.experience

The Internet of Everything

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ERNI

The Internet of Things is both an opportunity and a challenge

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The Internet has transformed our lives, and the Internet of Things (IoT) is now re-shaping the boundaries of the net, taking its impact to another level. It is changing how we produce goods and move them, how we react to climate change, how we drive and how we take care of the elderly. Sensors, connected devices and Artificial Intelligence can help cities to be cleaner and safer, factories to be more productive and farms to use less resources.

Market analysts and consultants are reporting on how the hype around the Internet of Things is steadily turning into reality. The number of businesses that use IoT technologies has increased from 13% in 2014 to about 25% today. It is estimated that by 2023 there will be 43 billion IoT-connected devices, and investments in IoT are projected to grow at 13.6% per year through 2022. Technology advancement will help boost the adoption of IoT solutions by companies, as sensors are becoming cheaper, more reliable and available all around the globe, and 5G is opening up a whole new world of possibilities for connected things.

Still, the Internet of Things is not only about technology. It is also a radical transformation in the way we think and imagine our future; companies and organisations have to change how they operate, where they invest, and they have to acquire new skills and attract different talents. They have to put data and digitalisation at the core of their structure, be aware of the pitfalls and know how to manage the risks. It is probably more than a simple turning point; it is a paradigm shift. And nobody is saying that it is an easy one.

Still, there is a lot to be won: developing better products and services, improving quality and security, using less resources and energy, having a company that is greener and more efficient. In other words, being more competitive in a changing world.

Will you accept the challenge?

I would like to thank all the experts in their fields who have contributed to this issue by sharing their thoughts. Namely Inma Martinez, one of the most relevant voices in Europe when it comes to Artificial Intelligence and Machine Learning; Pedro Mier, president of AMETIC, the most important technology association in Spain and member of the board of DigitalEurope; and last but not least, Dr Sergi Figuerola, CTO of the 5G Barcelona Alliance.

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In the magazine, published triannually by ERNI, we share important lessons learnt in collaboration and technology.

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Topic of the issue: The Internet of Everything

Digital twins, ready to help

The idea of twins is nothing new. The concept was used as far back as NASA's pairing technology in the Apollo 13 project. But digital twin technology will only be able to show its full potential after IoT devices become widespread and affordable.

Imagine a virtual copy of a busy building: the physics underlying the structure are comprehensively mimicked by the computer program, and sensors spread throughout the building's control system feed the simulation with real-time data about temperature, material degradation, water pressure, ventilation status, CO_2 levels inside the rooms, and so on. A failure occurs, and the maintenance team receives a phone call. From a remote location, the staff can immediately start an in-depth investigation of the digital avatar, detecting the cause of the problem without having to actually check the building. This is one of the futuristic scenarios opened up by advanced digital-twin technology.

A digital twin is a digital representation of a physical object. A complex computer program that implements a unique one-to-one correspondence to the object; it contains a model of the physical object, receives real-time data from it and has the ability to monitor its performances.

Digital twins have been made possible in recent years thanks to advances in sensor technology, the IoT, artificial intelligence and data science. Today, more and more companies – from the manufacturing sector to the engineering industry – are starting to use such technology to optimise products, refine processes and predict possible failures. Another example is a digital twin of an aircraft turbine – the avatar collects, analyses and monitors real-time data from the turbine's sensors, and simulates any potential problem that might occur before it happens in reality, saving both costs and the time needed for maintenance.

50 percent of large manufacturers will have at least one digital twin initiative launched by 2020, and the number of organisations using digital twins will triple by 2022, according to a Gartner Survey.

It is possible to have a digital twin of a single object or of a complex system. Avatars can emulate the storing process of a warehouse, a service offer of a company, a workflow in a factory, an entire car or an airplane: you can deploy a digital twin of something as small as a lightbulb or as complex as a whole city. Extremely accurate digital twins – also called predictive twins – that embed historical data from other similar devices might also simulate how a device will perform over time, predicting future performance under different conditions as well as possible failures. A digital twin can also be created for an object that doesn't yet exist. Take the example of a newly designed device: before one physically starts building anything, a digital twin can be used to run simulations and fine-tune the technology behind it.

However, building a digital twin is not such an easy job.

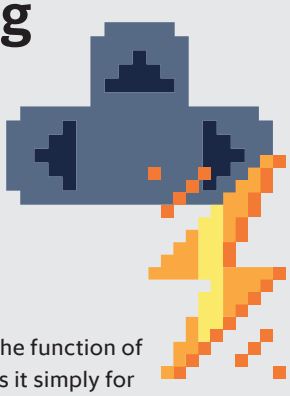
How to build a digital twin

Digital twins are complex computer programs. Inputs for the program are data from a real object or system; outputs will be simulations and predictions on how the data will react according to different parameter changes. The digital twin is anchored to its real twin through sensors transmitting real-time data, so that even the smallest change occurring to the physical object will instantly affect the digital copy.

To build a digital twin, you need a team of specialists, as currently there is no standardised platform for this task. Sensor experts map the real object, and applied mathematicians as well as data scientists – with strong skills in machine learning, artificial intelligence and predictive analytics – shape the simulation. The team analyses the status of multiple components of the specific asset and the physics that underlie it, then develops a mathematical model with which to emulate the object, taking real-time data from sensors. In the best-case scenario, any information that could be obtained from a physical asset can also be obtained from its digital twin.

Still, a digital twin can be as complex or as simple as needed: you can always decide how many of the thousands of physical variables to keep in the digital counterpart, thus modelling the digital twin according to the intended use.

Three steps to creating your digital twin



Beginning to create a digital twin can appear daunting, but can be broken down into three stages:

1 Design

There are two main elements to the design of a digital twin: first, you need to select the enabling technology you need to integrate the physical asset within its digital twin to enable the real-time flow of data from the IoT devices and integration with operational and transactional information from other enterprise systems. You need to be clear about the type of device you require, the modelling software needed to create the 3D representation of the asset and who is going to have access to the information within the digital twin or gain control of the physical asset through it. Secure IoT device management is crucial for overcoming the risks associated with identifying the devices on your network. It provides the capabilities to authenticate, provision, configure, monitor and manage each device. An identity-driven IoT platform allows you to do this quickly and securely at scale.

This leads to the second element in design. You must understand the type of information required across the life cycle of the asset, where that information is stored and how it can be accessed and used. It's important that information is structured in a reusable way that can be quickly and effectively exchanged between systems. An identity-driven IoT platform can manage the identity of every element involved in the digital twin and provide messaging services to automate the secure communications between these people, systems and things.

2 Operation

You must decide the function of your digital twin. Is it simply for monitoring the asset? Do you want the twin to control and alter the asset? Do you want to make data from the asset available for advanced analytics to assist with predictive maintenance? Or, do you want to use the data and models within the twin to perform simulations to help with operational performance and product development?

The answer to these questions will determine the types of devices you attach to the asset and whether you use more sophisticated devices that allow information processing to move to the edge. It will also determine your integration and data preparation, and will identify management requirements. The more sophisticated the application for the digital twin, the more comprehensive these capabilities. For example, most twins will look to exploit analytics to improve operational performance and decision making. Controlling how data is ingested, stored, prepared and presented is essential to enable you to apply advanced analytics. To achieve high-quality results, you have to guarantee the quality of data coming from your IoT devices. Each IoT device, including its rights to transfer and accept data, is verified. Taking an identity-by-design approach builds these capabilities into your digital twin from the outset.

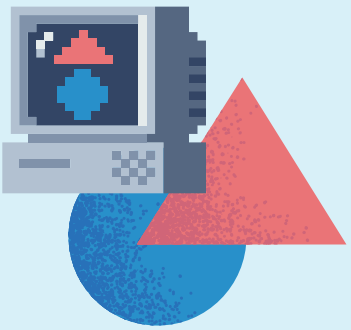
Augmentation

Most digital twin implementations start small, such as monitoring the performance of a single part within an asset, but expand over time. This happens in two ways: first, an organisation brings a number of smaller digital twins together to give a complete picture of an entire machine, asset or business process. Second, more sophisticated capabilities – such as simulations – can be added into an existing digital twin.

In either case, you don't want to rip and replace, but to layer up the functionality within the digital twin to meet these evolving requirements. You need to be able to securely add functionality to scale while maintaining performance to meet the extra data that needs to be gathered and managed.

An identity-driven IoT platform enables you to quickly and securely extend the capabilities of your digital twin though extensive integration and open APIs that allow new devices and applications to connect and interact with the twin.

Some types of digital twins

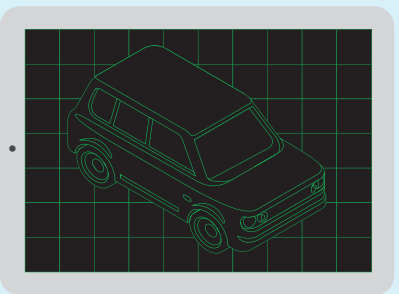


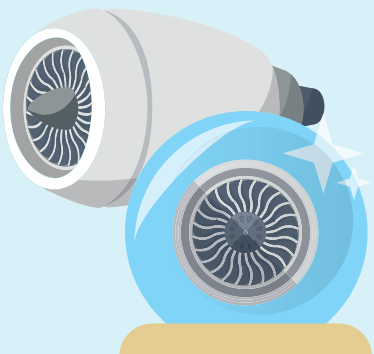
Digital Twin Prototype (DTP)

A Digital Twin Prototype exists before there is a physical product. It consists of the designs, analysis and processes that underlie a product, which can be used to run simulation and optimisation tests before the first physical prototype is born.

Digital twin

A digital twin is a digital replica of a single product that has already been manufactured, or of a process already in place within a company. It can be used for monitoring, what-if simulations and testing.





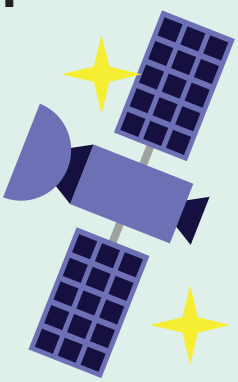
Predictive digital twin

A predictive digital twin is a complex digital twin of an object, which embeds historical data from other similar devices. It simulates how a device will perform over time, predicting future performance under various conditions and possible failures. It can be used for predictive maintenance and object failure simulation.

Five appropriate moments to start using a digital twin

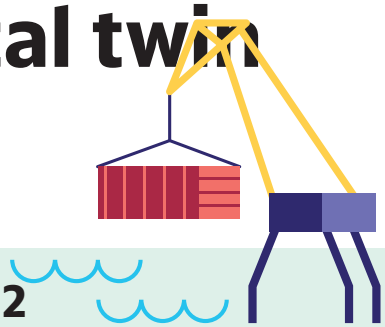
Below follows a list of scenarios where a company or a client should start implementing a digital twin strategy, saving them time and money.

1



A company developing technology for extreme environments, which has to face the challenge of recreating testing circumstances in the real world. For example, a space industry enterprise. Digital twin prototypes can be used to run what-if simulations before investing money on the first physical prototype.

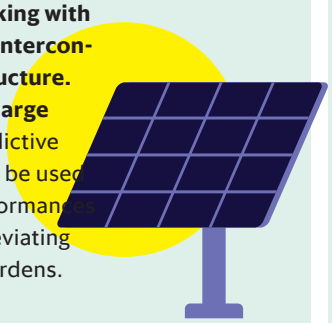
2



A firm willing to optimise an IoT deployment for maximum efficiency or to test the solution under several different circumstances. For instance, a big port company planning to use the IoT to organise unloading operations. Digital twins can be used to test different set-up combinations before actually implementing the solution.

3

A business working with a complex and interconnected infrastructure. For instance, a large solar farm. Predictive digital twins can be used to forecast performances and failures, alleviating maintenance burdens.



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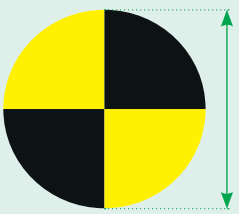

A corporation that designs devices with strong integration between hardware using real-time data and software. For instance, a company producing vehicle safety technology. Digital twins can be used to run optimising tests and avoid hardware dependency.

5

A municipality moving towards a smart city strategy, which has already installed monitoring sensors in some areas of the city. Predictive digital twins can be used to simulate possible consequences in case of natural disaster, and test evacuation scenarios.

6

A service that can suffer heavy economic loss from downtime or power outage. For instance, an operation centre of an airline company which manages hundreds of flights per hour. A digital twin can be used to predict downtime and reduce its length.

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A case study example: A multinational automotive company based in Spain

Who

A Spanish multinational corporation that has been operating for decades in the automotive sector. They are a global provider of vision, safety and connectivity systems, committed to technological innovation and research.

The challenge

The company's testing department had been performing several tests on the TCU (Telematic Control Unit) software. To collect all the necessary data for the test, they connected the software to the hardware part of the TCU – the set-up alone could thus sometimes take a number of days. Access to the hardware was also not always guaranteed and caused several delays, so simultaneous testing was often not possible. Under these conditions, the release of software updates could take several weeks.

The solution

We were hired to plan a general strategy to speed up the testing process. We proactively decided to create a digital twin of the hardware part of the TCU, as the hardware dependency was the most time-consuming factor and the main cause of delays.

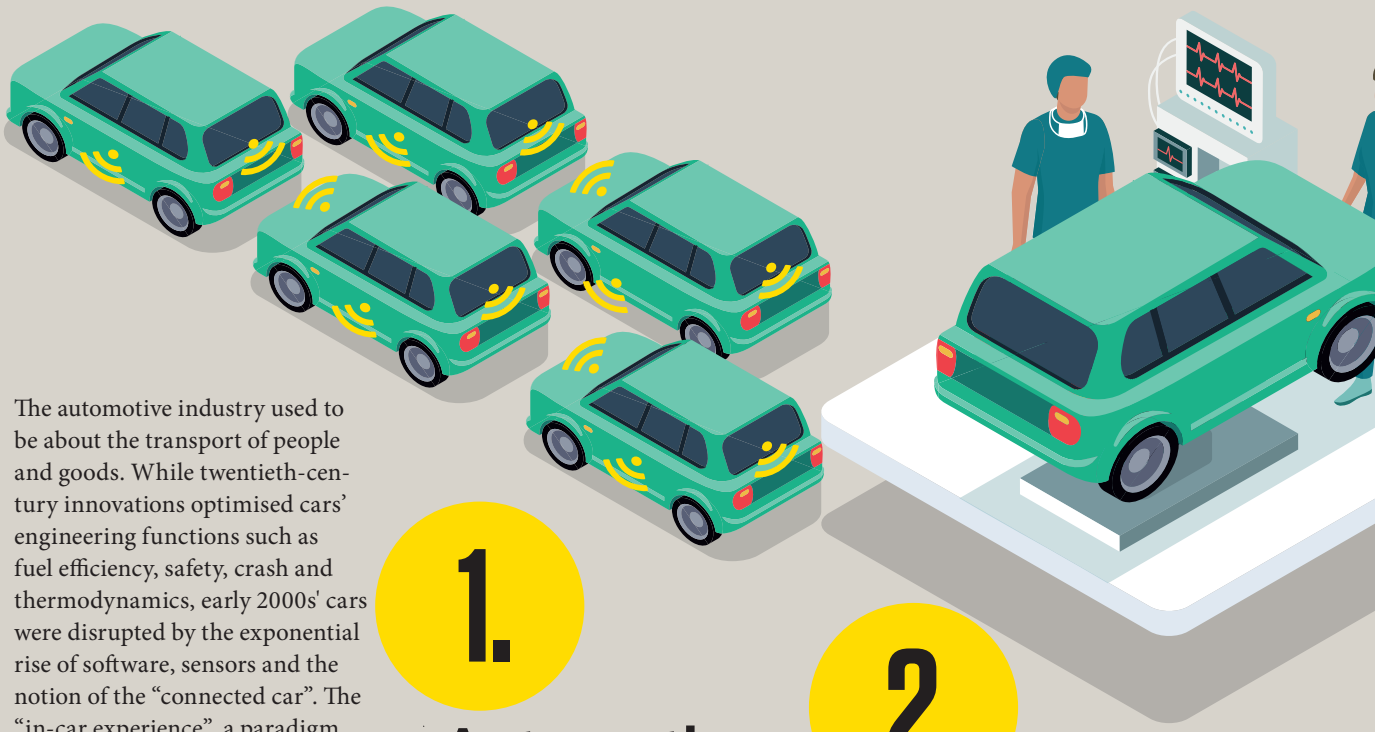
The TCU is a small computer the size and weight of a book, which collects all the data from the electronic systems in the vehicle, interprets them and communicates information to the driver as necessary. We built a framework environment that emulates everything a TCU should do: collecting data from rear-view sensors, from the accelerometer and from the temperature sensor, tracking the vehicle position through GPS, giving input to the user interface or triggering eCall systems to alert emergency services.

Having a digital twin that can simulate all the possible and actual conditions of the TCU has been a real milestone. The digital twin strategy reduced the company's testing time from days to hours. Multiple tests can also now be performed simultaneously. The project started in 2017 and it is now successfully closed.

"Cars will become living spaces"

Inma Martinez
Tech Pioneer and AI Scientist

Inma Martinez was a speaker at IAA 2019 on "New Transformers versus Reinvented Establishment" with her keynote "Brave New Digital World: The Future of Mobility in an AI, Data-Driven Society" @inma_martinez



The automotive industry used to be about the transport of people and goods. While twentieth-century innovations optimised cars' engineering functions such as fuel efficiency, safety, crash and thermodynamics, early 2000s' cars were disrupted by the exponential rise of software, sensors and the notion of the "connected car". The "in-car experience", a paradigm that endeavoured to integrate the cars' operations with smartphones and telecommunications, has turned cars into secondary work desks, and dashboards into mission control panels for navigation, in-car entertainment and communications. By 2021, 94 million connected cars are expected to be shipped globally each year, but as of 2025 we will be leaping forward towards an even more daring disruption: a true machine-to-machine environment where cars, powered by AI, will carry out automated tasks. The automotive sector will go beyond moving cargoes from A to B, or synchronising your smartphones, and will target a greater challenge: to solve the problems and needs of the 2030 society – to offer solutions that will expand beyond the core notion of driving and will address not just energy consumption and the switch to clean technologies, but real life in smart cities, the ageing population, mental health, oxygen deprivation and pollution in large urban centres, and even digital identity theft.

1.

Automotive situational awareness

V2V, or vehicle-to-vehicle connectivity, will allow cars to increase road safety levels by identifying potential nearby collisions, or by connecting to traffic management systems – rather than geolocation satellite data, which only delivers the number of mobiles connected to a given telecom call. V2I (vehicle-to-infrastructure) will optimise routes within traffic flows, identifying real road hazards and delivering other traffic-specific data that will allow cars to offer improved re-routing. Oxygen deprivation and harmful levels of pollution will also factor into the decisions taken by cars when planning routes or avoiding areas at particular times. Sensors detecting environmental harm will allow vehicles to suggest best times for commuting based on health issues, rather than just traffic.

2.

Advanced diagnostics & driver management

Proactive approaches to wear-and-tear and needs such as software updates will expand to encompass driver skills monitoring, prevention of traffic violations and the build-up of a trusted relationship between driver and machine where rewards such as increased safety and lower car insurance will encourage drivers to "obey" car indications. Cars will not only monitor themselves but also our own interactions with them and with road traffic. The concept of a car will evolve to one where the machine will offer opportunities to save money and energy, reduce stress and increase convenience over other means of transport.

3.

Driver digital identity

In the AI-led society, the need to improve the digital footprint of every human will also encompass the use of sensor-based and connected objects in our daily lives. How we prove that we are who or what we say we are during digital transactions and interactions is set to become one of the defining features of the next stage of the human digital transformation. In the 2020 era of hyper-connectivity, our devices will act for us and digital services will blend seamlessly into our daily lives; therefore, the need to identify oneself will put enormous pressure on analogue methods of passport information and even biometric data. Our future digital identities will have to solve the data puzzle of merging a wide variety of personal data ledgers, which will include our use of IoT-connected machines. Along with our current practices of Authentication Taxonomy (something you own [phone] – something you know [password] – something you are [fingerprint]), 2020 society will add a layer of "something particular to your life", which will be represented by our IoT machines and our use of them, as well as other items of our digital behaviour very specific to our lives, such as the "always on" items in our online grocery basket, our "most used ATM location", or the postcode of our work, gym or our kids' sports practice on Saturdays. Cars will be fitted with individual driver logins so that the data of each user will be allocated to the correct driver profile, and to our individual digital identity.

4.

Driver well-being

In 2050 society, up to 60% of the world's population is expected to live in urban centres exceeding tens of millions of inhabitants. The mega-cities of the future will have to address a large list of challenges, which will include needs beyond transportation issues, re-fuelling and re-charging of vehicles, parking and traffic management. Even when cars are expected to increase their level of autonomy in regular inner-city routes or on highways, people will be sat inside their cabins and will have to sustain whatever eventualities emerge from the traffic congestions, road hazards and flow of movement. Car seats will be fitted with sensors that will monitor body temperature, and abnormal body movements such as uncontrollable shaking, spasms, fainting episodes and other physical signs will be picked up by accelerometers. Beyond this, and progressing from the current 2019 IAA expo car models exhibited, voice commands will not only become a regular mode of activating car functions but will

5.

Adaptability to multi-functions

The modular car is a concept that will allow a single vehicle to be fitted with diverse components according to changes in lifestyle or drivers' use. Taking a LEGO approach to interiors, every inch will be able to be re-fitted and re-purposed beyond the basic modes of today. Telecommuters may wish to host working sessions with colleagues and conduct conference calls while on route; additional seats and containers may be put in the cargo areas for either people or groceries; smartphones and tablets may find themselves plugged into car-specific charging cradles for each passenger. Cars will lend themselves to being adaptable to all life circumstances because they will become "living spaces", not just transporters, and our digital lives will seamlessly migrate inside these new car interiors because they will provide versatility of interactions, all sustained by their ability to provide the same "always-on" digital connection while in motion. Upgrading individual components such as engines, electric battery power and other main engineering pieces will not just be more eco-friendly, but will offer improved bespoke approaches that customers will adopt with a deeper brand loyalty.

In the next ten years, cars will evolve to become what computers became in the 1990s: personal, multi-purpose, enablers, enhancers, providers of freedoms we are yet to comprehend, and above all this, digital spaces of human existence.

also allow the car to become aware of mental health issues by monitoring tonality, depth and other vocal signs of stress, change of mood and depression. Mental health is the 21st century cancer, and an increasing concern for governments who spend billions each year in addressing psychic dysfunctional behaviours and the effects of stress on alienated individuals. Sitting in our cars in the next ten years will allow us to perform basic stress level check-ups as well as set up automatic protocols for what should be done in the case of a driver emergency.

How IoT is taking logistics into the future

The IoT is revolutionising the way we move goods around the globe: sensors combined with machine learning, AI and blockchain seem to be some of the best ways to do things like cutting fuel consumption, improving efficiency and saving money and time.

Millions of tonnes of goods are shipped every day through a chain of coordinated and variable-dependent operations. Exact, real-time and smarter processed data can make every action smoother, reduce inefficient operations and support managers and operators in making the right decisions.

It has been estimated that by 2025, the IoT will have a potential economic impact on logistics of USD450 billion*. To see how, let's follow the journey of a cargo, from the arrival at the port through to home delivery.

* approximately 444 billion CHF and 421 billion EUR

Step one: The cargo reaches the port

Optimised space

A metre difference, even for gigantic cargo ships, can determine whether they will fit in the port or not. An intelligent cargo ship regularly transmits data to port operators, such as its exact measurements and real-time position within an accuracy of centimetres. This information then supports port managers in choosing the best area to reserve for the ship and the preferred route to reach it. This all means the port can dock more ships at the same time, and optimising its space becomes much easier.

Intelligent containers

New-generation containers can now continuously monitor the cold chain and immediately send an alert in case of any failure. The containers themselves send guaranteed documents to the port authority, allowing supervisors to decide whether to let the cargo in or alert the police. Information on the type of goods transported also helps port managers decide where to store them – for instance, dangerous materials should be isolated – and enables them to organise the unloading operations in advance.

Smarter loading/ unloading

Is the cargo on time and where is it going to land? Which vacant trucks are closer to the docking point and which one is most sensible to move? Port managers have to organise hundreds of interlinked operations, people and vehicles, so machine learning can prove a very useful tool. Artificial Intelligence fed by sensor data can support port managers in making the right decisions. Some of the processes can even be automated. Through data analysis, unnecessary or inefficient actions and movements can be reduced, thus resulting in a port that works more efficiently, with less costs and less emissions.

Blockchain-guaranteed documents

Control authorities, shipping companies and port operators can access, in real-time, the data related to both individual goods and the supply chain as a whole. Digital documents, verified and guaranteed by a blockchain system, contain information such as custom authorisations, current conditions of the cargo, shipping details and a list of the last checkpoints crossed. Those documents – updated in real-time, always available and easily accessible by authorised operators – allow companies to react more quickly to unforeseen events or itinerary changes. Last but not least, authority controls are faster and mistakes are less likely.

Step two: Goods are transported inland

Predictive maintenance

Connected trucks constantly collect data through intelligent sensors, monitoring the actual condition of components, material degradation and performances. Algorithms identify trends to predict when a failure is likely to occur, preventing unscheduled problems or automatically alerting maintenance teams.

Increased fuel efficiency

Sensors monitor a vehicle's acceleration, braking and other driving habits, so that intelligent apps can then be used to encourage optimised driver behaviours. Meanwhile, cameras in the vehicle estimate driver fatigue by analysing indicators such as the driver's pupil size, contributing to the prevention of accidents.

Better security

When transporting high-value, fragile or temperature-sensitive goods, the IoT can make a particular difference in increasing transport security and performance. Light and motion detectors trigger alarms when doors are opened and the temperature is constantly measured, with any interruption in the cold chain being immediately reported.

Step three: In the warehouse

Smart inventory management

Warehouse managers must constantly know the location of each pallet and its volume, dimensions, conditions, possible damages, and so on. Radio-Frequency Identification (RFID) chips can help to track packages in the warehouse and smart sensors can send information about temperature, humidity and such, eliminating time-consuming tasks such as manual measurement and counting. Data is sent directly to the Warehouse Management System, where AI then processes it to coordinate all the operations intelligently.

A safer warehouse

Smart tags warn operators in advance about the weight and size of packages, so that the most suitable transporting tools will be made available. Motion detectors also send alerts if boxes are in danger of falling, thus increasing the safety of the environment.

Step four: The last mile

Drone delivery

In some major cities, drone delivery is already being tested. Connected drones avoid traffic jams and deliver the right goods, with fewer errors.

Smart locks

By providing access to trusted third-party operators, smart locks make possible the delivery of parcels directly to your home, or even your parked car, while you are away. These systems make delivery more efficient and intelligent, optimising both time and routes.

Intelligent mailboxes

Sensors placed inside the mailbox warn operators when it's full, allowing the delivery to then be rescheduled, saving precious minutes: time is money! Sensors also monitor wetness and temperature, alerting recipients with notifications.

Source: https://www.reply.com/breed-reply/en/content/why-now-is-a-great-time-to-invest-in-iot

Oscar Vaquero: "There are two kinds of obstacles when adopting the IoT in logistics: technology and business organisation."

Oscar Vaquero Viñes is a developer, software architect and the IoT service lead at ERNI. In the following interview, he explains how a skilled IoT team can help a logistics company, as well as the challenges companies face when entering the IoT world.

Which sectors of the supply chain can benefit the most from the use of the IoT?

Potentially, each sector in the supply chain can become more efficient thanks to IoT solutions. Evidence from one of our projects showed a 95% increase in inventory efficiency, 30% decreased labour costs and 30% faster services. This is why more and more players in the logistics industry are focusing on this technology.

This technology is of importance to more than just the shipping companies, then?

That's right. Obviously shipping companies are the first beneficiaries that come to mind. Consumers & Sellers: For instance, IoT solutions can be applied to temperature-sensitive shipping such as vaccine delivery systems. Did you know that about 30% of vaccines are lost during transportation due to failures in the cold chain? The IoT can make a big difference in that.

However, using the maritime transport sector as an example other stakeholders must be mentioned. Shipbuilders, for example, are updating their fleets to provide real-time information, and new-generation containers or trucks are now being designed to send intelligent data that will help maintenance teams to predict maintenance and reduce downtime, consumption optimization and component degradation, among others.

Insurance companies are to be cited as well. One of their major concerns is how to verify that their insurance of goods is done correctly and according to the existing regulations. Finally, by digitising documents, port authorities can speed up paperwork and respond faster to changes in the schedule.

What kinds of solutions can a skilled IoT team offer to a company in the logistics sector?

Professional IoT teams can work with practically all the technologies and the enablers that make logistics more efficient.

Let's take the example of sensors: the IoT team can help a company to create sensor systems that measure location, temperature, humidity, position, light and movement of goods, to name a few. Then, they can set up the infrastructure that sends that data to the cloud or to the warehouse manager. Finally, experts can develop an AI system that helps the company to coordinate all the operations.

I would say that a solid IoT team can help a logistics operator from start to end, starting with sensors and ending with intelligent apps – the tools that make it possible for the company to effectively use the large amount of available data.

Can you give us some practical examples of IoT technologies that logistics companies can successfully adopt?

In the logistics sector, various companies have been working a good deal with Radio-Frequency Identification (RFID) stickers. The use of RFID has seen a gradual increase in the past decades, and is another example of enabling technology. These wireless microchips, attached to an object, emit radio waves which are read by a monitoring device. Concretely, placed on pallets, they track the movement upon arrival in the port or when leaving a warehouse.

You can see a special RFID technology: beacons. They are small radio transmitters using the Bluetooth standard. Compared to other RFID devices, beacons are cheaper, consume low amounts of power, the battery lasts longer and it is possible to power them with a small solar panel. Thanks to these characteristics, they can also be applied to single products or parcels, making information accessible via just a smartphone.

Connected vehicles are also often adopted in road logistics. Smart trucks, for example, help the driver to choose the optimal route, warn him in advance of possible mechanical failures and help managers to organise their fleet more efficiently.

What are the main challenges that companies must face in order to benefit from IoT?

I see two kinds of obstacles here: technology and business organisation.

Let's start with the one companies consider – wrongly, in my opinion – to be the most complex to overcome: technology. Companies already have their own tools and they often assume that they will have to buy everything again. I guess they think: "This is going to be expensive!" But that's not necessarily the case.

A skilled IoT team can help here too. They can take legacy technology – those devices that are considered outdated, or for one reason or another cannot be replaced – and connect and equip it with appropriate sensors. In short, experts can make legacy devices intelligent.

The second obstacle, conversely, is often underrated, even though it is the most challenging: company organisation. The IoT requires a new way of thinking; in other words, a paradigm shift within the companies. IT departments go from being merely a service to becoming one of the company's key hubs. It is here that data is provided, managed, analysed and made functional for the rest of the company. This usually implies the necessity to invest in skills that are often lacking.

So, it's a radical transformation from the old way of thinking about IT, and is no longer related only to computers, but rather to providing intelligence across the whole company.

Oscar Vaquero Viñes
oscar.vaquero@erni-espana.es
IoT service lead at ERNI, researching new technologies to resolve problems in the best possible way

IoT glossary

RFID STICKERS – Wireless chips or tags used to identify and track objects. They are quite similar to barcode labels; however, unlike barcodes these tags don't need to be within the line of sight of the reader, since they emit radio waves. Passive RFID have no internal power source and they are powered by the reader. Active RFID are battery-powered.

BEACONS – Special active RFID tags using Bluetooth standard. Compared to other types of active RFID, beacons are cheaper, consume low amounts of power and can be powered with a small solar panel. You can read a beacon with a smartphone or a tablet.

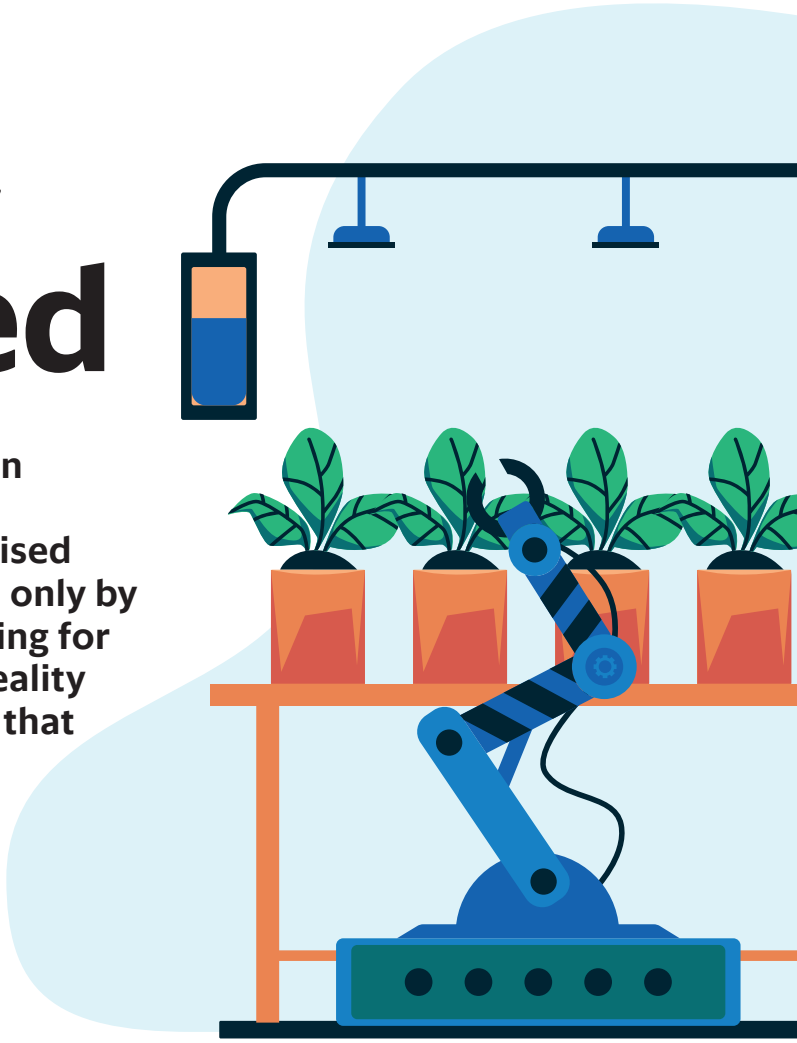
INTELLIGENT SENSORS – Sensor devices that are able to detect conditions and respond to them. These sensors understand the environment they are put into and they can manage a wide range of conditions, adapting themselves and self-validating data.

INTELLIGENT APPS – AI-enabled applications that use machine learning. The intelligence of the apps is derived from processing vast amounts of data and they have the ability to come to conclusions that are otherwise hidden to a human mind.

BLOCKCHAIN – Type of data structure that enables digital identification of the ownership of money and goods and digital tracking of transactions. Blockchain shares this information across a distributed network of computers, creating a distributed trust network that eliminates the need for trusted central authorities.

LEGACY TECHNOLOGY – Device or equipment that is outdated, obsolete or no longer in production. It can also refer to applications, platforms and programming languages that have been superseded by newer options.

Smart farming, explained



Thinking about technology within agriculture, many of us would instinctively imagine a dehumanised farm of endless fields populated only by robots. It could make a nice setting for a new sci-fi movie; however, in reality the IoT is a set of powerful tools that improve human ability.

A good farmer must have two virtues: precision and experience. The IoT boosts both of them.

On one hand, sensors improve accuracy and allow one to see what the human eye cannot, for instance – what happens 60 cm underground.

Machine learning and AI systems provide data, and expand the boundaries of a farmer's experience by providing helpful insights.

The story of the cherry tree

One of our colleagues at ERNI Spain once told us a story. He was a teenager, and in his village around Easter time, people used to celebrate together outside until late. One day, between midnight and 2am, something unusual happened: the temperature dropped significantly, by around 15 degrees, reaching almost zero degrees. The village was surrounded by large fields of cherry trees and, in the span of only two hours, the farmers in the area lost the entire year's yield. Just one farmer managed to save his cherries. He was kind of a geek, and had devised a rudimentary alarm to warn him of sudden temperature drops. That night the alarm had woken him up and, by lighting fires in his field, the farmer had raised the temperature and saved his precious cherries.

This story teaches us a lesson: it has always been vital for agriculture to have real-time data and systems capable of using that data intelligently. And we like to think that the memory of that night also inspired the future career of our Spanish colleague…

Let’s meet some smart farmers

Nathalie is an agronomist for a large apple company.
She recommended installing moisture sensors in the fields to check when it is really necessary to use fertilisers. These sensors send data to the AI-enabled irrigation system, which crosses the data with weather forecasts, and activates the sprinklers only when needed. The company has recorded remarkable savings in terms of water, fertiliser and energy usage, as well as increases in production.

Johan is a small cheese producer from the Alps. He is part of a cluster of local farmers, supported by the public administration with a territorial brand focusing on local, quality products. Each product is marked with a smart tag so that customers, using just their smartphones, can trace back to the farmer who produced it. The products now have an authentic story behind them.

An external certification body employs sensors to control the cheese quality at different stages of production. Thanks to the trust earned, the brand has now been able to increase the prices of the products.

Pedro is the CEO of a dairy company.
Last year, the company equipped each cow with various sensors. A necklace senses motion and temperature, monitoring the cow's eating habits. A pill inserted into the cow's rumen detects acid levels and highlights possible digestive problems, and a pedometer alerts the farmers if the cow has increased its pace – a typical sign that it has come into oestrus, the most appropriate time for insemination.

Through sensing and processed data, farmers can now detect any health problem in advance, act promptly with appropriate therapy and prevent the spread of diseases in the rest of the herd. The last company report highlighted increases in milk yield and reduced medical treatment costs.

Benefits of smart farming:

- Less waste of water, energy and other resources such as fertiliser
- Less pesticides and drugs
- Better control in the supply chain
- Better products: higher quality or quantity

ERNI .experience

How to take an old silo, and make it smart

The real case pictured here is based on an architectural project realised for a leader in the security, testing, verification and certification area.

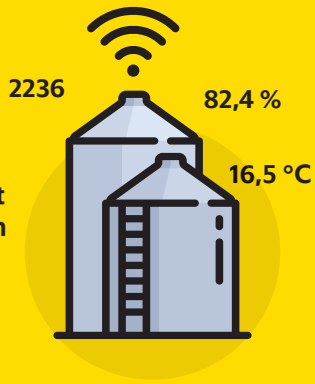
Look at this silo.

It doesn't seem particularly intelligent, but you know… it gets its work done: it loads grain in, it stores it, and then it offloads it.

The problem, however, is that the silo is not very communicative.

The farmer must be there when the grain is loaded in, to ensure that the parameters are the right ones to prevent seed germination and deterioration. But it's not just at this point he must be present: the farmer must return to the silo from time to time to check if everything is ok.

Sometimes the farmer arrives too late, and in those instances, well, he's just lost a lot of money!



So, the farmer decides to do something about that silo, which is when he comes to meet us.

We advise to put various sensors on the silo, measuring moisture and temperature in real-time.

If something goes wrong, an alarm will warn the farmer.

The farmer is happy enough, but we think the silo could do more. We connect the silo to some software.

The software considers actual temperature, moisture and grain variety and adjusts the cooling of the silo to prevent seed germination. The silo now works all alone, without the intervention of the farmer, who can now focus on other activities.

Our job is done. The silo looks much more intelligent now, doesn't it?

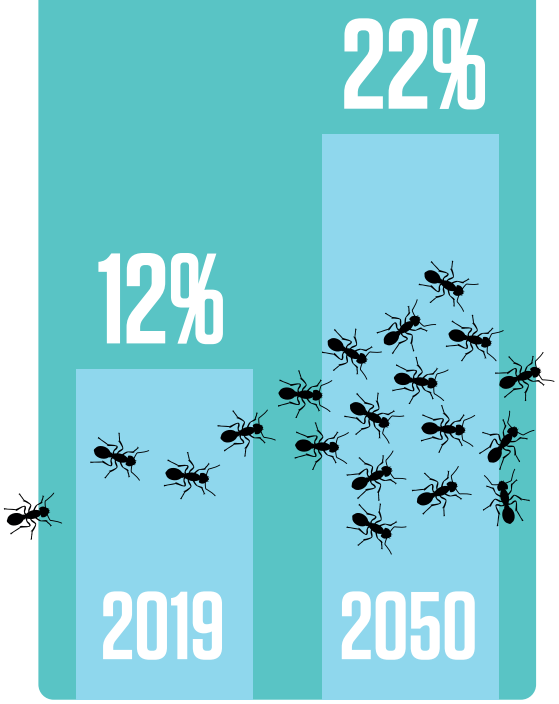
Business Briefing

B Medicine technology for the ageing population

Demographic forecasts show that we face numerous challenges not only with social policy-making but also at an individual level. Various solutions have been proposed, some more fitting than others, to work towards ensuring better lives for the ageing population. So how can medical technology help us live better lives?

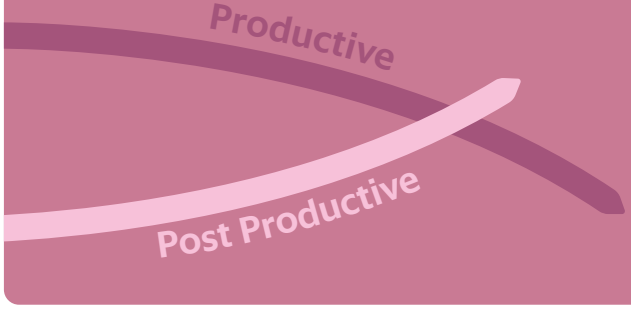
THE WORLD'S POPULATION IS AGEING. THERE WILL BE MORE OF US, AND WE WILL BE OLDER

By 2050, the proportion of people aged over 60 in the world's population will nearly double, from 12% to 22%.



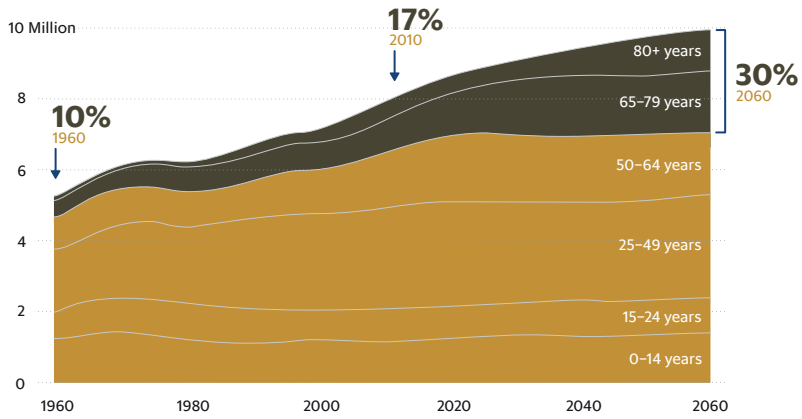
By 2020, there will be more people aged over 60 than under 5.

Life expectancy has increased and birth rates have started to decline. People of a working age will soon be outnumbered by those who are economically unproductive.



IN 2050, 80% OF OLDER PEOPLE WILL BE LIVING IN LOW – AND MIDDLE-INCOME COUNTRIES

Swiss population by age group, 1960–2060



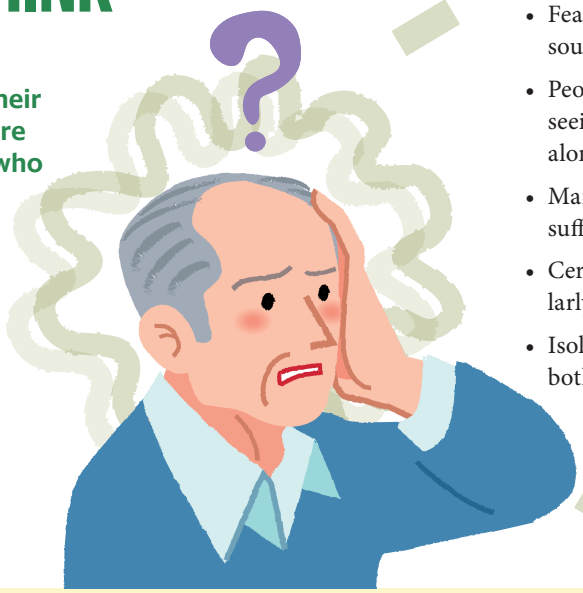
Source: OECD Economic Surveys: Switzerland 2019

POPULATION AGEING WILL INTESIFY IN SWITZERLAND

In Switzerland, retiring baby boomers and rising life expectancy will lift the share of the population aged 65 or over to almost 30% by the 2050s – a faster rate of ageing than most OECD countries. The share of people over 80 will double by 2045 to 10%.

THE FUTURE IS FASTER THAN YOU THINK

Countries will face major challenges to ensure that their health and social systems are ready. But it's also seniors who face challenges.



Many who work with older people have observed that social isolation and the feeling of loneliness are common problems for older people:

- Fear of being alone is a major source of anxiety.
- People who go for days without seeing another person may die alone.
- Many in deprived inner-city areas suffer severe loneliness.
- Certain ethnic groups are particularly vulnerable.
- Isolation and loneliness can damage both mental and physical health.

Source for pages 26-27: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

WHAT DO SMARTER SOLUTIONS LOOK LIKE?

Keeping tabs on the elderly through IoT

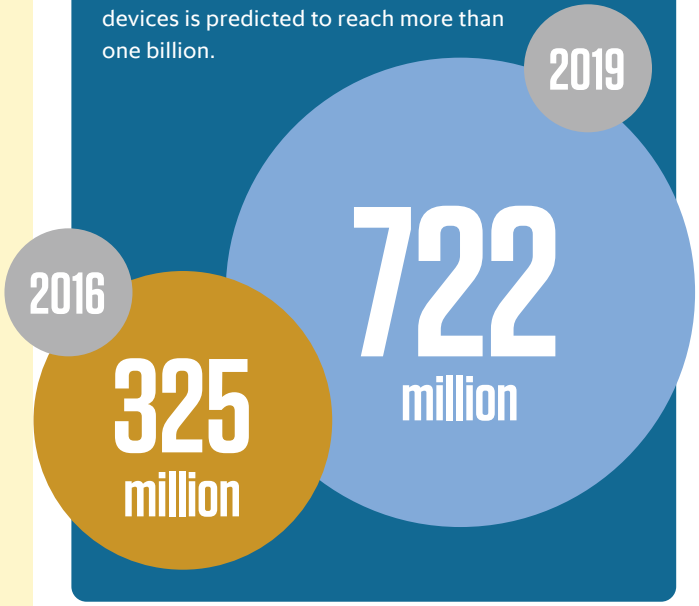
In developed countries, most elderly people live on their own, and checking up on our older relatives is becoming an increasingly less-manageable thing. Technologies that remotely monitor emergency systems and medication control are able to help us improve the care, as well as the emotional and physical well-being of seniors.

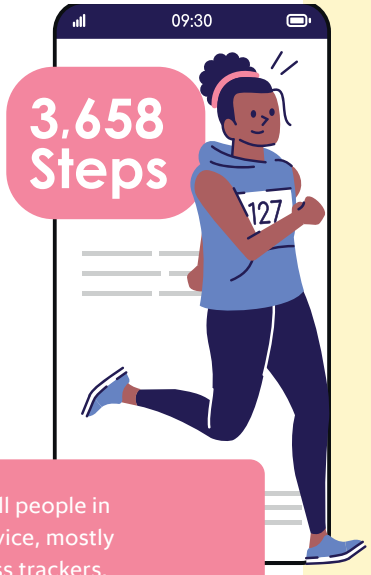
IoT medical technologies include:

- GPS tracking
- falling detection
- monitoring heart rate
- monitoring blood pressure
- medical reminders
- sedentarism management

The IoT can improve the quality of life of the ageing population, but it can serve other purposes too

Activity trackers and other smart electronic devices have been widely used for many years now. The number of connected wearable devices worldwide has more than doubled in the space of three years. By 2022, the number of devices is predicted to reach more than one billion.





49%

In 2018, 49 % – almost half of all people in the US – owned a wearable device, mostly represented by fitness/wellness trackers.

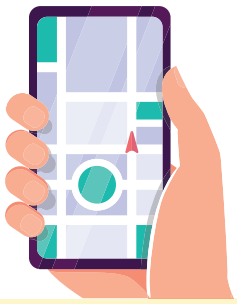
WEARABLE TRENDS

01

Thermometric pulses to heat, cool and soothe your body via a bracelet that senses temperature, pain and stress.

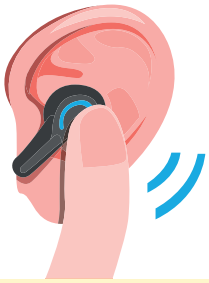
02

The ability to track your child's health, safety or location via wearables.



03

Name-recognition earbuds that feed you a person's basic bio when someone reintroduces him or herself.



04

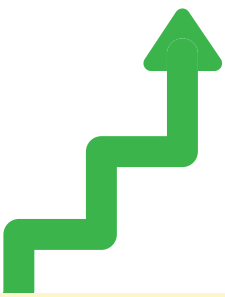
Safe-driver insurance discounts based on wearable technology.

05

Mood-monitoring headphones to select your streaming music line-up.

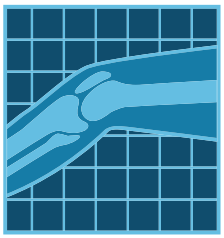
06

Rewards for productivity improvements based on employer-monitor wearables.



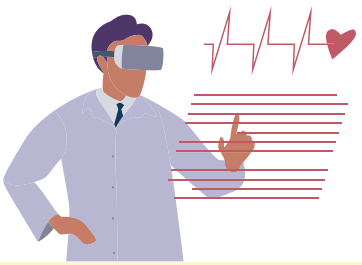
07

Simpler visualisation of the health conditions which can lead to greater motivation to live a healthy lifestyle.



08

Use of preventive action – doctors won't have to rely solely on their experience, but will be able to use computer-assisted diagnosis.



Source: https://www.un.org/en/development/desa/population/index.asp

Dust Measurement: Case study

As part of an ERNI Community project, we have developed an idea of building an IoT sensor network. In this Case Study we explain how we proceeded and further developed the initial idea.

Initial situation

One of our first goals was to come up with a rough architecture for our dust measurement network. The design needed to support modularity and be broad enough to allow easy extensibility, yet remain minimal enough to fit in the MVP scope and budget. The architecture had to be as broad as necessary, yet as narrow as possible.

Proceedings

As before, during the product vision workshop, we first went through a discovery phase in which we looked at the full product vision and identified the components and aspects that would be necessary to fulfil the whole scope. These were reduced to their essence during the design phase. We analysed the core architecture of our design and identified those elements that were necessary to fit the scope and budget of the MVP. The architecture had to be as broad as necessary, yet as narrow as possible. We followed the SOLID open/closed principle: the architecture should be open to extension, whilst we should not need to change components when we increase the product scope.

The dust measurement network consists of an IoT device that measures particulate matter. The device is connected to a cloud service through The Things Network (TTN). The raw measurements are aggregated on our backend with weather data. A prediction service using a model created with Machine Learning generates pollution forecasts. The actual and predicted pollution levels are rendered on a map in the browser.

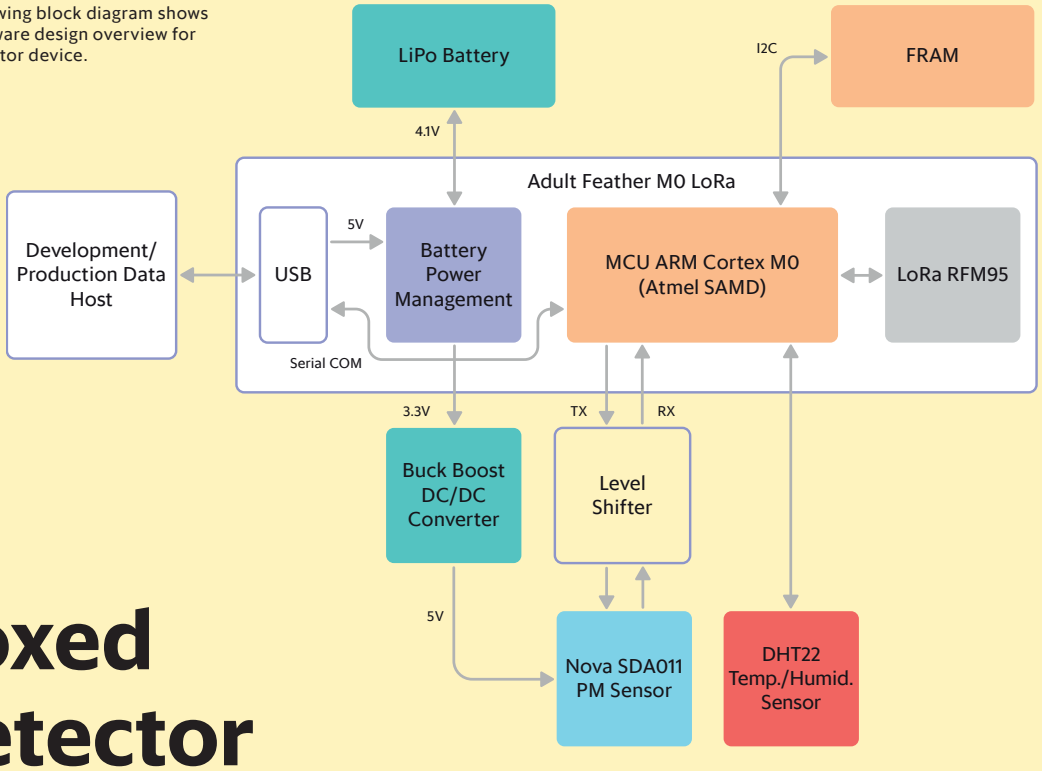
The detector hardware is built with a microcontroller (MCU) and a particulate matter (PM) sensor. The detector device also measures the ambient temperature and the relative humidity. All these sensor data is sent to a time series database (InfluxDB) over an IoT network. It is important to choose a low-power radio frequency network, so the detector can be deployed independently and with minimal maintenance. With LoRaWAN we get good network coverage and low power consumption.

In order to measure the air quality at any point, we needed a battery-powered device with a sensor that is affordable while proven to be accurate enough for our endeavour. Looking at projects with similar purposes (such as luftdaten.info), we learned that Nova's SDS 011 fit quite well. It has a serial interface and easily connects to a microcontroller UART.

We chose Adafruit's Feather M0 LoRa as the MCU (Microcontroller Unit) because this module combines a LiPo (Lithium Polymer) battery charger, a LoRa RFM (radio frequency module) and a decently performant CPU core (ARM Cortex-M0) in a design with low power consumption.

Device-specific security keys and configuration data must be kept in a non-volatile memory, so that the data is still available after a device restart. We added FRAM (ferroelectric random-access memory) to the design to cover this requirement.

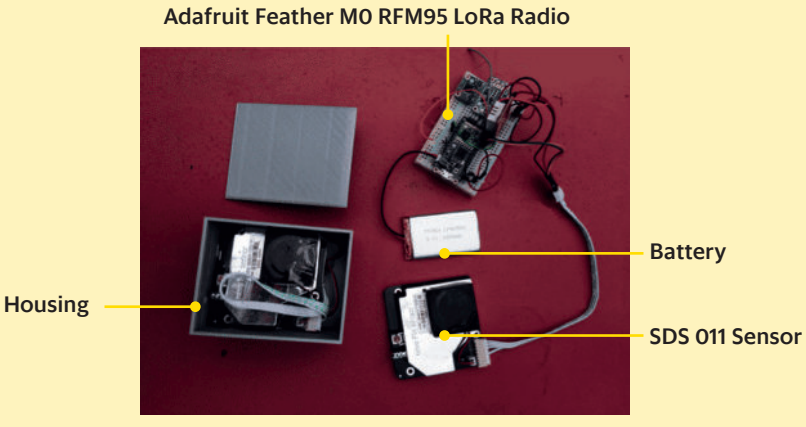
The following block diagram shows the hardware design overview for the detector device.

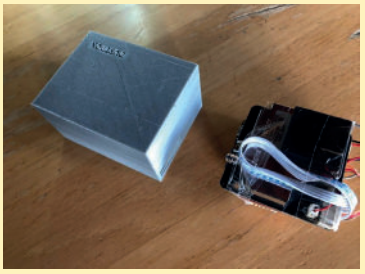


Boxed Detector

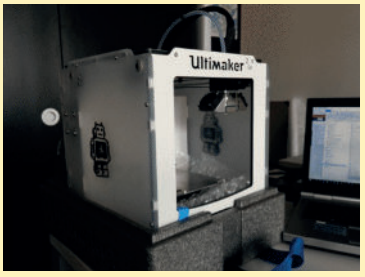
The detector device needed to be placed outside and withstand any kind of weather. The housing was required to provide protection against intrusion according to IP44 (avoid foreign solid substances ≥ 1mm and splashing water from entering).

The first housing prototype needed to just enclose the hardware and protect the electronics against impact. Holes were made to provide space for the Micro USB connector that would be plugged into the device in order to charge the battery, to update the latest firmware, to access debug console and to load security key data during device production. Another hole provided the dust measurement air intake of the sensor. The last opening was added to act as the sensor's air exhaust.



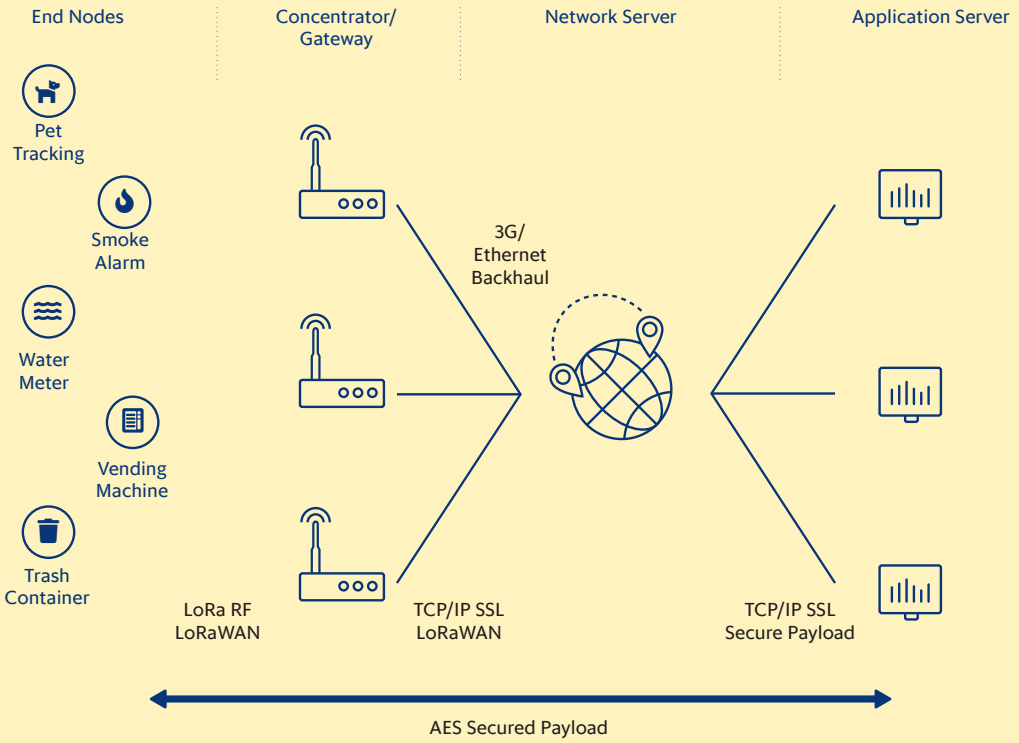


The detector device needed to be placed outside and withstand any kind of weather.



The prototype housing was designed and 3D printed by a portable 3D printer during the Hack & Hike weekend.

The network topology has 4 components: end notes, gateways, network server, and application server. The following figure illustrates the network topology of The Things Network.



The Things Network

The Things Network (TTN) is an open community-driven network that enables its members to deploy their own LoRaWAN-based IoT applications. Its architecture is built on the LoRaWAN standard, which is defined by the LoRa Alliance, of which TTN is also an active member. LoRaWAN is a media access control (MAC) protocol for wide area networks. It is designed to allow low-powered devices to communicate with internet-connected applications over long-range wireless connections. In most cases, LoRaWAN uses LoRa modulation. LoRa modulation is based on Chirp spread-spectrum technology, which makes it work well with channel noise, multipath fading and the Doppler effect, even at low power. The LoRa Radio Frequency link operates in an ISM band (i.e. in Europe between 863 MHz and 870 MHz).

The end nodes are the “things”. Our detector is such a node. The end nodes can send data packets through the LoRa Radio Frequency uplink channel randomly at any time. The packets are received by the gateways within radio link range. The same packets can be captured by multiple gateways at the same time. The duty cycle with which an end node sends packets shall not exceed 1% to ensure fair radio frequency channel usage.

The gateways receive the data packets from the nodes and send them to the TTN Network Server. The more gateways are available near the area where the nodes are located, the better the network coverage will be. If a spot of interest does not support any coverage, any TTN Community member is able to add a gateway. This enables not only the owner of the new gateway to access the network but also adds more TTN coverage for all community members.

The Network Server routes messages from the nodes to the right application. The Application Server provides the bridge to the user’s cloud application. The messages are handled by an MQTT broker, to which the application will be subscribed.

TICK in the Cloud

We chose to use the TICK stack as our cloud application. The TICK stack is a time series platform that is designed to handle metrics and events. It consists of four independent systems that can work in concert with each other.

For our purpose, we used the time series database InfluxDB. It is capable of storing large amounts of time-stamped data coming from our detector though The Things Network. It has a built-in HTTP API to which our TTN gateway connects. It is hosted in a Docker container so that it can be easily deployed in any cloud environment.

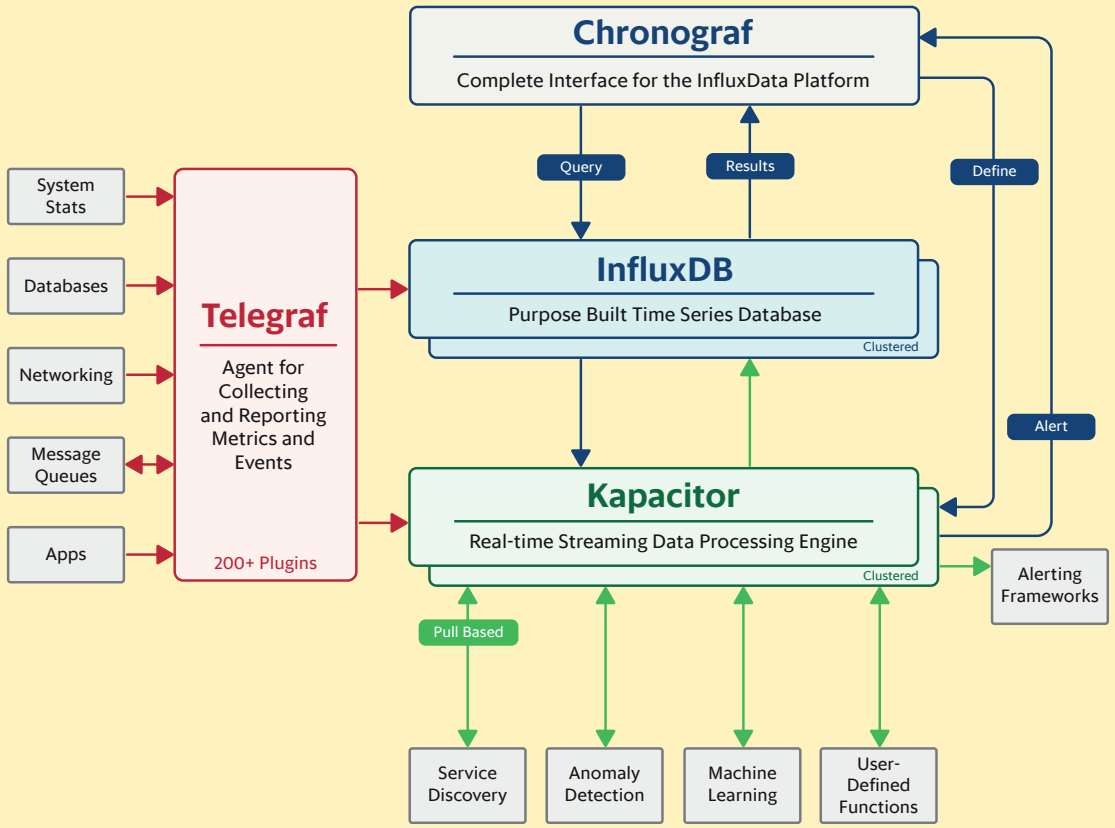
The TICK Stack is a loosely coupled yet tightly integrated set of open source projects designed to support your metrics analysis needs. It has four components:

Telegraf - a plugin-driven server agent for collecting and reporting metrics

InfluxDB - built from the ground up to handle high write and query loads, it is a custom high-performance datastore written specifically for time-stamped data

Chronograf - the administrative user interface and visualisation engine of the stack

Kapacitor - a native data processing engine that can process both stream and batch data from InfluxDB



Source: www.influxdata.com/time-series-platform/

Pedro Mier
President of AMETIC
and member of the board
of DigitalEurope

Creating opportunities with creativity and imagination

Who is Pedro Mier? President of AMETIC (the Association of Electronics, Information and Communications Technologies, Telecommunications and Digital Content Companies) and member of the board of DigitalEurope, with over 30 years' experience as an innovative entrepreneur in high-tech sectors. His current interest is focused on supporting the growth of companies with highly innovative content and growth potential.

What is DigitalEurope?

DigitalEurope is a European organisation that represents the digital technology industry, and whose members include 70 global technology corporations and 40 national associations.

It works to promote industry participation in the development and implementation of European Union policies and has several working groups that focus on different aspects of technological, commercial, technical and regulatory policy and the digital economy.

Its main objectives are to support its partners in their development and compliance with the Digital Manifesto, which is a proposal focused on 2025 goals, in which the main drivers are sustainability, maintenance, future and innovation. The main objectives of the Digital Manifesto include the following:

- A social and inclusive Europe that promotes participation and builds trust
- An innovative and sustainable Europe that provides benefits to society as a whole and invests in the future of new generations
- A united and strong Europe that reflects European values and plays a relevant role in the global economy

What are the most important challenges Europe faces in accelerating digital transformation?

There are many, and all of them are important. Training and availability of talent – both attracting new talent and developing existing talent, at all levels. A unique digital market is vital to be able to compete with other world powers. Innovation is very important to expand the effort since there are very powerful countries that invest around 4% of their GDP. However, it is important to not just invest but to invest well: to break the famous European paradox that scientific production, which is very good and punctual in Europe, reaches companies and improves co-creation mechanisms. At AMETIC and DigitalEurope, we support the importance of mission-centred innovation. It is important to have focused projects and programmes that serve to boost and develop the country. In Spain, four lines have been proposed: sustainable mobility, e-health, digital tourism and Smart Agro (the technification of agricultural production and the transformation of the food industry). And last but not least, the challenge of data security also needs to be considered.

"The role of civil society and of business associations as a part of that, which will have to modernise and adapt to the world we live in, is very important in advanced societies."

What impact does DigitalEurope see the IoT having?

The IoT will allow us to have a lot of data about everything. It will bring us obvious things that are already being worked on, such as the connected industry, intelligent and sustainable mobility or personalised medical treatments... but I am certain that many more applications are going to emerge that we are not yet aware of because we will have access to so much data, and from there the creativity and imagination are endless and can generate new opportunities and challenges.

But we must consider whether the data is being used for good or for bad, and here we confront the great issue of ethics; the question of proper use of data in every way, from ownership to good or bad use. It is one of the elements in which we think that Europe can play an essential role; it can become a world standard, with everything that implies, not just for the benefit of society but for the business itself or the guidance of the business from where it was generated.

What policy or regulation does the European Union need to implement to safeguard public security and privacy?

It's a huge challenge. Clearly, Europe is ahead and can take a very important and relevant strategic front for its role on the world stage. The initiatives in both the USA and China right now are much more focused on economic performance and efficiency. For example, Europe has already demonstrated with the data protection regulations that it goes one step further in terms of social sensitivity towards these kinds of issues. If Europe sticks to that strategic approach, which it surely will, more initiatives for the protection of people and society itself will follow. This, in turn, will generate standards, regulations and opportunities for capacity development and the development of businesses, systems and products to defend and protect those values.

Can DigitalEurope influence the digital policies defined in the European Union?

Yes, of course, it can and it does. The proposals of DigitalEurope are presented in the European Commission and the European Parliament. One of our main functions, both at the European level in DigitalEurope and the national level in AMETIC, is to influence policy towards regulations that favour the sector that we represent.

What do you think will be the trends in the field of digital transformation in the coming years?

The emergence of a new industry geared towards the conservation of the planet, and the issues of ethics and security will be the most important drivers in the coming years.

Sustainability will also move to another level. Right now we are still in a world of circularity – of the circular economy, of recovery, of optimal use of resources – but I think a new industry, oriented towards the conservation of the planet, is already beginning to emerge and will continue to develop strongly, opening many opportunities in the world of digitalisation.

Sustainable development: How the IoT can help us transform our future

In 2015, the United Nations member states set 17 ambitious goals to be accomplished by 2030 for a more equal, greener and more prosperous world. The so-called Sustainable Development Goals address, among other things, poverty eradication, access for all to basic resources such as food, water and energy, the fight against climate change, equal opportunities and the possibility for every person on the planet to live healthier lives, in cleaner and more inclusive communities.

It's a call to action for everyone: citizens, governments, businesses and civil society, and technology – as always in the history of mankind – has a relevant role to play.

An enabling technology such as the Internet of Things (IoT) is increasingly getting more reliable and pervasive. Costs of basic IoT applications are becoming more affordable for everyone, and people in the developing world now have better access to 2G cellular network coverage than they do to basic services like electricity, sanitation and clean water. IoT technologies, from the simplest to the most complex, can empower people to transform the world and make it a better, fairer place for everyone. It's a huge interconnected maze where everyone has the potential to contribute with their own piece of the puzzle.

Out of the 17 UN Sustainable Development Goals, we have focused on five, to see how IoT deployment can help.

United Nations: Sustainable Development Goals

In 2015, United Nations member states adopted the 2030 Agenda for Sustainable Development to improve prosperity and retain peace for people and the planet. You can find all 17 goals listed below:

1 No poverty	2 Zero hunger	3 Good health and well-being
4 Quality education	5 Gender equality	6 Clean water and sanitation
7 Affordable and clean energy	8 Decent work and economic growth	9 Industry, innovation and infrastructure
10 Reduced inequalities	11 Sustainable cities and communities	12 Responsible consumption and production
13 Climate action	14 Life below water	15 Life on land
16 Peace, justice and strong institutions	17 Partnerships for the goals	

1 No poverty

10% of the world's population still live in extreme poverty and are struggling to fulfil the most basic needs such as health, education and access to water and sanitation, to name just a few.

Poverty has many dimensions. Its causes include unemployment, social exclusion and high vulnerability of certain populations to disasters, diseases and other phenomena, which in turn prevent them from being economically productive. To tackle poverty's root causes, the UN adopted a detailed list of specific targets. The UN member states committed, among other things, to building resilience for the poor and those in vulnerable situations, and to reducing their exposure to extreme climate-related events and environmental shocks or disasters. IoT technologies can't stop disasters from happening, but they can help to mitigate their impact, especially in countries with poor infrastructure.

Each of us is called on, as well, to help ensure that all men and women have equal rights in terms of economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services. The IoT and its decentralising features make financial services cheaper and more accessible to everyone, empowering people and promoting economic growth in developing countries.

Early warning system

Moisture sensors located in areas prone to wildfires can provide valuable data for AI-based prediction models. Sensor data is matched with meteorological data and historical sequences and, in case of high risk, the system alerts the local population, allowing them to start evacuation procedures in advance.

Blockchain microfinance

Blockchain technology eliminates the need for a centralised bank or control system, thus reducing operational costs and rates of interest for small businesses and farmers who benefit from microcredit. People in developing countries can have easier access to loans and other financial services. Trust can be built via a blockchain-enabled digital identity.

2 Zero hunger

It is time to rethink how we grow, share and consume our food. If done right, agriculture, forestry and fisheries can provide nutritious food for all and generate decent incomes, while also supporting people-centred rural developments and protecting the environment.

Investments in agriculture are crucial to increasing the capacity for agricultural productivity, and sustainable food production systems are necessary to help alleviate the perils of hunger. The IoT can support agriculture both in boosting yields and in using resources in a more efficient way.

Reducing water consumption in farms

Connected items through the IoT, such as sensors measuring soil moisture near the plants, weather stations and valves controlling the dispensing of water, can utilise this combined data knowledge to only activate watering if needed, and when rain is not expected. All over China, India and Africa, farmers are starting to use smart solutions, saving important amounts of water.

6

Clean water and sanitation

Clean, accessible water for all is an essential part of the world we want to live in and there is sufficient fresh water on the planet to achieve this. One of the UN's targets is to improve water quality by lowering pollution, eliminating dumping and minimising the release of hazardous chemicals and materials. There is also a strong need for increasing water-use efficiency to substantially reduce the number of people suffering from water scarcity. Thanks to the IoT, water management systems can be more efficient and thus prevent or minimise the impacts of future droughts. IoT-based low-cost kits simplify water quality monitoring in remote areas.

Hazardous chemicals detection

In Bangladesh, wireless sensors have been installed in recent years to detect arsenic levels in water and prevent severe contamination. Sensors integrated in wireless devices are located in key points of the distribution network and also measure relevant water quality parameters such as acidity, nitrates and dissolved oxygen.

Prompt leakage detection

Cost-effective water flow monitoring systems – enabled by the IoT – trigger immediate reaction to the smallest leaks before they become a bigger problem. Water and moisture sensors located outside the pipeline send an alert signal as soon as a leakage is detected, meaning that the relevant network sector is immediately and automatically shut down so that further damage can be reduced.

Predicting water consumption and droughts

Drought and water scarcity are one of the challenges that an increasing number of cities in the world face today. Digital replicas of water networks connected through sensors (the so-called digital twins) can help in monitoring flow, evaluating available resources, predicting consumption and finally, in finding the most effective water-flow solutions through AI.

Preventive maintenance in rural areas

The IoT enables affordable predictive maintenance of pumps, distribution networks and storage cisterns, shortening the time needed to repair damages or avoid malfunctions. This has a direct impact on the access to clean potable water for the rural population.

7

Affordable and clean energy

Energy is central to nearly every major challenge and opportunity the world faces today. We should guarantee universal access to energy, increase energy efficiency and increase the use of renewable energy to create more sustainable and inclusive communities and challenge climate change.

Complex IoT technologies – like smart grids – can help cities and territories to manage energy production and consumption, and integrate renewable energy into end-use applications in buildings, transport and industry.

Smart grids

Smart grids are electricity networks of the new generation. Based on digital technology, they allow the exchange of not only electricity but also information about consumption and production. Traditional electricity networks go one way: the energy flows from a centralised power plant into homes, offices and factories. In smart grids, information on energy consumption is gathered from consumers so that the network tunes itself to an optimal state of performance and delivers electricity evenly. In other words, smart grids are a powerful tool in fighting energy waste and reducing carbon emissions.

Smart grids also introduce decentralised power plants into the network: local renewable energy sources integrated in buildings and factories – such as photovoltaic cells or small hydroelectric generators – that produce clean energy, and add it to the network as needed.

Reducing energy consumption in manufacturing

The industrial sector is one of the highest energy users, accounting for 54% of global delivered electricity. Thanks to the industrial IoT, energy managers are able to predict the energy demand and to optimise future energy consumption. Sensors monitor real-time energy output so that human operators, supported by prediction models, can determine when power should be on and when the factory can potentially power down and conserve energy.

11

Sustainable cities and communities

Cities are hubs for ideas, commerce, culture, science, productivity, social development and much more. At their best, they have enabled people to advance socially and economically. With the number of people living within cities projected to rise to 5 billion by 2030, it's important that efficient urban planning and management practices are in place. Rapid urbanisation brings challenges, such as lowering traffic congestion and pollution, reducing energy consumption and correctly managing solid waste – all of which can be tackled by smart administrators supported by IoT solutions.

Shared autonomous vehicles

IoT-enabled complex technologies like autonomous vehicles can help future cities in reducing traffic congestion and pollution in urban areas. Autonomous cars arrive on demand like a taxi, called via app. Using AI, the system will drive the nearest available vehicle to the requester's location. For inter-urban journeys, multiple vehicles are joined to create virtual trains that run on high-speed tracks to enable comfortable yet efficient transport. As needed, the vehicles disconnect from the train and take an individual route. Motorways are relieved from increasing traffic and the potential for traffic jams is minimised, while fewer parking spaces are also needed overall.

Efficient street lighting to reduce energy consumption

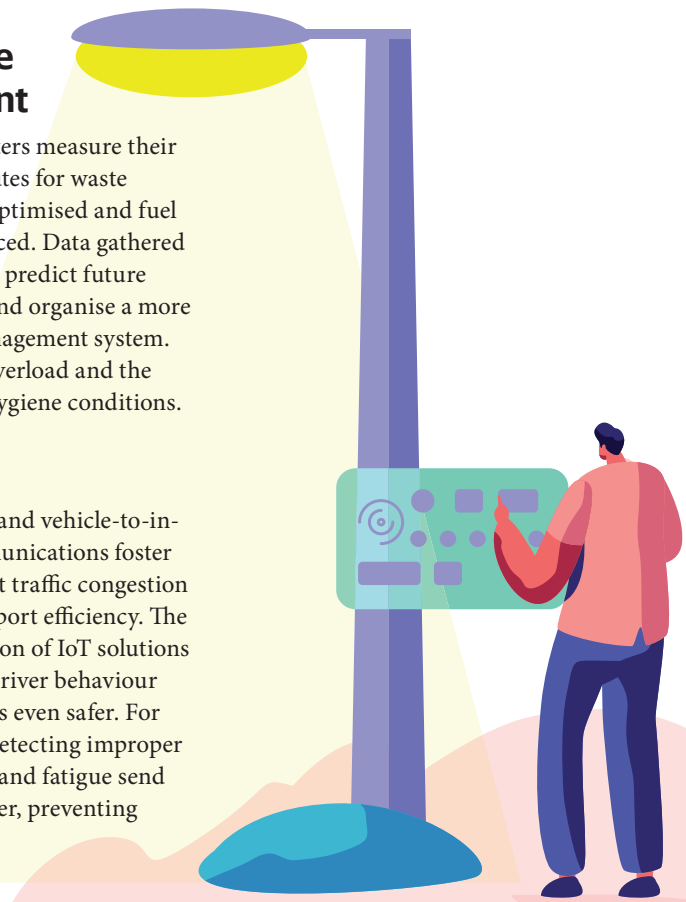
Public street lighting adapts to the movement of pedestrians, cyclists and cars. Lighting dims when no activity is detected and brightens when movement is sensed, saving energy by smartly reducing light intensity when none is needed.

Smart waste management

Sensors on dumpsters measure their fill level so that routes for waste collection can be optimised and fuel consumption reduced. Data gathered can also be used to predict future waste generation and organise a more efficient waste management system. This can prevent overload and the consequent poor hygiene conditions.

Safer roads

Vehicle-to-vehicle and vehicle-to-infrastructure communications foster road safety, prevent traffic congestion and increase transport efficiency. The right implementation of IoT solutions can also improve driver behaviour and make the roads even safer. For instance, sensors detecting improper driving behaviour and fatigue send an alert to the driver, preventing accidents.



3 colleagues and their opinion on the IoT

The IoT World Congress is the largest IoT event in the world, dedicated to helping increase productivity via disruptive technology. The ERNI engineers who attended the congress summarise their opinions and concerns regarding IoT deployment and development over the next few years.

Oscar Vaquero Viñes
Principal consultant in .net, and IoT competence centre lead

Data monetisation

Up until now we haven't had control over our personal data. The chances are high that in a couple of years we will be able to get paid thanks to the data we generate, let's say at home, and then sell. Every week we're getting closer to people having greater ownership of their data, compared to what we had two or three years ago. We have the possibility to make Google forget about us as we gradually return the ownership to people, not to other companies. With the increasing ownership, we're gaining more power and a new way to earn money.

Data transfer

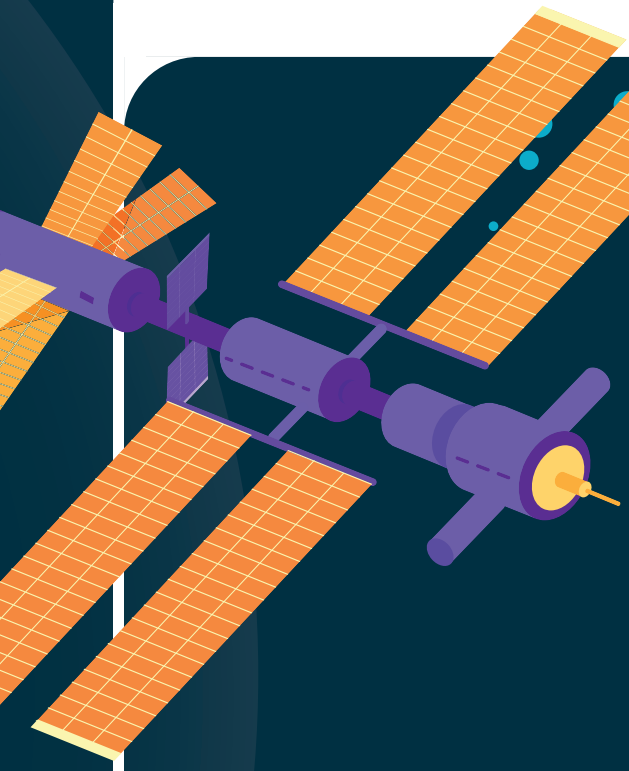
Implementation of IoT technologies to remote places where the Internet isn't fully reliable often becomes an impediment. The 5G network is seen by many as a miraculous thing able to solve all issues, but I don't see remote areas having the 5G connection any time soon. The penetration to the countryside will be rather difficult as we do not have the technology fully developed yet. Currently we aim to solve the data transfer issue by getting (artificial) intelligence closer to the device, hence reducing the amount of data which we transmit.

The logistics sector

Controlling the status of predictive maintenance within the logistics arena will become more common in the following years, even though this sector is a big challenge to manage. More and more security systems will be made of smart locks and real-time monitoring to keep an eye on the containers. The intelligent stickers on the transported goods will display the date of the warranty, sensors will make sure that no broken trucks are being transported and we will also be able to get all data out of the cold chain.

Turnkey solutions

A company that can offer, as we do in ERNI, a turnkey solution from the sensor to the app, is a company that will succeed. Big factories call for a single company to do an entire job, rather than asking one company to do the software and another one the wiring. Before, basic IT services were just about installing the computer, fixing the printer and managing the network. Nowadays, the engineering department and the IT department will have to be merged in order to give real value to a company.



Iván Bargalló Vaca
Web developer and blockchain enthusiast

Digitalisation of big enterprises

Companies need to make big investments into digitalisation to catch up with the competition, but such investments need many years to be able to generate a return on the investment. The problem established industries have is that they are often not very flexible and cannot react to current developments that swiftly. And even though their investments don't generate the results they want, they have to keep investing in digitalisation to avoid being eaten by bigger players. Just look at this indicator – we're in 2020, and a huge number of big factories use only Excel to work with their data. I believe that in ten years, companies will use and manage data in a much smarter way.

Data transfer
One of the main concerns of people working in blockchain companies is the regularisation of everything. For example, Spain issued a law saying that the public institutions cannot have servers outside of Europe. Since you're working with blockchains, this becomes a problem because you are connecting everyone everywhere. Such laws give companies insecurity about what to do, and until there are clear regulations, we're going to see many no-go's for technology development.

Data ownership
Within about five to ten years, ownership of data is going to become a regular thing. We will be owners of our own digital identity, and able to sell it to other companies for marketing purposes.

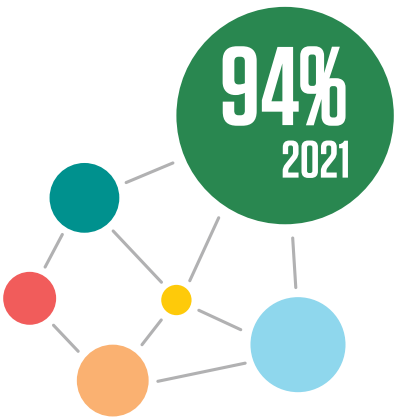
Skills
A lot of companies want to deploy the IoT within their factories, but don't really know where or how to do it. The roadblocks are often the same: complexity and technical challenges, security concerns and lack of knowledge and training.

Miguel Molina
Senior fullstack developer, tech enthusiast

Affordability
IoT technologies are becoming less and less expensive. A few years ago, making your home smart or having your own alarm system could cost you thousands. Now, it's just hundreds and I believe the price will continue dropping. We do have many IoT devices, but we're still far from making them a casual part of our daily lives. On the business side, companies do invest a lot into IoT, but they don't have a deep understanding of how to use the technologies effectively. Eventually, year after year, everything will gradually become more and more connected.

Cognitive services
The future of cognitive services lies with incorporating capabilities and intelligence straight into devices and not to the cloud. This is something that has already changed, and makes devices faster than before because the connection is not needed. In the automotive sector, cars are able to recognise sentiments now, but it's still very difficult for them to identify real feelings based only on one's facial expression.

IoT in numbers



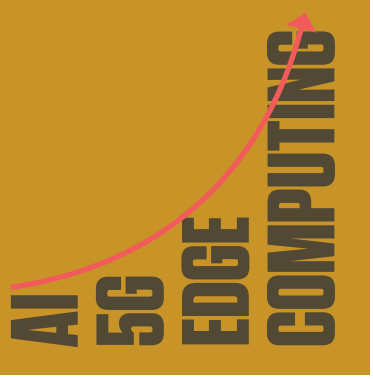
IoT growth shows no signs of slowing. According to Microsoft Azure's IoT Signals Report, the adoption is projected to increase by 9 points over the next two years, meaning 94% of businesses will be using the IoT by the end of 2021.

IoT adoption takes time. The average time in which companies have been able to successfully move from learn–trial–purchase into the "use" phase is 11 months.

85% of IoT decision makers say they have at least one IoT project in either the learning, proof of concept, purchase or use phase.

Nearly all decision makers are satisfied with IoT technology, most likely because they believe it has a strong return on investment (ROI), with the general expectation being that they will see a 30% ROI within two years, inclusive of cost savings and efficiencies.

COMPANIES BELIEVE THAT BY 2022, AI, EDGE COMPUTING AND 5G WILL BE CRITICAL TECHNOLOGICAL DRIVERS FOR IOT SUCCESS AND WILL DRIVE THE MARKET FORWARD.



Reasons behind IoT adoption

On average, the key motivators behind companies adopting the IoT are efficiency and productivity. Apart from the top reasons shown in the figure below, 30% to 40% of enterprise companies also adopt the IoT to manage supply chain, assure quality, track assets and enable sales.

OPERATIONS OPTIMISATION

56%

Especially important for: Japan

EMPLOYEE PRODUCTIVITY

47%

Especially important for: Retail/Wholesale

SAFETY AND SECURITY

44%

Especially important for: Government; the US

SUPPLY CHAIN MANAGEMENT

40%

Especially important for: Retail/Wholesale and manufacturing; China

QUALITY ASSURANCE

40%

Especially important for: Manufacturing and healthcare; Germany and the US

IoT technologies to have on your radar

What are the software and hardware technologies to watch, evaluate, and perhaps even deploy when working in IoT-type environments? Have a look at the most promising technologies that are relevant to IoT projects around the globe.

IoT software

Cloud computing
Using a network of remote servers to store, manage and process data.

IoT-based streaming analytics
Real-time processing of streaming of data from IoT devices back to a remote cloud.

Containers
Containers are processes with their own virtual resources and file systems.

Digital twins
Digital representations of physical assets, processes, systems and devices.

IoT security platforms
Platforms offering security solutions for any IoT device class.

Serverless / FaaS
Developing, running and managing application functionalities, without the complexity of building and maintaining the infrastructure associated with developing and launching an application.

Edge analytics
Collection and analysis of data at the sensor, device, gateway or edge data centre rather than waiting for the data to be sent back to a remote cloud.

Supervised machine learning
ML method where training data for the algorithm sends desired outputs back to a remote cloud.

IoT marketplaces
A one-stop click-and-buy store, offering complete IoT solutions.

Container security
Solutions that protect the integrity of containers.

Real-time database
Database that uses real-time processing to handle constantly changing workloads.

Deep learning
Part of a broader family of machine learning methods based on artificial neural networks.

IoT hardware

CPU
Central processing unit.

Edge gateways
Physical devices that serve as the connection point between the cloud and controllers, sensors and intelligent devices.

NAND
Non-volatile flash memory.

DRAM
Dynamic random-access memory.

Neuro-synaptic chip
Brain-inspired computer chip, in which transistors simulate neurons and synapses.

ML-optimised gateways
Controllers that are optimised for ML algorithms.

Security chips
Security-enhancing low-powered modules.

GPUs
Graphic processing units.

ASIC
Application-specific integrated circuit.

FPGA
Field programmable gate array.

Smart sensors
Sensors that take some predefined action when they sense the appropriate input.

Quantum computing
Computation using quantum-mechanical phenomena e.g., superposition entanglement.

Source: https://iot-analytics.com/40-emerging-iot-technologies-you-should-have-on-your-radar/

Top IoT benefits

Once organisations adopt IoT, the top benefits they see are usually aligned with the reasons they adopted the technology originally, with companies experiencing increases in:

EFFICIENCY
+91%

YIELD
+91%

QUALITY
+85%

Source: https://azure.microsoft.com/en-us/resources/iot-signals/

5G Barcelona: A digital innovation centre

An interview with Dr Sergi Figuerola, Founder and CTO of the 5G Barcelona Alliance.

What is 5G Barcelona, in simple terms?

It is about a city-wide "love" for the validation and adoption of 5G technologies into the wider environment. We're setting up pilot projects to experiment, to validate and to adopt the usage of 5G technologies, analysing its industrial, technical and market aspects.

There were many standalone trials happening in various tech labs around the city and the region, and our main idea was to bring them together in a public-private initiative.

5G Barcelona is an initiative that I took part in the creation of, together with the local consulate. We have four key research centres in Catalonia (i2CAT, CTTC, UPC and Atos) focused on 5G development, in addition to the City Council, the MWCB and the Generalitat of Catalonia, plus many people working with 5G and new associate collaborators, and so we all asked ourselves: why don't we, for the first time ever, create a joint effort and make a much bigger impact?

In this public-private consortium, we have connected the research centres with Barcelona city and the Catalan government, as well as a few research labs and private companies.

What has 5G Barcelona achieved so far and what are the next milestones of your initiative?

This initiative already creates synergies within this ecosystem. It isn't always easy to put together different research labs that on other occasions are competing against each other. We have created a strategic alliance that has never existed before, and that now offers an experimental environment infrastructure to stimulate existing innovation in Barcelona and to help attract foreign investment and bring tech startups to the country.

In Barcelona, we have created a momentum of 5G technologies and the impact is really visible. So far there have been around 60 initiatives and now we are "identifying" those that are moving forward most efficiently and also the number of those that are also producing events outside of the city of Barcelona. We don't want to focus merely on the city; we want to bring technology to everyone.

Another great leap forward was that 5G Barcelona, together with Vodafone and the Hospital Clinic (under the leadership of Dr Lacy), was the first initiative to set up a real-time remote surgery. A doctor was monitoring the surgery being performed by his team, in real-time, from another country.

This is a clear demonstration of how we are extending the capabilities of the health system by means of technology. We are often asked what the added value of bringing 5G technologies to the healthcare system is; 5G is able to provide not only faster but also higher-quality service whenever there are emergencies.

Can you share any more examples?

Another demonstration was with Telefonica, SEAT and other players, which provided us with very fast and direct connectivity to the city's mobility, such as self-driving cars, in order to increase safety. For example, whenever there is a bicycle about to cross a street, by means of central technologies, we are able to connect to a car in real-time, so that it will detect that there's a higher propensity for an accident to happen.

Also, we have established vertical liaisons to guide companies throughout the 5G trial and adoption. As a result, we now see that many organisations are getting in closer contact with 5G Barcelona and are interested in setting up a pilot.

In terms of knowledge and training, we have several training programmes for different companies and organisations. We are now putting together a postgraduate programme with the local university too.

What is your favourite 5G project of all?

The one I am coordinating, and that is dealing with the key infrastructure – which is neutral hosting with small cells (antennas). To give better performance to the citizens,

you need more connection points. We are working on the concept of having one antenna that shares all the resources between different telecom operators. So different telecom operators will not only share the place where the antenna is located, but will share the antenna itself.

This is a new business model and a new solution that somehow facilitates the deployment of technologies into the cities. Truth is, we need more confidence from, and collaboration between, operators because this will be the first time ever that they are starting to share what is called active infrastructure. This project is called 5GCity and is sponsored by the European Commission under the H2020 programme and the 5G PPP initiative. We are running this project in one neighbourhood of Barcelona, 22@, where we have a three-square-kilometre area with various technologies being applied.

What are the biggest benefits of 5G for cities, residents and businesses? And why should the urban areas implement this technology?

5G is, to put it simply, about huge data capacity with low latency. This means that you can work remotely in near real-time, on very complex projects. People, cars, sensors, city furniture and many other elements can be connected in very complex ways, in real-time, and this will change business models and city services.

5G also provides something that is called mobile computing technologies. This means that instead of processing in the cloud, we bring the processing closer to the user. For example, we are computing some process elements that are close to sensors and antennas.

Are there any hidden dangers that you see in 5G, or the IoT in general?

Well, the biggest danger is not in security, but in the lack of a holistic view.

Nowadays, you see many IoT projects and developments. But there isn't proper convergence of all the elements connected to the network. As soon as we have the right technology that will facilitate or provide us with the capability to provide correlations, integrations and merge all the connected elements together, there will be a bigger motivation to invest into IoT deployment.

For example, there are IoT sensors in one parking lot and more in another parking area. You'll have some sensors on the street, but the information is not connected yet. So if I invest into an IoT project, but I don't get the return on investment from the whole impact that it could have, it then becomes less attractive

What would be your advice for anyone who is trying to do the same as you?

The most important thing is the people and the network. This initiative has been successful thanks to the collaboration, and would not work without people connecting and working together.

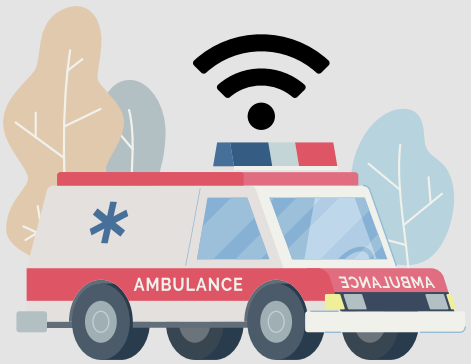
But the locality matters too. The fact that we're based in Barcelona and the Mobile World Congress is happening here has really helped. It is an event that generates lots of hype around the 5G networks naturally, and so it evolved into such a collaboration more easily. Thanks to these connections, we can do something that is unique worldwide.

5G Barcelona pilot projects

5G Barcelona has been testing the feasibility of 5G in making our environments safer, healthier and cleaner. These are some of the pilot schemes in deployment.

5G-connected ambulance

Thanks to the 5G network and the real-time high-definition videos, patients can benefit from remote support and care when in the ambulance, which previously would not have been possible until they reached a hospital.

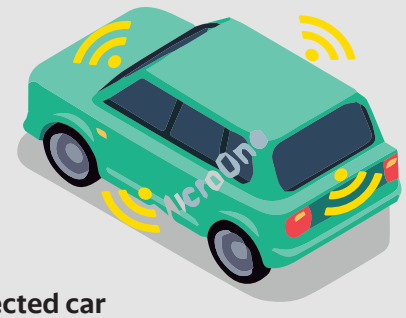


1,000x faster

5G will be 1,000 times faster than the current network

Drone emergency management

When faced with a wildfire, firefighters often lack the overview they need to organise an effective response. Drones can help manage the fire extinction more effectively. They provide a view of the area, including the localisation of the fire and the firefighters in the field.



5G-connected car

When it comes to avoiding accidents, human response time to unexpected situations is relatively slow. The connected 5G car allows the driver to be alerted to hazards such as pedestrians, bicycles or other obstacles, the moment they are detected.

Remote surgeon

Live surgery across the continents without any delay. 5G enables an expert surgeon to guide a mentored surgeon in real-time, without actually being physically present. This technology heightens the image resolution and eliminates latency.

1 ms

5G will have a latency of less than 1ms

My first year at ERNI Series: Teodor Vasile

Teodor Vasile joined ERNI at its site in Munich in 2019 working as a Professional Consultant in the area of MedTech. How did he spend his first year at the company? Read the following lines and find out yourself. We are happy to have you on board, Doru!

My first year at ERNI was amazing. Six months ago, I promised myself that the practice of self-reflection would become my habit, and so with that objective, I've reflected on the last 6 months within the ERNI family.

Today, I am very glad to still be involved in the same project, with its focus on MedTech and Software Engineering. I started almost at the very beginning of the development and there are confident indications that I will be involved until the development is finished. For some people it might be boring to be part of a project for more than 12 months, yet for me personally it was a goal right from the start to be part of the development from the very beginning to its end.

This way, I am gaining full experience with respect to the development of a state-of-the-art MedTech product. As an Embedded Systems Engineer, I am not only involved in the programming of new features but I am also in permanent exchange with the other departments, like the Hardware, Electrical or Validation & Verification Teams. This has helped me a lot in the last couple of months to extend my horizons in areas like software testing, software integration and also in fields like industrial design.

Furthermore, my programming skills have improved and my understanding of the customer-specific programming framework in which we are working has become more developed. Combining these two led me to contribute to the design of the hardware abstraction layer of our software component, which I am very proud of.

Teodor Vasile
Professional Consultant
ERNI Germany

An important milestone during these months was the integration week I spent on the customer site in Switzerland last fall, when we integrated the hardware (the machine itself) and the software into the whole system for the first time. This experience was extremely important for understanding how the developed product fits into the bigger picture and what requirements it must meet. This integration wasn't devoid of errors and failures; in order to reach our goal and pass the tests, we had to react fast and solve the problems efficiently. This experience was very valuable and helped us in the following integration. These are the moments which we are working for – moments when everyone involved in the project is "holding their breath" for the duration of these 5 days, waiting for updates and good news. I am proud to be part of the team.

A further milestone in our project has been the migration to the prototype version of the product, thus moving one step closer to the final product.

Since June last year, I have also been participating in various internal ERNI events like the 2019 Hack N' Hike, ERNI Introduction Rookie Day and the kick-off of the ERNI UNBOSS programme. These events were not only very useful in connecting with new colleagues but also in developing better social skills and building solid team collaborations. In addition to being recreational and relaxing, these kinds of events lead to some clear actions, such as the organisation and preparation of future ERNI Germany Meetups on technical and organisational topics, and improve our team spirit while helping new colleagues to integrate fast and incorporate the UNBOSS mentality.

The perspectives at ERNI Germany are bright for me as this year I am taking part in the ERNI Senior programme and will be completing the project at the customer. I am looking forward to contributing to the development of ERNI services in the area of IoT and tackling new topics like client acquisition or sales, which will surely complement a 2020 full of successes and accomplishments.

I would like to take this opportunity to thank all my colleagues for making every working day fun and for contributing to such a good team spirit. Also, I am thankful that the mid- and long-term vision of ERNI matches my personal perspectives. Having found a role in which I feel comfortable and through which I can easily gather new skills and improve my current ones suits my professional expectations perfectly. Moreover, the personification of a bigger responsibility on customer site and within the company keeps me focused and hungry day to day. Last but not least, I want thank Martin Bott, MD at ERNI Germany for decisively contributing to my growth in this last year, giving me confidence and the power to decide.

Enjoy your work every day and stay motivated!

.experience

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