

Holonic Multi-Agent System Programming Project:

An MAS application for creating digital twins of tractors on a farm

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Introduction

On a recent trip into town, a farmer met a young engineer who was passing through – on his way to a conference on Industry 4.0 in Johannesburg. Asking “so what is this Industry 4.0?”, the farmer learned a lot from what the engineer had to say. The engineer explained that this new way of thinking about technology could have great value for the management of his farms and equipment. Curious and excited, the farmer started to plan and implement a trial Industry 4.0 application on his farm – the management of his tractors through their digital twins!

He has tractors that drive around several of his farms, and would like their digital twins to show him two types of information:

- The location data of his tractors at any given time during the day.
- The fuel consumption of his tractors as they drive around the farms.

To get this information, the farmer installed a fuel consumption sensor and IoT device on each of his tractors, as well as an RFID tag. He also installs RFID readers next to the farm roads at different locations on his farms. Each farm has a microcontroller (green blocks), which is connected to the RFID readers (blue dots) on that farm and the Internet – as shown in Figure 1.

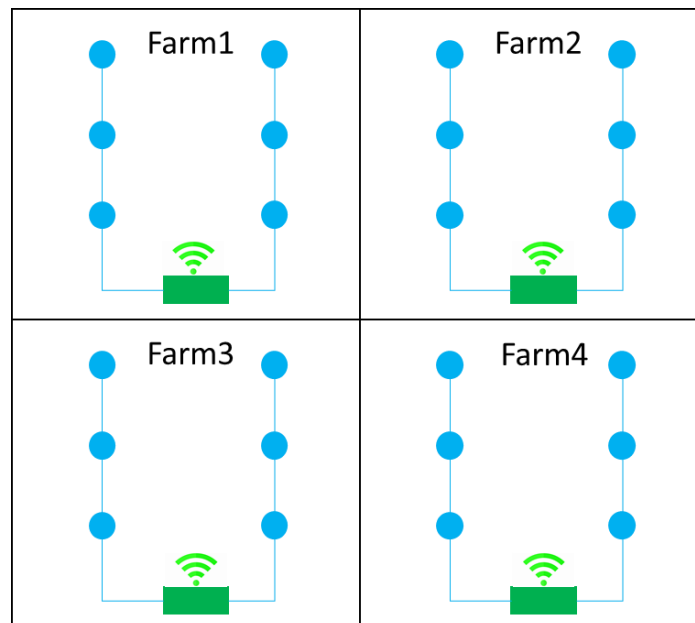


Figure 1: RFID readers (blue dots) and microcontrollers (green blocks) in the farms.

Objective

The objective of the project is to supply the farmer with an MAS application that can obtain the information from the installed sensors, and manage and display the information of each of his tractors – i.e. create their digital twins. The application must provide a dashboard, through which the information is displayed to the farmer. The information must also be saved in files for future analysis. Furthermore, the application must be scalable – allowing for additional tractors and farms to be added.

Requirements and Considerations

Your agent application must exhibit the following functionality:

- Launch agents from both the JADE GUI and by communicating with the JADE Agent Management System.
- Communication between agents using communication protocols and the accompanying JADE behaviours.
- Perform resource discovery using the JADE Directory Facilitator.
- Perform service-provider selection using the Contract Net Protocol.
- Use JADE behaviours to implement agent functionality.
- Use a JSON ontology to structure information in the agent communication.

The sensors will be simulated by a provided simulation program. The program will run a dedicated TCP server for each sensor and will supply simulated sensor information to your application. Each sensor must be managed by a dedicated agent in your multi-agent system application.

The RFID readers that are installed on the farms can only provide an “instantaneous” location when a tractor drives by (i.e. it indicates that a tractor was at a specific location at a specific moment in time). It is thus required for your application to search for the most recent location from the network of RFID readers, to ensure reliable location information.