ONEedge.io

A Software-defined Edge Computing Solution

D3.5. Software Source - b

Software Source

Version1.0

10 March 2021

Abstract

This report summarizes the technical implementation of each of the software requirements associated with the technology components that have been addressed during the Second Innovation Cycle (M10-M16). For each Software Requirement, this document provides a brief description, the licence that applies to the source code, the OpenNebula version, a reference to the relevant section in D3.2. "Software Report", a link to OpenNebula's public code repositories and user guides, and references to the relevant sections in D4.2. "Infrastructure Report".

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Lead Authors:	Vlastimil Holer, Rubén S. Montero and Constantino Vázquez
Authors:	Sergio Betanzos, Pavel Czerny, Ricardo Díaz, Jim Freeman, Christian González, Alejandro Huertas, Shivang Kapoor and Jorge M. Lobo
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Document History

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1.0	10/3/2021	Submitted	First final version of the D3.5 report

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

Executive Summary

The purpose of deliverable D3.5 is to offer a summary of the technical implementation of each of the software requirements associated with the technology components that have been addressed during the Second Innovation Cycle (M10-M16).

For each Software Requirement, this document provides a brief description, the licence that applies to the source code, the OpenNebula version, a reference to the relevant section in D3.2. "Software Report", a link to OpenNebula's public code repositories and user guides, and references to the relevant sections in D4.2. "Infrastructure Report".

During the Second Innovation Cycle (M10-M16), the project mostly focused on those software requirements needed to achieve our second milestone in M16, which is the base functionality needed for a multi-host edge deployment. The work carried out during this Second Innovation Cycle involved software requirements from components CPNT1, CPNT2, CPNT3, CPNT4 and CPNT5, with a special focus on the edge instance management (CPNT1) and the deployment and provision of edge infrastructures (CPNT4).

Table of Contents

1. Edge Instance Manager (CPNT1)

SR1.1. Simple Product Deployment

Description	New type of edge stack deployment architecture based on application containers, which vastly simplifies the deployment process. All required dependencies are bundled within a distributed all-in-one container image and internally dynamically (re)configured to work together on instantiation.
License	Apache License, Version 2.0 or OpenNebula Software License (follows the licence of production edition bundled in image)
Version	OpenNebula 6.0
Design	D3.2 - [SR1.1] Simple Product Deployment
Code	Private—Part of infrastructure image build descriptors/tools
User Guide	• OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ • OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Instance Manager (CPNT1)
Verification	D4.2 - Edge Instance Manager (CPNT1)

SR1.2. Automatic Product Upgrade

Description	Upgrade of edge stack and its dependencies is simplified and reduced only to the change of newer container image (introduced in SR1.1) the software runs from. On instantiation, the bootstrap mechanism inside the image ensures the parts which need upgrade (e.g., database) are upgraded automatically or rolled back on failure.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR1.2] Automatic Product Upgrade
Code	Public—Part of the main OpenNebula distribution: • OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master • OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0 and Private—Part of infrastructure image build descriptors/tools
User Guide	• OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ • OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Instance Manager (CPNT1)
Verification	D4.2 - Edge Instance Manager (CPNT1)

SR1.3. Instance Management

Description	Containerized edge stack deployment provides a new way to control the managed services including a (health check) reporting about the state to the management tools. On error conditions, the automatic recovery actions are triggered. Base deployment is customized via a set of environment parameters. Individual multi-VM services (managed by OpenNebula OneFlow, hence called OneFlow services) can be configured by a newly developed (onecfg patch) mechanism to update any relevant configuration by the end-user in a unified way. OpenNebula configuration defaults were adjusted to fit production needs.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR1.3] Instance Management
Code	Public—Part of the main OpenNebula distribution ● OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master ● OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	● OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ ● OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Instance Manager (CPNT1)
Verification	D4.2 - Edge Instance Manager (CPNT1)

2. Edge Workload Orchestration and Management (CPNT2)

SR2.2. Specialized Cache Datastore	
Description	An extension to the OpenNebula SSH drivers has been implemented to replicate datastore contents across Edge Locations. This allows for rapid deployment times. Additionally the new extensions performs regular disk snapshots to recover VMs from them in case of edge node failure
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR2.2] Specialized Cache Datastore
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.2 - Edge Workload Orchestration and Management (CPNT2)

SR2.4. Virtual Machine Management Operations: Backups	
Description	OpenNebula can backup running VMs to later restore them in case of node or edge failure. The backup consists of the VM disks as well as the metadata needed to recreate the instance. Users can define custom backup policies.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR2.4] Virtual Machine Management Operations: Backups
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.2 - Edge Workload Orchestration and Management (CPNT2)

SR2.8. Complete Service Flows

Description	OpenNebula Flows describe a multi VM application. Usually these applications are structured in tiers that communicate each component through dedicated or public networks. OpenNebula Flow engine has been extended to dynamically provision these networks.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR2.8] Complete Service Flows
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.2 - Edge Workload Orchestration and Management (CPNT2)

SR2.9. Web UI extensions

Description	The functionality developed in SR2.1 - SR2.7 required adaptations to current interfaces to include new options or improve its layout based on the new data model. This is separate from new interfaces such as a Fireedge/OneProvision GUI defined in other SRs in this document. The web extension task is a horizontal development task, and it affects the existing OpenNebula GUI component, Sunstone.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR2.9] Web UI extensions
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.2 - Edge Workload Orchestration and Management (CPNT2)

SR2.10. LXC virtualization drivers for OpenNebula	
Description	OpenNebula can deploy VM using LXC container technology with multiple storage and network backends.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR2.10] LXC virtualization drivers for OpenNebula
Code	Public—Part of the main OpenNebula distribution • OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master • OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	• OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ • OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.2 - Edge Workload Orchestration and Management (CPNT2)

3. Edge Provider Selection (CPNT3)

SR3.1. Edge Provider Catalog Service	
Description	This component is implemented in the OneProvision Fireedge service, built in Node.js and React/Redux. This is a brand new component (described as part of SR4.8) developed for ONEedge.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR3.1] Edge Provider Catalog Service
Code	Public—Part of the main OpenNebula distribution ● OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master ● OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	● OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ ● OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Provider Selection (CPNT3)
Verification	D4.2 - Edge Provider Selection (CPNT3)

SR3.4. Driver Maintenance Process	
Description	This process is used to certify third party companies that want to contribute into provision drivers and also the IPAM drivers. The process is fully automated and can test all the operations involved in each step, from the provider creation until the provision configuration to see if virtual machines can be run and reached through the public interface.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR3.4] Driver Maintenance Process
Code	Private—Part of the oneprovision RSpec functional tests
User Guide	● OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ ● OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Provider Selection (CPNT3)
Verification	D4.2 - Edge Provider Selection (CPNT3)

SR3.5. Edge Catalog Web Interface	
Description	The different edge providers that are part of the ONEedge catalog need to be presented in a comprehensive manner to the user to choose the optimal provider for their use cases. This is achieved through the OneProvision interface served by the Fireedge component described in SR4.8.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR3.5] Edge Catalog Web Interface
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Provider Selection (CPNT3)
Verification	D4.2 - Edge Provider Selection (CPNT3)

4. Edge Infrastructure Provision and Deployment (CPNT4)

SR4.1. Reliable Edge Resource Provision	
Description	In order to interface with multiple providers ONEedge uses Terraform. Each provider requires a different set of resources based on their characteristics. For example, in AWS a provision is built in its own VPC.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR4.1] Reliable Edge Resource Provision
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)

SR4.2. Usability, Functionality and Scalability of Provision	
Description	Provision engine has been extended to persist its state in the OpenNebula Database. Provisions also includes its terraform state so the driver can deploy the required resources. Also the provider has been modelled as a new managed by the OneProvision. Each provider represents a zone, the connection details and the zone characteristic like instance types or images.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR4.2] Usability, Functionality and Scalability of Provision
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)

SR4.3. Provision Template for Reference Architectures

Description	ONEedge comes with a predefined set of certified provision templates. These templates are ready to use, and deploy functional Edge provision on selected providers. The templates come with a curated list of options and defaults.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR4.3] Provision Template for Reference Architectures
Code	Public—Part of the main OpenNebula distribution • OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master • OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	• OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ • OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)

SR4.5. Drivers for Host Provision

Description	Oneprovision uses an uniform Terraform driver to provision cloud resources. Terraform provides a common layer to interface with different clouds. Each OpenNebula resource is represented by a separated Terraform description in each provider
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR4.5] Drivers for Host Provision
Code	Public—Part of the main OpenNebula distribution • OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master • OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	• OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ • OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)

SR4.6. Drivers for IP Address Management

Description	IPAM drivers have been rewritten from scratch as part of the SR4.7 task. Software and documentation of SR4.6 are included in SR4.7 (see below).

SR4.7. Drivers for Network Drivers and Helpers

Description	ONEedge implements a uniform network stack to provision virtual networks on Edge providers. The implementation comprises 3 main components: IPAM driver to allocate/release elastic IPs; a mapping driver to route elastic IP traffic to the target host; and the implementation of a VXLAN overlay to create VLANs.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR4.7] Drivers for Network Drivers and Helpers
Code	Public—Part of the main OpenNebula distribution • OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master • OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	• OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ • OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)

SR4.8. GUI for Edge Resource Provision

Description	The full list of operations that are available through the set of oneprovision and oneprovider commands can be performed too through the OneProvision GUI served by Fireedge. Fireedge is a Node.js server that delivers the OneProvision GUI written in React/Redux that has been developed in the context of ONEedge and will be included in OpenNebula 6.0
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR4.8] GUI for Edge Resource Provision
Code	Public—Part of the main OpenNebula distribution • OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master • OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0

User Guide	● OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ ● OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.2 - Edge Infrastructure Provision and Deployment (CPNT4)

5. Edge Apps Marketplace (CPNT5)

SR5.1. Edge Applications and Services in Marketplace	
Description	Extends the current OpenNebula VM and containers marketplace to deal with OneFlow services. The marketplace supports mainly three different types of applications: images, Virtual Machine Templates and OneFlow Service Templates
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR5.1] Edge Applications and Services in Marketplace
Code	Public—Part of the main OpenNebula distribution - OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master - OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	- OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ - OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Apps Marketplace (CPNT5)
Verification	D4.2 - Edge Apps Marketplace (CPNT5)

SR5.2. Built-in Management of Application Containers Engine	
Description	OpenNebula Kubernetes appliance provides an easy way to deploy a Kubernetes cluster. It utilizes the already present functionality of VM contextualization but it is also able to leverage OpenNebula's OneFlow feature to dynamically scale the cluster's nodes. The goal of this SR is to improve this OpenNebula and Kubernetes integration, enabling elasticity of the OpenNebula managed Kubernetes cluster. It is complementary to SR5.3, which provides an alternative way to run existing container appliances in ONEedge.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR5.2] Built-in Management of Application Containers Engine
Code	Public—Part of the OpenNebula Public Marketplace https://marketplace.opennebula.io/appliance/07520eee-6552-11eb-85e7-98fa9bde1a93
User Guide	https://docs.opennebula.io/appliances/service/kubernetes.html#oneflow-integration

Testing	D4.2 - Edge Apps Marketplace (CPNT5)
Verification	D4.2 - Edge Apps Marketplace (CPNT5)

SR5.3. Integration with Application Containers Marketplace

Description	Improve existing integration with application containers marketplace (i.e Docker Hub) to make it more customizable and straightforward to the user.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR5.3] Integration with Application Containers Marketplace
Code	Public—Part of the main OpenNebula distribution ● OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master ● OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	● OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ ● OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Apps Marketplace (CPNT5)
Verification	D4.2 - Edge Apps Marketplace (CPNT5)

SR5.5. Edge Market GUI Developments

Description	This component intends to enable end users to be able to deploy both Edge Applications based on VMs and system containers as well as application containers in the Distributed Edge Cloud using a simple point and click web interface. A technology preview of FireEdge Flow, a self service portal to deploy and manage applications on top of an OpenNebula cloud, will be included. It is not ready for production but it showcases the ability to create a full application (using a graph interface) based on VM Templates and containers (which can be mixed) and deploy it on-prem or over a provision created with the OneProvision GUI.
License	Apache License, Version 2.0
Version	OpenNebula 6.0
Design	D3.2 - [SR5.5] Edge Market GUI Developments
Code	Public—Part of the main OpenNebula distribution ● OpenNebula 6.0 Beta: https://github.com/OpenNebula/one/tree/master

	● OpenNebula 6.0 Stable: https://github.com/OpenNebula/one/releases/tag/release-6.0.0
User Guide	● OpenNebula 6.0 Beta: http://docs.opennebula.io/5.13/ ● OpenNebula 6.0 Stable: http://docs.opennebula.io/6.0/
Testing	D4.2 - Edge Apps Marketplace (CPNT5)
Verification	D4.2 - Edge Apps Marketplace (CPNT5)