Smart Anything Everywhere Initiative

Area 3: Advanced micro-electronics components and Smart System Integration

Project: H2020–No 761809

Digital Innovation Hubs boosting European Microelectronics Industry

Annex 1: Open Call #2 Text

Version 2.1

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Disclaimer

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01	INTRASOFT International S.A.	INTRA	BE
02	F6S NETWORK LIMITED	F6S	UK
03	BioSense	BIOS	SRB
04	Synelixis Solutions	SYN	EL
05	Instituto Pedro Nunes	IPN	PT
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List of Abbreviations

AME/SSI	Advanced Microelectronics and Smart Integration Systems
CC	Competence Centres
CPPS	Cyber-Physical Production System
DIH	Digital Innovation Hub
EC	European Commission
EU	European Union
I4MS	ICT Innovation for Manufacturing SMEs
RTD	Research and Technological Development
RTO	Research and Technology Organization
SAE	Smart Anything Everywhere
SME	Small and Medium-sized enterprises (including also mid-caps)
TRL	Technology Readiness Level

1 Introduction

A large percentage of the European SMEs and mid-caps from all sectors have ***limited knowledge*** of what smart electronics and smart systems can do. The situation is aggravated by the fact that the “Advanced Micro-Electronics (AME) and Smart System Integration (SSI)” technologies are a large family ***of technologies*** *with* ***diverse potential per sector:*** Micro-Nano-Bio-Systems are significantly more valuable in the health domain than in the manufacturing domain while reversely, smart system integration and combined sensing may be more effective in the agriculture sector. They also ***lack easy access*** to diverse competencies, primarily technological and scientific, but also competencies regarding business development and market access. While these competencies often exist locally or abroad, they find it difficult and costly to search, find and connect with the relevant players and the resources/ competencies they possess. Even when digital innovation is undertaken, companies must face the ***valley of death*** to reach TRLs of 7 or higher. One reason for this is the ***inability to reach critical market mass***. This challenge could be addressed by pursuing user-driven application development followed by *targeting a sufficiently large group of customers*, most likely located across national borders; however, this strategy requires a set of expertise not commonly available to SMEs.

Starting in FP7 and more broadly applied in Horizon 2020, the European Commission is supporting a group of initiatives supporting SMEs and mid-caps across the economy in digital value creation. The formula for success is the collaboration of industrial actors across the complete value chain in a large number of small experiments facilitated by Europe’s leading Competence Centres (CC). By going broad both in terms of applications and in terms of actors (e.g. SMEs and mid-caps both on provider and user side), this scheme is an important means for putting Europe’s industrial renaissance on a more solid foundation. The major initiatives are “ICT Innovation for Manufacturing SMEs” (I4MS), supporting largely process innovation, and “Smart Anything Everywhere” (SAE), supporting product and service innovation:

- *ICT Innovation for Manufacturing SMEs (I4MS)* is addressing process innovation through digital technologies such as simulation, modelling and data-analytics; robotics; advanced lasers and smart sensors; cyber-physical systems and the Internet of Things (IoT). Currently 40 competence centres in 17 Member States, 150 experiments and 150 SMEs or mid-caps are participating in I4MS.
- *Smart Anything Everywhere (SAE)* is supporting product and service innovation through digital technologies. Clustered in four projects with a total budget of 25M€, SAE aims to support at least 100 user-supplier experiments with 200 SMEs and mid-caps.

As shown in Figure 1, the primary target of SAE is to support the technology suppliers and the technology users crossing the “the chasm” (also known as “valley of death” for the SMEs) moving form innovators to early adopters and early majority. Thus, on one hand to support the technology suppliers in sustainability and on the other to support users gaining a competitive advantage through early technology adoption. As a secondary target, SAE aim to stimulate the replication potential through the dissemination of best practices

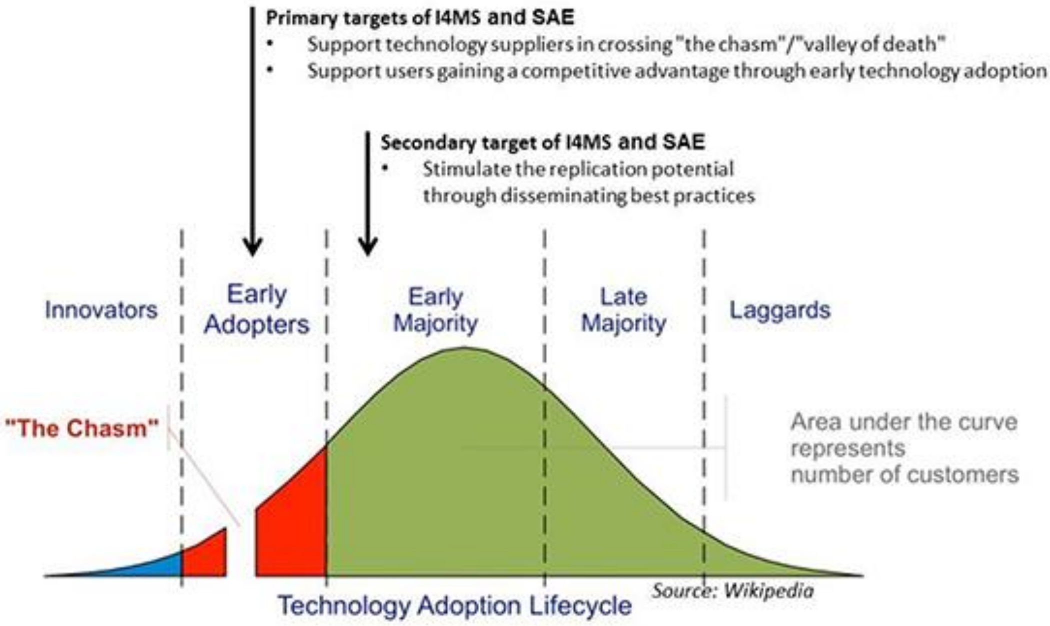

Figure 1: I4MS and SAE initiatives in the technology adoption lifecycle [1]

SAE actions aim at stimulating broad adoption of novel embedded, advanced microelectronics and smart integration systems technologies and their enablers in industrial and societal applications important for Europe. Experiments should bring together all actors of the value chain and experts necessary to equip new users with novel products or services. With special emphasis on SMEs, the focus of these experiments is on the adoption of emerging innovative technologies and processes, which are customised, integrated, tested and validated in the experiments before being able to compete on the market.

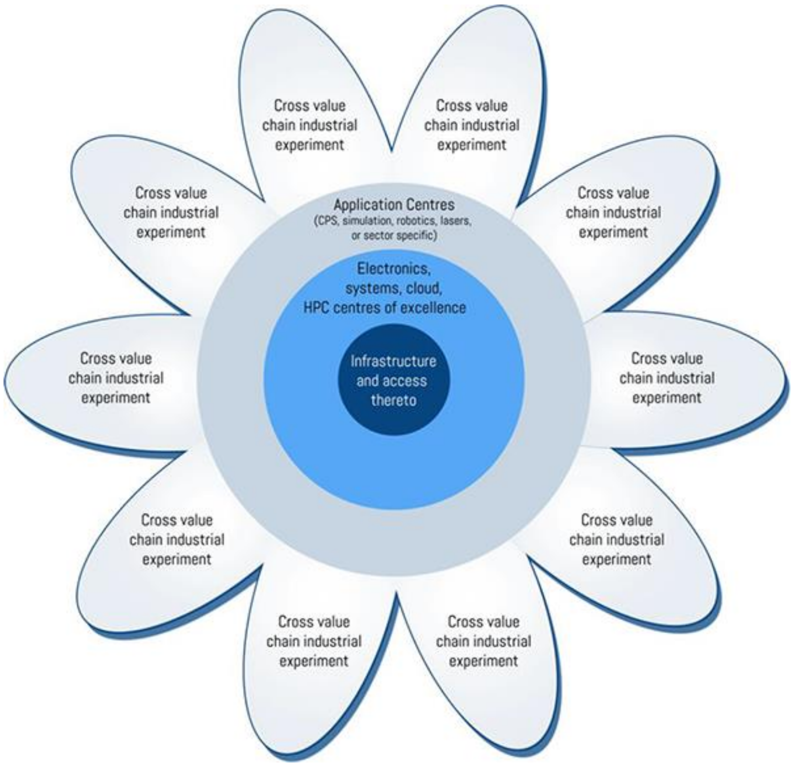

Figure 2: SAE ecosystems [1]

As shown in Figure 2, the core of the SAE ecosystems clusters knowledge and access to specific technology and platforms which can be used in experiments. The experiments may be driven by a competence centre or several competence centres are networked together leading to a European network of competence centres

In more details, SAE aims at supporting SMEs and mid-caps (in the later, SMEs may also mean SMEs and mid-caps for simplicity) along three dimensions:

- Provide access to competences that can help in assessing, planning and mastering the digital transformation.
- Provide access to innovation networks of a broad spectrum of competences and best practice examples.
- Provide financial support to SMEs on the demand and the supply side to master the digital transformation.

The underlying idea is to enable and to foster the collaboration of SMEs across their value chains via European competence centres / digital innovation hubs (e.g. top universities, application-oriented research organisations, platform providers) in predominantly cross-border experiments to create a win-win situation for all.

Within the focused experiments of short duration, brokerage and transfer of technology know-how are provided by the Digital innovation Hubs (DIH) to the SMEs. SAE not only resolves the competence gap of SMEs, but also provides them with the financial means to adopt leading edge digital technology. In this way, the SMEs are capable to bring innovative and highly competitive new products and services to the market.

Innovative platform providers profit from SAE as the experiments enable them to mature their existing technologies. The experiments also broaden the field of application and ultimately open them new markets and services.

Last but not least, the competence centres benefit from the initiative, as they extend their largely research oriented activities with industrial projects thereby gaining a new sustainable business model.

To allow for a lean and efficient support to the end user SMEs, the administrative procedures to benefit from EU funding have been simplified further using the flexible and dynamic "Financial Support to Third Parties" scheme of H2020 ("cascade funding"). Rather than entering into a direct contractual agreement with the European Commission, companies sign a light contract with one of the projects' beneficiaries.

1.1 DIATOMIC - project overview

DIATOMIC is an EU H2020 funded project, which aims to establish a sustainable ecosystem, which will facilitate *Advanced micro-electronics components and Smart System Integration* (AME/SSI) based innovation in the *health*, *agrifood* and *manufacturing* sectors, all of which are under-digitized and of prime importance for the European society and the economy. Ultimate goal of DIATOMIC is to support the take-up of electronic components, sensors, smart objects and systems by providing the means to gain access (i) for SMEs, academia and research institutes to advanced design and manufacturing facilities and (ii) for SMEs to rapid prototyping capabilities.

DIATOMIC consortium is a fusion between: technological research centres (IPA, IPN and BIOS), CCs (INTRA, LIB and SYN), innovation consulting (INO), SMEs community (F6S) and investors (FASTT). DIATOMIC ecosystem draws from the advanced technological excellence of the DIATOMIC consortium to execute three sector-specific cross-border Application Experiments (as best practices) to help technology adopters, end-users and smart solution developers realise tangible benefits of digitization. In-house excellence in dissemination is leveraged to ignite further ideation of digital products, processes and business models from non-tech SMEs and midcaps; thus promoting interest in experimentation with AME and SSI.

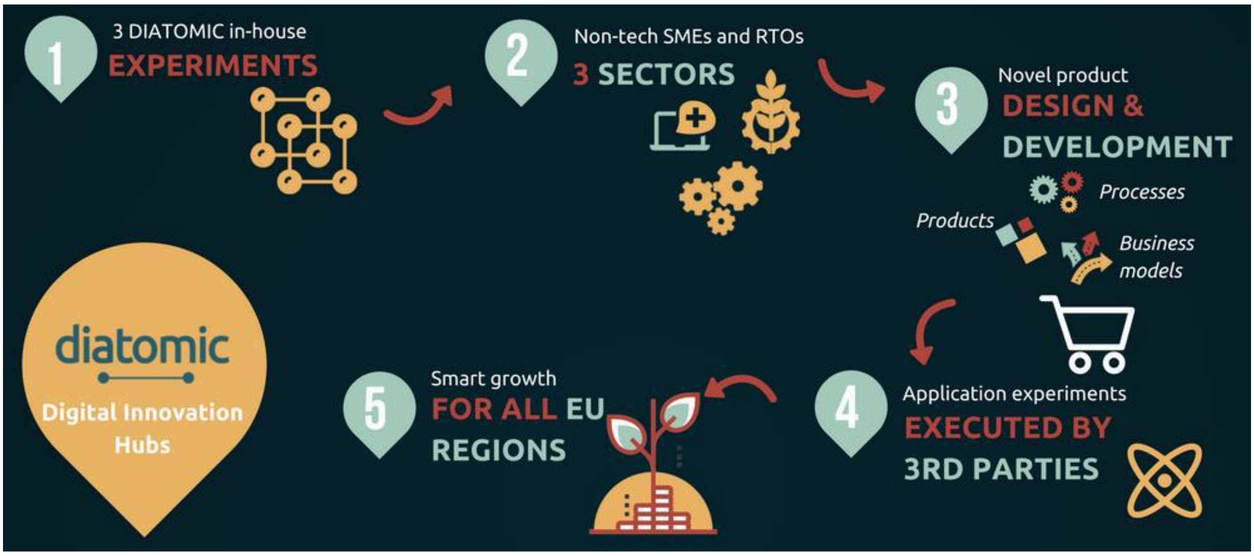

Figure 3: DIATOMIC digital ecosystem

Two open calls are organised to attract and select the best of the best consortia, consisting of tech adopters, tech providers and Competence Centres (CC). Application Experiments will be funded to generate AME/SSI-based products, processes and business models with strong market potential.

1.2 The rationale for selecting DIATOMIC domains

While DIATOMIC is apt for all sectors of the EU economy, we have selected three domains on the basis of: (currently low) **digitization level** of enterprises, (high) **market size and potential** and (high) **societal importance.** Their potential to act as flagships for industry digitization based on AME and SSI was also considered.

- **The health domain:** Smart Systems, with their in-built adaptive capabilities and great potential for portability brought about by miniaturization, can bring benefits across the entire spectrum of healthcare and wellbeing. Applications include personal diagnosis, monitoring and fitness, treatment and implants and ultimately, enhanced levels of telemedicine across the community. The health and personal wellbeing sector worldwide is immense in value: in 2011, $309bn for the worldwide medical device sector, including $90bn for medical electronics[1]. Currently Smart Systems account for ~10 to 12% of this but could rise to ~40% of the $130bn of medical electronics market (€50bn) by 2020. According to surveys[2], Smart Systems providers in the health sector rated "increased functionality" as the most important driver to compel the use of new devices or techniques compared to, in descending order, reduced cost, increased reliability, new markets, global competitiveness, simplicity in use, and legislative drives; the most obstructive difficulty reported was "untried techniques".
- **The agrifood domain:** Production and processing of food is one of the basic pillars of the EU economy. At the same time, "***the sector of the economy with the lowest IT intensity*** is farming, where IT accounts for just 1% of all capital spending"[3]. The sector has a turnover of €1 trillion and is the leading employer in the EU (16% of total)[4]. The EU has the largest share

[1] VisionGain, 2012. Medical devices industry and market prospects 2013-2023
[2] EXPRESS Project, 2016.
[3] IBM Institute for Business Value, 2015. Device democracy: Saving the future of the Internet of Things.
[4] FoodDrinkEurope, 2013. Trends of the European Food and Drink Industry 2013-2014.

of the global food and drinks market, but its share has dropped from 20% in 2001 to 16% in 2012[5]. As noted by the EC, slow growth in labor productivity and added-value have decreased the competitiveness of EU`s food producers[6]. R&D and innovation in the industry is ranked as below average[7]. Thus, investments in digital innovation have large inherent potential: production is a complex "input-output problem"[8] and supply chains, manufacturing/distribution a logistics problem; Smart Systems can radically increase data collection and processing enabling new efficiencies. In addition, consumer driven trends are changing the sector: interest in the link between food and health has changed mainstream consumption patterns by valorizing quality aspects related to good health. ICTs have the potential to enforce current strengths of the EU agrifood sector on the global market, and generate new products, processes and business models that better deliver value in line with arising consumer trends.

- **The manufacturing domain:** Manufacturing is ***among the most impervious to digital change*** with just 12% of high digital innovation index[9]. Smart Systems promise to carry out local optimization underpinned by local knowledge bases, ranging from the examination of raw materials and parts, predicting subsequent machine settings to compensate for variation, all the way through to optimizing manufacturing parameters. Smart Systems could compensate from measurements on-line, at end-of-line or from live data collected in the field as the product is used. The manufacturing equipment sector in EU27+EFTA is estimated at €57bn. Currently, Smart Systems account for ~10% of this, in machine automation, but could rise to ~20% by 2020 (€12bn). Front-running technologies are Microsensors & Microactuators, MEMS, MOEMS and Microfluidics, Design & Simulation, and Semiconductors & More-than-Moore technologies. Smart Systems providers to the Manufacturing automation sector rated "increased functionality" as the most important driver compared to, in descending order, reduced cost, increased reliability, global competitiveness, new markets, simplicity in use, and legislative drives to compel the use of new devices or techniques; the most obstructive difficulty reported was "fragmented supply chain".

[5] EUROSTAT database, 2014.

[6]EC, 2016. Growth: Food and Drinks Industry.

[7] Aslesen, H.W., 2008. Prospective innovation challenges in the food and drink sector.

[8] MIT Technology Review, 2016. 10 Breakthrough Technologies.

[9] EC, 2016. Europe's digital progress report 2016.

2 Call for Proposals

DIATOMIC ecosystem invites small consortia to design, develop, experiment and market innovative, smart SAE applications, which will facilitate *Advanced micro-electronics components and Smart System Integration* (AME/SSI) based innovation in the *health*, *agrifood* and *manufacturing* sectors. The consortia should consist of 2 to 3 partners consisting of:

- **AME/SSI Technology providers:** Technology SMEs, Competence Centres, Research Centres and academia
- **Technology adopters/users:** SMEs/mid-caps active in any of the three targeted sectors. Please note that the digitalization of non-tech SMEs is a focus on DIATOMIC.

Applicants shall consider the following general criteria when applying for the DIATOMIC project:

- **AME and SSI technologies:** The consortium must propose the development of novel products/ processes along with relevant experiments making use of AME and SSI technologies and starting from a TRL of 3. This must aim towards the digitization of products and/or processes.
- **Business mindset:** In addition to presenting the technological concept, applicants are requested to provide initial exploitation plans and business scenarios for their experiments.

The goal is for them to propose the development of novel products/processes along with relevant experiments making use of AME and SSI technologies, quantifying the benefits of digitization to further stimulate digital thinking.

The innovation, inspiration and productivity of tech adopter/user will be used as an evaluation criterion to ensure bottom-up application design. Proposals with cross-border aspects or bringing private funding to reduce the DIATOMIC funding rate will be favoured.

Example experiments are provided in Section 6.

Once funded, third parties are provided with business support and one-on-one coaching to support business development during all stages of the application experiment. In addition to presenting the technological concept, applicants are requested to provide initial exploitation plans and business scenarios for their experiments, as these are important elements of the DIATOMIC evaluation criteria. As the business plan of the technology adopter strongly depends on the technological development speed and cost, tech adopter SME/mid-caps are urged to collaborate with the most competent and efficient technology provider.

2.1 Basic Eligibility Rules

DIATOMIC will issue two open calls to maximise the quality and availability of the technical and business support services/resources and to gradually improve its offerings, integrating lessons learned during the first call.

A consortium is considered eligible if it complies will **<u>all</u>** the following rules:

- All consortium members are legal entities established and based in one of the EU Member States or an H2020 Associated country as defined in H2020 rules for participation[10]:
- All consortia members are SMEs (or midcaps) or research/non-industrial entities (i.e. research centres, universities, Competence Centres), either AME/SSI Technology providers or technology adopters/users in the AME/SSI sector or provide innovation in the

[10] Association to Horizon 2020 is governed by Article 7 of the Horizon 2020 Regulation. The list of associated countries is available at:
http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf

health, agrifood and manufacturing sectors.

- Consortia can only be led by industrial partners (SMEs and midcaps),
- Each consortium should include at least one Competence or Research centre specialized in the AME/SSI sector or provide innovation in the health, agrifood and manufacturing sectors.
- The total funding of the non-industry and/or non-profit partners (if any) cannot exceed the 40% of the entire experiment budget,
- Each partner can receive funding in the range of €20.000-€100.000.
- The budget per experiment may vary from €70.000 to €200.000.
- Experiments must have a clear European dimension, facilitate AME/SSI based innovation and contribute towards European Union digitization, with a clear economic and societal importance. As such cross-national/cross-border consortia are highly recommended.
- Non-industry partners should be members of the DIATOMIC DIH i.e. register at least ten days before the open call deadline through DIATOMIC DIH portal.
- There are **very strict limitations in the number of submitted proposal per organization**, which may result in excluding a proposal from the evaluation process (please check **Annex 2 "Open call guidelines for applicants" section 3.3)**

2.2 Funding Scheme

DIATOMIC ecosystem targets the *health*, *agrifood* and *manufacturing* sectors. The budget breakdown per target sector that will be addressed, as well as the budget distribution among the calls and among the sectors, are shown in the Table 1. Based on the above rules, the minimum and maximum numbers of experiments per call are planned as following:

DIATOMIC funding for Open Call #2:	≤ 1.610.000€
Total funding for DIATOMIC Open Calls:	**3.000.000€**
Funding per sector in Open Call #2:	Manufacturing: 40% Health: 25% Agrifood: 25% Others: 10%
Number of application experiments funded:	15 – 42
Number of entities supported:	30 – 140

Table 1: DIATOMIC Open Calls summary

With respect to the addressed sectors, DIATOMIC will focus on application experiments in the three sectors, putting emphasis on Open Call#2 to the manufacturing domain. It is planned that funding not allocated to a sector, will be moved to the rest of the categories so that at least 90% of the funding will be allocated to DIATOMIC selected sectors. **This is not a binding condition, and DIATOMIC consortium keeps the right to modify the final distribution, so that priority will be given to the best proposals in the areas of advanced micro-electronics and smart system integration in the three targeted sectors.**

An amount of 1.610.000Euros is allocated for Open Call #2. In case there is a leftover after the second call and the remaining funding is at least 50% of the requested funding from the proposal that is at the funding borderline to get funding, a negotiation may take place with the borderline consortium.

In case some funding remains after the end of the second call negotiations or if it is not sufficiently distributed (e.g. in case a sub-contract is not sufficiently executed, and it is terminated), a hackathon/ competition may be organised to attract the interest of entrepreneurs/ innovators in the experimentation with AME and SSI technologies.

Each sub-project (selected via the open calls) will receive the funding on a lump sum scheme and according to the terms of the contract signed between DIATOMIC consortium (represented by the Project Coordinator and the Budget Holder) and the selected project representative. In more details, each sub-project deliverable will be associated with a specific cost.

2.3 Financial Audits

The EC may, at any time during the implementation of the DIATOMIC project and up to five years after the end of the sub-project, arrange for financial audits to be carried out, by external auditors, or by the EC services themselves including the European Anti-Fraud office (OLAF) or on-the-spot checks and inspections in accordance with Council Regulation (Euratom, EC) No 2185/96 of 11 November 1996. Such audits and checks may cover financial, systemic and other aspects (such as accounting and management principles) relating to the proper execution of the grant agreement. Each member of the sub-project consortium shall make available directly to the EC all detailed information and data that may be requested by the EC or any representative authorized by it.

3 Programme activities

DIATOMIC will finance experiments carried out by the most talented actors exploiting advanced micro-electronics and smart system integration in the three targeted sectors. Along the experiments, DIATOMIC partners/ network will provide strong (i) technological support covering wide palette of technologies and (ii) business development coaching.

DIATOMIC experiments will be divided in 3 phases, which characterize the phase of development of the experiment and also defines the payment to respective consortium leaders:

- **Phase 1 - Design (1-2 months):**
    - Within this stage experiments are to be planned and detailed, jointly - experiment consortium leader and Digital Innovation Hub representative - design a work plan of the different activities and resources to be executed along the experiment duration. This information will be included in a project deliverable.
    - Positive assessment of this phase deliverable/deliverables may release a payment of up to 40% of the total sub-project funding (with a total value ceiling of €30.000,00).

- **Phase 2 - Develop (6-9 months**):
    - Within this stage, the sub-projects perform their technical developments and realises the work plan. At least one deliverable will be prepared by the experiment, which will be the demonstration of the experiment development results.
    - Positive assessment of this phase deliverable/deliverables may release an additional payment, so that the total funding of Phase 1 and Phase 2 will be up to 70% of the total sub-project funding.

- **Phase 3 - Market (2-3 months):**
    - Within this stage experiments focus on exploitation of the results/ achievements (preparation and performance of demonstrations; contacts with potential partners, investors, customers; be present at conferences/ events to promote and sell experiment achievements/ results). At least one deliverable will report on market associated activities (even the ones performed along the experiment development).
    - Positive assessment of this phase deliverable/deliverables will make the remaining payment of the DIATOMIC fund eligible. However, due to 15% project funds retained by EC, the total funding to be released after Phase 3 will be up to 85%, while the final 15% of the sub-project funding will be released from DIATOMIC to the sub-projects only after the EC transfers the final funding to the DIATOMIC consortium.

The maximum sub-project duration will be 15 months and should finish at least 2 months before the end of DIATOMIC project. As such reviews are scheduled to meet this requirement. Yet sub-projects with shorter duration may have development and market review together at end of month 10.

4 Open Call submission and selection process

Submission to the second Open Call will be enabled on the 1st of November 2018 and will end on the 31st of January 2019. Below are presented the current tentative dates for the different phases. The opening and closing dates can be subject to change in case of any modifications in the project's schedule.

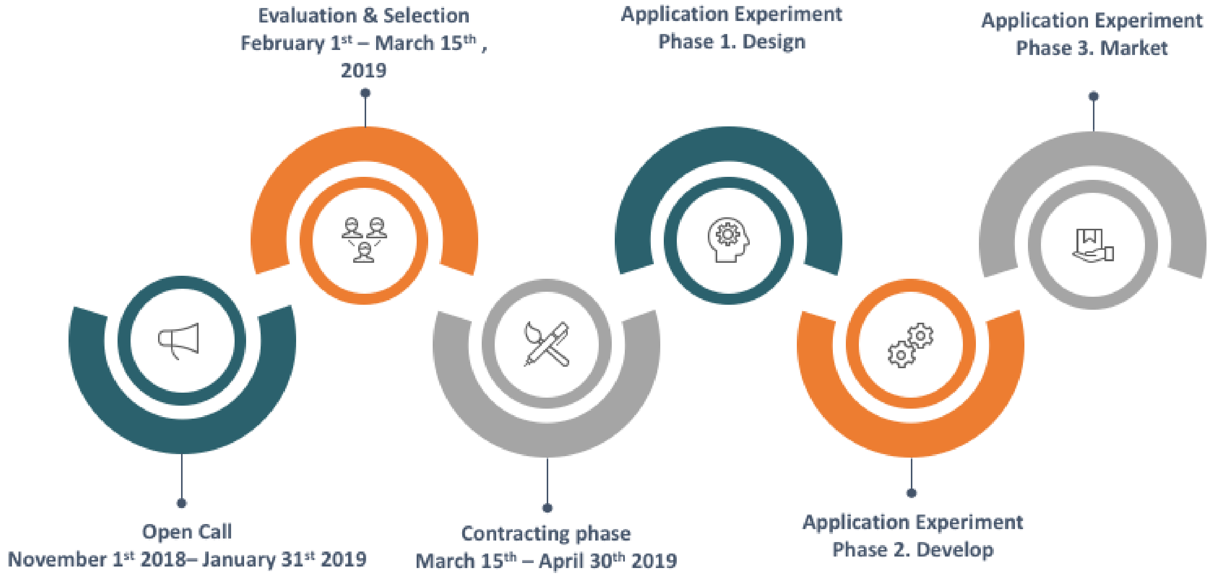

Figure 4: DIATOMIC Open Call 2 timeline

5 Intellectual Property Rights (IPR)

The following Intellectual property Rights conditions should be followed:

1. The proposals submitted should be solely based on original works by the applicants and their foreseen developments are free from third party rights, or they are clearly stated.
2. All IPR created by the applicants via the DIATOMIC funding will remain to the applicants, who will be the unique owners of the technologies created within the framework of their sub-granted projects.
3. Any communication or publication by the funded applicants shall clearly indicate that the project has received funding from the European Union, the SAE and DIATOMIC project displaying the EU logo and H2020 logo on all printed and digital material, including websites and press releases.
4. Parts of the projects selected for funding (including the publishable summary of page A-2 of the proposal) will be used for DIATOMIC dissemination purposes.
5. The sub-project consortium shall, throughout the duration of the Project, take appropriate measures to engage with the public and the media about the project and to highlight the financial support of the EC. Moreover, all measurements of the sub-project experiments should be published as open data (unless an exception it is fully justified), respecting DIATOMIC Data Management Plan and any Ethical issues defined by the European Commission and National Regulations. Any publicity made by the sub-project consortium in respect of the sub-project, in whatever form and on or by whatever medium, must specify a) that it is funded by the European Commission via the DIATOMIC project and b) that it reflects only the author’s views and that the EC and DIATOMIC is not liable for any use that may be made of the information contained therein. Moreover, the EC and the DIATOMIC consortium shall be authorized to publish, in whatever form and on or by whatever medium, information related to the sub-project.

6 Success Stories & Model Experiments

Success Stories in the area of SAE are available at the following web site: **https://smartanythingeverywhere.eu/success-stories/**

Additionally, DIATOMIC provides three experiments implemented by the DIATOMIC CCs in the areas of Smart Agrifood, Smart Health and Smart Manufacturing. More information on these experiments are available at: https://diatomic.eu/index.php/push-experiments/

The Health and Agrifood experiments focus on the development and implementation of communications between different platforms and IoT devices belonging to Health and Agriculture world. All these integrations end up into solutions where sensors collect data from different applications and all the information is stored on clouds to be available for end users or applications.

The Manufacturing experiment is focused on Industrial Automation and 3D printing activities, forming a cyber-physical production system (CPPS), a mechanism controlled and monitored by computer-based algorithms, and tightly integrated with the Internet and its users. All the devices will be controlled without the need of a PLC and will adapt to the user's order and optimize production according to their characteristics.

With these three experiments the group aims to show and demonstrate DIATOMIC technology and its modularity: all the hardware and platforms can be used independently, combined or even replaced by different ones.

6.1 Description of Agro Application Experiments

The objective of the Agro Application Experiments in DIATOMIC is to create a fully functional service that offers the opportunity to farmers/agronomists/farm logistics managers to access all important parameters to accomplish efficient and self-sustainable agricultural production and offer innovative and specialized services in the agricultural domain. The service is created by integration of Synelixis SynField solution/platform (http://www.synelixis.com/products/prod-synfield/) and BioSense Plant-O-Meter systems to offer unprecedented flexibility to prospective developers and an enhanced experience to technology adopters and users.

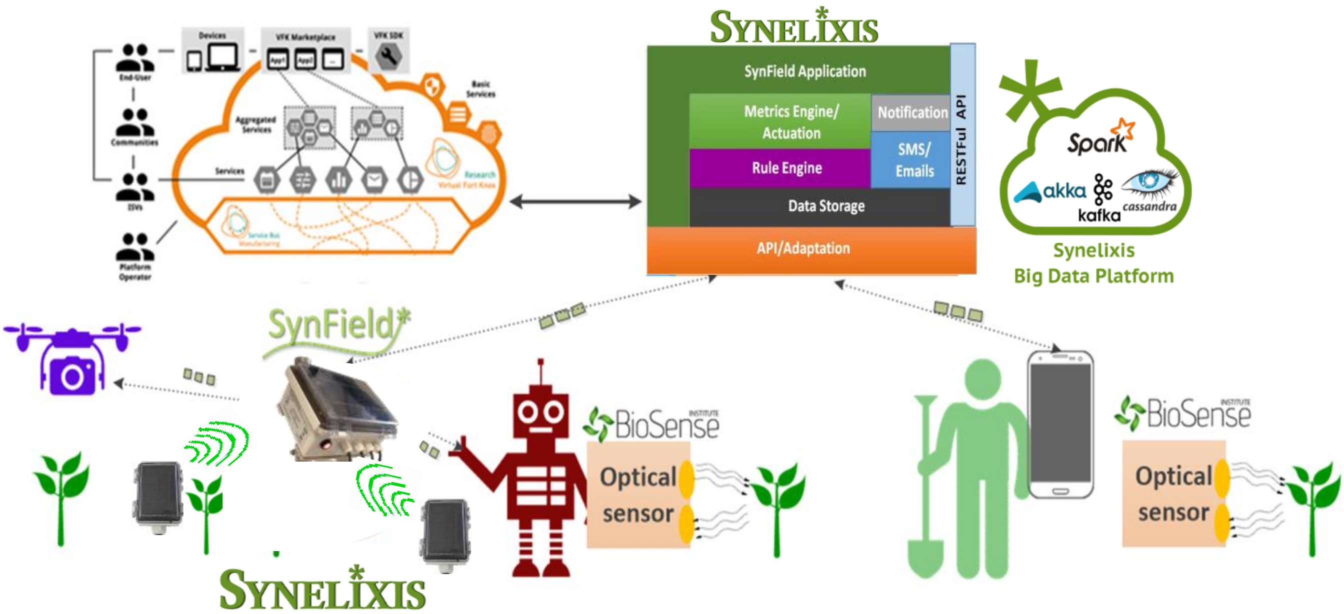

Figure 5: Agro Application Experiment

6.1.1 The SynField Monitoring System

SynField is Synelixis' flexible, vendor independent solution for smart agriculture applications. It comes to fill the gap of remote monitoring of the environmental conditions (i.e. air temperature, wind level and volume, rainfall level, soil and air humidity, leaf wetness) and rule based/remote control of the irrigation system, which is also expandable to other relay-controlled systems, based not only on time-parameters but also on sensed values.

SynField offers solutions that help farmers control their farming procedures remotely, with high accuracy and at low cost to meet the needs, not only of large, but also, of small and medium sized farms. The sensed data are delivered to the SynCloud Cloud platform where commands for actuations are decided. The system (currently TRL-9) also alerts the farmer under specific user-defined conditions so that they may take appropriate action.

6.1.1.1 Applications

SynField system is an advanced control and monitoring platform for small-medium sized farms that performs the following two main functions:

- ✓ ***Monitoring*** of soil, atmospheric and plant conditions, in order to predict for crop diseases probability
- ✓ ***Automatic irrigation and fertilization control***, based on calendar, crop growth or environmental conditions (i.e. soil-moisture levels and low-temperatures/ice prevention)
- ✓ ***Alerts/notification initiation*** through email/SMS when certain conditions/rules are met

6.1.1.2 Reference Deployment

The SynField ecosystem comprises of SynField nodes, which are sensor-logging and actuation systems installed in the field. They periodically or on demand collect values from various analogue and/or digital sensors and log them to the SynField Cloud Server via a cellular (GPRS/Edge) or WiFi connection. Moreover, they act as actuators to enable remotely controlled smart irrigation by handling solenoid valves, pumps start/stop or relay-switches. Thanks to its state-of the art and expandable design, SynField nodes can be interconnected in the field by means of a multi-hop mesh network (at the sub-GHz ISM band, 868/915MHz) supporting Line-of-Sight (LoS) distances of at least 1km .

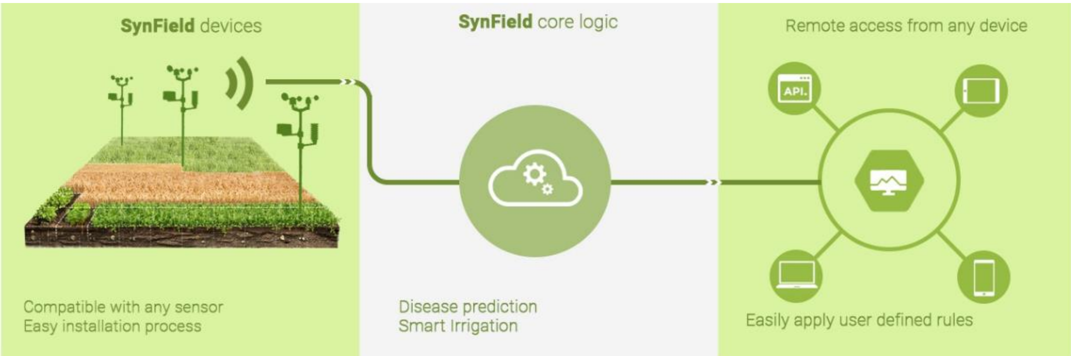

Figure 6: SynField ecosystem

The SynField Cloud Server portal enables the user to remotely monitor various environmental and soil parameters in his/her field and provides the means to define sophisticated rules that can trigger alarms (i.e. SMS/email messages) or remote control actuators (i.e. solenoid valves, relay-switches).

Typically, a SynField installation (see Figure 7) consists of:

- A SynField Head Node (SynField-HN), which is connected to the cloud utilizing cellular or WiFi interface.
- Optionally, several (up to 20) SynField Peripheral Nodes (SynField-PN), interconnected to the SynField-HN device by means of a mesh multi-hop RF network.
- Environmental/soil sensors and actuators (i.e. solenoid valves and relay-switches) attached to the SynField-HN and the SynField-PN devices.

The SynField web app communicates directly with a SynField-HN. All SynField-PN are associated with a SynField-HN, which is used as communication gateway/relay. When the distance between the SynField-HN and a SynField-PN is more than the above distance or in case of obstacles that reduce the communication distance multi-hop communications are utilized.

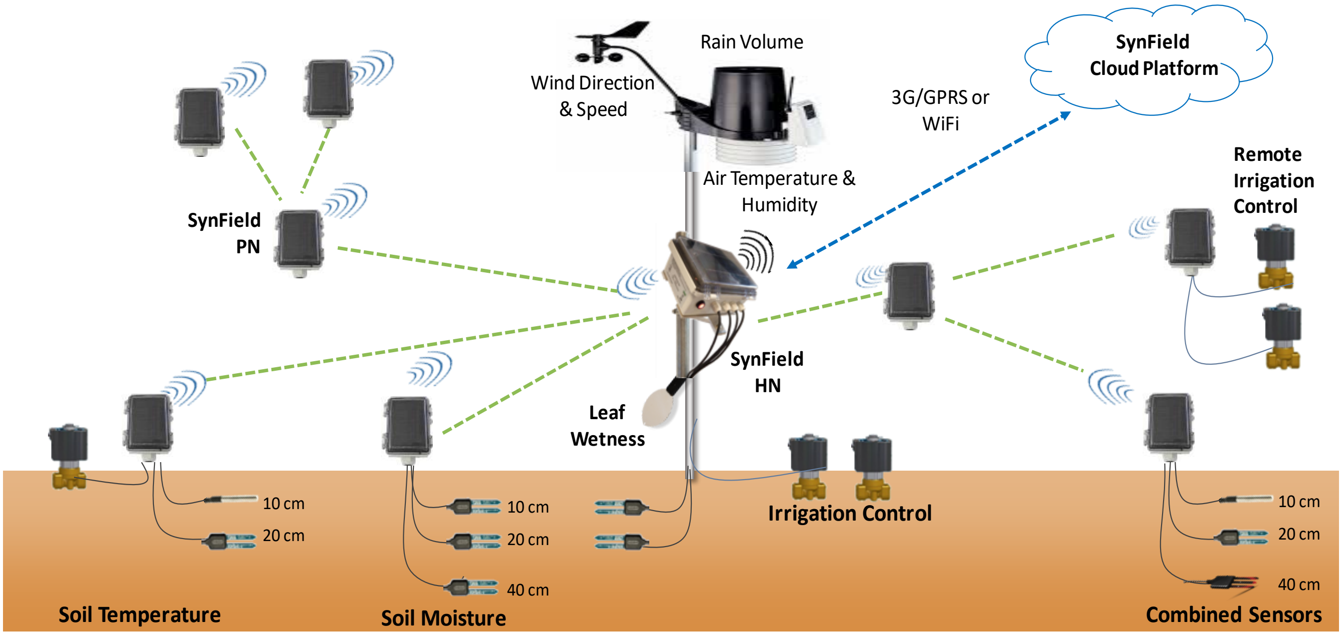

Figure 7: Typical SynField installation

In the case of multi-hop communications, SynField-PNs that are located between the associated SynField-HN and the communicating SynField-PN operate as communication relays. However, synchronization and message forwarding/relaying between the SynField-HN and the SynField-PNs is transparent to the cloud server, which considers that communicates each time with one SynField Device, either HN or PN.

6.1.1.3 SynField Main Features

- ✓ Support a wide range of analogue and digital sensors (Vendor independent): weather, environment, crop, soil, irrigation, hydrometer. Any combination of up to 5 analog sensors or 5 pulse counters may be directly connected. Moreover, via an I2C bus may interface up 16 digital sensors. SDI-12 interface is also offered for specific sensors.
- ✓ Automatic/manual remote control of up to 4 actuators (several types of solenoid valves, pumps start/stop or relay-switches are supported)
- ✓ Internet connectivity through Wi-Fi (802.11b/g/n) or GPRS/EDGE networks.
- ✓ Internodes multi-hop RF connectivity. Up to 20 Peripheral nodes may be attached to a SynField Head node, utilizing sub-GHz ISM RF channels. The standard Line of Site (LoS) with embedded antenna is up to 1Km. By utilizing external antennas the LoS distance may be extended up to 2Km, while long RF solutions of more than 4Km are also available on demand.
- ✓ Cloud based data acquisition, processing & rule based engine provision

- ✓ Energy autonomous nodes (based on solar panel & rechargeable battery).
- ✓ Easy on-site setup/control via a mobile application and Bluetooth 2.1 interface
- ✓ User friendly access via web/mobile applications and personalized interface.
- ✓ Extension memory card support and offline operation mode
- ✓ User defined Alarms & Notifications
- ✓ Configurable data acquisition/logging frequency
- ✓ Outdoor/weatherproof devices (IP65)
- ✓ ESD/lightning protection

6.1.1.4 Supported Sensors/Actuators (vendor independent)

A list of currently supported is depicted in the following figure. Other sensors (e.g. atmospheric pressure, trunk/stem/fruit Diameter etc.) are available on request.

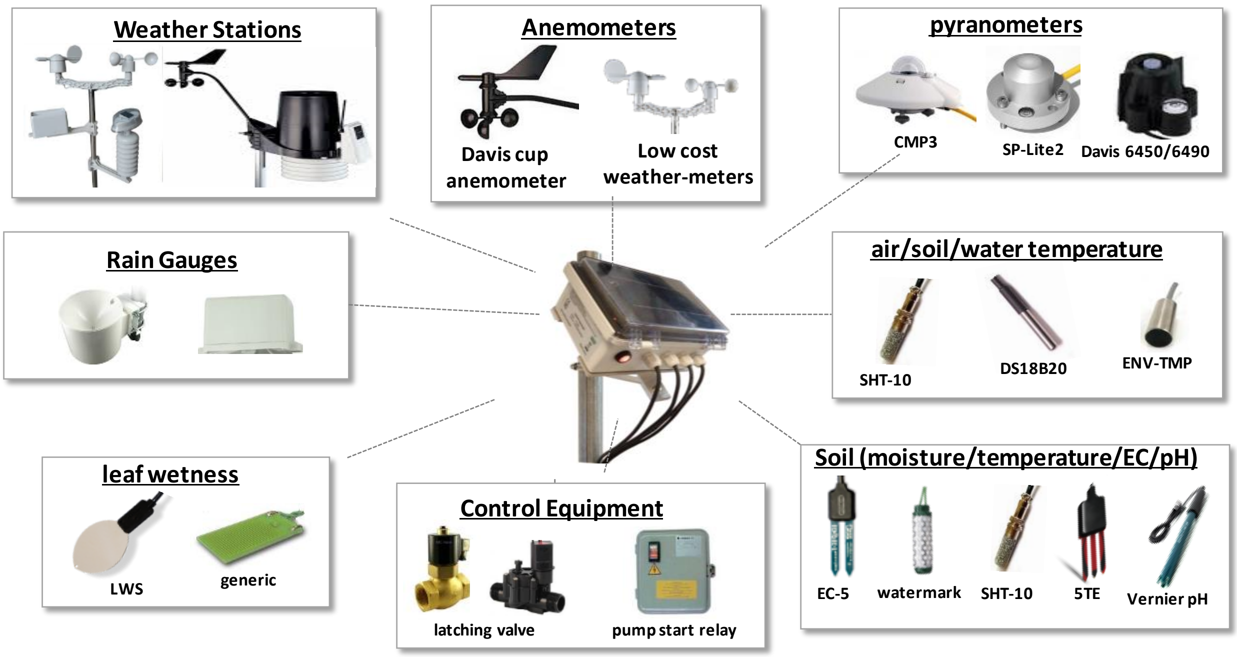

Figure 8: Supported sensors & actuators

6.1.1.5 SynField Platform High Level Description

SynField platform offers a modular approach as shown in **Error! Reference source not found.**. At the lower level there is an **adaptation & communication Layer**, which communicates with the SynField devices (directly with the SynField-HN and indirectly with the SynField-PN). This layer is responsible for all messages exchanges and conversions/adaptation. In order to maximize flexibility and support sensors and actuators from many vendors, network and devices/nodes configuration is stored in a relational data base at the ***structure data layer***. In this layer, use profiles, sensing data and (irrigation) rules are stored. Moreover, via a Restful API all sensed and monitored data can be exposed to 3rd party applications.

At the ***application Layer***, SynField offers a User Management and Network Configuration application, along with a Precision Agriculture Smart Irrigation Application. Finally, a native Android application is provided for in-field configuration of the devices utilizing a Bluetooth 2.1 interface,

6.1.1.6 SynField API

SynField offer an on-line comprehensive Application Programming Interface (API) dynamically documented at the swagger toolbox.

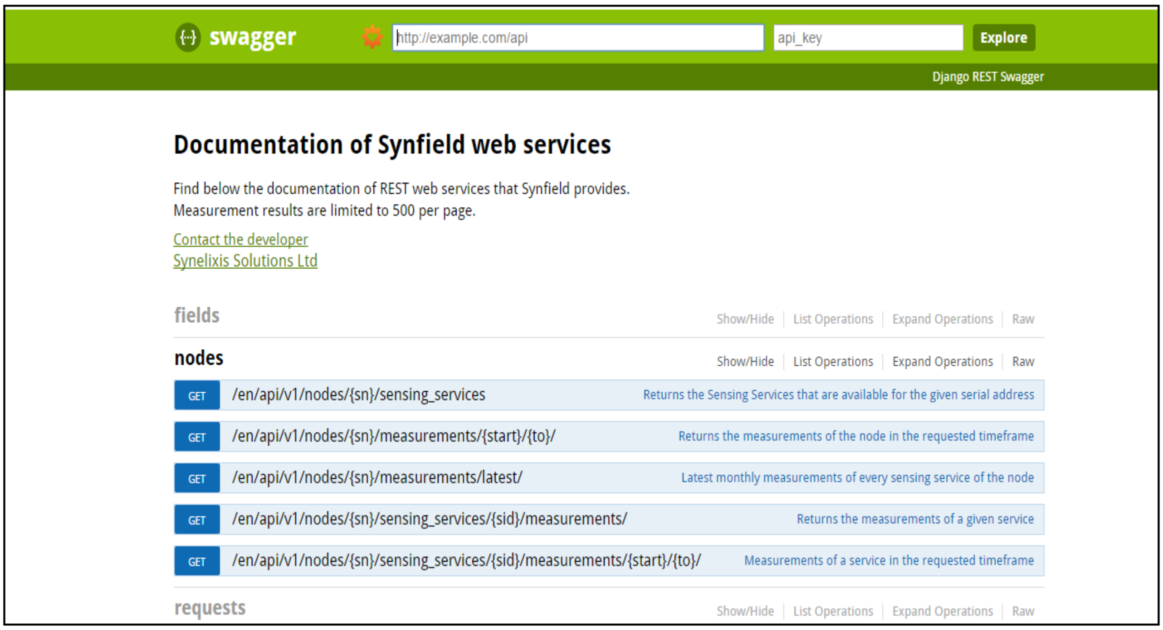

Figure 9: SynField API Documentation at swagger

The RESTful API exposes functions for:

- Retrieval of data/configuration
- Issuing explicit commands to the actuation services (bypassing automation) e.g. irrigation
- Retrieval of actuation logs

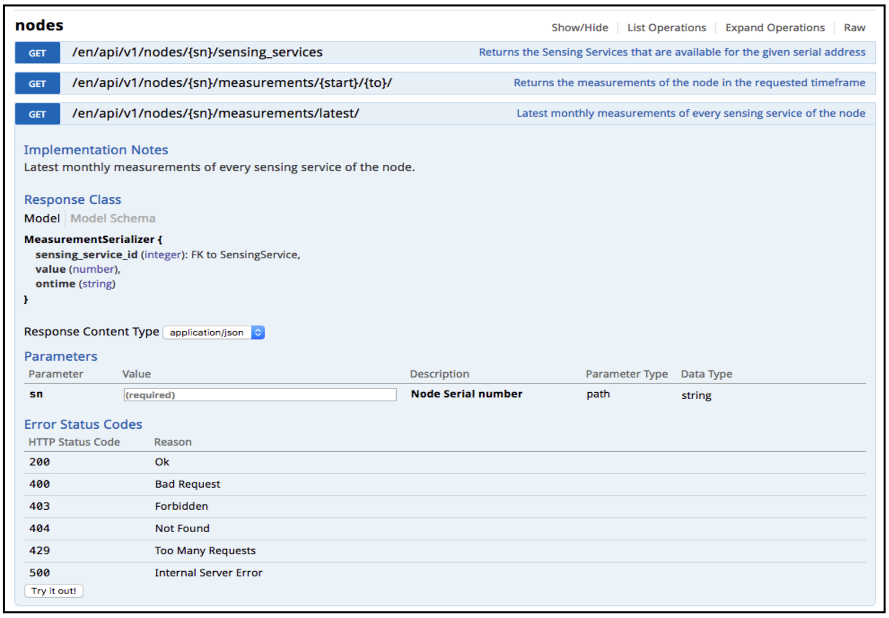

Figure 10: SynField API testing/experimentation

After successful authorization, the users are able to test and experiment with the API sending direct JSON messages to the SynField Cloud platform.

6.1.2 PLANT-O-METER

BIOS has developed a solution for effective nutrient balance management in precision agriculture, through the integration of an innovative instrument for on-the-fly monitoring of nitrogen needs into a versatile and low-cost system for expert support to farmers through a combination of disciplines like soil science, agronomy, economics and information technology. One of the cornerstones of precision agriculture is the maximization of the efficiency of the use of fertilizers through variable rate application technologies. Knowledge of soil nutrients available for plants, particularly nitrogen, and its spatial variability within a field is critical for a successful harvest. Plants which grow in nitrogen deficient soil develop two distinct syndromes: reduced number of chlorophyll molecules in leaves (chlorosis) manifested as gradually leaning plant to yellow and reduced absorption in red region, and reduced canopy size, compared to healthy plants, Figure 11.

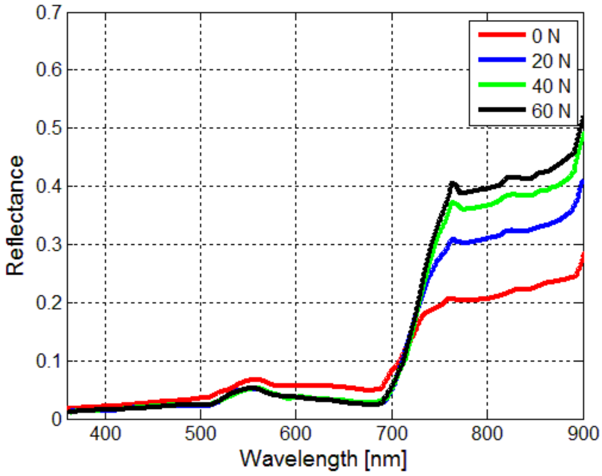

Figure 11: Reflectance spectra of a leaf as function of available nitrogen in soil

This change in reflectance spectra can be detected by Plant-O-Meter, an active handheld optical sensor (the current version is TRL 7) developed by BIOS. The sensor head contains a multispectral light source, a photo detector and a basic electronic circuitry for signal amplification and power supply. Multispectral source allows analysis of plant spectrum at four most indicative wavelengths. Accordingly, this approach enables calculation of multiple vegetation indices thus providing more reliable plant status detection. The sensor is connected to a smart phone using Bluetooth or Wi-Fi, Figure 12. It records the plant canopy reflectance and the location of and sends the measurements to the BIOS's server several vegetation indices can be calculated providing the ability to define the fertilizer needs supporting the farmer/agronomist to take the appropriate decisions.

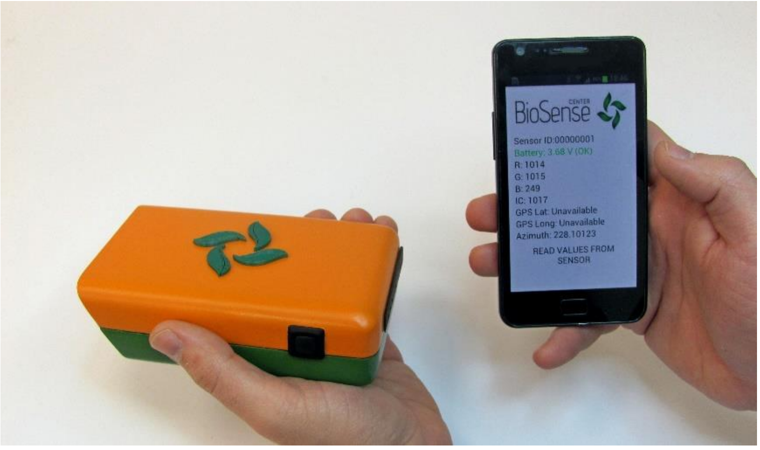

Figure 12: Plant-O-Meter and specifically designed smartphone application.

6.1.3 Description of Agrifood Experiment

Agrifood experiment is performed on two farms, one in Serbia and another one in Greece. To maximize the impact of the implemented experiment and ensure that such applications can be applied in different countries and crops, it is important to include farms from different countries. In Serbia, farm is selected from a User Panel of the Precision Agriculture Living Lab (PA4ALL) hosted by BIOS. The selected farm has signed a contract according to which it has to monitor specific aspects of the crop yields to enable appropriate experimentation and quantification of results.

The first task within setting up Agro Application experiment integrates Plant-O-Meter measurements data with SynField system to offer an opportunity to farmers/agronomists/farm logistics managers to monitor plant, environmental and soil conditions from a single point of access. The integration of Plant-O-Meter and the SynField system is realized through SynField Cloud RESTFul API. Multiple vegetation indices are calculated (NDVI, SIPI etc.), georeferenced and transferred to BIOS's server. Transfer of data is done by an android application which uses RESTful API to send data by HTTP requests to server. For the purpose of integration of handheld Plant-O-Meter with SynField system, the application is modified to adjust and send data according to RESTFul API used by SynField Cloud.

There are three parts of the Agrifood Application experiment:

1) Experiment with the Smart Irrigation application in a field of peppers
2) Use the Plant-O-Meter directly by farmers or experts as a handheld device and
3) Integrate the Plant-O-Meter with a robotic platform (Clearpath robotics Husky A200) to automate the data collection process.

6.1.3.1 Smart Irrigation Experiment

The 1st experiment associated with the SynField takes place in Monemvasia, Greece. A field of 1.5 hectares will be split in 2 irrigation zones. Each zones and it is irrigated using a network of pipes and irrigation pipelines/water valves of 1 inch.

Figure 13: SynField Smart Irrigation Experimentation

The field is connected with a SynFiedl HN and each irrigation zone is controlled by a SynField PN. Zone 1 is irrigated manually, while zone 2 is irrigated using automatic irrigation rules. During the experiment, the water consumed in both zones is evaluated (keeping the soil moisture at the same level), while at the end the crop volume is evaluated to check if there was any difference between the two irrigation zones. It is recorder that a reduction over 25% in water is recorded and similarly for fertilizers which represents 30% of farmers' expenses.

In case applicants select to utilised the DIATOMIC Agro experiment, they will be able to gain access to very important information such as the soil moisture at different levels in the soil, the leaf wetness and historical data related to the micro-clima conditions and the irrigation history. Moreover, they will be able to gain information on calculated parameters such as the Growing Degree Days (GDD) and the evapotranspiration in order to provide seasonal adjustment. For example Figure 14 shows some important parameters such as the rain fall (in mm), the air temperature (in Celsius), the soil moisture (in %), the rain level and a comparison between manual and smart irrigation in a field of Pomegranates Field (Thessalia, Greece).

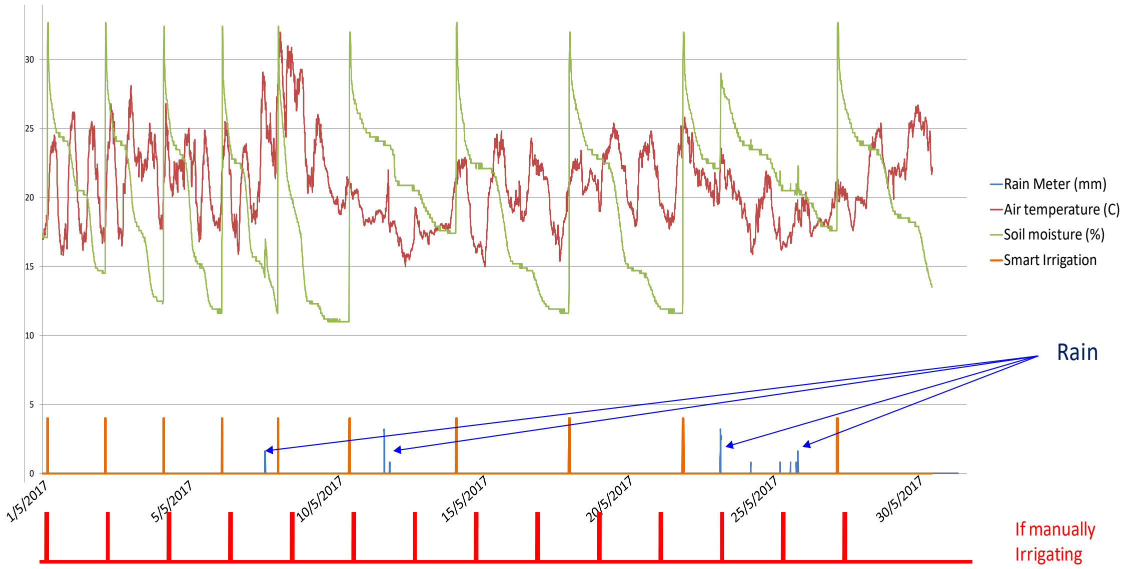

Figure 14: Example of DIATOMIC Agro experiment results

6.1.3.2 Plant-o-Meter as Handheld device experiment

The experiments for the handheld Plant-O-Meter option of Agro Application is performed on crops such as wheat, rye, barley, maize etc. Within this option of experiment device's measurement data is related to the appropriate SynField HN or SynField PN that is representative for location in the field where it is positioned. In this way higher level of integration of these two systems is accomplished.

Measurements of vegetation indices are done manually by farmer or expert at each location where SynField HN and SynField PN are positioned in homocentric circles with radius of 5, 10, 25 and 50 meters from the node. On each radius total of 8 point measurements is done with the angle shift of 45°. These canopy measurements estimate the health status of the plant surrounding the nodes with respect to nutrients levels based on vegetation indices provided by the device.

All the point measurements and their average are automatically related to appropriate node and uploaded to the SynField cloud. These data, together with the data obtained by sensors connected to the SF HN and SF PN, are used to select appropriate agro-technical measures. If significant variance or abnormal values of indices are recorded, alert message are sent to the user to perform additional measurements to extend scan area. Handheld Plant-O-Meter measurements is done periodically in accordance with observed crop growth stages.

6.1.3.3 Integrated Robotic Platform

For the purpose of another option of experiment Plant-O-Meter is integrated onto a mobile robotic platform Clearpath robotics Husky A200. In this way automation of measurement and data collection process are enabled. All-terrain Husky A200 comes with highly accurate RTK GPS system which achieves 2 cm accuracy. With the help of this system, Plant-O-Meter generates precise maps of a series of vegetation indices that are correlated to end-of-season yield. The Husky A200 Robot Operating System (ROS) initiates, collects and processes the measurements from Plant-O-Meter and sends them to the SynField HN. For this option of experiment, manually adjustable by height and angle sensor holder is manufactured to attach Plant-O-Meter to the robotic platform so that optimal position with the respect to canopy can always be obtained. This system is intended to be used on arable crops (wheat, maize etc.) and vegetable crops (cabbage, lettuce, tomatoes, egg plants, peppers etc) that are not higher than 70 cm. The main reason for this is in uneven terrain in the fields which causes significant change in angle and consequently dislocates Plant-O-Meter from target leading to unreliable measurements.

For the purpose of this type of experiment robotic platform always move on predefined routes in the fields. Measurements are attained every 20 cm which ensure smooth and continuous measuring of the canopy's reflectance since the width of the sensor's beam footprint hitting the canopy is approximately 30 cm. Each measurement is stored to the SynField Cloud. Several measurements will be done during the growing season according to the crops' growth stages.

Integrating the Plant-O-Meter with the robotic platform has several benefits. First, it proves the concept of automatic on-the-fly Plant-O-Meter measurements. Later this concept can be easily transferred to agricultural machinery such as tractor-mounted or can even be mounted on center-pivot irrigation systems. Next, this system can be activated on user's demand, unlike in the case of satellite imaging which is done every 5 days, with much lower resolution (~10 m) and is heavily influenced by weather conditions. In addition, the robotic platform offers the potential of adding more layers of information to the measurements such as landscape maps (using the RTK GPS) and data from a series of sensors that can be mounted on it such as hyper-spectral and thermal cameras, LiDAR sensors etc. This will enable the automated multi-layer data collection from the fields.

6.2 Description of Health Application Experiments

The Health Application Experiment in DIATOMIC aims to be an example of an ICT based solution for Active and Healthy Ageing, as this is a central topic defined by the EU under Societal Challenge 1, “Health, demographic change and wellbeing”. Its main policy objectives are to improve health and well-being outcomes, to promote healthy and active ageing, to promote market growth, and the EU as a global leader in the health area. Moreover, cross-sector actions support the development of evidence-based health and care policies, resulting from scientific research data, improving efficiency and quality of health and care systems. A large number of health applications rely on the scheme: sense - monitor - support action in the reading from bio-sensors are processed to trigger human actions (either from the patient/elderly or the caregiver/doctor with wearable/portable sensors playing an important role.

DIATOMIC integrates: a) Libelium’s hardware platform for healthcare My Signals which consists of a gateway collecting readings from various bio-metric sensors sensing more than 20 biometric parameters, b) IPA’s cloud-based Virtual FortKnox platform collecting the sensed data in the cloud for processing and c) IPN’s eVida platform for managing health-relevant applications and thus accelerate development and prototyping of health applications based on AME and SSI technologies. The integration of other than LIB’s sensors in the VFK and eVida platform is also possible.

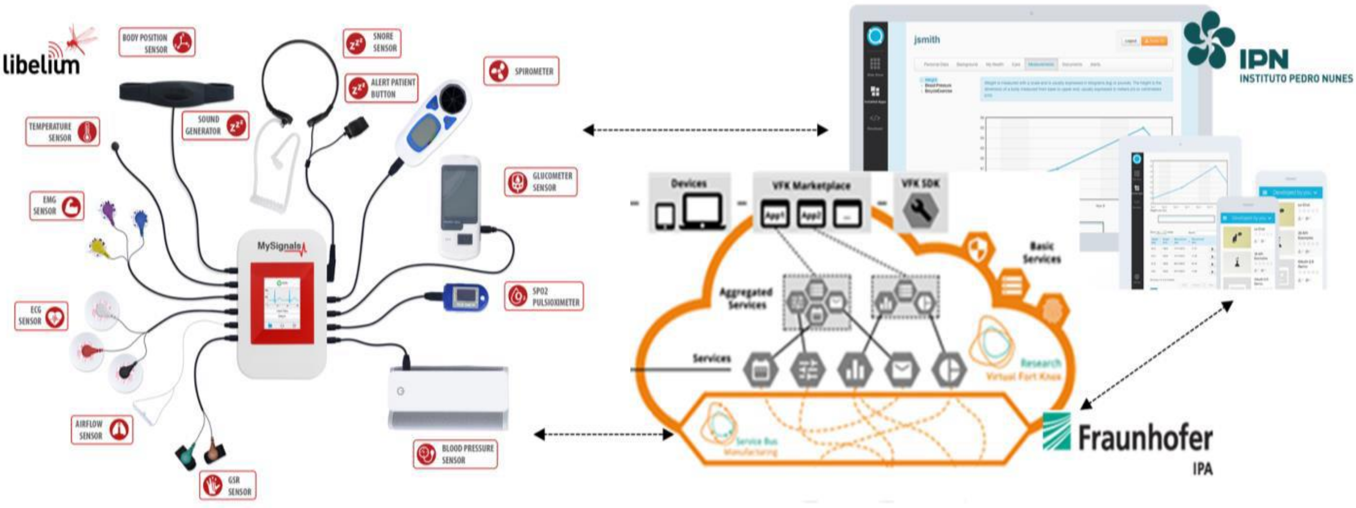

Figure 15: Overall architecture of DIATOMIC Health Application Experiment

eVida platform is a technological tool and a framework (i.e. eVida platform), which supports the connection to self-hosted, packaged and mobile applications to promote a rich and complete ecosystem. The main features of the platform are those of managing users, managing applications and providing interoperability mechanisms for the applications. This platform can directly receive data from the sensors, which are then consumed by the applications and can be shared using the common data repository, which is responsible to store clinical and demographic information. Any application that wants to have access to the platform resources must be registered and follow the adequate security policies.

While eVida comes with connectors for a set of devices, DIATOMIC applicants will also have the opportunity to use VFK for integrating additional devices and to further enhance flexibility in bio-metric sensor selection we will also develop a connector between My Signals and VFK. Additionally, applicants will be able to use the flexible VFK SDK to develop applications that combine data from multiple sensors. The developed applications can then be managed through eVida, leaving the developers concentrate on the business logic, (without developing user management components). The aim is to maximise flexibility for makers and accelerate as much as possible AME and SSI based application development, prototyping and experimentation.

6.2.1 MySignals

MySignals is a revolutionary eHealth platform that received several worldwide prestigious awards from healthcare, technological, innovative and social organizations.

It has been defined as one of the most complete development platforms for medical devices and eHealth applications. It allows the measurement of more than 15 biometric parameters and let users the possibility to add their own sensors to build new medical devices.

The user can choose between three different to visualize the data measured by sensors:

- **Standalone mode,** which uses the basic graphic TFT integrated in the device. The navigation touch interface allows instantaneous transitions between menu screens offering a great user experience.
- **Mobile Apps:** using the native Android/iOS connectivity to send all the data to the smartphone, those applications may be downloaded from the official App markets.
- **Web Server:** it is possible to access to the history of the information gathered by connecting to the Libelium Cloud through a web browser.

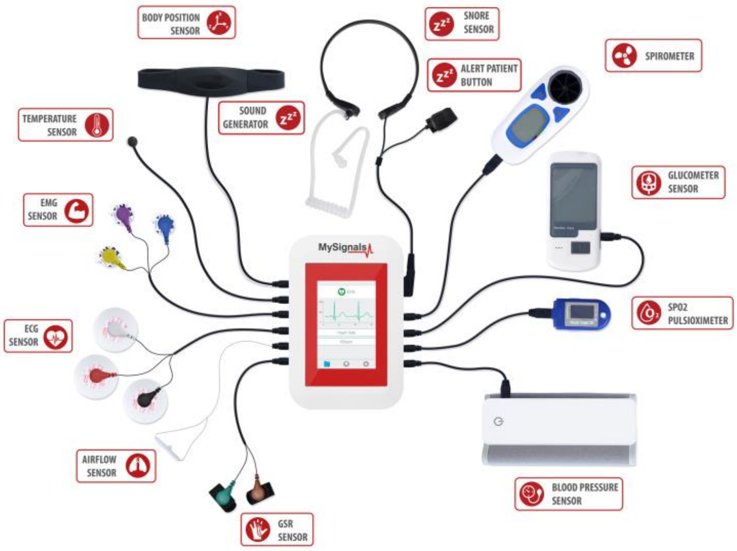

Figure 16: MySignals Overview

MySignals Software has two connectivity options available integrated: WiFi or Bluetooth Low Energy 4.0. All the data gathered by MySignals is encrypted in order to assure the safety of the users, and can be sent to the developer's private MySignals Cloud account directly to the cloud via WiFi or using your smartphone (BLE)

Figure 17: MySignals Cloud Communications

This device allows data sharing with the cloud and performs real-time analysis, given that MySignlas Web Server Application is a real-time viewing and plotting tool and has built-in data analysis functionality. It is very user friendly and contains many powerful built-in features. The Web Server Application allows users to configure MySignals for creating profiles and users, and help them to visualize the measured data.

MySignals web allows to playback previously recorded sessions and zoom in and out of specific periods. It includes sensor data acquisition from multiple devices and users.

Developers may migrate the information stored in the Libelium Cloud to a third party Cloud server easily using the API Cloud provided, where it is possible to see a list of members and read the values measured for a user by MySignals.

6.2.1.1 MySignals Sensors

As mentioned before, MySignals allows to measure more than 15 biometric parameters such as pulse, breath rate, oxygen in blood, electrocardiogram signals etc. These broad sensing portfolio makes MySignals the most complete eHealth platform in the market. Some of the sensors are wireless, as they use BLE, while others are wired directly to MySignals.

6.2.2 Virtual Fort Knox

Virtual Fort Knox is a platform designed for manufacturing companies that offers needs-based manufacturing IT solutions, the description of the platform and the features and possibilities that it can offer, are described in deep on section

6.2.3 eVida

The eVida platform (http://evida.pt) aims to bridge the gap between the demands for care and care providers. eVida is a web-based platform that focus on delivering services for personal health and wellbeing. The main objective of the platform is to provide the infrastructure and tools to quickly develop new applications and deliver them to end-users.

Therefore, eVida platform provides an answer to patient health self-management supported by technology (https://www.youtube.com/watch?v=fwHnHbcpVHY). The platform already provides an electronic personal health record and supports remote monitoring from devices. Additionally, eVida promotes the creation of a diversified ecosystem harnessing the connection to self-hosted, packaged and mobile applications that promote self-monitoring and self-management of health and wellbeing.

Figure 18: eVida conceptual Architecture

Moreover, it does not impose any technological restrictions in terms of self-hosted and mobile applications, and guarantees data integration through its APIs. Packaged applications are similar to widget applications and facilitate the developers to submit and publish their applications without the need of acquiring their own hardware infrastructure. The platform doesn't impose on the applications business processes. Therefore, the main features of the platform are those of managing users, managing applications and provide interoperability mechanisms for the applications.

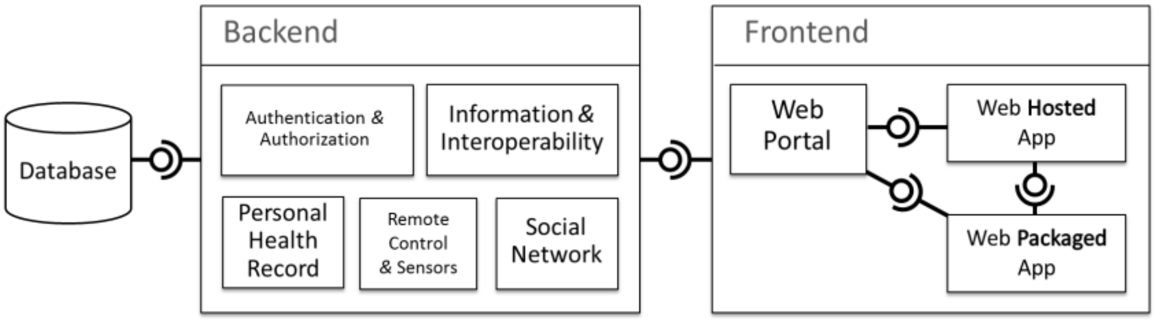

Figure 19: eVida Backend-Frontend Architecture

eVida platform is aligned with the trends for eHealth and mHealth. In fact, the majority of the applications in the ecosystem are accessed using a web browser or a using a mobile application. The data produced and consumed by the applications can be shared using the common data repository, which is responsible to store clinical and demographic information. Any application that wants to have access to the platform resources must be registered and follow the adequate security policies.

Regarding some technical aspects, the platform was developed using state-of-the-art web-based technologies. The front-end uses html, javascript and css to provide the user an appealing and responsive look and feel. To develop the front-end we created a Bootstrap (http://getbootstrap.com/) template to ease developers to use a similar GUI in their applications. The back-end was developed using several open-source frameworks, and is developed mostly in Python and Java. The most relevant framework used is Django (https://www.djangoproject.com/), which provides a full-stack to develop web-based applications.

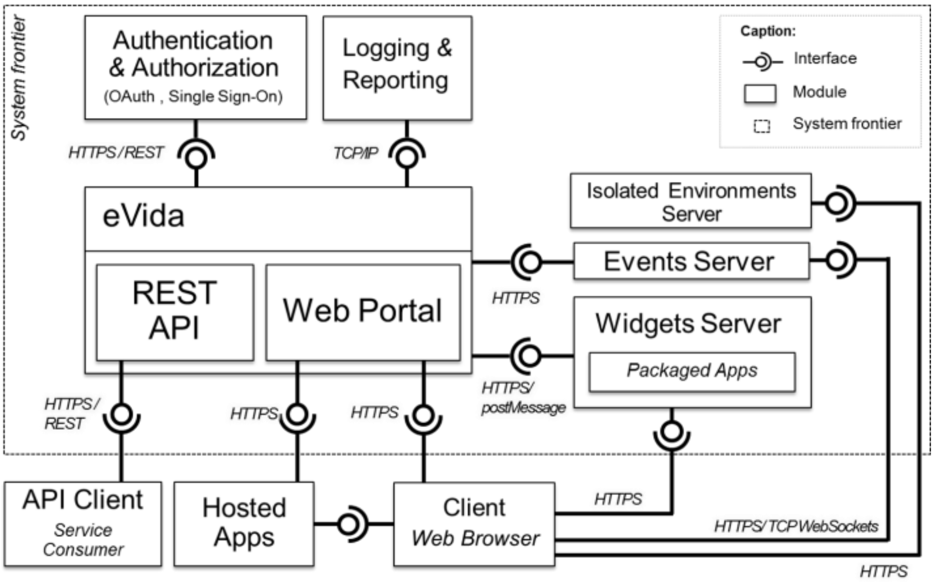

Figure 20: eVida Internal Architecture

Moreover, opportunities were identified in the development and integration of medical devices that allow the automation of biometric parameters acquisition. Therefore, the eVida platform is compliant with the most common standards for health related data (e.g. HL7) and device communication (e.g. IEEE11073). Thus, it has the potential to become part of the mainstream healthcare.

Nevertheless, implementing real-life scenarios with such technological approach imposes a challenge due to the lack of engagement of the different stakeholders involved in health care. However, challenges can be overcame with strategic partnerships that facilitate the adoption of innovative practices. In fact, reference sites from the EIP-AHA constitute the perfect environment to apply this tool and harness individual efforts into mobilizing efforts. eVida is already taking advantage of the synergies provided by the Portuguese reference site (aka. Ageing@Coimbra), where organization with complementary backgrounds from Research, Innovation and Education joint efforts to promote pilot actions based on the technology provided by eVida. In spite of local efforts, this example may be replicated to other reference sites, and by doing so the platform can also act as an integration channel that guarantees interoperability between different reference sites. This means, one reference site can create its own solutions locally and find an easy mean to share its technological solutions, without the need of refactoring what was already validated.

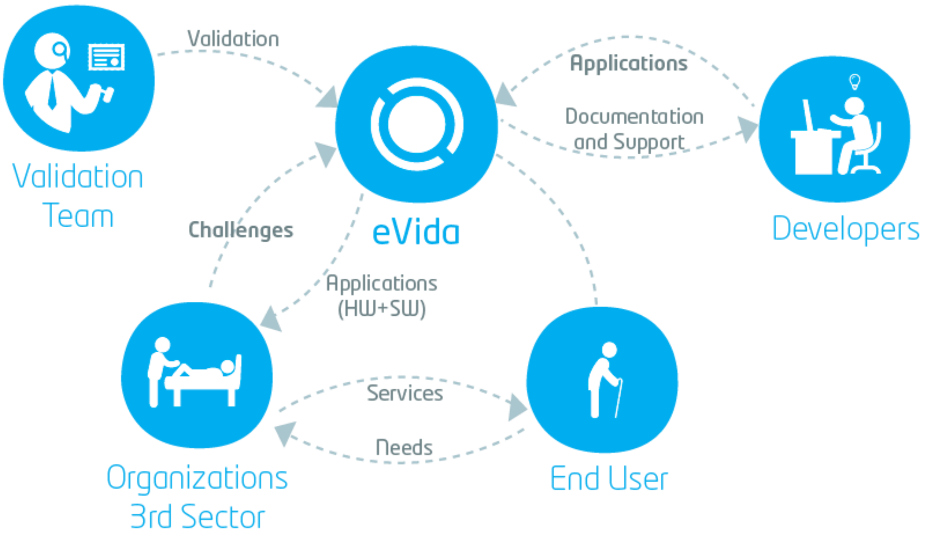

Figure 21: eVida eHealth Scenario

6.2.4 Integration between platforms

The goal of this experiment is to offer end users cost effective platform for medical devices that could be utilized as an alternative for measuring different health parameters without the need of a big investment in equipment.Talking about health, it is very important that doctors have as much information as possible before diagnosing patients' diseases. Commonly this is a hard task, as hospitals cannot afford having a doctor or a nurse paying attention to a patient during all day. This solution will help them to have all the information needed from their patients, and access to the data remotely for an efficient and personalized diagnosis. They will have the opportunity to set alarms to be notified in case any anomalous behaviour would be detected so that they may take appropriate action.

DIATOMIC Health experiment has integrated the three aforementioned platforms, as they need to interact between each other in order to collect, store and show the information measured by health sensors. Inside DIATOMIC project, the first goal was to make a very basic integration where some health sensors from the MySignals eHealth platform send data to Fortnox, Fraunhofer's Cloud Service, and this last interacts with eVida platform, specialized in eHealth applications. This offers doctors, nurses and other users to monitor medical conditions from a single point of access.

During the development of these experiments the modularity of the platforms is always kept in mind, so that not only the whole solution is functional, but should work independently and offer the same functionalities and integration possibilities separated from the whole solution. This allows developers to choose between using the whole application (MySignals, Fortnox and eVida), combining some platforms for the development of a new solution (eg MySignals and eVida), or even use only one of them with other external platforms (eg MySignals and an external Cloud) within DIATOMIC Environment.

Going into technical details, MySignals users can read the data stored in the Cloud by using the Open API available. It allows users to authenticate and save their information to a third Cloud platform or visualize it in an external web or mobile App through the RESTful API :

1. Open API Features
2. HTTP Rest Calls
3. JSON Files Management
4. Authentication + Read Calls
5. Retrieve your data and visualize it into own Apps
6. Duplicate the data in an own Cloud Server

Figure 22: MySignals API Documentation at swagger

6.3 Description of Manufacturing Application Experiments

Industry 4.0 demands a further consolidation of trade and technology. This requires the allocation of business processes in service-oriented tasks, which are then implemented in corresponding services. The cyber-physical production system (CPPS) Manufacturing Application Experiment is focused on industrial automation, and more precisely 3D printing activities, targeting emerging industries such as creative industries and eco industries. The application experiment implements an automated 3D-Printer equipment in the form of a CPPS. It is set up so that the personalized product requirements are fed to the platform, which searches for appropriate machinery to conduct the task, with the customer receiving personalized products at the end of the process. To conduct the complete production task several CPSs within the physical confines of the equipment, as well as several cloud-based software services collaborate. This demonstrates the services developed by Fraunhofer IPA on the VFK platform, which represent an instance of the Platform as a Service business model.

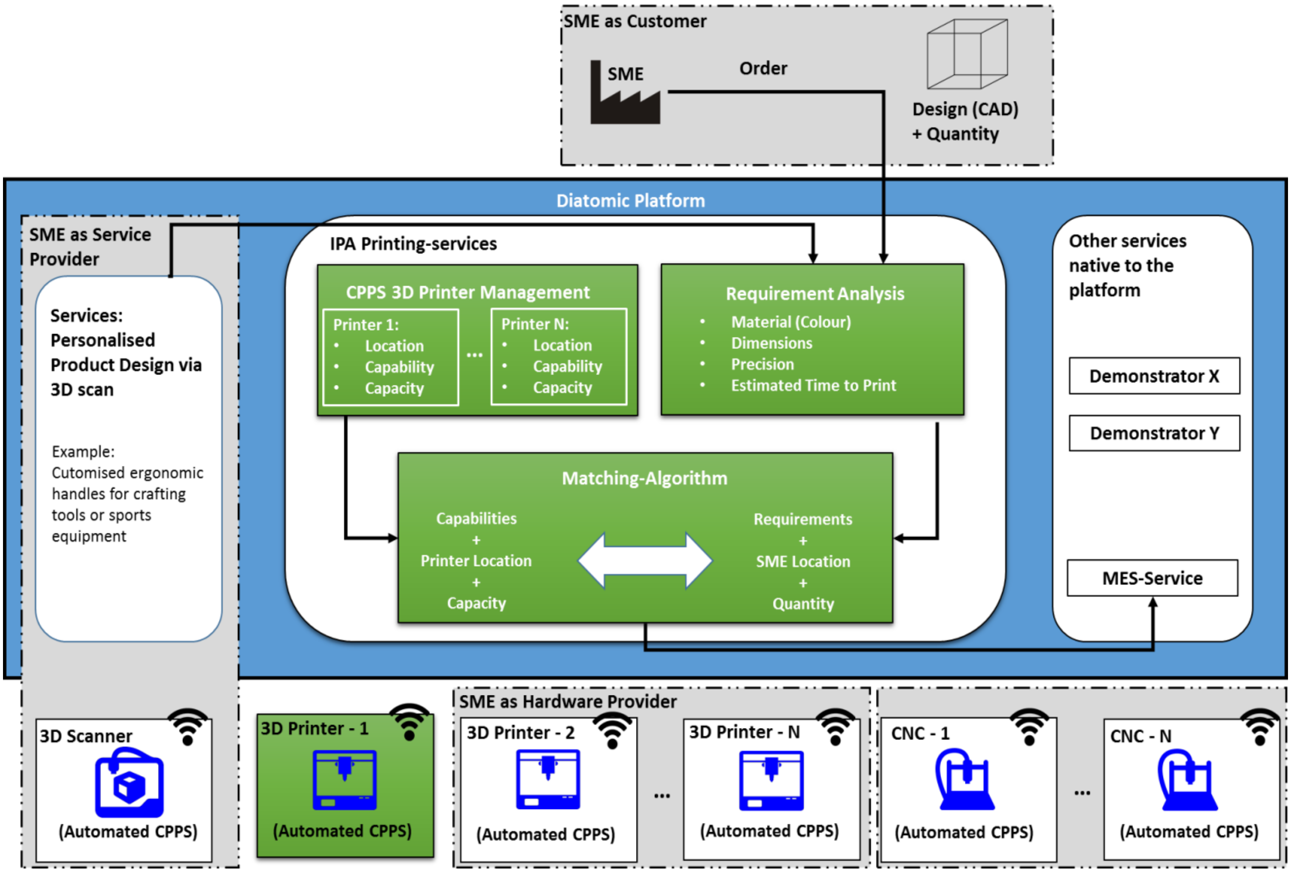

Figure 23: Fraunhofer IPA CPPS Manufacturing Application Experiments

The 3D-Printer CPPS is designed as a system of systems. This means that it consists of several cyber-physical systems (CPS) which are orchestrated by a super ordinate service. Each CPS propagates its functionality via interfaces to its environment. These functionalities are used by CPPS to supply a fully automated printing process. Every CPS can therefore be replaced by a new, compatible system with very little adaption to the orchestration.

The following smartified systems are included: work piece holders, two 3D-printers, a handling unit and a conveyor belt. For each order, a work piece holder is supplied from a buffer rack to the printer by the handling unit. Some 3D-printing processes require a temperature-controlled surface to ensure appropriate quality of the final product. Therefore, the smart work piece holder can heat itself up if required and communicate it current surface temperature to the other CPPS participants (i.e. to trigger the printing process once the required temperature is reached). Once the printing process is completed, the printer can then trigger the handling unit to pick up the work piece holder with the product and transport it to the conveyor belt. To avoid injury to humans outside the equipment, the surface temperature must be monitored before transportation outside of the equipment. The smart conveyor can therefore detect if work piece holders are present and will only initiate operation once safety regulation (here temperature) are met. In cyber-physical equivalence, virtual world and physical production environment or product are synchronised, often even with real-time requirements.

This CPPS consiss of the following key components:

- The **CPPS-framework** is the physical compound for the included CPSs and supplies the required energy and internet connectivity for the incorporated CPSs, as well as the machine`s safety logic. The CPSs can be positioned inside two separated shelves, while a handling unit is situated on the back. The framework allows a fluent production process by automatically delivering the finished products to the surrounding for further processing via a conveyer belt and grants easy accessibility to the service personnel for the restocking of material and maintenance.
- The ***automation unit*** is physically attached to the backside of the framework. It allows the handling of materials and tools inside the framework through its corresponding software services. In the DIATOMIC configuration, the automation unit is used to manoeuvre smart work-piece-holders from their storage facility in the first shelf into the 3D-printer in the second shelf and thereafter to conveyor belt for ejection.
- The ***two 3D-printers*** use plastic material to create 3D-products via the fused deposition modelling procedure. Incoming orders and production commands are received via a web-based software interface. Several smart work-piece-holders (WPH) are stored within the framework. Once they are positioned inside one of the printers by the automation unit, they can be commanded to heat up to the appropriate process temperature and maintain it throughout the printing process.

The components are confined to a physical housing and can be orchestrated from a software service in the Virtual Fort Knox platform. This set up makes the machine very flexible and allows SMEs to develop other CPSs that can replace parts of the machine to alter or optimise the machine. An example would be the transfer of the concept from 3D-printing to milling or cutting.

6.3.1 VIRTUAL FORT KNOX

Fraunhofer IPA operates the only open, federal IT cloud platform specifically for manufacturing. Virtual Fort Knox is a platform designed for manufacturing companies that offers needs-based manufacturing IT solutions. IPA considers the cloud to be an uncomplicated way for manufacturing companies to enter the world of digital production, or to adapt to the rising demand for networked and flexible production. Virtual Fort Knox features the following benefits:

a. Everything from one source via a one-stop shop for manufacturing companies,
b. Selection of the desired services via an online marketplace
c. Availability as a research or commercial platform
d. Function- and needs-based billing model without requirement for major hardware or software investments
e. Fast implementation and integration of new solutions through the cloud concept and the use of open standards
f. Safe operation of the “Virtual Fort Knox” platform, complying with national data protection laws and using Germany as a server location
g. Optimised networking beyond geographical and company boundaries.

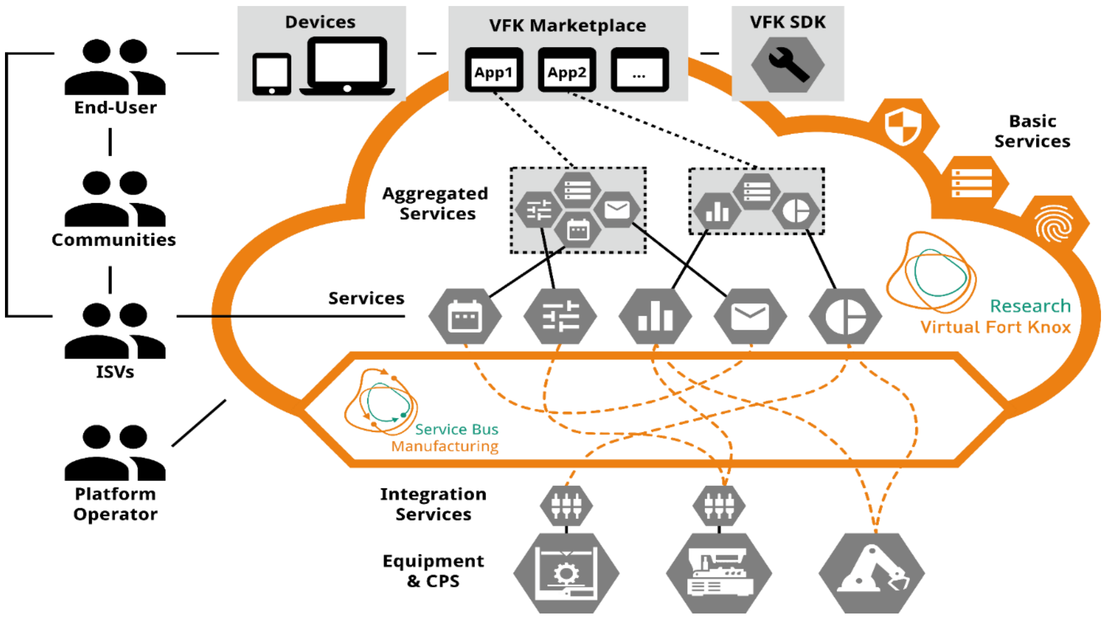

Figure 24: Virtual Fort Knox Components and Roles

Figure 24 shows the overall architecture of the Virtual Fort Knox platform. A central component is its newly designed middleware, Manufacturing Service Bus (MSB), which takes care of the orchestration of all partners, both hardware-based (equipment and CPS) and software-based services. The capabilities propagated by the self-description of the CPS within the CPPS-3D-printing framework (i.e. 3D-printer, handler, etc.) to the MSB are then orchestrated via a graphical user interface and arranged in order to perform the task of automated 3D-printing.

6.3.2 Manufacturing Application Experiment - Tasks Overview

In order to carry out this experiment, six main tasks have been performed:

6.3.2.1 Hardware Selection

Figure 25 shows the existing setup of the CPPS Framework. Currently, CPPS's operability is tested with one existing 3D printer (chamber 1). In order to demonstrate the capability matching and more complex order management, another 3D printer is utilized.

6.3.2.2 Integration of second Printer into CPPS

It is expected that both hardware and software modifications to the new printer, the work piece holders and possibly the handler will be required to allow fluent physical and IT-based interaction between the systems. Additional software services will be developed to allow the transformation of the printer into a CPS and integration of the printer functionalities into the orchestration via the MSB on the VFK-platform.

6.3.2.3 Smartification of Conveyor Belt

The existing conveyor belt is "always on", as it is not integrated into the CPPS. This task ensures the transformation of the belt with adjoined motor into a full CPS and integration of the conveyor belt CPS into the VFK middleware (Manufacturing Service Bus - MSB). It extends the conveyor belt's capabilities to ensure safety compliance of the CPPS by allowing it to detect if any work piece holders are present on the belt and to check their surface temperature. Transport is only allowed once no risk for the environment (e.g. human operators) is present.

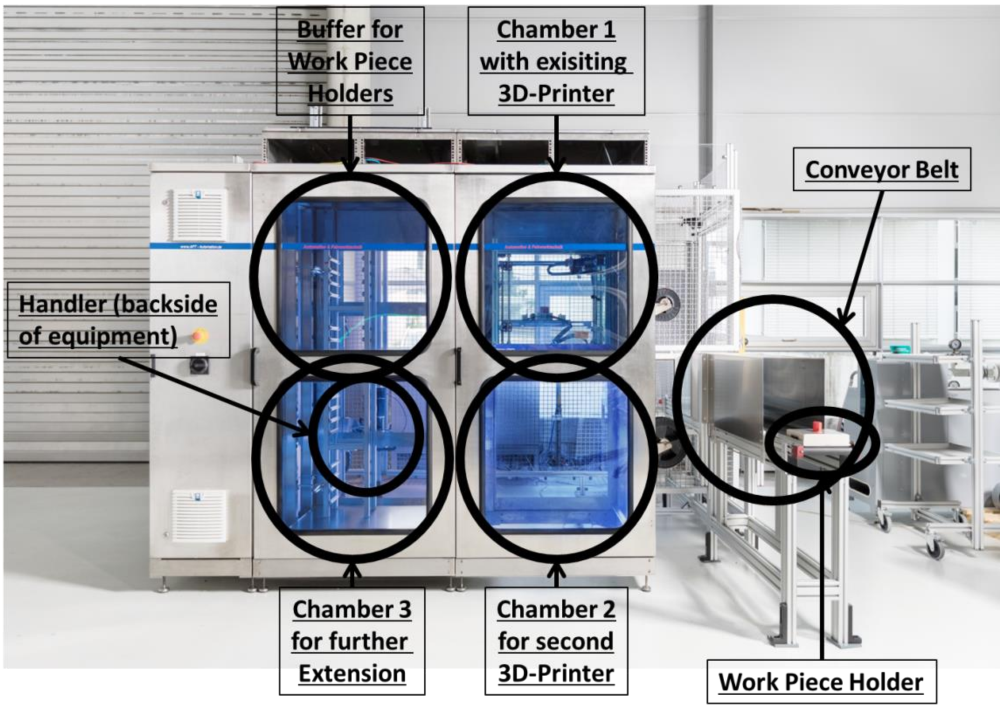

Figure 25: Existing Setup of CPPS-Framework

6.3.2.4 Slicer Integration

A slicer is a software that is required for the pre-processing of a 3D-printing order. It transforms the geometric design of the product idea from a CAD-file into the machine-readable path, which the printer head can then follow to manufacture the product. Slicing is typically done manually by the manufacturer for each new product, by loading the CAD-file into the program and setting the process parameters according to the utilised printer. We have integratde a slicing program into the Virtual Fort Knox Cloud Platform as part of the automated tool chain for the 3D-printing process, which enable the automated manufacturing.

6.3.2.5 Capability Matching

Based on an incoming customer order, the optimal production resource (i.e. 3D printer) has to be selected. This selection is based on a number of factors, such as product size, material and colour. A capability matching service has been developed and deployed into the Virtual Fort Knox platform to be used by the CPPS application experiment. This matching algorithm can be extended by SMEs to accommodate other manufacturing processes (e.g. CNC-milling) which they may add to the experiment through the open calls later in the project. The result of the matching algorithm is the most optimal production resource (from the pool of printers) which can then be fed into the order management (see following task)

6.3.2.6 Order Management

The 3D-printing framework requires the ability to manage incoming 3D printing orders: First, the optimal production resource (3D-printer) needs to be identified through forwarding the information attached to the order to the capability matching algorithm. With the resulting feedback, the order management service needs to schedule the optimal production order schedule to enable production within the set due date or trigger feedback to the customer, that the order will be delayed. Once scheduled, the order management deploys the information flows between the CPSs to the Manufacturing Service Bus accordingly, including the CAD-file for the slicer.

7 Points of contact

The DIATOMIC consortium will provide information to the applicants only via the F6S blog, so that the information (question and answer), will be visible to all participants.

No binding information will be provided via any other mean (e.g. telephone or email).

More info at: https://diatomic.eu/index.php/open-calls/

Apply via: https://www.f6s.com/diatomic/about

F6S support team: support@f6s.com

Online Q&A: https://www.f6s.com/diatomic/discuss

8 References

[1] Digital Innovation Initiatives based on European Networks of Competence Centres in H2020, available on line at https://smartanythingeverywhere.eu/smart-anything-everywhere/

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