RAINBOW NEWSLETTER

ISSUE 10, NOVEMBER 2022

RAINBOW is a Research and Innovation Action funded under the EU Horizon 2020 framework programme, focusing on developing an open, trusted **fog computing platform** facilitating the deployment, orchestration and management of scalable, heterogeneous and secure IoT services and cross-cloud apps.

RAINBOW PHYSICAL DEMONSTRATORS

In the previous months RAINBOW deployed the **second integrated release** of its fog computing platform at the infrastructure of each of the **three use cases** chosen to test and validate the platform under real-world scenarios:

- Use Case 1 - *Human-Robot Collaboration in Industrial Ecosystems*
- Use Case 2 - *Digital Transformation of Urban Mobility*
- Use Case 3 - *Power Line Surveillance via Swarm of Drones*

The **main challenge** for each use case was to perform the migration from the initial virtual lab setup to demonstrate the RAINBOW features within a more consolidated environment in terms of software components and trial set-up. The ultimate goal was to **evaluate** under a qualitative and quantitative perspective the technical and business KPIs already considered in the early demonstrator design phase and to **validate** the improvements made possible by the use of RAINBOW services and features.

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PROJECT INFORMATION

TITLE: RAINBOW - *A fog platform for secured IoT services*

GRANT AGREEMENT NO: 871403

CALL ID: ICT-15-2019-2020

CALL TOPIC: Cloud Computing

START DATE: January 1st, 2020

END DATE: December 31st, 2022

COORDINATOR: UBITECH Ubiquitous Solutions

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Look for our hashtags!

#RAINBOW_H2020
#FogComputing #Industry40
#EdgeComputing #secureIoT

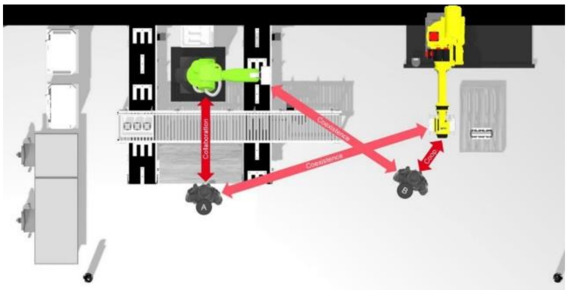
https://rainbow-h2020.eu

USE CASE 1

Demonstrator setup

A human-robot collaboration system with multiple applications such as robot motion tracking, personnel localization and collision prediction and avoidance applications presents challenges about efficient deployment, scaling and ensuring real-time execution of the running applications.

The scenario examined in RAINBOW involves two robots, where one robot works in collaboration with a human worker for the assembly of a transformer and the second robot aligns the assembled transformers in a container. During the process, another worker can enter the workplace for various reasons such as changing a filled container with an empty one. For safety reasons, personnel location information is simulated in the form of messages generated by UWB tags, instead of actual human workers being in the same space.



RAINBOW installation and deployment stage

The scripts provided with the 2nd RAINBOW release simplify and almost completely automate the installation process. In UC1 the installation consists of setting up the master and the worker nodes, then the RAINBOW Analytics Stack, which is required in order to receive the metrics of the running components and enable Service Level Objectives (SLOs) and analytics, and finally the RAINBOW Dashboard, which enables management of all the orchestration through a web-based interface. The next stage includes the creation of the application, which describes the interfaces and dependencies between the components, the definition of SLO scenarios and descriptions, the creation and deployment of the Service Graph.

Validation KPIs examined under UC1

- System Latency for collision prediction and avoidance
- Scaling-In/Out of Personnel Localization Motion Capturing services
- Scaling-In/Out of Collision Prediction and Avoidance services
- Scaling-In/Out of Robot Motion Tracking services
- Monitoring and evaluation of SLOs
- Data sharing with registered users for monitoring and analytics
- Security and Attestation of new device
- Data Synchronization
- Analytical query on distributed database

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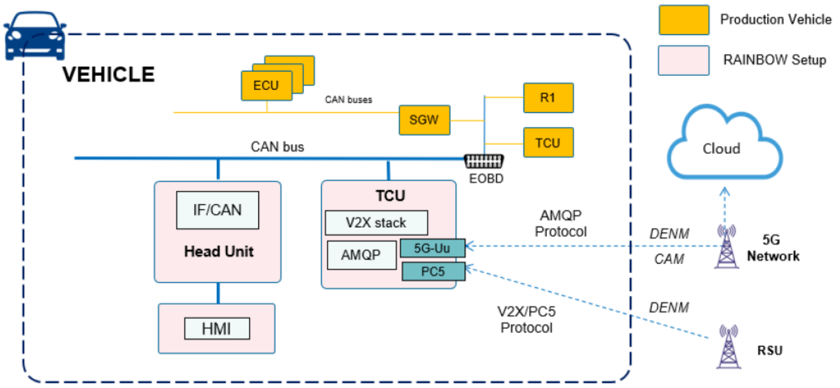
USE CASE 2

Demonstrator setup

The Fiat Ducato, a light commercial vehicle on the market since 1981, was utilized in UC2. To manage the safety of the driver and passengers, the vehicle was equipped with a standard production CAN bus as well as the experimental ad-hoc “RAINBOW bus”. All communication components are installed inside the Telematics Box in the vehicle which receives, process and converts messages from the network. A Vehicle Head Unit is added that can receive CAN bus messages and provide data to the Human Machine Interface that display alerts to the driver.



The Road Side Unit (fog node) integrates an Nvidia Jetson Xavier kit, that uses its GPU to timely detect a hazardous situation on the road, the communication modules and antennas, the power supply and all required connections. Finally, a camera along with a LiDAR unit are used to enhance the detection's precision and measure accurately the hazard's distance.

RAINBOW installation and deployment stage

The deployment of the 2nd RAINBOW release, facilitated by the comprehensive documentation compiled by the technical partners, went smooth and without challenges for UC2. The installation script successfully joined the AMQP Broker node to the Kubernetes Master node and verified their connection. The installation on the Nvidia Xavier was also performed flawlessly and was able to join the RAINBOW’s cluster with no issues. When creating the Service Graph on the RAINBOW Dashboard, the necessary components, such as "Object Detection", were described along with their docker containers and execution requirements, then connected with other components and finally verified in order to generate the UC2 application. At the next step, SLOs related to fog to edge Service Orchestration for saving energy and efficient bandwidth usage as well as event detection, were added. Finally, a series of tests was conducted to verify the complete deployment.

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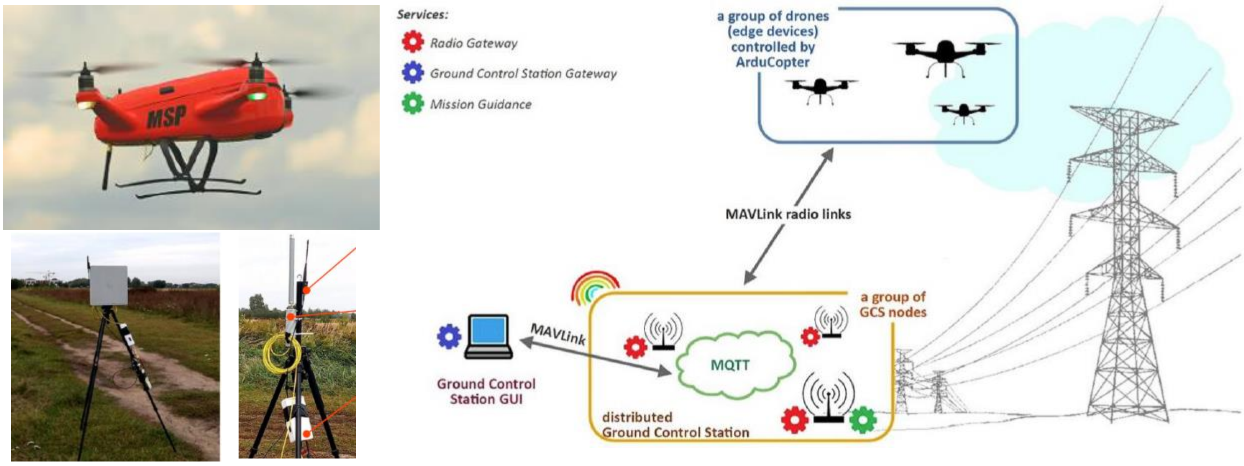
Validation KPIs examined under UC2

- Automatic hazardous events detection service orchestration power consumption
- Automatic hazardous events detection service orchestration bandwidth consumption
- C-V2X alerts delivery latency
- Number of C-V2X events managed

USE CASE 3

Demonstrator setup

In UC3 the opportunity to test the system in real conditions allowed for the verification of the impact of random weather and technical factors on the actual system performance. A group of Ground Control Stations (GCS), consisting of Nvidia Jetson TX2 single-board computers equipped with radio modems that allow to control drones over a large area, Mikrotik routers that provide long-range inter-GCS communication and SiK telemetry radio modem that provide radio link to the drones, were the RAINBOW-enabled fog nodes.



A group of drones controlled through a flight control system based on ArduCopter, an open-source firmware integrated on-board of each drone, were the edge devices that perform data collection during the inspection of the power infrastructure. The type of drone used was the geoHOVERFLY copter, designed specifically for photogrammetric flights.

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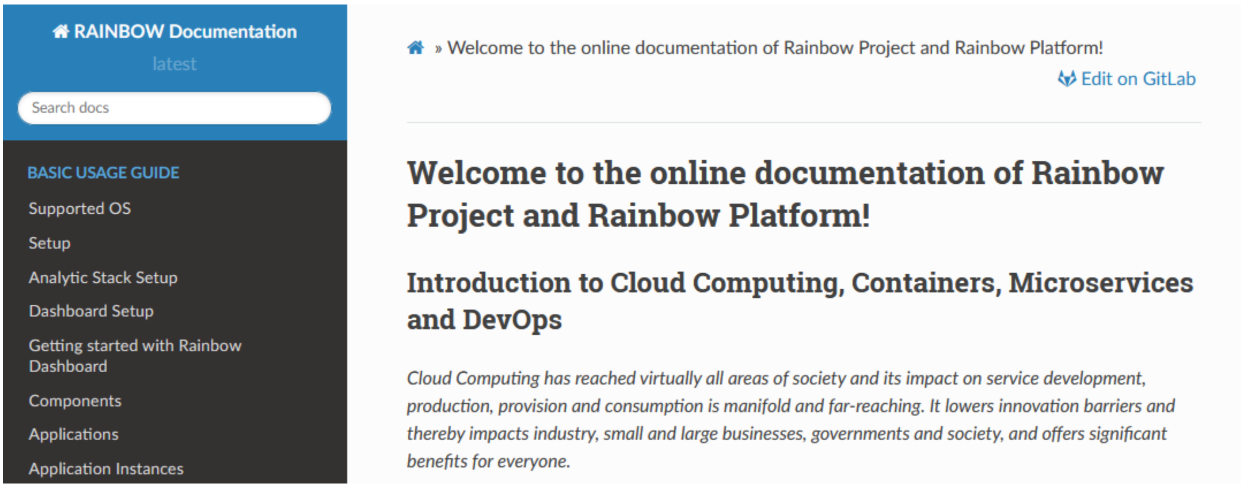
RAINBOW installation and deployment stage

The overall deployment of the 2nd RAINBOW release for UC3 was straightforward as it is mostly automatized by the provided scripts and all required steps are supported by the detailed RAINBOW documentation available online at https://rainbow-h2020.readthedocs.io



The creation of the Service Graph has been greatly simplified though the RAINBOW Dashboard. With the SLO editor and the other services in place, the required instances could be added as single nodes of the Service Graph. This demonstrated that SLOs can be used not only to adjust system performance, but also to make the system deployment adapt automatically to the available hardware infrastructure. Three SLO scenarios and related metrics were configured and added into the Service Graph to cater for mission critical system testing.

UC3 utilized RAINBOW's secure mesh overlay network support out of the box as well as it's attestation features since both are essential for the secure operation of the drones.

Validation KPIs examined under UC3

- Time to pass the control over the drone from one GCS to another GCS
- Increase of productive flight distance per drone
- Reduction of data acquisition time per kilometre of power line
- Reduction of overlaps between individual flight routes
- Efficiency of battery usage for a productive phase of the drone flight

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EUROPEAN BIG DATA VALUE FORUM

RAINBOW together with the EU-funded projects **PLEDGER** and **MORPHEMIC**, will host a session under the prestigious **European Big Data Value Forum 2022** (https://european-big-data-value-forum.eu). The European Big Data Value Forum, which has been organized by the **Big Data Value Association** and the **European Commission** (DG CNECT) for the last 5 years, is a major ICT event in Europe that brings together big industry, technology professionals, business developers, researchers and policy-makers and attracts a large number of visitors. This year the event will take place in Prague on November 21-23, 2022.

The session, which is titled "**Next-generation platforms for Europe's Cloud continuum**" and targets the Technology, Platforms and Impact track, will be held physically in Prague on November 23, 2022 from 10:00-11:00am CET and includes a discussion panel of prominent experts from academia and industry. The panel's main goal is to highlight the opportunities for the EU innovation landscape offered by the next-generation solutions developed by the 3 projects and to illustrate how the latest Edge/Fog/Cloud Continuum developments can strengthen EU competitiveness.

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