Alliance for IoT and Edge Computing Innovation

IoT and Edge Computing EU funded projects landscape

Release 1.0

AIOTI WG Standardisation

10 January 2023

Executive Summary

This deliverable provides landscapes of EU funded projects focusing on IoT and edge computing.

The main objective of this deliverable is to briefly present the EU funded projects focusing on IoT and edge computing, which can be used to:

1) leverage on existing IoT and edge computing research and innovation activities in Europe, and

2) provide input to IoT and edge computing standardisation gap analysis activities.

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Introduction

The integration and synergy of IoT/IIoT and edge computing, including also the applied federated learning solutions, can be considered as a part of the paradigm shift from centralised solutions to decentralised and distributed computing architectures.

The main objective of this deliverable is to briefly present the EU funded projects focusing on IoT and edge computing, which can be used to

1) Leverage on existing IoT and edge computing research and innovation activities in Europe, and

2) Provide input to IoT and edge computing standardisation gap analysis activities.

This report provides landscape visualizations of ongoing and completed projects on the IoT and Edge computing that are funded by the EU. For each of these EU funded completed and ongoing projects, two groups of landscape visualisations are realised, based on (1) Technology and Marketing Dimensions and (2) vertical industry domains.

Several of the received inputs were provided by EU funded ongoing projects, which we would like to acknowledge.

1. IoT EU funded projects landscape

This section provides information on IoT EU funded projects, which are grouped in completed and ongoing projects. The information related to each EU funded project, included in this section, has been collected using the template provided in Annex I of this report.

1.1 Completed Projects

This section provides a description of the completed IoT projects funded by the EU.

1.1.1 mySMARTLife: "Smart Transition of EU cities towards a new concept of smart Life and Economy

URL/Reference:

https://www.mysmartlife.eu/

https://cordis.europa.eu/project/id/731297

Abstract:

Activities are focusing on **"Inclusive Cities"**, offering a high quality of life to residents. **"Smart People"** are playing a vital role in their city's development. **"Smart Economy"** is an innovative and dynamic economic concept aiming at guaranteed employment and an adequate income, attracting talents and providing goods and services according to the actual requirements.

The interventions planned and carried out in the three Lighthouse Cities also include innovative technological solutions in connection with **refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions**.

An **integrated planning process,** where citizens are actively involved in the decision making, links the actions in different fields (e.g. mobility, sustainable energy, ICT). Following a structured city business model leads to an **integrated urban transformation strategy** which can be easily transferred to other cities.

Starting and (target) end time of project:

1.12.2016-30.09.2022

IoT and/or Edge Computing research challenges:

- **Transforming current cities into more sustainable places** where smart people and smart economy become reality.
- Making cities **more environmentally friendly** by reducing CO_2 emissions and increasing the use of renewable energy sources.
- Making cities **more inclusive** and allowing a high quality of life.
- **Involving citizens** in the development of an integrated urban transformation strategy, which is easily transferable to other cities.
- Increasing the digitalization of the cities by using **urban platforms.**

Expected activities on "Dissemination and Impact on Standards":

No standardization action in public deliverables.

1.1.2 RAINBOW: An Open, Trusted Fog Computing Platform Facilitating The Deployment, Orchestration And Management of Scalable, Heterogenous and Secure IoT Services and Cross-Cloud APPS

URL/Reference:

https://rainbow-h2020.eu/

https://cordis.europa.eu/project/id/871403

Abstract:

Automation in industry, connected cars and critical infrastructure observation with drones are some of the benefits associated with advanced technologies. However, these applications require more properties that can guaranty safety, including real-time reaction, secure and effective data protection and management, and industry-specific safety guidelines as well as energy efficiency. The EU-funded RAINBOW project will plan and develop an open and secured fog computing platform that will advance the management of extensible, diverse and safe IoT services and cross-cloud applications. The project envisages extending fog computing to its real potential by supplying the development, composition, data and network management to reach secure end-applications.

Starting and (target) end time of project:

1.01.2020-31.12.2022

IoT and/or Edge Computing research challenges:

The vision of RAINBOW is to design and develop an **open and trusted fog computing platform** that facilitates **the deployment and management** of scalable, heterogeneous and secure **IoT services and cross-cloud applications** (i.e. microservices). RAINBOW falls within the bigger vision of delivering a platform enabling users to remotely control the infrastructure that is running, potentially, on hundreds of edge devices (e.g. wearables), thousands of fog nodes in a factory building or flying in the sky (e.g. drones), and millions of vehicles travelling in a certain area or across Europe. RAINBOW aspires to enable fog computing to reach its true potential by providing the deployment, orchestration, network fabric and data management for scalable and secure edge applications, addressing the need to timely process the ever-increasing amount of data continuously gathered from heterogeneous IoT devices and appliances. Our solution will provide significant benefits for popular **cloud platforms, fog middleware, and distributed data management engines, and will extend the open-source ecosystem by pushing intelligence to the network edge** while also **ensuring security and privacy primitives** across the device-fog-cloud-application stack. To evaluate its wide applicability, RAINBOW will be demonstrated in various real world and demanding scenarios, such **as automated manufacturing (Industry 4.0) connected vehicles and critical infrastructure surveillance with drones**. These application areas are safety-critical and demanding; requiring guaranteed extra-functional properties, including real-time responsiveness, availability, data freshness, efficient data protection and management, energy-efficiency and industry-specific security standards.

Expected activities on "Dissemination and Impact on Standards":

Released Deliverable D7.4 about standardization activities:

The goal of the RAINBOW standardization activities is to influence fog computing architectures of future applications and allow them to benefit from the outcomes of RAINBOW. There are multiple ways to achieve this goal. One option is to influence relevant standards, such as OASIS TOSCA or Trusted Computing Group TPM, while another option is to contribute to software platforms that will likely be used as a base for creating a large number of fog applications in the future, making them similar to a de facto industry standard. For RAINBOW, we are pursuing both options.

We have chosen to target the following groups as part of the RAINBOW standardization activities:

- Open Horizon software platform for managing containerized workloads on the network edge (see Section 3). Originally started by IBM, Open Horizon is now part of the Linux Foundation Edge and has the potential for widespread adoption in edge/fog applications.

- Trusted Computing Group (TCG), which is the consortium responsible for the TPM standard (see Section 4).

1.1.3 5G!Drones: Unmanned Aerial Vehicle Vertical Applications' Trials Leveraging Advanced 5G Facilities

URL/Reference:

https://5gdrones.eu/

https://cordis.europa.eu/project/id/857031

Abstract:

5G network infrastructures are key in the digitalization of economy and society, impacting several sectors. Deploying 5G for vertical markets in Europe has put pressure on network resources and posed challenges. The 5G!Drones project will run trials on several unmanned aerial vehicles (UAVs) to prove that 5G infrastructure can support the simultaneous running of three types of UAV services, using network slicing. Running independently and simultaneously, each UAV application will not interfere with the performance of other applications. The UAV association will then be able to use the 5G!Drones results to improve 5G services.

Starting and (target) end time of project:

1.06.2019-30.11.2022

IoT and/or Edge Computing research challenges:

5G!Drones aim is **to trial several UAV use-cases** covering eMBB, URLLC, and mMTC **5G services**, and to validate 5G KPIs for supporting such challenging use-cases. The project drives the UAV verticals and 5G networks to a win-win position, on one hand, by showing that **5G is able to guarantee UAV vertical KPIs**, and on the other hand, by demonstrating that 5G can support challenging use-cases that put pressure on network resources, such as low-latency and reliable communication, massive number of connections and high bandwidth requirements, simultaneously. 5G!Drones builds on top of the 5G facilities provided by the ICT-17 projects and a number of support sites, while identifying and developing the missing components to trial UAV use-cases. The project features Network Slicing as the key component to simultaneously run the three types of UAV services on the same 5G infrastructure (including the RAN, back/fronthaul, Core), demonstrating that each UAV application runs independently and does not affect the performance of other UAV applications, while covering different 5G services. **While considering verticals** will be the main users of 5G!Drones, the project builds a software layer to automate the run of trials that exposes a **high level API** to request the execution of a trial **according to the scenario defined by the vertical**, while enforcing the trial's scenario using the API exposed by the 5G facility, as well as the 5G!Drones enablers API deployed at the facility. Thus, 5G!Drones will **enable abstracting all the low-level details to run the trials for a vertical** and aims at validating 5G KPIs to support several UAV use-cases via trials using a 5G shared infrastructure, showing that 5G supports the performance requirements of UAVs with several simultaneous UAV applications with different characteristics (eMBB, uRLLC and mMTC). Using the obtained results, **5G!Drones will allow the UAV association to make recommendations** for further improvements on 5G.

Expected activities on "Dissemination and Impact on Standards":

Released first version of D5.3 Report on contribution to standardization and international fora.

5G!Drones consortium has established a complete landscape of the standards Development Organization (SDOs) as well as various associations relevant within 5G!Drones frameworks, including 3GPP, GSMA, GUTMA, ACJA, IEEE, CEPT/ECC, ASTM, ETSI, IETF, BNAE, Drone REGIM, 5G-PPP (Pre standardization working group), FAA, SESAR JU, NASA, EUROCAE, EASA, ASD-STAN, ISO, LAANC, ARC.

They will continue monitoring and engaging in standardization activities related to 5G!Drones project. They are committed to explore potential contributions to SDOs as the project progresses until its completion in November 2022.

1.1.4 WorkinAge: "Smart Working environments for all Ages

URL/Reference:

https://www.workingage.eu/

https://cordis.europa.eu/project/id/826232

Abstract:

WorkingAge seeks to improve the well-being of people over 45 years, focusing on office, manufacturing and teleworking workplaces. It also considers the workers' daily activities outside work. The European workforce is aging. Older workers have specific conditions that need a specific response to maintain/improve their well-being, supporting motivation to stay working at higher age and enable better productivity. The WorkingAge team has developed the WAOW tool, which aims at improving the health and well-being of older workers at work and leisure time by supervising their working conditions and providing different types of advice through personalized technologies and friendly & intelligent human interfaces. The tool covers mental, physical, social aspects and the workers environment.

Starting and (target) end time of project:

1.02.2019-31.07.2022

IoT and/or Edge Computing research challenges:

WorkingAge used innovative **HCI methods** (augmented reality, virtual reality, gesture/voice recognition and eye tracking) **to measure the user emotional/cognitive/health state and create communication paths**. At the same time with the use of **IoT, sensors** will be able **to detect environmental conditions**. The purpose is to promote healthy habits of users in their **working environment and daily living activities** in order to improve their working and living conditions.

By studying the profile of the >50 (Year old) workers and the working place requirements in three different working environments (Office, Driving and Manufacturing), both profiles (user and environment) will be considered. The obtained Information will be used for the creation of interventions that can lead to healthy aging inside and outside the working environment.

WorkingAge provides an **integrated solution that learns the user's behaviour, health data and preferences,** and through continuing data collection and analysis **interacts naturally with the user**. This innovative system provides workers with assistance in their everyday routine in the form of reminders, risks avoidance and recommendations. In this way, the WorkingAge project has created a sustainable and scalable product that will ease the users' life by attenuating the impact of aging in their daily activities, work conditions, health and general well-being.

Expected activities on "Dissemination and Impact on Standards":

Released Deliverable D10.4 about standards use and a gap in standardization:

Given the standards utilized in the development of the WAOW tool technologies, the pathway for obtaining CE marking for the tool is broadly outlined as a rough guideline in case commercial exploitation of the WAOW solution is pursued. Through this process, any gaps in the present standardization landscape can be better identified.

In reviewing the relevant standards, a gap exists for tools such as the WAOW tool that live in the space between purely medical and purely ICT solutions. Tools such as digital health assistants, could benefit from some level of standardization, which could enable market competition and ensure the interoperability of devices, products and services with similar scope. We believe that there is **a gap in the standardization landscape relating to non-medical devices intended for improving the well-being of humans**.

1.1.5 IoTwins: Big Data Platform for Optimized and Replicable Industrial and Facility Management Models

URL/Reference:

https://www.iotwins.eu/

https://cordis.europa.eu/project/id/857191

Abstract:

While the concept of digital twins has been around for some time, the Internet of Things managed to enable its cost-effective implementation. Digital twins refer to a virtual representation of a physical product or process. The EU-funded IoTwins project plans to build testbeds for digital twins in the manufacturing and facility management sectors. The digital models will integrate data from various sources such as data APIs, historical data, embedded sensors and open data. This will give manufacturers an unprecedented view into how their products perform. In facility management, the technology will be instrumental in improving the way buildings and their systems operate and in preventing prospective problems.

Starting and (target) end time of project:

1.09.2019-31.08.2022

IoT and/or Edge Computing research challenges:

The IOTWINS project delivered large-scale industrial test-beds leveraging and combining data related to the manufacturing and facility management optimization domains, coming from diverse sources, such as data APIs, historical data, embedded sensors, and Open Data sources.

The goal was **to build a reference architecture** for the development and deployment of **distributed and edge-enabled digital twins of production plants and processes**. Digital Twins collect data from manufacturing, maintenance, operations, facilities and operating environments, and use them to create a model of each specific asset, system, or process.

These models are then used to detect and diagnose anomalies, to determine an optimal set of actions that maximize key performance metrics.

IOTWINS proposes **a hierarchical organization of digital twins** modelling **manufacturing production plants and facility management deployment environments** at increasing accuracy levels:

- IoT twins: featuring lightweight models of specific components **performing big-data stream processing and local control for quality management** operations (low latency and high reliability);
- Edge twins: deployed at plant gateways and/or at emerging Multi-access Edge Computing nodes, providing higher level control knobs and **orchestrating IoT sensors** and actuators in a production locality, thus fostering local optimizations and interoperability;
- Cloud twins: performing **time-consuming and typically off-line** parallel simulation and deep-learning, feeding the edge twin with pre-elaborated predictive models to be efficiently executed in the premises of the production plant for monitoring/control/tuning purposes

Expected activities on "Dissemination and Impact on Standards":

No standardization outcomes in the public deliverables of the project.

1.1.6 ACTIVAGE: ACTivating InnoVative IoT smart living environments for AGEing well

URL/Reference:

http://www.activageproject.eu/

Abstract (IoT project): Horizon 2020 (IA) ACTIVAGE is building the first European interoperable and open IoT ecosystem enabling the deployment, at large scale, of a wide range of Active & Healthy Ageing IoT based solutions and services. To achieve this, ACTIVAGE is integrating thousands of devices to collect and analyse older adults' environmental and lifestyle information, identify their needs, and provide customized solutions, ensuring users' data privacy and security.

Starting and (target) end time of project:

01.01.2017 – 30.09.2020

IoT and/or Edge Computing research challenges:

Objectives:

- To deliver the ACTIVAGE IoT Ecosystem Suite (AIOTES), a set of techniques, tools and methodologies **for interoperability at different layers between heterogeneous existing IoT Platforms** and an Open Framework for providing **Semantic Interoperability of IoT Platforms for AHA**, addressing trustworthiness, privacy, data protection and security.
- To set a common Reference Evaluation Framework implementing the GLOCAL approach able to complement Global and LOCAL reference features and requirements. The evaluation framework will allow the assessment of interoperable IoT-enabled Active & Healthy Ageing solutions enhancing and scaling up current existing services on every Deployment Site, **for the promotion of independent living, the mitigation of frailty, preservation of quality of life and autonomy of older adults in smart living environments.** The objective is to create significant evidence and value of the benefit produced on all these aspects, **for the sustainability of the H&SCS, and for validating new business, financial and organizational models for care delivery**, both in a local/national and European scope.
- To provide a co-creation framework that enables the **identification, measurement, understanding and prediction of the demands and needs of IoT ecosystem on AHA users**: older adults, caregivers, health and social care professionals and providers, assessing their needs, preferences and perceptions regarding user acceptance, trust, confidentiality, privacy, data protection and safety. The goal of this objective is to raise and identify some unknown key success factors related also to deployment and scaling up activities.

Focused on:

- Business System Integration
- Visualization
- Development Environment
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics

- Storage/Database
- Device Management
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Operating System
- Modules & Driver
- MPU / MCU

Expected activities on "Dissemination and Impact on Standards":

- **Technologies & Standards Used**: OSGI, IETF, W3C, Bluetooth, OASIS, WiFi, OMA, Zigbee, OCF, Docker, W3C/OWL, SAREF, SSN, ETSI ISG CIM
- **Open Source Software Use**d: FIWARE, OpenIoT, SENSINACT, IoTIVITY, UniversAAL, NodeRed, INTER-IoT, IoT, Eclipse, OneM2M
- **Dissemination on Standards** (Not much information could be found from public sites):
- IoT technology: innovation in interoperability, security and standardization. AIOTES designed and versioning strategy, in terms of progressive delivery of architectural elements and security and privacy components, developers and deployment tools, aligned with the development and deployment roadmap to support interoperability between DS and with Open Callers, aligned with the exploitation plan and consolidated as a key "Project Asset". Evaluation activities are confirming and will demonstrate the potential and timely need of AIOTES in the IoT-AHA market.
- The evaluation framework is composed of standard methods and instruments that allow to gather and measure the results of the evaluation activities and share them with communities. The protocol and the GLOCAL approach both represent a clear innovation.

Contributions on use cases and requirements have been provided to AIOTI.

1.1.7 AUTOPILOT: AUTOmated driving Progressed by Internet Of Things

URL/Reference:

www.autopilot-project.eu

Abstract (IoT project):

EC Horizon 2020 (IA) AUTOPILOT will develop an IoT connected vehicle platform and IoT architecture based on the existing and forthcoming standards, as well as open source and vendor solutions. The IoT ecosystem will accommodate vehicles, road infrastructure and connected IoT objects, with particular attention to safety critical aspects of automated driving.

Starting and (target) end time of project:

01.01.2017 – 29.02.2020

IoT and/or Edge Computing research challenges:

- **Objectives/challenges/results**
    - The developments include techniques for the identification and **discovery of internet connected devices and non-connected physical things, technologies for modelling data and services, IoT software engineering tools, schemes for safeguarding security/privacy, as well as infrastructures for deploying and operating IoT services within cloud computing infrastructures**.
    - Automated vehicles today rely largely on on-board sensors (LiDAR, radar, cameras, etc.) to detect the environment and make reliable decisions. However, the possibility of **interconnecting surrounding sensors (cameras, traffic light radars, road sensors) to reliably exchange complementary data could lead to new and improved ways of designing automated vehicle systems with reduced implementation costs**.
    - Connected cars and overall ITS solutions need to become horizontally integrated with IoT platforms/systems in order to benefit from self-configuration, device discovery, IoT-based services, data filtering, brokering and shared semantic world models of their environment. These communities, however, currently face some difficulties when it comes to taking advantage of IoT technologies. This is mostly due to the **lack of open standardized and easy-to-use APIs for accessing IoT technologies, but also due to the lack of essential interoperability between ITS systems and IoT platforms**.

Focused on:

- Visualization
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics
- Storage/Database
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Operating System
- Modules & Driver

Expected activities on "Dissemination and Impact on Standards":

Technologies & Standards Used: Python, QT, C++, MQTT, HTTP REST, JSON,

OneM2M, 4G, NoSQL, 3GPP LTE, NB-IoT, LTE-V2X, PexSi platform

Open Source Software Used: Mosquitto, OCEAN

Dissemination on Standards:

- Working on the needs to implement interoperable vehicle and cloud IoT platforms, together with heterogenic IoT sensor devices, triggered the success of defining a common data model. This common data model development has been carried out jointly with the SENSORIS platform, responsible to provide standards for the vehicle to cloud data.
- AUTOPILOT Platooning and Automated Valet Parking use cases are used as references in the ETSI Technical Report TR 103 508 (https://www.etsi.org/deliver/etsi_tr/103500_103599/103508/01.01.01_60/tr_103508v010101p.pdf) "SAREF extension investigation: Requirements for Automotive" (note: SAREF: Smart Appliances REFerence ontology). SAREF is an essential standardisation work to ensure intra-domain and x-domain interoperability.
- Relevant standardisation contributions have also been presented to OneM2M on the AUTOPILOT use cases, requirements and Interworking Proxy Entity.
- AUTOPILOT Open Data will help standardisation organisation and researchers to define common data model for the automotive domain. In the context of the evaluation, the FESTA methodology has been enhanced for including the IoT data.
- AUTOPILOT contributed as well to AIOTI on use cases, requirements and SAREF data models

1.1.8 IoF2020: Internet of Food and Farm 2020

URL/Reference:

https://www.iof2020.eu/

Abstract (IoT project):

EC Horizon 2020 (IA) IoF2020 is dedicated to accelerating the uptake of IoT technologies in the European farming and food chains and ultimately strengthening their competitiveness and sustainability. How? By demonstrating, together with end-users, the use of IoT in 19 use-cases spread throughout Europe, and focusing on 5 areas: dairy, meat, arable crops, fruits and vegetables.

Starting and (target) end time of project:

01.01.2017 – 31.03.2021

IoT and/or Edge Computing research challenges:

Objectives/challenges/results

- A smart web of sensors, actuators, cameras, robots, drones and other connected devices **allows for an unprecedented level of control and automated decision-mak**ing. The project Internet of Food & Farm 2020 (IoF2020) has explored the potential of IoT-technologies for the European food and farming industry.
- The goal was ambitious: to make precision farming a reality and to take a vital step towards **a more sustainable food value chain**. With the help of IoT technologies higher yields and **better-quality produce are within reach**. **Pesticide and fertilizer use will drop and overall efficiency is optimized**. IoT technologies also **enable better traceability of food, leading to increased food safety**.

- Therefore a **reference architecture with minimum interoperability mechanisms was defined based on common IoT architectures, standards and data models but extended and adapted for farming and food**. Each use case was an autonomous implementation of this architecture ensuring maximum interoperability between and re-use of components.

Focused on:

- Business System Integration
- Visualization
- Development Environment
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics
- Storage/Database
- Device Management
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Operating System
- Modules & Driver
- MPU / MCU

Expected activities on "Dissemination and Impact on Standards":

Technologies & Standards Used: LoRa Network, 365 Farmnet, Zoner, Crop-R and Akkerrweb platforms, Cloudfarm FMIS, Arvalis platform, ThingWorx IoT platforms, UNB technology, SigFox, oData, FiWare Analytics, infrared IoT sensors, collar-based cloud-based analytics, GPRS/4G and long RF communication, SensiNact IoT Platform, wireless sensor networks

(HSPDA, UMTS, GPRS, GSM), ZIgbee technology, LinkSmart, Bluetooth 4.0

SmartBands, Google Fit LiveLog

Open Source Software Used: FIWARE, FIspace, CRYSTAL, SOFIA, EPCIS, Fosstrack, AgroSense, Apache Cassandra, Apache Flink, Apache Spark

Dissemination on Standards (Not much information could be found from public sites):

- Most of results are taken up by succeeding projects (e.g. Atlas, Demeter) and are further exploited through the FIWARE community.
- Contributions to standards were made and adopted by the designated organizations such as AEF, AgGateway, GS1).
- Each use case implementation is described in the IoT catalogue (https://www.iot-catalogue.com/)
- IoF2020 contributed as well to AIOTI on use cases and requirements

1.1.9 MONICA: Management of Networked IoT Wearables – Very Large-Scale Demonstration of Cultural and Societal Applications

URL/Reference:

www.monica-project.eu

Abstract (IoT project):

MONICA is a large-scale demonstration of how cities can use existing and new IoT solutions to meet sound, noise and security challenges at big open-air cultural and sports events, which attract and affect many people. Innovations include the establishment of sound zones at outdoor concerts for noise mitigation as well as security measures improving crowd information and management.

Starting and (target) end time of project:

01.01.2017 – 31.03.2021

IoT and/or Edge Computing research challenges:

Objectives/challenges/results

- The innovations in MONICA comprise six main solutions: Sound Level Monitoring, Adaptive Sound Field Control, Crowd and Capacity Monitoring, Crowd Management and Communication, Visitor Experience and Collective Awareness Platform. The strength of MONICA lies in the comprehensiveness of the solutions in terms of features and integration capabilities, being combined and customised according to the actual needs and being founded on the ecosystems which consider technical, financial, regulatory and human aspects to ensure a wider uptake and acceptance of IoT.

Focused on:

- Business System Integration
- Visualization
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics
- Storage/Database
- Device Management
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Modules & Driver

Expected activities on "Dissemination and Impact on Standards":

- **Technologies & Standards Used**: ISO/IEC/IEEE 42010:2011, AIOTI HLA, Bluetooth BLE / DASH7 / WiFi – IEEE 802.11, UWB– IEEE 802.15.4a / ETSI EN 300 220-2 V3.1.1 subGHz wristbands, ETSI EN 302 065-2 V2.1.1 for UWB wristbands, 3GPP NB-IoT /LoRA; IEEE LR-WPAN / IETF 6LoWPAN / IETF ROLL / IETF CoAP; OASIS MQTT; ETSI SAREF, W3C SSN; IETF, Oauth / OASIS XACML; oneM2M Network Service Capability Layer / GW; OGC SensorThings AP
- **Open Source Software Used**: LinkSmart, RioT, SCRAL
- **Dissemination on Standards**:
    - An important element of the MONICA project has been to assess/identify if the European suite of Radio Frequency (RF) IoT standards was missing some elements, which might improve the performance and value of the MONICA results demonstrated. With regards to sound, a requirement was identified for a new standard/update of existing IoT standard that provides guaranteed low latency and time jitter for RF connected end-to-end communication. In relation to MONICA, this could ensure a more dependable end-to-end latency for synchronized data interlinking of the many sensors applied with the digital MONICA sound field calculations.
    - Followingly, liaison activities with the ETSI technical group on Short Range Devices (TG28) have taking place and continue to take place after the project ends. The finding was included in the comprehensive study 'High Priority IoT Standardisation Gaps and Relevant SDOs' 9 released in January 2020 by AIOTI – Alliance for Internet of Things Innovation, Working Group 3 on IoT Standardisation

1.1.10 SynchroniCity: Delivering an IoT-enabled Digital Single Market for Europe and Beyond

URL/Reference:

www.synchronicity-iot.eu

Abstract (IoT project):

The SynchroniCity consortium brings together 39 partners with worldwide outreach. The project represents the first attempt to deliver a digital single market for IoT-enabled urban services in Europe and beyond - in 8 European cities and more worldwide - connecting 39 partners from 13 countries over 3 continents.

Starting and (target) end time of project:

01.01.2017 – 31.12.2019

IoT and/or Edge Computing research challenges:

Objectives/challenges/results

SynchroniCity has shown how the Minimal Interoperability Mechanisms (MIMs) introduced by the Open & Agile Smart Cities network (OASC) can help unfreeze this market, based on a minimal but sufficient common technical ground for sharing data to deliver AI- and IoT-enabled services based on trust. Such services are essential for Europe to deliver a sustainable, prosperous and inclusive future for its citizens.

Focused on:

- Business System Integration
- Visualization
- Development Environment
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics
- Storage/Database
- Device Management
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Operating System
- Modules & Driver
- MPU / MCU

Expected activities on "Dissemination and Impact on Standards":

Technologies & Standards Used: OASC, FIWARE, NGSI, DCAT AP, OAuth 2.0 and XACLM, OneM2M, CoAP

Open Source Software Used: Orion Context Broker, Biz Ecosystem, CKAN, Backend Device Management – IDAS

- **Dissemination on Standards**:
    - Synchronicity led the MIM activities in Smart City domain
    - A Guide to SynchroniCity is available, and it shows, in practical terms, how to use the OASC MIMs to provision digital services for cities and communities: https://oascities.org/a-universal-guide-to-make-your-city-fit-for-the-digital-transformation/
    - The MIMs, as introduced in the attached "Guide to SynchroniCity", are simple, transparent mechanisms that form the foundation for sustainable, scalable and efficient deployment of AI- and IoT-enabled digital services. They are vendor-neutral and technology-agnostic, and they can be integrated with existing systems. Currently, there are three validated MIMs: Context Information Management, Common Data Models, Marketplace, and two underway as work items: Fair AI and Personal Data Management. As more cities and companies adopt them, the market grows and economies of scale reduce costs for buyers and developers. This breaks down barriers to procurement, also for smaller companies, and allows cities and communities to identify and tackle problems quickly and sustainably, to the benefit for their citizens.
    - The EU-wide recently announced "Join, Boost, Sustain" political declaration for scaling digital solutions in Europe (http://living-in.eu) has adopted the work from SynchroniCity as the basis. It is an initiative of EUROCITIS, OASC and ENoLL, together with the European Commission (CNECT, REGIO, GROW, DIGIT a.o.) and the European Committee of the Regions.
    - OASC was recognized by TM Forum, a global association of telecom providers as the most influential body in this space, especially for the work carried out in SynchroniCity, and the standards input to the European and global standards organisations
    - OASC was invited, on the basis of the SynchroniCity project, to join the G20 2019 Summit session in Osaka Japan on smart cities to present the work, which led to substantial impact in Japan and globally, and many other initiatives.
    - In total, SynchroniCity has shown a pathway to harnessing global dynamics to address local needs, heralding a potential new era of services similar to the mobile revolution brought about by simple, European standards.

1.1.11 U4IoT: User Engagement for Large Scale Pilots in the Internet of Things

URL/Reference:

https://cordis.europa.eu/project/id/732078

Abstract (IoT project):

End-user and societal acceptance is critical to the success of the IoT large-scale pilots. U4IoT combines complementary RRI-SSH expertise encompassing social and economic sciences, communication, crowdsourcing, living labs, co-creative workshops, meetups, and personal data protection to actively engage end-users and citizens in the large scale pilots.

Starting and (target) end time of project:

01.01.2017 – 31.12.2019

IoT and/or Edge Computing research challenges:

Objectives/challenges/results

- Develop toolkit for LSPs end-user engagement and adoption, including online resources, privacy-compliant crowdsourcing tools, guidelines and an innovative privacy game for personal data protection risk assessment and awareness, online training modules.
- Direct Support to mobilize end-user engagement with co-creative workshops and meetups, trainings, Living Labs support, and an online pool of experts to address LSPs specific questions.
- Analyse societal, ethical and ecological issues and adoption barriers related to the pilots with end-users and make recommendations for tackling IoT adoption barriers, including educational needs and sustainability models for LSPs and future IoT pilots' deployment in Europe.
- Support communication, knowledge sharing and dissemination with an online portal and interactive knowledge base gathering the lessons learned, FAQ, tools, solutions and end-user feedbacks.
- The U4IoT platform will support IoT take-up in Europe by better aligning it with end-user and societal expectations, mutualizing information and learning experiences, and improving communication with the public, -enabling Europe to take the lead in IoT user (and market) adoption. U4IoT will work in close cooperation with the other CSA, AIOTI and the IoT Forum who will maintain the platform after the end of the project to continue serving the European IoT community.

Focused on:

- Visualization
- Development Environment
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics
- Storage/Database
- Device Management
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Operating System
- Modules & Driver
- MPU / MCU

Expected activities on "Dissemination and Impact on Standards":

Regarding "Dissemination and Impact on Standards", not much information has been found in public sites, some abstract information is provided below:

- created a "one-stop shop" for end-user engagement with freely accessible tools, handbooks, and e-courses
- taken an integrated approach on ready to use support tools for ongoing and near-future IoT projects
- produced a broad range of tools ranging from privacy, end-user engagement in real life situations, sustainability, and adoptions
- made impact on all levels with needs earlier being unknown now made aware and moved higher on our target groups' agendas

1.1.12 CREATE-IoT: CRoss fErtilisation through AlignmenT, synchronisation and Exchanges for IoT

URL/Reference:

www.create-iot.eu

Abstract (IoT project):

CREATE-IoT's aim is to stimulate collaboration between IoT initiatives, foster the take up of IoT in Europe and support the development and growth of IoT ecosystems based on open technologies and platforms. This requires synchronisation and alignment on strategic and operational terms through frequent, multi-directional exchanges between the various activities under the IoT Focus Areas. Create-IoT provided the synchronization in different topics among the projects: ACTIVAGE, AUTOPILOT, IoF2020, MONICA, SynchroniCity.

Starting and (target) end time of project:

01.01.2017 – 30.06.2020

IoT and/or Edge Computing research challenges:

Objectives/challenges/results

- Launch a common internet-based forum in which LSPs and other IoT stakeholders can access information and participate in ongoing activities, in areas as diverse as the debate on privacy, common standards and protocols or cascade funding.
- Map the pilot architecture approaches, as well as the ecosystem stakeholders, across all the FAs to identify areas of common interest in which coordination will be of particular benefit.
- Establish mechanisms for exchanging best practices, fast-track learning and sharing of lessons-learned on a technological and business level.
- Encourage and co-ordinate activities that stimulate innovation, creativity and adoption including the combination of ICT and Arts as well as user-centric and bottom-up methodologies.
- Enhance the provision of SMEs (including start-ups and other early-stage organisations) and developer access to the LSPs, through to the sharing of cascade funding and the support to the development of Software Development Kits (SDKs) and similar initiatives.
- Define common Key Performance Indicators (KPIs) across the LSP's that can be used to measure design, testing and validation taking into account the possibility of an iterative, rather than lineal, development and deployment process.
- Gather insights that can contribute to pre-normative activities and future policy development in the context of the Digital Agenda and promoting European IoT thought leadership.

Focused on:

- Visualization
- Service Orchestration
- Advanced Analytics
- Event & Action Management
- Basic Analytics
- Storage/Database
- Edge Analytics
- Connectivity Network / Modules
- Edge Gateway (HW based)
- Operating System
- Modules & Driver

Expected activities on "Dissemination and Impact on Standards":

See the input provided by the projects: ACTIVAGE, AUTOPILOT, IoF2020, MONICA, SynchroniCity. Moreover, see the below table that shows the perceived criticality of standard gaps per LSP (ACTivage, AUTOpilot, IoF2020, MONica, SYNChronicity)

Nature of the gap	ACT	AUTO	IoF	MON	SYNC
Competing communications and networking technologies	Low	Medium	High	Medium	Medium
Easy standard translation mechanisms for data interoperability	Medium	Medium	Medium	Low	Medium
Standards to interpret the sensor data in an identical manner across heterogeneous platforms	Medium	High	Medium	High	High
APIs to support application portability among devices/terminals	Medium	Low	Medium	Medium	Medium
Fragmentation due to competitive platforms	High	Low	Medium	N/A	Medium
Tools to enable ease of installation, configuration, maintenance, operation of devices, technologies, and platforms	Medium	Medium	Low	High	High
Easy accessibility and usage to a large non-technical public	Medium		Low	High	High
Standardized methods to distribute software components to devices across a network	Medium	Low	Medium	Low	Medium
Unified model/tools for deployment and management of large-scale distributed networks of devices	Medium		Medium	Medium	Medium
Global reference for unique and secured naming mechanisms	Medium		Low	Low	Medium
Multiplicity of IoT HLAs, platforms and discovery mechanisms	High	Low	Medium	Medium	High
Certification mechanisms defining “classes of devices”	High		Low	N/A	Medium
Data rights management (ownership, storage, sharing, selling, etc.)	High	Medium	High	Medium	Medium
Risk Management Framework and Methodology	Medium	Medium	Medium	Medium	High

Table 1: Table copied from: taken from: H2020 – CREATE-IoT Project Deliverable 06.01, "Strategy and coordination plan for IoT interoperability and standard approaches", Rev. 1.0, 14-07-2017

1.1.13 Productive4.0 – Ambitious Project with a Unique Main Objective

URL/Reference:

https://productive40.eu/

https://cordis.europa.eu/project/id/737459/de

Abstract:

Productive4.0 is an ambitious holistic innovation project, meant to open the doors to the potentials of Digital Industry and to maintain a leadership position of the industries in Europe. All partners involved worked on creating the capability to efficiently design and integrate hardware and software of Internet of Things (IoT) devices. Linking the real with the digital world takes more than just adding software to the hardware.

What makes the project unique is the holistic system approach of consistently focusing on the three main pillars: digital automation, supply chain networks and product lifecycle management, all of which interact and influence each other.

This is part of the new concept of introducing seamless automation and network solutions as well as enhancing the transparency of data, their consistence and overall efficiency. Productive4.0 aims at hands-on solutions for the European digital industry:

- Productive4.0 tackles technological and conceptual approaches in the field of Industry 4.0. The term comprises IIoT (Industrial Internet of Things), CPS (Cyber Physical Systems) and Automation.
- The innovation project takes a step further towards hands-on solutions. In the process, practical reference implementations such as 3D printer farms, customized production or self-learning robot systems will benefit in fields like service-oriented architecture (SOA), IoT components & infrastructures, process virtualization or standardization.

Starting and (target) end time of project:

01.05.2017 – 31.10.2020

IoT and/or Edge Computing research challenges:

IoT and Edge-Computing were considered in the holistic context of a digital industry ecosystem and the whole supply chain, with 4 OEM use cases:

- Integration of vehicle individualization in a highly automated assembling process in the Automotive Industry
- Flying robots
- Industrial IoT
- Tracking, sensing and actuating services

and in 5 Tier-1 Use cases:

- Smart services for test equipment
- Simultaneous Cost Engineering for powertrain architectures
- Smart Services for Trusted Manufacturing Site
- Smart failure analysis lab

and furthermore, 16 Tier-2 Use cases and 8 Use cases along the supply chain, many of them related to/applying IoT or Digital Twin concepts.

One work package was particularly dedicated to "Innovative IoT-enabling Components (HW / SW)", with three major tasks:

- IoT enabling hardware for Digital Industry
- IoT enabling software for Digital Industry
- Integration and modelling of IIoT enabling components

Provide information about the expected activities on "Dissemination and Impact on Standards":

Some key achievements of the project with respect to IoT from the product use cases were:

- New automation industries adopting and implementing industrial IoT technologies
- Demonstration of the specific technological and conceptual approaches in filed like service-oriented architecture (SOA), IOT components & infrastructures, digital twin application or process virtualization.

Standardization activities had to cover the full spectrum of functional safety, cybersecurity, IoT and IIoT, Digital Twin, Industrial data, Digital Factory, Smart manufacturing (just evolving at this time in IEC TC65 standardization), and as further innovations the "Digital Reference Ontology" and SysML V2 contributions. Partners became aware of ISO/IEC JTC1 SC41 and SC42 standards as well as of AIOTI and ETSI activities (was reported in the (public) standardization deliverables), and Digital Twin standardization in ISO and ISO/IEC JTC1. Some joined these groups on national and international level and contributed to the evolving standards under development. As result and follow-up of Productive4.0 work, the ISO/IEC contributions on IoT, Digital Twin and Edge standards (including evolving New Work Items) were e.g., reported as AIT-contribution in the AIOTI publication "High Priority Edge Computing Standardisation Gaps and Relevant SDOs".

Acknowledgement:

The project received grants from the European H2020 Research and Innovation Programme, ECSEL Joint Undertaking, and National Funding Authorities from 19 involved countries under grant agreement no. GAP-737459 - 999978918. The participating countries have been Austria, Belgium, Finland, France, Czech Republic, Denmark, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Sweden and Turkey.

1.1.14 Visualization of the IoT EU funded completed projects landscape

This section provides a landscape visualization of the completed IoT projects funded by the EU, which are introduced in this report.

Figure 1 shows the "IoT EU funded completed projects landscape (Technology and Marketing Dimensions)", where these completed projects are projected in two dimensions. The horizontal axis represents the market type, while the vertical axis represents the technology/solution/knowledge area that these completed projects cover and focus. Notably, the extremity of the left-hand side of the horizontal axis represents the customer (i.e., Business to Customer: B2C) market. The part at the extremity of the right side of this axis, on the other hand, represents the industrial internet (i.e., Business to Business: B2B) market. Also, it should be noted that the top part of the vertical axis represents the technology areas that are related to services and applications, while the bottom part of the same axis represents the technology areas that are related to connectivity.

The projection of these completed projects on these two dimensions has been accomplished based on discussions among experts participating in both AIOTI WG Standardisation and relevant completed project participants.

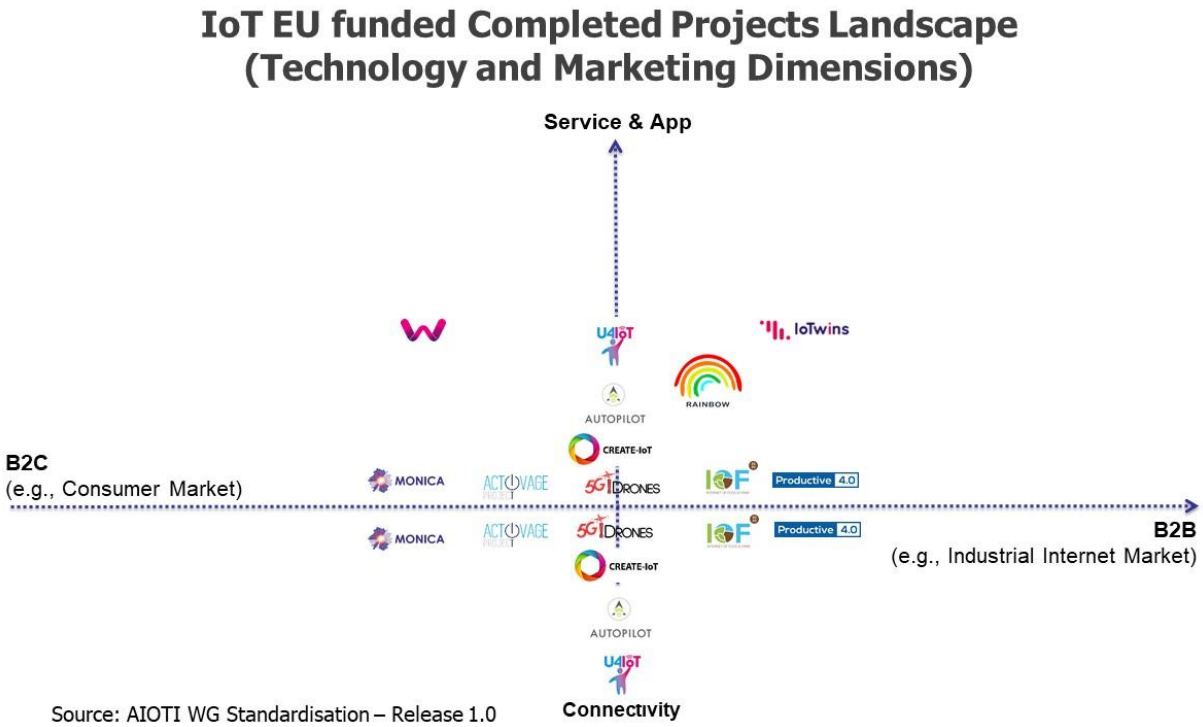


Figure 1: IoT EU funded completed projects landscape, when Technology and Marketing Dimensions are used

In addition to the IoT EU funded completed projects landscape shown in Figure 1 a projection of these completed projects into vertical industry domains is shown in Figure 2. The " IoT EU funded Completed Projects Landscape (Vertical and Horizontal Domains)" is a graphical representation aiming at highlighting the main activities (up to the day of generating this representation) of the completed projects with respect to the industrial domains/sectors represented as "verticals" and Telecommunication Infrastructure domain represented as "Horizontal/Telecommunication".

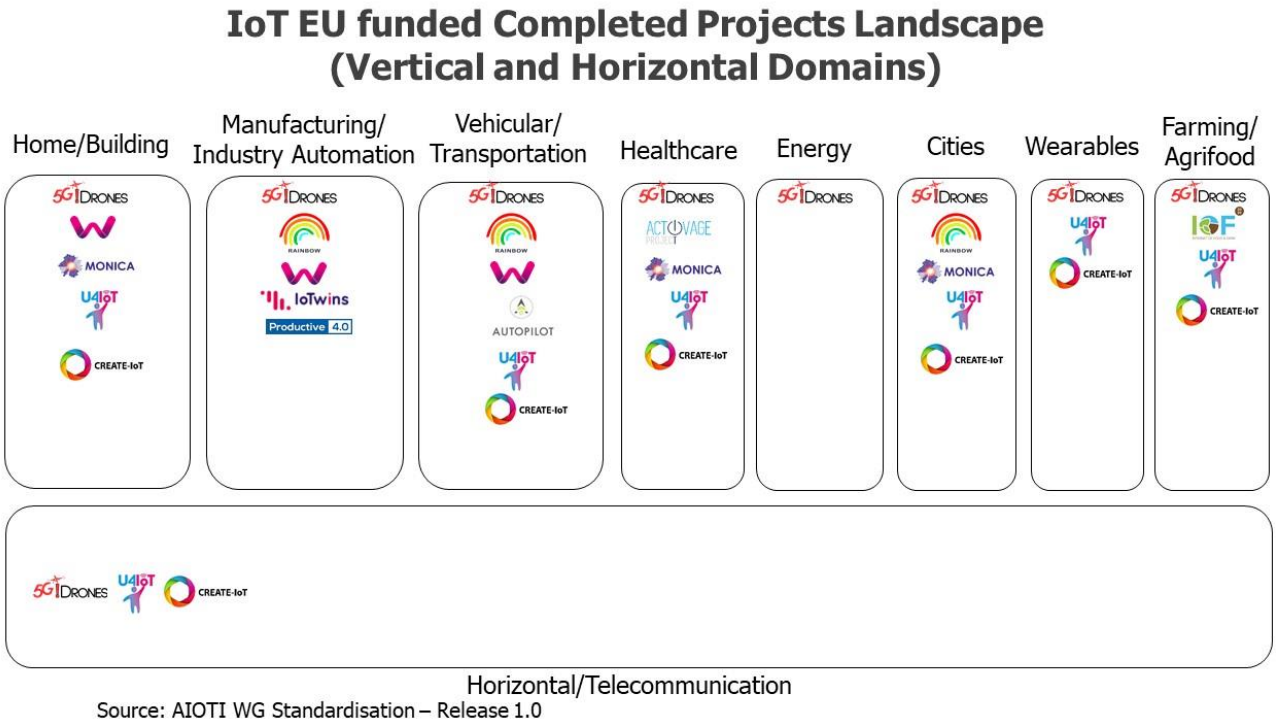


Figure 2: IoT EU funded Completed Projects Projection on Vertical and Horizontal Domains

1.2 Ongoing Projects

This section provides a description of IoT projects funded by the EU that are still ongoing.

1.2.1 DataPorts: A Data Platform for the Cognitive Ports of the Future

URL/Reference:

The URL of the project generated by the European Commission is:

https://cordis.europa.eu/project/id/871493.

The project's official URL is https://dataports-project.eu/. The DataPorts website is the main diffusion medium that aggregates and exhibits the main information associated with the progress of the project (deliverables, papers, news, events…). This website is regularly enriched with new material to document and communicate all the different aspects of the project's results and outcomes.

Abstract:

DataPorts is a project funded by the European Commission as part of the H2020 Big Data Value PPP programme. DataPorts brings together knowledge, expertise and innovation potential of very experienced partners in the fields of Industrial Data Platforms, IoT and Data Acquisition, Data Analytics and AI applications, blockchain, smart contracts and data sharing and trading, data providers, data protection and security, and technology integration. The consortium consists of 13 partners from 4 EU member countries: Spain, Greece, France and Germany, and an associated state: Israel. More specifically, the consortium involves 2 SMEs and 3 large-industry partners.

The project focuses on the design and implementation of a data platform and its deployment in two relevant European seaports. This platform aims at connecting to the existing digital infrastructures in order to address specific local constraints.

The DataPorts Platform main goal is to connect to the different IoT systems and to the digital infrastructures currently existing in digital seaports, enabling the interconnection of a wide variety of systems into a tightly integrated ecosystem. In addition, it offers reliable data sharing and trading based on data owners' rules and offering a clear value proposition. Finally, it also strives to leverage the collected data and provide advanced Data Analytics services whereby the different actors in the port value chain could develop novel AI and cognitive applications.

Starting and (target) end time of project:

01.01.2020 – 31.12.2022.

IoT and/or Edge Computing research challenges:

The main challenge related with IoT is the provision of all the technical tools and components through the platform for the acquisition, aggregation, processing and analysis of the data coming from the different stakeholders, sources and existing platforms. This entails the following:

- Contribute with specific activities related to standards in the freight sector, and with standardisation organisations and alliances related to IoT, security, cloud and big data and blockchain.

- Define data models, mechanisms and enablers to provide semantic interoperability with data platforms, IoT devices, and other data sources, and develop the interoperability tools needed to facilitate generation of interfaces for sensing.

- Offer an IoT SDK Framework where data providers can feed their data into the data platform. For example, this data can be obtained from sensors, IoT platforms, IT systems (open or private), PCS controlled by the ports or Market Agents.

- Provide support to develop advanced services for cognitive ports, linking the platform with existing initiatives and results from areas like IoT, Big Data analytics or Artificial Intelligence.

- Validation in two relevant European seaports connecting to their existing digital infrastructures and addressing specific local constraints.

Finally, it is important to highlight a specific scenario focused on the use of IoT sensors integrated with the DataPorts Platfom. In that scenario regular containers will be fitted with permanent IoT devices, turning them into "Smart Containers". These "Smart Containers" are embedded with a set of sensors, enabling the measurement of real-time information such as identifying location, door opening and closing, vibrations, temperature, humidity, and any measured physical parameters of the surrounding environment of the containers. These IoT devices help stakeholders to gain valuable knowledge on the exact whereabouts and status of their container, enabling them to improve their logistics. By receiving a notification that the container has been unloaded from the ship, the user is enabled to proceed to dispatch a truck to pick it up at the optimal time. In addition, having Smart Container data may also decrease cargo loss, legal costs, insurance fees and investigation processes and damage to goods. At the same time, door-to-door visibility may result in increased cargo security; better service level, on-time deliveries since the processes flow better.

Expected activities on "Dissemination and Impact on Standards":

DataPorts is created as a global frame for new cognitive services that follow the IoT Reference Architecture (HLA) functional model described by the AIOTI-WG3 which is compliant with ITU-T Y.2060 IoT Reference Model, OneM2M reference architecture, IIC's Industrial Internet Reference Architecture (IIRA) and mainly RAMI 3.0.

There are some expected activities related to the dissemination and Impact on Standards:

- Data Modeling: The DataPorts Data Model integrates concepts from existing ontologies and data models, including the Fiware Smart Data Model, the UN/CEFACT data model, the SAREF ontology and the IDSA Information Model.

- UN CEFACT Transport & Logistics: DataPorts foresees that the smart container data is generated, monitored and managed by neutral service providers who commercialize the needed IoT devices and their related data transmission technologies. These service providers have control of the data and the access to them through the Dataports Platform.

- Smart Data Models: Contributing to the Smart Data Models initiative with the concepts defined in the common DataPorts data model. The aim is to participate in the periodical meetings and to collaborate actively in the subject related to Ports.

- CEF: Alignment with CEF (Connecting Europe Facility) Digital program:
    - Fiware Orion Context Broker as core element of the component.
    - ETSI NGSI-LD API for right-time digital twin data exchange:
    - Ongoing task: From NGSI V2 to NGSI-LD. Use of Orion-LD Broker.
    - Smart Data Models initiative for description of data models: From internal project repositories to contribute to the Smart Data Models initiative.
- DSBA: Participation in the Data Spaces Business Alliance future activities, which is an initiative promoted in the scope of the Fiware, Data Spaces, Gaia-X, and BDVA activities. This initiative promotes the collaboration between organisations and projects sharing their vision on how to materialise an open standard-based, open source available and CEF-compatible software infrastructure for creation of data spaces in Europe.

1.2.2 DEMETER: IoT-based Data Analysis to Improve Farming

URL/Reference:

www.h2020-demeter.eu

https://cordis.europa.eu/project/id/857202

DEMETER Pilot Projects

https://h2020-demeter.eu/dissemination-material/

Abstract:

DEMETER's goal is to lead the digital transformation of Europe's agri-food sector through the rapid adoption of advanced IoT technologies, data science and smart farming, ensuring its long-term viability and sustainability.

Our key objective is to empower farmers and farmer cooperatives to a) use their existing platforms and machinery to extract new knowledge to improve their decision making and b) ease the acquisition, evolution and updating of their platforms, machinery and sensors by focusing their investments where these are needed. In parallel, DEMETER aims to transform the technology ecosystem for agriculture by reinforcing and establishing agreed standards, an agreed common information model, an interoperability space combined with an online/physical networked ecosystem and a set of interoperability components which will make the use of IoT technology effective and easy. This is achieved by a combination of human and digital solutions including the DEMETER Stakeholders Open Collaboration Space (SOCS) which is an online platform dedicated to all stakeholders (farmers, advisors, and technology suppliers) where they can collaborate, share best practices and participate in the co-creation processes.

In DEMETER, twenty pilot projects are used to demonstrate and evaluate how innovations and extended capabilities benefit from the interoperability mechanisms employed. Equally, these pilots monitor the evolution of the maturity level in the stakeholders involved.

A plethora of heterogeneous data is collected across pilots, ranging from simple temperature measurements to audio and video streaming. Various communication technologies are used, including LoRaWAN and 4G. Some data is processed locally, on the edge, while the main processing is done in cloud.

Starting and (target) end time of project:

- Start Date: September 2019
- End Date: September 2023

IoT and/or Edge Computing research challenges:

- development of a common agricultural data model (AIM) reflecting various dominant standards and existing models
- semantic interoperability and heterogeneous data integration over IoT infrastructures
- data analytics and knowledge extraction over IoT originating data

- decision making and recommendations for farmers and agri advisors based on IoT infrastructures
- syntactic interoperability over enablers deployed over IoT
- security, privacy, trust and confidentiality over IoT
- controlled sharing of resources in the agrifood domain, including IoT resource sharing support
- processing of collected data on the edge (audio-video) to streamline and optimize the process.
- validation of edge networking/ML technologies and integration with the cloud services.

Expected activities on "Dissemination and Impact on Standards":

The DEMETER project is investigating architectures and techniques for minimal interoperability mechanisms together, including the AIM - Agricultural Information Model, with other agricultural domain projects, i.e. ATLAS and earlier IoF2020. Under the OpenDEI project umbrella, Open DEI further standardisation needs and opportunities are being elaborated also linked to StandICT, Home | StandICT.eu 2023. This harmonisation is also done in collaboration with the Open Geodata Consortium (OGC) and relationship to ISO standards evolution from ISO/TC211 on Geospatial services, ISO SC41 IoT and Digital Twin and ISO SC42 AI and Big Data.

1.2.3 IoTAC: Security By Design IoT Development and Certificate Framework with Front-end Access Control

URL/Reference:

https://iotac.eu/

https://cordis.europa.eu/project/id/952684

Abstract:

The IoTAC project aims to deliver a novel, secure and privacy-friendly IoT architecture that will facilitate the development and operation of more resilient IoT service environments through (i) monitoring and evaluation of applications security throughout the broader software development lifecycle; (ii) the introduction of an advanced access control mechanism based on new interactions and workflow using chip card and PKI technology; (iii) the runtime monitoring of the system as well as provisioning of security countermeasures that are implemented both at hardware- and at software-level and (iv) associated platforms which will provide security certification of the produced applications and system, based on international security standards, best practices and the research results of the project.

Starting and (target) end time of project:

01.09.2020 - 31.08.2023

IoT and/or Edge Computing research challenges:

- Advanced Security by Design concepts and implementations
- Quality Assurance and Trustworthiness of IoT Systems and Applications

Expected activities on "Dissemination and Impact on Standards":

1. IoTAC is active and contributed to ISO/IEC and ETSI in the following committees:
    - ISO/IEC JTC1/SC41 (Internet of Things and Digital Twins)
    - ETSI TC MTS (Methods for Testing and Specification)

Furthermore, one partner of the Project is member of Global Platform and its IoTopia task force, to disseminate the project's results within the organisation.

2. The project IoTAC provided comments to the IoT Reference Architecture that have been discussed and accepted in the SC41/WG3 DoC meetings.

Furthermore, project members of IoTAC initiated two new Working items at ETSI TC MTS on IoT Security module testing and IoT security architecture conformity and provided the project rapporteurs for the new working items:

https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=66188
https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=66187

3. The work is aligned with the ISO/IEC and ETSI project schedules and is expected to be finished before the end of the project duration in summer 2023.

1.2.4 IoT-NGIN: Next Generation IoT as part of Next Generation Internet

URL/Reference:

https://iot-ngin.eu

https://cordis.europa.eu/project/id/957246

https://twitter.com/IotNgin

https://www.linkedin.com/company/iot-ngin/

https://www.facebook.com/IotNgin

https://gitlab.com/h2020-iot-ngin

https://hub.docker.com/u/iotngin

Abstract:

It is well known that the Internet of Things (IoT) has been identified as one of the next big concepts to support societal changes and economic growth. To address this opportunity, the EU-funded project IoT-NGIN introduces novel research and innovation concepts to establish itself as the 'engine' that will fuel the next generation IoT. It starts by uncovering a pattern based meta-architecture and optimises IoT/machine-to-machine and 5G/machine-cloud-machine communications by extending the edge cloud paradigm. Moreover, it enables user and self-aware autonomous IoT systems through privacy-preserving federated machine learning and ambient intelligence, with augmented reality support. Finally, IoT-NGIN research towards distributed IoT cybersecurity and privacy. IoT-NGIN will be validated using dozens of heterogeneous devices, including drones and robots.

Starting and (target) end time of project:

01.10.2020 – 30.09.2023

IoT and/or Edge Computing research challenges:

Research challenges in IoT-NGIN

- IoT Meta Architecture
- Enhance IoT/5G Further Enhancement Device-to-Device (FeD2D)
- Data sovereignty and privacy “by design”
- Privacy preserving federated ML
- Protection against attacks on federated ML
- DLT-based meta-level Digital Twins

Innovation challenges in IoT-NGIN

- Optimising 5G resource allocation
- Ultra reliable IoT based on Time Sensitive Networking
- Secure edge cloud IoT micro-services execution framework
- Ambient Intelligence monitoring and control
- Dynamic machine self-learning framework

Expected activities on "Dissemination and Impact on Standards":

IoT-NGIN partners follow the activities of standardisation bodies, which have been identified as relevant to the project developments, namely GAIA-X, IDSA, ITU Smart City, IEC, OGC, NIST, ENISA, and ISO. In addition, the IoT-NGIN project plans to contribute to 5G-ACIA, ONF, and 3GPP standardisation. Moreover, the project monitors closely and has active links with clusters and associations in the field of IoT, communication, software, open source, as well as domains related to the Living Labs, indicatively 5GPPP, 6G-IA, Networld Europe, NGI, BDVA and DIHs.

The timescale for interaction is from now until the end of the project (September 2023).

1.2.5 SHAPES: Smart and Healthy Ageing through People Engaging in Supportive Systems

URL/Reference:

https://cordis.europa.eu/project/id/857159

https://shapes2020.eu/

Abstract:

Throughout Europe, many people are handicapped by reduced capabilities that are either permanent or temporary. The EU-funded SHAPES project aims to create the first European open Ecosystem enabling the large-scale deployment of a broad range of digital solutions for supporting and extending healthy and independent living for such older individuals. SHAPES builds an interoperable platform integrating smart digital solutions to collect and analyze older individuals' health, environmental and lifestyle information, identify their needs and provide personalized solutions that uphold the individuals' data protection and trust. Important aspects are semantic IoT interoperability mechanisms developed as part of the core SHAPES Technological Platform that enables interoperability among more than 37 already integrated Digital Solutions, with open interfaces for third party solutions that can be integrated via the Marketplace. The project employs innovative approach to IoT interoperability, which avoids transferring private and identifiable data via the core of the platform, instead aligning the parties directly involved in data exchange with respect to to their Information Models and interfaces. Hence only types of data exchanged may be visible to potential intruders, but no actual data, since it physically is not transferred in SHAPES.

Starting and (target) end time of project:

01.11.2019 – 31.10.2023

IoT and/or Edge Computing research challenges:

As part of its IoT and edge technological developments, SHAPES project has defined and currently implements the SHAPES Technological Platform (TP), providing the architectural elements, APIs and SDKs and deployment of digital e-Health solutions, aimed at supporting seamless interoperability among IoT devices, platforms and services with respect for privacy and security of identifiable personal data:

- Develops SHAPES TP's Framework – including components, interfaces and data models – ensuring security, scalability, extensibility, reliability, modularity, configurability and seamless dynamic interoperability among IoT systems, devise and services.
- Deploys foundation capabilities, including Big Data collection, management and processing without need to exchange private data, including speech recognition and video analytics.
- Implements IoT interoperability services following applicable standards concerning IoT-based platforms and the cross border exchange of health-related information.
- Implements proprietary security mechanisms (Single-Sign-on authentication for enabling data host authorization), supporting human-friendly authentication mechanisms (e.g., multimodal biometrics) to ensure data protection and privacy.
- Integrates and tests e-Health Digital Solutions in the SHAPES Technological Platform, assessing their readiness for deployment in pilots. This includes 20 projects with dedicated solutions brought into SHAPES through three (3) Open Calls.
- Addresses secure e-Health systems interoperability via 5G mobile communication networks

Expected activities on "Dissemination and Impact on Standards":

(1) List of IoT and/or Edge related SDO and Alliances that project will interact on standardization:

- FHIR (Fast Healthcare Interoperability Resources)[1]
- Health Level Seven International (HL7) [2]
- Open mHealth[3]
- ETSI 303645 "Cyber Security for Consumer Internet of Things: Baseline Requirements"
- ISO/IEC JTC 1/SC 38 Cloud computing and distributed platforms[4]
- IEC 60601-1-2: EMC standard for medical applications[5]
- IHE-Europe[6]
- INSPIRE Directive[7]

(2) How the project want to interact

Project partners (EDGE, Gnomon and ICOM) have established working relation with FHIR and Open mHealth consortia aiming to align IoT interoperability standards in e-Health domain. ICOM has pursued interactions with ISO/IEC and ETSI, primarily adopting their standards with possibilities of contributing to enhancements for enhanced use in e-Health domain.

(3) Timescales for this interaction:

Interactions with all above organization have started during the development of the SHAPES architecture in mid of 2020 and are expected to continue throughout its operational time frame i.e. until Q3 of 2023.

1 http://hl7.org/fhir/2016may/protocol.html
2 http://www.hl7.org/index.cfm
3 Open mHealth: https://www.openmhealth.org/organization/about/
4 https://www.iso.org/committee/601355.html
5 IEC 60601-1-2: EMC standard : https://webstore.iec.ch/publication/59644
6 IHE Europe: https://www.ihe-europe.net
7 INSPIRE: https://eur-lex.europa.eu/eli/dir/2007/2/2019-06-26

1.2.6 ASSIST-IoT: Architecture for Scalable, Self-*, human-centric, Intelligent, Secure, and Tactile next generation IoT

URL/Reference:

https://assist-iot.eu/

https://cordis.europa.eu/project/id/957258

https://www.facebook.com/assistiot/

https://www.instagram.com/assistiot/

https://www.linkedin.com/in/assist-iot-project/?originalSubdomain=be

Abstract:

ASSIST-IoT will provide an innovative reference architecture, envisioned as a decentralized ecosystem, where intelligence is distributed among nodes by implementing AI/ML close to data generation and actuation, and hyperconnecting nodes, in the edge-cloud continuum, over softwarized smart network. Smart network will be realized by means of virtualized functions, with clear separation of control and data planes, facilitating efficient infrastructure programmability. Moreover, the action will follow a DevSecOps methodology to ensure the integration of security, privacy, and trust, by design, in all aspects of the envisioned ecosystems.

ASSIST-IoT will be supported by several pillars: (i) innovative IoT architecture, to adapt to the NGI paradigm, with three-dimensional approach, including intelligence, security and privacy by design, supporting decentralized collaborative decision-making; (ii) moving from semantic interoperability to semantically-enabled cross-platform, cross-domain data transactions, within decentralized governance, DLT-anchoring transaction security, privacy and trust; (iii) development and integration of innovative devices, supporting context-aware computing, to enable effective decision making close to events; (iv) introduction of self-* mechanisms, supporting self-awareness and (semi-)autonomous behaviors across IoT deployments, and (v) Tactile Internet support for latency applications, like AR/VR/MR, and human-centric interaction with IoT components. Results of the action will provide foundation for a comprehensive practice-based methodology, for future designers and implementers of smart IoT ecosystems.

Finally, to validate research results, and developed solutions, and to ensure their wide applicability, extended pilot deployments with strong end-user participation will take place in: (i) port automation; (ii) smart safety of workers, and (iii) cohesive vehicle monitoring and diagnostics, bringing about domain-agnostic aspect of the approach.

Starting and (target) end time of project:

1.11.2020 - 31.10.2023

IoT and/or Edge Computing research challenges:

Growth of volume of unstructured data, sent by IoT devices, exceeds that of structured data. Many existing applications do not benefit from opportunities and flexibility offered by the existence of multiple data sources/streams. As data grows in size and heterogeneity, issues of scalability and interoperability become a rising concern. Modern AI uses Big Data to support users, self-train, and continually improve its performance. Increasing need for near-real-time reaction, and automatic decision making, suggests/enforces application of AI close to events, utilizing edge computing, smart networking and smart devices. These challenges require novel approaches, leading to highly decentralized ecosystems, supported transversely by security, privacy and trust enablers, to facilitate data sharing and protect the growing attack surface. Last but not least, human-centricity and new ways of interacting with IoT ecosystems have to be a core part of an innovative proposal, like the decentralized and multi-plane architecture that ASSIST-IoT introduces.

The challenges in the project are particularly:

- Design, implementation and validation of an NGIoT Reference Architecture, decentralised architecture (and its reference implementations), validated in three real-life pilots backing the NGI approach,
- Definition and implementation of distributed smart networking components,
- Definition and implementation of decentralized security and privacy exploiting DLT,
- Definition and implementation of smart distributed AI enablers, AI components (including smart devices), to be deployed in the "proper locations" across the IoT ecosystem continuum,
- Definition and implementation of human-centric tools and interfaces,
- Support Tactile IoT/AR low latency networks are needed, since interaction between users, devices and systems has to be smooth enough to be considered real-time,
- Interoperability will be addressed in terms of scalability, security, privacy and heterogeneity of data sources.

Expected activities on "Dissemination and Impact on Standards":

Participation in ETSI:

- Further active participation in ETSI work.
- Follow up for new Specialist Task Forces and new work items.
- Participation in Working Groups for forthcoming standard actions.
- Cooperation using AIOTI for contribution to ETSI TR and evaluation of the ETSI reports and standards.

Participation in ITU-T:

- Active participation and follow up using OPL membership in ITU-T SG13 and SG20.
- Contributions to ITU-T, SG20 potential contributions under preparation.
- ITU-T SG meetings participation.
- New work items identification and analysis of new proposed subjects.

Participation in IEEE SA:

- Contributing to IEEE SA Open (GitLab)
- Contact IEEE SA Operational Program Management Team
- Explore membership of IEEE Societies to fostering Project submission.
- Participation as Working Groups for forthcoming standard actions.
- Participation as balloting stakeholder in 2 standardisation processes.
- Participation as public reviewer in 1 standardisation action of each relevant identified active project.

Participation in AIOTI:

- Participation in the AIOTI Board that will take place in IoT Week 2022 (Dublin, Ireland).
- Enrol in WG Standardisation WP3 to participate in the SDOs exploration and alignment.
- Enrol in WG Standardisation WP2 to actively contribute to the next release of HLA (v6.0).
- Contribution to white papers in data spaces subject.
- Participation (as external contributors) to next events/actions of WG Urban Society.
- Enrol and actively contribute in VWG Mobility and Logistics to deliver a new scope-wide document (latest is from 2015).
- Observe and contribute to the next documents and actions of VWG Buildings, emphasising on the role of IoT in combination with BIM and as an indoor geo-localisation commodity.

Participation in BDVA/DAIRO:

- Enrol in TF7.SG7 and TF7.SG11 to align technical work of pilots 1, 3A and 3B and potentially contribute with relevant inputs via UPV (member of BDVA).
- Follow closely the reports of TF6.SG6 Standardisation.
- Participate in TF6-SG1 Data technology and architectures.
- Collaborate in the edition of the forthcoming SRIDA – Strategic Research, Innovation and Deployment Agenda of DAIRO.
- Contribution to position paper about data spaces and interoperability.

Participation in ESCO/ENISA:

- Active participation and follow up by S21SEC.
- New work items: WG identifies the capacities and capabilities to sustain EU digital autonomy by developing and fostering trusted technologies.
- Next contribution to define the cyber security EU R&I roadmap and vision to strengthen and build a resilient EU ecosystem.
- Contribution to new white papers about best practices in cybersecurity.

1.2.7 IntellIoT: Intelligent, distributed, human-centered and trustworthy IoT environments

URL/Reference:

https://intelliot.eu/

https://cordis.europa.eu/project/id/957218

Twitter: https://www.twitter.com/intelliot_eu

Linkedin: https://www.linkedin.com/company/intellioteu/

Abstract:

Traditional IoT setups are cloud-centric and typically focused around a centralized IoT platform to which data is uploaded for further processing. Those have multiple limitations, such as unreliable cloud connectivity, limited bandwidth, long reaction time, lack of self-awareness, and privacy concerns. Next generation IoT applications are incorporating technologies such as artificial intelligence, distributed ledgers and augmented reality, in order to realize semi-autonomous behaviour of vehicles, guidance for human users, or machine-to-machine interaction. Such applications must move to the edge or closer to the operational assets to amplify the level of their performance, create a more stable operation, and enable faster response. This transformation needs to build on localized IoT environments comprised of heterogeneous devices (e.g., edge computers as well as resource-constrained devices) that can collaboratively execute highly automated IoT applications – which include functions for sensing, actuating, reasoning, and control. IntellIoT developed an architectural framework to enable IoT environments for semi-autonomous applications endowed with intelligence, built-in security, and trust and evolving with the human-in-the-loop. In IntellIoT, three exemplary use cases of next generation IoT applications in the area of agriculture, heathcare and manufacturing have been demonstrated in a lab environment.

Starting and (target) end time of project:

01.10.2020 - 30.09.2023

IoT and/or Edge Computing research challenges:

IntellIoT derive research challenges from three key classes of Next Generation (NG) IoT use cases described as scenarios from distinct vertical domains:

1) Agriculture, where a fleet of vehicles (e.g., tractors) is semi-autonomously operated in conjunction with supporting devices (e.g., drones);
2) Healthcare, where humans (patients) are semi-autonomously guided by artificial advisors based on IoT device input; and
3) Manufacturing, where semi-autonomous machine-to-machine collaboration is important (e.g., interaction between industrial robot arms and machinery). In all three use case areas, a human expert plays a key role in controlling, monitoring and teaching AI-enabled autonomous systems.

To achieve project's vision, following key enablers and resulting research challenges are highlighted below:

A. Autonomy and distributed intelligence: For the IntellIoT vision, distributed Machine Learning (ML) needs to consider application-specific target accuracies and worst-case training latencies under tolerable number of failures (reliability and robustness guarantees), wireless resources availability, on-device energy, storage, or computing restrictions. In addition, studying the control stability (plant, string, swarm- stabilities) of both single and multi-agent systems will be mandatory. Investigating the co-design of ML, communication-computation and control will be the basis of IntellIoT for developing the novel distributed AI solutions. For enabling the human-in-the-loop, the fusion between transfer learning, optimization and Federated Learning/Re-enforced Learning is a major research challenge.

B. Next generation IoT computation and communication infrastructure: IoT applications are moving from the cloud to the edge, so that computing happens in closer proximity to the data producers and consumers. While IoT/edge devices can provide the computation side of the infrastructure, the communication side needs to be driven by advanced networking technologies, such as 5G New Radio (NR) and its extensions towards private networks and Industrial IoT. Building on the computation and communication infrastructure, IoT artifacts need to be able to discover and interact with one another. A first major step towards this goal has been the Web of Things (WoT), where interactions between devices are based on the Web architecture. Crucially, however, interoperability on the semantic level is a central requirement in the future evolution of the Web. Based on efforts of the W3C WoT, new means to use hypermedia for designing evolvable Web APIs and general-purpose clients are being explored. IntellIoT builds up on these developments towards integrating them with research on multi-agent systems (MAS) towards enabling a hypermedia-based MAS (HyperMAS) that are vertically and horizontally scalable with respect to the number of agents, devices, and interactions among these components. It will support self-aware agents within IoT environments and semi-autonomous IoT systems.

C. Humans and trust in intelligent IoT: The wide adoption of IoT technologies in a plethora of domains, necessitates considering security, privacy, and trust requirements early in the design phase. Even securely initialised devices can be compromised, allowing attackers to affect connected devices, the network, or collaborative applications. Trust-based mechanisms can be used to defend against such attacks by monitoring the behaviour of each participant. An IoT deployment must also have the intelligence to protect itself proactively, e.g., through Moving Target Defence (MTD) techniques, where AI-driven agents periodically alter the network topology and/or configuration to counter attacks. Thereby, security assurance evaluations for IoT systems are still in their infancy. Supporting these security and trust mechanisms, IntellIoT will utilize blockchain, smart contracts, and distributed ledger (DLT) technologies to encode transaction logic and policies, which include the requirements and obligations of the party requesting access to an IoT resource as well as its provider.

All three use cases (agriculture, healthcare, and manufacturing) are based on semi-autonomous behaviour of the IoT system. Multiple heterogeneous devices are interacting, and autonomous control of their collaboration is provided through AI, which can be (re-)trained through human intervention. This pattern can be assumed for many next generation IoT applications.

Research challenges related to the described pattern are spread over three key areas:

(1) providing the distributed artificial intelligence for autonomous behaviour,

(2) providing efficient and reliable communication and computation resources, and

(3) incorporating the human (by providing trust in the system) and learning from his input.

Expected activities on "Dissemination and Impact on Standards":

IntellIoT project interact with following SDOs:

1) 5G-ACIA: SIEMENS and EURECOM contributed to the activities of the 5G ACIA standardization group with use cases for Edge computing in a 5G environment of a manufacturing shop floor as well as distributed AI.
2) W3C WoT WG: The IntellIoT use cases have been presented to the W3C WoT WG and are in the process of being included into the W3C WoT use cases and requirements document. WoT extensions have been developed within IntellIoT, which will be brought to W3C. More specifically, application-oriented contributions and extensions of the W3C WoT TD Standards are planned, such as:
    a. Alignment of Agent-Thing interaction and storage of an interactions journal in a distributed ledger
    b. Re-use of TD Templates as run-time resource provisioning mechanism to separate concrete Thing API from Thing affordances
    c. Application of TDs in a large scenario, with development of appropriate tooling
    d. Extension of TD Templates to include AI-related details, such as AI metadata and AI-related capabilities.

These extensions are being integrated and evaluated, and their impact will be presented to W3C.

3) 3GPP: 3GPP recently completed its rel.16 5G NR specification and is actively working on its rel.17. In a nutshell, 3GPP rel.15 provided the specification of 5G NR, with minor support for services and functions required by IntellIoT. 3GPP rel.16 proposed extended functions of 5G NR, such a Vehicular-to-Everything (V2X) architecture, preliminary URLL mechanisms or architecture for Private 5G Networks. It will however require to wait for rel.17 and rel.18 to actually see functions that would be beneficial to IntellIoT either in its tight integration of AI, private network management or extended Device-to-Device support.
4) AIOTI: participation in Standardization WG and relevant domain-specific WGs.

1.2.8 IM-TWIN: from Intrinsic Motivations to Transitional Wearable INtelligent companions for autism spectrum disorder

URL/Reference:

https://im-twin.eu/

https://cordis.europa.eu/project/id/952095

Abstract:

Research into autism spectrum disorder (ASD) is important since the condition affects about 1 in 10 newborn children in developed countries. Previous EU-funded research resulted in the development of a prototype wearable companion robot called PlusMe for ASD treatment and daily support. The EU-funded IM-TWIN project now aims to furnish PlusMe with intelligent behaviour, give it extra embedded biosensors and cameras for detecting a child's affective state and integrate all components into an Internet of Things system itself called IM-TWIN. It will also validate the device and its components with target stakeholders and perform activities to advance the system components to a higher technology readiness level. The project's work will help to meet the needs of ASD therapy centres and families with children with ASD.

Starting and (target) end time of project:

1.11.2020 - 31.10.2023

IoT and/or Edge Computing research challenges:

The IM-TWIN project aims to develop some of the outcomes of the FET GOAL-Robots project towards market exploitation. The basic-research FET GOAL-Robots project aimed to study how intrinsic motivations ("curiosity") drive exploration and learning in children, and how such processes can be used to develop innovative autonomous robots. This led to conceive the idea that intrinsic motivations can be used to build engaging interactive robots usable for the treatment of children with developmental disorders, in particular within the Autism Spectrum Disorder (ASD). ASD is a condition with dramatic importance for the well-being of society as it affects about 1 out of 10 newborns in developed countries. We thus developed a "wearable companion robot", usable for the treatment and daily support of ASD, called PlusMe, now at the stage of prototype.

The IM-TWIN project has two sets of objectives. The first is to develop a highly-modular system pivoting on the PlusMe, called the IM-TWIN, addressing the needs of the market segment involving ASD therapy centres and, potentially, families with ASD children: this involves endowing the PlusMe with intelligent behaviour, equipping it with additional embedded biosensors and cameras for detecting the child's affective/emotional state, and integrating all components as a whole IoT system. The second set of objectives aims to validate the device and its components with target stakeholders, and to carry out a number of activities directed to advance the system components to a higher Technological Readiness Level (TRL7 for the PlusMe): this involves identifying the target groups and analysing ASD-related markets, refining and implementing an effective IPR strategy, planning the steps for individual and collective exploitation of the project outcomes, and finally creating a startup for the exploitation of the IM-TWIN system and its components. IM-TWIN will also foster the development of a lively high-tech research and application ecosystem.

1.2.9 GATEKEEPER: Smart Living Homes – Whole Interventions Demonstrator For People At Health And Social Risks

URL/Reference:

https://www.gatekeeper-project.eu/about-gatekeeper/

https://cordis.europa.eu/project/id/857223

Abstract:

The rising population of elderly in the EU member states is giving rise to new challenges in relation to independent living. The EU-funded GATEKEEPER project aims to ensure healthier independent lives for the ageing populations. It will connect healthcare providers, businesses, entrepreneurs, elderly citizens and the communities they live in. The goal is to create an open, trust-based arena for matching ideas, technologies, user needs and processes. The project will also incorporate data protection while underpinning value creation using advanced marketing patterns. The solutions deployed will involve 40 000 elderly citizens, as well as authorities, institutions, companies, associations and academics, and 8 regional communities from 7 EU member states.

Starting and (target) end time of project:

1.10.2019 - 31.03.2023

IoT and/or Edge Computing research challenges:

- To deliver the **GATEKEEPER DIGITAL PLATFORM implemented through fault tolerant, secure, flexible and scalable micro-services infrastructure, based on open source and data standards**, built on top of reference W3C-Web of Things architectural models and including services referred to the health domain through HL7-FHIR and to the home domain through SAREF.

- To deliver the GATEKEEPER HEALTHCARE SPACE, where **intuitive and self-configuring dashboards, intelligent services for early risk detection and care plans, and a federated data infrastructure are provided** to healthcare professionals.

- To deliver the GATEKEEPER **CONSUMER SPACE**, where certified solutions, services and devices are provided to citizens for the management and prevention of health and social risks.

- To deliver the GATEKEEPER **BUSINESS SPACE**, where certified companies are able to develop solutions, services and devices alone or in partnership, following a set of standards in order to reach and boost the Digital Single Market.

- To deliver the GATEKEEPER ECOSYSTEM TRANSACTION SPACE, where services for data storage and processing, big data analytics and advanced visualization of business-oriented KPIs are provided for the exchange of solutions among providers and suppliers, based on data sharing and Value-based healthcare paradigms.

- To execute a series of PILOTS to demonstrate the effect, benefit, value and scalability of the GATEKEEPER solutions around REFERENCE USE CASES COVERING PRIMARY, SECONDARY and TERTIARY PREVENTION, initially deployed in 8 regions of 7 European countries.

- To provide an ECOSYSTEM COCREATION framework, resulting from Responsible and Social Innovation principles, aiming at engage and generate TRUST from Citizens, Healthcare Professionals, Supply and Demand Side, extended through open calls to SMEs, Start-ups, and new regions in an open innovation fashion.

- To implement a **STANDARDIZATION STRATEGY that allow the GATEKEEPER solution to be aligned with SDOs around legal and privacy aspects, healthcare, ageing, homes, cities and energies, IoT, Big Data and other Key Enabling Technologies, as well as value-based procurement**.

- To transform and process GATEKEEPER results in a reference and sustainable IMPACT FRAMEWORK for decision making about procurement of innovative solutions, integrating elements from Value-based Healthcare, Real World Data, and Health-Technology Assessment, involving relevant actors inside and outside the consortium through Communication and dissemination activities, for worldwide outreach of project activities and achievements.

Expected activities on "Dissemination and Impact on Standards":

- To **identify and analyse the relevant standards and standardization tracks** for GATEKEEPER,

- To coordinate and support the standardisation of relevant GATEKEEPER technology,

- To analyse and support an effective **certification strategy to develop trust in data processing and, Interoperability** of GATEKEEPER solutions.

- To develop and specify a model of procurement process for the outcomes of the GATEKEEPER platform.

1.2.10 CHARM: Challenging environments tolerant Smart systems for IoT and AI

URL/Reference:

https://charm-ecsel.eu/

https://cordis.europa.eu/project/id/876362

Abstract:

CHARM project will develop condition monitoring, predictive maintenance, automation, real-time manufacturing control and optimisation and virtual prototyping system demonstrators and test them in industrial settings. The ECS (Electronics, Components and Systems) technologies must be designed to withstand combinations of severe thermal, mechanical and chemical stress present during the manufacturing processes used in the industry.

Starting and (target) end time of project:

01.06.2020 - 31.05.2023

IoT and/or Edge Computing research challenges:

Digitalization has been identified as one of the key enablers for renewal and competitiveness of European manufacturing industries. However, grasping the digitalization and IoT-related opportunities can be limited by the harsh environmental conditions of the manufacturing processes and end use environments. The ECSEL-IA 2019 project initiative CHARM aims to contribute to solving this problem by **developing ECS technologies that tolerate harsh industrial environments**. The project concept centres around real industrial challenges from different types of end use industries. The synergies and impacts arise from similarities in technology solutions serving different applications and industry sectors.

The CHARM Use Cases include six different industry sectors, majority of them presented by innovative cutting-edge large enterprises that belong to the world-wide market leaders of their own sectors – while most of them being new to the ECSEL ecosystem: mining (Sandvik Mining and Construction Oy, FI), paper mills (Valmet Technologies Oy, FI), machining (Tornos SA, CH), solar panel manufacturing lines (Applied Materials Italia SRL, IT), nuclear power plants maintenance and decommissioning (ÚJV Řež a.s. CZ), and professional digital printing (Océ-Technologies B.V NL). The planned demonstrators engage these big players with European ECS value chains and showcase capabilities that serve manufacturing industries' needs at large. The **new technologies to be developed include novel multi-gas sensors, robust high temperature and pressure sensors, flexible sensors for paper machine rolls, wireless power transfer systems, connectivity solutions for rotating parts, advanced vision systems, and enablers for autonomous driving**.

Expected activities on "Dissemination and Impact on Standards":

No information about standardization work.

1.2.11 ATLAS: Agricultural Interoperability and Analysis System

URL/Reference:

https://www.atlas-h2020.eu/

https://cordis.europa.eu/project/id/857125

Abstract:

Advanced digital technology and data play a vital role in ensuring sustainable production in today's agricultural industry. The EU-funded ATLAS project aims to develop an **open platform and create a sustainable environment for innovative agriculture**. The project will address the lack of **data interoperability in agriculture** by combining the use of agricultural equipment with sensor systems and data analysis. The ATLAS platform aims to deliver a service offering hardware and software interoperability using data from sensors to demonstrate the benefits of digital agriculture in a wide range of sectors affecting modern agriculture.

Starting and (target) end time of project:

01.10.2019-31.03.2023

IoT and/or Edge Computing research challenges:

The overall objective of ATLAS, is the development of an open digital Interoperability Network service for agricultural applications and to build up a sustainable ecosystem for innovative data-driven agriculture using the Network.

The Interoperability Network will allow the flexible combination of agricultural machinery, sensor systems and data analysis tools to overcome the problem of lacking interoperability and will enable farmers to increase their productivity in a sustainable way by making use of the most advanced digital technology and data.

It will also define a service architecture, providing hardware and software interoperability layers which enable the acquisition and sharing of data from a multitude of sensors and the analysis of this data using a multitude of dedicated analysis approaches.

The technology developed in ATLAS will be tested and evaluated within pilot studies on a multitude of real agricultural operations across Europe along several use cases, e.g:

- precision agriculture tasks,
- sensor-driven irrigation management,
- data-based soil management,
- behavioural analysis of livestock.

Expected activities on "Dissemination and Impact on Standards":

Many areas of sensor technology depend on a network connectivity, as sensors are an indispensable part of the digitized and sustainable agri-food value chain. For this to be of fundamental importance in this area, compatibility and interoperability is an important factor.

ATLAS offers the opportunity to serve as a central component so that data-driven agriculture can be further promoted. The purpose of this survey was to determine the technical requirements of sensor manufacturers and sensor platform manufacturers due to the next generation of sensors. The aim of future systems is to promote successful interoperability between sensors and agricultural technology. In order for this to be possible, **the standardization of interfaces and data protocols is a crucial basis in which a valuable contribution to data-driven agriculture is made**.

Under preparation: **D9.3** Report on the advances of next generation machine interconnectivity standardization. Not yet published.

1.2.12 TERMINET: nexT gEneRation sMart INterconnectEd ioT

URL/Reference:

https://terminet-h2020.eu/

https://cordis.europa.eu/project/id/957406

Abstract:

Tens of billions of devices are connected to the Internet of Things (IoT), and the number of connections is growing every second. Information is being constantly sent and received from one smart device to another. Based on cutting-edge technologies such as software-defined networking (SDN), multiple-access edge computing, and virtualisation for next-generation IoT, the EU-funded TERMINET project will develop a novel next-generation reference architecture. Its main aim is to simplify the connection of a vast number of different devices through a flexible SDN-enabled middleware layer. To improve supply chain processes, the project will design an IoT-driven decentralised and distributed blockchain framework within manufacturing. TERMINET's approach will be tested in real-life situations such as energy, smart buildings, smart farming, healthcare and manufacturing.

Starting and (target) end time of project:

01.11.2020 – 31.10.2023

IoT and/or Edge Computing research challenges:

- natural sciences/computer and information sciences/internet/internet of things
- social sciences/economics and business/business and management/business models
- engineering and technology/materials engineering
- engineering and technology/electrical engineering/electronic
- engineering/information engineering/electronic engineering/robotics/autonomous robots/drones
- natural sciences/biological sciences/ecology/ecosystems

Expected activities on "Dissemination and Impact on Standards":

Some potential technical areas for further work on standardisation include:

- Digital Twins
- IoT Analytics
- AI Services
- Federated Machine Learning
- Knowledge Representation and Reasoning
- AR/VR

- Hardware Abstraction
- Software defined networking
- Secure processing of low latency data flows
- Streaming analytics
- Orchestration and provisioning
- End to End Management of Services

Including:

- Remote attestation techniques, Lightweight Crypto Primitives (LCP), Control Flow Attestation

There is potential for applying open-source tools/standards to:

- SDN-enabled container network interfaces (CNIs) in cloud environments
- SDN control plane and data plane interfaces for managing OpenFlow-based networks accommodating IoT traffic.
- Support local AI/ML model training with the use of distributed FL techniques

1.2.13 Hexa-X: A flagship for B5G/6G vision and intelligent fabric of technology enablers connecting human, physical, and digital worlds

URL/Reference:

https://hexa-x.eu/

https://cordis.europa.eu/project/id/101015956

Abstract

2030 and beyond the world will face tremendous opportunities and challenges of sustainable growth. The Hexa-X vision is to Connect human, physical and digital worlds with a fabric of 6G key enablers. The key objectives of the Hexa-X project are: (1) Foundation for an end-to-end system architecture towards 6G; (2) Radio performance towards 6G; (3) Connecting intelligence towards 6G; (4) Network evolution and expansion towards 6G; (5) Impact creation towards 6G.

Starting and (target) end time of project:

01-01 2021 – 30-06- 2023

IoT and/or Edge Computing research challenges:

Figure 3 ilustrates the key value areas as stated in the Hexa-X vision and associated KPIs and capabilities. Each key value area reflects multifaceted aspects for which KVIs need to be developed. The key values are sustainability, inclusiveness and trustworthiness, where sustainability is explicitly considered from two perspectives in Hexa-X. 6G in itself needs to be sustainable, which could, for example, be mapped to the network energy efficiency as a KPI. In addition, 6G is an enabler for sustainability and sustainable growth in other markets and value chains, potentially covering aspects of inclusiveness and trustworthiness. Trustworthiness as another core value for Hexa-X, in the context of security considerations for 6G. In addition, the value of new capabilities enabled with 6G needs to be captured; this includes integrated sensing, embedded devices, local compute integration and integrated intelligence, as illustrated in the lower right. Flexibility is seen as a core capability. As core capability, flexibility covers, for example, the applicability of 6G to a new value chain, including ease of deployment and operation in that environment and, consequently, the goal of enabling new business opportunities. Flexibility as new capability of 6G impacts, for example, AI-based network management and operation.

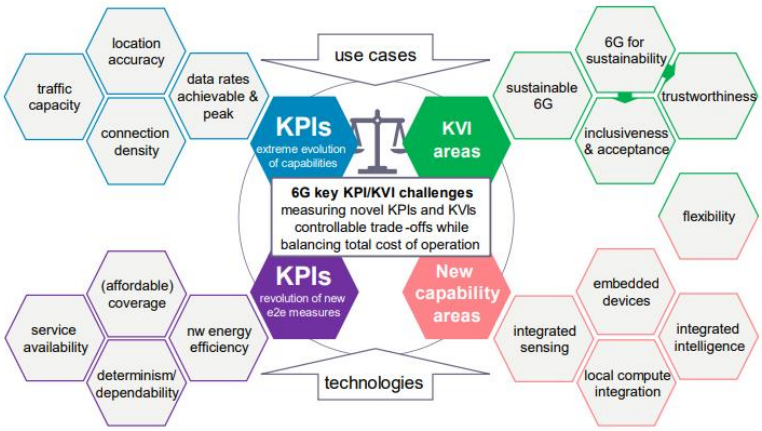


Figure 3: Clustering of Hexa-X Key Performance Indicators s and Key Value Indicators, copied from

In addition to the novel concept of KVIs, KPIs and performance goals need to go beyond what 5G can do to address new use cases discussed in the previous chapter. This includes increasing peak data rates and data rates achievable at the cell edge, density of connections, traffic capacity, and location accuracy to a substantial extent. For some performance goals, for example, dependability and determinism, service availability, affordable coverage, and network energy efficiency, the focus will shift more towards new end-to-end KPIs in specific use cases, and extreme performance in terms of data rates might be confined to specific scenarios rather than being a general, system-wide goal. Depending on the use case, novel KPIs for this end-to-end perspective will be defined. In addition, the relation between the fulfillment of KPIs and the associated total cost of operation becomes increasingly complex, given the number of stakeholders involved and the potential of networked intelligence and service-oriented ownership and business models on a local and global scale.

Expected activities on "Dissemination and Impact on Standards":

The standardisation dissemination targets and overall achievements of Hexa-X during the first project year (2021) are listed in Table 2.

Table 2: Standardization, Industrial impact and IP achievements of Hexa-X in 2021

Type	Target by the end of the project	Achieved
Standards and industry groups impacted	3GPP RAN, 3GPP SA, ETSI ENI, ETSI ZSM, ETSI PDL, ETSI OSM. ETSI NFV, ETSI MEC, NGMN, GSMA ITU, IETF, IEEE, TMF	3GPP, GSMA, ETSI, IETF, ITU-R
Total number of standards contributions by participants based on work in Hexa-X	More than 100	16
Number of patent applications	At least 50	6

1.2.14 InterConnect: Interoperable Solutions Connecting Smart Homes, Buildings and Grids

URL/Reference

https://interconnectproject.eu/about/

https://cordis.europa.eu/project/id/857237

Abstract:

The EU energy market is conditioned by digitalisation. New rules and technological developments allow the proliferation of energy service providers in the EU member states with users having full knowledge and control over their appliances. However, interoperability represents a serious problem as a change of provider could mean the replacement of installations. The EU-funded InterConnect project proposes effective energy management using a resilient and practical ecosystem that is user-centric and market-driven. The project involves a range of specialised stakeholders, including advanced technology actors, manufacturers, providers and energy users. Via seven pilots, they will showcase an effective digital market for ensuring energy-efficiency at reduced costs that is beneficial to end-users.

Starting and (target) end time of project:

1.10.2019-30.09.2023

IoT and/or Edge Computing research challenges:

- Large-scale pilots leading to market driven deployments
- Establish interoperability framework validating SAREF and semantic interoperability
- Marketplace of integrated digital platforms bringing the gap between IoT and Energy
- User centric energy and non-energy devices

Expected activities on "Dissemination and Impact on Standards":

The expected Interconnect activities on "Dissemination and Impact on Standards" are depicted in Figure 4.

Figure 4: Interconnect Ecosystem Strategy, copied from https://interconnectproject.eu/wp-content/uploads/2021/02/WP10_D10.1-Initial-communication-dissemination-and-exploitation-plan_draftVersion.pdf

1.2.15 Visualization of the IoT EU funded ongoing projects landscape

This section provides a landscape visualization of the ongoing IoT EU funded projects, introduced in this report.

The "IoT EU funded ongoing projects landscape (Technology and Marketing Dimensions)", shown in **Figure 5**, is a graphical representation that highlights the main activity (up to the day of generating this representation) of the ongoing projects in the area of IoT, according to the Business to Consumer (B2C) vs. Business to Business (B2B) (horizontal axis) and the Connectivity vs. Service & App (vertical axis) classifications.

The projection of these ongoing projects into vertical industry domains is shown in **Figure 6**.

The dimensions and the vertical/horizontal domains of the landscapes and the method used to visualize these ongoing projects into these landscapes shown in **Figure 5** and **Figure 6**, respectively, are the same ones as defined in Section 2.1.14.

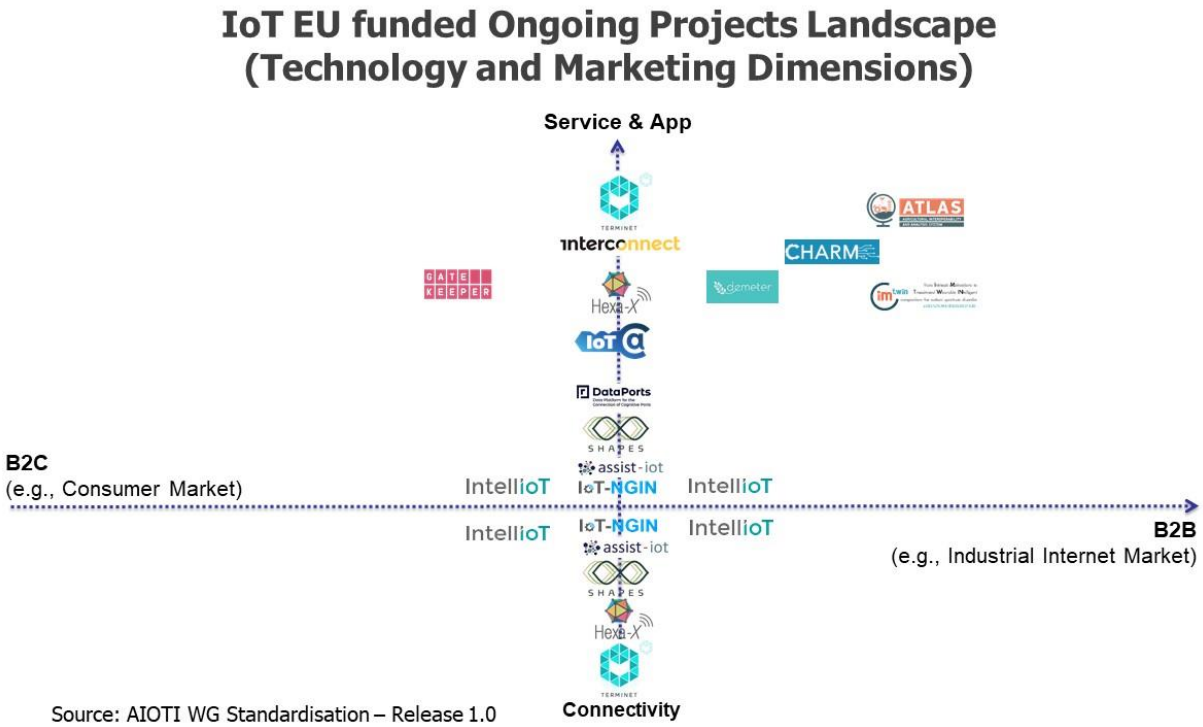
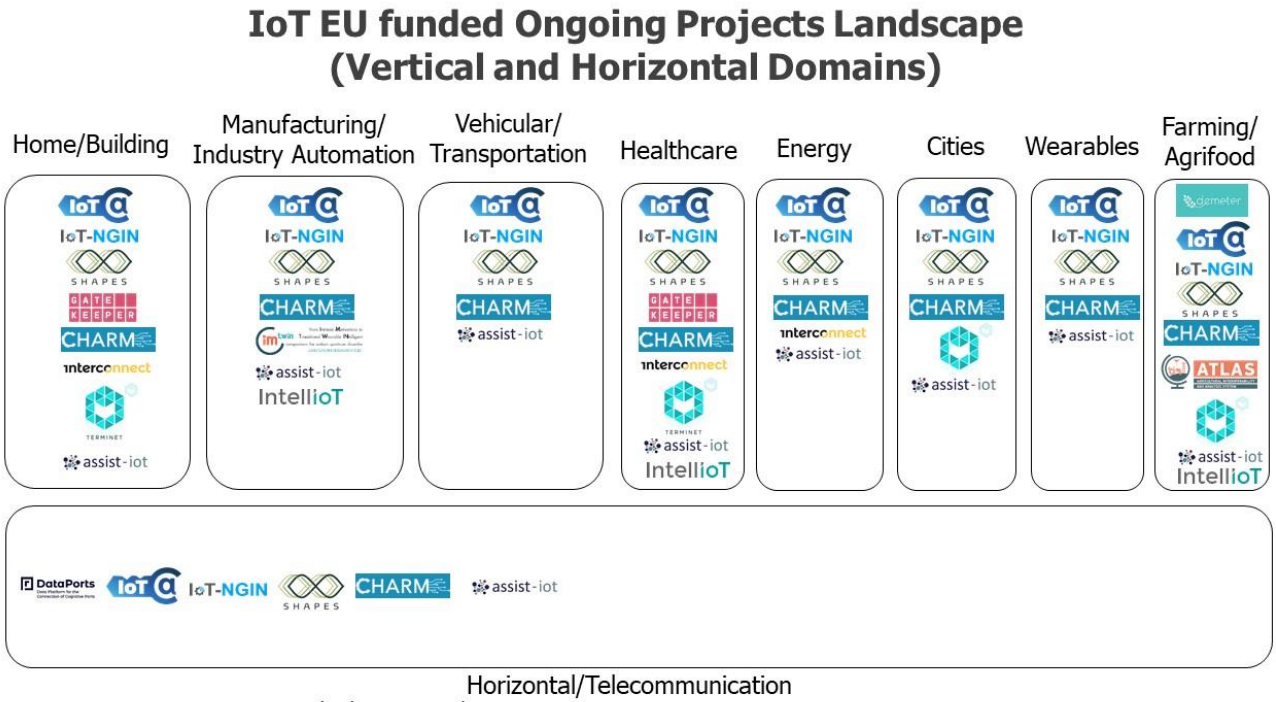


Figure 5: IoT EU funded ongoing projects landscape, when Technology and Marketing Dimensions are used



Source: AIOTI WG Standardisation – Release 1.0

Figure 6: IoT EU funded Ongoing Projects Projection on Vertical and Horizontal Domains

2. Edge Computing EU funded projects landscape

This section provides information on Edge Computing EU funded projects, which are grouped in completed and ongoing projects. The information related to each EU funded project, included in this section, has been collected using the template provided in Annex I of this report.

2.1 Completed Projects

This section provides a description of Edge Computing EU funded projects that are completed.

2.1.1 AFarCloud: Aggregate Farming in the Cloud

URL/Reference:

http://www.afarcloud.eu/

https://cordis.europa.eu/project/id/783221

Abstract:

Farming is facing many economic challenges in terms of productivity and cost-effectiveness, as well as an increasing labour shortage partly due to depopulation of rural areas. Furthermore, reliable detection, accurate identification and proper quantification of pathogens and other factors affecting both plant and animal health, are critical to be kept under control in order to reduce economic expenditures, trade disruptions and even human health risks.

AFarCloud provided a distributed platform for autonomous farming that will allow the integration and cooperation of agriculture Cyber Physical Systems in real-time in order to increase efficiency, productivity, animal health, food quality and reduce farm labor costs. IoT and Edge-computing (AI at the edge) are the basic technologies enabling this platform. This platform will be integrated with farm management software and will support monitoring and decision-making solutions based on big data and real time data mining techniques., enabling modern precision farming in an optimized way.

The AFarCloud project also made farming robots accessible to more users by enabling farming vehicles to work in a cooperative mesh, thus opening up new applications and ensuring re-usability, as heterogeneous standard vehicles can combine their capabilities in order to lift farmer revenue and reduce labour costs. Sensor technologies applied in the field are implemented in a secure manner as "secure IoT" devices.

It needed to take into account different application capabilities like the data collection and cloud computing, a sensing-on-the-move approach, cyber physical systems, secure IoT actuation, decision support systems, autonomous vehicles like UAVs and other partially and fully automatic devices for most aspects of agricultural processes, with the objective of realizing farming-as-a-service, adding a real-time monitoring level in a farm viewed as a whole.

Starting and (target) end time of project:

01.09.2018 – 30.11.2021

IoT and/or Edge Computing research challenges:

Many IoT models and communication approaches were implemented and further developed to be integrated in smart farming and precision farming context under different environmental and infrastructure conditions. The achievements from AFarCloud were demonstrated in three holistic demonstrators (Finland, Spain and Italy), including cropping and livestock management scenarios and eight local demonstrators (Latvia, Sweden, Spain and Czech Republic) in order to test specific functionalities and validate project results in relevant environments located in different European regions. IoT data models of the FIWARE[3] initiative and the domain model of the European Lighthouse Project IoT-A were used for describing the main IoT concepts and their relationships.

The platform combined data streams provided not only by deployed IoT-aided groups of devices (distributed sensors and vision systems deployed in the infrastructure and the automated and partially autonomous vehicles or UAVs operating in the farm) but also by data streams provided by cloud and data analytic components, that integrate the information coming from other farms and external heterogeneous data sources (e.g. meteorological data, logistics, etc.). In this way, a comprehensive representation of the actual status of cropping areas and livestock facilities can be achieved.

In communications, among others, the rising Sub-GHz IoT communication technologies (e.g., LoRA, in the 868–870 MHz band), were implemented in a secure manner.

The SED (Security Evaluation Demonstrator) was demonstrated in real environments, providing the following security features:

- Detection of unauthorised moving of the IoT device.
- Ensuring the physical integrity of the IoT device.
- Detection and notification of low power supply voltage level
- Inhibit unauthorised reuse of manipulated IoT device, Prevent manipulation of the IoT device communication data.

These features are applicable for future agriculture IoT devices, located unsupervised in the field and are also targeting especially at unsupervised unmanned and autonomous vehicles with IoT cooperating devices as enablers of new functionality, supervision and control.

Internet of Things networks such as SigFox, NB-IoT and LoRa offered a breakthrough solution especially to the extensive livestock farmers, including livestock movement control and health monitoring & behaviour analysis, e.g., with developed IoT-wearables.

The connection of IoT networks with the Cloud allows large data retrieval useful to the farmers to drive their activity and the actions of the IoT and vehicles, as cooperating devices in the farm in autonomous manner and analysis of the data in a useful way for optimization of farming services.

Provide information about the expected activities on "Dissemination and Impact on Standards":
AFarCloud technological results generate impact in the value-chain and accomplish the concept of *Farming-as-a-Service*:

- Automated farming equipment, vehicles, UAVs (Drones), robots, altogether with IoT networks and Cloud connectivity;

- Farming (crop) and Livestock Management optimization (Semi-autonomous optimized management of farming and livestock) using general IoT and wearables (IoT sensors and devices);

- Dependability and security of IoT sensors, networks and devices;

- IoT cloud and fog computing, particularly agri-IoT and IIoT;
- Cloud service offerings intermediation and orchestration services coming from multiple cloud service providers;
- Tracking and monitoring/control - GIS application;
- Hardware and SW Development;
- IoT and edge intelligence for smart and precision farming, animal and crop health, IoT;
- High Quality of Service (QoS) characteristics for controlling over every aspect of data.

Standardization was managed and supported by a separate task. Several partners are not only active in international and national mirror standardization committees of ISO, IEC and particularly in ISO/IEC JTC1 SC41 (IoT) and SC42 (AI), but also members of AIOTI (Standardization WG, Smart Farming & Food Security WG, Mobility & Logistics WG), ETSI and OASIS. Results were disseminated to these groups and international conferences, by ERCIM News (Special Theme: "Smart farming", 2018) and other articles, and this is continuing beyond the project.

Acknowledgement:

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 783221. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Austria, Belgium, Czech Republic, Finland, Germany, Greece, Italy, Latvia, Norway, Poland, Portugal, Spain, Sweden.

2.1.2 PLEDGER: "Performance optimization and edge computing orchestration for enhanced experience and Quality of Service"

URL/Reference:

http://www.pledger-project.eu/

https://cordis.europa.eu/project/id/871536

Abstract:

Next-generation edge computing infrastructures should confront the new challenges faced today with the power offered by cloud infrastructures. The EU-funded Pledger project aims to provide a new architectural model as well as a set of software tools that will prepare the future development of the next generation of edge computing. The project will allow edge computing providers to secure the stability and effective performance of the edge infrastructures. It will also allow edge computing users to understand the nature of their applications, research understandable quality of service metrics and optimise the competitiveness of their infrastructures. The project intends to introduce the set of tools in the application fields of manufacturing, mixed reality and smart cities.

Starting and (target) end time of project:

01.12.2019 - 30.11.2022

IoT and/or Edge Computing research challenges:

Edge computing allows data produced by Internet of Things (IoT) devices to be processed closer to where they are created instead of sending them across long routes to data centres or clouds. Doing this computing closer to the edge of the network enables organizations to run near real-time analysis of important data – a need of organizations across many domains, including manufacturing, healthcare, telecommunications and finance. The disruptive potential of edge computing is fuelled by the unprecedented growth of data, the imminent impact of 5th Generation (5G) networks and the growing importance of latency in modern applications. When specialized and expensive solutions are preferred over generic edge computing or cloud infrastructures, it creates additional costs or excludes a wide set of SMEs from being competitive or even operational.

It becomes clear that current approaches on edge computing are not sufficient to address this forthcoming massive usage of edge computing, especially in the frame of large IoT deployments in smart cities and industrial applications. The massive data generated by new modalities (e.g. Augmented Reality, Mixed Reality, real-time video processing for removing privacy-sensitive data etc.) are soon expected to account for an increasing portion of edge computing processing. The main goal in such scenarios is to ensure that the overall offered Quality of Service (QoS) fits the application needs over the edge or edge/cloud deployment. Speed and latency issues have been identified as the top barrier in this domain, while cost and reliability (meeting the provider Service Level Agreements - SLAs) are the top and second most important factors for evaluating edge and cloud services. Furthermore, achieving trust in such large scale IoT deployments is another crucial area of interest. With the recent introduction of blockchains as an enabling technology for distributed and peer-to-peer systems, it comes as a challenge to check whether modern edge computing approaches are suitable for being coupled with emerging decentralized applications built on blockchains. A distributed trust technology, ensuring scalability, privacy, and reliability, is a cornerstone for the growth of IoT and edge computing environments.

Provide information about the expected activities on "Dissemination and Impact on Standards":

Standardization activities results are:

- The "High Priority Edge Computing Standardisation Gaps and Relevant SDOs" AIOTI report43.
- The "Landscape of Internet of Things (IoT) Standards" StandICT report44 and the corresponding

  "Landscape of Edge-Computing" (to be published in December 2022).
- The "ETSI Technology Radar (ETR) 2022" report45 (to be updated at the end of 2022).
- The "Service Level Agreements Self-Assessment with Hyperledger Fabric" Hyperledger

  whitepaper46.
- A new NGSI "smart data model"47 in the context of FIWARE.

Pledger has produced contributions related to three standardisation landscape reports, one Open Source Framework whitepaper, and one Open Source guideline, by being active in WGs of SDOs (ETSI), Alliances (AIOTI, StandICT), and OSCs (Hyperledger, FIWARE). Moreover, the project has managed to exploit results from all of its technical WPs, with WP2 "Requirements Analysis and Architecture" input being used for the standardisation landscape reports to SDOs and Alliances, and WP3 "Performance, QoS and orchestration mechanisms" and WP4 "Trust, Smart Contracts and Decision Support mechanisms" outcomes being used for Frameworks and Guidelines to OSCs.

To sum up, Pledger has successfully met its standardisation goal of contributing to at least 2 standards with relation to SLA metrics and orchestration languages and has successfully established the baseline for future related activities extending beyond the official lifecycle of the project.

2.1.3 ARtwin: "An AR cloud and digital twins solution for industry and construction 4.0"

URL/Reference:

https://class-project.eu/

https://cordis.europa.eu/project/id/780622

Abstract:

EU-funded ARtwin aims at developing an Augmented Reality (AR) cloud platform for improving productivity and product quality of the European industry and construction 4.0. Based on 5G connectivity, the AR cloud platform will enable collaborative AR experiences adapted to factory and construction site environments. AR experience will operate on a large scale by using 3D mapping and vision-based localisation services. A remote rendering service will enable the display of complex 3D content on low-resources AR devices. Finally, dedicated tools will allow for service deployment and orchestration on any cloud infrastructure. Three pilot use cases will be used for validation, while contribution to **standardization** will aim at fostering the emergence of a sustainable and sovereign AR ecosystem in Europe.

Starting and (target) end time of project:

01.12.2017 - 30.11.2020

IoT and/or Edge Computing research challenges:

- To introduce an easily deployable platform that enables the design and maintenance of highly accurate real-time digital representations of large-scale real environments.
- To develop and deploy high quality interactive services set on improving business performance and well-tailored to the requirements of professional and industrial contexts.
- To demonstrate and validate the benefits of the ARCloud in major factories and construction sites, by deploying three demonstrators that will prove the quality and productivity gains.
- To contribute to **standardization** activities, by providing specifications of unified APIs and data representations, fostering in this way a growing and sustainable AR ecosystem in Europe.

Provide information about the expected activities on "Dissemination and Impact on Standards":

Developed platform is formally defined if:

- It exposes easy-to-use APIs: standardizing APIs (e.g., TM Forum Open APIs) is a critical success factor for realizing the full value of Platform Business Models. **Standard APIs** lower the cost of participating in Platform businesses to customers (write once, integrate everywhere), and the investment required by Platform Owners themselves in leveraging legacy internal capabilities.

- It exposes searchable capabilities as coherent and compose-able blocks of business functionalities and operational patterns, exposed or published in a catalogue accessible through one of the Catalogue APIs (e.g., compliant with **TM Forum Catalog API**). Capabilities editors may be business actors like organizations, governments, industry groups, and so on.

- It is modelled as structural hierarchies and layers, associated usage rules, capabilities and APIs. Modelling is managed through a Management API (e.g., TM Forum DSM-API).

Alongside, ARtwin partners, and mainly BCM and SIE, will seek to actively contribute to the activity Standardisation Bodies, with a view to fostering a growing and sustainable AR ecosystem across Europe, all while enhancing the brand of the ARtwin project and its solutions.

2.1.4 ELASTIC: "A Software Architecture for Extreme-ScaLe Big-Data AnalyticS in Fog CompuTIng ECosystems"

URL/Reference:

https://elastic-project.eu/

https://cordis.europa.eu/project/id/825473

Abstract:

Big data is nowadays being integrated in systems requiring to process a vast amount of information from (geographically) distributed data sources, while fulfilling the non-functional properties (real-time, energy-efficiency, communication quality and security) inherited from the domain in which analytics are applied. Examples include smart cities or smart manufacturing domains.

ELASTIC will develop a novel software architecture (SA) to help system designers to address this challenge. The SA will incorporate a novel elasticity concept to distribute and orchestrate the resources across the compute continuum (from edge to cloud) in an innovative fog computing environment. The new elasticity concept will enable to match analytics workload demands and fulfilling non-functional properties. The fog computing architecture will incorporate energy-efficient parallel architectures, combined with innovative distributed storage, secure communications and advanced cloud solutions. Overall, the SA will enable the combination of reactive data-in-motion and latent data-at-rest analytics into a single extreme-scale analytics solution, in which the analytics workloads will be efficiently distributed across the compute continuum based on their suitability and data processing needs.

The capabilities of ELASTIC will be demonstrated on a real smart-mobility use case, featuring a heavy sensor infrastructure to collect data across the Florence tramway network, equipped with advanced embedded architectures, heterogeneous sensors, V2I connectivity and access to cloud resources. Representative applications for advanced driving assistant systems, predictive maintenance and public/private transport interaction, have been selected to efficiently process very large heterogeneous data streams from distributed sensors.

ELASTIC technology will enable the development of innovative mobility services while preparing the technological background for the advent of full autonomous mobility systems.

Starting and (target) end time of project:

01.12.2018 - 31.05.2022

IoT and/or Edge Computing research challenges:

- ELASTIC develops a software architecture incorporating a new elasticity concept, that will enable smart systems to satisfy the performance requirements of extreme-scale analytics workloads. The new elasticity concept will efficiently distribute the workloads across the compute continuum, whilst guaranteeing real-time, energy, communication quality and security non-function properties inherited from the system domain.

- The vision of ELASTIC is that by extending the elasticity concept across the compute continuum in a fog computing environment, combined with the usage of advanced hardware architectures at the edge side, can significantly increase the capabilities of the extreme-scale analytics integrating both responsive data-in-motion and latent data-at-rest analytics into a single solution.

- ELASTIC considers a realistic yet visionary smart mobility use-case, which considers huge amounts of data coming from a large set of IoT sensors distributed along the Florence tramway network. ELASTIC adopts a very innovative federated/distributed fog architecture, supporting elasticity across the compute continuum whilst fulfilling real-time, energy, communication and secure properties.

Provide information about the expected activities on "Dissemination and Impact on Standards":

ELASTIC is a member of BDVA, and participates in the BDVA newsletter and in events

and conferences organized by the Association.

Different teams plan to publish the project results in open communities and public environments, as follows:

- OpenFog: OpenFog Reference Architecture (RA),

- Distributed Management Task Force (DMTF): cloud management standard called CIMI, that specifies a systematic and consistent way to define web service interfaces (REST),

- FIWARE: open and royalty-free API specification to interface among users and system developers,

- Linux Foundation EDGE: an umbrella organisation that aims to establish an open, interoperable framework for edge computing,

- OASIS: a non-profit open-standards body,

- Open Edge Computing Initiative: a collective effort driving the business opportunities and technologies surrounding edge computing.

2.1.5 CLASS: "Edge and CLoud Computation: A Highly Distributed Software Architecture for Big Data AnalyticS"

URL/Reference:

https://class-project.eu/

https://cordis.europa.eu/project/id/780622

Abstract:

Big data applications processing extreme amounts of complex data are nowadays being integrated with even more challenging requirements such as the need of continuously processing vast amount of information in real-time.

Current data analytics systems are usually designed following two conflicting priorities to provide (i) a quick and reactive response (referred to as data-in-motion analysis), possibly in real-time based on continuous data flows; or (ii) a thorough and more computationally intensive feedback (referred to as data-at-rest analysis), which typically implies aggregating more information into larger models. Given the apparently incompatible requirements, these approaches have been tackled separately although they provide complementary capabilities.

Starting and (target) end time of project:

01.01.2018 - 30.06.2021

IoT and/or Edge Computing research challenges:

1. Big data analytics are being applied to a wide range of applications domains, including those in charge of controlling critical real-time systems, challenging the need not only to efficiently processing extreme amounts of complex data, but also processing it in real-time.

2. CLASS developed a novel software architecture framework to help big data developers to efficiently distributing data analytics workloads along the compute continuum (from edge to cloud) in a complete and transparent way, while providing sound real-time guarantees. This ability opens the door to the use of big data into critical real-time systems, providing to them superior data analytics capabilities to implement more intelligent and autonomous control applications.

3. The capabilities of the CLASS framework have been demonstrated on a real smart-city use case in the City of Modena, featuring a heavy sensor infrastructure to collect real-time data across a wide urban area, and three connected vehicles equipped with heterogeneous sensors/actuators and V2X connectivity to enhance the driving experience.

Provide information about the expected activities on "Dissemination and Impact on Standards":

CLASS is a member of the Big Data Value Association (BDVA) and participates regularly in the BDVA newsletter and in the network's events and conferences, such as the BDVAPPP Summit 2019 and the BDVA webinar series. The project has been added to the BDVA Landscape, an online map of big data projects, institutions, and use cases, while an extended description of the CLASS pilot use case has been published on the BDVA list of pilot studies. In addition, the CLASS partners have participated with a chapter in BDVA's open access book "Technologies and Applications for Big Data Value" to be launched by Springer. BDVA has also disseminated the CLASS final event to their mailing lists and networks encouraging their members to attend.

CLASS is actively involved with open communities. One major route of this is involvement with open-source projects, by consuming, adapting and contributing back to a project's code base. More specifically, WP5 (Analytics Layer) employs OpenWhisk as a foundation for CLASS' event-driven and inclusive programming model.

Moreover, sequence of contributions has been made by CLASS to the open-source project of Lithops (also used by CLASS).

2.1.6 LEGaTO: "Low Energy Toolset for Heterogeneous Computing"

URL/Reference:

https://class-project.eu/

https://cordis.europa.eu/project/id/780622

Abstract:

Recently system integrators have dramatically increased their efforts in heterogeneous computing by integrating heterogeneous cores on die (ARM), utilizing general purpose GPUs (NVIDIA), combining CPUs and GPUs on same die (Intel, AMD), leveraging FPGAs (Altera, Xilinx), integrating CPUs with FPGAs (Xilinx), and coupling FPGAs and CPUs in the same package (IBM-Altera, Intel-Altera). Heterogeneity aims to solve the problems associated with the end of Moore´s Law by incorporating more specialized compute units in the system hardware and by utilizing the most efficient compute unit. However, while software-stack support for heterogeneity is relatively well developed for performance, software stack support for power- and energy-efficient computing it is severely lacking. Given that the ICT sector is responsible for 5% of global electricity consumption, software stack-support for energy-efficient heterogeneous computing is critical to the future growth of the ICT industry. The primary ambition of the LEGaTO project is to address this challenge by starting with a Made-in-Europe mature software stack, and by optimizing this stack to support energy-efficient computing on a commercial cutting-edge European-developed CPU-GPU-FPGA heterogeneous hardware substrate, which will lead to an order of magnitude increase in energy efficiency.

Starting and (target) end time of project:

01.12.2017 - 30.11.2020

IoT and/or Edge Computing research challenges:

1. One order of magnitude improvement in energy-efficiency for heterogeneous hardware through the use of the energy-optimized programming model and runtime.

2. 5× improvement in Mean Time to Failure through energy-efficient software-based fault tolerance.

3. Size reduction of the trusted computing base by at least an order of magnitude.

4. 5× increase in FPGA designer productivity through the design of novel features for hardware design using dataflow languages.

Provide information about the expected activities on "Dissemination and Impact on Standards":

While it has a major research focus, the work performed in the LEGaTO project also strongly affects new industry trends and standards. As an active member of the PCI Industrial Computer Manufacturers Group (PICMG), LEGaTO partner Bielefeld University, together with companies like congatec, Kontron, Intel, or Adlink Technology, is involved in the standardization of the new computer-on-module form factor COM-HPC. The new specification will allow easy, modular integration of new microserver technology into edge and IoT applications by defining common interfaces, mechanical dimensions and cooling.

2.1.7 Visualization of the Edge Computing EU funded completed projects landscape

This section provides a landscape visualization of the completed Edge Computing projects funded by the EU, that are introduced in this report.

The "Edge Computing EU funded completed projects landscape (Technology and Marketing Dimensions)", shown in **Figure 7**, is a graphical representation that highlights the main activity (up to the day of generating this representation) of the ongoing projects in the area of Edge Computing, according to the Business to Consumer (B2C) vs. Business to Business (B2B) (horizontal axis) and the Connectivity vs. Service & App (vertical axis) classifications.

The projection of these edge computing completed projects into vertical industry domains is shown in **Figure 8**.

The dimensions and the vertical/horizontal domains of the landscapes and the method used to visualize these ongoing projects into these landscapes shown in **Figure 7** and **Figure 8**, respectively, are the same ones as defined in Section 2.1.14.

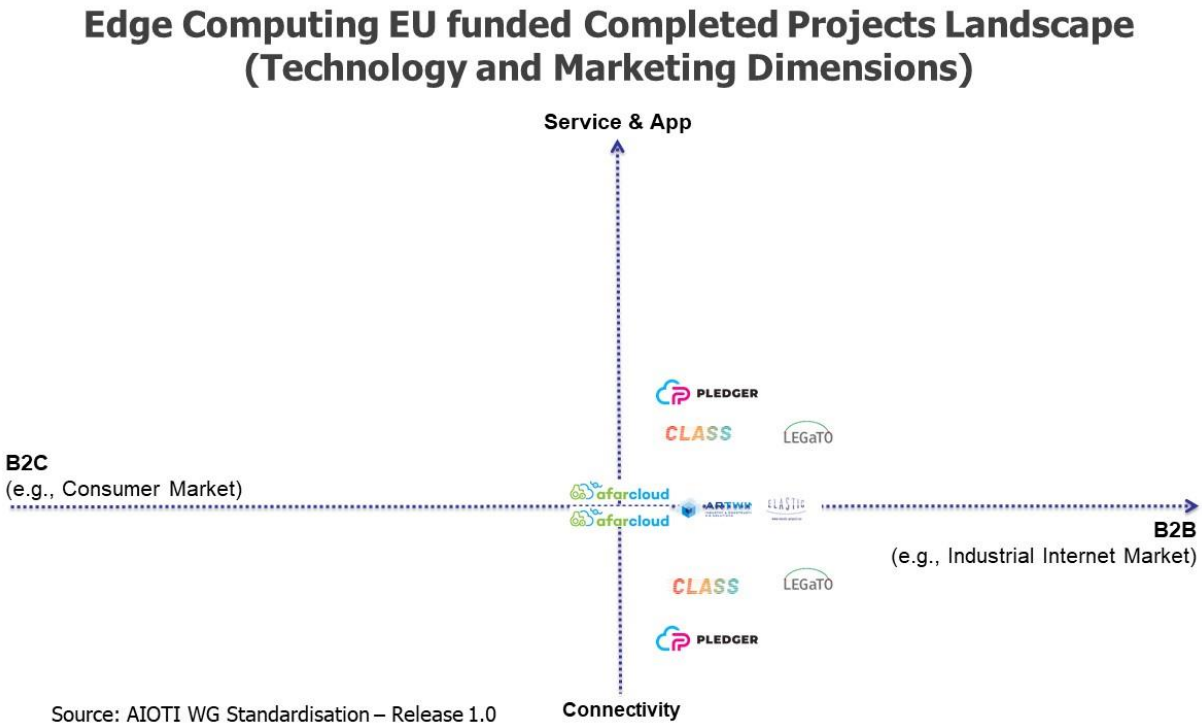


Figure 7: Edge Computing EU funded Completed Projects Landscape, when Technology and Marketing Dimensions are used

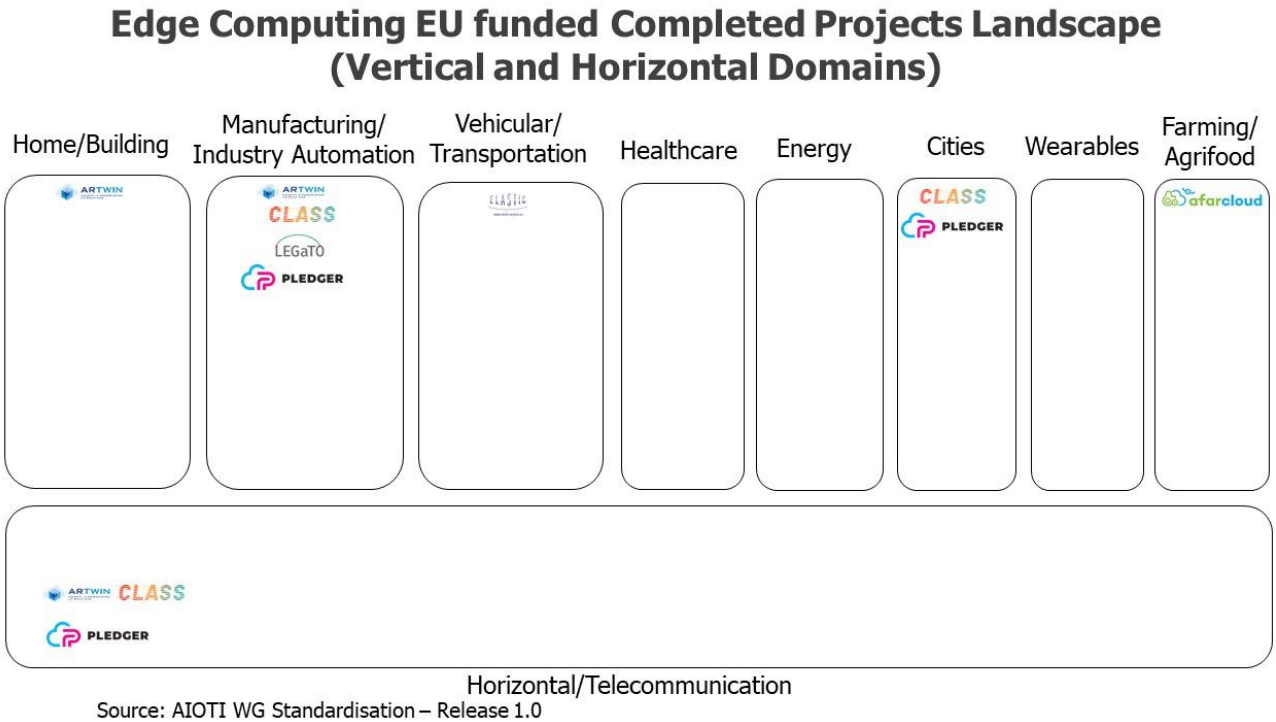


Figure 8: Edge Computing EU funded Completed Projects Projection on Vertical and Horizontal Domains

2.2 Ongoing Projects

This section provides description of Edge Computing EU funded ongoing projects.

2.2.1 BD4NRG: Big Data for Next Generation Energy

URL/Reference:

www.bd4nrg.eu

https://zenodo.org/communities/bd4nrg/

https://cordis.europa.eu/project/id/872613

Abstract:

The rising decentralization of the energy system is unveiling an enormous opportunity for energy stakeholders to leverage on big data & AI technologies to improve decision making. There are however some barriers hampering the exploitation of this potential, such as the lack of standardized big data architectures for smart grids and regulatory frameworks not enabling data sharing. In that respect BD4NRG is:

- Delivering a reference architecture for Smart Energy, which aligns BDVA SRIA, IDSA and FIWARE architectures, SAREF standard and extend COSMAG specification to enable B2B multi-party data exchange, while providing full interoperability of leading-edge big data technologies with smart grid standards and operational frameworks.
- Evolving and upscaling a number of technology enablers (such as scalable sovereignty-preserving hybrid DLT/off-chain data governance, big data elastic pipeline orchestration, IoT/edge-cloud AI-based federated learning and multi-resource sharing tokenized marketplace), loosely integrate and deploy them within the BD4NRG framework.
- Delivering an open modular big data analytic toolbox as front-end for one-stop-shop analytics services development by orchestrating legacy and/or third-party assets.
- Validating such framework through the delivery of predictive and prescriptive edge AI-based big data analytics on 12 large scale pilots, deployed by different energy stakeholders (TSOs and DSOs power network operators, aggregators, storage/renewable assets operators, local energy communities, ESCOs, power market operators, municipalities, financial institutions and ENTSO-E), fully covering the energy value chain.
- Setup a vibrant data-driven ecosystem, which will federate new energy data providers, attract SMEs for novel energy services provisioning through cascading funding.

Starting and (target) end time of project:

01.01.2021 – 31.12.2023

IoT and/or Edge Computing research challenges:

- Edge-based Big Data Analytics for smart energy grids
- Development of IoT/edge big data management enablers
- IoT/edge-cloud AI-based federated learning allowing sharing and learning across multiple organizations and stakeholders without sensitive data opening

Expected activities on "Dissemination and Impact on Standards"

- **AIOTI:** The project partners have (and are building new) different relationships with EU initiatives on the topics relevant to the project results for contributing on standardisation activities, but in the IoT and Edge computing the more relevant is the AIOTI where BD4NRG is represented and usually provides contributions according to the opportunities and if relevant, in the WG Energy, WG Standardization, WG Digital for Green.

2.2.2 SYNERGY: Big Energy Data Platform and AI Analytics Marketplace for new viable solutions

URL/Reference:

https://cordis.europa.eu/project/id/872734

https://www.synergyh2020.eu/

Abstract:

The European electricity sector is undergoing a major fundamental change with the increasing digitalization and roll-out of smart meters. This advent of the electricity sector modernization comes together with the fact that the power system is becoming more thoroughly monitored and controlled from "end to end" and through the whole value chain of stakeholders involved in the electricity system operation. This is a huge shift away from traditional monitoring and control approaches that have been applied exclusively over the transmission and distribution networks, since the smart electricity grid era is pushing sensing, control and data collection at the edge of electricity networks, which needs to be further re-defined due to the wide penetration of Distributed Energy Resources (DERs), such as renewable energy sources (RES), smart home devices and appliances (IoT-enabled), distributed storage, smart meters and electric vehicles (EVs). In response to this need for "end-to-end" coordination between the electricity sector stakeholders – not only in business terms but also in exchanging information between them – SYNERGY introduces a novel framework and references big data architecture that leverages data, primary or secondarily related to the electricity domain, coming from diverse sources (data APIs, historical data, statistics, sensor / IoT data, weather data, energy market data, and various other open data sources) to help the electricity value chain stakeholders to simultaneously enhance their data reach, improve their internal intelligence on electricity-related optimization functions while getting involved in novel sharing/trading models of data sources and intelligence, in order to gain better insights and shift individual decision-making at a collective intelligence level. SYNERGY addresses and takes the best of breed from a number of technologies, such as IoT for timely ingesting real-time data at the edge and performing in-situ analytics. On the other hand, big data analytics are performed in a secure experimentation playground in the SYNERGY cloud infrastructure, to extract as much information as possible from data assets.

Starting and (target) end time of project

01.01.2022 – 30.06.2023

IoT and/or Edge Computing research challenges:

- Interoperability: Common Information Model definition based on a number of standards (such as: IEC 61850 – 61968 – 61970 – 62056 – 62325 – 62361, OpenADR, USEF, SAREF – SAREF4ENER – SAREF4BLDG, IFC, SSN) for full IoT functionalities of the SYNERGY Big Data Platform and AI Marketplace.
- Research, development and testing of distributed architecture for edge on-premise deployment of the SYENRGY Big Data Platform and AI Marketplace

Expected activities on "Dissemination and Impact on Standards":

- Cooperation with BDVA and BRIDGE Initiative. Additional collaboration with ETIP-SNET for more related energy R&I strategies and OPENDEI for platform and digital knowledge share.
- Exchanging experiences and best practices, sharing the state -of-the-art, common C&D events with "sister" projects within the framework of the aforementioned organizations.
- Availability until June 2023

2.2.3 ACCORDION: Adaptive edge/cloud compute and network continuum over a heterogeneous sparse edge infrastructure to support NextGen applications

URL/Reference:

Project website: https://www.accordion-project.eu

Project website on CORDIS https://cordis.europa.eu/project/id/871793

Abstract:

There is an increasing number of signs that the edge computing concept is going to play a dominant role in the forthcoming technology developments, disrupting economies at a large scale. The big cloud providers promptly jumped in to get the lion's share, but edge computing is intrinsically more "democratic" than cloud computing. In fact, its distributed and localized nature can be an antibody for big trusts, if properly exploited. Synergistically employing edge computing with upcoming technologies such as 5G provides an opportunity for EU to capitalize on its local resource and infrastructure and its SME-dominated application development landscape and achieve an edge-computing-driven disruption with a local business scope. To this end, ACCORDION establishes an opportunistic approach in bringing together edge resource/infrastructures (public clouds, on-premises infrastructures, telco resources, even end-devices) in pools defined in terms of latency, that can support NextGen application requirements. To mitigate the expectation that these pools will be "sparse", providing low availability guarantees, ACCORDION will intelligently orchestrate the compute & network continuum formed between edge and public clouds, using the latter as a capacitor. Deployment decisions will be taken also based on privacy, security, cost, time and resource type criteria. The slow adoption rate of novel technological concepts from the EU SMEs will be tackled though an application framework, that will leverage DevOps and SecOps to facilitate the transition to the ACCORDION system. With a strong emphasis on European edge computing efforts (MEC, OSM) and 3 highly anticipated NextGen applications on collaborative VR, multiplayer mobile- and cloud-gaming, brought by the involved end users, ACCORDION is working to radically impact the application development and deployment landscape, also directing part of the related revenue from non-EU vendors to EU-local infrastructure and application providers.

Starting and (target) end time of project:

01.01.2020 – 30.04.2023

IoT and/or Edge Computing research challenges:

- ACCORDION project is facing a quite wide spectrum of challenges in Edge computing. In fact, it has the objective to deliver a comprehensive platform for easing the task of supporting the management of resources as well as the tailoring and optimization of applications on edge-based infrastructures. This goal is targeted by means of the development of three different frameworks, each devoted to a specific goal: resource indexing and pooling, application orchestration, application design and DevOps.
- Overall, the three main challenges faced are concerned with: (i) Intelligent resource brokering as well as efficient and secure application placement, (ii) efficient decentralised edge resource indexing, (iii) high-level representation of edge applications.

Expected activities on "Dissemination and Impact on Standards":

ACCORDION project interacts mainly with two Standard Organizations: ITU-T and ETSI. ACCORDION is contributing to the ETSI MEC standard via one of the consortium partners (NEC Europe). ACCORDION is promoting its vision of Edge Computing, in terms of application and resource management. The ACCORDION contribution to ITU-T is focused on the SG12, concerning the dynamic QoE assessment through its consortium partner Technische Universitat Berlin. ACCORDION expects that most of its contributions to standards will be materialised after the end of the project.

2.2.4 BRAINE: Big data pRocessing and Artificial Intelligence at the Network Edge

URL/Reference:

https://www.braine-project.eu/

https://twitter.com/braineproject?lang=en

https://www.linkedin.com/company/braineproject/

Abstract:

BRAINE provides a new vision for utilizing edge resources by providing novel network-edge workload distribution schemes. Predicting resource availability and workload demand, identifying trends, and taking proactive actions are all aspects of the novel workload distribution. The workload distribution technology developed in the context of BRAINE can be transferred to many other edge/fog computing environments to achieve different goals. Last but not least, BRAINE will have an important positive impact on the environment. Through BRAINE, edge computing can reduce this projected energy consumption by offloading many of the AI functions next to the end-users.

BRAINE demonstrates edge computing enabling AI through four use cases: healthcare assisted living (case 1), hyperconnected smart city (case 2), robotics in Factory 4.0 (case 3) and supply chain Industry 4.0 (case 4); the use cases are supported by organizations with specific domain expertise. Inside the UC1, the focus is given to IoT health sensors and actuators that are used by patients.

Starting and (target) end time of project:

01.05.2020 - 30.04.2023

IoT and/or Edge Computing research challenges:

Devising an EC infrastructure that offers control, computing, acceleration, storage, and 5G networking at the Edge and excels in scalability, agility, security, data privacy, and data sovereignty in Big Data and AI for low latency and mission-critical applications.

- Developing a future-proof Edge security framework and associated infrastructure based on 5G. With the latest software and hardware security technologies.
- Developing a distributed and partly-autonomous system that takes data privacy and sovereignty into account on each and every decision regarding workload placement, data transfer, and computation, while guaranteeing interoperability with the environment.
- Developing a heterogeneous, energy efficient Edge MicroDataCenter, suitable for stationed, mobile, and embedded autonomous applications, that goes beyond the current hardware and software architectures and offers Big Data processing and AI capabilities at the Edge.
- Testing and demonstrating the effectiveness and generality of the BRAINE approach by evaluating multiple real-world use cases and scenarios that exhibit the required scalability, security, efficiency, agility, and flexibility concerns.

Expected activities on "Dissemination and Impact on Standards":

- members of the BRAINE project follow the AIOTI activities in various areas (edge and 5G, standardization, energy)
- members of the project also follow the 6G IA (SNS JU) in the aspects of edge developments for beyond-5G and 6G
- BRAINE is following the 3GPP and ETSI specs related to workload placement in combination with network (and network slice) scaling and life-cycle management for the edge environments
- BRAINE also follows closely the recommendations related to the post-quantum protection protocols for the security keys distribution and protecting the links between edge data centers
    - Post-quantum cryptography emerging standards (NIST, ETSI)
    - Security evaluation methods (ISO 17825 / WG3 N2290 / WG3 N2291)
    - Edge related standardization (ETSI, AIOTI)
    - Ontologies (Digital Reference) (W3 org)
    - Open-source implementation of cryptographic standard (OpenSSL)
- IoT standards related to security are also followed from perspective of combining distributed ledger technologies and security challenges of IoT devices interacting with edge (EMDC)

2.2.5 MORPHEMIC: Modelling and Orchestrating heterogeneous Resources and Polymorphic applications for Holistic Execution and adaptation of Models In the Cloud

URL/Reference:

https://cordis.europa.eu/project/id/871643

https://www.morphemic.cloud/

Abstract:

MORPHEMIC proposes a unique way of adapting and optimizing Cloud computing applications by introducing the novel concepts of polymorph architecture and proactive adaptation. The former is when a component can run in different technical forms, i.e. in a Virtual Machine (VM), in a container, as a big data job, or as serverless components, etc. The technical form of deployment is chosen during the optimization process to fulfil the user's requirements and needs. The quality of the deployment is measured by a user defined and application specific utility. Depending on the application's requirements and its current workload, its components could be deployed in various forms in different environments to maximize the utility of the application deployment and the satisfaction of the user. Proactive adaptation is not only based on the current execution context and conditions but aims to forecast future resource needs and possible deployment configurations. This ensures that adaptation can be done effectively and seamlessly for the users of the application. The MORPHEMIC deployment platform will therefore be very beneficial for heterogeneous deployment in distributed environments combining various Cloud levels including Cloud data centres, edge Clouds, 5G base stations, and fog devices. Advanced forecasting methods, including the ES-Hybrid method recently winning the M4 forecasting competition, will be used to achieve the most accurate predictions. The outcome of the project will be implemented in the form of the complete solution, starting from modelling, through profiling, optimization, runtime reconfiguration and monitoring. Then the MORPHEMIC implementation will be integrated as a pre-processor for the existing MELODIC platform extending its deployment and adaptation capabilities beyond the multi-cloud and cross-cloud to the edge, 5G, and fog. This approach allows for a path to early demonstrations and commercial exploitation of the project results.

Starting and (target) end time of project:

01.01.2020 – 30.06.2023

IoT and/or Edge Computing research challenges:

MORPHEMIC is a multi-cloud management system that orchestrates the execution of applications while ensuring the meet of the application owner objectives. These objectives can be expressed in terms of computing performance or/and cost.

MORPHEMIC provides transparent management allowing not only the cloud but also the edge applications which often perform in very limited environment computational power and must satisfy availability and response time requirements. The cloud/edge computing domain offers approaches to attain business requirements that edge applications must meet. Dynamic adaptation, meaning, the real-time modification of the resources allocated to the application is an effective solution to ensure the performance of these applications knowing that the workload which is the main factor influencing the performance is not stable, therefore the resources assigned to an application must be adapted in accordance with the evolution of the managed workload. Although dynamic resource provisioning is a technique applied in cloud/edge computing, workload prediction enabling proactive adaptation is a feature implemented in Morphemic project to ensure the proper functioning of applications in an edge infrastructure.

We should be noted that an edge application can have several forms (script, container, serverless) and can run on different processing unit (CPU, GPU, FPGA, etc.). The latter influences the performance of the application.

As illustration, an application can present a specific performance on a hardware in accordance with the internal structure of the application (algorithm, workflow, etc ...). MORPHEMIC brings a mixed analysis of the performance model of the application which consists of static analysis (analysis of the source code) and dynamic with the correlation of performance indicators after several executions to allow polymorphic adaptation (change of the form and hardware executing the code) of the edge or cloud application.

In particular, the MORPHEMIC proposal in Section 1.4 Ambition Challenge 2 states: Self-healing federated event processing management system at the edge.

Expected activities on "Dissemination and Impact on Standards":

MORPHEMIC aims to collaborate with the AIOTI Alliance research and innovation, standardisation and ecosystem building.

A first case study description has been provided and the interaction will be followed up with further case study evolutions including potential standardization activities.

MORPHEMIC aims to Collaborate with projects RAINBOW & PLEDGER, a joint session will be presented at EBDVF 2022 on 22nd/23rd November 2022. With the rapidly exploding number of smart and connected devices today and the abundance of data constantly generated by new and emerging technologies such as **smart cities**, **5G/6G**, **IoT**, **autonomous mobility**, **smart manufacturing**, **extended reality**, etc. are putting higher demands on the cloud infrastructures, cloud services and cloud developers especially for real time and mission critical applications. This session will aim to highlight opportunities for **boosting data-driven digital transformation** of the EU innovation landscape and strengthening its competitiveness by leveraging on the next-generation Cloud Continuum platforms developed by three EU-funded Cloud Computing projects: **RAINBOW**, **PLEDGER** and **MORPHEMIC.**

A follow up group of interested partners will be created during the session and common potential standardization activities will be discussed.

MORPHEMIC collaborate with the open-source ecosystem of OW2, a project booth within the OW2 space, will be present at the Open Source Experience November 8-9, 2022 Venue: Paris Palais des Congrès Porte Maillot. The event will be an occasion to interact with the open source ecosystem and with the open source developers involved or wishing to be involved in the MORPHEMIC OW2 code base. The interactions will be followed up after the event by the team.

A follow up group of interested partners will be created during the event and common potential standardization activities will be discussed.

2.2.6 AI4CSM: Automotive Intelligence for Connected Shared Mobility

URL/Reference:

https://ai4csm.automotive.oth-aw.de/ ; https://ai4csm.eu/

https://cordis.europa.eu/project/id/101007326

Abstract:

The AI4CSM project will develop advanced electronic components, systems and architectures for future mass-market Electric, Connected, Automated and Shared (ECAS) vehicles for the digital transformation in the automotive sector to support the mobility trends and accelerate the transition towards a sustainable ecosystem based on the "Green Deal" principles.

The EC is taking initiatives to ensure that digital technologies such as AI, 5G, IoT and cloud/edge computing can accelerate the transition of the automotive industry to electrical, autonomous, connected, and shared vehicles. AI4CSM will deliver key innovations in technical areas including sensor fusion and perception platforms; efficient propulsion and energy modules; advanced connectivity for cooperative mobility applications; vehicle/edge/cloud computing integration concepts; new digital platforms for efficient and federated computing; and intelligent components based on trustworthy AI techniques and methods. AI4CSM will design scalable and embedded intelligence for edge and edge/cloud computing.

AI4CSM consists of 8 collaborative R&D clusters, gathering 41 partners from 10 countries. AI4CSM will reinforce user acceptance and affordability by convenience and services for the major transition to a diverse mobility. AI4CSM addresses the increasing demand of mobility, supporting future traffic concepts and strengthen the European automotive manufacturing base as a global industry leader.

Starting and (target) end time of project:

01.05.2021 - 30.04.2024

IoT and/or Edge Computing research challenges:

In the eight collaborative R&D clusters will be worked on the following IoT and Edge research challenges and innovations (only these innovations are referenced, of course there are others to meet too):

- Development of smart edge- and cloud-based building bricks for autonomous mobility interconnected with secure communication architectures and systems, particularly on secure edge/cloud data utilization
- Architectures and platforms (semiconductors, software, systems) on in-car, edge and cloud level
- C-ITS and cloud connectivity
- Driver's health monitoring
- Natively integrated telematics

- Cloud fusion of edge perception results into the digital twin
- Low-latency vehicle/edge/cloud connectivity
- Sensor-network fusion and AI-based perception
- Automated cloud-based learning and scenario generation
- Standardized data exchange for digital twins (via edge-cloud)
- Collaborating with standardization organizations on IoT, cloud, AI and automotive standardization for advanced and highly automated vehicles and intelligent transport systems.

Expected activities on "Dissemination and Impact on Standards":

One of the eight collaborative R&D clusters is dedicated to "Impact on Green Deal, Standardization, Certification, Ethical Aspects" in collaboration with the other seven R&D clusters.

- Evaluate the results of technology development and the experiences achieved in the demonstrators (use cases, in context of edge- and cloud computing, like robot taxi, virtual City routing, lessons from critical scenarios, trustworthy and secure AI in combination with cloud-based learning and scenario generation, C-ITS and cloud computing for multimodal connectivity, health monitoring supported by intelligent cloud data to achieve preventive maintenance, etc.),
- Raise awareness of existing and evolving standards in the addressed areas of interest (including IoT, Edge/cloud computing, connectivity, and others) and their application,
- Collaborate with/join relevant standardization groups in ISO, IEC, ETSI, and ISO/IEC JTC1 SC41 (IoT), SC 38 (Cloud computing and distributed platforms) and SC42 (AI) and related automotive standardization groups in ISO TC22 SC32 (road vehicles, e.g., automated driving systems, connected vehicles end-to-end safety), ISO TTC22 SC31 (Extended Vehicles) and others to contribute to standards and influence evolving standards based on AI4CSM experiences and results.
- Dissemination of the results among stakeholders, including standardization committees and authorities, and the industrial and scientific communities on fares, exhibitions and conferences
- Align stakeholders and relevant groups in the semiconductor industry and the automotive industry to support the green-deal initiative.

Acknowledgement:

AI4CSM project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 101007326. The JU receives support from the European Union's Horizon 2020 research and innovation programme. It is co-funded by the consortium members and grants from Germany, Netherlands, Czech Republic, Austria and Norway, Belgium, Italy, Latvia, India.

2.2.7 AURORAL: Architecture for Unified Regional and Open digital ecosystems for Smart Communities and Rural Areas Large scale application

URL/Reference:

Cordis: https://www.auroral.eu/#/

https://cordis.europa.eu/project/id/101016854

https://www.facebook.com/auroral-project/

https://www.instagram.com/auroral-project/

https://www.linkedin.com/in/auroral-project/

Abstract:

CO-DEVELOPMENT & INTEROPERABILITY

AURORAL focuses on delivering interoperable, open and integrated digital platforms that serve rural regions and contribute to a European, globally competitive, ecosystem of digital services and businesses to empower Smart Communities.

ECOSYSTEM & EMPOWERMENT

AURORAL aims to deliver a dense network of Smart Communities under a common multi-interoperability framework aimed at succeeding the just, fair and open digital transformation. AURORAL pilot regions implement the concept throughout Europe, targeting an investment platform of innovative services, primary focusing Smart Communities onto rural areas.

AURORAL digital environment is demonstrated by cost-efficient and flexible cross-domain applications through large-scale pilots in eight European regions: **Alentejo (PT), Southern Burgenland (AT), Penedès (ES), Piemont (IT), Lapland (FI), Hålogaland (NO) – Tourism, Hålogaland (NO) – Health, Västerbotten (SE).**

AURORAL is expected to be a driver of the emergence of a widespread network of Smart Communities in Europe and ultimately it is expected to contribute to balance urban and rural opportunities for all Europeans.

Starting and (target) end time of project:

01.1.2021-31.12.2024

Challenges:

In situations where life is at risk, technology and operators need to be efficient and well-coordinated. Technology for managing and navigating unstructured data need to in place and well-maintained. Knowledge of topography, available resources, previous experience and planning skills will be used to assist UAS (Unmanned Aerial System) in training, planning, tactical and operational missions.

The architecture of the AURORAL platform allow for sharing of horizontal services through agents. Data management is handled through VICINITY which offer a privacy-by-design approach. Thus, satellite data from ESA through the Copernicus network and situational alerts received from public databases can support local awareness. Furthermore, UAV planning tools from the aerial authorities provide information on no-fly zones and assist in relocating resources. Maps and GIS data with information on topography and infrastructure at land and at sea can further be used to identify areas of interest or concern. Other resources are based on public base maps, weather information and prognosis to further support local preparedness and contingency plans.

Collecting and processing data can be handled by service providers that offer the relevant subsets through the AURORAL platform. Thus, services can be replicated and scaled up based on need and location.

The health use case benefits from this approach. Scenarios such as search-and-alert along trails, search-and-rescue for lost persons in predefined geo-zones, assistance in on-site activities or observation along a predefined path can be built on shared resources.

In particular drones (UAV) hosting LiDAR, video and IR-camera supporting various filters, sensors measuring particles, humidity, temperature, geomagnetic changes are a source for up-to-date information relevant in assisting ongoing missions.

- Registering geolocations using coordinates alongside metadata, and identify points of interest based on dynamic geo-zones, i.e., interchangeable based on existing plans or to support planned or ongoing missions

- Local assignment of predefined settings based on priority and frequency, i.e., emergency, alert, regular services

- Automatic (in-situ) configuration of equipment based on task, i.e., transport of commodity vs. biological material, observation of area for changes in sediments, unauthorized entrance etc.

- Prognosis on scheduled actions based on machine-learning trained on rulesets for events such as entering no-fly zones, monitoring animal well-fare and tourists being caught in natural disasters (such as landslides, flooding, avalanches) at land or at sea.

- Automatic planning and strategy development and assisting in tactical and operational missions

- Establishing digital twin operating on dataspace with topographic data using content from UAV and previous missions

- Identify sources through open data, proprietary data and automatic registration

- Plan for flight and areas to traverse based on 5G coverage map and deploy equipment to alleviate poor reception in areas with ongoing rescue operations

- Integrate IoT devices from field personnel – volunteers, rescue dogs and mobile equipment

- Offering methodologies to reduce complexity in navigating static data and dynamic data from sensors.

Expected activities on "Dissemination and Impact on Standards":

Participation in ISO/IEC JTC 1/SC41:

- Further active participation in ISO/IEC work as mirror group leader.
- Follow up for new Task Forces and new work items.
- Participation in Working Groups for forthcoming standard actions.
- Cooperation using AIOTI for contribution to ISO/IEC TR and evaluation of the AIOTI reports and standards.

Participation in AIOTI:

- Participation in the AIOTI Board that will take place in IoT Week 2022 (Dublin, Ireland).
- Enrolled in WG Standardisation WP3 to participate in the SDOs exploration and alignment.
- Enrolled in WG Standardisation WP2 to actively contribute to the next release of HLA (v6.0).
- Contribution to white papers in data spaces subject.
- Enrolled in AIOTI WG Urban Society, WG Energy, WG Mobility, WG Agriculture, WG Building

2.2.8 Autonomous, scalablE, tRustworthy, intelligent European meta Operating System for the IoT edge-cloud continuum (aeROS)

URL/Reference:

https://aeros-project.eu/

Abstract:

The project will deliver common virtualised services to enable orchestration, virtual communication (network-related programmable functions), and efficient support for frugal, explainable AI and creation of distributed data-driven applications. aerOS will be based on continuum infrastructure elements like smart devices, tiny/far/near edge computing nodes, and public/private clouds (including virtual services and NetApps), providing scalable and secure access to applications and services while keeping its data autonomy. The solution will be generic and directly applicable to any vertical, cross-vertical business process, and several different physical or virtual platforms.

Starting and (target) end time of project:

01.09.2022 – 31.08.2025

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- Optimal orchestration
- Definition and implementation of distributed AI components with explain ability
- Definition and implementation of decentralised security, privacy and trust
- Specification and implementation of a data autonomy strategy for the IoT edge cloud continuum
- Intelligent realisation of Smart Network Functions
- Global ecosystem creation, maximisation of impact and open call conduction
- Definition, Deployment and Evaluation of real-life use cases

2.2.9 Flexible, scaLable, secUre, and decentralIseD Operating System (FluiDOS)

URL/Reference:

https://www.fluidos.eu/

Abstract:

This project will deliver a fluid, dynamic, scalable, and trustworthy computing continuum, spanning across devices and unifying edge and cloud in an energy-efficient manner. FluiDOS will build on consolidated operating systems and orchestration solutions, resource sharing in the computing continuum, AI-based optimisation for cost and energy, and a zero-trust paradigm to enable an open, collaborative ecosystem that will support European digital autonomy. Stakeholders will be involved through pilots and demonstrators in the fields of agriculture, energy, and logistics, challenging the project's ability to adapt to different environments and operating conditions, showcasing its true innovation potential

Starting and (target) end time of project:

01.09.2022 – 31.08.2025

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- OPTIMAL ORCHESTRATION Fluidify the edge and unify it with the cloud through a borderless, decentralised continuum leveraging automatic, autonomous resource discovery and integration.
- Move the gravity outside the data centre, creating a cross-provider, community-based computing and service fabric leveraging open-source software.
- Orchestrate services and hyper-distributed applications in a continuous, automated fashion over multiple devices and domains, leveraging energy-efficient AI learning algorithms and training for mobility/behaviour prediction and traffic forecasting.
- Introduce a Zero Trust paradigm aimed at securing the access of geographically scattered resources in an authenticated, authorised manner.
- Enable the emergence of a multi-stakeholder market of edge services and apps, independent from cloud providers and crucial to ensuring European digital autonomy.

2.2.10 Towards a functional continuum operating system (ICOS)

URL/Reference:

https://www.icos-project.eu/

Abstract:

This project will cover challenges of the IoT-edge-cloud paradigm, proposing an approach to embed a set of functionalities, defining an IoT-Cloud Operating System (ICOS). Its aim is to design, develop and validate a meta-operating system by addressing the challenges of device volatility and heterogeneity, continuum infrastructure virtualisation and diverse network connectivity, optimised and scalable service execution and performance, as well as resources consumptions. It will also cover security, privacy, and trust, and reduce integration costs and effective mitigation of cloud provider lock-in effects, in a data-driven system built on openness, adaptability, data sharing and a future edge market scenario for services and data.

Starting and (target) end time of project:

01.09.2022 – 31.08.2025

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- Design of an intelligent meta OS for the continuum
- Exploiting novel intelligent data and resource utilization methods
- Enforce trustworthy yet open operation
- Demonstrate the project outcomes in key relevant scenarios
- Building an open innovation environment and fostering the creation of new applications in the continuum as well as the science and engineering community

2.2.11 A META operating system for brokering hyper-distributed applications on cloud computing continuums (NebulOus)

URL/Reference:

https://cordis.europa.eu/project/id/101070516

Abstract:

NebulOus will contribute to research in cloud and fog computing brokerage, by introducing advanced methods to enable secure and optimal application provisioning, resource adaptation and reconfiguration. It will contribute to the cloud computing continuum through the development of a meta-operating system and platform to exploit edge and fog nodes, in conjunction with multi-cloud resources, to cope with requirements posed by low latency applications.

Starting and (target) end time of project:

01.09.2022 – 31.08.2025

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- Development of appropriate modelling methods and tools for describing the cloud computing continuum, application requirements, and data streams; these methods and tools will be used for assuring the QoS of the provisioned brokered services. Efficient comparison of available offerings, using appropriate multi-criteria decision-making methods that are able to consider all dimensions of consumer requirements.

- Intelligent applications, workflows and data streams management in the cloud computing continuum. Addressing in a unified manner the security aspects emerging in of transient cloud computing continuums (e.g. access control, secure network overlay etc.). Conducting and monitoring smart contracts-based service level agreements.

2.2.12 Next Generation Meta Operating System (NEMO)

URL/Reference:

https://meta-os.eu/

Abstract:

This project establishes itself as the gamechanger of the AIoT-edge-cloud continuum by introducing an open source, modular and cybersecure meta-operating system, leveraging on existing technologies and introducing novel concepts, methods, tools, testing and engagement campaigns. NEMO will bring intelligence closer to the data and make AI-as-a-Service an integral part of network self-organisation and micro-services execution orchestration. Its widespread penetration and massive acceptance will be achieved via new technology, pre-commercial exploitation components and liaison with open-source communities.

Starting and (target) end time of project:

01.09.2022 – 31.08.2025

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- Next Generation meta Operating System (mOS)
    - high availability, openness, adaptability and flexibility,
    - development and deployment simplicity,
    - optimized to IoT-to-Edge-to-Cloud continuum
- Federated meta Network Cluster Controller (mNCC)
    - Network management for existing/emerging IoT/5G/6G technologies
    - offering time-triggered multipath/multitenant/multi-cloud clusters
    - supporting zero-delay failback/self-healing "by design"
- "by-design" Secure Execution Environment(SEE)
    - Transparent sandbox creation
    - secure micro-services
    - unikernels (remote) execution
- meta-Orchestrator
    - optimal cluster construction
    - micro-services scheduling/ migration
    - respecting policies and KPIs, including significant reduction of the energy consumption and the CO2 footprint

- ZeroOps Management Tools
    - Plugin & Applications Life-Cycle Manager for over the air and on-time deployment
    - Monetization and Consensus-based Accounting (MOCA) towards flexible business models and pre-commercial exploitation
    - Intent Migration as a Service to automate manual processes and full-stack configurations
- Cybersecurity and policy/privacy at every stage of the mOS and during migration of micro-services.
    - Decentralized, cybersecure FML/DRL for IoT node decision or autonomous operations
    - CF-DRL against cyber-attacks
    - PRESS & policy compliance
    - Cybersecurity and unified/federated Access control

2.2.13 A lightweight software stack and synergetic meta-orchestration framework for the next generation compute continuum (NEPHELE)

URL/Reference:

https://nephele-project.eu/

Abstract:

This project's vision is to enable the efficient, reliable, and secure end-to-end orchestration of hyper distributed applications over a programmable infrastructure spanning across the cloud-edge-IoT continuum, removing existing openness and interoperability barriers in the convergence of IoT technologies against cloud and edge computing orchestration platforms, and introducing automation and decentralised intelligence mechanisms powered by 5G and distributed AI technologies. The outcomes will be demonstrated, validated, and evaluated in a set of use cases across vertical industries such as energy, healthcare, and logistics.

Starting and (target) end time of project:

01.09.2022 – 31.08.2025

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- To conceptualize and develop a breakthrough and open reference architecture for end-to-end and secure orchestration of hyper-distributed applications over IoT, edge and cloud infrastructure, tackling IoT technologies convergence, openness and interoperability and introducing intelligence and automation powered by 5G and distributed AI technologies.

- To develop a multi-layered lightweight software stack (VOStack) for virtualization of IoT devices and functions at the edge, aiming to tackle IoT technologies convergence and interoperability aspects, support distributed data management and analysis, autonomic networking and ad-hoc groups management functionalities, generic IoT-oriented functions (e.g., authentication, trust management, decentralized AI, blockchain) and interaction with cloud/edge computing orchestration mechanisms.

- To introduce and promote a softwarized hyper-distributed applications development ecosystem (based on ECLIPSE open-source development environments for IoT applications), where hyper-distributed application graphs can be composed by cloud/edge application functions, VOs and generic/supportive functions (IoT enablers) and deployed over programmable infrastructure in the compute continuum, enhancing productivity, reusability and quality of the produced applications and IoT data in various industries.

- To develop a synergetic meta-orchestration framework, able to manage deployments of hyperdistributed applications across the compute continuum from IoT-to-edge-to-cloud over trusted and distributed infrastructure, following a "system-of-systems" approach and activating in a modular way the most relevant and efficient orchestration mechanisms, while taking advantage of emerging 5G, AI and cybersecurity technologies.

2.2.14 High Performance, Edge And Cloud computing (HiPEAC)

URL/Reference:

https://cordis.europa.eu/project/id/101069836

Abstract:

HiPEAC will reinforce the development of Europe's computing ecosystem to support our digitalisation by guiding the research and innovation (R&I) of key emerging technologies, sectors, and value chains. Its goal is to strengthen European leadership in the global data economy and accelerate the digital and green transitions through human-centred innovation. This will be achieved by mobilising partnerships and stakeholders to provide roadmaps on the creation of next-generation computing technologies, infrastructures, and platforms. The aim is to contribute to the technological development and market uptake of advanced applications across the value chain. This next generation of computing will increase European autonomy in the data economy, which is required to support future hyper-distributed applications and provide opportunities for the digital transformation of our economy and society, new business models, economic growth, and job creation.

Starting and (target) end time of project:

01.12.2022 – 31.05.2025

IoT and/or Edge Computing research challenges:

The key aim is to support and contribute to rapid technological development, market uptake and digital autonomy for Europe in advanced digital technology (hardware and software) and applications across the whole European digital value chain. HiPEAC will do this by connecting and upscaling existing initiatives and efforts, by involving the key stakeholders, and by improving the conditions for large-scale market deployment. The next-generation computing and systems technologies and applications developed will increase European autonomy in the data economy. This is required to support future hyper-distributed applications and provide new opportunities for further disruptive digital transformation of the economy and society, new business models, economic growth, and job creation.

2.2.15 An Open Ecosystem for European strategic autonomy and interoperability across the computing continuum industry (OpenContinuum)

URL/Reference:

https://cordis.europa.eu/project/id/101070030

Abstract:

OpenContinuum supports the cloud-edge-IoT domain by focusing on the supply side of the computing continuum landscape. Its goal is to foster European strategic autonomy and interoperability through an open ecosystem for the computing continuum, with open source and open standards as two key enablers to be supported and leveraged throughout the community. Such an ecosystem will contain R&I projects in the cloud-edge-IoT portfolio to be coordinated, the diverse community evolved from the current cloud and IoT ones, with the addition of actors, initiatives, and significant alliances. The supply-side nature of OpenContinuum's agenda will orient the themes and focus of project activities but will not limit the scope of community building. The project's active landscaping and engagement work will bring the cloud and IoT communities together and express all points of view with a common understanding. It will then provide guidance to European actors to contribute to and lead open-source projects and standardisation efforts.

Starting and (target) end time of project:

01.09.2022 – 31.08.2024

IoT and/or Edge Computing research challenges:

The project has just been initiated. The following challenges are mentioned:

- baseline common open architecture for computing continuum research projects, reinforced collaboration between European public and private initiatives from Cloud to edge to IoT
- increased awareness on the importance of Open Source and standards for EU digital autonomy.

2.2.16 Unlocking the Cloud Edge IoT demand potential in Europe (Unlock-CEI)

URL/Reference:

https://cordis.europa.eu/project/id/101070571

Abstract:

Unlock-CEI's ambition is to unlock the potential for accelerating the deployment of the cloud-edge-IoT (CEI) computing continuum in Europe by focusing on demand-side drivers and challenges to identify technology driven innovation and business opportunities driving demand value chains. The project represents the cloudedge-IoT demand constituency, provides insights and guidance to Horizon Europe R&I projects, and contributes to a proactive dialogue with suppliers to encourage the development of an open European cloud-edge-IoT ecosystem. It focuses on emerging value chains where investment is needed to foster the deployment of the cloud-edge-IoT continuum through forthcoming large-scale pilots, which will ultimately foster European autonomy in the digital economy.

Starting and (target) end time of project:

01.06.2022 – 30.11.2024

IoT and/or Edge Computing research challenges:

The project pays specific attention to data governance issues, leveraging the relationship with industry-driven initiatives such as Gaia-X and CCAM (Connected, Co-operative & Automated Mobility) partnership. UNLOCK carries out a systematic assessment of the state of the open European CEI ecosystem and develop future market scenarios and related market pathways for the development of the open European CEI ecosystem. It will engage with industry stakeholders representing the most relevant industry value chains in Europe for CEI potential demand and develops a productive and effective interface between the demand constituency and the supply side, including the coordination of HE projects resulting from CL4-2021-DATA-01-05, CL4-2022-DATA-01-02, and CL4-2022-DATA-01-03 and Cluster 3 cybersecurity projects. It finally designs and implement a coordinated communication and dissemination strategy running throughout the lifetime of the project to create awareness about the whole of the European demand-side landscape.

2.2.17 Visualization of the Edge Computing EU funded ongoing projects landscape

This section provides a landscape visualization of the ongoing Edge Computing EU funded projects, introduced in this report.

The "Edge Computed EU funded ongoing projects landscape (Technology and Marketing Dimensions)", shown in **Figure 5**, is a graphical representation that highlights the main activity (up to the day of generating this representation) of the ongoing projects in the area of Edge Computing, according to the Business to Consumer (B2C) vs. Business to Business (B2B) (horizontal axis) and the Connectivity vs. Service & App (vertical axis) classifications.

The projection of these ongoing projects into vertical industry domains is shown in **Figure 6**.

The dimensions and the vertical/horizontal domains of the landscapes and the method used to visualize these ongoing projects into these landscapes shown in **Figure 9** and **Figure 10**, respectively, are the same ones as defined in Section 2.1.14.

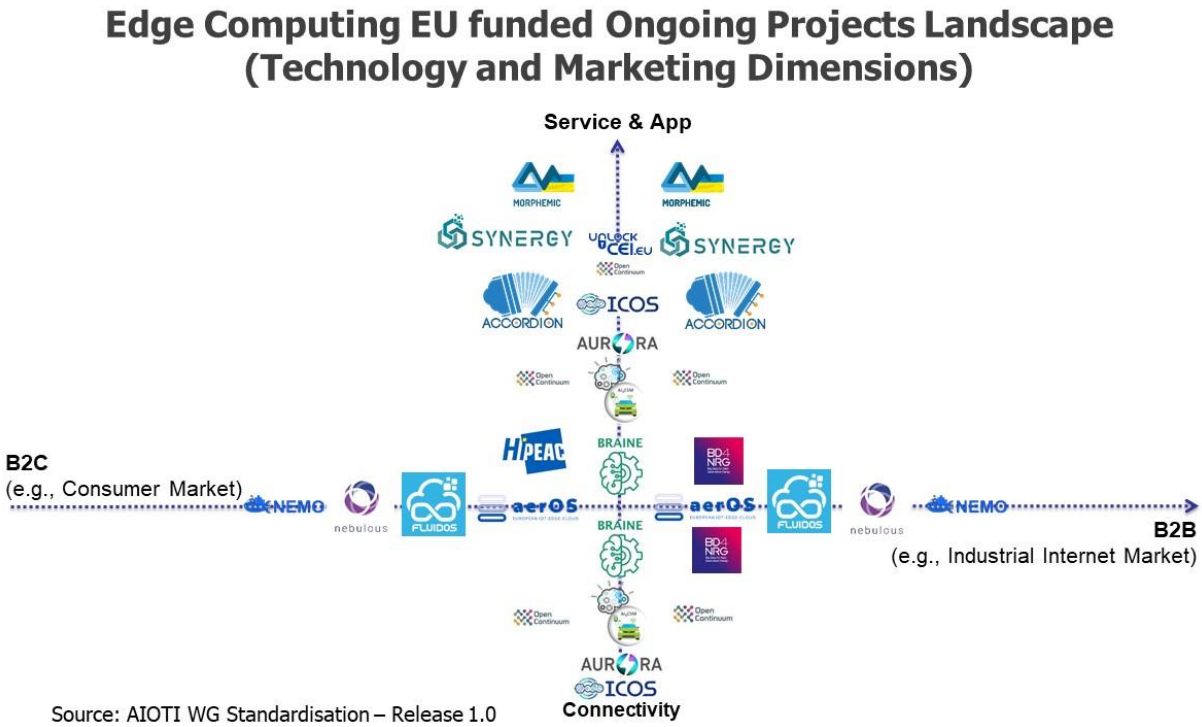


Figure 9: Edge Computing EU funded ongoing projects landscape, when Technology and Marketing Dimensions are used

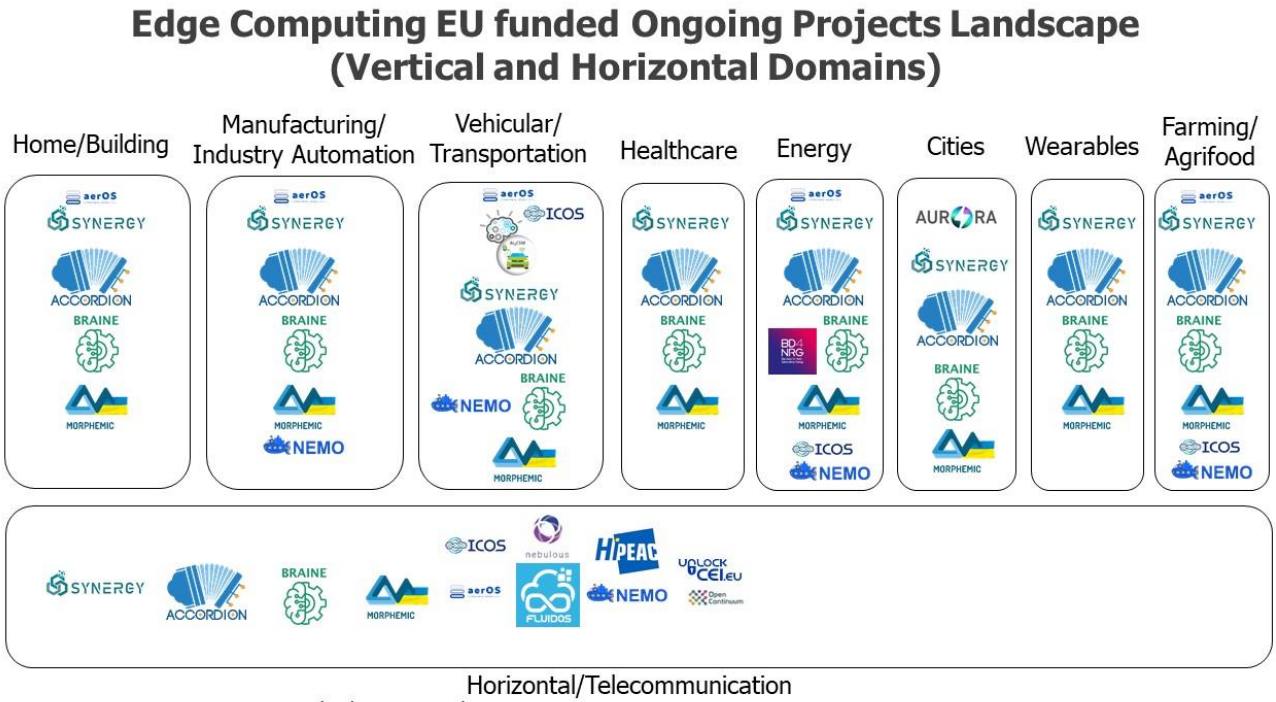


Figure 10: Edge Computing EU funded Ongoing Projects Projection on Vertical and Horizontal Domains

Annex I. Used Template for input collection

Proposed template for IoT and edge computing EU funded projects (version 25 February 2022)

This document includes the used template to collect contributions on IoT and edge computing EU funded projects; The key information to be collected is: (1) Title, (2) URL/Reference where information regarding the project can be found (Website, published documents (reports, position papers and reports, scientific papers), (3) abstract, (4) starting and (target) end time, (5) covered IoT and/or Edge Computing research challenges; Please fill in the Yellow coloured field; Note that if the required information is not available, please fill in "Unable to find information"

Title:

<<Please fill in the Project name>>

URL/Reference:

<<Location where information regarding the project can be found (Website, published documents (reports, position papers and reports, scientific papers). Please provide the URL/Reference of the project generated by the European Commission and the project official URL of your project (if available) >>

Abstract:

<<Provide the summary of the project, in particular emphasize the relation to IoT and/or edge computing>>

Starting and (target) end time of project:

<<Provide for the completed projects the start and end time; For the ongoing projects provide the starting and targeting end time>>

IoT and/or Edge Computing research challenges:

<< List the IoT and/or Edge Computing research challenges that are being focused in the EU funded projects>>

Expected activities on "Dissemination and Impact on Standards":

<<Please provide information on:

(1) List of IoT and/or Edge computing related of SDO and Alliances that the project will interact with, on standardisation activities,

(2) How the project want to interact and

(3) timescales for this interaction>>

Contributors

The document was written by several participants of the AIOTI WG Standardisation.

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Acknowledgements

About AIOTI

AIOTI is the multi-stakeholder platform for stimulating IoT and Edge Computing Innovation in Europe, bringing together small and large companies, academia, policy makers and end-users and representatives of society in an end-to-end approach. We work with partners in a global context. We strive to leverage, share and promote best practices in the IoT and Edge Computing ecosystems, be a one-stop point of information on all relevant aspects of IoT Innovation to its members while proactively addressing key issues and roadblocks for economic growth, acceptance and adoption of IoT and Edge Computing Innovation in society. AIOTI's contribution goes beyond technology and addresses horizontal elements across application domains, such as matchmaking and stimulating cooperation in IoT and Edge Computing ecosystems, creating joint research roadmaps, driving convergence of standards and interoperability and defining policies.