



VTT

FIWARE IoT Platform for Agricultural Robot Fleet Management

23/02/2024 VTT – beyond the obvious

Contents

- Intro
- Problem
- Proposed solution
 - System design
 - Components
- Piloting
- Experiences
- Conclusions



Introduction

- VTT has been involved for a long time with FIWARE
- FIWARE has been deployed and piloted in various EU project pilots
 - Smart cities and buildings
 - Agriculture
 - Sensor networks
- Standard data model (NGSI) is the heart of the FIWARE
- Most common Generic Enablers
 - Context Broker, Timeseries Database
 - Other components as needed

Agricultural Robotics and FIWARE

- Use case in FlexiGroBots EU Project
 - The use of heterogenous fleets of robots to perform agricultural tasks
 - Multiple operators, multiple robotic platforms
 - No integration of robots on the robot system level
- Goal
 - To enable robots to work on the same field performing their tasks
 - With a minimal operator workforce
 - Additional safety layers

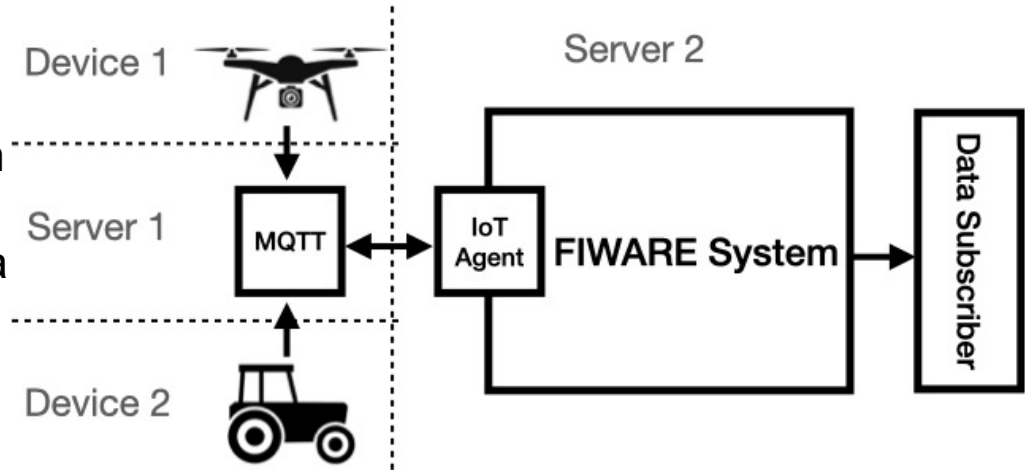


Proposed Solution

- Introduce minimal integration of different robot systems
- Basic set of functions (Start, Stop, Pause, Resume, Status)
 - Geared towards safety
- Simple adapters for each robotic system consuming and producing data in common format -> NGSII

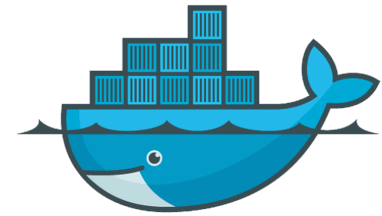
System Design

- Adapter for robot control system
 - For instance DJI Mobile SDK
- FIWARE platform deployed on a cloud server in Docker environment
 - Situational Awareness service as well
- Desktop application for fleet operators to monitor all robots during operation
 - Uses MQTT to receive statuses and events



Components

- Robot control system
- MQTT Broker
- IoT Agent
- Orion
- MongoDB
- QuantumLeap
- TimescaleDB
- SituationalAwareness Service
- FleetManager



docker



FIWARE

Piloting

- Drones
 - Survey drones, Surveillance drone, Spraying Drone
- Ground Robots
 - Weeding COBOT, Robot gantry, Tractor, Seeding robot, Collector robot
- Connectivity via 4G/5G
- Services running in private cloud

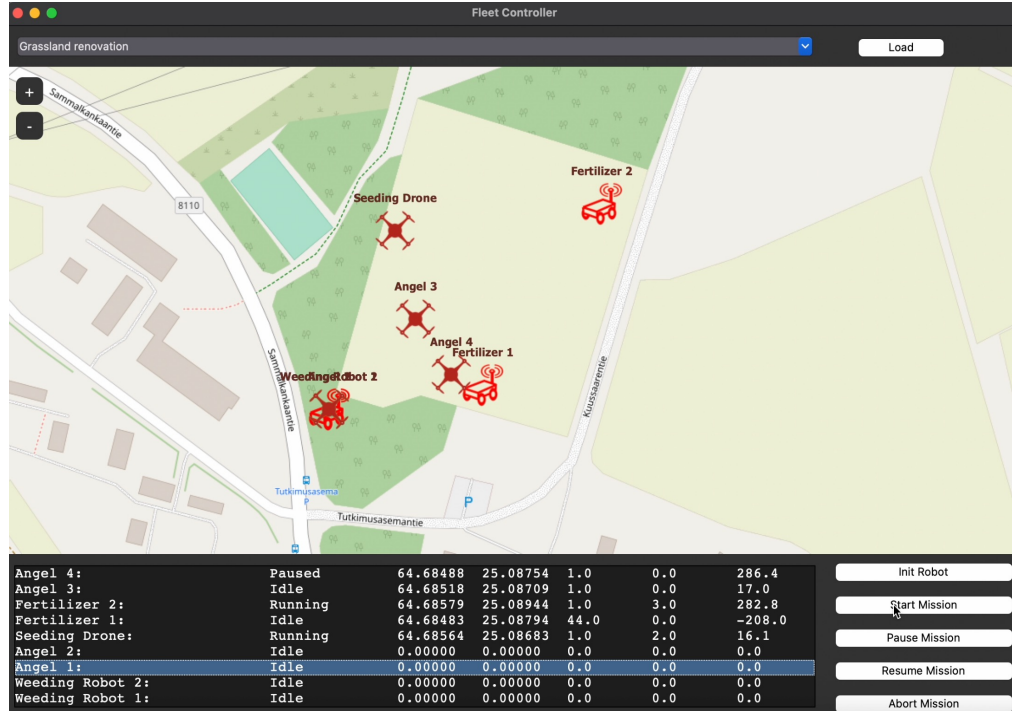


Data Model

- Simple Two entity type data model
 - NGS1 v2 because NGS1-LD broker was still not at the beginning of the project
- Robot –entity
 - ID
 - Location
 - Speed
 - Status
 - Heading
 - Time
- Collision
 - Location
 - Array of Robots involved
 - Time to Collision
 - Timestamp

Fleet Management

- Monitor & Control robots and drones
- Connected to FIWARE via MQTT broker and IoT Agent
- Also connected to data space

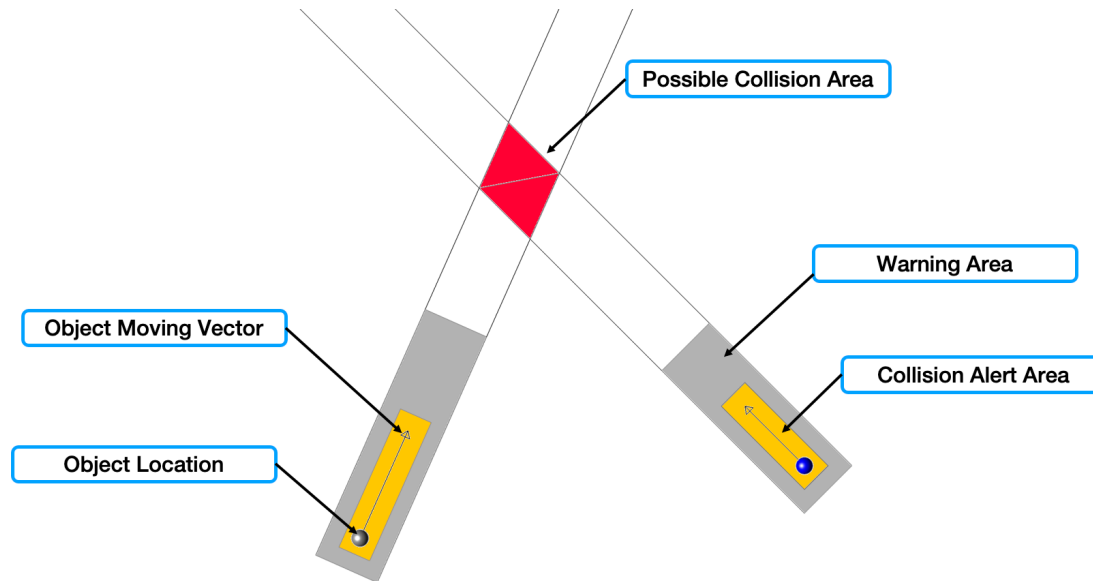


The screenshot shows the 'Fleet Controller' interface for a 'Grassland renovation' mission. The map displays several robots and drones: Seeding Drone, Angel 3, Angel 4, Fertilizer 1, Weeding Robot 2, and Fertilizer 2. The status table at the bottom provides detailed information for each robot.

Angel 4:	Paused	64.68488	25.08754	1.0	0.0	286.4	Init Robot
Angel 3:	Idle	64.68518	25.08709	1.0	0.0	17.0	Start Mission
Fertilizer 2:	Running	64.68579	25.08944	1.0	3.0	282.8	Pause Mission
Fertilizer 1:	Idle	64.68483	25.08794	44.0	0.0	-208.0	Resume Mission
Seeding Drone:	Running	64.68564	25.08683	1.0	2.0	16.1	Abort Mission
Angel 2:	Idle	0.00000	0.00000	0.0	0.0	0.0	
Angel 1:	Idle	0.00000	0.00000	0.0	0.0	0.0	
Weeding Robot 2:	Idle	0.00000	0.00000	0.0	0.0	0.0	
Weeding Robot 1:	Idle	0.00000	0.00000	0.0	0.0	0.0	

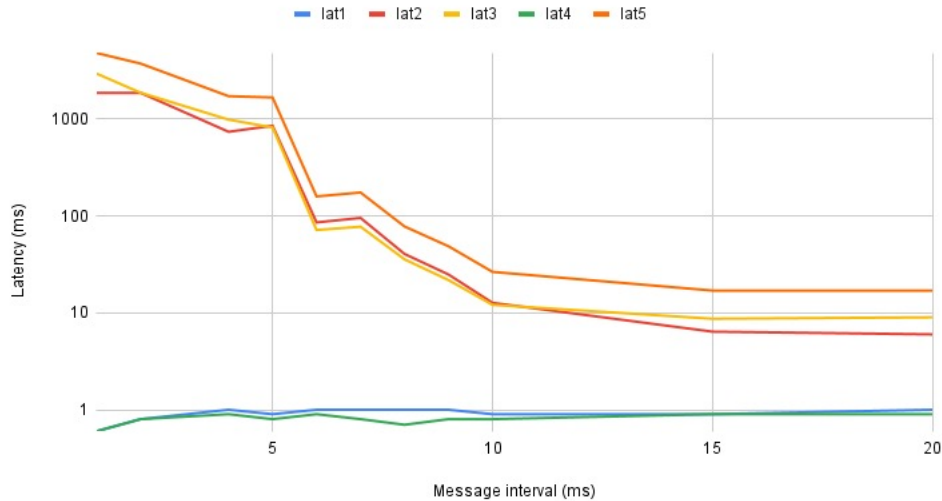
Collision Avoidance

- FIWARE application subscribing to robot statuses and calculating possible collision events



Experiences

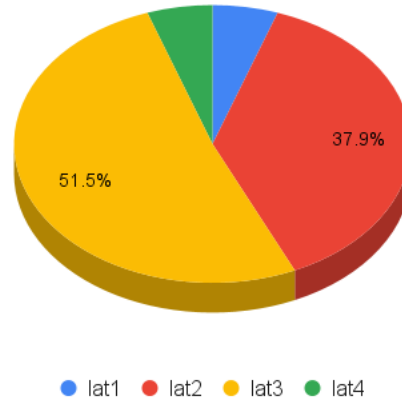
Average Latencies vs Message Frequency (log)



- Critical factor is latency
 - Latency affects the safety margins
- With close to 10 robots, the system is still useable

Experiences

Latency Distribution at 15ms Message Interval



- IoT Agent and Orion are responsible of most of the latencies
 - MQTT UltraLight to NGSI IoT agent consumes 37.9% of the time (lat2)
 - Orion context broker consumer 51.5% of the time (lat2)

Conclusions

- Platform build using FIWARE components is relatively easy to deploy and use
- Standard data models help in the integration
- The downside of the standard data model is the performance
 - Data conversion is heavy compared to native binary protocols
 - This has to be taken into account in system design

Thank You!

- Question & Answers
- Kari Kolehmainen
- kari.kolehmainen@vtt.fi
- +358 40 5330649