INTERNET OF THINGS

The key to make the connection that transforms the real world into data, creating new ecosystems of knowledge

ENGINEERING

WHAT ARE WE DISCUSSING?

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After her studies in Economics and Management at the University of Florence, she joined Engineering Group in 2017. She was involved in various consulting projects at contact with the Client, particularly as regards fiscal advantages related to Industry 4.0. She currently works together with the Marketing team in the IT industry world, supporting the enhancement and the development of business portfolio, new digital services and products towards Digital Transformation.

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In brief

"If you can't connect it you need it, full stop".

Ironic although it may seem, this is the new real challenge that the technologies of the Internet of Things (IoT) are bringing into the design of every new service, product and method of interacting with objects, individuals and our environment.

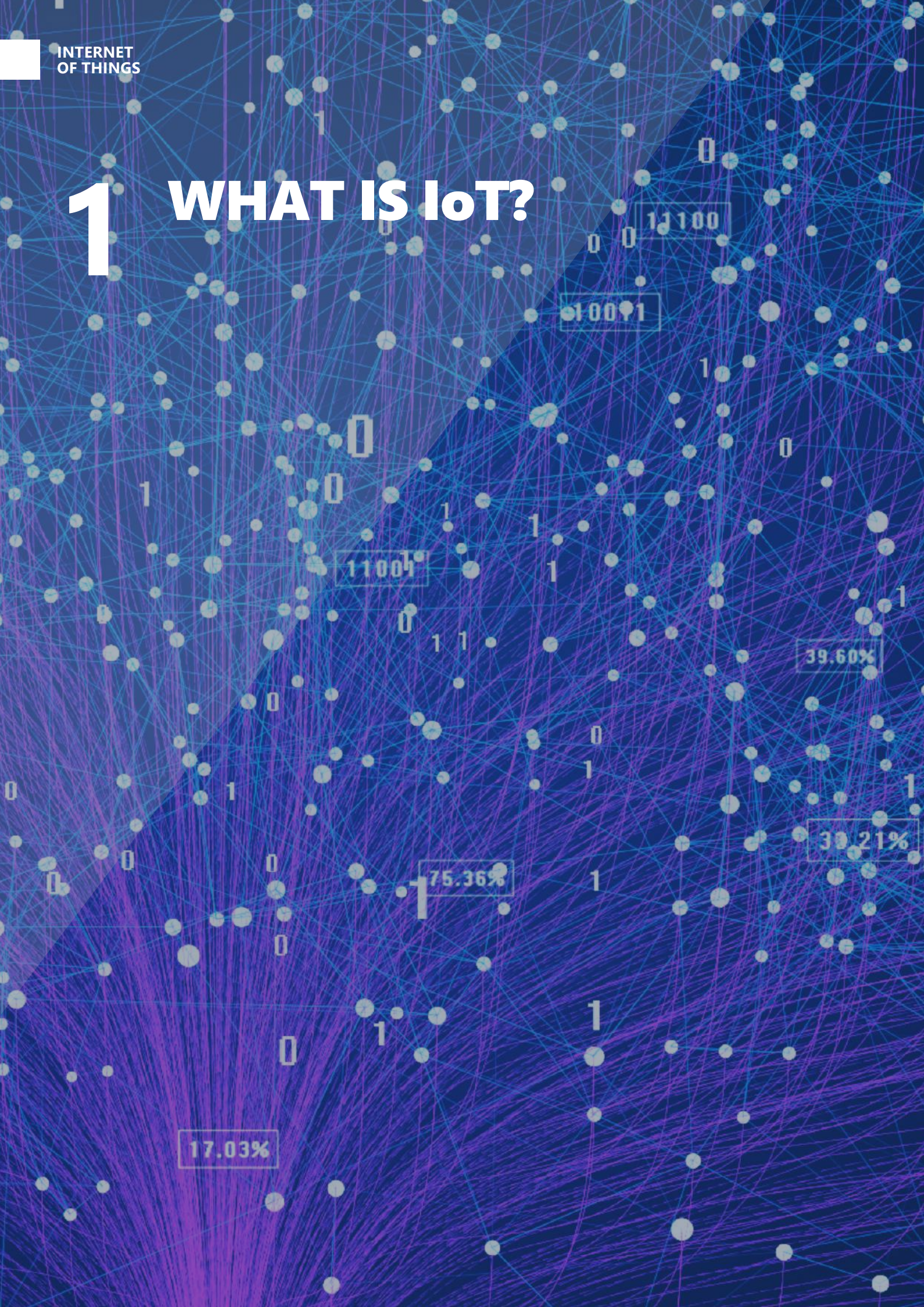
In an ever closer future, foreshadowed by self-driving cars or smart homes managed entirely via smartphones and voice commands, **the vision of an interconnected, smart world** that is sensitive to environmental conditions and the context in which an object is used, is decisively guiding the development of new products and services for citizens and businesses.

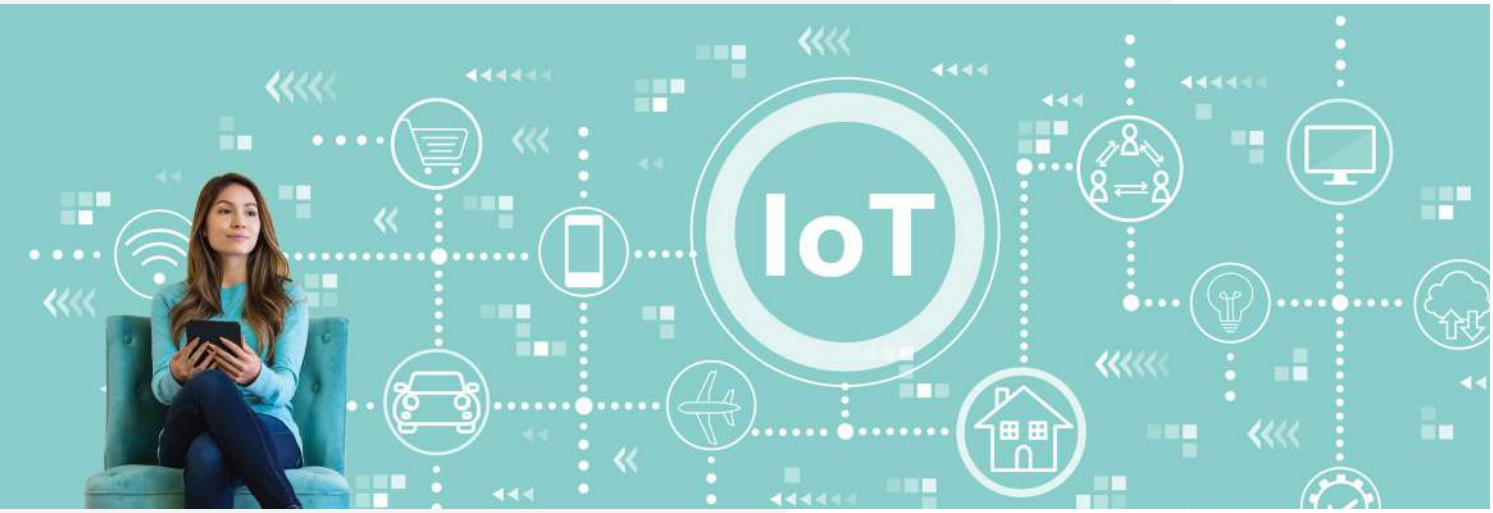
By their nature, **IoT technologies are not self-consistent, but the result of the simultaneous evolution**, over a very short period, of a set of enabling technologies needed to reinvent the world with which we interact on a daily basis: the availability of Internet bandwidth, the density of objects managed in a defined space, the very low latency of communication protocols, the lower energy consumption of devices, the range of connections and, finally, the decreasing cost of physical devices. Moreover, this cost is now totally negligible compared to the value-added component: one example of this are the OBUs (On-Board Units) installed on customers' cars free of charge by insurance companies to monitor their behaviour, driving style and thus the degree of risk to which the price of the policy is linked.

It is also no coincidence that **5G technology plays such a strategic role in supporting the spread of IoT**, as it alone solves the first three points just mentioned, namely bandwidth, density and latency. Remarkable progress is also being made at an impressive speed in the miniaturisation of devices, which are already able to host microprocessors equipped with an operating system and software to support Artificial Intelligence (AI) algorithms. This condition allows local analyses to be carried out, transmitting to the data centre only information that is qualified and useful for the specific context.

It is precisely **this constant convergence of different enabling technologies**, in particular Big Data and AI, together with the virtually unlimited processing capabilities of the Cloud, that make it possible to foresee and steer the potential of IoT.

1 WHAT IS IoT?





The term IoT defines the ability of various types of objects to be interconnected via the Internet in order to send or receive information that is useful for managing a given context. **In common IoT jargon, objects are generically referred to as "edge devices" and classified as "sensors" or "actuators"** that can also coexist within the same physical device. The information generated is then collected, analysed and interpreted both in assisted mode, i.e. through interaction with a human operator, and in fully automated mode. Most of the data collected are, in fact, processed with the support of machine learning systems and AI algorithms that are able to process a huge amount of data by dynamically allocating the computing resources needed to quickly process the data acquired from different contexts.

IoT is an open technology, based on the use of a wide range of protocols, algorithms, databases, models of interaction and use of information. All of these are united by the fact that the piece of information originates or ends on a device that is designed to be sensitive to an "event" associated with a specific context, such as a vocal command or a sensor capable of detecting cardiac fibrillation.

The most interesting and creative aspect of this technology is, in fact, **its bi-directionality, namely its ability to work with a mix of detectors and actuators**. If, for example, I say "Alexa, switch off the lights", the device recognises my voice command (event) and activates a standard communication protocol with my home automation system. Devices such as Alexa or Google Home, which are used by millions of users every day, use voice and image recognition as standard human-machine communication protocols; this gives us a measure of just how pervasive IoT is and what future scenarios it represents, where smart building management or the potential of home automation are already regarded as mature solutions and are increasingly being placed as a matter of course in the early stages of designing new buildings.

This technology thus opens up endless possibilities. Through chains of interconnected objects that are capable of performing complex processes fully autonomously, we can, for example, order a pizza, choose the toppings with simple voice commands, pay for it electronically and have it delivered to our homes by drone, without any human intervention.

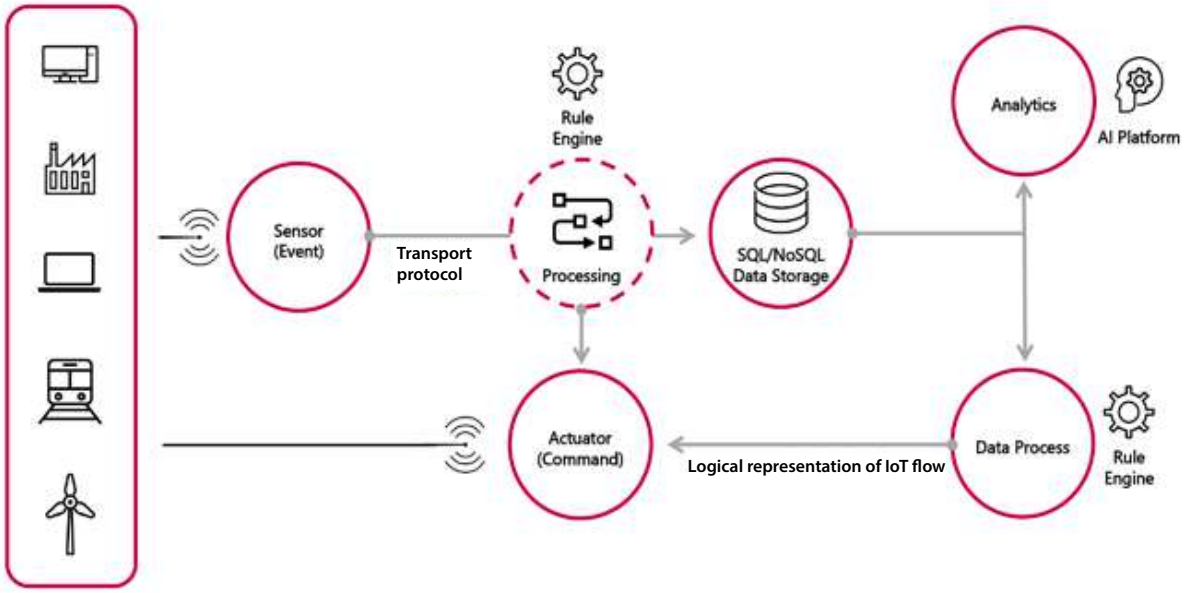
It is no surprise, therefore, that **IoT is the fastest growing area of technology in the entire history of Information Technology**, both in terms of the new devices launched on the market every day and of the volume of transactions exchanged.

Naturally, none of this would be possible without the combined help of other technologies such as the Cloud and Edge Computing, Big Data and Artificial Intelligence. All play an essential role in the ecosystem:

- **the Cloud and Edge Computing** enable the virtually infinite scalability of the computational, storage and network resources required to process billions of transactions;
- **with Big Data**, it is possible to use all data in their entirety, not just sampled subsets; it means working with volumes of information that were unthinkable just a few years ago;
- **AI analyses and recognises** significant 'patterns' on which to base decisions, exploiting the enormous computational capacity available (bandwidth, data analysis processors) combined with increasingly advanced algorithms that are capable of learning quickly and effectively interpret the managed contexts.

2 HOW DOES IT WORK?

From a technical viewpoint, t**he principle on which most IoT models are based (depicted in the figure below)** is quite simple and consists of a few essential elements that are common to most cases of practical use.



Starting from the macro-classification between **passive devices (sensors) and active devices (actuators)**, a sensor recognises certain environmental conditions of the context for which it was designed, encodes this information and transfers it via the Internet to a collection point for analysis.

A sensor can combine two or more of these functions and react in line with the level of specialisation of the software it is equipped with. Once a certain condition has been detected, the data is transferred via multiple communication protocols to a collection point **(Database)**, which is then examined with respect to the specific context **(Analytics)** in order to activate appropriate "operational protocols" **(Data Process)**.

Often, the analysis of the events collected triggers "event driven" logics, in which expert systems analyse the events detected by triggering predefined "If-then" actions.

For example, the unauthorised opening of a door with badge-authenticated access triggers an automatic break-in and alarm procedure.

In remote control and monitoring processes, many applications use measurement variation in a constant time unit "time series" to detect abnormal conditions and anticipate the occurrence of a critical event.

A simple example of this is **the monitoring of a temperature-controlled room within a defined range**. In this case, a sensor detects the temperature every x seconds and forwards this information to a central control system, which sequences and processes the various temperature readings so that it can 'predict' how soon the room will enter a critical state, triggering the relevant alarms. Similarly, the algorithm used to detect and analyse the temperature can, on the basis of the parameters set, trigger an actuator device in the secondary cooling circuit, thus preventing any damage.

More recently, data analysis has been anticipated and made possible already in the streaming phase. This allows critical patterns to be identified even before the event is stored and processed by other applications. This technology has opened up new possibilities where reaction time is the most crucial factor, such as in the autonomous driving of a vehicle.

One interesting aspect of the IoT world is the positioning **logic of the artificial intelligence algorithms that process the data received**. Depending on the different contexts of use, in fact, it may be necessary to process the data as close as possible to the monitored infrastructure (**Edge Computing**) rather than on a single central monitoring system (**Cloud Computing**) or a hybrid.

This is an extremely important point in the definition of IoT architectures, especially those dedicated to the monitoring of sensitive infrastructures based on "event-driven" processes. As is well-known, the unavailability of network services remains one of the weak points of all internet-based ecosystems, leading to the need to evaluate, on a case-by-case basis, the minimum level of operation that must be guaranteed through local Edge Computing technologies.

These are complex evaluations and are not limited to the cost/benefit ratio, but also concern the analysis of the risks connected with the unavailability, albeit temporary, of the Internet or central systems.

For many applications, distributing "near-edge" computational capacity is thus a complementary redundancy option. This need arises, for example, when it is necessary to combine local processing capabilities with the need to feed machine learning processes centrally; in turn, these periodically update the AI algorithms running on local systems, constantly improving their performance and effectiveness.

This hybrid approach between Edge Computing and Cloud Central is essential in order to examine the cumulative trends of a specific context, aggregating all the data generated by distributed sensors. Anomalous data could in fact be interpreted as "false positives" and thereby irrelevant if interpreted only locally and within limited time-frames.

Finally, the use of data produced by IoT devices may need to be integrated with other 'enterprise' class data sources, or data provided by third parties by subscription or by 'open data'. In all these cases, **the use of robust API-based integration** tools is a fundamental structural enabler for the implementation of complex IoT projects.

3 WHAT ARE ITS APPLICATIONS?

Like many IT technologies, IoT has different fields of application and diverse user models, both in the consumer and B2B spheres, with no predominance of one model over the other.

There are fields of application wherever there are conditions for an object, placed to control or support a process, to be able to exchange information with other objects and control systems, or where it may require the activation of on-demand services.

A short list includes:

- **smart home management, home automation**, autonomous power generation, consumption and interchange management.
- **smart buildings**, security management and energy efficiency;
- **all manufacturing and monitoring activities** in industry, robotics and automated logistics;
- **assisted driving systems**, monitoring of rental fleets, dynamic tariffs adapted to the customer's driving behaviour;
- **healthcare**, remote assistance and the connectivity of a variety of biomedical devices;
- **fitness and wellness wearables**, smart gyms and home fitness equipment;
- **land management and protection** and all areas of telemetry;
- **the monitoring of multi-utility distribution infrastructures** (gas, electricity and water);
- all areas of **industrial and urban surveillance** and security;
- **Smart Cities** and smart integrated mobility;
- **new forms** of machine-to-machine **payments**;
- **smart and precision agriculture**, the installation of sensors in soil and the management of images;
- the protection of **DOC food chains**, also in the livestock sector.

Each of the above points requires both the appropriate technologies and the development of new, increasingly specialised devices and sensors, and once again the rapid development of technologies is helping us. Indeed, we are witnessing the impressive acceleration of certain 'technological factors' that will in turn lead to an ever-increasing penetration of these technologies in every sphere of daily life.

The following **trends in the innovation cycle** are of particular relevance:

- the process of miniaturisation of devices;
- the progressive autonomy from external power supply devices or consumption at such low levels that the life cycle of components can be estimated in the range of years;
- active and smart devices, able to host operating systems, computational resources and software on a square centimetre;
- new families of sensors, which can also be ingested and are capable of carrying out a variety of diagnostic tests (blood, hormones, etc.);
- new sensors on innovative physical supports (nanomaterials) adaptable to different physical engineering;
- low-cost LIDAR sensors, such as remote sensing devices that enable the precise determination of the distance to an object or surface, or the concentration of specific chemicals in the atmosphere or in bodies of water.

In the consumer world, smartphones have long been the device of choice in the IoT world, as they are equipped with GPS, Bluetooth and Wi-Fi interfaces. These features, which are also present in basic models, allow smartphones to act as local gateways to wearable devices for fitness and wellness, or specialised devices for remote medical assistance to frail people or those suffering from particular diseases. Of interest, for instance, is the availability of IoT sensors equipped with micro gyroscopes capable of recognising the 'man down' state.

More recently, **the spread of e-commerce and new home automation solutions are forcing increasingly specialised and user-friendly multifunctional devices**, mainly based on voice interfaces, which greatly simplify access. At the same time, they offer unhoped-for opportunities in the field of disability support and home management for the frail. Adoption trends are growing and irreversible. All the main names in the Web, audio/video technology, household appliances and home automation now have catalogues full of IoT-based products, tools and accessories that are literally changing **the habits of the new generations, who are no longer just "Internet natives" but also "IoT natives"**.

For public agencies and institutions in charge of environmental and territorial protection, the protection of people's health and services to citizens in urban areas, IoT technology represents an enormous opportunity to pursue objectives of improving the quality of life in large urban centres in a broader context of social responsibility. One example of this is the different Contact Tracing solutions that national governments have developed and promoted to monitor the Covid-19 pandemic.

In the B2B sector, the approach follows more consolidated channels and models, which on the one hand pursue the reduction of operating and maintenance costs of infrastructures and, on the other, focus on the "top line", the true point of attention of CEOs in the process of transformation and evolution of products and services in a digital perspective.

The offer of IoT solutions therefore focuses on enabling technology platforms that cut across different markets, increasingly enriched with vertical and process content and know-how, which represent the real added value to the technological factor. The IoT proposition thus becomes an opportunity to reposition oneself and give more value to customers. A good example of this approach is the re-engineering process of products and durable goods with the pervasive placement of sensors and IoT devices within the products themselves. This is important not only to monitor performance and possible anomalies in current use (predictive maintenance, fault avoidance, etc.), but also all the product usage data such as processing cycles, units produced, hours worked, which are needed to support the transition to pay-per-use models and which, aggregated and analysed on a time basis, reveal a lot about customers' habits and preferences. A practical example of this commonly used model are the on-board-units (OBUs) that several insurance companies offer together with car insurance policies: the aggregation of data on km travelled, speed, accelerometer data (acceleration, braking, lateral pressure, etc.) provide a very precise 'profile' of the user's driving and risk propensity, which can also define a personalised policy price.

4 WHAT DOES IoT MEAN FOR YOUR ORGANISATION?

From being an emerging technology that generated a lot of hype around it, IoT has now entered a pragmatic and operational phase. IoT, and with it the set of related technologies, is able to effectively contribute to redefine the ways in which organisations generate added value, improve the customer experience and effectively resolve any critical issues.

Companies that adopt innovative and successful Digital Transformation processes are those that apply at least one or more of these scenarios:

- **provide new sources of value** through IoT-supported services, using IoT to discover customer preferences, implementing IoT products to improve security and well-being;
- **create new economic models** based on recurring revenues or results-based models (KPIs) in which the company acts in response to data from sensors;
- **use IoT in conjunction with other advanced technologies** such as drones, Artificial Intelligence, machine learning, Artificial, Virtual and Mixed Reality, Blockchain;
- **connect previously unconnected domains** through IoT-generated data collected by one company and used by others;
- **deploy IoT sensors and devices beyond artificial environments**, for rainforest and wildlife conservation, livestock management and aquaculture;
- **extend IoT to aspects of life beyond work**, from enhancing recreation to making communities safer.

It should also be kept in mind that IoT is, by definition, ecosystemic and requires the contextual use of a plurality of technologies in different domains, fixed and mobile networks, real-time (data stream) or batch (analytics) data processing, Big Data, Machine Learning and AI tools.

With this in mind, the question companies really need to ask themselves is: **how does IoT affect the market I operate in, my organisation and my business?**

There are at least three scenarios where the Internet of things can really make a difference:

- **design and manage sensor-fitted products** that are inherently connected and sensitive to the conditions of use of a given asset;
- **structurally introducing the principle of the connected asset** as the power point of the CRM or of a more generic Asset Control Plane;
- **to use data from connected devices** to obtain and analyse new information on the consumption pattern of an asset and therefore on the behaviour of the customers or users associated with the asset.

5 WHERE DO WE APPLY IoT?

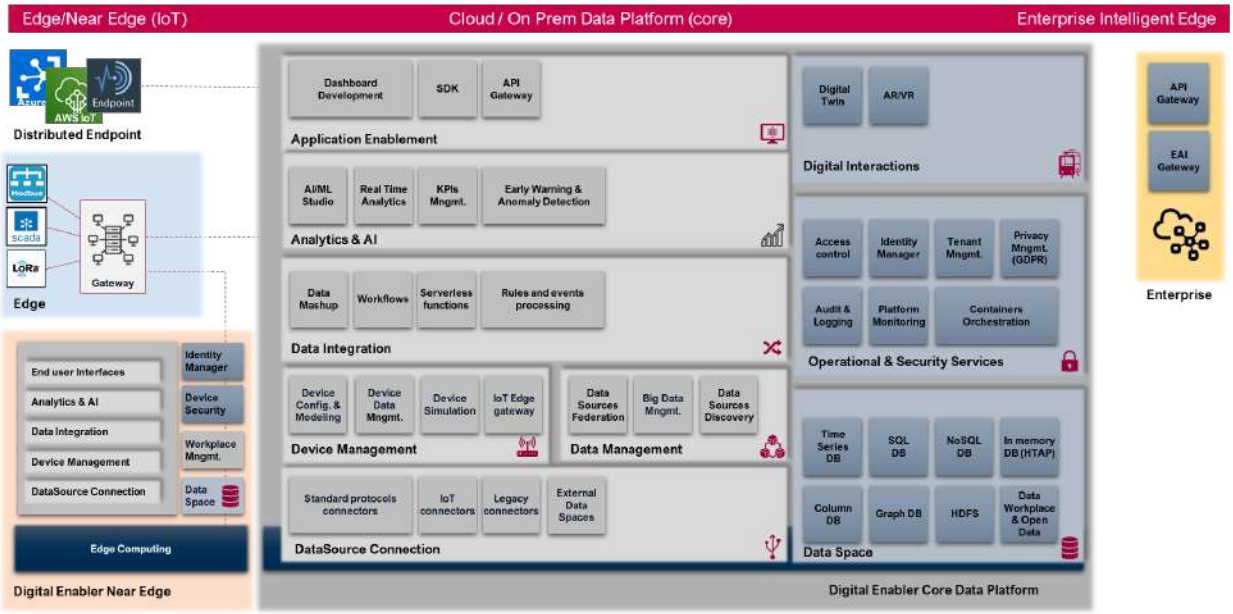
Our offer considers the strategic role of enabling technology that IoT plays now and will play even more in the future in support of Digital Transformation processes. Engineering's strategy is therefore twofold: to continue to develop a horizontal ecosystem platform that incorporates, harmonises and facilitates access to core technologies, and to integrate these technologies with the specific skills of the core processes accumulated in the various reference markets. In addition to this, there are professional services to support the various projects, both in terms of technological and process skills, and necessary for the adoption of new technologies: process consulting, technical training and support tools for change management using Design Thinking and collaborative innovation tools.

Digital Enabler: Ecosystem Platform

Digital Enabler
Engineering's Ecosystem Platform

Digital Enabler™ is our reference ecosystem platform in the area of Data Management, Data integration, AI, IoT and Industrial IoT. Its purpose is to address a strategic market segment, supported by a growing demand for Digital Platforms capable of managing and orchestrating a large amount of data scattered in heterogeneous sources as well as guiding the users to the fast development of innovative applications.

The platform enables public/private organisations and developers to the fast creation and deployment of innovative IoT applications in the most diverse scenarios and contexts of use. Digital Enabler is an open platform, based on open-source components and micro-services architecture that allows the management of multi-source Enterprise-class data avoiding any lock-in with vendors and technologies.



Functional platform landscape

Digital Enabler supports the entire value chain of data (including IoT and Industrial IoT), from the collection to the analysis, harmonization, combination, deduction of valuable information and visualization at right-time.

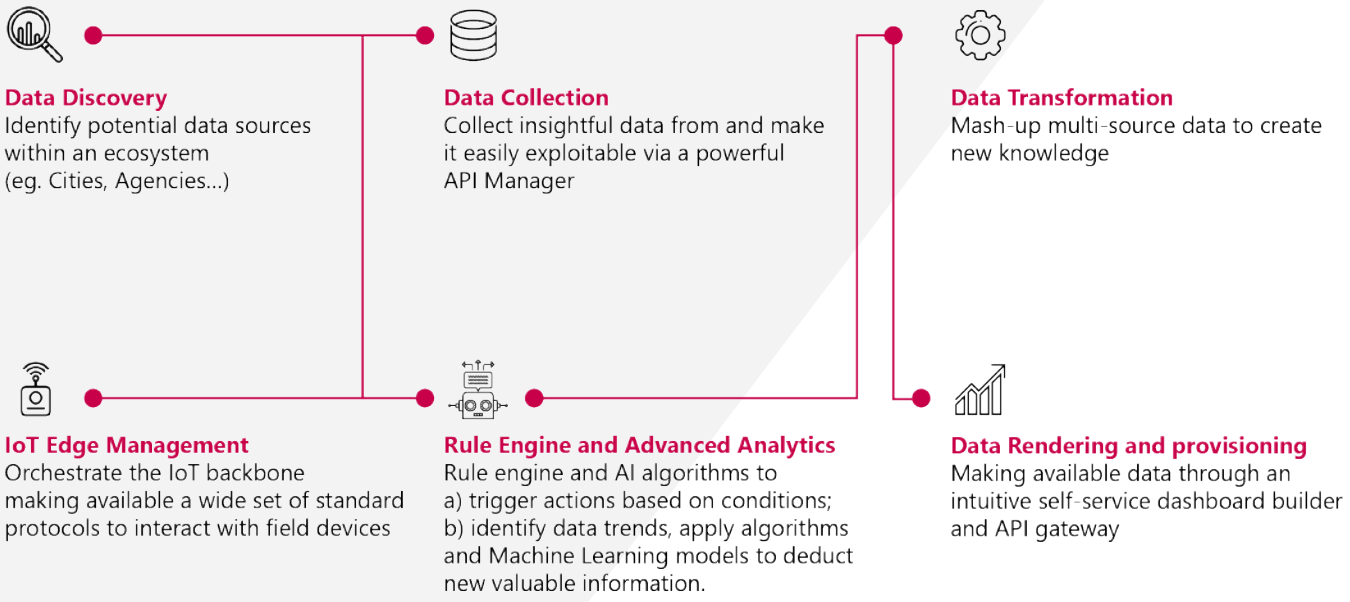
Main features of the Digital Enabler include the followings:

- It is composed by a set of **independent and interoperable tools**
- It enables the **interoperability** among existing systems, IoT gateways and IoT devices
- **Management of IoT devices** at different levels (Edge, Near Edge and Cloud) interacting through standard protocols such as HTTP, MQTT, OPC-UA, ModBus and BACnet.
- It includes tools that guarantee the scalable management of **Big Data and Data Streams**
- Developers are enabled to the fast build and deploy of IoT applications thanks to a numerous **serverless functions.**
- Automatic **Discovery** of public data sources
- Non-technical users can benefit from **graphical tools** to design and monitor data correlation processes as well as to integrate data (**low code**)
- **Deduction of new information** from data and automatically detection of trends thanks to AI and a ready to use catalogue of algorithms
- **Based on opensource software**, it complies with standardization specifications promoted by well-known communities at international level, such as FIWARE[1] , GAIA-X [2] and Eclipse [3].
- A layer of **standard APIs** guarantees high levels of interoperability with any external existing systems
- It guarantees **personal data processing** in compliance with the EU GDPR

1 https://www.fiware.org/

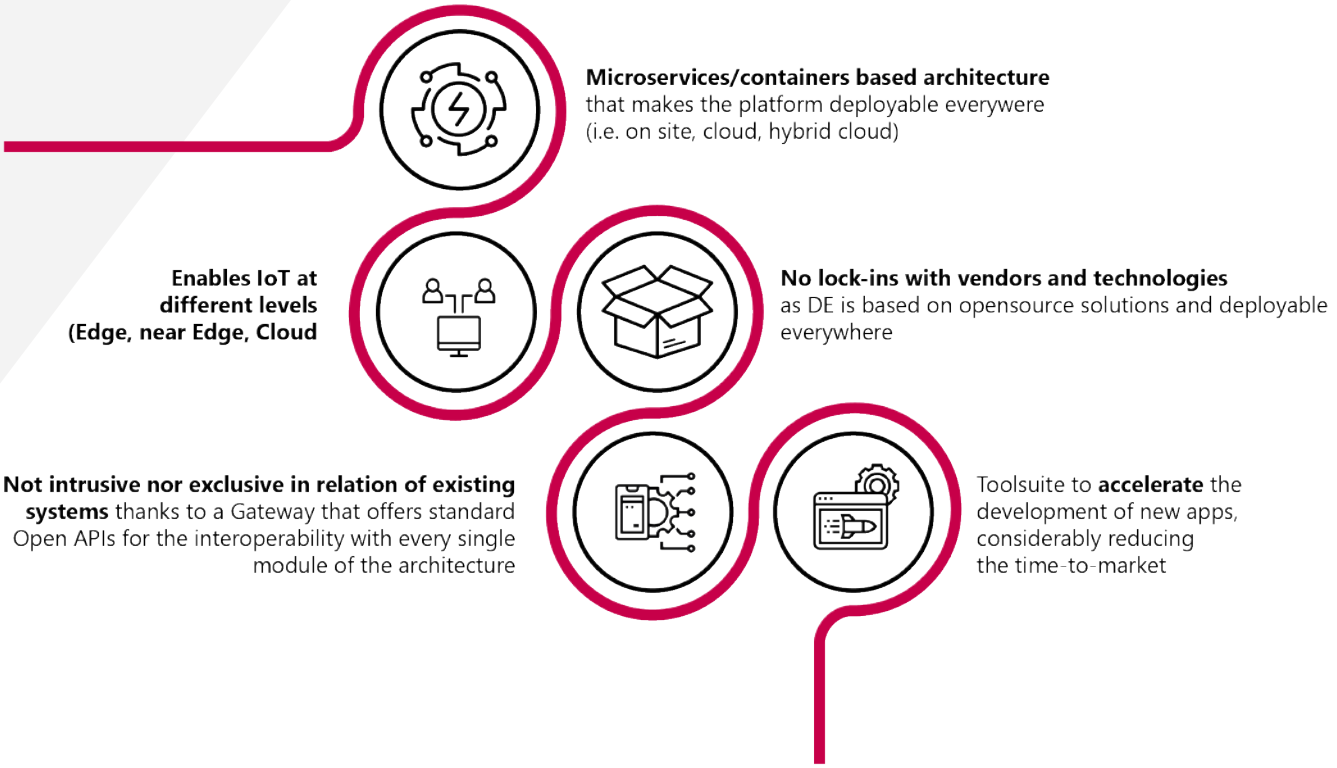
2 https://www.data-infrastructure.eu/GAIAX/Navigation/EN/Home/home.html

3 https://www.eclipse.org/org/workinggroups/



Through data stream procedures, data mash-up, the application of Machine Learning models and AI algorithms, Digital Enabler is able not only to enrich the available information, but also to deduct new information, predict trends and potentially critical events.

Key strenghts

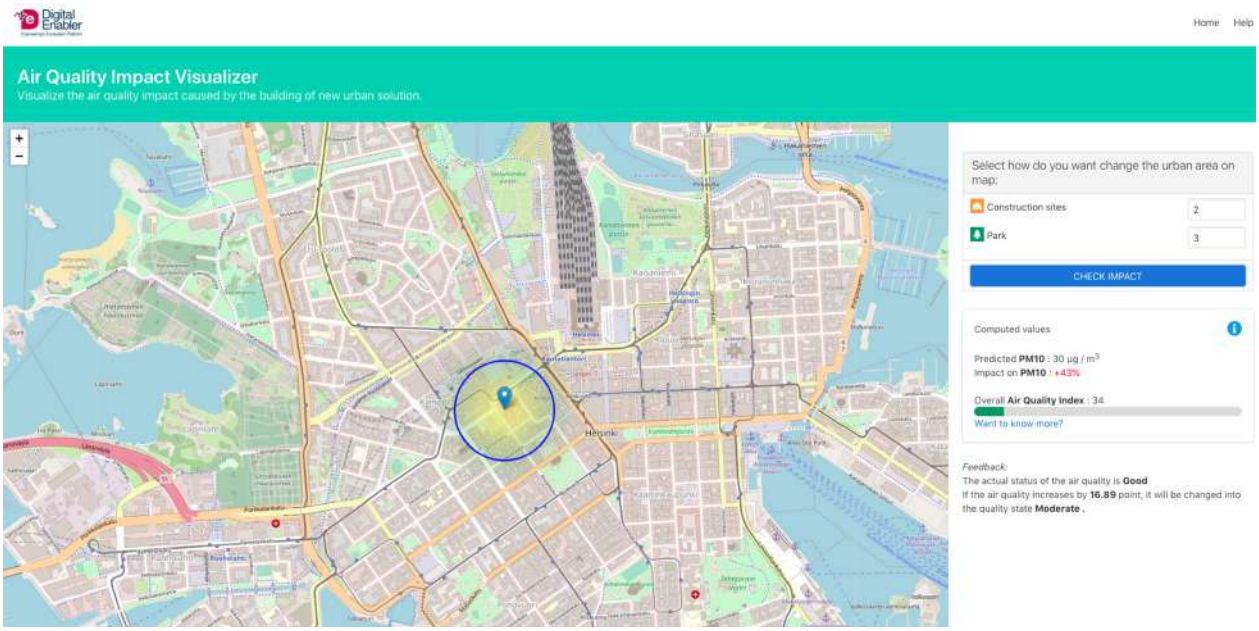


Digital Enabler for Smart City

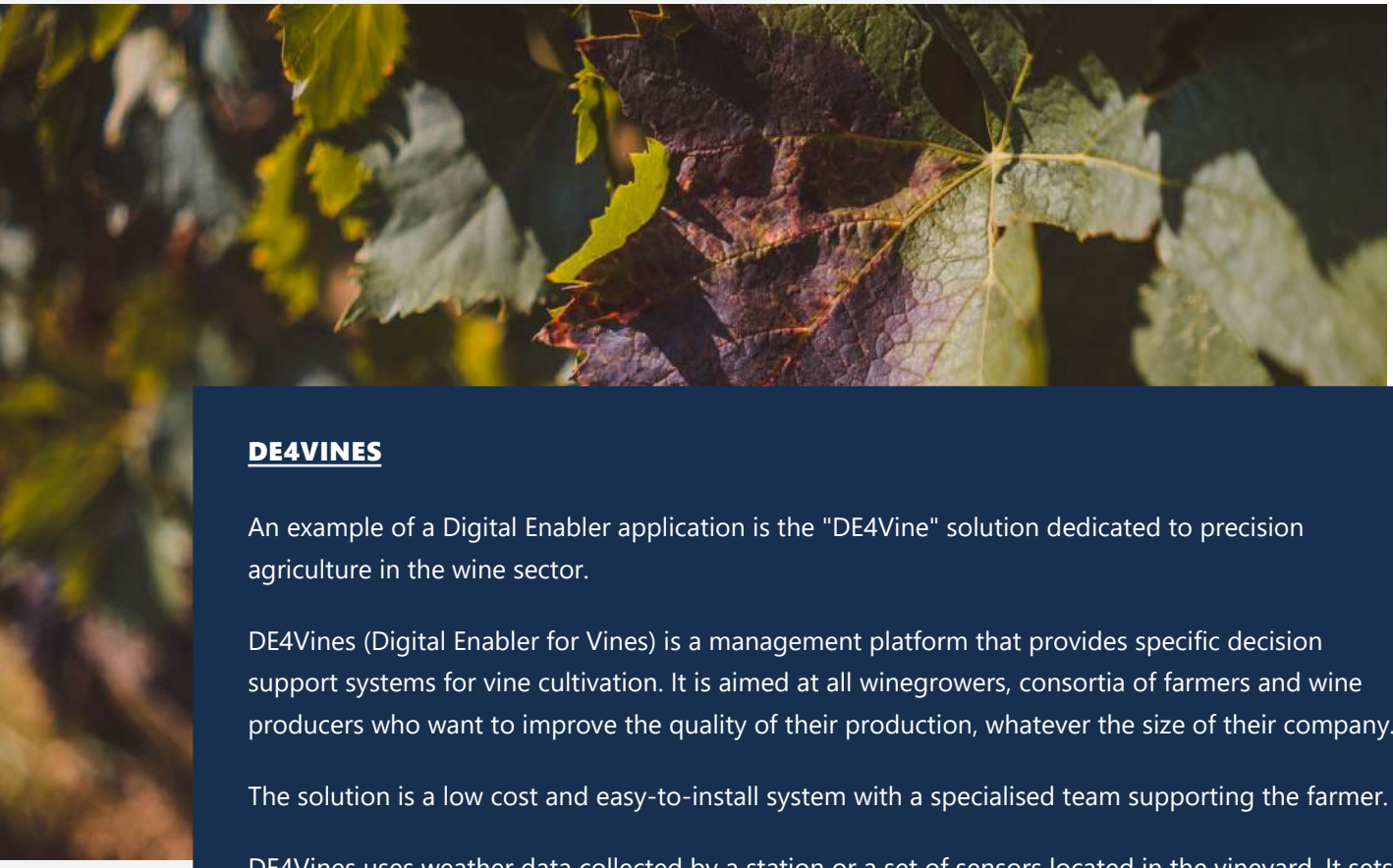
SELECT for Cities is a European Pre-Commercial Procurement aiming at developing an open, standardized, data-driven, and user-centric platform for European cities, with the common challenge to develop "cities as large-scale Internet of Everything labs".

In this context, Digital Enabler has been used to design and build use cases for three big European cities:

- Antwerp (Belgium) – The city of Antwerp had several IoT devices placed in the city (e.g., cameras, air quality sensors, noise level sensors). With Digital Enabler we were able to easily plug-in all the devices in the platform and develop several application scenarios on top of the data from IoT and other public data sources found by the Data Discovery Engine. Applying AI techniques, we provided the City with an instrument to make a forecast of the impact on air pollution caused by the construction of new buildings in a specific area.
- Copenhagen (Denmark) - Integrating IoT sensors already placed in the city, with Digital Enabler local stakeholders were able to combine real-time mobility and air quality data with the aim to produce reliable insights for city planners and citizens for a healthier city.
- Helsinki (Finland) – Digital Enabler has been used to correlate data collected from devices scattered in the City that measure air quality and noise level to deduct information about traffic and send interested citizens suggestions of alternative itineraries in a mobile app.



Other success stories of the Digital Enabler for smart cities are in Montevideo area in Uruguay (for air quality monitoring and smart parking), in Monheim am Rhein in Germany (for smart public illumination monitoring) and in the city of Bonn in Germany (smart parking using AI).



DE4VINES

An example of a Digital Enabler application is the "DE4Vine" solution dedicated to precision agriculture in the wine sector.

DE4Vines (Digital Enabler for Vines) is a management platform that provides specific decision support systems for vine cultivation. It is aimed at all winegrowers, consortia of farmers and wine producers who want to improve the quality of their production, whatever the size of their company.

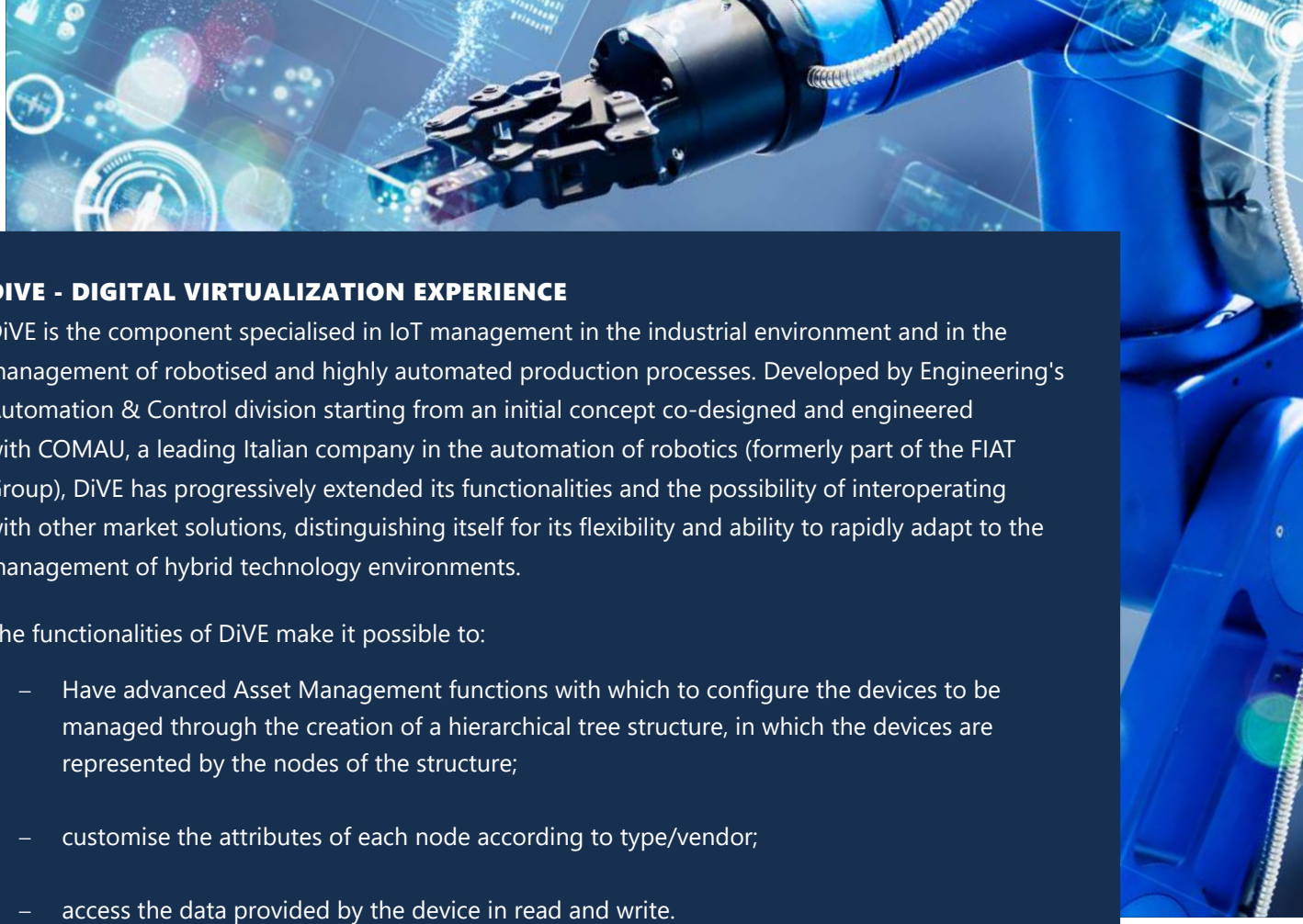
The solution is a low cost and easy-to-install system with a specialised team supporting the farmer.

DE4Vines uses weather data collected by a station or a set of sensors located in the vineyard. It sets up specific phenological phases for each vine variety and uses self-adapting evolutionary models. Based on the weather data, the platform then provides immediate information on the state of the crop, using predictive models for the main fungal diseases and insect risks, while also identifying water stress conditions.

The application allows for diversified functions depending on the role of the user: farm owner, consultant, agricultural operator, consortium manager.

The benefits of DE4Vines include:

- reduced costs of cultivation processes;
- increased soil yield;
- increased product quality;
- reduction of the environmental impacts of cultivation processes.



DIVE - DIGITAL VIRTUALIZATION EXPERIENCE

DiVE is the component specialised in IoT management in the industrial environment and in the management of robotised and highly automated production processes. Developed by Engineering's Automation & Control division starting from an initial concept co-designed and engineered with COMAU, a leading Italian company in the automation of robotics (formerly part of the FIAT Group), DiVE has progressively extended its functionalities and the possibility of interoperating with other market solutions, distinguishing itself for its flexibility and ability to rapidly adapt to the management of hybrid technology environments.

The functionalities of DiVE make it possible to:

- Have advanced Asset Management functions with which to configure the devices to be managed through the creation of a hierarchical tree structure, in which the devices are represented by the nodes of the structure;
- customise the attributes of each node according to type/vendor;
- access the data provided by the device in read and write.

Other modules that make up the Digital Enabler platform are Knowage and Cloudesire, respectively focused on data rendering processes through advanced analytics and event-driven data management functionalities, and on supporting the management of APIs and public interfaces by subscription.

Both modules are developed and supported directly by Engineering's development labs and can also be offered as self-consistent modules to support customer projects that need to import these technologies as sub-components to support wider projects in line with the service structure of the Digital Enabler platform.

IoT for Industry 4.0

With the introduction of IoT in industry, the Industry 4.0 plan has accelerated the innovation process, pushing companies, including SMEs, towards a digital transformation that would certainly have been slower and less impactful.

The drive has therefore been considerable and has also stimulated integration companies to be more proactive and invest in new solutions.

Hence the synergy between technology producers, integrators and software companies, in an attempt to offer solutions and skills that go beyond simple software applications, guaranteeing a complete product, able to fit into the production context, bringing benefits to both product quality and production processes.

The use of AI & Advanced Analytics technologies makes it possible to analyse in a new and effective way the huge amount of data provided by all the elements of the production process: machinery, management systems, operators, environmental sensors and many others. These enabling technologies also make it possible to identify relationships and correlations that the human eye cannot intercept, both because of the volume of information and because of the culture and professional history that lead it to a known approach focused on qualitative results and production performance.

Using predictive models to analyse all the data available on a production line, for example, can help not only to intercept malfunctions or deviations in product quality in advance but can also lead to the identification of unexpected causes, linked to factors that are apparently unrelated or not strictly connected with the production process.

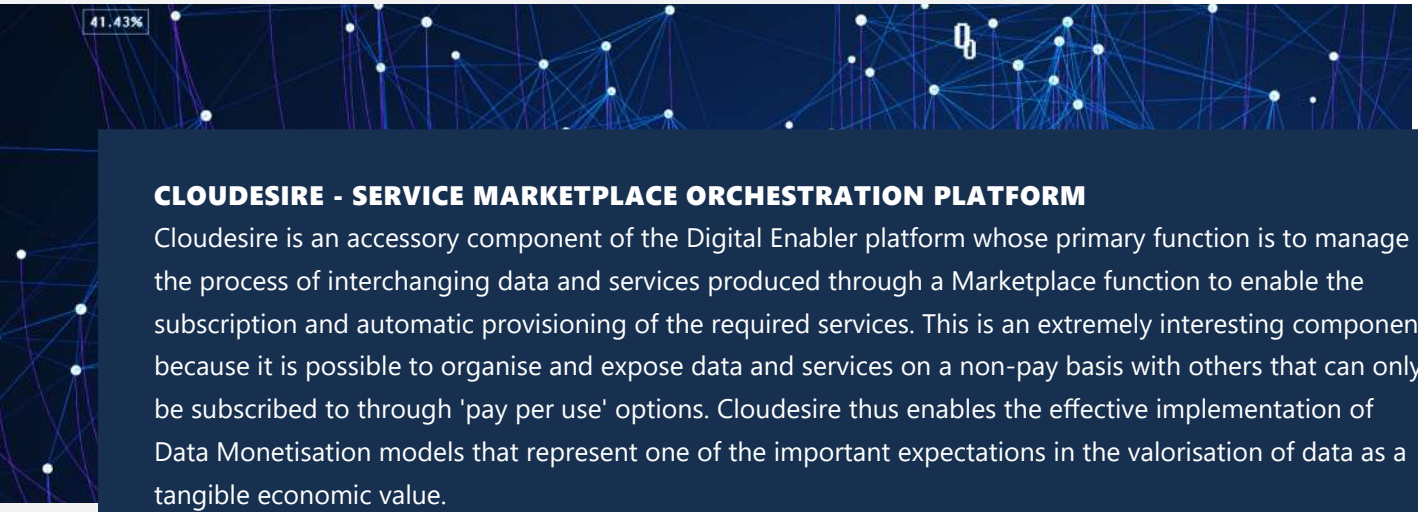
The core elements of our Industry 4.0 offering include **IoT platforms with solutions that can quickly interface with all field devices**, from simple sensors to controllers and PLCs.

We work on two fronts: the creation of assets and products by our own teams of specialists, and the integration of market solutions offered by big vendors and specific manufacturers in the manufacturing sector. Our Competence Centres working on automation, data analytics and digital solutions have been working in recent years on the creation of assets and products to be offered to companies during their digital transformation process. Digital Enabler DiVE, for example, is an IoT platform proposed for the integration of industrial devices, for predictive analysis on machinery and for the verticalisation of applications typical of execution and maintenance processes.

KNOWAGE - THE OPEN SOURCE BUSINESS ANALYTICS SUITE

Knowage allows the self-service creation of reusable dashboards from the data stored in the data sources registered in the Digital Enabler and from the integrated and normalized data. Dashboards are created graphically through wizards and using different types of widgets (charts, maps, tables and external web applications). Knowage also allows you to:

- define KPIs through the definition of mathematical formulas capable of transforming raw data into meaningful indicators;
- integrate smart Machine Learning systems to provide suggestions and forecasts on certain events;
- organise dashboards into thematic categories to make the use of contextual information simpler and more logical;
- show business analytics: the data collected is analysed and the results are reported in reports that can be exported in various formats.



CLOUDESIRE - SERVICE MARKETPLACE ORCHESTRATION PLATFORM

Cloudesire is an accessory component of the Digital Enabler platform whose primary function is to manage the process of interchanging data and services produced through a Marketplace function to enable the subscription and automatic provisioning of the required services. This is an extremely interesting component because it is possible to organise and expose data and services on a non-pay basis with others that can only be subscribed to through 'pay per use' options. Cloudesire thus enables the effective implementation of Data Monetisation models that represent one of the important expectations in the valorisation of data as a tangible economic value.

Other scenarios of use to be implemented soon have already been identified and represented in as many "Digital Enabler Reference Frames" concerning:

- the management of production and distribution assets for multi-utilities;
- the integrated geo-referenced management of the logistic, physical and logical assets of an organisation distributed over the territory;
- support for home healthcare and integrated management of health surveillance systems;
- security and urban mobility;
- the process of transformation from product to service in all sectors of capital goods with high added value;
- tools for identifying and monitoring tax avoidance and tax evasion.

Finally, Engineering Group is committed to strengthening its portfolio of offerings with complementary solutions related to advanced IoT Data Stream technologies (telemetry), LoRA WAN technologies for data transport, as well as manufacturers of IoT devices increasingly specialised in different vertical market applications. It is doing so through collaboration with start-ups and partnerships with Italian and foreign companies active in the data-oriented solutions segment.

Overall, the resources and investments made by Engineering Group in support of IoT technologies, also in view of the growing role of 5G in Italy and the infinite opportunities that will derive from it, place this line of offer at the top of the priorities to be pursued in the coming years.

6 IoT IN ENGINEERING

Engineering's presence in the field of IoT technologies is now ten years old, born to support the automation of industrial production sites and then evolving in all market sectors. The experiences and projects carried out include logistics, industry, Augmented City, Smart Agriculture, Digital Retail & Fashion, Digital Media & Communication, Smart Energy & Utilities, E-Health and Smart Government, and a growing number of contexts where interaction with sensors and intelligent ecosystems has become widespread and ubiquitous in the lives of people and advanced societies.

Engineering's positioning therefore covers all areas and social contexts. The solutions proposed have evolved gradually, identifying both vertical solutions and horizontal platforms capable of supporting the development of new contexts and scenarios of use, resulting in as many verticalisations.

THE WORLD **WE LIVE IN**

Augmented City

CASE STUDY / Città di Pisa: smart mobility a regola d'arte

Approach

Pisa, is one of the most visited cities of art in the world, it hosts the main airport of Tuscany and its universityis an important center of scientific and technological excellence. It is the socioeconomic engine for an urban area of 200,000 inhabitants, with a monthly influx of 300,000 tourists, Pisa was characterized by heavy congestion, with traffic both in the historic center and on the main access roads, obstructing public transport. In order to regulate traffic flows, it was necessary to introduce a highly flexible system of rules and access tariffs that could be configured by time slots and users, together with digitization of related mobility and parking permits.

Solution

Today, thanks to implementation of innovative solutions provided by Kiunsys, the innovative start-up that is part of the Engineering group:

- users can purchase and renew their parking and ZTL (limited traffic areas) access permits online with INES Cloud BSS Pisamo;
- the tickets purchased are associated with the personal PisaPass, the RFID card that abolishes paper permits;
- thanks to an app for smartphone with RFID reader, on-road staff can immediately check the validity of the permit and can issue the fine on the spot;

- localized RFID Gates on the urban perimeter identify the ZTL permit on the vehicle and measure traffic flows;
- 150 Parking Spot Sensors detect the occupation status of individual parking bays and send the information to LED panels and the mobile Tap&Park app.

Smart Energy & Utilities

CASE STUDY / Intelligent water distribution system

Approach

Our Client is an entirely public multi-utility company, one of the largest in Italy in terms of size and turnover, both for integrated water services and for environmental services. The company needed an integrated water cycle management system able to be configured with the ongoing infrastructure review and exploit the innovative digital technologies of the Industry 4.0 thread.

In particular, the needs were:

- real-time analysis and monitoring of assets;
- automatic diagnosis of potential failure situations, currently dependent solely on the experience of operators;
- integration with other IT components of the group for an automatic exchange of information (i.e. management of maintenance interventions to reduce response time).

Solution

DiVE, our proprietary platform, provides a complete system of asset monitoring and supervision, performance calculation and predictive analysis based on machine learning algorithms.

Given the versatility of the product, it can be used not only in the industrial sector, but also in the Energy & Utilities field, as in this case. Specifically, the MAPs, Early Warning and Analytics modules offer real-time monitoring functions as well as machine learning and analytics functions for predictive asset diagnostics. The DiVE solution is also open to integration with existing management systems and thanks to our experience as a system integrator we can provide 360° support to achieve this integration.

Smart Transportation

RESEARCH PROJECT / MAIA - Security is onboard

Approach

One of the biggest challenges and priorities for managers of railway lines is to effectively monitor and protect their vast infrastructures, not only from a technical and physical point of view, but also in terms of Cybersecurity.

Current monitoring solutions are not sufficient yet: most inspections on rail infrastructures are still carried out by operators through manual inspections.

The MAIA project addresses the need to effectively manage infrastructure monitoring and protection through innovative ICT solutions, in order to guarantee high standards of safety and reliability.

Solution

Our solution will provide valuable support for decision-making processes and infrastructure monitoring, for a systemic and comprehensive vision of the operational status and transport safety.

In particular, our solution will facilitate:

- real-time and remote monitoring and control, thanks to the potential offered by the Internet of Things;
- a better ability to analyse large amounts of diverse data, relying on Artificial Intelligence (AI) and Advanced Analytics;
- the introduction of new technologies to detect cyber threats and anomalies, currently not available in the railway sector.

MAIA will rely on the use of on-board diagnostic systems, for an immersive view of the infrastructure, and a mobile diagnostic service through the use of drones.

Digital Media & Communication

RESEARCH PROJECT / 5G: The network of the future

Approach

Among the technologies capable of enabling digital transformation, 5G is certainly one of those for which there are greater expectations. According to the "MIT Technology Review" technology magazine, 5G is a "change of technological paradigm, similar to the transition from typewriter to computer". It will be a very complex system, which requires real-time management of resources based on a hierarchy of complex decision-making techniques that will analyze historical, temporal and frequency network data. Our Research and Development division is preparing to meet this challenge with the coordination of a project called "5G-Media", which exploits 5G performance in the media industry for supporting and managing production, distribution and use of advanced digital content, such as that of virtual and augmented reality.

Solution

Our solution uses an innovative management of the cognitive network that involves the use of Machine Learning techniques to develop self-aware, self-configuring, self-optimizing, self-repairing and self-protective systems. A technology which is absolutely necessary for the management of a demanding infrastructure, but still needs further improvements in terms of scalability and flexibility.

The introduction of "cognition" and programmability are necessary for ensuring the flexibility, reliability and automatic reconfiguration necessary to apply 5G to the media sector, but the management of the huge data traffic volumes, with different QoS requirements generated by a huge load of heterogeneous devices is still one of the main challenges of 5G technology.

THE WORLD **WE WORK IN**

Digital Industry

CASE STUDY / **Big Data e IoT for Centro Ricerche Fiat**

Approach

Develop innovative solutions for the European manufacturing sector. With this objective, OEDIPUS (Operate European Digital Industry with Products and Services) was born, a research project belonging to the Digital Industry Action Line of EIT Digital. One of the results of this initiative is DIDA (Digital Industry Data Analytics), a data analysis platform developed by Engineering and tested with the FIAT Research Center.

DIDA enables the collection, storage, analysis and visualization of a considerable amount of Big Data coming from different sensors placed on the production lines inside an FCA plant, such as those of sensorized welding cells.

Solution

DIDA follows the approaches defined for platforms within the Industry 4.0 paradigm (Platform I4.0) and the RAMI 4.0 architectural model. Furthermore, it exploits the existing open source components in the FIWARE and Knowage ecosystem, the Engineering software that supports Business Intelligence, Big Data analysis and advanced data visualization features.

Thanks to these features, DIDA allows to:

- manage and analyze heterogeneous data even from users without specific IT skills, such as analysts and managers;
- monitor and identify events from production lines;
- have a clear view of the parameters of interest supporting decision-making processes;
- develop different applications aimed, for example, at monitoring the production system and quality control.

Digital Finance

CASE STUDY / SUNRISE: Proximity services and technologies for Smart Mobility

Approach

Proximity technologies and services are assuming a fundamental role in facilitating everyday life: from NFC payment apps, to QR scanning, up to technologies such as Beacon, BLE, RFID, ZigBee, Wi-Fi, etc.

SUNRISE ("Technologies for proximity services and mobility in smart cities and areas") is an innovative project born from the fruitful collaboration between companies belonging to the Tuscan area. The aim of the project is to create a modular, open ecosystem of proximity services and technologies as well as Location Based Services (LBS), which will be more integrated and advanced, leveraging IoT technologies.

Engineering is the coordinator of the project and one of the partners together with: PLANET, LEONET (VAR Group), PROJECT, DATAPOS, CUBIT, LIBEROLOGICO.

Solution

Within the project, Engineering provides a complete User Experience through the following services:

- indoor/outdoor localization (“core” service);
- payment, ticketing and booking ("device independent" service);
- infomobility, parking payment, access authorizations, etc.;
- dematerialization of payment cards and fidelity cards;
- loyalty;
- business Intelligence for data elaboration of big data;
- “Personal service card”: a digital, unique ID for vehicles and people;
- prototypes for city, health and tourist contexts.

Digital Retail & Fashion

CASE STUDY / Radicalbit: Data Stream Analytics

Approach

Radicalbit is a startup at the forefront of the development of products and solutions for streaming data analysis. In order to process a very high number of transactions in a very small unit of time, it developed RNA, a platform that enables the development of data stream control algorithms capable of extracting and correlating key information from raw data, in real time and seamlessly. Radicalbit turned to Engineering to further strengthen its solution offering in the Data Stream Analytics segment in the Fashion and Retail sectors.

Solution

Prompted also by the current restrictions imposed by the pandemic, Radicalbit developed the GoLive solution that Engineering is able to integrate and customize with customers' eCommerce systems thanks to the Digital Enabler ecosystem platform. The solution makes it possible, in a very short time, to activate LIVE STREAM SHOPPING campaigns, a trend now established in the East, where AI supports the retailer, through this new digital channel, in proposing its collections by virtualizing the active experience of participating in a Live Show. The continuous analysis of the data flow allows for the real-time interpretation of a great deal of information on product satisfaction, the emotional 'sentiment' of the participants, the location and concentration of the participants, the groupings by spending profile and so on, which is very useful for activating 'instant promotion' actions, all with the strictest respect for security and privacy profiles.

Smart Agriculture

CASE STUDY / Maison Anselmet

Approach

Il Maison Anselmet is one of the most important and appreciated wineries in Valle d'Aosta which, from generation to generation, has defied the particular climatic and environmental conditions of the territory to ensure the excellence of its products over time. Our goal has been to support the yield of the winery's highest value vineyard. With our experts we have used the latest technologies in the field of Big Data and the Internet of Things to analyze the microclimate and identify the environmental factors that can optimize crop development and prevent the spread of plant diseases.

Solution

We structured the project in two phases:

- in the first, we built an infrastructure of sensors based on the LoRaWAN™ (Long Range Wide Area Network) protocol, with a technology capable of collecting data on climate and soil conditions in real time and forwarding them to a cloud platform for their analysis;

- in the second phase, the collected data was processed to turn them into information useful for the agronomist in his/her daily activities, from irrigation needs to plant treatment.

THE WORLD **THAT LOOKS AFTER US**

Smart Government

CASE STUDY / **Inf@nzia DIGI.Tales for a digital scholl**

Approach

Inf@nzia DIGI.Tales project, financed by MIUR, was born to improve children's learning experience (aged from 3 to 6) through educational activities that leverage Digital Media solutions, thanks to the creation of new digital environments for learning, free expression and multisensorial experiences, enabled by user-friendly interfaces and IoT solutions. Through Design Thinking, the Involvement of school, teachers and parents in children's learning activities is optimized, enabling a continuous sharing through a single digital platform.

Solution

Engineering developed a Learning Experience Platform, a ready to use and open source solution that supports learning processes and knowledge management and represents a SPOCK (Single Point of Contact & Knowledge) for all its users.

The platform integrates authoring tools to provide accessible informational and training contents in order to update teachers and parents, validating the competences of parents and teachers by releasing badges (Open Badge compliant) and adopts Big Data solutions to trace online users' activity, and machine learning to predict school dropout.

Digital Defense, Aerospace & Homeland Security

RESEARCH PROJECT / CONNEXIONs: next-generation detection, prediction, prevention and investigation services

Approach

CONNEXIONs (InterCONnected NEXt-Generation Immersive IoT Platform of Crime and Terrorism DetectiON, PredictiON, InvestigatiON, and PreventiON Services) aims to develop and demonstrate next-generation detection, prediction, prevention, and investigation services.

These services will be based on multidimensional integration and correlation of heterogeneous multimodal data, and delivery of pertinent information to various stakeholders in an interactive manner tailored to their needs, through Augmented and Virtual Reality environments.

CONNEXIONs solution encompasses the entire lifecycle of law enforcement operations including:

- pre-occurrence crime prediction and prevention;
- during-occurrence LEA operations;
- post-occurrence investigation, and crime-scene simulation and 3D reconstruction.

Solution

CONNEXIONs has been conceived as an integrated solution that significantly improves LEAs' capability to gather intelligence, analyse, engage, and investigate crime and terrorism effectively and efficiently.

The multimodal data sources include Surface/Deep/Dark Web and social media content, as well as data acquired by Internet of Things (IoT) devices (e.g., wearable and fixed sensors, static, mobile, body-worn, or drone-carried cameras).

Real-time services will benefit from:

- advanced operation command and management solutions, integrated with IoT devices and sensors;
- from multimodal multimedia data fusion and analysis;
- computer vision and deep learning (face identification, suspicious object recognition, and abnormal activity detection).

E-Health

CASE STUDY / Proximate: Anonymous Tracing System

Approach

The COVID-19 Pandemic has created an unprecedented need to track people's movements in order to limit virus transmission. Contact tracing makes it possible to break the chain of infection transmission through the rapid identification of all the people that a COVID-19 infected person has come in contact with.

Proximate proposes to any organization of people co-living an experience in space and time (e.g. sport facilities, leisure facilities, schools, universities, private and public organizations) a wearable device, small, cheap, anonymous and using standard technology to avoid lock-in.

Solution

The complete solution is composed by: a wearable device (token), a dedicated app for COVID Manager / Health Operator (running on iOS/Android), the back-end system to manage infected list and a gateway using BLE technology to broadcast the infected list to the tokens.

The token protects people's privac, is chosen randomly, and no one is able to connect people to the serial number. In case of a positive COVID-19 test of the owner of the wearable device this will notify to the system the serial number and a notification is broadcasted to nearby tokens. No one is informed about the status of the owner of the wearable device and no one is in the position to know where and when he/she has been in contact with an infected person.

7 WHAT IS THE FUTURE OF IoT?

The combination of the pervasive technological factor, together with the worldwide spread of millions of smartphones acting as a potential hub for IoT devices, are the two factors that can offer endless opportunities to transform the daily lives of individuals and organisations.

The challenge is therefore between those who will be able to offer tangible benefits to users and organisations, gaining new competitive advantages, and those who will be able to transfer these contents into the products and services they offer. IoT enables potentially unlimited scenarios, ranging from the care of fragile people, suffering from more or less severe diseases, to the monitoring of the territory and infrastructures, from the logistics of materials to precision agriculture, from the management of security and crime prevention to the management of shared mobility services in urban areas, as well as the intelligent management of energy and household consumption.

But the real turning point, which is engaging and challenging most manufacturing companies, i**s to rethink the concept of the product which, in its future meaning, will be intelligent and inherently managed by IoT**. This transition will make it possible to make the generational leap from product to service managed according to clearly defined consumption, flexibility and cost metrics, with continuous availability. New business models based on the concept of servitization and new data-driven services represent, therefore, new opportunities towards the realisation of the Digital Transformation of many organisations, both in B2C and B2B scenarios.

Among the many enabling technologies that are now mainstream, IoT has assumed a universally recognised relevance: IoT is, in fact, the first enabler of the diffusion of other technologies (such as Big Data, Artificial Intelligence, 5G).

For companies managing large assets spread across the territory, the combination of IoT and AI will activate sensitive networks for transporting people and goods. The advantage will be to monitor the state of their infrastructures with the possibility of preventing the maintenance operations necessary to guarantee the safety of users, the quality of the service provided, the containment of management and insurance costs linked to operation.

For example, in the Augmented City, different platforms cooperate in a "System of Systems" logic that uses AI and IoT as technological enablers for synergistic dynamics. Electric mobility, renewable energy producers (photovoltaic and wind power), electricity distribution network, charging stations and service providers will interact within the "augmented city". In all of this, **IoT, used in conjunction with AI, will act as the 'glue', enabling the exchange of information between different platforms and paving the way for new scenarios** in which electric vehicles can be recharged in order to stabilise excess renewable energy production in certain areas of the grid. Increasingly reliable consumption forecasts and real-time optimisation will therefore be the strengths of advanced services within these scenarios.

IoT has opened up new and important opportunities not only for companies but also for public administrations, which are faced with a multitude of possibilities for innovation and social, political and economic progress that were unthinkable just a few years ago. The advantages that this new paradigm can bring to public administrations, and consequently to cities and citizens, are innumerable: they range from greater efficiency, effectiveness, sustainability and flexibility of services, to a reduction in costs and therefore an improvement in the empowerment of citizens, to greater transparency of government activity, more efficient application of regulations and an improved capacity for planning and forecasting. In the very near future, IoT will have an increasingly important and significant impact on public services, generating new models of governance and revenue, but above all enabling the creation of innovative and personalised services capable of addressing the complex challenges of contemporary society.

All these scenarios have in common that they are interconnected thanks to intelligent devices that communicate with central systems and other objects distributed throughout the territory: this is what we stand for when we talk about IoT.

The real challenge of IoT, however, will be to make "objects" an active part of the complex urban system made up of people, regulations, infrastructures, interactions, services, thus creating an interconnected "whole" that can be much more than the sum of its individual parts.

IoT is often rightly regarded as the primary enabler in the exploitation of the Digital Twin. Not only does this technology play a central role in the exchange of data between the real world and the digital world that transforms the Digital Twin into a "Digital Product Memory" with practically unlimited applications, but it also becomes an exchange currency between different Digital Twins that, by connecting with each other, can offer new value-added services from a holistic system-of-systems perspective.

Organisations cannot ignore these perspectives and their implications, perhaps for external reasons such as lack of appropriate skills or simply because they believe they are of interest to others. Digital Transformation is already underway. **And in this process, which the pandemic has accelerated, making it no longer an option but a necessity, IoT technologies play a central role in redefining human behaviour, decision-making mechanisms, and economic and social models.** This is because IoT allows information to be taken from the closest possible source in a certain way and without intermediation.

Understanding the features and opportunities offered by IoT technologies, and which will even more mark our future, is an act of individual and collective responsibility of all organisations and governments. And it requires investment in technological, process and regulatory expertise to accompany the introduction of the new models. The experience of Covid-19, the need for broad and massive contact tracing solutions to contain and monitor the pandemic are a clear declination of this concept.

But along with an understanding of the benefits, the ethical and social implications implicit in the technology must be assessed, as well as those relating to the protection of the data acquired and the security management applied to the devices that collect and analyse them. The risk of deregulation is real, determined by the fact that there is no way to slow down these processes and their applications. Some web giants have already realised the huge opportunities behind the massive adoption of IoT (and more) in sectors that are completely new to them. One example is healthcare, where huge investments are flowing in, to offer new services by exploiting the channels opened by the various voice devices in the home.

Engineering is ready to support companies, organisations and institutions to understand and face these challenges through a total vision of technological scenarios, possible applications, the implications necessary to revise processes and paths of adoption and training. As always in its history, the ability to offer an overall view and to address the different cases with the expertise of each sector of the economy and local and central administration, make Engineering the reference partner to drive change by playing a leading role capable of seizing the incredible opportunities that this time offers us.

ENGINEERING

For more than 40 years Engineering has been one of the main actors in the digital transformation of both public and private companies and organisations, with an innovative range of services for the main market segments.

With approximately 12,000 professionals in 40+ locations (in Italy, Belgium, Germany, Norway, Serbia, Spain, Switzerland, Sweden, Argentina, Brazil, and the USA), the Engineering Group designs, develops, and manages innovative solutions for the areas of business where digitalisation generates major change, such as digital finance, smart government & e-health, augmented cities, digital industry, smart energy & utilities, and digital media & communication. In the course of 2020, Engineering has supported its partners in the continuation and protection of their businesses and key processes, assisting in the design of their 'new normal' and the mapping of new digital ecosystems. With its activities and projects, the Group is helping to modernise the world in which we live and work, combining specialist skills in the final frontier of technologies, technological infrastructures organised in a unique hybrid multi-cloud model, and the ability to interpret new business models. With important investments in R&D, Engineering plays a leading role in research, coordinating national and international projects with a team of 450 researchers and data scientists and a network of scientific and academic partners throughout Europe. One of the Group's strategic assets is the expertise of its employees, whose development is promoted by a dedicated multi-disciplinary training school that provided more than 19,000 training days over the last year.

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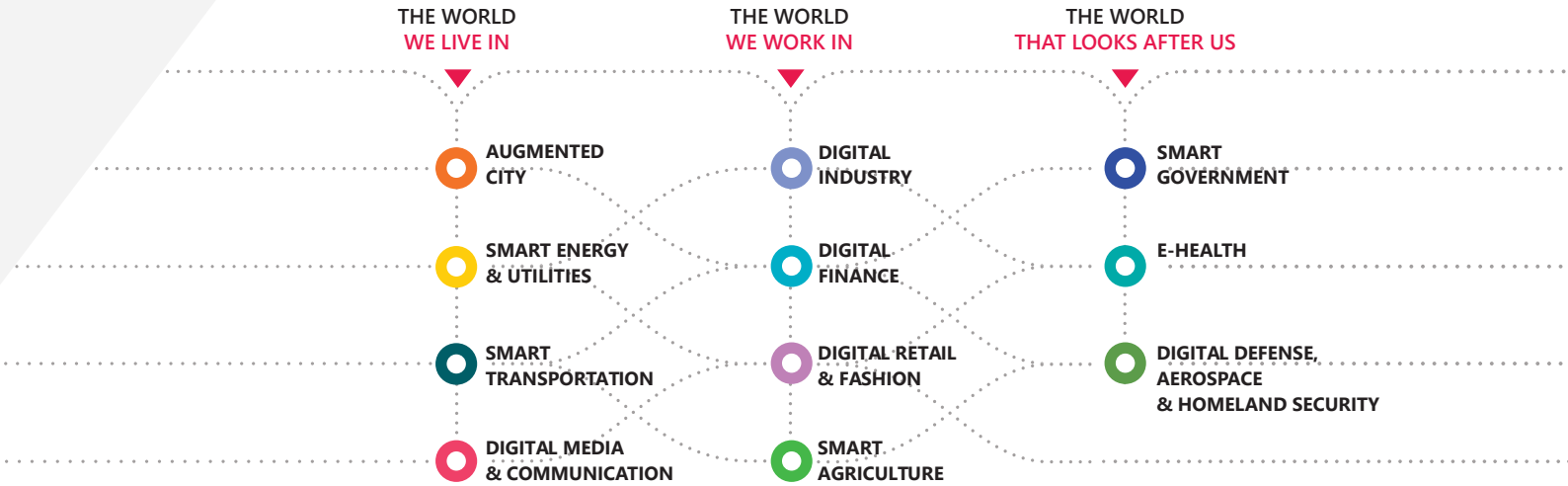

Our point of view

DIGITAL TRANSFORMATION

ENGINEERING INNOVATION

ENGINEERING THE NEW NORMAL

WHERE BUSINESS MEETS TECHNOLOGY

AUGMENTED CITY

DIGITAL DEFENCE, AEROSPACE & HOMELAND SECURITY

DIGITAL FINANCE

AUGMENTED MIXED AND VIRTUAL REALITY

BLOCKCHAIN

DIGITAL INDUSTRY

DIGITAL MEDIA & COMMUNICATION

DIGITAL RETAIL & FASHION

CLOUD

CYBERSECURITY

E-HEALTH

SMART ENERGY & UTILITIES

SMART AGRICULTURE

DIGITAL TWIN

IOT INTERNET OF THINGS

SMART GOVERNMENT

SMART TRANSPORTATION

Coming Soon

ROBOTIC PROCESS AUTOMATION

AI & ADVANCED ANALYTICS

DIGITAL WORKPLACE

DIGITAL WASTE

DIGITAL EXPERIENCE: CULTURE & TOURISM

SUPPLY CHAIN

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