DigiFed

Digital Innovation Hubs Federation
For Large Scale adoption of
digital technologies by European SMEs

D2.2 - Three Generic Experiments implemented

June 2022

Technical References

Project Details	
Project Acronym	DigiFed
Project Title	Digital Innovation Hubs (DIH) federation for large scale adoption of digital technologies by European SMEs.
Project Coordination	CEA
Project Duration	39 months, 1.1.2020 – 31.3.2023

Document Details		
Deliverable No.	D2.2	
Dissemination level	☒	**PU** = Public
	☐	**PP** = Restricted to other programme participants (including the Commission Services)
	☐	**RE** = Restricted to a group specified by the consortium (including the Commission Services)
	☐	**CO** = Confidential, only for members of the consortium (including the Commission Services)
Work package	WP 2	
Task	WP 2.T2	
Lead beneficiary	UL	
Due date	30.6.2022	
Delivery date	30.9.2022	
Actual Submission date	15.10.2022	
Authors	Jure Trilar, Isabelle Chartier, Andras Poppe, Xabier Eguiluz, Leticia Montalvillo	

Short Description / Executive Summary

This Deliverable D2.2 within Work package 2 in H2020 DigiFed Project titled "Three Generic Experiments Implemented" documents the implementation phase of four Generic Experiments (GE) co-funding and technology co-design mechanism. The Implementation phase follows the common preparation phase and contributes to the process of identifying the co-funding entities, SME community selection and constitution and iteratively developing the designated key enabling technologies, selected by GE owner (a partner in DigiFed consortium). The deliverable reports on the status of GEs on M30 (June 2022) within H2020 DigiFed project.
In this document, initially the context of DigiFed GE Community-driven mechanism is presented, along with rationale and global GE status at M30 is described. Then, to provide with more detailed pre-implementation phase context, the distinct GEs are presented: CEA (France) GE on Secure platform for IoT, IKERLAN (Spain) GE in Trust platform for Digital Assets, BME (Hungary) GE on LED lightning optimisation and UL (Slovenia) GE on Iot in Agriculture. Next, the preparation phase on each GE is described, including timeline and promotion step. Further, the implementation phase of each GE Community is reported in detail, about the structure of selected SME group that consists each GE community, technical visions with development process and updates that result from GE community interaction. Important for transferability capacities, the co-financing entity and model description, with sustainability potentials of particular GEs' that arose during the selected implementation period are documented. The implementation phase description is followed by discussion on insights and lessons learned during this period, and concluded with perspectives and future assessment analysis plans and timeline.

Document history

Form	Version	Date	Author	Organization	Modifications made – remarks
Draft	V0.0	14.01.2022	J. Trilar I. Chartier	UL, CEA	*Structure validation, first inputs*
Revision	V0.1	02/05/2022	I.Chartier	CEA	*Contribution to CEA GE chapters*
Revision	V0.1.a	20/06/22	L. Montalvillo J. Trilar	IKL UL	IKL and UL contribution
Revision	V0.2	05/07/22	A. Poppe	BME	BME contribution
Revision	V0.3	03/08/22	I. Chartier	CEA	Accepted most contribution, completed sections
Revision	V0.4	18/08/22	I. Chartier	Cea	CEA sections completed
Revision	V0.5	26/08/2022	J. Trilar	UL	Content consolidation, last inputs request
Revision	V0.5.1	4/9/2022	X. Eguiluz	IKL	Ikerlan contribution update
Revision	V0.6	16/9/2022	J. Trilar A. Poppe	UL, BME	BME update, content consolidation, abstract
Internal review	V0.7	30/9/2022	J. Trilar	UL	Internal review updates
Final	V.1.0	1/10/2022	J. Trilar	UL	Updates according to two internal reviewers
Review validated	V1.1	20/10/2022	I chartier	CEA	Final check for submission

Contents

List of Figures

List of Tables

List of Abbreviations

AE	Application Experiment
B2B	Business to Business
CPS	Cyber Physical System
DC	Digital Challenge
DIH – eDIH	Digital Innovation Hub – European DIH
GA	Grant Agreement
GDPR	General Data Protection Regulation
GE- GEO – GEC	Generic Experiment, GE Owner – GE Communty
HW	Hardware
SME	Small and Medium Enterprises
SW	Software

1. Context of DigiFed project

DigiFed, part of the SAE initiative, is dedicated to supporting EU industries to digitalise their product & services and reaching new markets enabled by Cyber Physical Systems (CPS) & Embedded Systems. DigiFed gathers twelve partners with expertise in digital technologies and/or innovation management from nine EU countries.

The main aim of DigiFed is to accelerate and promote the digitalisation of European companies by providing significant support mechanisms for individual and groups of SMEs and midcaps to foster the introduction of digital technologies in their product and service offerings.

DigiFed partnerships are designed to strengthen the European digital ecosystem through the adoption of advanced digital technologies (CPS & Embedded Systems) and a combination of regional, national and European funding instruments so that SMEs and midcaps can benefit from knowledge sharing regardless of their location.

Three main interrelated Innovation Pathways are proposed to EU companies. Until 2022, based on the following three kinds of Innovation Pathways, DigiFed has implemented the following projects:

- 44 Application Experiments (AE) – and the innovative model of "Low digital TWIN AE" involving two cross-border SMEs/midcaps, one of which with low digital maturity level – allowed 71 companies to define an R&I project to disrupt, upgrade or manufacture an innovative digital product or service;
- 3 Digital Challenges (DC) with a focus on trialing new co-funding mechanisms with companies directly involving the enterprise demand side.
- 4 Generic Experiments (GE) communities involving a group of SMEs and mid-caps to implement advanced technology demonstrators through co-financing mechanisms of European and regional funding;

Overall, DigiFed provided a cascade funding of 4,0 million € to European companies as well as technical and innovation management support corresponding to 1,1 M€ of resources provided by the consortium.

2. GE introduction

2.1 Rationale of DigiFed GE Communities

Generic Experiments (GE) are designed to test new collaborations between research centres and a group of SMEs and midcaps as well as evaluate new co-financing mechanisms be-tween European and regional funding to foster European industry digitalization.

The objective of the Generic Experiment program is to build communities of SMEs & Mid-Caps (GEC members) around a specific technical topic (GEC Topic) proposed by a DigiFed research center (the GEC Owner).

DigiFed Generic Experiment program main objectives are:

- Develop the GE technical program for the GE members sharing common interest and needs
- Bring the GE community to define common generic requirement for the GE technical topics
- Demonstrate the technology performance to the GE community for future adoption
- Test new co-financing mechanisms between Europe and Regions to support SMEs and Mid-Caps with their digitalisation ambitions.
- Set up and experiment at least 3 GE communities with different model (technical topics, service and regional ecosystems) and involving a minimum of 20 SMEs.
- Assess Generic Experiment new service and best practice for the network of EDIH.

The main expected impact for each stakeholder group is:

For RTOs to:

- Bring Start-ups, SMEs and Mid-Caps to contribute to RTOs' technical roadmaps by bringing their use case, needs and constraints
- Develop the GE technology topics closer to SMEs needs

- Foster future adoption of the RTO technologies by the GE members to develop new CPS products and services.

For the community members to:

- Share their requirements and Use Case with other SMEs/Mid-Caps from different domains with the same technological needs
- Have direct access to experts of the GEC owner topic and contribute to the technology roadmap of a leading research center
- Be in the loop of latest technological results on the GEC topic to be ready for market movements and stay a step ahead of your competitors
- Become an active member of the DigiFed Network (12 Digital Innovation Hub and research centers) and expand your own network.

Local ecosystem:

- Regional authorities: leverage on existing local innovation program, attract European companies
- DIH: sustainability model, assess a new potential service to be proposed to their members and networks

Being an experimental innovation pathway that will require adjustment along the implementation, it was decided to propose 5k€ Cascade Funding to the SME's that will join one of the community, this lump sum support will cover the time spent by the members to contribute to the community building, the interaction with the community members to share their use cased and needs, and also to give feedback about this new type of collaboration between RTO's and SME's.

In order to allocated the 5k€, the H2020 rules impose to organise Open Call to select the beneficiaries of the Cascade Funding. This Open call will be described in following chapters.

2.2 Global GE program status at M 30

In 2021 DigiFed program has launched

- 4 GE Communities define involving 51 SMEs from 13 EU countries (Figure 1), that
- attributed 230k€ of Cascade Funding to GE members, 46 beneficiaries selected through 4 Open calls,
- and raised 270k€ of co-financing from regional authorities.

In June 2022 the implementation phase status of 4 GE's was:

- CEA, Cybersecurity topic: completed with assessment
- IKERLAN, Cybersecurity topic: ongoing, final workshop to be organized, assessment following
- BME, LED lightning topic: late start with the implementation phase, main activities completed, final workshop to be organized, assessment following
- University of Ljubljana, IoT in Agriculture: ongoing, final workshop to be organized, assessment following

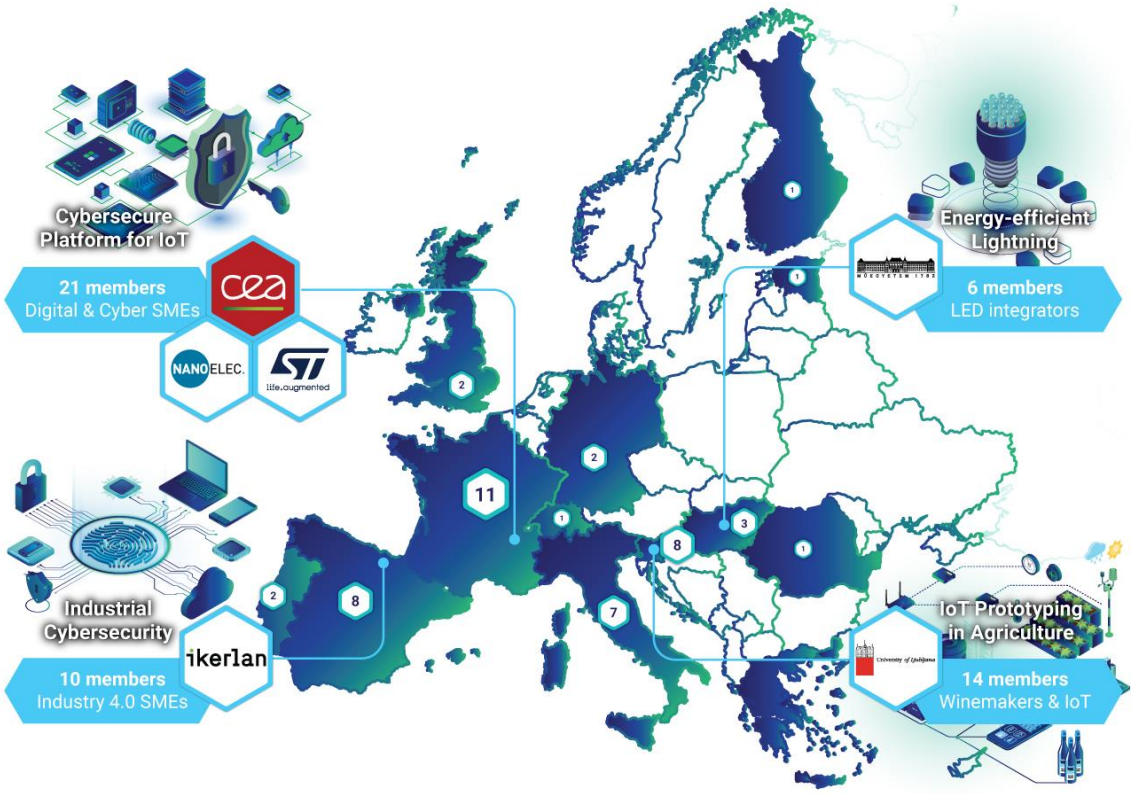


Figure 1: Map with the 51 GE members location

Each GE has its specificity in term of technical topic, type of service proposed to the members, size of the community and type of co-financing stakeholder (Table 1). The 4 technical programs (TRL4-6) will be implemented in 2022 by the GE owner. These different models are complementary and will enrich the GE model assessment that will be done after the GE completion.

Table 1: DigiFed GE main characteristics and complementarity of the 4 GE

GE Owner & Topic	Techno and development	Sector	Service to SMEs	Members	Co-financing
CEA Cyber-security 	Secure PF for IOT Cyber-attack monitoring **HW - SW**	Transverse digital	Access to CEA expertise and technical results Evaluation of the prototype	21 SMEs 4 Regional SMEs 10% Low digital maturity	Region AURA EASYPOC 100 k€ DigiFed 8PM
IKERLAN Cyber-security 	Industrial Cyber-security: Smart contract **SW**	Industry 4.0 Value Chain	Opening Basque project to EU Access technical program results	10 SMEs 5 Regional SMEs 0% Low digital maturity	Basque Region Project 72k€ DigiFed 5 PM

BME LED Lightning 	LEDsBeSmart: lab of excellence for design and characterization	LED Lightning Industry Value chain	Support in LED design and quality test	6 SMEs 3 Regional SMEs 66% Low digital maturity	National Project 34k€ DigiFed: 8 PM + 20 k€ equipment
UJL Agronomics 	Develop a new IOT prototype for vineyards	Wine Yards Value chain	Get digital experience in IoT technology Collect field measurement	14 SMEs 5 Regional SMEs 40% Low digital maturity	Ministry of Agriculture Project 72k€ DigiFed 6 PM

3. Four GEs presentation

3.1 GE Secure PF for IoT - CEA

3.1.1 Presentation

Based in the French Auvergne Rhone Alps region (AURA), CEA and ST both partner of IRT Nanoelec (French Public Private Partnership on micro and nanoelectronics) have define a Generic Experiment with the support of AURA EASYPOC innovation program.

EasyPOC is a programme designed for AURA companies (<2,000 employees) from all sectors of activity wishing to integrate technological innovation. Its objective is to secure companies' innovation process with high technological content by financing the proof-of-concept stage TRL (4-5). It finances a feasibility study and/or a proof of concept POC, realised by CEA teams, 100% financed by the Auvergne-Rhône-Alpes Region. EASYPOC is based on CEA's expertise in different Key Generic Technologies for digital, health and energy.

In the running EASYPOC programme, only one company is working with CEA to define the POC to be developed and to test it. No budget is allocated to the SME but it offers the possibility to test the POC and de-risk the decision to launch a specific development program.

In order to simplify and foster the legal aspect, no IP is transferred to the SME in this first phase but it will be discussed if a second phase is decided. In the second phase a dedicated prototype can be developed together with the SME which can be supported by AURA up to 60% through the EASYTECH innovation program.

Within the DigiFed GE, the goal is to trial a multipartite EASYPOC with a group of SMEs form AURA and Europe. The POC will be co-financed by AURA for the AURA members and by DigiFed for the European companies and the community animation. Community animations includes organisation of workshops, individual interviews, awareness events and other community based communication.

Cybersecurity is a major topic both for IRT Nanoelec and AURA development strategy, CEA-LETI and ST-F being Cybersecurity excellence centre of this ecosystem. Therefore, the proposed GE was focus on cybersecurity for SMEs.

3.1.2 Goals of CEA GE

IoT infrastructures are facing cyber risks from edge to cloud, from sensors and gateways to terminals and servers. There is a market need to secure these types of infrastructures and their data. Today's secure platforms are too complex to implement and suffer from a lack of certain key functionalities, so enterprises rely on less effective software solutions against attacks. In the framework of IRT Nanoelec, CEA and ST-F are working on a novel secure platform, easy to use and implement that will provide a higher level of protection to IoT infrastructure while fulfilling high performance levels.

This technology is based on CEA platform integrating STM32MP1 microprocessor based on the ARM TrustZone hardware isolation combined with STSAFE-TPM (Trusted Platform Module) certified CC EAL4+ and FIPS140-2 level 2; it enables a safe area of execution with a secure module providing secure key storage for long term keys and a cryptographic toolbox for companies who want to secure devices communication.

The new platform uses standard ST components and open-source frameworks. CEA Generic Experiment technical program will focus on STM32MP1 trusted platform with two development axes:

- Establish the security bases for the Trusted platform (secure boot, first level of secure communications, trusted isolated environment…)
- Develop the Monitoring of the Trusted platform against intrusions and security vulnerabilities exploitation.

3.2 GE Trust Platform for Digital Assets Management - IKERLAN

3.2.1 Presentation

The Trust Platform for Digital Assets Management GE leverages a Basque Business Development Agency (SPRI) funded project and enlarges it thanks to DigiFed co-financing force.

The SPRI programme called HAZITEK ESTRATEGICO aims "to support the generation of new knowledge that is expected to result in the creation of new or improved products, processes or services or the integration of technologies of strategic interest, or to create new IP and science and technology-based companies". Indeed, the SPRI agency funds projects where a set of Basque industrial companies join to solve a common problem with the support of local research & technology centres.

In particular, the HAZITEK Basque Country Programme funded in 2019 a 3-year-period project called SmartCON, whereby three Basque research companies, three technology start-ups and eight industrial machine-tool leading companies joined together to address a common industrial channel: *provide trust across the industrial value chain*.

In a nutshell, SMARTCON is built upon the concept of interconnected assets and services offered by different companies along the value chain. In this context, the project proposes to develop new business models that are based on trusted relationships between companies that are backed by cyber secure data transactions associated to physical asset transactions in their daily operations (i.e., Smart Contracts). More specifically, mutual trust between companies is to be achieved by creating a digital identity of company assets and registering their movement through Blockchain to create trusted value-added services based on industrial smart contracts for the machine tool sector.

The technical outcome for IKERLAN, thanks to the SmartCON project, is a Blockchain-based platform where Blockchain based Smart Contracts, that model different business cases through the value chain, can be executed to ensure trust across value-chain parties (i.e., client-provider relationship). Concretely, different business cases have been developed and tested for the different companies involved:

- machine warranty smart contract, meant for ensuring that machines are used under the conditions agreed between the client and the machine provider,
- machine maintenance smart contract, meant for ensuring that maintenance of the machine is done by the provider whenever the machine in operation reaches certain thresholds,
- machine productivity & production quality smart contract, meant for ensuring that machines reach the productivity and product quality rate agreed between the client and the machine provider,
- machine pay-per-use smart contract, meant for enabling a pay-per-use of the machine, where the client that uses the machine pays only for the usage of the tool.

The IKERLAN platform, hence, enables to operate all these smart contracts that are defined within an industrial machine-tool context. All this Smart Contracts share a common root design based on the idea of using machines telemetry data, to stablish thresholds and define business rules.

The objective of this GE is to **help improve the capabilities of the Trust platform that is being developed in the SmartCON project, as well as enhance its reach-out by including other companies across the EU**. Hence, for the

GE, we selected five Basque Country machine-tool companies, that were also part of the SMARTCON project, as well as, other five European SMEs companies (from domains other than machine-tool).

3.2.2 Goals

The goals that we define within the DigiFed GE framework are the following:

- Evaluate the external validity of the platform. External validity refers to the extent to which results from a study can be applied (generalized) to other situations, groups, or events. Hence, we aim to evaluate whether the platform and smart contract model developed with SMARTCON can also be applied for domains other than machine-tool companies and, if these are applicable to SMEs. This evaluation will be done taking into consideration the input from European companies.
- Evaluate the internal validity of the platform. Internal validity is the extent to which you can be confident that a cause-and-effect relationship established in a study cannot be explained by other factors. This is something that within the framework of SmartCON has not been conducted. Hence, we aim at drawing also internal validity of the platform: weather the ideas and developments done within SmartCON have fulfilled their initial needs.
- Technically improve the platform: continue the effort made on SmartCON to make the platform more robust and account for machine's identity-based data. This entails technical effort, whereby the blockchain-based platform is enhanced and improved with the use cases from both Basque and EU companies.

3.3 GE BME

3.3.1 Presentation

In the past 1.5 decade BME has been active in modelling, simulation and testing of solid-state lighting products on national and European level, resulting in multiple national and European public funded projects with multiple dozens of Hungarian and European companies – both large enterprises and SMEs – active in the lighting industry. The most recent such project was the Delphi4LED H2020 ECSEL project in which an LED package level testing and compact modelling methodology was developed with which the so called multi-domain behavior of LED packages which could be captured and turned into a multi-domain Digital Twin of LED packages, suitable both for design purposes (virtual prototyping or digital twinning in the product design and development phase) and for the purpose of being part of a Digital Twin embedded into the lighting product itself. Using a cyber-physical systems approach, such digital twins can be connected to signals of external sensors (such as temperature sensors) for the purpose of e.g. performing different control functions during field operation.

Within the Delphi4LED project compact modelling was also applied at higher levels of product integration beyond LED package level, going up to the level of a complete LED luminaire (system level). This is fully covered by a proposed, Industry 4.0 type workflow also proposed within Delphi4LED.

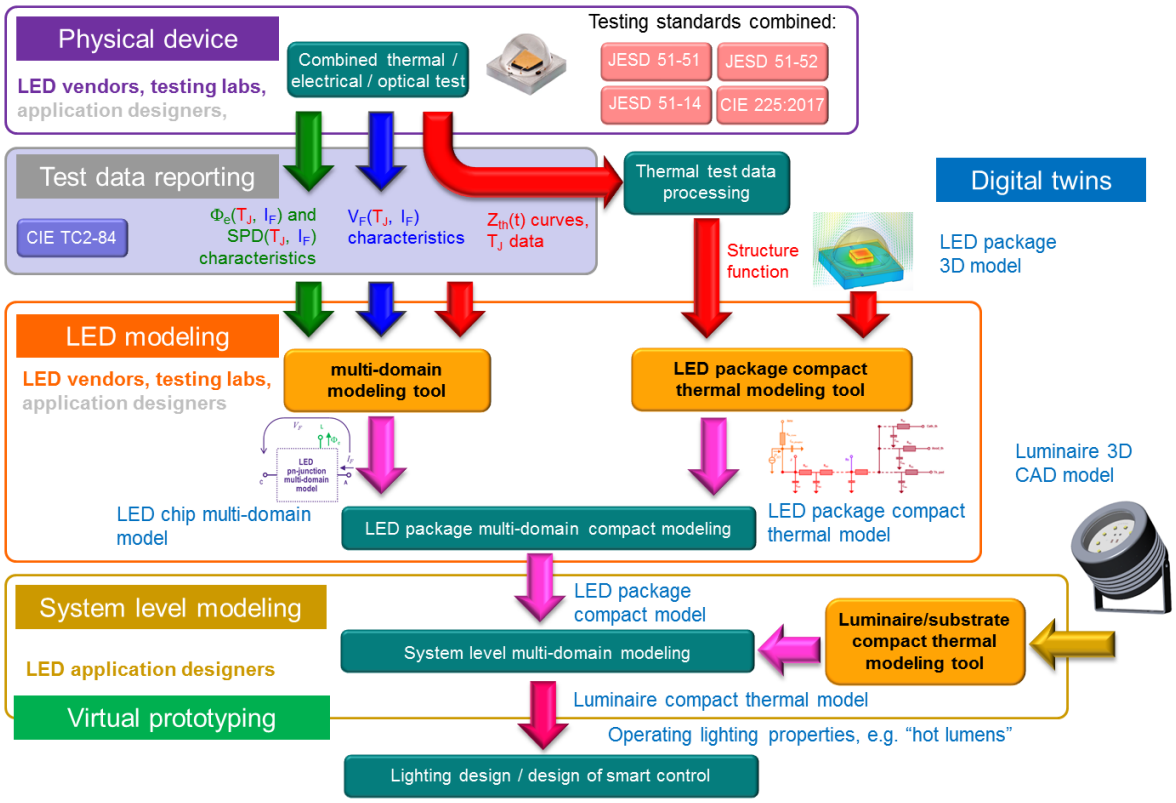


Figure 2: The fully digitalized solid-state lighting product development workflow as proposed by the Delphi4LED project, considered as the baseline for the generic experiment championed by BME

The possible benefits both for big companies and SMEs have been evaluated through two demonstrator use-cases in Delphi4LED[1]. The overall result is that about 30-40% cost reduction is achievable by replacing physical product prototypes by virtual prototypes realized by the luminaire's multi-domain digital twins. In the trial implementation of the workflow shown in Figure 12 specialized software tools were used that are regularly available for larger companies only, who have sufficient resources to cover the license fees of such tools. Test equipment used for the new types of Delphi4LED-style measurements are also expensive for the typical SME-s active in the European (solid-state) lighting industry, not to mention the time and effort needed to perform the required tests. Besides the direct cost benefits of digitalizing the luminaire development process, one also has to mention, that the digitalized workflow allows better product optimization as well, such as making complex technical-business decisions possible already early in the design phase. Examples of such optimizations are LED package type selection (LED package from "vendor A" or from "vendor B") or "higher forward current with fewer LED packages and advanced thermal management solution" vs. "lower forward current with more LED packages and simpler thermal management solution" with complex objective functions in terms of overall cost, projected product lifetime and maximal temperature[2].

3.3.2 Goals

The primary objective of the GE of BME was to collect direct feedback from different SMEs to find ways of improvements of the original workflow. The secondary objective was, to make prior research results of BME accessible in a realistic, digitalized product development workflow the implementation of which would be affordable by these SMEs, assuring this way that the achieved results of the Delphi4LED project may become industrial reality. Thus, the goals of this generic experiment are

[1] Poppe A, Farkas G, Gaál L, Hantos G, Hegedüs J, Rencz M. Multi-Domain Modelling of LEDs for Supporting Virtual Prototyping of Luminaires. Energies. 2019; 12(10):1909. https://doi.org/10.3390/en12101909
[2] Pohl L, Hantos G, Hegedüs J, Németh M, Kohári Z, Poppe A. Mixed Detailed and Compact Multi-Domain Modeling to Describe CoB LEDs. Energies. 2020; 13(16):4051. https://doi.org/10.3390/en13164051

- identify bottlenecks of the original Delphi4LED workflow, such as
- cost and throughput of the package level LED testing
- effective extraction of model parameters of Spice-like multi-domain models of LED chips
- effective identification of compact thermal models of LED packages
- identify missing bits in the modelling and simulation workflow, such as
- inclusion of LED drivers into the system level modelling and simulation workflow
- inclusion of ageing and reliability aspects in the modelling
- making sure that most elements of the workflow are performed with software tools available by SMEs
- making sure that bits of the workflow that need certain type of special expertise and tools could be offered as a dedicated service by SMEs who have the required special skills (such as LED testing by accredited labs) for other SMEs who need such services

3.4 GE IOT PROTOTYPING IN AGRICULTURE - UL

3.4.1 Presentation

UL GE propose to enlarge a National project to European companies thanks to DigiFed co-financing. The GE is proposing a digital platform for wine growers to implement common environmental approaches to reduce the environmental impact of agriculture – developed in the project SMART AGRO GRAPE. SMART AGRO GRAPE is the complementary project running along the UL GE community. SMART AGRO GRAPE project duration is 2021 – 2024.

The EIP (European Innovation Partnership) project SMART AGRO GRAPE addresses the following themes by setting up a digital platform for wine growers to implement common environmental approaches to reduce the environmental impact of agriculture:

- Sustainable use of agricultural land by ensuring soil fertility and preventing soil erosion and degradation.
- Sustainable plant protection.
- Reducing the pressures from agriculture on surface and groundwater and the efficient and sustainable use of water on the farm

The Slovenian project establishes an innovative partnership that will use its joint strengths, experience, and knowledge to address the challenge of technological and economically more efficient approaches, technologies and practices to optimize vineyard management in the context of the smart vineyard concept on the participating farms. Thanks to DigiFed GE program, UL will propose to European SMEs to join Smart Agro Grape partnership.

3.4.2 Goals

The Generic Experiment Community on IoT and agriculture lead by University of Ljubljana is based on SMART AGRO GRAPE project, developing the technical pilot solutions in parallel to target group (SMEs, integrators, and winegrowers) workgroup activities. The overall SMART AGRO GRAPE objective of the project is enhancing traditional vineyards to “smart vineyard”. Smart vineyard can obtain relevant sensory data directly and indirectly from selected farm locations to store, analyse and deploy an advanced digital platform that will enable a more technologically, economically and environmentally efficient management of agricultural land, and will consequently have an impact on the reduction of the environmental burden of agriculture through the implementation of common environmental approaches.

The specific goals of the project are:

- To establish an innovative project partnership that is professionally competent and able to carry out the necessary development and testing to improve management efficiency.
- To increase the knowledge and digital competences in advanced digital technologies and IoT tools of the involved wine growers.

- Procure and integrate into testing the necessary new technologically advanced digital sensor equipment to collect the necessary data in the field and to install and integrate into use in the selected vineyards.
- Collect high quality sensory and other environmental data and archive and analyze the data in a database to build and deploy an effective prognostic module.
- Develop new farming practices and indirectly ensure savings and efficiency improvements in the use of farm labor time.
- Contribute to the sustainable use of agricultural land through new solutions, practices and knowledge.
- To carry out effective training and knowledge transfer to project stakeholders and to carry out effective dissemination of results.
- Provide sustainable solutions in viticulture in the framework of the "smart vineyard" concept.

4. GE preparation phase

4.1 GE shared common work

The preparation phase (Task 2.1) was reported in detail in D2.1.

CEA was responsible for the global GE methodology. CEA has initiated the preparation process flow and defined the necessary tools that have been optimised with the other GE owners and adapted to each GE specificity.

- The common process includes the different steps to set up a GE program:
- Build the right technological service offer adapted to the GE owner
- Engage regional authorities, design the co-financing mechanism.
- Define the Open call processes
- Select companies that will join the GE as GE members (Local and EU)
- Prepare the adapted legal contracts SGEA (Standard Generic Experiment Agreement) that describes the terms and conditions for the financial support. (The SGEA is given in D2.1 Annex 1)

The GE preparation timeline is detailed in Figure 3 below:

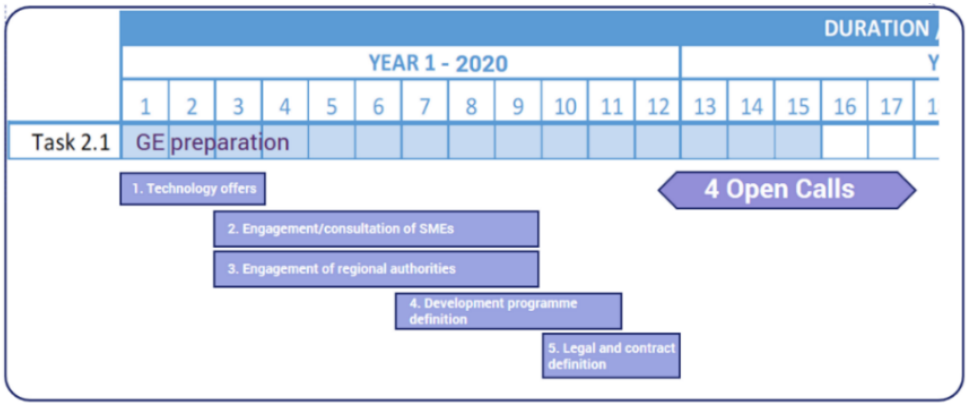


Figure 3: Generic Experiment preparation task 2.1 timeline

The open call process was also precisely described in D2.1. The challenge for this open call has been to have a simple process as light as possible, still enabling to select SMEs adapted to each GE. The submission was a single online questionnaire, evaluation was done by the GE Owner team plus one person from another GE owner, for objectivity and homogeneity of the process over the 4 GE's. The questionnaire included common selection criteria which have been defined and used by the 4 GEs, and technical question specific to each GE's programme.

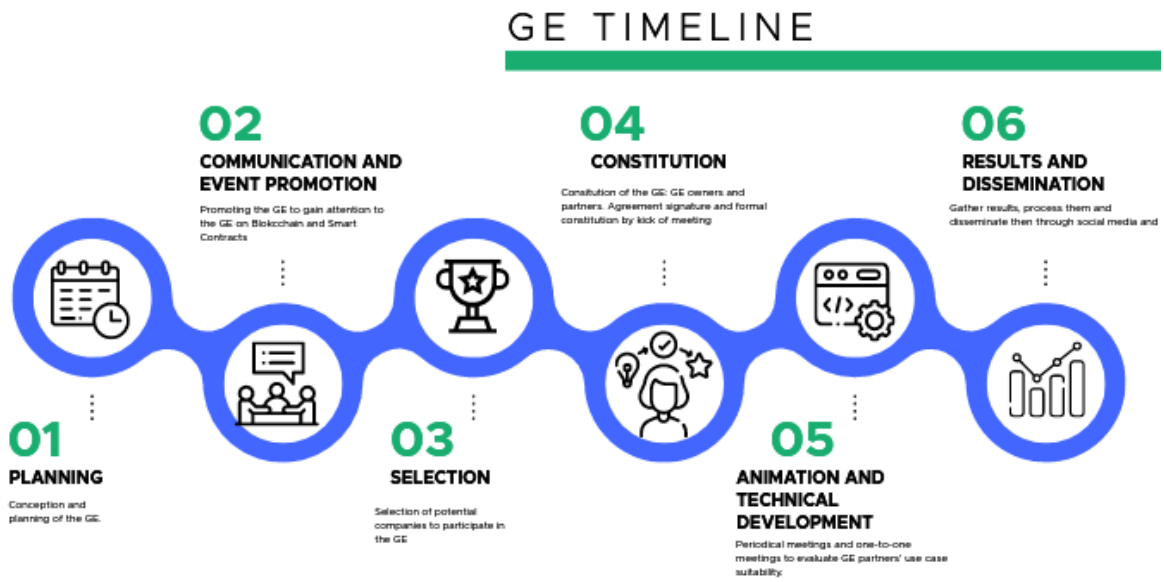


Figure 4: GE Timeline

Figure 4 represents the Generic experiment common timeline phases implementation. These phases were common for each GE. The first "Preparation" stage, from Planning, Communication and event promotion and GE constitution described in detail in this Deliverable D2.2.: Three Generic Experiments implemented, chapter 3.5. Generic experiment preparation phase. The second phase "Generic experiment implementation", is further described in detail in the next chapter 3.6. Generic experiment implementation.

4.1.1 Common promotion of Generic experiments

The promotion of common open call has been carried out in posting news items to DigiFed website as well as promoting these and other common content throughout social media profile of DigiFed project and project partners, GE owners.

Website content:

- **https://digifed.org/open-calls/generic-experiment/**
- **https://digifed.org/2020/12/17/digifed-launches-open-calls-for-generic-experiment-communities/**
- **https://digifed.org/2021/03/31/new-generic-experiment-communities-now-open/**
- **https://digifed.org/2021/06/09/last-chance-to-apply-for-digifed-generic-experiment-communities/**

Social media posts (Figure 5):

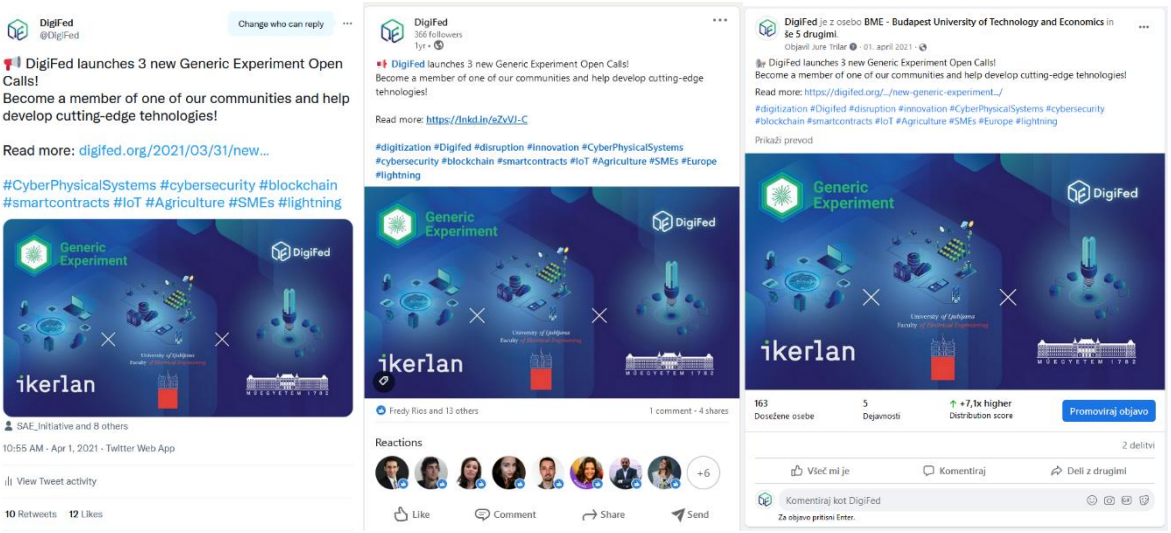


Figure 5: Social media posts with common invitation to multiple GE's

4.2 GE CEA

4.2.1 Timeline

The CEA GE open call was fully reported in D2.1, 2020 Year 1 of DigiFed CEA supported its Open Innovation Center (YSPOT), built a community of 18 SMEs. LETI together with ST Microelectronic animate several collaborative sessions and individual interviews to define the GE technical program jointly with these 18 SMEs.

Initially it was foreseen to invite the 18 SME that contributed to the GE program elaboration to join the GE program on a voluntary basis. Because of the 5k€ Cascaded Funding support given to the GE members, it was not possible to invite them without an open selection process.

- The Open Call for CEA GE was launched 15/12/2020 and it closed 15/02/2021. It described the technical program set up with the 1st community and the legal agreement SGEA to be signed by the members with their engagement.
- The evaluation and selection process ended 05/03/2021 and was published on the DigiFed website
- SGEA Standard Generic Experiment Agreement was signed by all members before 16/06/2021
- 03/06/2021: First GE community workshop: kick off the implementation phase
- 05/11/2021: Second GE community workshop: demonstrated the version 1 of the prototype
- 20/06/2022: Final and closure workshop of CEA GE community: demonstration of the final prototype and feedback from the GE members

4.2.2 Open Call promotion

The Open call was published on DigiFed webpage, and widely promoted using the SAE channels, as well as DIHs both from and outside DigiFed. Outside DigiFed common social media channels and website this was posted on:

- https://smartanythingeverywhere.eu/digifed-ge-call-now-open/
- https://mobile.twitter.com/digifed/status/1339553220054675456
- https://www.facebook.com/DigiFedHorizon2020/photos/a.103720754525069/226093782287765/?type=3

Local ecosystem was also supportive with IRT NanoElec, Minalogic , Avergne Rhône Alpes Enterprises

- https://irtnanoelec.fr/actualites/seize-entreprises-se-rassemblent-pour-renforcer-la-securite-de-linternet-des-objets/
- https://www.minalogic.com/digifed-generic-experiment-on-cybersecurity-secure-platform-for-iot/

As CEA GE focused on a transverse generic topic "Cybersecurity of IoT" all the DigiFed AE applicants have been encouraged to apply to CEA GE open call.

4.3 GE IKERLAN

4.3.1 Timeline

The followed timeline for the IKERLAN's GE is depicted in the Figure 4: GE Timeline: The phases followed are described below:

- Planning Phase: this phase entails the conception and the overall planning of the GE.
- Communication and Event Promotion Phase: in this phase IKERLAN promoted the GE through social media (LinkedIn) and DigiFed's official web page.
- Selection Phase: this phase entails the selection of the companies that applied to take part on the GE experiment.
- Constitution Phase: once the selection phase resulted in the 10 companies to take part in the GE, the agreement document was written and signed by all partners. Afterwards, a kick-off meeting was held on February 2022. The agenda followed at the kick-off meeting was as follow (animated by IKERLAN):
    - Introduction of each GE partner: each partner took the time to present themselves, by stating what is their actual business and why they joined to the GE.
    - A bite on Blockchain: IKERLAN introduced the basics for Blockchain and smart contracts.
    - Industrial use case with Blockchain and Smart Contract: IKERLAN showed cased and industrial pilot using IKERLAN'S Blockchain Platform for machine-tool production quality assurance.
- Animation and Technical Development Phase: after the kick-off meeting the animations and technical development phase follows. Specifically, the following sub-phases are followed:
- Analysis of GE partners' use cases:
    First, one-to-one meetings should be taken between to be taken so that GE partners' use cases can be understood by the GE owner (IKL). Here an IKERLAN expert had several one-to-one meetings with each GE partner. The objective was to (1) better understand GE partner's use cases, (2) evaluate if a blockchain-based solution made sense, and (3) design a potential architecture to bring together GE partner's ecosystem with IKERLAN's Blockchain Platform.
    - Evaluation for the selection of uses cases to implement: Once all GE partners' use cases where evaluated, a couple of them where selected so that the actual development is carried out to implement them. The suitability of the use cases was evaluated according to the distinct criteria.
- Development: The use cases matching all the criteria will be the ones selected for final development. First, a design of the solution needs to be defined, so that suits GE partners' context. Afterward, development efforts should be taken.
- Results and Dissemination Phase: this phase entails the gathering of the results for all GE partners and the dissemination of them through social media and physical events.

4.3.2 Open Call Promotion

GE promotion was done through DigiFed's official web page (Figure 6):

- **https://digifed.org/generic-experiment/generic-experiment-on-cybersecurity-trust-platform-for-digital-assets-management/**
- **https://digifed.org/2021/06/09/last-chance-to-apply-for-digifed-generic-experiment-communities/**
- as well as, through LinkedIn posts **https://www.linkedin.com/posts/digifed_cybersecurity-funding-blockchain-activity-6815189453859020800-1oyw?utm_source=linkedin_share&utm_medium=member_desktop_web**

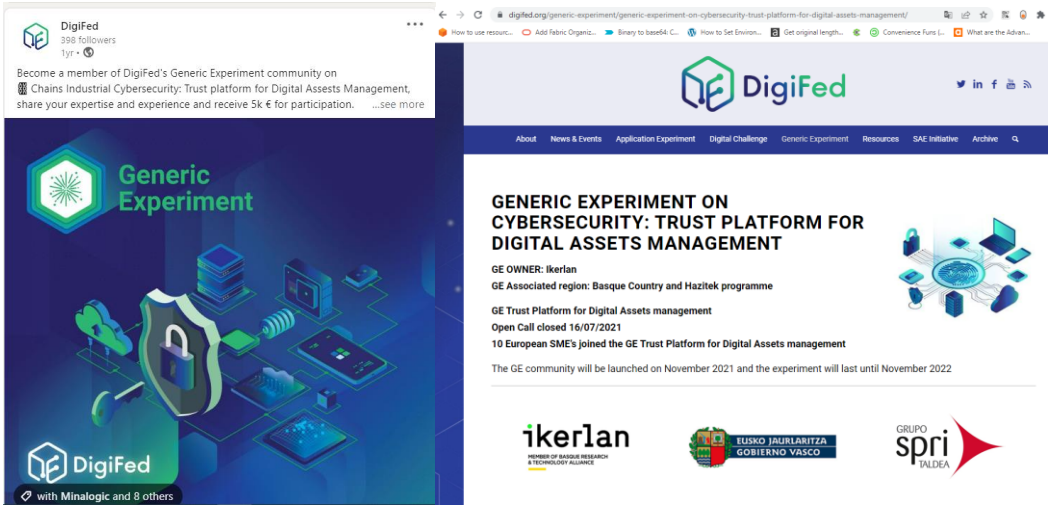


Figure 6: Website presentation of the IKERLAN GE

Social media posts (Figure 7):

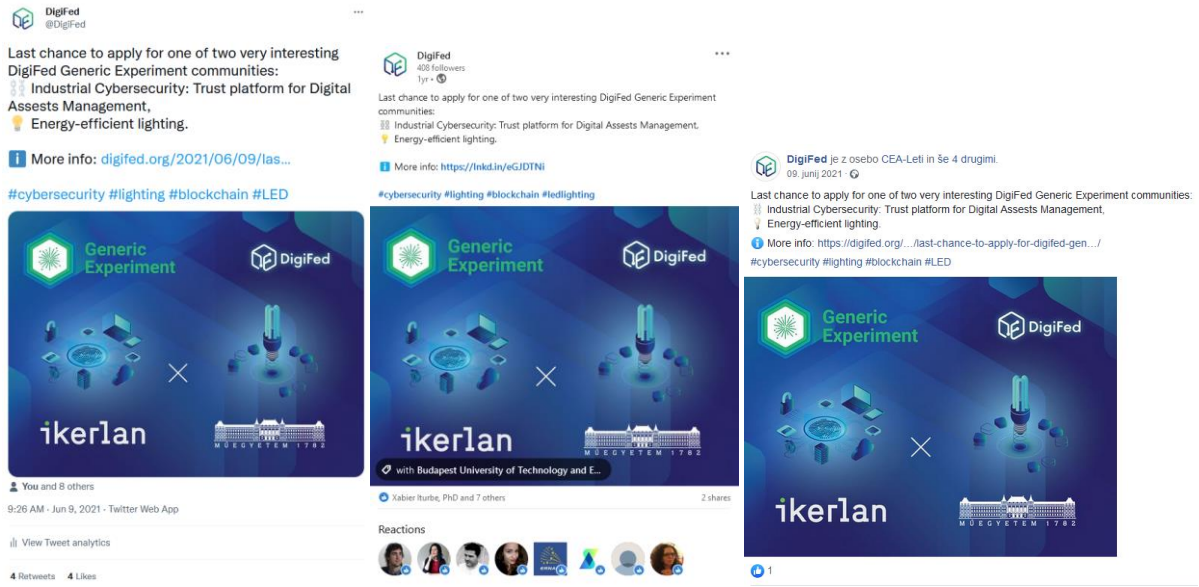


Figure 7: Social media posts with invitation to IKERLAN's GE

4.4 GE BME

4.4.1 Timeline

Due to longer legal process regarding intellectual property right and participation rules in BME GE there was some delay and on M30 the phases completed were:

- Planning phase - this phase entailed the conception and the overall planning of the GE, for the specific GE and common actions and content.
- Communication and event promotion phase in this phase BME promoted the GE through social media (LinkedIn) and DigiFed's official web page as described in previous Open call promotion section. .
- Selection phase entailed the selection of all the companies that applied to take part in the BME GE experiment.

The remaining phases, namely, related to GE Implementation: Constitution phase, Animation, and technical development phase with Results dissemination phase, will be completed after M30 (June 2022).

4.4.2 Open Call Promotion

Besides common promotion efforts for GE open call the specific social media and articles have been posted on relevant DigiFed channels.

Website presentation:

- **https://digifed.org/2021/06/09/last-chance-to-apply-for-digifed-generic-experiment-communities/**
- **https://digifed.org/generic-experiment/generic-experiment-on-energy-efficient-smart-led-lighting/**

Social media posts (Figure 8):

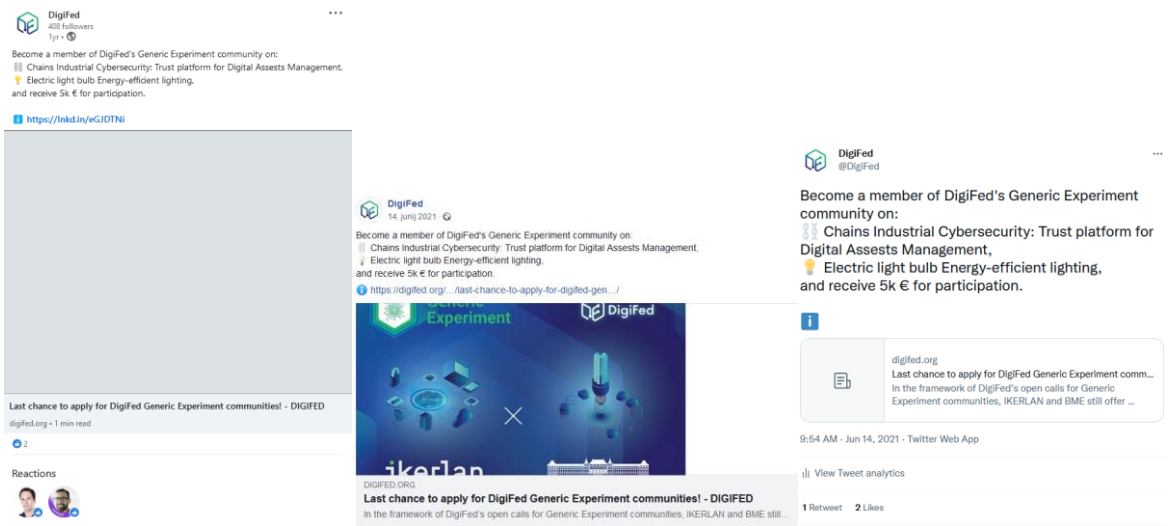


Figure 8: Social media posts with invitation to BME's GE

4.5 GE UL

4.5.1 Timeline

The community animation (engagement) activities were organised in the following order:

- Planning phase - this phase entailed the conception and the overall planning of the GE, for the specific ULGE and common actions and content.
- Communication and event promotion phase - in this phase UL promoted the GE through social media (LinkedIn) and DigiFed's official web page as described in previous Open call promotion section.
- GE UL Open Call deadline was set to 31.5.2021.
- Selection phase - entailed the selection of all the companies that applied to take part in the UL GE experiment. There were 16 SMEs members spots available in the UL GE workgroup on IoT in Agriculture:
    - 14 SMEs applied to become members of GE UL workgroup in the GE Open Call process. All were relevant and were accepted into the workgroup consisting GE UL community
    - 3 additional SMEs have joined after the closure of the Open Call. These SMEs did not receive the cascade funding as the other GE UL members; however, they were very interested in being part of the GE UL community as it gave them the opportunity to network with sectoral partners and solution providers
- After the selection phase, the Standard Generic Experiment Agreement was circulated for comments and subsequential updates in case of specific national and regional authority requirements. Along the contract agreement signature process there was financial identification statement collection.

- Constitution phase – GE Community KickOff meeting with the selected parties was organized on 9.9.2021. Agenda was structured as:
  - 1 introductory section on GE codevelopment and cofounding mechanism:
  - 2 technical sections
  - 2 panels: 1 with solution providers and 1 with wineproducers
- Animation and technical development
- Initial GE UL members' surveys were collected that included:
  - data on the organization,
  - data on their product and market maturity,
  - data on digital maturity,
  - data and inputs on their technical development and market penetration vision
  - separated into 2 groups of answers for 2 key stakeholder groups (wine producers and solution providers)
    - challenges in using the technology
    - key, vital parts of their production processes
    - existing IT infrastructure in vineyards
    - existing IT solution provided to customers
    - cybersecurity issues
    - GE community expectations (technical, networking) related questions
- Interviews with GE UL members about the technical requirements in distinct use-cases:
  - 3 interviews with representatives of IT solution provider SMEs
  - 3 interviews with representatives of vine producing value-chain SMEs
- Intermediate workshop showcasing development status was organized on 20.4.2022:
  - Showcasing sensors and infrastructure used and developed within the project
  - Presenting pilot sites presentation and area specifics
  - Presenting use cases and developed monitoring app
  - Round table with all participants for additional insights

Results dissemination phase will be conducted after the final workshop organisation which is foreseen in Q3 2022. The final workshop timing in not crucial for the GE Implementation phase and no additional costs are bound to that - it is more important to find the right timing for the vine producing value chain SMEs, who have either touristic season related activities and order fulfilment before the peak summer season or grape harvesting from September to October.

4.5.2 Open Call Promotion

Besides common promotion efforts for GE open call the specific social media and articles have been posted on relevant DigiFed channels.

Website presentation:

- **https://digifed.org/open-calls/generic-experiment/generic-experiment-on-iot-prototyping-in-agriculture/**

Social media posts (Figure 9):

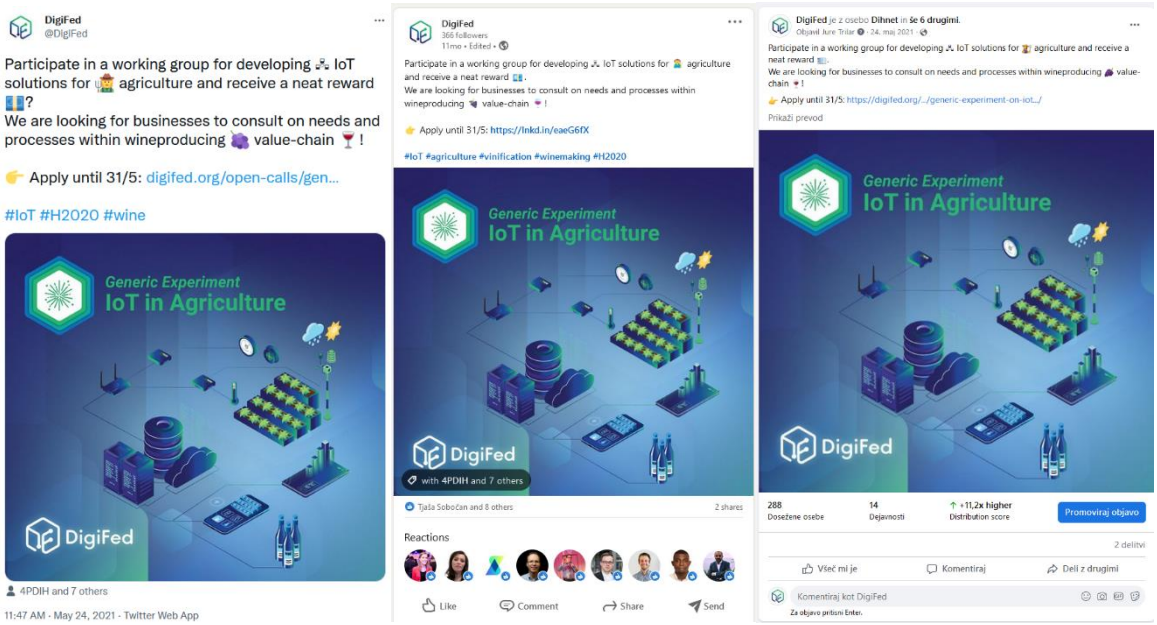


Figure 9: Social media posts with invitation to UL's GE

5. GE implementation phase

This section describes the activities completed on M30 (June 2022) of DigiFed after the GE open calls were finalized (Communication and event promotion and Selection phases). Please note that there are different dynamics in the implementation phase of each GE, thus the report includes information on the finished activities. The remaining activities to be completed, will be presented in the final GE report.

- CEA completed, closed and made assessment of their GE. All activities are described in relevant sections. Final assessment results will be presented in Deliverable 2.3.

- IKERLAN finished most of the technical development and animation activities of the GE implementation phase. To be completed:
  - Final IKERLAN GE workshop (planned in October 2022), presenting the results of technical development with report on demonstration.
  - Assessment of GE owner's staff, GE members SMEs, co-financing authority feedback.

- BME GE UL M30 status is related mostly to efforts for the finalization of Standard Generic Experiment Agreements signing, thus the activities yet to be completed include the majority of the GE implementation phase:
  - Final BME GE workshop (planned in Q3 2022), presenting the results of technical development with report on demonstration.
  - Assessment of GE owner's staff, GE members SMEs, co-financing authority feedback.

- UL as well finished most of the technical development and animation activities of the GE implementation phase. To be completed:
  - Final UL GE workshop (planned in Q3 2022), presenting the results of technical development with report on demonstration.
  - Assessment of GE owner's staff, GE members SMEs, co-financing authority feedback.

5.1 GE CEA

5.1.1 Community

CEA open call received 32 applications from 14 EU countries. CEA GEC Open Call selection ranked in 16 SMEs including 3 AURA Region SMEs which was mandatory to receive the co-financing from AURA local authorities.

Impact of DigiFed network:

- 16 applicants to CEA GE also applied to DigiFed Application Experiment open call
- Among these, 6 were selected both for an AE and to join the GE: 2 SMEs have been selected to join CEA GE with CF and 4 accepted to join without CF.
- DigiFed Consortium members' countries are well represented in the applicants and Italy is the first applicant country.

Impact of the preparation phase:

- 10 applicants to CEA GE participated to the preparation phase to co-define the GE technical program
- Among them, only 5 SMEs have been selected this is a major drawback of the GE open call process. This has generated frustration to the non-selected SMEs which would have join the GE community otherwise.
- 3 SMEs selected are from AURA region, 2 of them selected have participated to the 2020 co-definition phase
- 8 SMEs are newcomers that did not participated in the preparation phase nor in DigiFed Application Experiment.
- As some NOT selected DigiFed partners' companies still have concrete interest in participating to CEA GE, CEA GE Team proposed to these companies, when already part of DigiFed Application Experiment program to join the GE without receiving the funding. 8 companies were proposed to join and 5 accepted.

This makes CEA GE community composed of 16 SME funded (13 EU + 3 AURA region) and 5 SMEs not funded making a total of 21 GEC members, 8 of these members participated to the preparation phase.

The main drawback of the Open Call selection is that we lose part of the synergy created during the collaborative preparation phase. Indeed, no interaction with the initial group of SMEs was possible during the Open call process, and when we kicked off the GE community only 8 members know each other and contributed to the GE program.

Lesson learnt: to build an efficient and collaborative community we propose to work in collaborative working sessions with volunteers' companies to define the GE technical program, and then build the community on a co-optation process where companies will be invited to join by the core group and signed the SGEA

5.1.1.1 Structure and description of selected SMEs

16 European SME were selected among the applicants and received 5K€ Cascade Funding, 4 accepted to join without Cascade Funding and 1 (Witekio) was invited by a participant (Charvet) and co-opted by the community (Figure 10).

6 Members are also involved in DigiFed AE pathway.

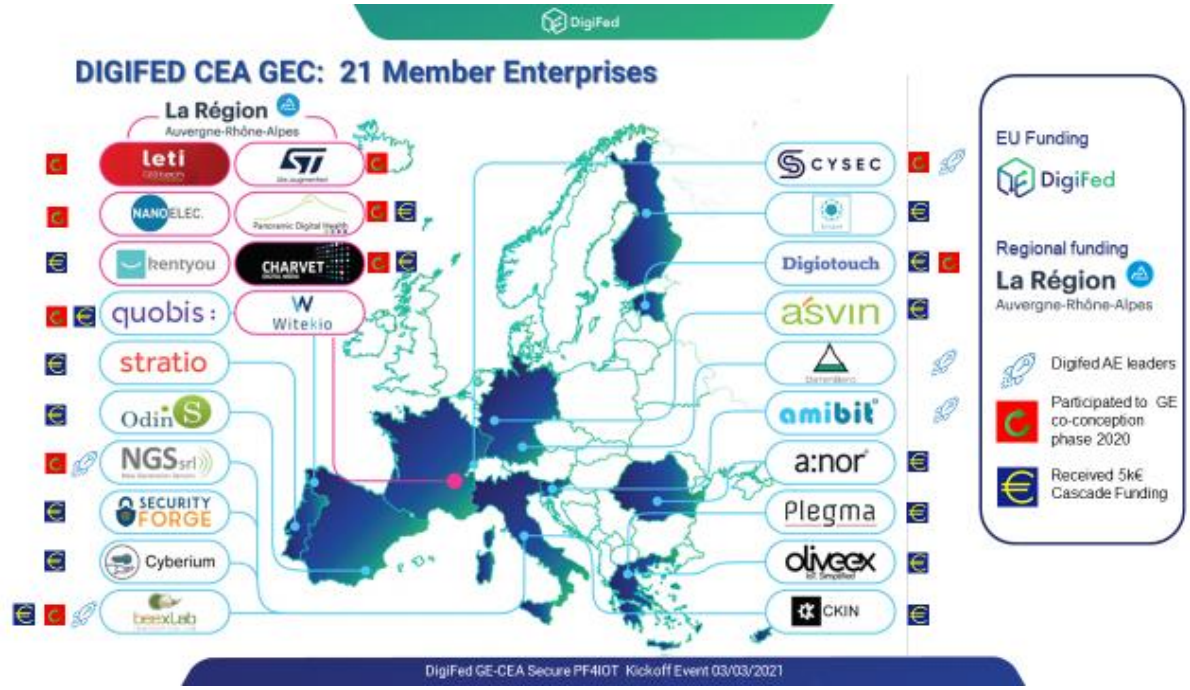


Figure 10: CEA GE community participants map

Size of the members. Most of the selected SMEs are very small companies below 10 persons 15 members), only 6 employs between 11-50 persons (Figure 11).

Figure 11: CEA GE community participants size

Digital maturity of the members: a large majority of members are high digital maturity companies (19) which core activity is based on digital (Table 2). This was expected as Cybersecurity address products with digital features.

Table 2: CEA's GE community participants' digital maturity assessment

	Applicants	selected
LOW Digital Maturity	4	2
HIGH Digital Maturity	28	19

Members activity sectors: most of the industrial sector are represented, the main one being industry 4.0 (Figure 12).

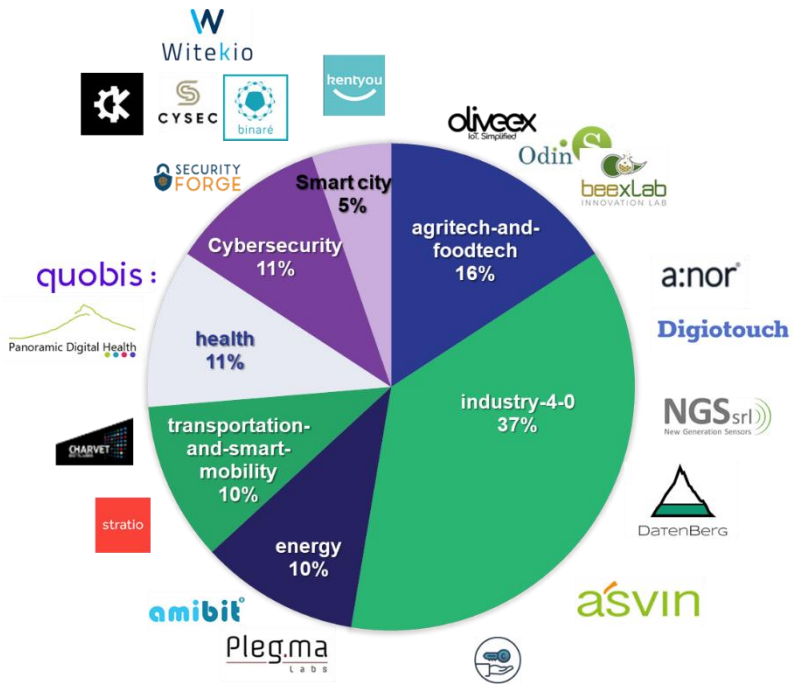


Figure 12: CEA GE community sectors

Member main expertise: Most of the members are Software oriented companies (10 members) which is surprising as the GE topics are strongly focus on Hardware and embedded software. 5 members are full end-to-end companies and 5 are pure hardware developer (Figure 13).

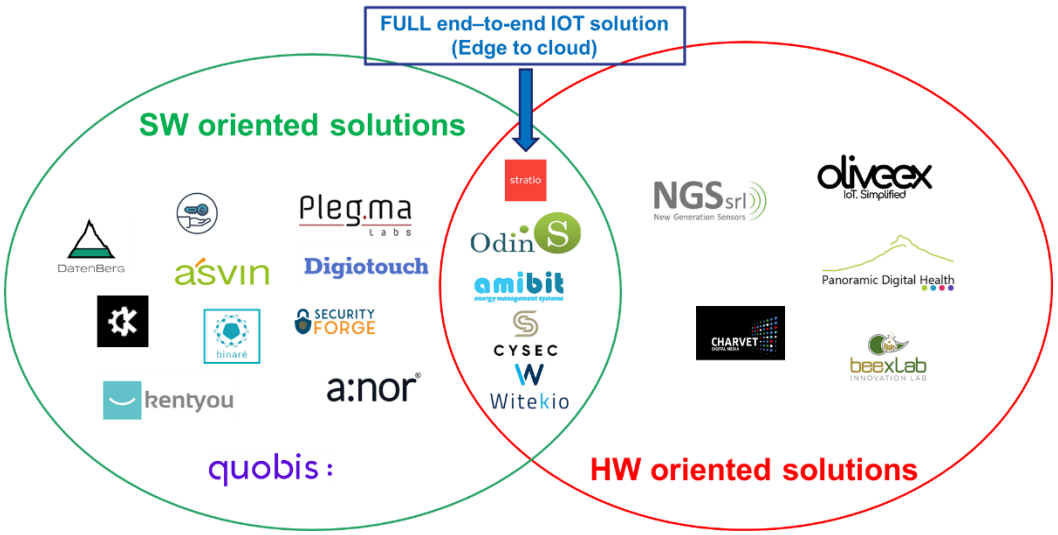


Figure 13: CEA GE community expertise mapping

This make a very complementary community addressing wide spectrum of use case and application field (Table 3).

Table 3: CEA GE community participants' information

Company name	Company country	Sector	website
Charvet Industries	France AURA	Transportation and smart mobility	https://www.charvet-digitalmedia.com/
Kentyou	France AURA	Smart Cities	https://kentyou.com/
Panoramic Digital Health	France AURA	Health	https://www.panoramicdigitalhealth.com/
DatenBerg GmbH	Germany	Industry 4.0	https://datenberg.eu/
asvin GmbH	Germany	Industry 4.0	https://asvin.io/
CYSEC SA	Switzerland	Cybersecurity	https://www.cysec.com/
Security Forge srl	Italy	Cybersecurity	https://security-forge.com/
Beexlab Srl	Italy	Agritech and foodtech	http://beexlab.com/
CKIN srls	Italy	Cybersecurity	https://com.ckin.it
Cyberium	Italy	Industry 4.0	https://thecyberium.com/
New Generation Sensors	Italy	Industry 4.0	https://ngs-sensors.it/
Oliveex P.C.	Greece	Agritech and foodtech	https://www.oliveex.io/
Plegma Labs S.A.	Greece	Energy	https://pleg.ma/
PROVA NOR	Romania	Industry 4.0	
Digiotouch	Estonia	Industry 4.0	https://www.digiotouch.com/
Binare Oy	Finland	Cybersecurity	https://binare.io/
Quobis Networks SL	Spain	Health	https://quobis.com/
Odin Solutions SL	Spain	Agritech and foodtech	https://www.odins.es/en/
STRA, S.A.	Portugal	Transportation and smart mobility	https://stratioautomotive.com/
Witekio	France AURA	Digital product, embedded systems	https://witekio.com/fr/

5.1.2 Organisation of the GE

Different teams have been involved in CEA GE set up and coordination.

1. CEA/LETI/System Department/ Security of Objects and Physical Systems Laboratory (LSOSP)
2. CEAOpen Innovation Center: Y.SPOT
3. ST microelectronics as technology provider of the core component of the secure platform.
4. IRT Nanoelec through its Cybersecurity program
5. Region Auvergne Rhône-Alpes (AURA region) as regional co-funding authority trough the Easypoc program

1- LSOSP laboratory

LSOSP (20 researcher) is the GE owner and has defined the GE technical topics based on its background developed since 3 years together with ST Microelectronic in the framework of IRT Nanoelec Cybersecurity program: a secure reference design based on ST secure components.

3 people from LSOSP were involved in the GE implementation: R Jayles and Thibault Franco-Rondisson engineers from LSOSP have been responsible for the GE technical program implementation, and in charge of the technical

discussion with the GE members. Isabelle Chartier DigiFed coordinator was in charge of the animation of CEA GE community.

2- YSPOT

CEA open Innovation Center YSPOT, oversaw the GE methodology definition and the animation of collaborative sessions with the community.

During the preparation phase 2 people from YSPOT were involved. Gorka Arrizabalaga was leading the task which involved the volunteering SMEs in the co-definition phase. During the implementation only Gorka Arrizabalaga was involved for the organisation and animation of GE event and in charge of the GE assessment methodology which is a task common to all the GE's.

3- ST Microelectronic

ST Microelectronic brings to the GE the secure component used for the reference design and the secure platform based on ST devices. During the preparation phase 3 engineers from ST France and Italy were involved in the technical program definition collaborative session. During the implementation phase Marcello Coppola, DigiFed contact for ST France, participated to the different working sessions, as well as T Fensch responsible for ST in the IRT Nanoelec Cybersecurity program.

ST role was to supply critical secure component for the GE and to share with SMEs their industrial strategy about STM32 and secure components.

4- IRT Nanoelec PULSE program

IRT Nanoelec is a Public Private Partnership supported by French government. One of its program PULSE is dedicated to DIGITAL TRUST, which mission is to develop and test new security features for components and systems in three fields of application: Industry 4.0, Homecare and Robotics:

- **https://irtnanoelec.fr/pulse-digital-trust/**
- **https://irtnanoelec.fr/actualites/to-live-in-a-trusted-digital-world/**

Both CEA/LETI and ST are partners of the PULSE program, where they have developed the secure reference design which is the background supporting the GE technical program.

5 – Auvergne Rhône Alpes Region

Auvergne Rhône-Alpes (AURA) region is co-financing CEA GE on Cybersecurity. The co-funding is based on an existing program between AURA and CEA called EASYPOC. Céline Soubeyrat responsible of EASYPOC program was involved in the GE for the involvement of SME's based in AURA. She participated to the animation of the 3 GE workshops and contributed to the GE communication, promotion and sustainability model.

5.1.3 Technical development

5.1.3.1 Technical vision

As explain previously, CEA GE technical program was build based on background from CEA-LETI and ST issued from IRT nanoelec PULSE Cyber security program.

CEA Generic Experiment Technical Program was defined during "Phase 1 Generic Experiment definition" of DigiFed by CEA-Leti together with ST and 18 volunteers European SMEs which were invited to several workshop organized in 2020. The technical program was included to the Open Call and annexed to the SGEA.

Rationale of the CEA GE Technical Programme: *Use of the Trustzone on a STM32MP1 chip to monitor a Linux OS*.

The TrustZone is an isolation mechanism present on some ARM cores, which allows two execution modes to be implemented: a "Secure" mode with full control over the core and its peripherals and a "NonSecure" mode with restricted access. It is therefore possible to use certain privileges of the "Secure" mode to ensure that the "NonSecure" mode has not been corrupted. In our case, two OS are used:

- a Linux OS runs in "NonSecure" mode, which is used to run user applications.
- the OPTEE OS runs in the "Secure" mode which is used to run applications requiring a high level of security.

To meet the needs of the industry, it is proposed within the framework of the Generic Experiment to develop monitoring mechanisms for a Linux OS running the TrustZone on a STM32MP1 board. These monitoring mechanisms aim to ensure that the "NonSecure" world has not been attacked. These monitoring mechanisms will eventually be based on a standardized secure element called TPM.

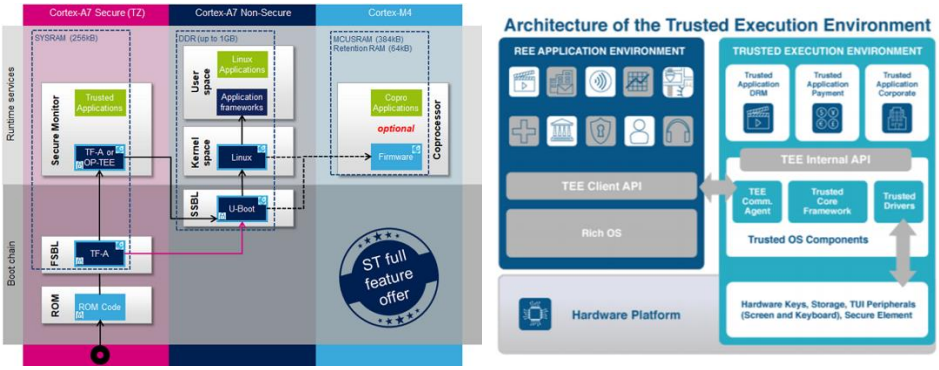
CEA GE Technical Program is organized in 3 WPs which are described in detail in Annexes - 9.1 Annex 1: CEA Development Work Plan.

5.1.3.2Process and updates

- **T0+6** the PoC Version was demonstrated during GE second workshop 05/11/2021
- **T0+12** advanced security monitoring features have been implemented in the POC and presented during the third Workshop on 20/06/2022.

WP1: Proof of Concept: Deployment of an infrastructure in the TrustZone reinforcing the security of a Linux OS (Figure14).

Figure 14: PoC V1 based on STM32 MP1 and TPM from ST



STM32MP1 Bootchain OPTEE-OS: Open Portable Trusted Execution Environment
Figure 15: Different solutions architecture

Demonstration of the PoC V1 which implements an initial solution for advanced system monitoring, but also set up an architecture (Figure 15) that facilitates the implementation of new monitoring solutions.

WP2: First security monitoring function developed implemented on the PoC.

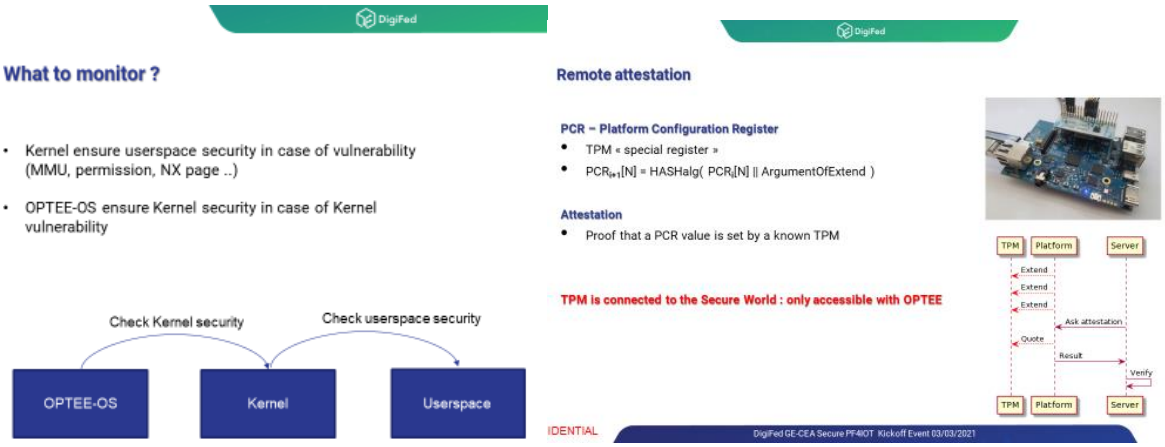


Figure 16: CEA GE solution security monitoring

Advanced security monitoring features addresses dynamic monitoring (Figure 16), this part was presented to the members which have signed an NDA with LETI.

The GE advanced security features have been implemented in a secure by design Gateway developed by ST and CEA-LETI in the IRT Nanoelec PULSE program and presented to the community (Figure 17).

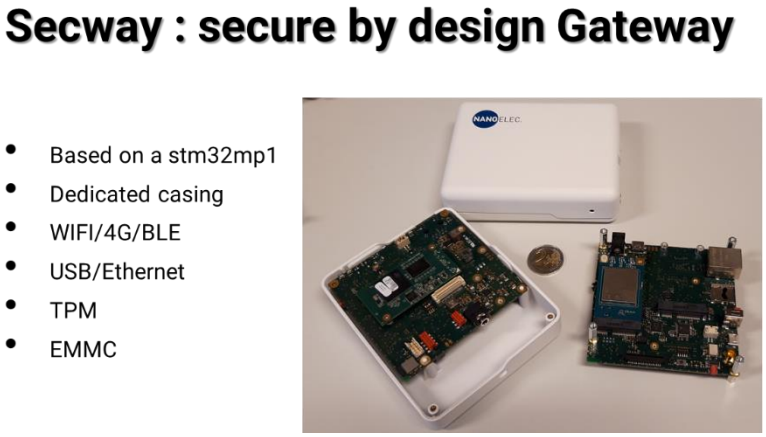


Figure 17: CEA GE gateway design

Questionnaire were asked to the GE members to understand their specifications (Figure 18):

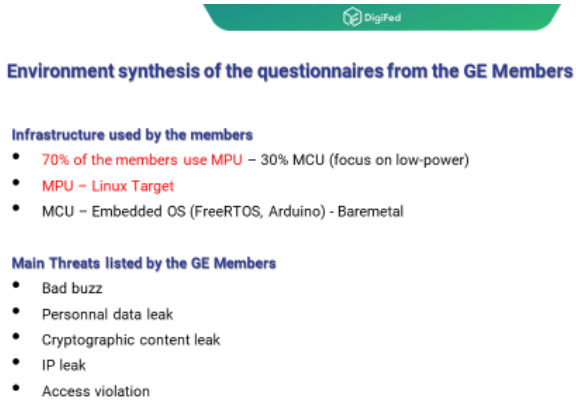


Figure 18: CEA GE specification questionnaire results

As most of the GE members are using Rasberry Py as a gateway, a comparison between the proposed secure platform and RasPy was presented by CEA-Leti team to the Ge members (Figure 19).

Security features comparison RasPY- Secure PF for IoT STM32-MP1 1/2

feature		RaspberryPi		CEA-Secure Platform for IOT : STM32MP1 + TPM	
		Status	Comments	Status	Maturity
Secure boot					
	Root of trust	No by default	possible with HW additionnal ??	ROMcode+OTP	TRL:9 (ST environement)
	Mesured boot	No by default	need TPM	TPM	TRL:4 (need maturity on PCR usage)
Secure communication		SSH, TLS		SSH , TLS	TRL:9 (State of the art OpenSource)
	Key/Crypto TrustZone	No	TZ not isolated	Need dev / portage	Existing linux solution to be adapted
	Key/Crypto TPM	No by default	need TPM	Need dev / portage	Existing linux solution to be adapted
Device Authentification					
	TPM provisitionning/Attestation	No by default	need TPM		TRL:4 (need maturity on PCR usage)
Secure Firmware update					
	Linux package manager		Authentication can be handled by the TPM	Need dev	Authentication can be handled by the TPM
	Custom	Need dev		Need dev	
Access Control					
	Linux security				TRL:9 (State of the art OpenSource)
	TrustZone for sensitive contents	no	TZ not isolated	Need dev	
	Debug Diseable	config.txt file	Not documented	RDP	TRL:9 (ST environement)

Figure 19: CEA GE secure PF comparison

5.1.3.3 Report on demonstration

Members were invited to candidate to test their use case using the GE Proof of Concept, 5 members have been selected among 10 candidates.

The 5 members: CYSEC, Panoramic Digital Health, CKIN, ASVIN, Binare Oi have signed a Mutual Transfer Agreement with CEA which as then land them a Prototype for testing. The test started in March 2022, and some are still running as of July 2022. The results of the test will be reported in the D2.3.

5 members would have been interested to test the prototype: Witekio, Prova.nor, Quobis, Oliveex, Security forge.

5.1.4 Animation (Events, communications, interviews)

To enable interaction and communication between community members and with the GE leader CEA-LETI and ST different channel have been set up and organized.

3 workshops have been organized.

- at major GE milestones
- The goal of the workshop was to present the GE technical status and to animate working session with all the members.
- These workshops were organized both in physical and remote because of covid situation (Figure 20).

Figure 20: CEA GE workshops, live and online

Interact live Chat with DigiFed expert

- Last Thursdays each month
- Open to all GEC members, if available
- 15 min of presentation of the last technical sprint
- 15 min Open question from GEC members FAQs
- 15 min Chat discussion between members

Collaborative tools:

A share point (Figure 21) was set up by CEA (Talkspirit)

- Contract SGEA signed
- Members documents: presentation …
- Presentation made at different event and monthly livechat
- Technical documentation and results

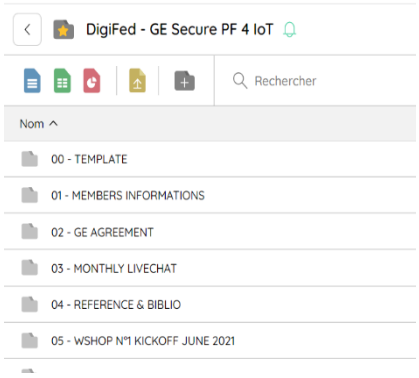


Figure 21: CEA's share point

Collaborative white board for remote meeting – Klaxoon (Figure 21)

- Adapted for collaborative workshop and brainstorming session
- Used by YSPOT, easy to handle
- Allow: post it, visio, pool, edit minutes …

Member presentation template (Figure 22)

- Who we are
- What we do
- Why did we join the GE
- Cybersecurity expertise level

Use case and needs description

- Company description
- Product and market

- Technical Solution
- Cybersecurity issues
- Generic Experiment Community expectations

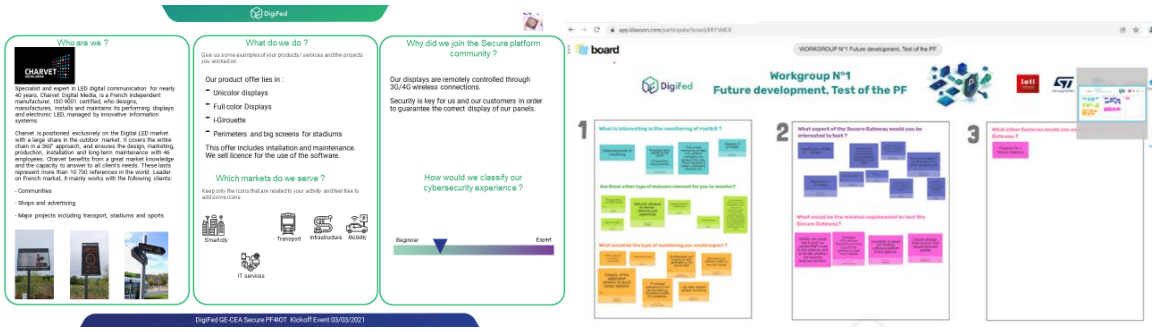


Figure 22: GE community engagement tools and member's presentation slide

All these tools and templates have been first tested by CEA GE and shared with the other GEs.

In more detail, the following events have been organized: 3 workshop and 8 monthly live chats.

03/06/2021 Workshop N°1: Kickoff meeting (Figure 23)

- Local Ecosystem presentation: ST, CEA-LETI , IRT Nanoelec
- Finance presentation DigiFed and Auvergne Rhône Alpes
- Community building – members presentation
- Technical introduction: STM32 ecosystem and the cyber secure PF feature
- Working session: GE expectation and exploitation

GEC kickoff workshop - Agenda

9:30	Introduction	Laurent MALNOE	Region Auvergnes Rhône Alpes Mission Recherche Innovation
9:40	IRT Nanoelec and Pulse Cybersecurity program	Vincent CACHARD	IRT nanoelec Director of PULSE
9:50	STMicro Technology partner of Digifed	Marcello COPPOLA	STM R&D Technical Director
10:00	**Round table 1 : "Cybersecurity and SME"**	Céline SOUBEYRAT	Easypoc programm coordinator
10:30	Coffee/tea break		
10:40	Digifed presentation, CEA-GEC experimentation scope and objective	Isabelle CHARTIER	Leti-IRT Nanoelec, Digifed Coordinator
10:50	CEA - GE Community building and animation	Gorka ARRIZABALAGA	CEA-DRT, YSPOT Open Innovation center
11:00	CEA - GEC technical program	Romain JAYLES	Leti GEC Project Leader
11:20	**Round table 2 : "What are you expectation joining the GE Community"**	Isabelle CHARTIER Romain JAYLES	Leti-IRT Nanoelec, Digifed Coordinator Cybersecurity expert
11:50	**Round table 3: How will you use the GEC results in your product development**	Marie Sophie MASSELOT	Leti Cybersecurity Business developper
12:20	Discussion and Conclusion	Isabelle CHARTIER	Leti-IRT Nanoelec, Digifed Coordinator
12:35	closure		

DigiFed GE-CEA Secure PF4IOT Kickoff Event 03/03/2021

Figure 23: CEA GE kick-off workshop agenda

Participants: 40

- GE leader 11: CEA, ST, IRT Nanoelec, in presence
- GE members: 25 online
- DigiFed partners: 2 Minalogic
- Co-financing authorities: 2 Auvergne Rhône Alps

05/11/20221 Workshop N°2 Proof of Concept demonstration (Figure 24)

- Technical status of the secure platform – POC demonstration Q&A by members
- Security features comparison secure PF versus RasPi, members' common needs synthesis
- Working session:
    1. Future development and test of the POC,
    2. GE animation: members' feedback and requirements

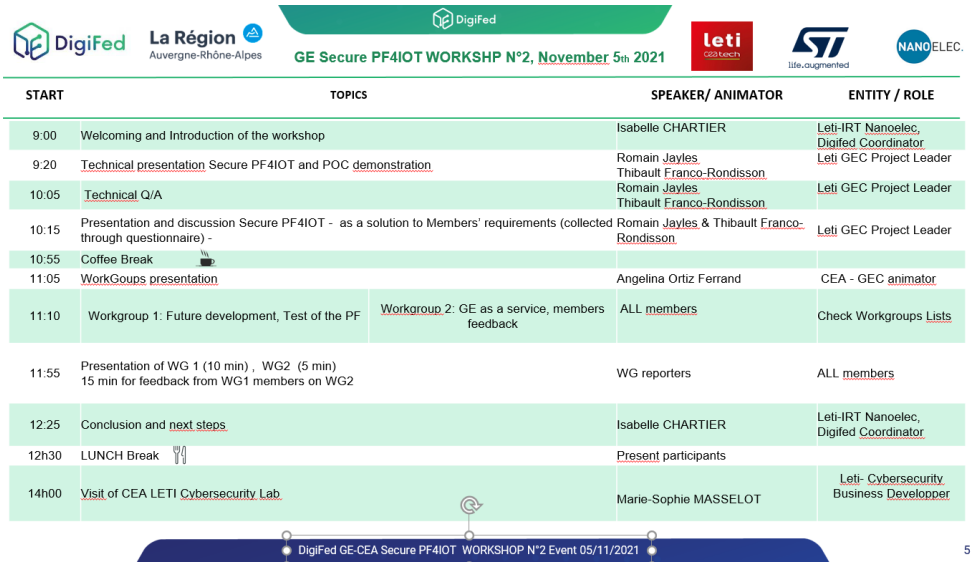


Figure 24: CEA GE POC workshop agenda

Participants: 32

- GE leader 10: CEA, ST, IRT Nanoelec
- GE members: 20 (4 in person)
- DigiFed partners: 1 Minalogic
- Cofinancing authorities: 1 Easypoc

20/06/2022 Workshop N°3 Final meeting demonstration of advanced security features (Figure 25)

- Technical status of the secure platform – advanced features demonstration: attack monitoring
- Members test results presentation and discussion
- Working session:
    1. New needs regarding cybersecurity for IoT,
    2. GE model assessment: members' feedback and suggestions

20/06/2022			GE SECURE PF FOR IOT FINAL WORKSHOP	
Start	End	Duration	Topics	Speaker
13:45	14:00	00:15	WELCOME COFFEE for participant in Grenoble	Isabelle Chartier
14:00	14:40	00:40	Technical results : Secure PF for IoT presentation + CEA prototype SEC-WAY (MP1) and SEC-IOT (U5)	Romain Jayles Thibault Franco-Rondisson
14:40	14:55	00:15	Panoramic Digital Health Use case demo and test feedback	Derek Hill
14:55	15:10	00:15	CKIN Use case demo and test feedback	Pierpaolo Giacomin
15:10	15:25	00:15	CYSEC Use case demo and test feedback	Yacin Felk
15:25	15:40	00:15	ASVIN Use case and test feedback	Miko Ross - Remote
15:40	15:55	00:15	Binare Use case and test feedback	Andrei Costin - Remote
15:55	16:10	00:15	NGS Use case and test feedback	Claudio Salvadori - Remote
16:10	16:25	00:15	COFFEE BREAK	
16:25	16:55	00:30	Technical Working session : what next , others needs in term of cybersecurity for IoT.	all
16:55	17:25	00:30	GE model Working session : collect you feedback and suugestion about the GE collective approach.	all
19h30			DINNER for participant in Grenoble	

Figure 25: CEA GE Final demonstration workshop agenda

Participants: 25

- GE leader 8: CEA, ST, IRT Nanoelec, in presence
- GE members: 17 (5 in person)

Participation to the event along the GE implementation is shown on the graph below (Figure 26).
The global participation to the different GE event has been high with an average participation of more than 15 persons. LiveChat low participation is due to connection problem.

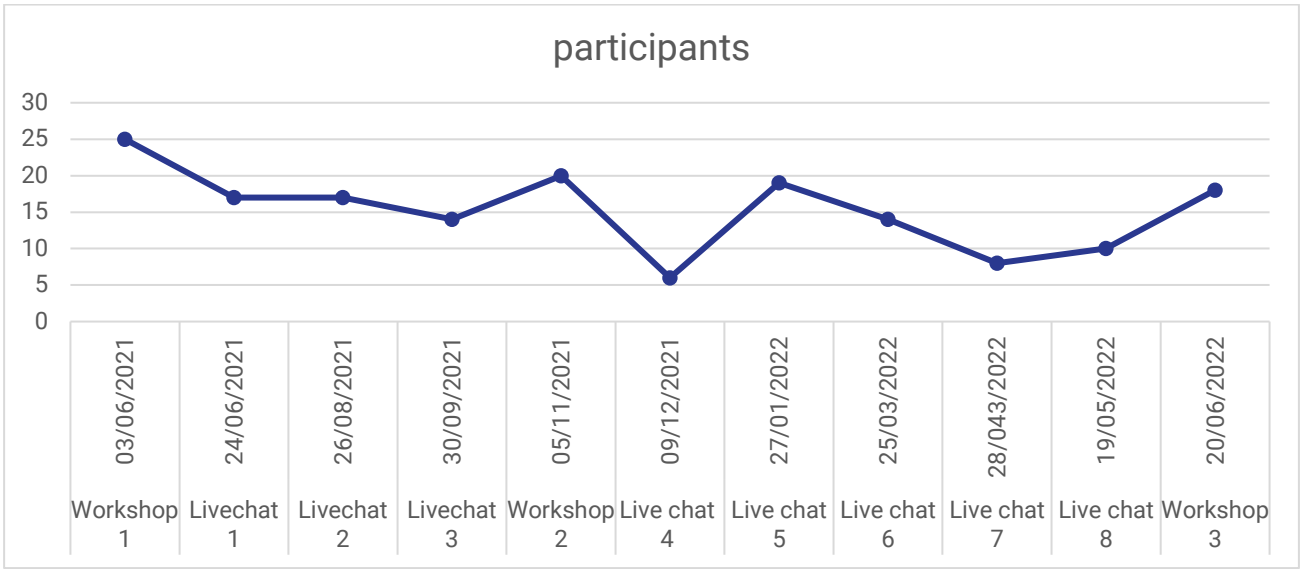


Figure 26: CEA GE event participation frequency

Communication event

- IoT solution world congress 10-12/05/2022 Barcelona- Spain

DigiFed GE pathway was present on DigiFed Booth during IoT Barcelona with ST, CEA-LETI and Ikerlan (Figure 27)

Figure 27: DigiFed collective area and GE booth at IoT SWC

- LETI Innovation days 21-23/06/2022 Grenoble (Figure 28)

Figure 28: LETI innovation days' flyer

CEA GE hold a booth together with 2 members CYSEC and Panoramic during LETI Innovation Days. CYSEC, Panoramic and ST were invited to present at the forum area. A round table dedicated to DigiFed GE model was organized 22/06/2022 during the SME workshop. Isabelle Chartier presented DigiFed and CEA GE, ST and CYSEC give a testimony about their participation to the GE.

5.1.5 Co-financing

DigiFed proposed through the GE Secure PF for IOT to test a multipartite EASYPOC project, were the POC will be define for a group of SMEs from AURA and Europe. Cybersecurity was selected because it is a major topic for the AURA region which is supported by a strong ecosystem including CEA, STM, IRT Nanoelec, MINALOGIC, cyber@alps.

In the proposed model DigiFed and EASYPOC co-finance 50/50 the implementation program. EASYPOC bring 100k€ for the POC realisation and DigiFed attribute 8 PM from CEA (~100k€).

The GE service assessment is interesting for DigiFed for the future EDIH, but as well for AURA and CEA-Leti that could propose a new model of multipartite EASYPOC on other topics.

To enlighten this collaboration, AURA EASYPOC program was launched jointly with DIGIFED January 21st 2020 in Grenoble at CEA facility. The 3rd of June 2021, the official kick-off of the GE Secure PF for IOT was inaugurated by Laurent Malnoe from AURA, Vincent Cachard from IRT-Nanoelec and Marcello Coppola from ST-Grenoble.

DigiFed Generic Experiment co-funding was officially validated by AURA Enterprise commission on January the 28th 2020.

5.1.5.1 Entity

CEA involved Auvergne Rhône-Alpes (AURA) region to co-finance the Generic Experiment Community on Cybersecurity. The co-funding is based on an existing program EASYPOC between AURA and CEA.

The GE technical program is based on background of CEA-LETI and ST developed in IRT Nanoelec PULSE program[3]

5.1.5.2 Model

EasyPOC is a program designed for AURA companies (<2,000 employees) from all sectors of activity wishing to integrate technological innovation. Its objective is to secure companies' innovation process with high technological content by financing the proof-of-concept stage TRL (4-5).

EASYPOC finances a feasibility study and/or a proof-of-concept POC which specifications are defined by the SMEs, and the development done by CEA teams. CEA work is 100% financed by the Auvergne-Rhône-Alpes Region.

The EASYPOC program was inspired by a former SAE project GateOne[4,5]. EASYPOC relies on CEA's expertise in mature Key Enabling Technologies KET for digital, health and energy. Starting from one KET, CEA develops PoC for the SME which test the performances. This is typically a "test before invest" service.

In the running EASYPOC program, only one company is working with CEA to define the POC to be developed and tested.

Within DigiFed Generic Experiment pathway the innovation is to involve **a group** of SMEs to define a common PoC specification that will be tested by this group. The goal is to leverage on the investment made to realize the PoC to benefits to more than one company. The second main interest is to co-define the common specification of the PoC to develop GENERIC solution adapted to SMEs.

The expected interest for CEA and ST was to have access to SME needs and use case though the discussion and co-conception session, to be able to orientate future development roadmap toward SME needs.

For AURA the goal was to support more SMEs with the same budget and to support regional SME to gain in maturity in the Cybersecurity strategic field.

The Cybersecurity PoC was elaborated during the GE preparation phase, and the co-financing by AURA validated according to EASYPOC process and was selected by EASYPOC management board 20/01/2021. Below the PoC sheet presented for the validation (Annexes: 9.2 Annex 2: CEA Model Figures - Figure 46, 47) and participants' slides (see Annexes: 9.2 Annex 2: CEA Model Figures - Figure 48).

The budget attributed for the GE implementation is 100k€ from AURA and 100k€ from DigiFed.

To be compliant with both HE and EASYPOC financial rules, the technical program was split in 3 work packages supported by the different program:

- WP1 PoC development → supported by EasyPOC
  Proof of Concept – PoC, with generic specifications defined in common with the GE Community of European SMEs
- WP2 Security attack monitoring → supported by DIGIFED
  Integration basic security functions on the PoC. Development of advanced cybersecurity monitoring features on the PoC (intrusion, vulnerability).
- WP3 Community animation → supported by DIGIFED:
  Community animation and GE assessment.

Resources were affected and reported on the 2 programs.

[3] https://irtnanoelec.fr/pulse-digital-trust/
[4] GateOne project on Cordis
5 GateONe PoC realized by CEA-LETI https://www.youtube.com/channel/UCIP-apDyNN1JORlMxHpb8kA

5.1.5.3 Sustainability

The Generic Experiment model has been exposed and promoted with MINALOGIC, the Auvergne Rhône Alpes DIH at different occasions.

22/11/2021 DIH Ecosystem building event AURA: A new European trans-regional open innovation pathway, the Generic Experiment (GE)

https://www.minalogic. com/minasmart-ledih-dauvergne-rhone-alpes-reconnu-par-ses-pairs-europeens/

Figure 29: CEA and Minalogic GE organisation team

MINASMART the EDIH coordinated by MINALOGIC was selected by the commission and will start 2022. MINASMART includes in its portfolio a service based on the Generic Experiment.

https://www.minasmart-auvergnerhonealpes.com/

20/05/2022 Discussion started between CEA, MINALOGI, AURA and EASYPOC to assess the impact of Cybersecurity GE and evaluate the potential to launch another EASYPOC with a group of SMEs. This discussion will continue until the end Q4 2022.

5.1.6 Evaluation, feedback

As GE is a new innovation pathway tested by DigiFed, assessment is an important task of the experimentation to evaluate the interest and impact of such new type of service for SMEs.

Each GE has its specifics in terms of technical topic, type of service proposed to the members, size of the community and type of the co-financing model. These different models are complementary and will enrich the GE model assessment that will be done after the four GE completion.

The Assessment methodology will address two levels:

- LOCAL level:
  This analysis will be done by each GE taking into account its specifics and ecosystem; the goal is to evaluate the impact and the exploitation of the action, the sustainability at the regional level.

- GLOBAL level:
  The analysis will be done based on the feedback collected form the four GEs , to give return on experiment depending on each GE specifics and common aspects, in order to give global recommendation and lesson learnt. The goal of this global assessment is to define a sustainable model at European level such as EDIHs.

CEA-LETI and YSPOT have been leading the assessment methodology that will be presented in D2.3 after completion. Assessment questionnaire have been organised towards main GE aspects:

- Technical objectives
- Impacts of the GE program: Technical, business, competences,
- Animation and networking
- Sustainability, cost and resource
- Lesson learnt.

All the stakeholders involved in the GE will be interviewed separately.

- GE members
- GE owners' team
- Co-financing authorities, local ecosystem (DIH…)

Questionnaire have been set up for each stakeholder, including some common questions for the Global analysis and questions specific to each GE for the Local assessment.

CEA GE has ended 20/06/2022, CEA has started the assessment mainly for the GE members. So far 11/21 members have been interviewed. The full analysis will be addressed in deliverable D2.3.

5.2 GE IKERLAN

5.2.1 Community

IKERLAN open call received 10 applications from 5 EU countries of which all were relevant to technology development topic and accepted by the IKERLAN GE community.

The suitability of the use cases was evaluated according to the following criteria:

- C1: The use case suits Blockchain. If the use case presented by the partner, is a use case where Blockchain makes sense.
- C2: The use case can be implemented with Smart Contracts. If the use case requires the need of smart contracts. Smart Contracts are a centerpiece of IKERLAN's Blockchain platform, so use cases with the need to use Smart Contracts are best seen.
- C3: The use case can be implemented by utilizing IKERLAN's services feasibly. IKERLAN's platform have a set of services so that machines' data can be sent to the platform and stored in the Blockchain. This criterion evaluates if IKERLAN's services are used, if other services are required to be developed, and how feasible is to develop them with the resources available for the GE (time and budget-wise)

5.2.1.1 Structure and description of selected SMEs

10 European SME were selected among the applicants: 5 SMEs are from the Basque Country and the other 5 are European start-ups (Figure 30 and Table 4) from Slovenia, France, Italy, Portugal and UK.

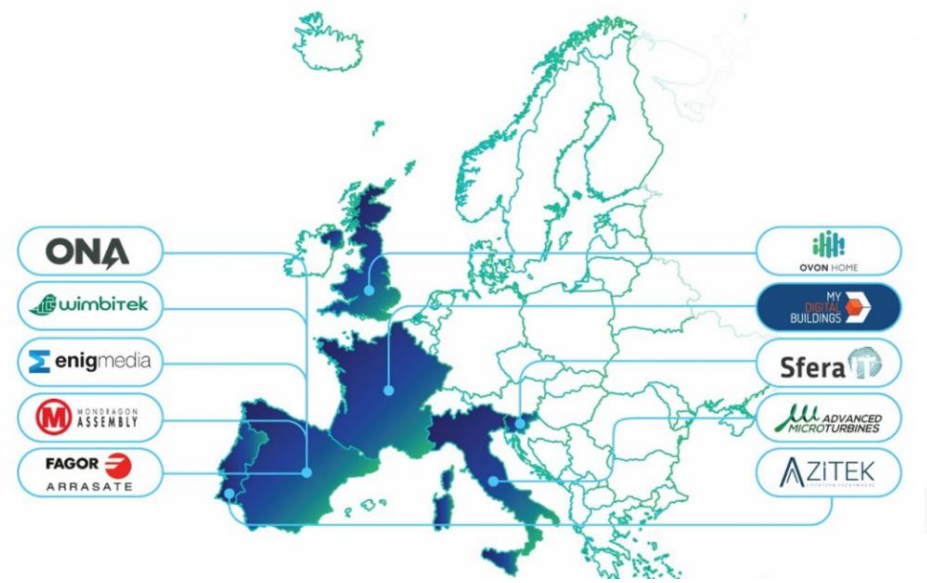


Figure 30: Geographic distribution of IKERLAN GE community members

Table 4: IKERLAN GE community participants' information

Company name	Website	Country	Size	Application domain	Specific application domain
ONA	https://onaedm.es/	Spain	Big Company Worldwide	EDM technology	Aerospace (Turbines) Automotion Microelectronicas
Wimbitek	http://www.wimbitek.com/	Spain	SME	Secure IoT tracking system	Birds, Sea Buoys, Assets
Enigmedia	https://enigmedia.es/	Spain	SME	Industry 4.0	Any Industrial and productive sector
Mondragon Assembly	https://www.mondragon-assembly.com/es/	Spain	Big Company Worldwide	Machine-Tool Turnkey provider	Industrial components
Mondragon Arrasate	https://fagorarrasate.com/es/	Spain	Big Company Worldwide	Machine-Tool Hydraulic Press provider	Industrial components, automotive, industrial machinery, aerospacial, Forging …
Ovon Home	https://www.ovonhome.com/	UK	SME	IoT Home Boilers IT consultants	Social Housing Big Flat Renting companies and Landlords Comodities
My Digital Buildings	https://www.mydigitalbuildings.com/	France	SME	Digitalization of Big Plants and buildings	2D, 3D scanning and building digitalization
Sfera	https://www.sfera-it.si/	Slovenia	SME	IT Solution provider	IT system management, consultancy, leasing complete IT infraestructure
Advanced Microturbines	https://microturbines.it	Italy	SME	Energy harvesting through water and gas pumps	Any builing that has whater or gas pumps
Azitek	**https://azitek.io/**	Portugal	SME	5G IoT Tracking system through RDIF technology	Industrial Assets, Returnable Containers, Garbage Trucks

5.2.2 Organisation of the Generic Experiment

To carry out the GE, IKERLAN designated a Researcher to conduct all the tasks needed for the experiment:

- Technical Management
- Project Management
- GE community management and engagement

Additionally, we divided the group of SMEs in two subgroups:

- Machine-tool local companies.
- EU SMEs: these companies are SMEs with heterogenic domains.

5.2.3 Technical development

5.2.3.1 Technical vision

IKERLAN has already an initial Blockchain platform thanks to the co-financing entity SPRI. This platform has been developed for the use cases of various Industrial companies. Hence, it is very industry oriented, and tailored to their specific needs, which is building trust across the industrial value chain in Industry 4.0 ecosystems (those that occur between machinery provider and machinery client/user) as illustrated in Figure 31.

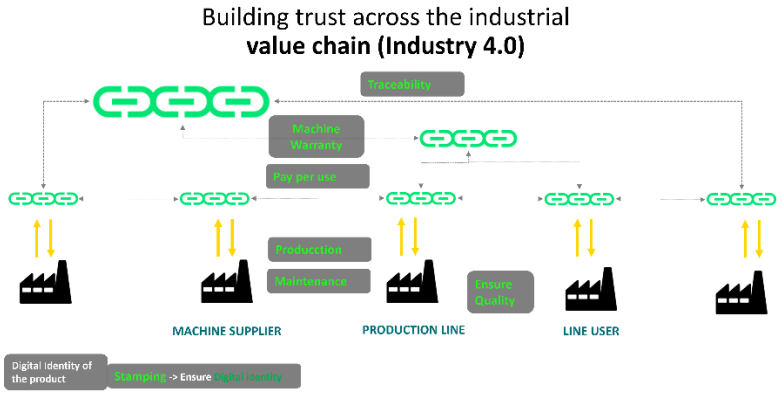


Figure 31: Trust in industrial the value chain

At the core of IKERLAN's platform we have the following pieces:

- industrial (telemetry) machine-tool data is sent by devices.
- a Blockchain securely stores the machines data.
- and Smart Contracts model the agreements between different stakeholders in the value chain.

More specifically, the Smart Contracts models that IKERLAN's platform support are based on the idea that these agreements can be modelled as conditions over machine variables, in the way that machine values respect certain upper and lower limits (thresholds). Additionally, both stakeholders agree (iteratively) in these conditions. The following Figure 32 depicts the use case "model" that IKERLAN's platform supports.

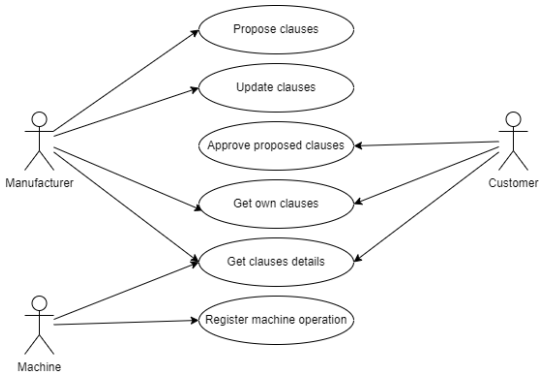


Figure 32: IKERLAN's Blokchain Schema for Industry

The technical outcome for IKERLAN, thanks to the SmartCON project, is a Blockchain-based platform where Blockchain based Smart Contracts, that models different business cases through the value chain, can be executed

to ensure trust across value-chain parties (i.e., client-provider relationship). Concretely, different business cases have been developed and tested for the different companies that build machine-tools:

- Machine warranty smart contract, meant for ensuring that machines are used under the conditions agreed between the client and the machine provider,
- Machine maintenance smart contract, meant for ensuring that maintenance of the machine is done by the provider whenever the machine in operation reaches certain thresholds,
- Machine productivity & production quality smart contract, meant for ensuring that machines reach the productivity and product quality rate agreed between the client and the machine provider,
- Machine pay-per-use smart contract, meant for enabling a pay-per-use of the machine, where the client that uses the machine pays only for the usage of the tool.

Specifically, this is the structure of the platform to serve these purposes (Figure 33):

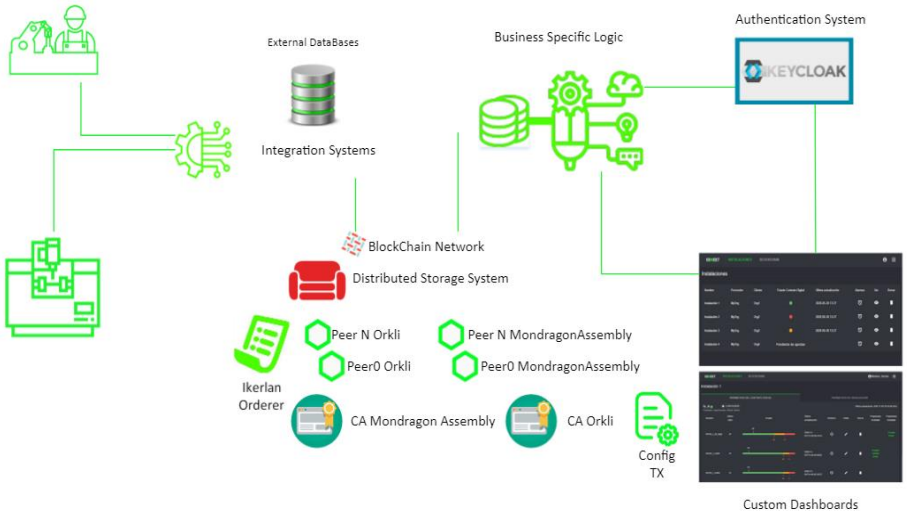


Figure 33: IKERLAN GE solution platform architecture

The challenge now is bringing the platform to SMEs that are not machine-tool companies. Here in, different developments are foreseen. Specifically, we are currently acknowledging that Smart Contracts models might not be fully adequate and need adaptation, as well as the integration service (based on MQTT broker) for sending machine and devices data might not be suitable for all the SMEs taking part in the experiment.

5.2.3.2 Process and updates

Currently, we are in the 5th step of the timeline (expected to be finished by October 2022) – Figure 34.

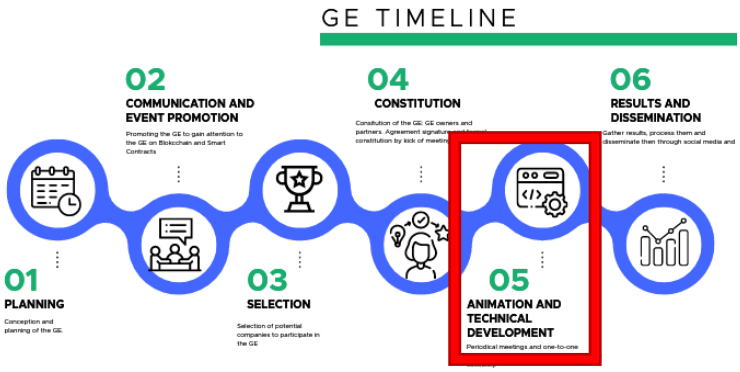


Figure 34: IKERLAN GE solution timeline steps

Specifically, we have performed the following tasks defined for the 5th phase "Animation and technical development":

- Analysis of GE partners' use cases (done): one-to-one meetings were taken between IKERLAN's Blockchain and cloud experts and each GE partner. Here, GE partners had the chance to better explain their use case to IKERLAN. IKERLAN experts had several one-to-one meetings with each GE partner so that IKERLAN (1) better understood GE partner's use case, (2) evaluate if a blockchain-based solution made sense, (3) design a potential architecture to bring together GE partner's ecosystem with IKERLAN's Blockchain Platform.
- Evaluation for the selection of uses cases to implement (doing): Once all GE partners' use cases where evaluated and prioritised, two use cases have been selected for implementation. The suitability of the use cases was evaluated according to the following criteria:
    - C1: The use case suits Blockchain. If the use case presented by the partner, is a use case where Blockchain makes sense.
    - C2: The use case can be implemented with Smart Contracts. If the use case requires the need of smart contracts. Smart Contracts are a centerpiece of IKERLAN's Blockchain platform, so use cases with the need to use Smart Contracts are best seen.
    - C3: The use case can be implemented by utilizing IKERLAN's services feasibly. IKERLAN's platform have a set of services so that machines' data can be sent to the platform and stored in the Blockchain. This criterion evaluates if IKERLAN's services are used, if other services are required to be developed, and how feasible is to develop them with the resources available for the GE (time and budget-wise)
- Development (pending): The use cases matching all the criteria will be the ones selected for final development. First a design of the solution needs to be defined, so that suits GE partners' context. Afterwards, development efforts should be taken.

5.2.4 Animation (Events, communications, interviews)

Five one to one meetings have been organised to enable interaction and communication between members. The interactions are structured by members in following subsections:

5.2.4.1 ADVANCED MICROTURBINES

- **Participants**: Emmanuelle Guglielmino (Advanced Microturbines - CEO) and Leticia Montalvillo (IKERLAN), see Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 49.

- **Meetings type**: online

Advanced microturbines was founded in 2013 and their activity focuses on harvesting the energy from microturbines of water and gas grids.

The GE member is interested in having a kind of certificate or a digital proof that assures and proves the amount of energy produced by the microturbines. This would add value to the product, since it can be sold as a green

product (good for the vendor). Customers/building owners etc can also prove that they help reducing the CO2, and eventually ask for any reduction in taxes (if applicable), see Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 50.

The Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 51, depicts a possible architecture for the mentioned use case. In the left-hand side Advanced Microturbines devices, whereas in the right hand-side IKERLAN's Blockchain Platform.

Suitability for IKERLAN-s Platform:

- This use case is interesting and Blockchain technology fits into their need but Ikerlan´s Platform does not suit completely.
- The Smart Contract is not directly related to our model based on limits and constraints.

5.2.4.2MY DIGITAL BUILDING

- **Participants**: Emeric Mourot (My Digital Building), Leticia Montalvillo (IKERLAN), see Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 52.
- **Meetings type**: online

My Digital Building company was founded in 2019 and centres its effort on providing digitalization services for buildings. My Digital Building are experts on generating digital models of buildings and industrial plants (from the inside and outside) by the means of images and videos taken by drones, 3D scanners, 360/panoramic pictures, and other equipment.

The company is underway to develop a *Platform* to help operators (the ones making the digitalization of the building) do their job: carrying on the operation, saving the data collected on site and upload it to the platform, and adding value to their outputs / deliverables .

The image below (see Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 53) depicts the overall overview of a possible solution.

Suitability for IKERLAN-s Platform:

- There are many pieces that would need to be implemented for this use case (UI, UI API, IPFS storage system among others).
- Additionally, currently, Ikerlan cannot identify any clear scenario where any Smart Contract can be implemented/used and deployed
- Ikerlan's Platform centrepiece are Smart Contracts with Constraints and limits - which model agreements between different parties (e.g., building owners, insurance companies).

5.2.4.3SFERA

- **Participants**: Renato Pulco (Sfera) and Leticia Montalvillo, see Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 54.
- **Meetings type**: online

Sfera is an IT solution company that provides a set of services, including IT outsourcing, Lease, IT System maintenance, consultancy, seminars and training. Additionally, Sfera offers a set of solutions, including the following: server hosting, security, and networks, monitoring system.

Sfera does not have any Use Case with potential clients in the near future. Their goal is to understand the needs of the companies and how Blockchain can be used for industrial cases.

5.2.4.4OVON HOME

- **Participants**: Marta Isach (Ovon Home) and Leticia Montalvillo (IKERLAN), Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 55.

- **Meetings type**: online

Ovon Home is a UK-based company that focuses on two main duties. First, Ovon Home provides consulting to other companies and develops products for their customers

A potential use case was identified that involves Manchester's Social Housing, which provides social housing for hundreds of people in Manchester. The agreements between tenants and Manchester's social housing (according to the aforementioned scenario) can be trustworthily implemented. The data collected at tenants' houses can be stored in a Blockchain (only the data needed for ensuring the contract's clauses). And the clauses that need to be hold can be implemented in a smart contract. The Smart Contract can be executed, and the clauses can be checked against the data stored in the Blockchain, to know if the tenant is fulfilling or not the agreed clauses.

The Annexes: 9.3 Annex 3: IKERLAN GE Members Presentation Slides - Figure 56 depicts a possible solution, involving IKERLAN's Trust platform for the OVON Home use case.

Suitability for IKERLAN-s Platform:

- Ikerlan's Platform can suit the use case, but the data model must be modified.

- Ikerlan's Platform centrepiece are Smart Contracts with Constraints and limits -which model agreements between different parties must be modified for the use case.

5.2.5 Co-financing

5.2.5.1Entity

The funding program through which SmartCON is funded is called HAZITEK ESTRATEGICO, and the objective of this program is "to support the generation of new knowledge that is expected to result in the creation of new or improved products, processes or services or the integration of technologies of strategic interest, or to create new IP and science and technology-based companies".

The Basque Business Development Agency (SPRI) has dedicated 72 k€ to co-finance the GE. Their objective is to help improve the capabilities of the Trust platform that is being developed in the SmartCOM project as well as enhance its reach out by including other companies across the EU.

5.2.5.2Model

SmartCON is a three-year project with a total budget of 6,821,805€, which is funded by the Basque Business Development Agency (SPRI).

The project is built upon the concept of interconnected assets and services offered by different companies along the value chain. In this context, the project proposes to develop new business models that are based on trusted relationships between companies that are backed by cyber secure data transactions associated to physical asset transactions in their daily operations (i.e., SmartContracts). More specifically, mutual trust between companies is to be achieved by creating a digital identity of company assets and registering their movement through Blockchain to create trusted value-added services based on industrial smart contracts for the machine tool sector.

The partners in the SmartCON consortium are leading Basque companies in the machine tool sector. Their goal is to develop a cooperative project, which will provide 4.0 services of great relevance to the industry. The general coordination is assumed by AFM, and the rest of the consortium includes companies such as Fagor Arrasate, Mondragon Assembly, Corporacion Mondragon, ONA, Dimeco, Ibarmia, Danobat, Loire, Savvy and Vixion. In addition, there is a collaboration of technology-based companies such as Enigmedia and Wimbitek to promote industrial digitisation with technologically advanced solutions that can meet the requirements for availability, efficiency and process optimisation in the search for new services and business models.

5.2.5.3 Sustainability

SmartCON is expected to produce outcomes in two main lines of business. First, the technology companies that make up the ecosystem, called SmartCON Pack, aim to exploit machine tools as productive digital assets. This means that SmartCON Pack will be used as a commercial product for technology companies to integrate into their existing solutions. Secondly, the new digital products and advanced services will be tailored for different types of industrial products associated to the different industrial partners.

5.3 GE BME

5.3.1 Community

5.3.1.1 Structure and description of selected SMEs

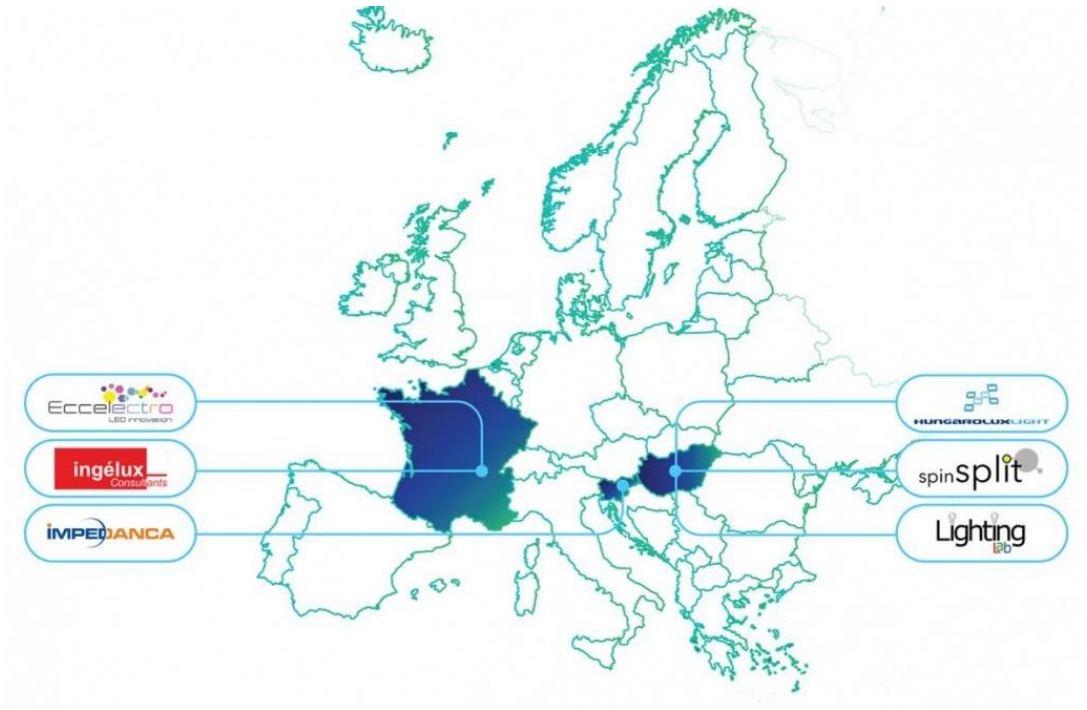


Figure 35: Geographic distribution of BME GE community members

Table 5: BME GE community participants' information

Company name	Website	Country	Size	Application domain	Specific application domain
Ecceelectro	https://www.eccelectro.com/?lang=en	France	1-10	electronics assembly - LED luminaire mfg	industrial, indoor, outdoor, horticulture lighting
Ingelux	http://www.ingelux.com/en/	France	1-10	lighting systems specifications and design	indoor lighting, decorative lighting, museum lighting
Impedanca	https://www.impedanca.si/	Slovenia	11-50	electronics assembly	smart LED controller electronics
HungaroluxLight	https://hungarolux.hu/en/	Hungary	1-10	lighting system manufacturer	street-lighting solutions, special antireflective coatings
SpinSplit	https://spinsplit.com/	Hungary	1-10	Industry 4.0 (IoT and CPS system development)	measurement control software
Lightning Lab	https://lightinglab.eu/index.html	Hungary	1-10	measurement services	accredited optical testing lab for LED based solutions

5.3.2 Organisation of Generic Experiment

The aim of the GE was to define common visions of BME (as a research organization) and the involved SMEs, based on their domain specific expertise, with the goal of improving the BME's results achieved during the Delphi4LED project in order to allow the real industrialization of the accumulated know-how. Therefore, online thematic meetings were held involving the SMEs with the corresponding competence. The topics covered were as follows:

- Requirements against the digital twins along the SSL supply chain, corresponding to different integration levels of LED products (LED package, LED module, LED luminaire) with two focus areas:
  - what should be the digital twins used in the product design and development phase, what are their major characteristics;
  - what should be the embedded, so called executable digital twins and what specs should the new, smart LED driver modules meet in order to accommodate such executable digital twins.
- Overview of the measurement equipment used in multi-domain LED measurements (combined isothermal IVL characterization and thermal impedance measurements) used in the Delphi4LED project, identification of the bottlenecks of the measurement process and definition of a new measurement process that makes comprehensive package level LED testing and LED model parameter extraction feasible for industrial testing labs both at LED vendors and at independent, accredited LED testing laboratories that provide measurement services for the lighting industry.
- Overview of possible use-case where the application of the above executable digital twins may provide benefits, definition of selected use-cases and definition of the requirements of the use-case specific digital twins. 3 specific lighting applications
- Overview of the most used LED package types in the selected application domains

5.3.3 Technical development

Along the lines outlined in the previous subsection, the following internal technical documents were created:

- Holistic view on the use LED digital twins in the use-cases (presentation). Major contributors: Ingelux, Eccelectro, Hungarolux
- Recommendations on LED digital twin development, requirements for modelling (internal report, presentations). Major contributors: Ingelux, Hungarolux, LightingLab
- New LED testing concepts for increasing the efficiency of multi-domain measurement of operating characteristics for a larger population of LED samples, e.g. for 3x3, 4x4 or 5x5 samples (internal report, IEEE conference publication, presentation). Major contributors: LightingLab, SpinSplit

The following use-cases were discussed:

- indoor lighting application,
- horticulture lighting application,
- street-lighting application.

In terms developing LED digital twins the following recommendations were made:

- To allow SMEs to use LED digital twins for their design work, only cheap, widely available simulation tools should be assumed, such as the freely available LT-Spice circuit simulation program.
- Digital twins on all integration levels must be finally implemented as a generic ("electrical-only") Spice netlist using subcircuit macros in a hierarchical, modular manner as illustrated in Figure 36.

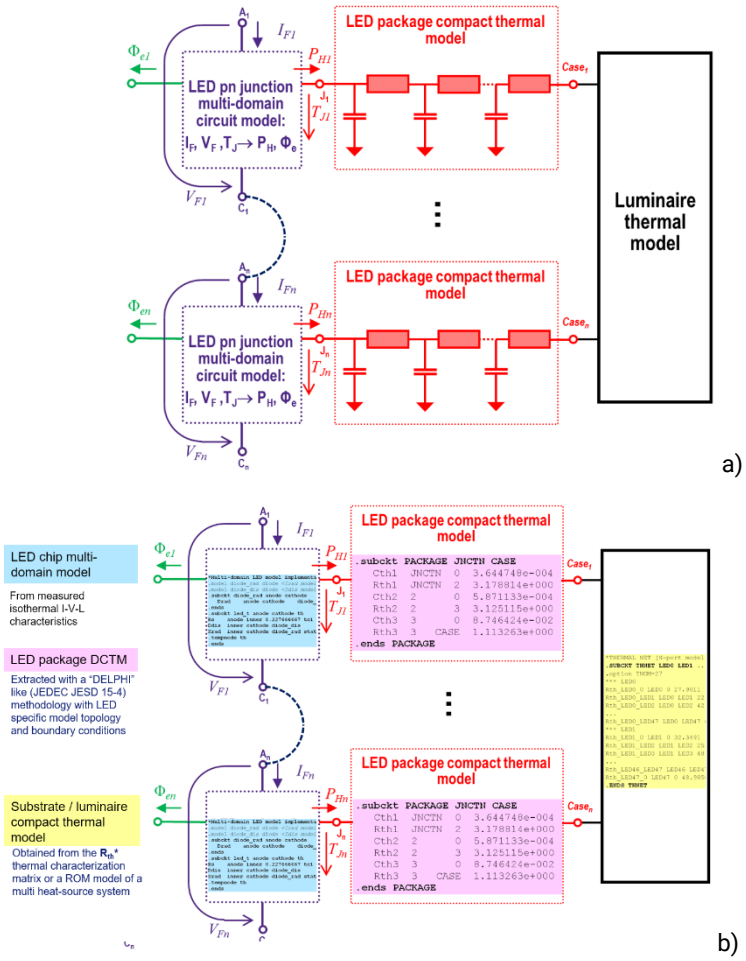


Figure 36: The modular structure of Delphi4LED-style LED luminaire digital twin (a) and its implementation by means of subcircuit macros suitable for simulations by a generic Spice circuit simulation program (b).

- The original Delphi4LED models have to be extended by the description of LED aging, e.g. through adding elapsed product lifetime as and additional model parameter to allow designers to simulate luminaire performance at any time during the planned life-span of the luminaire.
- Besides modelling the electrical, thermal and basic light output properties spectral power distributions (SPD-s) of the LEDs has also to be modelled as function of the applied forward current, LED temperature and the elapsed ageing time.
- Efficient parameter extraction procedures must be developed in order to speed up and fully automate the identification of LED model parameters. This is essential for both for the LED vendors (who are expected in the future to provide such parameters in the electronic data-sheets of their products) and for third parties (such as independent LED testing labs) who plan to launch their own LED modelling services. Both advanced, conventional methods and artificial intelligence (AI) based methods need to be considered. Possible application of AI primarily important for modelling aging during design or predicting actual parametric degradation in the embedded, executable digital twins.
- In the original Delphi4LED approach the driver electronics was not considered at all. It is recommended to include the digital twin of the driver electronics in the overall digital twin of an LED luminaire. Using generic Spice format as a common modelling platform is recommended also in the case of the drivers.

The original Delphi4LED-style digital twins extended with the above items is illustrated in Figure 37.

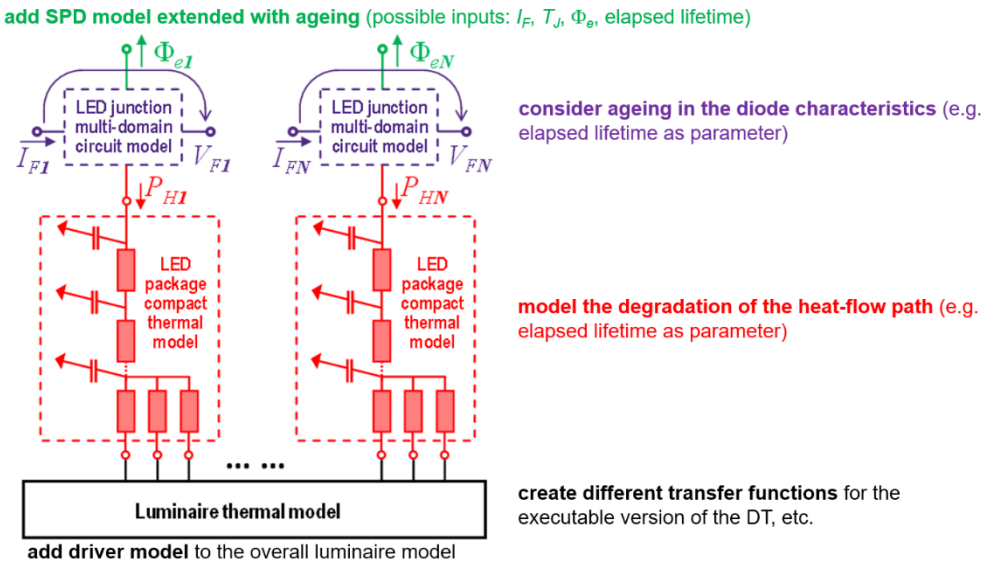


Figure 37: The recommended extensions of the Delphi4LED-style LED luminaire digital twin.

Since during the real-life operation of luminaires LEDs are subject of different so called operation profiles as they may experience different driving current levels, different lengths of on/off cycles and temperature swings with different magnitudes and durations, the aging models need to capture the effect of speeding up or slowing down the actual aging. (Higher currents and higher temperatures speed up ageing, lower one slow down the aging processes.) Thus, when the current or the temperature changes, the aging process of an LED would follow different trajectories, as illustrated in Figure 38.

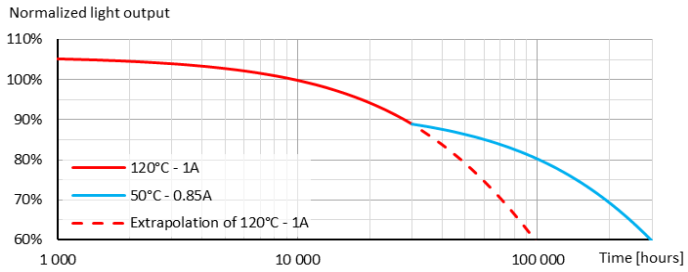


Figure 38: An LED changes its ageing curve due to change in its operating conditions

The aging models derived from test data performed under standard conditions (fixed current and fixed temperature) need to be scaled according to the above-mentioned factors.

In terms improving the efficiency of the multi-domain LED measurement process, the following recommendations were made:

- Maintain the compliance to JEDEC's and CIE's LED testing standards and recommendations in a smart way. The key elements of this are:
  - Measurements on a cold-plate, CIE 225:2017 compliant 2π geometry in an integrating sphere / semi-sphere
- Combine the thermal/radiometric LED test station with an LM80 compliant LED life-time test setup
- De-couple the optical tests from the thermal ones in time
- Apply pulsed optical measurements, also used at in-line testing of LEDs
- The $\mathrm{F}_e(t)$ radiant flux transients as response to the current pulse should be captured with high speed/resolution.
- Detailed light output properties are measured with a spectroradiometer.
- Subsequent data processing is needed to obtain LEDs' junction temperature that corresponds to the measured average flux provided by the spectroradiometer.

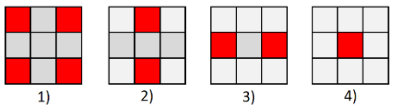
- Apply the procedure to an array of LEDs packages, e.g. to 3x3, 4x4, 5x5.

Thus, the key elements in speeding up the isothermal IVL characteristics of LEDs in a combined thermal and radiometric test setup are:

1. Short-pulse measurement of the light output characteristics of all test LEDs one by one, in series
   - collect and store all transients and static scalar/vector values measured in this phase, such as $\Delta V_F(t)$, $\mathrm{F}_e(t)$, F_{e-ave}, T_{cp}, I_{F-test}, LED spectra
   - One of the values of the I_{F-test} *current pulse heights should be the* I_M *measurement current* to be used during the subsequent thermal transient measurements

   Loop by the I_{F-test} current pulse height

   Loop by T_{cp} cold-plate temperature
2. Perform thermal transient measurements for all LEDs, switching "on/off" multiple, thermally un-coupled LEDs simultaneously, e.g. for a 3x3 array in 4 subsequent runs, with the following pattern:



3. Perform final data processing.

5.3.3.1 Technical vision, achievements so far

The ultimate vision of this GE is to contribute to the development and the implementation of Industry 4.0 concept in the wider lighting industry (Lighting 4.0) through the widespread use of LED digital twins. This vision is illustrated in Figure 39. Achieving all items indicated in Figure 39 is unrealistic; it requires wider cooperation with more academic and industrial partners.

Nevertheless, the smaller improvements outlined above have been well identified within this GE, and actual experimental and development work has already been started by BME with the help of the GE partners. In particular:

- A new, programmable thermal transient test equipment was purchased by BME that allows powering LEDs in a combined thermal and radiometric/photometric test setup with series of current pulses as well as with a steady DC current.
- As results of meetings with SpinSplit and LightingLab, the specs for the optical measurements and the physical arrangement of the optical measurement hardware have been finalized and the design of the measurement control software for the new equipment was started.
- A new experimental parameter extraction tool has been developed, providing many orders of magnitudes speed improvement of the parameter identification process compared to the one used previously (in the Delphi4LED project).
- The first trials of extending the multi-domain LED model with the elapsed lifetime as parameter are promising. Applied to archived aging test data the new model precisely predicted the decay of the emitted radiant flux of the LED tested (Figure 40).
- The first application use-case with aging extended executable digital twin has been defined with HungaroLux (Figure 41). The LEDs to be used in the luminare were provided by HungaroLux. Requirements against the executable digital twin of the luminare have been aligned with Ingelux. The necessary laboratory and field tests have been defined with a joint effort of BME, HungaroLux and LightingLab.

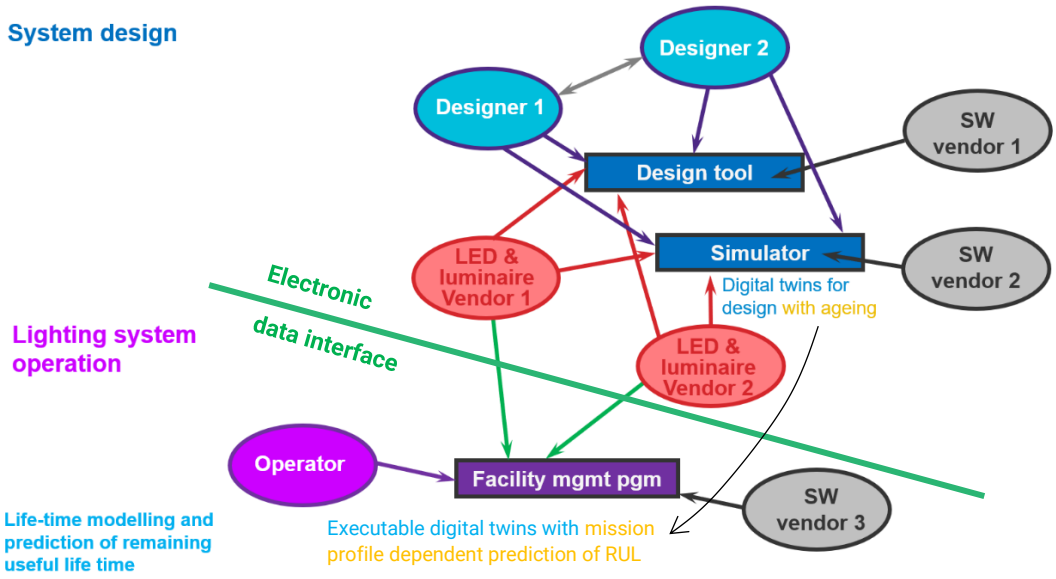


Figure 39: The wider vision: "Lighting 4.0" with standardized LED digital twins in the system design phase and application specific executable digital twins supporting the operation of lighting infrastructures.

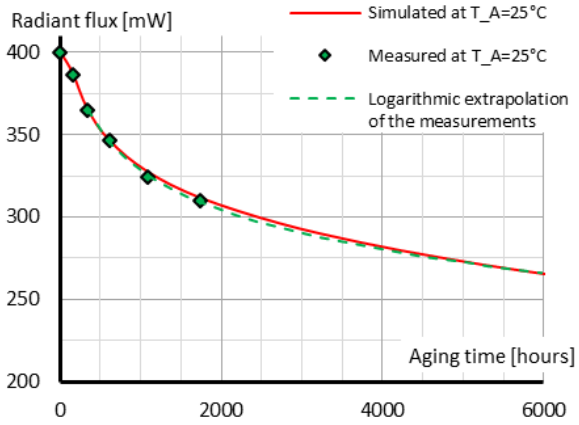


Figure 40: Results of the first trial of extending the multi-domain LED model with aging: the model's prediction perfectly matches the measured decaying light output.

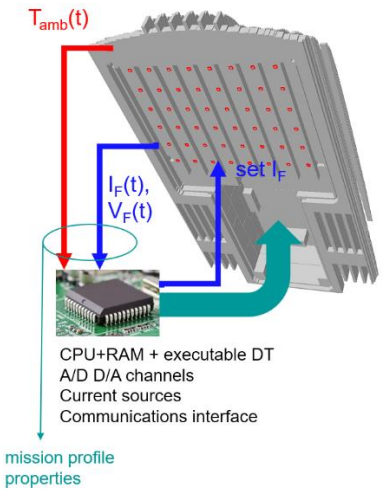


Figure 41: Illustration of the concept of a new temperature and aging compensated constant light output (CLO) control scheme of a street-lighting luminaire of HungaroLux.

5.3.3.2 Process and updates

Use-case prototypes have been defined and the involved SMEs started building them. BME started the component level testing e.g. for HungaroLux's new streetlighting luminaire (still with old, low-throughput test procedures) in order to obtain data for setting up the LED digital twins. Test luminaires have also been built with a mock-up of the foreseen new smart driver for which the in-field testing within the luminaire has been commonly designed by HungaroLux, LightingLab and BME, following the recommendations also aligned with Ingelux and Eccelectro.

The duration of the GE is insufficient for the actual LED aging tests necessary to crate the aging extended digital twins. This work will be further pursued in the framework of the AI-TWILIGHT H2020 ECSEL project.

5.3.4 Animation (Events, communications, interviews)

As described in section 5.3.2, animation took place through thematic online meeting with the GE partners. The partners were involved in discussions which were aligned with their competences and specific interest in the GE. As an example, LightingLab and SpinSplit contributed to the development of the concept of the new, improved multi-domain LED testing procedure.

The following thematic meetings were organized:

- requirements for LED model development (2 meetings)
- definition of the application use-cases (3 meetings)
- definition of the new test procedures (4 meetings)

With LightingLab and HungaroLux a few physical meetings were also hold at the site of the foreseen trial operation and in-field testing of the planned new street-lighting luminaire.

The work of this generic experiment was also aligned with the AI-TWILIGHT project since the long aging tests needed for the extension of the digital twins can only be executed in a longer period and by additional funding that the AI-TWILIGHT project can provide.

Reports on the GE work were provided the seminars of the Hungarian Lighting Society. A joint paper with LightingLab was selected for oral presentation at the IEEE THERMINIC Workshop in Dublin, Ireland and will be published in IEEE Xplore.

5.3.5 Co-financing

5.3.5.1 Entity

A national project NKFIH K 128315 titled "Research for new ageing indicators of LEDs" was lunched and is still in progress at BME, ending at the same time as the DigiFed project. In the meanwhile, at the phase of planning the GE, the international research proposal under the acronym AI-TWILIGHT was granted by ECSEL as well as by the Hungarian Research and Development Fund (H2020 ECSEL RIA grant no. 101007319 and NKFIH 2019-2.1.3-NEMZ_ECSEL-2021-00008 grant).

5.3.5.2 Model

The "Research for new ageing indicators of LEDs" project's remaining budget is almost 34K EUR. The resources of this project will be used for setting up and executing real, physical experiments tailored to the application conditions defined by the GE community to see, how these particular conditions (real LED mission profiles) affect LED ageing and how these effects can be quantified, modelled and included in the product development workflow presented.

One major aspect of these experiments is to learn how properties of pulsed width modulation widely used in dimming of LEDs affects their thermo-mechanical properties and their ageing. The relevance of this will be assessed by this GE community.

The extension of LED digital twins with reliability and life-time prediction aspects is the main focus of the AI-TWILIGHT project. Speeding up the physical tests of LEDs to obtain the necessary input data for LED modelling is also a key aspect in AI-TWILIGHT. Therefore, the costs related to this activity at BME are shared between DigiFed, AI-TWILIGHT and BME's other resources such as the above-mentioned project NKFIH K 128315 project. The equipment costs are shared between DigiFed and AI-TWILIGHT, personal costs are shared also with the NKFIH K 128315 project.

5.3.5.3 Sustainability

Further national funding at BME is expected in the framework of the calls for proposals for national support of future European Digital Innovation Hubs in Hungary. Furthermore, physical prototypes of the demonstration use-cases of this GE will be finally built and tested within the AI-TWILIGHT project, including the long-term reliability/lifetime investigations.

As short-term exploitation of the learnings of this GE, SpinSplit and LightingLab are foreseen to turn the gained knowledge into commercial products and services: SpinSplit is likely to develop a flexible commercial version of the measurement control software of the new LED measurement procedure on the one hand; on the other hand, LightingLab plans to launch a LED package characterization service using their existing equipment and the commercial measurement control software. With the new model parameter extraction tool BME also plans to launch their LED package modelling services.

The other participating SMEs plan to implement the digital twinning methods in their product development processes (Spice models of LED packages and driver electronics) as well as in their product specs and actual products (embedded executable digital twins to optimize LED luminaire operation and maintenance).

5.4 GE UL

5.4.1 Community

There were 16 SMEs members spots available in the UL GE workgroup on IoT in Agriculture. 14 SMEs applied to become members of GE UL workgroup in the GE Open Call process. All were relevant and were accepted into the workgroup consisting of GE UL community (Figure 53 and Table 6).

3 additional SMEs have joined after the closure of the Open Call. These SMEs did not receive the funding for GE UL members, their motivation was mainly around the opportunity to network and engage with sectoral partners and solution providers.

5.4.1.1 Structure and description of selected SMEs

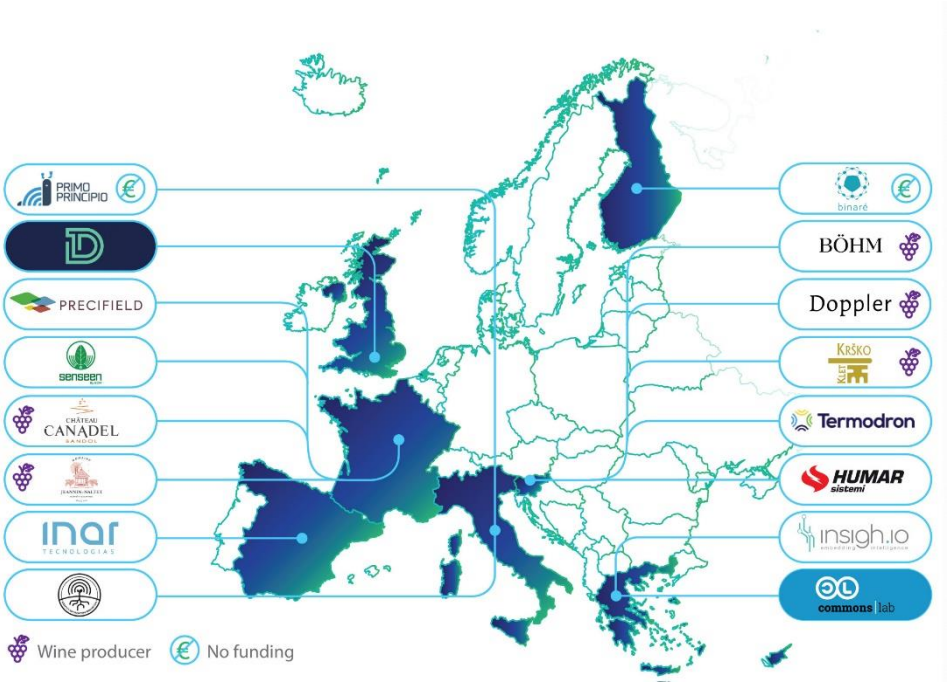


Figure 42: Geographic distribution of UL GE community members

Table 6: UL GE community participants' information

Company name	Website	Country	Region	Size	Application domain	Specific application domain
Simon Bohm, grape and wine producer	under construction	Slovenia	Štajerska	SME 1-10	Agritech & foodtech	Vinification / Winemaking
Chateau Canadel	**www.chateau-canadel.com**	France	Provence	SME 1-10	Other...	Agriculture - Viticulture
CommonsLab Koin.S.Ep.	**https://commonslab.gr/**	Greece	Crete	SME 1-10	Other...	IoT prototyping
Dominus Tech Ltd	**https://dominus.technology/**	United Kingdom	London	SME 1-10	Industry 4.0	risk modelling, data management, analysis, model calibration
Mihaela Žarka Krsnik Kopše, grape and wine producer	**https://doppler.si/**	Slovenia	Štajerska	SME 1-10	Agritech & foodtech	Vinification / Winemaking
Humar sistemi d.o.o.	/	Slovenia	Gorenjska	SME 1-10	Manufacturing	Sensors solutions and software
Inar Tecnologias y Soluciones S.L.	**https://inartecnologias.es/**	Spain	Aragon (Zaragoza)	Start-up	Industry 4.0	Electronics Developers (IoT)
INSIGHIO P.C.	**https://insigh.io/**	Greece	ATTICA	Start-up	Other...	IoT Products & Solutions
Domaine Jeannin-Naltet	**www.jeannin-naltet.fr**	France	Burgundy	SME 1-10	Agritech & foodtech	vineyard
Precifield	**https://www.precifield.com/**	France	Ile-de-France	SME 1-10	Agritech & foodtech	Precision Agriculture
SENSEEN	**www.senseen.io**	FRANCE	PACA (Provence Alpes Cote d'AZur)	Start-up	Agritech & foodtech	develop scanners for sustainability including sustainable agriculture , Agroecology including for wine makers
SISSPre s.r.l.	**www.sisspre.it**	Italy	CO	Start-up	Agritech & foodtech	IoT devices definition, prototyping and development for tracing agrifood productions
Termodron, sodobne tehnologije d.o.o.	**www.termodron.si**	Slovenia	Podravska	SME 1-10	Agritech & foodtech	IoT and drone tracing agrifood productions
Kmečka zadruga Krško, z. o. o.	**www.klet-krsko.si**	Slovenia	Štajerska	SME 11-50	Agritech & foodtech	Vinification / Winemaking
***NON-FUNDED**						
***Binare.io**	**https://binare.io**	Finland		SME 1-10	IoT & Software	IoT and data solutions
***Primo Principio - WiForAgri 2022**	**https://www.primoprincipio.it**	Italy		Start-up	Agritech & foodtech	IoT platform
***SC Robotics**	**https://scrobotics.es/**	Spain		SME	IoT & Software	IoT hardware

5.4.2 Organisation of Generic Experiment

To ensure a successful implementation of the agreed goals, multiple people were involved on both Smart Agro Grape side and DigiFed's side:

Project management:

- Lead project manager: responsible for the implementation of Smart Agro Grape

- Project manager: process documentation and coordination with Smart Agro Grape consortium partners

Innovation management:

- Junior researcher: national project exploitation channels, multimedia support and pilot site coordination.
- Pilot site manager: pilot site coordinator, agricultural consultation service

Technical team:

- Senior technologist, researcher: concerned primarily with infrastructure and data brokerage setup.
- Junior technologist: frontend programming, dashboard development
- Junior technologist: sensor adaptation, pilot site installation
- Junior technologist: technical support and programming in other's tasks

Pilot site owners:

- Grape producers, winemakers involved in Smart Agro Grape. They are not part of GE community.

GE community animation:

- DigiFed dedicated project manager: organizing UL GE, gathering, and sharing GE community feedback with the technical and the project team.

5.4.3 Technical development

Combining digitalization with a multidisciplinary methodology on one hand and community engagement via a bottom-up, non-hierarchical approach on the other hand, can help to develop tools for innovative and above all sustainable agriculture. In this context, an already working prototype for automated disease detection in vineyards has been presented. The combined approach to its development has brought invaluable experience and data for future developments of the digital platform itself. This platform is being developed in close collaboration with the local communities by actively involving viticulture stakeholders and other public and private bodies.

5.4.3.1 Technical vision

The data-collection and data-processing platform is being developed by the Laboratory for Telecommunications at Faculty of electrical engineering, University of Ljubljana, in close collaboration with the winegrowing communities from two identified, geographically diverse Slovenian viticulture research regions (Primorska and Štajerska). Specific characteristics of the presented model can be summarized by three section-contexts: 1. the context of its development; 2. the context of a multidisciplinary approach: due to the platform's holistic approach to digitalization, its development is based on the principle of digital innovation ecosystems, ensuring a multidisciplinary approach to smart viticulture by working closely with the winegrowers and other stakeholders; and, 3. future scenarios: as the platform is designed to combine different digital technologies and sensor systems to ensure collected data will be displayed efficiently and above all in a user-friendly manner. It is designed to allow further development for universal use for various users.

5.4.3.2 Process and updates

ThingsBoard is an open-source IoT platform that enables rapid development, management, and scaling of IoT projects. In the prototype phase, the UL dedicated Thingsboard server received and stored data hourly. The parametric data and alerts were displayed on the ThingsBoard dashboard and could be remotely accessed. Stored data was used to predict the likelihood of downy mildew infection in the vineyards. In the future, additional predictive models for other vineyard diseases will be introduced to further develop the model to operate as a fully operational digital farming platform. Based on the model's results, redundant sensors (parameters) will likely be removed in the future to reduce the overall costs of the sensor system. IOS and Android apps will be developed to provide farmers with relevant information on the parameters and condition of their vineyards via their smartphones.

Model

To build the disease control (e.g. downy mildew) model, the weather conditions in which the disease is most likely to occur, needed to be researched to identify which parameters could be used. If the conditions of the model for primary infection (longer rainy periods or several successive thunderstorms) of certain disease are met, the data are used to determine if the conditions for a secondary infection are also present. To achieve this, readings from sensors for humidity, precipitation and temperature from the time period of the last three days are used in the model. Otherwise, the model is based on the so-called 10:10:24 'rule of thumb'[6], which refers to conditions necessary to develop primary infection, i.e. > 10 mm of precipitation and > 10°C in a given 24-hour period. The only change was to lower the precipitation level to >5 mm, rather than 10 mm, i.e. a 5:10:24 'rule of thumb' was used. If these conditions are met (>5 mm precipitation and >10°C in the next 24 hours), an alert is sent to the winegrower to inform them that there is a chance of a primary infection of downy mildew. After primary infection, oil spots begin to appear on the leaves, which are necessary for secondary infections, but are hard to notice. Secondary infection is promoted by warm humid nighttime conditions. Sporulation occurs when there is at least 4 hours of darkness, and the temperature is >12°C but <29°C. For this reason, the developed model of secondary infection concentrates on data obtained between 9pm and 6am from March to October, when the required temperature is most likely to be reached. Therefore, if the average nighttime temperature is > 12°C and <29°C and the humidity is above 95%, an alert for a secondary infection event is sent to the winegrower by email or mobile phone.

Thingsboard platform

The data-processing model is implemented as a rule chain on the Thingsboard platform, through which the alerts are sent to notify winegrowers if there is a chance of Downy mildew infection. Thingsboard is an open-source platform used for device management, data collection, visualization and processing (ThingsBoard 2021) and it provides MQTT, HTTP, CoAP and LwM2M-based APIs that are available to the devices and enable a server-side infrastructure for IoT applications. The data transmitted from devices via NB-IoT connection (described below) can be visualized in real-time via an end-user dashboard. With rule nodes in a rule engine, the model is compiled in such a way, that it can filter and process the data and if necessary, create an alert. The notification can be done either by sending a message to their phone or to their email. The model is open-source and could benefit the communities in terms of a reduction of plant disease due to presupposed exchange of data collected from the Thingsboard platform.

Sensor system

Figure 43: Sensor hub installed in pilot site

A sensor system needs to be able to measure viticultural parameters and manage the data aggregation and data sending. When deciding on a sensor system that would be able to measure parameters and report them to the server, a priority was placed on internet connectivity, having the flexibility to allow the development of in-house software and on ensuring that the system could operate independently from the power grid. As the sensor system will be located in the vineyard (Figure 43), consideration was also given to the robustness of the system and its ability to to withstand different weather events. Among the solutions currently available on the market, the professional Libelium Plug & Sense Smart Agriculture Xtreme was the most suitable due to wider set of sensor integration possibilities, batery standalone capabilities and standardized data communication approach. Since the goal of the project is to provide better agricultural solutions and not develop new sensors it was important to choose a sensor platform that could be easily upgraded or modularly changed during the development phase.

[6] Fisher, D, Taylor, A, Gordon, C, and Magarey, P. (2007), *Downy mildew in vineyards*. Department of Primary Industries and Regional Development, Western Australia, Perth. Bulletin 4708.

The system is supplied by an internal rechargeable battery with a capacity of 6600 mAh and solar cells (7 V - 500 mA). The central unit of the sensor system contains a microprocessor and various modules (ex. networking module, SD card module…) and it is responsible for the aggregation of measured parameters and sending the data to the server. The Libelium device has six inputs to which different sensors can be connected. Some sensors have the ability to measure multiple parameters. Because there are multiple sensors to choose from, multiple sensor configurations could be programmed with this set-up.

Sensor configuration

When working on the pilot system, there was an initial focus on ensuring that the required parameters for downy mildew disease detection were captured. During the development phase of the project, technical team's decision was made to include additional sensors that collect other parameters so that grapevine disease models can be implemented later. The parameters that the selected sensor system measures are soil volumetric water content, soil conductivity, soil temperature, leaf wetness, oxygen levels in the soil, air temperature, air humidity, air pressure, solar radiation, wind speed, wind direction and rainfall. Resulting from the research and collaboration with the winegrowing community, the Libelium Plug & Sense Smart Agriculture Xtreme version of the sensor system was used (Libelium, Zaragoza, Spain).

Connectivity

Originally LoRaWAN® (www.thethingsnetwork.org) was intended for connectivity. However, LoRaWAN required additional gateways that increased costs and implementation complexity. For this reason, a Libelium device with a configuration that allows NB-IoT (GSMA, London, UK) connectivity was chosen. NB-IoT is suitable for the proposed model due to its low energy consumption and high network availability in the selected pilot regions. The disadvantage to NB-IoT is the requirement for a SIM card and with it the monthly network operator fees. The communication architecture between the sensor system and the server is shown in Figure 44. The devices are connected to NB-IoT cell towers, which send telemetry data to the ThingsBoard server where it is stored. Communication is bi-directional. When a Libelium device requests to receive settings from the server, the server sends new sensor configuration to the Libelium device. The protocol used for packet transfer is HTTP (Hypertext Transfer Protocol -- HTTP/1.1 2021).

Program flow

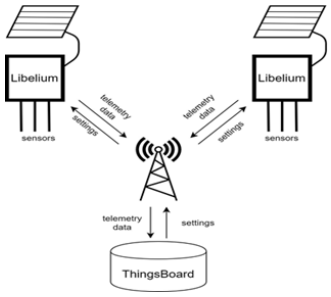


Figure 44: Data exchange infrastructure

For the system to work according to the needs of the developed model (Figure 55), actions that the device software had to take needed to be determined to periodically send data to the server. The Libelium device comes out of sleep mode and measures parameters using the connected sensors. Afterwards it encapsulates the measurements into a data frame and sends it to the ThingsBoard using HTTP. Afterwards, the device sends another HTTP request to the ThingsBoard server to obtain the device specific settings (for example the sleep period). Settings are changed only if they are first changed on the server. At the end, the cycle, the system goes back to the sleep mode, to lower energy consumption. This process repeats periodically by default once per hour. The reason why the second HTTP request is sent, is so that the sleep period setting can be changed remotely without the need to reprogram the device itself. With this option, the device's power consumption can be easily managed. For example, when there are cloudier days, the solar cell is unable to recharge the battery fast enough. To tackle this weather condition, the sleep mode can be extended, resulting in less frequent measurements and data sending, ensuring an overall decrease in power consumption

Monitoring application design and development

Data collected from the sensor infrastructure, sent through data pipeline, including Thingsboard, was available through application programming interfaces and processed and visualized in prototype mobile application (Figure 45) that was a subject of iterative development. In instances presented in intermediate GE community workshop there were several features developed that included the capacity for monitoring of immediate and historical parameters from the pilot sites sensors. In future extension the data collected will be marked according to data processing model to provide simple, yet effective, signals for potential dangers to winegrowers.

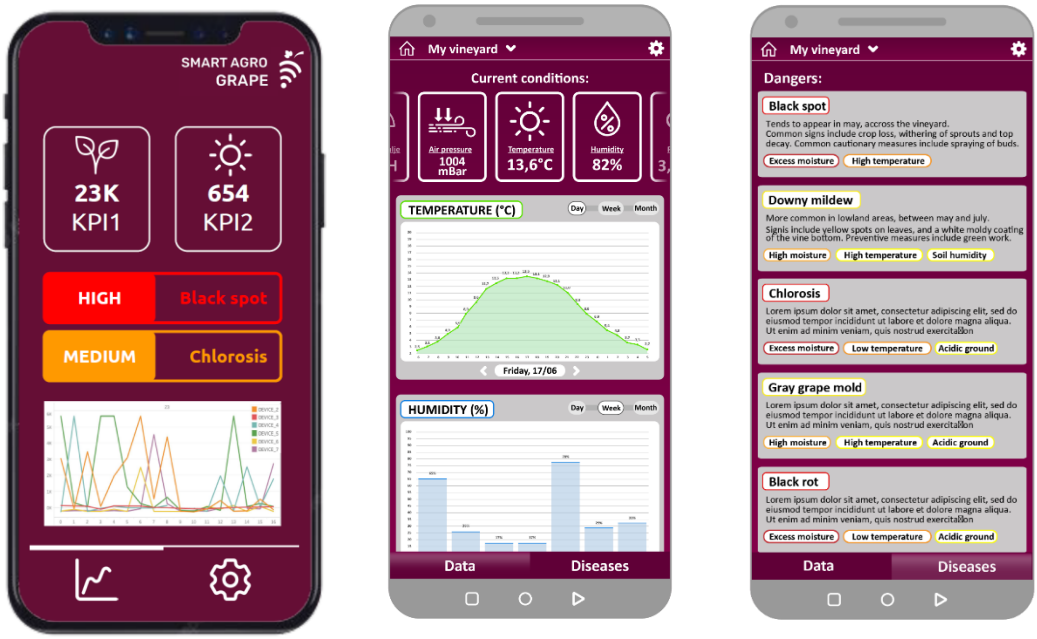


Figure 45: UL GE monitoring application prototype interfaces

5.4.4 Animation (Events, communications, interviews)

Kick-off workshop on 9.9.2021, see Annexes: 9.4 Annex 4: UL Presentation Slides - Figure 57.

After the Standard Generic Experiment Agreement contract dissemination, comments and signing process and financial identification and documentation gathering, the GE community constitution event was organized.

1st Generic Experiment Community Workshop Agenda, organised online, 9.9.2021 in Table 7.

Table 7: UL GE kick-off workshop agenda

10:00	Welcome and introduction
10:10	Generic experiment owner - University of Ljubljana, Faculty of Electrical Engineering & 4P DIH – presentation
10:15	DigiFed H2020 project & Generic Experiment presentation
10:20	Smart Agro Grape project presentation
10:30	**Round Table 1: Vinemakers** **(5 winemakers presentation and discussion)**
11:00	Coffee/Tea Break
11:15	Smart Agro Grape technical and pilot implementation presentation
11:45	**Round Table 2: Solution providers** **(10 solution providers presentation and discussion)**
12:45	Discussion, Q&A, Conclusions
13:00	Closure

Some of the key slides, presenting the Smart Agro Grape project, project goals and key components, participants winemakers and participant technology providers (see Annexes: 9.4 Annex 4: UL Presentation Slides - Figure 58).

All representatives of 15 out of total 15 (14 funded and 1 non-funded at that time) collaborating SMEs were present on the GE community constitution, Kick-off meeting and actively participated in discussions on the selected topics.

Interviews with UL GE members (January 2022 – April 2022)

To gain additional insight on how to improve sensor and data infrastructure, monitoring application needs and minimum viable product requirements, various meetings with the UL GE members were organized. These meeting were either held face to face, or online/phone calls between January 2022 and April 2022. Below you can find their contribution in terms of knowledge sharing, solution's design and technical development:

- IT solution providers - Meetings organization based on availability and their technical solution propositions.
    - Dominus Tech Ltd, from United Kingdom, developing various data based, security, sensor and monitoring solutions, outlined the general infrastructure design approach, cyber-security challenges and possible data anomalies detection and their dashboard presentation.
    - Humar sistemi d.o.o., from Slovenia, the SME concerned with sensor development for agricultural sector, presented complex automation solutions for the farming industry and helped GE owner understand technical development, market constraints and design approaches in other agricultural sectors (dairy), apart from wine producing segment.
    - Termodron, sodobne tehnologije d.o.o., from Slovenia, helped GE owner extend the knowledge of possibilities of drone and geo-photography, agriculture-based data solutions future integrations.
    - Primo Principio s.r.l., from Italy, developing sensor based agricultural solutions within DigiFed's Application Experiment, presented their implementation of data collection and their original approaches to effectively detect the soil and plant capacity for various vine diseases. Note that some pilot sites in Slovenia have installed in parallel their sensors and cameras and GE owner's infrastructure. Both are different in technical implementation, thus will be interesting to see what provides better data quality, works better and/or is cheaper to install.
- Vine producers - Meetings organization based on availability and pilot areas proximity.
    - Simon Bohm, grape and wine producer, from Slovenia, suggested to GE owners the solution requirements of small size (in Slovenian terms) wine producers with single product line.
    - Mihaela Žarka Krsnik Kopše, grape and wine producer, from Slovenia, proposed to GE owners the solution requirements of medium size (in Slovenian terms) wine producers with several product lines.
    - Kmečka zadruga Krško, z. o. o., from Slovenia, as a hub for wine products and barrel logistics, helped GE owner understand value-chain depth and interrelations of larger producers, retailers in intermediaries within mature wine sector and market.

Intermediate results presentation and workshop on 20.4.2022, see Annexes: 9.4 Annex 4: UL Presentation Slides - Figure 59.

2nd Generic Experiment Community Workshop Agenda, organized online, 20.4.2022, Table 8.

Table 8: UL GE intermediate workshop agenda

10:00	Welcome and recap of DigiFed GE mechanism and relation to Smart Agro Grape Project by UL
10:15	Sensors and infrastructure used within Smart Agro Grape
10:45	Coffee/Tea Break
11:00	Pilot sites presentation and area specifics
11:20	Use cases and monitoring app
11:45	Round table discussion, Q&A
12:15	Closure

For some of the key slides, presenting the pilot areas, intermediate results, data infrastructure and advanced monitoring application, please see Annexes: 9.4 Annex 4: UL Presentation Slides - Figure 60:

Representatives of 13 out of total 17 (14 funded and 3 non-funded) collaborating SMEs were present and actively participated in discussions on the selected topics.

5.4.5 Co-financing

5.4.5.1 Entity

SMART AGRO GRAPE project is co-financed by Ministry of Agriculture, Forestry and Food to support rural development. The common agricultural policy contributes to the sustainable development of rural areas through three long-term objectives:

- fostering the competitiveness of agriculture and forestry,
- ensuring the sustainable management of natural resources and climate action and
- achieving a balanced territorial development of rural economies and communities including the creation and maintenance of employment.

More information is available online:

- **https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development**
- **https://skp.si/en/rdp-2014-2020-2022**
- **www.program-podezelja.si/**

Ministry of Agriculture, Forestry and Food's *4th call for tender for sub-measure 16.5 Support for joint action to mitigate or adapt to climate change and for joint approaches to environmental projects and permanent environmental practices* is closely related to common agricultural policy development interconnected with regional and national context.

Namely, the common agricultural policy supports the vibrancy and economic viability of rural areas through funding and actions that support rural development. Rural development is the 'second pillar' of the common agricultural policy, reinforcing the 'first pillar' of income supports and market measures by strengthening the social, environmental, and economic sustainability of rural areas with the help of Local action groups (LAG) and Community-Led Local Development/LEADER cooperation (originally from the acronym for "Liaison Entre Actions de Développement de l'Économie Rurale"), supporting links between the rural economy and development actions.

5.4.5.2 Model

UL has responded to Open call for co-financing by Ministry of Agriculture, Forestry and Food: *4th call for tender for sub-measure 16.5 Support for joint action to mitigate or adapt to climate change and for joint approaches to environmental projects and permanent environmental practices.*

UL GE Community is complementary for gaining insights and feedback in the initial planning phase to the project SMART AGRO GRAPE with longer duration for technical development and pilot site integration.

More information is available online:

- **https://enrd.ec.europa.eu/leader-clld_en**

5.4.5.3 Sustainability

UL GE implementation phase timeline fits in the preparation and design phase of the longer SMART AGRO GRAPE project duration (Maj 2021- April 2024) and has served as excellent stakeholder requirements analysis basis and initial prototypes technical development phase that will benefit the later phases of the umbrella project – thus

ensuring later exploitations of technical and user-requirements related activities in UL GE to further develop decision support system algorithms and end-consumer applications.

Additionally, the UL, Faculty of Electrical Engineering has submitted the application to enhance and upgrade the prototypes and decision support mechanisms developed in the GE UL in auxiliary project “IoT for young farmers” which connects the groups of students (6-12 participants) to develop industry (1-2 SMEs participating) grade solution, oversighted by pedagogic and technical mentors from UL FE. If the submitted application will be accepted, the student group will develop these upgraded technical solutions of the initial prototype for 5 months, from February 2023 to June 2023.

The sustainability of the GE UL technical development, knowledge and practical lessons learned, will be preserved after the UL GE and SMART AGRO GRAPE project, as the pilot areas participants (wine producers) are legal owners of the sensor and data infrastructure and will continue to use the solutions after the related projects end – yet allowing for further development on top of this existing infrastructure if new opportunities arise.

6. Discussion Lessons learned

Low digital maturity involvement. In the DOA, one of the GE targets was to involve low digital maturity SMEs to support them in their digitalization route. First feedback is that GE can be a very efficient pathway to reach these low digital maturity SMEs.

- Overall 23 % of GE members are low digital maturity companies compared to 15% in the case of the AE pathway.
- This is specifically true when the GE topic is adapted for these companies. This is the case for UL and BME GE topics which are more suited to Low Digital Maturity Companies. For these 2 GE's, the pathway attracted high number of Low Digital Companies 36% for UL and 67% for BME as shown in the following table (9).

Table 9: GE SME's maturity involvement

GE	Members	Low Digital Maturity	% of Low Digital Maturity	AE applicant	AE selected
CEA: Cyber secure PF IOT	21	2	10%	16	9
IKERLAN:Smart contract	10	0	0%	2	0
UL: IoT in agriculture	14 (+3 non funded)	5	**36%**	6	2
BME: LED lighting	6	4	**67%**	1	0
ALL GEs	51	11	**23%**	**25**	**11**

Synergy with AE innovation pathway.

- 40% of the GE applicants also applied to AE open call, and 25% of the GE members run an AE.

Geographical attraction: As seen in Figure 1 (page 8) The GE members are from 15 EU countries which is a good geographical attraction of DigiFed.

- We can see a strong participation of SME from DigiFed DIH-ecosystem, which illustrate the added value of DIH from DigiFed ecosystem: France, Spain, Slovenia and Greece.

7. Difficulty in DigiFed GE flow and Covid impact

During the overall DigiFed project there were **Covid impacts** present, in terms of GE preparation and implementation phase the processes were affected, yet not disrupted and mitigated in timely manner. Global Covid pandemic has caused some issues on 2 distinct levels:

- Generic experiment community constitution events, workshops and intermediate GE community events were organized online. While this had ensured participation in large GE groups, whose members are from all over the Europe, it would be preferable to meet in person, and have more time to discuss, formally and informally, about the organizational approaches, technical roadmaps instead of limited time intended for online events.
- Logistics and electronics equipment supply chain problems were even more evident throughout the world in from Q2 2021 than at the start of global pandemic in Q2 2020. This was critical in all GEs technical implementation initial periods, for example all GE owners had to wait a few months to receive

sensors, electronic boards and other electronic equipment to start developing and testing their initial solutions.

Legal and co-funding aspects had to be addressed in each GE and usually resolved by GE owners' legal department:

- In some cases, there was legal insecurity between the participating SMEs and GE owner in relation to intellectual property rights, co-funding and participation agreement that had to be resolved, which included legal department's process and resulted in prolonging the GE community constitution. In other cases, (UL), these developments were resolved in due time, which has not caused additional delays, while, particularly in BME case, this meant longer timeframe in the implementation phase beginning of the GE, yet without critical delays.
  These aspects had to be addressed according to GE owners' organization type, public or private source of primary organizational funding, auxiliary regional funding rules, regional laws and intellectual property practices while involving comments from the participants in the process.

GE community structural and geographical differences typically represented an opportunity to include many perspectives and reach greater synergies, yet in some cases there can be an issue of divergence in design and development approaches of GE solution. These disparity issues are not a great problem for experienced community organiser, who strives to consolidate and focus the whole GE community, though it is relevant to include them in this chapter. To illustrate:

- Difference in TRLs levels, market and business maturity, and sector focus was noted in workshops as some GE community participants already have products that address solutions to similar problems than GE goals. Some are already established market presence or leadership in certain sectors. The others might have only begun to develop similar solutions and started to analyze the markets. Nevertheless, the exchange in knowledge of established SMEs and innovative ones (start-ups) was beneficial for SME participants of all types – though these exchanges, sometimes may not benefit directly the GE owner technical development goals.
- Geographic distribution, a good mix of diverse European SMEs was one of the DigiFed's project main benefits, yet we must note that in particular cases, for example in University of Ljubljana's GE IoT in Agriculture, focusing on grape and vine production, the majority of SMEs come from vine producing regions of France, Italy and Slovenia. This of course is not particularly limiting factor, though we have to acknowledge the existence of regional uniqueness in terms of challenges to be addressed – even different vine producing regions prioritize specific solutions and goals – e.g. water supply management, pest control, logistics, vineyard plots fragmentation – and that can be reflected in corresponding GE owner's technical solutions.

8. Perspectives and conclusion

Following the initial preparation phase concerned with creating common organisational processes, common communication programmes, seeking co-funding regional authorities, promoting GE calls, selecting and onboarding the participating SMEs, the implementation phase was crucial for co-designing and developing key enabling technology blocks amending to each GE's goals while observing the process, different models of co-funding and sector specific approaches to produce key insights that can be transferred and introduced elsewhere in different geographically, sectorial, institutional settings.

Status of each GE in June 2022 (M30 of the DigiFed project) is described further.

GE CEA, on topic of IoT Cybersecurity, has completed all foreseen activities by June 2022 and gathered results of the model assessment, including responses of co-funding authorities, GE owner's project managers and technical developers and GE community members. These results will be later analysed and presented in subsequential deliverables.

With GE led by BME on energy saving in outdoor LED lighting, there was some delay in Generic Experiment Standard Agreement contract signing that was prolonged by legal department processes, thus this GE started later than initially foreseen with implementation phase period remaining within DigiFed project timeframe. Main development and co-design activities have been implemented, with finalisation workshop coming in Q3 2022. The activities and assessment will be reported in following deliverable.

GE community organised by IKERLAN, on Cybersecurity topic specifically Trust Platform for Digital Assets management is ongoing with most development and co-design activities completed, only final workshop to be organized in October 2022. After the final workshop event the assessment will follow and will be included in consecutive deliverable.

Similar to IKERLAN GE, the University of Ljubljana's GE community organised around IoT in Agriculture topic is ongoing, with most development and community co-design activities completed, final workshop to be organized in Q3 2022 with assessment following.

Generic experiments implementation phase was intended for different GE models to be tested and assessed in terms of: (1) service proposed - prototype development, access to excellence centres, test before invest; (2) community - transverse digital sector or dedicated to a market segment, building a value chain; (3) co-financing model - specific programmes, enlarging existing Regional to EU partnership. Final assessment of the GE co-design and co-founding mechanism by the GE member SMEs representatives, GE owner staff (managers, technicians) and cofounding authority representatives was completed in CEA GE case, as it has been finished before M30. For other ongoing Generic Experiments, the final assessments will take place right after the final workshops. The assessments by key stakeholder groups will be enabled by Assessment stakeholder kit, compiled, updated, and improved by CEA, based on experience with their assessment of CEA GE.

The data will be aggregated, refined, analysed in-depth and reported in Deliverable 2.3: Generic experiments assessment. The GE assessment methodology and results will be presented at DigiFed final event December 2022. Sustainability prospects and information on the GE model will be shared with European DIH network within activities of DigiFed Workgroup 4 on DIH network.

9. Annexes

9.1 Annex 1: CEA Development Work Plan

WP1 - Proof of Concept (POC): Deployment of an infrastructure in the TrustZone reinforcing the security of a Linux OS

Duration: T0 - T0+ 13

WP1 is financed by EASYPOC and lead by LETI/DSYS/LSOSP.

This first WP lays the basics for using the TrustZone to improve the security of the "NonSecure" part.

Several functionalities will be integrated to the POC:

- Enslavement of the " Non-Secure " world by the " Secure " world
- Enable OPTEE to carry out monitoring operations on a periodic basis
- Using secure communication to alert when attacks are detected
- Monitoring base
- Attestation of the basic bricks of the system

Demonstration of the POC to a few companies (1-5) who would volunteer to test it and give their feedback is planned. An appropriate Material Transfer Agreement shall be executed by the concerned parties prior to any loan contemplated for POC testing purposes.

Deliverables:

T0+6: POC reporting an alert via a secure connection when an attack is detected, along with the POC documentation. TRL5

T0+13: Demonstration Feedback from the SME

WP2: Using the TrustZone to detect abnormal behaviour in a partially non-secure OS.

Duration: T0+4 - T0+12

WP2 is financed by DigiFed and led by LETI/DSYS /LSOSP

The aim of this development is to implement an initial solution for advanced system monitoring, but also to set up an architecture that facilitates the implementation of new monitoring solutions.

Several functionalities will be integrated in this WP2:

- Extraction of signals allowing to decide on the security of a system.
- Monitoring architecture: Implementation of an architecture facilitating the deployment of new monitoring strategies.

Deliverable: T0+ 12: Demonstration of malware detection by the TrustZone (TRL4), which integrates monitoring functions into the POC of WP1.

WP3: Animation of the Generic Experiment Community
Duration: T0 –T+13

WP3 is financed by DigiFed and led by CEA/DRT/YSPOT with support of technical team (LETI/DSYS/LSOSP).

The aim of this WP is to animate exchanges with the Generic Experiment Community in order to:

- To exchange on the companies' use cases:

  - What are the main attacks/threats encountered or potential?
  - What are the different Uses Cases of the companies?
  - What are the configurations used by companies?
- To communicate on the technical choices:
  - Which are the attacks that could be monitored,
  - What are the technical solutions envisaged,
  - To answer the technical questions asked by industrialists for their future use of the POC. (Acting as an intermediary/entry point between companies and the LSOSP laboratory).
- To gather the interest of companies for:
  - The solution developed,
  - A possible exploitation,
  - The proposed GEC collaboration model.

Deliverable: 3 Workshops will be organised:

- one at the kick-off to launch the Generic Experiment Technical Program, T0+1
- one in the middle of the Generic Experiment Technical Program to present the POC, T0+6
- one at the end of the Generic Experiment Technical Program , T0+13

9.2 Annex 2: CEA Model Figures

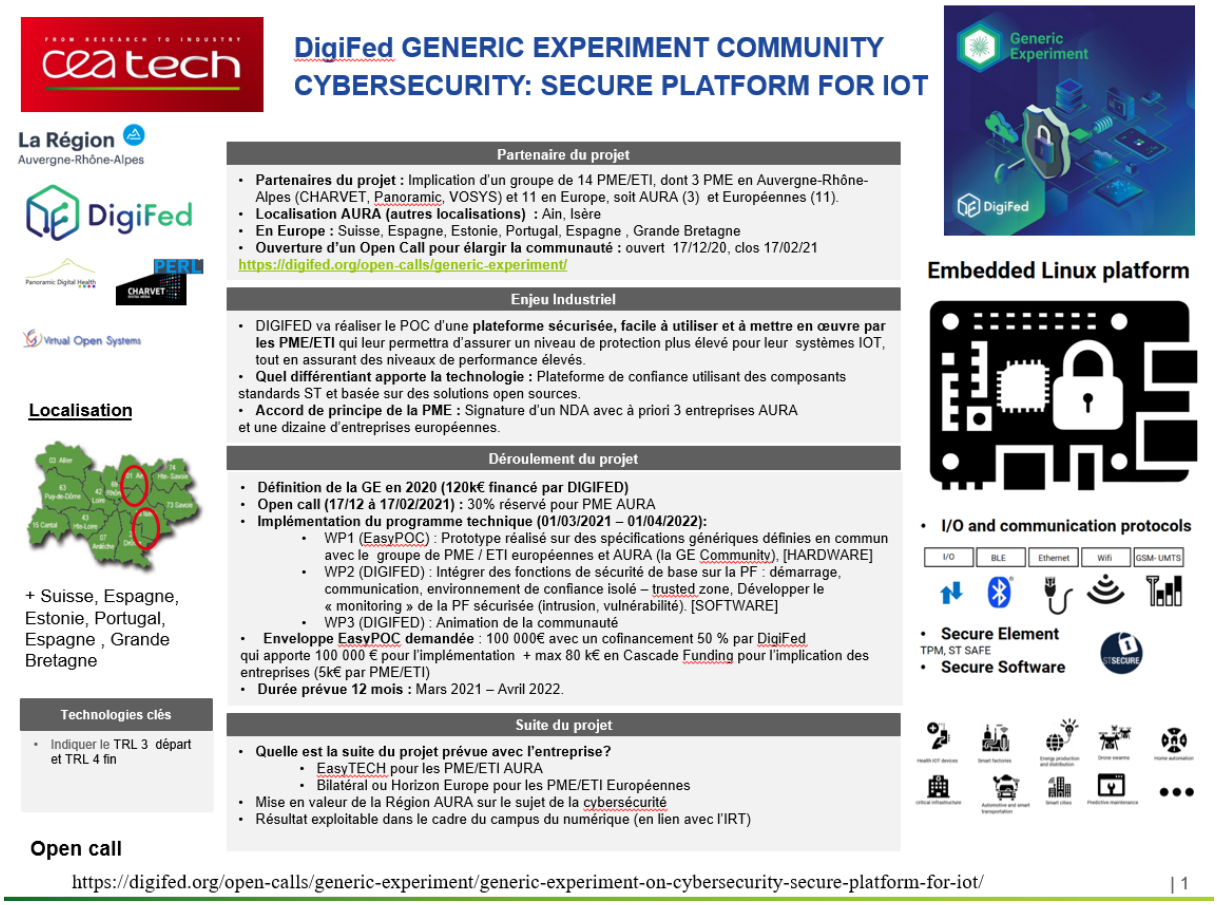


Figure 46: CEA GE PoC solution presentation

Figure 47: CEA GE participants' presentation slides

Liste des entreprises déjà impliquées dans la définition de la SECURE PLATFORM FOR IOT

Au 18/01/2021: 20 entreprises approchées - 11 inscrites au CALL GEC dont 2 AURA

	Nom entreprise	Activité	Logo	Status	Taille
Auvergne-Rhône-Alpes	Panoramic	Health - Wearable pour le suivi médical		Inscrite au CALL	1..10
	Charvet	Construction de Signalisation Digitale		Inscrite au CALL	50..99
	Vosys	Développeur de software pour plateforme sécurisée		Intéressé	10..19
	ID3	biométrie et de l'électronique		Intéressé – contact prochain	20..49
France	Inocess (FR)	Industry 4.0, Health, Energy		Inscrite au CALL Souhaite s'installé en AURA	1..10
	eRTOS (FR)	Développeur OS pour IOT		Inscrite au CALL	Start-up
	Nexiode (FR)	Développeur SW et HW - Smart Lightning- Smart Cities		Intéressé	3..4
	OneWave (FR)	Smart card - Développeur SW et HW		Intéressé	10..19
	CRESITT Industrie (FR)	Electronics and instrumentation		Inscrite au CALL	1..10
Europe Hors France	Cysec (CH)	Trusted solution for Data Confidentiality and Integrity		Intéressé	20
	Asvin GmbH (UK)	Industry 4.0		Inscrite au CALL	1..10
	Odin Solutions SL (SP)	Agritech & foodtech		Inscrite au CALL	11..50
	Volvero (IT)	transportation-and-smart-mobility		Inscrite au CALL	Start-up
	Quobis (Esp)	ICT		Intéressé	50
	Digiotouch (EST)	Secure, sustainable Digital Transformation products and service provider		Intéressé	7
	Allbesmart (IT)	Internet of Things, wireless communications and high-performance software development		Intéressé	4
	Beexlab (IT) = Albichiere	agritech-and-foodtech- Smart Product Startup – (smart platform for wine)		Inscrite au CALL	Start-up
	SAT (IT)	Innovative start-up – Wearable development for drowsiness prediction		Intéressé	1..10
	NGS (IT)	Industry 4.0		Inscrite au CALL	1..10
	Ovon (UK)	Energy - IOT products forSmart Home		Inscrite au CALL	1..10

Figure 48: CEA GE participants to 18/1/2021 AURA call

9.3 Annex 3: IKERLAN GE Members Presentation Slides

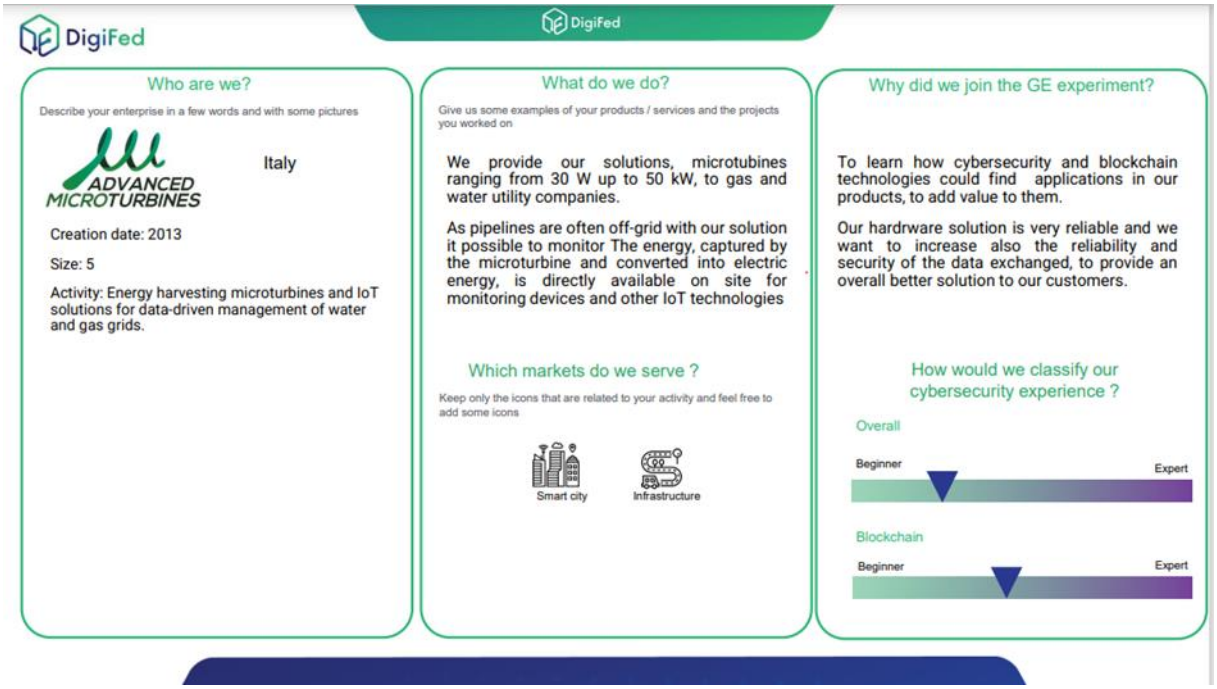


Figure 49: IKERLAN GE participants' presentation slide

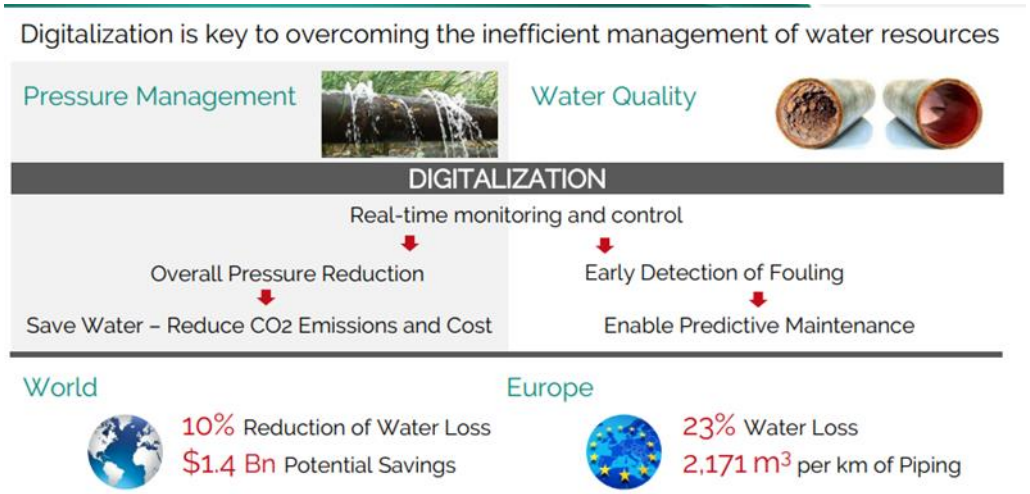


Figure 50: KERLAN GE member's solution proposal

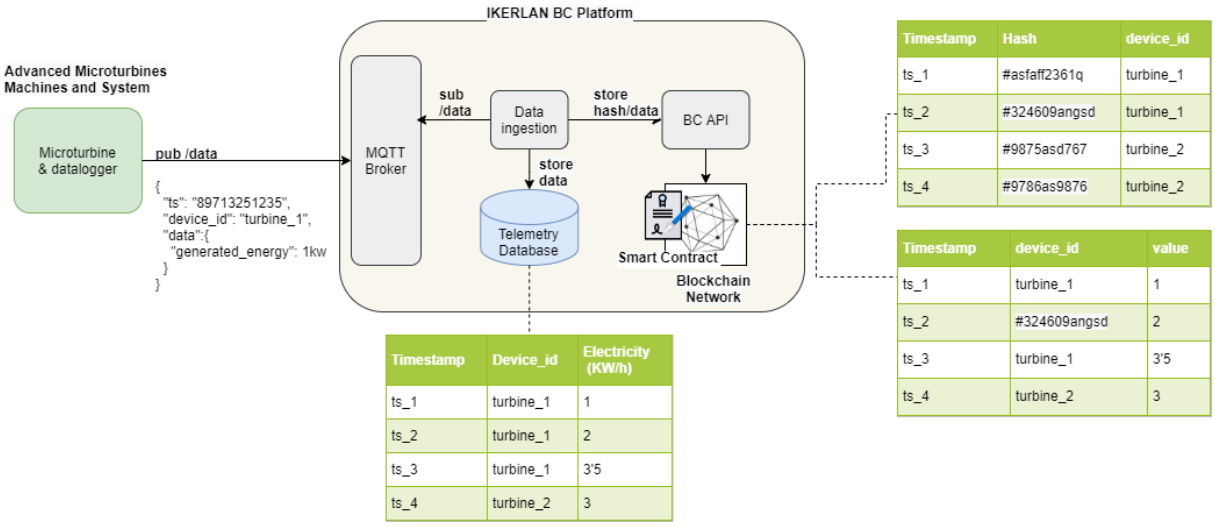


Figure 51: IKERLAN GE member' platform architecture

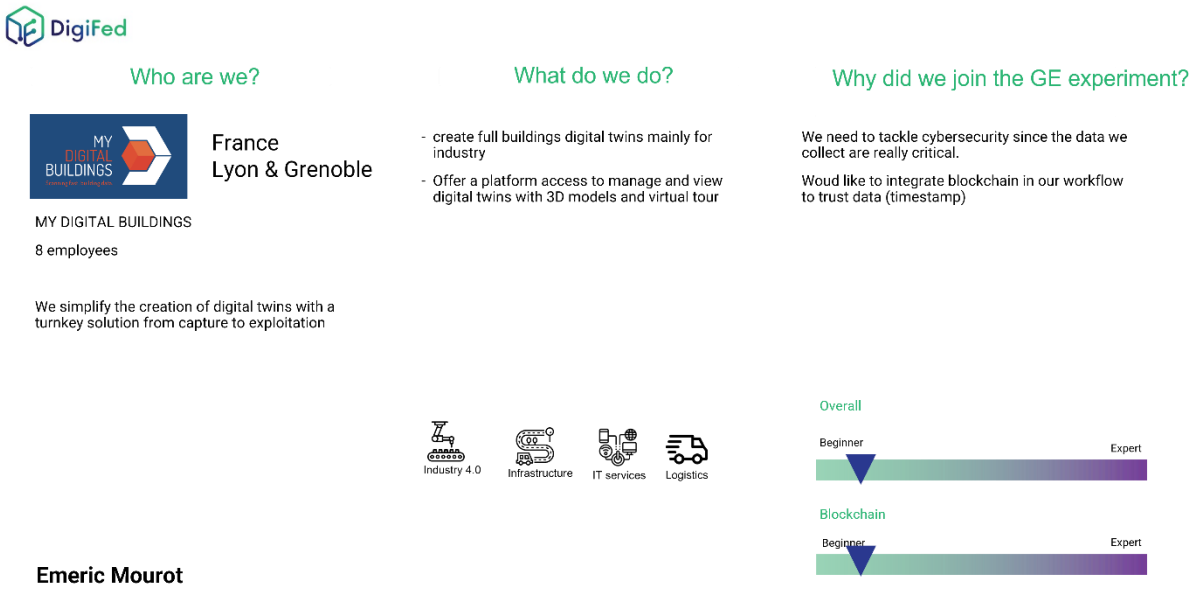
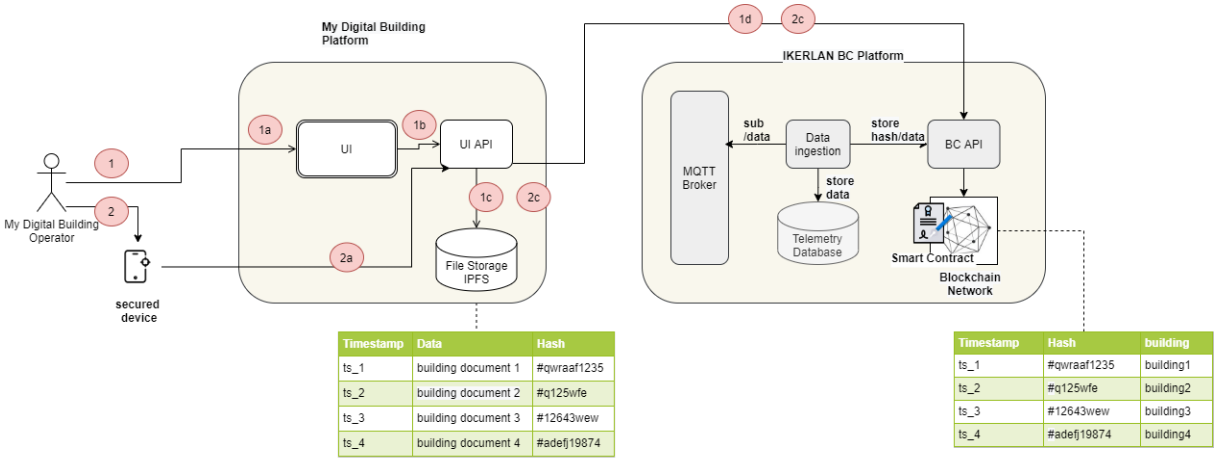


Figure 52: IKERLAN GE member's solution presentation slide



Timestamp	Data	Hash
ts_1	building document 1	#qwraaf1235
ts_2	building document 2	#q125wfe
ts_3	building document 3	#12643wew
ts_4	building document 4	#adefj19874

Timestamp	Hash	building
ts_1	#qwraaf1235	building1
ts_2	#q125wfe	building2
ts_3	#12643wew	building3
ts_4	#adefj19874	building4

Figure 53: IKERLAN GE member' platform architecture

Figure 54: IKERLAN GE member's solution presentation slide

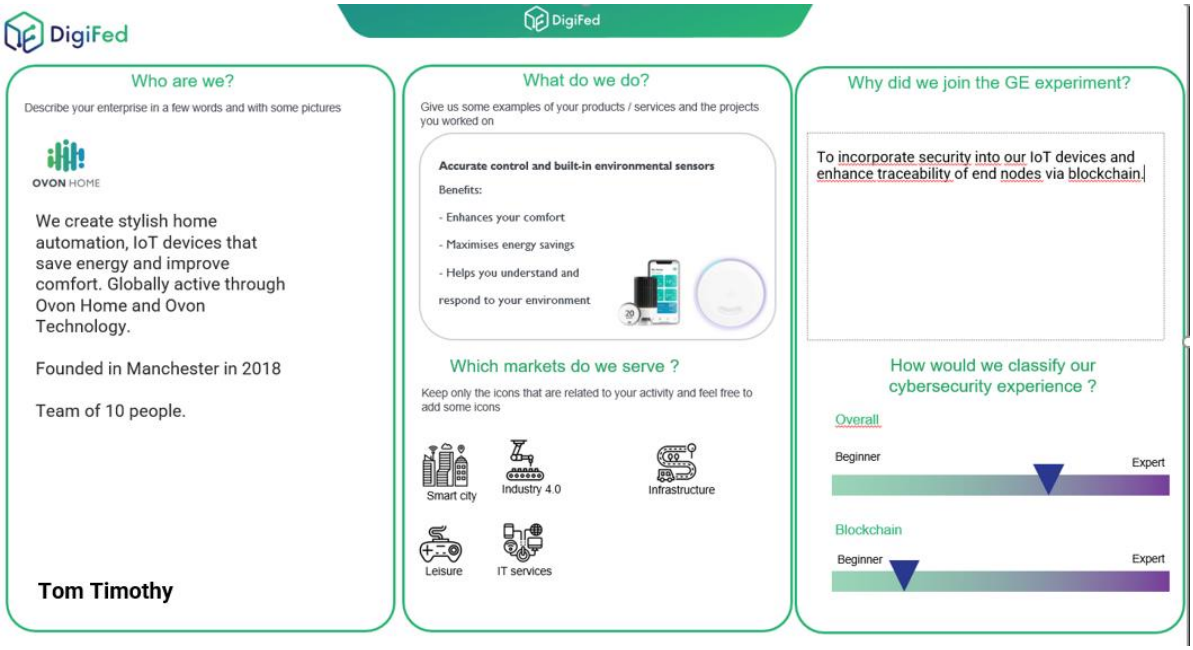


Figure 55: IKERLAN GE member's solution presentation slide

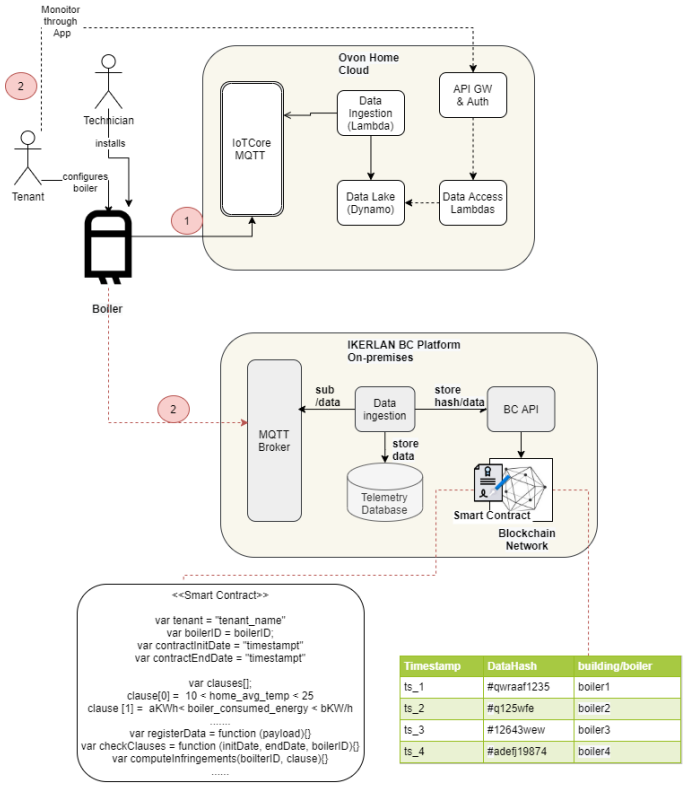


Figure 56: IKERLAN GE solution platform architecture

9.4 Annex 4: UL GE Presentation Slides

Figure 57: UL GE kick-off intro presentation slide

Figure 58: UL GE kick-off project and partner presentation slides

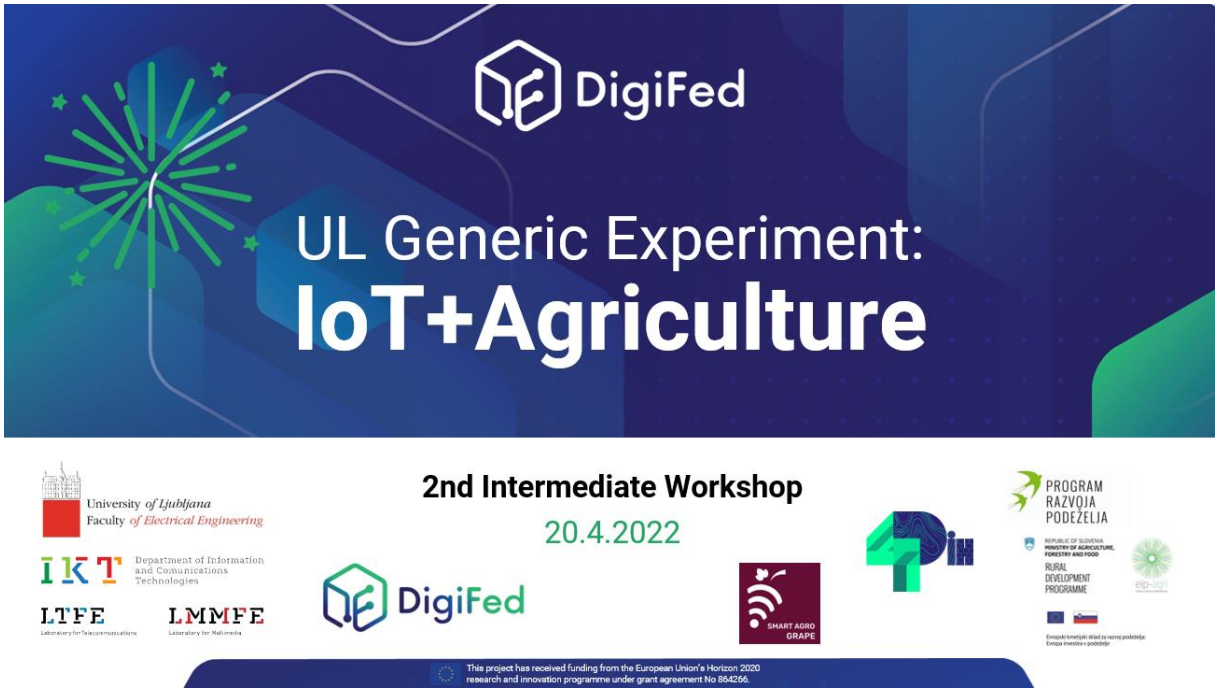


Figure 59: UL GE intermediate workshop intro presentation slide

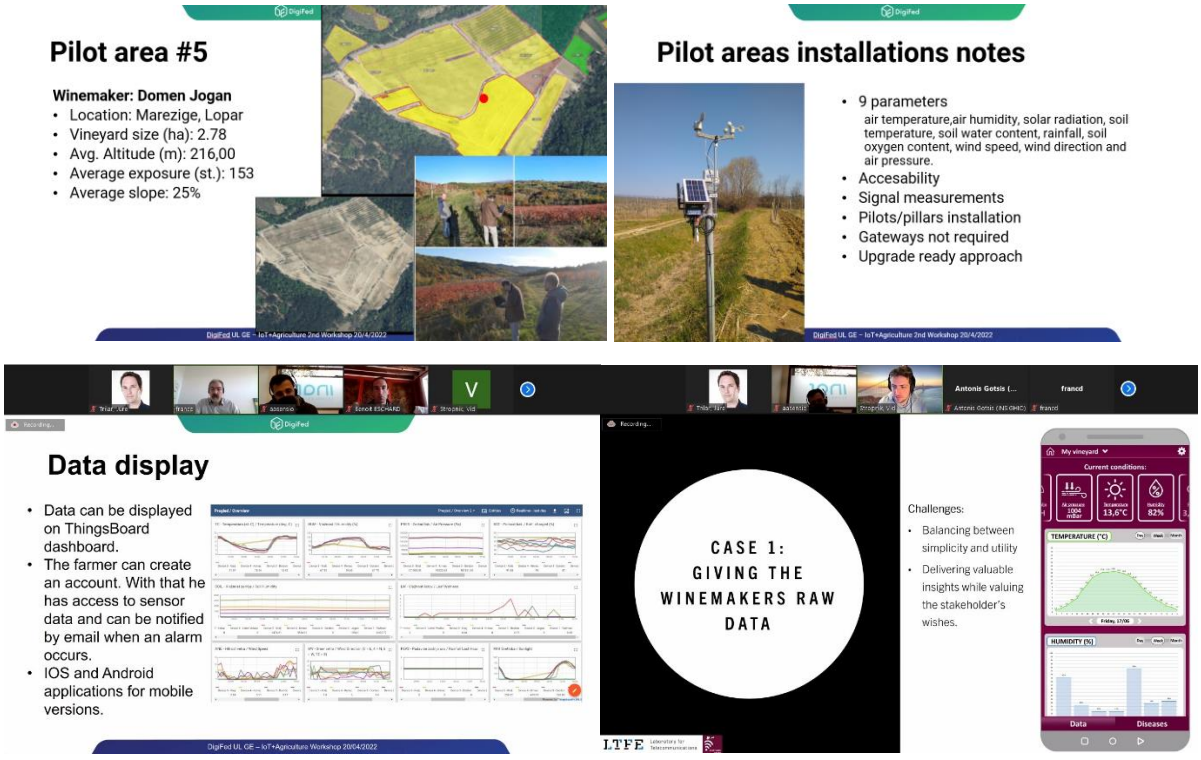


Figure 60: UL GE intermediate workshop project and partner presentation slides