D5.9 COGNIT Framework

- Software Source - c

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Abstract

COGNIT is an AI-Enabled Adaptive Serverless Framework for the Cognitive Cloud-Edge Continuum that enables the seamless, transparent, and trustworthy integration of data processing resources from providers and on-premises data centers in the cloud-edge continuum, and their automatic and intelligent adaptation to optimise where and how data is processed according to application requirements, changes in application demands and behaviour, and the operation of the infrastructure in terms of the main environmental sustainability metrics. This standalone document provides a comprehensive catalogue of the open source software for integrating and deploying the COGNIT Framework, including its user and admin guides, as well as the public source code for the toolkits for the Use Cases developed throughout the project.

Deliverable Metadata

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Status:	Submitted

Document History

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1.0	31/12/2025	Submitted	Final Version
1.1	27/02/2026	Draft	Initial Draft
1.2	28/02/2026	Peer-Reviewed	Reviewed Draft
2.0	01/03/2026	Submitted	Final Version

Peer Review History

Version	Peer Review Date	Reviewed By
0.2	31/12/2025	Antonio Álvarez (OpenNebula), Marco Mancini(OpenNebula)
1.2	28/02/2026	Antonio Álvarez (OpenNebula), Marco Mancini(OpenNebula)

Summary of Changes from Previous Versions

This is the second version of the Deliverable D5.9

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[1] A deliverable can be in one of these stages: Draft, Peer-Reviewed, Submitted, and Approved.

Executive Summary

Deliverable D5.9 provides an overview of the source code for integrating and deploying the final and stable version of the COGNIT Framework released with the conclusion of the project, as well as the public source code for the toolkits developed for the Use Cases. The source code is contained in six separate GitHub repositories:

- **COGNIT OpsForge**: An administrator tool that automates integration and deployment of the COGNIT Platform, forming a Cognitive Serverless Framework for the Cloud-Edge Continuum. This tool is able to create an instance of the COGNIT software stack control plane and deploy it on a target infrastructure or automatically provision a public infrastructure on AWS, creating a private cloud running on top of infrastructure resources that can span along the cloud-edge continuum. OpsForge currently sets up the following components: 1) COGNIT Frontend, 2) Cloud/Edge Manager (OpenNebula), 3) Edge Cluster Frontend, 4) AI-Enabled Orchestrator and 5) Serverless Runtime.

- **Use Case #1 (Smart Cities)**: Toolkit used for the Smart Cities use case. It includes the functions to offload to the Serverless Runtime and the image customizations needed to run the simulations of the traffic.

- **Use Case #2 (Wildfire Detection)**: Toolkit used for the Wildfire Detection use case. It includes an example Serverless Runtime with the Machine Learning model for fire detection that leverages the COGNIT Framework. It also includes the two UC2 demos, the statistical one and the geographical one, for testing the behaviour of the framework during a wildfire event along with the example maps and images used for testing it. Finally, a dataset of parameters collected by devices during tests is present with software tools to interpret them.

- **Use Case #3 (Smart Energy)**: Toolkit used for the Smart Energy use case. It is divided into four separate repositories:

  - **use-case-3**: Energy Use Case basic demo, which simulates a user application running on a smart energy meter. The app manages various appliances and energy assets (e.g. photovoltaic or heating devices) according to the decision algorithm, which it offloads to the COGNIT Serverless Runtime.

  - **use-case-3-sem-simulator**: Simulator of the smart energy meter that provides an interface for user applications that can be installed on the meter. It can run predefined scenarios and be integrated with simulators of various appliances to simulate an entire energy optimisation scenario.

  - **use-case-3-home-energy-management**: Package with a decision-making algorithm used to optimize energy management at home and simulators of end devices in the local grid. The algorithm retrieves information about all controller settings and current values. Based on them, it determines parameters for the next time step and calculates energy transmission in the household.

  - **use-case-3-phoenix-demo:** Use Case 3 demo application running on the Phoenix RTOS operating system.

- **Use Case #4 (Cybersecurity)**: Toolkit used for the Cybersecurity use case. It contains an example anomaly detection function capable of determining unauthorised connection attempts by examining logs of the SSH protocol.

This deliverable also presents the documentation for the integrated COGNIT Framework, including both user and admin guides.

This deliverable, along with D5.6 and D5.12, closes WP5.

Table of Contents

1. Introduction

This report contains the catalogue of the software code used for the integration and deployment of the COGNIT Framework, and software code for the integration of COGNIT with the use cases.

It also includes toolkits developed for the four use cases: 1) smart city focusing on smart traffic control, 2) wildfire detection, 3) smart energy meters for optimising home energy use, and 4) cybersecurity focusing on anomaly detection for connected devices using log data.

The OpsForge tool streamlines the deployment of the COGNIT software stack. With this tool, it is possible to create an instance of the COGNIT control plane software stack and deploy it on a target infrastructure or automatically provision an infrastructure on AWS, setting up a private cloud, including resources (Edge Clusters) from the cloud-edge continuum.

Toolkits that have been developed as part of the research activities of the four use cases have been released to the public.

The documentation for the integrated COGNIT Framework, including both user and admin guides, is presented towards the end of the document, followed by conclusions.

2. COGNIT OpsForge

OpsForge Tool	
Description	The OpsForge is an administrator tool that facilitates the deployment of the COGNIT Stack, forming a Cognitive Serverless Framework for the Cloud-Edge Continuum. This tool is able to create an instance of the COGNIT Software stack and deploy it on a target infrastructure, creating a private cloud running on top of resources that can span the cloud-edge continuum. The current latest version of this tool can be used to deploy the 4.0 version of the COGNIT Framework.
Licence	Apache 2.0
Version	release-cognit-4.0
Design	D5.6 → 7. Software Integration Process and Infrastructure
Code	Public Repository
User Guide	Repository README

3. Use Cases Toolkits

Use Case #1: Smart Cities

use-case-1	
Description	The toolkit used for the Smart Cities use case. It includes examples of remote FaaS calls to run SUMO simulation models for the Smart City Use Case using the COGNIT Framework. It includes the Serverless Runtime image specific files and configuration for this use case that returns estimates of delay in public service vehicles in order to make a decision about granting or not priority to an incoming bus, to the edge.
	The updated version of the functions to offload code for the new architecture.
	Updated models for the Junctions of Granada in the pilot phase.
	Includes testing configuration for workload tests against the new edge node.
Licence	Apache 2.0
Version	Release v.2.3.0
Design	D5.6 → 3. Use Case #1: Smart Cities
Code	Public Repository
User Guide	Repository README

Use Case #2: Wildfire Detection

use-case-2	
Description	Source code for the wildfire image recognition function, and the code for offloading it to a COGNIT Serverless Runtime.
Licence	Apache 2.0
Version	release-v3.0.0

Design	D5.6 → 4. Use Case #2: Wildfire Detection
Code	Public Repository
User Guide	Repository README

Use Case #3: Energy

use-case-3	
Description	Energy Use Case basic demo. Simulates a user application running on a smart energy meter. The application manages various appliances and energy assets (e.g. photovoltaic or heating devices) according to the decision algorithm, which it offloads to the COGNIT Serverless Runtime.
Licence	BSD 3-Clause
Version	release-v3.1.0
Design	D5.6 → 5. Use Case #3: Energy
Code	Public Repository
User Guide	Repository README

use-case-3-sem-simulator	
Description	Simulator of smart energy meter that provides interface for user applications that can be installed on the meter. The simulator can run predefined scenarios and be integrated with simulators of various appliances.
Licence	BSD 3-Clause
Version	release-v1.1.1
Design	D5.6 → 5. Use Case #3: Energy

use-case-3-sem-simulator	
Description	Simulator of smart energy meter that provides interface for user applications that can be installed on the meter. The simulator can run predefined scenarios and be integrated with simulators of various appliances.
Code	Public Repository
User Guide	Repository README
Testing	Unit tests

use-case-3-home-energy-management	
Description	Package with a decision-making algorithm used to optimize energy management at home and simulators of end devices in the local grid. The algorithm retrieves information about all controller settings and current values. Based on them, it determines parameters for the next time step and calculates energy transmission in the household.
Licence	BSD 3-Clause
Version	release-v2.2.4
Design	D5.6 → 5. Use Case #3: Energy
Code	Public Repository
User Guide	Repository README

use-case-3-phoenix-demo	
Description	Use Case 3 demo application running on the Phoenix RTOS
Licence	BSD 3-Clause
Version	release-v1.0.0

Design	D5.6 → 5. Use Case #3: Energy
Code	Public Repository
User Guide	Repository README

Use Case #4: Cybersecurity

use-case-4	
Description	Example of an anomaly detection function that analyzes SSH authentication attempts using machine learning and rule-based validation.
	The system monitors SSH authentication logs (auth.log) and GPS location, and uses an Isolation Forest algorithm combined with rule-based validation to detect suspicious activities. The detection function is offloaded for execution, while automated responses are handled locally by a Response Daemon.
	Use case 4 utilizes Confidential Computing to execute sensitive workloads within hardware-enforced Trusted Execution Environments (TEEs), in our testbeds we have used AMD SEV based infrastructure.
Licence	Apache 2.0
Version	release-ad-v2.3
Design	D5.5 → 6. Use Case #4: Cybersecurity
Code	Public Repository
User Guide	Repository README

4. COGNIT Integrated Framework Documentation

4.1 User Guide

Users of the COGNIT Framework are the application developers who want to offload functions from their edge applications to the cloud continuum. Therefore, User Documentation on how to use the Device Client, which abstracts the interaction with the different COGNIT components, is effectively the User documentation:

4.2 Admin Guide

Administrators of the COGNIT Framework are responsible for the deployment of the COGNIT Framework on a target infrastructure. Therefore, they will be using the OpsForge Tool to define this target infrastructure and deploy all COGNIT components using an automated process, and their reference documentation is the latest version of the OpsForge documentation.

5. Conclusions

Deliverable D5.9 provides an overview of the source code for integrating and deploying the final public version of the COGNIT Framework, as well as the public source code for the toolkits developed for the use cases. It also presents the documentation for the integrated COGNIT Framework, including both the User and Admin public documentation guides.

This report was released at the conclusion of WP5 activities.