# **Container4NFV**

**Release Latest** 

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# CHAPTER 1

# Container4NFV Gap Analysis

Project Container4NFV, https://wiki.opnfv.org/display/OpenRetriever/Container4NFV

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Abstract This document provides the users with top-down gap analysis regarding OpenRetriever feature requirements with OPNFV Installer, OpenStack Official Release and Kubernetes Official Release.

## 1.1 Container4NFV architecture options

Analyzis of the architecture options were moved to the Container4NFV wiki.

# 1.2 Container4NFV Gap Analysis with OPNFV Installer

This section provides users with Container4NFV gap analysis regarding feature requirement with OPNFV Installer in Danube Official Release. The following table lists the use cases / feature requirements of container integrated functionality, and its gap analysis with OPNFV Installer in Danube Official Release. OPNFV installer should support them.

Use Case / Requirement	Supported in Danube	Notes
Use Openstack Magnum to install container environment	No	Magnum is supported in Openstack Official Re
Use Openstack Ironic to supervise bare metal machine	No	Container could be installed in bare metal mac
Use Openstack Kuryr to provide network for container	No	Container has its own network solution. Contain

# 1.3 Container4NFV Gap Analysis with OpenStack

This section provides a gap analyzis between the targets of Container4NFV for release Euphrates (E) or later and the features provided by OpenStack in release Ocata. As the OPNFV and OpenStack releases tend to change over time this analyzis is planned to be countinously updated. During the analyzis all OpenStack projects considered.

(Editors note: Maybe we should define a scope of OpenStack projects which is considered. All OpenStack projects can mean anything.)

The following table lists the use cases / feature requirements of container integrated functionality, and its gap analysis with OpenStack.

Use Case / Requirement	Related OpenStack project	Notes
ose base / nequirement		10103
Manage container and virtual machine lifecycle with the same NB API	Zun or nova-docker driver	Magnum can deploy a Con
Container private registry to store container images	Swift, Cinder, Glance, Glare	Container images need a st
Kuryr needs to support MACVLAN and IPVLAN	Kuryr	Using MACVLAN or IPV
Kuryr Kubernetes integration is needed	Kuryr	It is done in the frame of C
HA support for Kuryr	Kuryr	
HA support for Zun	Zun	

# 1.4 Container4NFV Gap Analysis with Kubernetes v1.5

This section provides users with Container4NFV gap analysis regarding feature requirement with Kubernetes Official Release. The following table lists the use cases / feature requirements of container integrated functionality, and its gap analysis with Kubernetes Official Release.

Use Case / Requirement	Supported in v1.5	Notes
Manage conainter and virtual ma-	No	There are some ways how Kuber-
chine in the same platform.		netes could manage VM-s:
		1. Kubevirt
		2. Kubernetes can start rkt and
		with rkt it is possible to start
		VM-s
		3. Virtlet
		4. Hypercontainer
Kubernetes support multiple net-	No	As VNF needs at least three inter-
works.		faces. Management, control plane,
		data plane. CNI already supports
		multiple interfaces in the API defi-
		nition.
		1. Multus
		2. CNI-Genie
		3. A solution built into Kuber-
		netes
Kubernetes support NAT-less con-	No	SIP/SDP and SCTP are not working
nections to a container		with NAT-ed networks
Kubernetes scheduling support CPU	No	The kubernetes schedular don't sup-
bindingNUMA features		port these features

Continued on next page

Use Case / Requirement	Supported in v1.5	Notes
DPDK need to support CNI	No	DPDK is the technology to acceler-
		ate the data plane. Container need
		support it, the same with virtual ma-
		chine.
SR-IOV can support CNI (Optional)	No	SR-IOV could let container get high
		performance

Table	3 –	continued	from	previous	page
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# CHAPTER 2

# Container4NFV Release Notes

### 2.1 Container4NFV E release Notes

- 1. Gap analysis for openstack, kubernetes, opnfv installer
- 2. Container architecture options
- 3. Joid could support Kubernetes
- 4. Using vagrant tool to setup an env with DPDK enabled.

# 2.2 Container4NFV F release Notes

- 1. Enable Multus in Kubernetes
- 2. Enable SR-IOV in Kubernetes
- 3. Support ARM platform

### 2.3 Container4NFV G release Notes

- 1. Enable Virtlet in Kubernetes
- 2. Enable Kata in Kubernetes
- 3. Enable VPP in Kubernetes
- 4. Enable Vagrant tools.

# CHAPTER 3

# Container4NFV User Guide

### 3.1 Installation

This quickstart shows you how to easily install a Kubernetes cluster on VMs running with Vagrant. You can find the four projects inside *container4nfv/src/vagrant* and their documentation: - kubeadm\_basic: weave.rst - kubeadm\_multus: multus.rst - kubeadm\_ovsdpdk: ovs-dpdk.rst - kubeadm\_virtlet: virtlet.rst

Vagrant is installed in Ubuntu 16.04 64bit. vagrant is to create kubernetes cluster using kubeadm. kubernetes installation by kubeadm can be refered to https://kubernetes.io/docs/getting-started-guides/kubeadm.

### 3.2 e release

#### 3.2.1 Vagrant Setup

sudo apt-get install -y virtualbox wget –no-check-certificate https://releases.hashicorp.com/vagrant/1.8.7/vagrant\_1.8.7\_x86\_64.deb sudo dpkg -i vagrant\_1.8.7\_x86\_64.deb

#### 3.2.2 K8s Setup

git clone http://gerrit.opnfv.org/gerrit/container4nfv -b stable/euphrates cd container4nfv/src/vagrant/k8s\_kubeadm/ vagrant up

### 3.2.3 Run K8s Example

vagrant ssh master -c "kubectl apply -f /vagrant/examples/virtio-user.yaml"

### 3.2.4 K8s Cleanup

vagrant destroy -f

# 3.3 f release

### 3.3.1 Vagrant Setup

1. setup\_vagrant.sh may install all for you. The project uses vagrant with libvirt as default because of performance.

` container4nfv/src/vagrant# ./setup\_vagrant.sh `

Consequently, we need to reboot to make libvirtd group effective.

2. Deploy:

To test all the projects inside *vagrant/* just run the next script:

```
` container4nfv/ci# ./deploy.sh `
```

# 3.4 Senario:

#### 3.4.1 k8-nosdn-nofeature-noha

Using Joid to deploy Kubernetes in bare metal machine https://build.opnfv.org/ci/job/ joid-k8-nosdn-nofeature-noha-baremetal-daily-euphrates/lastBuild/

#### 3.4.2 k8-nosdn-lb-noha

Using Joid to deploy Kubernetes in bare metal machine with load balance enabled https://build.opnfv.org/ci/job/ joid-k8-nosdn-lb-noha-baremetal-daily-euphrates/

# 3.5 YardStick test Cases

#### 3.5.1 opnfv\_yardstick\_tc080

measure network latency between containers in k8s using ping https://git.opnfv.org/yardstick/tree/tests/opnfv/test\_cases/opnfv\_yardstick\_tc080.yaml

### 3.5.2 opnfv\_yardstick\_tc081

measure network latency between container and VM using ping https://git.opnfv.org/yardstick/tree/tests/opnfv/test\_cases/opnfv\_yardstick\_tc081.yaml

# 3.6 Multus implementation for OPNFV

This quickstart shows you how to easily install a Kubernetes cluster on VMs running with Vagrant. The installation uses a tool called kubeadm which is part of Kubernetes.

kubeadm assumes you have a set of machines (virtual or bare metal) that are up and running. In this way we can get a cluster with one master node and 2 workers (default). If you want to increase the number of workers nodes, please check the Vagrantfile inside the project.

### 3.6.1 About Multus

[Multus](https://github.com/Intel-Corp/multus-cni) is a CNI proxy and arbiter of other CNI plugins.

With the help of Multus CNI plugin, multiple interfaces can be added at the same time when deploying a pod. Notably, Virtual Network Functions (VNFs) are typically requiring connectivity to multiple network interfaces.

The Multus CNI has the following features: - It is a contact between the container runtime and other plugins, and it doesn't have any of its own net configuration, it calls other plugins like flannel/calico to do the real net conf. job. - Multus reuses the concept of invoking the delegates in flannel, it groups the multi plugins into delegates and invoke each other in sequential order, according to the JSON scheme in the cni configuration. - No. of plugins supported is dependent upon the number of delegates in the conf file. - Master plugin invokes "eth0" interface in the pod, rest of plugins(Mininon plugins eg: sriov,ipam) invoke interfaces as "net0", "net1"... "netn". - The "masterplugin" is the only net conf option of Multus cni, it identifies the primary network. The default route will point to the primary network.

#### 3.6.2 Multus example



# 3.7 Nginx implementation for OPNFV

This quickstart shows you how to easily install a Kubernetes cluster on VMs running with Vagrant. The installation uses a tool called kubeadm which is part of Kubernetes.

kubeadm assumes you have a set of machines (virtual or bare metal) that are up and running. In this way we can get a cluster with one master node and 2 workers (default). If you want to increase the number of workers nodes, please check the Vagrantfile inside the *kubeadm\_basic/*.

### 3.7.1 About Nginx

Nginx is a web server which can also be used as a reverse proxy, load balancer and HTTP cache.

# 3.8 Ovsdpdk implementation for OPNFV

This quickstart shows you how to easily install a Kubernetes cluster on VMs running with Vagrant. The installation uses a tool called kubeadm which is part of Kubernetes.

kubeadm assumes you have a set of machines (virtual or bare metal) that are up and running. In this way we can get a cluster with one master node and 2 workers (default). If you want to increase the number of workers nodes, please check the Vagrantfile inside the project.

### 3.8.1 About OvS-dpdk

Open vSwitch\* with the Data Plane Development Kit [OvS-DPDK](http://openvswitch.org/) is a high performance, open source virtual switch.

Using DPDK with OVS gives us tremendous performance benefits. Similar to other DPDK-based applications, we see a huge increase in network packet throughput and much lower latencies.

# 3.9 Clearwater implementation for OPNFV

CONTAINER4NFV setup a Kubernetes cluster on VMs running with Vagrant and kubeadm.

kubeadm assumes you have a set of machines (virtual or bare metal) that are up and running. In this way we can get a cluster with one master node and 2 workers (default). If you want to increase the number of workers nodes, please check the Vagrantfile inside the project.

#### Is Clearwater suitable for Network Functions Virtualization?

Network Functions Virtualization or NFV is, without any doubt, the hottest topic in the telco network space right now. It's an approach to building telco networks that moves away from proprietary boxes wherever possible to use software components running on industry-standard virtualized IT infrastructures. Over time, many telcos expect to run all their network functions operating at Layer 2 and above in an NFV environment, including IMS. Since Clearwater was designed from the ground up to run in virtualized environments and take full advantage of the flexibility of the Cloud, it is extremely well suited for NFV. Almost all of the ongoing trials of Clearwater with major network operators are closely associated with NFV-related initiatives.

#### 3.9.1 About Clearwater

Clearwater follows IMS architectural principles and supports all of the key standardized interfaces expected of an IMS core network. But unlike traditional implementations of IMS, Clearwater was designed from the ground up for the Cloud. By incorporating design patterns and open source software components that have been proven in many global Web applications, Clearwater achieves an unprecedented combination of massive scalability and exceptional cost-effectiveness.

Clearwater provides SIP-based call control for voice and video communications and for SIP-based messaging applications. You can use Clearwater as a standalone solution for mass-market VoIP services, relying on its built-in set of basic calling features and standalone subscriber database, or you can deploy Clearwater as an IMS core in conjunction with other elements such as Telephony Application Servers and a Home Subscriber Server. Clearwater was designed from the ground up to be optimized for deployment in virtualized and cloud environments. It leans heavily on established design patterns for building and deploying massively scalable web applications, adapting these design patterns to fit the constraints of SIP and IMS. The Clearwater architecture therefore has some similarities to the traditional IMS architecture but is not identical.

- All components are horizontally scalable using simple, stateless load-balancing.
- All long lived state is stored on dedicated "Vellum" nodes which make use of cloud-optimized storage technologies such as Cassandra. No long lived state is stored on other production nodes, making it quick and easy to dynamically scale the clusters and minimizing the impact if a node is lost.
- Interfaces between the front-end SIP components and the back-end services use RESTful web services interfaces.
- Interfaces between the various components use connection pooling with statistical recycling of connections to ensure load is spread evenly as nodes are added and removed from each layer.



### 3.9.2 Clearwater Architecture

## 3.10 Quickstart

This repository contains instructions and resources for deploying Metaswitch's Clearwater project with Kubernetes.

If you need more information about Clearwater project please checkout our [documentation](https://github.com/opnfv/ container4nfv/blob/master/docs/release/userguide/clearwater-project.rst) or the official repository.

### 3.10.1 Exposed Services

The deployment exposes:

- the Ellis web UI on port 30080 for self-provisioning.
- STUN/TURN on port 3478 for media relay.
- SIP on port 5060 for service.
- SIP/WebSocket on port 5062 for service.

SIP devices can register with bono.:5060 and the Ellis provisioning interface can be accessed at port 30080.

#### 3.10.2 Prerequirement

#### **Install Docker and Vagrant**

CONTAINER4NFV uses setup\_vagrant.sh to install all resource used by this repository.

```
container4nfv/src/vagrant# ./setup_vagrant.sh -b libvirt
```

#### 3.10.3 Instalation

#### Deploy Clearwater with kubeadm

Check clearwater/clearwater\_setup.sh for details about k8s deployment.

container4nfv/src/vagrant/kubeadm\_clearwater# ./deploy.sh

#### 3.10.4 Destroy

container4nfv/src/vagrant# ./cleanup.sh

#### 3.10.5 Making calls through Clearwater

#### **Connect to Ellis service**

It's important to connect to Ellis to generate the SIP username, password and domain we will use with the SIP client. Use your <master ip addres> + port 30080 (k8s default port). If you are not which Ellis's url is, please check inside your master node.

```
kubeadm_clearwater# vagrant ssh master
master@vagrant# ifconfig eth0 | grep "inet addr" | cut -d ':' -f 2 | cut -d ' ' -f 1
192.168.121.3
```

In your browser connect to <master\_ip>:30080 (ex. 192.168.121.3:30080).

After that, signup and generate two users. The signup key is **secret**. Ellis will automatically allocate you a new number and display its password to you. Remember this password as it will only be displayed once. From now on, we will use <username> to refer to the SIP username (e.g. 6505551234) and password> to refer to the password.

#### Config and install two SIP clients

We'll use both Twinkle and Blink SIP client., since we are going to try this out inside a LAN network. This is, of course, only a local test inside a LAN network. Configure the clients may be a little bit trickie, so we add some screenshots:

#### **Blink setup**

1. Add <username> and <password>.

Private Identity:	Associated Public Identities:
6505550111@default.svc.cluster.local	sip:6505550111@default.svc.cluster.local
Password: n4qn37FD7	Reset
only shown once	New Public Identity
😣 🖨 🗊 Blink Preferences	
Private Ide	
65055502	hat Screep Sharing Logging Advanced
anty shown an	
O Bonjour	Account Information Media Server Settings Network Advanced
6505550111@default.svo	clu 🗹 Use account
Private Ide () 6505550270@default.svo	
65055503	Display Name: 6505550111
Password: I	Password:
ony snown on	
Drivete Ide	
05055505 Password: I	
only shown on	
Private Ide	
65055509	
Password: I	
only shown on	
Private Ide	
65055509	
Decentrardi I	Depictration Success

2. Configure a proxy to k8s.

Clearwater Dashboard	Addressbook
Private Identity:	Associated Public Identities:
6505550111@default svc.cl	
Password: n4qn37FD7	Boost Boost
only shown once	New Public Identity
	references
Private Ide	
65055502 🚢 🐛	
Password: Accounts Audi	o Video Chat Screen Sharing Logging Advanced
only shown one O Bonjour	Account Information Media Server Settings Network Advanced
65055501110	@default.svc.clu SIP Proxy
Private Ide 0 65055502700	@default.svc.clu
65055503	Always use my proxy ror outgoing sessions
Password: I	Outbound Proxy: 192.168.121.145 Port: 5060 Transport: TCP
only shown one	Auth Username: 6505550111@default.svc.
	MSRP Relay
Private Ide	
DOUDDOUD Password: L	Always use my relay for outgoing sessions
only shown on	MSRP Relay: Relay address taken from Port: 2855 Transport: TLS
	Extra Server Settings
Private Ide	Voicemail URI: Discovered by subscribing to 6505550111@default.svc.cluster.l
65055509	YCAP Poot LIPI . Taken from the DNS TYT record for year default sur cluster loc
Password: I	
only shown one	Server Tools URL:
	Conference Server: conference.sip2sip.info
Private Ide	
65055509	

3. Configure the network to use TCP only.

Clearwater	Dashboard A	adressbook						
Private Iden	tity:			Associ	ated Pub	lic Identities:		
650555011	1@default.svc.clus	ster.local		sip:650	5550111@	Ddefault.svc.cluste	r.local	С
Password: n4	21.145:30080/index.html?data={"username"         Clearwater       Dashboard       Addressbool         Private Identity:       6505550111@default.svc.cluster.local         Password: n4qn37FD7       only shown once         Only shown once       Image: Clearwater of the shown once         Private Ide       Image: Clearwater of the shown once         Private Ide       Image: Clearwater of the shown once         Only shown once       Image: Clearwater of the shown once         Private Ide       Image: Clearwater of the shown once         O Bonjour       Image: Clearwater of the shown once         Private Ide       65055503         Password: I       only shown once         Private Ide       65055505         Password: I       only shown once		Reset					
only shown once				New Pt	ublic Identit	у 👻		
	😕 🖨 🔲 🛛 Blink Pre	ferences						
Private Ide		2		4	105			
65055502 Baseword	Accounts Audio	Video Chat S	creen Sharing		Advance	d		
only shown on		video cilde s		Logging	Advance			
		default svc clu	Account Inf	ormation	Media	Server Settings	Network	Advar
Drivata Ida		default sve elu	Network S	Settings				
65055503	0 0303330270@0	Jei autt.svc.ctu			🗹 Use	ICE to improve N	AT traversa	l for m
Password <sup>•</sup>			MSRP	Transport	: TCP	•		
only shown on								
Private Ide								
65055505								
Password: I								
only shown one								
Private Ide								
65055509								
Password: I								
only shown one								
Private Ide								
65055509 Bacaward								
Password: I								

😣 🗖 🗊 Blink Preferences				
Accounts       Image: Construction of the second seco				
SIP and RTP				
Transports: Enable UDP UDP port: Auto 🗘 Set SIP ports to 0 for automatic allocation				
🗹 Enable TCP				
Enable TLS TLS port: Auto				
RTP Ports: 500 🗘 starting at: 50000 🗘				
Files and directories				
Save received files to: ~/Downloads				
Save screenshots to: ~/Downloads				
TLS settings				
Certificate Authority: //usr/share/blink/tls/ca.crt				
	Enable UDP UDP port:   Auto Set SIP ports to 0 for automatic allocation   Enable TCP TCP port:   Auto Set SIP ports to 0 for automatic allocation   Enable TLS TLS port:   Auto Set SIP ports to 0 for automatic allocation			

### Twinkle setup

1. Configure a proxy to k8s.

Private Identity:	Associated Public Identities:
6505550111@default.s	cluster.local sip:6505550111@default.svc.cluster.local Configure
Password: n4qn3/FD/ only shown once	Reset New Public Identity -
Private Identity:	Associated Public Identities:
6505550270@default.s	cluster.local sip:6505550270@default.svc.cluster.local Configure
Password: zba6H6yKG	Reset New Public Identity
😣 🗊 🛛 Twinkle - U	er profile: sofi
Privat	
6505t	
Passw User	SIP server
SIP server	Registrar
Privat Voice mail	Registrar:
6505t Sinstant me	ge Expiry: 3600 🗘 seconds
Passw Presence	S Register at startup
only sho	Add q-value to registration 1.000
SIP protoco	Outhourd Draw
Passw Address fo	at Outbound proxy: 192.168.121.145
only sho	Send in-dialog reguests to proxy
	Don't send a request to proxy if its destination can be resolved locally.
Privat d Ring tones	
Passw	
only sho	
Add F	

2. Add <username> and <password>.

Q 192.168.121.145:300 Clearwat	080/index.html?data={"use t <b>er D</b> ashboard Add	rname"%3A "lsofia. ressbook	enriquz <sup>ı</sup>	%40gmail.com"%2C "full_name"%3A "sofia"}&m	essage=Created	&status=201&s
Private 650555 Passwo only show	e Identity: 50111@default.svc.cluste rd: <b>n4qn37FD7</b> m once	r.local	eset	Associated Public Identities: sip:6505550111@default.svc.cluster.local New Public Identity	Configure	Delete
Private 65055 Passwo only show	e Identity: 50270@default.svc.cluste rd: <b>zba6H6yKG</b> monce	r.local	eset	Associated Public Identities: sip:6505550270@default.svc.cluster.local New Public Identity	Configure	Delete
Privat 65055 Passw only sho	User profile: sofi				¢)	Delete
Privat 65055 Passw only sho	Voice mail <ul> <li>Instant message</li> <li>Presence</li> <li>RTP audio</li> </ul>	Your name: User name*: Do <u>m</u> ain*: Organization:	650555 default	50270 svc.cluster.local		Delete
Privat 65055 Passw only sho	SIP protocol fransport/NAT Address format fimers	SIP authentication	<b>on</b> n <u>n</u> ame:			Delete
Privat 65055 Passw only sho	Ring tones Scripts Security	AKA AM <u>F</u> :		000000000000000000000000000000000000000		Delete
Add F Create	OK Cancel					

3. Configure the network to use TCP only.

Private Identity: 6505550111@default Password: <b>n4qn37FD7</b> only shown once	Associated Public Identities: sip:6505550111@default.svc.cluster.local Config Reset New Public Identity
Private Identity: 6505550270@default Password: <b>zba6H6yKG</b> only shown once	Associated Public Identities: sip:6505550270@default.svc.cluster.local Config Reset New Public Identity
Privat 65055	profile: sofi
Passw only sho	Transport/NAT SIP transport
Privat 65055 Passw only sho	Transport protocol: TCP UDP threshold: 1300bytes NAT traversal
Privat SIP proto 65055 Transpor Passw	<ul> <li><u>N</u>AT traversal not needed</li> <li><u>U</u>se statically configured public IP address inside SIP messages</li> <li><u>Public IP address:</u></li> <li>Use STUN (does not work for incoming TCP)</li> </ul>
only sho Only s	STUN server:         Ø Persistent TCP connection         Enable NAT keep alive
Passw only sho	

#### Make the call

	Associated Public Identities:				
	nkle		)elete		
Call Answe	r <b>Bye</b> Reject Redirect Xfer Hold Con	f Mute Dtmf Redial Msg	SO Blink		
			⊙ 6505550111@default.svc.clu		
Buddy list		User: sofi 🔅 🗢 🏹 🛠	Q Search Contacts or Ente		
t son		Call:	6505550111		
		Display	Switch to Cal		
		200 04	Bonjour Neighbours		
- It	6505550270@default. 6505550270@default.svc.clu	svc.cluster.local	<ul> <li>Test Call</li> <li>echo@conference.sig</li> <li>Test Conference</li> <li>test@conference.sip</li> </ul>		
le		Audio call sip:	All Contacts     Test Call		
-	Reject Busy	Accept	<ul> <li>echo@conference.sig</li> <li>Test Conference</li> <li>test@conference.sip</li> </ul>		
It		Line 1: call rejected.			
le		Line status			
		Line 1: Ringing			
-		From:			
14		То:			
le		Subject:			
		○ Line <u>2</u> : idle			
		From:	+ / 14 9		
		То:			
t		Subject:	Delete		
	INCW. FILMING INFERIO				