A Cognitive Serverless Framework for the Cloud-Edge Continuum

D5.7 COGNIT Framework - Software Source - a

Version 1.0

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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 document provides a catalogue of the open source software for integrating and deploying the first public version of the COGNIT Framework, including its user and admin guides, as well as the public source code for the toolkits for the Use Cases developed during the Second Research & Innovation Cycle (M10-M15).

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Deliverable Metadata

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Document History

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0.2	25/04/2024	Peer-Reviewed	Reviewed Draft
1.0	30/04/2024	Submitted	Final Version

Peer Review History

Version	Peer Review Date	Reviewed By
0.1	25/04/2024	Nikolaos Matskanis (CETIC)
0.1	25/04/2024	Antonio Álvarez (OpenNebula)

Summary of Changes from Previous Versions

First Version of Deliverable D5.7

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

Executive Summary

Deliverable D5.7 provides an overview of the source code for integrating and deploying the first public version of the COGNIT Framework released in M15, 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 and deploy it on a target infrastructure, 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) Cloud/Edge Manager (OpenNebula), 2) AI-Enabled Orchestrator, 3) Serverless Runtime, and 4) Provisioning Engine.
- **Use Case #1 (Smart Cities)**: Toolkit used for the Smart Cities use case. It includes example data and code for remote FaaS calls to run Simulation of Urban Mobility (SUMO)[2] models using the COGNIT Framework.
- **Use Case #2 (Wildfire Detection)**: Toolkit used for the Wildfire Detection use case. It includes an example Serverless Runtime with a Machine Learning model for fire detection that leverages the COGNIT Framework.
- **Use Case #3 (Smart Energy)**: Toolkit used for the Smart Energy use case. It is divided into two 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 optimization scenario.
- **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 was released at the end of the Second Research and Innovation Cycle (M15), and will be updated with incremental releases in M27 and M33.

[2] An open source, highly portable, microscopic and continuous multi-modal traffic simulation package designed to handle large networks (https://eclipse.dev/sumo/).

Table of Contents

1. Introduction

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

The initial version of the COGNIT Framework Source Code, released in M15, provides the necessary tools for automating integration of the components of the COGNIT Framework and deployment of the whole COGNIT stack. 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 software stack and deploy it on a target infrastructure, setting up a private cloud, including resources from the cloud-edge continuum. The current version of the OpsForge Tool sets up the following components:

- Cloud/Edge Manager (OpenNebula).
- AI-Enabled Orchestrator.
- Serverless Runtime Appliance.
- Provisioning Engine.

Currently, OpsForge will create the needed virtual resources to contain the AI-Enabled Orchestrator. However, the AI-Enabled Orchestrator must be separately set up manually in this second development cycle. Later versions of the OpsForge Tool will include the AI-Enabled Orchestrator component in the automatic setup.

Some of the toolkits that have been developed as part of the research activities of the four use cases, have been released to the public together with the first version of the COGNIT Framework.

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 along the cloud-edge continuum. As shown in D5.3 and D5.10, this tool can be used to deploy the 1.0 version of the COGNIT framework.
Licence	Apache 2.0
Version	release-cognit-1.0
Design	D5.3 → 8. Software Integration Process and Infrastructure
Code	Public Repository
User Guide	Repository README
Testing	D5.3 → 8.3 Testing of COGNIT components
Verification	D5.3 → 10.1 Device Client

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 for this use case that returns emission estimates for different scenarios to the edge.
Licence	Apache 2.0
Version	release-v1.0.0
Design	D5.3 → 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-v1.0.0
Design	D5.3 → 4. Use Case #2: Wildfire Detection
Code	Public Repository
User Guide	Repository README

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.
Licence	BSD 3-Clause
Version	release-v1.0.0
Design	D5.3 → 5. Use Case #3: Energy
Code	Public Repository
User Guide	Repository README
Testing	Unit tests

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-v1.0.0
Design	D5.3 → 5. Use Case #3: Energy
Code	Public Repository
User Guide	Repository README

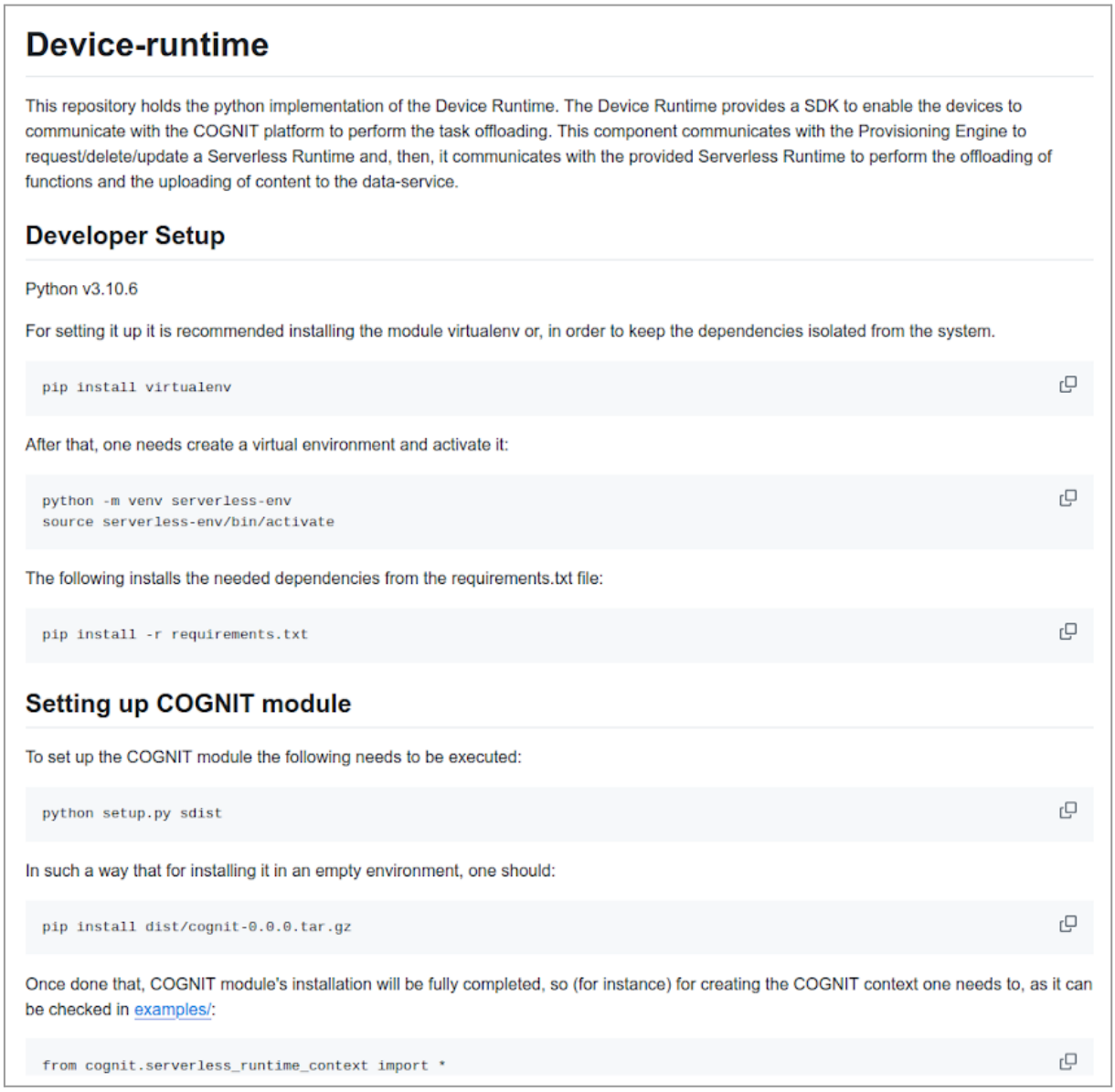
Use Case #4: Cybersecurity

use-case-4	
Description	Example of an anomaly detection function capable of determining if connection attempts have been made via the SSH protocol. We use a regular expression to check for the presence of connection failures in a log file (auth.log) passed as a parameter.
Licence	Apache 2.0
Version	release-ad-v1.0
Design	D5.3 → 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 that 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:



Device-runtime

This repository holds the python implementation of the Device Runtime. The Device Runtime provides a SDK to enable the devices to communicate with the COGNIT platform to perform the task offloading. This component communicates with the Provisioning Engine to request/delete/update a Serverless Runtime and, then, it communicates with the provided Serverless Runtime to perform the offloading of functions and the uploading of content to the data-service.

Developer Setup

Python v3.10.6

For setting it up it is recommended installing the module virtualenv or, in order to keep the dependencies isolated from the system.

```
pip install virtualenv
```

After that, one needs create a virtual environment and activate it:

```
python -m venv serverless-env
source serverless-env/bin/activate
```

The following installs the needed dependencies from the requirements.txt file:

```
pip install -r requirements.txt
```

Setting up COGNIT module

To set up the COGNIT module the following needs to be executed:

```
python setup.py sdist
```

In such a way that for installing it in an empty environment, one should:

```
pip install dist/cognit-0.0.0.tar.gz
```

Once done that, COGNIT module's installation will be fully completed, so (for instance) for creating the COGNIT context one needs to, as it can be checked in examples/:

```
from cognit.serverless_runtime_context import *
```

Figure 4.1. Extract from the User Guide

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 OpsForge documentation.

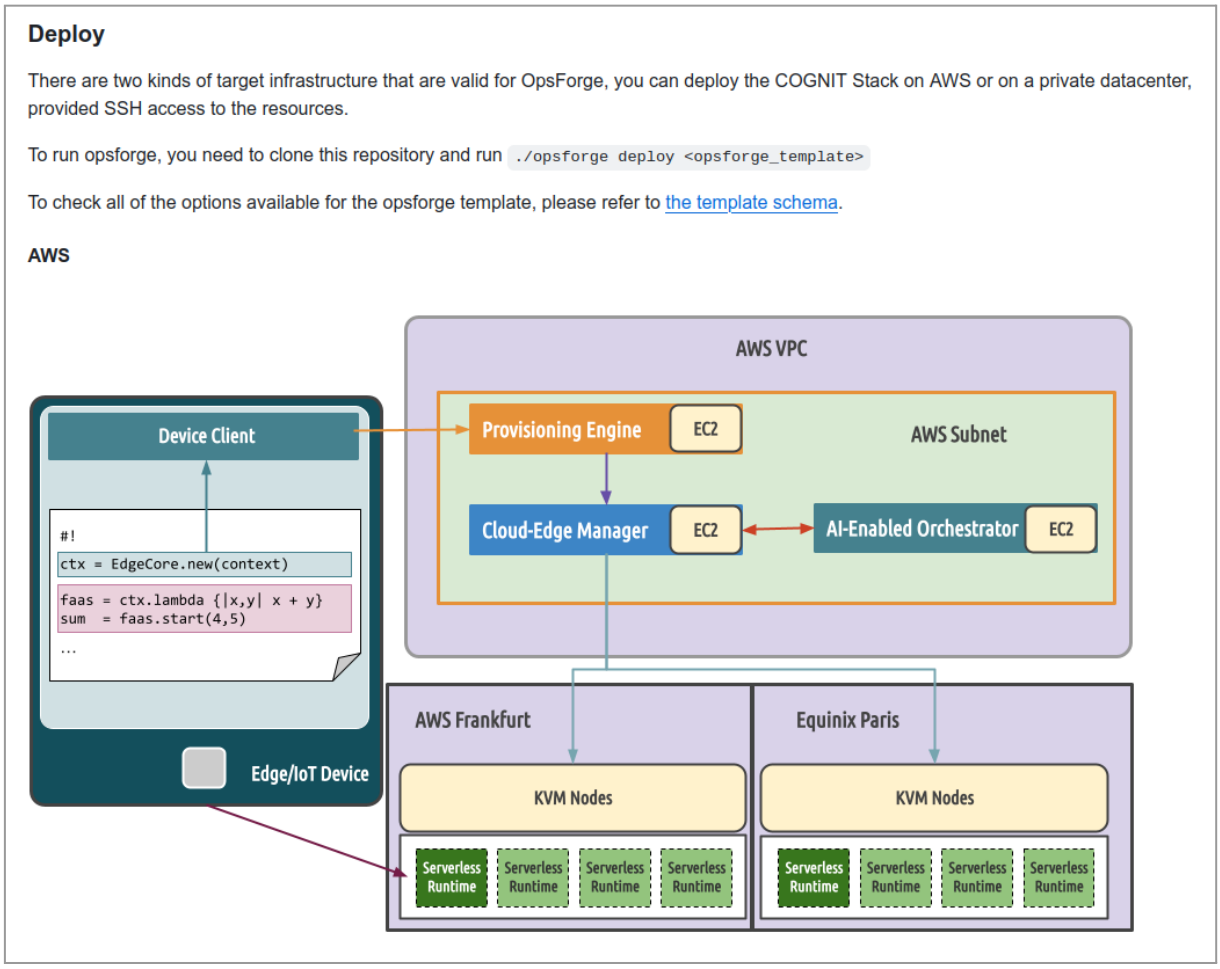


Figure 4.2. Extract from the Admin Guide

5. Conclusions

Deliverable D5.7 provides an overview of the source code for integrating and deploying the first public version of the COGNIT Framework, released in M15, 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 end of the Second Research and Innovation Cycle (M15), and will be updated with incremental releases in M27 and M33.