Unlocking the Value of IoT Data in Underwriting: From Raw Signals to Smart Decisions

A whitepaper by HDI TH!NX Campus, IoT Insurance Observatory & PROTH!NX



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Introduction: Unlocking the Potential of IoT Data in Underwriting

The integration of Internet of Things (IoT) data into insurance underwriting is no longer an experimental edge case. In some lines of business, it has already become a mature and proven approach. In private motor insurance, for example, Italy has emerged as a global leader. According to IVASS data, more than one-fifth of the cars circulating in the Italian market are equipped with telematics devices provided by the insurer covering the vehicle [9]. In the United States, Progressive has built a competitive advantage through its telematics-based pricing sophistication, achieving a loss ratio around 20% better than the rest of the market in private passenger auto liability [10]. Recent developments have further expanded the relevance of telematics approaches in markets such as Japan and South Korea. Commercial auto is also beginning to follow the path of personal lines, particularly in markets such as the United States.

In other sectors, however, such as health and life insurance, property, logistics, or energy infrastructure, the role of IoT is still less pronounced. While a few success stories have demonstrated promising results in certain geographies, for example in property in the US, many efforts are still in pilot mode. Yet, the need for scalable, data-driven models has never been greater: the faster technology advances, the more interconnected and complex insured systems become. From smart factories to distributed energy assets, risks are more systemic, dynamic, and opaque than ever before, requiring new ways to observe and quantify risk.

Here, IoT plays a critical role: enabling insurers to "look inside the system", uncover latent risks, and monitor evolving exposures in real time. In doing so, it shifts underwriting from a static, one-time decision into a continuous, responsive process. But that is easier said than done, and the devil is in the details of changing underwriting processes, contractual terms, and deriving actual business value.



Example: Battery Storage Systems as a Blind Spot in Underwriting

Battery energy storage systems (BESS) are expanding rapidly, with the global market expected to grow by 33% annually through 2030 [8]. Yet for insurers, they represent a major blind spot, as the technology is evolving faster than underwriting models can keep up with. Production lines are young, quality control procedures are still maturing, and many sites are built and operated by teams with limited long-term experience. Historical claims data is scarce, risk profiles are unclear, and fires, when they occur, can be catastrophic and nearly impossible to extinguish.

This is a prime example of how IoT and predictive maintenance are becoming essential tools. Insurers can finally gain visibility into assets such as BESS that were previously considered uninsurable black boxes. Given this new kind of insight provided by tools like PROTH!NX's SmartBattery, underwriters are able to get a better understanding of the risks they are insuring and make better decisions going forward, turning uncertainty into manageable exposure.

Already today, IoT data is shaping risk selection and contract terms and conditions in areas such as:

- Vehicle and fleet insurance, e.g. telematics and driver behavior scoring
- Health insurance, through wearables for health monitoring
- Workers' compensation through wearables and video recognition for workspace safety
- Leak detection and smart plumbing in property lines
- Supply chain, e.g. cold chain tracking in pharma logistics
- Wind turbines, to predict damages and assess the portfolio health
- Battery storage, to provide health diagnostics and reduce operational risks

Despite this progress, most underwriting processes are still anchored in outdated assumptions, with rigid data cycles and minimal automation. Drawing on a workshop with industry professionals, which took place at the IoT Insurance Observatory European Peer Discussion in May 2025, expert interviews, and third-party publications, this paper explores the emerging gap between the potential of IoT and current realities of underwriting. It aims to outline where the industry stands today, and what steps may help to close the gap between reality and ambition.

The current state of affairs: Disconnects and Bottlenecks

After years of investment in digital capabilities, the integration of IoT data into underwriting remains patchy, with a persistent gap between what is technically possible and what is operationally implemented. Both studies and our peer workshop reveal that, although data-driven underwriting is widely welcomed, actual adoption is constrained by legacy structures, unclear strategies, and a lack of coordination across stakeholders.

Expert voice:

"The tech's definitely there… what's missing is the courage to go all in."

- Paul Scott, CMT

Four key disconnects continue to slow the progress:

1 From Static to Dynamic Risk Views

Many underwriting processes are still built around annual policy cycles, fixed rating tables, and retrospective risk assessment, even though IoT offers continuous, real-time data flows. Traditional actuarial models often fail to incorporate emerging risks or evolving asset conditions, relying on historical loss ratios and manual questionnaires. Or, as Subbian and Gollapudi [2] put it: "traditional models struggle to incorporate unstructured data from modern sources like IoT devices, social media, and aerial imagery, resulting in incomplete risk profiles."

This rigidity limits the potential of IoT to surface and act on real-time changes. Already in 2020, a Capgemini study noted that most property and casualty (P&C) insurers continue to base pricing on point-in-time submissions despite acknowledging that real-time data from connected assets could significantly improve portfolio performance [3].

This misalignment was echoed in the workshop we conducted with underwriters and tech representatives at the European plenary session of the IoT Insurance Observatory in May 2025: participants shared examples of real-time data being available but not usable, either because the pricing model could not handle mid-term changes or because underwriting decisions were locked until renewal.

Looking at the experience with insurers using auto telematics around the world over the past two decades, it becomes clear that overcoming internal barriers alone is not enough to successfully scale such programs. Mileage-based policies, where the price fluctuates monthly based on the actual distance driven, and in some cases is adjusted for the quality of driving behavior, have been tested by different carriers in various geographies. Still, they have consistently generated only a fraction of the volumes achieved with telematics products where the premium is adjusted at the end of the policy period.



Customer surveys and feedback from market participants suggest that uncertainty about the amount to be paid represents one of the main reasons for the limited adoption of such products. Many policyholders are reluctant to commit to a policy when the monthly cost remains unpredictable.

In recent years, some auto Insurtech startups have attempted to address this barrier by introducing a concept where actual driving behavior influences the pricing for the following month, and policyholders are free to switch if they don't like the proposed price. In the German insurance market, oftentimes driving behavior can only trigger rebates, but not actually increase the base premium.

But even when there is robust actuarial evidence that allows for the development of a risk model incorporating the new IoT-based variables and the product structure implementation often remains challenging.

2 Data Strategy Gaps

Although insurers are collecting more data than ever via IoT sensors, vendor platforms, and partner APIs, most still lack a clear data strategy. Rather than defining specific risk hypotheses or underwriting goals, many teams accumulate data reactively, without clarity on what to extract, normalize, or monitor. As a result, vast data lakes emerge with limited business utility.

Studies consistently cite this as a top concern: even back in 2017, KPMG observed that most insurers were still in the early stages of building capabilities for emerging technologies such as IoT. In particular, they lacked the data infrastructure and strategic clarity required to capture its full value, leading to operational inefficiencies and limited returns [4]. Notably, this issue has persisted, with data strategy still being identified as a key "insurance trend" in reports as recent as 2024. Insights from our workshop further reinforce this gap. Participants expressed frustration with data that is either "too raw to use" or "pre-scored in a black box," limiting both usability and transparency. Some insurers described shifting from external scores to granular telematics data, but many found themselves unprepared to derive underwriting value. A few noted the growing pressure to align underwriters, data scientists, and IT professionals using a common language. As Paul Scott, CMT, summarized: "Insurers have to want to be data-centric and understand that data can make a difference for them… Not many insurers are data-centric."

3 Contractual & Legal Friction

In consumer-centric IoT use cases, a lot of effort goes into privacy discussions. As Katarzyna Malinowska from Kozminski University states, on the consumer side, "It's about awareness and trust. People need to see how the data impacts their personal situation." At the same time, recent customer field research on nine thousand auto policyholders around the world has found that insurers are among the top two most trusted payers for dealing with customer data in all the markets [1].

Whereas on the insurers' side, uncertainty remains around "regulatory transparency – how far we can go with the data, with the privacy issues" (Katarzyna Malinowska, Kozminski University), the value of handing over personal and potentially sensitive data must be tangible and thoroughly communicated; otherwise, adoption will suffer. This is less of an issue in industrial insurance, where B2B relationships reduce the regulatory burden.

While IoT opens the door to new forms of risk visibility, it also raises legal questions about how to capture obligations, dynamic behaviors, and real-time changes in binding form. Most contracts today remain static, offering little flexibility for changes triggered by sensor data or behavioral shifts. According to The Digital Insurer (2021), this is one of the top barriers to scaling IoT use cases, as insurers are uncertain how to embed dynamic obligations or define performance-based clauses that regulators will accept [6].

Workshop participants explored concepts like adjusting deductibles based on asset performance or attaching risk mitigation measures (e.g., leakage sensors) as contract annexes. While technically feasible, most ideas remain unimplemented due to legal conservatism and lack of audit-proof frameworks. Some relevant exceptions have emerged in the U.S. market, where risk prevention solutions are mandated for some categories of risks:

- Telematics-based safety programs are increasingly mandated for certain business classes or specific underperforming fleets;
- Water shut-off valves are mandated by insurers for high-value homes and homes that had a non-weather-related water claim.

The challenge grows when multiple parties are involved, whether OEMs, operators, or tech vendors, making it harder to attribute cause and liability. This complexity intensifies in large commercial risks underwritten by panels of insurers. If only one carrier supports IoT-based underwriting while others stick to traditional models, misalignment on obligations, data interpretation, and response protocols creates friction. Once several insurers with different maturity levels are involved, things can get very complex and are usually settled on the lowest common denominator.

4 Partnership Complexity

Insurers increasingly rely on external partners, such as hardware vendors, software providers, analytics platforms, middle layers, and diverse endpoints, to enable IoT-driven underwriting. Yet collaboration often falters due to differing expectations, unclear data ownership, and limited insurance context and expertise on the tech side. An old article from Origami Risk (2018) highlights that many providers focus on engineering-grade metrics that are difficult to translate into risk-relevant insights [8]. Translating industry-specific KPIs derived from asset data, which are typically built with an operator rather than an insurer in mind, is a challenge in itself.

This disconnect was a recurring theme at our workshop. Some participants reported receiving dashboards that offered little to no insight into policy performance or pricing relevance, while others lamented a lack of iteration: "Once the vendor delivers the feed, we're on our own." The most promising cases were those where data outputs were co-developed with underwriters in mind, turning raw sensor signals into insurance-ready KPIs like fire risk scores, maintenance compliance, or performance anomalies.

The key takeaway is clear: sustainable IoT underwriting models require joint development rather than one-sided technology delivery. Only through close collaboration can data be translated into meaningful insights that support underwriting decisions and drive adoption at scale.



Bridging the Gap Between Asset Data and Insurance Logic - Insights from Dr. Verena Brenner

Translating operational IoT data into underwriting-relevant insights remains one of the central challenges in data-driven insurance models. As monitoring technologies for wind turbines and battery energy storage systems mature, insurers increasingly ask how engineering signals can be translated into indicators that are meaningful for underwriting and risk assessment. Dr. Verena Brenner, Managing Director of PROTH!NX, addresses some of these key questions and explains how technical monitoring data can evolve into actionable underwriting intelligence.

In the development of IoT-based monitoring solutions for wind energy and battery storage systems, how do you translate engineering-driven KPIs into indicators that are meaningful for underwriting and risk assessment?

Dr. Verena Brenner: We start by changing the question the KPI is trying to answer. Operators ask: "How do I keep the asset producing?" Underwriters ask: "How likely is a loss event; how big could it be; and how controllable is it?" That translation typically follows three steps:

1. Map engineering signals to loss drivers - risk logic first, KPI second

We begin by defining a small set of insurance-relevant loss narratives. For example, progressive technical deterioration may increase the probability of a major component loss, chronic anomalies can raise business interruption exposure, and in BESS systems, certain unsafe operating patterns can increase the likelihood of safety events. Once these narratives are defined, we map which monitoring outputs actually influence them.

2. Use validated predictive maintenance outputs - but repackage them as KRIs (Key Risk Indicators)

In our setup, predictive maintenance (PM) systems, such as Turbit Blue for wind turbines or ACCURE for battery storage, detect anomalies in asset behavior. The insurance layer does not attempt to replicate that detection. Instead, it selects the operational signals and alarms that are relevant from a risk perspective and translates them into risk KPIs and risk profiles, including trend views and benchmarks that underwriting, risk engineering, and claims teams can actually work with. This also reflects the difference between KPIs and KRIs: while KPIs measure operational performance, KRIs are forward-looking indicators that signal the likelihood and potential impact of risk.

3. Express risk in underwriting-native "levers"

Finally, we translate technical signals into the language underwriting teams use for decision-making. Instead of reporting something like bearing temperature variance, we frame outputs in terms such as risk classification, deterioration trends, benchmark positioning versus comparable assets, or documented events that can serve as evidence in underwriting, renewals, risk consulting, or claims handling. The goal is to produce outputs that directly connect to underwriting levers such as pricing, capacity decisions, policy clauses or obligations, and portfolio steering—not to maintenance work orders.



What are the key differences between metrics infrastructure operators typically rely on and the risk indicators underwriters need for pricing and exposure evaluation?

Dr. Verena Brenner: Operators and underwriters look at the same asset, but they optimize for different outcomes. For example, operators' metrics (performance & operations) typically focus on availability, uptime/downtime, yield, and maintenance efficiency. Condition monitoring is used to spot issues early and reduce unexpected outages—often leveraging SCADA or Battery Monitoring System (BMS) data and anomaly detection to improve reliability. Underwriters' indicators (risk & insurability) are different: underwriters need predictive, comparable, decision-grade KRIs: signals that help estimate frequency and severity potential, BI exposure, and whether risk is improving or deteriorating over time (trend and benchmark), plus how strong the risk management process is (e.g., how quickly anomalies are validated and closed, how well events are documented). For BESS specifically, monitoring commonly includes parameters like temperature and SoC/SoH that are relevant to safety/degradation.

A practical way to summarize it: operators measure "how the asset performs", underwriters measure "how the asset can hurt the balance sheet."

From your experience, what determines whether IoT-derived KPIs truly create value for underwriting rather than remaining purely technical metrics?

Dr. Verena Brenner: Three things decide whether IoT KPIs become underwriting value:

1. Causal relevance to insured loss mechanisms
If a metric can't be defensibly tied to a loss driver (or at least a credible proxy for likelihood/impact), it stays "engineering-interesting" but underwriting-irrelevant. This is exactly why KRIs are framed around predicting potential negative impact, not just tracking system behavior.

2. Comparability + standardization (benchmarks, trends, portfolios)
Underwriting needs to compare: turbine-to-turbine, site-to-site, customer-to-customer, and across time (renewal). If KPIs aren't normalized and benchmarked, they don't support pricing/exposure decisions at scale. The insurance dashboards explicitly emphasize trend analysis and benchmarking for insurers/brokers.

3. Actionability inside insurance workflows (not just dashboards)
KPIs create value only when they connect to an underwriting "next move": adjust premiums, deductibles, and capacity; define obligations on alarm handling; add data clauses; support risk engineering recommendations; or strengthen claims/regress documentation and root-cause analysis.

How it can be done: Emerging Best Practices

Despite the structural challenges described earlier, a growing number of insurers are beginning to evolve their underwriting practices, positioning IoT data not as a peripheral input, but as a central component in how risk is assessed, priced, and managed. Insights from our interviews, workshop discussions, and case studies reveal several recurring themes that illustrate how IoT can be effectively embedded into underwriting practice.

1 Adaptive, Modular Underwriting

Leading insurers are moving away from rigid, annual underwriting cycles toward more modular frameworks that allow for dynamic updates, shorter review cycles, and risk-adjusted obligations. These adaptive models are particularly relevant in commercial lines, where asset conditions evolve rapidly and ongoing performance directly affects exposure.

During our workshop, one participant described piloting deductible structures that adjust based on adherence to sensor-based thresholds (e.g., leakage detection or fire prevention readiness). Such approaches reflect a broader shift from fixed assumptions to flexible frameworks that can accommodate real-time insights. This evolution aligns with what studies by Capgemini (2020) and Apinity (2024) describe as "data-driven underwriting ecosystems", which are considered critical for scaling IoT in commercial insurance [3][8].

2 Actionable IoT Insights, Not Raw Feeds

A recurring theme across literature and peer discussions is the need to turn IoT data into decision-grade indicators. Leading insurers are developing internal frameworks that translate sensor signals into underwriting logic, such as maintenance compliance scores, alert history, or behavioral trends. In one case, a workshop participant noted their shift from generic telemetry dashboards to underwriting-ready KPIs co-created with tech partners. Reflecting this, Subbian and Gollapudi (2023) also highlighted that value comes not from data volume, but from contextualization and relevance [2].

Jörn Watzke from Garmin illustrated this, explaining how wearables can support underwriting, engagement, and prevention, provided the user sees the benefit and the data sharing process is transparent. "Wearables have a low entry barrier. It's just about the user deciding to share the data," he emphasized.

3 Embedding IoT Across Functions

Success also depends on embedding these insights into operational workflows. IoT data is not only relevant for underwriting, it also supports risk engineering, enables post-bind monitoring, improves first notice of loss (FNOL) processes, and informs automated renewal decisions. Leading organizations use IoT not only to select or price risks, but to shape portfolio strategy and improve loss prevention. Predictive maintenance in battery storage or leak detection in commercial property are clear examples. In such cases, underwriters, engineers, and claims managers share a common understanding of what the data means and how to act on it. This requires more than dashboards: it requires cross-functional fluency between insurance logic and technical systems. Organizations treating IoT as a standalone data stream often struggle to achieve business impact. Those embedding it across roles and workflows, turning real-time signals into shared decisions, are building the internal capability to scale.

4 Evolving Partnerships

A key enabler of maturity is the evolution of insurer-vendor partnerships. Rather than using off-the-shelf platforms, leading insurers co-create IoT programs with tech partners, defining not only what to measure, but how it affects contracts, policy conditions, and claims logic. This collaborative approach allows tailored risk scoring, auditability, and shared accountability. Capgemini [4] notes that these partnerships often outperform plug-and-play integrations, as they build internal trust and external transparency from the outset.

In short: successful implementations are not just about adding more data; it's a smarter use across the underwriting lifecycle, with systems and people aligned to turn insight into action. It is underwriting that evolves with the risk it protects.



Recommendations & Next Steps

From Experiment to Impact – How Insurers Can Operationalize IoT in Underwriting

Priority Area	Actionable Step	Why It Matters
Make risk models dynamic	Shift from point-in-time underwriting to live or adaptive risk assessment	Enables pricing and obligations to respond to changing asset conditions
Define a data strategy	Decide what IoT data to collect, why, and how it maps to underwriting logic	Avoids data overload and ensures insights align with business decisions
Rethink contracts	Develop frameworks for dynamic clauses, IoT-triggered obligations, and annex-based structures	Unlocks the ability to tie sensor data directly to contractual terms and liability
Build cross-functional fluency	Train underwriters, engineers, and legal teams to interpret and act on IoT insights	Breaks silos and ensures data is turned into action at every stage
Co-create with tech partners	Move from generic IoT dashboards to co-designed solutions that serve underwriting needs. Partner with experienced vendors with demonstrated history in the space	Builds trust, relevance, and integration-readiness from day one and builds on prior experience
Pilot with purpose	Launch test cases tied to specific business KPIs (e.g. reduced loss ratio, faster renewals)	Demonstrates ROI and builds internal support for broader rollout

Our verdict: As insurers continue to navigate a world of increasingly complex and connected risks, the integration of IoT data into underwriting represents a defining opportunity. But realizing the potential takes effort, dedication, and time. Turning raw signals into actionable insights requires not only technology, but new ways of thinking, collaborating, and measuring success. Those who embrace this shift early will not only gain a competitive edge, but help redefine underwriting as a continuous, data-driven discipline that protects and enables progress.



The Dynamic Underwriting Opportunity - Matteo Carbone

The usage of the IoT paradigm is a game-changer for many insurance functions, as some of the most advanced carriers in the usage of telematics data have rationalized for the future of their auto business (figure below).

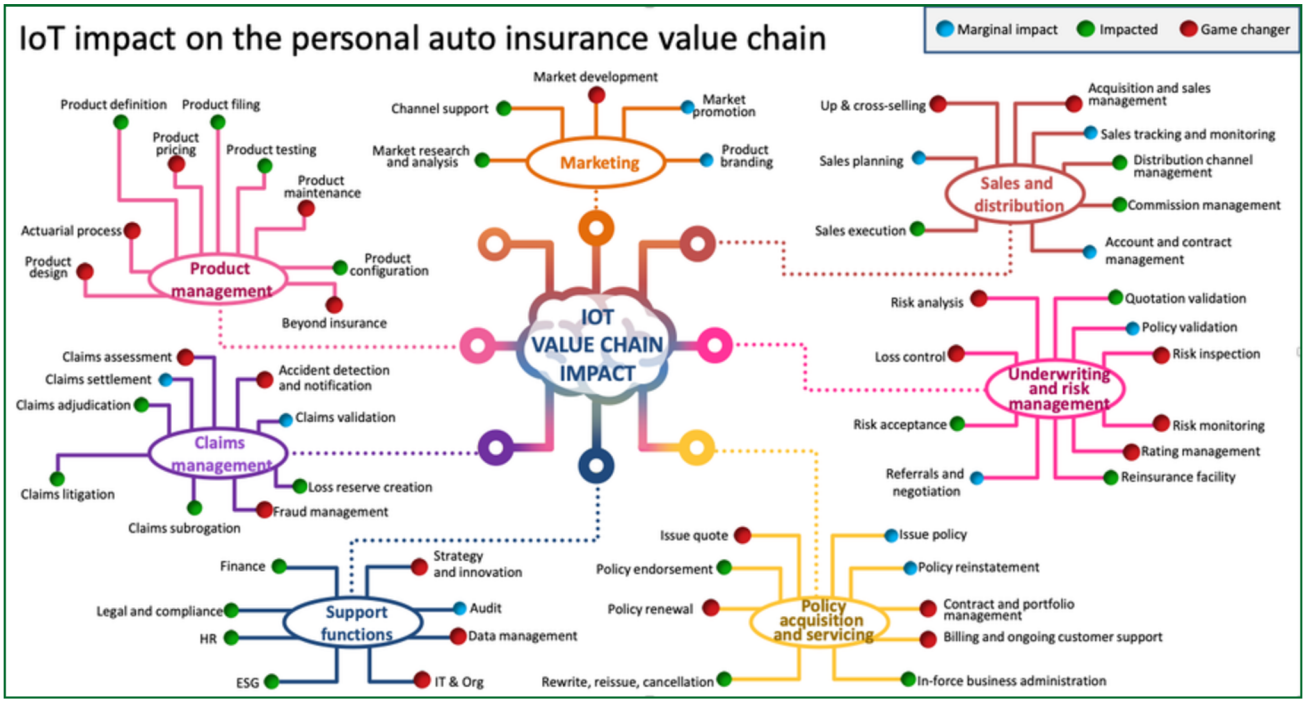
The potential impact of telematics on the auto insurance value chain

The use of new data, collected from different sensors, and its incorporation into underwriting and pricing decisions presents an extraordinary opportunity for insurers to create economic value. Even without introducing a new archetype of risk transfer solution where all components are dynamic and adjusted in real time, there are numerous opportunities in each business line to introduce point solutions that target only a few specific activities of the underwriting department but unlock significant economic value.

Just looking at auto telematics, the most mature connected insurance, a recent study [5] on a retail UK portfolio showed that using a risk score to adjust the renewal price – both with discounts and surcharges – can bring a 13% improvement in the portfolio loss ratio.

Looking at commercial auto, mandating the use of dashcams has demonstrated a strong self-selection effect in insuring fleets of trucks. Using the adoption of the IoT paradigm is a multi-year journey, and it is important to obtain quick wins along the journey to create and maintain the necessary C-level sponsorship.

Connected insurance itself doesn't create value; however, effectively mastering the IoT paradigm can lower loss ratios by better aligning rates with risks and reducing expected claims. When this value is shared with policyholders, insurers contribute to social good by enhancing the availability and affordability of coverage while maintaining the target technical profitability in their insurance portfolio.



Source: Hernandez & Carbone (Nov. 2023), "Nationwide Insurance: Using a Decade of Learnings to Create Next Generation Telematics Solutions"

About the Contributors

IoT Insurance Observatory (IoTInsObs)

The IoT Insurance Observatory is a membership-based think tank uniting insurers, reinsurers, and technology leaders to advance evidence-driven innovation in insurance. Founded by Matteo Carbone, it explores how connected devices—telematics, smart-home and building sensors, industrial IoT, smartphone sensors, and wearables—can reduce risk, sharpen underwriting and pricing, streamline claims, and deepen customer engagement.

Spanning auto, property, workers' comp, marine and health, its program blends comparative research with practitioner dialogue. Members gain access to rigorous case studies linking sensor-driven prevention to loss ratios and retention, and practical frameworks for scaling pilots into operations. Curated executive peer forums in North America and Europe discuss topics such as IoT program ROIs, driving-behavior analytics, water- and electrical fire mitigation, claim triage, data governance, and vendor landscapes—always with commercial neutrality.

Across ten annual editions, the Observatory has delivered almost 4500 hours of one-to-one workshops and hosted 49 plenary symposiums between North America and Europe; engaged 97 insurance groups (including 6 of the top 8 Reinsurers, 11 of the top 15 European Insurance Groups, 10 of the top 15 US P&C Insurance Groups, 2 of the top 3 Japanese P&C Insurance Groups, one of the top 2 Brazilian P&C Insurers, the largest Australian insurer, and 2 of the top 10 Global Brokers); and involved 65 tech players and vendors.

The Observatory generates and promotes innovation in the insurance sector: representing the cutting edge of global innovation, offering a strategic vision to exploit the insurance IoT's full potential, and stimulating research and debate among the participants.

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About the Contributors

HDI TH!NX Campus

Bringing together industrial risk expertise and emerging technologies, HDI TH!NX creates a space where new approaches to risk management can be explored, tested, and applied in practice. Corporates, risk engineers, and technology partners work side by side to challenge established perspectives and develop more dynamic ways of understanding and managing industrial risk.

The focus is not on theory, but on application. Through workshops, expert roundtables, and industry events, ideas are shaped and translated into tangible solutions. These activities are complemented by research-driven formats, such as whitepapers and industry insights, which capture key learnings and make them accessible beyond individual engagements.

Together, this hands-on and analytical approach creates an environment where innovation is grounded in real-world relevance and directly connected to decision-making. By fostering collaboration across disciplines and focusing on actionable outcomes, HDI TH!NX contributes to more transparent, adaptive, and forward-looking approaches to industrial risk management.

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PROTH!NX

PROTH!NX is a Berlin-based software company focused on developing data-driven risk solutions for industrial insurance. Combining agile product development with deep industry expertise, PROTH!NX addresses complex and evolving risks for insurers and brokers across industrial sectors.

At the core of its approach is the transformation of operational and sensor data into actionable, underwriting-relevant insights. Through solutions such as SmartBattery and SmartWind, PROTH!NX enables insurers and industrial operators to improve risk transparency, enhance loss prevention, and make more informed decisions—particularly in areas like battery energy storage systems (BESS) and wind energy, where traditional approaches reach their limits.

By embedding these insights into underwriting and risk engineering processes, PROTH!NX supports a shift from static assessments toward a more continuous and evidence-based understanding of risk, contributing to a proactive and data-driven approach to industrial risk management and insurance.

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