Inside magazine

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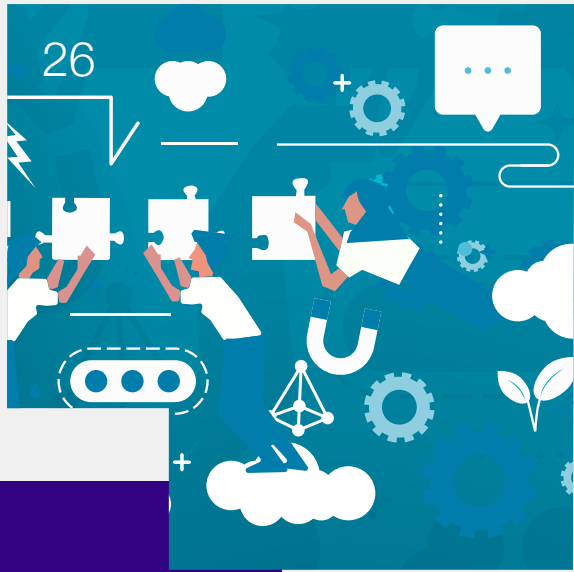
In this issue:

Inside
Industry Association

In this issue



Dear reader,

Inside Industry Association is entering an important phase: different challenges in a stormy and rapidly changing world and the need for technological advances and new forms of collaboration. Complexity, heterogeneity, fragmentation, lack of trust in technologies, these are constant themes in our search for solutions supported by interdisciplinarity that can lead to a better and more sustainable world. As always, it is the role and responsibility of the Inside community to enable players along the entire ECS value chain to play a key role in shaping the future.

In this edition of the magazine, you can read how the Inside community tackle these challenges, advances and collaborations. Such as through the Scientific Council, whose role is to advise the Inside Steering Board and Inside community in all fields of the ECS domain and medium- to long-term developments in programmes and related projects. The Scientific Council members are heterogenous, technologically oriented people from all parts of Europe; they form a strongly connected, interdisciplinary and flexible team, ready to address all kinds of aspects and questions raised by the Inside community.

Other highlights in this magazine include the role of Inside as a driver to create a panacea for digital road mobility in Europe, which was demonstrated on July 1st, 2022, in Versailles. Leading representatives from the automotive and electronics R&D worlds convened to tackle the crucial issue of how to make verticalisation efficient between the micro/nano electronics industries and their much-needed applications in order to steer the innovative axes of road mobility and the vehicle of the future. The workshop not only resulted in much consensus about what is needed but also paved the way for the definition of a road map for the Software Defined Vehicle and related focus topics to be developed in the coming years. Furthermore, we outline a review of Arrowhead Tools' results and technology, which is regarded as "a gamechanger on digitalisation and automation engineering, providing a new and open approach on how to engineer 'System of Systems' for industrial usage." The work performed in the industrial use-cases and associated demonstrators is remarkable.

Read about the Secure Connected Factory created by the Italian company Leonardo and how use is made of a wide range of best practices for the protection of data when connecting a vast array of heterogenous devices: the new geopolitical situation has made it clear how much we have neglected cybersecurity for ECS and their applications in recent years and how necessary it is to invest in this complex technological domain. Security (or, more generally, trustworthiness) is critically impacted by software with growing complexity: the AIDOaRt project tries to respond to this challenge affecting all software and systems engineering phases as well as during operations and maintenance, whereby AI-augmented automation can provide solutions to tackle the lack of professionals and to more efficiently support continuous software and system engineering along their lifecycle. Speaking of AI, the EdgeAI project investigates how the application of artificial intelligence (AI) at the edge brings a myriad of opportunities, including higher processing speeds to allow real-time analytics, greater scalability to work with large amounts of data, and improved cybersecurity as less data is processed externally or off-premises.

I hope you will enjoy going through all the different sections of the publication and, if you are attending EFECS 2022, I wish you a very fruitful meeting in Amsterdam this coming November 24th-25th.

Paolo Azzoni
Secretary General

Seizing the opportunities fo verticalisation

The Inside(r) role in creating a panacea for digital road mobility in Europe

On July 1st, 2022, the Chambre de Commerce et d'Industrie in Versailles (France) hosted a meeting of leading representatives from the automotive and electronics R&D worlds to convene with the aim of tackling the crucial issue of how to make efficient verticalisation between the micro/nano electronics industry and their much-needed applications to steer the innovative axes of road mobility. The workshop resulted not only in much consensus about what is needed but also about the next steps that need to be taken. What follows is a review of the main points of discussion, conclusions and takeaways.

Paolo Azzoni

Jean-Luc di Paola Galloni

Challenge as a shared research opportunity for the two communities

The automotive industry is subject to three key trends: electrification, prompted by regulations; progressive automated driving, urged on by safety requirements and user demand; and the need to optimise the supply chain. While these trends have been driving digitalisation of the industry for the past few years, if not decades, pre-existing collaboration between the semiconductor and automotive industries has been disrupted by recent chip shortages. This has amplified the existing challenges in terms of a lack of availability of raw materials, manufacturing infrastructure and qualified workforce. The outcome is that the affordability of mobility in the future and the resilience of the corresponding supply chain are critically at stake.

But what may seem to be a difficult challenge could, and should, be regarded as a huge opportunity, not only for guaranteeing consumer access to affordable mobility but also for both industry (with the automotive industry set to drive 20% of the global growth of the semiconductor market in the coming years) and for Europe (to set the standards, regain technological control and broadcast its core values, such as privacy, security, efficiency and circularity). All in all, the whole automotive value chain offers a €3 trillion value opportunity before 2030. And if we are to seize it, we have to accelerate both the speed and level of strategic funding.

Need for political choices to identify priorities

This workshop revealed a consensus on the need for a European vision and strategic planning by both political and industrial players, with a strong technical side driven by industry and based on political decisions that support the defined vision and strategy, the focal points being:

- Compliance regarding competition.
- Standardisation, data sovereignty and cybersecurity to gain a competitive advantage and a channel to broadcast our values.
- Independence vs. edge innovation. All stakeholders stressed the wide gap between the technologies promoted by the Chips Act (<5 nm) and those required by industry (>180-20 nm).

The amount of investment in production capacity is certainly good news, but only if it is reoriented to fund both mature and future technologies and if implemented very rapidly. After all, the semiconductor supply chain needs to multiply its capacity fourfold before 2030, and capacity building takes years. On the other hand, the effects of shortages on capacity building are clearly highlighted in the context of geopolitical tensions (in the world post-2022). The Chips Act cannot solve this issue with the gigafactories that are being built in Europe. To maintain the consistency of supply, we also need to secure the upstream supply chain in raw materials wherever Europe can, with proper European (social and environmental) standards to strengthen and fluidify the overall value chain of the digital ecosystem.

The automotive industry benefits from the technologies pushed by other markets (not only European), so the question is how it can be competitive and remain not independent but resilient and strong, with an eye to maintaining the competency to understand the technologies as well as master and drive them. The art lies in taking lessons from one sector and translating them to another (technology cross-fertilisation). Furthermore, it is vital that production capacity is reinforced (11 million cars were lost last year due to supply issues, including a shortage of chips) and maintained for all technologies (mixed signals, 40 nm). It is essential that the structure of the industry undergoes a change, and a readjustment of border taxes will add the necessary flexibility.

Addressing the gaps

So how can the investment gap be bridged? Verticality needs to exploit horizontal synergies between markets to reduce costs, like developing domain-independent chips (to enable economies of scale) and specific software. The automotive industry can help by building vertical synergies and horizontal synergies with other industries that attract more investments: agriculture, industry, defence, etc. Of course, it should be noted that the dynamics of the dual (civilian/military) use market is completely different; stock markets and shareholders look at sustainable/military grids of evaluation while some investors' statements prohibit investments in military matters.

Then the issue arises of how to bridge the timeline gaps to align all the stakeholders. Jerker Delsing (Lulea University, INSIDE, KDT) has highlighted the timeline problem when it comes to industry and academia, citing the lack of a precise vision of R&D that makes it impossible to have a proper innovation roadmap. "When industry people come to academia, they talk about what they need today: brains and very short-sighted issues; they seldom describe what they need in the long term. Academia has a longer-term perspective; aligning long-term strategies is crucial."

In commenting on the timeline gaps between automotive and digital innovation, Stefan Deix, director of EUCAR (European OEM's R&D association) points out that while the automotive sector is very volatile, it still needs to show visibility to the value chain. "We're talking about building roadmaps," he says. "A typical exchange looks like this:

- What do you need in 10 years?
- Better sensors.
- What sensors? Do you have the specs?
- No."

The problem is only compounded by digital obsolescence (electronics or software) in the

production cycle. "A vehicle is in production for seven years. It is already digitally old-fashioned when production starts and outdated soon after. How to keep the vehicle modern? Always updated? We are talking of two tonnes of materials and several grams of chips!" says Stephan Neugebauer, BMW Director for global research cooperation and China and member of the EUCAR board. Clearly, there is a need to rethink design. Several requirements should be taken into account at an early stage – integration, AI and energy, for instance – to bridge the gap between automotive and digital lifespan/ innovation rate. We have to consider it from the two sides: software update + hardware influence on the software. We need to introduce backward compatibility in the automotive industry.

The right questions and specific answers

"The next generation of digitalisation has to address a high level of complexity," states Paolo Azzoni, Secretary General of Inside and Head of European Technology Programmes at Eurotech, "and it is based on interdisciplinarity, that is to say requiring more varied expertise in very different engineering and scientific domains." It all comes down to competency building whereby verticalisation is complementary with horizontal transfers. Education and training are crucial components in compensating the workforce shortage in industry. For example, 30 million people work in coding today (i.e. 5 to 6% of the European workforce) – this amount will need to double in the coming years. We can start by educating people very early (e.g. getting kids to start coding in primary school) and working on the attractiveness of electronics curricula (and of industry) as well as ensuring the coverage of domains such as photonics, acoustics, radio frequency (RF) and telecommunication, which are becoming extremely important. In addition, improving the synergies between industry and academia (e.g. professors working part-time in industry) can help solve the lack of professors and strengthen mutual insights.

There will be a shift in the workforce, with fewer electrical engineers and more of a focus on systems integration. Reusing the brainpower across domains – collaboration – would be an attractive proposition. By centralising the knowledge gained from cross-technology collaboration in a specially designed mobility technology stack, many of the issues referred to above could be resolved. European design houses could design chips for all applications and thereby provide much needed engineering support as well as reduce costs for the application industries. Indeed, according to Geoffrey Bouquot, CTO & Strategy VP, Valeo, "collaborative research is key – within the scope of compliance – as it saves time and money to take strategic orientation and, as a matter of fact, we need to be efficient."

So how can the building of roadmaps be organised, concretely? By asking the right questions and providing specific answers. This enables the needs to be evaluated in terms of volume for each technology. An example provided by Jochen Langheim of ST Microelectronics poses the question of how many wafers are needed to produce zone controllers and how these are produced. The ADAS project cites 200 mm^2 chip/car, which is equivalent to one or two months of production by two TMSC sites, so is perfectly feasible. Furthermore, by adopting design strategies that are built on the practice of reuse (e.g. multi-domain chips), it becomes possible to reduce the effect of the shortage and costs, and simplify the supply, production, maintenance, etc.

Software represents a crucial part of the technology stack, but it comes at a price. It is expensive and we need to finance it through long-term investments, something that could help Europe in recovering the position lost in the Operating Systems (OS) market. Another crucial level in the automotive technology stack is the hardware abstraction/virtualisation level, which is totally software-based and which represents one of the enablers of OS independence.

Protect, save, consolidate and strengthen

A practical approach to supporting these objectives could be refreshing the current process of collaborative project selection. A concrete way to boost competencies and increase efficiency is for evaluators to prevent the current mismatch (of ideas or interpretation) between the teams that are writing the ECS Strategic Research and Innovation Agenda (ECS-SRIA)[2] and the team of reviewers that selects the projects. We need to either train the reviewers to understand the ECS-SRIA or have the participation of a representative from the ECS-SRIA editing team in the project evaluation. A bottom-up approach through workshops that focus on and reduce/limit the list of contributors would also go a long way to boosting efficiency. The inclusion of stakeholders (research, industry, other users) representing nano-micro applications will give the opportunity for them to express their needs and requirements in the discussions and the evaluations. This will help (i) to solve the current low level of analysis in the software domain and (ii) ensure that software technologies are included in long-term strategic plans. The ECS-SRIA is updated every year and this contributes to preventing any gap/misalignment between the needs of the industry when the roadmap is written and implemented. But this is not enough: points (i) and (ii) must be considered.

A focus on technology domains and markets where Europe is strong is essential to protect, save, consolidate and strengthen these domains and markets that are strategically important for Europe. When it comes to focusing the investments on the objectives that have a higher success potential and higher impact, working together on these objectives and co-developing them is key. Since this approach is aligned with the fact that the European Commission can only support communities that have already come together, workshops should be organised in every sector. Obviously, KDT cannot cover all industrial needs. It should be an extension of a well-established European strategic policy, made by industry. Delegating the exact interpretation of your needs to the institution of contractual Public Private Partnerships (cPPP) is not possible, but KDT should ensure, through the overall projects within a work package, that the ECS part of automotive R&D incorporates a sequence of exploitable values that will be covered in a further step by the different perimeters of the cPPP.

Future technical focuses

So, what European programmes should be developed for? The whole technology stack

Output of brainstorming session

What is needed from the ECS value chain to make EV better and CCAM possible?

What can KDT deliver for the progress of 2Zero and CCAM?

must be taken into account when developing a new chip and more generally any new hardware, starting from firmware to the OS level (drivers, system libraries, etc.) and middleware level and up to application support software. Ralf Drauz of Forvia underlines the need for strategies for OS. "Europe has lost the capacity to develop OS specifically for mobility, a pillar to ensure strategic autonomy, security, etc., in the automotive market. We could have the capacity to build it back for embedded systems and IoT (in particular, vehicle OS), although there is a risk of OS multiplication."

Middleware may be a first, easier step to solving the problem of OS multiplication but this approach requires funding from Europe for standardisation. It brings an abstraction between hardware and software and could be a solution to bridge the timeline gap. Other important technological areas include silicon carbide and gallium nitride (which are strong markets but complex technologies), infotainment and high-performance sensing solutions (external and internal). It is worth noting that the inside of the vehicle is becoming more important.[1] Software sustainability, algorithms which adjust to weather conditions, and physiology (influencing how the user perceives information) must also be kept in mind. Fortunately, most hardware growth will be led by power electronics, so this gives Europe a clear advantage over China and the US.

So, what can we take away from this discussion and how can this exchange be converted into action? The value of such a workshop is clear. With a mix of high-level representatives from the ECS value chain and automotive sector, the format is strong and should be maintained. More diversity among the participants would only serve to enhance this format. The goal should be to build a simple, clear message for policy makers so that they know what to develop and to evaluate priorities (KDT can fund what is critical for sector applications). Moreover, workshops can help establish better synergies and collaboration activities between the European Associations and Platforms (e.g. Inside, Aeneas, EPOSS, BEPA, 2ZERO, CCAM, ERTRAC). To maintain momentum, meetings should be held on a regular basis in this kind of format – at least twice a year. A suggestion might be to schedule sessions concurrent with the country of the Presidency of the EU, so the next meeting will be held, December 20th 2022, in Prague, the Czech Republic (Valeo has offered to host this at its tech centre location).

Finally, the role of Inside in promoting the workshop and creating the environment for the exchange of ideas and concrete propositions for solutions shows not only a new ambition to exert a real influence on the way ahead but also its value in bringing together a community in which collaboration across the board – from research to industry and application – can, and must, make the difference.

[1] The position of the PFA and VDA on production facilities in Europe to manufacture state-of-the-art nodes (<7 nm) is contained in the position paper sent to Commissioner Thierry Breton in 2021.

Eclipse Arrowhe and greener digi

Reduced engineering costs, significant time savings and less use of environmental resources. The Arrowhead Tools project has achieved game-changing results after three years of technology R&D&I and extensive validation and verification in industry.

Jerker Delsing

Over the last several decades, automation and digital transformation have become a natural part of our society and our industries. But there are huge costs related to it, not least for automation engineering and maintenance. The Arrowhead Tools project set out to build a software architecture and implementation platform that could substantially reduce time and engineering costs for industrial digitalisation and automation solutions. The result, Eclipse Arrowhead, led to significant time savings: processes that took a month now take a week and what took a week now takes just hours, saving not only time but resources and money. Eclipse Arrowhead can be applied to all kinds of industries, such as construction, mining, automotive and manufacturing. Eclipse Arrowhead has been created to assist industries and organisations no matter their size and scale. In summary, it provides cost-efficiency, high performance, security, interoperability, flexibility, scalability and real-time operations.

In a factory, for example, there are many digital systems of different ages working side by side without really communicating with each other. Eclipse Arrowhead allows these systems to become part of an integrated solution that communicates seamlessly in cooperation with the latest internet technology by using the 'System of Systems' approach based on a microservice architecture with a strong support for interoperability. This is integrated into the Eclipse Arrowhead open-source implementation platform. Validation and verification of the platform has been undertaken in more than 25 industrial use-cases with spectacular results.

We have succeeded in demonstrating exceptional cost savings of 30-95%. The industrial use-cases range from semiconductors to mining and automotive to smart cities, taking in a wide array of domains in which new jobs and business opportunities can make Europe more competitive. The resulting Eclipse Arrowhead technology is provided open source, which includes over 25 core building blocks, engineering procedures and tools. Together, these support the aforementioned automation digitalisation features.

Savings on automation also have knock-on benefits beyond the world of business. If you look at overall production, any improvement in efficiency will directly affect energy usage. Very often, when you improve efficiency and get better automation, you get better quality. It has long been known that high quality and efficiency mean better raw material yield and less waste.

Arrowhead Tools' results were achieved, to a large extent, during the COVID-19 pandemic. This was possible thanks to numerous online meetings and a few very productive face-to-face gatherings. Once together face-to-face, people saw that they could do various things together, which never happens online. In the end, the project was able to carry out more than 40 demonstrations and ten industrial forum talks at the IEEE ICPS 2022 conference in Warwick, UK.

The project has now triggered processes in a number of companies on how they can use the new technology. This knowledge has even escalated up to the board level in some cases. They are now aware of this new technology through which they can make huge improvements on how they build automation and substantially reduce investment costs.

ad for cheaper talisation

However, it is still a complicated task to widely roll out this knowledge and technology within any production company. Such upscaling of Arrowhead Tools' industrial usage can allow its impressive cost-savings to percolate throughout entire companies and value networks, not just the core engineering domains.
According to the KDT-JU's final review, the project features excellent initial exploitation activities which have a high potential impact for the commercialisation of results.

While Arrowhead Tools may have come to a close, the journey is far from over. A core contribution to this is the Eclispe Arrowhead commercial ecosystem, with over 20 companies already actively creating business based on Eclispe Arrowhead technology.
An example is Thingwave, which recently announced a partnership with global mining player Epiroc. Epiroc will market ThingWave sensors, data acquisition and integration technologies which are built on the Eclipse Arrowhead architecture and integration platform.

The ecosystem has a complete focus on the commercialisation of the Eclipse Arrowhead technology. Their last meeting is in Stockholm on 9 November 2022 and more information can be found on the Arrowhead.eu site.
Our continuous mission is to further simplify usage and improve the robustness of Eclipse Arrowhead. We hope to continue and accelerate this journey toward a greener and more digital future.
To mention another impact example, end-users in Sweden are pushing to learn to use and benefit from these technologies. For that purpose, ProcessIT Innovations has produced an initial webinar featuring three companies – Boliden, BnearIT and Thingwave – and focusing on their interest in Eclipse Arrowhead. For further details, visit the Arrowhead.eu site.
Yet another impact is the granting of more than ten new EU and national projects, all relying on Eclispe Arrowhead as a core architecture and integration platform.

As for any final words to the people and companies who made this monumental project possible, there's a lot to say!

People have done a great job, not just in solving their internal interests but in joining forces and combining the knowledge of universities, RTOs, technology SMEs and large companies. This has really propelled the results to where we are. The 30-95% improvement is an amazing achievement - HATS OFF TO THE TEAM!

This view was shared by the KDT-JU review panel, which was highly enthusiastic and described Arrowhead Tools' results and technology as "a gamechanger on digitalisation and automation engineering, providing a new and open approach on how to engineer 'System of Systems' for industrial usage. The work performed in the industrial use-cases and associated demonstrators is remarkable."

FACTS
The Arrowhead Tools Project consisted of 80 industrial and academic partners from 18 European countries with a €90 M budget. The project was coordinated by Luleå University of Technology. The funding was received from the EU KDT Joint Undertaking and from the partners' national programs and funding authorities.

The project's aim was to find efficient digitalisation and automation solutions engineering for European industry and to close the gaps that hinder IT/OT integration by introducing new technologies in an open-source platform for the design and run-time engineering of IoT and System of Systems.

Further sources of knowledge:
Youtube: https://www.youtube.com/channel/UCC-kTqFXh7StNwR7IFCRCjw
Web Eclipse Arrowhead: https://arrowhead.eu/eclipse-arrowhead-2/
Code: www.github.com/eclispe-arrowhead

Secure connected factory

Securing the digitalisation process of complex and heterogeneous industrial plants

Stefano Garavaglia

Luigi Picari

Francesco Rogo

Leonardo S.p.A. is an Italian multinational company specialising in the Aerospace, Defence and Security sectors. With 106 sites, this is one of the leading defence contractors worldwide and plays a prominent role in major international strategic programmes, as well as serving as a trusted technological partner for governments, defence agencies, institutions and enterprises. But with so many plants, heterogeneity is a major obstacle: machinery of different ages and with various network interfaces must communicate effectively to guarantee safety and efficiency in production. How can one company respond to the challenge of creating secure connections between heterogeneous devices?

The new geopolitical situation clearly highlights how critical the investments on security are

The challenge of heterogeneity

Building a new plant from scratch is, relatively speaking, a straightforward endeavour as a company can opt for the state of the art in communication technology. However, when machines are built to last decades, any longstanding production company will inevitably end up with equipment from different technological eras and domains. Leonardo uses, for example, milling machines that work with raw metal and environmental stress screening (ESS) machinery based on electronic components, neither of which has been designed for communication with the other. The replacement of such machines could potentially cost millions, even discounting the knock-on costs of shutting down production during the changeover time and teaching employees to use the new equipment. So, Leonardo's focus is instead on enabling greater capabilities within the existing ecosystem.

In a company like Leonardo, thousands of heterogeneous assets are deployed at different time periods, from production and auxiliary machinery (i.e. milling machines, furnaces, galvanic systems, HVAC systems etc.), sensors and actuators (i.e. T&H, pressure, meters, cameras, etc.) to tablets and smartphones. The heterogeneous network interfaces (i.e. Serial, eth0, radio, etc.) interconnect the heterogeneous assets in operational technology (OT) networks, which are used to connect production devices within a plant. As OT networks may be as simple as a cable connecting to production machinery with no internet exposure, data gathering requires a further connection to information technology (IT) networks. While the last decade has seen a convergence of OT and IT, this also brings with it new challenges in data security.

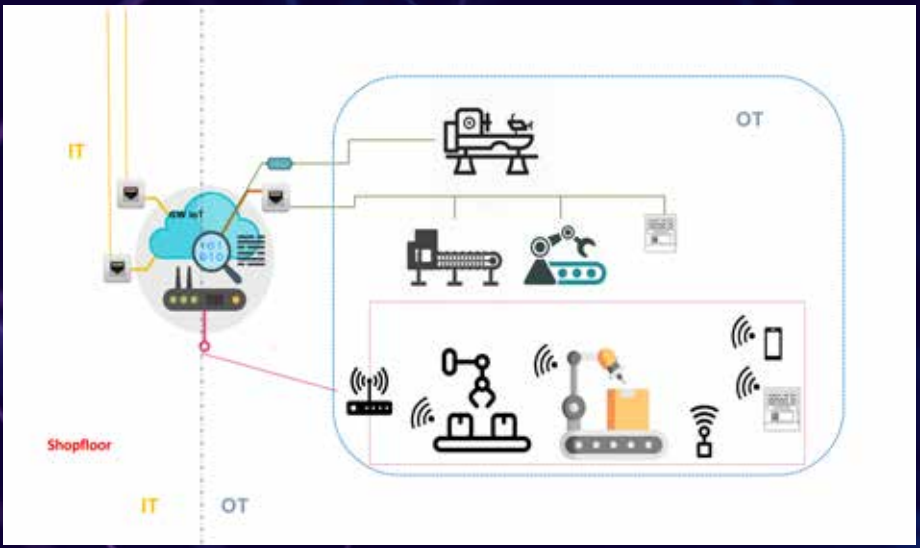
According to new business requirements, the need for asset management is also becoming increasingly urgent with the fast growth in the number of in-field devices. In respect of in-field security, IoT gateways enable OT/IT network segregation and are equipped with a security software stack that includes an Endpoint Detection and Response (EDR), a form of software endpoint at the edge which detects and repels security threats. This also involves a device authentication mechanism based on the IEEE 802.1X standard (to attach to a LAN or WLAN network). In addition, IoT gateways deployed in Leonardo's plants must be equipped with a secure Trust Platform Module (TPM) to avoid physical tampering while there is mutual authentication between IoT devices and Leonardo's digital platforms.

The Secure Connected Factory

Leonardo employs three layers to describe the macro elements involved in an Industry 4.0 solution whereby Leonardo's digital platforms for data collection, elaboration and visualisation are hosted on the Leonardo private cloud with no data on the public cloud. The connectivity delivers data gathered from in-field devices, which is transferred to digital platforms via the Leonardo private network or using dedicated telco networks (i.e. 2G/3G/4G/5G). The production machinery that enables business in the related company division is usually connected to production systems for which digitalisation enables different use cases such as manufacturing efficiency and quality control. In respect of the auxiliary machinery and apparatus forming the non-production equipment installed in the facilities (i.e. HVAC systems), digitalisation enables different use cases such as energy efficiency and management.

In broad terms, Leonardo's private network interconnects each site (plant, building, data centre, etc.) and enables secure communications between the digital platforms and plants exploiting Firewall and Web Application Firewall (WAF) that are deployed through the route. Data communications are encrypted both at the routing level and at the application level using keys or certificates, and commands from digital platforms to the in-field devices are carried out using 'diode mode'. Indeed, all communication starts from the in-field gateway towards a digital platform which establishes a safe communication channel.

This is achieved via the Secure Connected Factory (SCF), a solution conceived to support the digital transformation in the industrial sector through a model that integrates advanced applications, hyper-connectivity and digital security. Using this platform, data can be transferred from the factory to the cloud in real time, allowing immediate use by remote monitoring and analysis tools that supervise and optimise production. Dashboards can be also used to display data intuitively and interactively, such as on industrial predictions, overall equipment effectiveness, plant energy management and worker movement. Via predictive maintenance, Leonardo aims for the utilisation of SCF along the entire supply chain, resulting in a reduction of unplanned downtime.



Complex industrial plants are typically composed of thousands of heterogeneous assets deployed at different times, like production machinery, auxiliary machinery, sensors (T&H, pressure, meters, cameras, etc.), actuators, PLCs, tablet/smartphone, etc., provided with heterogeneous network interfaces and based on completely different technologies, spanning frequently 20-30 years. The amount of in-field devices grows fast according to new business requirements.

Human and machine-oriented security

The SCF solution was implemented with a secure-by-design paradigm approach specifically conceived to reduce the risks posed by potential fraud or sabotage, which already begins in the software design and development phase. Indeed, the SCF is fully compliant with the NIST cybersecurity framework's functions: Identify, Protect, Detect, Respond, and Recover. To further guarantee the safety of their solutions, Leonardo has also developed a security workflow to address roles, responsibilities and operational rules related to the management and control of security requirements in ICT projects.

When Leonardo develops a new Industry 4.0 project, coordination is necessary between in-field devices in plants around the world and private cloud connectivity. The workflow – known internally as 'Procedura 44' – is therefore a 'stamp of approval' that the project has been developed according to security requirements. Two professional roles are elected per project: a requirement specialist (responsible for assigning security requirements to the project according to a requirement baseline and the project design) and a requirement implementer (responsible for the development of the requirements defined and assigned by the requirement specialist). Alongside the technological protections already in place, this introduces a focus on the human element of security, which could be as simple and easy to overlook as forgetting to set up a password for a Wi-Fi network.

The Leonardo Production System

Leonardo's vision of Industry 4.0 is not limited to the technological aspects but is completed with the definition of a methodology of continuous process improvement, internally referred to as the Leonardo Production System (LPS). Basic concepts are in accordance with principles of WCM - World Class Manufacturing as evolution of the well-known former methodologies (Lean Manufacturing, Just in Time, Quick Response Manufacturing and Total Productive Maintenance). The LPS methodology is based on a continuous improvement methodology that tackles the technical aspects of day-to-day execution while also focusing on managerial aspects with robust governance. Its purpose is to eliminate waste losses while improving the competence of individuals to make the organization more competitive, accelerating in parallel the transition towards the Smart Manufacturing/Factory.

The business applications developed within the SCF platform are therefore designed to foster and simplify the adoption of this methodology in which the technological state of the art becomes the enabler of an excellent process rather than the goal.

A variety of benefits

In short, Leonardo's ecosystem aims to enable secure data gathering from the entirety of their software and hardware production platforms, such as machinery, devices and sensors. The key benefits are that software and hardware data correlation ensures the fast deployment of use cases related to Industry 4.0 software alongside the development of innovative use cases that could not be built by a single standalone system (i.e. a shopfloor digital twin). Furthermore, the SCF platform avoids the proliferation of standalone systems developed by different vendors.

Of course, technology isn't the only decisive factor: through their implementation of strict security methodologies that incorporate human expertise, Leonardo is able to utilise a wide range of best practices for the protection of data when connecting a vast array of heterogenous devices. From the reduction of costs caused by anomalies to the increased availability of information geared towards continuous product improvement, this approach should allow Leonardo to maintain and expand its position as a leading defence specialist both now and in the future.

Save the date!

ECS BROKERAGE EVENT 2023

7 & 8 February

Hotel Le Plaza, Brussels

Aeneas

EPoSS. European Association on Smart Systems Integration

Inside Industry Association

Closing the gap between use case and tools

AIDOaRt hackathon collaboration can boost the uptake of new technology

In the post-COVID era, the coordinating teams of EU projects are facing the issues brought about by geography and industry barriers. This challenge is particularly relevant for major projects involving many partners from different countries and industries. AIDOaRt uses a hackathon-based novel method to exploit the important role of gathering internal resources to tackle the uppermost problem in use cases in a short time. This article describes how the AIDOaRt project organises the hackathon to achieve the goal of effective collaboration in complex project settings.

Romina Eramo

Tiziana Fanni

Gunnar Widforss

Katiusca Zedda

Yi Wei

The AI factor

The growing complexity of Cyber-Physical Systems (CPS) and of Cyber-Physical Systems of Systems (CPSoS) poses several challenges throughout all software development and analysis phases, but also during their usage and maintenance. Many leading companies have started envisaging the automation that could be generated by full-blown Artificial Intelligence (AI) technology. While the number of companies that invest significant resources in software development is constantly increasing, the use of AI in development and design techniques has yet to mature. The AIDOaRt project focuses on AI-augmented automation, providing a model-based framework to more efficiently support the continuous software and system engineering of CPS and CPSoS.

Observe, Analyse, Automate

AIDOaRt aims to enhance the DevOps toolchain by employing AI techniques, in particular Machine Learning (ML), in multiple aspects of the system engineering process (design and modelling quality, source code performance, testing coverage, predictive monitoring, just to name a few). According to AIOps, the toolkit should support: 1) the collection and monitoring of both runtime data (e.g., logs, events and metrics) and software data (e.g., design models) as well as the management of their traceability (**Observe**); 2) the analysis of both these historical and real-time data (**Analyse**); and 3) the guidance for and automation of (when relevant) design and development operations (**Automate**). Thanks to the application of advanced Modelling/MDE principles and techniques, all data coming from these heterogeneous sources will be processed, collected, traced and analysed in a more homogeneous way (e.g., by relying on a common shared repository) so that it can then be made available to all the AI-based services that require it. Using AIOps will aid decision/process tools and support the various system engineering tasks. Furthermore, AI technological innovations have to ensure that systems are designed responsibly and contribute to our trust in their behaviour (in terms of both accountability and explicability), e.g., as promoted by the Ethics Guidelines from the AI High-Level Group.

Integrating AI

The information recovered from a given system execution (either historical data or real-time traces, such as car sensor data or radar-based traffic monitoring data) has a potentially very high value in enabling the assessment of the validity and required properties of a system design. However, it requires dedicated methods and tools to extract knowledge from large volumes of such runtime data as well as to analyse and (re)use it in a productive manner. To this end, AIDOaRt aims at integrating AI technological innovations to ensure that systems are designed responsibly in a way that contributes to our trust in their behaviour. The integration of AI techniques can affect the whole development process of systems. Thus, AIDOaRt aims at providing a holistic approach to continuous systems engineering that:

(i) Provides a core model-based framework to support the CPS continuous systems engineering process by benefiting from AI-augmented automation;
(ii) Enhances the corresponding DevOps toolchain by integrating the use of AI techniques (notably Machine Learning) in multiple aspects of the system development process (e.g., to support requirements, monitoring, modelling, coding and testing activities);
(iii) Supports the collection, representation and traceability of runtime data (such as logs, events and metrics) and software models (Observe), assists in the analysis of both historical and real-time data in combination new methodologies applied for improving discussion and exchange of know-how inside and outside the project (so brief explanation of how the hackathon has been organised and what we achieved till now) with design information (Analyse) and supports the automation of tasks of the DevOps pipeline according to the results of the previous analysis (Automate).

Leveraging AI

In order to fully realise this potential, the AIDOaRt Consortium needs to accomplish the following **mission**: *to create a framework incorporating methods and tools for continuous software and system engineering and validation leveraging the advantages of AI techniques*

List of partners

Austria cluster
AIT Austrian institute of technology gmbh
Automated software testing gmbh
AVL list gmbh
Dynatrace austria gmbh technische Universitaet Graz
Universitaet Linz

Czech Republic cluster
Camea, spol. s r.o.
Brno university of technology
Finland cluster
Åbo Akademi University
Anders innovations OY
Copado

France cluster
Clearsy sas
Institut Mines-Telecom Atlantique
Softeam

Italy cluster
Abinsula srl
Intecs Solutions s.p.a.
Ro Technology srl
Tekne srl
Università degli Studi dell'Aquila
Università degli Studi di Sassari

Spain cluster
Acorde technologies s.a.
Fundació per a la universitat Oberta de Catalunya Hi iberia ingeniería y proyectos s.l.
Instituto Tecnológico de Informática
Prodevelop sl
Universidad de Cantabria

Sweden cluster
Alstom group
Mälardalen university
RISE
Volvo Construction Equipment AB
Westermo

(notably Machine Learning) in order to provide benefits in significantly improved productivity, quality and predictability of CPSs, CPSoSs and, more generally, large and complex industrial systems. Thanks to the capabilities provided, AIDOaRt aims to impact organisations where continuous deployment and operations management are standard operating procedures. DevOps teams may use the AIDOaRt framework to analyse event streams (for real-time and historical data) together with the design information (e.g., in different system models) in order to extract meaningful insights for continuous system development improvement, to drive faster deployments and foster better collaboration, and to reduce downtime with proactive detection. We expect an industrial uptake of AIDOaRt technologies in the development of complex systems that scale up to real systems demand with relevance for all critical applications.

New hackathon-based collaboration method

One of the main barriers to be considered in research projects is the acceptance of new technology. In large projects that involve many partners in particular, there is the risk that the investigated solutions diverge from real industry needs. Since the AIDOaRt project involves 31 partners from 7 European countries and 10 use cases (UCs) from different industries, how to efficiently utilise the internal resources to solve the technical problems that industry partners are facing is a big challenge for the project. The internal hackathon provides an effective approach to creating positive synergies between UC and solution providers, enabling the solution providers to define and develop specific solutions (tools, technical components, methodologies…) that meet the UC needs, facilitating direct collaborations with the UC providers.

Before the hackathon day, the organisers publish the hackathon goal and ask UC providers to define a challenge: a specific issue general problem that can be analysed or experimented within four hours of joint work. The hackathon can be exploited as a tool for investigating new possible collaborations, offering to UC providers the possibility of publishing the challenge and appealing to interested partners ("Request for additional members"), while solution provider partners can respond ("Expressions of interest"). This leads to the definition of academic-industrial working teams composed of at least one technical person from the UC provider, who replies to all the technical questions and provides detailed insights about the case study and the challenge, and at least one technical person from each solution provider. If there are already established collaborations among UC providers and solution providers, the hackathon also becomes an opportunity to confront ongoing activities, and a dedicated time slot to brainstorm on the next steps. The results of the Hackathon are shared with the rest of the consortium to provide updates on the ongoing activities and offer also the opportunity to discover similarities that could lead to further collaborations among more partners.

Hackathon in practice

The AIDoaRt hackathon was held twice in the plenary meetings and it was demonstrated to be an effective tool for promoting collaboration among UC providers and solution providers that led to fruitful results. Overall, 26 challenges were published by UC providers (14 challenges during the first hackathon and 12 challenges during the second one). The challenges concerned specific scenarios relating to the AIDOaRt UC such as *diagnostics and prognostics of the vehicle's power electronics, prediction of new safety critical scenarios in the automotive domain, simulation and validation of thermal management system modelling, and anomaly detection for smart platforms.*

The working groups addressed the challenges by studying the application of AI techniques, such as formal verification, machine learning, neural network for the sake of analysis or prediction, as well as the application of MDE methods and tools according to the AIDOaRt general architecture. At the end of the hackathon, the teams pitched the result with a short presentation showing the progress. These presentations are intended not only to provide updates on the ongoing activities and but also to give interesting food for thought, offering the opportunity to discover similarities that could lead to further collaborations among more partners. Participants vote via online live polls to rank the presentations and identify the best ones that are candidates as showcases for the project's official review.

Safety-critical systems in the automotive domain - the Abinsula use case

Modern cars can be considered CPS, embedding as they do a large number of sensors and actuators, and being equipped with advanced computational capabilities. These vehicles are connected systems that exchange data about the local environment, traffic situation, emergency alerts and weather conditions. This enables cars to continuously

generate and process a large variety of data to analyse their geographical position, condition of the traffic, state of the vehicle, passenger comfort and safety.

Disruption technology

This new source of information opens new challenges in the development process, where hardware specialists, software developers and system designers have to work together with safety engineers to ensure a reliable and safe system. The emergence of the recent ISO 21434 helps the automotive industry to focus on practice to address cybersecurity in a systematic and consistent way, and together with the ISO 26262, defines the necessary requirements to provide safety and cyber-security in cars. This opens new challenges in the development process. In such a context, the combination of new and disruption technology like AI and ML can enhance the entire development of safety-critical systems and support the prediction of new scenarios that might be considered safety-critical. However, they are far from being applied in real safety-critical applications due to the lack of methodologies, for example for the predictability of the system in domains such as the automotive one.

Mirror-less cars

In AIDOaRt, Abinsula is collaborating with the University of Sassari and Intecs Solutions to study the adoption of formal methods in the automotive domain to support the predictability of AI based systems and loosen the current technological limitations so that the development of futuristic cars can employ the possibility of freely playing with the all available technology. The Abinsula UC presents a futuristic virtual rear-view mirror scenario in which multiple cooperative cameras are used to capture the context outside the vehicle. The system is expected to autonomously react according to the external stimuli and internal needs. The idea is going towards mirror-less cars in which AI and NN replace what the human brain does in terms of recognition and processing while driving. Even though AI is a recognised innovative technology, it is still far from being applied in real safety-critical applications, just as cameras are far from completely replacing mirrors. This is something allowed only in concept cars and small productions that do not apply the same regulations of large productions. The main goal of the Abinsula UC is to investigate an approach, based on AIDOaRt methods, that introduces AI and ML techniques in the automotive context.

Use case list

- Abinsula Safety-critical systems in the automotive domain using disruption technology
- AVL - AI supported Digital Twin Synthesis supporting secure vehicle development and testing for novel propulsion systems
- ALSTOM - DevOps for Railway Propulsion System Design
- CAMEA - AI for Traffic Monitoring Systems
- ClearSy - Machine learning in interactive proving
- HI Iberia - AI DevOps in the restaurants business
- Prodevelop - Smart Port Platform monitoring
- Tekne - Agile process and Electric/ Electronic Architecture of a vehicle for professional
- Applications
- Volvo - Data modelling to support product development cost and efficiency
- Westermo - Automated continuous decision-making in the testing of robust and industrial-grade network equipments

Football retreat

The AIDOaRt Hackathons can be considered as the equivalent of a football retreat. They are an opportunity to create new synergies among the UC providers and the solution providers or to consolidate existing ones, dedicating a time slot to focus on specific issues and think out of the box. With regard to Abinsula UC, we exploited the first AIDOaRt hackathon to address the problems related to the consistency verification of requirements, a task that can be time consuming and error prone. We defined a challenge related to the usage of automated formal verification, at the design stage, of aspects related to ambiguity, consistency, and completeness of the system design with respect to some given specifications and property constraints.

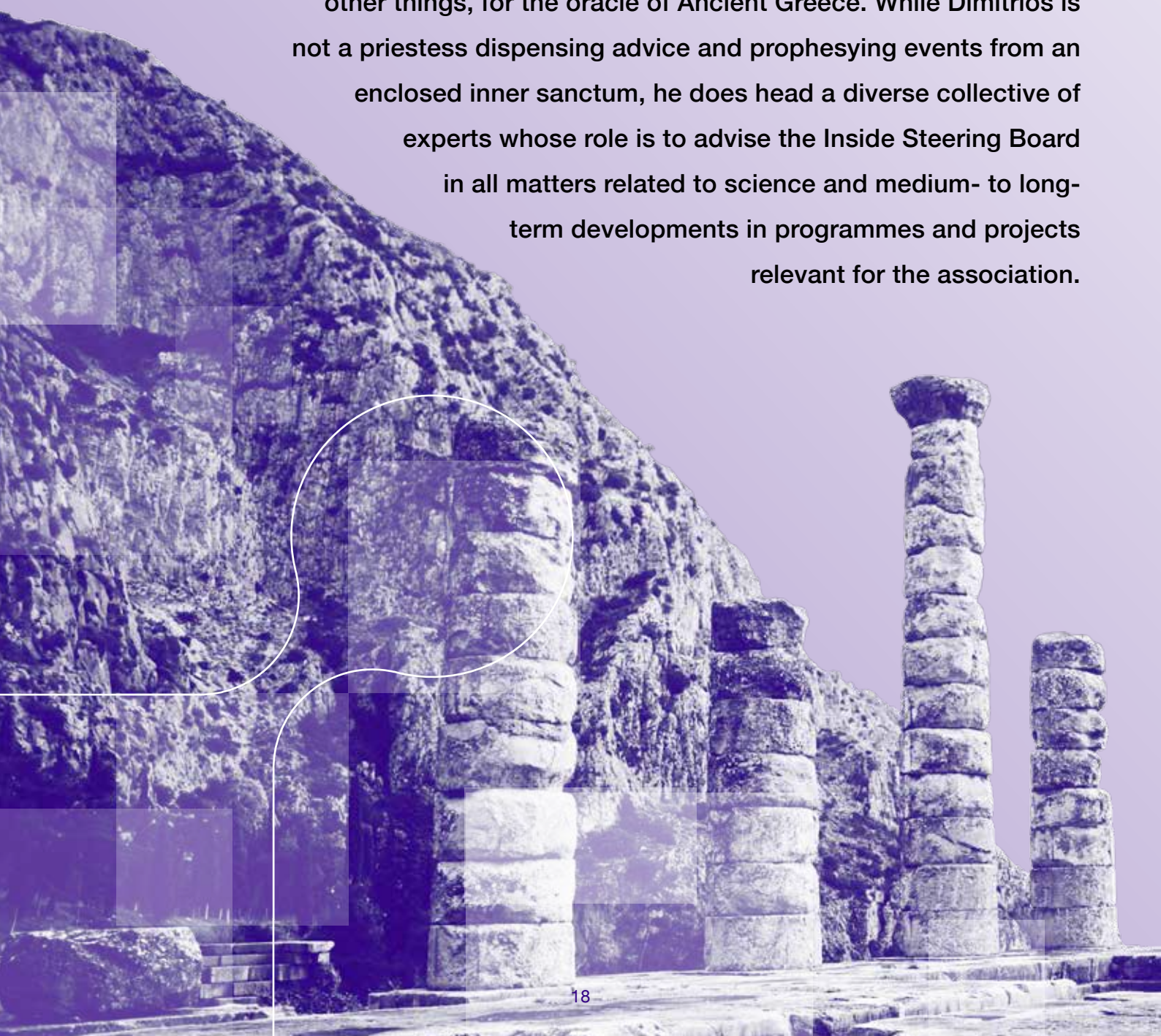
Consistency

The usage of automated verification tools, such as those developed in AIDOaRt by the University of Sassari, can help the designer to guarantee consistency of the requirement while saving time and effort. The main challenge is that, on one hand, such tools need the requirement to be represented in a certain rigorous way while, on the other hand, companies have already established working procedures that cannot be overturned. Together with the team from the University of Sassari, we analysed the Abinsula processes and a set of the Abinsula UC requirements and studied the keywords and properties for writing the requirements in a controlled and comprehensible language that is also suitable for processing by automated tools. The result of this industry-academy tandem was the definition of a set of rules to translate the UC requirements, expressed in natural language, into a set of requirement specifications expressed in a controlled language that could be compliant also with Abinsula internal process and that could be integrated into them in future.

Inside the Sci

Interview by Chris Horgan

Just an hour's drive from Patras, the home of Dimitrios Serpanos, President of Computer Technology Institute and Press "Diophantus" and chair of the Inside Scientific Council, lies Delphi – famed, among other things, for the oracle of Ancient Greece. While Dimitrios is not a priestess dispensing advice and prophesying events from an enclosed inner sanctum, he does head a diverse collective of experts whose role is to advise the Inside Steering Board in all matters related to science and medium- to long-term developments in programmes and projects relevant for the association.



entific Council

An oracle for the new era

The members of the Scientific Council, appointed by the Inside Steering Board, are an appropriate representation of the European electronic and components and systems value chain with their scientific and technical expertise in collaborative R&D&I programmes. Currently, the Scientific Council comprises the following members and areas of expertise:

- Jon Perez, Ikerlan (Spain) - Dependable embedded systems
- Markus Tauber - Research Studios Austria (Austria) - Security in automation and digitalisation solutions
- Stefan Van Baelen, IMEC (Belgium) - AI, Distributed AI, Edge Computing and Connectivity
- Gianluigi Ferrari, Università di Parma (Italy) - Telecommunications and Internet of Things
- Dimitrios Serpanos, University of Patras (Greece) - Electric and computer engineering
- George Nikolakopoulos, Luleå University of Technology (Sweden) - Control in continuous production and automotive

Communication, collaboration and a long-term vision

This autumn, 2022, the six members of the Scientific Council gathered to discuss questions such as: How can strategies be developed that align with the goals of Inside members? And what are the benefits for the members, the industry association and society at large?

In its founding mission, the Scientific Council's focus was defined as Technology Readiness Levels 1-3, the stages not covered by the Electronic Components and Systems Strategic Research and Innovation Agenda (ECS-SRIA). As a result, it provides guidance on research priorities, including through the drafting of the long-term vision chapter of the ECS-SRIA. This forms the basis for the calls of the Key Digital Technologies (KDT) Joint Undertaking, the Eureka Cluster Xecs and the upcoming Chips Act, as well as a wider set of European research programmes, giving the Scientific Council a significant role in shaping how Europe approaches technologies like embedded systems, edge computing and artificial intelligence.

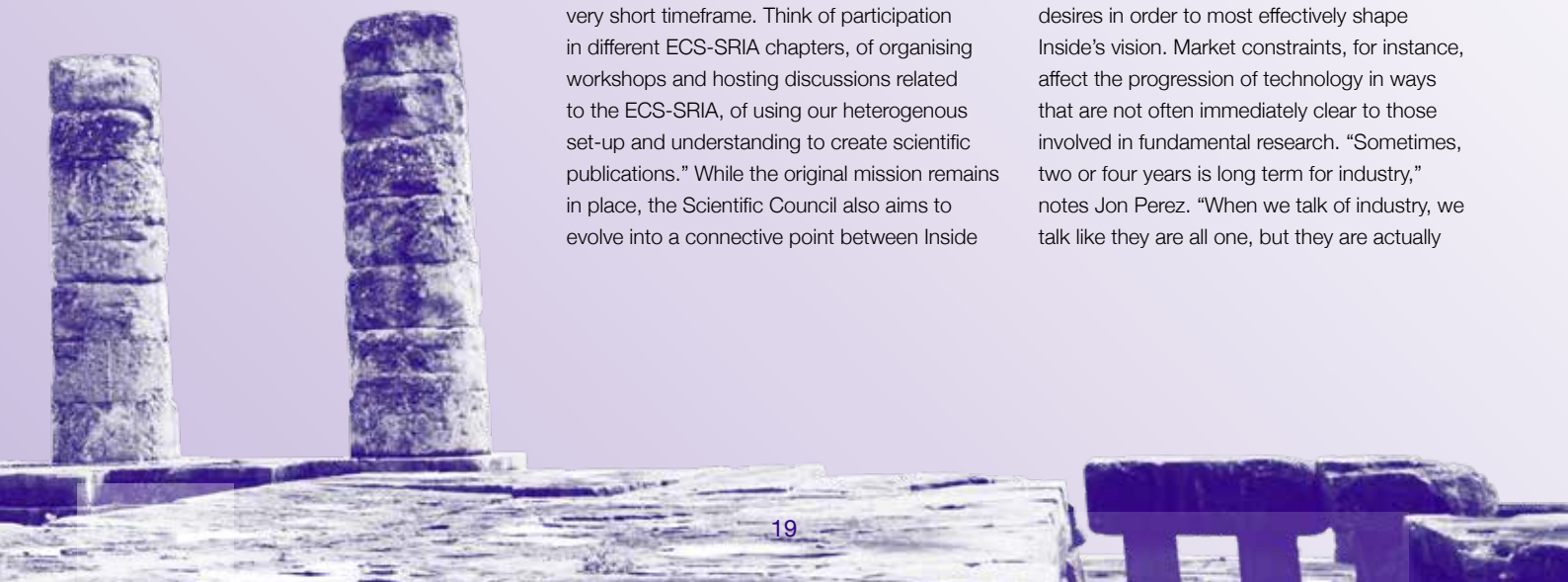
A pool of heterogenous experts

"To summarise it briefly," says Markus Tauber, "we are a pool of heterogenous experts who are very flexible and capable of contributing to different activities of the association in a very short timeframe. Think of participation in different ECS-SRIA chapters, of organising workshops and hosting discussions related to the ECS-SRIA, of using our heterogenous set-up and understanding to create scientific publications." While the original mission remains in place, the Scientific Council also aims to evolve into a connective point between Inside members and the Steering Board – efforts that were unfortunately hampered by the switch to virtual events during the COVID-19 pandemic. Now that physical meetings are making their return, Dimitrios Serpanos sees opportunities for a more forward-facing role.

"As the Scientific Council, we soon realised that we needed a source of feedback from members and I believe that we should be working on stronger ties with them. Although our mission relates to supporting the Steering Board, all those activities and tasks have an effect on the Inside community in the sense that the SRIA sets up their directions and pointers. It's actually one of the major tools used as input by the Commission in setting up funding areas, which definitely benefits our members directly. Our dissemination activities also have an impact on the community because they can learn about the tools and opportunities that exist. Up to now, I think that we have delivered strong messages about research and development that relate to the subject areas of Inside."

Becoming a two-way street

In building up stronger ties with members, the Scientific Council also recognises that communication must take place along bi-directional channels. In addition to assisting members with research directions, the council wishes to learn from their current needs and desires in order to most effectively shape Inside's vision. Market constraints, for instance, affect the progression of technology in ways that are not often immediately clear to those involved in fundamental research. "Sometimes, two or four years is long term for industry," notes Jon Perez. "When we talk of industry, we talk like they are all one, but they are actually



multidisciplinary and their technology changes in importance over time. The Scientific Council can help to draw a line between short and long-term developments."

A greater understanding of industrial needs is especially relevant to the Scientific Council. "I think that the Scientific Council plays a key role because we are mostly from academia or research agendas and Inside is an industry association," says Gianluigi Ferrari. "So, our role for Inside is to network as much as possible and gain ideas from fundamental research to see how they can be mapped to industrial developments. It would be very good for Europe's competitiveness if we can connect ideas that live in academia with a more practical approach leading to prototypes and products."

Stefan Van Baelen agrees. "There should indeed be a good interaction between the members and the Scientific Council. We contain a limited set of people covering a lot of areas and it's impossible to cover all areas of all members involved in Inside. But there are different channels open to us: on one hand, you have scientific information available through publications; on the other, you have the SRIA, on which members can provide input and feedback. Also, the Scientific Council is active in the community and participates in many events, so input can be given either formally during the events or informally during the coffee breaks."

Reflecting the diversity of our members

In respect to the achievements of the Scientific Council so far, Inside Secretary General Paolo Azzoni is overwhelmingly positive. "We had difficulties during the pandemic, but who didn't? I'm very happy with the results of the Scientific Council. One element that differentiates Inside from the other industry associations is that we have a really heterogenous community in regard to expertise and background. We are so heterogenous that we are capable of covering the entire ECS value chain from semiconductors to applications. This is of huge value, especially considering the complexity of ECS, and is even more important as we try to achieve strategic autonomy in Europe. If you cannot address the entire value chain, you do not have strategic autonomy because you have to rely on somebody else."

This heterogeneity is reflected in the composition of the Scientific Council, and while researchers in different domains have a reputation for speaking different technical 'languages', the Scientific Council has proven an excellent medium for building up mutual understanding in order to achieve the much-needed coverage of the entire value chain. Gianluigi: "One of the most important things from my perspective has been the opportunity to interact with people with heterogenous competencies. This has been very positive and has brought several ideas and discussions forward. One of the main results achieved is the possibility of a wide perspective on what might happen regarding scientific research in the future. I see that academic colleagues, in general, are isolated and keep doing what they've been doing for years. It's good to see other perspectives and think of different evolutions combining different competencies. This is an intangible result that might provide a lot in the future."

Looking to the long term in the ECS-SRIA

So far, this confluence of competencies has seen perhaps its biggest benefit in the shaping of the ECS-SRIA. Since 2019, the Scientific Council has contributed to various chapters and has coordinated the chapter on the long-term vision, which presents research subjects that need to be addressed by European organisations to enable and support the development of industry over the course of around a decade – the approximate lead time from an initial scientific breakthrough to

Dimitrios Serpanos

In addition to serving as a professor in the Department of Electrical and Computer Engineering of the University of Patras (Greece) and the president of the Computer Technology Institute and Press "Diophantus", Dimitrios Serpanos is the chair of the Scientific Council. His research interests include embedded and cyber-physical system architectures, cybersecurity, Internet of Things and industrial systems & networks.

Jon Perez

As a Principal Researcher on dependable and autonomous systems at IKERLAN (Spain), Jon Perez serves as a team leader for the development of multidisciplinary safety-critical systems. Bringing over 15 years of experience in R&D projects in domains such as railway signalling and semiconductors, his primary research interests are functional safety, machine learning and cybersecurity for dependable intelligent systems.

Markus Tauber

Markus Tauber received a PhD in computer science with a focus on autonomic management in distributed storage systems. He brings many years of experience, e.g.as Researcher in the University of St Andrews, or Professor at the University of Applied Sciences Burgenland. He now works as Chief Scientific Officer at Research Studios Austria, where he focuses on digital intelligence and core technologies and engages in international initiatives in the field of IT security, digitalisation and artificial intelligence.

The scientific council members are heterogenous, technologically oriented people from all parts of Europe; they form a strongly connected, interdisciplinary and flexible team, ready to address all kinds of aspects and questions raised by the Inside community.

the market presence of products. Through a shared approach to technology, application domains and policies, this chapter aims to boost industrial competitiveness, ensure digital autonomy, strengthen sustainable value chains in support of the Green Deal and unleash the full potential of intelligent and autonomous ECS-based systems for a European digital era. "It's important to highlight that we are focusing on the future: where things will go, not where things are," explains George Nikolakopoulos. "That's why we're mainly academics. We need to meet industry in the middle so that they have ideas for the next few years, but we are more for the long term. And we want to build a community in which members can share feedback and ideas, which will hopefully be established soon. There are already roadmaps, but we must identify what is coming early on – not only from a research point of view but in relation to potential impact in an industrial direction. This is our fundamental role, and we perform it with the whole community."

The most recent version of the long-term vision indeed includes contributions from across the ECS community via six workshops on themes such as software in ECS-based digitisation, micro-nanoelectronics and RISC-V. The scope of the ECS-SRIA has also been extended to quantum technologies, integrated photonics, flexible electronics and open-source hardware, and Paolo considers the juggling of such complex concepts to be another major achievement. "The long-term vision chapter is currently very organically structured and covers the entire ECS-SRIA. For every topic in the ECS-SRIA, there is something in the long-term vision. This is something we've achieved in the last two editions thanks to the main contribution of the Scientific Council to this chapter."

Stefan Van Baelen
Having joined IMEC (Belgium) in 2012 (via the research centre iMinds, which was merged with IMEC in 2016), Stefan Van Baelen is currently Senior Manager Public Funding with a focus on digital and user-centric solutions and the enablement of digital transformations. He is currently engaged in European initiatives in the fields of data, AI, distributed AI, edge computing and connectivity.

Gianluigi Ferrari
At the University of Parma (Italy), Gianluigi Ferrari focuses on the study and design of innovative communications systems. As an associate professor, his specialities include signal processing, communication and networking, Internet of Things and smart systems. He is also the coordinator of the Internet of Things (IoT) Lab within the Department of Engineering and Architecture and a co-founder of a spin-off company.

George Nikolakopoulos
George Nikolakopoulos works as a Chair Professor in Robotics and Artificial Intelligence (RAI) while heading the Robotics Team at Luleå University of Technology (Sweden). In addition to his work as a member of the Scientific Council of Inside, George is a member of the Board of Directors at euRobotics and an elected expert for the permanent working group of A.SPIRE.

Lessons learned from workshops

"Another message I want to highlight relates to the three associations of Inside, EPoSS and AENEAS," continues Paolo, "a rich, interdisciplinary and diverse ecosystem, where diversity represents a value. Building on this, Inside started the idea of the joint initiative of the 3A Scientific Bodies working group. This entity is becoming extremely successful and we already organised three workshops."

One of the main lessons from these workshops, as well as other Inside activities, is the need for a shift away from a focus solely on the physical and digital worlds and the incorporation of the information world, collectively forming Intelligent Digital Systems. Paolo: "This represents the transformation of raw data into valuable knowledge and actionable information – a major piece of the ECS puzzle in terms of both potential revenues and impact on society, ranging from controlling complexity more cost-effectively to improving machine-human to new functionalities that boost sustainability and resilience. Given the potential tenfold return on investment from the information world, Inside will continue to pursue this important centre of gravity in the short and long term."

"Today, you don't look at hardware alone or the cloud by itself," notes Gianluigi. "You look at distributed systems where you can embed intelligence everywhere. This can improve how you control systems or make more autonomous systems. A system perspective is very valuable in terms of what will happen next for Inside and the Scientific Council." Workshops will continue to support this system perspective and have a strong backing from the community: those that took place virtually during the pandemic each attracted around 100 participants despite limited publicity. Future workshops will be promoted more widely at physical events such as EFECS 2022, providing an important opportunity for Inside members to share their views and requirements.

A solid baseline for future research

As a final achievement so far, the Scientific Council also point to *Embedded Artificial Intelligence: The ARTEMIS Vision*, an article co-authored by the six of them and originally published in IEEE Computer Society's Computer journal in 2020. In this examination of embedded and cyber-physical systems, they identify priority areas for Europe (such as energy, health and digital industry) and several illustrative research challenges, such as how to automatically orchestrate different devices and layers while guaranteeing privacy and data integrity in complex systems of systems. The conclusion is clear: advances in embedded and cyber-physical technologies and the growth of IoT, cloud computing and AI are generating disruptive growth models in countless domains worldwide.

In 2021, *Embedded Artificial Intelligence* received a boost when it was selected as the leading article in the year's first issue of Computing Edge, which curates the top contributions from 13 IEEE publications. For the Scientific Council, this is evidence of the topic's high importance to the wider community and that their long-term guidance is on the right track. The challenges and requirements identified within the article can therefore provide a solid baseline for future research and development by Inside members and funding by European public authorities and bodies.

What lies ahead

Looking to the future, increased contact and communication with Inside members is just one of the Scientific Council's next steps forward. Additionally, the Steering Board is keen to reintroduce Working Groups as an instrument for the Scientific Council to determine focus points in various domains. Paolo: "We have been talking about them not only in Inside but from a networking perspective, also with EPOSS and AENEAS. Working Groups are a very powerful instrument because they allow us to represent industries and academia in one entity and work closely on a specific topic. In the first and second KDT calls, focus topics were developed by Working Groups with very good outcomes. This is the path we have to follow and is an important way for the Scientific Council to recover the original DNA we had. I would focus on Inside-specific Working Groups to cover the association focus areas."

"It would be very nice to eventually become a point of reference for European industry as a whole when it comes to the future of topics like embedded intelligence and AI in order to influence roadmaps or at least discuss new trends and build a community hand in hand with the industrial community," adds George. In part, this future growth in status will be supported by a growth of the Scientific Council, which is currently looking for new members from other technological and geographical areas. This will help the council to even more closely match the diversity of members, domains and ideas present within the association.

"Another part is more active participation at the level of the association's decision-making bodies to whatever degree they consider appropriate. We have also planned for more dissemination and have been discussing new workshops: increased networking and bi-directional communication with members to have more competitive proposals and hopefully projects," concludes Dimitrios. "I also want to take this opportunity to thank the members of the Scientific Council. These heterogenous, technologically oriented people from all parts of Europe have become a strongly connected and flexible team that have addressed the aspects and questions posed to us. We have very regular meetings and have even become friends, I would say. This has helped us achieve goals very fast. I don't remember one assignment that we did not deliver."

The Scientific Council is open to collaboration with all members of Inside and beyond. Visit their webpage at https://inside-association.eu/scientific-council to find out how to contact them collectively or individually.

Insights into ECSEL project InSecTT

Bringing internet of things and artificial intelligence together – but is it trustworthy?

Michael Karner

Can Artificial Intelligence (AI) improve the safety of public transport passengers? Can AI be trusted for clinical decision making in a hospital? Can AI improve the rail capacity and decrease delays? Why would we trust connected vehicles? InSecTT is providing answers on this and more crucial questions.

The Internet of Things (IoT) is a revolutionary change for many sectors: fitness trackers measure our movements, smart fire extinguishers monitor their own readiness for action, and cars turned out to become fully connected vehicles. The availability of the collected data goes hand in hand with the development of Artificial Intelligence (AI) and Machine Learning (ML) algorithms to process them. Despite numerous benefits, the vulnerability of these devices in terms of security remains an issue. Hacks of webcams, printers, children's toys, and even vacuum cleaners as well as Distributed Denial-of-service (DDoS) attacks reduce confidence in this technology. Users are also challenged to understand and trust their increasingly complex and smart devices, sometimes resulting in mistrust, usage hesitation and even rejection.

This is where InSecTT weighs in. The pan-European project InSecTT (Intelligent Secure Trustable Things) provides intelligent, secure and trustworthy systems for industrial applications as well as comprehensive, cost-efficient solutions of intelligent, end-to-end secure, trustworthy connectivity and interoperability. The project with more than 50 partners, coordinated by VIRTUAL VEHICLE, aims at creating trust in AI-based intelligent systems and solutions as a major part of the Artificial Intelligence of Things (AIoT).

The InSecTT partners believe that AIoT is the natural evolution for both AI and IoT because they are mutually beneficial. AI increases the value of the IoT through Machine Learning by transforming the data into useful information knowledge, while the IoT increases the value of AI through connectivity and data exchange: AI + IoT = AIoT.

The overall objectives of InSecTT are to develop solutions for (1) Intelligent, (2) Secure, (3) Trustable (4) Things applied in (5) industrial solutions for European industry throughout the whole Supply Chain (6). More precisely:

1. Providing intelligent processing of data applications and communication characteristics locally at the Edge to enable real-time and safety-critical industrial applications.
2. Developing industrial-grade secure, safe and reliable solutions that can cope with cyberattacks and difficult network conditions.
3. Providing measures to increase trust for user acceptance, make AI/ML explainable and give the user control over AI functionality.
4. Developing solutions for the Internet of Things, i.e., mostly wireless devices with energy- and processing-constraints, in heterogeneous and also hostile/harsh environments.
5. Providing re-usable solutions across industrial domains.
6. Creating a methodological approach with the Integral Supply Chain, from academic, to system designers and integrators to component providers, applications and services developers & providers and end users.

Combating air pollution through intelligent IoT systems

Air pollution has increased considerably in recent decades due to the ever-growing number of people moving around the world and the accelerated industrial growth of most countries. Given the irreversible effects of air pollution on the environment and on human life, intelligent and efficient approaches must be developed to monitor (and possibly predict) environmental parameters (particularly air quality) in a distributed manner. This can be performed by exploiting trustable and secure paradigms for decoupling the sensing nodes in charge of collecting data in the environment in which they are deployed, thereby exploiting a *cloud-edge-device continuum* distributed processing philosophy. In the ECSEL project InSecTT (Intelligent, Secure and Trustable Things), air quality monitoring with an Artificial Intelligence of Things (AIoT) approach has been proposed for part of the activities within two use-cases: intelligent safety & security of public transport in the urban environment and structured & unstructured people flow in airports.

Figure 1. Prototypical air quality sensing nodes developed by the University of Parma (left, academic) and Eurotech (right, industrial).

Based on bubbles

The distributed architecture considered in the two use-cases follows this cloud-edge-device continuum paradigm and features a layered model in which consecutive layers (from the device to the cloud) embed intelligent systems. Each layer is based on the concept of a 'bubble' containing one or more wireless sensors or network nodes, embedding the processing functionalities to be performed on the data being collected, such as the exploitation of AI algorithms – in other words, a systems of systems approach.

Figure 1 shows the two prototypical wireless sensing nodes developed respectively by the University of Parma (lab prototype) and Eurotech (industrial prototype) in the InSecTT project. Each node collects relevant air quality data which can then be used to evaluate an air quality indicator, such as an Air Quality Index (AQI), on the basis of heterogeneous data.[1] Thanks to the layered architecture outlined above – and, in particular, its integration strategy and the distribution of intelligence across the overall system of systems – environmental sensing can be carried out in various ways that exploit heterogeneous IoT systems. Four integration steps are being followed in InSecTT.

InSecTT integration

The *first integration step* simply requires the installation of the heterogeneous IoT air quality monitoring systems that were created by the University of Parma and Eurotech. These systems send data to the cloud in parallel. Processing tasks are then concentrated in the cloud within closed and proprietary cloud computing-based infrastructures, for instance. This prevents direct interoperability between the IoT systems deployed.

In the *second integration step*, data flows are transferred from one IoT system to another, such as through routers. This enables the possibility to integrate IoT systems at various layers of the distributed architecture proposed and simplifies the transmission of data to the cloud, but still leaves data analysis to be carried out in the cloud.

The *third integration step* moves data processing from the cloud to the edge. This approach allows the use of constrained devices that can limit their power consumption, maximising their operational time while embedding intelligence. As a result, it will be possible to directly process data 'near' the sensing nodes via AI algorithms – both machine learning (ML) and deep learning (DL). This will also enable the optimisation of the processing-communication trade-off by extracting the minimum amount of relevant information at the edge. This information can then be forwarded to the cloud via constrained communication protocols (for example, protocols with duty cycle limitations like LoRaWAN, which offers low-power, wide-area networking).

As the *final integration step*, we envision a move to intelligence which is directly situated in the sensing node, which could encompass recently developed smart boards with embedded AI such as STM32Cube.AI.[2] This will also enable the effective distribution of intelligence across multiple architectural layers (from the device to the edge), allowing the processing load to be dynamically changed at

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Elisa Londero

each layer (device, edge, cloud) depending on the specific application.

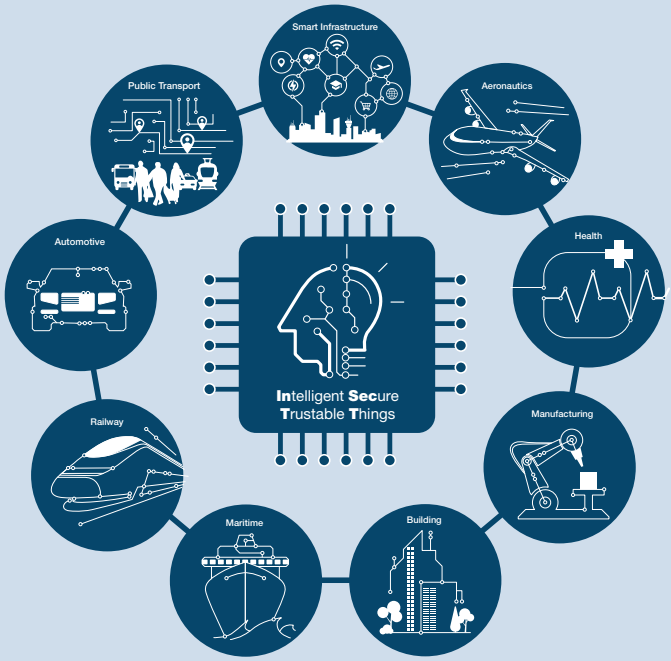
In the longer term, this innovative distributed approach to air pollution monitoring will open the door to greater efficiency in global transportation and movement, helping to reduce its environmental impact via fewer emissions and less fuel use. In turn, the InSecTT consortium hopes to improve quality of life for those living in areas currently affected by poor air quality and ultimately reduce the risk of health damage through exposure to this.

1 S. S. Somvanshi, A. Vashisht, U. Chandra, and G. Kaushik, "Delhi air pollution modelling using remote sensing technique," *Handbook of environmental materials management*, pp. 1–27, 2019.

2 STMicroelectronics Artificial Intelligence Ecosystem, URL: https://www.st.com/content/st_com/en/ecosystems/artificial-intelligence-ecosystem-stm32.html

The issues of ethics and public trust in deployed AI systems are now receiving significant international interest. In InSecTT, we focus on robustness and ethics, ensuring our developed systems are resilient, secure, and reliable, while prioritising the principles of explainability and privacy. In InSecTT and its predecessor projects (DEWI, SCOTT) we have investigated this problem and recently released a white paper where we summarise the lessons learned from several years of working with industrial and research partners on developing trustworthy technologies. As result, we propose an approach for research and development of trustworthy AI systems that is based on current EU guidelines of developing ethical AI as well as the proposed EU AI act. That approach puts the human concerns and needs at the center of the development process and consists sets of concrete recommendations for how to develop trustworthy intelligent systems. The full white paper is available for download on our website (https://www.insectt.eu/).

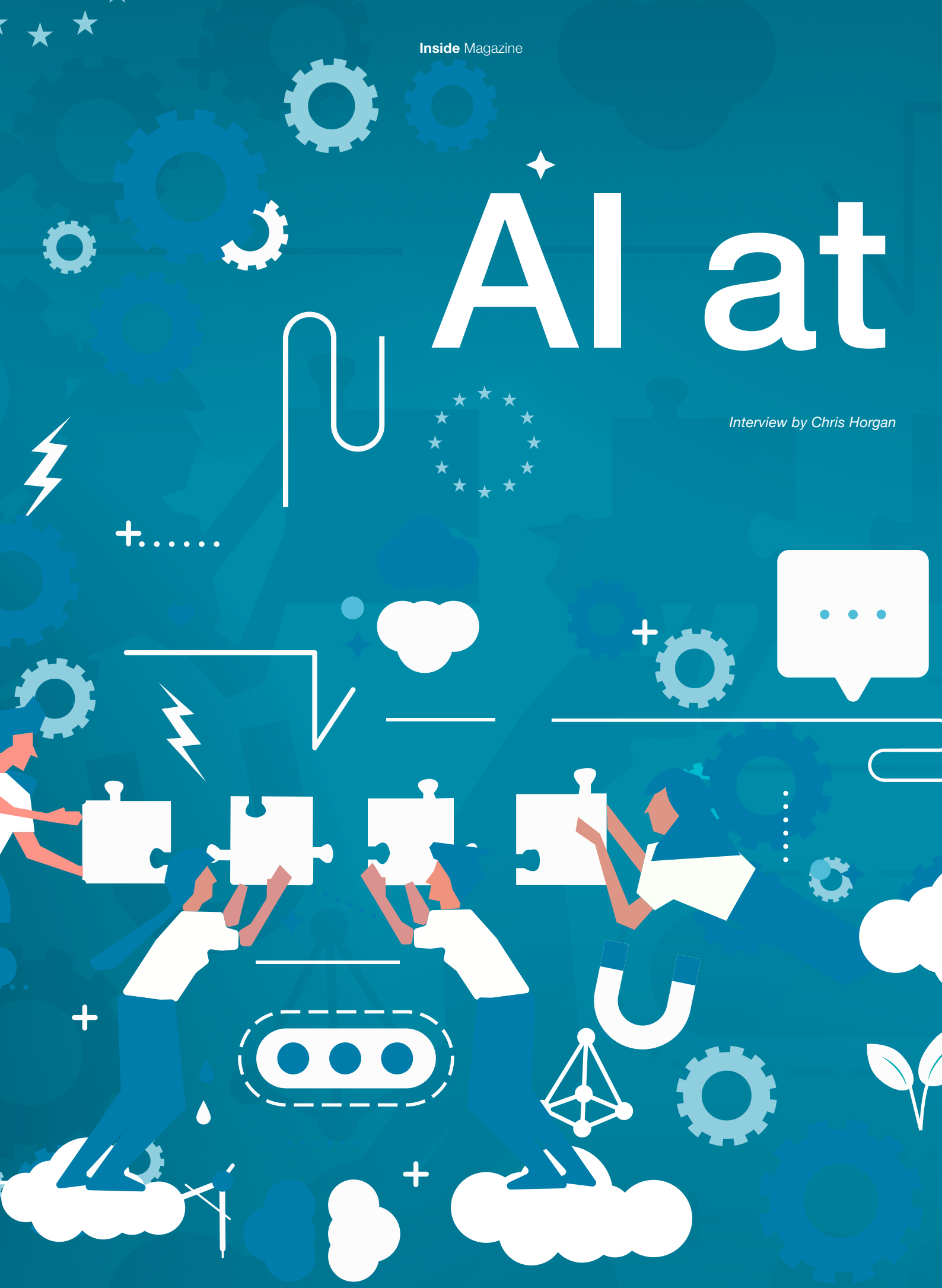
InSecTT provides, implemented in 16 different AIoT use cases, cross-domain solutions for nine industrial domains: Health, Smart Infrastructure, Urban Public Transport, Aeronautics, Automotive, Railway, Manufacturing, Maritime, and Building (see the following diagram). The cross-domain aspect is not only realised by bringing in components to different domains, but also by interconnecting the domains in a truly cross-domain communication. This can be seen e.g. in use cases on airports or harbours, where information from buildings, vehicles and infrastructure needs to be exchanged with each other. One example of our use cases is described in detail in the highlight of this article (see page 24).



If you would like to know more about InSecTT, visit our website (https://www.insectt.eu/), or follow us on social media. Or listen to one of our brand-new podcasts, where we are talking with our experts on topics like what "trust" and the "secret sauce" for managing a project with over 50 partners really are, or what to do if you don't want your car to be hacked.

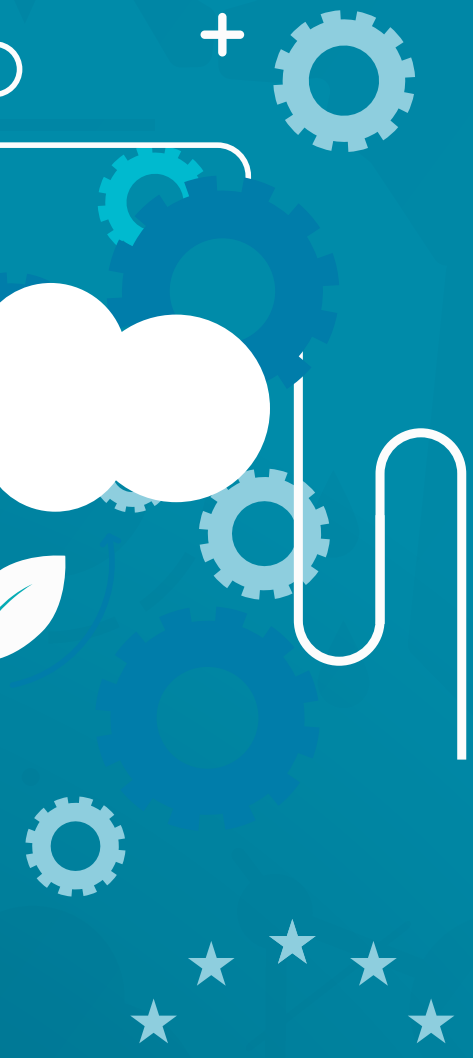
AI at

Interview by Chris Horgan



the edge

Challenges and opportunities for pan-European collaboration in advanced digital technologies and applications



The application of artificial intelligence (AI) at the edge brings a myriad of opportunities, including higher processing speeds to allow real-time analytics, greater scalability to work with large amounts of data, and improved cybersecurity as less data is processed externally or off-premises. But these innovations also bring significant challenges, from technological heterogeneity and processing architectures to energy efficiency. Dr Ovidiu Vermesan, Chief Scientist at SINTEF Digital and coordinator of the upcoming KDT JU project *Edge AI Technologies for Optimised Performance Embedded Processing* – or EdgeAI for short – outlines how the project will unlock the full potential of AI at the edge and meet these challenges and demands.

Cross-continent collaboration

Starting in December 2022 and running for approximately 37 months, the EdgeAI project has been formed on the basis of established collaboration: Ovidiu was heavily involved in ECSEL JU's AI for Digitising Industry (AI4DI) project that set out to accelerate AI-based edge processing adoption in different industries through reference demonstrators. EdgeAI also draws from the ECSEL JU projects ANDANTE and TEMPO, which addressed different facets of edge processing and AI techniques and helped lay a foundation for edge AI technology in Europe.

"We created an arena for exchanging ideas between projects," begins Ovidiu. "AI4DI addressed the move of AI methods and techniques from the cloud to the edge and we also noticed that the technology is evolving so fast that things we considered four years ago require new methods and AI techniques. This

was the basis for the ideas that we put forward in a new proposal, EdgeAI, to address the processing of data at the edge and the use of new AI techniques, which combines hardware platforms, software, AI frameworks, algorithms, and data analysis."

With 49 partners across eleven countries and a total budget of €35.4 million, Edge AI aims to address five value chains with various demonstrators: *digital industry, energy, agrifood & beverage, mobility, and digital society*. "This intersection helps us to interact with different stakeholders that have the possibility to exchange their experience of implementation in different industrial domains," says Ovidiu. "And we see a lot of opportunities for increased synergies between the developments in these domains. For example, we have all the major semiconductor manufacturers in Europe in the project and they will bring the latest technology developments in edge AI toolchains, new microcontroller architectures and AI-based hardware platforms."

Edge heterogeneity

Alongside a wide variety of domains, the project will address all layers of a full edge AI technology stack and application: sensors, hardware (such as microcontrollers or processing units), SW/HW interfaces, AI frameworks, algorithms, neural network architectures & topologies and new learning data types & methods. A driving force is the importance of dependability for edge AI systems. This means addressing interoperability, interpretability, reliability, maintainability, portability, scalability, and trustworthiness. Without handling these system engineering properties, edge AI technologies will not meet the technological readiness level or degree of public acceptance needed for edge AI applications to become widespread in Europe.

"Today, we see the development of very specific AI tools from the producers of different AI-based components, so the project will develop toolchains and engineering tools that can be used for the design of systems based on components from different providers," Ovidiu explains. "The idea is to address horizontal application areas in which we will try to have a proof of concept of the technology development and the advancements in performance related to hardware, software, algorithms, and data processing. The underlying element is common, but it applies to different industries."

One of the most significant challenges for edge AI technology developments is improving the energy efficiency and scalability of processing performance, given the different resource constraints for devices, algorithms, and platforms at the edge. In addition, edge AI applications feature enormous heterogeneity in their combined technologies and algorithms, which presents difficulty when solutions must be optimised in different sectors and benchmarked against one another. Heterogenous processing is a key aspect of this as the project will seek to advance neuromorphic architectures and combine different hardware architectures to provide optimal AI processing. As Ovidiu puts it, edge AI is a matter of comparing the features of devices with varying processing capabilities and resources, attempting to evaluate technologies to the same level using valid parameters for all implementations.

Multiple kinds of intelligence

To address the heterogeneity of devices, EdgeAI will address processing at the edge as a granular continuum encompassing the micro-edge (processing capabilities which are very close to the sensors, microcontrollers, etc.), the deep edge (processing units with extended processing power, such as mobile phones, gateways, etc.) and the meta-edge (micro-servers combining full processing units and different microcontrollers for specific operations, for instance). These developments will be partly based on trends observed over the past years that relate to distributed autonomic systems which employ edge AI techniques to enhance autonomous behaviour in different implementations or collaborative systems.

Ovidiu: "That could be, for example, systems based on swarm intelligence, which includes cooperation between intelligent devices at the edge. Another trend is hyper-automation, so our AI at the edge will accelerate the integration of automation tools, platforms, and multiple sensing/actuating technologies. This enables more intelligent functionality and can create cross-functional, scalable autonomous systems that have what I call 'intrinsic intelligence' and 'extrinsic intelligence'. Intrinsic intelligence is the intelligence built within the unit, such as an intelligent IoT device, intelligent robot, or intelligent autonomous vehicle. And extrinsic intelligence is the intelligence used for collaboration between these entities."

The AI engineering involved in such developments is far beyond what can be achieved by a single type of company or specialist, requiring collaborative work with multidisciplinary teams that combine system engineering, hardware/software, communication technology, computer science and integration design. But by bringing together organisations and individuals with such skills

> "Today, moving data processing using AI from the cloud to the devices at the edge offers companies the opportunity to fundamentally improve their IoT applications and industrial processes. Thanks to the EdgeAI project, ST's AI teams are adding new functionalities to the NanoEdge AI software. Embedded AI makes it possible to optimise maintenance costs with equipment capable of detecting and processing data but also of acting locally to improve responsiveness (latency) and information security while reducing power consumption. The EdgeAI project is a great accelerator for developing new ST software, allowing developers who use STM32 microcontrollers and who are not AI experts to quickly, easily and inexpensively integrate advanced machine learning capabilities directly into their objects (industrial machines, IoT, automotive, household appliances, etc.)."
>
> - Pierrick Autret, *Nanoedge.AI Studio Marketing and Product Offering, STMicroelectronics, France*

> "EdgeAI is a forward-looking, exciting, and innovative research project where mature and ground-breaking technologies will meet to drive industrial innovation through AI applied at the edge. An example? EdgeAI will pursue the design of edge systems with neuromorphic (i.e., brain-like) accelerators used to process data from new sensors. By looking at these new technologies with an industrial focus, EdgeAI will support European competition on the embedded AI market in the coming years."
>
> – *Adjunct Professor Francesco Barchi and Professor Andrea Acquaviva, University of Bologna, Italy.*

> "Edge AI opens new opportunities for AI research and development on industrial and smart-agricultural scenarios. Adapting and optimising AI for the edge brings interesting challenges and the expected outcome shall boost the efficiency of key economic sectors in Europe."
>
> - *Luiz Angelo Steffenel, Professor at Université de Reims Champagne-Ardenne, France.*

under the banner of the project, the consortium will be able to push forward the state of the art in areas such as generative AI – in other words, AI technology which can generate synthetic data to train models, thereby automating edge AI processing and accelerating the design and development of new components, algorithms and even products and services.

Differences across the domains

Regarding the expected impact of such innovations, Ovidiu initially focuses on the domains addressed within the project.

"Digital society is a combination of advancements by adopting and integrating information, communication and AI technologies at home and in work, education and recreation, so edge AI can develop new technologies to be more trustworthy and offer more secure development, as well of the possibility for technology to be controlled by the end-user. For digital industry, we can see an impact on productivity by having these new edge AI technologies and distributed intelligence automating industrial processes and providing seamless integration of intelligent devices into production lines. This can result in lower costs, less energy consumption, higher yields, better quality and safer human-machine cooperation."

As for the energy sector, edge AI technology could enable much easier data collection: smart meters, for instance, do not typically process data themselves, whereas EdgeAI can move intelligence to the meters themselves, closer to the sensors. By carrying out most of the processing locally, actions can be taken automatically in real time, allowing energy consumption to be optimised according to user behaviour, historical data and weather conditions. Similar optimisation will occur in the agrifood and beverage use-cases, where edge AI will be used to monitor potential issues at every step of the champagne supply chain to guarantee safer, healthier, and more efficient production. And for mobility, Ovidiu considers edge AI an enabler in the development of autonomous vehicles, which require sensors and intelligence close to the edge to combine the distributed intelligence, perception, information fusion, security, safety, and reliability needed for public acceptance.

> "In the EdgeAI project, we will gain expertise for future intelligent manufacturing. Currently, most AI processes require substantial centralised computing capacity. Connectivity or network issues can cause downtime or a significant slowdown in industrial operations. With EdgeAI, we can directly integrate intelligence into manufacturing equipment."
>
> *- Astrid Khokhar, Director Program Management, SoftwareCUBE, Austria*

> "EdgeAI will be a catalyst for driving new AI-based applications that were not possible in the past due to data-privacy concerns and a lack of knowledge and trust. We believe that industry, especially in Europe, has a big optimisation potential that can be unlocked with the latest edge AI technology."
>
> *- Dr Claus Lenz, CEO, Cognition Factory GmbH, Germany*

> "EdgeAI accelerates the growth of a European ecosystem that boosts smart applications in the lighting domain. Bringing AI to the edge will increasingly lead to more pleasant and sustainable lighting environments." - Fetze Pijlman, Principal Scientist at Signify, the Netherlands.
>
> "Edge AI drives next-generation AI applications, building on cross-disciplinary technology research. The EdgeAI project fertilises the pan-European edge AI ecosystem and collaborative research. This pivots Europe to a leading position in the emerging market of embedded AI and its applications."
>
> *- Björn Debaillie, Program Manager Collaborative R&D at imec, Belgium*

> "EDGE-AI is an opportunity to strengthen our competitiveness by developing a 4.0 viticulture. The embedded sensors, close to the data sources from the vineyard to the cellar, will accelerate the development of AI in our industrial process. This project will allow us to increase our performance and productivity while respecting the tradition and artisanal practices of the Vranken-Pommery domain."
>
> *- Dr. Marine Rondeau, R&D Project Manager, Vranken-Pommery Monopole, France*

Reaching the wider world

And for impacts on wider society? As a new and rapidly emerging field with strong business promise, edge AI is another step in Europe's goal of retaining digital autonomy and competitiveness with countries like China and the United States. "I see a huge opportunity because Europe already has advantages in the industrial sectors involved in the development of embedded systems and processing at the edge," says Ovidiu. "At the same time, we can create a strong ecosystem of developers of edge AI technologies because several major companies, such as Infineon, STMicroelectronics, NXP and AMS, are in Europe. That will be advantageous in creating a European platform for edge AI."

Of course, edge AI is no 'magic bullet' that guarantees improvements in all areas. As Ovidiu emphasises, edge technology always brings the risk of exponentially increasing the number of electronic devices on a site, thereby increasing energy consumption. But by addressing scalability, energy efficiency and performance in the early phases of development, he believes that the EdgeAI project can positively influence the European Union's climate-neutral ambitions. "I would say that moving to the edge and adding intelligence at the edge could have an impact on the Green Deal in two directions: one is by increasing energy efficiency and lowering the power consumption of the electronic components, algorithms and AI methods at the edge and the other is by increasing the processing capabilities and reducing the overall energy consumption and CO_2 footprint of the applications that use edge AI components."

"At the same time, this will help in exchanging ideas and identifying gaps for future developments of edge AI technologies and applications. This could have a strong impact related to the European Chips Act because we will identify some of the challenges that can be put forward as topics for development within the initiative," concludes Ovidiu. "With 49 partners working together across Europe to develop these technologies, the project could be a flagship for AI at the edge."

For more information on the EdgeAI project, including opportunities for collaboration, Ovidiu can be reached at ovidiu.vermesan@sintef.no.

Upcoming events

EFECS 2022

Amsterdam, The Netherlands
24-25 Nov 2022
EFECS is the international forum to 'Create impact by collaborative innovation! for an autonomous and sustainable Europe along the Electronic Components and Systems value chain in Europe.

Semiconductors competence centers workshop

Hybrid event: Warsaw & Online
30 Nov 2022
This workshop discusses the next steps in setting up semiconductors competence centers. These competence centers are crucial elements of the Chips for Europe Initiative, which is part of the proposed Chips Act. The competence centers are expected to support SMEs with semiconductor technologies, and to contribute to training the workforce. The workshop will include discussions and presentations from centers with similar goals, such as the HPC and AI competence centers and the European Digital Innovation Hubs.

ECS Brokerage 2023

Brussels
07-08 Feb 2023
This event facilitates the ECS communities and collects all project proposals and experts together, making it easier for the ECS research community to find and create information and project proposals.

Webinar

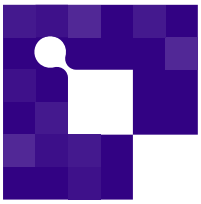
Online
15 Dec 2022
This webinar on R&I goals and opportunities on micro-electronics for 6G networks is organised by 6G-IA (with Aeneas support) and has the purpose is to identify the European policies and goals and discuss the related 2023 calls on this area by the KDT JU and the SNS JU.

Embedded world 2023

Nuremberg, Germany
14-16 Mar 2023
Embedded world is the global platform of the embedded community. From the safety of electronic systems to distributed intelligence, the Internet of Things, e-mobility and energy efficiency – experience the whole world of embedded systems.

DATE 2023

Antwerp, Belgium
17-19 Apr 2023
The DATE conference is the main European event bringing together designers and design automation users, researchers and vendors as well as specialists in the hardware and software design, test and manufacturing of electronic circuits and systems.



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