EPoSS
European Technology Platform
on Smart Systems Integration

SAE
SmartAnythingEverywhere

SMARTER - SI
Smart Access to Manufacturing for
Systems Integration

White Paper

Smart Systems Manufacturing

in small lot sizes meeting the demands of SMEs

April 2018

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SMARTER-SI

"SMARTER-SI" is an Innovation Action aligned to the "Smart Anything Everywhere" Initiative of the European Commission. The project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 644596 (SEFRE contract number 15.0085).

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1. Introduction

On the way to digital transformation of their products, European small and medium-sized enterprises (SMEs) need access to manufacturing facilities for the necessary electronic components and systems. Since SMEs in general are more successful by adopting a niche market strategy for their products, it is expected that quick, flexible, and low-cost production of small lot-sizes is an essential condition for their market success.

In order to provide access to manufacturing capabilities generally not accessible for SMEs, several European Research and Technology Organisations (RTOs) joined efforts and formed the SMARTER-SI project. The ultimate goal of SMARTER-SI is to test a new concept for distributed small lot production, the Cooperative Foundry Model (CFM). Electronic components and functional parts of Smart Systems that are available at the participating RTOs and that are characterised by high Technology Readiness Levels (TRLs)[1] are considered as "Building Blocks". These Building Blocks can be combined creating innovative Smart Systems which serve the needs of SMEs. The re-use of Building Blocks allows for their quick and flexible adaption to new needs – and facilitates their production at reasonable costs. This access is successfully demonstrated by the implementation of eleven "Application Experiments"[2].

Tangible benefits of SMARTER-SI and the CFM are:

- Enhanced collaboration between European RTOs by working together to deliver technology solutions that meet SMEs' needs and guarantee a return on investment
- Customised integration of technology Building Blocks from project partners to deliver Smart Systems for SMEs to serve both new and existing markets
- Proactive participation of industry in the SMARTER-SI Application Experiments
- Ability to tailor Building Block technology to adapt the integration requirements for specific applications making the process flexible and highly modular in nature

2. Smart Systems

"Smart Systems Integration" represents the evolution of microsystems technology towards functional systems combining cognitive functions with sensing, actuation, data communication, and energy management in an integrated way (Figure 1).

Hence, the term does not refer to technologies or dimensions, but to functionalities. The enablers of these functions include nano-electronics, micro-electro-mechanics, magnetism, photonics, chemistry, and radiation. What separates a Smart System from a system that is purely reactive is the knowledge base which ranges from a set of parameters for a feedback loop to embedded databases and algorithms. It is a necessary condition for the smartness of a system to provide safe and reliable autonomous operation under all relevant circumstances. Smart Systems are often integrated with the (natural, built, and social) environment, networks for power and data, other Smart Systems, and the human. It is a sufficient (or extrinsic) condition for the smartness of a system to provide (and use) cognitive support to (and from) its surroundings.

[1] EU HORIZON 2020 – Work Programme 2016-2017, page 29:
https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf
[2] Application Experiments of SMARTER-SI: https://www.smart-systems-integration.org/smarter-si/application-experiments

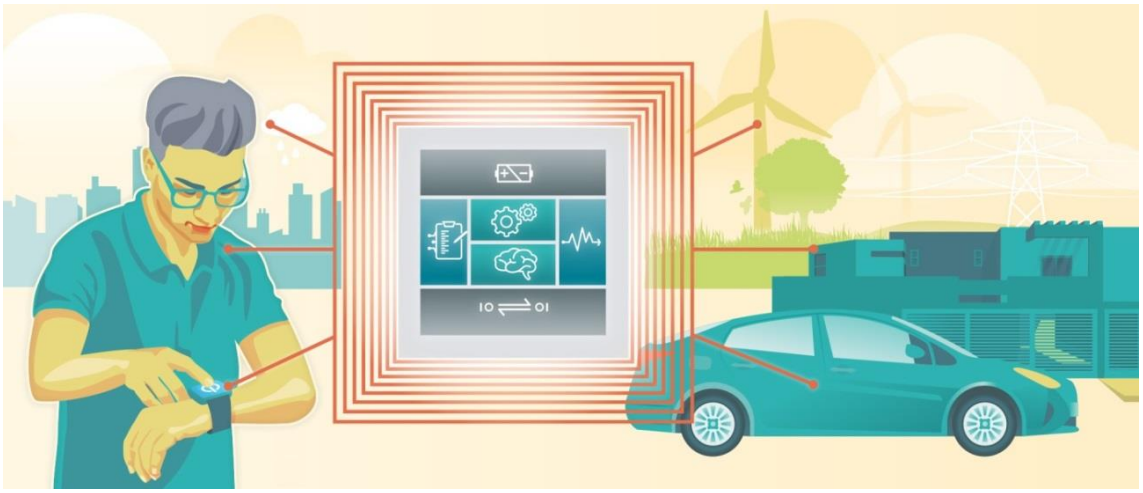


Figure 1: Schematic illustration of Smart Systems Integration. Source: EPoSS[3]

3. Market Considerations, Innovation, and Value Added by Smart Systems

Globally, Smart Systems Integration has been a key driver of the technological advances of the past decade and is still a key contributor to economic growth and prosperity as well as an important enabler of industrial success in Europe. Due to its enormous influence and leverage effect, this technology is a driver of the European economy.

According to analyses conducted in 2011 and 2013[4], Smart Systems Integration realizes on its own approx. € 120 billion market value in Europe per year. As technology enabler of products, Smart Systems Integration is significantly influencing the whole value creation of a € 3,290 billion European market share of the world markets in important application fields, such as mechanical engineering, industrial automation, automotive and aerospace, consumer electronics, health/life sciences, or information and communication technology. Due to its multi-disciplinarity and the integration of multiple scales, Smart Systems Integration is an enabler for a multitude of innovative products. It also enhances existing product characteristics substantially and adds new characteristics and functionalities to products. The value added by Smart Systems Integration is approx. 10% of the € 113 billion global market in the case of industrial automation and approx. 3% of the € 260 billion life science, medicine, and global pharma market in the case of the health sector[4]. In markets such as automotive and aerospace that are of high importance for Europe, this figure is considerably higher due to their immense Smart Systems Integration intensity.

4. EPoSS, the European Technology Platform for Smart Systems

European Technology Platforms (ETPs) are industry-led stakeholder fora recognised by the European Commission as key actors in specific sectors to drive innovation, knowledge transfer, and European competitiveness[5]. They are independent and self-financing entities whose missions are to compile research and innovation priorities and develop strategies for their particular domain as well to mobilize ecosystems and disseminate information about European funding opportunities. Today, about 40 ETPs[5] are acting as channels

[3] European Technology Platform for Smart Systems Integration (EPoSS): https://www.smart-systems-integration.org
[4] Prognos, Analyse zur ökonomischen Bedeutung der Mikrosystemtechnik, 2011, and VDI/VDE-IT research, 2013.
[5] European Technology Platforms (ETPs): http://ec.europa.eu/research/innovation-union/index.cfm?pg=etp

of external advice for the programming and implementation of Horizon 2020 and are notably key driving forces behind the launch of high profile public-private partnerships.

EPoSS is the European Technology Platform for Smart Systems Integration[6] representing a dynamic ecosystem formed by a variety of engaged large companies, small and medium-sized enterprises (SMEs), public and private research organizations, and universities in the fields of microsystems, micro- and nanoelectronics, sensor technologies, micro-nano-bio systems and related application areas. EPoSS has been created in 2005, counts now 50 active member organisations and is registered as an association under German law since 2013.

Currently, the platform is organised in six working groups as operational elements, each chaired by an industrial representative and covering the fields of automotive, healthy living, manufacturing & robotics, communication for smart devices, applied micro-nano-bio systems, and key technologies[7]. In the working groups, experiences are shared and strategic research agendas (SRAs) as well as related roadmaps for implementation are developed.

Over the last decade, EPoSS succeeded in partnering with two other initiatives in the fields of nanoelectronics (AENEAS) and embedded systems (ARTEMISIA) to launch the ECSEL Joint Undertaking[8], an EU-driven public-private partnership empowering innovation in electronic components and systems. With this funding instrument under Horizon 2020, EPoSS strengthens the position of Smart Systems Integration by including SSI-priorities in ECSEL annual work programs and related calls for projects.

5. Small and Medium-sized Enterprises – A Key Pillar for Growth in Europe

SMEs having less than 250 employees[9] are the backbone of Europe's economy. They represent the vast majority (99.8%) of all registered enterprises and SMEs employ two out of three jobholders (66.8%) while creating 57.4% of the gross value added as shown in Figure 2.

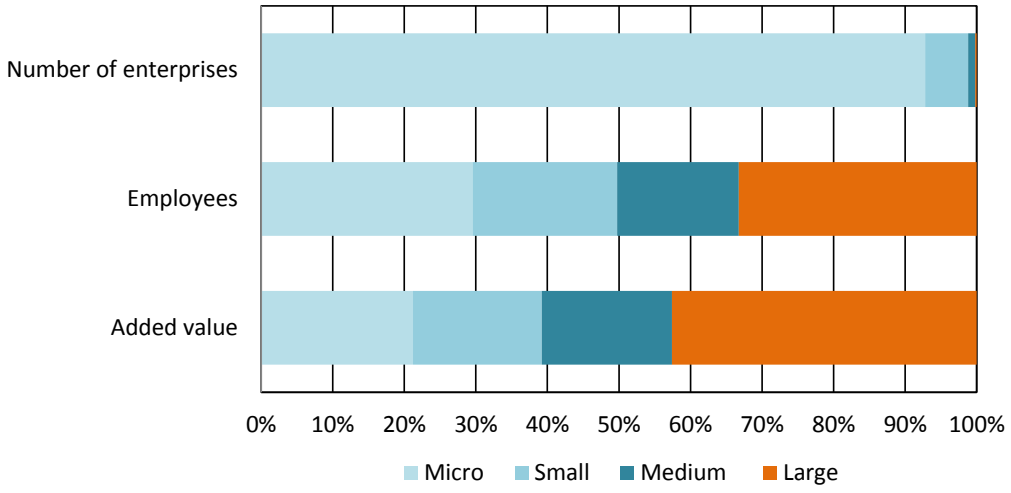


Figure 2: Number of enterprises, employees, and their contributions to the added value in the EU-28[10].

[6] European Technology Platform for Smart Systems Integration (EPoSS): https://www.smart-systems-integration.org
[7] EPoSS Working Groups: https://www.smart-systems-integration.org/public/about/structure/working-groups
[8] Electronic Components and Systems for European Leadership (ECSEL): https://www.ecsel.eu
[9] SME definition of the European Commission: https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en
[10] Estimation of the European Commission 2015 according to: EUROSTAT SME performance review 2017/2016 (DIW Econ)

The European Commission considers SMEs and entrepreneurship as key to ensure economic growth, innovation, job creation, and social integration in the EU. Therefore, the EU launched several dedicated programs and initiatives to support SMEs with the access to finance, but also with resources and knowledge in order to be able to face globalization, societal challenges, and changing environments. Their small size (the average number of employees in SMEs is about 4) and light structures allow agile management and high reactivity and adaptability to new trends, emerging technologies, and evolving markets. However, R&D-performing SMEs often suffer from a lack of internal human and financial resources to cope with the large amount of information, contacts, and connections required to successfully foster innovation as well as to respond to the multitude of calls for funding. As a consequence, they often tend to avoid publicly funded projects due to the following reasons.

Four reasons why SMEs tend to avoid publicly funded projects

- Administration, complexity, low cost-benefit-ratio, non-transparent scoring, and huge efforts allocated to the submission of proposals prevail over potential benefits and huge efforts allocated to the submission of proposals.
- The mandatory publication of results from publicly funded R&D projects is often conflicting with the interests and IP strategies of businesses.
- Unclarities and ambiguities in communicating with other stakeholders having divergent views, interests, or other semantic levels can make it difficult to find commonalities for a partnership, e.g. RTOs possibly do not speak the same “language” and have another understanding of “what is worth being solved ... and why”.
- Trust is important for SMEs who often select partners from their geographical comfort zone rather than unknown organisations, especially if those come from different regions or countries.

Although considered as key players, SMEs often play an integrating role in the ecosystem. Even if they create much of the value as specialised world-market leaders providing unique solutions or services in niche markets, they remain the “hidden champions” suffering from a lack of visibility and recognition from the general public and sometimes from the other stakeholder groups within their ecosystem.

However, in order to stay competitive and to consolidate their assets, SMEs have to adapt to market-driven megatrends such as digitization. The currently ongoing digital transformation indeed imposes new challenges but also opportunities for these SMEs in the following areas.

New challenges and opportunities for SMEs

- Digitization of existing and future processes, i.e. manufacturing or testing chains.
- Adding value to existing and future products through digitization.
- Definition and adoption of new business and supplier models in changing economic environments.

Currently, less than 2% of the European SMEs are using advanced digital technologies in their innovation and production processes[11], with a high heterogeneity across the different European Member States and regions. Therefore, tremendous efforts are needed to avoid that this situation evolves into a digital divide in Europe.

[11] Khalil Rouhana, "Digital Transformation of Industry: Challenges and opportunities for Europe", The European Files no. 45, Jan 2017

6. Smart Anything Everywhere – A Young Initiative of the European Commission

The European Commission wants to enable SMEs to meet the challenges of digital transformation and therefore has announced several initiatives. Among them, the so-called "Smart Anything Everywhere" (SAE) Initiative[12] is considered to be a main pillar (Figure 3).

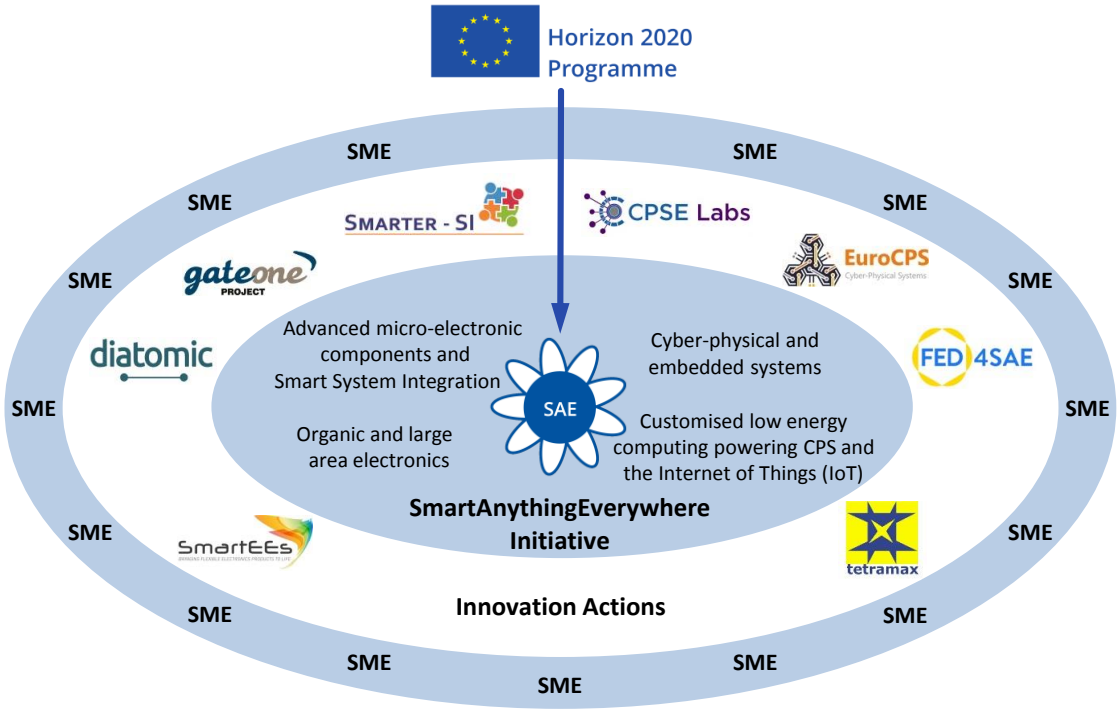


Figure 3: Smart Anything Everywhere Initiative of Horizon 2020 and the funded Innovation Actions promoting the digital transformation of SMEs.

The initiative comprises about a dozen projects amounting to approx. € 60 million funding to date. By setting up and implementing an exhaustive network of regional "Digital Innovation Hubs" (DIHs), all partners in projects under the SAE-Initiative guarantee local access for SMEs to experts in digitization limiting thereby the risk of isolation. The role of the regional DIHs is manifold as they shall educate SMEs about the opportunities offered by digital technologies both in terms of hardware and software, and support them to integrate digital technologies in their products, services, and processes.

The projects of the SAE-Initiative use a new funding instrument within the Horizon 2020 program, the so-called "Innovation Action (IA)" scheme. This instrument does not provide funding for research or development activities, but rather selectively invests in results close to the market which are to be achieved and, if possible, also commercialised in the course of the project. In addition, the projects funded under the SAE Initiative may also apply the instrument "Cascade Funding", i.e. issue their own calls. This enables smaller "sub-projects" which can implement new applications in the area of digitization in close collaboration between companies and research institutes, so-called "Application Experiments" aiming at testing under real conditions.

On top of that, the use of the cascade funding scheme implies that SMEs can bypass the administrative and contractual complexity related to contracts with the European Commission. The only contract SMEs have to agree on is managed by the Digital Innovation Hubs. All other administrative and financial issues with the

[12] Smart Anything Everywhere Initiative (SAE): https://www.smartanythingeverywhere.eu

Commission are incumbent on the Digital Innovation Hubs, so that SMEs can concentrate on their core business.

Consequently, these new instruments drastically reduce the efforts required by SMEs to access leading-edge digital technologies, to reduce the related risks, and to benefit from reliable partners for further joint endeavours. The SAE Initiative represents a strong contribution for SMEs to manage the digital shift and to strengthen the competitiveness of the European industry.

7. The SMARTER-SI Cooperative Foundry Approach to Promote Smart Systems Integration for SMEs

One of these Innovation Actions is SMARTER-SI[13], a project originating from the EPoSS Working Groups presented in section 4. The underlying idea of this project is that business-related research institutes undertake small-batch productions for SMEs if this results in a win-win-situation.

On the one hand, SMEs are encountering major difficulties to find affordable commercial foundries for the small-scale production of custom sensor systems to be integrated in their products. The costs to develop new production processes for these systems cannot be solely covered by the return on investment due to the small quantity of sensors produced and the small size of the market. Such a situation might jeopardize the whole product development and diminish the SME's innovation capacities.

On the other hand, small series might be exactly in the scope and interest of industry-oriented research institutions, especially if demonstrators and prototypes developed in previous R&D projects are available which can potentially solve some SMEs' needs for a faster and less expensive commercialisation in new fields of application. Certainly, interfaces might have to be adapted, other form factors found, or new software added, but the effort for these adaptations is in any case much lower than for a new development from the scratch.

SMARTER-SI sets up a test bed for a so-called Cooperative Foundry of Smart Systems in which high-TRL Building Blocks of RTOs are made available to SMEs and their custom applications. Consequently, SMARTER-SI is part of the DIH-network mentioned in the previous section with RTOs acting as local, technological access points. For this purpose, SMARTER-SI bundles the expertise of 6 internationally recognised RTOs (the Cooperative Foundry, see Appendix) to provide SMEs with access to small lot manufacturing of systems (up to 200 units) in form of Building Blocks which can be selected and combined from a common "catalogue"[14]. In this context, the term "Building Block" is used in a pragmatic way, i.e. it describes technological modules such as a sensitive thin film, a sensor chip, an electronic module, a user interface, a software, etc. that are interoperable and can be combined into fully functional systems. This modular approach is schematically illustrated in Figure 4 for a point-of-care testing device.

The possibilities offered by this modular approach are manifold and cover a large scope of SMEs requirements. However, the approach also raises some challenges along the different implementation steps, starting with the translation of SMEs needs into a complex assembly of Building Blocks up to a small series of integrated systems:

[13] SMARTER-SI: http://www.smarter-si.eu
[14] Catalogue of SMARTER-SI Building Blocks: https://www.smart-systems-integration.org/smarter-si/catalogue-of-building-blocks

1. Selection of the right items among a substantial number of Building Blocks. This requires in-depth knowledge of each block as well as interoperability with the others.
2. Provision of a detailed documentation for each block and the whole assembled system. This is key to support market acceptance and usability since users demand for transparent systems and a clear overview of relevant system parameters, e.g. operating conditions, geometrical dimensions, handling instructions, and prize.
3. Guarantee for a smooth and seamless manufacturing process of the systems. Each RTO integrating its own Building Block(s) into the systems. Consequently, as the batches of systems being assembled are travelling from one RTO to another between production steps, the transfers and interfaces between the RTOs have to be accurately planned and clearly defined. In addition, a documented final "hand-shake" has to seal the correct transmission of the production batch.

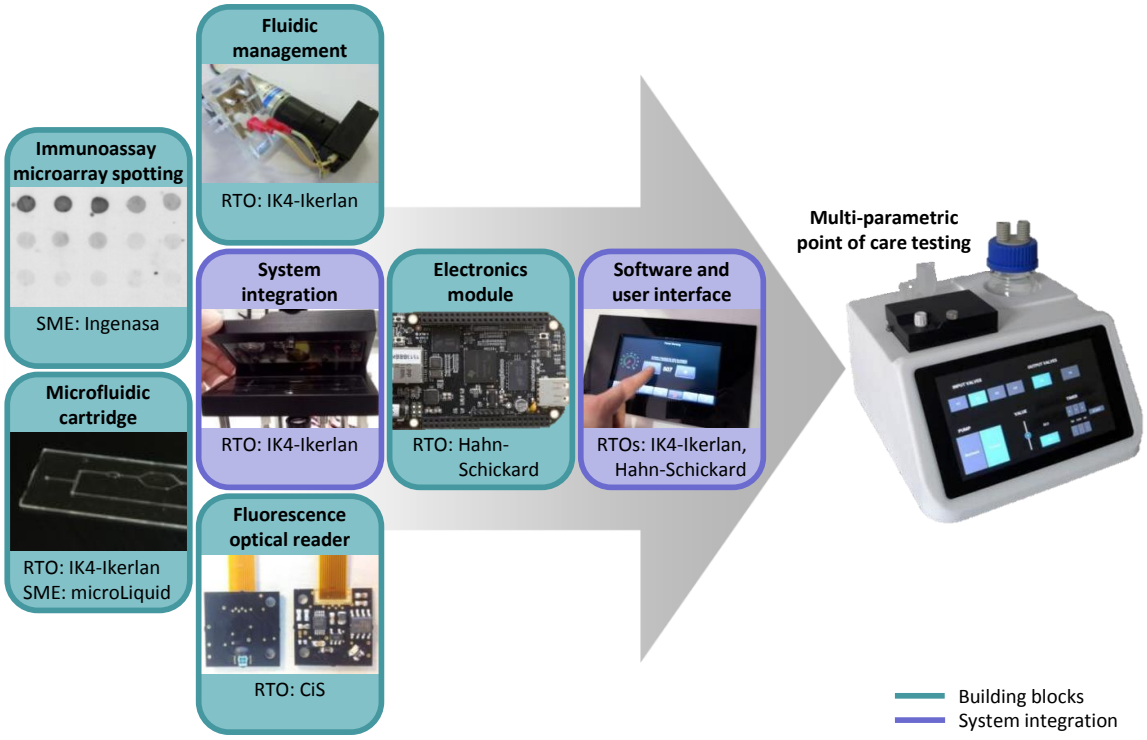


Figure 4: Modular approach of Smart Systems Integration in case of multi-parametric point of care testing. More details on this point of care device can be found in the appendix.

SMARTER-SI supported a total of 18 SMEs from different European countries thereby performing 11 "Application Experiments" (AEs). Each benefiting SME has been provided with a few dozen of integrated Smart Systems to conduct appropriate beta tests with their customers.

All AEs have been tailored to answer a specific and individual need, but there is a tremendous range of possible solutions. In order to raise the interest of further SMEs in Smart Systems and to motivate them to join such Cooperative Foundry Models, illustrative showcases highlighting the SME's need and the developed modular system as well as the different Building Blocks constituting the system were derived from the AEs. In addition, the added value and the economic impact were detailed. This allows SMEs to evaluate the direct benefit they can gain from such endeavours. From a commercial point of view, about a quarter of the AEs will become marketable products within one year after end of the funded project phase and the others expectedly in about three years. On a timescale of five years, all AEs are expected to have become products and to contribute to a

positive balance of sales of the involved SMEs. The invested funding will be leveraged by factors of 2-5 according to the actual market analyses performed by the SMEs that are responsible for the commercialisation of the results of the AEs. Some of the Building Blocks that can be reused will even reach leverages up to factors of 10 to 50. A list of all AEs together with selected showcases is available in the appendix.

SMARTER-SI fully implements the concept of regional Digital Innovation Hubs as well as the EPoSS strategy towards SMEs. 15 SMEs could be attracted and involved although they had never been participating in European projects before. This shows that beyond the expertise in Smart Systems provided by local hubs, proximity and close cultural background are additional key factors to overcome the previously mentioned barriers for SMEs to participate in European activities.

8. Perspectives

8.1. Sustainability of the Cooperative Foundry Model

Considering sustainability of the implemented Cooperative Foundry Model, it is obvious that innovative developments go along with high economic risks. The larger the company, the easier such initial risks can be carried and a potential total loss be compensated. However, keeping in mind that the average SME has about 4 employees, it becomes clear that most SMEs cannot risk losing the € 300-400 thousand required during the initial development phase. Hence, funding is required in this case to bridge the gap.

There are different initiatives on European, national, and regional levels to specifically support SMEs in this respect. On the European level, this includes the "SME instrument"[15] of Horizon 2020 and the "Eurostars"[16] program. Among the initiatives on national levels, for instance Germany has well-established programs to support innovative but risky developments and to promote the collaboration between SMEs and RTOs. Programs to be mentioned here are the "Zentrales Innovationsprogramm Mittelstand"[17] (ZIM, Central Innovation Programme for SMEs) and "KMU-innovativ"[18] (SME Innovative). Furthermore, the involvement of donations, trusts, or venture capital is in principle also possible, especially for SMEs in the start-up phase.

8.2. Towards Standardised Smart Systems Building Blocks

When conducting the Application Experiments that the project committed to in order to verify if the Cooperative Foundry Model works for small lot manufacturing of Smart Systems, it became clear that

1. a classification of Building Blocks and
2. the standardisation of Building Blocks

would not only help to address the three challenges mentioned previously, but would even substantially contribute to a globally competitive Cooperative Foundry for Smart Systems.

Extensive research was undertaken in 2016 that mapped standardisation committees at the European and international levels with the technologies, production processes, and application fields of Smart Systems

[15] EU SME instrument: https://ec.europa.eu/programmes/horizon2020/en/h2020-section/sme-instrument
[16] Eurostars: https://www.eurostars-eureka.eu
[17] ZIM: https://www.zim-bmwi.de/zim-overview
[18] KMU-innovativ: https://www.bmbf.de/de/kmu-innovativ-561.html

Integration with the results being publicly available[19]. This mapping was consulted to see whether there are ongoing standardisation activities matching the needs described above. However, this was not the case. The partners of the SMARTER-SI project have therefore started working on a taxonomy of standardised Smart Systems Building Blocks for the Building Blocks that were used in the 11 mentioned Application Experiments. According to this taxonomy, the standardised Building Blocks – in line with the definition of Smart Systems – are classified in the four generalised categories: sensor system, actuator system, energy system, and supporting system, the latter including simulation and testing & verification, etc. For each of these top level categories, a second level classification is proposed according to the process steps, the respective interfaces, and the technology used.

The targeted approach to the standardisation of Building Blocks requires for each Building Block the provision of a pre-defined set of information. This set consists of the technical specification in the form of a data sheet, but in addition includes further information which is indispensable for a successful hand-shake, namely a description of the provider of the Building Block, information on the design process, the technology flow, the manufacturing process, and the quality management process. Very practically it is foreseen to

- use the work conducted in the SMARTER-SI project as a basis for the development of a European or international standard,
- gather further contributions and support for the proposed classification and standardisation approach from relevant experts,
- thereby put the work on a broader stakeholder and consensus base,
- achieve a wide dissemination and use of the classification and standardisation approach,
- ultimately enable and support the manufacturing of innovative Smart Systems.

Note: In line with the World Trade Organization (WTO) criteria for standardisation, such as transparency, openness, impartiality and consensus, relevance and effectiveness, and coherence, an open approach to standardisation will be followed, so as to involve further relevant and interested experts.

9. Conclusion and Recommendation

The foundry platform implemented in SMARTER-SI lowers the entry threshold for SMEs and provides rapid access to available technology Building Blocks across Europe. However, close interaction and trust between the partners is a key requirement. This applies especially to the collaboration with SMEs and is a necessity if a marketable product is targeted. Typically, the funded period of the Application Experiments has been on the order of one to two years. However, the multilateral commitments of SMARTER-SI already go far beyond the project. It is estimated that the Cooperative Foundry Model reduces the time from idea to product by a factor of two. Compared to conventional funding formats, “cascaded funding” can further accelerate developments since a project can be initiated very quickly with no dedicated deadlines for proposals.

Currently the Cooperative Foundry SMARTER-SI covers RTOs from Germany, Sweden, Ireland, Spain, and Switzerland. Hence, SMEs from these countries interested in the manufacturing services provided, can directly contact a RTO acting as local contact point. Further contact details of the involved RTOs are given in the appendix of this brochure.

[19] Standardisation committees of relevance for Smart Systems Integration:
https://www.vdivde-it.de/eutool-express/public/ecosystem-knowledge-gateway/references/references-standardisation

Some of the presented products will be launched at the end of the project or only a few months later. In the first three years after the project, this already generates additional revenues for the SMEs which exceed the funds invested. This demonstrates that the new funding instrument "Innovation Action" of Horizon 2020 can be very effectively applied to support SMEs. Therefore, this instrument should be continued and further extended. In general, the SAE initiative is a great opportunity to bring the two worlds of hardware and software closer together.

10. Appendix – Application Experiments and Showcases of SMARTER-SI

10.1. List of All Application Experiments

Challenge and application	Cooperative Foundry solution
#1 Multi-parametric point of care testing to check food products (groceries) on micro-toxins	A portable, multi-parametric device to detect toxins / allergens being operable without previous knowledge
#2 Dew-point measurement during freeze-drying and in process control	An energy-autonomous measurement system with short response time and high precision
#3 Carbon dioxide measurement in industrial climate control / special environments	A maintenance free system with minimum power consumption, high sensitivity, and low detection limit
#4 Screening of water quality in household applications and industrial processes	A portable device to detect chloroform and other water pollutants
#5 Clutch-brake wear monitoring to extend the periods of maintenance	An autonomous smart sensor system enabling predictive maintenance by continuous wear control
#6 Smart well plate for cell and tissue culture	A 12-well plate with Si_3N_4 microporous membranes and trans epitheal electric resistance measurement
#7 Environmental supervision unit for the development phase of a product	A modular multi sensor unit to supervise and understand the specific working environment
#8 High-stability pressure sensor for process industry 4.0	A high-sensitive, robust sensor based on a silicon strain gauge and a ceramics membrane
#9 Capillary electrophoresis system to replace expensive and cumbersome methods	A portable and miniaturized device for the detection of bio-markers and drugs
#10 Smart respiration system for patient-side resuscitation / artificial respiration	A miniaturised medical sensor platform for flow, temperature, pressure, and CO_2
#11 Attachment of false eyelashes without substances causing health damages	A new attachment process without hazardous substances superseding the hitherto existing ones

10.2. Selected Showcases

Challenge: #1 Multi-parametric point of care testing

The quality of food that is part of our daily diet is becoming more and more important. Thanks to immune-enzymatic techniques it is possible to detect and even quantify a large number of substances of interest. However, current solutions require a set of individual kits.

SME: Ingenasa, Spain (http://www.ingenasa.eu)
microLIQUID SL, Spain (http://www.microliquid.com)

Cooperative Foundry solution

A portable, multi-parametric device to detect allergens and a set of toxins in food products in a friendly, automatised, and low cost way.

Building Block	TRL	Provision*
Microarray spotting	8	Ingenasa
Microfluidic cartridge	8	IK4-Ikerlan, microLIQUID SL
Fluidic management	7	IK4-Ikerlan
Optical reader	7	CiS
Electronics module	7	Hahn-Schickard

Technical benefits

- Modular system for multi-parametric optical detection
- A low cost disposable plastic microfluidic cartridge
- Open concept for different applications

Commercial benefits

- Multi-parametric instead of unitary tests
- Ingenasa will benefit for food and veterinary applications
- microLIQUID SL will be able to adapt the concept for niche markets

Challenge: #5 Clutch-brake wear monitoring

A clutch-brake system transfers the continuous motion from a motor flywheel to pieces of a machine that need repetitive motion steps, mainly where power transmission is needed. In case of bad conditions running, the system becomes uncontrolled and can be damaged. Currently, the wear check is done manually by qualified technical staff and requires a complete stop of the machine with associated downtime costs.

SME: Goizper, Spain (http://www.goizper.com)

Cooperative Foundry solution

An autonomous smart sensor system enabling predictive maintenance by continuous wear control.

Building Block	TRL	Provision*
Sensors	8	IK4-Ikerlan
Electronics	8	IK4-Ikerlan
Energy harvester	7	Hahn-Schickard
Wireless comm.	8	Hahn-Schickard

Technical benefits

- Monitoring of pad wear as well maximum temperature at the friction point
- Sensor integration in a rotating wheel ensuring direct measurement
- Energy harvesting, wireless data transfer, and low power electronics

Commercial benefits

- Added self-monitoring capability which is a key solution in big machinery
- Increased revenues by avoided mechanical damages and reduced maintenance costs
- Goizper will benefit by strengthened market position and share

Challenge: #7 Environmental supervision unit

As soon as electronic equipment is to be used in harsh environments and long expected lifetimes have to be addressed, there is a need to understand the specific environmental conditions in more detail. Today, this situation is reality in many application areas including the automotive sector, the heavy industry, and the defence sector.

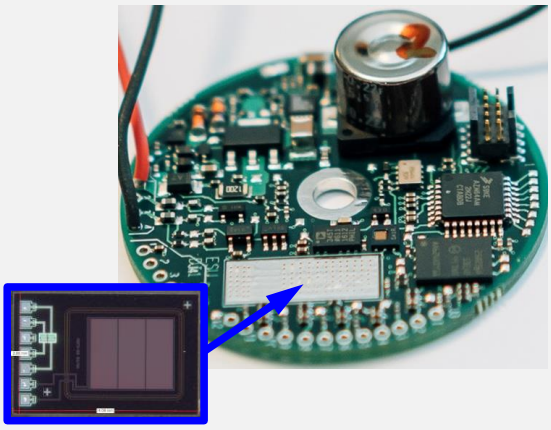
SME: SETEK Elektronik AB, Sweden (http://setek.se)
Niranova AB, Sweden (http://www.niranova.se)

Cooperative Foundry solution

To fully understand the specific working environment, a modular multi sensor supervision unit to be used during the product development phase of new products has been developed.

Building Block	TRL	Provision*
Condensation sensor	7	CiS
HALT / HASS	9	Swerea IVF AB
EMC	9	Swerea IVF AB

HALT – Highly accelerated life test
HASS – Highly accelerated stress screen
EMC – Electromagnetic compatibility



Technical benefits

- Environmental sensor system monitoring temperature, vibration, humidity, condensation, etc.
- Unique condensation sensor
- Modularity regarding sensors and software

Commercial benefits

- Unique solution on the market
- SETEK Elektronik AB tests the unit using an industrial reference group
- New markets and new customer relations could be established

***RTOs forming the Cooperative Foundry of SMARTER-SI (in alphabetical order)**

Centre Suisse d'Electronique et de Microtechnique, Neuchâtel, Switzerland
https://www.csem.ch

CiS Forschungsinstitut für Mikrosensorik GmbH, Erfurt, Germany
https://cismst.org

Hahn-Schickard-Gesellschaft für angewandte Forschung e.V., Villingen-Schwenningen, Germany
https://www.hahn-schickard.de

IK4-Ikerlan, Arrasate / Mondragón, Spain
http://www.ikerlan.es

Swerea IVF AB, Mölndal, Sweden
https://www.swerea.se

Tyndall National Institute, Cork, Ireland
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