White Paper - AFarCloud

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1. Abstract

Like other application domains, farming is undergoing a transition towards digitalization as major technologies are developing at a high pace such as autonomous vehicles, sensors and actuators, wireless communication, cloud computing, etc. The use of these rising trends ultimately affects the amount/quality of the food that is put on each of our plates.

Starting in 2018 as a research and development project funded by the EU program ECSEL, the AFarCloud (Aggregate Farming in the Cloud) project aims to provide advanced ICT solutions for the agriculture world. With the usage of cutting-edge technologies such as cloud computing, big data, and deterministic machine learning algorithms, the AFarCloud intends to be the be-all and end-all solution for every farming business.

Our goal is to improve upon the existing methods in the field and incorporate them into a single platform that both supports legacy technologies like ISOBUS as well as introduces new viable solutions to enhance farming in every aspect possible. By doing so, we believe that AFarCloud can enable new solutions to every farm, bring in progress to optimize the processes in the agriculture sector, and reduce the costs by increasing the efficiency of business operations.

While still being a project that is in development, the AFarCloud have reached many exciting milestones that break ground in the farming sector. As instance thereof are the business model of farming-as-a-service (FaaS) as well as various technological advancements that were developed.

This document provides an overview of the AFarCloud project by describing the methodological approach utilized, the technologies as well as methods we use within it, and how you and likewise your business could benefit from using it. This is divided into the following chapters:

- Development methodology
- Overview of Farming-as-a-service
- Technologies used in the project
- Solutions offered within the project

2. Development Methodology

As an ECSEL research project, the AFarCloud project consists of a varied consortium, which contains 56 organizations from 13 European countries, who is working together to bring the project's vision to fruition. The development teams are comprised of differently-sized industrial companies, research institutes and universities, each with its own capabilities and skills to contribute to the larger whole.

The work and developments described in the following chapters followed a test-driven and iterative development methodology all throughout. The developed components were deployed in various demonstration scenarios on site in order to test specific functionalities and validate the project's results inside of relevant environments located in different European regions.

The results of said demonstrations were evaluated, analysed, and later adapted or adjusted according to the findings made on the field as well as users' feedback. After each scenario demonstration we continued to work on the next iteration of the project, with each new one further growing the scope of the components and devices integrated into our platform. One such example is illustrated in figure 1, which depicts the methodology for developing autonomous systems in the agriculture domain.

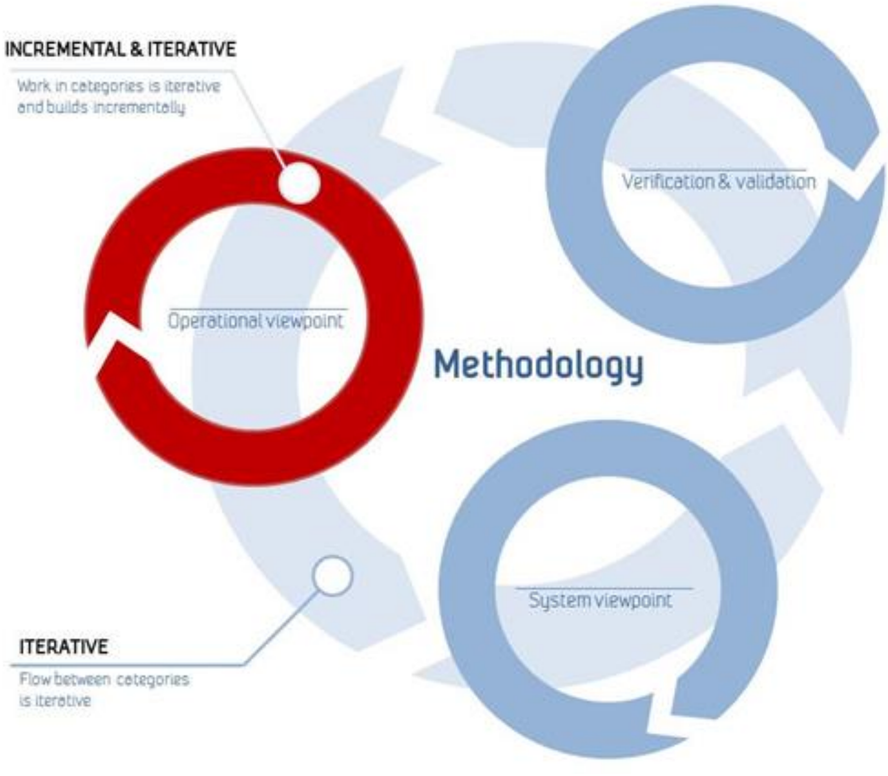

Figure 1: The methodology for analysis of autonomous operations

The autonomous operation is analysed from three iterative viewpoints; the *Operational Viewpoint*, the *System Viewpoint*, and the *Verification and Validation Viewpoint* as shown above. Each iteration goes through these viewpoints and adjusts future work according to the results, thus resulting operations that are more finely tuned.

3. Overview of Farming-as-a-service

In everyday life we buy services that provide us something that we need or like to use. For a company this translates to an investment for labour, hardware, and software to use a service and/or product. This inevitable investment may be high and in many cases the tendency is to minimize the expenses as much as possible.

To assist companies in alleviating their costs of investment, new opportunities have appeared which are generally called “Software as a service” (SaaS). In SaaS the company can purchase only the functionality to the needed software tool instead of purchasing the whole software.

Farming as a Service (FaaS) is based on the general concept of SaaS, albeit modified to agriculture. In general, a FaaS solution provides a functionality to the end user, which means software or cloud-based solutions for a certain task they have. It may also include hardware, but in such cases, the end user does not purchase the hardware itself but a service that provides it. The machinery involved in precision farming solutions can be costly to individual farmers. Service based solutions are one option for this challenge as they do not involve large capital investments.

The ultimate goal of the AFarCloud project is to ease the farmer’s everyday life through the integration of software, sensors, and farm machinery. For the farmer, the AFarCloud solution is a FaaS which provides tools and options that enable the farmer doing tasks more easily.

An instance of AFarCloud’s tech is if information about low crop growth is gained via NDVI (normalized difference vegetation index), the user can check the soil moisture sensor status from that specific field through AFarCloud. One of the unique solutions that AFarCloud offers is that a farmer can send a drone or a robot for a mission to take specific measurements of the object.

The system is developed in multiple applications for several platforms like Windows, mobile devices, and web interfaces. The main data storage and processing however is placed on cloud services as to reduce the investment needed from the farmer’s side. The customer has access to those functionalities which are included in the modules, which s/he purchases.

The intuitive user-friendly interface is included in the service package and through it the user can, for example, receive warnings and notifications about the current situation based on data acquired by a drone sent there or the sensors in that location.

The data is processed remotely on the cloud and the user receives a set of recommendations as well as the available real-time information needed for decision making in the farm. This consequently presents more detailed information about the change or parameters that can be related to the change.

Therefore, the AFarCloud platform opens new business opportunities by offering precision farming services, such as yield data interpretation and carbon footprint calculation for milk production, which would be able to maximize the productivity of the resources to farmers.

AFarCloud also benefits both the service provider and the clients with its big data capabilities, as the shared information it will gather allows for taking preventive actions instead of reactions.

4. Technologies Used

Technologies used in the AFarCloud platform cover the whole process of transforming data to information and knowledge, making it accessible and allowing for interactions with it to efficiently manage the farm. Different categories of technologies can be identified, and we have divided them into the following categories:

1. Data collection and processing
2. Data storage
3. Data analysis
4. Decision-support system
5. Supporting components

When speaking about these technologies, we were fully aware that standards and technical specifications are playing an important role in the process of integrating AFarCloud to existing workflows to ensure interoperability and replaceability. Therefore, we made it our mission to incorporate as many of them as possible while planning to add more in the future.

4.1. Data Collection and Processing

Components for data collection in AFarCloud are sensors, IoT devices, smart devices, vehicles or any technical component that is measuring and transmitting data. These measurements can be provided to other components automatically or by the operator's intervention.

We built the hardware and software infrastructure for monitoring crops and livestock by developing sensors, actuators, wireless IoT networks, and systems' prototypes. The software is for sensors' signal processing and data formatting at the edge, electronics as well as sensor system control, and wireless communication.

The sensors' systems are based on commercial-of-the-shelf components and are specifically modified and likewise developed to obtain a monitoring system for the needs of each functionality and field installation requirements. The design of the sensing system is done for low-power consumption to help reduce maintenance costs.

The main sensors' systems used for crops, i.e., for monitoring them, the soil properties, and their environment are:

- Soil sensors measuring soil water content, humidity, electrical conductivity, and temperature. The data is used mainly for water optimization on the field, vineyard, and greenhouse. The used commercial soil sensors are from Decagon and Meter group.
- Solar radiation sensor for vineyards that also measures temperature and humidity allows to calculate the evapotranspiration. The solar pyranometer is from Davis Instruments.
- Environmental sensors for field, vineyard, and greenhouse: Temperature and humidity sensor (AMS ENS210), hygrometer and barometer (Bosch Sensortec), weather station (Renkforce) for local climate data to be correlated to soil and crops data.

- As to environmental sensors, work is in progress to use passive sensors that can be read from unmanned aerial vehicles (UAV) ether by Bluetooth low energy (BLE) or by Radio Frequency Identification (RFID) from UAVs that have active reader integrated on them for energizing and reading the sensor data.
- Flow meter to monitor the amount of water used for daily irrigation in a greenhouse.
- The utilization of UAVs with embedded sensors simplifies monitoring of big crops' areas. The sensors are multispectral, NIR (Near-infrared spectroscopy), electro-optical and infrared (by Maritime robotics), VNIR (visible and near-infrared, by Termisk Systemteknik), and imaging for measuring grass growth.
- Image Processing software for determining the presence of weed, dead plants, and non-well-watered regions in a vineyard (Rovimatica, Acciona).
- In relation to the work on the crop field, we have developments for machine data from tractor CANbus for position (GNSS), engine speed, velocity as well as from an ISObus implement for sprayer rate (by AVL GmbH).

Regarding livestock, there are many parameters that we can monitor in AFarCloud:

- Environmental sensors inside a cowshed that measure air temperature, humidity, gasses such as carbon dioxide and methane (from SenseAir).
- A hand-held (Near InfraRed) NIR sensor (NIRONE Sensor developed by Spectral Engines) which measures the silage's DM (dry matter) and CP (crude protein) that are used as inputs for TMR (Total Mixed Ration) feeding. In dairy and beef production farms the quality of silage plays and important role and is essential to animal wellbeing and performance. There are many nutritional parameters that contribute to the overall silage and feed quality. The two parameters that have a high impact in the quality are the DM and CP contents. Many farms prepare feed using a TMR method, where feeds are combined into a single mix that a has a pre-determined optimal nutrient content for the cows.
- The cereals nutrition and moisture content of fresh grass and silage is done by VIS-NIR hyperspectral and miniature spectrometer technologies in development for a mobile system.
- The cows can be monitored for their outdoor activities (position, movements, habits, etc.) by using collars (Sensowave) that have embedded accelerometer and GNSS (Global Navigation Satellite System).
- Air temperature, humidity, and pressure are measured via animal collars for to monitor their environment and wellbeing.
- Collecting data from livestock movement (using collars and/or imaging camera) to obtain classification and behaviour classification. This also requires machine learning/ AI models and training that used algorithms that we developed (Imagimob, Qamcom).
- Indoor localization of cows done by Real Time Location Systems (RTLS) for which eTag RFID earmark, UWB (Ultra-Wide Band), and BLE are used.
- Ruminal sensors are under development for measuring the pH in the rumen as an indicator of the metabolic processes, and the redox / ORP (Oxidoreduction potential) for getting information on the fermentation processes in rumen (microbiota).

The developed actuators in AFarCloud are utilized for:

- Non-Thermal plasma sanitation and the chemical and microbiological treatment for air, water and surfaces contamination in greenhouses and slaughterhouses.
- Rooftop closing/opening for environmental control in greenhouses.
- Machine data from a tractor's ISObus implement for spraying nozzles.

The sensors' data is sent to the Semantic Middleware for data processing, semantic formatting, and storage in the AFarCloud database such that algorithms can be developed for data analysis and system configurations, environment characterisation, coordination, and decision support.

We gather this data automatically to the cloud and analyse it to help reach the full potential of farming operations. The small size of the sensors together with their high sensitivity make them a good fit for practical use in farms. Automatic transference of data is common for the most of modern sensors and IoT devices utilizing low power IoT transfer networks.

Data from these sensors is sent wirelessly by LoRaWAN, SigFox, NB-IoT, BLE, RFID, 3G/4G technologies, depending on the communication coverage, thus supporting a large array of communication channels. All these reading systems are stationary. Some of our work that is in progress is for autonomous data collection based on RFID and BLE with sensor localization capabilities.

An example of a data collection component used in the AFarCloud scenario is AgroNode. AgroNode is a radio-based data logger device primarily intended to be used in agriculture scenario (but not limited to) as device for online measuring of agro-technical phenomena directly on the field. The device interoperates with a wide spectrum of sensors for agriculture and industry.

It is able to permanently save sensor measurement data and/or make them accessible online. Thanks to it being solar powered, its life span is, from a device point of view, virtually unlimited. AgroNode can utilize various radio transfer technologies, such as GPRS, SigFox, IQRF, LoRa, and NB-IoT.

4.2. Data Storage

Components for storage of data are represented by different data management systems - traditional object-relational database management systems, modern NoSQL systems, semantic repositories and data cloud infrastructures. The main goal of this component layer is to store data persistently and consistent for further processing. Data is stored and retrieved in a scenario-based manner on the AFarCloud database. If suitable and useful information exists in external databases, such sources can be used to support data analysis.

The main elements of the AFarCloud architecture that guarantee interoperability at the syntactic and semantic levels are the AFarCloud Data and Information Model and the Semantic Middleware. The Information Model clearly establishes concepts and attributes of the information managed in AFarCloud, whereas the Data Model defines the data format and the messages that the AFarCloud components will interchange either among them, with external components, or elements that will be used to interact with AFarCloud.

Therefore, they are key elements that enable interoperability of the AFarCloud elements among themselves and with other external assets. Well-known and accepted standards and vocabularies from different application domains, including farming, are used.

4.3. Data Analysis

To analyse the large amounts of varying data we use an environmental characterization, which utilizes data that can come from the sensors, drones, images, weather, third parties, historic data, etc.

Environmental characterization explores different ways of pre-processing, processing, and analysing data essentially provided by sensors deployed in most AFarCloud demonstrators, in the form of raw or pre-processed data, either numerical or images and video, stored in AFarCloud repositories and made available to the developed algorithms and tools through queries via AFarCloud's Data Query middleware component.

Environmental characterization involves the following steps:

a) Pre-processing and formatting of the 'raw' data,
b) Providing algorithms for livestock and crop quality,
c) Monitoring of the cloud resources of the cloud-based environment platform and of environmental factors along with their impact.

The environmental characterization platform is responsible of the local (edge) data formatting, filtering, preparation (e.g. preliminary data fusion) to get the sensors and actuators data in the right format to be further sent to the AFarCloud Middleware for fusion, storage and subsequent usage by algorithms developers and visualization in the AFarCloud platform, such as the mission management tool (MMT), decision support system (DSS) and knowledge extractor (KE).

As any other middleware, AFarCloud semantic middleware aims at providing a kind of abstraction layer that will let high level applications readily access to data and services provided by heterogeneous elements, components, or systems.

Moreover, the AFarCloud semantic middleware also guarantees that all the transactions comply with the AFarCloud data model. It also defines the interactions protocol: which messages are exchanged, in which order they are interchanged, and what the scope of the interaction is.

AFarCloud semantic middleware includes various components.

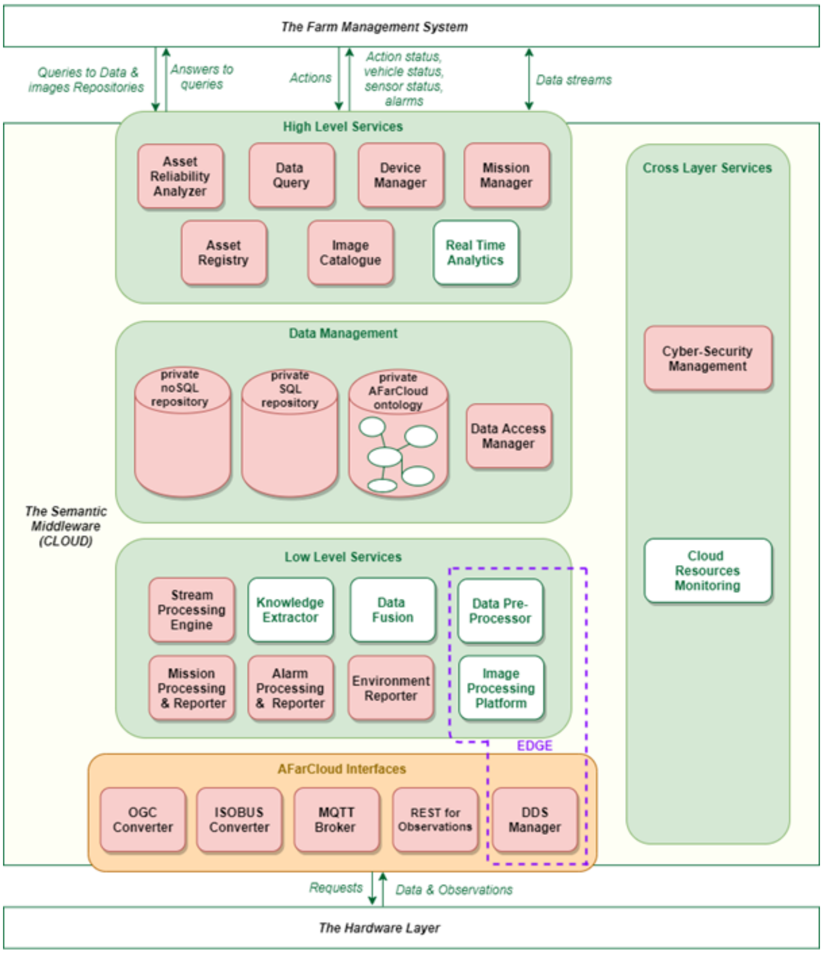

Figure 2. AFarCloud architecture.

The variety of use cases in AFarCloud is large. In some pre-processing is needed on a sensor level and the technologies used for this purpose vary from analogue on-chip capacities via signal processing (Direction of Arrival, DoA) to solution specific libraries (e.g. AgroNode, SensLog).

In most cases, after retrieving the information from dataspace, the data processing is done using for example Azure Event Hub, Azure Stream Analytics, Apache Kafka. In addition to existing general processing tools, custom tools have been created using Microsoft .NET -architecture, JavaScript libraries, Kubernetes infrastructure, OpenCV library for Python, Pytorch, native Kotlin, Microsoft COCO and Yolo algorithm.

Each scenario and sensors/hardware have their specificity, and this is reflected in the developed algorithms. An example of this are the spectral data/images collected by drones that need to be processed in a particular way based on their final application. Even if the images are of RGB type, they need to be pre-processed differently for the livestock scenario than for crops. Or even for the same application, e.g. pattern behaviour in livestock, the image angle and distance is different for pattern recognition for animal localization than for bulling.

Additionally, how the images are acquired also plays an important role, as multispectral images can have 1 wavelength per acquisition column or 5 bands of frequencies. Most of the wireless soil sensors networks contain commercial soil sensors that have in-built data pre-processing (e.g. temperature). This type of sensors does not need specific data pre-processing.

However, extra features have been added to some of the soil sensors, such as conversion at the device level and not in the cloud or the voltage level of an analogue sensor to a percentage value. The inertial sensors from collars, even if some of them are commercial devices, need data pre-processing as this type of sensors require extra signal processing (e.g., for drift).

A variety of data analysis was completed: simple algorithms (such as clustering, outlier detection or basic image analysis functions) and risk analysis combining information from several sources, complex machine learning algorithms and fully-connected Deep Neural Network and Convolutional Neural Network, physico-mathematical models and lifecycle analysis depending on the needs of each specific case. In some cases, the processing needs to be done closer to the location of the application where edge AI computing was used as a solution.

All the cases have their own needs of information and that is why common information descriptions and standards have been used to harmonise data exchange as much as possible. This approach was specifically applied in animal data exchange (NCDX) and in soil quality indicators. This has been implemented by utilizing commonly used modern web-based technologies, such as REST and JSON.

4.4. Decision-Support System

One of the biggest trends in the agricultural sector is the application of autonomous operations for both the software and the machinery components. To allow for such independent work we have developed several technologies that enable it on 2 levels:

1. Execution of tasks' level.
2. User's decisions' level.

For the former, we have created planning algorithms that allow for the scheduling and coordination of various jobs, ranging from sensor data collection to scanning a field to taking a photograph of an area that a wild boar has destroyed. We currently support the planning of 10-15 robotic systems (drones, ground vehicles) that are involved in 50-60 tasks.

For the latter we made a decision-support system, which pre-processes, analyzes, and refines collected raw data to provide practical information about a phenomenon or a situation in the farm. Based on the data analysis, the decisions can be made and collected information further utilized more efficiently in the farm's operative management.

The decision-support is provided in different forms; it can be just a set of calculations, it can represent data by charts and tables, maps, or other interactive graphical visualizations. An example of an integrated system of data storage, processing and publication used in a AFarCloud scenario is SensLog. SensLog is an open sensor data management solution for receiving, storing, managing, analyzing, and presenting sensor data.

This solution is suitable for static in-situ sensors, sensors deployed on mobile carriers and Volunteered geographic information (VGI) gathered by smart devices. SensLog stores data in a relational data model which is based on the ISO 19156 Observations & Measurements standard and contains additional extensions. SensLog provides a REST API with JSON data encoding. A system of "Connectors" improves interoperability of the solution.

An example of a library for building a decision-support system in the form of web map application is HSLayers-NG. HSLayers-NG is a library which extends web mapping library OpenLayers 6 and provides a foundation to build map GUI and extra components such as layer manager, permalink generating, styling of vector features, including OpenGIS® Web Map Service Interface Standard (WMS) layers to the map in a user-friendly way etc.

4.5. Supporting Components

The environmental characterization platform provides the Cloud Resource Discovery component, whose main aim is to provide the DevOps teams, namely the developers of the AFarCloud platform, with the means to be able and search for the cloud services that best match their requirements out of a catalogue. In addition, this component is the one that allows keeping track of the instances that have been deployed for the proper function of the AFarCloud platform through a one stop shop.

Supporting components are mainly oriented on easier data usage and information searching. With a lot of formats and files exported, it is complicated for the common user to manage the importing of data to the system from different sources and offline systems. On the other side of the data line, it is sometimes necessary to find additional data provided by other systems or different data producers. A typical example of external data suitable for FaaS is thematic spatial data. There are a lot of different providers of spatial data supplying data as datasets, services or direct applications.

An example of supporting applications that help users in finding appropriate thematic spatial data is Micka. "(Open)Micka" is a tool which is a set of libraries and a web application for the management and discovery of geospatial (meta)data. It can discover services, datasets and applications providing spatial data in various forms. It allows the user to filter in the catalogue by different attributes.

An additional supporting component used for data management is Layman. Layman is used for easy management, access control, and publishing of vector based spatial data and their visualisations. Also, a powerful REST API is available, where users can upload data in different formats to the storage and then work with it in the form of services, thus providing standardized access.

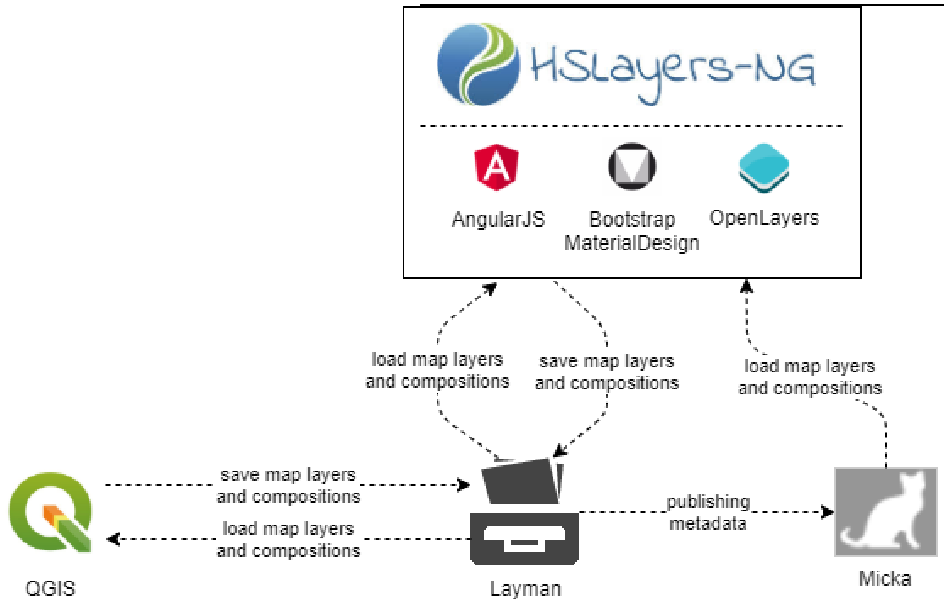

Figure 3. AFarCloud supporting applications.

In the realm of automated farming, AFarCloud is developing a general Unmanned Aerial System (UAS) intended to address the needs of the agricultural sector. The AFarCloud is compatible with vehicles, drones, tractors, and autonomous ground vehicles (AGVs), with the following list providing a short overview thereof:

- Several drone platforms, ISO-bus compatible tractors and UGVs by different vendors have been integrated with the AFarCloud system. Three examples of drone platforms integrated with the AFarCloud system:
  1. Maritime Robotics UAS is a fixed-wing platform that has a much longer range than all the other (multi-copter) AFarCloud UAS. The idea is that such a platform can remain airborne for long periods of time for various mapping or surveillance tasks. For some applications, it is planned to be available in the air during a normal farmer workday, performing automated and on-demand tasks supporting the running of the farm.
  2. In collaboration, PMDFC and BEV developed a custom drone, aimed at the agricultural sector, which is denominated as HEIFU (Hexa Exterior Intelligent Flying Unit). The versatile HEIFU design provides an easy transportation method and allows the installation of different modules to fulfil the user needs. This is an open platform that allows integration of different inputs and is used to run multiple tasks, such as image processing, data relaying, remote control of drone, among others. HEIFU can be used with different communication systems, such as mobile network or Wi-Fi connection.
  3. CENT has two types of UAS platforms available, fully commercial and self-developed custom drones, aimed for various sectors such as industrial, agricultural, public safety and many other. At the moment, there are two large drones available;
     - DJI S900 is a hexacopter with a dimension of 900 mm in the diagonal wheelbase, weight is around 6.28 kg including battery, and hovering time is around 20 min.
     - Tarot X4 is a quadcopter with a dimension of 960 mm in the diagonal wheelbase, weight is around 5.3 kg including battery, and hovering time is around 25 min.

To allow for integration of autonomous vehicles we developed specific features in the Mission Management Tool (MMT). The MMT facilitates operation with multiple autonomous robots and provides the option to incorporate an adaptive autonomy architecture, i.e, the degree of autonomy can change over the course of the mission. This can allow an operator to take manual control of a vehicle when needed or to allow the UAS to adapt to changes in the environment.

To ease the process of adding UAS to AFarCloud, we also made a specification of how the UAS can be integrated into the Platform. Furthermore, we are developing in AFarCloud several sensors and algorithms that are needed for increased levels of autonomy, such as dynamic collision avoidance algorithms. Advanced perception for increased insight into the (semi-)autonomous operations is possible through the integration of the high-level awareness function in the MMT.

To help the development of secure autonomous solutions, a cyber security assessment tool was developed, which considers the security standard IEC 62443 from the Industrial Automation Control domain with relevant adaptions for the applications in agriculture.

Beyond that, the unmanned aerial system (UAS) payloads and applications that were developed as part of the project include the following:

- Autonomous UAS charging.
- UAS-based data collection from remote sensors.
- UAS-based low altitude grass analysis.
- UAS-based monitoring for frost detection.
- Fixed-wing UAS large-area multi-farm monitoring.
- A simple UAS manipulator for in-situ measurements.
- UAS-carried motion-compensated hyperspectral camera.

5. Solutions Offered

AFarCloud provides a distributed platform for autonomous farming that will allow the integration and cooperation of agriculture Cyber Physical Systems in real-time. The precision farming and Cyber-Physical Systems technologies can support the farm management. This platform titled as the Mission Management Tool (MMT), which is an integrated farm management software that supports monitoring as well as decision-making solutions based on big data and real time data mining techniques.

The following figure shows the various technologies that are at play within the AFarCloud project:

Figure 4: Technologies used in AFarCloud

Since AFarCloud is such a large project with many moving parts and capabilities, we have composed the following highlights of the solutions that it offers to users.

Accessibility

The entire platform is accessed through a software tool called the mission management tool (MMT) which runs on Windows operating systems. It serves as the main point of contact for the users to manage, control and plan their work in the farm. As stated previously, other access points to the AFarCloud services include a mobile version of the MMT (mobile MMT) as well as a drone terminal that is accessed through a web browser.

We also have software interfaces between the MMT and legacy tractors using the ISObus standard, along with a web interface for the registration of the hardware. This covers the integration of all components from individual sensors to tractors and their implements into the AFarCloud platform. These systems can then be accessed, monitored, and controlled by the MMT.

Interoperability

Don’t you hate it when you buy a new device but then you realize that it does not work properly with the other equipment you have? This usually forces you to then replace the other equipment you have, which adds to the costs, whereas you only wanted to change one device. AFarCloud aims to eliminate this problem.

By taking a modular approach in AFarCloud users can integrate their existing equipment into our system and use the advanced computing technology we provide to manage their farm and/or agricultural institute. This means that the users do not need to change their equipment when integrating the AFarCloud system.

This includes both different types of vehicles with existing machinery, and a variety of robot systems commonly in use for different farming purposes, as well as sensor and monitoring systems widely in use today, many of which are covered in the previous chapters.

Comprehensive

Do you ever feel like you are losing the focus of what is going on in your farm? Well, fear no more. The AFarCloud platform offers a broad management system that can give a real-time overview of the connected elements (vehicles, sensors etc.), plan missions in the farm thereby automate as well as streamline processes. The amount of information can be scaled and limited according to your liking to ensure that you can get the insight you need about your farm in the most efficient and comfortable way.

The platform also allows for integration of new vehicles, sensors, and components modularly into it. This means that once you connect any of those components to the system, you could see its status in the management system and start managing it. Other users could also access the system on their mobile devices, so tasks could be assigned, changed and tracked. This helps with managing the different workforce, see when you need maintenance for your equipment, and eases the workload.

Real-Time

Your equipment is always connected to the AFarCloud platform, so once you have it running, you can always check on the status of your devices and other connected components from the management system. You can even track and monitor the movement of livestock by connecting GPS collars to AFarCloud.

Beyond that, issues and alerts with the components appear instantly in the platform to inform the user about problems in their connected equipment, so maintaining your devices becomes clearer and easier to track. AFarCloud also supports a large variety of networking protocols and methods, so connectivity will not be a problem.

Security

The AFarCloud platform has strong integrated security functionality. Securing the data from sensors to the farmers’ usage on different media is essential. Cyber security in this context is an integrated part of food security. Cyber-Security Management (CSM) is an AFarCloud cross-layer service that is supporting the different security layers.

AFarCloud is adapting the Industrial Automated Control System Security standard IEC 62443 to the precision agriculture domain. The platform includes access and use control by restricting the knowledge accessed within it with user authentication as they are defined when setting up the system. This allows you to manage data access to your and your personnel's needs.

Deterministic

The weather is a fickle thing that can suddenly change in a matter of minutes, which forces some farmers to react within a short time. Not only is an accurate weather prediction important for the growing of crops but also to taking care of livestock.

To give users the most accurate status possible, AFarCloud can use weather sensors that are placed on the fields along with deterministic algorithms to predict the changes in the weather in real-time. However, that is not all. AFarCloud uses other deterministic algorithms based on the data in your farm to better adjust its reports, give recommendations for the ways to handle, and to accurately portray the most recent information.

Service

AFarCloud brings the Farming-as-a-Service solution to your farm by keeping it modular to your needs. We provide an array for products and features to choose from in the Cloud Resource Discovery component; from emission prediction of milk production to high level mission planning for autonomous vehicles, and the list goes on.

Since AFarCloud is working in an open architecture, additional plug-ins and extensions will be developed in the future to add more features, algorithms, capabilities, and tools with no additional costs accruing. Thanks to the Cloud Resource Discovery, you can always keep track of the instances that have been deployed in one centralized location in the AFarCloud platform.

While you may not use all of the features in the system, we ensure that our solutions are like a one-size-fits-all; you could utilize and customize them to your own needs. The solutions can fit to whichever scope and organization size you like and are future-proof.

6. Conclusion

This short document provides but an overall overview of the accomplishments made within AFarCloud. The collaboration of so many partners across Europe has managed to achieve something great that holds the potential to revolutionize the farming industry.

The sensors and IoT developments made in AFarCloud bring a variety of possibilities to farming, from environmental analysis and fertilization optimization to lowering costs and improving the quality of products. With so much developed, we still continue with developing the project until November 2021 and more features will be added in the coming months.

If we sparked your interest, please feel free to contact the project coordinator José-Fernán Martínez from Universidad Politécnica de Madrid in the following e-mail address: jf.martinez@upm.es

For more information you can also follow us on our social media channels on LinkedIn, Facebook, Twitter, and YouTube. To make sure that you are always up to date, you could also sign up to our newsletter from our website: http://afarcloud.eu/