Boosting Digitalization Across European Regions: The AMBITIOUS Approach

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Abstract. AMBITIOUS [1] aims at providing a fundamental technological infrastructure, which will offer advanced data aggregation and clean-up, analytics, AI-enabled forecasting and secure information exchange mechanisms, via a transparent computing continuum infrastructure, to be integrated with existing, mature services of SMEs, unleashing for them yet unforeseen functionalities and opening up new pathways of commercial exploitation. The envisaged fundamental infrastructure will be provided via the deployment of technological pillars, which will interact with existing services towards supporting the envisioned functionalities. The purpose of a pillar is to provide the same generic functionalities to diverse services, demonstrated by a various set of specific use cases, as a concrete processing chain, aiming at avoiding unnecessary redundancy of resources and budget. This paper presents the focused use cases.

Keywords: 5G · AI · digital health · intelligent living · IoT · precise agriculture · real-time monitoring · safety · smart water management · Unmanned Aerial Vehicles (UAVs)

1 Introduction

Several activities for the development of digital solutions based on 5G technology are currently taking off in many parts of Europe, giving businesses and consumers many opportunities for connecting and efficiently interacting with other business partners,

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service providers and social networks. New ecosystems and value networks will evolve and many business opportunities will occur [2].

At the same time, 5G is not only a new radio access technology offering higher data rates and lower latencies, but it is considered as an enabler for supporting cutting edge tools and applications in the new era of computing continuum, mixing cloud, edge and Internet of Things (IoT) resources [3, 4]. 5G is being developed to be used in industry, especially for real-time applications like autonomous driving. To provide capability to industrial applications, the 5G network uses dedicated technologies like "slicing" [5] and "Edge computing" [6]. The resulting new technology platform enables developers to deploy their software not only centrally in the cloud and distributed in the end-users' laptops and mobile phones, but also at the network edge. This new architecture paves the way for new business models, value chains and deployment models offering Small- and Medium-sized Enterprises (SMEs) to serve their clients even better with highly responsive applications and services. Systems could be designed to be more fault tolerant and robust using a combination of backend components deployed centrally and closer to the end-users.

The main goal of AMBITIOUS [1] is to deliver a fundamental technological infrastructure, which will provide advanced data aggregation and clean-up, analytics, Artificial Intelligence- (AI-) enabled forecasting and secure information exchange mechanisms, via a transparent computing continuum infrastructure, to be integrated with existing, mature services (of at least Technology Readiness Level 6 (TRL6)) of the relevant stakeholders (i.e., SMEs), unleashing for them yet unforeseen functionalities and opening up new pathways of commercial exploitation. The envisaged fundamental infrastructure will be provided via the deployment of technological pillars, which will interact with existing services towards supporting the envisioned functionalities. The purpose of a "pillar" is to provide the same generic functionalities to diverse services (demonstrated by a diverse set of specific use cases) as a concrete processing chain, aiming at avoiding unnecessary redundancy of resources and budget.

A variety of sectors will be targeted including safety, smart water management, precise agriculture, as well as innovative digital health and wellbeing services. Our objectives are aligned with the smart specialization priority areas of the participating regions in the AMBITIOUS project. They are also long-term sustainable both from an ecological, social and economical viewpoint.

This paper presents the focused use cases. We group the considered use cases by using two main pillars, that is: (i) The *AIDA pillar* includes use cases which employ *AI-enabled Data Analytics and forecAsting*, and; (ii) the *AGORA pillar* covers the use cases which focus upon cooperation and data security in health and wellbeing applications. The paper is organized as follows: Sect. 2 presents the ambition and the main objectives of AMBITIOUS. Section 3 presents the AIDA use cases. The AGORA pillar use cases are investigated in Sect. 4. We conclude our remarks and present our future steps in Sect. 5.

2 Motivation

We are facing new challenges to combat climate change, urbanization, energy production, workers' safety and many other issues. In addition, large segments of today's economy are going digital with new services and novel solutions. For the European Union (EU) to be able to cope with all these challenges, it is vital that European companies, especially the SMEs, are at the forefront of digitalization. New digital solutions offer possibilities to reduce the carbon footprint while improving the life of millions of people with increased safety and security, and better comfort, thus drastically enhancing living standards. By being in the forefront of the digital era, European companies will also be able to export solutions and services, being competitive in a world market framework.

The AMBITIOUS project aims to address a number of the challenges that are important to European companies to be competitive on the world market. By advancing their expertise in areas such as data analytics, AI, 5G, computing continuum and IoT, the European SMEs can both address challenges within Europe, but also grow and become more competitive in the global market sector. The AMBITIOUS project is focused on ***safety***, ***smart water management***, ***precise agriculture***, and ***innovative digital health and wellbeing*** services, while at the same time it aims at improving competence and attractiveness in European SMEs. The core of the project is focused on scaling-up digital innovations, demonstrators of state-of-the-art technologies such as data analytics, AI-enabled prediction mechanisms, 5G, computing continuum and IoT sensing capabilities [7]. By providing several test beds in Sweden, Finland, Italy and Greece, participating SMEs will have first class access to multiple sites to perform early technology tests and, most importantly, to complete trials of digital products and services they intend to offer in the market.

AMBITIOUS project is divided in two technological pillars (i.e., AIDA and AGORA), providing a virtual backbend of raw data aggregation, management and analytics, generic AI-enabled forecasting mechanisms, and data communication and exchange platforms, all residing at a transparent computing-continuum infrastructure [8]. All these fundamental technologies will then be exploited by properly designed use cases, which will integrate their own specialized mature services with advanced data analytics, prediction and secure communication capabilities. These use cases will be evaluated "in-situ" at appropriate regional/inter-regional demonstration sites that will act as our "success stories" and which will attract new stakeholders (i.e., SMEs) willing to exploit the proposed machinery for the sake of their own services and business plans. The next sections present in more detail the considered use cases.

3 AIDA Pillar: AI-Enabled Data Analytics and ForecAsting

A typical scenario of a real-time monitoring and surveillance application of shared spaces and/or resources is to gather raw data (measurements), clean-up the inherent noise, visualize some kind of data analytics and then allow the human factor to make the well-thought and justified decisions towards improving the utilization of the entire system.

The role of the AIDA pillar is the provision of the necessary computing resources and functionalities that would constitute a sophisticated data analytics engine, as well

as an AI-enabled event forecasting module, which would be part of a sophisticated automated Decision Support System (DSS). This generic DSS platform, after being customized for a specific use case, would significantly assist the human controllers in making educated and justified decisions on the operation of the entire monitored system. Since all these functional requirements for providing advanced data analytics and AI-enabled forecasting services are typically computationally demanding, the AIDA pillar will employ computing-continuum technologies that blend cloud infrastructures with edge devices and IoT sensing sources, for exploiting the ambient computational power but also keeping computations "as close as possible" to the raw data sources.

To better illustrate our rationale, we provide two indicative scenarios: (i) *Pre-trained data, contributed from multiple sources* (e.g., from several use cases with the same business profile), could be created at cloud level as "social capital" and then be disseminated to several edge devices of particular stakeholders (e.g., SMEs) to provide advanced classification or forecasting tasks for the purposes of their own use cases. (ii) *Specific AI-enabled forecasting services* (e.g., localized weather forecasting reports) might be of interest for diverse use cases (e.g., marina surveillance and smart agriculture).

These forecasting services would then run in a public cloud infrastructure, avoiding redundancy either in computational efforts or in costs, and then feed all the interested applications with real-time streams of predictions and emergency alerts. The AIDA pillar comprises of the use cases discussed in the following sections.

3.1 Surveillance/Monitoring of Controlled Areas

This use case aims to integrate a mature IoT platform with an Artificial Intelligence Platform that spans from edge to cloud, in order to provide an AI-enabled forecasting prediction system, for marina surveillance and emergent incidents in real time. In this use case, images from digital cameras as well as information from various sensors (noise level, temperature and humidity measurement, etc.) will provide the raw data necessary to identify unexpected presence – or activity – within the main area of a marina and predict potential incidents (fire, collision, future congestion, etc.).

The existing smart marina demonstrator is based on an advanced IoT grid including sensors, actuators and cameras with edge computing capabilities, able to collect, process and aggregate data from diverse data sources. The existing platform brings in an existing visualization and monitoring set of services that provides real-time snapshots of the marina. The end-users (e.g., marina administrators, operators, safety offices, etc.) have access to all the necessary information about the vessel positions and their behaviour inside the harbor.

The integration of the AIDA pillar with the existing platform brings in a certain added value: The raw data generated for monitoring the marina will be collected and persisted to a computing-continuum infrastructure, at which the envisaged data analytics engine and the prediction models will be applied to provide meaningful feedback to the end-user, such as thorough analytics for the usage of the marina, prediction of short-term future incidents (e.g., potential collisions) and also long-term future incidents (e.g., availability of spaces in combination with current and future weather conditions or special events that might potentially be of interest to the customers of the marina).

A modern marina is a highly dynamic environment with a lot of traffic during peak periods. Digitalization of the marina processes and services is still at an early stage. Most of the existing ICT infrastructures offer monitoring capabilities of the marinas [9] and delegate the responsibility for event detection and decisions to personnel required for continuous monitoring of the entire operational area. On the other hand, more sophisticated services that detect events and predict the status and behaviour of customers in the marina based on history data is still an open issue and would facilitate and improve the operation of modern marina facilities.

Currently, the existing platform still lacks some important intelligent features and products that would allow the prediction of critical events (e.g., collision detection, weather forecasting, etc.) in a marina and would elevate the levels of safety for the marina guests. Additionally, new services that deliver prediction of the marina traffic in short/mid and long term and will optimize berth allocation and resource utilization are not yet available. The main objective of this use case is to integrate the existing platform with the envisioned AIDA pillar that will be developed within AMBITIOUS. Such an integration will "reflect" in cost reduction and considerably improved services to the yachters and to the marina operators. The components that will be produced by the AIDA pillar are a condition "*sine qua non*" that will enable the enrichment of the existing services portfolio. The existing services will be extended beyond the real-time monitoring of raw data and images from camera streams. AI-enabled forecasting technology will be utilized to produce semantically enriched information. The objectives of the new services and products developed will be addressed by the following components:

1. AIDA.UC1.1 – Detection: On-demand image annotation (specific for every field area) for creating datasets to enable accurate object detection. Each application – demonstrator's requirements define the demand for high-resolution images (number, quality, etc.). The images are received from the sensing devices (e.g., IP drones) and are sent then to a dedicated server through wireless network. Consequently, the set of images are annotated to create the necessary datasets to feed object identification algorithms (e.g., Detectron2[1], TensorFlow[2], etc.).

2. AIDA.UC1.2 – Open area surveillance: Video streaming that is transferrable almost in real-time to a cloud-based infrastructure. A UAV (Unmanned Aerial Vehicle or drone) transmits close-to-real-time video streams to a second device within a specific range. Onsite edge computing methods improve the data processing efficiency and transmit them to a media server, where the operation can be visualized and events of interests will be identified (e.g., detection of water pollution).

3. AIDA.UC1.3 – Berth allocation optimization: The existing platform will collect raw data related to berth reservation and usage and feed the AI-enabled berth usage prediction model that will be deployed. This prediction model will be trained and configured to enable prediction of future requests for reserving berths from yachters. The marina will be able to provision usage of its facilities in short/mid/long term and better manage required resources.

[1] https://github.com/facebookresearch/detectron2.

[2] https://www.tensorflow.org/.

3.2 Smart Water Management

There is a need to monitor various types of water resources in real-time. Understanding environmental conditions through the IoT and Artificial Intelligence enhances our awareness of our surroundings, proving invaluable for predicting and monitoring such scenarios [10]. Online regional flood inundation forecasting in urban areas is crucial for city flood management, especially as flood disasters become more frequent [11]. Monitoring of water tanks requires reliable data network and sensors as well as easy to use monitoring dashboard for end-users (for example employees of water treatment plants/harbors/other companies such as logistics). Another place, where real-time monitoring is needed, is related to storm water wells. Climate change and dense urban areas may cause city floods. To predict these, it is important to know how local precipitation impacts storm water wells' water level. Intelligent monitoring provides several benefits such as improved situational awareness and predictive maintenance capabilities, as well as urban planning to take account flood risky areas. However, building intelligent IoT based monitoring systems requires broad expertise from different domains and digital technologies (cloud platforms, mobile app development [12], data network, IoT).

The existing deployed solutions comprise of a constellation of pressure sensors installed throughout the network of water management. Prominent wireless technologies are used for collecting sensor values and present the overall state of the network in web dashboards. The administrators of the infrastructure are able not only to monitor the state of the water infrastructure but to control it as well through respective interconnected actuators that are able to control the flow of the water. However, more sophisticated mechanisms that detect and predict failures and water demands while they are highly expected from end-user, are still missing.

This use case aims to extend the existing solution and implement intelligent management tools for water supply and distribution networks. The derived tools will be designed in such a way so that they can be applied to any level of an existing infrastructure (raw water collection, storage, urban network of pipes) and for any scope (potable water supply or irrigation). The purpose of such a solution is to give the ability to the administrators of the network (water utility or industrial user) for remote monitoring, enhanced with meaningful insights on the water consumption and how the network operates, in general. In this context, IoT devices (smart meters and actuators) will be installed, which will interact with the water network infrastructure for data collection and water flow control.

The integration of the AIDA pillar with the existing platform brings in a certain added value: Novel edge and cloud computing services that will be developed within AMBITIOUS will execute various critical tasks of the system, such as: (i) data collection; (ii) data persistence; (iii) AI algorithms for pattern recognition, abnormality detection and localization; (iv) remote control of devices, and; (v) visualizations.

A water management system handles data and information with a high level of heterogeneity (e.g., events of various criticality, time series raw data, device controls, etc.) that generate various Quality-of-Service (QoS) demands. The optimal allocation of these operators to the nodes of this edge-cloud chain is determinant for the performance of the system. Parallel operations, queuing delays, available hardware and network resources are factors that need to be optimized to serve the application's functional and non-functional requirements without jeopardizing the total cost.

The main objective of this use case is to take advantage of the collected data and feed novel AI operators that span to all the four categories of analytics, that is: (i) Descriptive analytics will give a primary assessment of the data aiming to extract patterns from the water usage and detect unexpected behaviour based on historical data; (ii) diagnostic analytics will drill down to identify the reasons behind these deviations (e.g., water leakage, water theft, etc.) and an accurate location where the abnormalities occur; (iii) based on data availability, predictive analytics will be able to predict such events and facilitate their prevention, and finally; (iv) prescriptive analytics leveraged on all the aforementioned knowledge will facilitate the automatic response of the system to the events.

AMBITIOUS will develop and deploy new AI-enabled prediction services and data analytics services, hosted by an edge/cloud infrastructure, to allow event detection and reaction to be executed without depending on network availability and delays. The solutions will build upon an existing IoT infrastructure equipped with pressure sensors installed throughout the water distribution network. Data collection mechanisms will be responsible to gather and fuse the raw data for feeding prediction models able to detect critical events in water distribution network, such as leakages. The prompt detection of these events will allow newly created decision support modules to intervene through the network of actuators and reduce the water waste. In particular, the objectives of the new services and products developed will be addressed by the following components:

1. AIDA.UC2.1 - Leakage detection: This component will collect pressure values from sensors of the water distribution network and, based on proper/expected behaviour, will be able to detect abnormalities that indicate the presence of water leakage and estimate the location of the leakage. This will facilitate the fast intervention and resolution of water management problems and finally improve the quality of service offered to marina clients.

2. AIDA.UC2.2 - Prediction of water and energy needs: This component is trained (based on historical data) to predict the needs for water and energy on the upcoming period (short/mid/long). This functionality will be offered as a service that will support administrators to foresee the future water/energy demands, adjust operational costs and service costs charged to yachters.

3. AIDA.UC2.3 – Prediction of potential urban flood: This component will be trained to predict urban floods based on local precipitation and storm water wells' water level. This functionality will be offered as a service that will support cities and property owners to foresee the potential city floods and improve situational awareness and take potential risk account in the future urban planning. Service costs charged from cities and property owners.

3.3 Precision Agriculture

Precision agriculture is a farming management concept based on observing, measuring and responding to variability in crops, aiming to increase yield and efficiency [13]. More yield from fewer resources while retaining high-quality standards is an equation that farmers worldwide are looking to solve. The digitalization of agriculture with real-time data insights and control will enable more precise and efficient management of crops and livestock.

Currently, there is an established network of crops where sensor devices are deployed to monitor ambient and soil parameters. Such parameters regard air temperature/humidity, soil humidity, wind and solar radiation. The collected sets of data are stored and presented in real time to the producer, so as to have a clear overview on the climatic conditions of his cultivation. These data sets are utilized in collaboration with the agronomist to define an optimal irrigation plan. Irrigation is then controlled by a water management system comprised of water pipes and actuators that the producer can control remotely. While the existing solution facilitates the management of the cultivation, the producer is not able to predict how his irrigation plan combined with environmental conditions must be adjusted in future. Soil humidity along with ambient conditions are strongly related to the presence and growth of bacteria that might affect and deteriorate the production, in terms of volume and quality. Thus, early detection and/or prediction of plant disease will optimize the use of fertilizers and improve production.

This use case will focus on utilizing the smart devices and sensors under the existing IoT platform, enhanced with the sophisticated data analytics engine and an AI-enabled prediction module that will be developed within the AIDA pillar, to boost precision agriculture towards increased yields and efficiency. The IoT constellation that will be applied in this use case will encompass all these variabilities by installing on site and integrate with new AI-enabled cloud services the appropriate sensors and actuators that will monitor the conditions of the cultivation. Such conditions are described by environmental conditions (e.g., temperature and humidity), soil humidity, light, irrigation patterns, etc. Moreover, the early detection of various phyto-pathological factors will further benefit the crop in terms of volume and quality as well. Image acquisition and processing techniques will be employed for capturing diseases in plants caused by pathogens (infectious organisms) and environmental conditions (physiological factors).

The integration of the AIDA pillar with the existing platform brings in a certain added value: The new tools that will be provided will facilitate the entire operation of farming, thereby maximizing profits and minimizing excessive resource use. The adoption of such solution will support producers to become better stewards of the land by incorporating nutrient best management practices into their farming operation, while optimizing the use of resources (e.g., fertilizers and irrigation). Moreover, the exposure of the cultivation conditions and techniques to the end-user increases the traceability and the transparency of the agricultural product, thus reflecting to the increase of trust between consumers and producers.

The AIDA pillar will develop and deploy all the necessary AI-enabled prediction and data analytics services, hosted by an IoT/edge/cloud infrastructure aiming at deploying a computing-continuum approach for distributing data processing closer to the data source. Moreover, this use case will utilize the knowledge and expertise available in the consortium for incorporating drones in existing IoT infrastructures. Drones will be utilized for scanning the area of interest and extract valuable information from image acquisition, processing and classification. This approach will allow event detection and reaction to be executed without depending on network availability and communication delays. In particular, the new services will be addressed by the following components, which will be deployed and evaluated in the demonstration sites:

1. AIDA.UC3.1 – Plant disease detection: This component will use images captured by the respective equipment installed in drones to perform image processing and classification and detect the most common plant diseases that are present on the leaves of the plants.

2. AIDA.UC3.2 – Crop irrigation optimization: This component will be responsible to give a detailed overview of the crop's irrigation. Based on historical data and current environment conditions, it will be able to predict the water needs, soon. The benefits from this optimization are two-fold: (i) The producer gives his crop a more stable environment in terms of irrigation, thus allowing the delivery of a more consistent quality to the final product, and; (ii) optimized water management reflects a more efficient use of the water resources. This is maximized when the same water resources are shared among multiple producers. The AI-enabled prediction models generated in the context of this use case will be based on the Open Neural Network Exchange (ONNX) open standard[3] (where applicable) that allows framework interoperability for fast training, network architecture flexibility or inferencing on mobile devices.

3.4 Intelligent Living-as-a-Service

This use case aims to enhance the portfolio of care giving providers with innovative digital services [14]. Towards this digitalization, cutting-edge IoT technologies will be deployed to improve the living conditions and give primary healthcare assessment of people that belong to sensitive social groups, such as the elderly people.

The existing IoT services are used to collect and store data anonymized in backend systems in order to be evaluated by the medical expert. While this process facilitates the data management and evaluation of the medical condition of the monitored people, it still lacks to handle more urgent events where fast intervention is needed. Additionally, the active involvement of the care givers is a prerequisite for success.

The integration of the AIDA pillar with the existing platform brings in a certain added value to all these services, which is magnified on occasions when social distance measures and mobility restrictions are applied due to pandemic outbreaks. The main objectives are: (i) Collection and storage of ambient parameters and physiological human data for remote monitoring by healthcare providers; (ii) definition of the comfort zone of the end-user and detection of possible deviations that can cause discomfort; (iii) primary detection of health status degradation and identification of critical detection (e.g., fall detection); (iv) visual access to the space the end-user lives and acts when needed, and; (v) delivery of all the required functionality without compromising data security and privacy. The delivery of the aforementioned features raises significant challenges due to data heterogeneity and the criticality of the corresponding events. This introduces non-functional requirements with increased variability in execution time guarantees, fault tolerance and network availability.

The new AI-enabled prediction and data analytics services that will be deployed for the AIDA pillar, hosted by an IoT/edge/cloud infrastructure, will address functionalities issues. This approach will allow event detection and reaction to be executed without

[3] https://onnx.ai/.

depending on network availability and communication delays. Especially in the healthcare domain, the benefits from the decreased network delays and tolerance in network availability are crucial. In particular, the new services will be addressed by the following components, which will be deployed and evaluated in the demonstration sites:

1. AIDA.UC4.1 – Automated heart activity screening: ECG (ElectroCardioGram) signal will be collected by the edge unit, which will perform all the required tasks for a primary screening of heart activity. The early detection of arrhythmia or atrial fibrillation has been proven critical in most cases for patients with heart diseases.

2. AIDA.UC4.2 – Fall detection: Fall detection algorithms will be implemented and executed on edge devices based on acceleration data collected from wearables (e.g., smart watch). The AI models generated in the context of this use case will be based on the ONNX open standard (where applicable) that allows framework interoperability for fast training, network architecture flexibility or inferencing on mobile devices.

3.5 Innovative Digital Technologies for Real-Time Monitoring

Today, there are many challenges that are vital for the growth and prosperity in Europe. Lowered CO_2 emissions and safer working places and cities are high on up the agenda. New solutions are needed to: (i) Ensure the safety of both remote and physical actors/humans, and; (ii) support low-latency and secure communication between the digital and physical worlds. Through novel edge technologies and their enhanced operation, we can enable novel ways of blending the virtual and physical work.

The aim of this use case is to develop a holistic solution for supporting real-time data acquisition of high-bandwidth streams such as logistics, cameras, vibrations and acoustic and creating of Digital Twins [15]. By enabling massive amounts of important data that can reveal pending danger for workers at an industrial site, or citizens in a city, large savings in energy efficiency can be achieved by minimizing waste, unplanned stops in productions and avoidance of risks and hazardous situations.

The use of low-cost IoT sensors enables mass monitoring of various (e.g., industrial and logistics) sites and can be used for remote sensing of various parameters (e.g., gas levels, fire and smoke, position, unnatural behavior of motors and other rotating or vibrating devices, etc.). On the other hand, UAVs are capable of performing fully autonomous flights within structures while creating/updating a 3D map and performing object detection and recognition [16].

In this use case (AIDA.UC5), the following object types to recognize will be considered: (i) Humans in restricted areas and remote operations; (ii) unexpected situations; (iii) tools and machines, and; (iv) leakages, objects at the wrong place, etc. Here the main objective is to be able to integrate real-time data streams with an IoT Cloud solution for large-scale data processing. A multi-tier solution will be implemented both on device, at the Edge and Cloud infrastructures. 5G and other high-performance connectivity solutions will be used to allow high-resolution sensor data to be collected and later processed. The main benefit of such a solution is to increase safety in multiple industrial areas as well as to boost efficiency and productivity.

Today, UAVs are capable of performing various tasks with autonomous and by direct human control. However, when performing large-scale data collection, it is very important to achieve a higher level of autonomy since requiring human operations will drastically reduce scalability and increase costs. "Key" missing technologies are: (i) Integration platform for ultra-high bandwidth sensor data streams; (ii) UAVs with sensing in real-time using 5G; (iii) multi-tier (Edge) applications for data analysis and fusion using AI, and; (iv) real-time Digital Twins.

The AIDA.UC5 will complement and extend existing technologies with the missing features in order to "meet" the objectives.

This use case aims to develop solutions capable of data handling, devices management, security and visualization. The platform supports a multitude of communication technologies. Together with Edge computing, fusion of multiple sensors will be performed to reach a fully digitalized Digital Twin which can be used to increase safety and efficiency in multiple industrial scenarios, smart cities, logistics, etc. Furthermore, this use case will develop new solutions for managing both IoT data and 3D data. By data fusion of different data sources in the physical world into an accurate digital representation, it is possible to work in a 3D environment with a multitude of signal types to collect data from IoT devices, UAVs, Long-Term Evolution (LTE) devices, legacy systems, etc. The capability to fusion sensor data and 3D models for Digital Twins into a holistic solution is therefore a "key" enabler to create a large variety of different applications and solutions. Moreover, all necessary algorithms, which will run onboard at the drones as well as on the Edge cloud side, will be developed to meet requirements of the real-time IoT data and camera fusion.

This use case targets to define and implement distributed functionalities for task allocation and placement at the edge-cloud continuum. Data management at the edge, devices having adequate processing capability and fulfilling security protocols and features, visualization and orchestration of resources are aspects of our objectives. We are interested in remote operation, devices that can be programmed, supervised and remotely managed as well as autonomy of systems.

4 AGORA Pillar: Cooperation and Data Security in Health and Wellbeing Applications

Several Health and Wellbeing Applications are currently available for addressing focused targets. The development of such applications is usually made by very specialized SMEs that provide their vertical silos solution, from the patient side to the medical, including the technical configuration and management of the technological devices. SMEs are "forced" to behave this way because of poor digital standardization level and the lack of a stable and common reference framework in charge to guarantee cooperation and data security.

Within the AGORA pillar, the goal is not to develop new technology. Instead, the goal is to provide a comfortable environment where silos applications developed by different SMEs can share data (export, import) to generate more value from the collaboration. Data will be made available in a controlled way for the benefit of the cooperating applications and also for developing new services. In short, this AGORA platform will implement a

data economy management. A function dedicated to authentication, authorization and accounting will manage not only the controlled access to the data but it will also be capable of accounting for the use of data and other resources from an economical point of view. SME's interest in participating to AGORA is to share their data in a safe and controlled way, increasing their value from the integration with data from other applications, or from the AGORA platform itself. Moreover, their interest is also in accessing to functionalities provided by the platform instead of developing them in each application.

4.1 Telemedicine Platform for Continuous Remote Monitoring and Patient Support

COVID-19 pandemic has underlined the need to support patients at home through the remote monitoring system. Much of the information required to assess patient's health status can be attained electronically, thanks to technologies like wearables devices to monitor patients' physiological parameters and ePRO (electronic Patient Reported Outcomes) to collect subjective information provided by patients through their mobile phones. Frailty people and patients who need long-term follow-up and have difficulty reaching hospitals or treatment centers are facing the major issues. The continuous monitoring of the physiological parameters and remote support provided by medical staff allows health providers to monitor diseases and symptoms progression remotely and then virtually engage with patients to optimize care plans and to provide education on self-care, based on changes in the patient's condition.

This use case will be focused on telemonitoring and supporting patients with chronic respiratory diseases and patients diagnosed with cancer not hospitalized and not in critical conditions within their long-term treatment and follow-up. In this use case, the *MyHealth* telemedicine platform [17] will be exploited for the remote monitoring and support of patients, with the aim of promoting and improving the people's quality of life. *MyHealth* is a web and mobile platform that has been exploited in several clinical trials promoted by hospitals and clinical centres for the monitoring of patients with COVID-19 disease and patients suffering from cardiological and diabetic pathologies. *MyHealth* is a unique solution able to exchange data with hospital Electronic Health Records (EHR) and combines several technologies such as: software solution for doctor-patient communication, vocal assistant tool, telemonitoring system, medical and wearable devices to monitor patient physiological parameters and collect data on physical activities and rehabilitation performed by patients at home. The collected data are processed through Machine Learning (ML) and AI algorithms supporting a correct understanding of clinical manifestations, planning personalized care pathways, prevention programs and visits for online doctors [18].

The integration with the AGORA cooperation framework will allow *MyHealth* to offer new services for patients not in critical conditions within their long-term treatment and follow-up, such as personalized training and support services and personalized coaching and engagement services. The coupling with other services available through the AGORA framework will allow the development of new business strategies and applications in the healthcare sector to guarantee an improvement to patient's quality of life in their therapeutic and long-term care path.

4.2 Pediatric Cardiac Arrest Support Management (PediAppRREST)

Pediatric Cardiac Arrest (PCA), although rare, is associated with high mortality. *PediAppRREST* [19, 20] is a new application (app) to support the management of PCA by applying an iterative design approach (i.e., design–prototyping-evaluation iterative loops). At the beginning, a single-center non-randomized controlled simulation-based pilot study with pediatric residents was conducted. The effectiveness of the application in reducing deviations from guidelines recommendations in the management of PCA and its impact on time to critical actions has been evaluated in a multicentre, simulation-based, randomized controlled, three-parallel-arm study [21].

The current project's objective is to enhance the app design, as a tool; also to assess its effectiveness, as well as to measure the retention of the training information (learning impact) on the trainees. In addition to that, the project will aim to standardize the adoption of such tools for training institutions and healthcare professionals, by publishing the app and making it available. The current simulation-based setting of the study conducted does not provide data on actual patient outcomes and, therefore, future investigations during real-life, in-hospital, will be necessary to evaluate the actual effectiveness of the *PediAppRREST* app in clinical practice.

Thus, the app will be re-designed and developed, via integrating the feedback provided by the simulation. The app will then integrate services provided by the AGORA cooperation framework developed by Italtel S.p.A. (partner of the AMBITIOUS project) aimed to protect users' data and guarantee a user authentication procedure according to cybersecurity requirements specified by the respective framework. Such services will be integrated in the *PediAppRREST* application. Secondly, the app and the validated training protocol will be made available to other health educational private and public institutions through the AGORA cooperation framework, to improve the cooperation and collaboration at an inter-regional and international level. Thirdly, AGORA will implement certification procedures, by applying distributed ledger of resources allocation and usage methodology (blockchain) [22], for each completed training of operators in CardioPulmonary Resuscitation (CPR) manoeuvres. The training will be recorded in a blockchain, thus creating an international record of training certificates whose authenticity cannot be counterfeit, being available for both physicians as well as training institutions.

5 Discussion

AMBITIOUS aims to support innovative SMEs with access to 5G test sites and a competence network. Furthermore, the planned inter-regional collaboration between Finnish, Swedish, Italian and Greek companies and universities will provide a multi-disciplinary competence body that will benefit each partner and enable faster technology development, field testing and shorten the time-to-market. In addition, this will be further strengthened by promoting the use of digital technologies such as Cloud, AI, 5G and IoT combined with, *for example*, UAVs, smart cameras and sensor systems.

For medium term benefits, this project will assist the participating companies to increase their digitalization competence and improve their technology capabilities. The project's results contribute to new innovations, products and solutions that will strengthen EU's competitiveness. For long term impact, the project aims to deliver results to the

participating SMEs and society. The obtained results will improve work safety and the environment, while promoting inter-regional collaboration within the EU. This innovative environment, combined with access to 5G testbeds, will promote the development of new innovations and digital solutions in AI, UAVs, 5G, IoT, etc.

The overall aim of the project is to enable rapid enhancements for today's state of the solutions and deliver novel technological improvements that can be transformed soon into new products, services and ICT solutions.

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