Smart Anything Everywhere

LET'S SHAPE EUROPE'S DIGITAL FUTURE TOGETHER

EMPOWERING SMES IN THE DIGITAL AGE THROUGH DIGITAL INNOVATION HUBS

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DIGITAL INNOVATION HUBS (DIH) – THE CONTRIBUTION OF SMART ANYTHING EVERYWHERE

Smart Anything Everywhere – in a nutshell

The Smart Anything Everywhere (SAE) initiative aligns different projects (so-called Innovation Actions) in various technology areas such as:
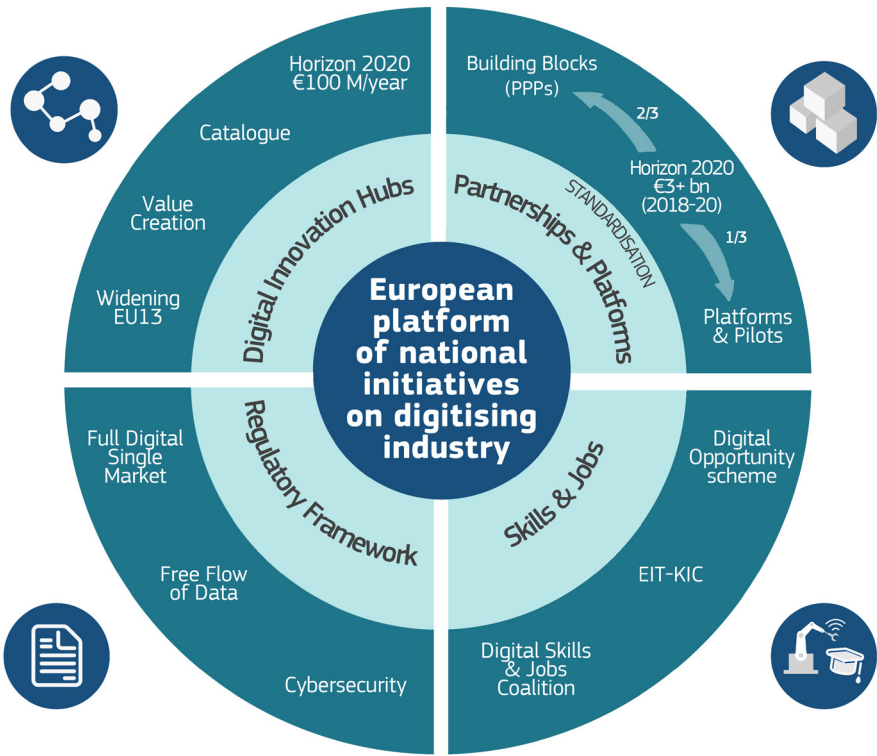
- Cyber-physical and embedded systems
- Customised low energy computing powering cyber-physical systems (CPS) and the Internet of Things (IoT)
- Advanced micro-electronics components and Smart System Integration
- Organic large area electronics / flexible and wearable electronics

Equally addressed are ecosystem building and the widening of the network of Digital Innovation Hubs (DIH).

All Innovation Actions (IAs) offered funding to small and medium-sized enterprises (SMEs) and mid-caps to enhance their products and services through the inclusion of innovative digital technologies. Companies could apply for funding via open calls in their corresponding technology areas. Guidelines on how to apply for funding and application documents were provided by every IA directly. All-in-all, €100 million of funding have been available for the IAs stimulating the uptake of advanced digital technologies by European industry – especially SMEs and mid-caps – in products that include innovative electronic components, software and systems, especially in sectors where digital technologies are underexploited.

The initiative and its goals

In April 2016 the European Commission presented the Digitising European Industry Strategy (DEI). The overall objective of this initiative was to ensure that any industry in Europe - big or small, wherever situated and in whichever sector - can fully benefit from digital innovations to upgrade its products, improve its processes and

adapt its business models to the digital age. This required not only a dynamic digital sector in Europe but also the full integration of digital innovations across all sectors of the economy. The DEI strategy was based on an ambitious collective effort involving public and private stakeholders across Europe at regional, national and EU level. It consisted of four areas of work: Digital Innovation Hubs, Partnerships & Platforms, Skills & Jobs, Regulatory Framework. The work was monitored and stirred by the European Platform of national initiatives on digitising industry.

Digital Innovation Hubs (DIHs) are one of the key elements of the DEI strategy. They are support facilities that help companies – notably SMEs, start-ups and mid-caps – to become more competitive through the adoption of latest digital technologies. The DIHs act as a one-stop-shop, providing their customers with

- access to digital technologies and competences,
- infrastructure to test digital innovations,
- training to develop digital skills,
- financing advice,
- market intelligence and
- networking opportunities.

Every company in Europe should have a DIH at a working distance, and the aim is to have at least one in every region in Europe. Member States and regions have been investing to establish the DIHs infrastructure with different sources of funding at national and regional level, but also through the management of European funds such as EFSI (European Fund for Strategic Investments). The European Commission, from its side, has been investing in EU-wide collaboration across the network of DIHs and networking among the DIHs. This started in 2013 with the ICT Innovation for Manufacturing SMEs (I4MS) initiative[1] followed by the Smart Anything Everywhere initiative (SAE) in 2015 and the Digital Europe Programme (DIGITAL) in 2021.

Enhancing the digital transformation of the European industry through Digital Innovation Hubs

The goal of Smart Anything Everywhere (SAE) is to let SMEs, start-ups and mid-caps enhance their products and services through the inclusion of innovative digital technologies. DIHs bring user companies (with a need to invest in digital technologies) in contact with supply companies which have suitable ICT products that address the needs of the users. Within SAE, Innovation Actions (IAs) offered funding and companies got the opportunity to do a focused application experiment where the novel product or service is developed. This creates a win-win situation for all actors: the user company can evaluate whether this innovative product brings benefit to its business. The supply company has an early customer and can improve its offering based on this experience. The DIH has grown its ecosystem and can support both companies to nurture their innovations further. In addition to the primary target of SAE to support "early adopters" of technologies, a secondary target is to stimulate the replication potential of the subsequent "early majority" in the technology adoption lifecycle. The application experiments involved tech (innovative companies) as well as non-tech companies (traditional companies) from various application domains, e.g. smart cities, smart transportation, smart health & well-being, smart agriculture, smart industry, smart energy, etc. Their ultimate goal was on the one hand to help foster competitiveness of in particular SMEs and mid-caps, and on the other hand to establish fully functional ecosystems of DIHs that can also provide services beyond technical advice such as business consulting and training.

The three phases of the SAE initiative have been dedicated to the creation of well-functioning ecosystems around regional DIHs in different technology areas.

1 https://i4ms.eu
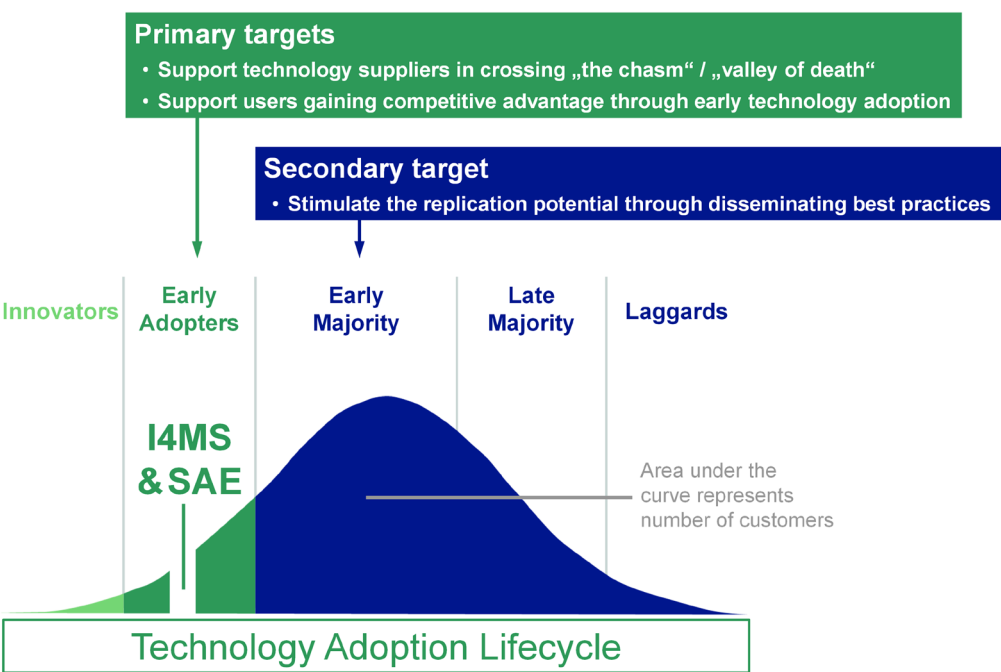
Phase 1: Creating a well-functioning ecosystem

The first phase of the Smart Anything Everywhere initiative started in 2015 under Horizon 2020 (H2020). It was building on the successful experience of the COLAE and TETRACOM projects of the previous 7th Framework Programme (FP7). The total funding of these projects was €26 million dedicated to the following four technology areas:

Area 1: Cyber-physical and embedded systems: The goal is to help businesses from any sector uplift the quality and performance of their products and services with innovative embedded ICT components and systems and to support eco-system building for promising platforms developed in earlier R&I products.

Area 2: Customised low energy computing powering CPS and the IoT: The goal is to help businesses who are developing products for situations where high computing capacity and low energy would be a competitive advantage and to support eco-system building for promising platforms developed in earlier low power computing projects.

Area 3: Advanced micro-electronics components and Smart System Integration: The goal is to support electronic components, sensors, smart objects and systems (i) access to advanced design and manufacturing for academia, research institutes and SMEs, and (ii) rapid prototyping targeting SMEs.

Area 4: Organic and large area electronics: The goal is to help businesses in further maturing, innovating and validating their products with organic and large area electronics technologies. Focus is on i) access to design, technology and prototyping which are mature and ready to use, and ii) application experiments driven by concrete user requirements and business cases.

The 160 application experiments that were conducted both in FP7 and H2020 involved 48 DIHS, 150 SMEs and mid-caps. They created enormous economic and societal impact. In addition, H2020 brought a major improvement. Through using the new "Financial Support to Third Parties (FSTP)" scheme (the so-called "cascade funding"), companies can sign a light contract with one of the projects' beneficiaries rather than entering into a direct and more complex contract with the European Commission. In detail, it offered the following advantages:

- Funds from the EU are passed on to the SMEs directly by the Innovation Action
- SMEs are not entering into a complex contract with the European Commission
- Lean contract with a representative of the Innovation Action

About 20 % of the total phase 1 funding was provided directly to SMEs and mid-caps.

Phase 2: Expanding the ecosystem and its European dimension

The second phase of SAE started in autumn 2017 with 4 new Innovation Actions (IA) and one Coordination and Support Action (CSA) to support the existing and new DIHs into forming a coherent pan-European network of hubs with a total funding of €26 million. Special focus was on reinforcing the role of the DIHs in offering all innovation services that companies need. Not only testing and experimentation, but also skills development and having access to finance. Furthermore, collaboration with nationally/regionally funded DIHs was highly encouraged to be able to cover the whole of Europe.

The CSA, Smart4Europe, played an important role in integrating new DIHs in the existing network. They organised networking events e.g. back to back to relevant world class events such as the Hannover Messe. Through these projects, a new set of application experiments involving 40 new DIHs and 190 SMEs were conducted. They all had a cross-border dimension to foster collaboration on European level. In addition, this new phase also reflected the evolution of technology since the start of the initiative.

Skilling SMEs in digitising their business

A major role DIHs have to play is to deepen the understanding of the decision makers in SMEs, start-ups and mid-caps about which opportunities the digitisation provides for their company. This goes clearly beyond just technology transfer or offering digital services in an affordable manner. DIHs should provide the relevant staff in companies with the skills to use digital technology in order to improve their way of working and to digitise their products and services, processes and business models. The target was that at least 10-20 % of the efforts in application experiments are devoted to skills development.

Further supporting SMEs and mid-caps

From 2018-2020, SMEs and mid-caps could apply for funding in 14 open calls to address their individual needs. The additional presence of large industrial players in SAE ultimately helped SMEs and mid-caps, as establishing a customer relationship with such big players as reference could boost their business. The existing marketplaces were also further enriched with new service offers and a new marketplace for additive manufacturing services was established. Furthermore, the DIHs attracted investors to support business development of SMEs and mid-cap actors in successful application experiments.

Phase 3: Consolidating collaboration and widening the pan-European network of DIHs

In 2019, a H2020 call for Smart Anything Everywhere projects in the focus area „Digitising and transforming European Industry and Services" was launched for stimulating the uptake of advanced digital technologies by European industry – especially SMEs and mid-caps – in products that include innovative electronic components, software and systems, particularly in sectors where digital technologies are underexploited. A total funding of €49 million was made available to support 6 new IAs and one accompanying CSA. Compared to phase 1 and 2, the addressed technology areas were slightly changed and the collaboration effort was widened. The areas addressed were:
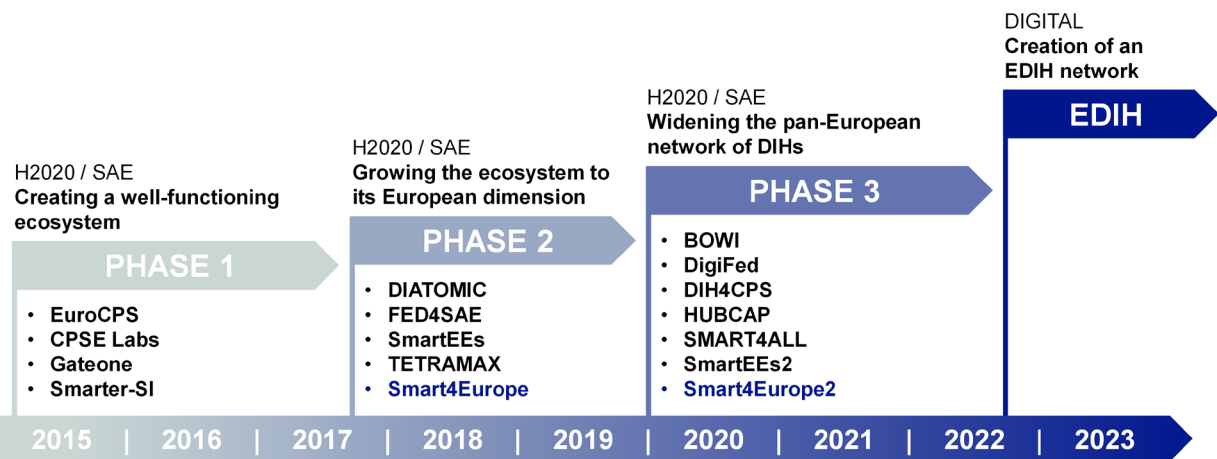
Area 1: Cyber-physical and embedded systems: The goal is to help businesses from any sector uplift the quality and performance of their products and services by including (semi)-autonomy, paying special attention to security and privacy and to the collaboration between humans and machines.

Area 2: Customised low energy computing powering CPS and the IoT: The goal is to help businesses who are developing products for situations where high computing capacity and low energy would be a competitive advantage.

Area 3: Flexible and wearable electronics: The goal is to help businesses in further maturing, innovating and validating their products with thin, organic and large area electronics technologies, including wearable, portable and embedded objects. Focus is on i) access to design, technology and prototyping which are ready to use, and ii) application experiments driven by concrete user requirements and business cases.

Area 4: Widening Digital Innovation Hubs: It addresses all three technology areas mentioned above and the technologies addressed in I4MS. It calls for Digital Innovation Hubs in industrial regions which are so far underrepresented in Smart Anything Everywhere and I4MS, and builds upon a mentoring programme developed by I4MS and Smart Factories in new EU Member States. These hubs should strongly collaborate with other Innovation Actions funded under SAE and I4MS, e.g. through joint highly innovative cross-border experiments.

The new IAs contributed heavily to meet the goal of the DEI to have at least one DIH in every region by 2020. In the context of the Smart Factories project, 30 organisations were selected at the end of 2017 to study the feasibility of becoming a Digital Innovation Hub that serves the needs of their region. Area 4 was the opportunity for the coached hubs to become an integral part of the EU ecosystem of DIHs. The CSA Smart4Europe2 reinforced the collaboration among the projects supported under the SAE initiative to increase their outreach and impact. It provided wide coverage of stakeholders in technological, application, innovation, and geographic terms.

All in all, the European Commission has invested €100 million until 2023 in SAE to foster DIHs as a main pillar of its Digitising European Industry strategy. Apart from SAE, additional calls for DIHs were launched for other related initiatives such as I4MS (2020), for photonics technologies (2020), for robotics technologies (2018), for big data (2020), and for their overall coordination (2019).

Accelerating best use of technologies: European Digital Innovation Hubs

From 2022, the SAE activities of H2020 transition to the Digital Europe Programme (DIGITAL)[2] parallel to Horizon Europe with the first goal to deploy a network of European Digital Innovation Hubs (EDIHs), see page 16.

H2020 / SAE — Creating a well-functioning ecosystem
PHASE 1
- EuroCPS
- CPSE Labs
- Gateone
- Smarter-SI

H2020 / SAE — Growing the ecosystem to its European dimension
PHASE 2
- DIATOMIC
- FED4SAE
- SmartEEs
- TETRAMAX
- Smart4Europe

H2020 / SAE — Widening the pan-European network of DIHs
PHASE 3
- BOWI
- DigiFed
- DIH4CPS
- HUBCAP
- SMART4ALL
- SmartEEs2
- Smart4Europe2

DIGITAL — Creation of an EDIH network
EDIH

2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023

THE SAE INITIATIVE

- Three phases 2015–2023: creation, expansion, and consolidation of the SAE ecosystem
- 14 IAs plus two supporting CSAs
- €100 million total funding
- €32 million funding distributed by FSTP-scheme mainly to SMEs and small mid-caps

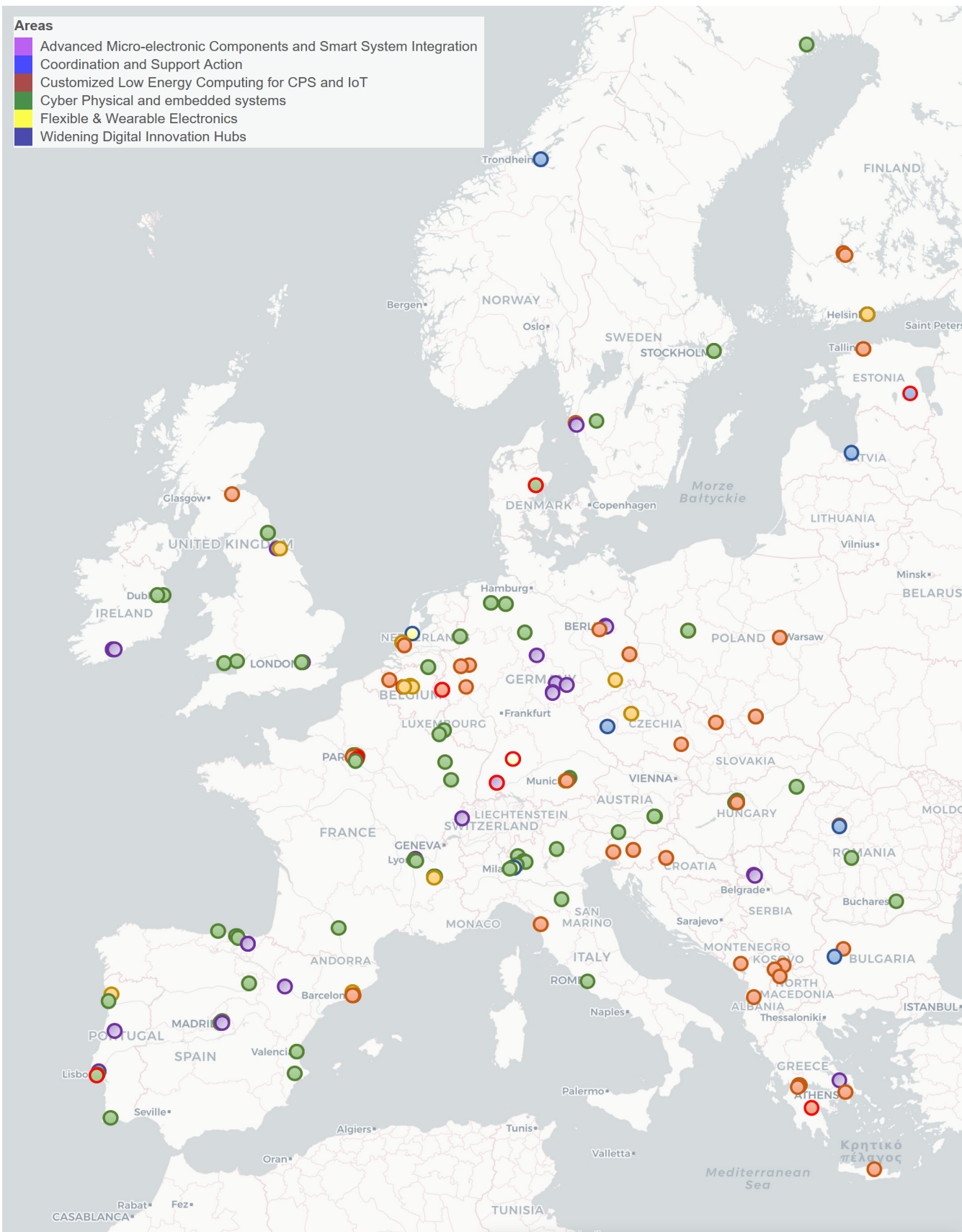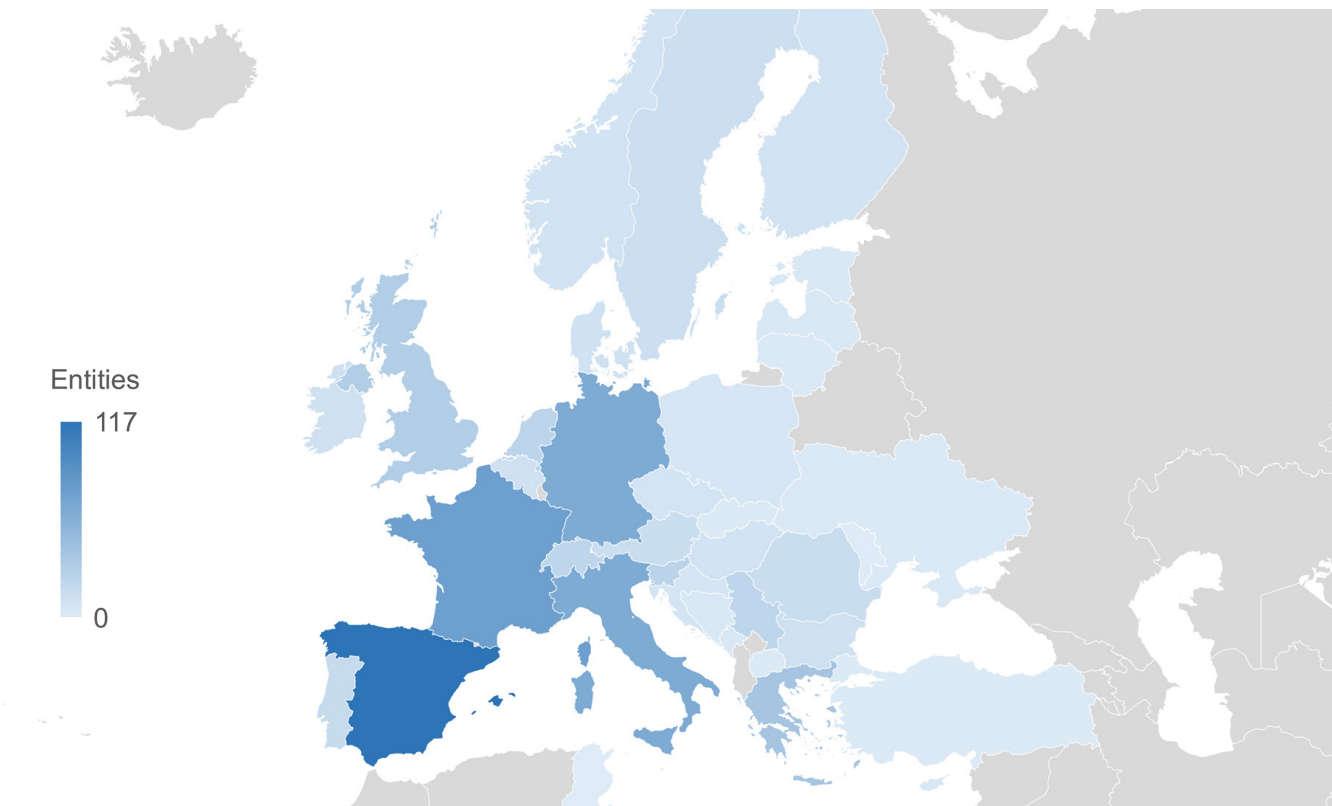## 48 OPEN CALLS FOR RAPID RESPONSE TO NEW MARKET CHALLENGES

- Funding opportunities for individual application experiments, typically €20,000 – €100,000 each
- Light, SME-friendly application scheme:
  10 page proposal, calls tailored to market challenges, very short time to start
- Average success rate 20–25 %

OVER 400 APPLICATION EXPERIMENTS REALISED

- More than 660 companies and entities involved
- About 90 % of the supported entities are SMEs or small mid-caps

36 COUNTRIES PARTICIPATED

Most of the application experiments had a relevant European dimension and were executed in collaboration of partners from different EU member states and associated countries combining existing regional strengths and know-how. Even more of them facilitated collaboration and interaction across different regions.

Entities
117

0

3 Figures as of 31.12.2021. The COLAE and TETRACOM projects already funded under FP7 are not included.

Areas
Advanced Micro-electronic Components and Smart System Integration
Coordination and Support Action
Customized Low Energy Computing for CPS and IoT
Cyber Physical and embedded systems
Flexible & Wearable Electronics
Widening Digital Innovation Hubs

Cyber-physical and embedded systems

HUBCAP
01/2020 – 12/2022

HUBCAP provides a one-stop-shop for European SMEs wanting to join the CPS revolution. It builds on seven established DIHs in seven European countries, each deeply embedded in its regional digital innovation ecosystem, and offering specialist expertise, experimental capabilities, and focused application domain knowledge in CPS engineering. HUBCAP extended an existing open collaboration platform to enable SMEs to co-create, analyse, and validate new CPS products in a virtual setting. This is realised by accessing CPS assets (models, tools, services) and experimenting with new solutions de-risking investments in skills or resources.

DigiFed
01/2020 – 12/2022

DigiFed acts as pan European accelerator for the deployment of embedded and cyber-physical systems encouraging the adoption of advanced digital technologies by SMEs with a focus on non-digital businesses. The emphasis is on security and privacy, autonomy, and human-machine interaction. Its innovation pathways offered two main instruments: "Generic experiments" to target a group of mainly non-tech SMEs to implement advanced technology demonstrators with co-funding from regional authorities. "Application experiments" to allow individual SMEs to define an R&I project to disrupt, upgrade, or manufacture an innovative digital product or service.

DIH4CPS
01/2020 – 12/2022

DIH4CPS is the initiative for fostering DIHs for embedding interoperability in CPS of European SMEs helping European companies to overcome innovation hurdles and ultimately establishing Europe as a world-leading innovator of the Fourth Industrial Revolution. It has created a comprehensive, interdisciplinary network of DIHs and solution providers from different, especially digitally underdeveloped sectors and regions. The network is focused on cyber-physical and embedded systems linking knowledge and technologies from different fields and connecting regional clusters with the DIHs' pan-European pool of experts.

FED4SAE
09/2017 – 01/2021

FED4SAE represents a pan-European network of DIHs leveraging existing regional tech or businesses ecosystems across complete value chains and multiple competencies. The network enables start-ups, SMEs, and mid-cap companies in all sectors to build and create new digital products and services providing a complete solution. This includes combining hardware and software tested in a market environment prior to a large deployment to the targeted market as well as support in business modelling and market insights through guidance from conceptual design through market launch.

EuroCPS
02/2015 – 04/2018

EuroCPS gathers several design centres in order to boost and initiate synergies between innovative companies, major CPS-platforms, and CPS-competency providers. The motivation of the project was to enable companies making new CPS products to get access to leading edge technology platforms from large companies and support from competency partners. Thereby, the two main goals were to bring innovative CPS to companies in all industries with the help of network partners and to connect users and providers across value chains and regions with the help of competence partners.

CPSE Labs
02/2015 – 04/2018

CPSE Labs' mission is to expedite and accelerate the realisation of trustworthy CPS. The CPS Engineering Labs therefore equip innovators, businesses, researchers, and students with CPS engineering infrastructure, knowledge, and tools for realising novel CPS-based products and services. This includes a pan-European network of design centres committed to transitioning science and technology for engineering trustworthy and dependable CPS into the marketplace, the spread of best CPS engineering practices, and the promotion of cross-regional and cross-sectorial learning among industry and academia.

Organic and large area electronics / flexible and wearable electronics

SmartEEs2
01/2020 – 12/2022

SmartEEs2 orchestrates a pan-EU collaboration network of regional DIHs promoting the best quality level of digitalization experience to show where organic and large area electronics (OLAE) can valorise its uniqueness (flexibility, conformability) and its promises for solutions in the fast growing business of wearables and the Internet of Everything. To address both market and technology specific challenges, SmartEEs2 links technology promises with real use and business cases. These cases are implemented through a unique digitalization experience providing experimentation, testing, or support to manufacturing.

SmartEEs
09/2017 – 11/2020

SmartEEs was dedicated to Large Area Electronics (LAEs) and provided competencies and business support for innovation adoption, access to disruptive (LAEs) technologies, and innovation support in a pragmatic, operative and efficient Pan European manner. Several application experiments were conducted to explore the transfer of technologies into business, organisation of cooperation, access to finance, services to be provided, and act as showcases to raise awareness and activate potential users. The established ecosystem was harnessed by the consortium to propel the continuity of the initiative beyond the project in SmartEEs2.

COLAE
09/2011 – 08/2014

COLAE promoted the commercial exploitation of OLAE technologies for the benefit of European industry and economies. It aimed to bring together the leading European companies and new start-ups along the present and potential OLAE value chains, harness the knowledge base and technology know-how of the European research partners and their regional clusters, and provide a range of services to support new product and business development. COLAE has developed a virtual European OLAE foundry concept as well as manufacturing and pilot production services.

Advanced micro-electronic components and Smart System Integration

DIATOMIC
09/2017 – 08/2020

DIATOMIC acts as a "one-stop-shop" for microelectronics SMEs and mid-caps, for tech adopters, tech providers, and competence centres to generate digitised products, processes, and business models with strong growth potential in the industries of health, agrifood, and manufacturing. In addition, innovators get access to cutting edge infrastructure and experimentation facilities to test and experiment. They receive tailored support as they move along the innovation pipeline and exploit new market opportunities through funding, business training services, and cross-border brokerage.

Gateone
01/2015 – 06/2018

Gateone accelerates the adoption of smart systems in European SMEs by facilitating their access to advanced technologies. It targets radical or disruptive innovation in a techno-push approach as an incentive for SMEs to engage with European Technology Excellence in smart systems. In order to generate innovation opportunities for SMEs while reducing and managing their investment risk, Gateone enabled state-of-the-art technology assessment by SMEs with demonstrators. In addition, the innovation action generated a structured dialogue through concrete collaborations between the research community (research centres and academics) and SMEs.

Smarter-SI
02/2015 – 01/2018

Smarter-SI provides access to advanced Smart Systems Integration as well as cross-cutting key enabling technologies to support SMEs in gaining access to markets for smart products. The focus is on products where only some hundreds to thousands items per year are needed. The necessary expertise is provided by a group of RTOs with a wide range of experience. SMEs can test the application-specific systems manufactured by the RTO-foundry with their clients. Smarter-SI provides a single access point for Smart Systems design, manufacturing, and testing to SMEs in Europe and covers the whole chain from RTD through manufacturing and usage in products to final customers.

Customised low energy computing powering CPS and the IoT

SMART4ALL
01/2020 – 12/2023

SMART4ALL brings a new paradigm for revealing "hidden innovation treasures" helping them to find the path to market via new, innovative commercial products. As part of its strategy, the project has developed an active network of DIHs for supporting academics, start-ups, SMEs, and mid-caps entering the digitisation era. This includes the transfer of knowledge and technology between academia and industry. The domains targeted are digitised environment, digitised transport, digitised agriculture, and digitised anything. Within the framework of knowledge transfer experiments, less mature ideas can be presented and tested to develop their product potential.

TETRAMAX acts as a European Competence Centre Network in customised low-energy computing (CLEC), providing easy access for SMEs and mid-caps via local contact points. SMEs can demand CLEC technologies and solutions via the network, and vice versa academic research institutions can actively and effectively offer their new technologies to European industries. TETRAMAX supports industry clients and third parties with innovative technologies using different kinds of technology transfer experiments to accelerate innovation within European industries and to create a competitive advantage in the global economy.

TETRAMAX
09/2017 – 12/2021

TETRACOM offered technology transfer projects to lower the barrier for researchers to make the first steps towards commercialization of their research results. With a special focus on SMEs, the project established and reinforced long-term collaborations on a local, national, and also on a multi-national level. Based on its highly recognised success demonstrating its effectiveness as key enabler of the digital transformation of the European Industry, TETRACOM has evolved into TETRAMAX operating at much larger scale and with even higher ambitions.

TETRACOM
09/2013 – 08/2016

Ecosystem building and the widening of the network of DIHs

BOWI aims to boost innovation uptake across Europe through widening and knowledge transfer between different regions and innovation hubs. The project supports the collaboration between DIHs across Europe to increase their capacity to support SMEs with digital technologies and thus strengthen regional economy and the competitiveness of the European SMEs. BOWI ensures technology and experience transfer from established DIHs located in mature regions to developing hubs in underrepresented regions by direct funding through technology transfer experiments.

BOWI
01/2020 – 06/2023

The ultimate goals of Smart4Europe and Smart4Europe2 are to provide support for SAE by

- reinforcing the collaboration between projects supported under SAE,
- increasing their outreach and impact,
- providing wide coverage of stakeholders in technological, application, innovation, and geographic terms.

Smart4Europe2
01/2020 – 12/2021

Smart4Europe
09/2017 – 08/2019

In order to achieve this, the two Coordination and Support Actions have set up the SAE website, created an innovation portal, and provided a service centre to facilitate brokerage. In addition, the communication and dissemination activities of SAE have been coordinated, e.g. the SAE newsletter or the SAE brochures. To identify SAE technologies from which SMEs can benefit, a Technology Radar was created. Last but not least, links have been established with regional/national initiatives to leverage investments and stimulate growth.

"Even before the Corona pandemic, companies really have understood how important the uptake of digital technologies is to innovate their products and thus gain a competitive advantage. EC funded projects and initiatives like SAE and I4MS have supported this development enormously. All of the SAE success stories are truly a source of inspiration of all the things you can do with digital technologies. And this development will further be strengthened with the implementation of the EDIHs all across Europe."

Anne-Marie Sassen
Acting Head of Unit, CNECT A4, Digital Transformation of Industrial Ecosystems, EC, Belgium

"The Technology Radar has been developed to help companies understand emerging technologies with a focus on the twin green and digital transition. It provides a clear picture of advanced digital technologies being developed, their technical and commercial challenges, potential green opportunities as well as applications in many sectors. This allows companies to make strategic decisions. We have received so much positive feedback on the Technology Radar and its usefulness by companies, especially SMEs saying that they really benefit from this tool."

Haydn Thompson
Founder and Owner of THHINK, United Kingdom | Project Member Smart4Europe and Smart4Europe2

"The past 7 years have been such an incredible journey, not only for the SAE initiative but also for all its 150 partners. They are located all across Europe and are forming a tremendous network to support European businesses. SAE is offering so much more than only technologies: A well-functioning ecosystem with a marketplace, brokerage activities, best practices as well as networking opportunities to support SMEs in the best way possible."

Meike Reimann
Steinbeis Europa Zentrum, Germany | Project Coordinator Smart4Europe2

"Thanks to FED4SAE we were able to obtain funding support together with marketing, financial, and technical assistance which has helped us to better fund and develop our early stage solution in an effort to bring it to the market."

José Luis Vilches
General Manager of Enerclic, Spain | FSTP Recipient FED4SAE

"I strongly believe that simplifying the administrative requirements helped a lot to easily reach out to so many SMEs since the start of the SAE initiative in 2015. SMEs do not have the time to enter into complex contracts with the EC but welcomed the "cascade funding" where they receive funds directly from the Innovation Actions. This is for sure the main reason for the huge success of the SAE Initiative which has provided €32 million to more than 600 SMEs and small mid-caps across Europe."

Rainer Günzler
Hahn-Schickard, Germany | Project Coordinator Smart4Europe

"Whilst we are experts in the field of IoT, having worked in the industry for a number of years, starting our own organisation presented a variety of fresh challenges. The support of FED4SAE gave us a huge boost in confidence, as well as providing access to specialist expertise and independent perspectives. Along with access to funding, they helped us build a corporate CV and enhance our approach to the market. Having their backing has also provided us with valuable credibility, which greatly assisted our investment efforts."

Neal Forse
Co-Founder IoT Solutions Group, United Kingdom | FSTP Recipient FED4SAE

"Being involved in the SAE initiative as coordinator of the Innovation Actions FED-4SAE and DigiFed as well as member of both CSAs, I can definitively say that trust is one of the main factors for success. Trust between the project partners leads to trust in the technical solutions which is essential for a fruitful collaboration within the consortium. Only with this common understanding, you can provide the best solution for the SME's need."

Isabelle Dor
CEA, France | Project Coordinator FED4SAE and DigiFed

"TETRAMAX has demonstrated once again which amazing results are possible when enthusiastic people from both academia and industry drive innovation. This allows not only for turning great ideas to reality, but also linking researcher and engineers across Europe."
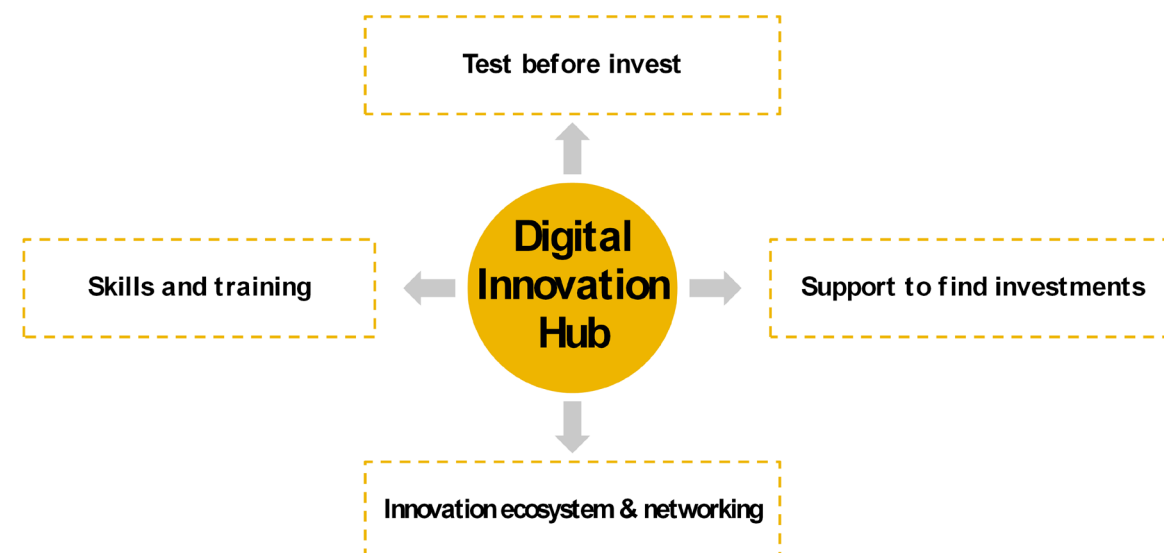
Matthias Weiss
Managing Director CommSolid GmbH, Germany | FSTP Recipient TETRAMAX

14

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The digital transformation of the economy is key for Europe to remain competitive internationally. Four years after the launch of the Digitising European Industry Strategy and the eGovernment Action Plan, the European economy has made significant progress. The level of digitalisation however remains uneven, depending on the sector, country and size of company: only 20 % of SMEs in the EU are highly digitised. A similar pattern is observed for the adoption of eGovernment.
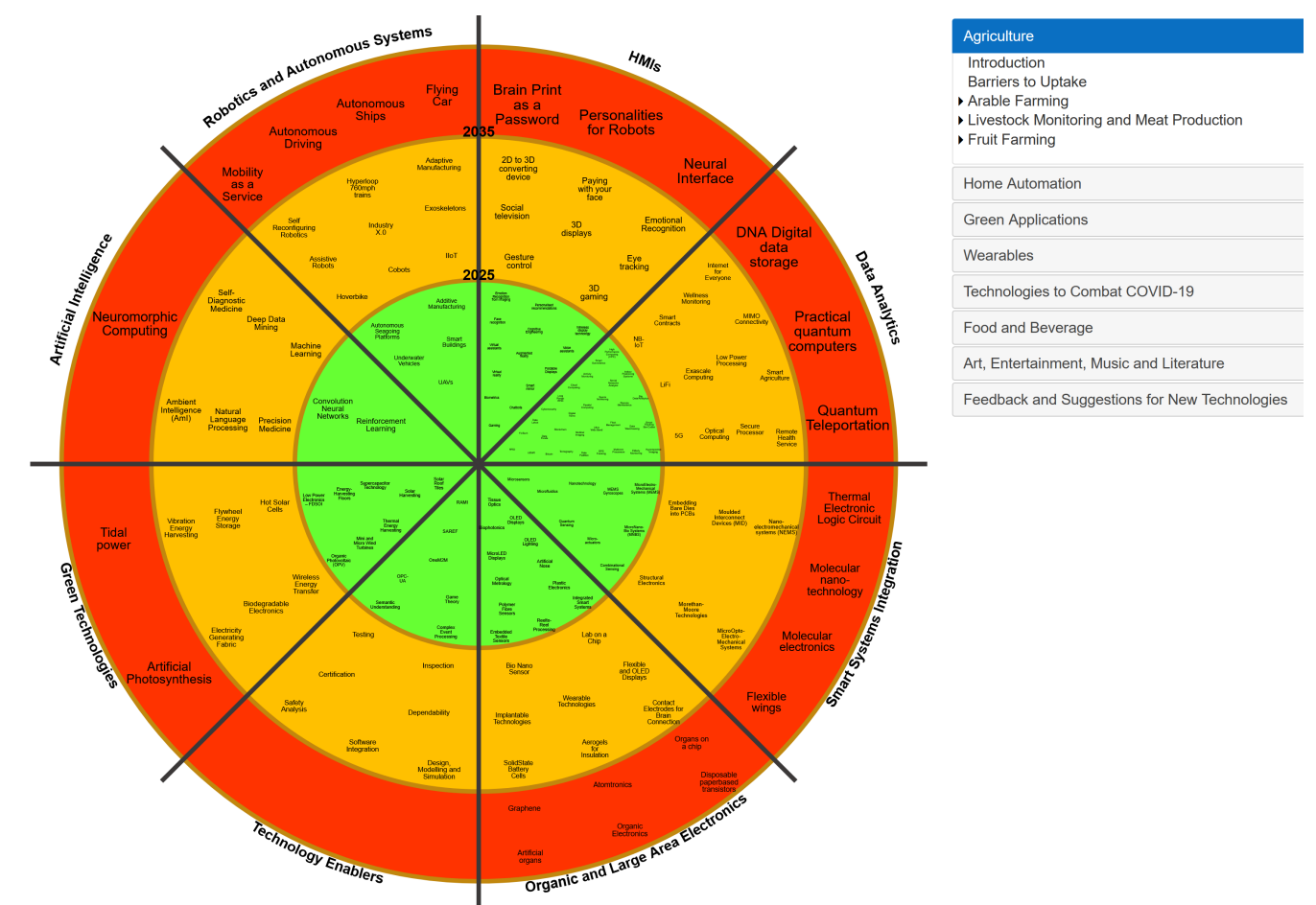
The Digital Europe Programme (DIGITAL) reinforces EU critical digital capacities 2021-2027 by focusing on the key areas of artificial intelligence (AI), cybersecurity, advanced computing, data infrastructures, data governance and processing, the deployment of these technologies and their best use for critical sectors like energy climate change and environment, manufacturing, agriculture and health. For this purpose, DIGITAL deploys a network of European Digital Innovation Hubs (EDIHs) offering access to technology testing and support in their digital transformation for private and public organisations all across Europe, including government at national, regional or local level, as appropriate. Compared to the DIHs of DEI and the SAE initiative, the EDIHs aim at a clear European added value and focus on the four service areas "test before invest", "skills and training", "support to find investments" and "innovation ecosystem and networking".

EDIHs have both local and European functions. EU funding is made available for hubs that are already (or will be) supported by their Member States (or regions), in order to increase the impact of public funding. The Digital Europe Programme increases the capacities of the selected hubs to cover activities with a clear European added value, based on networking the hubs and promoting the transfer of expertise. Member States have an essential role in the selection process of the EDIHs; the initial network of EDIHs is established from a list of hubs designated by the Member States. The Joint Research Centre of the European Commission has developed a practical handbook with good practices on investments in Digital Innovation Hubs.[4] The handbook aims to support regional, national, and RIS3 (Regional Strategy for Research and Innovation for Smart Specialisation) Implementation policymakers.

Many EDIHs will be based on existing clusters, or include organisations that are part of an Enterprise Europe Network (EEN) consortia. The SME Strategy also commits to expand Digital Innovation Hubs in connection with Startup Europe and the EEN and provide a seamless service within local and regional ecosystems. The first restricted call for EDIHs opened on November 17th, 2021 to enable selected EDIHs to start their operations towards September 2022.

SMEs and mid-caps often struggle to keep track of new technologies that may be important to their business in the short, medium and long term. Therefore, a SAE Technology Radar has been developed in the Smart4Europe and Smart4Europe2 projects to help companies quickly see the technologies that could provide business opportunities over the next 10-20 years as we make a twin green and digital transition. The radar has an emphasis on green and sustainable applications of technologies and provides SMEs with a classified overview on Smart Technologies, Smart Services, SAE Tools and SAE Platforms according to their level of market readiness. It covers 200 technologies providing technology descriptions, an assessment of maturity to answer the question "should my company be looking at this now?" as well as an overview of the technical challenges, commercial barriers and green opportunities for each:

- Green – technologies that SMEs and mid-caps can consider to be mature in the short term.
- Amber – technologies that are coming in the 2025-2035 timescale that SMEs/mid-caps should be aware of for the future and may have an interest in that they may wish to monitor.
- Red – technologies that are still very immature and should not be considered at this time.

In addition, the applications accordion provides examples of applications in smart agriculture, home automation, wearables, sustainable manufacturing of electronic goods, intelligent energy and low carbon technologies, ocean monitoring, food and beverage, art, entertainment, music, and literature.

Access the SAE Technology Radar by this link: https://www.thhinkbv.com/docs/New1Radar/index.html

4 https://publications.jrc.ec.europa.eu/repository/handle/JRC121604

Q: What is Smart Anything Everywhere all about?

A: The overall goal of Smart Anything Everywhere (SAE) is to let SMEs, start-ups and mid-caps enhance their products and services through the inclusion of innovative digital technologies.

Q: What is stated in the Digitising European Industry initiative (DEI)?

A: The Digitising European Industry initiative (DEI) was launched by the European Commission in April 2016 and was a key element of the Digital Single Market Strategy, which aimed at reinforcing the European Union's competitiveness in digital technologies and ensuring that business of any size, in any sector and country can fully benefit from digital innovation. DEI supported and linked up national initiatives and boosted investment through strategic partnerships and networks. It consisted of five main pillars:

- European platform of national initiatives on digitising industry
- Strengthening leadership through partnerships & industrial platforms
- Digital innovations for all: Digital Innovation Hubs
- A regulatory framework fit for the digital age
- Preparing Europeans for the digital future

Q: What is an Innovation Action (IA)?

A: Innovation Actions (IAs) are a class of EU-funded projects. They are primarily consisting of activities directly aiming at producing plans and arrangements or designs for new, altered or improved products, processes, or services. For this purpose, they may include prototyping, testing, demonstrating, piloting, large-scale product validation, and market replication.

Q: What is Financial Support to Third Parties (FSTP) also known as "Cascade Funding"?

A: This funding scheme aims at simplifying the administrative procedures creating a light and SME-friendly application scheme. Funds from the EU are passed on directly to the SMEs by the Innovation Action. Consequently, SMEs are not entering into a complex contract with the European Commission but have a lean contract with a representative of the IA.
Based on this funding scheme, the IAs of the SAE initiative provided access to advanced digital technologies and competences especially for start-ups, SMEs, or mid-caps that needed technical and financial support to benefit from digital innovations. This included upgrading products or services, improving processes or adapting business models to the digital age.

Q: What is a Digital Innovation Hub (DIH)?

A: DIHs support the faster adoption of latest digital technologies notably by SMEs, start-ups and mid-caps. They act as a one-stop-shop, providing customers with access to digital technologies and competences, infrastructure and training to test digital innovations, financing advice, market intelligence and networking opportunities.[5]

Q: What is a European Digital Innovation Hub (EDIH)?

A: EDIHs are hubs funded within the Digital Europe Programme that cover activities with a clear European added value, based on networking of the hubs and promoting the transfer of expertise. They can, but do not have to, be based on hubs that are already supported by their Member States (or regions) and can be considered as "next level DIHs" with expanded European functions.[5]

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5 Catalogue of DIHs and EDIHs: https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool

COOPERATIVE ARCHITECTURE FOR GARDENING WITH OPEN MONITORING SYSTEMS

Problem and solution
Many gardening lovers need an aid to grow and take care of their plants. The lack of time and the high effort are a challenge for hobbyists. In addition, gardening lovers suffer under a lack of data since soil and plants do not speak. Therefore, customers do not know what is really happening. They are lacking information and skills.

To address this, two SMEs, Proventus and Lifely, joined their forces in a TETRAMAX application experiment to develop CARROTS. CARROTS is the cooperative architecture for gardening with open monitoring systems. It provides users with real time data on their plants and tips on how to take care of their own garden. CARROTS is based on the Tomappo app, a digital gardening assistant from Proventus enabling everyone to grow their own vegetables. Within the application experiment, Lifely's Agrumino wireless sensors (temperature and soil humidity) were optimised for use with Tomappo and the garden planner was improved with new features. This added a new IoT dimension to the Tomappo app.

The role of the DIH
In this TETRAMAX application experiment, the Innovation Action itself was considered as DIH and inspired the direct collaboration of two SMEs without the need to involve further institutions. Proventus provided the app technology and Lifely the wireless sensor technology.

Impact
The CARROTS bilateral TETRAMAX project lead to positive results for both parties involved: the technology provider and technology receiver. Tomappo as the technology receiver improved its product and generated a new revenue stream. The project's activities contributed to the growth of Tomappo resulting in 11,000 new registered users within one year doubling the number of Tomappo PRO licenses sold and generating 12 new B2B partnerships. On the other hand, Lifely as technology provider got a use-case for its sensors in a new domain and could improve them. The new Agrumino wireless sensors have 35 % reduced energy consumption and 18 % cost reduction in sensor manufacturing.

End-user: Proventus (SME, SI), Lifely (SME, IT)
Technology provider: Proventus (SME, SI), Lifely (SME, IT)
DIH: –
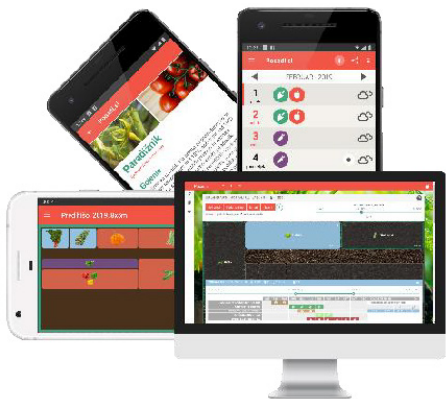
SUSTAINABLE FARMING – FEWER PESTICIDES THANKS TO IOT TECHNOLOGY

Problem and solution

It is estimated that agriculture accounts for more than 70 % of the world's water consumption and that up to 58 % of the pesticides applied in agriculture is unnecessary. Therefore, the ability to determine whether crops in the field need water, fertilisers or pesticides – and if so, when and how much – is vital to sustainable agriculture and to fight hunger in an ever-growing world population. Decisions on crop management are at best made based on records collected at public climate monitoring stations. While this information applies to very large areas, agro-climatic conditions vary over short distances and thus global information is of little use for the optimisation of crop growing. For example, key variables such as soil-moisture content may change within just a few meters.

In order to collect and analyse key parameters for optimised crop growing, the CNODE experiment within the EuroCPS project designed and built low-cost sensor nodes with just a few sensors to monitor highly variable and critical parameters: air temperature and humidity, and soil moisture at three different depths. The solution is based on spectrally efficient modulations such as differential binary phase-shift keying (DBPSK) and Gaussian frequency-shift keying (GFSK) and simultaneously optimises network capacity and maximises the communication link budget. Despite sending data directly to the server over long distances, the nodes require minimal maintenance and enable a battery life of at least five years using Sigfox's low-power, wide-area (LPWA) connectivity. This makes the solution affordable and practical to use. The accurate information collected by the solution will on average enable farmers to reduce pesticide application by 35 % and irrigation-water consumption by 50 %.

The role of the DIH

CEA-Leti, a research institute of CEA Tech, acted in this experiment as DIH connecting its Sigfox transceiver to the STM32L0 Microcontroller Platform and transferring the entire solution suitable for the sustainable farming application to the SME Encore that is active in that field.

Impact

The CNODE technology is being integrated in Cesens, Encore Lab's flagship, sensor-based product for providing farmers with real-time information about their crops. Thanks to the extended functionality of its flagship product, the company expects to sell more than 10,000 units within the first five years after its 2017 market launch. Sales are estimated to reach €1 million by 2022. In addition, the company expects to double its staff to 20 during that period, thanks to the results of the CNODE project.

Dramatically optimising water consumption in crop farming also has a huge humanitarian dimension, as persistent hunger is in particular observed in areas where water availability is limited. Increasing harvests thanks to optimised consumption of the rare resource water will strongly contribute to the fight against hunger.

Finally, the considerable reduction of pesticides has also environmental impact in using fewer chemicals that contaminate the soil.

End-user: Encore Lab (SME, FR)
Technology provider: STMicroelectronics (LE, FR)
DIH: CEA-Leti (RTO, FR)

ROBOTS MAKE AGRICULTURE ECO-FRIENDLY

Problem and solution

Agricultural robots have emerged as innovative and eco-friendly means for easier farming. In particular, autonomous weeding allows farmers to efficiently maintain their crops without using herbicides or chemical weed control products. Electrically-driven robots require less energy than a tractor. They are also lighter than a tractor and thus avoid compacting the soil, even when used frequently.
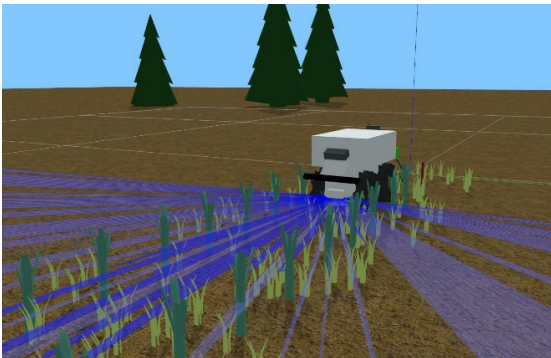
Naïo Technologies is a pioneering SME in this domain. Their first product was Oz, a weeding robot for small crops of vegetables. The company is now targeting the market of large-scale vegetable crops and vineyards, and has started the development of bigger and faster robots. However, the deployment of such robots introduces new potential risks to the users and their farm. Since the safety regulations and standards are not yet established for autonomous robots in agriculture, SMEs like Naïo need to adopt a proactive approach in the acquisition of dependability-related technologies.

In order to implement a successful solution Naïo needed skills concerning safety analysis and validation technologies. More precisely, Naïo increased its ability in performing structured and systematic analysis of operational risks, formal assessment of architectures and simulation-based testing.

The role of the DIH

In this CPSE Labs experiment, the DIH provided Naïo with access to leading edge safety methods such as HAZOP-UML for the analysis of the operational risks induced by the robots and Altarica for the assessment of candidate robot architectures. It also helped Naïo to establish simulation-based testing as an essential part of their validation process, based on recent research results on testing robots in virtual worlds. The DIH facilitated the collaboration of its members with Naïo by not only providing academic tutorials but also by focusing on practical problems and bridging the gap from robot prototypes to mature products.

Impact

An immediate impact of the experiment was a one-third reduction in validation costs, for the functionalities that can be tested with the developed simulator. Naïo now uses this simulator for two robots out of the four they have in development. In the longer-term, the transfer of safety-related technologies has put Naïo into a better position to get into the market of large-scale crop maintenance. Meeting legal requirements, in particular as regards safety, is a prerequisite for selling their robots at the European and international levels.

RAST was part of Naïo's continuous effort to reach the business objective of doubling their turnover each year. They expect to go from €1.2 million this year and 40 robots sold, to more than €10 million of turnover and 300 robots in 2020. This ambitious objective is in line with the huge potential for development in agricultural robotics. Tractica, a US research organisation, forecasts that the agricultural robot market will increase exponentially from $3 billion in 2015 to $16 billion in 2020 and then $73 billion in 2024.

End-user: Naïo Technologies (SME, FR)
Technology provider: LAAS-CNRS (RTO, FR), ONERA (RTO, FR)
DIH: LAAS-CNRS (RTO, FR), ONERA (RTO, FR)
(design centre for dependability of autonomous vehicles)

HELPING SMALL FARMERS TO BENEFIT FROM VARIABLE-RATE FERTILIZING TECHNOLOGY

Problem and solution

With the world population predicted to increase to 9 billion, food production will also need to increase by up to 70 %. Currently, to obtain high yields, farmers often overuse fertiliser which causes severe problems in the health of rivers with the overgrowth of algae.

By reducing the volume of fertiliser used, both the farmer and the environment can benefit. In a DIATOMIC application experiment, two SMEs and one RTO collaborated to develop the AgriNav software for application of variable quantities of fertiliser to a crop according to the specific need. The team carried out a market research to understand customer requirements and liaised with local farmers. The developed guidance system combines the global navigation satellite system (GNSS), laser-following, and image processing to obtain similar accuracy than real-time kinematic positioning (RTK) systems. By using 3 sensors, the guidance system has better accuracy compared to a standard GNSS. Finally, a route to market was tested and the viable market was fruit farms. Using software from Vultus and the AgriNav guidance, all-terrain vehicles with fertiliser spreaders are enabled to move precisely along each crop row.

The role of the DIH

In this DIATOMIC application experiment, the Innovation Action itself was considered as DIH and supported the AgriNav project with training and coaching. Adept Communications Systems lead the project with its background in GPS/GNSS products. The Agricultural University of Athens carried out research and development in the agricultural disciplines and Vultus brought in its expertise on nitrogen distribution models for the optimal distribution of nitrogen fertilisers.

Impact

Variable-rate fertiliser spreading has the potential to improve the efficiency of small farms in developing countries. The feedback given by many farmers is that large tractors and machinery are unaffordable and small fertiliser spreaders do not have variable rate capabilities. The types of farms that benefit from variable rate fertiliser spreading grow vegetables and fruits. In a research carried out by the Agricultural University of Athens, lettuces were found to be adversely affected by too much fertiliser and therefore benefit from the variable-rate fertilization. The initial version of the product will be sold directly, while it is anticipated that in the future, the product will be sold through integrators.

A POWERFUL LTE TURBO – CODE DECODER – ENABLING COMPONENT FOR NEXT GENERATION MOBILE TECHNOLOGY

Problem and solution

Mobile Communication is one of the key technologies of modern information societies. Increased mobile communication and services require an ever increasing data throughput. Therefore, the next generation of wireless systems needs to provide for higher data rates greater than 16 Gbps, shorter delays (latencies), and even greater capacity. To meet the challenges of such future high throughput wireless systems an LTE Turbo-Code Decoder (Forward Error Correction – FEC) is required that has the capabilities to deliver these very high data rates being compliant with the mobile broadband standard specifications.

Hierarchical View of the LTE-IP

To make their existing solution future proof CREONIC teamed up with the University of Kaiserslautern in order to develop a cutting-edge LTE Turbo-Code Decoder solution within a technology transfer experiment of the TETRACOM project. The major technical advantages of the achieved new LTE Decoder solution are the small chip size, which leads to less energy consumption and an extended battery life. The higher throughput (> 1 Gbit/s) enables mobile internet connection with a seamless user experience due to short response times and fast downloads. The architecture is highly scalable to fit perfect to the target application (e.g. base station or mobile device). The near ideal communications performance allows for a reliable communications even at places with poor network coverage. This decoder (see the figure above) is a near to marketable solution and will become a future product of CREONIC.

The role of the DIH:

The Microelectronic Systems Research Group at the University of Kaiserslautern transferred more than 250 person-years of experience and knowledge in designing and verifying high throughput channel decoders to CREONIC. This upskilled the engineering capacities of CREONIC significantly facilitating them to offer highly competitive solutions on the market.

Impact

The LTE solution is one major step to enhance CREONIC's product portfolio towards a complete set of solutions for forward error correction cores. This provides CREONIC with the significant competitive advantage to serve its existing and new customers with highly sophisticated solutions. It is expected that CREONIC will increase its number of employees by 50 % and its revenues by 20 % until 2020 thanks to this TTP.

End-user: Adept Communications Systems (SME, UK)
Technology provider: Agricultural University of Athens (RTO, GR), Vultus (SME, SE)
DIH: –

End-user: Creonic (SME, DE)
Technology provider: University of Kaiserslautern (DE)
DIH: University of Kaiserslautern (DE)
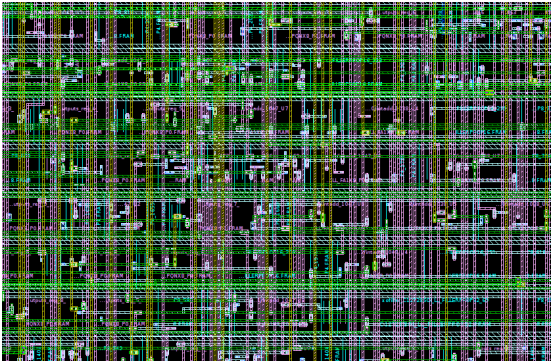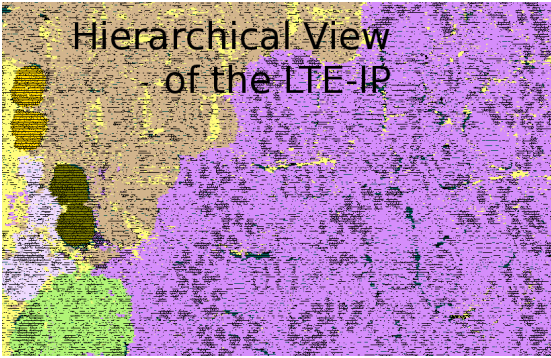
CALLING MOUNTAIN RESCUE WITH NO NETWORK

Problem and solution

There is a strong evolution of the ski practice towards freeride or ski mountaineering with an increased number of skiers at risk. Every year, the number of interventions by mountain rescue teams augments where victims cannot be located because of bad weather conditions or lack of GSM network availability or exhausted GSM batteries.

The SECURELOC solution of LETI is using PMR radio frequencies (Walkie Talkie) in a point to point link enabling to send GPS coordinates over a distance of 10 km without the need of a network. Furthermore, the solution provides for a Bluetooth connection to the user smartphone where a network is available, transmitting a distress message including the position.

In the frame of the Gateone project, LETI's solution was integrated with Alpride's airbag system that maintains the skier on top of the snow slide. Whenever the airbag is inflated, GPS coordinates are sent both on the GSM network whenever it is available and also on PMR frequencies for a longer reach and extended operation time under harsh conditions (e.g. a person hit by an avalanche).

The role of the DIH

Following customer requests, Alpride had the need to integrate positioning into their existing airbag solution. However, the company did not have the required know-how to initiate such a product development. The DIH CEA-LETI provided Alpride with their SECURELOC solution and guided Alpride in the integration process. This important technology transfer puts Alpride into a highly competitive position.

Impact

Alpride's new airbag solution has been showcased to rescue teams and existing Alpride customers and received a lot of interest. The new airbag product will help the SME to strengthen its position in its respective market as a security supplier for mountain practice.

End-user: Alpride (SME, CH)
Technology provider: CEA-Leti (RTO, FR)
Business support: Blumorpho (SME, FR)
DIH: CEA-Leti (RTO, FR)

DEVELOPING EFFICIENT SOFTWARE AND HARDWARE FOR ARTIFICIAL INTELLIGENCE VIA COLLABORATIVE OPTIMISATION

Problem and solution

Developing competitive products based on Artificial Intelligence (AI) requires years of intensive R&D to come up with an efficient software and hardware solution given an overwhelming number of combinations of algorithms, models, features, data sets, frameworks, libraries and platforms. The main risk is to make wrong choices which can lead to a slower, less accurate and expensive solution than from a competitor and potentially waste the whole investment. To give a concrete example: autonomous driving requires robustly detecting cars, pedestrians and other objects under a variety of conditions. State-of-the-art algorithms for object detection, however, either process accurate images too slowly (1 image 4 seconds) or do not meet functional safety requirements, for example, fail to recognise pedestrians in low-light conditions. Nevertheless, they require running on compute platforms that consume hundreds Watts of power and cost thousands of euros. While this is acceptable for proof-of-concepts, it is prohibitively expensive for mass production. Collaborative optimisation can bring automotive platforms that consume perhaps under ten Watts of power and cost perhaps under a hundred euros, while meeting recognised safety standards.

In a TETRACOM experiment, the non-profit cTuning foundation has developed a collaborative optimisation framework called Collective Knowledge (CK) to collaboratively optimise software and hardware for emerging workloads. CK enables industry and academia to share reusable and customisable AI artefacts and workflows with a common application programming interface (API) while facilitating technology transfer. Continuously aggregating collaborative optimisation results obtained on systems ranging from Internet of Things (IoT) devices to supercomputers helps automatically predict most efficient solutions, and therefore dramatically accelerate R&D, save millions of Euros, minimise risks and reduce time to market for new AI products. Automatic and collaborative CK-based software optimisation has already enabled several components of deep neural networks (essential part of AI) to run 10-30x faster on ARM-based hardware while reducing time to market by 5-10 times.

The role of the DIH

The cTuning foundation served as a DIH to transfer the CK technology to ARM, the world-leading supplier of microprocessor technology with over 100 billion ARM-based chips deployed since 1991. Adopting CK-based workflows provided the critical know-how and skills to extrapolate experimental results using predictive analytics and enabled ARM to optimise their software and hardware for AI workloads in only a fraction of the time required by conventional optimisation. Furthermore, the DIH facilitated the foundation of a start-up company that commercially exploits the developed solution.

Impact

The knowledge, experience and open source technology acquired from this experiment helped establishing a start-up called dividiti in 2015. Within 2 years, dividiti became a leading provider of AI optimisation services for ARM and several Fortune 50 companies including General Motors, and grew from the 2 co-founders to 7 staff with over €1 million in revenue.

End-user: ARM (LE, UK), dividiti (SME/start-up, UK)
Technology provider: cTuning foundation (RTO, FR)
DIH: cTuning foundation (RTO, FR)

24

25

ENABLING EFFICIENT CPS TOOLCHAIN INTEGRATION

Problem and solution
The development of cyber-physical systems (CPS) includes multiple experts from different disciplines and is characterised by fragmented descriptions components to be considered. These fragments are stored in and managed through a multitude of tools and databases. Since the corresponding items are interrelated, it is important to be able to relate them, to keep them consistent and to efficiently be able understand how a change in one item impacts other. There is an immense need for European CPS industry to be efficient in product development to maintain a competitive advantage on a global market. Especially speed in product development is of great importance, as the market windows are getting smaller and smaller. Before, it was acceptable with release cycles of typically 6 to 18 months to introduce new features in industries such as telecom and automotive, but now it can be a matter of weeks. This challenge can be addressed by better use of information throughout the product development lifecycle. Reducing manual efforts for duplicating and reproducing data and making more information available for decision makers decreases development time and effort. A key success factor is to manage data and tool integration among the wide range of engineering tools used in the CPS domain. The Digital Innovation Hub KTH (Sweden) has addressed this opportunity in a CPSE Labs experiment with an aim to lower the threshold of integrating and managing data among software tools, thereby improving end-user processes. This is accomplished by providing support tools – for creating tailored "toolchains" and integrations of data for the engineering of CPS. The approach targets data integration based on open standards (such as OASIS OSLC) and open source software.

The specific objective for FindOut Technologies in this experiment was to further develop and exploit the increased use of OSLC in the CPS industry, focusing on demonstrating how visualisation of OSLC resources can support better understanding and better decision-making during the development of complex CPS products. The main outcome of the experiment is a software application called LDVis, Linked Data Visualiser, now contributed to open source. Through the experiment, the application has shown to be a powerful component for visualisation of OSLC/LinkedData resources and hence a means for improved CPS product development.

The role of the DIH
The DIH skills in OSLC and Linked-data have been crucial for the project; skills and technology insight were transferred during the experiment to FindOut. The combination of skills by the DIH and the skills of FindOut provided for a synergetic collaboration and the technological means for success. The DIH played an important role of providing not only technical expertise but also contacts with other industrial players, in particular exposure to CPS industry and domain particulars. For the visualisation demo case, the data was obtained from a research project between the CPSE Labs partners KTH and OFFIS. As an SME with limited resources and networks, FindOut would not have been able to establish this kind of partnership and project relations without a programme such as the SAE initiative.

Impact
With LDVis FindOut Technologies has obtained a unique selling point by improving on their already existing knowledge in this field. It is estimated that the commercial outcome of the experiment will lead to an increase of revenue in the order of one million Euro over a five-year period of time. FindOut Technologies is an SME with approx. 30 employees and an ambition to grow to 50 employees until year 2020. A significant part of that growth will be related to the increased revenues in the field of toolchain integration services and visualisation solutions. Already because of this experiment, a commercial relation with the automotive company Scania has emerged within this field.

End-user: FindOut Technologies (SME, SE)
Technology provider: KTH (RTO, SE)
DIH: KTH (RTO, SE)

SILICON CAPACITORS FOR NON-VOLATILE MEMORIES

Problem and solution
ANVO-Systems is providing their clients with solutions to protect the data generated by their exploitation systems even in case of power shutdown. To do so, they are associating an external capacitor with their proprietary non-volatile SRAM. However, the semiconductor company had the ambition to deliver a stand-alone solution that would integrate the energy storage in the package. This co-packaging approach can only be made possible if a very high-density capacitor is available. This new version would also permit a full compliance of the pinout with the market standards. The problem is that there is no capacitor commercially available that can be small enough and store the required amount of energy.

Non-volatile SRAM co-packed with ultrathin high density silicon caps as System in Package (SiP)

Fraunhofer IPMS has developed a design and process that combines high-K material deposition and a 3D configuration that permits to achieve record capacitance values. The challenge was to demonstrate the expected energy density storage capability which meant to break a record in capacitance density.

Main contributions to the solution are:
- Semiconductor capacitors
- Atomic layer deposition
- Conformal deposition of high-K material on 3D structure
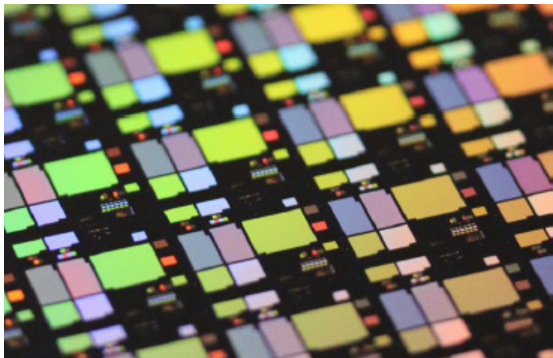- 300 mm semiconductor processing

The role of the DIH
Thanks to the Gateone project, they were able to beat this record by shifting from a 2D to a 3D technology using atomic layer deposition of high-K material on structured substrates. With their silicon capacitor, they increase their memory capacity from 100 nF/mm^2 to 500 nF/mm^2. Their new technology is now available in 300 mm which makes the solution immediately available in an industrial standard. This approach is the only acceptable format to produce at the expected cost.

Impact
By meeting this technical and economical challenge a new product can hit the market in a short timeframe. This new approach will open new market opportunities for ANVO-Systems for an accessible market estimated to at least one million Euros. The company and the research organisation are now planning the production phase of this concept.

End-user: ANVO-Systems (SME, DE)
Technology provider: Fraunhofer IPMS (RTO, DE)
Business support: Blumorpho (SME, FR)
DIH: Fraunhofer IPMS (RTO, DE)

MAPPING URBAN AIR QUALITY IN HIGH RESOLUTION

Problem and solution

Air pollution in cities is an EU and global challenge that most developed and developing countries are facing. According to the World Health Organisation (WHO), ambient air pollution kills over 4 million people every year, largely in cities. It is an invisible killer and the problem is increasing due to the unprecedented population growth in cities.

bettair® offered by the SME Bettair Cities is a Platform as a Service (PaaS) that permits, for the first time, to map air and noise pollution in cities on a previously unimaginable scale based on the large deployment of outstandingly accurate gas sensors by using an advanced post-processing algorithm. The information provided by the bettair® platform allows cities to implement appropriate urban plans to enhance the air quality and to make smart and better decisions to mitigate air pollution. A complete front and back-end solution is provided to municipalities and an app for citizens. The microcontroller-based bettair® nodes are equipped with up to 6 electrochemical sensors to measure gases, an optical particle counter to measure PMs, a noise pollution sensor, and other ambient quality indicators.

To reduce power consumption of the nodes and to enable new features such as a long range wide area network (LoRaWAN) module, in a FED4SAE application experiment the existing microcontroller solution has been migrated to a new platform with a processor of the STM32 family and tested in real-world scenarios.

The role of the DIH:

In this FED4SAE application experiment, the DIHs University of Cantabria and Digital Catapult supported Bettair Cities and teamed up with other relevant partners. Blumorpho provided innovation management and STMicroelectronics supported the integration of the new processor. Digital Catapult and the University of Cantabria enabled testing in their testbeds in London and Santander, respectively.

Impact

The results enabled Bettair Cities to improve their environmental monitoring solution enabling any city worldwide to monitor pollutants and other environmental parameters with high accuracy. Thanks to these results, Bettair Cities could secure further funding and aims at increasing its presence in new cities worldwide during the forthcoming years, supporting them to improve their citizens' quality of life. Among other awards, Bettair Cities has been awarded with the ship2be label as a company with social and environmental impact.

End-user: Bettair Cities (SME, ES)
Technology provider: University of Cantabria (ES), Digital Catapult (RTO, UK), STMicroelectronics (LE, FR)
Business support: Blumorpho (SME, FR)
DIH: University of Cantabria (ES), Digital Catapult (RTO, UK)

ENVIRONMENTAL SUPERVISION UNIT

Problem and solution

When electronic equipment is used in harsh environments with long expected lifetime, there is a need to understand that environment in detail. This situation is today a reality for many application areas including the automotive sector, heavy industry, defence sector and more. To fully understand the working environment, a unit has been developed to monitor physical data to be used as input in the product development phase.

Within the SMARTER-SI consortium, a unique condensation sensor developed by CiS is available that can detect if condensation occurs. A combination of this sensor and commercially available sensors for other parameters was combined in a prototype environmental supervision unit (ESU) developed by the SMEs SETEK Elektronik and Niranova in Sweden. In the design work of the ESU a number of industries in Sweden were involved giving an insight into the varying demands for sensor configurations for different industrial sectors. The ESU is a modular design that rapidly can be adopted to different measurement situations.

The contributions required for the solution have been:
- A physical understanding on the requirements for electronic units in harsh environments and related tests (provided by Swerea IVF)
- A unique sensor for the detection of condensation (provided by CiS) and identification of the substances that condensate (provided by Hahn-Schickard).
- A packaging concept (provided by CSEM)

The role of the DIH

SMARTER-SI, conformed by different RTOs acting as DIHs, allows, through their cooperation, to provide a solution to this problem. The four DIHs involved are Swerea IVF, CiS, CSEM and Hahn-Schickard. The smart system designed to solve this application problem consists of a condensation sensor and the integration of this together with various commercial sensors that withstand harsh environments.

Impact

SETEK Elektronik and Niranova can provide a multi sensor module for the industries that have a high demand on reliable electronics in harsh environments. Currently, there are three industrial sectors being approached by the SME that show an interest in the ESU. Since electronics are used more and more in harsh environment today the potential market for this unit is steadily growing. Expected yearly sales are in the range a few hundred the first year. Revenues will be in the range of €50,000 the first year and increasing the following years as a result of acceptance by the industry of the concept of "physics of failure".

End-user: SETEK Elektronik (SME, SE), Niranova (SME, SE)
Technology provider: Swerea IVF (RTO, SE), CiS (RTO, DE), Hahn-Schickard (RTO, DE), CSEM (RTO, CH)
DIH: Swerea IVF (RTO, SE)
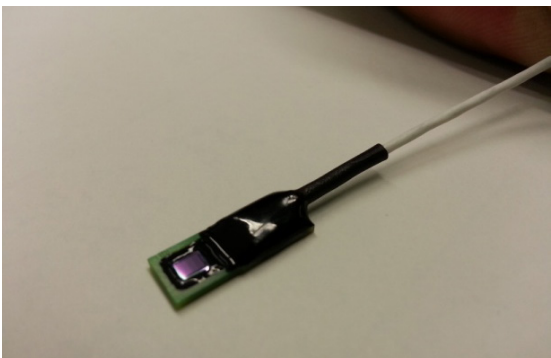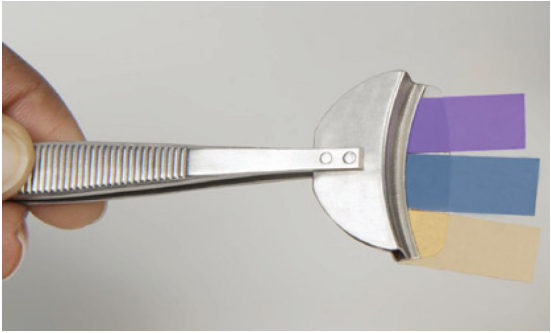
HEALTHY CLIMATE BY AN INNOVATIVE SENSOR SYSTEM

Problem and solution

As a natural part of the air, carbon dioxide (CO_2) is also the most important indicator of indoor air quality. A human, who is working in an office, exhales about 20 litres per hour of that odourless and tasteless gas. High CO_2 concentrations affect the performances of humans and can lead to fatigue and headaches. So, smart gas sensors provide the necessary data for a demand-based and energy-saving ventilation and air-conditioning in industrial and public buildings. But in this sector the business models of smaller companies are increasingly being restricted or endangered by dwindling component suppliers, which suddenly act as competitor. That is why SMEs have to look for new customers by use of competitive high-performance technologies and that means adapting supply chain management. Here, we introduce a novel sensor principle using an encapsulated sensitive dye that changes the colour upon CO_2 exposure, which can be reliably detected by a unique optical-electrical sensor:

- Sensor system based on highly-sensitive optical-electrical transducer
- Signal pre-processing module (provided by CiS)
- CO2 sensitive sol-gel film nanotechnologies (provided by CSEM)
- Hermetic casing (provided by IL Metronic)
- Signal processing, calibration and device (provided by ConSens)

The role of the DIH

In this Smarter-SI experiment the RTOs CiS and CSEM invested their specific knowledge on advanced micro- and nanotechnologies and their verified research results and components. Thereby assuming their role as DIHs, they helped the system manufacturing SME ConSens to develop an innovative solution for the building automation market.

Impact

There is an increasing demand on the market for CO_2 sensors and for other gases like ammonia, chlorine or nitrogen oxides in air. For ConSens the turnover with CO_2 sensors is most important. Required stability and cost of the novel sensor system presupposed, 5,000 pieces per year are targeted with a grown revenue up to €500,000 per year. According to the recent changes in the competition situation worldwide, the SME has included in this forecast evaluation kits for other gases as well as customer specific solutions. Here the activities of DIH partners CSEM and CiS will come into action and play an important role in further development. The cooperation with the DIH will be steadily expanded using the diversity potential of building blocks for new markets and customers.

End-user: ConSens GmbH (SME, DE) as system manufacturer for the building automation market
Technology provider: CiS (RTO, DE), CSEM (RTO, CH), IL Metronic Sensortechnik GmbH (SME, DE)
DIH: CiS (RTO, DE)

SAVVY ECG BODY SENSOR FOR DETECTION OF CARDIAC ARRHYTHMIAS

Problem and solution

The main causes of death among the elderly population are cardiovascular disease and cancer. For example, the atrial fibrillation (AF) is a cardiac arrhythmia that affects more than 4 million people in the European Union and about 100 million worldwide. The AF is associated with more frequent hospitalisations because of stroke, transient ischemias, and heart failure. Long-term electrocardiographic (ECG) recordings are recommended from the European Society of Cardiology and European Heart Rhythm Association for detection and maintenance of AF and other threatening arrhythmias. Screening for the early detection and appropriate management of diseases could dramatically improve health outcomes and reduce the cost of medical treatment. Existing long-term ECG recording technology is costly, cumbersome in management and bulky therefore hindering the movement of the patient, e.g. in doing sports. Furthermore, it is mostly applied for 24 hours only.

In a TETRACOM experiment, the Jožef Stefan Institute (JSI) and medical centre SIMED d.o.o developed a medical graded ECG wireless body sensor with a low power Bluetooth connection to a smartphone, and corresponding software for interpretation of measurements. The system is suitable for long-term monitoring of the heart activity, from a few hours up to a whole year or even longer. Because of its simple use and acceptable price, the system can be used as a personal medical device or in a mobile health system. The system can support solutions to every-day problems of the medical personal in hospitals, health clinics, homes for the elderly and health resorts.

The role of the DIH

The CE certification of the innovation as a medical device was recognised as a crucial requirement for further industrialisation and mass production. The DIH Jožef Stefan Institute supported the activities for CE certification, and consequently, the successful know-how transfer from research to industry. The activities included preparation of technical maps and other documentation for medical device certification. SIMED d.o.o. established the spin-off company Saving d.o.o exclusively for the purpose to take up the developed technology and organise the production and marketing of the Savvy ECG sensor recognised as CE marked Class IIa professional device serving as Event Recorder or Long Term ECG Monitor.

Impact

End of January 2017, Saving d.o.o has completed all necessary registrations for selling the solution in the EU, which started in February 2017. The Savvy ECG sensor has already been successfully implemented in the public and private health care sector such as cardio centres and hospitals. In 2018, the company expects 5,000 customers growing to 50,000 until 2020. The company estimates revenues of €200,000 still in 2017 that should grow to €1.75 million by 2020.

The societal impact of the developed solution is enormous. The low cost of the Savvy ECG sensor allows for more monitoring ultimately saving lives without increasing health care cost. The patient enjoys more flexibility whilst being monitored also being informed in real time about his heart activity.

End-user: Saving d.o.o. (SME, SI)
Technology provider: SIMED d.o.o (SME, SI)
DIH: Jožef Stefan Institute (RTO, SI)

SMART SENSOR KIT FOR MONITORING OF SCOLIOSIS TREATMENT BRACES

Problem and solution

Each year about 2 % of European teenagers must be treated with braces (spinal orthosis) to counteract the evolution of scoliotic curve by applying a mechanical stress against the body and favouring the correct posture of rachis. Despite the need of recording the exerted pressure expressed by orthopaedic specialists, there is currently no device available, in the market, able to quantitatively measure acting forces inside the braces and to monitor the wearing time. Market analysis outlines big potential in the scoliosis management market, stressing increasing year to year demand still not satisfied by products on the market.

The SME Protolab aimed to develop an innovative plug & play wearable sensor kit for monitoring the pressure inside scoliosis braces. Specific targets included improved compliance with medical prescriptions and boosting the active patient participation to reach satisfying results from the care treatment.
The FED4SAE application experiment leveraged collaboration with CEA, IRT Nanoelec, STM, and Blumorpho to develop a prototype system based on a novel STM32WB microcontroller that integrates all the hardware means to support Bluetooth™ 5.0 and IEEE 802.15.4 wireless standards such as ZigBee 3.0 and Openthread. The STM32WB is used to collect data from sensors, to process and transfer them via BLE to a dedicated smartphone app for representation and further analysis.

The role of the DIH

CEA and IRT Nanoelec served as DIHs in this application experiment. Blumorpho helped to identify strategy and regulatory requirements to secure the go-to-market strategy as well as to find investors. STMicroelectronics supported the integration of their STM32 microcontroller. Data communication tests under realistic conditions were performed in collaboration with the Products & Technologies Living-Lab (PTL) of IRT Nanoelec at CEA in Grenoble. The cybersecurity and privacy risk analysis and the evaluation of regulatory constraints related to patient's data management were assessed with the support of CEA.

Impact

The overall EU market is estimated at 100,000 braces per year, e.g. more than €60 million/year. Protolab could launch product qualification and certifications in July 2020 and entered the market in 2021 (customer acquisition). In addition, they could start the process to obtain support from the Italian Health System to refund IoT braces and attracted the interest of Business Angels during the INPHO venture Event in 2020. For the innovative digital and sensors approach, Protolab was awarded the 1st prize in the Smart Anything Everywhere contest.

End-user:	Protolab (SME, IT)
Technology provider:	CEA (RTO, FR), IRT Nanoelec (RTO, FR), STMicroelectronics (LE, IT)
Business support:	Blumorpho (SME, FR)
DIH:	CEA (RTO, FR)

SECURE MONITORING OF MEDICAL SAMPLES THROUGHOUT THE LAB

Problem and solution

High-throughput medical-diagnostics laboratories and bio-banks face an ever-growing number of biomedical samples to be processed and stored locally. This requires reliable and secure identification of test tubes in the entire laboratory ecosystem. In just one large-scale lab, this could involve tens of thousands of sample test tubes. These facilities are under constant pressure to monitor samples during processing, transportation and storage of tubes and to shorten the time it takes to provide patient results.

The innovative solution called SmartLAB responds to all these challenges. With Intel's embedded Edison platform, the system uses RFID-tagged test tubes and sample holders. The touchless and highly flexible radio-frequency-identification technology ensures reliable and secure monitoring of test tubes. It enables tracking sample movement with continuous quality assurance seamlessly integrated in the laboratory ecosystem, therefore reducing risk of sample loss or misprocessing, while providing patient results more efficiently.

The role of the DIH

In this experiment of the EuroCPS project, BME took the role of the DIH enabling an SME of their eco-system to take advantage of newest digital technology. They integrated their leading-edge knowledge about cyber-physical systems (CPS) into the platforms of technology providers INTEL and STM such that the SME Neumann Diagnostics was provided with the solution and guidance to add important features to their existing tests for cancer prevention and related laboratory products.

Impact

Neumann expects SmartLAB to boost its revenue by up to €2 million over the next five years. It is positioned to enable highly automated workflows extended with quality-controlled, sample-handling solutions for high-throughput labs, especially in the field of infectious diseases like STDs and HPV screening, which involve millions of patients in the EU.
The reagent market for HPV screening in Europe is forecasted to reach €500 million within 10 years. In addition, SmartLAB as an additional service may increase the value of the laboratory systems the company offers.

End-user:	Neumann Diagnostics Ltd. (SME, HU)
Technology provider:	Intel (LE, IE), STMicroelectronics (LE)
DIH:	BME (University, HU)
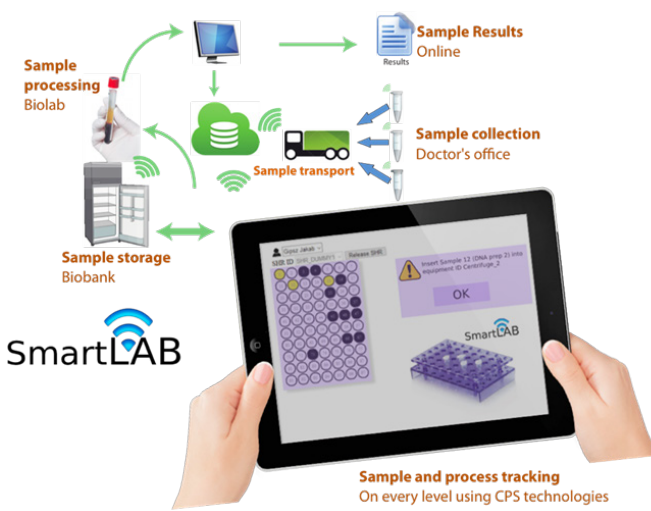
HAND HYGIENE GUIDANCE AND MEASUREMENT SYSTEM OVER THE SINK

Problem and solution

According to the European Centre for Disease Control (ECDC), almost 9 million infections occur each year in European hospitals. In fact, 7 % of all hospital patients in developed countries acquire infections. The World Health Organisation (WHO) estimates that 50 % of infections could be prevented by better hand hygiene. In response to this challenge, the WHO has developed a seven-step handwashing protocol that mitigates the risk of bacteria remaining on washed hands.

SureWash, part of GLANTA, developed an over-the-sink handwashing monitoring system (SureWash-OTS™) that improves hand hygiene in healthcare. The system provides real-time feedback to hospital and nursing staff on whether they are washing their hands according to the WHO handwashing protocol. In addition, multiple of the units deployed across hospitals can report real-time data on hand hygiene enabling the management to visualise utilization, track compliance, compare sites and prevent the outbreak of infections. This increases staff compliance thereby reducing infections, avoiding the need for antibiotics, improving patient experience and shortening the hospital stay. Overall, this results in saved lives and significantly reduced costs.

In a FED4SAE application experiment, SureWash collaborated with other partners to develop, deploy, and validate a number of prototypes of the SureWash-OTS™. The solution leverages Intel's MyriadX™ technology which accelerates the execution of convolutional neural networks used in Artificial Intelligence based computer vision along with the Intel Realsense™ depth sensing camera.

The role of the DIH

In this application experiment, CEA and IRT Nanoelec served as DIHs and involved other partners. Together with Blumorpho, the CEA Open Innovation team provided required support in business modelling, market insights, and design to cost. Intel Movidius engineers provided assistance on their technologies and CEA's IRT-Nanoelec testbed facility performed functional testing including privacy and cybersecurity compliance assessment, usability analysis, and user acceptance of potential customers.

Impact

CEA connected SureWash to Korian Nursing Homes (France) and valuable feedback on the prototypes was provided. In addition, a UK National Health Service (NHS) clinical trial demonstrated that hand hygiene quality increased by 197 % and hand washing increased by 147 %. SureWash is now seeking a partner to commercialise this product on a large scale. To accelerate its path to market, Intel has introduced SureWash to a number of potential partners.

End-user:	SureWash (SME, Ireland)
Technology provider:	CEA (RTO, FR), IRT Nanoelec (RTO, FR), Intel (LE, IE)
Business support:	Blumorpho (SME, FR)
DIH:	CEA (RTO, FR)

PHYSICAL AND OCCUPATIONAL REHABILITATION AT HOME

Problem and solution

One of the major challenges in the healthcare field is the shifting of quantitative assessment and therapy delivery from clinical settings to home. This concept is particularly important for upper limbs physical rehabilitation, a condition with a high impact both on patients' quality of life and on healthcare costs. Indeed, physical and occupational rehabilitation require constant practice to regain the functionalities needed to perform the activities of daily living and could benefit from home-based care. New easy-to-use and evidence-based solutions are needed to promote self management of care and boost the introduction of home-based physical rehabilitation in clinical practice.
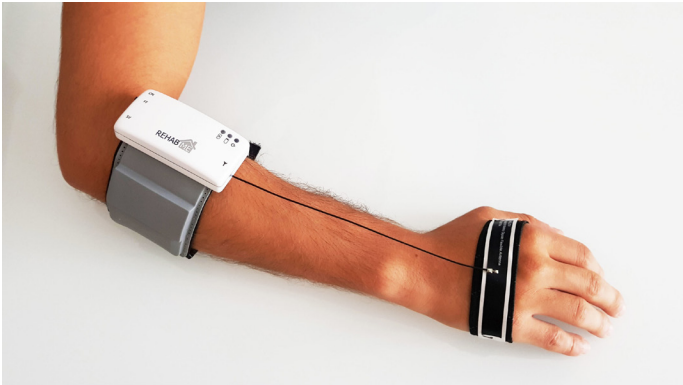
RehabMe is a platform based on RF technology for the provision of physical and occupational rehabilitation at home developed by the high-tech SME Ab.Acus. An application experiment of SmartEEs helped to improve the wearability of the device worn on the patient's forearm and hand, to track the interactions with everyday objects, to measure performance, and to guide the execution of the exercises. The solution is characterised by a light setup and easiness of use. Moreover, the use of everyday objects promotes the performance of functional tasks according to occupational therapy rehabilitation paradigm, for the patients to regain upper limbs functionalities.

The role of the DIH

Eurecat took the role as DIH and helped Ab.Acus in improving the RehabMe device. Additionally, Blumorpho provided innovation management and supported on business modelling as well as market insights.

Impact

RehabMe addresses the market of occupational therapy for the rehabilitation of post-stroke patients. The number of patients has been constantly growing in the last decade, together with the associated care costs, especially in the northern EU countries, as well as the number of professional occupational therapists. The application experiment helped in the targeting and sizing of the reference market and in the identification of possible distributors of the RehabMe solution that are already present on the market with complementary solutions.

End-user:	Ab.Acus (SME, IT)
Technology provider:	Eurecat (RTO, ES)
Business support:	Blumorpho (SME, FR)
DIH:	Eurecat (RTO, ES)
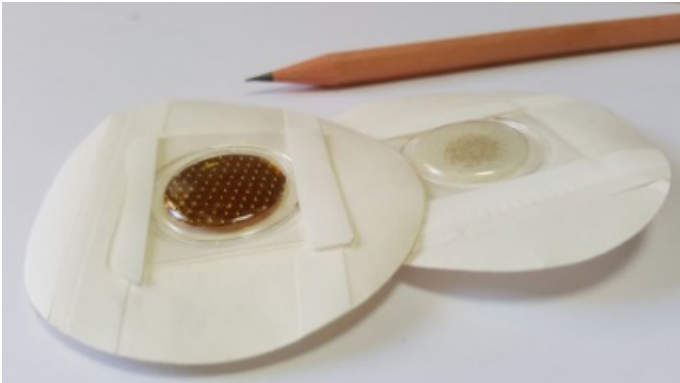
SKIN INTERFACE FOR A WEARABLE MEDICAL DEVICE

Problem and solution

When patients are admitted to hospital, it is of utmost importance to monitor their vital signs with accuracy. The current solutions require multiple systems and it is not possible to monitor all hospitalised patients. Currently, 10 % of patients in the UK are harmed during their hospital visit and this represents an extra cost to cover the additional length of stay.

Sensium Healthcare develops and sells a low cost wearable patch to monitor the vital signs which will enable early detection of sepsis, cardiac arrest and respiratory depression. However, reliable data requires a good interface between the body and the monitoring system, and therefore careful skin preparation is the key to acquiring quality data. Despite this, in many situations such as emergency admissions, the skin preparation guidelines are not adequately followed because it is time consuming and adds a burden to the clinical flow. Moreover, the silicone gel becomes progressively hard over time and the reliability of the electrode-skin interface deteriorates during long term monitoring.

The Tyndall National Institute in Cork has developed a strong knowledge in the manufacturing of microneedles which has progressively evolved towards a proprietary process using a biocompatible polymer and metal coating. Those patches are painlessly applied without skin preparation and have already proven their potential to deliver accurate electrocardiography (ECG) measurements. The combination of Tyndall's technology with Sensium's wearable patch was a perfect match between a problem and a potential solution.

The role of the DIH

At this stage of the respective technologies of both partners, it was important to move to a clinical proof of concept demonstrator. It was necessary to test these patches on real patients to record data under controlled conditions. The Gateone project was the perfect Open Innovation tool for this cross border experiment. The European funding was used by Tyndall to pass the ethical clearances and deliver the probes in sufficient quantity and quality. Sensium invested resources and money to tailor their patch to accommodate the use of microneedles and recruited 12 patients on whom to perform the tests.

Impact

The probes proved to work remarkably well and delivered very good ECG recordings without skin preparation. A future partnership will help to move to the production level of the patches and the production ecosystem is already known. Both parties are currently discussing the future steps required to reach the market at the end of 2018.

SELF LEARNING TANK MONITORING SYSTEM

Problem and solution

Inferior digitisation of industrial mobile and stationary tank systems is a pressing global problem to today's globalised world. Over 50 % of Diesel fuel is supplied via mobile and non-commercial industrial tank systems which in their vast majority do not offer any monitoring infrastructure. Key reasons are the very heterogeneous tank constructions whose components are provided by numerous suppliers and sensor technologies as key elements that are designed for very specific use cases concerning tank form, size, or material. Consequently, expensive and inaccurate sensor hardware must be adapted to each tank type leading to a high degree of manual customisation, high production costs for sensor hardware, complex installation, individual calibration of each tank, and low production volumes.

To address this, a self-learning tank monitoring system (SANTO) was developed in a TETRAMAX application experiment with the SME Cipacto. SANTO provides sensor data for a self-calibration algorithm, which determines autonomously tank size and shape. Advantages are a low-power consuming micro controller, connection via Bluetooth Low Energy (BLE) to a smartphone app, user authentication and authorisation as well as solar cells and a battery buffer for self-sufficient sensor system energy.

The role of the DIH

In the TETRAMAX application experiment, the Universidad Autónoma de Madrid served as DIH and collaborated with KAPITEL D to support the SME Cipacto in developing an innovative, energy-saving sensor technology in combination with modern web technologies for commercial use. The Universidad Autónoma de Madrid provided know-how on sensor hardware, embedded engineering as well as self-learning algorithms. KAPITEL D, a specialist in digital transformation, defined and set-up an electro-mechanical interface between the sensor solution and industrial tanks.

Impact

The impacts of SANTO are digitally transferred and interpreted data, automated optimised tank and periphery configuration, and predictive tank re-filling. This enabled the first integrated end-to-end digital solution to monitor and manage critical industrial liquids.

Upgrade tanks — Intelligent sensors

Control access & usage — Internet & smartphone

Visualise the value — Process data in real time into intelligence

End-user: Sensium (SME, UK)
Technology provider: Tyndall National Institute (RTO, IE)
Business support: Blumorpho (SME, FR)
DIH: Tyndall National Institute (RTO, IE)

End-user: Cipacto (SME, Austria)
Technology provider: Universidad Autónoma de Madrid (ES), KAPITEL D (SME, AU)
DIH: Universidad Autónoma de Madrid (ES)
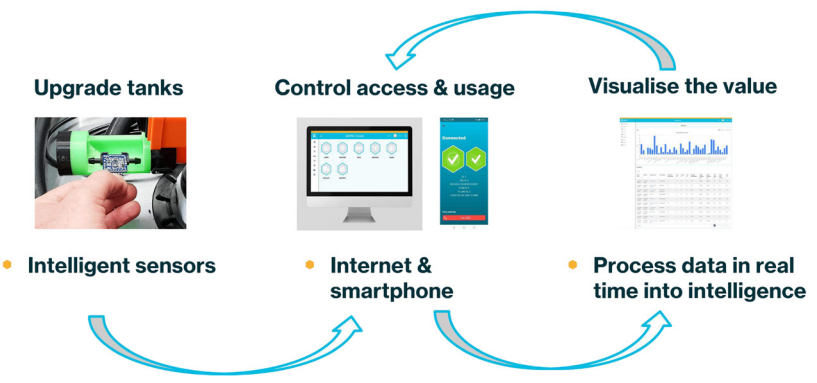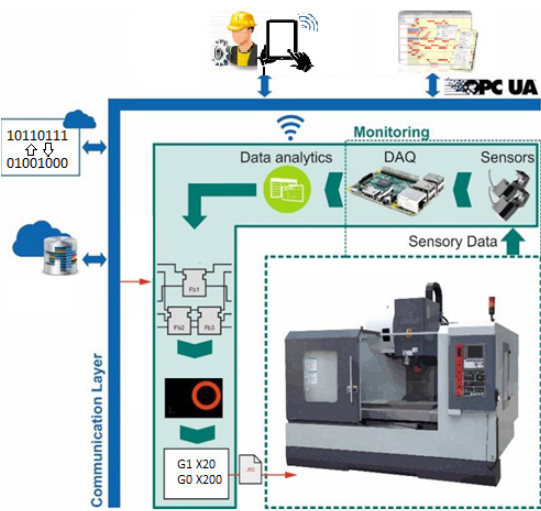
ADVANCING LEGACY MACHINE TOOLS TO DIGITAL MANUFACTURING

Problem and solution

A new trend in industry is to offer production services on a digital marketplace, with the vision to minimise the overhead needed to create and organise production chains. While computational power is getting cheaper every year, the backend processing is still relying on expensive machine tools – for example to create metal parts via milling. The investment cycle for such machines is completely different from the rapid changes in information technology. Especially SMEs use the machine tools for decades which binds a large amount of equity capital. A solution to prevent that new trends in manufacturing become disruptive for SMEs is to integrate legacy machine tools into digital production chains. Hence, the main goal of the LegInt project (short for LEGacy INTegration) was to develop and verify the necessary toolset to support this integration. LegInt developed a "shell" that augments legacy machine tools through a set of interfaces to embed them into an advanced Cloud Manufacturing environment. This shell contains hardware and software components, and its potential has been demonstrated in practice using legacy numerical controlled milling machines.

To enable the integration of legacy milling machines into digitised production chains, LegInt uses Function Blocks, which represent features to be created by milling processes. The DIH at fortiss provided their open source framework Eclipse 4diac and the necessary expertise to enable the product designer to describe complex milling processes with parametric Function Blocks. The contributing SME FormTec brought the knowledge and skills to generate traditional numerical control code files on the fly from the Function Blocks via a driver-based system.

The role of the DIH

CPSE Labs provided the ideal setting to bring together the necessary partners to realise the LegInt ambition: the SME FormTec with expertise in cutting technologies and software development, and two universities in Patras and Cranfield as additional technology providers for monitoring and cloud systems. The CPSE Labs DIH at fortiss offered Eclipse 4diac for distributed industrial control based on the Function Block standard IEC 61499 and provided necessary technical training and consulting. For SMEs such as FormTec realising research activities alongside the daily business is a challenge. The CPSE Labs funding enabled FormTec to devote time and effort to evaluate Eclipse 4diac, and the DIH also supported the consortium to demonstrate their results at the 2017 Hannover Fair to connect to potential new customers and initiate further exploitation activities.

Impact

The LegInt results allow to adapt large investments in machine tools for future digitised usage. FormTec estimates that over 1,000 companies in Europe running expensive legacy production milling machines in the range of several billion Euros can benefit from the technology or at least parts of it and constitute potential FormTec customers. The results of the project build the base for consultancy and individual solution development for this large customer base, and is a foundation of a new branch of business of FormTec with an expected potential of additional revenue of €500,000 over the next five years.

End-user: FormTec GmbH (SME, DE)
Technology provider: University of Patras (EL), Cranfield University (UK)
DIH: fortiss (RTO, DE)

RAPID VERIFICATION OF NEW FUNCTIONALITY FEATURES FOR TRACTORS AND MEDICAL DEVICES

Problem and solution

Tractors and other off-road vehicles have strongly evolved from just plough-pulling machines to complex systems allowing for a huge variety of functions. New digital technologies have enabled many innovative, efficiency-enhancing functions such as autonomous farming applications using GPS data or automatic transmissions driving very diverse farming machines. As for any product, the safety and reliability of new features must be tested in realistic environments before finding their way to commercial markets. In particular, real field tests add significant costs and delay time to market. They are not really reproducible due to varying real-life conditions. Software glitches occurring during field-testing are nearly impossible to fix, because there is rarely an opportunity to take the vehicle back to a garage for error analysis.

In a EuroCPS experiment, an automatic test and verification system platform has been developed to shorten testing time and to improve testing quality. By integrating real hardware and virtual components (simulation models), the platform provides a seamless exchange of data and know-how from the concept phase to road testing. It allows plugging the test system into a real environment with the capability to switch between real data and generated stimuli. This affordable hardware-in-the-loop (HIL) system uses remote data tracking in the field to collect data from real vehicles. The data is then used for reproducible test-and-simulation models in the lab. The new solution was applied to test innovative commercial off-road-vehicle features. The system reduces both the testing effort and time by 30-50 %. This also holds for application areas that combine generated and real data as part of testing cycles such as medical equipment. For example, the platform was also used to test an innovative type of catheter, which is a highest-risk-class medical device requiring extensive testing before market launch. The PiCSO Impulse Catheter, which is designed for patients with myocardial infarction, redistributes blood flow into the damaged area of the heart. The HIL system's automated testing capability accelerated product development by eliminating the need for costly and time-intensive manual testing.

The role of the DIH

In this experiment, CEA was the DIH that helped to bring the technology provider AVL and the SME CDE together. As a catalyser, CEA set up the process of technology transfer and supported the technology transfer between the technology provider and SME throughout the experiment live-time.

Impact

CDE is an Austrian embedded hardware and software company. Thanks to the enormous gain in testing time and effort, an agreement with a major, new customer has already been signed. Furthermore, discussions with multiple potential customers are underway. New medical-equipment applications are being developed. New business models suggested by these enhanced capabilities offer the potential to diversify CDE offerings into mobility, industrial services and energy-supply industries. It is expected that the revenue will increase by 30 % by 2020. Moreover, the company estimates that reusing components, tools and skills will boost earnings by more than 10 %.

End-user: CDE (SME, AT)
Technology provider: AVL Graz (LE, AT)
DIH: CEA-Leti (RTO, FR)
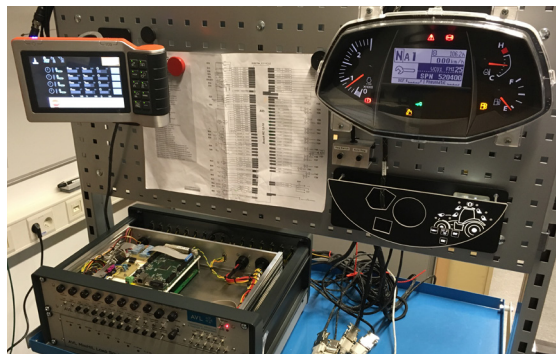
MONITORING OF WINDMILL BEARINGS

Problem and solution

The change of paradigm from fossil to renewable energy production for a greener world is somewhat affected by the cost of renewable energy. The cost of wind energy is strongly impacted by the expenses related to servicing in particular offshore wind turbines including condition monitoring, fault diagnosis and structural health monitoring (SHM). Cost of servicing could be considerably cut if parameters such as temperature, stress and vibration of the bearings of windmills that are located in hostile and hard to access environments would be measured and transmitted constantly and without the need to access the wind turbine. The information transfer by radio signal poses particular challenges due to the metallic environment of the bearing.

Within the Gateone project, a solution based on an existing system has been developed that facilitates health monitoring of the bearing through autonomous sensor nodes for measurement of temperature, strain and vibration, including the wireless operation of the sensor nodes. This will ultimately reduce servicing cost of wind turbines considerably.

The role of the DIH

In this experiment, IK4-Ikerlan took the role of the DIH and transferred their knowledge about miniaturised wireless sensor technology to Laulagun Bearings providing them with knowledge and technology that the SME did not have and that potentially would have been a show stopper for any sophisticated solution to the problem.

Impact

Laulagun Bearings produces different types of bearings for wind turbines, both blade (pitch) bearings and slewing rings (yaw) that generate up to 10 MW of power. Marketing of the new bearings will start through discussion/negotiation with customer and evaluation "in the field" along 2017 to get the feedback from the windmill customers, followed by industrialisation/qualification in 2018. The company delivers between 3,000 and 5,000 products a year with revenue of €40 million. It is estimated that the new monitoring capability will increase the revenue of Laulagun Bearings by €5 million over the next 5 years.

CLUTCH–BRAKE WEAR MONITORING

Problem and solution

The clutch-brakes transfer the continuous motion from a motor flywheel to pieces of a machine that need repetitive motion steps, being the key solution in machinery in different sectors, mainly where power transmission is needed, like servo presses. The clutch-brake system has three main parts: the body connected to machine shaft, the clutch friction disc and the brake friction disc. Currently, the wear check is done manually by qualified technical staff, stopping the machine, with all involved downtime cost. Furthermore, in case of bad conditions running, it is uncontrolled. A predictive maintenance based on continuous wearing control would provide a high added value solution.

The contributions required for the solution have been:
- Sensor concepts, packaged intrinsically in the piece
- Signal conditioning
- Data processing and low power electronics
- Low power wireless communication
- Energy harvester and power management

The role of the DIH

Different RTOs acting as DIHs could provide a solution to this problem by their cooperation in the Smarter-SI project. The two DIHs involved are IK4-Ikerlan and Hahn-Schickard. The smart system designed to solve this application problem consists of an inductive distance transducer, a thermocouple temperature transducer, a kinetic energy harvester, a Bluetooth low energy module and electronics which assists both data processing and data transmission needs.

Impact

The main benefit of this new smart sensor will be the optimum use of the pad/lining wear volume, no unscheduled downtime, to avoid other malfunctions in the clutch-brake (assembly or alignment error), and therefore to reduce the maintenance costs. It is estimated that this monitoring capability will increase the revenue of a company which delivers between 1,500 and 2,000 clutch–brake units per year, by €1 million over the next 5 years from the integration of this smart system in their product.

End-user: Laulagun Bearings (SME, ES)
Technology provider: IK4-Ikerlan (RTO, ES)
Business support: Blumorpho (SME, FR)
DIH: IK4-Ikerlan (RTO, ES)

End-user: Goizper (SME, ES)
Technology provider: IK4-Ikerlan (RTO, ES), Hahn-Schickard (RTO, DE)
DIH: IK4-Ikerlan (RTO, ES)

DELIVER SELECTIVE SENSING TO VISION

Problem and solution

Short-wavelength infrared (SWIR) cameras with InGaAs detectors are not only an important technology in the domain of security and safety, they can also be used in the agriculture, transport and automotive sector, or food and waste sorting industries. At this time, most existing SWIR cameras face issues for all-weather outdoor use with strong illumination variations.

The French SME New Imaging Technologies (NIT) is specialised in manufacturing logarithmic wide dynamic range (WDR) imaging sensors and cameras in the visible and SWIR domain. The combination of hyperspectral imaging and WDR logarithmic contrast-based imaging sensors guarantees a high robustness in spectral measurements whatever the light source and its variations. Many applications can be fulfilled, like ice detection on road surfaces, plastic recycling, food chain monitoring, smart agriculture, de-camouflage, but also in the art industry for detecting underlying painting layers or counterfeiters.

Main contributions to the solution are:
- Tunable Fabry-Pérot filters design and fabrication
- Hyperspectral imaging
- Hypercube capture
- Spectral analysis
- Optical design
- Camera integration

The role of the DIH

New Imaging Technologies has joined the Gateone project to make its product evolve from multispectral to the hyperspectral level. Multispectral means multiple filters or even multiple cameras. In this demonstration, with a single tunable Fabry-Pérot filter mounted onto a NIT camera, it is now possible to acquire a full cube of high contrast images with different focal lengths. Images can be collected from 1100 to 1600 nm frame-by-frame with full control of required wavelengths. This is achieved with a bandwidth that can be selected (10 nm or 20 nm) and with resolution down to 10 nm.

Impact

The identification of plastic types or ice versus water detection has been demonstrated in the VTT lab and the camera will now follow a test campaign by NIT to explore all the capabilities offered by this camera. This demonstrator is an addition of two high technology building blocks. Multiple customers have already submitted use case studies to the company. The two partners will enter into an agreement to embed the filter into a more compact and lightweight version of a hyperspectral camera.

End-user: NIT (SME, FR)
Technology provider: VTT (RTO, FI)
Business support: Blumorpho (SME, FR)
DIH: VTT (RTO, FI)

SMART STREETLIGHTING INCREASES SAFETY AND REDUCES ENERGY USE

Problem and solution

Citizens' feelings of safety while walking in the city at night correlate strongly to light levels. For municipalities, this presents the challenge of providing sufficient light at clearly reduced levels of energy consumption.

Cities are investing in new (LED) lighting installations, but available solutions are proprietary. That binds municipalities to a single vendor for services and replacement lamps, among other drawbacks. Moreover, these systems are not smart enough to incorporate new flexible, sophisticated features enabled by bi-directional communication capacities of the luminaire. For example, a smart street light should transmit its health status to the operator to ensure that defective lighting elements are replaced before they fail – providing the double benefits of lower maintenance costs and ensured illumination. In addition, the communication capacity of street lighting could be useful for giving driving instructions for autonomously driven cars. Finally, energy-conscious operators would benefit from smarter dimming by reducing the electric current in cooler weather conditions, when LEDs are more efficient.

In response to these challenges and opportunities, this EuroCPS project developed an upgradeable, re-configurable lighting-control solution constituting a "future-safe" investment with clear benefits both for citizens and operators of the lighting installations. The non-proprietary "smart SSL solutions" concept targets system-level applications with advanced communications. These allow LED luminaires to become part of smart-city solutions through bi-directional communication, separating the communications protocol from the actual physical medium of the data transfer. Using Intel's Edison IoT/CPS platform, various smart functions could be added to LED-based street-lighting luminaires: e.g. performance-status data and smart dimming.

The role of the DIH

BME assumed the role of the DIH in this EuroCPS experiment in consulting the SME Hungaro Lux on system design and implementation of the new intelligent LED luminaire controller. With its detailed knowledge of Intel's IoT platform BME helped realising missing device drivers and interfaces. Furthermore, BME provided the SME with laboratory testing facilities, which is a second dimension of a DIH's role.

Impact

Hungaro Lux Light is building a new production facility for its PearlLight luminaires that will go into production in 2018. The company also developed a new smart luminaire control centre. A pilot setup was built with a Hungarian electric utility, and production planning is in the final phase. With this pilot implementation, predicted energy savings of 6-8 % will be tested. A further ~5 % energy-efficiency improvement is also expected from the new anti-reflective coating introduced by the company's optics design.

End-user: Hungaro Lux Light (SME, HU)
Technology provider: Intel (LE, IE)
DIH: BME (RTO, HU)
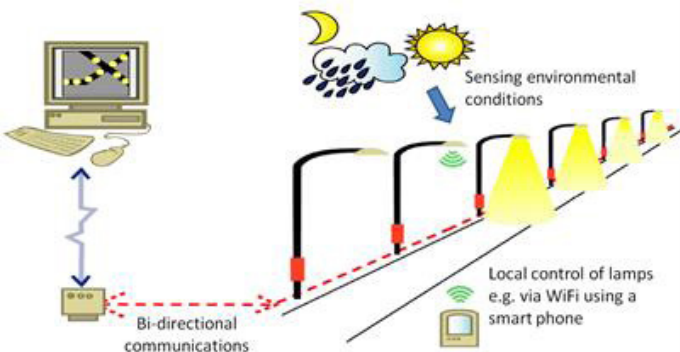
NETWORKED TRAFFIC MANAGEMENT

Problem and solution

Many European countries have dense road networks and significant traffic problems. The flow of traffic on Europe's roads is managed by a series of traffic management systems that are owned and controlled by various local and national authorities. A traffic management system (TMS) consists of a collection of digital control systems linked to physical devices installed along the roadside. These can be sensors that collect traffic data (such as cameras, radar detection systems, and induction loops) or actuators that are used as control measures by giving instructions to road users through signs and signals. Existing traffic management solutions are run centrally from regional control centres. While cooperation between various road authorities at a governance level has improved recently, technical barriers for collaborative and distributed traffic management systems over regional borders must still be removed.

The TEMPO experiment aimed to tackle this problem by providing collaborative, distributed control architectures for traffic management systems that engage with each other in automated negotiation. The negotiations are targeted to find control measures that optimise traffic flow cross-border and for the traffic network as a whole. The experiment applied an existing modelling and simulation platform called Overture for TMSs. Models can demonstrate the correctness and benefits of designs prior to costly implementation. Traffic simulations produce a large amount of numerical data that need to be interpreted and presented in an understandable way to non-IT experts. The existing Overture technology has been extended with 2D/3D visualisation to illustrate the effect of the automated negotiations on the traffic flow.

The role of the DIH

In this CPSE Labs experiment, the DIH at Newcastle University brought together the partners and facilitated technology transfer of Overture from Aarhus University to West IT through training, guidance and support. Apart from upskilling West IT on Overture, the DIH helped West IT reach potential customers by engaging with road network stakeholders from across Europe from the outset and throughout the experiment.

Impact

West IT has increased its competitive capabilities in the smart mobility area and expects additional revenue of €200,000 in the first year, leading to an increase of €1.5 million over five years. The digital skills obtained by West IT employees will benefit the company in current and future projects, both in traffic management and other domains. The results can also be of benefit to organisations such as stadiums, harbours and airports not commonly associated with traffic management, who increasingly take the initiative in guiding large volumes of traffic themselves.

The results will have significant societal impact if adopted by national, urban and commercial road authorities, greatly improving road network performance and reducing pollution.

End-user: West IT (SME, NL)
Technology provider: Aarhus University (RTO, DK)
DIH: Newcastle University (UK)

REMOTE BATTERY STATUS MONITORING AND REPORTING FOR MOTORCYCLES

Problem and solution

Smart connectivity represents both a challenge and a huge market opportunity in the transportation sector, resulting in an increasing number of services, starting from advanced driver assistance systems (ADAS) and intelligent transport systems (ITS) that have been developed in the last two decades.

The FIM Enel MotoE™ World Cup made its debut in the 2019 MotoGP World Championship, an all-electric series powered by Energica Motor Company, which has witnessed first hand the breathtaking battles on the most famous motorcycle racetracks. In this respect, safer battery charging operations and better management of battery cycles during the races while providing vital compliance data in both a reliable and timely manner are key concerns.

To address these issues, the SME Energica Motor teamed up with DIHs and companies in a FED4SAE application experiment to design, implement, and validate a novel smart LoRa based connectivity architecture for electric two-wheelers using the STM32 microcontroller module. Apart from motorsports, the solution increases the service offer within the whole value chain of electric motorbikes, starting from vehicle to the riders. The feasibility of providing geolocation services for motorcycles and charging station localization has been additionally explored.

The role of the DIH

CSEM and Digital Catapult served as DIHs in this application experiment and involved other partners. STMicroelectronics supported the development of the novel LoRa platform based on their SMT32L5552 microcontroller unit and validation was done by Digital Catapult in their LoRaWAN testbed infrastructure in London as well as during the test sessions of MotoE™. CSEM provided the time difference of arrival (TDOA)-based solver for LoRa geolocation. In addition, Digital Catapult and Blumorpho supported business development and a commercialization plan.

Impact

Energica Motor could develop the proof of concept for a market-ready product and commercial plan. Thanks to the introduction of the connectivity board, the safety during the charging section and during the night (vehicles with key off) inside the paddock of FIM MotoE™ World Cup could be improved. All MotoE™ races were completed without problems and Energica Motor sold the connectivity board to racing teams. Conversations with many more potential investors and partners took place and gave access to a huge network of large and small businesses. In the future, the connectivity board will be integrated in the commercial line of motorbikes to offer a wide range of applications and services to Energica Motor's customers.

End-user: Energica Motor Company (SME, IT)
Technology provider: CSEM (RTO, CH), Digital Catapult (RTO, UK), STMicroelectronics (LE, FR)
Business support: Blumorpho (SME, FR)
DIH: CSEM (RTO, CH), Digital Catapult (RTO, UK)

DRUG ROADSIDE CONTROL

Problem and solution

Detection of driving under the influence of drugs, and in particular cannabinoids (one of the most consumed illegal drugs in Europe), is important for the safety of roads. Ideally, road tests would allow the analysis of human fluid samples by a police patrol and reduce significantly the time between the initial collection and testing. This would be a major advantage as by the time the sample arrives to a laboratory the drug can have degraded or changed its composition.

The solution presented by this system is a portable system for detection of cannabinoid consumption with high precision. The system will provide a quick analysis of an oral sample (saliva) on the roadside. Such system aims to offer highest accuracy in comparison with existent drug detection system, without compromising its portability.

The required knowledge/efforts from the different partners in this project have been: capillary electrophoresis separation, microfabrication and system integration (Tyndall); high power electronics (IK4-Ikerlan); polymer 3D fabrication.

The role of the DIH

The availability of the Smarter-Si hub provided the conditions to explore alternative materials from the standard use of silicon and glass, which can be costly and complex. In addition, the access to a custom made high power module allowed the optimisation of the system's size, which is important in regard to portability.

Impact

The company Glantreo has been able to access a market (roadside testing) that otherwise would have been out of its reach. The company is already establishing links with USA companies for further testing and applications of the system.

According to figures in the USA, there were over 1.1 million police officers in the US in 2008. A conservative estimate of one car per 5 police officers would give an estimated 220,000 police cars in the US. Even assuming that 50 % of these would be fitted with drug screening technology and a device price of $5,000. This would give an estimated market size of $550 million.

The system also offers potential applications as point of care testing device for testing that prescribed drugs are taken by the patient and not used in the black market. This is also a possibility that the SME is currently investigating.

HUMAN MACHINE INTERFACE IN SUPER THIN BENT WOOD

Problem and solution

3DMA is smart wood with integrated electronics developed by the SME Prototypen & Sonderlösungen. It is made of 80 % natural wood and can be equipped with various features as well as electronics. The SME wanted to integrate super thin flexible electronics including OLED into super thin bent wood to obtain a human machine interface in the 3DMA structure: operable wood with information return as wood backlighting. The aim was to create touch-capable OLEDs that can be operated by the user through the outer surface of the wood without shortening the lifetime by means of an additional touch solution.

In a SmartEEs application experiment, the DIHs Fraunhofer FEP and EBN collaborated with Prototypen & Sonderlösungen to develop prototypes of a highly complex OLED matrix well ahead of the current possibilities of OLED lighting design and manufacturing. The prototype uses additional touch FPCBs to underline the value of the electronics with functional reliability. Lidar sensor technology was integrated for first interactions over a longer range creating the bridge from near-field interaction to spatial interaction. The first application is a trade fair mode to animate visitors to operate the interfaced, i.e. the interface signals „Hello, here I am, touch me!".

The role of the DIH

In the application experiment, the two DIHs Fraunhofer FEP and EBN supported Prototypen & Sonderlösungen. Having a strong background in organic electronics, Fraunhofer FEP provided development expertise and manufacturing resources. EBN supported business development and network building.

Impact

The flexible electronics technologies represent a cornerstone in the business strategy development of Prototypen & Sonderlösungen that focuses on integrating disruptive technologies in its 3DMA product. The developed prototype was used to show customers and partners what is possible with 3DMA wood and how new areas of application can be opened up by combining modern technologies. With the help of the prototype, it has been possible to address new interest groups, for example in the aviation industry.

End-user:	Glantreo (SME, IE)
Technology provider:	Tyndall National Institute (RTO, IE), Swerea IVF (RTO, SE), IK4-Ikerlan (RTO, ES)
DIH:	Tyndall National Institute (RTO, IE)

End-user:	Prototypen & Sonderlösungen (SME, DE)
Technology provider:	Fraunhofer FEP (RTO, DE)
Business support:	EBN (RTO, BE)
DIH:	Fraunhofer FEP (RTO, DE), EBN (RTO, BE)

FLEXIBLE SENSOR STRUCTURE

Problem and solution

Small Data Garden is a Finland based growth company established in 2017 and has its background in wireless IoT sensor nodes and related applications. Their first IOTSU-product family was realised with state-of-the-art electronics and rigid enclosures. As a challenge, the customer needs were driving towards a thin, bendable, space efficient, low-cost, and easy to integrate sensor structure having autonomous functions. Thus, a new technical design and realisation possibility was sought. The identified key business cases were in logistics and industrial processes.

An application experiment within SmartEEs enabled a collaboration of Small Data Garden with VTT and AMIRES. The existing IOTSU-products were taken as a starting point. The design and development targeted a light-in-weight, flexible, and flat structure, which included all the functionalities such as wireless communication, location tracking, temperature, and activity sensor. The flat form factor induced a profound redesign round to fulfil the requirements related to assembly environments such as metal sheets and human body. The manufacturing of prototypes also utilised a new value chain.

The role of the DIH

VTT served as DIH in the SmartEEs application experiment and provided expertise and technological support in flexible electronics to complement the existing IoT expertise of Small Data Garden. AMIRES supported business development and the creation of strategic partnerships.

Impact

The prototypes were presented in several fairs in Finland and France and in seminars and workshops organised by SmartEEs during the year 2019. Two customer test cases in food logistics and industrial process monitoring in Finland and in Sweden were successfully piloted during the SmartEEs project. Further product concept and business development will be continued with several other identified/contacted cases. The scale-up of product manufacturing is on the way and the IOTSU® Flexi has been launched during 2020 for selected markets.

End-user: Small Data Garden (SME, FI)
Technology provider: VTT (RTO, FI)
Business support: AMIRES (SME, CZ)
DIH: Tyndall National Institute (RTO, IE)

SMART FLOORING TECHNOLOGIES PREVENTING THE FALLING OF ELDERLY PEOPLE WORLDWIDE

Problem and solution

The costs related to falling accidents of elderly people (75+ years) are rising each year in Europe. In 2018 in the Netherlands, the costs amounted to approximately €900 million. Not only are the costs a problem, but even more so the injuries and the emotional stress for the elderly, their families and healthcare workers, as a result of these falling accidents. However, falling accidents can be prevented when health care workers know if the elderly are at risk of falling. In this case, the elderly must use a rollator or, for example, airbag trousers while walking, in order to prevent falling and injuring themselves. Alternatively, they can get special physiotherapy treatment to improve their walking capabilities.

In a DIATOMIC application experiment, an innovative Smart Floor technology was developed and tested with the SME Connective Floors. The Smart Floor allows to objectively assess the falling risk of elderly with aid of a wearable while they are walking and informs healthcare workers and their families when there is a risk. Data from the miniature wearable can be transported through a stable Wi-Fi gateway to the cloud, analysed in the cloud and sent to the web application as information.

The Smart Floor technology has been integrated into the floors of the nursing home tanteLouise and the physiotherapy centre Steenbergen. In addition, the technology has been integrated into the sports floorings of the PSV Performance Center Eindhoven and the Maaspoort arena in 's-Hertogenbosch. The Data of moving patients and sportsman was analysed and the first Smart Floor app for fall prevention has been developed with relevant information for healthcare takers and specialists.

The role of the DIH

In this DIATOMIC application experiment, three companies collaborated trilaterally. The Innovation Action itself was considered as DIH. The DIH helped to structure the project, provided advice with difficult issues, and enabled access to the (technical) network of the DIATOMIC partners. FreeSense Solutions provided knowledge in wireless sensing technologies and nora Flooring Systems in flooring to support Connective Floors in the development of the Smart Floor technology.

Impact

The ability to deliver KPIs of human movements with the aid of floorings in order to prevent human accidents, injuries or improve human performance has turned out to be huge. A market research covering Healthcare in the Netherlands and Germany as well as sports in Europe and the USA showed that all world leading flooring companies are embracing this solution and costumers are willing to pay extra for this. Flooring companies will market the Smart Floor solution, while Connective Floors will sell the foil, wearables and the software. Collaborations with 4 flooring companies to market and sell the Smart Floor were established and nearly 25,000 subscriptions reached.

End-user: Connective Floors (SME, NL)
Technology provider: FreeSense Solutions (SME, NL), nora Flooring Systems (LE, DE)
DIH: –

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