

# Inside

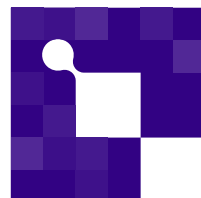
magazine



June 2024 — Issue 07

In this issue:

- **A blind spot on software**
- **Engineering automation**
- **Embedded World 2024**



**Inside**  
Industry Association

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INSIDE Industry Association shines at Embedded World 2024

Dear reader,

In this magazine issue we want to focus your attention on a dual transformation that is shaping the digital landscape. On the one hand, Europe is grappling with securing its semiconductor supply chain, with a strategy that overlooks the critical software international dependencies and hidden vulnerabilities across the technology stack. This represents a crucial software blind spot that threatens EU technological autonomy and requires a holistic EU strategy that encompasses both hardware and software, ensuring true strategic autonomy, security and safeguarding the full technological stack in the rapidly evolving geopolitical and economic landscapes. On the other hand, the ever-growing complexity of software in the Electronic Components and Systems (ECS) domain and their applications demands innovative solutions and we examine how, supported by artificial intelligence, engineering automation and hyper-automation can empower engineers, and address the insatiable demand for experts, the limited pool of available talents and the lack of appropriate solutions to alleviate these problems. Hyper-automation will become ubiquitous in almost every organisation's process (decision-making, research and development, critical operations, customer management, etc), and it is here to stay as a powerful ally, empowering people to achieve more, and to be more efficient and productive.

We also report the continuous effort to promote and support SMEs, which represent a key asset for Europe and for our Association. At Embedded World 2024 we organised an initiative aimed to subsidise SME participation in a high-profile and very expensive event, showcasing the benefits of the Association membership and its core values. The intention was to provide great visibility to four SMEs (Ropardo, Abinsula, Virtual Vehicle and Verum Software) showcasing cutting-edge products and solutions, and opening up new business prospects. The initiative was successful, and we plan to expand our presence at Embedded World 2025 to offer more space for our SME members. In this issue we also present two SMEs, ACORDE and CISC, who valuably contributed to several research projects and represent important members of our community.

ACORDE, an SME based in Santander (Spain), is a designer and manufacturer of RF subsystems for the defence, space and telecommunications sectors. Here, we look at the ingredients for success from its origins around a cutting-edge RF communication lab of the University of Cantabria, to a team of interdisciplinary experts in highly complex RF technologies, which transformed in a company operating in fields as diverse as PCB design & manufacturing, mechanical design and embedded system development.

CISC Semiconductor is presented through an interview with the CEO, Dr Markus Pistauer, explaining how the company has grown over the past 25 years to become a leader in the area of communication and security, and an active member of various fora and platforms, including INSIDE. Looking back to CISC's foundation in 1999, Markus recalls how he "couldn't have imagined that one day companies within the top 50 of the fortune 500 list would be our customers" and how being an INSIDE member "helps us determine our strategy and influence the environment in which we operate at the same time. Here you have the opportunity to create, to be part of the process."

As always, we provide insights about research projects involving our members: in this issue we focus on AIMS 5.0 and H2TRAIN. AIMS 5.0 focuses on the adoption of AI to find solutions for a more sustainable, efficient, and user-friendly production towards Industry 5.0 and European digital sovereignty. H2TRAIN addresses the impact of demographic ageing in Europe and aims at developing enabling digital technologies in a holistic health-lifestyle supported by AI, where various advanced wearable devices and biosensors allow continuous and smart monitoring of health, rehabilitation and sports activities. This market is expected to achieve double-digit growth at least until 2030.

Finally, we look back at the ECS Brokerage Event in Brussels, which represented for our community an important moment for networking, information about the future calls and preparation of future project proposals: 48 new ideas were presented in a vibrant environment that gathered together more than 550 people. In this context, we organised the EUCEI RIAs Challenge 2024, an initiative to bridge important projects in the Edge to Cloud Computing Continuum domain with the industry to identify prospects for further exploitation.

The articles in this magazine represent the diversity and allure of the topics that punctuate our INSIDE community. We are fortunate that you, our members, are enthusiastic contributors willing to share your stories and successes. As we continue to grow and develop, we hope more of you will share your experiences and continue to be actively involved.



Paolo Azzoni  
*Secretary General*

# Europe's semiconductor strategy: a software blind spot?

An urgent call for a holistic approach consistent with our Chips Act



Paolo Azzoni



Jean-Luc di Paola Galloni



Remi Cornubert



Jerker Delsing

**Semiconductors are the foundation of the software industries and services, and a more holistic strategy is required to maximise European investment in semiconductors and put in place the condition of success of big software leaders that Europe is missing.**

China and the US have well understood the critical importance of mastering both hardware and software and of creating leaders in both domains. Both countries have launched massive public programmes to grant dozens of billions for both hardware and software developments. This trend has been accelerating with the surge of AI. Other countries such as Japan, Canada and Korea are following the same route.

The European Union's (EU) current approach to semiconductor strategic autonomy, heavily influenced by political agendas and semiconductor companies, prioritises safeguarding upstream production – the chips themselves. While this focus is understandable, it creates a critical blind spot – the software stack – since the investment level should be at least similar to, if not bigger than, the one in hardware.

In 2022, \$130 billion was spent globally on software CAPEX: the US accounts for 80% with \$103 billion and Europe only a small 1%. For private R&D spend the ratios are similar: in 2022, the software industry invested around

\$240 billion in R&D, with American companies accounting for 74% and their European counterparts for only 6%.

Neglecting the software dimension risks negating the substantial investments in chip production and ultimately leads to a crippling dependency on software from other regions like the US and China, generating damage in the downstream segments of the value chain which, in terms of revenues, far exceeds the harm generated by dependencies in the upstream.

**The need to invest massively in software has become even more critical with the rise of AI.** AI will boom in the next few years: the market was valued at \$420 billion in 2023 and is expected to grow by 29% CAGR up to 2030, accounting for \$2480 billion.

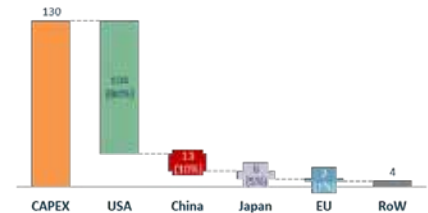
According to Bloomberg, Generative AI alone could reach \$900 billion in revenues by 2030, growing at 39% per year.

Recent years have seen many public AI investment plans around the globe:

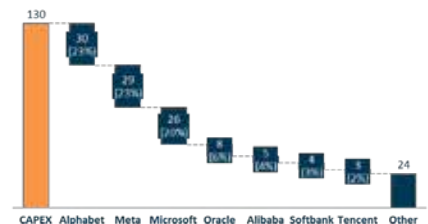
TOP SOFTWARE & COMPUTER SERVICES PLAYERS RESEARCH & DEVELOPMENT | % of R&D spends, Selected Countries, 2022



SOFTWARE CAPEX BY REGION | B\$, Worldwide, 2022

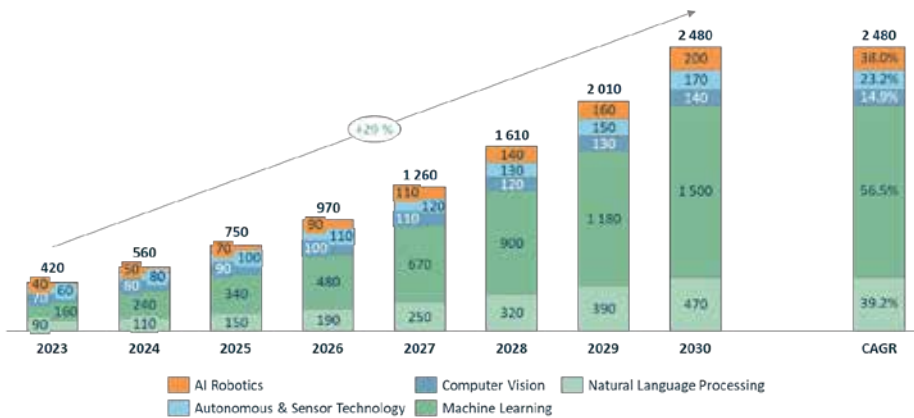


SOFTWARE MAIN CAPEX INVESTORS | B\$, Worldwide, 2022



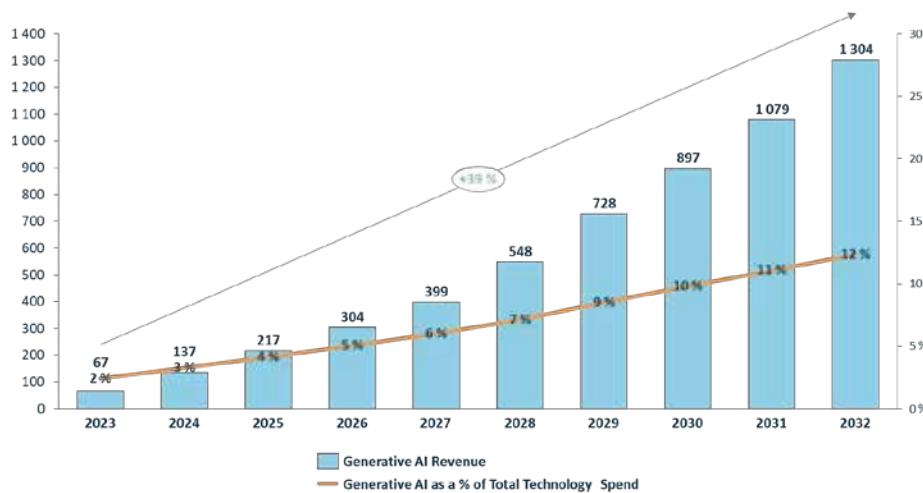
Note: RoA: rest of Asia including Taiwan, South Korea and Japan. Amazon not included in Software Capex & R&D. Source: Industrial Research & Innovation Scoreboard of the European Commission, Strat Anticipation research and analysis

ARTIFICIAL INTELLIGENCE - GLOBAL REVENUE PER FUNCTIONALITY FORECAST | \$B, 2024-2028



Source: Statista, March 2024, Strat Anticipation research and analysis

ARTIFICIAL INTELLIGENCE - GENERATIVE AI REVENUE AND GENERATIVE AI AS A % OF TOTAL TECHNOLOGY SPEND | \$B, 2024-2028



Source: Bloomberg, June 2023, Strat Anticipation research and analysis

- Each year the US spends about \$8 bn in AI, big data and software R&D, constantly increasing, with a 50-50 split between defence and non-defence spending.
- The public investments of China in AI are unclear because they are made through numerous guided investment funds, but a CSET study estimates it at a few billion dollars each year.
- Japan has several public funding agencies that spend \$700 m each year on AI and software. In 2023 \$49 m was spent to build a new supercomputer.
- There is also a \$50 m plan between Japan and US to fund AI research, including funds for Nvidia.
- The federal government of Germany has a €5 billion plan to promote research on AI until 2025.
- In 2021, Spain enacted its €600 m plan for research in AI.
- France launched a €500 m plan for AI,

which includes research and education, in its plan "France 2030".

The European Union has already launched its own €300 m plan to fund AI research, but this plan is not at the scale of the expected market rise.

However, the US dominates private investments in AI with an important increase of investments in generative AI; the EU accounts for less than 5% of private investment.

In an optimistic scenario, AI chips are projected to constitute roughly 45% of the global demand for chips by 2027, fuelling an increase in overall chip demand.

But the moves made by the players are showing that hardware and software will be more and more interrelated/integrated: a

significant investment in chips must go along with a massive investment in all software layers to stay in the competitive race and create the jobs of tomorrow in EU.

**The uncontrollable software stack**

Europe doesn't yet have leaders such as Google, Apple, Microsoft, Amazon, Meta, Baidu, Alibaba and Huawei due to lack of political resolve. These giants can decide to spend billions of dollars by themselves whereas European companies simply cannot afford to, and European strategic autonomy is at stake!

Unlike chips, which are pieces of physical objects, software presents a far more complex challenge. Applications can comprise billions of lines of code. Complexity, uncontrollability and unpredictability reach critical levels in the case of all software stacks, including AI. Even seemingly transparent open-source software often lacks rigorous testing and evaluation. Open-source development typically addresses bugs reactively, once they've been discovered, lacking the structured testing procedures of closed-source software.

Therefore, while ensuring secure chip production is vital, safeguarding the entire software stack is even more critical. Reliance on US and Chinese software creates dependencies and vulnerabilities beyond the chip itself, potentially exposing entire systems to manipulation by uncontrollable entities. Imagine a scenario where malicious actors gain control of software components residing at different layers of the technology stack. This could potentially expose sensitive data, disrupt critical infrastructure, or manipulate entire systems, all without ever physically touching the chips themselves.

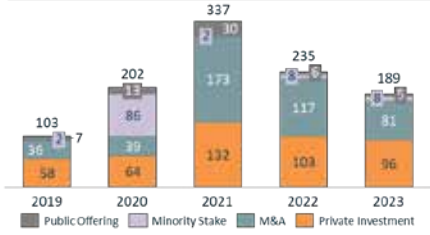
**The unforeseen threat: a lack of awareness**

Alarmingly, there seems to be a lack of awareness at the EU Commission and political leadership levels regarding the necessity to safeguard the software stack and minimise its dependencies on other regions of the world, which could critically impact on the strategic autonomy of the value chain of EU key applications based on digitalisation.

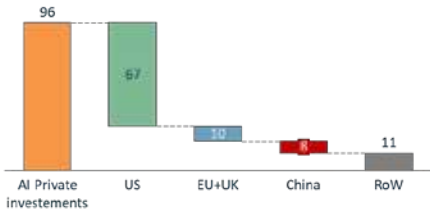
Several layers of the software stack are affected by these risks, especially in the lower layers close to the hardware:

- Firmware:** This low-level software resides on the chip itself and acts as its interface with other software layers. While

GLOBAL CORPORATE INVESTMENT IN AI | B\$, Worldwide, 2023

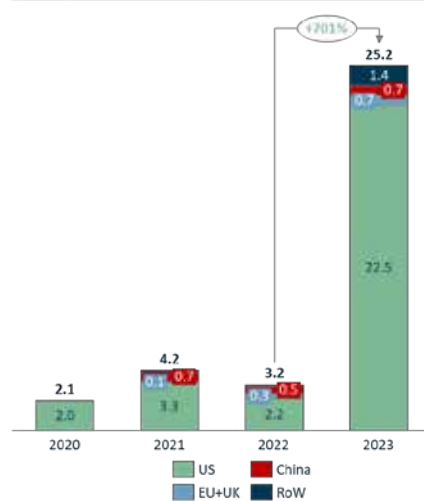


PRIVATE INVESTMENTS IN AI | B\$, Selected Countries, 2023



Note: Private Investments correspond to private sale of newly issued securities (equity or debt) by a company to an investor  
Source: Stanford AI Index 2023, Strat Anticipation research and analysis

PRIVATE INVESTMENTS IN GENERATIVE AI | B\$, Selected Countries, 2020-2023



compromised, can trick smartphones or laptops into recognising them as keyboards (headsets typically have a button for pairing), potentially enabling unauthorised access or data exfiltration. Now, imagine scaling this vulnerability to complex systems like vehicles, manufacturing lines or healthcare devices with million or billion-fold increases in complexity. The consequences of lack of control of software and its vulnerabilities in such critical systems can be catastrophic.

**AI: a unique challenge within software**

As anticipated, AI adds another layer of complexity to the software landscape, in terms of both dependencies and security. AI's specific features and functionalities demand unique safeguards due to its potential impact, far exceeding other software categories. This strengthens the case for EU strategic autonomy across the entire AI technology stack, ensuring control over its development and deployment. Moreover, having AI European leaders compliant with the AI Act is an efficient way to influence other companies to respect European law.

AI has been driving significant moves in the value chain for a few years. Hardware players are developing software suites and platforms to help their clients leverage the computing power of their hardware in AI.

*From hardware to software*, the traditional chip maker business model is integrating software development activities. Major chip manufacturers are now engaged in developing both hardware and software simultaneously, aiming to enhance their solutions' support capabilities. Critical fields of play are AI training, cybersecurity, and simulation.

NVIDIA is the best example of this move with its software suite called AI Enterprise. It is also developing its next generation AI Platform called Rubin AI which should be launched in 2026. AMD and INTEL are following the same path with their own software package around development and graphic tools, but also cybersecurity, cloud services and infrastructures.

Nvidia has acquired two small optimisation technologies to integrate them into their emerging cloud activity, to reduce costs and improve their competitiveness.

*From software to hardware*, the traditional software providers have entered the fabless design hardware market through fabless

some firmware is developed by chip manufacturers, it's often created by board integrators, potentially falling outside of EU control. Since firmware forms the very foundation of the software stack, its security is paramount, making it crucial to secure.

- **Virtualisation Software:** This critical software enables resource sharing and isolation on a single physical system. Vulnerabilities in virtualisation software can expose all virtual machines and containers running on that system.
- **Drivers:** These software components act as translators between hardware devices and the operating system. Insecure drivers can allow attackers to manipulate hardware functionality, potentially leading to data breaches or system disruptions.
- **Operating Systems (OS):** Currently, no major OS vendor is headquartered in the EU. This creates a significant dependency, as all subsequent software

layers – business logic, applications, and Systems-of-Systems (SoS) platforms – rely on the underlying OS.

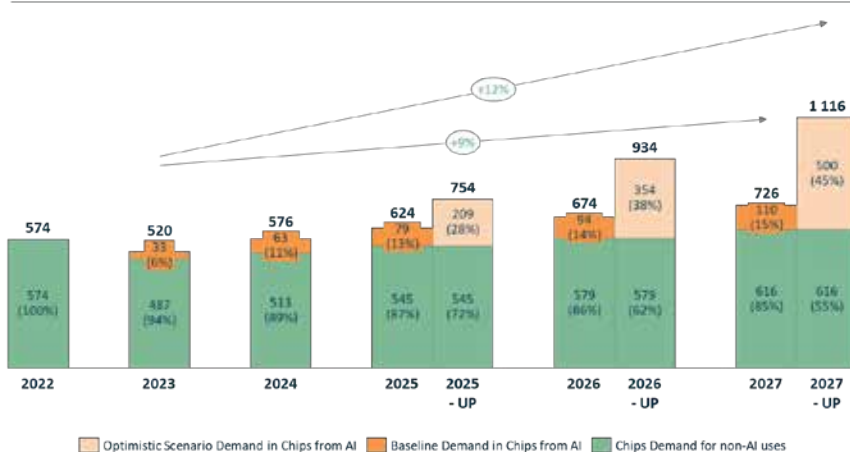
The risks affect also the high-level layers of the software stack:

- **Cloud applications, development tools:** These layers are critical to develop services, get access to data and monetise it.
- **Application layers:** these layers include application specific software, e.g. autonomous driving stacks (Waymo-Google, Weride, Baidu) are not currently covered by European companies.





**Case in point: the weaponisation of simplicity**

To understand the exposure generated by software dependencies and the potential risks, consider as an example a wireless headset, which almost everyone owns. These seemingly simple devices, when

SEMICONDUCTOR MARKET AND PART DEDICATED TO AI FORECAST | B\$, 2022-2027, Optimistic Scenario and Baseline




Source: Deloitte, Strat Anticipation research and analysis

COMPANY	SOFTWARE DEVELOPMENT PROJECTS
 NVIDIA	NVIDIA has now new proposals in terms of software for companies and private person, such as NVIDIA AI Enterprise, to use generative AI in companies but also development software
 AMD	AMD has less software product but sells development tools and graphics tools
 Intel	Intel is developing a wide spectrum of software in cybersecurity, AI, performance management and cloud infrastructures
 STMicroelectronics	STMicroelectronics has several technical software that are made for their product (including electro-thermal simulations) but also embedded software for their products or development tools
 Infineon	As STMicroelectronics, Infineon has several technical software, simulation and development of their product and embedded software
 NXP	NXP has developed more than 2 500 software : there are mainly embedded software and development tools for several industries including automotive and telecoms
 ARM	ARM built tools for developers so they can optimize their code on ARM's chips. They have also a range a software for the automotive industry and functions.

Source : Intel, NVIDIA, ARM, AMD, Infineon, NXP, StratAnticipation research and analysis

**RUN AI : A MIDDLEWARE FOR AI** 

- Run AI : Run AI make optimization on Graphical Processing Units (GPU) with optimize the workload of the GPUs and fraction the GPU.
- Run AI announces 10 times more workload on the same infrastructure. However, in real conditions, the benefit seems to be more 2 or 3 times better, which stays substantial
- Run AI has been bought at an estimated price of about 700 m\$, which seems a reasonable price considering the potential economical benefits of such an app

**DECI : A SERVICE FOR AI** 

- Deci is an Israeli company which optimize the inference (response to an input) of the models to accelerate it without compromising its accuracy. It automated the Neural Architecture Search to accelerate it
- According to the tests made by Deci, it accelerate the inference 2 times. It can therefore reduce costs
- Deci has also development tools to help the creation of generative AI and deep learning

**NVIDIA OBJECTIVE : COST REDUCTION**

- Nvidia objective : this acquisition is part of their cloud road map, which is an integrated product for enterprise developer. Nvidia aim to integrate those technologies in their datacenters to reduce costs. It is part of Nvidia strategy of not becoming only a hardware player but also a cloud player

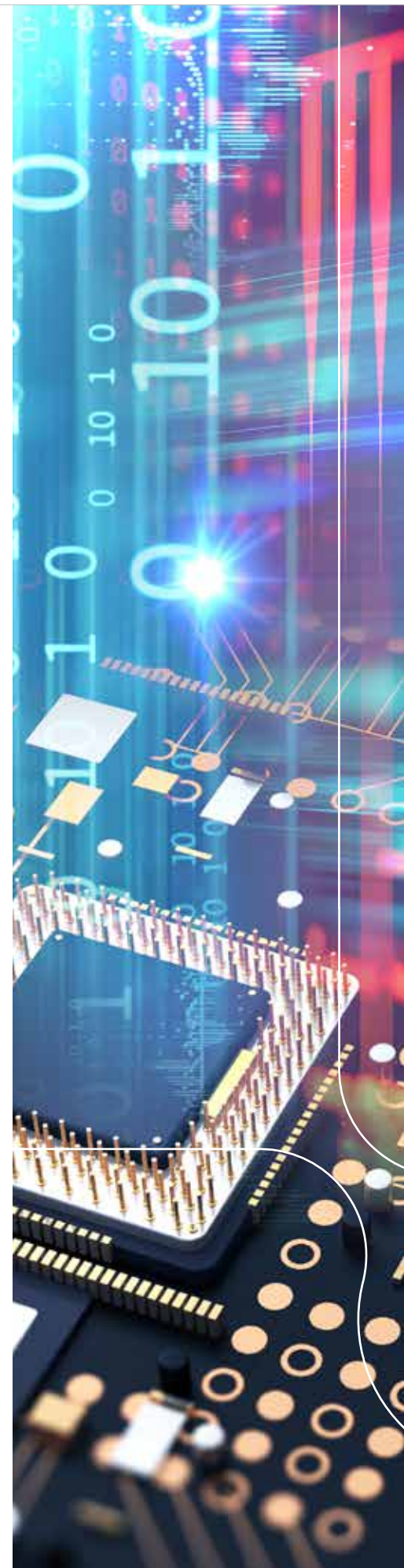
design. Apple M-Series chips, Amazon Chips are examples of commercial success. New chips are arriving from Microsoft and Google. Most Chinese players have also integrated toward chip production or design.

On the other hand, software players are designing, developing or even planning to produce their own chips dedicated to AI. Apple started to develop its own chips years ago for its Mac laptops and is now doing the same for AI. Google, Meta and Microsoft have entered the race to catch up with AI by developing specific GPUs. It is worth mentioning that Europe has a few chips players that could be competing such as foundry-free ARM, NXP and Kalray but we have only a few limited players in AI like the French Licorne Mistral aiming at competing with ChatGPT.

Finally, telco and internet hardware players have entered the game to provide software platforms to allow the development of

specific applications based on connectivity but are moving forward by using AI to provide autonomous features in automotive: BlackBerry which offers four platforms (QNX Software Development Platform, cybersecurity & OTA management services, a cloud-connected software platform) and Qualcomm (Snapdragon Ride Flex SoC: a central compute solution that acts as the brain for SDVs, Car-to-Cloud Services, Connectivity and ADAS/AD Capabilities and Snapdragon Automotive 5G Platform). None of them are European with the exception Elektrobit, which has developed an interesting platform for automotive based on an open-source Linux OS.

Elektrobit is launching the first open-source software development kit certified for safety-critical automotive systems. Elektrobit has been looking for a way to accelerate automotive software development to match this new pace, bridging the gap between speed and safety regulation. Its new software stack is EB Corbos Linux for Safety Applications. This







safety-certified electronic architecture allows OEMs and Tier 1 suppliers to employ Linux coding for safety applications, making it vastly easier to program AI applications, perception stacks (cameras, lidar, radar), cockpit systems and more.

#### From identification to action: securing the software stack

Having identified the critical role and impact of software on the value chain and related applications, the question remains: how do we address it? Urgent actions to safeguard EU strategic autonomy in software include:

- **Increased investment in EU software stack development:** the existing Chips for EU initiative should allocate a larger portion of its budget to software development efforts. This will foster innovation and create a robust EU software ecosystem, limiting the dependencies on other regions of the world, increasing control on the software stack and safeguarding the applications that depend on it. The Chips JU is the most reasonable initiative because an efficient software stack can be designed and developed only in close conjunction to hardware development.
- **Dedicated software programs:** establishing specific programs closely linked to the Chips JU would incentivise collaboration and accelerate progress in securing the software stack. Developing AI specific software layers would leverage the power of AI GPUs and allow the development of software dedicated applications in EU.
- **The EU Software Act:** a dedicated act should outline regulations, funding initiatives and research programmes aimed at strengthening the security of software components across the hardware stack.
- **Political commitment to create European leaders in software** is critical to motivate large-scale public-private collaborations.

#### Practical considerations: addressing the skills gap

Beyond policy changes, practical challenges exist. The EU faces a significant shortage of skilled software engineers. To address this critical gap, we need:

- **Engineering automation:** automation is the only viable solution to mitigate the skills gap, to increase software productivity and to reduce lead times to develop new software applications. The

EU is currently lagging behind in this area, with US companies dominating the engineering automation market.

- **Investing in EU engineering automation development:** supporting EU-based companies developing engineering automation tools is essential to reduce reliance on foreign solutions and foster domestic innovation. This will create a self-sustaining ecosystem with a skilled workforce capable of addressing future challenges.
- **Train software developers and specialists:** accelerating the creation of dedicated software training programmes at Universities and Engineering Schools across the EU is crucial.
- **Attract foreigners with software skills:** develop a specific programme to locate and attract experienced software engineers in EU coming from NAFTA, India, etc.

#### Where to invest? The power of proximity

Investing in the Chips JU for software development is key. The low software layers (firmware, drivers, OS, virtualisation) need to be designed and developed alongside the new generation of chips. This co-location fosters synergies and optimises efficiency and performance, ensuring the creation of a solid and independent hardware/software ecosystem - what we call the "full technology stack". In this stack, the service layer is needed to develop innovative services that will generate huge revenues so that Europe remains a leading region.

Chips pilot lines and accelerator programmes must be included in this ecosystem, by facilitating technology transfer to industry and ensuring large-scale production. Without the corresponding software layers, the full potential of these initiatives and the new chip generations they will generate cannot be realised.

#### Conclusion: a holistic approach for a secure future

While the EU's focus on semiconductor strategic autonomy is commendable, the current strategy overlooks the critical software dimension. Highlighting the software international dependencies and hidden vulnerabilities across the technology stack is crucial. A holistic EU strategy encompassing both hardware and software, ensuring true strategic autonomy, security and safeguarding the full technological stack is crucial in the rapidly evolving geopolitical and economic landscapes.

# The inevitable rise of engineering automation

Conquering complexity, fuelling innovation and strengthening competitiveness



Paolo Azzoni

**The software development landscape is undergoing a metamorphosis driven by complexity. Applications are morphing into intricate ecosystems, with complex architectures, intricate and frequently uncontrollable dependencies, with a very rich set of functionalities, resulting in an ever-growing number of lines of code. From an average iPhone app with around 40k lines of code and Google Chrome with 6 million lines of code to a complex machine like the F-35 fighter jet with 24 million, today a modern high-end car contains more than 100m of lines of code<sup>1</sup>. This rising complexity is also reflected in the domain of the Electronic Components and Systems (ECS) and presents a critical challenge: the widening abyss between the insatiable demand for skilled engineers, the limited pool of talents readily available and the lack of appropriate solutions to alleviate the lack of human resources. The spectre of a talent shortage looms large and is alarmingly already affecting our companies, strongly limiting their autonomy, competitiveness, sustainability and economic security, threatening to throttle innovation, creating dangerous dependencies on critical assets from the US, India and China, harming security and potentially stalling product development and launch.**

Software engineering automation emerges as the powerful weapon in this battle, leveraging technology such as AI to streamline processes, offload developers from repetitive and valueless tasks, empower them, and let them focalise the attention, energy and resources only where there is more value and where human qualities can generate the most relevant impact, reducing the operational and engineering costs, increasing profits and customer satisfaction.

#### **The lack of skill: an obstacle to progress**

The digital revolution has ignited an explosion in software development needs, across industries, vertical applications and the entire software stack. From mobile apps revolutionising healthcare to AI-powered algorithms driving autonomous vehicles, the demand for robust, secure and innovative software is relentless. Unfortunately, the number of qualified software engineers hasn't kept pace with this rapid growth. Universities struggle to churn out graduates fast enough to meet the ever-increasing demand, and scientific research will have to

significantly invest to identify solutions that can compensate the lack of resources with automation. The talent shortage and the lack of appropriate engineering solutions leave businesses scrambling, forced to choose between compromising on quality, relying on solutions they cannot control, extending timelines, increasing the time to market, etc. Unfortunately, European companies operating in key application domains such as automotive, aeronautics, healthcare, to mention a few, cannot tolerate similar compromises to maintain their market position and are forced to look at the US and China to find solutions.

#### **Engineering automation**

Engineering automation emerges as the hero in this narrative, wielding the power of technology not for replacing human limitations and inefficiencies, but leveraging technology to augment and empower human capabilities. Automation takes over the repetitive, valueless tasks that bog down developers, freeing them to focus on the more creative and strategic aspects of

engineering to crafting elegant solutions and pushing the boundaries of innovation: the objective is to free the developers from the fatigue of requirements analysis, basic software components implementation, API development, manual testing, bug reporting, configuration management, code reviews, API documentation and report generation, certification processes, etc.

### AI: the engine of automation

Artificial intelligence plays a pivotal role in engineering automation, to such an extent that it can be compared to the engine in a car. Machine learning algorithms, trained on vast codebases, can identify patterns and automate tasks with remarkable accuracy, efficiency and enormous speed. These algorithms can even predict and anticipate potential issues or unwanted/unintended behaviours in code, allowing developers to proactively address them before they become concrete problems.

The adoption of AI contributes to increasing the automation level of several phases of software engineering, including:

- Requirements analysis: AI can analyse requirement documents and user stories written in natural language to identify key functionalities and potential conflicts.
- Code completion: AI can assist the developer suggesting how to write a drafted or partially developed code and it can also automatically complete it.
- Code generation: AI can generate code snippets and more complex blocks of code, entire functions and even entire software modules based on pre-defined specifications. AI has demonstrated the capability to generate even simple but complete applications. This frees developers from the tedium of writing code that adheres to established patterns.
- Static code analysis: AI can analyse code to identify potential bugs, security vulnerabilities, code quality KPIs and adherence to coding standards. This helps developers write cleaner and more maintainable code.
- Code style enforcement: AI can enforce consistent coding styles by automatically identifying and correcting code-formatting inconsistencies.
- Unit test case generation: AI can analyse existing code and automatically generate basic unit test cases, ensuring core functionalities are covered during testing.
- Test and debugging: automated testing and debugging frameworks powered

by AI can meticulously scrutinise code for bugs and vulnerabilities. These frameworks can not only execute pre-defined test suites but also learn and adapt, uncovering potential issues that traditional testing methods might miss. Tasks that can be automated include automated test execution, test data generation, bug detection and management. This significantly boosts continuous software development.

- Prediction and prevention: AI can analyse code to predict potential bugs and security vulnerabilities before they manifest in production environments. This proactive approach allows developers to address issues early on, significantly reducing the time and resources spent fixing problems after release, and preventing problems, damage, malfunctions, etc. when the application is deployed and becomes operational.
- Documentation and report generation: AI can automatically generate software documentation from code comments and annotations, saving developers time and ensuring accurate description of features, functionalities, API, data structures, etc.

### A double-edged sword: automation and the human element

Despite the urgent necessity of engineering automation, a critical concern emerges: the potential erosion of human knowledge and expertise. While automation offers undeniable benefits by streamlining repetitive tasks, its indiscriminate use could inadvertently create generations of engineers with gaps in their knowledge base and skills, potentially further deteriorating the future availability of experts and talented engineers.

The motivation lies in the role of those seemingly "boring, repetitive and valueless tasks", which serve to young engineers as the building blocks of fundamental knowledge. Imagine a young developer learning to write basic code by hand, following a repetitive process which not only reinforces the knowledge and mastery of the programming language, but also fosters a deeper understanding of how the code runs and how the application interacts with the context. Automation removes this hands-on experience, potentially hindering the development of foundational knowledge and skills.

The loss of these foundational skills can have a domino effect, impacting on competence erosion, reduce creativity and innovation:



AI must not be a replacement of human expertise and capacities. AI must become a powerful human ally, finding the right balance as in a symbiotic relation.

without a strong knowledge base, building advanced expertise becomes more challenging. Imagine an engineer unfamiliar with manual testing who relies solely on automated testing tools. While these tools are becoming essential today, the complexity of systems may lead to missing specific test cases or bugs categories, the identification of which requires a deeper understanding of the entire system. This lack of comprehensive knowledge could limit an engineer's ability to troubleshoot complex issues and ultimately negatively impact innovation.

AI excels at automating tasks and providing valuable insights, but it lacks the human capacity for creative problem-solving and the nuanced understanding of the specific technical domain. The key lies in finding the right balance between automation and human involvement: engineering automation should be employed strategically to free up engineers for higher-level and more creative tasks without replacing engineers entirely, ensuring their knowledge base is preserved, grows and matures. By adopting a balanced approach, engineering automation can become a powerful tool that enhances rather than diminishes human capabilities.

#### The automation arsenal beyond AI

While AI plays a central role, software engineering automation encompasses a diverse set of mature technologies that never adopted AI and that could be today boosted by AI. To evaluate the diversity of these technologies consider for example:

- **Low code/no code:** this technology is not a novelty and was known also as Rapid Application Development (RAD). It comprises building software applications leveraging visual tools (visual programming with drag and drop interfaces) and pre-built templates and components instead of the manual writing of extensive lines of code. Imagine it as a Lego set for software development, where pre-constructed pieces snap together to form a functioning application.
- **Static Code Analysis:** this technology consists of analysing code without executing it. It can identify potential bugs, security vulnerabilities and code quality issues, allowing developers to address them before they impact the software's functionality or security.
- **Infrastructure as Code (IaC):** this approach enables the provisioning and management of infrastructure through code. Imagine declaring the desired server configuration in code instead of

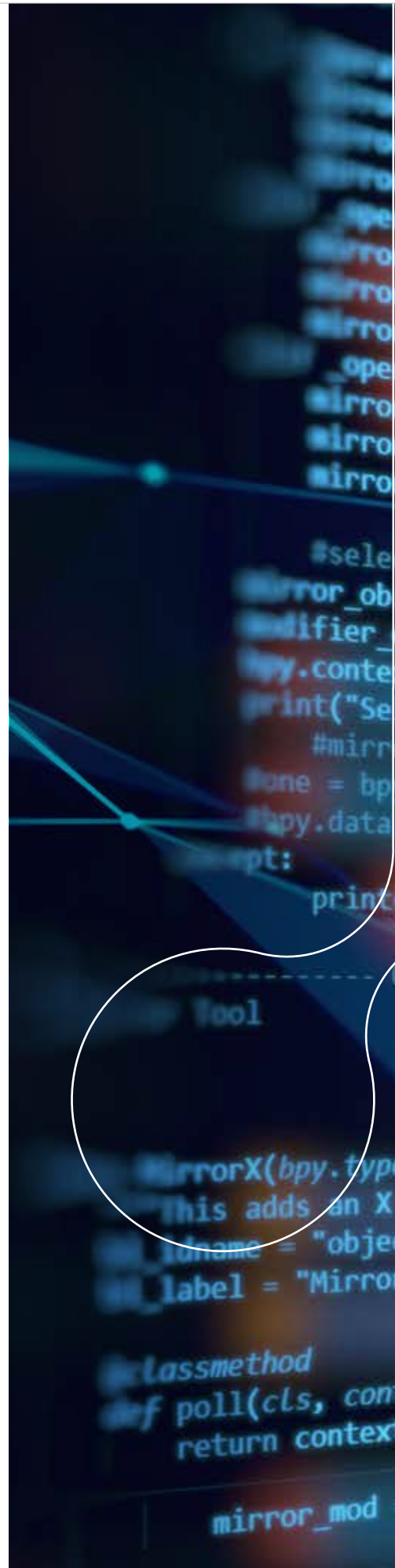
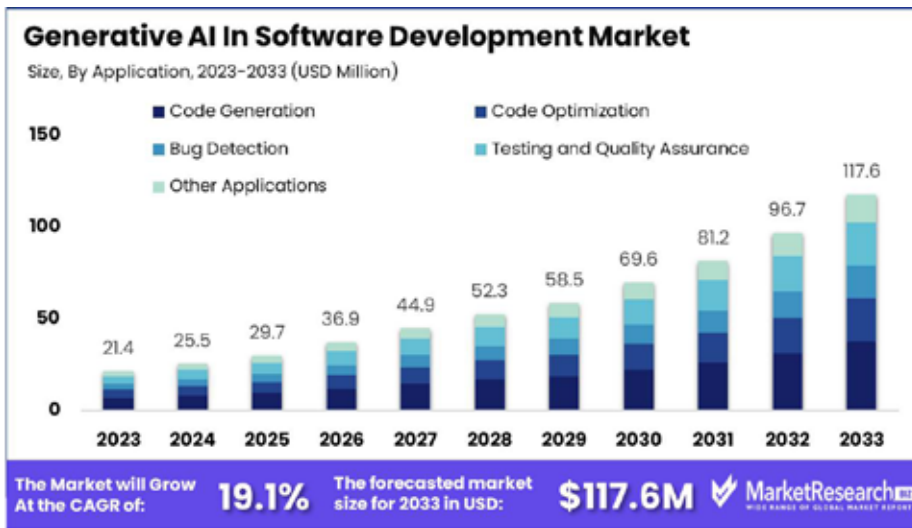
manually configuring individual servers. IaC streamlines infrastructure deployment and management, making it highly scalable and repeatable.

- **Continuous Integration and Continuous Delivery (CI/CD):** This methodology automates the entire software delivery pipeline, from building and testing code to deploying it to production environments. CI/CD ensures a smooth and efficient flow of software throughout the development lifecycle.
- **Robotic Process Automation (RPA):** RPA mimics human interactions with software, automating repetitive tasks like data entry, configuration management and report generation. This frees developers from the burden of administrative tasks, allowing them to focus on core engineering activities.

#### Engineering automation benefits

The benefits of engineering automation extend far beyond simply addressing the skill gap and are not limited to the software domain. The list of advantages is endless:

- **Increased efficiency:** automation streamlines workflows, reducing development time and effort, and improving the accuracy and quality of the result.
- **Enhanced productivity and competitiveness:** faster development cycles and improved product quality lead to a significant competitive edge in the marketplace. Companies can bring innovative products to market faster, take advantage of fleeting opportunities and stay ahead of the game.
- **Reduced time to market:** automation accelerates the entire engineering process and assists the whole product lifecycle. This facilitates businesses to capitalise on market opportunities and respond to customer needs more quickly.
- **Improved product quality:** automated code generation reduces the presence of bugs, while testing and code analysis allows to catch bugs early on in the development process. This leads to higher-quality software with fewer defects and a lower risk of post-release issues, reducing significantly operational and maintenance costs.
- **Boosted business and economic growth:** increased efficiency, faster time to market and an enhanced competitive edge translate to business growth. This, in turn, contributes to a more vibrant digital economy, fostering innovation and job creation in related fields.



### The road ahead: towards hyper-automation

The impact of digital automation extends beyond the engineering process: from optimising management and operations to market analysis, to the redefinition of customer experiences, improvement and optimisation of product maintenance and evolution, etc. Companies are currently already trying to leverage the power of digital automation to unlock new opportunities, drive innovation and gain a competitive edge. However, according to a McKinsey study<sup>2</sup>, 69% of interviewed enterprises have not yet implemented any automation process: “Businesses should be focused on delivering a better experience for customers and on innovating, not using their teams to process repetitive tasks that are full of errors,” states a 2023 report by Activant Research<sup>3</sup>.

In 2020 Gartner coined the word “hyper-automation”<sup>5</sup>, referring to a “business-driven,

According to Accenture’s Technology Vision 2023<sup>4</sup> report, the adoption of automation technologies has the potential to boost productivity by 45% by 2028, with a subsequent economic impact of USD 16.3 bn.

disciplined approach that organisations use to rapidly identify, vet and automate as many business and IT processes as possible”, going significantly beyond the simple mechanisation of repetitive manual tasks towards the automation of complex decision-making processes previously requiring human intervention or design and developments tasks requiring human creativity. Hyper-automation consists of business, management and operational strategies based on a combination of diverse IT technologies and intended to augment and boost human capacities and



**Hyper-automation**  
 Hyper-automation is a business-driven, disciplined approach that organizations use to rapidly identify, vet and automate as many business and IT processes as possible. Hyper-automation involves the orchestrated use of multiple technologies, tools or platforms, including: artificial intelligence (AI), machine learning, event-driven software architecture, robotic process automation (RPA), business process management (BPM) and intelligent business process management suites (iBPMS), integration platform as a service (iPaaS), low-code/no-code tools, packaged software, and other types of decision, process and task automation tools.

Gartner

automate the processes in which they are involved. It extends traditional automation by adopting machine learning, natural language processing, generative AI, new event driven architectures and software solutions, systems integration platforms, design flow and, more generally, engineering tools automation, intelligent platforms for business process management, etc.

Despite the delays in the adoption of automation highlighted by Activant Research, for the third year in a row, 80% of Gartner clients reported that they will increase the investments in automation technologies. Gartner predicts a future where automation touches every step of the product journey, in a fully automated value chain. By 2025, over 20% of goods globally could be manufactured, packaged, shipped and delivered without human intervention. Consumers will be the first to make physical contact with these products.

**Engineering automation is here to stay**

Technological progress in different domains is helping engineering automation and hyper-automation to emerge, supporting organisations to execute more and more complex tasks autonomously, with more robust orchestration and decision-making capabilities, along the entire product lifecycle. Hyper-automation will not be adopted only to automate the whole value chain, but it will also be ubiquitous in organisations' decision-making, research and development, critical operations, customer management, sales, front-end offices, infrastructure, etc. And it is here to stay, to minimise uncontrollable technological dependencies and to cope with the lack of human resources. However, engineering automation and hyper-automation are not a replacement for human expertise. Instead, they serve as a powerful ally, empowering people to achieve more, and to be more efficient and productive.

<sup>1</sup> <https://informationisbeautiful.net/visualizations/million-lines-of-code/>  
<sup>2</sup> <https://www.mckinsey.com/capabilities/operations/our-insights/the-imperatives-for-automation-success>  
<sup>3</sup> <https://activantcapital.com/research/hyperautomation>  
<sup>4</sup> <https://www.accenture.com/us-en/insights/technology/technology-trends-2023>  
<sup>5</sup> <https://www.gartner.com/en/information-technology/glossary/hyperautomation>

Events

# INSIDE Industry Association shines at Embedded World 2024

Creating intelligent Systems together





Heidi Teunissen



Andre Hebben



**The Embedded World Exhibition & Conference 2024, held from April 9-11 at the Exhibition Centre Nuremberg, marked as usual a remarkable milestone for the international embedded community. With over 1,100 exhibitors from nearly 50 countries and an impressive turnout of more than 32,000 visitors from 80 countries, this year’s event was a testament to the growing significance of the embedded and cyber-physical domains as the key meeting place for industry professionals.**

Amidst the bustling exhibition halls and lively discussions, the INSIDE Industry Association proudly hosted a booth that featured four of our innovative SME members: Ropardo, Abinsula, Virtual Vehicle, and Verum Software. This initiative aimed to subsidize SME participation in a high-profile and very expensive event, showcasing the benefits of the Association membership and its core values. Our booth was a vibrant hub of activity, providing great visibility to the SMEs, showcasing cutting-edge products and

solutions, and fostering intensive dialogue that led to numerous new business prospects for our SMEs.

**A Platform for Growth and Innovation**

The enthusiastic response to our booth underscored the importance of providing SMEs with opportunities to shine on a global stage. Each of our participating companies brought unique strengths and innovations:

- **Ropardo** showcased their groundbreaking demo featuring real-time visual tracking of eye movements, and AI driven real-time analysis. This innovative technology can gauge demographics, and interest based on pictures, paving the way for advancements in personalized ads, billboards, and a multitude of other applications. The demo captivated visitors, demonstrating the potential of eye-tracking technology in enhancing user engagement and experience.
- **Abinsula** impressed attendees with their expertise in embedded software and system integration, offering robust solutions that cater to a variety of industries. Their commitment to delivering

*“Participating in the INSIDE Industry Association’s booth at Embedded World has been an enriching experience. Being part of such a rich, diverse, and interdisciplinary network of experts has highlighted the transformative power of intelligent digital systems in shaping the future of European technology.”*

**Lukas Kusching – Virtual Vehicle**



*“For Abinsula, being at Embedded World as an INSIDE partner was an enormous opportunity both to explore market-relevant research trends through the exchange of ideas and opinions with exhibitors and visitors. At Embedded World, the Abinsula team had the chance to engage with significant industry players to understand which technologies are the most promising for the next five years. Additionally, on a commercial level, it provided the opportunity to make new contacts, meet, and strengthen relationships with existing clients—an invaluable chance given the importance of the event in the embedded market.”*

**Katiuscia Zedda – Abinsula**

high-quality embedded systems resonated with many potential partners and clients, further solidifying their reputation as a leader in the field.

- **Virtual Vehicle** highlighted their research in mobility and automotive technology with a walking robot. This demonstration drew a crowd, illustrating the potential of autonomous systems and the role of embedded technology in advancing mobility solutions.
- **Verum Software** demonstrated their advanced software design tools that enable the creation, simulation, mathematical verification, and automatic generation of code for embedded and cyber-physical systems. Their tools support software engineers in developing defect-free software quickly and reliably, making the application of formal methods as straightforward as using a grammar checker in a word processor. This innovative approach to software

thousands of happy faces and in-depth conversations that took place. The high-caliber conference sessions, featuring 1,871 participants and speakers from 45 countries, further enriched the experience with topical presentations and intensive discussions. Highlights included keynotes on “Embedded AI” by industry giants AMD and Analog Devices, as well as sessions on “Display Innovations” and “Display Market & UX.” The conferences’ success demonstrated the community’s appreciation for the intensive work and careful selection of the program committees.

**Empowering the Next Generation and Promoting Diversity**

Embedded World 2024 also emphasized the importance of diversity and the next generation of industry leaders. The #women4ew event provided a platform for female empowerment and networking, while the Student Day offered young enthusiasts



*“Embedded World was a great opportunity to exchange and compare our ideas with colleagues from INSIDE and participating companies, serving as a source of the latest novelties and emerging trends in the industry. As a result, we are delighted to have made new connections and received demo requests from companies seeking collaboration.”*

**Bert de Jonge and Karol Kobiela - Verum**

development drew significant interest from attendees looking for reliable and efficient solutions.

The high engagement at our booth translated into promising new leads and collaborations, reaffirming the value of our association in supporting SME growth.

**Embedded World 2024: A Resounding Success**

The overall success of Embedded World 2024 was evident in the packed exhibition halls and the vibrant exchange of ideas. Executive Director Benedikt Weyerer summarized the event as “simply great,” highlighting the

a glimpse into the fascinating world of embedded technology, complete with inspiring keynotes and hands-on activities.

**Looking Ahead: Expanding Our Presence in 2025**

Building on the success of this year, INSIDE Industry Association is excited to announce that we will be doubling the size of our booth at Embedded World 2025. This expansion will allow us to offer even more space for our members to showcase their innovations and connect with potential clients and partners.

In addition, we are considering the possibility to include a “Speaker Corner” where industry



*"ROPARDO proudly introduced its latest AI-based computer vision technology, emphasizing its edge computing capabilities for object and people counting. IoT and Digital Signage solutions were also showcased. Participating to this event provided us with a platform to highlight how our innovations address current industry challenges and pave the way for sustainable, future-ready operations, driving digital transformation and delivering substantial value across various sectors. Our team engaged with industry leaders and potential partners, opening avenues for robust partnerships and showcasing our commitment to providing both turnkey and customizable innovative solutions. The event was a truly rewarding experience for our company."*

**Ciprian Hategan – Ropardo**

experts will deliver lectures on the latest trends and technologies. This new feature aims to enhance the educational aspect of our booth, providing valuable insights and fostering knowledge sharing within the embedded community.

#### **Join Us Next Year**

As we look forward to Embedded World 2025, scheduled for March 11-13, we invite more SMEs to join our growing community. Together, we can continue to drive innovation, foster collaboration, and showcase the incredible potential of the embedded industry.

For more information about joining the INSIDE Industry Association and participating in our booth at Embedded World 2025, please contact us at [info@inside-association.eu](mailto:info@inside-association.eu).

Research Project Highlight

# The next big step in digital transformation is taking shape





Thomas Gutt

**Aiming at a more sustainable, efficient, and user-friendly production, AIMS5.0 is about to show how artificial intelligence (AI) can take a decisive step towards Industry 5.0 and European digital sovereignty. The ambitious research project started a year ago and is part of the EU programme Horizon 2020. Its characteristics represent the self-image of EU-funded projects as an intelligent collaboration between partners and other projects, for mutual benefit and growth.**

AIMS5.0, the project title sets the direction. The acronym stands for "Artificial Intelligence in Manufacturing leading to Sustainability and Industry5.0" and aims at the potential of artificial intelligence (AI) in the development and manufacture of hardware and software components. In addition to comprehensive sustainability and user-friendliness, the desired goals include significantly increased efficiency in production.

#### **Semiconductor production predestined for use of AI**

The semiconductor industry in particular is perfectly suited for exploiting the potential of AI. There are many barely visible data-generating manufacturing processes here. At least 250 systems contribute to the manufacture of a product. Each has 20 parameters and 100,000 wafers with up to 10,000 different design variants run in the factory. Considering these figures could be even higher, it is clear that human beings alone are not able to fully comprehend these highly complex processes, let alone monitor them. This is where it takes the assistance of AI. Automatic error detection, for instance, can ensure fewer rejects and an overall higher quality.

Apart from a better efficiency, an increased resilience, optimised supply chains as well as time-to-market parameters are intended to strengthen the international competitiveness of the European location. They can reduce dependencies and, for example, prevent another chip crisis. The project thus fits into the EU's drive for more digital sovereignty.

As part of the EU funding programme Horizon 2020 and sponsored by KDT JU (Key Digital Technologies Joint Undertaking), AIMS5.0 started in 2023 as the youngest of the central,

large European research projects with 53 partners from 12 countries and a budget of approximately 70 million euros in the area of digitalisation. Coordinated by semiconductor manufacturer Infineon Technologies, the consortium represents the chain of producers, suppliers, specialists, research institutes, and universities.

#### **Designed for intelligent collaboration**

During the first year, major steps were taken for a successful intensive research work to elaborate crucial foundations for the next big step in the digital transformation of European industry. As part of its formula for success and in its self-image for an overall benefit for Europe, AIMS5.0 is designed for intelligent collaboration between partners and other projects. Despite the size of the project with its numerous partners, it is obviously worth taking on the organisational challenge involved. As expected, it pays off for a joint success, for mutual benefit, and growth.

As an example of collaboration and synergy effects within and across the project, a major event is worth being noted which, in fact, was a two-in-one event. In September 2023, the University of Applied Sciences in St. Pölten, Austria, hosted the Deep Tech Workshop as part of the two large-scale European initiatives AIMS5.0 and Arrowhead fPVN, while at the same time, the new Research Studio Smart Digital Industries and Services (SDIS) was opened on the premises of the university.

Both Arrowhead fPVN coordinator Luleå University of Technology (LTU) in Sweden and SDIS founder Research Studios Austria Forschungsgesellschaft (RSA FG) are members of the AIMS5.0 consortium. LTU is responsible for the common cyber



architecture, and RSA is dealing with human acceptance, trust and ethics for Digital Workspaces.

### Deep Tech Workshop to drive innovation in Europe

The Deep Tech Workshop's primary focus was on common technologies and initial use of use cases both in AIMS5.0 and Arrowhead fPVN. The latter stands for the Arrowhead framework and implementation platform focusing on flexible Production Value Network (fPVN) in the research project. The workshop provided a valuable forum for sharing knowledge and exchanging ideas on topics such as cyber architecture, data models or AI code generation. Bringing together experts from industry and academia to discuss the latest advances and future perspectives, it highlighted the importance of collaboration when it comes to drive innovation in Europe.

The next example is a three-day meeting at the end of January this year in Luleå, Sweden. The workshop was initiated by the University of Technology (LTU), updating and monitoring the progress and common potentials of the two projects AIMS5.0 and Arrowhead fPVN. As for AIMS5.0, certain milestones had already been reached, well ahead of time. Numerous demonstrators showed that more results than expected had been achieved. The ambition of the workshop was to integrate, highlight and demonstrate the core AI and cyber architecture technologies as well as the utilisation in use cases of both projects.

### Autonomous drones for scans and digital twins

Speaking of which, the AIMS5.0 project profile includes 20 use cases from nine industrial domains, the results will be exchanged across disciplines. First fundamental research activities in AIMS5.0 prepare the way to get the use cases off the ground bringing the future of a highly efficient fabrication to life. One of the striking examples is an autonomous indoor drone. It will demonstrate an AI-based improved connection between production and logistics. Developed by IPH, "Institut für integrierte Produktion Hannover" from Germany under the assistance of Spanish UPM "Universidad Politécnica de Madrid", it will work as a scanning device covering a complete production site of car maker BMW to create a digital twin of it.

### Transparency, shared knowledge, and a common language

A strong focus in the area of the Internet of Things (IoT) lies on ontology creating a language, which is understood by humans and computers alike aiming at a smooth interaction throughout the entire supply chain. On that behalf, there is an intensive exchange with two highly specialised projects. One is the former project SC<sup>3</sup>, and the subject in question is a Digital Reference (DR), a holistic ontology for supply chains in the field of semiconductor. With its results, it lives on in AIMS5.0, just to be reborn in the follow-up project SC4EU that aims at taking the supply chain management of semiconductor production in Europe to a new level.

SC4EU creates a true demand platform and its ontology as a formal description of all information within the chain. Thus, it will push a close interaction to a smooth and transparent collaboration making even highly complex supply chains resilient, flexible and agile. Since the true demand approach relies on high-quality data shared by the partners involved, SC4EU guarantees confidentiality through anonymity and security in order to generate a reliable demand forecast.

### Passing on the fire for new horizons

The technique is a perfect foundation for exchanging, analysing and finding new ways to optimise systems and procedures with regard to the use cases and the overall goals of AIMS5.0. With respect to a superordinate level, the whole approach with transparent information in a common mindset stands for major EU-funded projects like AIMS5.0 - as a driving force in a collaborative network, much like a beacon passing on the fire for new horizons.

Overall, AIMS5.0 is the first project to pursue a common approach to the application of AI and AI-based hardware across a wide range of industries. With this overarching claim, the project is in the tradition of its predecessor project Productive4.0, which, as the largest European lighthouse project and winner of the ECSEL JU Technology Pioneer Award 2021, paved the way for the digital transformation of Europe's industry.

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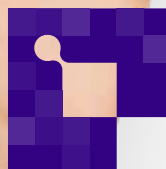
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Industry Association

## Research Project Highlight



Juan Antonio Montiel Nelson



Marco Ottella



Chris Horgan

# H2TRAIN

Bridging the technology gap for impactful e-health applications



**In a Eurostat article on population structure and ageing, with data extracted in February 2024, an overview of the impact of demographic ageing within the European Union (EU) claims that “probably the most important change will be the marked transition towards a much older population structure, a development that is already apparent in several EU Member States.”**

Ageing is, of course, an unavoidable process and the progress of medicine as well as the improvement in conditions of life (including lower mortality from illnesses) has given the possibility to live longer. However, longer does not mean ‘quality’. Diseases like dementia and diabetes type 2, as well as cancer to some extent, have a strong correlation with ageing and with the progressive deterioration of the DNA-replication mechanism. However, a healthy lifestyle in terms of regular movement and a balanced diet has been proven to extend quality life. However, stress and other factors can hinder the purpose where we, as humans, also need motivation and support to move around properly to avoid injuries (you don’t run a marathon starting from the couch) and so on. The H2TRAIN idea is to advance the available technologies (sensors, AI, edge-cloud continuum...) and integrate them smartly up to a higher TRL to achieve an ecosystem for remote coaching.

Similarly, in the Healthcare sector, in the area of rehabilitation of patients with chronic diseases or post-surgery treatment, we found a high technology demand for remote monitoring (home hospitalisation). Undoubtedly, these two technologically greedy topics demand impactful applications in terms of economic and societal value whereas wearables technology has grown dramatically in the area of sport and physical recreation. From our perspective, a technology gap exists between both kinds of applications, one that H2TRAIN will reduce.

### **Health, wellbeing and the digital society**

H2TRAIN is an innovation action, more precisely, a Joint Undertaking Innovation Action under the Horizon Europe Framework Programme, in the Non-Initiative (former KDT) of the Chips JU. The research and innovation in H2TRAIN address the enabling digital technologies in holistic health-lifestyle supported by artificial intelligence (AI) networks. H2TRAIN is focused on the major challenges and priorities of the Strategic

Research and Innovation Agenda for the Electronic Components and Systems of the European industry: health and wellbeing and digital society. In H2TRAIN a number of advanced wearable devices and biosensors are integrated into textiles for monitoring physiological signals, including biomarkers. The physiological signals are pre-processed by AI on the edge, and by digital twins in the cloud while health or sport experts monitor the evolution of individuals.

Many technologies are already available in the form of chips or in the form of algorithms. H2TRAIN intends to bring them to a higher level of maturity, leveraging on the strength of the European industry to tackle the weakness of the application part of the supply chain. In the meanwhile, we aim to create a platform, an ecosystem also in the sense of cluster or projects (for instance, through a specific focus topic) to put this on the same table with other actors (industry, healthcare institutions, sports teams) and projects (Chips JU but also HORIZON as well as other national and transnational initiatives – for instance, THCS) and work together towards the same objective. Make Europe a leader, or at least recoup part of the terrain that has been lost in these applications which are of strategic importance for our future.

### **The power of collaboration**

The Horizon magazine (<https://projects.research-and-innovation.ec.europa.eu/en/horizon-magazine>), is a comprehensive site containing plenty of information on several topics and Horizon projects, but under the topic of health there is no action regarding the application of AI to health and wellbeing. Nor are there any innovation actions for elderly people or the rehabilitation of patients with chronic diseases. These are two areas that demand major impact in terms of economic and societal value.

Research cannot be done alone with only the technical experts. Other competencies (the

so-called non-STEM, for instance, SSH) must be brought to the table to support the vision. Stakeholders as well as end users must be involved from the very beginning and during the development process as living KPIs that monitor the execution and the deviations from the original purpose and ensure that systems are made affordable, useful, easy to use and our lives better, healthier, more fun.

### **The brokerage as a springboard**

Marco Ottella looks back at where it all began. “At the 2022 brokerage, the first face-to-face event after COVID, thanks to preliminary discussion I had with experts in sports sciences and in artificial intelligence, I conceived a project idea to bring to a higher level the wearable sensors that many of us hobby sporters use every day in order to address the possibility to better monitor sports activities both from professional trainers and from AI-based virtual trainers, with the evident benefits for society as discussed above (quality of life, reduced costs for healthcare). At the brokerage, I had the good fortune to meet some representatives from the semiconductor industry with whom we discussed the weakness (costs) and the opportunities (multimarket) of such an approach. Interest at the presentation and at the poster sessions was big. More than 100 business cards were collected and same number of emails received in the following days. As I said to all of them, I was ready to write the project from A to Z, but with Xtremion being a startup, I could not be eligible as a coordinator. Many of the potential partners who had said they were interested also said that they could not be a coordinator. Luckily, I met Juan at the Brokerage, and a few weeks later I came back to him to ask if he would be happy to coordinate. Thanks to his superior capacities of coordination and my ideas as basic ingredients, he was able to write an outstanding project outline which was evaluated even better than expected.” The rest is history. “The FPP was excellent,” Marco continues, “and we scored 14.5 points

out of 15, something that had never happened to me in the last 15 years. One of the best coordinators I have ever seen: not just asking partners for inputs (and many times neglecting them) but being positive everyday with well written and sound text, charts, figures, tables.... A very fruitful cooperation which I hope will last a long time."

Juan goes on: "While there is no unique method for building a consortium, the ECS Brokerage Event organised by the industry associations AENEAS, EPoSS and INSIDE, is an efficient tool for creating a group of interest around an idea. By promoting an idea as a poster, you will discover how much interest it creates. The project idea presentation is a perfect opportunity for partner finding and, finally, face-to-face consortia building meetings help build the structure of your future proposal. I have attended ECS Brokerage each year, after the pandemic, and promoted several ideas in the area of graphene sensors and thermoelectricity. In 2023, I promoted a biomarker-sensing wearable for stress monitoring. I had previously written a proposal of 45 pages for a Horizon 2020 RIA call and a poster for presenting the idea behind it. During the brokerage the high number of business cards on my poster area and the received emails from potential members suggested to me to prepare a preliminary meeting. After the event, I met Marco and through two video conferences, we expanded the original ideas, from foundational to cross-sectional technologies, incorporating AI/ML from the edge to the cloud. In two weeks, I wrote the proposal and provided the draft to Marco for his revision, and we began to scale up for building the consortium. Marco is the best technical manager, his broader view and industrial experience are the key factors for a winning proposal. One year later, here we are, continuing to work at the kick-off meeting of H2TRAIN. There is more work behind project consortium building, of course, but the ECS Brokerage Event was a good start."

### **Building an innovation action plan**

H2TRAIN is focused on the major challenges and priorities of the ECS-SRIA 2023 and 2024 in the application areas of health and wellbeing and digital society. The project aims to unleash the innovation potential of digital technologies onto the smart healthcare market with a focus on the elderly, rehab of chronic disease patients and recreational sports activities. H2TRAIN IA is spanning the entire electronics components and systems, and systems of systems, value chain, from foundational and cross-sectional technologies to the

application fields of remote assisted-living, for elderly people, patient rehab monitoring and recreational sports training.

In technology, most projects build from bottom to top. While this approach has its advantages and disadvantages, the major handicap concerns defining the application in terms of the technology, and this is a big issue because it reduces the freedom of degrees when you approach the top. However, when moving from top to bottom, most concepts at application level have no limitations. The problems begin when the foundational technology is not available, but this is not the case. From top to bottom, a number of technology demonstrators are defined, like a tattoo sweat-sensing device, a glycaemic instrument, a pH device based on printed electrodes, ECG, EMG and SpO2 on-textile device; the cortisol, lactate and C-reactive protein based on graphene; the in-water activity tracker; the energy harvester based on thermoelectricity, RF and magneto-mechanical; the biometric cryptography device; the textile activity tracker, and the edge-cloud AI continuum processor. But as cross-sectional technologies, there is a huge number of software layers for implementing the functionalities at the edge such as plug-and-play, smart boot for software loading and update, IP licensing, fog AI/ML computing, smart communication interface, embedded intelligence (both supervised and unsupervised operation modes) and advanced embedded intelligence.

The semiconductor industry, with its enormous complexity, suffers from a major structural issue, where investments for fabrication (usually amounting to billions of euros) can be justified if, and only if, the volumes are in the order of several millions per year. This makes the healthcare sector a very difficult one for semiconductor manufacturers. Although miniaturisation can unleash immeasurable benefits (think for instance of miniaturised dispensers for drugs, or blood/heart screening, as well as nanoscale x-ray machines and so on), they are simply not available because they are not affordable. The key is reuse: using the same hardware in several sectors (including consumer) and let the advanced features be implemented as software or ML algorithms.

### **Innovating the applications**

In H2TRAIN, an interoperative hardware/software layer between the application level and the technology demonstrators provides the transition between edge and cloud worlds, as an edge-cloud AI continuum. Technology demonstrators have already

been introduced. The application level is a common infrastructure for each use case: Remote Assisted Living (RAL), Intelligent Adaptive Sport Coaching (IASC) and Remote Post-Surgery & Rehab Monitoring (RPS&RM). The application is a set of hardware/software development based on computer desktop technology for: 1) information and communication technology, abbreviated as ICT; 2) ambience monitoring technology, abbreviated as Ambience; 3) digital twin technology; as Digital Twin 4) expert centre technology, as Expert Centre; 5) individual communication gadget, as Individual; 6) individual related communication gadget, as Individual Related.

All these applications are available through cloud-computing networks as against edge-computing as is the case with technology demonstrators. It should be noted that a particular technology demonstrator, named TD10, acts as an interoperative hardware/software layer between the application level and the rest of technology demonstrators. For example, TD10 incorporates smart switching capabilities for quality of service when the rest of technology demonstrators deliver data to the main servers of the cloud-computing network. In addition, TD10 provides extra capabilities for AI/ML algorithms more beyond the embedded intelligence layer of the technology demonstrators. Data compression is also a characteristic of the TD10 layer, where data compression standards are applied for reducing the amount of network-traffic load. Plug-and-Play (PnP) operation is included in TD10 for enabling the system to adapt to hardware changes with minimal intervention by the user. A user can add and remove devices without having to do manual configuration, and without knowledge of computer hardware. An Intellectual Property (IP) security layer is provided by TD10, by checking the hardware/software licence both locally and in remote licence servers. Similar to system integration of human-centric technology and embedded intelligence, here an embedded intelligence system is being developed based on an ultra-low power microcontroller for pushing foundational technologies toward Artificial Intelligence & IoT or Artificial Intelligence of Thing (AIoT) applications in health and sport. Therefore, this goal is also geared towards the development of AIoT devices, bringing new opportunities for sensor data management, as applications and services are moving developments towards the edge instead of in the traditional centralized cloud data centre. TD10 is aimed at the implementation of sensor fusion functionalities, using microcontrollers

based on processor architectures such as ARM Cortex Mi ( $i = 0, \dots, 4$ ) or recently RISC-V.

### From cross-sectional technologies to fog layers

AI/ML are technologies that flood everything nowadays, but at application level, and not at technology level. H2TRAIN goes from application to foundational technologies. We use digital twins for performance estimation when individual monitoring, and the acquired information is very useful for an expert, which is the medical centre in charge of the supervision for a patient or an elderly person or even the sports coach. Wearable devices and IoT are the media for supplying the information, but the cross-sectional technologies play a key role; where some AI/ML processes run on the edge in comparison with the vast majority of AI/ML algorithms that are executed in the cloud. This is exactly what we incorporate as innovation to overcome the limitations of wearable technologies, which are limited in terms of energy and power consumption, an issue that is very well known for sports practitioners. We found that a proper distribution of the AI between edge and cloud will relax the energy consumption of data communication.

In H2TRAIN, an interoperative hardware/software layer between the application level and the technology demonstrators provides the transition between edge and cloud worlds, as an edge-cloud AI continuum. In between the edge and cloud computing worlds, an intermediate layer acts as a transition between them, as a fog layer. The benefit and value of the edge-cloud AI continuum comes from enabling the low-level sensor components, i.e., the technology devices, to realise Internet; this ability is what moves data from endpoint devices through the IoT pipeline to central servers. This ensures that data sent from endpoint devices, such as sensors, is received and understood by the next and subsequent steps in the connected environment, whether the next step for that data is to another endpoint device or a gateway or an application. In communication networks, smart switches adapt network bandwidth and quality of service to the channel communication requirements. At the core of network switches, smart schedule units provide the channel-control decisions according to the bandwidth and quality of service for the network traffic. In between the edge and cloud computing worlds is a transitional intermediate layer, or fog layer. The AI-supported transmission schemes can make the edge-cloud continuum more reliable and capable of working also in harsh environments (e.g., water).



### Trends and challenges

H2TRAIN includes new biosensors that are at the cutting edge of the technology development, as is the case of the cortisol, lactate and C-reactive protein. They are based on graphene, a 2D material that is functionalised for detecting biomarkers. In cross-sectional technologies, edge AI is a new trend and a dramatically growing area, but no standard products exist in the market. Edge-cloud AI continuum is a novel concept, and the approach that we follow will generate intellectual properties.

H2TRAIN holds a number of future challenges. In the area of sensing of human biomarkers, the research and innovation field is still open to new contributions for sweat tattoos with improved sensitivity and reliability. Flexible substrates for wearable sweat sensor and micro fluidic devices will be integrated on the same substrate, but the low secretion rate and rapid evaporation of sweat at rest limit the volume available to be collected in a sensor. In terms of system in package and integration in textile, i.e., textile-based platforms, this is a growing field and future challenges will focus on the screen printing process. However, in textile-based platform for bio-sensing the challenge is open to form thread-based sensors. There is a short-term need to reinforce learning in the area of embedded intelligence and, in the longer term, collaborative edge AI ecosystems will be needed.

"This is only the first project of a long series; you can be sure of this," says Marco. The market of wearable technologies for sport and healthcare is expected to achieve double-digit growth at least until 2030 and many opportunities (and challenges) need to be grasped. "More ideas will come, and many more partners will sit around this table."

## ABOUT H2TRAIN

The consortium comprises 35 partners, 34 beneficiaries and one associated partner, from seven countries: Austria, Germany, Spain, Finland, France, Italy and Poland. There are technological, life science, social science and humanities, and intellectual property partners. Most partners are SMEs and large enterprises (LEs), although leading research institutions from different fields (hospitals, sports universities, technical universities) are also part of the group. SMEs and LEs cover a broad range of expertise in the Electronic Components and Systems industry, from application to cross-sectional and foundational technologies. H2TRAIN is a multidisciplinary group whose enterprises come from various technology arenas (semiconductors, embedded system developers and integrators, AI and IoT software developers) and different fields such as life science, social science and humanities, intellectual property and dissemination experts, and public institutions.

## SME Focus



# ACORDE Technologies

How European collaboration lead an RF expert to innovative industrial monitoring solutions exploiting AI and suited to the computing continuum



Fernando Herrera

**ACORDE<sup>1</sup>, an SME based in Santander (Spain), has recently reached 25 years of experience in the design and manufacture of RF subsystems for the Defence, Space and Telecommunications sectors. From its origins around a cutting-edge RF communication lab of the University of Cantabria, ACORDE has grown into a team of experts in highly complex RF projects working on innovative research. 25 years of innovation and experience have enabled a wide range of products for transmission and reception in different bands, with different power levels, where quality, reliability and robustness ensure durability and proper operation in the most hostile environments and complex missions. Reaching this point from that initial 100% RF focus has required ACORDE to learn and transform into an interdisciplinary group of experts, acquiring expertise in fields as diverse as PCB design & manufacturing, mechanical design and embedded system development.**

From this technological base, ACORDE has pursued a research strategy that contributes to additional and cutting-edge technologies as a way to generate further products & services able to support new business models. This strategy has proven to be right as it has enabled ACORDE to provide in-house IT-related services (with important advantages, e.g. in confidentiality, for a company like ACORDE)<sup>2</sup> and consultancy on aspects like networking, servers, virtualisation, VoIP, access control and CCTV, etc, but also to its research partners, public and private customers.

While the skills and commitment of ACORDE IT team is a main ingredient of these new business branches in the company, a necessary, additional ingredient of the aforementioned research strategy is **collaborative research**. This means collaboration in national and **international, European research projects**, but also belonging to and collaboration with different national (e.g. AMETIC) and European industrial associations, like INSIDE. The investment by ACORDE in these collaborative platforms, and in the collaboration in European projects with an industrial initiative, e.g., ECSEL, KDT, Chips JU, is greatly rewarded in the many benefits of participation. This has facilitated ACORDE

personnel gaining access to a **European network of experts** and **early and close touch with the cutting-edge and forthcoming technologies** that are strategic for regaining European leadership in ECS.

ACORDE's capabilities for embedded and electronic design (applied, for example, to digital control of RF equipment), plus its aim to collaborate with and learn from leading European experts, have been a perfect entry point for ACORDE as a trusted system integrator in many collaborative research projects. A system integration role is of such necessity that it would have been sufficient to guarantee ACORDE's activity in collaborative projects. However, such collaboration has been also crucial to gain **further knowledge and expertise in new technologies**.

An example of one of those technologies where ACORDE has gained an important capability is in the provision of **geo-positioning/location solutions**. In this sense ACORDE has been able to develop expertise and provide solutions in several key layers of positioning solutions, from multi-frequency GNSS front ends up to multi-antenna, multi-constellation fusion algorithms combining GNSS and low-cost sensors (accelerometer, gyroscope, barometer), GNSS compass algorithms,



Figure 1 - ACORDE staff at the 25-year anniversary event on 23 April 2024 at the wonderful Centro Botin (<https://www.centrobotin.org/en/>) in Santander.

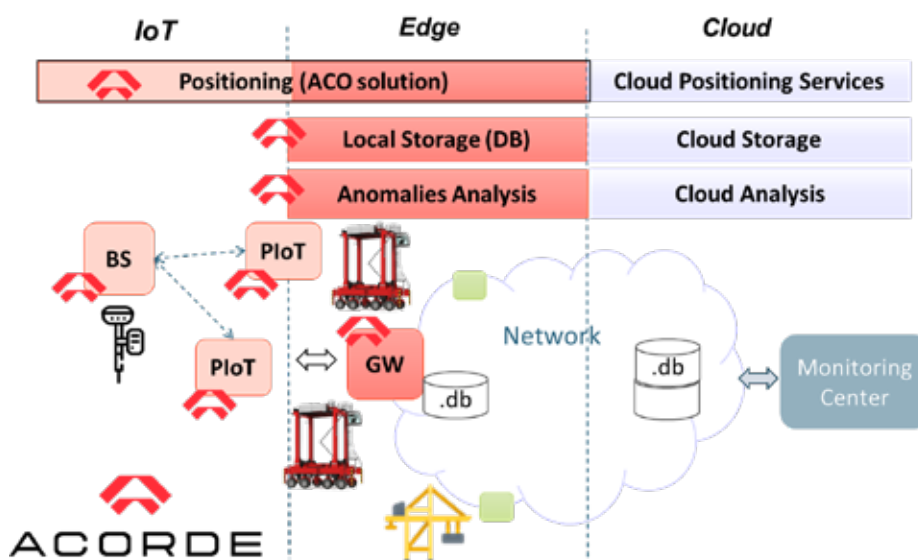


Figure 2 - ACORDE IoT-Edge monitoring solution suited to the IoT-Edge-Cloud continuum paradigm developed in the AIDOaRt ECSEL project. An industrial robust and precise geo-location sensing solution provides data to a robust, edge gateway which enables local geolocation data storage and analysis, before synchronisation with the cloud.

secure positioning (anti-jamming, anti-spoofing), real-time precise positioning (RTK), and indoor positioning solutions. This capability was extensively developed in European projects like AUDITOR, GLAD-2, COMP4DRONES and GALIRUMI. Now, this capability is employed in other customer-driven projects, e.g. for floating solar plants.

A more recent, and very promising technological development of ACORDE is on **advanced industrial monitoring solutions**. Figure 2 sketches how the proposed industrial monitoring solution in a recent

project called AIDOaRt<sup>3</sup> encompasses the expertise acquired so far, with its upgrade and combination with novel approaches and technologies acquired within the project. The AIDOaRt experience can indeed be considered as a paradigmatic case on the **aspects which collaborative research** in these type of industrial driven research projects **can lead to a qualitative improvement** of ACORDE solutions. While some initial publications on this monitoring solution can be found in<sup>4,5</sup>, the rest of the article will focus on the aforementioned aspects.

First, the AIDOaRt project enabled a *classical, incremental* advance in the company capabilities through the development of a new industrial geo-location solution suited to a harsh environment, precise (cm-level) for real-time (10 Hz) positioning of port cranes. For that solution, previous knowhow was employed to develop Positioning IoTs (PIoTs) and Base Station (BS) prototypes but, at the same time, it also required acquiring cutting edge knowledge in PPP positioning to eventually enable a more automated, user-friendly configuration. Advanced embedded edge development was also required to ensure service reliability.

Second, this development exemplifies the adaptation and adoption of new paradigms, like *edge computing, IoT-Edge-Cloud continuum* or *computing continuum* architecture. In this solution, ACORDE developed an industrial Gateway (GW in Figure 2, see its prototype implementation in Figure 3), an edge device, where ACORDE also demonstrated the capability to run a set of containerised services for gathering sensed data, formatting them, and dumping the data into a local data base. Containerisation was known and exploited by the company as it provides relevant advantages in terms of fast service deployment, easy management, better security, and the avoidance of incompatibilities among software packages. The project served to endorse the possibility to run these types of containerised services on the edge monitoring infrastructure and, moreover, to learn and incorporate cutting-edge features, related to *federated databases*, which exploit and boost the advantages of the edge-cloud collaboration. The new approach enables specific analysis to be performed at the edge and, depending on their result, decisions about the different data that is shared with the cloud, ranging from full synchronisation to no sending of data. Within that range, specific metadata, summary metrics, issue reports or down sampled data can be sent to the cloud. This enables more flexible and resource-efficient monitoring solutions.

Third, the AIDOaRt experience enabled *wilder* experimentation on technologies where the company started to accumulate previous research experience, looking for its exploitation in domains like industrial monitoring, where ACORDE had found how to exploit AI/DL for sensor drift anticipation, thus to improve predictive maintenance. This research answered the question of

how to exploit AI/DL for the health of the monitoring system provided by ACORDE. It is also interesting for the stakeholder and/or expert of the monitored plant whose first goal is to have a transparent, reliable monitoring system, which provides monitored parameters with the best precision, frequency and cost. Then, AIDOaRt served to answer a further question, i.e., whether the same AI/DL techniques could be also exploited to offer analyses of the plant at the edge, as a complementary analysis useful for the plant stakeholder. The expectation was that deep learning (DL) could make useful domain-agnostic analysis possible thanks to its capability to learn the *features* from historical data. This question was studied through the development of a *Location Anomaly Analysis (LAA)* service, based on a neural network trained with the *normal* operation of a set of straddle carrier cranes. The result of the experiment was positive, once it was shown that anomalous behaviours, i.e., unusual trajectories considering both spatial and time variables, were possible. This is illustrated in the dashboards developed by ACORDE for the graphical visualisation of the detected anomalies (see Figure 3).

Fourth, the continuous feedback from project collaborations and from the community is vital. Direct collaborations, like the one in AIDOaRt with Prodevelop<sup>6</sup>, leader in ports digitalisation and a reference in Spanish ports<sup>7</sup>. It guided ACORDE into actual port

monitoring needs (e.g., precise, robust, and cost-effective real-time positioning monitoring of straddle carriers) and moreover is leading to a fruitful collaboration towards synergistic solutions relying on Prodevelop management software and edge monitoring infrastructure from ACORDE. The community feedback is acquired via event attendance and publications that enable the company to check its alignment, e.g. sharing lessons learned, realise divergences, and the type of added value that is being developed. A direct example of this, with regard to the aforementioned AI/DL anomaly analysis, was found by ACORDE in a recent INSIDE publication on AI for semiconductor manufacturing<sup>8</sup>, exposing a number of aspects and advantages (release from tagged data requirement, more comprehensive understanding from multivariate analysis, xAI for root cause analysis to identify feature important) which were found to be common for the ACORDE LAA. At the same time,<sup>9</sup> also shows other aspects, e.g. “*What-if*” scenarios that can serve as good guides to future improvements of the ACORDE LAA. Finally, ACORDE makes seriously consideration of global strategic documents generated by the Electronics Components and Systems (ECS) community, i.e. the ECS Strategic Research and Innovation Agenda (ECS-SRIA)<sup>9</sup>. To this extent, ACORDE is aligned in more novel key technologies, like *quantum computing* and *RISC-V architectures*. It is difficult to

distinguish how much of this alignment comes from ECS-SRIA awareness, but what it is sure is that there is a significant part that comes from strategic needs that can be foreseen from the current ACORDE market. Security is now a must in RF monitoring and control electronics, as well as for other non-RF ACORDE developments; and the capability to port some ACORDE portfolio to RISC-V is expected to lead to benefits in terms of technological independence and new business opportunities.

Therefore, while the future guarantees nothing, the aforementioned alignments, and undoubted commitment of ACORDE to ‘*Challenge the limits*’, in collaboration with prominent European companies and research institutions, gives us confidence that we are heading in the right direction for future innovative and profitable solutions for European society.

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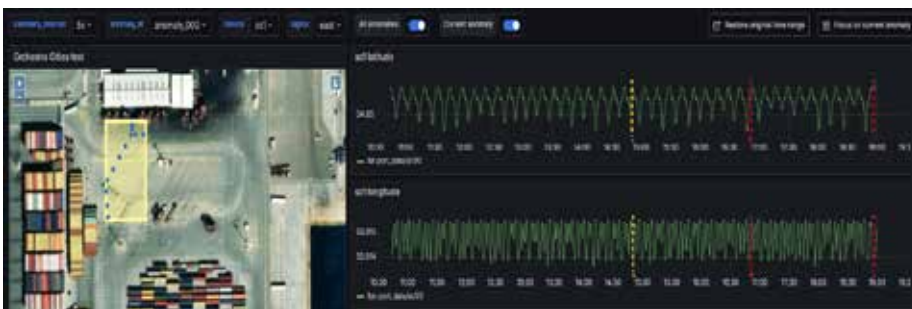


Figure 3 - Industrial Gateway prototype (up) designed and implemented by ACORDE in the ECSEL AIDOaRt project. This gateway supports different types of services at the edge, i.e. geolocation data gathering and local database storage, and, as demonstrated in AIDOaRt, IA/DL based analysis for location anomaly detection (below).

SME Focus

# Adding trust in a connected world

Insight into the workings of a  
successful SME





Markus Pistauer



Chris Horgan

**CISC Semiconductor enhances communication technologies by providing competitive and innovative products with customer-oriented engineering solutions to boost performance, conformance, interoperability, security and privacy. Dr Markus Pistauer is the CEO of CISC and here he explains how the company has grown over the past 25 years to become a leading SME in the area of communication and an active member of various fora and platforms, including INSIDE Industry Association of which he is a steering board member. Headquartered in Klagenfurt, Austria, with subsidiaries in Graz, Austria, and Mountain View (CA), US, CISC is also a shareholder of the Silicon Alps Cluster GmbH that helps bring together players from industry, science and public authorities to develop and position the electronics and microelectronics sector in Austria.**

#### **Starting from nothing**

When looking back to CISC's foundation in 1999, Markus recalls how he "couldn't have imagined that one day companies within the top 50 of the fortune 500 list would be our customers. In the 1990s when I became an assistant professor in electronics, I remember my professor telling me that a good engineer doesn't need a computer, so ... I set my course on the growing field of simulation, or modelling languages to cover the engineering work that was being done by machines and no longer by engineers due to the increasing complexity humans wouldn't be able to manage. I personally started coding the first models in the automotive area to see what happens if you crash your car against a wall or another obstacle, so that the airbag chip fires appropriately. I had to abstract the hardware functionality, and from that we got into the design methodology topic. I had contacts, background information to the research areas and to the activities from the semiconductor companies being done at that time in the framework of a pre-programme of CHIPS KDT. Even though design methodology was a big topic, I couldn't secure the investments I had planned because the banks told me 'If you want to build a house and build a nice pool, I can understand what you're doing, but why simulation software? It's so expensive. Microsoft products are cheap, so software can't be that expensive.' So, you have to swallow that and start what you have:

myself and a small computer. I started to do some first models. With success. The first employees were hired, we got into contact with other companies in the research area, semiconductor companies, undertook our first funding projects and developed our first design framework to put in different models. In a nutshell, we found our niche and specialised in three areas: automotive, semiconductor companies that had to develop the tools, and RFID."

#### **Connecting assets with the grid**

CISC recently launched Internet of Energy to its existing business lines, a fully engineered set of industrial IoT solutions for sustainable and stable energy grids. "It's a software platform with a lot of technology insight from security and also for access to infrastructure," Markus explains. "Connectivity is a key element in the energy market. The point here is that if you have energy assets, you want to get the most out of them. You want to be able to steer the energy demand within your personal grid, firstly by providing the energy you need and then if you have surplus energy, being able to trade that energy on the market. Our role is to connect these assets, collect the data and transfer it to a trading system. If you need to supply energy to the grid, immediately, then you need connectivity, reliable connectivity, safe connectivity. Because energy production and distribution can be a key target for cyber crime as well as physical attacks, as we see in Ukraine. The

latter we cannot defend but cyber attacks we can and should defend and that's what we're working on, the communication in our Internet of Energy unit."

### **Dare to leave your comfort zone**

CISC is market leader in testing RFID and NFC, chips and labels, for both readers and labels. Product tagging is a market driver and nowhere is this no truer than in the health and pharmaceutical industry, which wants to have medication tagged, whether interacting with machines, on the body, small injectors or electronic devices. "There are still a lot of other challenges ahead," Markus admits. "And we don't really know what these may be or when they may come. In 2009, I remember we started an automotive project in the EV area, and the forecast was that production of road-going electric vehicles would probably be 20% by 2015. We've far exceeded that figure. Now, forecasts are that production of combustion engine powered cars will be outlawed in Europe by 2035. Change can take us by surprise, so we have to be ready for such challenges as a small company and be able to act fast and worldwide. That was definitely my approach in our business strategy, not to be a single supplier for a local semiconductor company. Get out of the country, get out of the comfort zone, and provide the best technology. As a small and medium sized enterprise, we definitely have more flexibility in structuring our product and development plans. You have to be fast and see the opportunities you have, but also fast in dropping things that don't work out anymore. It's a challenge we've taken up and we are doing well so far."

### **A to B, wirelessly**

The CISC credo is 'adding trust in a connected world', and this is both a challenge and a goal. "What we mean by this is adding trust in communications. In simple terms, a message goes from A to B. Is it understood? Can somebody else read it? Is it received as I sent it, or was it somehow scrambled? Is it received in time?" Markus says. "I'm pretty sure your smartphone's technology has been tested in our lab. We can read and write NFC and RFID chips in one step, which dramatically increases the speed, the throughput in production. Incidentally, we had a nice project where we managed a sensor that's put directly on the brain of a human and, of course, that needs some power supply without cables coming out of your skull. Wireless charging, and we designed it here. Hopefully, hearing aids or glasses in the future will be wirelessly charged, and

designed with our competence. Safely and securely."

### **Personal assistant**

Another CISC product is COYERO, a secure and trusted technology that enables the digitalisation of various infrastructures and services in a particular city or region through a single, individually branded mobile app. It generates new business models and improves customer experience by linking various services like parking, EV charging, retail, restaurants, public transport, bike sharing, events and other attractions with one another. "Think of it as a marketplace for all your city services," Markus proposes. "It's essentially a platform that can put different service providers under one roof to provide services based on infrastructure. A personal assistant that you can talk to, even take care of a reservation, and can cover the entire process from selecting based on user preferences to entry, including payment. The root lies in the payment and ticketing, for which we have a patented technology. That's some way away from semiconductors, but you have to be alert to the possibilities and opportunities, and make optimal use of your competencies. Of course, data security in any internet transaction by consumers remains a challenge, one that's been highlight in recent hacks (Ticketmaster, for example). It's a central theme in the R&D roadmap that we have in Europe and the strategic, research and innovation agenda with daily updates to which I personally contribute. That's definitely a challenge we have as a company. You work on a particularly challenging technology but then how do you transfer this to a product? It's difficult."

### **European security ... for back-up**

CISC has two subsidiaries in the US, in California, and he recalls attending a visit some eight or nine years ago from the European Commissioner for DG Connect who said that in the US, they are very good at transferring knowhow into money whereas in Europe, we transfer money into knowhow. "This is the challenge we have. And I think even we as a company haven't solved that yet. If we could invest more in new ideas, in something stimulated by the environment, that would be cool." But it's not all about making a quick buck. "I mean, we have certain standards here. Back to security. You may get the same stuff a lot cheaper from Asia, for example, but your data will not be handled with the same security as it would be in the European Union. That might be the added layer of trust because the EU is very





strict with its regulation. So, you know that the quality of the products you get, the way that they handle their data is just a lot more strictly regulated. Our challenge is probably that we have to be faster or more effective, or simply provide a better product that we can also ship in time. Just to cite a large US company that asked us to be a second supplier to their (cheaper) Taiwanese supplier, they said Europe seems to be the more secure country so just in case something happened, they would like a contingency in place.”

### **Biodegradable materials**

When it comes to future trends in technology, “we are now applying artificial intelligence in our digital assistant products to help manage what’s available on the platform for services as well as your personal preferences, without having to click this and that,” Markus says. “Also, in our Internet of Energy business unit where forecasts need to be delivered for trading. How much sun is likely tomorrow? What will be the energy use for my vehicle? How can we optimise the energy matching? Energy is a core demand of mankind. If you have energy, then you have development and prosperity. Without energy, you can’t have both. So, we need to give access to energy to as many people as possible. Simply and affordably. In times where we need to reduce CO2 emissions as well as satisfy the increasing demand for energy, something needs to be done. Optimisation of the energy assets is essential, and communication plays a key role.” In the wireless identification field, there has been a ramp up of the RFID and NFC technology widely used to optimise transport logistics and reduce efforts to monitor product origins. One interesting use case is cannabis for health. The whole supply chain needs to be identified in much the same way as it is already done for meat products, for example. And how it can be recycled. This is what we are doing here, and we are at quite an advanced stage, testing biodegradable electronics made from a biodegradable liquid. They are very small but if you’re talking about billions of those things, which makes a difference. Sustainability is an issue that affects whatever your business is. We’ve come a long way in this respect, but we must remember that the biodegradability actually takes hundreds of years.”

### **Opportunities abound**

Finally, Markus turns to the benefits his company has derived from being in the INSIDE community. “I am convinced that for an SME networking and collaboration are of immeasurable value and working in

joint research projects, being an INSIDE member brings is in close contact with what’s going on in Europe. It helps us determine our strategy and influence the environment in which we operate at the same time. I mean if you don’t stand up and express your opinion, then it’s a wasted opportunity. Here you have the opportunity to create, to be part of the process. And I think it pays off because competition is global and being part of a group is definitely better than being on your own. We have benefited a lot in the past from being part of research projects and got a lot of ideas, not all of which succeeded. But here we are, 25 years in the business. We are stable and understand that our stability and prospects go hand in hand with offering our employees excellent quality of life and prospects to grow within an innovative international company. It stimulates their creativity and passion, and generates maximum technical output.” Ateesha Sethia, Head of Marketing and Communication (USA and Europe), echoes the sentiment: “I can definitely speak on behalf of a lot of people in the company that I am not the only one who feels the same way. I think in terms of employer feeling and the belief in the company and what we’re doing is very, very high.”

Events

# Building bridges to shape Europe's future



Paolo Azzoni



Josh Grindrod

Revisiting the Brokerage Event 2024

**On 20 and 21 February 2024, the ECS Brokerage Event returned to Hotel Le Plaza, Brussels. In bringing together the members of the three industry associations – AENEAS, EPoSS and INSIDE – this annual gathering connects the ECS community and sets the ball rolling on proposals and consortia that will mould the contours of European research and development. As one of the most consistently highly rated events of the three associations, this gives participants the opportunity both to address a full audience in SME and project pitches and to build bridges in face-to-face meetings. In short, this is where the seeds are planted to shape our technological future.**

### The state of play

This year's Brokerage was particularly noteworthy as the first to take place since the launch of the Chips Joint Undertaking (JU). This serves as the implementing vehicle for the Chips for Europe Initiative, which will support technological capacity building and innovation by bridging the gap between the European Union's advanced research and innovation capabilities and its industrial exploitation. The Chips JU does not replace the Key Digital Technologies JU, as is sometimes mistakenly believed, but retains and extend its topics and objectives while adopting a name more recognisably related to the explosive demand for semiconductor technology and the recent chips shortage, both of which have highlighted Europe's lack of market share and autonomy in this domain.

The projects generated by the Brokerage Event therefore fall under the Chips JU Calls 2024. As a result, opening speaker Lucilla Sioli, Director for Artificial Intelligence and Digital Industry at the European Commission, wasted no time in addressing the current state of play: on 1 December 2023, the first calls on the initiative's four pilot lines were launched to the tune of €3.3 billion, while €5.75 billion in investment in infrastructure is expected by 2027.

### The correct approach

In her speech, Sioli also took the opportunity to highlight the bottom-up and bottom-down nature of the Chips JU and thus the Brokerage, whereby support is given to R&D activities decided by participants while important focus topics are defined by the Commission, member states, public authorities and industry associations. "One of these is automotive," Sioli noted. "If you look at the evolution of the automotive industry towards automated driving, it is essential to

think of the electronics part of the car and it is also important to make sure that it works with the software part. We are concerned that the electronic side will end up depending completely on chips and other components from other regions in the world. This is a very strong sector that we have in the European Union, so we are trying to work with the different tiers of the automotive industry to see if we can, for example, invest in inspired architecture."

As a possible implementation roadmap for an automotive hardware platform via the Chips Act, her example included support not just for hardware like chips and cores but also for the software stack of the Software Defined Vehicle (SDV) initiative that aims to create standardised software building blocks and interfaces in the vehicle and at its edge. Such a dual approach, including by the SDV, has been highlighted in articles across previous editions of the INSIDE Magazine; we are therefore pleased that the Brokerage Event marked the first announcement by the European Commission that this support for both hardware and software is the correct approach to vertical application.

### Reaching wider

This was far from the only interesting information to emerge in these early sessions: Patrick Cogez, Technical Director of AENEAS, also presented the first look at detailed data from behind the scenes of the updated ECS-SRIA website. The Strategic Research and Innovation Agenda, created by the three associations to determine challenges and industry objectives, societal benefits and strategic advantages for Europe, has achieved excellent results in terms of readership. As Cogez' overview revealed, the ECS-SRIA was accessed over 48,000 times in the last year alone, including visitors from

110 countries and with near parity in gender. Notably, the number of visits and users were equally distributed across the main sections (foundational technology layers, cross-sectional technologies and ECS key application areas), suggesting purposeful and in-depth readership – including from outside of the world of technology, with 30-40% of users reported to be interested in economy, business and/or politics.

The capacity for the ECS-SRIA to reach beyond its existing audience is especially pertinent to the Brokerage, which is open to all interested parties and not just members of the associations. The event is therefore often the entry point for newcomers to the ECS community and allows the ecosystem to be continually renewed with fresh ideas and expertise. With this in mind, association directors Paolo Azzoni, Caroline Bedran and Elisabeth Steimetz collectively outlined the role of the industry associations as private members in the Chips JU, as well as the services they offer. These include representing the interests of their members in the Chips JU Governing Board, advocating for attractive content and funding conditions in calls, proposing and discussing the aforementioned focus topics, and organising, in addition to the Brokerage itself, workshops and a yearly stakeholders' forum.

At this year's Brokerage, the benefits of such membership were amply demonstrated – among other ways – through the awarding of the 2024 RIAs Challenge winners. Organised by INSIDE in the context of the European initiative EUCEI, this highlighted four research and innovation action (RIA) projects with strong results and exploitation opportunities in the Edge to Cloud Continuum. Given the associations' services in networking and consortia building, the challenge forms part



of a wider effort to build up an ecosystem among European industries involved in edge, IoT and cloud technologies and applications. More information and interviews with this year's winners can be found in a dedicated article in this magazine.

### Cycle of success

For the three associations, the key advantage of one shared Brokerage is bringing people together from their different communities and beyond, through which projects are generated that are far more varied in scope than one association alone could hope to achieve. The benefit of such an approach was on full display in the poster presentations, stretching across multiple rooms of Hotel La Plaza and providing information on 48 future project proposals.

Many of them were seeded in Brokerages gone by, largely thanks to dedicated sessions in which projects can be presented to potential partners. On the afternoon of the first day, dozens of projects were pitched on a wealth of topics, ranging from autonomous machinery, AI chiplets and quantum design automation to wearable ultrasound patches, digital democracy and the minimisation of waste in the food supply. At this year's

event, 16 SMEs also pitched themselves, encompassing anywhere from ten to a thousand employees and demonstrating a wide geographical spread across Europe, such as established powerhouses like France and growing innovation centres like Slovenia. Each year, both sets of pitches are facilitated by the dedicated ECS Collaboration Tool, which allows users to initiate projects, invite partners and search for both.

### Overarching ambitions

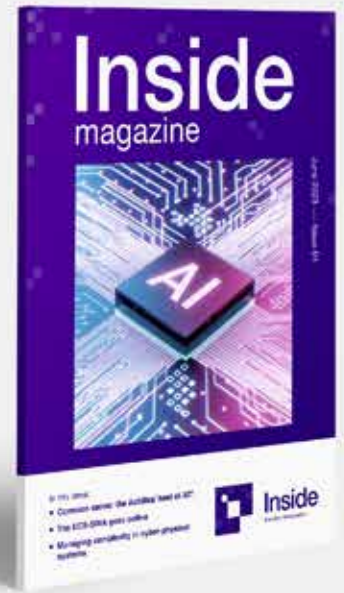
As always, the second day of the Brokerage was more informal, featuring only a speech on the 2023 and 2024 Chips JU Initiative calls before leaving participants to bilaterally build up consortia on the basis of the first day. While recognising the successes of the Brokerage Event, we remain mindful of our commitment to delivering the latest and most relevant information to attendees. We therefore acknowledge that the final presentation by the Chips JU was intended also for participants from outside of the community who may be less intimately familiar with it. With the aforementioned name change from Key Digital Technologies to Chips JU, for example, repeating information can be a means of avoiding further confusion.

Nonetheless, the final session contained a number of new elements for even the most dedicated attendees, including a more detailed motivation of the Chips for Europe pilot lines by demonstrating their intersection with the initiative's proposed design platform and competence centres, as well as the mutual exchange between the initiative, users and suppliers and the industrial uptake of technologies developed. The overarching ambition is to provide start-ups, SMEs and other users with a design environment similar to what is expected at larger companies.

As the Chips JU gets fully underway, we expect such efforts to have an increasingly large impact on the ease of running effective projects and on the results achieved. We very much look forward to seeing which projects emerge from this year's gathering and we hope to meet you again at the ECS Brokerage Event 2025, where we will continue to promote our members' interests and help push Europe into a leading position in intelligent digital systems.

# Inside magazine

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2024

# Innovating the Edge to Cloud Continuum

Insights from the 2024 RIAs  
Challenge winners







Paolo Azzoni



Josh Grindrod

**Research and Innovation Action (RIA) projects focus on activities primarily at TRL 3-6, involving consortiums that may comprise SMEs, large enterprises, universities and public organisations. They emphasise the development and application of innovative technologies to address industrial and societal challenges, showcasing their value and potential in a realistic lab environment or use case.**

In the previous magazine, INSIDE Industry Association, in partnership with the European initiative EUCEI, awarded the four winners of their 2024 RIAs Challenge. EUCEI aims to build a European continuum among industries involved in edge, IoT and cloud technologies and their applications. As a member of the OpenContinuum CSA, INSIDE participates to the EUCEI initiative facilitating networking and collaboration opportunities that expand and safeguard Europe's position in Intelligent Digital Systems and in the Edge-to-Cloud Computing Continuum. In the previous magazine, we presented projects that have reached significant milestones in this domain and that hold promising avenues for further exploitation and industrial impact.

As evidence of these accomplishments, the winning projects were showcased and celebrated at the ECS Brokerage Event 2024, organised by the three industry associations (AENAS, EPoSS and INSIDE) in Brussels on 20 and 21 February. In the poster presentation hall of Hotel La Plaza, the event provided a platform for the winners to engage with industry stakeholders, policymakers and fellow innovators, and propose follow-ups and new project ideas. This presented the perfect opportunity to speak with the leaders of the projects on their successes so far, their future ambitions and their impressions of the Brokerage as a whole.



## FLUIDOS

**Fulvio Riso is a Full Professor in the Department of Control and Computer Engineering at the Polytechnic University of Turin. FLUIDOS (Flexible, scaLable, secUre, and decentrallSeD Operating System) aims to leverage the enormous, unused processing capacity at the edge, scattered across heterogeneous edge devices that struggle to integrate with each other and to coherently form a seamless computing continuum.**

*As a project leader and a professor, what makes the Brokerage event worth attending?*

I'm coming from a world that is probably a little bit orthogonal to most of the people here. People are coming here from the hardware side – chips, systems and so on – while I'm coming from the top, so cloud and then moving down to the edge. This kind of matching is really useful for me because in order to make cloud systems and edge systems that actually work, I need support and requirements from people in the lower technology levels and a strong connection to industry. So, this event is definitely a huge opportunity for me.

*Your poster mentions follow-up and new project ideas. How can the Brokerage help to shape and give momentum to these ideas?*

We have to look forward to the next project opportunities because what we are doing right now in this project is to create a sort of first version of the continuum. For that, we need two main ingredients. First, more use-cases. We definitely need to make our computing infrastructure more efficient and more intelligent. But this has to be put together with more intelligence at the orchestration layer too. If I have a smartphone that is more intelligent, can it work alone or is it better if it talks and shares data and computing with



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other smartphones that are more intelligent? In the end, having this kind of orchestration on top of better, more efficient and more intelligent hardware will probably help us to better shape the future. Second, we need better integration with the physical world, which means sensor actuators, hardware accelerators and so on. This event is really useful in that respect because of the merging of different communities from ECS. We had a lot of chances to talk with other people just today and there is still tomorrow too.

**What has been the highlight of the event so far for you?**

I was impressed by the number of people who came to our booth asking what we're doing. This gives us a lot of use-cases and a lot of new ideas in terms of the usage of the technology that we provide, which is our duty as a university. For example, we were talking to somebody from automotive and they were saying that our project can be used to reduce the number of integrated circuits, CPUs and microcontrollers in a single car,

which means saving costs and decreasing problems with the supply chain. This very important right now. In other words, better and more intelligent orchestration can mean more integrated and smarter components, but a reduced number of them. These sorts of discussions are what I feel is most valuable at this event.



**MYRTUS**

Francesca Palumbo is an Associate Professor at the University of Cagliari, working on reconfigurable system design, and Katuscia Zedda is R&D&I Programme Manager at Abinsula, which creates software solutions for the embedded, digital and IoT markets. MYRTUS (Multi-layer 360° dYnamic orchestration and interopeRable design environment for compute-continUum Systems) leverages a cognitive engine based on swarm intelligence and federated learning to orchestrate collaborative distributed and decentralised components.

**What are your biggest technical and societal ambitions for MYRTUS?**

**Francesca:** From the technical point of view, the idea is to create key enabling technologies for a real continuum. The ambition is to create an infrastructure capable of offering connection, monitoring and orchestration capabilities of all the resources from edge to cloud in a homogeneous manner – as in, with the same type of techniques. These resources will be orchestrated by the main result of MYRTUS: a cognitive engine to use artificial intelligence in a transparent manner for users. This project is not to create services for users but to orchestrate the continuum of resources with swarm intelligence and federated learning to learn from the execution in order to evolve and be able to offer better usage of resources. In terms of sustainability, the goal of this cognitive engine is to be able to better orchestrate the resources and distribute the computation, lowering the power consumption where needed. And if you want to have a societal impact with something this complex, you need instruments to facilitate the designer's work, so we are preparing a design and programming environment to facilitate usage.

**Katuscia:** Another ambition is to be part of the open-source community. In fact, all of the methodologies that we are developing will be released in an open-source version. Even the tools released by the company are open source and we will try to keep it that way. So, it's a big investment in open source and open-source strategies.

**Francesca:** We also have two use-cases that have a lot of ambition and impact at the societal level. For example, one is about remote telerehabilitation in virtual environments. The idea here is if you have this continuum, you allow people to train at home for rehabilitation after accidents. In this collaborative environment, there will be real agents, cooperating on a task to do with rehabilitation, but we can be aided by other virtual agents that learn from our actions and mimic our actions to guide us to complete tasks. The other use-case is about cooperative, connected and automated mobility to have, for example, better orchestration of vehicles in the city. So, there are many technical aspects that will have societal value.

**The MYRTUS project wants to establish synergies with other projects and initiatives. How does the Brokerage help with this?**

**Katuscia:** The first interaction on this synergy was actually at the previous Brokerage event because one of the key points of the call – not only of the project – is to establish synergies with the IPCEI initiative. When we were in Amsterdam last year, it was an opportunity to contact STMicroelectronics, which is part of the IPCEI initiative, and we were able to include some very preliminary information on what we can do together using the results of the MYRTUS project. This year has been even better because, of course, we are excited about the project that we are starting. We have had the opportunity to talk with people who are interested in the results

and can maybe bring in new use-cases, or at least want to be informed of the results. On our website, we will have a special page where we will try to collect all the input that comes from different projects and initiatives at the European level, but also from South Korea and Japan. We will try to use all this information to have the right solution after three years.

**What has been the highlight of the event for you?**

**Francesca:** For sure, the fact that it's a great opportunity to create synergies. There are so many people here, including many people from industry who are difficult to catch in their normal routines. On this kind of occasion, it's easier to establish contact. I come from academia, so this is really the perfect event to meet the big players from industry. This is basically the first big event that MYRTUS is participating in as a group, so it's really nice that, at the start, we have already collected many contacts for follow-ups on the activities.

**Katuscia:** I've been involved in these kinds of projects for more than 15 years now, so the main highlight of my day is to meet all the old and new friends because it's really a community here. That's the difference between other brokerages and this event. We know each other. Sometimes, we work together on the same projects, sometimes we arrive with different projects, but we all try to provide the technology for our community.



**Anastasios Zafeiropoulos is a Postdoctoral Researcher in the School of Electrical and Computer Engineering at the National Technical University of Athens. The NEPHELE project aims to enable the efficient, reliable and secure end-to-end orchestration of hyper-distributed applications over programmable infrastructure that span across the computing continuum from cloud to edge to IoT, removing existing openness and interoperability barriers.**



*What are some concrete examples of how your project has added value to industry so far?*

In the NEPHELE project, we work a lot on developing solutions that tackle the overall phase of the continuum. How can we manage deployment that considers computing and networking infrastructure in IoT devices? We have two main artifacts. One has to do with the virtualisation of your devices: we provide an open-source software stack that is aligned with the emerging specifications from working groups like the W3C Web of Things Working Group. So, we have close interaction to follow the standard specifications in order to be more ready for industry. We also have validation within the project with industrial use-cases using this software stack and we follow guidelines from the Open Mobile Alliance. We follow these two groups for the IoT part of our solution. Then, for the orchestration platform, we once again try to develop open-source solutions and validate them in various industrial use-cases, like energy management in smart buildings, logistical operations in ports, healthcare and

disaster recovery. Finally, we run two open calls where we get applications from SMEs and mid-caps so that they can get access to our solutions, validate them, develop extensions and give feedback to us.

*Your poster mentions follow-up and new project ideas. How can you use the Brokerage to shape and gain momentum for these ideas?*

This comes into play as an evolution of the software that we develop, this being open source and close to standard. We have ideas for the addition of extra functionalities related to IoT virtualisation, more advanced security features and more advanced scenarios with regards to ad-hoc networking mechanisms, for instance, as well as solving more interoperability challenges for the IoT part. For the meta-orchestration part, the main motivation is to introduce more autonomy to the system and more decentralised intelligence characteristics. The Brokerage is very helpful in all this because we are coming from a domain where we tackle a lot of software development and management aspects. This event is bringing us into closer

interaction with people who work a lot with hardware solutions. Bridging these two worlds can lead to the development of more innovative and end-to-end solutions in a more holistic way. I have really enjoyed the nice and helpful discussions all around.

*What are your biggest ambitions for follow-up projects in terms of the technical and societal challenges that you want to solve?*

Energy efficiency is one of the main societal challenges. It would be great if we can manage to provide solutions that have a direct impact on energy. You can reduce energy consumption by using information communication technologies, but you can also reduce the energy consumption of this same ICT infrastructure. That's really important. On top of this, we do a lot with data fusion and management, so I think that we can also provide advanced solutions related to disaster management in areas that feel the most effects of climate change. For me, these two are the most crucial.

# The future of Edge Computing: a united effort



Paolo Azzoni

RIAs challenge 2024: step 2



**The industrial landscape is undergoing a transformative shift, driven by the ever-increasing integration of data, computation, and connectivity. In this evolving environment, the Edge-to-Cloud Computing Continuum represents a central concept, encompassing the seamless interplay between distributed processing at the edge and centralized cloud resources, and bringing processing power and data analysis closer to where it is really needed. The full potential of the Edge-to-Cloud Computing Continuum requires a multifaceted approach, and several European projects are actively shaping its future, each contributing unique solutions to specific aspects of the Computing Continuum to empower a smarter, more efficient, and interconnected world.**

As a follow-up of the RIAs challenge 2024, we decided to extend the initiative and identify a group of important projects that by working together could build the foundations for a robust, adaptable, and secure Edge-to-Cloud Computing Continuum: CODECO, INTEND, NebulOuS, INCODE, AEROS and VEDLIoT.

CODECO addresses the management challenges of the continuum, creating a cognitive framework for seamless and smart orchestration of decentralized data flow, computation, and networking across the entire Edge-Cloud continuum (e.g. in internet and IoT service decentralization). INTEND, NebulOuS, and INCODE further delves deeper into the realm of service orchestration, focusing on specific use cases (e.g. smart cities, energy management, and manufacturing). INTEND aims to provide an open-source platform that facilitates the deployment and management of applications across the continuum, leveraging the distributed nature of the continuum and fostering the creation of innovative and scalable services. However, managing the sheer volume of data generated at the edge

requires robust and scalable solutions, and NebulOuS tackles this challenge by developing a novel edge-based data virtualization framework, offering a unified view of data residing across various edge nodes, and ensuring efficient data access and analysis. This fosters a collaborative environment where data gathered from diverse sources can be seamlessly integrated and utilized. Moving beyond data management, INCODE focuses on the secure and seamless integration of IoT devices within the continuum. The project aims to develop a unified platform that facilitates the secure onboarding, management, and operation of IoT devices, paving the way for the widespread adoption of IoT technology within the continuum. The need for real-time processing at the edge is addressed by EDGELESS, which focuses on creating a decentralised micro-cloud platform for edge computing, allowing the possibility to deploy and execute applications directly on edge devices, enabling real-time processing and analysis where data is generated, reducing latency and increasing overall efficiency. Taking flight in the realm of aerial data collection, aerOS aims to develop an innovative aerial Edge-to-Cloud platform specifically designed for unmanned aerial vehicles (UAVs). Their solution allows UAVs to process data onboard, reducing latency and bandwidth requirements, while enabling real-time decision-making for critical applications. Finally, VEDLIoT presents a unique perspective by focusing on the needs of the video analytics industry within the continuum. The project aims to develop a distributed video intelligence platform that enables real-time video analysis at the edge, minimizing bandwidth and facilitating faster response times in applications such as video

surveillance and traffic monitoring.

By working together, these projects are building the foundation for a robust, adaptable, and secure Edge-to-Cloud Computing Continuum ecosystem. By harnessing the power of distributed computing, robust data management, and secure device integration, these initiatives open doors to innovative applications across various industrial sectors, driving progress and shaping a dynamic edge ecosystem. In this article you'll find a short description of the projects, highlighting the project focus, the research and technology domains, the project's added value, impact, innovation, and results. We invite you to visit the projects' websites and contact the coordinators for further information and future collaboration.



# CODECO

A novel Edge-Cloud orchestration framework, focusing on data-compute-network



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Website: <https://he-codeco.eu/>

## Project focus

CODECO stands for Cognitive Decentralized Edge to Cloud Orchestration. It is an open-source software framework pluggable to Kubernetes. CODECO improves the energy efficiency and robustness of the Edge-Cloud infrastructure (compute, network, data) by improving application deployment and run-time. CODECO's vision is based on a cognitive and cross-layer orchestration. It considers as layers the dataflow, computation, network. Its focus is on creating a flexible and resource efficient Edge-Cloud infrastructure.

## Research and technology domains

The project focuses on IoT-Cloud-Edge AI-based orchestration. Specific topics relate with:

- decentralised and privacy preserving AI (key topics., swarm learning; MARL; DL);
- network exposure across federated environments (key topics, ALTO, FaaS, SDN);
- context-aware orchestration (e.g., integration of network-data-compute metrics based on a continuous data-aggregation approach);
- application and data-oriented scheduling (keywords: seamless computing).

## Project's added value, impact, innovation, and results

*Value:*

- the unique data-compute-network approach of CODECO brings the IoT-Edge-Cloud computing to a new level, as it aims at providing support for the next generation IoT infrastructures with a combined view, and not just addressing the infrastructure per layers. This reduces required complexity, improves energy-efficiency, and is less error-prone.
- the capability to adjust to different environments, including different networking technologies, makes CODECO a relevant solution to address mobile scenarios involving dense IoT use-cases.

*Impact:*

CODECO is being released as a full OSS framework. An early release is already available in the Eclipse CODECO research lab, thus allowing for broad experimentation: <https://gitlab.eclipse.org/eclipse-research-labs/codeco-project>

*Key Research Contributions:*

- Automated configuration and cognitive edge-cloud management, taking into consideration computational, network, and data observability.
- Privacy and context-aware decentralized learning. CODECO provides decentralized orchestration across single and multi-cluster environments beyond federated learning approaches.

- Dynamic scheduling and workload migration. Ensures that applications and their micro-services are supported across the Edge-Cloud continuum with increased automation.
- Joint orchestration of data. Takes an all-layers approach (network, compute, data resources).
- Global view of data in the IoT-edge-cloud continuum. Where are datasets stored, what are their characteristics, and what constraints limit data processing and replication? In order to accomplish this, CODECO will collect, manage, and make available metadata to the orchestration engine.

*Key results:*

In addition to its OSS orchestration framework, CODECO key results are as follows:

- Open-source, cognitive toolkits and smart Apps, integrating the elastic and advanced concepts to manage, in a smart and flexible way, containerized applications across Edge and Cloud (dynamic cluster and multi-cluster environment).
- A developer-oriented Eclipse open-source software repository, thus allowing for early exploitation of initial, advanced results and a better adaptation throughout the project lifetime.
- Training tools and events, to support the development of services based on the CODECO framework.
- 6 Use-cases across 4 domains (Smart Cities, Energy, Manufacturing, Smart Buildings), to be deployed in operational environments.
- An Innovation and Research Community Engagement Programme, with awards and multiple community events, based on the different use-cases and including different CODECO stakeholders.

CODECO framework integration into a large-scale experimentation infrastructure such as EdgeNet, to assist in the development of experimentation with CODECO across different environments.



# INTEND

## Intent-based data operation in the continuum



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### Project focus

The overall objective of INTEND is to deliver breakthrough AI solutions to achieve novel intent-based data operation, capable of continually learning how to adapt heterogeneous cloud/edge resources, strategic decision making across the decentralized continuum, and human-friendly interaction with data stakeholders based on shared intents. The results will realize the novel concept of intent-based data operation in the continuum: Data stakeholders chat with the toolbox about how they intend their data pipelines to perform in the continuum. In this way, the project aims at paving the way of migrating EU's data industry from cloud to the continuum, and implements EC's strategy of human-centric AI.

### Research and technology domains

The project will push forward the state of the art in the following research and technology domains..

- Data operation in the continuum: With virtualizations and orchestration across the cloud, fog and edge, Function as a Service (FaaS) can be achieved on the whole continuum. INTEND will be built on top of these achievements but aiming at more advanced intelligence and human involvement.
- Advanced artificial intelligence: AI has been fuelling the continuum for higher automation. Machine learning approaches are used to optimize the placement and resource usages of data pipelines, and continual learning to cope with the heterogeneity and dynamicity. INTEND will build on top of federated learning and decentralized intelligence to coordinate multiple AI models for concurrent but harmonized decision-making, borrowing the theory of brain conscious.
- Human-AI involvement: the earlier research in self-adaptive systems relies on predefined adaptation policies from data operators. Intent-based management was first used on network management, and later on intent-based orchestration. We will go further to realize natural language interface for the data stakeholders to "talk to the continuum about their intents", achieving the "collaboration via shared intents".

### Project's added value, impact, innovation, and results

#### Value:

Novel way for high-level intent-based data operation, lowering the threshold for data stakeholders to manage the data pipelines in the complex computing continuum. Investigation of advanced AI techniques, including continual learning, decentralized intelligence, neural symbolic AI, and Generative AI, into the data operation and resource management in the computing continuum

#### Impact:

- Scientific: The project will investigate and prototype the novel concept of intent-based data operation and push forward

the state of the art in data engineering, decentralized AI, and human-AI interaction.

- Business: The result will increase the efficiency of data processing in the continuum, utilize unconventional devices on the edge, and eventually boost the open edge ecosystem across the entire supply chain from chip producers, server builders, infrastructure providers to software and service developers.
- Environment: Through intelligent data operation, the project aims at reducing the total environment footprint of the data processing in the continuum.
- Society: Intent-based data operation will facilitate wide stakeholder involvement in data processing, helping to bring digital solutions closer to citizens.
- Politics: By pushing data processing from the cloud to the edge, the project will contribute to EU's objective of open strategic autonomy in the data and AI economies.

#### Results:

INTEND's ambitious research in the three directions will lead to 11 novel software tools, to realize the novel concept of intent-based data operation in the continuum: Data stakeholders chat with the toolbox about how they intend their data pipelines to perform in the continuum. Understanding the intents, the toolbox will keep adapting the data pipelines in the continuum and explain to the stakeholders what it did or could not achieve, in order that the stakeholders can trust the AI and collaborate with AI for better data operation. The new intent-based operation will be validated in five use cases, in the domain of video streaming, machine data analysis, 5G data infrastructure, urban dataspace and robotic AI.

The main contribution of the project will be on exploring and exploiting the advance AI techniques, including continuous learning, decentralized intelligence, neural-symbolic AI and Generative AI, for advanced resource management and data operation in the continuum. This will increase the efficiency of data processing, ease the use of edge resource, and reduce environmental footprint. In particular, the project aims at the effective usage of unconventional hardware resources in the continuum, in particular,

Neural Processing Units, edge storage units, and the computing resources within 5G networking devices. By exploiting the potential of such edge resources, we aim at contributing to EU's objective towards strategic autonomy in data and AI.

# NebulOuS



**A meta operating system for brokering hyper-distributed applications on cloud computing continuums**

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## Project focus

NebulOuS is a research project focused on advancing cloud and fog computing brokerage. The project aims to make significant contributions in these fields by introducing advanced methods and tools. NebulOuS aims to enable secure and optimal application provisioning and reconfiguration over the cloud computing continuum. It involves the development of a novel Meta Operating System (Meta-OS) and platform for transient fog brokerage ecosystems. These ecosystems seamlessly utilize edge and fog nodes, along with multi-cloud resources, to meet the requirements of low-latency applications, such as those in autonomous vehicles and smart cities.

The main directions of work within NebulOuS include:

- Development of modelling methods and tools: creating appropriate methods and tools for describing the cloud computing continuum, application requirements, and data streams to ensure Quality of Service (QoS) for provisioned brokered services.
- Efficient comparison of offerings: implementing multi-criteria decision-making methods to compare available cloud offerings, considering all dimensions of consumer requirements.
- Intelligent applications management: managing intelligent applications, workflows, and data streams in the cloud computing continuum.
- Unified security approach: addressing security aspects in transient cloud computing continuums in a unified manner, including access control, secure network overlays, etc.
- Smart contracts-based SLA monitoring: conducting and monitoring service level agreements using smart contracts.

NebulOuS strives to innovate in the realms of cloud and fog computing, aiming to create a flexible and secure environment for applications that require low-latency and dynamic resource provisioning.

## Research and technology domains

NebulOuS covers several key areas of research:

- Development of modelling methods and tools for describing the cloud computing continuum, application requirements, and data streams.
- Efficient comparison of available cloud offerings using multi-criteria decision-making methods.
- Intelligent applications, workflows, and data streams management in the cloud computing continuum.
- Unified addressing of security aspects in transient cloud computing continuums, including access control and secure network overlays.

- Conducting and monitoring smart contracts-based service level agreements.

Conducting and monitoring smart contracts-based service level agreements.

## Project's added value, impact, innovation, and results

*Added Value:*

- Efficient Resource Allocation: Advanced methods optimize cloud and fog resource use, improving efficiency and cost-effectiveness.
- Seamless Application Provisioning: A novel Meta-OS simplifies deployment and management across diverse computing environments.

*Impact:*

- Low-Latency Applications: Supports applications with low-latency needs, such as autonomous vehicles and smart cities, using efficient edge and fog node utilization.
- Unified Security Measures: Enhances security across transient cloud computing continuums, contributing to a more secure environment.

*Innovation:*

- Modeling Methods and Tools: Develops innovative methods for describing cloud continuums, application requirements, and data streams, enhancing Quality of Service (QoS).
- Smart Contracts-Based SLA Monitoring: Uses smart contracts for transparent and reliable SLA monitoring and enforcement.

*Results:*

- Scalable and Adaptive Infrastructure: Delivers a flexible infrastructure capable of handling diverse application scenarios via the Meta-OS and fog brokerage ecosystems.
- Efficient Comparison Methods: Implements multi-criteria decision-making for informed cloud service comparisons, aiding consumer decision-making.

In summary, NebulOuS aims to provide added value through efficient resource management, impact through support for low-latency applications, innovation in modelling and monitoring tools, and results in the form of a flexible and secure computing infrastructure.





# EDGELESS



Cognitive edge-cloud with serverless computing.

Coordinator: *Antonio Paradell*

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## Project focus

EDGELESS has the ambition to realise an efficient and transparent horizontal pooling of the resources on edge nodes with constrained capabilities or specialised hardware, smoothly integrated with cloud resources, by leveraging the serverless concept across the entire edge-cloud continuum and fully benefiting from diverse and decentralised computational resources available on-demand close to where data are produced or consumed.

## Research and technology domains

EDGELESS addresses the following research areas:

- Innovative programming models that provide developers with a stateful Function-as-a-Service abstraction and advance beyond classical serverless computing.
- Multi-tier Service Level Agreement management.
- Lightweight virtualisation solutions that can run efficiently in a broad range of heterogeneous edge devices and virtualised infrastructures in the cloud.
- Cognitive tools and solutions that can be smoothly deployed in the edge-cloud continuum for, e.g., the detection of anomaly events for a more robust operation.
- Enhanced trust for stateful FaaS workflows based on authenticated onboarding of resources and execution in Trusted Execution Environment enclaves.
- Efficient management and orchestration of Artificial Intelligence inference tasks on specialised hardware.
- Decentralised orchestration services for the allocation of resources at scale.
- Distributed consensus schemes for the synchronisation of operations and data consistency at application- and administration-level.

## Project's added value, impact, innovation, and results

*Key value propositions:*

- Enable novel dynamic use cases for serverless technologies in the edge-cloud continuum and across business domains.
- Reach a new efficiency level for running data-intensive applications in the edge-cloud continuum.
- Develop cognitive tools to harvest the full potential of the edge device clusters, and allow smooth and resource-efficient operation of applications.
- Augment today's serverless computing approaches with new functional extensions.
- Make complex FaaS application deployment easy to use and flexibly applicable for different environments with heterogeneous physical device infrastructure.

*Impact:*

- Improve performance and reduce application response time in more efficient resource management, while ensuring data privacy and security.
- Demonstrate through pilots execution costs reduction and additional benefits due to its use.
- Reduce the environmental footprint associated with edge-cloud service by considering energy sources, reducing network traffic by executing applications on the edge, and measuring energy efficiency at resource level before taking any deployment decisions.
- Take advantage of the so-called cognitive cloud, following a user-centric approach, where reasoning performed through AI/ML algorithms helps solving the most complex problems deploying applications in the continuum.

*Innovation:*

- EDGELESS aims to pioneer the development of a stateful FaaS paradigm, moving beyond traditional stateless serverless architectures. This innovation allows functions in the edge-cloud continuum to maintain and manage state information, offering a more versatile and comprehensive solution.
- EDGELESS is designed to seamlessly integrate with the edge-cloud continuum, acknowledging the importance of distributed computing across a spectrum of devices. This ensures that computing resources are optimally utilised, reducing latency and enhancing overall performance.
- Dynamic state management capabilities within the FaaS framework. Functions can now retain and manipulate state information, facilitating the development of more complex and interactive applications across distributed environments.
- EDGELESS is optimized for scalability, allowing stateful functions to dynamically scale based on real-time demand. This not only enhances resource efficiency but also adapts to varying workloads, ensuring that the system can handle a diverse range of applications effectively.
- Leveraging an event-driven architecture, the stateful FaaS framework of EDGELESS enables seamless communication and coordination between distributed functions.
- Security and privacy concerns are given a prominent role in EDGELESS, by implementing robust security measures, such as encryption and access controls, ensures that sensitive data is protected, and user privacy is maintained even in a distributed edge-cloud environment.
- Developer-friendly interfaces and tools so that the adoption of stateful FaaS becomes accessible to a broader developer community, fostering innovation and collaboration.





#### Tangible results:

- Reference implementation on GitHub: <https://github.com/edgeless-project/edgeless>.
- Orchestration algorithms at multiple levels, local edge, cross-edge, edge-cloud. AI models for anomaly detection in relevant environments.
- Enabling technologies: lightweight virtualisation techniques, secure authentication based on Hardware Security Modules,

secure execution of functions in trusted enclaves, transparent offloading to GPUs, distributed consensus schemes.

- Demonstration of the crucial features of EDGELESS in three realistic use cases: Advanced Smart City Analysis, Internet of Robotic Things, and HealthCare Assistant.
- Guidelines and best practices from the adoption of EDGELESS in the use cases and other testbed activities.

# aerOS

**Autonomous, scalable, trustworthy, intelligent European meta Operating System for the IoT edge-cloud continuum**



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#### Project focus

aerOS overarching goal is to design and build a virtualised, platform-agnostic meta operating system for the IoT edge-cloud continuum, delivering (i) common virtualised services to enable orchestration, virtual communication (network-related programmable functions), and efficient support for frugal, explainable AI and creation of distributed data-driven applications; (ii) expose an API to be available anywhere and anytime (location-time independent), flexible, resilient and platform-agnostic; and (iii) include a set of infrastructural services and features addressing cybersecurity, trustworthiness, and manageability.

#### Research and technology domains

IoT-edge-cloud computing continuum, resource orchestration, service orchestration, networking, data management, cybersecurity, trust, virtualization, IoT.

#### Project's added value, impact, innovation, and results

One of the sectors that will benefit most from the vibrant emergent innovations in the chips area is the computing continuum. By definition, the continuum is defined as the environment where multiple computing resources, ranging from IoT devices, edge elements up to cloud data centers can come together, interact, interconnect and cooperate as to resemble a single entity for the user. Also, from another perspective, innovating in tools and methods to manage such heterogeneity can clearly contribute to enhance the research in chips. Either by identifying bottlenecks, potential risks, hot application areas or by discovering relevant testing, scenarios, the mutual benefit is clear. Good software and tools will also help uptake the innovations in chips. Win-win situations are easily foreseeable in a world that we can pitch as: "chips are not useful without high level computation and users, and vice versa". In this sense, aerOS will support exposed standardised services APIs, hardware abstraction, cross-domain resource orchestration, and explainable/decentralised frugal AI. Moreover, aerOS will allow for distributed data management to make user-side applications more intelligent and proactive,

and to provide foundation for hyper-distributed applications and services, closer to data sources and event-generating processes without sacrificing aggregated data analysis and insights. Additionally, aerOS will leverage concept of services as a "unifying abstraction", across resources (i.e., any physical or virtual IoT edge-cloud continuum resource, from device to far-edge, edge or cloud); across multiple infrastructure domains and service levels, supporting federation. Several aspects of aerOS will utilise the (semi)autonomous approaches.

Moreover, aerOS will leverage European leadership in automation systems in industry (where edge resides) and pointedly prove how European industry can benefit from decentralised, platform-agnostic IoT edge-cloud continuum data-processing ecosystem, to build competitive advantages e.g., reduced time to decisions; cost and time efficient, secure, trustworthy data sharing and control; semi-autonomous action taking; agile operations; sustainable, human-centric data processing, governance, and interoperability; reduced external traffic; and improved latency. The aerOS approach will be generic and directly applicable to any vertical, cross-vertical business process, and several different physical or virtual platforms. It will answer the urgent need for a trustworthy, decentralised, autonomous, orchestrated solution, enabling bottom-up formation of compute continuum ecosystems, where hyper-distributed applications will be efficiently executed, within any selected "fragment" of heterogeneous physical infrastructure.

Finally, both the exposed objectives and the evolution of the mentioned technologies will be validated by deploying a series of real-life use-cases divided in five different pilots: (1) Data-Driven Cognitive Production Lines - Manufacturing Autonomy Level 4, (2) Containerised Edge Computing near Renewable Energy Sources, (3) High Performance Computing Platform for Connected and Cooperative Agricultural Mobile Machinery to Enable CO2 Neutral Farming, (4) Smart edge services for the Port Continuum, (5) Energy Efficient, Health Safe & Sustainable Smart Buildings.



# VEDLIoT

Very Efficient Deep Learning in IoT



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## Project focus

The VEDLIoT project has pioneered the development of energy-efficient Deep Learning methodologies specifically designed for distributed Artificial Intelligence of Things (AIoT) applications. Throughout the project, we have adopted a comprehensive approach that not only optimizes algorithms but also tackles the inherent safety and security challenges associated with AIoT systems. Central to this approach is a modular and scalable cognitive IoT hardware platform. This platform utilizes microserver technology, allowing users to customize the hardware to suit the diverse requirements of various applications. This ensures that the system is adaptable and capable of meeting the unique demands of a wide range of use cases.

## Research and technology domains

The VEDLIoT project tackles demanding and distributed IoT and edge applications, addressing a spectrum of use cases from Smart Home environments to Automotive and Industrial IoT appliances. Additionally, an open call has incorporated ten more use cases, expanding the project's scope and application areas. The project has delved into several research and technology domains, contributing to its interdisciplinary approach. One focus area is on security-related research, particularly on distributed remote attestation and Trusted Execution Environments (TEEs) for various hardware architectures, including ARM and RISC-V. The project investigates safety and requirements engineering methods tailored for AI and AIoT systems. Moreover, significant efforts are directed towards heterogeneous computing and the development of modular and scalable systems. The project also includes research into hardware acceleration and co-design, alongside efforts to optimize toolchains for enhanced performance and efficiency.

## Project's added value, impact, innovation, and results

The VEDLIoT project brings substantial added value, impactful innovations, and meaningful results for next-generation AIoT applications.

### *Added Value:*

VEDLIoT provides significant added value in the design of distributed AIoT, edge, and cloud applications across the entire compute continuum. It enables the creation of scalable applications while simultaneously increasing energy efficiency and enhancing security and safety. The project's hardware platform, combined with various hardware accelerators and an optimized toolchain, facilitates streamlined application development. VEDLIoT supports advancing innovative and efficient AIoT solutions by addressing these critical aspects.

### *Impact:*

VEDLIoT significantly simplifies the development of energy-efficient AIoT, edge, and cloud applications by offering a holistic approach that focuses on optimizing algorithms while addressing the inherent safety and security challenges of these systems. By providing cross-vendor solutions for development, optimization, emulation, and verification, VEDLIoT offers an alternative to vendor lock-in and closed platforms. This approach enhances the flexibility and adaptability of AIoT solutions, promoting innovation and broader adoption across various industries.

### *Innovation:*

VEDLIoT drives innovation across all project areas, delivering significant advancements in several key domains. In hardware, VEDLIoT offers a platform that spans the complete compute continuum, enabling heterogeneous computing and integrated accelerators. The project introduces co-designed accelerators, applying application-optimized solutions tailored to specific needs. In terms of security, VEDLIoT pioneers methods for utilizing Trusted Execution Environments (TEEs) and distributed attestation, enhancing the robustness of AIoT systems. For safety, the project proposes a comprehensive design framework for AI-based, safety-critical systems, ensuring that these advanced technologies meet stringent safety requirements. These innovations collectively push the boundaries of what is possible in AIoT, edge, and cloud applications.

### *Key results:*

VEDLIoT has demonstrated more than an order of magnitude (>10x) improvement in performance and energy efficiency across all key application areas. This remarkable achievement results from comprehensive optimizations at the hardware level, such as the use of heterogeneous hardware and accelerators, combined with various optimizations at the toolchain and model levels, including hardware-aware pruning. Additionally, VEDLIoT has developed numerous components across different project areas—hardware, accelerators, toolchain, and methodology—available as open-source or commercially. Notable examples include a modular and scalable heterogeneous hardware platform that supports AIoT, edge, and cloud applications; WebAssembly-based open-source Trusted Execution Environments (TEEs) abstractions and attestation mechanisms; a design framework and methodology for AI-based distributed systems; and an optimizing toolchain and emulation environment. These key results underscore VEDLIoT's contribution to advancing AIoT technologies, providing scalable, efficient, and secure solutions.

# INCODE

## Programming Platform for INtelligent COllaborative DEployments over Heterogeneous Edge-IoT Environments.

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### Project focus

INCODE over Heterogeneous Edge-IoT Environments brings together nineteen partners committed to breaking the edge computing status quo by creating a wide-open, secure and trusted IoT-to-edge-to-cloud compute continuum that will realize the true potential of edge intelligence. To this end, over a three-year period, the project consortium will design and develop an open platform for the deployment and dynamic management of end-user applications across distributed, heterogeneous, and trusted internet-of-things (IoT) edge node infrastructures, with enhanced programmability features and tools. The platform will do so by implementing innovative design approaches and will constitute a fully integrated infrastructure under the cloud managed architecture.

### Research and technology domains

IoT, edge computing, swarm intelligence, programmability, computing continuum.

### Project's added value, impact, innovation, and results

The rise of cloud computing technologies and the shift of processing intelligence to the network edge has made the private use of the edge at scale more accessible. However, increasing edge capacity is not enough to unlock the full potential of edge computing systems. The project is a pioneering initiative which aims to address this challenge. Programmability is at the heart of its unique approach to reimagining the IoT and the potential of edge computing. In the project's vision, all smart devices – from everyday sensors to sophisticated industrial machines – work together seamlessly, driven by the ability to be fully programmable. Imagine each device having its own unique identity, a digital fingerprint secured by blockchain and advanced hardware certification. This authentication ensures not only the legitimacy but also the integrity of each device.



# Event calendar



18 June 2024

## Open-source silicon and EDA F2F workshop

Paris, Sorbonne University, France



16-20 September 2024

## CPS Summer School

Alghero, Italy



14-20 July 2024

## ACACES 2024

Fiuggi, Italy



24-25 Sept 2024

## AIOTI Days 2024

Brussels, Belgium



18-23 August 2024

## ECS Summer School

Bertinoro, Italy



11-13 March 2025

## Embedded World

Nürnberg, Germany

Online version is available at [Inside-association.eu](https://inside-association.eu)

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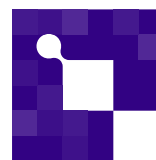
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**Contributions**

The INSIDE Industry Association office is interested in receiving news or events in the field of Intelligent Digital Systems. Please submit your information to [info@inside-association.eu](mailto:info@inside-association.eu)

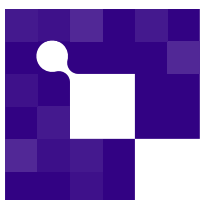
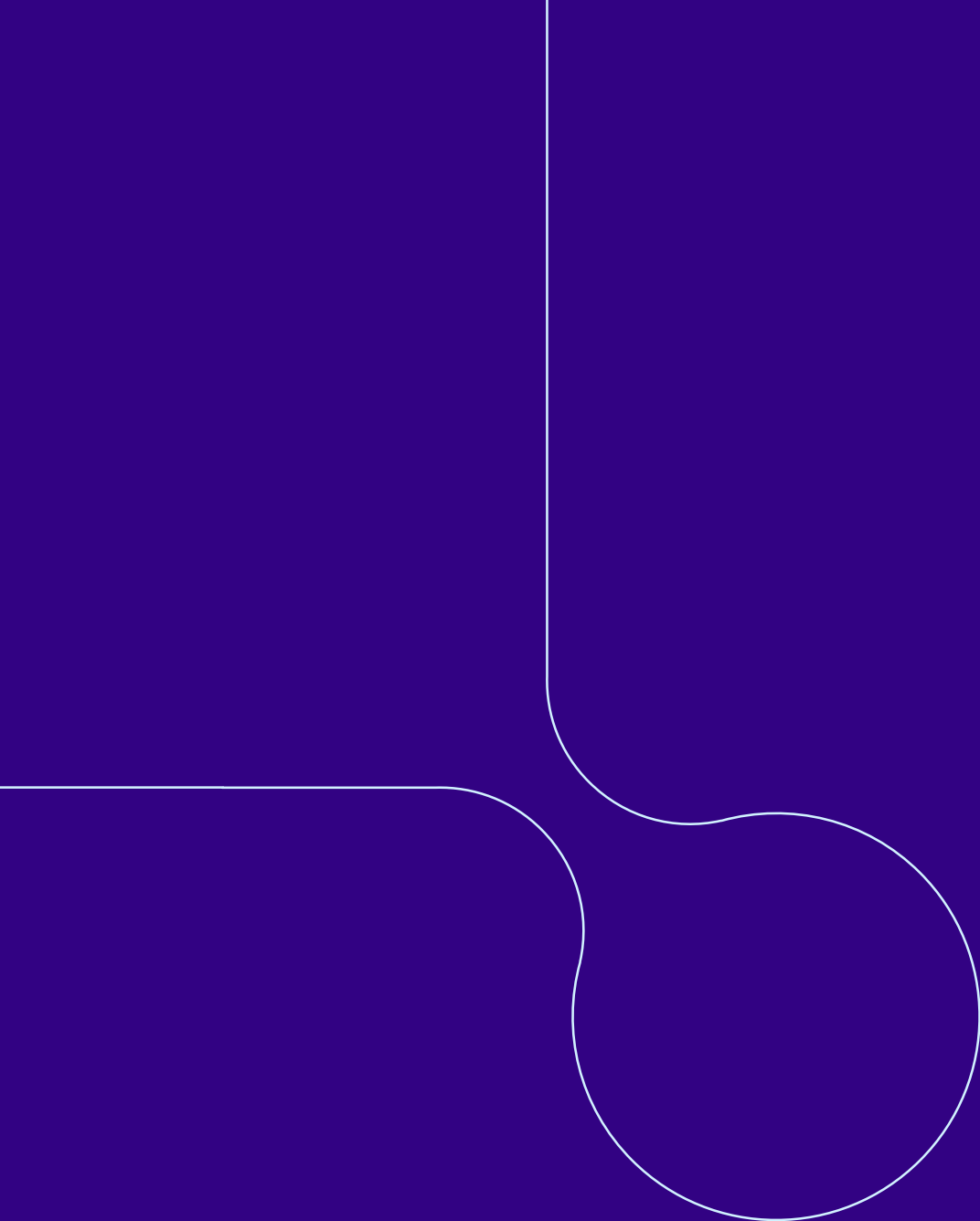


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