



ONEedge.io

A Software-defined Edge Computing Solution

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## D3.4. Software Source - a

Software Source v.1.0

31 July 2020

### Abstract

This report summarizes the technical implementation of each of the software requirements associated with the technology components that have been addressed during the First Innovation Cycle (M4-M9). 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 D3.1. "Software Report", a link to OpenNebula's public code repositories and user guides, and references to the relevant sections in D4.1. "Infrastructure Report".



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## Document History

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1.0	31/7/2020	Submitted	First final version of the report

<sup>1</sup> A deliverable can be in one of these stages: Draft, Peer-Reviewed, Submitted and Approved.



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## Executive Summary

The purpose of deliverable D3.4 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 First Innovation Cycle (M4-M9).

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 D3.1. "Software Report", a link to OpenNebula's public code repositories and user guides, and references to the relevant sections in D4.1. "Infrastructure Report".

During the First Innovation Cycle (M4-M9), the project mostly focused on those software requirements needed to achieve our first milestone in M9, which is the base functionality needed for a single-host edge deployment. The work carried out during this First Innovation Cycle has involved the software requirements of components CPNT1, CPNT2, CPNT3, CPNT4 and CPNT5, with a special focus on laying the technological foundation of ONEedge.



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## 1. Edge Instance Manager (CPNT1)

### SR1.2. Automatic Product Upgrade

Description	Mechanism for automated upgrade of configurations of EdgeStack components was implemented (tool <code>onecfg</code> ) and released as part of EdgeScape (OneScape).
License	OpenNebula Software License <sup>2</sup>
Version	OneScape 5.12
Design	D3.1 - [SR1.2] Automatic Product Upgrade
Code	Private - Part of the OneScape distribution
User Guide	<a href="http://docs.opennebula.io/onescape/5.12/">http://docs.opennebula.io/onescape/5.12/</a>
Testing	D4.1 - Edge Instance Manager (CPNT1)
Verification	D4.1 - Edge Instance Manager (CPNT1)

<sup>2</sup> <https://support.opennebula.pro/hc/en-us/articles/360016168931-OpenNebula-Software-License-Agreement>



## 2. Edge Workload Orchestration and Management (CPNT2)

### SR2.1. Integration with Serverless Hypervisor

Description	A new driver to interact with Firecracker VMM has been implemented. This allows ONEedge to support light microVMs. The support is complete and includes basic operations (create, terminate, poweroff...) as well as a complete integration with the storage network stack (file based datastores) and network stack (linux bridge based drivers). Additional ONEedge features VNC support and contextualization support for Firecracker microVMs.
License	Apache License, Version 2.0 <sup>3</sup>
Version	OpenNebula 5.12
Design	D3.1 - [SR2.1] Integration with Serverless Hypervisor
Code	Public - Part of the main OpenNebula distribution <ul style="list-style-type: none"> <li>Virtualization Driver: <a href="https://github.com/OpenNebula/one/tree/master/src/vmm_mad/remotes/firecracker">https://github.com/OpenNebula/one/tree/master/src/vmm_mad/remotes/firecracker</a></li> <li>Monitoring Driver: <a href="https://github.com/OpenNebula/one/tree/master/src/im_mad/remotes/firecracker-probes.d">https://github.com/OpenNebula/one/tree/master/src/im_mad/remotes/firecracker-probes.d</a></li> </ul>
User Guide	<ul style="list-style-type: none"> <li>Installation: <a href="http://docs.opennebula.io/5.12/deployment/node_installation/fc_node_installation.html">http://docs.opennebula.io/5.12/deployment/node_installation/fc_node_installation.html</a></li> <li>Usage: <a href="http://docs.opennebula.io/5.12/deployment/open_cloud_host_setup/fc_driver.html">http://docs.opennebula.io/5.12/deployment/open_cloud_host_setup/fc_driver.html</a></li> </ul>
Testing	D4.1 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.1 - Edge Workload Orchestration and Management (CPNT2)

### SR2.3. Secure and Scalable Distributed Monitoring

Description	A new monitoring architecture is now in place. The new monitor architecture follows a push approach where the nodes send information to the monitor front-end. It also features a modular probe system with multiple timeouts, and decouples the monitor workflow from the system. The result is a monitor system that scales better and supports high-latency and public network links.
License	Apache License, Version 2.0

<sup>3</sup> <https://www.apache.org/licenses/LICENSE-2.0>



Version	OpenNebula 5.12
Design	D3.1 - [SR2.3] Secure and Scalable Distributed Monitoring
Code	Public - Part of the main OpenNebula distribution <ul style="list-style-type: none"> <li>New monitor daemon: <a href="https://github.com/OpenNebula/one/tree/master/src/monitor">https://github.com/OpenNebula/one/tree/master/src/monitor</a></li> <li>New monitor probes: <a href="https://github.com/OpenNebula/one/tree/master/src/im_mad">https://github.com/OpenNebula/one/tree/master/src/im_mad</a></li> </ul>
User Guide	<ul style="list-style-type: none"> <li>Configuration: <a href="https://github.com/OpenNebula/one/tree/master/src/monitor">https://github.com/OpenNebula/one/tree/master/src/monitor</a></li> <li>Integration and Development: <a href="http://docs.opennebula.io/5.12/integration/infrastructure_integration/devel-im.html">http://docs.opennebula.io/5.12/integration/infrastructure_integration/devel-im.html</a></li> </ul>
Testing	D4.1 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.1 - Edge Workload Orchestration and Management (CPNT2)

### SR2.5. Integration with Remote VMware vCenter Service

Description	The capabilities of ONEedge to interface with VMware services has been improved to extend its networking capabilities. The new drivers can define virtual networks and security groups leveraging the VMware native capabilities (NSX-t & NSX-v)
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR2.5] Integration with Remote VMware vCenter Service
Code	Public - Part of the main OpenNebula distribution <ul style="list-style-type: none"> <li>NSX Driver: <a href="https://github.com/OpenNebula/one/tree/master/src/vmm_mad/notes/nsx">https://github.com/OpenNebula/one/tree/master/src/vmm_mad/notes/nsx</a></li> <li>NSX Monitoring: <a href="https://github.com/OpenNebula/one/blob/master/src/im_mad/remotes/lib/vcenter_cluster.rb">https://github.com/OpenNebula/one/blob/master/src/im_mad/remotes/lib/vcenter_cluster.rb</a></li> </ul>
User Guide	Driver Documentation: <a href="http://docs.opennebula.io/5.12/integration/infrastructure_integration/nsx_driver.html">http://docs.opennebula.io/5.12/integration/infrastructure_integration/nsx_driver.html</a>
Testing	D4.1 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.1 - Edge Workload Orchestration and Management (CPNT2)



## SR2.6. VNF Support

Description	ONEedge can allocate and schedule VMs with specific NUMA topologies. The drivers have been extended to define the virtual server topology including NUMA nodes, cores per node, and memory per node. Additionally, the monitor system includes specific probes to gather the host topology to optimize the placement of the virtual nodes. The scheduler of ONEedge now considers NUMA allocation status to place NUMA-enabled VMs. Finally, KVM drivers have been extended to support DPDK data-plane for Open vSwitch bridges.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR2.6] VNF Support
Code	Public - Part of the main OpenNebula distribution <ul style="list-style-type: none"> <li>NUMA allocation and Scheduling: <a href="https://github.com/OpenNebula/one/blob/master/src/host/HostShareNUMA.cc">https://github.com/OpenNebula/one/blob/master/src/host/HostShareNUMA.cc</a></li> <li>DPDK Driver: <a href="https://github.com/OpenNebula/one/blob/master/src/vnm_adapter/ovswitch/OpenvSwitch.rb">https://github.com/OpenNebula/one/blob/master/src/vnm_adapter/ovswitch/OpenvSwitch.rb</a></li> </ul>
User Guide	<ul style="list-style-type: none"> <li>NUMA and CPU Pinning: <a href="http://docs.opennebula.io/5.12/operation/host_cluster_management/numa.html">http://docs.opennebula.io/5.12/operation/host_cluster_management/numa.html</a></li> <li>DPDK Driver: <a href="http://docs.opennebula.io/5.12/deployment/open_cloud_networking_setup/openvswitch.html#open-vswitch-with-dpdk">http://docs.opennebula.io/5.12/deployment/open_cloud_networking_setup/openvswitch.html#open-vswitch-with-dpdk</a></li> </ul>
Testing	D4.1 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.1 - Edge Workload Orchestration and Management (CPNT2)

## SR2.8. Complete Service Flows

Description	ONEedge can allocate and schedule VMs with specific NUMA topologies. The drivers have been extended to define the virtual server topology including NUMA nodes, cores per node, and memory per node. Additionally, the monitor system includes specific probes to gather the host topology to optimize the placement of the virtual nodes. The scheduler of ONEedge now considers NUMA allocation status to place NUMA-enabled VMs. Finally, KVM drivers have been extended to support DPDK data-plane for Open vSwitch bridges.
License	Apache License, Version 2.0
Version	OpenNebula 5.12





Design	D3.1 - [SR2.8] Complete Service Flows
Code	Public - Part of the main OpenNebula distribution <a href="https://github.com/OpenNebula/one/tree/master/src/flow">https://github.com/OpenNebula/one/tree/master/src/flow</a>
User Guide	Including configuration and Service Management: <a href="http://docs.opennebula.io/5.12/advanced_components/application_flow_and_auto-scaling/index.html">http://docs.opennebula.io/5.12/advanced_components/application_flow_and_auto-scaling/index.html</a>
Testing	D4.1 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.1 - Edge Workload Orchestration and Management (CPNT2)

### SR2.9. Web UI extensions

Description	The UI has been extended to include the new features developed in this cycle. In particular: OneFlow has been re-design to include a flexible network definition tab; Host and VM information now shows the NUMA topology and allocation status. Also a special view has been developed to include NSX information and usage.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - Described for each SR that extends the UI in sections API & Interfaces.
Code	Public - Part of the main OpenNebula distribution <a href="https://github.com/OpenNebula/one/tree/master/src/sunstone">https://github.com/OpenNebula/one/tree/master/src/sunstone</a>
User Guide	Included in the User Guide of each SR when appropriate.
Testing	D4.1 - Edge Workload Orchestration and Management (CPNT2)
Verification	D4.1 - Edge Workload Orchestration and Management (CPNT2)



### 3. Edge Provider Selection (CPNT3)

SR3.4 Driver Maintenance Process	
Description	The Amazon EC2 and Packet drivers from the Edge Infrastructure Provision component drivers lay the basis to build an acceptance and certification process as well as the needed testing framework and documentation.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR3.4] Driver Maintenance Process
Code	Public - Part of the main OpenNebula distribution <a href="https://github.com/OpenNebula/one/tree/master/src/pm_mad/remotes/ec2">https://github.com/OpenNebula/one/tree/master/src/pm_mad/remotes/ec2</a>
User Guide	<a href="http://docs.opennebula.io/5.12/advanced_components/ddc/drivers/ec2.html">http://docs.opennebula.io/5.12/advanced_components/ddc/drivers/ec2.html</a>
Testing	D4.1 - Edge Provider Selection (CPNT3)
Verification	D4.1 - Edge Provider Selection (CPNT3)



## 4. Edge Infrastructure Provision and Deployment (CPNT4)

### SR4.1. Reliable Edge Resource Provision

Description	Provisioning tools were improved for better resilience to the errors by multi-staged handling of error situations (called as failover combinations). Prototype of background cleaner of orphaned deployments (running hosts without clear connection to the deployments in the inventory) is currently under testing and evaluation.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR4.1] Reliable Edge Resource Provision
Code	Public - Part of the main OpenNebula distribution <a href="https://github.com/OpenNebula/one/tree/master/src/oneprovision/lib">https://github.com/OpenNebula/one/tree/master/src/oneprovision/lib</a>
User Guide	<a href="http://docs.opennebula.io/5.12/advanced_components/ddc/usage.html#running-modes">http://docs.opennebula.io/5.12/advanced_components/ddc/usage.html#running-modes</a>
Testing	D4.1 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.1 - Edge Infrastructure Provision and Deployment (CPNT4)

### SR4.2. Usability, Functionality and Scalability of Provision

Description	Provisioning tools were extended to create more complete deployments with new entities for end-users. Such deployment can be created based on a combination of multiple descriptors within a single deployment process. Also, can contain entities created for direct use by end users - e.g., virtual machine images and templates, multi-VM deployments descriptors.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR4.2] Usability, Functionality and Scalability of Provision
Code	Public - Part of the main OpenNebula distribution <a href="https://github.com/OpenNebula/one/tree/master/src/oneprovision/lib">https://github.com/OpenNebula/one/tree/master/src/oneprovision/lib</a>
User Guide	<a href="http://docs.opennebula.io/5.12/advanced_components/ddc/template/virtual.html">http://docs.opennebula.io/5.12/advanced_components/ddc/template/virtual.html</a>
Testing	D4.1 - Edge Infrastructure Provision and Deployment (CPNT4)
Verification	D4.1 - Edge Infrastructure Provision and Deployment (CPNT4)



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### SR4.3. Provision Template for Reference Architectures

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Description	Provision templates were extended with examples of complete deployment specifications of fully usable clusters. The example specifications can be used by experienced cloud administrators to easily create ready-to-use clusters with a single run of provisioning tools.
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License	Apache License, Version 2.0
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Version	OpenNebula 5.12
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Design	D3.1- [SR4.3] Provision Template for Reference Architectures
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Code	Public - Part of the main OpenNebula distribution <a href="https://github.com/OpenNebula/one/tree/master/share/oneprovision/examples">https://github.com/OpenNebula/one/tree/master/share/oneprovision/examples</a>
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User Guide	<a href="http://docs.opennebula.io/5.12/advanced_components/ddc/default.html">http://docs.opennebula.io/5.12/advanced_components/ddc/default.html</a>
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Testing	D4.1 - Edge Infrastructure Provision and Deployment (CPNT4)
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Verification	D4.1 - Edge Infrastructure Provision and Deployment (CPNT4)
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## 5. Edge Apps Marketplace (CPNT5)

### SR5.2. Built-in Management of Application Containers Engine SR5.4. New Edge Applications Marketplace Entries

Name	Kubernetes OpenNebula appliance
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.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR5.2] Built-in Management of Application Containers Engine
Code	Public - Part of the main OpenNebula distribution <a href="http://marketplace.opennebula.io/appliance/edc648b6-5958-4370-9b66-555fd5846182">http://marketplace.opennebula.io/appliance/edc648b6-5958-4370-9b66-555fd5846182</a>
User Guide	Kubernetes Services documentation: <a href="https://docs.opennebula.io/appliances/service/kubernetes.html">https://docs.opennebula.io/appliances/service/kubernetes.html</a>
Testing	D4.1 - Edge Apps Marketplace (CPNT5)
Verification	D4.1 - Edge Apps Marketplace (CPNT5)

### SR5.3. Integration with Application Containers Marketplace

Description	Leveraging the new Firecracker support in OpenNebula, a new marketplace offering all the DockerHub applications have been added to OpenNebula 5.12. Any docker application can therefore be instantiated in an OpenNebula cloud, backed by a microVM in a fully transparent way.
License	Apache License, Version 2.0
Version	OpenNebula 5.12
Design	D3.1 - [SR5.3] Integration with Application Containers Marketplace
Code	Public - Part of the main OpenNebula distribution <ul style="list-style-type: none"> <li>DocketHub Marketplace driver: <a href="https://github.com/OpenNebula/one/tree/master/src/market_mad/remotes/dockerhub">https://github.com/OpenNebula/one/tree/master/src/market_mad/remotes/dockerhub</a></li> <li>Docker image downloader &amp; builder: <a href="https://github.com/OpenNebula/one/blob/master/src/datastore_mad/remotes/docker_downloader.sh">https://github.com/OpenNebula/one/blob/master/src/datastore_mad/remotes/docker_downloader.sh</a></li> </ul>



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User Guide	<ul style="list-style-type: none"><li>• DocketHub Marketplace Configuration &amp; Usage: <a href="http://docs.opennebula.io/5.12/advanced_components/marketplace/market_dh.html">http://docs.opennebula.io/5.12/advanced_components/marketplace/market_dh.html</a></li><li>• Using VMs with Container Images: <a href="http://docs.opennebula.io/5.12/advanced_components/marketplace/container_images_usage.html#container-image-usage">http://docs.opennebula.io/5.12/advanced_components/marketplace/container_images_usage.html#container-image-usage</a></li></ul>
Testing	D4.1 - Edge Apps Marketplace (CPNT5)
Verification	D4.1 - Edge Apps Marketplace (CPNT5)

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