** USD 0.003 per remote action (job), USD 2.25 per million index updates, USD 1.00 per secure tunnel.[16]
- **Azure Device Update:** USD 0.07 per device per month plus USD 70 per instance.[266]
- **nRF Cloud:** from USD 0.10 per device per month.[285]
- **balena:** Production plan USD 1,439 a month for 110 devices, plus USD 2 per additional device.[28]
- **Mender:** USD 291 a month for up to 250 devices, fleets above 2,000 devices on request.[292]
- **Memfault:** from USD 3,495 a month for 1,000 monthly active devices.[260]

PKI and SBOM. AWS Private CA:[19]

- USD 400 per CA per month in general-purpose mode, or USD 50 in short-lived certificate mode
- certificates at USD 0.75 each for the first 1,000, USD 0.35 up to 10,000 and USD 0.001 above

We use a pre-provisioned Trust&GO part in place of a factory provisioning service where such a part is on sale. OWASP Dependency-Track is free.[321] FOSSA Business costs USD 20 per project per month, and the vendor's example plan comes to USD 207 a month.[189] Snyk Team starts at USD 25 a month.[363]

C.3 Line items per archetype

The machine's cellular tariff, at €2.07 per device per month, is the largest single line in any archetype.[97] The monthly figures add each one-off cost divided by 60 to the recurring fees.

For the battery tool, the premium is almost the whole cost (Table 24).

LINE ITEM	CATEGORY	ONE-OFF PER DEVICE (EUR)	MONTHLY PER DEVICE (EUR)
BLE SoC nRF54L15, USD 2.40 at 3,000[110]	base	2.14	0.036
Connectivity via app or site gateway (assumption)	base	0	0
AWS IoT Core: messages, connection, shadow[15]	base	0	0.001
ATECC608B Trust&GO, USD 1.91 at 100[108]	premium	1.70	0.028
Device certificate and CA share[19]	premium	0.35	0.041
Signed OTA, Golioth[199]	premium	0	0.223
Per-product compliance block (Table 28)	premium	7.37	0.175
Base cost			**0.037**
Security premium			**0.468**

Table 24: **Line items: battery tool**
Note: rows may not add up because of rounding. Source: RUBINLAKE cost model.

For the machine, the cellular tariff is two thirds of the cost (Table 25).

LINE ITEM	CATEGORY	ONE-OFF PER DEVICE (EUR)	MONTHLY PER DEVICE (EUR)
LTE Cat-1 Quectel EG915U, USD 17.61 at 500[113]	base	15.71	0.262
Telekom IoT Business Classic, 100 MB[97]	base	0	2.070
AWS IoT Core: 259,200 messages a month, rules, shadow[15]	base	0	0.366
TPM 2.0 SLB9672, USD 2.19 at 5,000[107]	premium	1.95	0.032
Device certificate and CA share[19]	premium	0.35	0.041
Signed OTA, jobs, fleet index, tunnels[16]	premium	0	0.153
Per-product compliance block (Table 28)	premium	7.37	0.175
Base cost			**2.698**
Security premium			**0.401**

Table 25: **Line items: machine**
Note: rows may not add up because of rounding. Source: RUBINLAKE cost model.

For the building device, signed OTA is the largest line (Table 26).

LINE ITEM	CATEGORY	ONE-OFF PER DEVICE (EUR)	MONTHLY PER DEVICE (EUR)
Wi-Fi 6/BLE module ESP32-C6-WROOM-1, USD 3.13 at 650[106]	base	2.79	0.047
Connectivity via the customer's network (assumption)	base	0	0
AWS IoT Core: 43,200 messages a month, rules, shadow[15]	base	0	0.064

LINE ITEM	CATEGORY	ONE-OFF PER DEVICE (EUR)	MONTHLY PER DEVICE (EUR)
Secure element SE050C2, USD 2.87 at 3,000[112]	premium	2.56	0.043
Device certificate and CA share[19]	premium	0.35	0.041
Signed OTA, Golioth[199]	premium	0	0.223
Per-product compliance block (Table 28)	premium	7.37	0.175
Base cost			**0.111**
Security premium			**0.482**

Table 26: **Line items: building device**
Note: rows may not add up because of rounding. Source: RUBINLAKE cost model.

For the logistics tracker, radio and SIM are half the cost (Table 27).

LINE ITEM	CATEGORY	ONE-OFF PER DEVICE (EUR)	MONTHLY PER DEVICE (EUR)
LTE-M/NB-IoT and GNSS nRF9151, USD 17.46 at 500[111]	base	15.58	0.260
1NCE Lifetime Flat (€12) and chip SIM (€2.50)[3]	base	14.50	0.242
AWS IoT Core and 30 location fixes a month[15]	base	0	0.028
Secure element STSAFE-A110, USD 1.27 at 5,000[114]	premium	1.13	0.019
Device certificate and CA share[19]	premium	0.35	0.041
Signed OTA, Golioth[199]	premium	0	0.223
Per-product compliance block (Table 28)	premium	7.37	0.175
Base cost			**0.529**
Security premium			**0.458**

Table 27: **Line items: logistics tracker**
Note: rows may not add up because of rounding. Source: RUBINLAKE cost model.

The tracker uses about 1 MB a month. The 1NCE package allows 8.3 MB a month over five years and so lasts the device's life.[3] The battery tool and the building device carry no SIM. Their base cost is the radio chip and the cloud traffic.

C.4 Per-product compliance block

In our model the compliance block costs €104,781 per product over five years and is the same for all four archetypes (Table 28). We take the Commission's per-product CRA estimates in full.[144] For secure development we use 30.5 %, the Commission's central value from a range of 19 to 42 % in its model.[144] The Commission puts recurring testing at €3,000 to 5,000 per product without a period. We take the midpoint, €4,000, as a yearly cost.[144] For tooling we assume one FOSSA Business subscription, paid for by a single product line.[189]

COST ITEM	PER PRODUCT (EUR)	PER DEVICE PER MONTH (EUR)
Secure development (+30.5 % of €140,000)	42,700	0.071
Documentation, declaration of conformity, CE marking, reporting	12,600	0.021

COST ITEM	PER PRODUCT (EUR)	PER DEVICE PER MONTH (EUR)
Conformity assessment (self-assessment)	18,400	0.031
Recurring testing, €4,000 a year for 5 years (assumption)	20,000	0.033
SBOM and vulnerability tooling, USD 207 a month for 5 years	11,081	0.018
Total	**104,781**	**0.175**

Table 28: **CRA compliance cost per product**
Note: rows may not add up to the total because of rounding. Sources: RUBINLAKE cost model; [144, 189].

C.5 Conformity assessment fees

Notified bodies rarely publish fees. The one public offer is an EU-type examination by LCIE (notified body 0081), offered through Serma Safety & Security from €3,900.[359] It lies below every Commission estimate of third-party assessment[140, 144, 410] (Table 29).

PROVIDER OR ESTIMATE	SERVICE OR PRODUCT TYPE	TYPE OF FIGURE	AMOUNT (EUR)
Serma Safety & Security[359]	EU-type examination by LCIE	published offer, from	3,900
Serma Safety & Security[359]	Gap analysis against EN 18031 or ETSI EN 303 645	published offer, from	3,750
Serma Safety & Security[359]	Gap analysis with intrusion testing	published offer, from	13,500
RED impact assessment[140]	Third-party testing, simple products	estimate per model	5,000-15,000
RED impact assessment[140]	Third-party testing, complex products	estimate per model	20,000-30,000
RED impact assessment[140]	Third-party testing, heavily software-dependent equipment	estimate per model	50,000+
CRA support study, 2021[410]	Third-party assessment	estimate	15,000-50,000
CRA impact assessment[144]	Self-assessment (base case of our model)	estimate	18,400
CRA impact assessment[144]	Third-party assessment (sensitivity case of our model)	estimate	25,000

Table 29: **Conformity assessment fees**

Per unit sold, the Commission puts third-party testing under the RED at €3 to 13 for a connected lawnmower and €0.35 for a router.[140] Third-party assessment at €25,000 and €50,000 raises the premium by €0.01 and €0.05 per device per month respectively (Table 30).

C.6 Sensitivity

Fleet size moves the premium more than any other input. The assessment route changes it by cents. The radio leaves it unchanged and moves only the base cost (Table 30).

CASE (EUR PER DEVICE PER MONTH)	BATTERY TOOL	MACHINE	BUILDING DEVICE	LOGISTICS TRACKER
Premium, 10,000 units (base case)	0.47	0.40	0.48	0.46
Premium, 1,000 units	2.37	2.30	2.38	2.36
Premium, 100,000 units	0.27	0.21	0.29	0.26
Premium, third-party assessment at €25,000[144]	0.48	0.41	0.49	0.47

CASE (EUR PER DEVICE PER MONTH)	BATTERY TOOL	MACHINE	BUILDING DEVICE	LOGISTICS TRACKER
Premium, third-party assessment at €50,000[140]	0.52	0.45	0.53	0.51
Premium, half of secure development already in place[144]	0.43	0.37	0.45	0.42
Base cost, base case	0.04	2.70	0.11	0.53
Base cost, Swisscom CMP Mobile Lite instead of Telekom[376]	n/a	1.70	n/a	n/a
Base cost, nRF9151 and Telekom LPWA instead of Wi-Fi[96]	n/a	n/a	0.57	n/a
Base cost, LoRaWAN on The Things Stack instead of LTE-M[109, 115, 385]	n/a	n/a	n/a	0.52
Base cost, Myriota plan added to LTE-M, modem not priced[274]	n/a	n/a	n/a	1.41

Table 30: **Sensitivity of premium and base cost**
Source: RUBINLAKE cost model.

The Swisscom case leaves out the CHF 69 activation fee and covers no roaming.[376] In the LoRaWAN case we price a Murata Type 1SJ module at USD 11.11 and a u-blox MAX-M10S at USD 9.33, both at DigiKey, plus €0.19 a month for the network server.[109, 115, 385]

D Vendor directory

We neither rank nor recommend any of the vendors, and the selection is not exhaustive.

D.1 Vendor layers by archetype

Each archetype touches only some of the layers and vendor groups.

1. **Battery tool with BLE tracker.** BLE SoC and secure element vendors (Table 33), an MCU-capable OTA service (Table 31), binary or source SBOM tooling for the radio stack (Table 32), and a RED body for EN 18031 (Table 38). No SIM.
2. **Machine with gateway.** TPM and PKI vendors, a Linux OTA service, an IoT platform or cloud (Table 35), a cellular provider (Table 34), and, if the gateway is Class I under the CRA, a CRA notified body (Table 38).
3. **Building device under § 14a EnWG.** Secure element, Wi-Fi or Ethernet OTA, SBOM tooling and a RED body. The smart meter gateway side is regulated separately.
4. **Logistics tracker for assets, containers and trailers.** Cellular module and GNSS suppliers (Table 36), an MVNO with SGP.32 eSIM (Table 34), MCU OTA, and a RED body.

D.2 Device management and OTA

For device management and OTA, the selection runs from the open-source project Eclipse hawkBit to the services of AWS and Microsoft (Table 31). Kontron markets KontronOS as meeting the CRA, EN 18031 and NIS-2 and ships delta updates four times a year.[241]

VENDOR (PRODUCT)	HEADQUARTERS	SIZE, OWNERSHIP AND FUNDING	EVENTS 2024-2026
Northern.tech (Mender)	Oslo legal entity; offices in Palo Alto, Oslo, Shanghai	Founded 2008; customers in more than 70 countries	NVIDIA Jetson integration (Aug 2024); MCU support (May 2026); Shanghai subsidiary (2025)
Memfault	San Francisco	Series B USD 24m (Jan 2023, led by Stripes)	Acquired by Nordic Semiconductor (24 Jun 2025); price not disclosed
Golioth	San Francisco	Pre-seed and seed USD 7.1m in total (to May 2023)	Part of Canonical since 3 Mar 2026
balena	Distributed team	-	-
AWS IoT Device Management	Seattle	Part of Amazon Web Services	IoT Analytics, IoT Events and FleetWise retired or closed to new customers (2024-2026)
Azure Device Update for IoT Hub	Redmond	Part of Microsoft	Generally available; preview of updates through Azure Device Registry (2026)
Bosch IoT Rollouts / Eclipse hawkBit	Bosch Global Software Technologies; Eclipse Foundation	Open source, EPL-2.0	hawkBit 1.0.0 (30 Mar 2026), 1.1.0 (3 Jul 2026)
Kontron (KontronOS, susietec)	Linz, Austria	About 7,000 staff; FY2025 revenue €1,607.3m	Ennoconn holds 48.36 % after a mandatory offer at €23.50 (Aug 2026)
emteria	Aachen	-	Partner programme incl. Raspberry Pi, PHYTEC, Intel
querdenker engineering (qdCloud)	Offenburg	-	OTA, SBOM per firmware version and vulnerability tracking in one product

Table 31: **Device management and OTA vendors**
Sources: [14, 17, 18, 28, 44, 119, 131, 197, 198, 241, 242, 243, 259, 267, 286, 289, 290, 291, 332].

Mender's customers include Siemens, Volkswagen and ZF Group.[291]

D.3 SBOM, vulnerability management and PSIRT

For SBOM, firmware analysis and vulnerability management, the selection runs from the open-source project OWASP Dependency-Track to Exein (Table 32). Black Duck left Synopsys for Clearlake Capital and Francisco Partners on 1 October 2024, Finite State bought MergeBase, and FOSSA bought StackShare and EdgeBit.[38, 184, 187, 188]

VENDOR	HEADQUARTERS	SIZE, OWNERSHIP AND FUNDING	EVENTS 2024-2026
ONEKEY	Düsseldorf	Spin-off of SEC Consult (2020, as IoT Inspector); in PwC Germany's portfolio	Joint solution with ETAS/ESCRYPT CycurRISK (May 2024)

VENDOR	HEADQUARTERS	SIZE, OWNERSHIP AND FUNDING	EVENTS 2024-2026
Cybellum	Tel Aviv; offices in Frankfurt, Beijing, Tokyo, Taipei	About 64 % acquired by LG Electronics (Sep 2021, valuation USD 140m)	-
Finite State	Columbus, Ohio	USD 20m growth round led by Energy Impact Partners (Mar 2024)	Acquired MergeBase (Jun 2024)
Black Duck	Burlington, Massachusetts	Owned by Clearlake Capital and Francisco Partners; independent of Synopsys since 1 Oct 2024	STMicroelectronics adopts Black Duck SCA for SBOM generation (Mar 2025)
FOSSA	-	Series B USD 23.2m (2020)	Acquired StackShare (Aug 2024) and EdgeBit (Sep 2025)
Exein	Rome; offices in Karlsruhe, San Francisco, Taipei	€70m (Jul 2025), €100m (Dec 2025), USD 270m at USD 1.7bn (Sep 2026)	Partnership with Deutsche Telekom IoT (Sep 2026)
Cybeats	Toronto (listed on CSE)	Small placements in 2025-2026	OEM deal: Keysight sells its platform as Keysight SBOM Manager (Feb 2026)
NetRise	-	Series A USD 10m (2025)	Acquired by Dragos (Sep 2026)
OWASP Dependency-Track	Open source	OWASP Flagship project, Apache 2.0	Used by more than 20,000 organisations

Table 32: **SBOM and vulnerability management vendors**
Sources: [38, 39, 40, 89, 90, 91, 118, 177, 178, 179, 180, 184, 185, 187, 188, 252, 304, 305, 306, 308, 321].

Cybellum's board has four members, the two founders and two LG Electronics executives.[90] PwC Germany took a minority stake in ONEKEY in December 2023, after eCAPITAL, without disclosing the amount.[101] JFrog acquired Vdoo in 2021, which has not been an independent vendor since.[230]

D.4 Secure element and PKI

The secure-element makers are the largest companies in the directory (Table 33). Infineon reported revenue of €14,662 million for the year to 30 September 2025, NXP USD 12,269 million for 2025.[219, 299]

VENDOR	HEADQUARTERS	SIZE, OWNERSHIP AND FUNDING	EVENTS 2024-2026
Infineon	Neubiberg, Germany	FY2025 (to 30 Sep 2025) revenue €14,662m; 57,077 staff	Acquired Marvell's Automotive Ethernet business for USD 2.5bn in cash (closed 14 Aug 2025)
NXP	Eindhoven	FY2025 revenue USD 12,269m; about 32,169 staff	Acquired TTTech Auto (USD 766m), Aviva Links (USD 222m), Kinara (USD 284m) in 2025; sold MEMS sensors to ST (Feb 2026)

VENDOR	HEADQUARTERS	SIZE, OWNERSHIP AND FUNDING	EVENTS 2024-2026
STMicroelectronics	Schiphol (NL), operations in Geneva	2025 revenue USD 11,800m	Acquired NXP's MEMS sensor business (2 Feb 2026)
Microchip	Chandler, Arizona	FY2026 (to 31 Mar 2026) sales USD 4,713.1m; about 17,900 staff	-
Giesecke+Devrient	Munich	2025 revenue €3,173m; 14,561 FTE	eSIM and IoT connectivity in the Connectivity & IoT business area
Thales (Cyber & Digital)	Meudon, France	2025 segment sales €3,852m, of which Digital Identity €2,397m	SGP.32 eSIM for IoT with AT&T (Oct 2025)
achelos	Paderborn	Founded 2008; size and shareholders not published	Partners include Keyfactor, Sectigo, Thales
Kudelski Group (Kudelski IoT)	Cheseaux-sur-Lausanne, Switzerland	2025 revenue USD 371.0m, of which IoT USD 39.1m; about 1,671 staff	Sold SKIDATA to ASSA ABLOY (€340m EV, Sep 2024); Matter partnership with Silicon Labs (Oct 2024)
Utimaco	Aachen and Campbell, California	400+ staff; investor SGT Capital	Sold lawful-interception unit (Sep 2025); Keyfactor partnership (Mar 2025)
Keyfactor	Atlanta and Stockholm	ARR above USD 200m (Sep 2026)	Acquired InfoSec Global and CipherInsights (May 2025); growth investment above USD 1bn led by Summit Partners (Jul 2026)
DigiCert	Lehi, Utah	Not published	Acquired Vercara (Sep 2024) and Valimail (Sep 2025)
GlobalSign (GMO GlobalSign Holdings)	Tokyo	Holding: 962 full-time staff; FY2025 net sales JPY 20,670m	-
Sectigo	Scottsdale, Arizona	Majority owner GI Partners	Acquired Entrust's public certificate business (Jan 2025)
Bundesdruckerei (D-Trust)	Berlin	2024 revenue €1,111.9m; about 4,577 staff; owned by the federal government	D-Trust certificates for the Delos Cloud (May 2025)
Swissbit	Bronschhofen, Switzerland	More than 500 staff; own fab in Berlin	Post-quantum authentication with Intercede (Jun 2026)

Table 33: **Secure element, HSM and PKI vendors**
Sources: [9, 58, 103, 104, 191, 196, 219, 231, 233, 234, 244, 245, 246, 248, 257, 262, 299, 352, 369, 372, 383, 384, 399, 400, 401].

Thales' Cyber & Digital segment fell 4.3 % in 2025, and its Digital Identity sales fell 2.5 %.[384] achelos is led by three managing directors and does not publish its shareholders.[9] Kudelski's IoT segment grew 5.1 % to USD 20.3m in the first half of 2026.[247]

D.5 IoT connectivity

Only the MVNOs and Vodafone publish their IoT connection counts (Table 34).

VENDOR	HEADQUARTERS	SIZE, OWNERSHIP AND FUNDING	EVENTS 2024-2026
1NCE	Cologne	40m+ SIM connections; 280+ staff	USD 60m round (Apr 2025), Deutsche Telekom among investors
emnify	Berlin	23m+ connections; ARR above €50m	New CEO (Sep 2026), CFO and CRO (Oct 2026); SGP.32 eSIM (Mar 2026)
Onomondo	Copenhagen	500+ customers	Majority investment by Aspirity Partners, combined investment above €100m (Sep 2026)
Deutsche Telekom IoT	Bonn	LTE-M/NB-IoT coverage in Germany above 99 %; 600 roaming and satellite partners	Satellite partners Skylo, Satellot, OQ Technology
Vodafone IoT	Newbury, UK	244m IoT connections group-wide (FY to Mar 2026)	-
Telefónica Germany (o2 Business)	Munich	742,000 M2M net additions in 2025	-
Swisscom	Switzerland	Not published	LoRaWAN, NB-IoT and LTE-M on one platform
A1 Digital	Vienna	More than 200 staff	Managed IoT connectivity

Table 34: **IoT connectivity providers**
Sources: [1, 4, 7, 98, 99, 127, 128, 129, 130, 309, 375, 380, 409].

1NCE was founded in 2017 together with Deutsche Telekom and reports more than 30,000 customers.[4] Its April 2025 round came from Deutsche Telekom, iSquared, Kensington, SoftBank Corp., Vicenda and its founder and brought its total funding to about USD 160 million.[1] emnify reports growth of 30 %[127, 130] and raised its Series B of USD 57 million from One Peak in January 2022.[126]

Neither Deutsche Telekom nor Swisscom reports an IoT connection count. Telekom's 46.75 million prepaid customers in Germany at the end of 2025 include M2M cards and grew 11.3 %, mainly through M2M SIM cards in the automotive industry.[98] Swisscom names IoT as a growth area but publishes no count.[374]

D.6 IoT platforms

Three of the five platforms belong to industrial groups, Siemens, Bosch and KUKA[44, 102, 361] (Table 35).

PLATFORM	OWNER AND HEADQUARTERS	SIZE	EVENTS 2024-2026
Cumulocity	Independent, Düsseldorf	More than 1,000 customer companies in 28 countries	Management buyout from Software AG (Jan 2025); Visionary in Gartner's first Magic Quadrant for industrial AIoT platforms (Sep 2026)

PLATFORM	OWNER AND HEADQUARTERS	SIZE	EVENTS 2024-2026
ThingWorx and Kepware	TPG	Not published	Sold by PTC to TPG, closed 13 Mar 2026
Insights Hub (formerly MindSphere)	Siemens	Not published	Renamed
Bosch IoT Suite (Remote Manager, Rollouts, Insights, Edge)	Bosch	Not published	Release notes into Aug 2026; no end-of-life notice
Device Insight	KUKA, Munich	Not published	Wholly owned KUKA subsidiary since 2019

Table 35: **IoT platform vendors**
Sources: [44, 86, 87, 88, 102, 327, 361].

Avedon, Schroders Capital and Verso Capital financed the Cumulocity buyout.[249] TPG pays PTC up to USD 725 million for ThingWorx and Kepware, of which up to USD 600 million at closing and up to USD 125 million if TPG later sells the business.[328]

D.7 Tracker vendors

The tracker market splits by the asset a vendor serves, not by radio (Table 36). Sensolus in Ghent, one of the container and trailer specialists, tracks more than 1.5 million assets for 500 companies.[356]

ASSET TYPE	VENDOR AND PRODUCT	TRACKER CLASS	TERMS AND FEATURES
Tools and small equipment	Hilti ON!Track (Smart Tag AI T320, Geo Tag AI T400, gateways)	BLE, GNSS + cellular	Software works with other makers' equipment; quote-based
Tools and small equipment	Milwaukee ONE-KEY	BLE	Free app, community network
Construction and rental equipment	Trackunit (Raw, Spot, Kin, Beam, Pass)	Telematics, BLE	Contracts of 36 or 42 months
Load carriers, pallets, returnable transport items	Bosch Sense I with All-in-One gateways	LTE-M / NB-IoT, 2G fallback	Small and large load carriers (KLT, GLT), pallets, special carriers; ATEX variants
Containers, trailers, returnable transport items	Sensolus	LTE-M / NB-IoT, BLE	€6 / €1 per month all-in
Cargo and shipments	Tive; Decklar (formerly Roambee); Arviem (Baar, CH)	Cellular	Tive: LTE-M with 2G fallback; Arviem as a managed service
Device platforms	Digital Matter; Teltonika; Abeeway; Minew	BLE, LoRaWAN, LTE-M, GNSS, UWB	Hardware for integrators and platforms

Table 36: **Tracker vendors in DACH by asset type**
Sources: [8, 23, 43, 92, 116, 207, 270, 271, 357, 382, 389, 391, 392].

Hilti reported group sales of CHF 6,297 million for 2025.[206] At Trackunit, the previous investor Hg reinvested.[390] Tive in Boston reported USD 100 million booked ARR and a USD 20 million round led by the Lightsmith Group in 2026.[388]

D.8 Engineering service providers

The selection runs from listed groups with revenue near €1 billion, Bertrandt with €978 million and EDAG with €714.0 million, to family-owned embedded firms in Austria and Switzerland[34, 122, 193] (Table 37). RUBINLAKE is itself an IoT engineering consultancy and does not list itself.

PROVIDER	HEADQUARTERS	SIZE (LATEST PUBLISHED YEAR)
Bertrandt	Ehningen, Germany	FY2024/25 revenue €978m (−18 %); 11,932 staff at 31 Dec 2025
EDAG Group	Arbon, Switzerland; operations in Fulda	2025 revenue €714.0m (−13 %); 8,303 staff
FERCHAU	Gummersbach, Germany	About 10,000 staff
Akkodis (Adecco Group)	-	More than 40,000 engineers worldwide
ALTEN (ALTEN GmbH in Germany)	Paris (group)	Group 2025 revenue €4,099.0m; 57,400 staff; no German figures published
Ginzinger electronic systems	Weng im Innkreis, Austria	Family company founded 1991; size not published
Zühlke	Schlieren, Switzerland	Founded 1968; owned by its partners; 2023 net revenue CHF 246m, about 1,900 staff
Noser Group	Switzerland	More than 600 staff in eight companies
Kontron (susietec)	Linz, Austria	See Table 31
Device Insight (KUKA)	Munich	See Table 35

Table 37: **Engineering service providers in DACH**
Note: A selection. Sources: [12, 13, 34, 122, 183, 193, 283, 293, 415].

ALTEN names Germany among the countries whose economic conditions weighed on its 2025 operating margin.[13] In December 2024 Vodafone Germany announced the closure of grandcentrix, the IoT developer it had acquired about five years earlier.[379]

D.9 Notified bodies for RED and CRA

Eight of the 13 bodies listed are active under the RED and seven under the Machinery Regulation[160] (Table 38). TÜV NORD CERT and DEKRA Testing and Certification GmbH in Germany are notified under the Machinery Regulation but not under the RED.

BODY	COUNTRY	NUMBER	RED	MACHINERY REGULATION	CRA
TÜV SÜD Product Service GmbH	Germany	0123	Active	Active	Not notified
TÜV Rheinland LGA Products GmbH	Germany	0197	Active	Active	Not notified
TÜV NORD CERT GmbH	Germany	0044	Not notified	Active	Not notified; TÜViT intends to apply
TÜV AUSTRIA GMBH	Austria	0408	Active	Active	Not notified

BODY	COUNTRY	NUMBER	RED	MACHINERY REGULATION	CRA
DEKRA Testing and Certification GmbH	Germany	0158	Not notified	Active	Not notified
VDE Prüf- und Zertifizierungsinstitut GmbH	Germany	0366	Active	Active	Not notified
SGS-TÜV Saar GmbH	Germany	1637	Not notified	Active	Not notified
SGS Fimko Oy	Finland	0598	Expired	Expired	Not notified
SGS Brightsight	Netherlands	-	-	-	Accredited for Module B; notification pending
Eurofins Product Service GmbH	Germany	0681	Active	Not notified	Not notified
cetecom advanced GmbH	Germany	0682	Active	Not notified	Not notified
NMi Testlab GmbH (formerly Phoenix Testlab)	Germany	0700	Active	Not notified	Not notified
Bureau Veritas CPS Germany GmbH	Germany	2004	Active	Not notified	Not notified

Table 38: **Notified bodies by act**
Sources: [160, 161, 162, 360, 396].

DEKRA's Dutch entity has no RED notification either, and its Spanish entity with number 1909 is suspended for the RED until 1 December 2026.[160] NANDO lists SGS Fimko's RED and Machinery Regulation notifications as expired, with an end date of 20 March 2030 and no reason given.[162] Two bodies in Austria are active for the RED, TÜV AUSTRIA and OVE, and none in Switzerland, although the RED is in the MRA.[160] The bodies rarely publish their fees[359] (Table 29).

D.10 Indicative prices

Published entry prices run from €12 one-off for a ten-year 1NCE SIM to USD 6,695 a month for Memfault's Scale plan.[2, 260] A per-device fee for OTA, a flat fee per plan and a fee per megabyte cannot be compared without a fleet model (Table 39).

VENDOR	PLAN	PUBLISHED PRICE	UNIT AND TIER
Mender	Basic	USD 34 a month	Up to 50 devices
Mender	Professional	USD 291 a month	Up to 250 devices
Memfault	Growth / Scale	USD 3,495 / USD 6,695 a month	Per plan
Golioth	Connect / Fleet Control	USD 0.25 per active device a month; USD 0.0095 per MB of OTA	Usage-based, no tiers
balena	Prototype / Pilot / Production	USD 159 / 329 / 1,439 a month	30 / 60 / 110 devices, then USD 2-3 per device
emteria	Small / Medium / Large	From €80 / 360 / 890 a month	Fleet size per tier not published
qdCloud	Hosting	€0.01 per GB of traffic, €0.10 per GB of storage	Licence per active device and year, amount not published

VENDOR	PLAN	PUBLISHED PRICE	UNIT AND TIER
1NCE	Lifetime Flat	€12 one-off	10 years, 500 MB, 250 SMS; high-data option €5 per GB
Onomondo	Data	From €0.0025 per MB	Plan fee on request
FOSSA	Business	USD 20 per project a month	Per project

Table 39: **Published entry prices**
Note: List prices excluding VAT where stated, only for vendors that are not in our cost model (Appendix C) or are there at one tier only. Sources: [2, 28, 131, 189, 199, 260, 292, 310, 332].

Most vendors publish no prices, among them ONEKEY, Cybellum, Finite State, Exein, emnify, all PKI vendors for device certificates, all notified bodies, and Cumulocity, Bosch IoT Suite and Insights Hub.

E Funding programmes

The funding programmes behind Section 8 cover digitalisation, IoT and product cybersecurity in Germany, Austria, Switzerland and the EU. Almost all of them require the application before the project starts.

E.1 Germany: federal programmes

KfW ERP-Förderkredit Digitalisierung (511, 512) and Innovation (513, 514). Since 1 July 2025 these two ERP promotional loans have replaced the ERP-Digitalisierungs- und Innovationskredit (380, 390, 391),[235] which many funding guides still name but which no longer accepts applications.[236] Both are loans through the house bank, in three stages:[237]

- **Stage 1 (Basis):** up to €7.5 million, for SMEs and freelancers only, after the KfW Digitalisierungs-Check, without a grant.
- **Stage 2 (LevelUp):** up to €25 million, with an ERP-Förderzuschuss of 3 % of the amount paid out.
- **Stage 3 (HighEnd):** up to €25 million, with a grant of 5 % of the amount paid out.

The grant is capped at €200,000 and is paid only after the loan has been fully drawn.[237] Companies with group turnover of up to €500 million and a seat or branch in Germany are eligible. Programme 512 adds a 50 % liability release for the bank.[237] The digitalisation loan names IT security, security standards and data security concepts as Stage 2 themes, as well as the building of digital business models, and finances running costs as well as investment.[237] The CRA security work and the device platform of a connected product fit Stage 2, while the development of the product itself fits the innovation loan.[238] Neither loan has an application deadline. The loan must be drawn within 24 months (511) or 12 months (512) of the commitment.[237] The interest rate depends on the price class the house bank assigns. For 511 over ten years, with two repayment-free years and the rate fixed for ten years, the nominal rate valid from 9 October 2026 ran from 4.48 % in the best to 10.88 % in the worst of nine classes in Stage 1, from 4.33 to 10.73 % in Stage 2 and from 4.18 to 10.58 % in Stage 3.[239]

BAFA EEW Modul 3. The federal energy and resource efficiency programme funds measurement, control and sensor technology and energy-management software in a company's own operations,

at 45 % for small, 35 % for medium-sized and 25 % for large companies.[57] BAFA still runs it, with no application stop. It funds software and hardware for setting up or running an energy or environmental management system in the applicant's own plant, not sensors or software in products sold to customers.[57] A manufacturer can use it to meter its own production, not to develop its connected products.

Digital Jetzt. The economics ministry's investment grant ran until 31 December 2023.[70]

Digital-Tech-to-Product. The Federal Ministry for Digital Affairs and State Modernisation (BMDS) funds start-ups and SMEs, alone or in a consortium, that take a digital technology from proof of concept to TRL 8. Applicants must show a business model and how their technology stack contributes to digital sovereignty.[66, 68] The BMDS awards up to €5 million per project in a two-stage procedure. The first call set AI, data ecosystems, cybersecurity and cloud and edge computing as focus areas.[68] The first call closed on 11 October 2026, and the ministry expects to publish further calls in the coming months.[66]

InnoNT+ (Smarte Konnektivität für die Wirtschaft). The BMDS provides at least €60 million until 2029 for sector-specific application centres where companies test connectivity solutions in real operations. Consortia submitted sketches by 13 April or 6 May 2026.[67] The programme funds centres, not a manufacturer's own product. A maker can, however, join a consortium or use a centre.

ZIM. The central innovation programme for SMEs has run under a guideline of 28 November 2024 since 1 January 2025.[71] It pays 25 to 45 % of eligible costs for single projects and 30 to 55 % for cooperation projects (40 to 60 % with a foreign partner), depending on company size and region, on costs of up to €690,000 per single project and €560,000 per company in a cooperation.[71] SMEs and other mid-sized companies with fewer than 500 staff are eligible, or with fewer than 1,000 if they cooperate with a funded SME.[71] The Federal Ministry for Economic Affairs and Energy (BMWE) stopped new applications on 7 July 2026. It cites demand that had risen sharply since the fourth quarter of 2025 and limited federal funds. The funds planned for 2026 were used up by mid-year.[387]

Forschungszulage. The R&D tax allowance is 25 % of the assessment base, and SMEs can claim ten percentage points more.[62] For costs incurred from 1 January 2026 the maximum assessment base rose to €12 million a year.[35, 62] The flat rate for an owner's own work rose from €70 to €100 per hour, and overheads are recognised at a flat 20 % for projects starting after 31 December 2025.[35, 62] In our assessment, development of a new connected product with real technical uncertainty can qualify, while routine compliance work does not.

Transferstelle Cybersicherheit im Mittelstand. It offers free checks, first consultations and emergency help to SMEs, start-ups and craft businesses.[393] It is advice, not money, and it targets the company's own IT rather than its products.

E.2 Germany: state programmes

The states carried most of the grant funding for digitalisation after Digital Jetzt ended in 2023.[70] Most of their grants are reserved for small or medium-sized companies, and several have closed or paused.

- **Baden-Württemberg.** The Digitalisierungsprämie Plus expired on 30 June 2025.[250] Its successor is the L-Bank **Digitalisierungsfinanzierung**, a development loan with an interest subsidy and a repayment grant of up to 5 % for SMEs, from €10,000 to €5 million and up to €25 million for larger companies. It can be combined with the KfW grant in Stages 2 and 3.[251]

- **Bavaria. Digitalbonus.Bayern** runs until 31 December 2027. Small enterprises with a site in Bavaria receive up to €7,500 (Standard, cut to this amount in 2026) or up to €30,000 (Plus, for measures with particular innovation content), at up to 50 % of eligible costs.[29] IT security is a funding area of its own, covering security processes and hardware such as firewalls.[29]
- **Berlin.** The **Digitalprämie Berlin** closed with its deadline of 31 December 2023.[229]
- **Hamburg.** The **Hamburg Digital Check** of the IFB Hamburg pays up to 50 % of consulting costs on information security and digital change, at most €7,500, to SMEs with a site in Hamburg.[203] The **Hamburg-Kredit Digital**, in its version of 15 April 2026, combines a loan of €25,000 to €2.5 million, refinanced from KfW programme 511, with a Hamburg grant of up to 12 % of the loan, at most €20,000, on top of the KfW grant. It is open to SMEs and runs until 31 December 2028 at the latest.[204]
- **Hesse.** The **DIGI-Zuschuss** pays up to 50 % of external costs, at most €10,000, to SMEs. Projects above €50,000 are excluded, and IT security measures are eligible. Applicants must first take part in a WIBank funding call.[205] **Distr@l** funds digital product innovation with up to €500,000 at 50 % for SMEs, after a project sketch to the Hessian digital ministry.[412]
- **Lower Saxony.** The **Digitalbonus.Niedersachsen-innovativ** expired on 31 December 2025. NBank has announced a new edition but has not published its terms yet.[282]
- **North Rhine-Westphalia. Mittelstand Innovativ & Digital (MID)** pays up to €15,000 for investments in digital products, security and processes, and up to €48,000 for hiring a graduate for an innovation project. The programme moved to NRW.BANK in 2026.[294] MID-Digitalisierung and MID-Digitale Sicherheit are allocated by lottery, MID-Assistent(in) through a waiting list. Demand had used up the quota for MID-Digitale Prozesse, and the state added €650,000. Applications open on 19 October 2026 at 10:00 in the NRW.BANK portal.[294] The project must not start before approval.
- **Rhineland-Palatinate.** The state has no digitalisation grant. DigiBoost is no longer among the ISB's innovation and digitalisation programmes.[228] What remains is **InnoTop**, an R&D grant for SMEs and companies with up to 499 staff, at a base rate of 25 % for experimental development plus up to 20 points for company size and 15 for cooperation with research, at most 80 %,[226] and **IBI-EFRE**, an investment grant of up to 20 % for small and 10 % for medium-sized companies for product and process innovations, from €50,000 to €5 million.[227]
- **Saxony** offers a digitalisation loan (**Digi-D**) of €30,000 to €250,000 for SMEs.[339]
- **Schleswig-Holstein.** The **DKU** guideline, in force since June 2026, pays small enterprises with fewer than 50 staff 40 % of up to €20,000 for consulting and up to €200,000 for implementation. Every project must improve IT and information security, and the guideline runs until 30 June 2027.[273] Manufacturers with 100 to 4,999 staff are therefore not eligible.
- **Thuringia.** The funds of the **Digitalbonus Thüringen** are used up. The programme accepts no more applications.[386]

E.3 Austria: aws and FFG

Austria's federal budget consolidation reached digitalisation funding directly. **KMU.DIGITAL**, run by the WKO and aws, paid for consulting and implementation, including an IT and cybersecurity track, at up to 30 % and €6,000 per track for implementation.[24] The budget of KMU.DIGITAL 4.0 is exhausted, and no further applications are possible. The programme will not continue from 2027 because of the federal budget consolidation.[414]

aws Digitalisierung is a call-based grant of up to €150,000 depending on the call. No call is open. The AI adoption call closed on 28 February 2025, and no further call has been announced.[25] aws still offers finance year-round:

- **aws erp-Kredit:** €10,000 to €37.5 million, up to 100 % of project costs, at a fixed or step-fixed rate. The loan must be fully secured by a bank or an aws guarantee, and the application must be filed before the project starts. Digitalisation is one of the named purposes.[26]
- **aws Garantie:** up to 80 % of a loan, with a maximum aws exposure of €30 million.[27]

FFG Basisprogramm is the main route for product development in Austria. It is open to all topics and company sizes and accepts applications at any time in 2026.[313] It funds R&D projects with a mix of grant and loan at 1.75 % a year. The total funding rate is 45 % for small companies (grant up to 28 %), 35 % for medium-sized (grant up to 25 %) and 25 % for large companies (grant up to 19 %), with up to €3 million per project.[316] The **Kleinprojekt** variant gives SMEs a grant of up to €88,500 for projects of up to €150,000.[318] The budget of **Projekt.Start 2026**, for feasibility work, ran out, and the programme closed early on 4 May 2026.[320] **KIRAS**, the security research programme, has a call open from 5 October 2026 to 26 February 2027, with up to €2 million per project. It targets civil security and critical infrastructure, not product compliance.[317] The FFG's 2026 DACH call funds transport infrastructure research and does not apply to product makers.[314]

The **Forschungsprämie** of 14 % of R&D expenses remains in force. Claims require an annual expert opinion from the FFG.[315]

E.4 Switzerland: Innosuisse

Innosuisse does not fund companies directly in its main instrument. In an **innovation project with an implementation partner**, it pays the Swiss research partner (a university or university of applied sciences). The company bears 40 to 60 % of the total project costs, at least 5 % of them in cash.[223] Applications are due at least six weeks before the meetings of the Innovation Council and are decided in six to eight weeks.[223] For a Swiss maker, this suits work with a technical research question, such as a secure update architecture or a low-power tracker design. It does not suit routine compliance.

The **Innovation Cheque** covers 100 % of a research partner's costs up to CHF 15,000 for companies with fewer than 250 FTE, once every two years.[222] **Start-up innovation projects** fund up to 70 % of direct costs for pre-market start-ups with fewer than 50 FTE.[224] Innosuisse plans no call for the **Swiss Accelerator** for SMEs already on the market. Since 1 January 2025 Swiss companies can take part in the EIC Accelerator as full beneficiaries instead.[225]

The Federal Council's relief package 2027 proposed cutting the federal contribution to Innosuisse by about 10 %, or CHF 32 million in 2027.[221, 348]

E.5 EU calls related to the CRA

SECURE, a project supported by the European Cybersecurity Competence Centre (ECCC), passes EU money on to micro, small and medium-sized enterprises within the scope of the CRA: up to €30,000 per grant at 50 % co-financing, from a budget of €11.5 million in its second call, open from 1 October to 11 December 2026.[353] The Digital Europe Programme topic **DIGITAL-ECCC-2027-DEPLOY-CYBER-11-EULEG** funds the implementation of EU cyber legislation, including the CRA, NIS2, the GDPR, DORA and the Cybersecurity Act. It has a budget of €20 million at a 50 % funding rate and is open from 1 September 2026 to 14 January 2027.[280] A sister topic in the same call, **AI4SME**, has €20 million for SME security with AI tools, at up to 75 % for SMEs, but does not mention the CRA.[279]

The national coordination centres run no CRA cascade call of their own. Neither the German NCC (NKCS) nor the Austrian NCC-AT currently lists one.[281, 319] The European Digital Innovation Hubs offer services to companies. In October 2025, 83 of them were selected for renewed funding.[152]

E.6 Overview

Of the 41 programmes, 24 accept applications (Table 40).

PROGRAMME	COUNTRY OR STATE	INSTRUMENT	AMOUNT OR RATE	ELIGIBLE APPLICANTS	APPLICATION DEADLINE	STATUS
KfW ERP-Digitalisierungs- und Innovationskredit (380, 390, 391)	Germany	Loan	-	-	-	Closed; replaced on 1 Jul 2025
KfW ERP-Förderkredit Digitalisierung (511, 512)	Germany	Loan plus grant	Up to €7.5m (Stage 1) or €25m; grant 3 % or 5 %, at most €200,000	Group turnover up to €500m	None	Open
KfW ERP-Förderkredit Innovation (513, 514)	Germany	Loan plus grant	As 511, 512	As 511, 512	None	Open
BAFA EEW Modul 3	Germany	Grant	45 / 35 / 25 %	All sizes; own plant only	None shown	Open; not for products
Digital Jetzt	Germany	Grant	-	-	31 Dec 2023	Ended
BMDS Digital-Tech-to-Product	Germany	Project grant	Up to €5m per project	Start-ups, SMEs; consortia	First call 11 Oct 2026	Between calls
BMDS InnoNT+	Germany	Grant to consortia	At least €60m to 2029	Consortia for application centres	13 Apr / 6 May 2026 (sketches)	First call closed
ZIM	Germany	Grant	25-45 % (single), 30-60 % (cooperation); costs up to €690,000	SMEs; fewer than 500 staff (1,000 in a cooperation)	-	Applications stopped since 7 Jul 2026
Forschungszulage	Germany	Tax allowance	25 % (SMEs 35 %) of up to €12m a year	All taxpayers	After year end	Open
L-Bank Digitalisierungsfinanzierung	Baden-Württemberg	Loan plus repayment grant	€10,000 to €5m (€25m for larger companies); grant up to 5 %	SMEs; companies up to €500m turnover	None	Open
Digitalisierungsprämie Plus	Baden-Württemberg	Grant or loan	-	-	30 Jun 2025	Ended
Digitalbonus.Bayern	Bavaria	Grant	Up to €7,500 or €30,000; up to 50 %	Small enterprises	31 Dec 2027	Open

PROGRAMME	COUNTRY OR STATE	INSTRUMENT	AMOUNT OR RATE	ELIGIBLE APPLICANTS	APPLICATION DEADLINE	STATUS
Digitalprämie Berlin	Berlin	Grant	-	-	31 Dec 2023	Ended
Hamburg Digital Check	Hamburg	Consulting grant	Up to 50 %, at most €7,500	SMEs	-	Open
Hamburg-Kredit Digital	Hamburg	Loan plus grant	€25,000 to €2.5m; grant up to 12 %, at most €20,000	SMEs	31 Dec 2028 at the latest	Open
DIGI-Zuschuss	Hesse	Grant	Up to 50 %, at most €10,000	SMEs; projects up to €50,000	Per funding call	Call-based
Distr@l	Hesse	Grant	Up to €500,000; 50 % for SMEs	SMEs, start-ups, research institutions	-	Not published
Digitalbonus.Niedersachsen-innovativ	Lower Saxony	Grant	-	-	31 Dec 2025	Ended
Mittelstand Innovativ & Digital (MID)	North Rhine-Westphalia	Grant	Up to €15,000; up to €48,000 (graduate)	SMEs	Digitale Prozesse from 19 Oct 2026	Open; lottery for two modules
DigiBoost	Rhineland-Palatinate	Grant	-	-	-	No longer listed
InnoTop	Rhineland-Palatinate	R&D grant	Base rate 25 % for experimental development; at most 80 %	SMEs; companies up to 499 staff	-	Open
IBI-EFRE	Rhineland-Palatinate	Investment grant	20 % (small) or 10 % (medium-sized); €50,000 to €5m	SMEs	-	Open
Digi-D	Saxony	Loan	€30,000 to €250,000	SMEs	-	Open
DKU	Schleswig-Holstein	Grant	40 % of up to €20,000 (consulting) or €200,000 (implementation)	Small enterprises (fewer than 50 staff)	30 Jun 2027	Open
Digitalbonus Thüringen	Thuringia	Grant	-	-	-	Closed; funds used up

PROGRAMME	COUNTRY OR STATE	INSTRUMENT	AMOUNT OR RATE	ELIGIBLE APPLICANTS	APPLICATION DEAD-LINE	STATUS
KMU.DIGITAL 4.0	Austria	Grant	Up to 30 %, €6,000 per track	SMEs	-	Closed; not continued from 2027
aws Digitalisierung	Austria	Grant	Up to €150,000 per call	Companies	Per call	No open call
aws erp-Kredit	Austria	Loan	€10,000 to €37.5m	Fully secured projects	Rolling	Open
aws Garantie	Austria	Guarantee	Up to 80 % of a loan; at most €30m	-	Rolling	Open
FFG Basisprogramm	Austria	Grant plus loan	45 / 35 / 25 %; up to €3m	All sizes	31 Dec 2026	Open
FFG Kleinprojekt	Austria	Grant	Up to €88,500	SMEs	31 Dec 2026	Open
FFG Projekt.Start 2026	Austria	Grant	-	SMEs, start-ups	4 May 2026	Closed early; budget used up
KIRAS	Austria	Grant	Up to €2m per project	Civil security research	26 Feb 2027	Open; not for product compliance
Forschungsprämie	Austria	Tax premium	14 % of R&D ex-penses	All companies	After year end	Open
Innosuisse innovation project	Switzerland	Grant to research partner	Company bears 40-60 %	Swiss research part-ner	Six weeks before council meetings	Open
Innosuisse Innovation Cheque	Switzerland	Voucher	Up to CHF 15,000	Fewer than 250 FTE	Rolling	Open
Innosuisse start-up innovation project	Switzerland	Grant	Up to 70 % of direct costs	Pre-market start-ups, fewer than 50 FTE	-	-
Swiss Accelerator	Switzerland	Grant	-	SMEs	-	No call planned; EIC Accelerator instead
SECURE, second open call	EU	Cascade grant	Up to €30,000 at 50 %; call €11.5m	Micro, small and medium-sized enter-prises within CRA scope	11 Dec 2026	Open

PROGRAMME	COUNTRY OR STATE	INSTRUMENT	AMOUNT OR RATE	ELIGIBLE APPLICANTS	APPLICATION DEAD-LINE	STATUS
DIGITAL-ECCC-2027-DEPLOY-CYBER-11-EULEG	EU	Grant	€20m topic; 50 %	All stakeholders	14 Jan 2027	Open
DIGITAL-ECCC-2027-DEPLOY-CYBER-11-AI4SME	EU	Grant	€20m topic; up to 75 % for SMEs	-	14 Jan 2027	Open; does not name the CRA

Table 40: Public funding programmes in DACH and the EU

Note: Swiss cantonal programmes are not included. Sources: [25, 26, 27, 29, 35, 57, 62, 66, 67, 68, 70, 71, 203, 204, 205, 222, 223, 224, 225, 226, 227, 228, 229, 236, 237, 238, 250, 251, 273, 279, 280, 282, 294, 315, 316, 317, 318, 320, 339, 353, 386, 387, 412, 414].

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