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Cloud-Edge-IoT Innovations in Manufacturing: Unveiling Market Insights and Use Cases

Post-webinar Report

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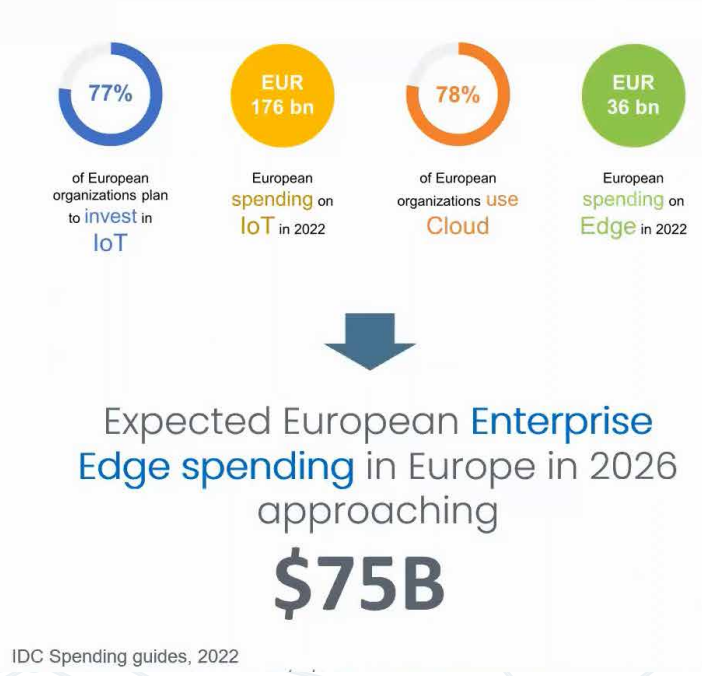
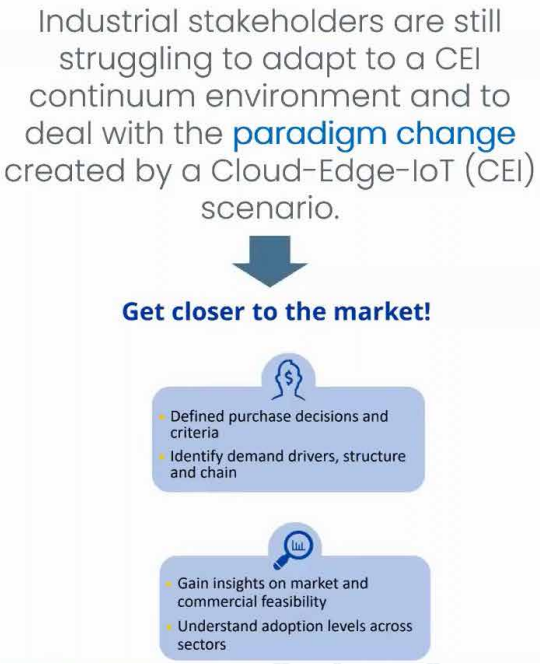
July 10 saw the organisation of the webinar "Cloud-Edge-IoT Innovations in Manufacturing". The event explored the transformations witnessed by the manufacturing industry in recent years, providing in-depth market and industry insights for the manufacturing sector, specifically focusing on cloud-edge-IoT use cases. It also provided valuable information and knowledge to navigate the evolving manufacturing landscape and unlock this sector's true potential of the Cloud-Edge-IoT continuum. The event was co-organised with the Meta Operating Systems projects of the EUCEI Community aerOS and FLUIDOS.

The event was part of the "Cloud-Edge-IoT industry innovations" webinar series, which explores the latest industry trends, discusses sector-specific service requirements, showcases real-world use case presentations, and engages in panel discussions with industry experts to shed light on the challenges and opportunities faced by companies in adopting and harnessing the full potential of these technologies. Each webinar focuses on a specific sector.

The first speaker, **Golboo Pourabdollahian**, consulting manager at IDC, outlined the first results of the Unlock-CEI project, exploring the demand side of cloud-edge IoT technologies with specific insights on the manufacturing sector. Unlock-CEI, part of the EUCloudEdgeIoT umbrella initiative, was conceived to investigate the growing adoption of this spending on Cloud edge IoT across Europe. According to IDC's forecasts, by 2026, Europe's expected spending on edge technologies will reach 270 $5 billion. Although this is a significant figure, industrial stakeholders still have trouble implementing and adopting these solutions.



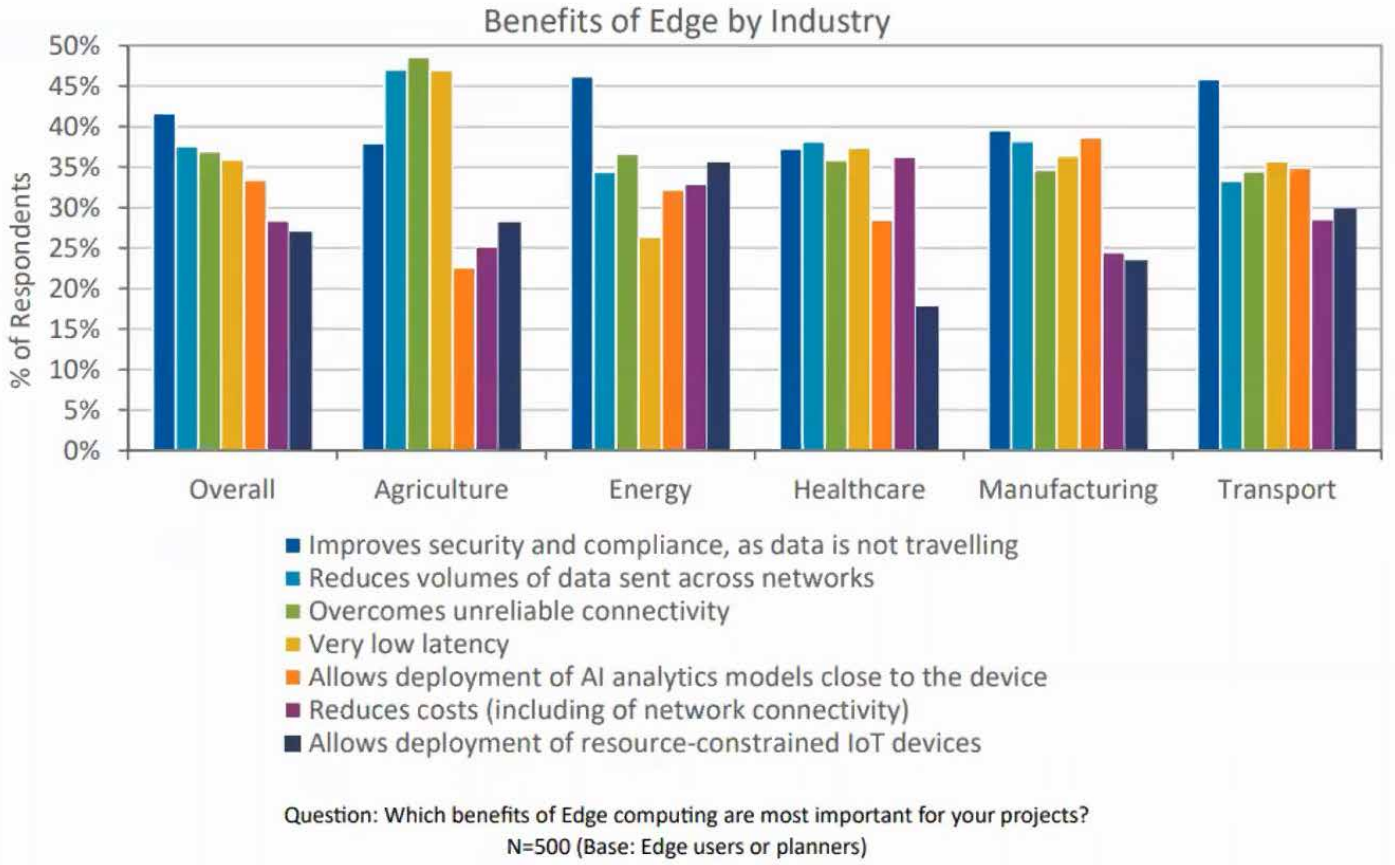


Europe's expected spending on edge technologies will reach $275 billion by 2026, but industrial stakeholders still face challenges in implementing and adopting cloud-edge-IoT solutions.

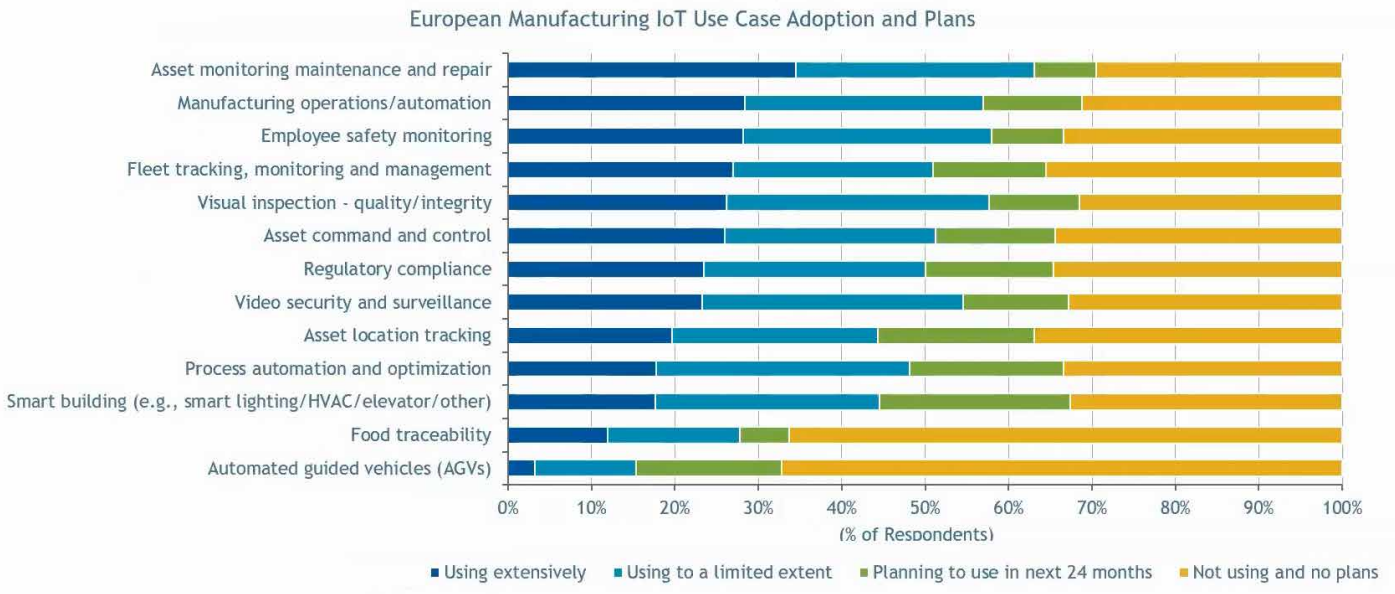
In this context, the mission of Unlock CEI is to understand what's happening in the European market and to accelerate and facilitate the deployment and implementation of Cloud-Edge-IoT adoptions across the computing continuum by understanding the drivers and, most importantly, the business opportunities for European stakeholders for cloud edge IoT. In this context, the project has five main objectives. First of all, assess the demand landscape of cloud-edge-IoT technologies. Second, define some market scenarios and guidance to understand potential market scenarios and pathways. Third, establish a dialogue between the industry and technology providers. Fourth, get engaged directly with the industrial stakeholders. Fifth, coordinate with the portfolio projects and technology providers.

Five main market sectors are engaged: agriculture, energy, healthcare, manufacturing, and transportation. Zooming in on manufacturing, the Unlock-CEI survey demonstrated that the adoption of cloud-edge-IoT solutions is increasing across Europe. However, it is still very limited, especially in terms of technologies which are on edge. Current edge adoption is really small, ranging around 9%. However, interestingly, many companies plan to adopt and move towards edge or distributed cloud computing continuing in the next two years. Thus, there is a huge potential for the computing continuum and moving the resources towards the edge.

Security and compliance improvement are the main drivers pushing manufacturing companies to such a paradigm shift. Other factors include the reduction of the volume of data across the networks, deploying AI and analytics models closer to the device and low latency.



The most relevant use cases include asset monitoring, maintenance and repair, manufacturing operations, employee safety and fleet tracking. However, although other use cases have currently not a high adoption rate, there is a significant implementation opportunity for future adoption. Among the use cases with the most potential are asset monitoring and maintenance, autonomic operations, autonomously guided vehicles and robots and visual inspections and quality control. The benefits of the cloud-edge-IoT paradigm for these use cases vary according to how the workload is distributed across cloud and edge and from some specificities.



To conclude, according to the survey, less than 25% of companies are already using these technologies on a larger scale. Thus, despite its potential, much work is needed to implement these solutions on a larger scale. There are also top barriers to adopting cloud-edge-IoT like any other technology. And one of the

most important is the lack of adequate IT infrastructure. Other significant concerns include security, deployment costs and lack of scale. Current solutions are indeed complex, costly, and slow. Moreover, in many cases, their technologies are not mature, and their ecosystem is still fragmented and evolving.

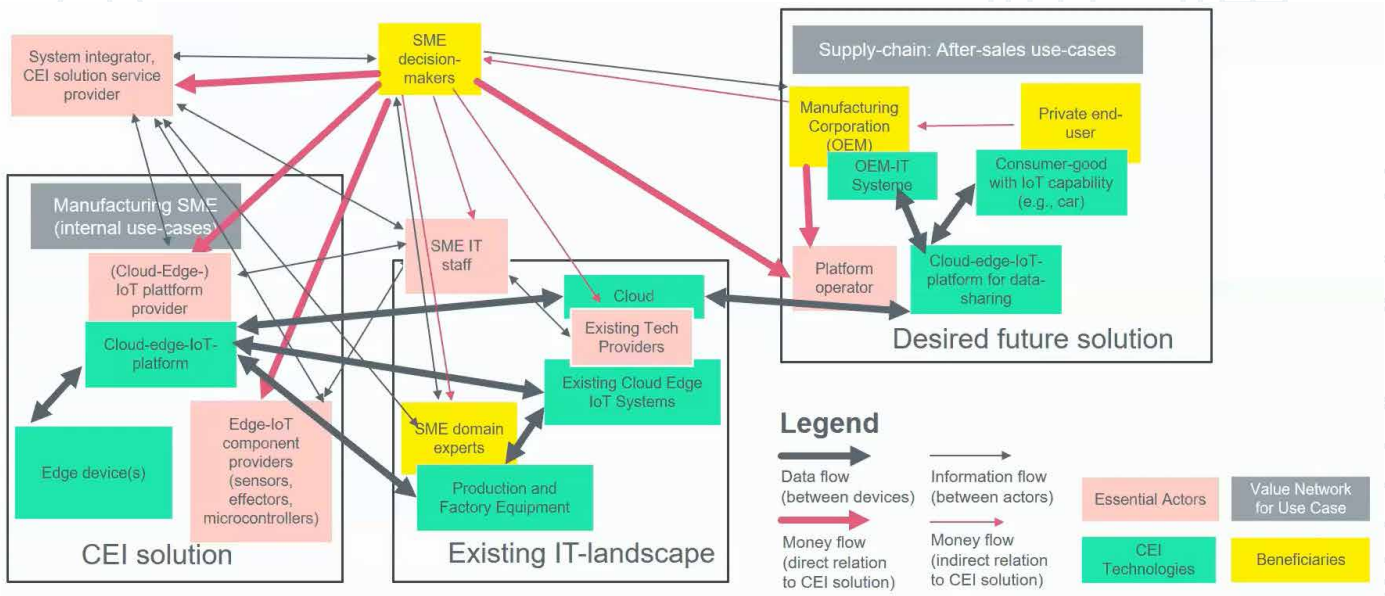
The adoption of cloud-edge-IoT solutions in manufacturing is increasing, with many companies planning to move towards edge or distributed cloud computing in the next two years, indicating a significant potential for the computing continuum.

These challenges can, however, constitute opportunities for technology providers from the supply side to craft solutions for complexity, cost integration and adoption.

Read the updated CEI demand landscape report

The second speaker, **Marieke Rohde**, Scientific Consultant for Computer Science and Artificial Intelligence, VDI/VDE Innovation + Technik, discussed how Unlock-CEI entered a dialogue with stakeholders from the manufacturing sector to identify promising use cases that could be recommended to the European Commission for large scale pilot. Through an interactive online workshop with industry associations and stakeholders, two interviews were done with a German cloud-edge technology provider from the aerospace sector and an Italian metal sheet manufacturer.

The interview findings demonstrated that in the manufacturing sector, especially in small and midsize companies, use cases do not use edge and cloud applications to share data along the value chain. Moreover, on a holistic level, the solutions have low transferability as standardisation lags in this sector. Therefore, solutions are extremely individualised, slowing down the market uptake.



As for the solutions, it appears clear that company stakeholders undertake similar projects for economic reasons and to gain competitive advantages. A very important driver of innovation is a skilled labour shortage. In this context, becoming a domain expert is an important step. Another concern of the manufacturing company decision-makers is to prepare for a changing market. For example, the decarbonisation of manufacturing will change established processes creating new demands from the main clients. This demands companies improve resilience.

Use cases in the manufacturing sector do not currently leverage edge and cloud applications for data sharing along the value chain, and the lack of standardisation hinders their transferability, resulting in individualised solutions and slower market uptake.

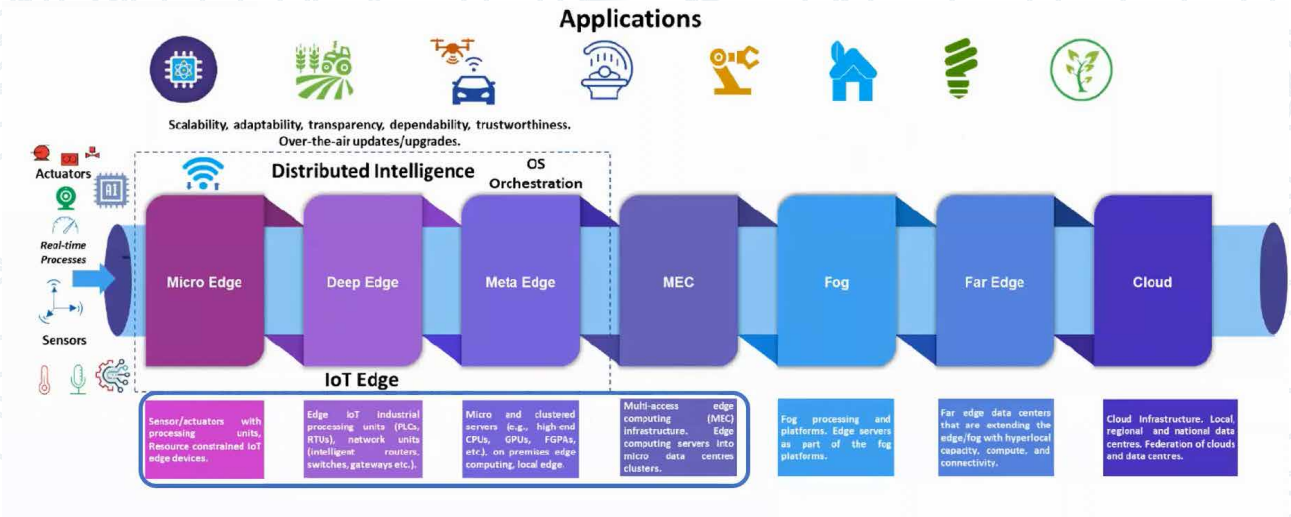
From a design perspective, creating operation environment-tailored solutions affordable to SMEs is also essential. Another important point is the solution's robustness ensuring real-time deployment, even in scarce network connectivity. Other critical requirements are low system maintenance and trained on-site staff to perform basic maintenance and updates.

Design	Installation	Operation	Value-added supplements	Maintenance, Upgrade, Disposal
Clear competitive advantage, economical, digestible investment	Cost-effective (by reuse and adaptation)	Regulatory compliance, adherence to quality standards	CEI Readiness: economical reuse of the assets should be possible	Long lifetime
Tailored to operation environment		Robust operation, trustworthy system, Real-time (10s of ms)	Scalability, Extendability and Adaptability	little maintenance (robustness)
System should learn guru knowledge	Staff training for operation (digital/data literacy)	Good usability, smooth integration in workflow, no additional chores		basic system maintenance/upgrade by non-engineers (no-code/ low-code approaches), staff training for major upgrades
Hardware available in small lots	Open standards (to facilitate reuse and adaptation)	Good and reliable network connectivity		Reliable customer-service

In conclusion, manufacturing needs to be considered as a two-stage way. First, it is essential to boost site technology readiness, company by company, by funding individual sites for innovation projects while at the same time supporting standardisation initiatives to improve robustness and reliability. Second, it is crucial to implement visionary use cases across the supply chain, understanding potential and pioneering initiatives in a given domain.

Learn more about sector-specific service requirements

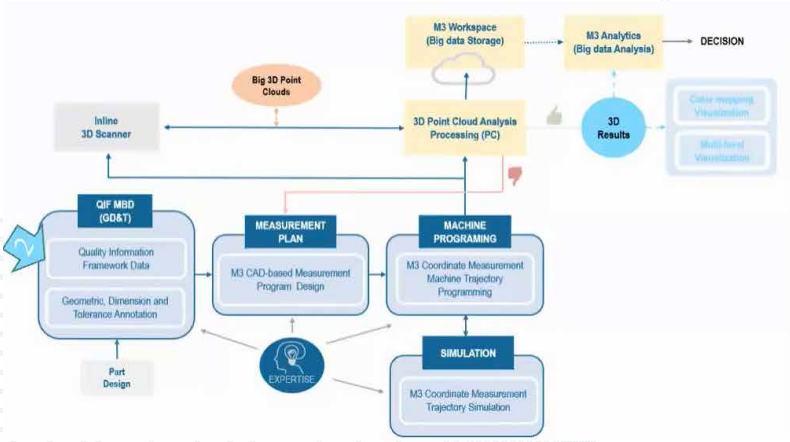
The third speaker, **Eneko Rada**, R&D Project Manager, Innovalia, presented the aerOS project manufacturing use case. Specifically, he focused on one of the project's main scenarios, visual inspection for manufacturing lines. This is interrelated to scenario one on green manufacturing and CO_2 footprint monitoring and to the third scenario on autonomous vehicles. The second scenario's main aim is to implement a four-dimensional measurement process of physical components through a CMM coordinate measurement machine allowing to read the dimensions of any pieces by laser. This provides a complete overview of the dimensions of a piece and analyses all the data related to production on the base. The main objective is to promote manufacturing autonomy Level 4 and remote operations of CMS, thus ensuring fast data processing and human-assisted automated decisions.

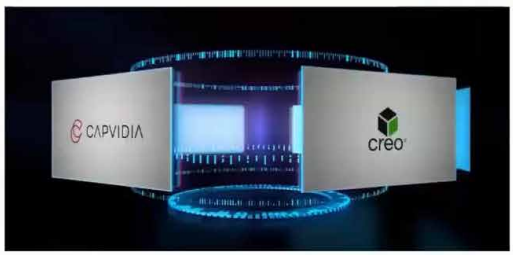


In this context, the main challenge is effectively handling the large amount of dimensional data related to different pieces and quickly analysing it. For example, a car door has 50 million points per piece, requiring high accuracy. In this context, the aerOS project is working to develop an effective

dimensional quality inspection process. The first step implies taking the cost file of the measured party, analysing the dimensions and identifying the best measurement machines. The second step concerns defining geometry dimension tolerances and creating the quality information framework. This step manually transfers the dimensional information from the CAD file to the software. The third step implies defining the measurement plan based on determining the point of a piece to be measured based on external conditions and the scan density. The fourth step consists of defining the machining trajectory and understanding the needed steps to accomplish a successful measurement dimension. The fifth point consists of the simulation of a machine trajectory. In the sixth point, the measurement is run in the interface to obtain the point cloud to analyse in the software. Finally, in the seventh point, the data generated is analysed.

The aerOS project is working to develop an effective dimensional quality inspection process in manufacturing, involving capturing reality, digitalising parts, analysing data, and integrating artificial intelligence applications to optimise measurement plans and enable real-time operations.





As can be noticed, the whole process consists of a mix of manual processes and heavy data volumes to be analysed. The main challenges include experience in metrology, consuming process and increasingly large data volumes. Conversely, opportunities concern the ability to include fast applications to automate and assist metrologists. This can be accomplished by integrating artificial intelligence applications to optimise measurement plans in low latency and real-time operations. The CMM measurement machine sends alignment and sensor data to run artificial intelligence applications and optimise CMM sequences. This allows effective data management and running artificial intelligence applications in the air in nearly real-time, optimising time and resources. Moreover, from an analytics standpoint, predictive maintenance of CMM components allows the detection of anomalies and optimises measurement sequences.

Learn more about aerOS

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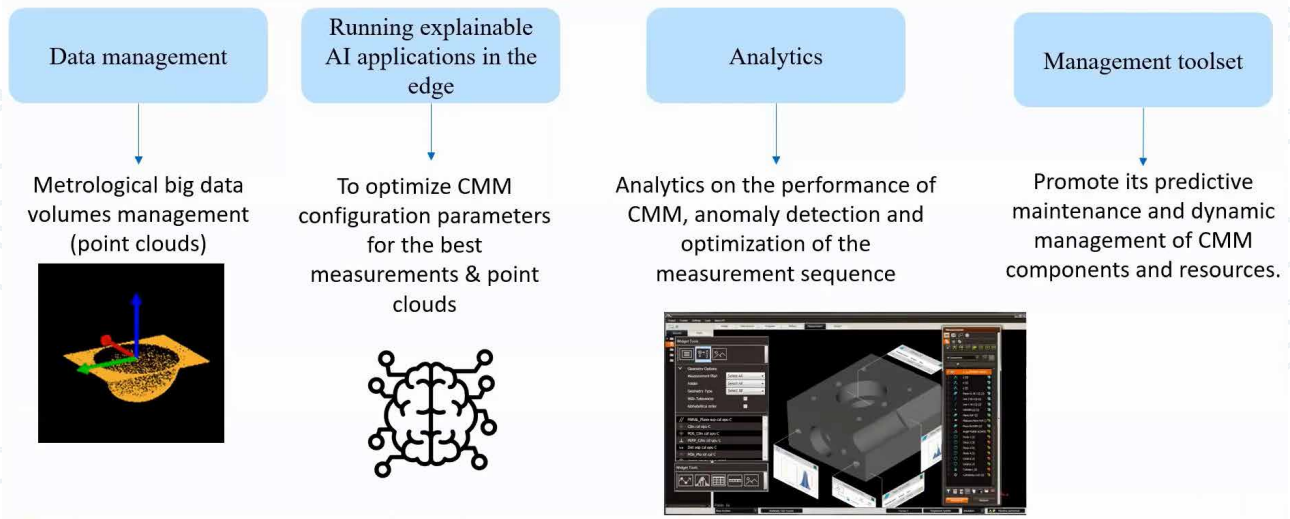
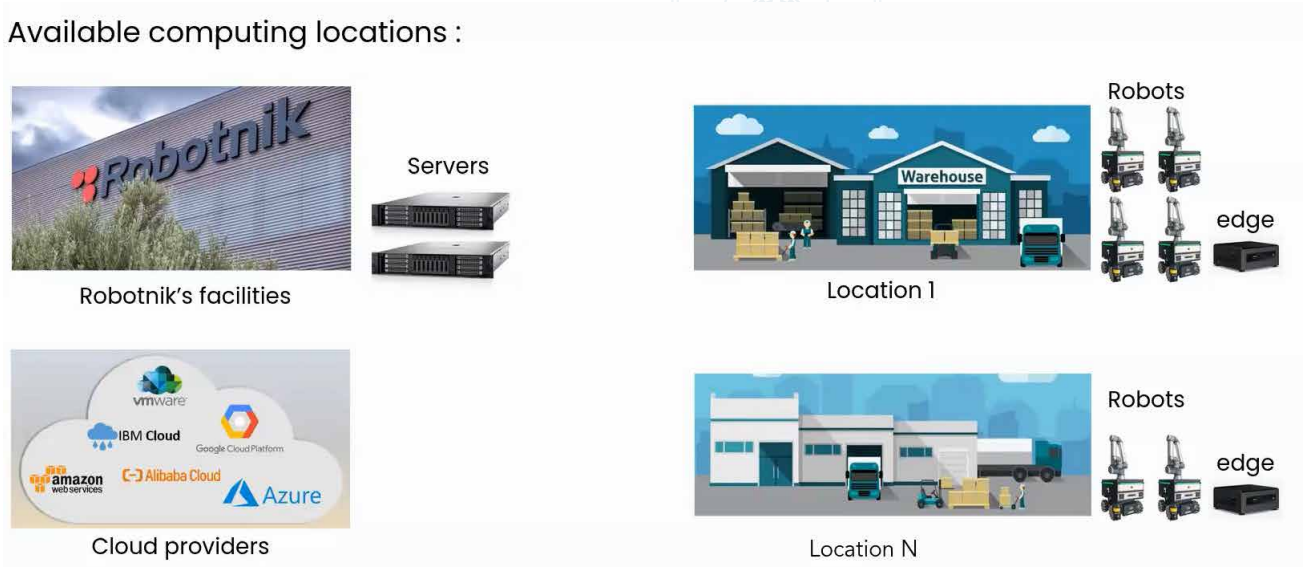
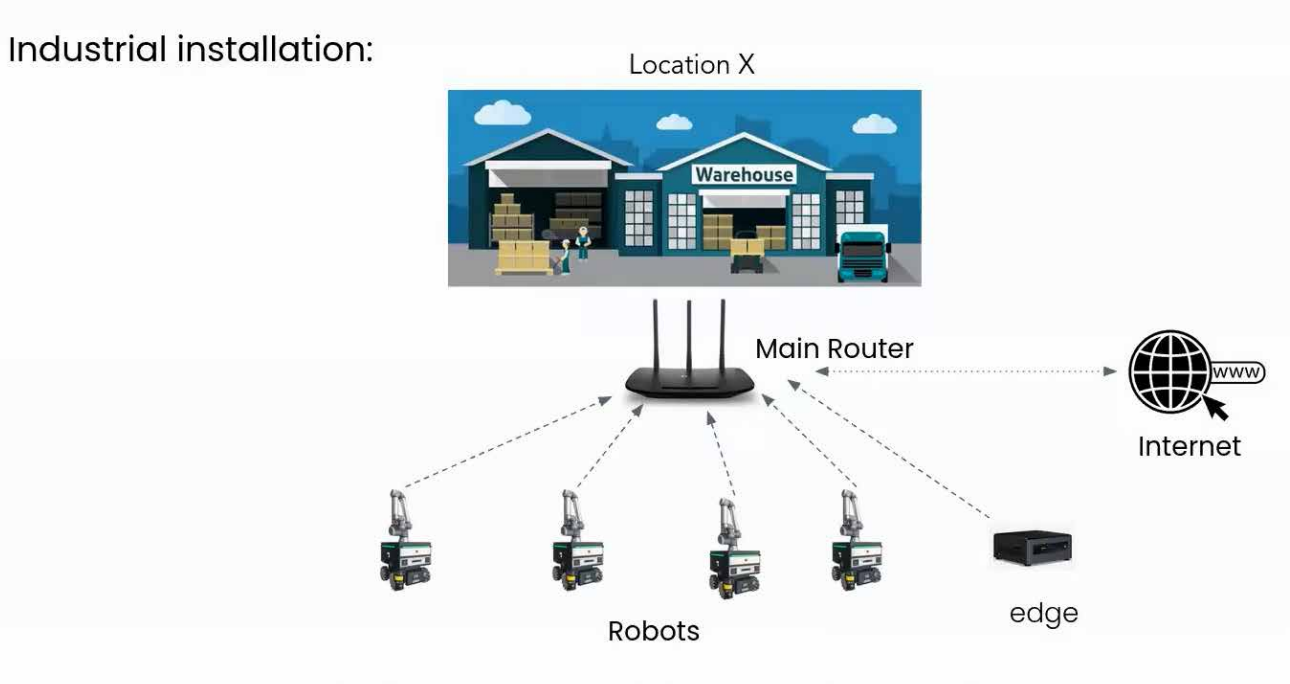


The fourth speaker, **Guillem Gari**, R&D Engineer, Robotnik Automation SLL, presented one of the use cases of the FLUIDOS project: autonomous mobile robots for logistics. These are based on complex algorithms requiring increased computational efficiency through dynamical workload orchestration to reduce costs and power consumption. Several software devices (or workloads) are placed inside fixed and mobile robots to accomplish these aims. Also, different kinds of sensors are connected to the locations where the robot acts (cloud servers, edge devices). These are all independent and connected through the internet.

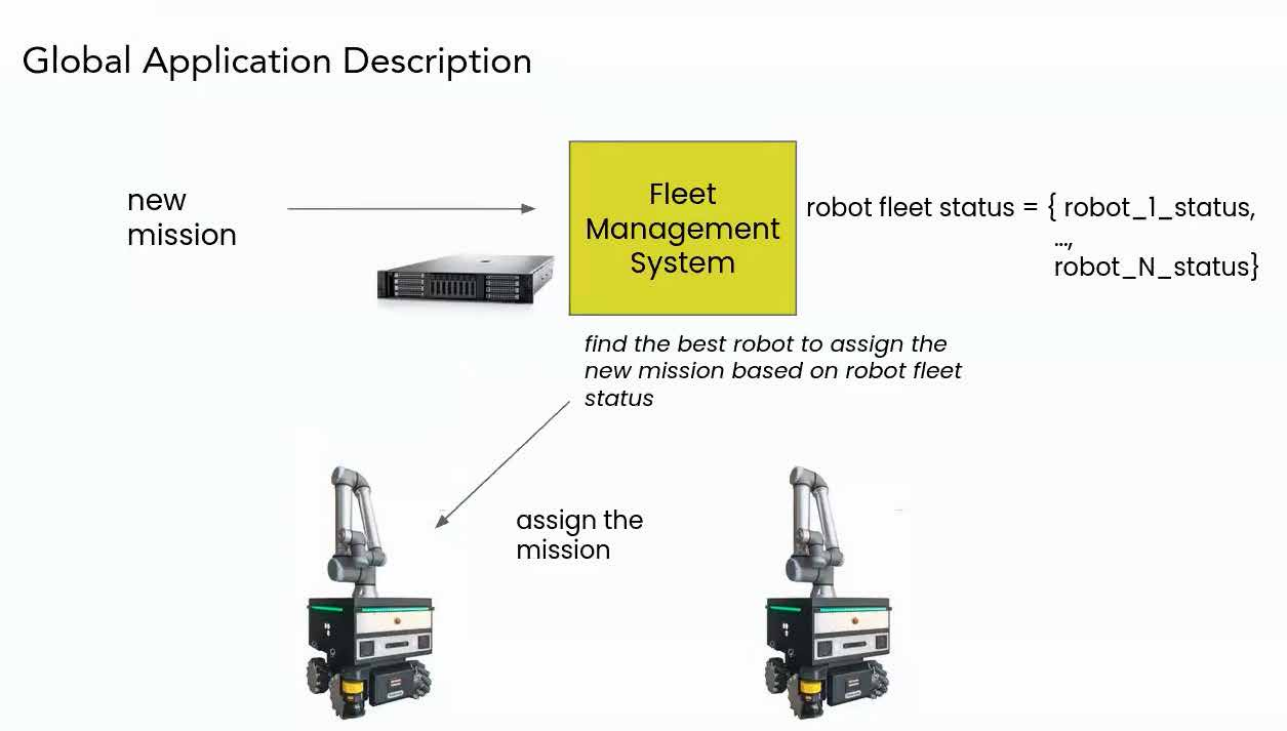


"The FLUIDOS project introduces an innovative approach to robotics by enabling autonomous mobile robots to dynamically allocate tasks and optimise computational workloads and energy consumption, increasing their autonomy and efficiency."

The FLUIDOS robotic fleet is connected to software interacting with the edge and cloud servers that manage the different robots, thus optimising goods transportation. The fleet management system allocates tasks between different robots to find the optimal individual to assign it a mission.



This constitutes an innovation of the traditional approach to robotics, where robots cannot exchange processes and tasks. FLUIDOS also attempts to define the rules that determine robot behaviours to optimise the fleet's computational workloads and energy consumption according to specific metrics like network quality, battery level, etc.



This provides a way to increase the robot's autonomy by dynamically switching or offloading workloads independently through cloud applications. This system also allows the robots to extend their computational capability by delegating the workloads according to their power. Predefined metrics allow understanding of the robots' live status (e.g., idle, ready, on a mission and charging). These states have different specifications that allow them to accept certain workloads according to their present status.

Learn more about FLUIDOS

Panel Discussion

A panel discussion focused on cloud-edge-IoT e-manufacturing followed, featuring Guillem Gari, Eneko Rada, Ignacio Lacalle (Researcher, Universitat Politècnica de València), Clara Pezuela (Vice-President Funded Programs, Fiware), Maria Rossetti (Project Manager, MADE Competence Center), Walter Quadrini (Research Fellow, Politecnico di Milano) and Alissa Zaccaria (EU Project Manager, Intellimech).

Round #1 - Current Challenges

What are the specific challenges for the development of e-manufacturing use cases? What are the current needs and requirements at the moment?

Guillem Gari pointed out that network reliability is today's biggest challenge for robotics and logistics. Currently, it is impossible to offload outside due to the blackspots. Another challenge concerns the architecture of the robotic software for cloud technologies. Finally, the cloud is not a consolidated field for robotic developers.

What are the main challenges in testing activities?

Maria Rossetti and **Walter Quadrini** remarked that the main testing challenges concern data availability. Crucial datasets, such as data models for robots' dynamic allocation, are unavailable for companies. For this reason, facilities at academic institutions need to be used to understand the minimum viable data set for industrial robots.

What are the barriers for companies to implement and integrate technologies enabling integration in the computing continuum concept?

Eneko Rada described three main barriers. First, IT infrastructure companies might have outdated technologies implemented many years ago, such as monolithic resource-management software not allowing connectivity or data sharing. In this context, the main challenge is to adopt these new technologies to older non-digitalised factories. Second, it is essential to train workers in new technologies, even when they do not have technical knowledge, designing appropriate training modules. Third, costs should be minimised, adopting the most suitable technologies for specific instances.

What challenges do industry companies face in adopting and implementing use cases for cloud-edge-IoT in manufacturing?

Alissa Zaccaria added more relevant barriers, focusing on the difficulty in building a cost-advantages analysis or evaluating the return on investment due to several uncertainties. These include, for instance: the integration of old and outdated assets; maintenance and updating costs, especially for the most recent technologies; and implementation of effective training, which is essential to ensure employee acceptance. In this context, sharing best practices with quantitative information on the opportunities linked to these technologies is crucial, as well as supporting companies that would like to embark on this innovation path (even from a financial point of view).

What are the key requirements of data spaces to be integrated into the computing continuum?

Clara Pezuela responded that once data spaces are set up, they are deployed across the continuum through edge, cloud or IoT solutions. Therefore, data spaces are relevant for the spectrum of the computing continuum. The first challenge for the manufacturing industry regarding dataspaces is to allow people to understand the data space concept, clarifying notions such as data ecosystem, governance, functionality, and digital infrastructures. The second challenge is understanding what data spaces are needed and their value and practical uses (e.g., sharing costs, addressing an added service value, and reaching a common goal). In this context, trustworthiness and interoperability are crucial, considering that data spaces are based on common models and shared APIs.

Round #2 - Future Perspectives and Way Forward

What could be the role of data spaces in data space technology to enable collaboration and interoperability among different data and stakeholders?

Clara Pezuela responded that data spaces are the ideal landscape to merge different technologies to reach the common goal of trustworthy data sharing. However, it is essential to make data-sharing APIs interoperable using the same models. Moreover, since trust and management are endemically decentralised in dataspaces, verifying credentials through universal registers is necessary. This also requires moving from a centralised to a decentralised paradigm, creating trust frameworks compatible with the European Commission standards or recommendations. Once the data is available, metadata brokers and marketplaces are essential to publish and discover it. Just as important are connectors facilitating the engagement and deployment of databases.

What are the possible drivers to overcome the adoption barriers mentioned before?

Guillem Gari highlighted the potential of 5G/6G network technologies to increase application reliability, improve service quality and eliminate black spots. Also, for the robotic field, AI-learning algorithms can potentially help manage complex rules and handle path planning in difficult situations. From a more theoretical perspective, cloud technology standards could also be extended to low-end devices, like microcontrollers, PCs, or single-board computers, helping server-grade developments in robotics.

What are the potential advantages of cloud and edge native technologies?

Ignacio Lacalle remarked on the importance of translating cloud-native technologies into the manufacturing sector. Such a step implies taking advantage of cloud-native distribution principles and applying them to different locations, taking advantage of the available resources. Such principles apply to a wide range of systems – e.g. small computing devices very close to the robots in a manufacturing plant, computers in the plant, and small cloud platforms that the manufacturing companies could access. From an infrastructure level, bringing these together and managing them in a single place would reduce complications and help apply better AI and AI services across companies across manufacturing plants. This would, in turn, allow optimising processes without the need to move data up to the cloud and easily distribute the workload, thus increasing efficiency. Conversely, from the users' perspective, helping the IT system administrator and the manufacturing stakeholder understand computing capabilities would increase their potential, using most of the computing resources available. Such discourse also relates to concepts such as plant digital twin or zero-touch manufacturing which are slowly automating decisions and processes.

How does the support from various partners help the overall impact and outcome of the use case?

Maria Rossetti remarked that Competence Center involves 49 partners, including companies, technical providers, users, and universities. All partners share their competence and know-how with machinery. The main contributions can be divided into two levels. First, the technical partners support the requirements definition, both from the technical provision and on the platform users, facilitating optimisation. Second, the ecosystem structure gathers different end users' perspectives and provides technology and market application feedback. These are essential to collect information on optimisation and possibly solve some of the challenges.

How could emerging technologies such as 5G and AI contribute to a functioning value chain?

Alissa Zaccaria remarked that emergent technologies allow the collection of datasets concerning products and services throughout the work product lifecycle and to share this data text with diverse spaces. In this context, tech enablers gain even more significance when considering circularity and manufacturing as a service paradigms. All the information generated by this data can be extracted to support product performance improvement and ultimately achieve a sustainable manufacturing ecosystem.

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