P5 – Resilient Smart Farming a conceptual and technological opportunity to strengthen resilience

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Introduction

The process of agricultural production is undergoing progressive digitalization worldwide, which is referred to as digital farming or smart farming [1,2], i.e., the share of software-based tools and purely software-based processes such as planning tasks is demonstrably increasing steadily [1,2]. Agriculture is an essential part of Critical Infrastructure as it is essential for global food production. This becomes especially important in times of diverse crisis events such as: War, Pandemics and Climate Change. Centralized and internet-dependent software-based infrastructures and applications are then particularly vulnerable. The concept and technological possibilities as well as the current developments of Resilient Smart Farming (RSF) show how data management can be designed according to the offline-first principle. A central building block here is Resilient Edge Computing (REC) and the developed HofBox: a mini-server that takes over data management on the farm and implements it with innovative, open source-based container technology Open Horizon [3,4,5].

Objectives

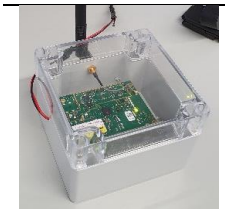
The central question here is: (How) Can decentralized data management with hybrid IT infrastructure be implemented and at the same time support the economic and ecological benefits of smart farming applications and increase resilience? Can the concept of Resilient Smart Farming provide a conceptual and technological way to strengthen resilience of digital infrastructures in agriculture?

Materials and methods

For the practical implementation of Resilient Smart Farming in the form of Resilient Edge Computing, a so-called HofBox was used as a miniserver with the hardware of a Raspberry Pi 4, 4GB with LoRa board in the first step. This simple and commercially available hardware could be manually integrated into the Open Horizon infrastructure. The LoRa board is used as a gateway for an autonomous sensor network on the farm. In the second prototype, a HofBox 2.0 with x86 and Secure Device Onboarding (SDO) was used for automated deployment of software containers.

At the infrastructure level, Resilient Edge Computing is deployed via the open source framework Open Horizon [3,4] at the professional level as IBM Edge Application Manager. The software used to deploy software containers in the project is open source software in the first step, such as Libre Office, MQTT broker or the GeoBox application. The Long Range Wide Area Network is supported, among other things, by its own gateways, which store the sensor data via the commnitiy-based and central platform The Things Network and make it available via APIs. You can see the different variants of the HofBoxes in (Table 1).

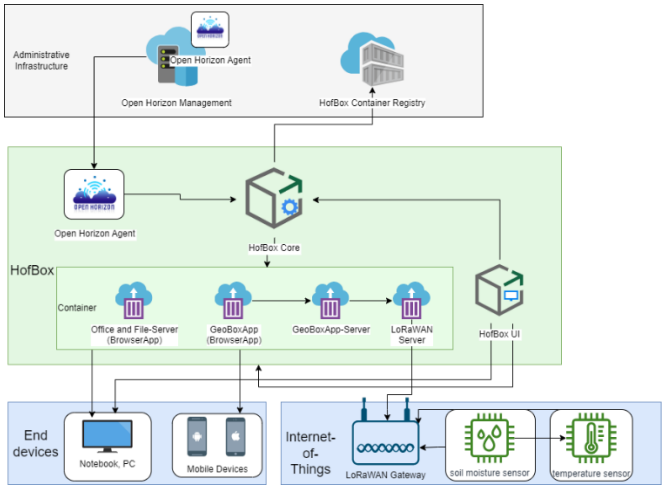
Table 1. Two different HofBox hardware were used

HofBox 1.2	description	HofBox 2.0	description
	Our first usable prototype of HofBox 1.2 was based on a Raspberry Pi 4 with 4 GB RAM and an extension of a LoRa-Board		The second usable prototype of HofBox 2.0 is a x86 with a secure device onboarding (SDO)

Results

The HofBoxes are initialized, installed and updated without user interaction (zero touch) via the open source edge computing platform "Open Horizon". The application layer applications shall be containerizable" to run in the data center, cloud-based or locally on the HofBox.

Figure 1. IT-Architecture for Resilient Smart Farming



The applications should be usable by means of a standard Internet browser, i.e. without additional software, accessible via a special start page on the HofBox and basically functioning without connection to the Internet. Furthermore, additional applications can be installed via the integration of an app store if desired by the user. To support the daily work, an (extendable) basic software (GeoBox app) is supplied as standard. The hofbox is a dedicated, self-contained, ruggedized compute server delivered to the farm, managed remotely, and providing localized workload ad data processing services to the farmer. In order to realize resilient smart farming into practiice, farmers data will be on the hofbox edge device. Only by agreeing, the data can be sent and stored elsewhere. The solution is fully resilient, because of a hybrid-cloud architecture which means that the solution is cloud agnostic.

Resilient smart farming thru rersilient edge computing is a role model for critical infrastructures.

Discussion and conclusions

The solution we designed and developed to strengthen digital resilience in agriculture, Resilient Smart Farming, is technologically feasible and can be tested in practice in the future. This will show whether the solution is also successful under the conditions of agricultural practice. We were able to practically demonstrate the technological feasibility with Resilient Edge Computing, as described above. We expect containerized software to be increasingly used in agriculture in the coming years. Under Open Horizon, we show that these can also be managed and administered.

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