connect. digitize. get ahead.

Strategy Guide

Every product can be smart

How our IoT connectivity is transforming products, services, and business models

Connecting your world.

Contents

Prologue: Creating a connected product means building an ecosystem

If things could talk — what would they tell you?

A product is no longer just an inanimate object. It sees, hears, even feels. Collects data, recognizes patterns, makes decisions. It's now part of the network, connected with others, embedded in an intelligent system that's paying attention and anticipating.

What does that mean for you, a company that develops, markets, and operates these products? This is about more than simply manufacturing and sales. It's about the art of orchestrating interactions between things and people. When you build a connected product, you're also creating an ecosystem.

You need sensors to perceive the surroundings. Algorithms that transform data into knowledge. Networks that connect it to the world. Software that gives it the ability to learn. And most of all, a strategy that unifies it all.

A smart connected product does not exist in isolation. It's always communicating — with users, with other machines, with platforms that control and optimize it. **The question is not whether it talks, but who is listening and who sets the rules.** Who owns the data the product generates? Who protects it? And who ensures that the value of that data is not wasted?

Marketing connected products doesn't start with the sales cycle, but rather with the question: **How do we take connectivity and turn it into a business model?** It's not enough to simply create a one-time product. It takes a strategy that enables growth, an architecture that supports further development, and service that expands possibilities. A smart product isn't completed when it ships — it should continue to learn, evolve, and find new ways to generate value.

And that's exactly what **Deutsche Telekom's IoT Community** is all about: **How do we shape this new dynamic?** How do companies become conductors of a digital orchestra in which products, data, and services work in concert? This is a place where developers, decision-makers, and visionaries come together to find answers. Because the future belongs to products that are able to not only exist but also talk, understand, and act.

Hannes Händel
Telekom Deutschland GmbH
Head of Smart Connected Products

> *This is about more than just manufacturing and sales. It's about the art of orchestrating interactions between things and people.*
>
> *– Hannes Händel,*
> *Head of Smart Connected Products, Deutsche Telekom*

Executive Summary — The key takeaways

Industrial value generation is undergoing a fundamental transformation. Where once the sale of physical products was the focus, data-driven services now determine competitiveness. The Internet of Things forms the backbone of this transformation. It connects machines, optimizes supply chains, and makes business models more flexible, intelligent, and sustainable.

Companies such as John Deere are demonstrating how real-time machine data can enable predictive maintenance to prevent downtime and maximize availability. Bosch is using IoT-enabled tools to improve maintenance strategies. BMW is extending vehicle lifespans via over-the-air updates. Deutsche Telekom is working with Controlant to optimize pharmaceutical supply chains using smart sensors. According to a Capgemini study, 67% of consumers already view connected products as indispensable.

Digital product upgrades are no longer some futuristic concept, they've already arrived. Trilux, for example, now offers "Light as a Service" — instead of purchasing lighting solutions, customers sign up for flexible IoT-managed subscriptions. Octopus Energy is using the IoT to optimize energy consumption in real time, combining operational efficiency with sustainability. Siemens and Airbus are using digital twins to simulate production processes and modify them in real time. Deloitte estimates that predictive maintenance will be standard at 90% of industrial operations by 2027, reducing maintenance costs by 30% and increasing uptime by 20%.

Smart connected products consist of five layers: data acquisition, transmission, storage, processing, and application. New technologies are driving progress: Edge computing reduces latency and enables real-time processing at the source. LPWA technologies deliver energy-efficient connectivity over great distances. Zero trust security architectures are raising the bar when it comes to protecting connected systems. Starting in 2027, the Cyber Resilience Act will mandate security measures for IoT solutions.

According to IDC, the market for IoT-assisted AI will grow to over $80 billion by 2027. PwC estimates that 40% of medical facilities worldwide will use connected healthcare solutions by 2026. The World Economic Forum forecasts that the combination of IoT and AI will generate $15 trillion in economic value by 2035.

The implementation of intelligent IoT strategies is a challenge that can be greatly simplified by following the right principles: Define clear business objectives — successful IoT strategies begin with a precise definition of the problem and the value that will be generated for customers. Use standardized, open platforms — proprietary systems hinder innovation. Scalable cloud and edge architectures ensure future viability.

Implement security-by-design — security must be an integral part of the architecture from the beginning, not an afterthought. Use data to create value — raw data is worthless without a strategy for generating knowledge and new services.

Test, optimize, and iterate — agile methods and minimum viable products (MVPs) accelerate time-to-market and limit investments in non-viable products. Build partner networks — the IoT doesn't work in isolation. Working with technology and industry partners maximizes success. Companies are increasingly adopting open platforms, flexible business models, and data-driven services. The IoT and AI are no longer optional, but rather the foundation for long-term competitiveness. Those who no longer simply develop smart products but rather understand that they are part of a comprehensive digital ecosystem will not only lead their markets, but also contribute to creating a new industrial era.

AI-generated image

1. TREND — Why “business as usual” is no longer an option

The dawn of the connected product era

The economy is undergoing a transformation. It’s no longer just about selling products, but rather creating data-driven services that anticipate customer needs, optimize processes, and revolutionize value chains.

The Internet of Things (IoT) is the key driver of this transformation and forms the backbone of the smart service economy.

John Deere’s IoT platform, for example, lets farmers monitor their machines in real time and minimize costly downtime through predictive maintenance.

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Similarly, smart factories like the Xunxi Digital Factory demonstrate how IoT, sensors, cloud systems, and artificial intelligence (AI) can work together seamlessly. Deutsche Telekom has collaborated with Controlant to deliver an impressive IoT innovation. The jointly developed **Saga Card** ensures seamless monitoring of pharmaceutical supply chains. Companies like DHL are using smart packages to monitor the location, temperature, and status of goods in real time. This visibility reduces losses and improves customer satisfaction.

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In **healthcare**, IoT devices now enable continuous monitoring of vital signs. The smart inhaler from **Propeller Health** lets providers not only collect data but also augment patient therapies for better quality of life.

Smart services are changing the rules of the game

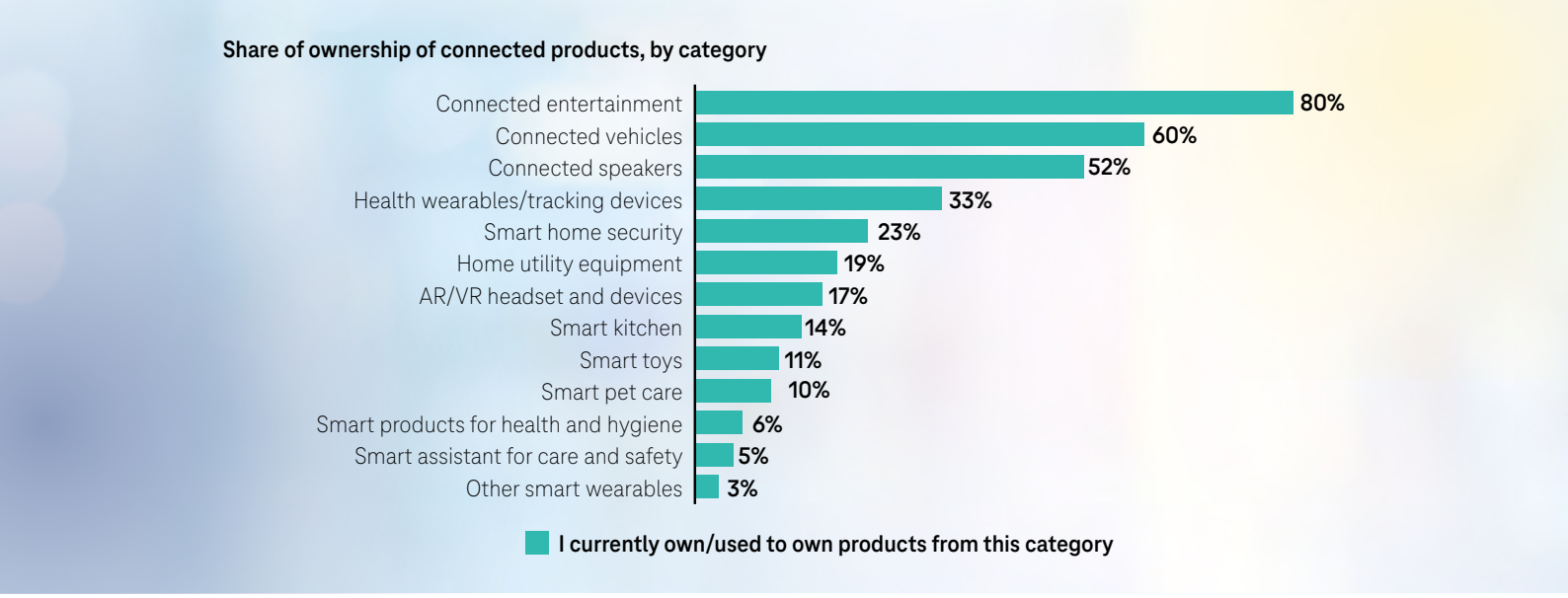
Physical products are being enhanced with digital services and added value: The concept is called **servitization** — the transformation of products into services. Studies like the one by Capgemini (2024) show that over 80% of companies worldwide **view the shift from a product-based to a service-based economy** as a key trend. BMW, for example, has transformed its business model using over-the-air updates. New features can be activated at the press of a button without the customer bringing their car to the workshop.

Without smart services, you don't have a chance with customers

Smart services are irrevocably changing expectations. Customers now expect products to actually solve their problems — quickly, reliably, and definitively.

People want things simple, easy, and affordable. Smart services are reshaping our relationship with physical products — take for example the energy management software from Nordwestdeutsche Zählerrevision (NZR). This application in the Open Telekom Cloud allows companies to monitor their energy use in real time and lower it without placing an additional burden on their own IT infrastructure.

Connected products are a major component of consumer lifestyles. The majority (67%) of consumers feel that connected products are a necessity, while one-third use some type of connected product around the clock.



Capgemini Connected Products 2024

Industrial consumerism: why usability is a key success factor

How user-friendly a product or service is determines to a great extent whether or not it is accepted — not only in a private context, but increasingly in the business world as well. Business leaders experience on a daily basis how intuitive and connected systems make life easier. This applies whether they are on the road with Apple Connect which enables seamless mobility and communications or at home using smart devices such as automated smart lighting systems or keyless entry solutions. These developments are also evident in the workplace, where ease of use determines the success of technologies and processes.

Rethinking connectivity — we accompany you on the journey

Companies gain a competitive edge when they stop selling their offerings as products and start delivering them as services. A recent Simon-Kucher study highlights the opportunity: Around 95% of respondents expect their service revenue to double over the next three years from the current 8% to 18% of total revenue. Comprehensive service solutions offer the highest growth potential and often have a disruptive impact on the value chain.

> *Without smart services, we couldn't compete on the global market.*
>
> *– Tom Oelsener, CDO, GEA*

Click here to listen to the podcast
(only in German language)

In the digital age, service has evolved from a mere add-on to become a pillar of successful business models. Companies that fuse digital value-added services with their products not only create new revenue streams, they also strengthen customer loyalty. Smart services expand traditional value creation and open the door to new market opportunities.

While the economic climate is pushing companies towards service-centric business models, technological advances, especially in AI, are enabling a host of new approaches. Businesses that invest in intelligent services today are actively shaping their future. This will allow them to secure a competitive advantage in a market that is increasingly defined by digital and data-driven offerings.

To continue generating revenue from their products, companies must rethink their business models and factor in evolving customer expectations.

The Internet of Things (IoT) is transforming industries through data-driven services, optimized processes, and entirely new business models. IoT-based smart services are redefining efficiency and customer expectations in many industries including manufacturing, logistics, and healthcare. Companies that fail to keep pace risk losing their ability to compete.

It’s magic: The new capabilities of smart services in the AI era

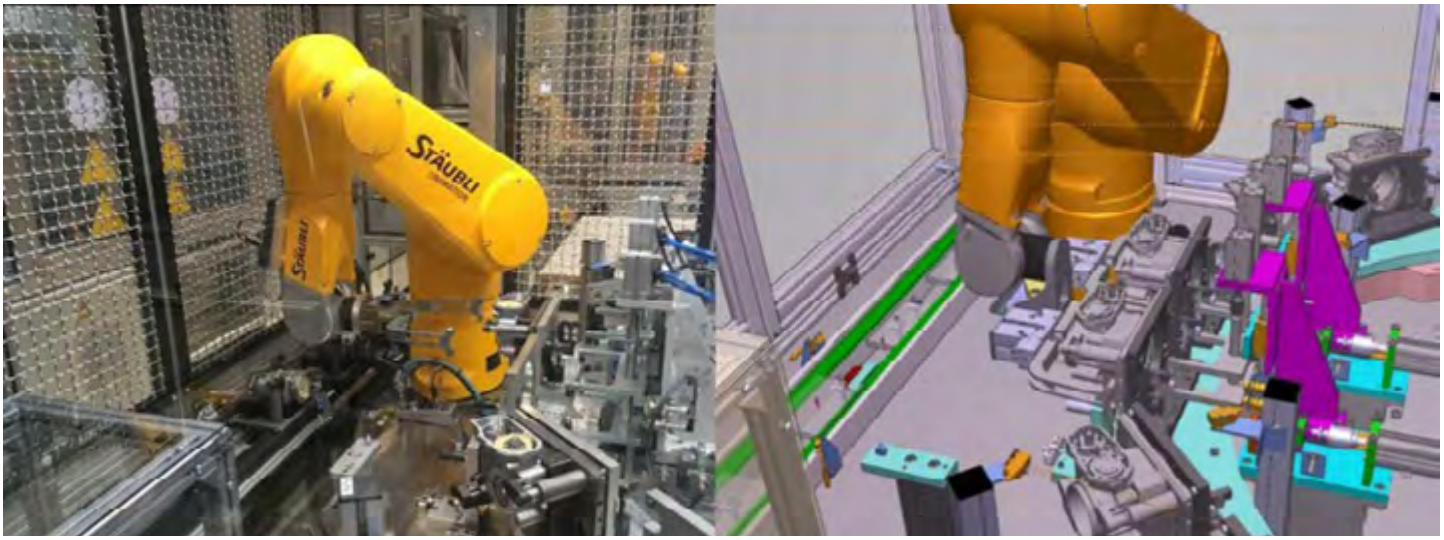
The use of AI is fundamentally transforming smart services by moving away from reactive solutions to intelligent, proactive control. Three key innovations are at the heart of this shift: Predictive maintenance that detects potential problems before they arise, digital twins that simulate and optimize real-world processes in virtual spaces, and AI agents that make autonomous decisions and are continuously evolving.

Predictive service and maintenance: From reaction to prevention

In a connected world, reacting to technical issues only after they have occurred is no longer good enough. Predictive maintenance leverages AI- and IoT-enabled sensors to monitor the condition of machines, equipment, or infrastructure in real time and detect potential faults at an early stage.

Modern aircraft engines that continuously collect sensor data during operation are a perfect example. Analysis in the cloud identifies wear patterns before they lead to costly failures or potential safety risks. This approach will continue to evolve in years to come. Predictive maintenance is becoming standard. Deloitte estimates that by 2027, predictive maintenance solutions that use a combination of IoT and AI will be in use at 90% of large industrial companies worldwide. On average, this will lead to a 30% reduction in maintenance costs and 20% more uptime.

Simulating operating conditions with digital twins



Digital twins in engineering

The digital twin is the next logical step and plays a key role in the factory of the future. These digital replicas make it possible to accurately simulate physical systems in a virtual environment. Energy providers are using digital twins to identify bottlenecks at an early stage. At Siemens, the integration of IoT sensors ensures that every change in the physical system is instantly mirrored in the digital twin.

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Achieving autonomy by using AI agents

The integration of AI agents into IoT systems is transforming how machines and systems communicate and make decisions. CB Insights points out that AI agents are already being used in smart grids. They are making autonomous decisions here — for example, about how to distribute energy during peak loads.

Current forecasts: Integrating IoT and AI agents has enormous potential

Growth of the IoT-powered AI market

According to IDC, the global market for IoT-powered AI is expected to exceed USD 80 billion by 2027. This growth is being driven by the rising demand for automated decision-making and predictive analytics in industries such as healthcare, manufacturing, and energy.

Autonomous vehicles as forerunners

A recent study by CB Insights revealed that autonomous vehicles powered by IoT and AI agents could account for more than 60% of urban delivery logistics by 2030.

Energy efficiency and smart grids

Gartner predicts that smart grids with AI agents could reduce urban energy consumption by up to 25% by 2028. This is possible by using adaptive energy distribution and accurate consumption forecasting.

Connected healthcare solutions

PwC (only in German language) forecasts that by 2026, over 40% of healthcare providers will be using IoT devices with integrated AI agents. (Source only in German language)

IoT and climate protection

According to Boston Consulting Group, IoT-based AI agents could help reduce global CO_2 emissions by 10%. Supply chain optimization, smart cities, and sustainable production make it possible.

Platforms and ecosystems

Accenture reports that by 2030, **over 50%** of IoT devices will be integrated into platform ecosystems controlled by AI agents. This will significantly accelerate the development of new "Everything as a Service" (XaaS) business models.

A boost to global economic output

A study by the World Economic Forum estimates that integrating IoT and AI agents could generate **$15 trillion** in economic value by 2035.

What is the cost of inaction? The critical role of data

In a globalized economy, offering excellent products is no longer enough — data-driven business models determine who wins and who loses.

While many companies in Europe continue to rely on engineering expertise and quality, Chinese manufacturers have gained an understanding of the market and offer "good enough" products that often cost 30–40% less than comparable European machines. The key difference: Chinese providers augment their products with a customer-centric, data-driven approach. They analyze operating data in real time, optimize machine use through predictive maintenance, and create strong customer loyalty by using digital platforms. European manufacturers who neglect the systematic use of data risk having to withdraw from lucrative market segments.

The smart service economy is more than just a trend — it's the future of value creation. Companies that fail to adapt risk losing market share and the ability to innovate. The good news: The technologies and ideas are already here — all we need is the courage to follow through.

Start, don’t stall — Three paths to achieving (growth) goals

Trilux Lighting Management as a Service in the Telekom Flagship Store

The transformation to the smart service economy can be distilled down to three key concepts:

1. **Hyperautomation:** AI, IoT, and robotics automate complex processes, thereby freeing up resources for strategic decision-making. In logistics, IoT-enabled supply chain platforms like **DHL’s** help shorten delivery times while reducing CO_2 emissions.

2. **Radically improve the customer experience:** Companies like **Mosca**, a manufacturer of strapping machines, rely on IoT technologies for user-friendliness, automated maintenance, and remote monitoring. At the heart of these smart machines is an integrated web interface that provides operators with all relevant data from performance metrics to alerts in real time.

3. **Develop new data-driven business models:** The shift to “Everything as a Service” (XaaS) opens up countless possibilities. With its “Lighting Management as a Service” offering, **Trilux** has created a solution that not only reduces energy costs but also emphasizes sustainability. The company combines intelligent lighting with comprehensive maintenance and data analytics to provide businesses with the ability to deploy efficient and sustainable lighting.

Adding value beyond the Industry 4.0 paradigm

Industry 4.0 got things started, but the true transformation lies in the smart service economy. The acatech Maturity Index demonstrates how companies that combine IoT, AI, and blockchain can not only optimize processes but also develop entirely new business models. One example is the integration of blockchain into IoT networks to make supply chains more transparent.

AI-generated image

Smart products and services: Improving the customer experience

The transformation to a smart service economy requires a combination of data, algorithms, and platforms. IoT technology is the enabler behind this shift. The following two examples illustrate how it's taking shape:

Connected healthcare: Stick-on wearables like those from BioIntelliSense are improving healthcare. These discreet, wearable devices continuously monitor vital signs such as temperature, heart rate, and respiration. They immediately report anomalies to physicians, helping to ensure accurate diagnoses and early interventions. It's a step toward seamless, proactive healthcare.

The IoT is also improving efficiency in winter sports: Kässbohrer has connected its snow grooming machines to SNOWsat to measure snow depth in real time, intelligently manage fleets, and optimize fuel use and artificial snowmaking. This not only ensures perfectly groomed ski slopes, but also enables more sustainable operations.

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Improving the customer experience: From the user experience perspective

In the age of AI, customers expect more than just convenience—they demand **hyperpersonalization**. Consumer electronics offer some of the best examples:

- **Amazon Alexa:** This IoT ecosystem shows how AI can revolutionize everyday life from controlling household devices to personalized recommendations.
- **Smart home:** Products like Google Nest are leading the market with devices that seamlessly integrate into daily life and help save energy.

A Capgemini study shows that 84% of companies who have started using data-driven services report improved customer satisfaction.

Artificial intelligence makes smart services proactive: Predictive maintenance prevents downtime, digital twins optimize workflows, and autonomous AI agents control processes. Industries are undergoing a fundamental change — those who don't adapt risk falling behind. There's no way around the smart service economy. It's the new reality.

From cars to pacemakers: How the IoT connects the world

Interview with Benjamin Bastians, CCO Deutsche Telekom IoT

Over 25 billion IoT devices are currently active worldwide with more coming online every day. But how can all of it stay connected — even at sea or in the desert? Benjamin Bastians, CCO at Deutsche Telekom IoT, explains how data delivers tangible value, why pacemakers should be online, and what dormant connectivity is all about.

Current estimates place the number of connected IoT devices worldwide at over 25 billion. How many of them are managed by Deutsche Telekom?

We connect around 55 million devices for customers each year, and that number is growing fast. The demand for IoT connectivity is enormous. At the same time, expectations regarding bandwidth, availability, data security, and operational flexibility are also rising. That's why we employ over 400 IoT specialists especially in the automotive, transport and logistics, and manufacturing sectors.

How do markets differ around the world?

Every continent — and sometimes every country — comes with its own set of challenges: Network technologies, regulations, economic factors. What they all have in common is the desire for simple solutions that can scale globally. That's why we rely on strong partnerships with mobile network providers around the world.

What do your customers say are their biggest challenges?

Deriving value from connected products is a key issue. The type of connectivity is also a critical factor: Wi-Fi, Bluetooth, or mobile data? With cars, cellular is standard. But for home appliances, it's often a question of cost versus benefit.

In what specific ways does Deutsche Telekom support its customers?

We keep devices online around the world. We integrate with your production processes, enable automated control, and ensure regulatory compliance. We reliably transport data to where it's needed.

Which real-world examples have impressed you most?

The automotive industry sets the pace for IoT—vehicles lose functionality the moment they go offline. Our medical technology clients are adding connectivity to their pacemakers to greatly improve patients' lives.

What are you doing to lower entry barriers?

It doesn't have to be a product that's ready to launch or a large vehicle fleet right away. It's worth engaging with us from the initial concept. Our solutions are modular and can be tested early in the development process. Often, our capabilities progress alongside our customer's, resulting in strong partnerships.

What does "dormant connectivity" mean?

If it's still unclear whether or when a device will be connected, cellular technology can be preinstalled and activated as needed. That saves electricity and reduces costs.

How do you ensure connectivity even in the middle of the ocean?

Even the best mobile networks have limits — for instance at sea or in remote areas. To solve this problem, we seamlessly integrate satellite communications into our solutions.

How do you ensure the continuous flow of data?

For many products, maintaining a connection to the digital world is of vital importance. That's why we design our IoT solutions with redundancy and maximum availability in mind.

What role does AI play in the IoT context?

Predictive maintenance lets us monitor machines remotely and automatically trigger alerts in the event of anomalies. These methods have been around for a while, but new AI technologies are making them even more effective—and the data more valuable than ever.

Click here to listen to the podcast
(only in German language)

2. IMPACT — How smart services are transforming entire industries

Monitor all building functions with intelligent control systems that reduce energy consumption

Smart buildings: Greater efficiency, flexibility, and sustainability

Buildings are much more than just four walls now. They're actually becoming intelligent. The IoT, sensors, and AI are transforming offices, factories, and entire city districts into smart environments that conserve energy, adapt to user needs, and operate with greater sustainability.

More efficiency: Intelligent systems optimize heating, ventilation, and lighting in real time, significantly reducing operating costs.

More flexibility: Smart buildings adapt seamlessly to changing requirements, for instance with automated room management or personalized workstations.

More sustainability: Digital control and data analysis allow smart buildings to reduce CO_2 emissions, resulting in resource-efficient infrastructure.

For everything from connected office buildings and energy-autonomous districts to AI-powered facility management systems, smart buildings hold the key to the future of construction and real estate.

Energy efficiency as the key to sustainability

The efficient use of office space is important not just economically, but ecologically as well. Imagine this: A city fifteen times the size of Cologne, filled with offices, desks, and meeting rooms, many of them empty and unused but with heat and lights on. An urban desert of glass and concrete, where more energy is wasted than used.

Given that the construction and building sector is responsible for around 38 percent of global CO_2 emissions, it's clear that sustainable strategies are not optional — they're essential. Intelligent control systems in office buildings can reduce energy consumption by up to 30 percent.

Automation potential in buildings and properties

A case study from Scandinavia (only in German language) shows that **IoT-based building automation** reduced operating costs by up to 25 percent:

- Networked fire alarm systems, emergency lighting, and automatic shading systems work together to increase safety, efficiency, and comfort in modern buildings.
- Biometric access control and systems that use digital keys allow secure entry management. Water management systems with connected water meters and leak sensors help prevent waste and detect damage early.
- Desk sharing can reduce the necessary office space by up to 40 percent.
- Integrating remote work structures with digital booking systems helps companies reduce office space while maintaining maximum productivity.
- Automated ventilation systems provide demand-based airflow while also reducing energy costs.

CO_2-neutral production and autonomous energy systems

One pioneering approach some industrial operations are adopting is **CO_2-neutral production**. True autonomy, however, requires more than just renewable energy. Entrepreneurs like Alois Meyer rely on a smart combination of **solar panels, battery storage, and hydrogen technology** to become independent from the grid.

IoT meets weather data: Make products while the sun shines

Alois Müller GmbH employs a simple yet powerful principle: Run the machines when enough solar power is available. IoT sensors measure energy consumption in real time and compare it to the weather forecast. The **ERP system** then determines which processes should have priority.

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Cybersecurity and data protection in connected buildings

As connectivity increases, so do the demands placed on IT security. Zero trust architectures and AI-powered threat detection are two of the key strategies. Blockchain technologies for secure and decentralized building data management prevent manipulation and increase transparency. The Edge in Amsterdam is a striking example. This smart office building successfully combines zero-trust, AI analytics, and blockchain pilot projects. The transition of the building sector to greater efficiency, sustainability, and digital connectivity has evolved from a futuristic ideal to an economic and ecological necessity.

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Smart buildings reduce costs, carefully manage energy consumption, and adapt to changing conditions. IoT and AI optimize processes while connected districts distribute energy efficiently. CO_2-neutral factories are operating autonomously. Investing in these technologies delivers measurable benefits.

Understand energy, reduce costs: A digital map of energy consumption

Interview with Horst Lange, Head of Sales, PSsystec GmbH

Not knowing your energy flows is like trying to sail the ocean without a map. Companies face the challenge of not only documenting what they consume, but understanding it in real time. Horst Lange of PSsystec explains how non-invasive sensors create transparency and reveal potential savings.

Why is precise energy monitoring so important for companies?

Many companies don't know exactly where their energy goes — they only see the total bill. But reducing costs and meeting sustainability goals demands detailed insights. Our technology makes this possible — without complex installations or interventions in existing infrastructure. Once installed, the sensors provide real-time data on electricity, water, and gas consumption. This lets companies immediately identify times when peak loads occur and see areas where energy is being wasted.

A key benefit of this visibility is that it lets you optimize operating costs. When companies know exactly when and where energy is being consumed, they can take specific actions to shift loads or improve efficiency. This can result in significant savings, especially in energy-intensive sectors like manufacturing and logistics. Consumption analysis also plays a key role in meeting regulatory requirements and ESG standards, since accurate data is essential for sustainability reporting.

How does the technology work in practice?

Our sensors are non-invasive—they simply clamp onto existing lines or meters and start measuring immediately. Clamp-on current sensors measure consumption directly from cables, while optical sensors read the rotation of water and gas meters. The advantage is that no structural modifications or long installation times are required. A secure cloud platform collects the data and makes it available for direct use by ERP and ESG reporting systems. Companies gain a detailed, digital map of their energy consumption.

The platform also allows for cross-site monitoring, which is especially relevant for companies with multiple production sites or branches. You can analyze energy-intensive machines individually to address specific inefficiencies. Another advantage is the ability to link consumption data with external factors such as weather data or production capacity utilization. This allows companies not only to analyze historical data but also to forecast future consumption more accurately and be strategic about energy procurement.

What role does artificial intelligence play in optimization?

AI goes beyond mere pure measurement by also detecting patterns and helping control consumption. It immediately detects anomalies such as air conditioners running at night or furnaces consuming more energy than necessary. Combined with weather and building information, the system can even estimate the potential energy savings from targeting specific areas. Companies benefit from transparency, reduced costs, and a sustainable, future-proof energy management system.

AI also enables automatic control for energy-intensive processes. This can involve factory machines ramping up during periods of low electricity prices, for example, or reducing peak loads via intelligent control. Integrating with smart grids also optimizes renewable energy use by synchronizing production processes with the availability of solar or wind power. This way, AI not only boosts efficiency but also supports sustainable energy, a key factor in preparing businesses for the future.

Smart health: Rethinking healthcare

ECG at your fingertips

A diagnostician in your pocket: How AI and sensors are changing everyday life

Imagine your doctor was always at your side, a silent but ever-vigilant companion. That's exactly what telemedicine platforms are making possible. The **Ada** app, for instance, uses artificial intelligence to analyze symptoms and deliver diagnoses so precise they rival the instincts of an experienced doctor. It's like having Sherlock Holmes looking after your health. Even more impressive, **KardiaMobile** is a palm-sized ECG device that detects heart problems early and provides medical feedback via app.

These technologies are at the forefront of a new frontier in healthcare. It's all about being preventive, personalized, and always available. And not only patients are benefiting from digital innovation. Smart IoT solutions are also helping healthcare workers. In hospitals and nursing facilities, documentation takes up valuable time that is urgently needed for patient care. Medical asset tracking, for example, uses real-time positioning to reduce the time spent looking for medical equipment.

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Apps, subscriptions, and algorithms: Digital solutions are transforming the field of medicine

Healthcare is no longer just about hospitals and doctor's offices. Platforms such as **Doctolib** are evolving into digital healthcare marketplaces where patients, doctors, and even therapists offer their services. Subscriptions similar to **Peloton** but for mental health are giving rise to business ideas that are as visionary as they are profitable.

The inCareNet HF platform from Biotronik and Getemed connects telemedical care worldwide

The inCareNet HF platform from Biotronik and Getemed was specifically developed for patients with heart failure who have a cardiac implant or require remote medical monitoring. The IoT-based solution not only integrates the data streams from implants and external sensors but also creates a unified digital infrastructure for interdisciplinary care regardless of location.

Until now, physicians have had to work with several platforms in parallel to capture relevant health data. With inCareNet HF, that fragmentation is a thing of the past. The platform makes it possible to collect and analyze remote healthcare data from a central location and then deliver it across healthcare networks , in hospitals, at doctor's offices, and in home care settings. This not only makes collaboration in healthcare more efficient, but also enables global scalability for medical IoT solutions. In addition, medication data from the nationwide standardized medication plan can be incorporated via the platform for safe and coordinated treatments.

One key advantage of the platform relates to multi-site patient care. Physicians gain access to a comprehensive, consistent repository of data to base their decisions on, regardless of where the patient is currently located. This not only facilitates seamless care, it also improves the quality and safety of the treatment.

How ecosystems are making healthcare future-proof

A **clearly defined value proposition** is critical to the success of a healthcare ecosystem. These value propositions vary depending on the medical specialization (the number of clinical scenarios and whether the focus is on treatment, prevention, or both) and whether you're addressing only medical concerns or going beyond. Based on this, there are four main approaches to building a healthcare ecosystem:

- **Making it easier to live with a disease:** Healthcare ecosystems can focus on the treatment of specific conditions such as heart disease or cancer.
- **Providing digital care solutions:** Another key strategy of healthcare ecosystems is to improve processes. This can include electronic health records, comprehensive telemedical services, or personalized medicine.
- **Maintaining health through prevention:** Ecosystems have the potential to augment conventional medical treatments to improve patients' lives. This involves linking medical care with other aspects of life, such as nutrition, housing, mobility, and wellness.
- **Promoting a healthy lifestyle:** Preventing disease through a healthy lifestyle is a meaningful value proposition for a healthcare ecosystem. To achieve this, solutions must cover a wide range of scenarios including education, nutrition, and fitness.

Maintaining health
- binah.ai monitors vital signs with only a smartphone camera
- ADA: symptom check
- Vivy: personal health assistant with digital vaccination passport

Making it easier to live with disease
- Cardisio facilitates early detection of cardiovascular diseases
- mySugr is an app for diabetes management
- Mika supports cancer patients during and after cancer therapy
- Ambulanzpartner treats rare neurological diseases such as ALS

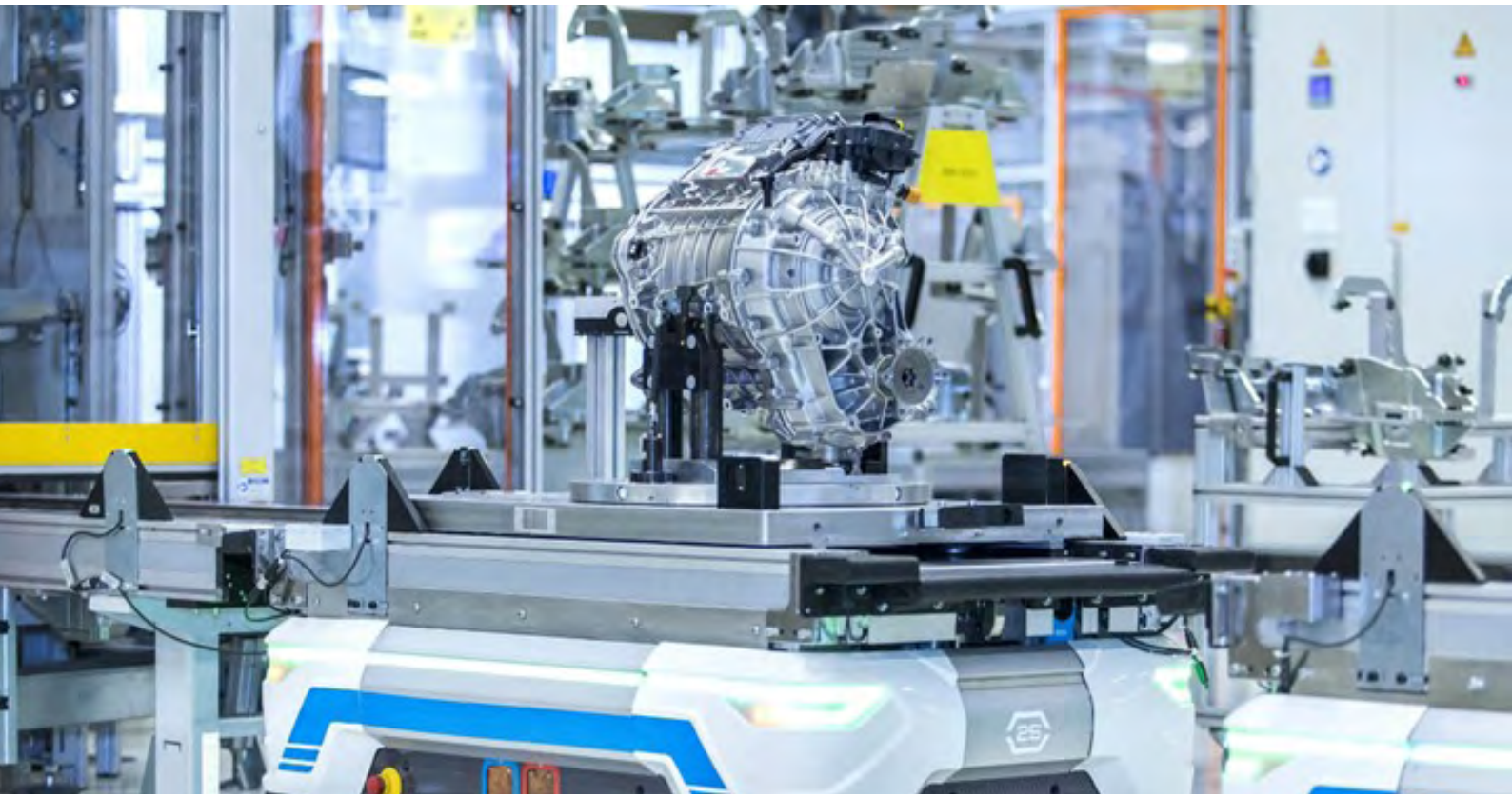
Promoting a healthy lifestyle
- **Aware:** preventive screenings that are more personalized, digital, and faster
- Well: health platform that provides access to digital healthcare services.
- Compassana is the smart ecosystem of Swiss healthcare
- Migros Impulse promotes a healthy lifestyle

Digital care solutions
- **Avi Medical** is a digital primary care practice
- **Medgate** makes doctors available to patients around the clock.
- **gesund.de** brings together pharmacists, doctors, and other healthcare professionals

Smart healthcare examples by aspect of life and disease; Source (only in German language)

Digitalization connects medical data, optimizes diagnoses, and eases the burden on healthcare staff. AI, telemedicine, and the IoT are improving processes and the quality of care. Platforms such as inCareNet HF enable interdisciplinary treatment. Connected ecosystems are creating new models for providing care and new business strategies.

Smart manufacturing: The factory of the future



Automated guided vehicles in a shopfloor environment

The learning factory: From silent tool to digital partner

Imagine a factory where machines are not just tools, but thinking partners. **Audi's Factory of the Future** shows how robots can do more than just bolt on parts. This facility's machines use IoT sensors and AI to quickly detect mistakes and come up with solutions autonomously.

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GE Aviation is using digital twins to simulate engines and optimize their performance virtually. Think of it as a "digital tryout" before the engine is cleared for takeoff.

You could say that, instead of being contained within their walls, the factories of the future are boundless networks. These systems connect supply chains, suppliers, and customers so tightly that they function with the precision of clockwork. Companies like **Achenbach Buschhütten** have even gone one step further: Their smart factories "listen" to the machines and "talk" to them to orchestrate the perfect production flow.

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Predictive maintenance and digital twins as key technologies

A key driver of this development is predictive maintenance. Instead of reacting to malfunctions, IoT-based solutions predict potential failures so companies can intervene before issues arise. Deutsche Telekom supports companies like BASF and T-Systems by using sensors and AI-powered algorithms to optimize maintenance intervals on the fly.

Digital twin technology is also revolutionizing industrial management. Digital twins not only enable simulations but also predictive control of production processes. **Airbus**, for example, is using digital twins to make aircraft component manufacturing more efficient.

Another example is smart intralogistics. IoT-based tracking systems allow raw materials and finished goods to be monitored in real time, from incoming goods monitoring to storage to delivery. This not only optimizes production processes, but also reduces material waste and transportation costs.

New business models: From manufacturer to service provider

Manufacturers like Bosch no longer sell their machines solely as products but also as subscriptions. Customers pay for use and receive regular updates the same way they do for Software-as-a-Service. Even medium-sized companies like Mader (only in German language) benefit from Product-as-a-Service models. Real-time operating data from the IoT allows manufacturers to bill customers precisely according to actual usage.

Efficiency, sustainability, and human-machine collaboration

Deutsche Telekom customers like BASF are demonstrating how smart sensors can help maximize energy efficiency in production. Workforce enablement also plays a crucial role here. Smart assistance systems, such as pick-by-vision or guided worker solutions, improve ergonomics to help employees complete tasks.

Manufacturing-X: The dawn of the connected industrial era

Industrial value creation is increasingly shaped by digital ecosystems in which companies no longer act in isolation but intelligently interconnect their data and processes with one another. The Manufacturing-X initiative is a major force behind this development, creating an open, sovereign, and cross-industry data space. This heralds a new era of collaborative business in which machine makers, suppliers, and customers work together in a digitally connected production and supply network.

New business models and data-driven innovations

This open exchange of data gives rise to entirely new business models. Machine manufacturers can not only sell their products, but also offer them as a “Product as a Service” by leveraging machine data to develop pay-per-use offerings. Companies like Bosch and Kaeser Kompressoren are already providing solutions that customers pay for based on actual usage instead of making large upfront investments.

Click here to watch the video

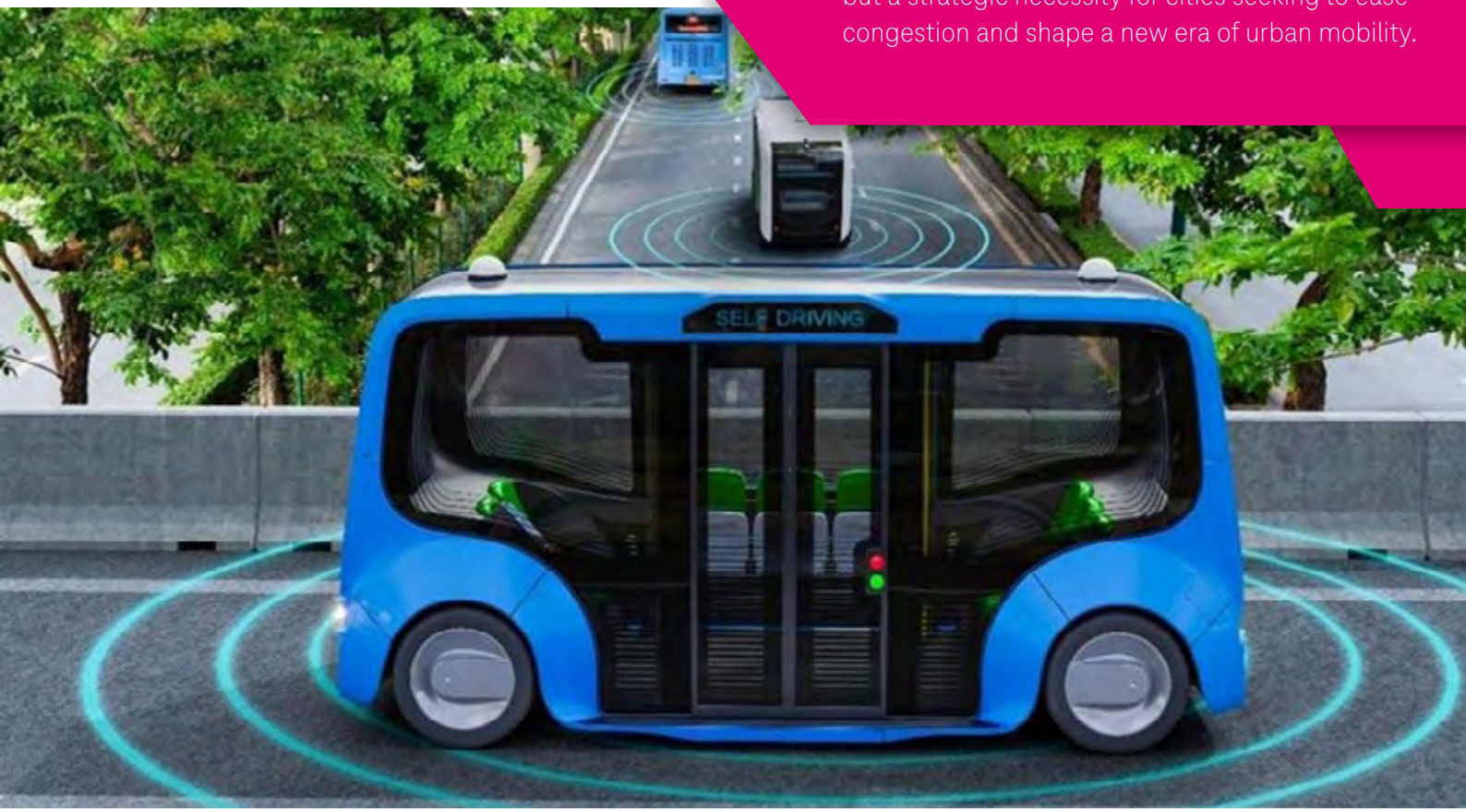
Industrial operations are integrating AI, digital twins, and predictive maintenance to autonomously optimize processes. Connected production systems and interoperable data spaces are replacing isolated solutions. Initiatives like Manufacturing-X promote open collaboration. Smart factories will fundamentally transform value creation and the status quo.

Smart Mobility: The future of transportation

The automotive industry stands on the cusp of a new era. What was once a self-contained steel box with an engine is now a connected nervous system that pumps rivers of data through digital arteries. Tomorrow's mobility will be not only more efficient but also smarter. Vehicles will communicate with one another, with infrastructure, and even with their surroundings. Cars will traverse urban and rural environments with AI-powered precision as hubs in a digital ecosystem.

As the era of the combustion engine nears its end, electric vehicles are emerging — powered by IoT-based infrastructures and precise navigation systems.

Autonomous driving is no longer a distant dream but a strategic necessity for cities seeking to ease congestion and shape a new era of urban mobility.



The new face of urban mobility: robo-buses are conquering the city

Trends and opportunities: The car as a digital entity

Mechanical components used to be what made up a car. Now, algorithms, sensors, and real-time data define mobility. A vehicle is no longer an isolated object—it's a node in the global data stream.

With Precise Positioning, Deutsche Telekom's high-precision, IoT-supported navigation solution, vehicles move with centimeter-level accuracy through cities, industrial parks, and rural roads. But smart mobility doesn't end on the road; a comprehensive understanding of mobility is only the beginning. Deutsche Telekom's Connected Car & Vehicle Services lay the foundation for a universal network where vehicles interact seamlessly with digital platforms. Smart charging systems, connected parking management, and self-organizing fleets are already operating as pilot projects.

New business models: Unchaining mobility

In the past, a car was built, sold, and driven—and that was it. Today, a vehicle only achieves its true value upon delivery. This is the point at which it becomes a service, an intelligent assistant, a data-driven economic asset.

Track & Trace for fleet management allows companies to monitor their vehicles in real time, predict maintenance needs, and optimize operations.

The consumer market is also evolving: Manufacturers like Daimler and BMW are offering flexible **Car-as-a-Service** mobility solutions where customers no longer own cars but use them on demand. The line between public and private transport is becoming increasingly blurred.

Automated mobility: Human-free logistics?

The port of Emden in Germany shows how radically mobility can change: Here, autonomous trucks already move across the premises, directed by IoT-driven algorithms and networked sensor systems. Instead of traffic jams, there is scheduling; instead of delays, optimization. Autonomous shuttles and robo-taxis could become the backbone of urban mobility while **predictive maintenance** powered by the IoT ensures vehicles are serviced before problems occur.

Smart connected ecosystems for electric vehicles: The charging station as a data hub

While the automotive industry works feverishly on new battery technologies, another question is equally important: **Where and how will vehicles charge?** Electromobility can only succeed if the charging infrastructure does not become a bottleneck.

Ionity, a joint venture of leading automakers, has recognized that ultra-fast charging alone isn't enough — it must also be **intelligent**. By connecting to Deutsche Telekom IoT platforms, charging points can be analyzed and managed in real time. Variable pricing models, prioritized charging, and grid optimization ensure that electromobility remains both environmentally friendly and efficient.

And it doesn't stop there. **Valeo is setting new standards with LIDAR technology**. Equipped with **SCALA™ 2,** the Mercedes-Benz EQS is one of the first vehicles in Germany to drive autonomously at up to 95 km/h—and thanks to over-the-air updates, it always stays up-to-date. Tomorrow's car won't just be driven—it will be **continuously updated**, even after the sale.

Click here to watch the video

Leading the charge of the new mobility

Mobility is no longer just about travel — it's also about **availability of data, connectivity, and intelligent control**. Telecommunications is no longer just a service provider for automakers. It is now one of the central architects of tomorrow's automotive industry.

Every traffic light, every charging station, every vehicle becomes part of a vast network that optimizes and orchestrates itself. Deutsche Telekom's **Smart Mobility technologies** create infrastructure that not only transports people and goods more efficiently, but also defines a new era of mobility — one that's connected, intelligent, and sustainable.

Cars are connecting with infrastructure, managing and adapting to changing traffic, and making new business models possible. Autonomous driving, smart charging infrastructure, and Car-as-a-Service are transforming ownership. Real-time data coordinates logistics and resource use. Smart mobility is already a reality, and it's shaping the future of transportation.

The IoT in automotive manufacturing: How connected vehicles are transforming mobility

Interview with Erol Gökcek, Head of Business Development Automotive, Deutsche Telekom IoT

The automotive industry is undergoing a digital transformation. Connected vehicles are enabling new business models, offering improved safety features, and delivering a seamless user experience. Erol Gökcek from Telekom Deutschland explains how cellular networks, artificial intelligence, and software updates are shaping the industry.

How is connectivity changing the automotive industry?

Vehicles have long been digital platforms. With cellular connectivity, automakers can offer standardized digital services around the world and unlock new revenue streams, for example by selling vehicle data to navigation and weather services. Autonomous driving also introduces a new type of use: While the vehicle drives itself, passengers can access connected entertainment or other vehicle options.

Connectivity not only enhances the customer experience but also improves operational efficiency in fleet and car-sharing services. Manufacturers can access vehicle data in real time to detect maintenance needs and minimize downtime. This creates a win-win situation: Customers benefit from seamless mobility services while companies reduce operational costs and create new opportunities for monetization.

What are the challenges surrounding emergency systems and software updates?

The EU-mandated emergency call (eCall) system relies on 2G technology, and its phase-out poses challenges for older vehicles. Private emergency call systems, on the other hand, offer added value by transmitting medical data. At the same time, software-defined vehicles are enabling new business models: Manufacturers can retrofit or enhance features via updates much the way an app store does.

Over-the-air (OTA) software updates are becoming a key competitive advantage for manufacturers. This technology lets manufacturers fix bugs, release new features, and even address security vulnerabilities without the customer bringing the vehicle to a service center. In the future, software-based vehicle platforms may allow customers to subscribe to driver assistance systems or infotainment features to personalize their vehicles and keep them up-to-date.

What role does artificial intelligence play in vehicle connectivity?

AI can analyze vehicle data, detect anomalies, and optimize network utilization. Especially in logistics, 5G Standalone enables data stream prioritization through network slicing — for example, for autonomous driving or real-time updates of deliveries. Connected ecosystems also boost customer retention. User profiles, personal settings, and digital services persist across vehicles, strengthening brand loyalty.

In addition, AI is accelerating the development of personalized mobility services. Driving profiles, habits, and individual preferences can be leveraged to enhance the driving experience — whether through automatic temperature and seat adjustments or predictive navigation based on traffic and weather data. At the same time, AI helps reduce energy consumption by optimizing charging processes and calculating efficient routes for electric vehicles.

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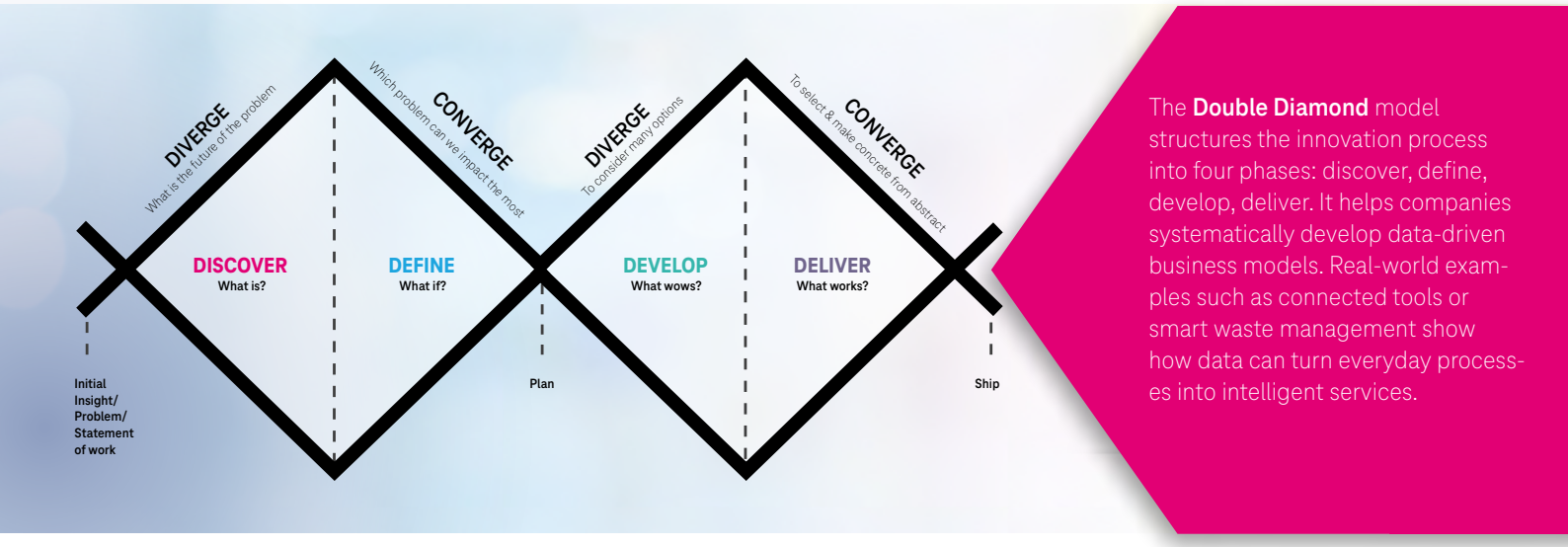
(only in German language)

3. ACTION — Discovering and designing smart services

The Double Diamond model offers companies a structured approach to move from initial idea to completed innovation. It divides the innovation process into four phases: **Discover, Define, Develop, and Deliver**. Each phase has a clear objective and methodology, enabling companies to systematically discover, develop, and successfully implement data-driven business models.



The **Double Diamond** model structures the innovation process into four phases: discover, define, develop, deliver. It helps companies systematically develop data-driven business models. Real-world examples such as connected tools or smart waste management show how data can turn everyday processes into intelligent services.

The double diamond of design thinking

Discover: Inspiration through exploration

The objective of this phase:
Identify opportunities and understand the challenges and needs that drive customers.

Methodology: Tools for discovery

- **Design Thinking:** Customer needs take center stage here. Companies work in multidisciplinary teams to view existing problems from new perspectives.
- **User research:** Interviews, observations, and surveys uncover the pain points of the target group. This method provides deep insights into untapped market potential.
- **Business Model Canvas:** A strategic tool to visualize initial business ideas and assess their feasibility.

Data as raw material

Smart services don't occur in a vacuum. They arise from the creative and purposeful use of data. Spotify demonstrates how analyzing user data can create personalized experiences that go beyond mere consumption. The goal is not only to meet customers' needs but to enable a new kind of interaction.

Practical examples

Barcelona and waste management: Installing IoT sensors in waste containers may seem unremarkable, but the result is revolutionary: efficiency, lower resource consumption, and cost reduction. The data transforms mundane processes into innovative services.

Bosch and its connected tools: Bosch is developing IoT-enabled drills that record usage data. The results not only optimize maintenance but also provide insights into the way customers go about their work.

Define: Specifying the right problem

The goal of this phase:
Identify the specific challenges that smart services are meant to solve.

Methodology: Focusing and prioritizing

- **Problem mapping:** Visual tools like empathy maps and customer journey maps highlight where customers experience problems and how a smart service could help.
- **Hypothesis generation:** What would happen if...? This central question helps formulate possible solutions and test their feasibility.
- **Prioritization:** Which solution has the greatest impact for the least effort? This consideration determines the focus of the next phase.

Data as a starting point for solutions

The Double Diamond model emphasizes the importance of clearly defining: What data is available, and how can it be used? TreeMetrics, an Irish forestry project, uses sensor data to analyze timber stocks in real time. This saves resources and supports sustainable management.

The **Define phase** clarifies which problems smart services should solve. Methods like problem mapping and hypothesis generation help to prioritize specific solutions. FarmBeats and connected e-scooters show how data-driven systems can make agriculture and mobility more efficient and sustainable.

Practical examples

Rethinking agriculture: FarmBeats, a Microsoft project, is revolutionizing agriculture by combining IoT sensors, drones, and AI analytics into a comprehensive system. Sensors in the ground measure moisture, nutrient levels, and temperature, while drones capture aerial images of the fields. This data flows in real time to the cloud and is analyzed using AI to provide precise recommendations for irrigation, fertilization, and pest control. Particularly notable is the use of "TV white spaces", which allow data transmission even in remote areas, making FarmBeats accessible worldwide. Through targeted resource management and increased productivity, FarmBeats creates a symbiosis of efficiency and sustainability that benefits both large-scale farms and smallholders in developing countries. This example shows how data-driven smart services can transform traditional industries and address global challenges like climate change.

Click here to watch the video

Urban mobility: Connected electric scooters not only shape the urban landscape, they also provide valuable data for more efficient traffic planning. Equipped with GPS sensors and IoT connectivity, they collect information about routes, frequency of use, and typical destinations. This data flows in real time into central platforms, enabling planners to identify bottlenecks and analyze traffic patterns. Cities can then expand bike lanes, determine the best locations for sharing stations, or better integrate multimodal transport systems. The data also supports sustainable mobility initiatives, such as dynamic pricing models that make switching from cars to e-scooters more attractive. Connected e-scooters demonstrate how digital technologies are not only making mobility more convenient but also enhancing the quality of life in cities.

Develop: Prototypes as a bridge between idea and reality

The goal of this phase
Turn ideas into real, testable prototypes

Methodology: Test and iterate

- **Rapid prototyping:** Quick, low-cost models help validate assumptions and obtain early feedback.
- **Minimum Viable Product (MVP):** A product that includes the core features is released to the target group to gather insights and make improvements.
- **Agile development:** The product is refined through iterative cycles. Teams work with the flexibility to adapt to new requirements.

From vision to MVP

A standout example is Peloton. By combining hardware (bikes), software (training platform), and community, a product emerges that retains customers over the long term. Focusing on emotion and functionality is the way to design successful smart services.

Real-world examples: When services get smart

Innovative business models emerge whenever technology creates real value. Instead of simply selling products, usage-based models can be established that adapt to individual needs. Two examples illustrate how connected intelligence creates new opportunities:

"Pay as you Sweat" — fitness gets smarter

Instead of a fixed subscription, users pay only for the activity they actually complete. Smart wearables track workouts, monitor movement patterns, and calculate costs on the fly. It's a completely new, transparent fitness experience. Anyone who exercises benefits immediately without having to commit to long-term contracts. By combining IoT and AI, this model adapts to users' lifestyles while offering fitness providers new monetization opportunities.

Real-time healthcare: Intelligent stick-on wearables save lives

Digital health solutions not only improve daily life but also save lives. Wearable sensors like those from BioIntelliSense continuously monitor vital signs including heart rate, body temperature, and breathing patterns and transmit them directly to physicians. This opens up entirely new possibilities for preventive medicine. Health risks can be detected early, hospital stays reduced, and care for chronically ill patients optimized. What used to require regular check-ups now happens automatically. It's safer for patients and a more efficient way to provide care.

These examples show how connected products can go far beyond convenience to transform entire industries. They adapt to users and streamline processes, making smart services a part of everyday life.

Develop takes the idea and generates a prototype that is subsequently tested and refined using agile methods.

Deliver: Scaling as the key to success

The goal of this phase
Turning prototypes into marketable products and enabling growth.

Methodology: Building scalable systems

- **Cross-functional teams:** Teams from marketing, development, and production work together to implement solutions.
- **Automation:** Cloud platforms and IoT devices make it possible to enter new markets.
- **Feedback loops:** Continuous monitoring and customer feedback drive product improvement.

Examples of successful scaling

Trilux — lighting as a service

Now there's a more flexible way to use smart lighting. Instead of buying permanently installed systems, companies can opt to subscribe to smart lighting solutions. Trilux has combined IoT technology with needs-based control that optimizes lighting solutions in real time. Customers benefit from reduced energy costs, lower investments, and sustainable operation. Dynamic brightness adjustments, remote maintenance, and continuous updates make lighting not just more efficient, but also more economical.

Octopus Energy — the energy market goes digital

The era of fixed electricity rates is over. Octopus Energy uses IoT-enabled sensors to analyze energy consumption in real time and align it with dynamic pricing. Smart rates adjust automatically based on demand and availability, offering consumers transparent costs and sustainable operation. This intelligent control allows households, businesses, and even entire neighborhoods to gain more efficient access to power.

Urban farming — fresh produce from connected greenhouses

Sustainable food production no longer requires large plots of land. Connected mini-greenhouses let you grow fresh herbs and vegetables at any location including balconies, offices, or restaurants. A subscription model provides users with seeds, nutrients, and automated cultivation. IoT sensors monitor temperature, light, and humidity, while AI-powered recommendations optimize plant growth. This creates a new ecosystem for local food production that combines freshness, autonomy, and resource efficiency.

These models show: With smart products, a one-time purchase can turn into a long-term service relationship that delivers real value for both businesses and consumers.

The **Deliver phase** transforms prototypes into scalable products. Cross-functional teams, automation, and feedback loops ensure success on the market. Trilux, Octopus Energy, and urban farming are demonstrating how data-driven models can unlock new markets and establish sustainable business models.

Transform: Adjusting organizational structures for the future

The success of innovative business models depends to a great degree on organizational structure. Creativity and willingness to change only emerge when companies establish the necessary freedom. This requires conscious change as part of a managed process.

Eight steps to organizational transformation

John P. Kotter, Professor Emeritus at Harvard Business School, developed a model for sustainable change in 1996. This proven eight-step change management process first described in Leading Change is now recognized as the standard for transformation processes. Here's how it applies to smart service transformation:

Create a sense of urgency
Change only succeeds when there is an awareness of its necessity. Leaders must not only deliver rational arguments, but also be compelling on an emotional level.

Build a strong guiding coalition
Change requires role models. A powerful team of advocates to drive transformation forward and communicate the vision internally.

Develop a pragmatic vision and strategy
A clear, compelling vision provides direction. However, feasibility is essential: Only a feasible strategy that specifies concrete actions can succeed long term.

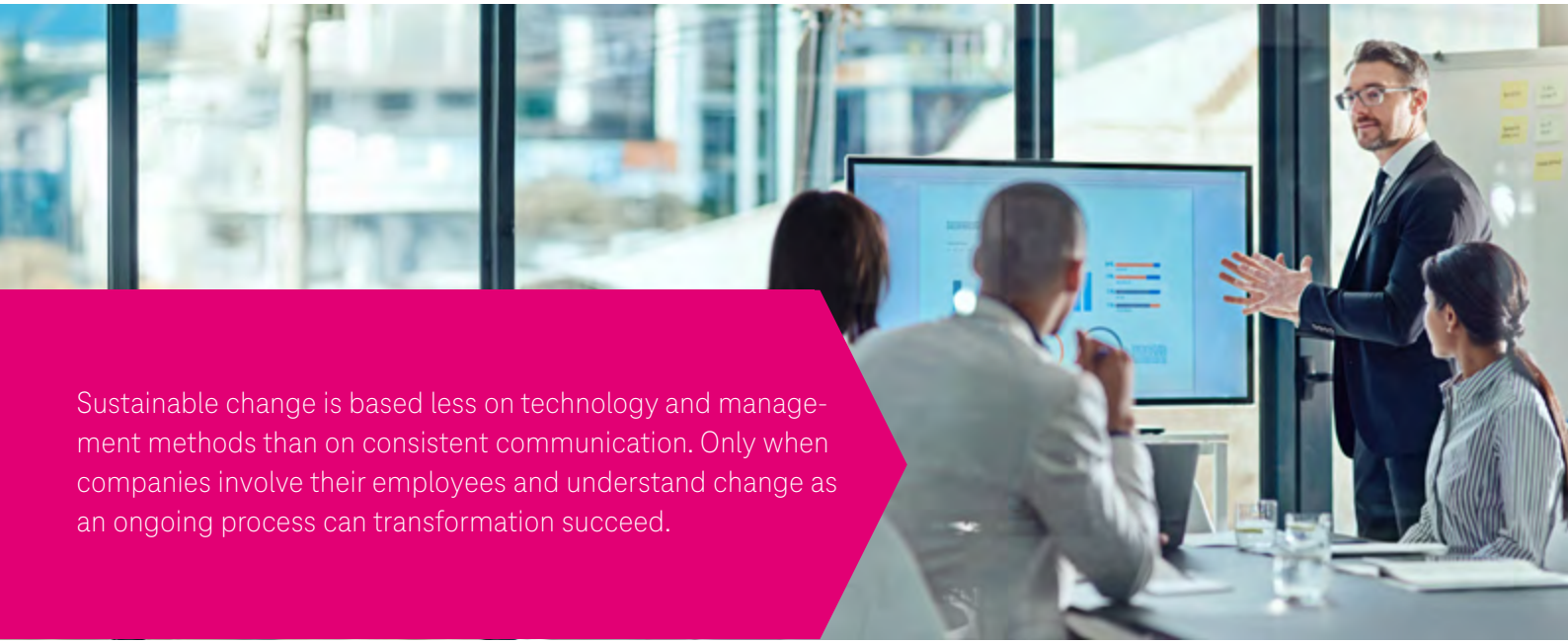
Create a network of engaged employees
Transformation only works if there is a critical mass within the organization actively shaping the change.

Remove obstacles
Inefficient processes, rigid hierarchies, and siloed departments block innovation. Successful companies break down silos, think across departments, and foster cross-functional teams. True innovation often happens at the intersection of disciplines.

Make quick wins visible
Fast, measurable successes boost motivation. Milestones should be communicated early to make progress tangible. Especially with digital products, clear responsibility is essential: Who should react when something doesn't work?

Keep the momentum of change going
Change is not a one-time project, but an ongoing process. Companies should remain agile and allow room for experimentation. Instead of relying on a single solution, it's worth testing multiple approaches and selectively developing promising ideas.

Permanently establishing changes
New structures and values must be deeply rooted inside the company culture. Service design experts can help consolidate methodological expertise and bring together knowledge from different domains.



Sustainable change is based less on technology and management methods than on consistent communication. Only when companies involve their employees and understand change as an ongoing process can transformation succeed.

A clean sweep: How Kärcher is connecting the cleaning industry

Interview with Marco Cardinale, CTO, Kärcher

Kärcher has made a name for itself around the world with its pressure washers, floor cleaning machines, and innovative cleaning solutions for both commercial and private applications. But the German manufacturer is increasingly evolving into a provider of smart, connected services.

Marco Cardinale, CTO and board member since 2024, discusses customer proximity as a driver of innovation, the autonomous cleaning robot KIRA B 50, and the role of artificial intelligence in tomorrow's cleaning market.

How does Kärcher identify new opportunities for smart services?

Our innovation journey always starts with the customer. And for our B2B business, that means around twelve different target groups ranging from facility management providers to farmers. Our teams around the world observe and interview users in everyday situations, analyze processes and pain points, and derive from these insights so-called demand spaces. Based on those spaces, we generate product concepts and then test and refine them until we have actual solutions — either physical or digital. One thing that's important here: it's not just what the customer says that counts, but also what we observe.

The KIRA B 50 cleaning robot is a smart product that Kärcher has successfully scaled. What were the critical factors here?

Two things coincided here: First, the shortage of skilled labor was driving demand for automated solutions. Second, technological developments such as falling prices for LiDAR sensors had made a feasible business case for customers possible. Our partnership with Deutsche Telekom was key to scaling, specifically because of the robust SIM cards we could use anywhere in the world. This was complemented by AWS cloud infrastructure and the transformation of our sales processes. We offer our cleaning robot with a service contract and digital reporting, which have clear benefits for our customers. The key was always being open to partnerships and the ability to complement our mechanical engineering expertise with digital services.

How does Kärcher envision the future of the cleaning industry, and what role will AI play in it?

We call it "Connected Cleaning". It's a vision of needs-based cleaning that leaves behind inflexible schedules. Sensor technology, automation, and data analysis will play a central role. Robots should only clean when it's really necessary, which is more efficient and sustainable. AI helps us achieve this in two ways. On the one hand, it optimizes cleaning processes for our customers. On the other, the usage data helps us develop the next generation of our products. This requires expertise in data science — people who can structure, analyze, and translate data into innovation. That doesn't mean Kärcher is now a software company. What we are is a provider of intelligent end-to-end solutions that combine mechanics, electronics, and digitalization.

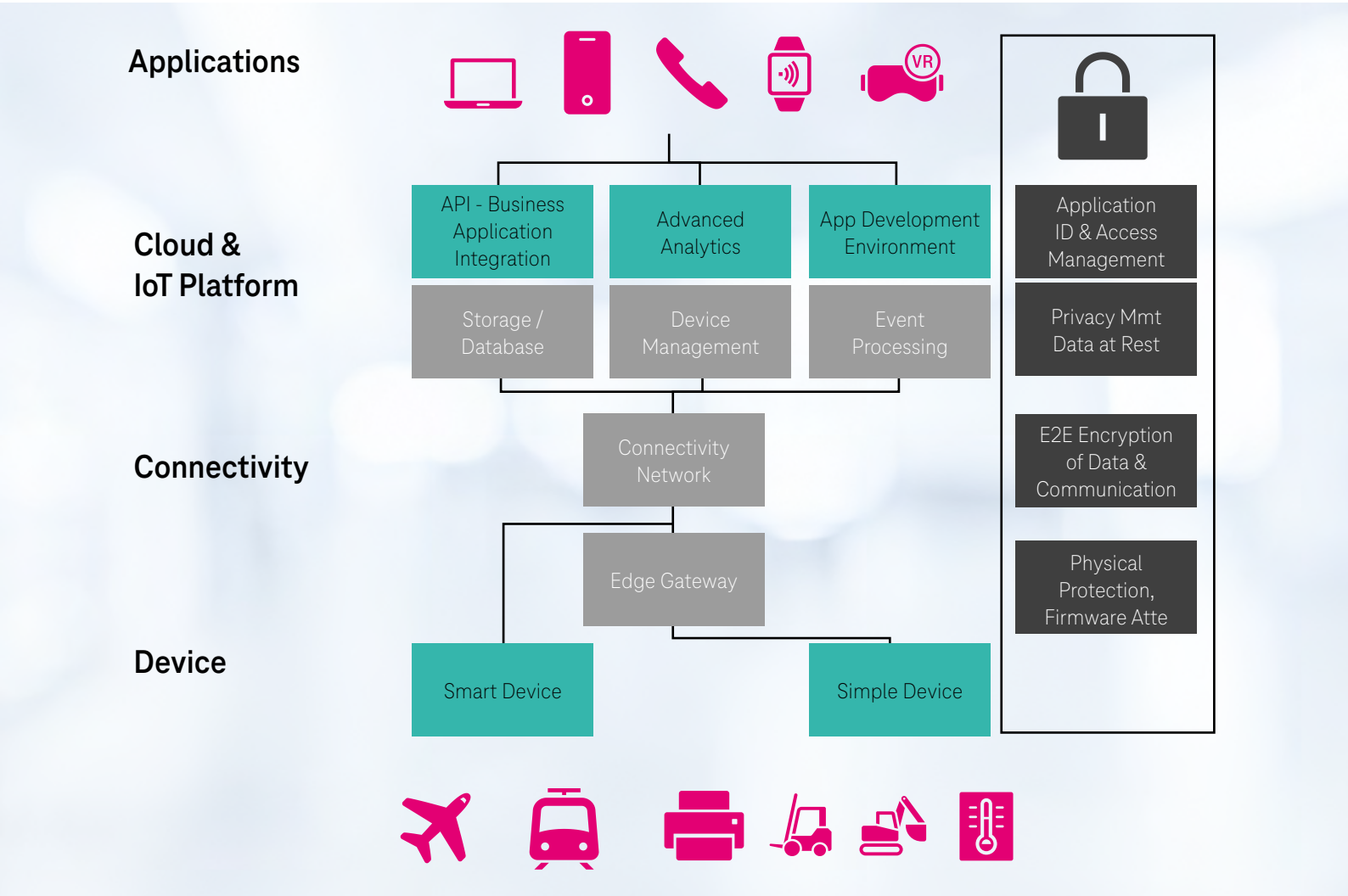
Click here to listen to the podcast
(only in German language)

4. TECHNOLOGY — Choosing the right architecture

Looking under the hood: Understanding the technology stack

An end-to-end solution in the Internet of Things can be illustrated using a basic five-layer model. The first four layers build on one another: At the bottom is the device, followed by the communication layer, cloud services, and finally the applications. IoT Security cuts across all these layers — a reminder that it's not just an add-on, but must be embedded throughout.

Choosing the right hardware and configuration can considerably reduce the cost of an IoT solution without compromising performance. The path that data takes through the tech stack provides an excellent indicator of which components are especially important to achieve this.



The IoT full stack

There are four key sections here: Data acquisition, data transmission, data storage, and data processing. Along this chain, a number of infrastructure components fulfill specific functions.

The architecture of smart services and IoT solutions resembles a finely tuned orchestra in which every instrument, be it a sensor, gateway, or cloud service, must play in perfect harmony with the rest.

The 5-layer model for IoT architecture

An end-to-end IoT solution can be divided into five layers. Each layer has a specific function, while security is embedded as a foundational element across all layers:

1. **Data acquisition:** Devices and sensors capture environmental or usage data—for example, temperature, motion, or energy consumption.
2. **Data transmission:** Communication between devices and the cloud takes place via protocols like MQTT or HTTP.
3. **Data storage:** NoSQL databases such as Cassandra or Hadoop store the large volumes of raw data.
4. **Data processing:** Analytics tools, often supported by AI, extract valuable insights from the data.
5. **Applications:** Users access the analyzed data and control devices via apps or dashboards.

Each of these layers must interact seamlessly with the others to unlock the full value of an IoT solution.

Layer 1: Data acquisition — The devices' senses

Sensors are the eyes and ears of the IoT. They continuously capture data including everything from vibrations in industrial machinery to moisture levels in agricultural soil. An example of this is the Bosch Manufacturing Solutions platform presented at CES in 2025. Smart sensors not only help optimize production, they also contribute to energy savings. These data streams lay the foundation for predictive maintenance and process improvements.

Layer 2: Data transmission — The flow of data

Data is the lifeblood of the IoT stack. Technologies such as narrowband IoT (NB-IoT) or LoRaWAN enable cost-effective and energy-efficient data transmission, even in remote areas. **For example: E.ON uses LPWAN technology for its smart meters. These devices consume little power while nonetheless communicating to deliver real-time data and enable more precise grid management.** This demonstrates how important it is to have a robust and diverse digital infrastructure. From energy-efficient Low Power Wide Area Networks (LPWAN) and high-performance 5G networks to satellite communications — especially in remote regions — technological diversity is opening up entirely new possibilities for comprehensive, resilient connectivity of critical infrastructure.

Layer 3: Data storage — The treasure chest

Hadoop, originally developed by Google, provides a framework for distributed software. This technology makes it possible to process extremely large datasets of several petabytes or more on clustered computers. You could say Hadoop is the invisible infrastructure that builds the bridge between raw data streams and usable insights. Cassandra was originally developed by Facebook to manage the massive volumes of data in its social network. As a distributed NoSQL database system, Cassandra is optimized not only for high scalability but fault tolerance as well.

Layer 4: Data processing — The think tank

In the processing layer, raw data is transformed into valuable insights. Cloud platforms such as AWS IoT Analytics or Microsoft Azure play a central role here. But edge computing is also gaining importance, especially in industrial applications that require local data processing to enable real-time decision-making.

Layer 5: Applications — The visible tip of the iceberg

Applications are the surface of the IoT stack that we can see. Dashboards, mobile apps, or automated control systems allow users to interact with the processed data. Amazon Web Services, for example, offers a toolkit for building custom applications, allowing companies to create their own smart services.

An IoT infrastructure includes data acquisition, transmission, storage, and processing. Edge computing handles real-time processing while LPWAN ensures energy-efficient connectivity. Security must be included as an integral part of all layers. A well-designed IoT stack forms the foundation of data-driven business models.

IoT connectivity: Why cellular is the better choice

Interview with Uday Patil, Head of IoT Hardware & Services, Deutsche Telekom IoT

Choosing the right connectivity determines the success of an IoT product. Uday Patil, Head of IoT Devices at Deutsche Telekom, explains why companies should move away from Wi-Fi and Bluetooth—and how cellular offers a more sustainable solution.

Why are Wi-Fi and Bluetooth often insufficient for IoT devices?

Many companies opt for Wi-Fi or Bluetooth because these technologies seem simple and cost-effective in the short term. But they come with significant drawbacks: The range is limited, they're prone to interference, and the connection can drop when the device is in motion. This results in severe limitations in logistics, smart cities, and healthcare. Cellular connectivity offers a widespread, secure, and scalable solution regardless of location or computer network infrastructure.

Wi-Fi and Bluetooth also come with high implementation and maintenance costs. Especially in industrial environments or distributed IoT networks, setting up and maintaining a stable Wi-Fi network can quickly become complex and expensive. Companies also need to handle the security of their networks, since unsecured Wi-Fi connections pose a higher risk of cyberattacks. Cellular networks, on the other hand, offer built-in encryption standards and centralized management and protection of all connected devices via SIM management platforms.

What challenges have people had implementing cellular solutions for IoT?

The three biggest hurdles have been cost, complex pricing, and a lack of expertise. Historically, cellular modules were more expensive than Wi-Fi alternatives, and many providers imposed inflexible contract terms. Additionally, many developers are familiar with software and apps, but less so with cellular technologies. To address this, Telekom developed "Make Everything Cellular Connected" (M-E-C-C). This concept involves preconfigured modules, flexible plans, and low entry costs to make cellular as easy to use as Wi-Fi.

Beyond those challenges, network coverage also plays a critical role. Companies need a reliable solution that works globally—especially for logistics or smart city applications. Roaming costs and incompatibilities between network providers have been a common problem in the past. With M-E-C-C, Deutsche Telekom offers global IoT connectivity that allows devices to connect seamlessly across regions without companies needing to worry about network handover or country-specific configurations. This not only reduces costs but also administrative overhead significantly.

What role do 5G, eSIM, and iSIM play in the future of the IoT?

These technologies are completely changing the nature of the game. With 5G, large volumes of data can be transmitted in real time, a crucial capability for AI-powered applications like smart home devices or predictive maintenance. eSIMs and iSIMs are making connectivity easier. Instead of swapping physical SIM cards, devices can now register on different networks around the world without manual configuration. Companies that adopt cellular IoT connectivity now are laying the foundation for smart, reliable IoT products that work all over the world.

5G standalone (5G SA) in particular is opening up new opportunities for industrial IoT applications by enabling ultra-low-latency connections and network slicing. This allows companies to reserve guaranteed bandwidth for critical use cases. The introduction of the iSIM (integrated SIM) will also be a game changer: The SIM card is embedded right into the chip, reducing hardware costs and simplifying production. These technologies make IoT devices more efficient, cost-effective, and sustainable over the long term, an essential step for any company investing in smart, connected products.

Secure by design

Why the Internet of Things must be resilient from the very start

The connected world is growing—and so are attack surfaces. What starts out as a seemingly harmless sensor can turn into an open backdoor through which attackers penetrate networks, manipulate systems, and cripple entire infrastructures. Anyone who treats security as an afterthought is like an architect who only starts thinking about the stability of a skyscraper's foundation after construction has finished. Security by Design means not making those mistakes in the first place.

Find out more about IoT security

Cyber Resilience Act: From optional to mandatory

For a long time, cybersecurity was optional—until the increasing number of attacks made it clear that this approach was no longer feasible. The Cyber Resilience Act (CRA), which becomes mandatory in 2027, forces manufacturers to treat security not as an afterthought, but rather an integral part of their products. From connected household appliances to industrial control systems: If you want to sell digital products, you have to prove they are resilient to attack.

The CRA makes **penetration testing, regular security updates, and ongoing risk assessments** mandatory. The idea is simple: A system is only as secure as its weakest link. When connected devices form a chain, it's crucial that none of the links in the chain can break.

The deceptive security of legacy systems

Many companies have built their IT architectures for a static world—hard-wired processes, closed systems, and planned updates over long cycles. But **the Internet of Things doesn't grow at a linear rate—it grows exponentially**. Companies launching IoT platforms today can expect user numbers, data volumes, and business models to change radically in just a few years.

But how do you build infrastructure for a future you can't yet see?

1. **Agility over stagnation:** IoT systems must be designed for expansion, adaptation, and connectivity. Not as monolithic structures, but as dynamic, scalable networks.
2. **Resilience over retrofitting:** Security measures must not be treated as patches to add on later. Everything from encrypted data transmission to ongoing anomaly detection has to be integrated into the architecture right from the start.
3. **Openness over siloed solutions:** The trend is moving away from proprietary systems towards platforms that are connected via interfaces. Those who lock themselves into a closed ecosystem today will be overtaken by tomorrow's developments.

From cost center to competitive advantage

There was a time when cybersecurity was considered a necessary evil—an expense businesses reluctantly included in their budgets. But those days are over. **Security is no longer a luxury. It's a fundamental prerequisite** for surviving in a connected world.

The **Cyber Resilience Act** marks a turning point: Companies that treat security as a hoop they have to jump through will face serious challenges in the years to come. Those who recognize **resilience as the currency of our digital future** will not only have secure operations but also build trust, stability, and long-term success.

Security as a competitive advantage. Security is no longer a luxury, but a must-have — and a core element of innovation. The CRA makes one thing clear: Businesses that fail to integrate cybersecurity early on risk more than just attacks, they may also lose people's trust. The future belongs to those who view security as a core part of the value chain.

Design for change: Ready for anything

Companies traditionally built their legacy systems based on standard software to reflect standardized processes.

Business models can change

Operating IoT infrastructures, on the other hand, requires far greater flexibility and the use of agile methods (see Chapter 3). The reason: Many companies are only just entering the world of IoT and are still in the process of defining their digital business models. But it is highly likely that these models will evolve significantly over the next few years. Their infrastructure needs to be flexible enough to adapt and grow with them.

A future-ready IoT platform may, for instance, need to apply a given business scenario to new user groups. For example, product maintenance for connected devices may until now have been performed once or twice a year by technicians using proprietary interfaces. A new business model might involve opening up these interfaces to customers. This, however, represents an entirely new use case. Because now it's about continuous access to data, in some cases in real time.

A platform that makes growth possible must be open and adaptable. Instead of investing in siloed solutions, successful companies will rely on systems that can create and expand connections. Those who prioritize modularity and compatibility from the outset obtain not only the freedom but also the strength to thrive in an increasingly connected world.

Scalable growth while keeping costs under control

This places entirely new demands on the performance of the IoT platform. Often, the infrastructure intended for the original use case won't be able to keep up. There's a considerable difference between serving 20,000 customers on a platform and serving a hundred times that number. Problems arise when scaling technology: For example, the servers and databases need to be able to support this level of scaling. Another critical factor is the cost aspect for things like hosting and licensing fees. Companies need to make sure that costs grow proportionally. Doubling the number of users should not result in costs that are more than twice as high.

It is highly likely that new technologies and ecosystems will emerge in the coming years, and they will need to function alongside existing systems. One example is human-machine interaction using AR glasses. These systems have their own data transmission performance requirements and must be integrated into the platform.

On the provider side, there's also a growing trend of not even attempting to harmonize certain standards and instead just connecting platforms via interfaces through the cloud layer. This quickly gives rise to large ecosystems with heterogeneous landscapes that the operator must support.

Put simply: Anyone entering the world of smart services needs a stable, future-proof solution that is built to easily scale to the maximum foreseeable requirements. However, another precondition must also be met: Companies must move away from proprietary systems and design their IoT architectures with openness in mind from the outset.

Design for the future instead of putting out fires

The Internet of Things compels companies to leave behind the inflexible systems of the past. Those adopting IoT technologies today must plan with an eye to the future: How can you design an infrastructure that can meet not only today's requirements, but also those that have yet to emerge? Connected products that were once monitored occasionally by technicians may soon be accessed in real time by customers.

Open platforms as future-proof solutions

Scalable solutions: Architecture for the future

Cloud services are no longer optional components but rather the backbone of modern IoT ecosystems. Building smart business models based on data-driven processes requires not just technical expertise but also a nuanced strategy. Companies face the challenge of clearly defining the boundary between internal capabilities and external resources. Which tasks can be efficiently delegated to cloud service providers, and where does it make sense to do things in-house? For sustainable scaling, this is a critical decision.

OTA updates: The key to flexibility and security

For IoT devices and platforms to keep pace, they must be optimized for over-the-air (OTA) updates. These updates make it possible to fix bugs, add new features, and—most importantly—close security vulnerabilities. The demands on memory and processing power are high: The task is not simply updating individual devices, but in many cases pushing out updates to millions of units in a very short time. This requires technical expertise as well as a robust infrastructure.

A recent study demonstrated how security updates are crucial for market viability: In 2024, vulnerabilities were identified in several billion IoT devices. Companies that reacted quickly were able to retain customer trust—a testament to the critical importance of OTA updates.

APIs: The bridge between systems

Open IoT platforms rely on APIs that serve as channels for data. But deploying them requires precision and security. The key requirements are:

1. **Transparent user account management**
   Operators must clearly define access rights and be able to track who is accessing the API.

2. **Comprehensive security measures**
   Unauthorized access and manipulation must be made impossible. In 2024, innovative approaches such as zero-trust architectures made headlines by redefining security standards.

3. **Data stream analysis**
   APIs must be able to deliver detailed information on data volumes, user behavior, and the times that access occurs. This lays the foundation for future business models.

4. **Usability**
   Developers expect clear documentation and sample code so there is nothing standing in the way of them using the APIs. Best practices from 2024 show that platforms with plug-and-play approaches enjoy the highest adoption rates.

5. **Service-oriented design**
   Things get more complex when external partners or customers are to be given access. It quickly becomes clear that service-oriented designs based on modularity from the start are much more robust.

Open platforms require scalable cloud architectures, secure OTA updates, and precise API management. Zero-trust security, plug-and-play APIs, and modular system architectures are crucial for success. Companies must weigh internal competencies against external resources. Openness and interoperability are crucial for future-ready IoT models.

The three fundamental technology decisions

Connect legacy systems, take a smart approach to new products: Embedded vs. Retrofit

Integrating older devices into the Internet of Things is one of the bigger challenges that companies face. While new devices come equipped with IoT technology, many machines and systems from previous product generations require extensive modifications.

This type of retrofitting involves installing sensors and networking equipment to enable data transmission. Recent studies show that retrofitting can deliver significant efficiency gains without the need to completely replace systems.

> IoT systems must be scalable, updatable, and connected. Companies must decide between modernization or replacement, local or cloud data processing, and in-house development or standard solutions. Hybrid strategies and open platforms will ensure flexibility and competitiveness.

Processing: Embedded, edge, or cloud?

Choosing where to process data is crucial for the performance of IoT systems. Companies have three main options.

Embedded computing: Data is processed by the device itself. This approach is ideal for applications that require response times of just a few milliseconds. However, integrating powerful computing systems significantly increases production costs.

Edge computing: Data is processed in close proximity to the IoT devices—for example, on gateways. This method combines fast processing with the ability to aggregate and pre-process data locally before sending it to the cloud. Edge computing has proven to be an ideal solution for scenarios where both speed and security are essential.

Cloud computing: Centralized processing in public or private clouds offers virtually unlimited computing power and storage capacity. Cloud solutions are particularly well-suited for data-intensive applications and ongoing analytics—but they must bow out as soon as real-time processing is required.

The make-or-buy decision

No single provider currently covers all aspects of an IoT solution. Companies must therefore weigh the pros and cons of in-house development versus ready-to-deploy systems:

Make: In-house development offers maximum control and adaptability. It also requires large investments and specialized expertise, however.

Buy: Off-the-shelf solutions reduce time and risk. Providers such as Deutsche Telekom, Microsoft, Amazon, and IBM offer comprehensive ecosystems that are easy to integrate into existing applications.

Mixed: Hybrid approaches are gaining traction. Companies are combining standard solutions with custom builds. Open-source initiatives and standardized interfaces are making it easier for developers to integrate different applications. Successful projects have a number of things in common including a clear strategy, scalability, security, and cost-effectiveness.

Success factors for smart, connected products

Smart products: The connected future of the economy

Smart products and data-driven services are no longer just the playground of ambitious start-ups. They mark a tectonic shift in value creation across all industries—a revolution no company can afford to ignore without risking its future. Because a world in which machines communicate across continents and products no longer exist in isolation but act as intelligent nodes in a global network will give rise to entirely new value creation opportunities. This practical guide has demonstrated how companies can not only harness this dynamic but actively shape it.

The key here is: **Start, don't stall.**

Speed and flexibility: The need to execute

Traditional, drawn-out planning processes are a thing of the past. In a digitized world where products, data, and services converge, those who test ideas early and then iterate come out ahead. Rather than spending months developing a business case, the path to success lies in rapid execution: **Develop ideas for IoT applications, test them in pilot projects, and continue advancing them using agile methods.** Prototypes are no longer built in isolated labs—they're tested directly in real environments, with data flowing back in real time, enabling companies to learn faster where the opportunities and weaknesses lie.

Global connectivity: When products think beyond borders

Product connectivity doesn't stop at national borders — on the contrary: To fully leverage the power of data-driven business models, you have to think in global networks. **An intelligent IoT ecosystem cannot exist in isolation. It thrives instead on connectivity.** A shipping container leaving Hamburg, a cleaning robot in Singapore, a digital pacemaker in the US—they're all part of a global nervous system that communicates in real time.

The challenge lies in the architecture. **How do you orchestrate a network that reliably connects billions of devices?** Companies that implement scalable, secure, and flexible solutions will gain a strategic advantage. The future belongs to those who see their products not as isolated units but as interacting actors on a global information stage.

Architecture: The invisible key to scalability

IoT infrastructures follow their own rules. While traditional IT systems operate within the closed boundaries of a company, smart products require an architecture that scales across national borders. **The ability to efficiently manage millions of connected devices becomes a core competency.** Energy consumption, security architectures, and compatibility with future standards are more than just technical details — they are strategic decisions with long-term consequences.

Data flow: The new currency of the digital economy

The true strength of connected products lies not in their mere existence, but in the data they generate — and the intelligence with which that data is used. **Anyone who only collects data without systematically analyzing it is wasting a crucial advantage.** Modern analytics platforms transform raw data into business-critical insights, enabling predictive maintenance, personalized services, and data-driven business models. But all of this requires an optimized data architecture—and a corporate strategy that sees data not as a byproduct but as a core asset.

Knowledge and skills: Digitalization's bottleneck

Technology is not an end in itself. **The biggest hurdles in the IoT revolution lie not in the hardware or the cloud, but in the human factor.** Recent studies show: The demand for data scientists, cloud architects, and IoT security experts far exceeds the available supply. Companies must therefore invest heavily in training, continuing education, and interdisciplinary knowledge. At the same time, the increasing integration of technologies such as Python, edge computing, and machine learning requires a fundamental shift in traditional development processes. Those who fail to adapt risk being left behind.

Organization: Shape change, don't just manage it

The Internet of Things is fundamentally transforming business models. **The sale of a product takes a back seat while data-based services come into focus.** A smart product is not a finished good, but a platform for ongoing development and new business models. This transformation requires more than technological excellence—it demands a change in organizational structures. Companies that involve their employees early in the process, foster a culture of innovation, and break down rigid hierarchies will come out on top in this era.

The connected world won't wait

The question is not whether companies are headed towards a future of smart devices or not — it's more a matter of velocity. Those who see the global connectivity of their products as a strategic opportunity, test boldly, learn with agility, and consistently adapt their business models will not only survive, they will actively shape the transformation. The name of the game is to be a leader, not a follower.

Conclusion: The future belongs to the bold

Join the Telekom IoT Community

In the Telekom IoT Community, customers and partners from a wide range of industries come together to share their experiences. Take this opportunity to gain fresh insights, connect with decision-makers from other companies, and benefit from their knowledge.

What type of offerings can you expect?

Success stories from our customers and partners

Cooperation is the key to success in the Internet of Things. We develop solutions to the challenges our customers and partners face as a collaborative sparing partner with a wealth of practical experience. We're proud that you rely on our expertise. Explore our references to see how we successfully implement projects spanning multiple industries.

Find out more

Podcasts to expand your knowledge

Technology is advancing rapidly—new business applications are boosting efficiency, convenience, and growth. Stay up to date on digitalization. Compact, practical, and always accessible. Our experts provide valuable insights on and best practices for IoT connectivity.

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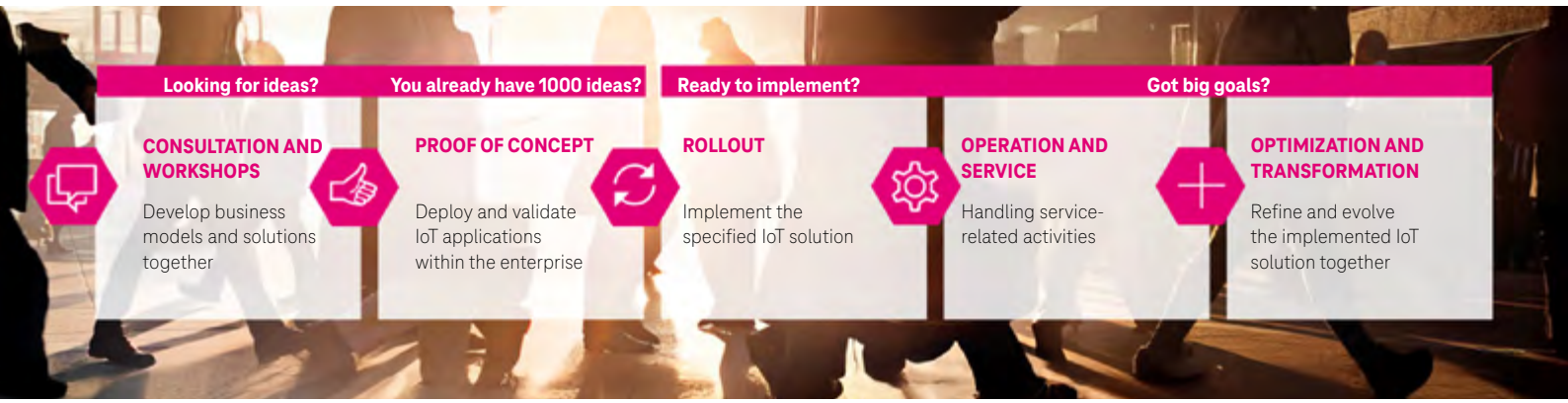

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