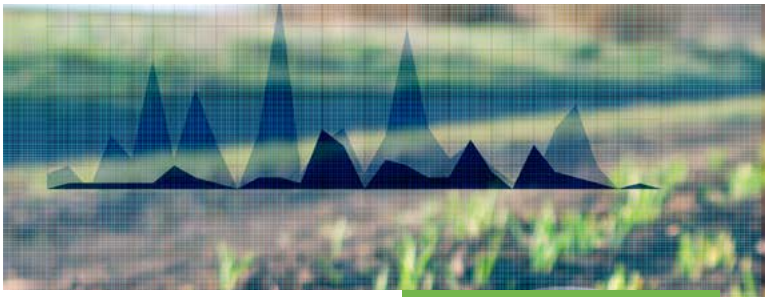
From smart agricultural systems to intelligent digital systems

Successes of the AFarCloud project



Growing urbanisation, decreasing productivity and higher costs are all major obstacles to modern agriculture. How can these factors by mitigated by individual farms while they continue to keep tabs on animal and plant health? The ECSEL project AFarCloud has developed a solution: a distributed platform for autonomous farming which enables real-time integration and cooperation between cyber-physical systems. Professor José-Fernán Martínez-Ortega of Universidad Politécnica de Madrid and Professor Gianluigi Ferrari of the University of Parma discuss their results and future plans in the smart farming domain.

José-Fernán Martínez-Ortega

Gianluigi Ferrari

Cooperation on cows and crops

As the project coordinator, José-Fernán – or J.F. to those who know him – was responsible for juggling 60 partners across 13 countries, including SMEs, large industry, universities, research centres and end-users. "It was a very interesting exercise for me – and very challenging," he admits. "We're technicians, so seeing the farmer's perspective is quite difficult! Of course, they know all the cows and crops. But, as technicians, we take care of how technology can really help farms. The idea was to create a special system for intelligent cooperation and AFarCloud is able to bring the power of autonomy to this."

As an acronym for 'Aggregate Farming in the Cloud', it's no surprise that AFarCloud incorporates a huge array of innovations: (semi-)autonomous ground vehicles that carry out missions in the field, artificial intelligence for quick decision-making, drone analysis of crops and cattle to detect sickness or abnormal behaviour, blockchain for traceability and cybersecurity for both data and systems, to name just a few. Tying this all together is a semantic middleware that integrates heterogenous protocols to vastly increase connectivity, which was Gianluigi's main focus in the project.

"I got involved in AFarCloud through the Brokerage Event in 2017," he begins. "It was interesting to me because I'm coordinating the Internet of Things Lab, and J.F. was very open to potential inclusion in the project proposal. From my point of view, the semantic middleware is the key achievement of the project as this intermediate layer allows data to be collected in a highly heterogenous sense. You can collect it with literally any kind of connectivity – WiFi, Bluetooth, Zigbee, anything you can think of. The idea is that you can collect data, normalise it in a common AFarCloud format and then expose this on top of the middleware layer, which makes AFarCloud flexible and coherent with the focus of Inside on intelligent digital systems."

Common control and characterisation

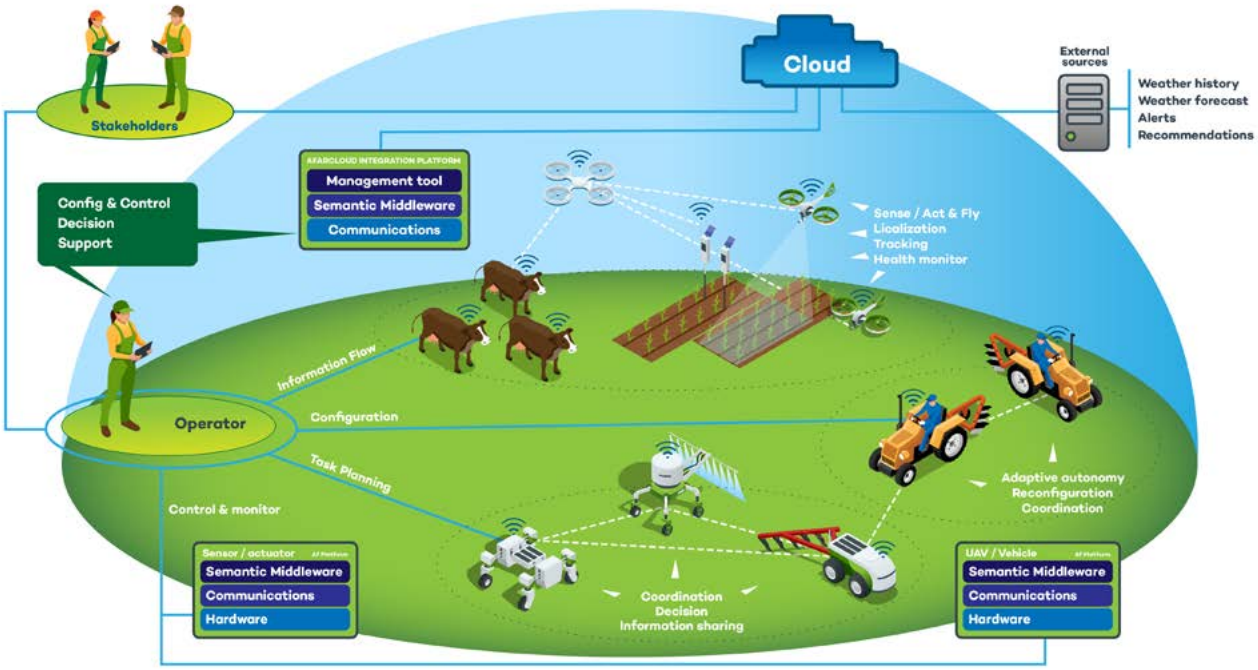
Naturally, one of the main technical challenges for the project was to manage all of the different technologies for characterising the environment within one ecosystem. "We created the concept of the farm as a service, so farmers can add services to AFarCloud according to their own requirements," explains José-Fernán. "But how do you collect all of the information in the environment and detect that something is wrong? Autonomy is a huge part of many things. Using sensors and actuators, the system is able to say, for example, that 30% more fertiliser is needed in a particular part of a field."

By offering a platform through which heterogeneous devices and vehicles can autonomously combine their capabilities, AFarCloud aims to make farming robots accessible to more users and provides farmers with a means to reduce labour costs and increase efficiency. These benefits are heightened by the new opportunities that the semantic middleware offers in communication between farms, such as data analytics on commonalities that were previously unrecognised. Milk and meat production, for instance, appear to be relatively dissimilar but actually share common needs in grass control and nutrition. In turn, such insights could provide a pathway to new business models and revenue streams – even for small to medium-sized farms.

"An important achievement for me was the fact that we were able to embed intelligence into IoT devices and at the edge," notes Gianluigi. "Instead of sending a lot of information to the cloud, the approach that emerged was to embed intelligence locally, extract the most important information and then send just that information to the cloud. This makes a system really scalable, which is another big result for AFarCloud."

Capabilities across countries

While all ECSEL projects bring together partners from across Europe, AFarCloud had the unique challenge of needing to be equally applicable



in all *climates* of Europe. To this end, eight local demonstrators were established in which groups of nearby partners could collaborate to develop technologies and services in the Czech Republic, Italy, Latvia, Spain and Sweden. Three holistic demonstrators in Italy, Finland and Spain – one at the end of each year of the project – then combined all of the technologies developed locally in order to test and validate the project's effectiveness on issues such as reducing the use of antibiotics and managing livestock behaviour in farms of varying sizes and weather conditions.

As a member of Inside's Scientific Council, Gianluigi is well-aware of the wider implications of such collaboration, which Inside seeks to facilitate in order to strengthen European competitiveness, self-sufficiency and sustainability as a whole. "I found the fact that there were so many partners spread around Europe very interesting because we had different perspectives and each partner had particular problems," he continues. "For example, northern countries had the problem of crops freezing. But we had IoT nodes with sensing capabilities on a farm in Italy and we were able to move these to a farm in Finland, get connected and collect data as if we were still in Italy. From a Scientific Council perspective, AFarCloud showed that you can take a smart agricultural system and reinterpret it as an intelligent digital system."

"This was a multicultural project and, of course, this is good as some of the impact is to improve European industry at different levels," adds José-Fernán. "Another thing is environmental protection: the reduction of agrochemicals in farming activities is good for the final product and contributes to biodiversity protection. AFarCloud showed plenty of promise for precision farming, so the fact that we then brought in many other things was a big deal. As a project coordinator, it was a headache! But the important thing was that we had good partners who were committed to the project, so it was very successful."

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Coordination for circularity

As for the future, most of the innovations are at TRL 5 and some have even reached TRL 7. With market uptake of the AFarCloud platform a tangible prospect in the coming years, the partners have already created value chains for the different stakeholders and generated various business models for farmers to help compensate their investments in the technology. Although the project came to a close in November 2021, José-Fernán and Gianluigi are far from done.

"We're already building on the results of AFarCloud for new developments," concludes Gianluigi. "A project proposal we just submitted to Horizon Europe is focused on circular agriculture and applying new concepts to the base we have, particularly to make smart agriculture services available to small and medium farms with limited economic resources. Perhaps the next project that J.F. can coordinate could be 'AFarEdge'."

"Why not?" smiles José-Fernán. "The future of the technology, especially for cyber-physical systems and autonomy, is the edge and making decisions there. The next step within the framework of Inside is to bring at least 80% of the system to the edge. I would like to create some new projects to generate more power and scalability for the system because I'm really proud of how AFarCloud can manage the precision farming process in a very efficient way."