

# SAPC VNF Network Configuration Guide

Ericsson Service-Aware Policy Controller

USER GUIDE

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# 1 SAPC VNF Network Configuration Guide Introduction

This document provides information to define the hardware, software, network components, and networks configuration needed to run the SAPC in the supported Cloud environments:

- Cloud Execution Environment (CEE)
- VMware vSphere
- VMware vSphere + vCloudDirector





## 2 SAPC VNF Network Configuration Guide Overview

This section provides an overview of the hardware and software components used for the SAPC internal and external networks in a Cloud deployment, as well as a general networks description. The Cloud deployment, as one of its intrinsic characteristics, untie the SAPC from hardware, therefore all hardware components, and some of the software components are not part of the SAPC but the Cloud provided platform.

Even though those components are not part of the SAPC and they are out of the scope of this document, they are briefly described in this chapter to make it more understandable.

From the point of view of networks configuration, the following elements must be considered:

### — Hardware components

- Gateway, specified as part of the Cloud Infrastructure, sometimes named as Site Router.
- Compute Hosts on which the virtual machines execute, specified as part of the Cloud Infrastructure.
- Controller Hosts on which the CEE Cloud Infrastructure Controller executes, specified as part of the Cloud Infrastructure for CEE deployments.
- Hosts on which the Cloud Manager, ECM/Atlas for CEE deployments and vCenter/vCloudDirector for VMware, execute, specified as part of the Cloud Infrastructure.

### — Software components

- CEE: Based on Mirantis OpenStack, includes Ubuntu Linux as operating system, Kernel-based Virtual Machine (KVM) as hypervisor and the Open Virtual Switch (OVS) as virtual switch on the compute hosts.
- VMware: vSphere virtualization platform including ESXi as operating system and hypervisor and Distributed Virtual Switches (vDS) for the switching configuration.
- Virtual Routers (Optional part of the virtual SAPC).
- The SAPC software.

The Figure 1, describes the SAPC networks model used on Cloud environment. There are four virtual machines each one of them with a different role.

- SC-1 and SC-2 are the system controllers (SC).
- PL-3 and PL-4 are the traffic payloads.

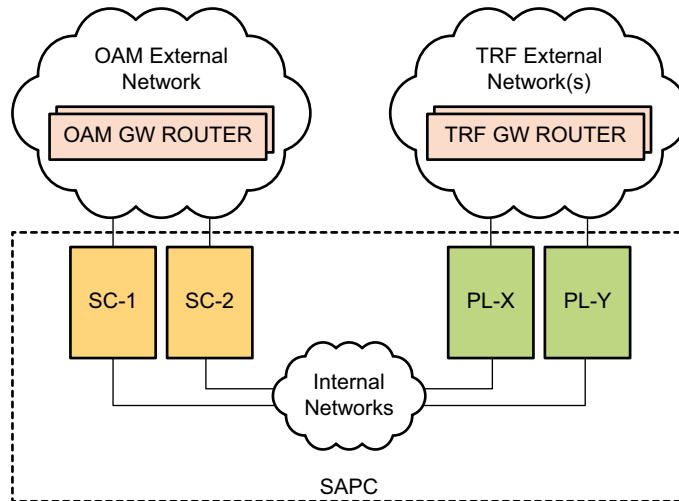


Figure 1 SAPC deployed in Cloud Environment

There are some scenarios where customer might choose to deploy virtual routers. For such cases, Figure 2 describes the correspondent network model. There are four additional virtual machines, which are directly connected to the Gateways.

- SC-1 and SC-2 are the system controllers (SC).
- PL-3 and PL-4 are the traffic payloads.
- VR-1 and VR-2 are the virtual routers providing access to the SAPC OAM VIP.
- VR-3 and VR-4 are the virtual routers providing access to the SAPC Traffic VIP.



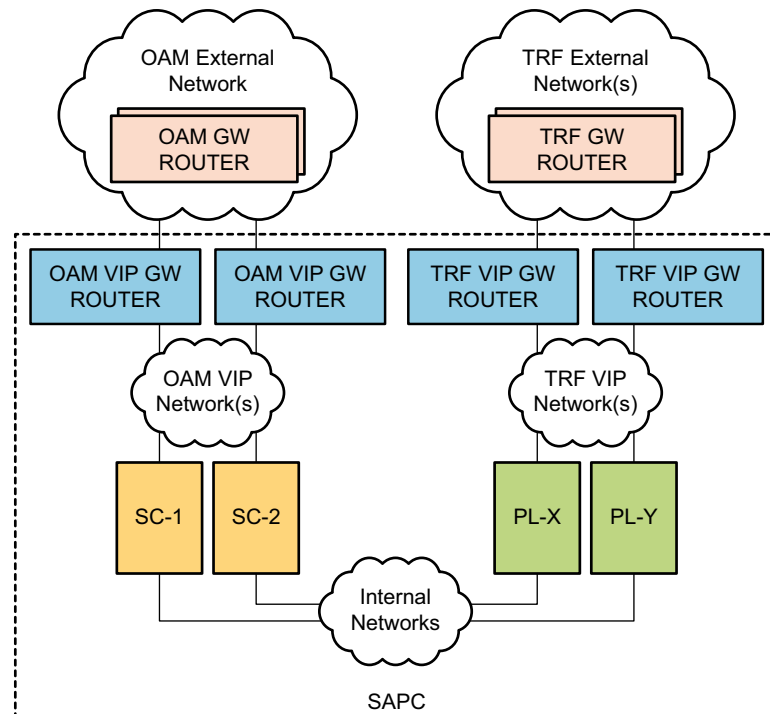


Figure 2 SAPC deployed in Cloud Environment with virtual routers

## 2.1 Hardware Components

### 2.1.1 Gateway

The Gateway is the connection point between the physical world and the Cloud virtual infrastructure. It can be also referred as Site Router.

### 2.1.2 Compute Hosts

Compute hosts provides infrastructure resources (CPU, RAM, and Disk) to the Cloud environment and they make possible connectivity among different virtual machines deployed in the Cloud environment.

### 2.1.3 Controller Hosts

Controller hosts manage infrastructure resources (CPU, RAM, and Disk) to the Cloud environment and it provides the OpenStack APIs towards upper layer (that is Ericsson Cloud Manager application).



### 2.1.4 Cloud Manager Hosts

Hosts where the Cloud Manager is deployed. The Cloud Manager is the central point for managing the Cloud infrastructure and the vAPPs deployed on top of it.

## 2.2 Software Components

### 2.2.1 Mirantis OpenStack (MOS)

The OpenStack delivery included into CEE, provided by Mirantis.

### 2.2.2 Ubuntu Hypervisor (KVM)

Linux distribution used on physical hosts as part of CEE Both compute and controller hosts counts on this Linux distribution as Operating System to provide required services as part of the OpenStack Cloud Manager Platform.

However Kernel-Based Virtual Machine (KVM) modules are only installed in Compute Hosts case, while controllers do not require them since they do not provide any compute or infrastructure resources to the cloud environment. Ubuntu OS and KVM modules are included into Mirantis OpenStack delivery (CEE) and they are automatically deployed into the specific physical hosts depending on the assigned role during deployment.

As far as KVM is concerned, KVM is a full virtualization solution for x86 processors supporting hardware virtualization (Intel VT or AMD-V). It consists of two main components: A set of Kernel modules (kvm.ko, kvm-intel.ko, and kvm-amd.ko) providing the core virtualization infrastructure and processor-specific drivers and a userspace program (qemu-kvm) that provides emulation for virtual devices and control mechanisms to manage VM Guests (virtual machines). The term KVM more properly refers to the Kernel level virtualization functionality, but is in practice more commonly used to reference the userspace component. VM Guests (virtual machines), virtual storage, and networks can be managed with libvirt-based and QEMU tools. Libvirt is a library that provides an API to manage VM Guests based on different virtualization solutions, among them KVM and Xen. It offers a graphical user interface and a command line program. The QEMU tools are KVM/QEMU specific and are only available for the command line.

### 2.2.3 Open Virtual Switch

Similarly to KVM, Open Virtual Switch modules are used to provide network connectivity among all members of the OpenStack Cloud Manager Platform, being the base for virtual machines connectivity in the Cloud Infrastructure.

Open vSwitch is also included into Mirantis OpenStack delivery (CEE) and is also deployed at the time of CEE installation.



## 2.2.4 vSphere ESXi

VMWare hypervisor for deploying and serving virtual machines.

## 2.2.5 vSphere Distributed Virtual Switch

vSphere Distributed Switch (VDS) provides a centralized interface to configure, monitor, and administer virtual machine access switching for the entire data center.

## 2.2.6 Virtual Router

When Virtual routers are used in active-active geographical redundancy or standalone deployments, they eliminate the need of OSPF manual configuration and OSPF protocol support or license handling in the physical routers in which the SAPC is finally deployed during SAPC instantiation.

Also, they provide redundancy access to the SAPC from the Cloud environment through VRRP protocol.

Virtual routers use Vyatta Software for this purpose.

## 2.2.7 eVIP

The eVIP Component is used for making Virtual IP addresses accessible from customer network and isolate the SAPC cluster to the outside network.

**Note:** In this document, Virtual IP means a moveable IP address that can be found in one VM of a high-availability VM cluster. It has no relation with the concept of a virtual IP address in OpenStack.

There are two ways to achieve this:

- Using OSPF v2 protocol by creating adjacency with the OSPF neighbors, either with the virtual routers or with site routers.
- Using static routing with a set of predefined IP addresses.

# 2.3 Network

## 2.3.1 General Overview

The following networks are used for SAPC connectivity:

- Network for internal communication purposes between all the virtual machines in the SAPC Cluster.

- Network for TIPC communication purposes between all the virtual machines belonging to the SAPC cluster.
- Network for OAM VIPs between the System Controllers virtual machines and either:
  - The Virtual routers VR-1 and VR-2. Used to provide access to OAM VIP for the SAPC. OSPF v2 protocol is enabled in this network.or
  - The OAM site routers, where either static routing is used in most deployments, or OSPF in GeoRed active-standby environments.
- Network or networks for Traffic VIPs between the Traffic Payloads virtual machines with external access (PL-3 and PL-4) and either:
  - The Virtual routers VR-3 and VR-4. Used to provide access to Traffic VIP for the SAPC. OSPF v2 protocol is enabled in this networkor
  - The traffic site routers, where either static routing is used in most deployments, or OSPF in GeoRed active-standby environments.

In addition, when virtual routers are part of the deployment,

- External OAM networks to provide external access to VR-1 and VR-2.
- External Traffic network or networks to provide external access to VR-3 and VR-4.

## 2.3.2 External Connectivity

The SAPC provides several VIP addresses to provide service to other Network Virtualization Functions which are VIPs for OAM to serve Operations and Managements functions and VIPs for Traffic to provide Policy Controller functions to the rest of the nodes.

VIPs for OAM are provided by both SCs while VIPs for Traffic are provided by a maximum of 6 PLs at the same time. Those VIPs addresses are reachable from outside world either directly with static routing, or discovered using OSPF protocol, with or without Virtual Routers (VR-1, VR-2, VR-3, and VR-4).

### 2.3.2.1 SAPC networks Designated for static routing

The networks used in the SAPC for interconnection between so called Node Front Ends (SC-1 and SC-2 to provide VIPs for OAM and some of the PLs to VIPs for Traffic) and site routers are named OAMVip<x> and TrafficVip<y>.



The site routers have to be configured with static routes to all front ends for reaching each specific VIP; the SAPC provides redundancy mechanism to make sure all defined IP destination addresses (front-end IP addresses) are available even in case a front-end element goes down.

When virtual routers are deployed, there is a particular case where static routing from site routers is set up, but internally in SAPC OSPF is used; this option is described in next chapter.

### 2.3.2.2 SAPC networks Designated for OSPF Discovery

When OSPF is used, again OAMVip<x> and TrafficVip<y> networks are used for distributing the VIP addresses, but in this case, they are part of OSPF Areas.

Because of OSPF protocol activation among these virtual machines and virtual routers, all VIPs addresses are automatically included in the routing tables of the virtual routers, and the SAPC automatically learn their default routes.

Also, these networks provide redundancy to the SAPC to guarantee VIPs availability if any possible failure (One SC down, One Traffic Payload down, or One Virtual Router Down). When virtual routers are deployed, these networks are internal and not visible or routable from the customer network.

With these virtual routers, the connection to customer network is done through ExtOam<x> and ExtTraffic<y> networks; two possibilities appear now:

- The customer has got an OSPF backbone area, adjacent to SAPC virtual routers. In this case, the ExtOam<x> and ExtTraffic<y> networks can be included in the backbone, or they can be included in the corresponding OSPF area together with OAMVip<x> and TrafficVip<y> networks.
- There is no backbone area in the customer network. The area 0.0.0.0 is now created internally between virtual routers, for VIPs propagation. Routing to VIP address from site routers is done statically; a VRRP address for each external network is provided also for this purpose.

**Note:** Although the VIP addresses are propagated internally in the SAPC using OSPF, they are actually accessed externally from site routers using static routing.

### 2.3.3 Internal Connectivity

In the SAPC, the SAPC cluster consists of four processors in the minimal configuration of the node, SC-1, SC-2, PL-3, and PL-4 that requires connectivity among them for the different traffic that needs to be interchanged for different purposes. This is possible through two internal Subnets, one for TIPC communication and other for other internal communication. All VMs are connected internally through those Subnets through **eth0** and **eth1** interfaces.



### 2.3.4 Preconfigured Values

The particular values of the networking configuration described in this document, are the ones preconfigured in the SAPC . Some of them can be changed, based on operator needs, during deployment. To check which values can be modified, see SAPC VNF Descriptor Generator Tool.



## 3 Networks Configuration Solutions

This section specifies how the SAPC is connected to the network. All the external networks and IP addresses described in this chapter are reachable through customer network after a successful SAPC deployment in Cloud environment. Since the SAPC Node Cloud based uses full previously installed images for their virtual machines, all the details (IP addresses, Networks, and Gateways) referenced in this section are already configured by default in the SAPC.

### 3.1 Solution to Define Unique OAM and Traffic Networks

This section describes the SAPC configuration to support one OAM Network to serve Operations and Managements functions and one Traffic Network to provide Policy Controller functions to the rest of the nodes.

Next figure shows the general network overview:

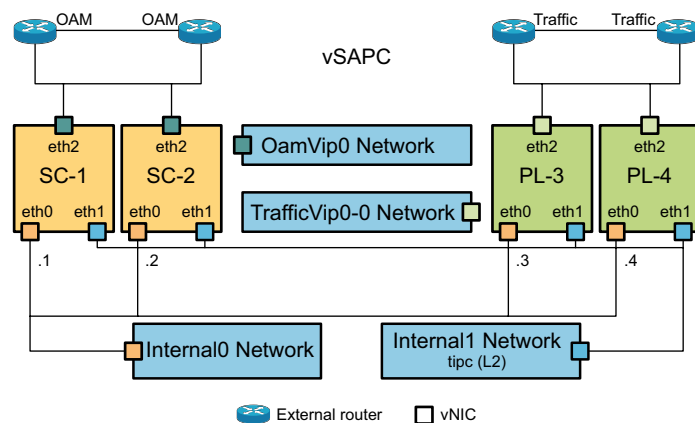


Figure 3 SAPC node solution with Unique OAM and Traffic Networks

#### 3.1.1 Internal Network Configuration

##### 3.1.1.1 IP Addressing

The **Internal0** and **Internal1** networks, see Figure 3, provides network connectivity between processors in the SAPC cluster. Each processor has two interfaces, **eth0**, and **eth1** connected to internal networks composing the SAPC backplane.

Table 1 Internal0 (Cluster Internal Network)

IP Address	Assign To
172.16.100.0/24	Network



IP Address	Assign To
.1	SC-1
.2	SC-2
.3	PL-3
.4	PL-4
.x	PL-X in case more traffic payloads are needed

Table 2 Internal Network 1 (TIPC Network)

TIPC Node Address	Assign To
1.1.1	SC-1
1.1.2	SC-2
1.1.3	PL-3
1.1.4	PL-4
1.1.x	PL-x in case more traffic payloads are needed

### 3.1.1.2 Extra Services over Internal0 Network

Every service (NFS, and so on) is offered in a different IP and is offered by the SC acting as primary.

Table 3 Extra IPs on 172.16.100.0/24 Network

IP Address	Assign To
172.16.100.0/24	Network
.100 <sup>(1)</sup>	SC-1 SC-2
.105 <sup>(2)</sup>	SC-1 SC-2
.200 <sup>(3)</sup>	SC-1 SC-2
.241 <sup>(4)</sup>	SC-1 SC-2
.244 <sup>(5)</sup>	PL-3 <sup>(6)</sup> PL-4 <sup>(6)</sup>
.245 to .254 <sup>(7)</sup>	Scalability temporary pool for any added payload
.255	Broadcast

(1) NFS movable IP. eth0:1 alias interface

(2) la-ldap movable IP. eth0:3 alias interface

(3) boot movable IP. eth0:2 alias interface

(4) uetrace movable IP. eth0:4 alias interface

(5) SCTP movable IP. eth0:1 alias interface

(6) In the minimal configuration of the SAPC node

(7) Scalability temporary pool





### 3.1.2 External/VIP Networks Configuration

#### 3.1.2.1 eVIP Configuration Overview

Traffic is separated in two networks through which **VIP-OAM** and **VIP-GX** VIPs are reachable. OAM-VIP networks enclose SCs and Traffic-VIP networks encloses PLs. From eVIP point of view, one FEE manages each kind of traffic in each processor they run on.

The following figure shows how VIP-OAM is configured.

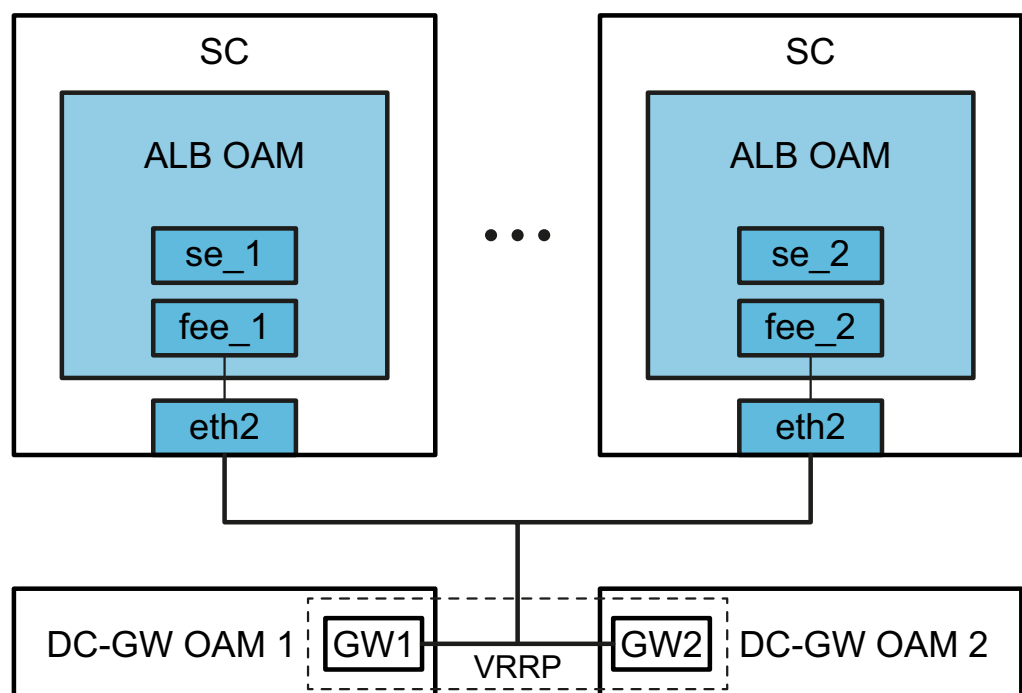


Figure 4 eVIP VIP-OAM Overview

In deployments that requires Provisioning Address different than OAM Address, SAPC requires a new Virtual IP for handling Provisioning, VIP-PROVISIONING. This new VIP is published to the External Network through the same FEEs than VIP-OAM.

The following figure shows how VIP-GX (traffic VIP) is configured.

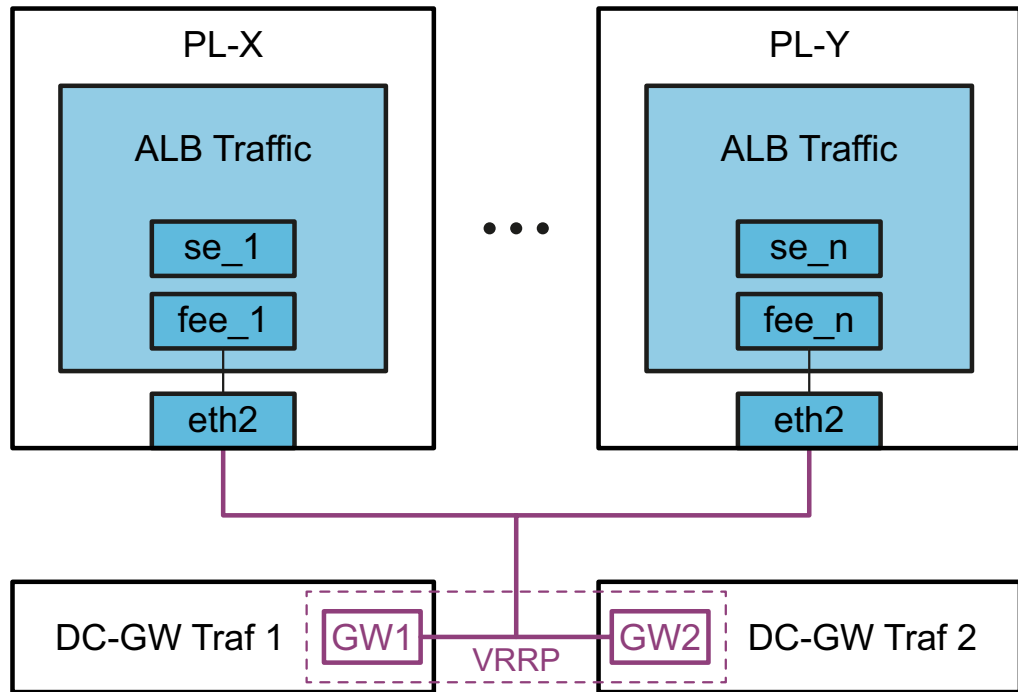


Figure 5 eVIP VIP-GX Overview

Additional VIPs can be also made available through the same network. For instance, In deployments with an external database like CUDb, SAPC requires a new Virtual IP for handling the LDAP traffic and the SOAP notifications traffic with the external database.

For both OAM and traffic VIPs, static routes are created from gateways to the FEEs, and VRRP address between gateways be default gateway for eVIP front ends.

### 3.1.2.2

#### SAPC VIP Addresses

Table 4 VIP Addresses

VIP Description	VIP	Use
<b>VIP-OAM</b>	<b>10.58.31.7/32</b>	SAPC OAM VIP Address
<b>VIP-PROVISIONING<sup>(1)</sup></b>	N/A	SAPC Provisioning VIP Address
<b>VIP-GX</b>	<b>10.58.31.137/32</b>	SAPC Traffic VIP Address. All the payload traffic from all the available interfaces (Gx, Rx, Sy, and so on) is handled through this VIP.
<b>VIP-ExtDB<sup>(2)</sup></b>	N/A	VIP address for handling the access to the external Database

(1) Only for deployment that requires Provisioning Address different than OAM Address.

(2) Only in deployment with an external database.



### 3.1.2.3 External Networks

The following networks are configured in the configuration file delivered as a template to interconnect the SAPC with the customer network. The provided network IDs and IP addresses are just an example.

Table 5 External Networks

Network Name	Network	Default Gateway	Use
<b>OAMVip</b>	<b>10.41.30.224/29</b>	10.41.30.225 <sup>(1)</sup> 10.41.30.226 <sup>(2)</sup>	Network for the OAM VIP in SAPC
<b>TrafficVip</b>	<b>10.41.70.224/28</b>	10.41.70.225 <sup>(1)</sup> 10.41.70.226 <sup>(1)</sup>	Network for the Traffic VIP in SAPC

(1) VRRP address with static routing

(2) Only used in GeoRed deployments with OSPF

### 3.1.2.4 IP Addressing of External Elements

This section covers all the IP addresses in the customer network that do not belong to the SAPC but are configured in the SAPC to interoperate with other nodes. No default values are configured for them, since they are customer dependant.

Table 6 IP Addresses of External Elements

IP Address	Network	Use
<b>&lt;NTP - SERVER&gt;</b>	<b>&lt;NTP-NETWORK&gt; / &lt;NTP-NETMASK&gt;</b>	NTP Server
<b>&lt;SNMP - SERVER&gt;</b>	<b>&lt;SNMP-NETWORK&gt; / &lt;SNMP-NETMASK&gt;</b>	SNMP Server
<b>&lt;DNS - SERVER&gt;</b>	<b>&lt;DNS-NETWORK&gt; / &lt;DNS-NETMASK&gt;</b>	DNS Server

NTP servers are configured by the adapt\_cluster tool during deployment. For further details, see [SAPC VNF Descriptor Generator Tool](#).

SNMP servers are configured for Fault Management. For security reasons, it is highly recommended to use [Create SNMPv3 Target](#). Also, legacy versions can be used as [Create SNMPv2C Target](#) and [Create SNMPv1 Target](#).

Optionally, DNS servers can be defined in the SAPC. For further details on their configuration, refer to [LDE Management Guide](#).

### 3.1.3 Gateway Router Configuration

This section covers all the IP routes to be configured in the Gateway Routers to interoperate with each SAPC.

- Configuration in OAM GWs: To get to the OAM VIP, define static routes for the FEE IP addresses configured in the SCs.

- Configuration in Traffic GWs: To get to the Traffic VIP, define static routes for the FEE IP addresses configured in the PLs.

ECMP is configured for traffic distribution among FEE IP addresses for each traffic type.

## 3.2 Solution to Define Unique OAM and Traffic Networks with virtual routers

This section describes the SAPC configuration to support one OAM Network to serve Operations and Managements functions and one Traffic Network to provide Policy Controller functions to the rest of the nodes.

Next figure shows the general network overview:

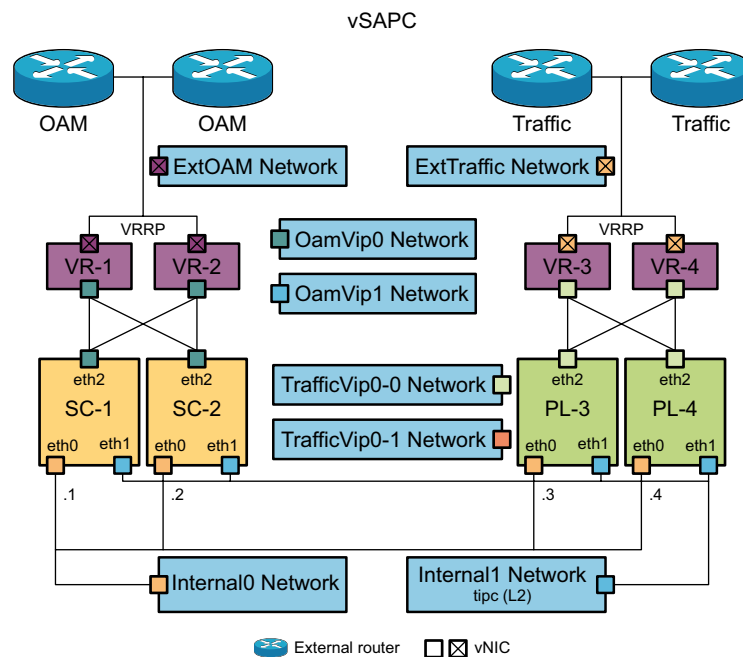


Figure 6 SAPC node solution with Unique OAM and Traffic Networks

### 3.2.1 Internal Network Configuration

See Section 3.1.1 on page 11



## 3.2.2 VIP Networks Configuration

### 3.2.2.1 Networks for OSPF v2

The following table shows the networks allocated inside the SAPC node images, in which OSPF protocol is enabled. They are already defined by default in the SAPC and in the configuration of the virtual routers to ensure a proper operation after the SAPC deployment in Cloud environment.

Table 7 Private Networks Allocated inside the SAPC for SAPC VIPs population Through OSPF Protocol

Network Name	Subnet	Use
OamVip0	172.16.213.0/29	OSPFv2 Attachment between SCs and VR-1, VR-2
TrafficVip0-0	172.16.113.0/28	OSPFv2 Attachment between PL-3 and PL-4, and VR-3, VR-4

### 3.2.2.2 SAPC VIP Addresses

Table 8 VIP Addresses

VIP Description	VIP	Use
<b>VIP-OAM</b>	<b>10.58.31.7/32</b>	SAPC OAM VIP Address
<b>VIP-PROVISIONING<sup>(1)</sup></b>	N/A	SAPC Provisioning VIP Address
<b>VIP-GX</b>	<b>10.58.31.137/32</b>	SAPC Traffic VIP Address. All the payload traffic from all the available interfaces (Gx, Rx, Sy, and so on) is handled through this VIP.
<b>VIP-ExtDB<sup>(2)</sup></b>	N/A	VIP address for handling the access to the external Database

(1) Only for deployment that requires Provisioning Address different than OAM Address.

(2) Only in deployment with an external database.

### 3.2.2.3 eVIP Configuration

This section describes the mapping of networks to vNICs in the different pieces of networking equipment related to eVIP components.

This section describes the eVIP configuration defined in the SAPC images for Cloud environment. The `evip.xml` configuration file included into the SAPC images holds many parameters however this document describes the ones that are key to the design.

#### 3.2.2.3.1 eVIP Configuration Overview

Traffic is separated in four networks through which **VIP-OAM** and **VIP-GX** VIPs are propagated. OAM-VIP networks enclose SCs and Traffic-VIP networks

encloses PLs. From eVIP point of view, one FEE manages each kind of traffic in each processor they run on.

The following figure shows how VIP-OAM is configured as specified at Section 3.2.2.3.3 on page 19.

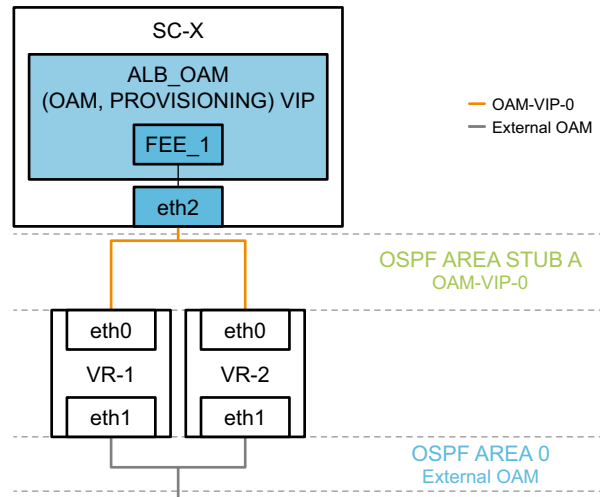


Figure 7 eVIP VIP-OAM Overview

In deployments that requires Provisioning Address different than OAM Address, SAPC requires a new Virtual IP for handling Provisioning, VIP-PROVISIONING. This new VIP is published to the External Network through the same FEEs than VIP-OAM.

The following figure shows how VIP-GX is configured as specified at Section 3.2.2.3.3 on page 19.

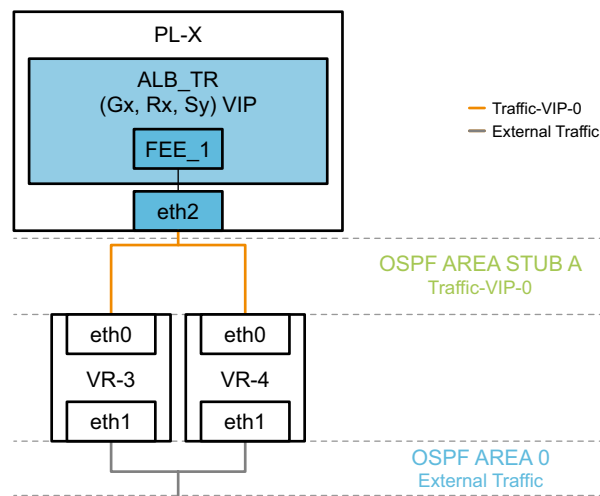


Figure 8 eVIP VIP-GX Overview



In deployments with an external database like CUDb, SAPC requires a new Virtual IP for handling the LDAP traffic and the SOAP notifications traffic with the external database. This new VIP is published to the External Network through the same FEEs than VIP-GX.

### 3.2.2.3.2 eVIP Elements

In the table below, the distribution of eVIP elements is listed. The location of eVIP front ends (FEE) requires corresponding configuration in the network, that is, virtual routers. This configuration is already made by default and adjustment is not required.

Table 9 Distribution of eVIP Elements

Abstract Load Balancer (ALB)	VIP	Front-End Element (FEE)	Load Balancer Element (LBE)	Security Element (SE)
alb_oam	<VIP-OAM> 10.58.31.7/32	SC-1 (fee_1) SC-2 (fee_2)	lbe_1 lbe_2	se_1 se_2
alb_tr	<VIP-GX> 10.58.31.137/32 <VIP-ExtDB> <sup>(1)</sup>	PL-3 (fee_1) PL-4 (fee_2) PL-5 (fee_3) PL-6 (fee_4) PL-7 (fee_5) PL-8 (fee_6)	lbe_1 lbe_2 lbe_3 lbe_4 lbe_5 lbe_6	se_1 se_2 se_3 se_4 se_5 se_6

(1) Only in deployment with an external database.

### 3.2.2.3.3 OSPF v2 Areas

The traffic is separated into two OSPF v2 areas and ALBs. Each ALB has links with IPs defined for the FEEs and the remote gateway which are the virtual routers in this design. Next table shows how the networks IPs are defined in this Cloud configuration.

Table 10 FEEs and OSPF v2 Configuration

Abstract Load Balancer (ALB)	Front-End Element (FEE)	Network	FEE IP	FEE Interface	Virtual Router IP
alb_oam Area=10.1.13.1 Hello=3 Dead=9 Retransmit = 5 Delay=1 Priority=0	fee_1	172.16.213.0/29	.3	SC-1 eth2	.1, .2
	fee_2		.4	SC-2 eth2	



Abstract Load Balancer (ALB)	Front-End Element (FEE)	Network	FEE IP	FEE Interface	Virtual Router IP
alb_tr Area=10.1.13.2 Hello=3 Dead=9 Retransmit = 5 Delay=1 Priority=0	fee_1	172.16.113.0/28	.3	PL-3 eth2	.1, .2
	fee_2		.4	PL-4 eth2	
	fee_3		.5	PL-5 eth2	
	fee_4		.6	PL-6 eth2	
	fee_5		.7	PL-7 eth2	
	fee_6		.8	PL-8 eth2	

### 3.2.2.4 Virtual Router Configuration

Virtual router configurations are part of their images, similarly to other virtual machines composing the SAPC. Apart of the OSPF-related configuration previously described into Section 3.2.2.3.3 on page 19, the following remarkable configuration has been set up into the respective images and is part of the SAPC delivery.

Table 11 OSPF Areas for Internal Networks Configuration

OSPF Area	Router IDs	OSPF Parameters	Use
10.1.13.1	172.16.213.1 (Virtual Router 1)	Hello=3 seconds Dead=9 seconds Retransmit = 5 seconds	SAPC OAM and Provisioning VIP Addresses
	172.16.213.2 (Virtual Router 2)		
10.1.13.2	172.16.113.1 (Virtual Router 3)	Delay=1 second Priority=1	SAPC Traffic VIPs Addresses
	172.16.113.2 (Virtual Router 4)		

## 3.2.3 External Networks Configuration

### 3.2.3.1 External Networks

The following networks are configured to interconnect the SAPC with the customer network.





Table 12 External-OAM Networks

Network Name	Network	Default Gateway	Use
<b>External-OAM</b>	<b>10.41.30.224/29</b>	10.41.30.225 <sup>(1)</sup> 10.41.30.226 <sup>(2)</sup>	OAM network for the SAPC
<b>External-Traffic</b>	<b>10.41.70.224/29</b>	10.41.70.225 <sup>(1)</sup> 10.41.70.226 <sup>(1)</sup>	Traffic network for the SAPC node (VR-3, VR-4),

(1) External VRRP address between gateways

(2) Internal VRRP address between virtual routers

### 3.2.3.2 IP Addressing

Each SAPC Node includes a set of IP addresses configured.

#### 3.2.3.2.1 Virtual Routers IP Addresses

Table 13 IP Addresses

IP Address	Network	Value	Use
<b>VR-1 OAM</b>	<b>10.41.30.224/29</b>	<b>10.41.30.227/29</b>	IP Address of VR-1 on ExtOAM Network
<b>VR-2 OAM</b>		<b>10.41.30.228/29</b>	IP Address of VR-2 on ExtOAM Network
<b>OAM VRRP</b>		<b>10.41.30.226/29</b>	IP Address for OAM VRRP (Virtual Router Redundancy Protocol)
<b>VR-3 Traffic</b>	<b>10.41.70.224/29</b>	<b>10.41.70.227/29</b>	IP Address of VR-3 on ExtTraffic Network
<b>VR-4 Traffic</b>		<b>10.41.70.228/29</b>	IP Address of VR-4 on ExtTraffic Network
<b>Traffic VRRP</b>		<b>10.41.70.226/29</b>	IP Address for Traffic VRRP (Virtual Router Redundancy Protocol)

#### 3.2.3.2.2 IP Addresses of External Elements

See Section 3.1.2.4 on page 15

### 3.2.3.3 Virtual Router Configuration

Virtual router configurations are part of their images, similarly to other virtual machines composing the SAPC. The following remarkable configuration has been set up into the respective images and is part of the SAPC delivery.

Table 14 OSPF Backbone Area Configuration

OSPF Area	OSPF Parameters	Use
<b>Backbone area (0.0.0.0)</b>	Dead Interval: 9 seconds, Hello Interval: 3 seconds, Retransmit: 5 seconds, Delay: 1 second, Priority= 1	OSPF backbone

Table 15 VRRP Configuration

VRRP Group	Virtual Router	VRRP Parameters	Use
<b>10</b>	Virtual Router 1	Priority= 150	External OAM VRRP ( <b>10.41.30.226</b> )
	Virtual Router 2	Priority= 100	
<b>20</b>	Virtual Router 3	Priority= 150	External Traffic VRRP ( <b>10.41.70.226</b> )
	Virtual Router 4	Priority= 100	

### 3.3 Solution to Define Unique OAM and Multiple Traffic Networks

This section describes the SAPC configuration to support one OAM Network to serve Operations and Managements functions and several Traffic Networks to provide Policy Controller functions to the rest of the nodes. These functions can be separated as follows:

- Network for Rx and Sy traffic support, which in turn can be also separated in different networks.
- Network for the rest of Policy Controller functions supported, mainly Gx traffic support.
- Network for connection to external database.
- Network for connection to redundant SAPC in GeoRed scenario.
- More networks can be used for other traffic purposes not explicitly mentioned above.

Next figure shows the general network overview with two traffic networks; same concept is applicable when more traffic networks are to be created, with and additional eth interface in the payload elements for each extra network.

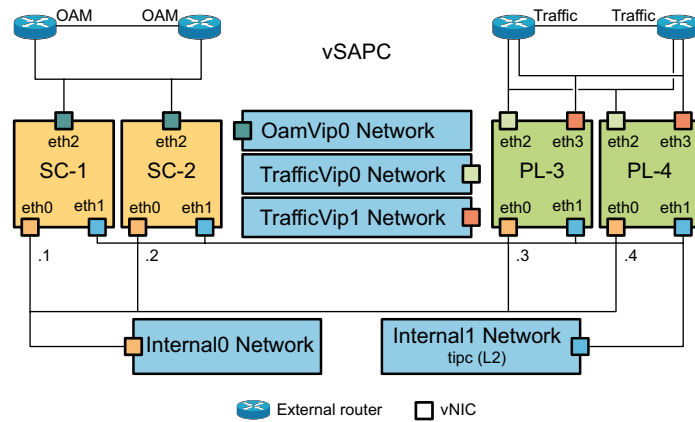


Figure 9 SAPC Node solution with Unique OAM and two Traffic Networks

### 3.3.1 Internal Network Configuration

In this section applies the same configuration described into Section 3.1.1 on page 11.

### 3.3.2 External/VIP Networks Configuration

#### 3.3.2.1 Networks for eVIP

The following table shows a proposal for the networks to be allocated, in which VIP addresses are made available. They are customer dependant, since some of the addresses have to be defined in elements acting as gateways.

Table 16 Networks to be allocated for SAPC VIPs population

Network Name	Subnet	Use
OamVip0	172.16.213.0/29	Between OAM FEEs and Gateways
TrafficVip0	172.16.113.0/28	Between Traffic0 FEEs and Gateways
TrafficVip1	172.16.113.32/28	Between Traffic1 FEEs and Gateways
TrafficVipn	172.16.113.xx/28	Between Trafficn FEEs and Gateways

#### 3.3.2.2 SAPC VIP Addresses

Comment about additional VIPs



Table 17 VIP Addresses

VIP Description	VIP	Use
<b>VIP-OAM</b>	<b>10.58.31.7/32</b>	SAPC OAM VIP Address
<b>VIP-PROVISIONING<sup>(1)</sup></b>	N/A	SAPC Provisioning VIP Address
<b>VIP-GX</b>	<b>10.58.31.137/32</b>	SAPC Traffic VIP Address for Gx mainly
<b>VIP-RX</b>	<b>10.58.32.142/32</b>	SAPC Traffic VIP Address for Rx/Sy
<b>VIP-ExtDB<sup>(2)</sup></b>	N/A	VIP address for handling the access to the external Database

(1) Only for deployment that requires Provisioning Address different than OAM Address.

(2) Only in deployment with an external database.

Additional VIPs can be configured in the SAPC node. Each VIP is assigned to a traffic network. Several VIPs can share a traffic network for communication purposes.

### 3.3.2.3 eVIP Configuration

This section describes the mapping of networks to vNICs in the different pieces of networking equipment related to eVIP components.

This section describes the eVIP configuration defined in the SAPC images for Cloud environment. The `evip.xml` configuration file included into the SAPC images holds many parameters however this document describes the ones that are key to the design.

#### 3.3.2.3.1 eVIP Configuration Overview

Traffic is separated in different networks through which **VIP-OAM**, **VIP-GX** and **VIP-RX**, and other traffic VIPs are propagated. VIP-OAM networks enclose SCs, traffic VIPs enclose PLs. From eVIP point of view, one FEE manages each kind of traffic in each processor they run on.

The following figure shows how VIP-OAM is configured as specified at Section 3.3.2.3.2 on page 26.

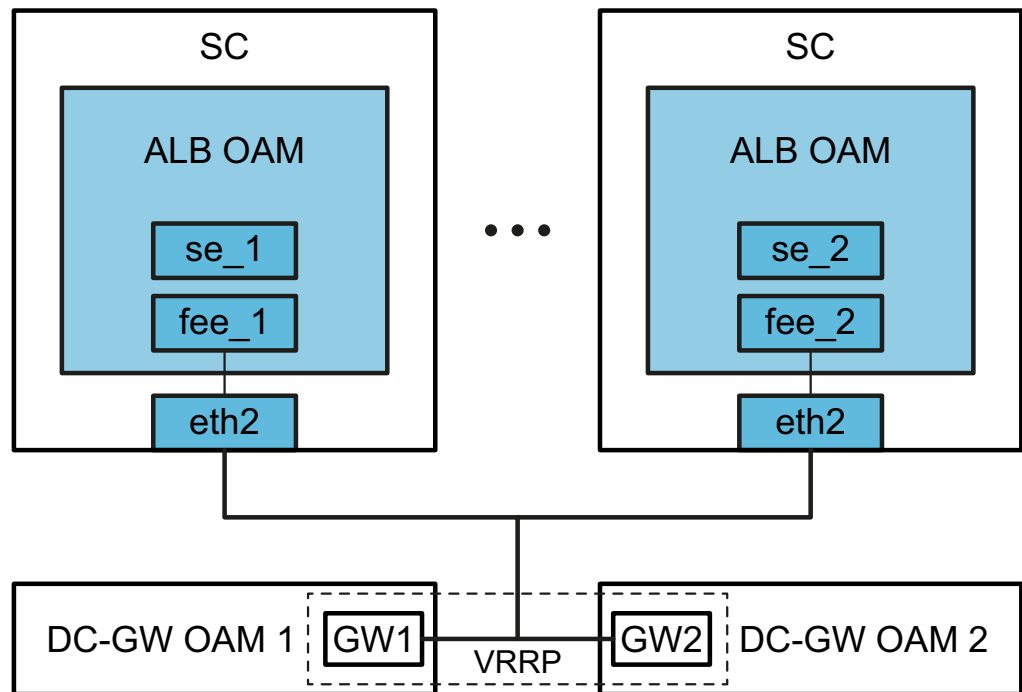


Figure 10 eVIP VIP-OAM Overview

In deployments that requires Provisioning Address different than OAM Address, SAPC requires a new Virtual IP for handling Provisioning, VIP-PROVISIONING. This new VIP is published to the External Network through the same FEEs than VIP-OAM.

The following figure shows how several traffic VIPs are configured as specified at Section 3.3.2.3.2 on page 26.

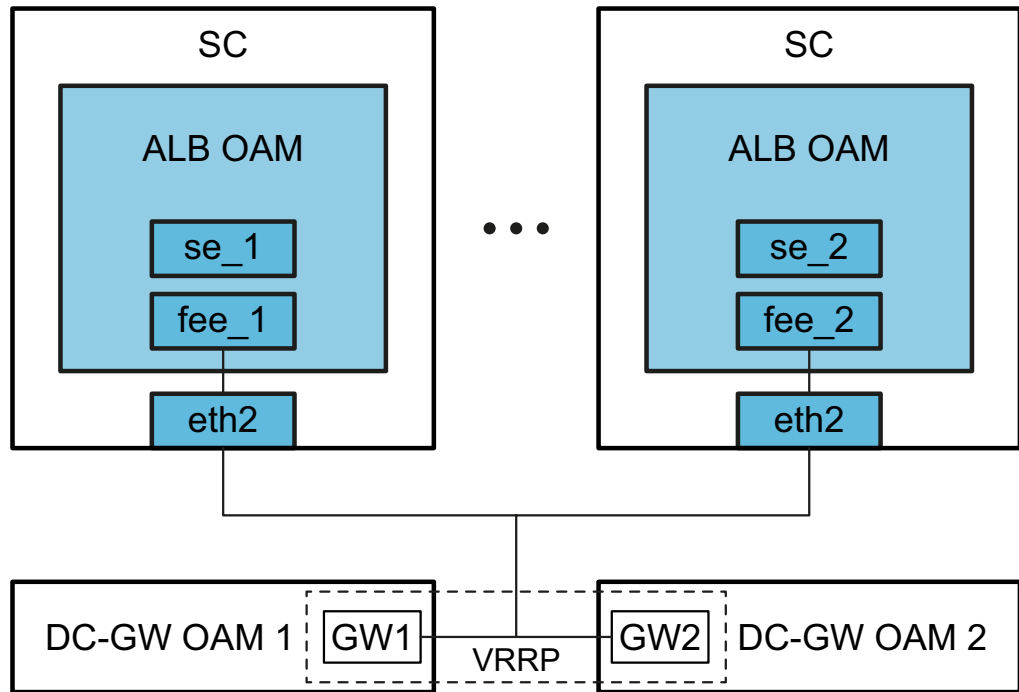


Figure 11 Traffic Separation Overview

In deployments with an external database like CUDB, SAPC requires a new Virtual IP for handling the LDAP traffic and the SOAP notifications traffic with the external database. This new VIP can be published to the External Network through the same FEEs than existing VIPs, or through an extra separated traffic channel.

For both OAM and traffic VIPs, static routes are created from gateways to the FEEs, and VRRP address between gateways is default gateway for eVIP frontends.

### 3.3.2.3.2

#### eVIP Elements

In the table below, the distribution of eVIP elements is listed. The location of eVIP front ends (FEE) requires corresponding configuration in the network, that is, site routers.

Table 18 Distribution of eVIP Elements

Abstract Load Balancer (ALB)	VIP	Front-End Element (FEE) (1)	Load Balancer Element (LBE)	Security Element (SE)
alb_oam	<VIP-OAM> 10.58.31.7/32	SC-1 (fee_1) SC-2 (fee_2)	lbe_1 lbe_2	se_1 se_2



Abstract Load Balancer (ALB)	VIP	Front-End Element (FEE) (1)	Load Balancer Element (LBE)	Security Element (SE)
alb_trf_1	<VIP-GX> <b>10.58.31.137/32</b> <VIP-ExtDB> <sup>(2)</sup>	PL-3 (fee_1) PL-4 (fee_2) PL-5 (fee_3) PL-6 (fee_4) PL-7 (fee_5) PL-8 (fee_6)	lbe_1 lbe_2 lbe_3 lbe_4 lbe_5 lbe_6	se_1 se_2 se_3 se_4 se_5 se_6
alb_trf_2	<VIP-RX> <b>10.58.32.142/32</b>	PL-3 (fee_1) PL-4 (fee_2) PL-5 (fee_3) PL-6 (fee_4) PL-7 (fee_5) PL-8 (fee_6)	lbe_1 lbe_2 lbe_3 lbe_4 lbe_5 lbe_6	se_1 se_2 se_3 se_4 se_5 se_6

(1) When there are fewer FEE elements than the indicated here, its corresponding IP addresses are automatically distributed among the existing FEEs.

(2) Only in deployment with an external database, can also be separated on its own ALB.

### 3.3.2.4 IP Addressing

Each SAPC includes a set of IP addresses configured.

#### 3.3.2.4.1 IP Addresses of External Elements

In this section applies the same configuration described in Section 3.1.2.4 on page 15.

### 3.3.3 Gateway Router Configuration

This section covers all the IP routes to be configured in the Gateway Routers to interoperate with each SAPC.

- Configuration in OAM GWs: To get to the OAM VIP, define static routes for the FEE IP addresses configured in the SCs.
- Configuration in Traffic GWs:
  - To get to the default Traffic VIP, define static routes for the FEE IP addresses configured in the PLs.
  - To get to the other Traffic VIPs, define static routes for the FEE IP addresses configured in the PLs for every traffic type.

ECMP shall be configured for traffic distribution among FEE IP addresses for each traffic type.

## 3.4 Solution to Define Unique OAM and Multiple Traffic Networks with Virtual Routers

This section describes the SAPC configuration, with virtual routers included, to support one OAM Network to serve Operations and Managements functions and several Traffic Networks to provide Policy Controller functions to the rest of the nodes. These functions can be separated as follows:

- Network for Rx and Sy traffic support, which in turn can be also separated in different networks.
- Network for the rest of Policy Controller functions supported, mainly Gx traffic support.
- Network for connection to external database.
- Network for connection to redundant SAPC in GeoRed scenario.
- More networks can be used for other traffic purposes not explicitly mentioned above.

Next figure shows the general network overview with two traffic networks; same concept is applicable when more traffic networks are to be created, with and additional eth interfaces (1 in the payload elements, 2 on virtual routers) for each extra network.

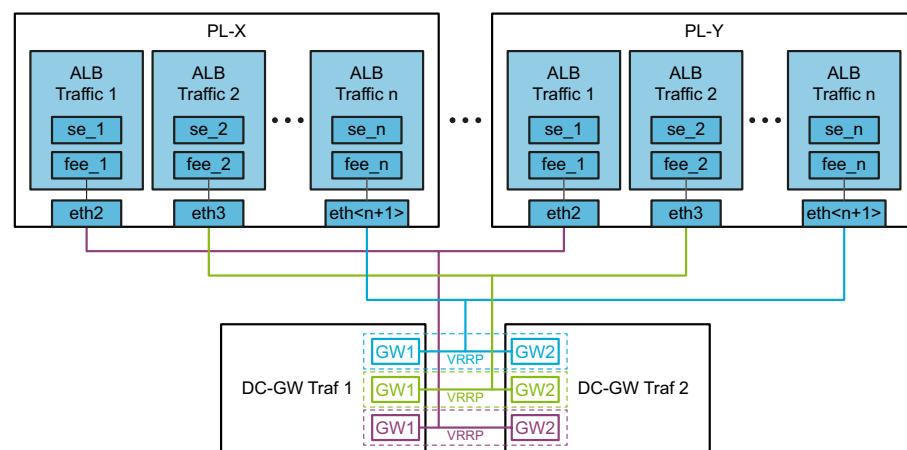


Figure 12 SAPC Node solution with Unique OAM and two Traffic Networks

### 3.4.1 Internal Network Configuration

In this section applies the same configuration described into Section 3.1.1 on page 11.





## 3.4.2 VIP Networks Configuration

### 3.4.2.1 Networks for OSPF v2

The following table shows the networks allocated inside the SAPC node images, in which OSPF protocol is enabled. They are already defined by default in the SAPC and in the configuration of the virtual routers to ensure a proper operation after the SAPC deployment in Cloud environment.

Table 19 Private Networks Allocated inside the SAPC node for SAPC VIPs population with OSPF

Network Name	Subnet	Use
OamVip0	172.16.213.0/29	Between OAM FEEs and Gateways
TrafficVip0	172.16.113.0/28	Between Traffic0 FEEs and Gateways
TrafficVip1	172.16.113.32/28	Between Traffic1 FEEs and Gateways
TrafficVipn	172.16.113.xx/28	Between Trafficn FEEs and Gateways

### 3.4.2.2 SAPC VIP Addresses

See Section 3.3.2.2 on page 23

### 3.4.2.3 eVIP Configuration

This section describes the mapping of networks to vNICs in the different pieces of networking equipment related to eVIP components.

This section describes the eVIP configuration defined in the SAPC images for Cloud environment. The `evip.xml` configuration file included into the SAPC images holds many parameters however this document describes the ones that are key to the design.

#### 3.4.2.3.1 eVIP Configuration Overview

Traffic is separated in several pairs of networks through which **VIP-OAM**, **VIP-GX**, **VIP-RX**, and other traffic VIPs are propagated. On each pair of network, there is an internal network between FEEs and Virtual Routers, and another external network between VRs and site routers. VIP-OAM networks enclose SCs, VIP-GX, and VIP-RX enclose PLs. From eVIP point of view, one FEE manages each kind of traffic in each processor they run on.

The following figure shows how VIP-OAM is configured as specified at Section 3.4.2.3.3 on page 32.

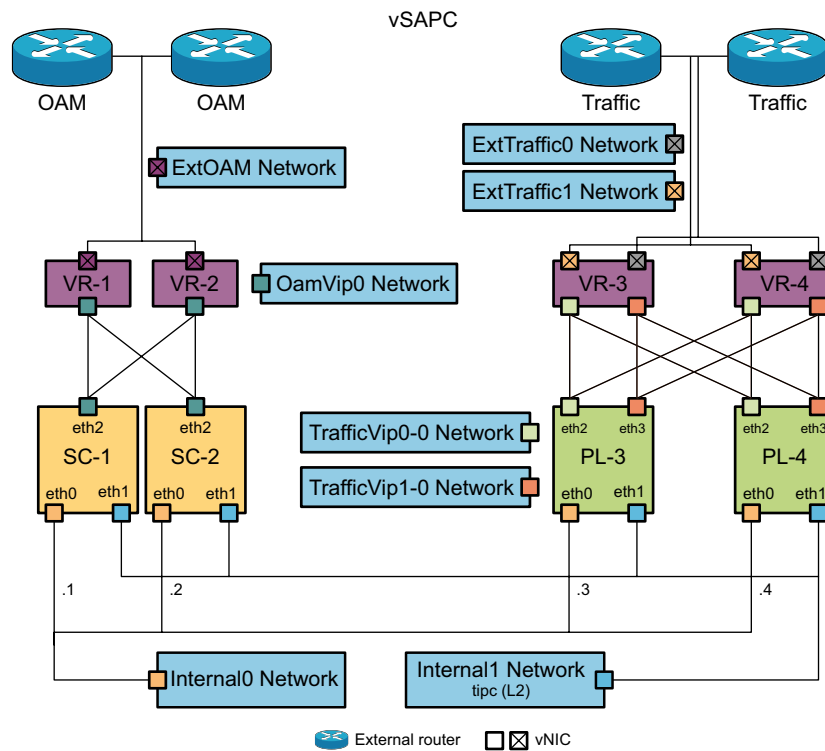


Figure 13 eVIP VIP-OAM Overview

In deployments that requires Provisioning Address different than OAM Address, SAPC requires a new Virtual IP for handling Provisioning, VIP-PROVISIONING. This new VIP is published to the External Network through the same FEEs than VIP-OAM.

The following figure shows how VIP-GX and VIP-RX are configured as specified at Section 3.4.2.3.3 on page 32. The same principle is applicable when additional traffic VIPs need to be configured.

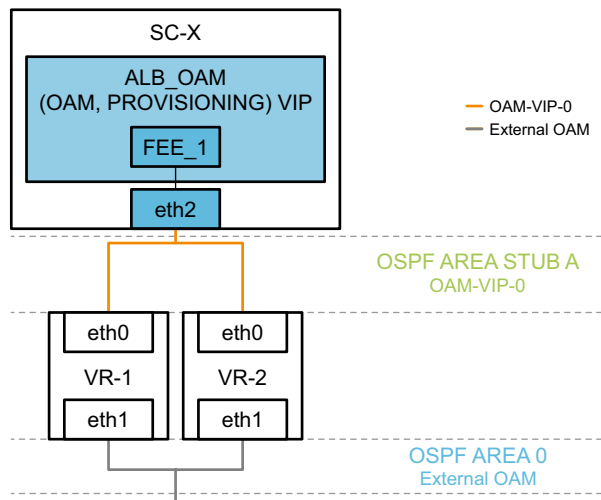


Figure 14 eVIP VIP-GX Overview

In deployments with an external database like CUDb, SAPC requires a new Virtual IP for handling the LDAP traffic and the SOAP notifications traffic with the external database. This new VIP can be published to the External Network through the same FEEs than VIP-GX, or through a separated ALB, with its corresponding FEEs.

#### 3.4.2.3.2 eVIP Elements

In the table below, the distribution of eVIP elements is listed. The location of eVIP front ends (FEE) requires corresponding configuration in the network, that is, virtual routers. This configuration is already made by default and adjustment is not required.

Table 20 Distribution of eVIP Elements

Abstract Load Balancer (ALB)	VIP	Front-End Element (FEE)	Load Balancer Element (LBE)	Security Element (SE)
alb_oam	<VIP-OAM> 10.58.31.7/32	SC-1 (fee_1) SC-2 (fee_2)	lbe_1 lbe_2	se_1 se_2



Abstract Load Balancer (ALB)	VIP	Front-End Element (FEE)	Load Balancer Element (LBE)	Security Element (SE)
alb_trf_1	<VIP-GX> <b>10.58.31.137/32</b> <VIP-ExtDB> <sup>(1)</sup>	PL-3 (fee_1) PL-4 (fee_2) PL-5 (fee_3) PL-6 (fee_4) PL-7 (fee_5) PL-8 (fee_6)	lbe_1 lbe_2 lbe_3 lbe_4 lbe_5 lbe_6	se_1 se_2 se_3 se_4 se_5 se_6
alb_trf_2	<VIP-RX> <b>10.58.32.142/32</b>	PL-3 (fee_1) PL-4 (fee_2) PL-5 (fee_3) PL-6 (fee_4) PL-7 (fee_5) PL-8 (fee_6)	lbe_1 lbe_2 lbe_3 lbe_4 lbe_5 lbe_6	se_1 se_2 se_3 se_4 se_5 se_6

(1) Only in deployment with an external database.

### 3.4.2.3.3

#### OSPF v2 Areas

In the example with two traffic ALBs, the traffic is separated into three OSPF v2 areas and ALBs. If additional VIPs are to be separated, corresponding OSPF area and ALB is configured, following the same principles as in the provided example. Each ALB has links with IPs defined for the FEEs and the remote gateway which are the virtual routers in this design. Next table shows how the networks IPs are defined in this Cloud configuration.

Table 21 FEEs and OSPF v2 Configuration

Abstract Load Balancer (ALB)	Front-End Element (FEE)	Network	FEE IP	FEE Interface	Virtual Router IP
alb_oam Area=10.1.13.1 Hello=3 Dead=9 Retransmit = 5 Delay=1 Priority=0	fee_1	172.16.213.0/29	.3	SC-1 eth2	.1, .2
	fee_2		.4	SC-2 eth2	



Abstract Load Balancer (ALB)	Front-End Element (FEE)	Network	FEE IP	FEE Interface	Virtual Router IP
alb_trf_1 Area=10.1.13.2 Hello=3 Dead=9 Retransmit = 5 Delay=1 Priority=0	fee_1	172.16.113.0/28	.3	PL-3 eth2 PL-4 eth2	.1, .2
	fee_2		.4	PL-4 eth2	
	fee_3		.5	PL-5 eth2 PL-8 eth2	
	fee_4		.6	PL-6 eth2	
	fee_5		.7	PL-7 eth2	
	fee_6		.8	PL-8 eth2	
alb_trf_2 Area=10.1.13.3 Hello=3 Dead=9 Retransmit = 5 Delay=1 Priority=0	fee_1	172.16.113.16/28	.19	PL-3 eth4	.17, .18
	fee_2		.20	PL-4 eth4	
	fee_3		.21	PL-5 eth4	
	fee_4		.22	PL-6 eth4	
	fee_5		.23	PL-7 eth4	
	fee_6		.24	PL-8 eth4	

### 3.4.2.4

### Virtual Router Configuration

Virtual router configurations are part of their images, similarly to other virtual machines composing the SAPC. Apart of the OSPF-related configuration previously described into Section 3.4.2.3.3 on page 32, the following remarkable configuration has been set up into the respective images and is part of the SAPC delivery.



Table 22 OSPF Areas for Internal Networks Configuration

OSPF Area	Router IDs	OSPF Parameters	Use
10.1.13.1	172.16.213.1 (Virtual Router 1)	Hello=3 seconds	SAPC OAM and Provisioning VIP Addresses
	172.16.213.2 (Virtual Router 2)		
10.1.13.2	172.16.113.1 (Virtual Router 3)	Dead=9 seconds Retransmit =5 seconds Delay=1 second	SAPC VIPs Addresses for the rest of the traffic, mainly for Gx traffic
	172.16.113.2 (Virtual Router 4)		
10.1.13.3	172.16.113.17 (Virtual Router 3)	Priority=1	SAPC VIP Address for Rx/Sy traffic
	172.16.113.18 (Virtual Router 4)		

### 3.4.3 External Networks Configuration

#### 3.4.3.1 External Networks

The following networks are configured to interconnect the SAPC with the customer network.

Table 23 External-OAM Networks

Network Name	Network	Default Gateway	Use
External-OAM	10.41.30.224/29	10.41.30.225	OAM network for the SAPC
External-Traffic-1	10.41.70.224/29	10.41.70.225	Traffic network for Gx traffic for the SAPC (VR-3, VR-4),
External-Traffic-2	10.41.90.224/29	10.41.90.225	Traffic network for Rx and Sy traffic for the SAPC (VR-3, VR-4),

#### 3.4.3.2 IP Addressing

Each SAPC includes a set of IP addresses configured.



### 3.4.3.2.1 Virtual Routers IP Addresses

Table 24 IP Addresses

IP Address	Network	Value	Use
VR-1 OAM	10.41.30.224/29	10.41.30.227/29	IP Address of VR-1 on ExtOAM Network
VR-2 OAM		10.41.30.228/29	IP Address of VR-2 on ExtOAM Network
OAM VRRP		10.41.30.226/29	IP Address for OAM VRRP (Virtual Router Redundancy Protocol)
VR-3 Traffic-1	10.41.70.224/29	10.41.70.227/29	IP Address of VR-3 on ExtTraffic-1 Network
VR-4 Traffic-1		10.41.70.228/29	IP Address of VR-4 on ExtTraffic-1 Network
Traffic-1 VRRP		10.41.70.226/29	IP Address for Traffic-1 VRRP (Virtual Router Redundancy Protocol)
VR-3 Traffic-2	10.41.90.224/29	10.41.90.227/29	IP Address of VR-3 on ExtTraffic-2 Network
VR-4 Traffic-2		10.41.90.228/29	IP Address of VR-4 on ExtTraffic-2 Network
Traffic-2 VRRP		10.41.90.226/29	IP Address for Traffic-2 VRRP (Virtual Router Redundancy Protocol)

### 3.4.3.2.2 IP Addresses of External Elements

In this section applies the same configuration described into Section 3.1.2.4 on page 15.

### 3.4.3.3 Virtual Router Configuration

Virtual router configurations are part of their images, similarly to other virtual machines composing the SAPC. The following remarkable configuration has been set up into the respective images and is part of the SAPC delivery.

Table 25 OSPF Backbone Area Configuration

OSPF Area	OSPF Parameters	Use
Backbone area (0.0.0.0)	Dead Interval: 9 seconds, Hello Interval: 3 seconds, Retransmit: 5 seconds, Delay: 1 second, Priority= 1	OSPF backbone



Table 26 VRRP Configuration

VRRP Group	Virtual Router	VRRP Parameters	Use
10	Virtual Router 1	Priority= 150	External OAM VRRP (10.41.30.226)
	Virtual Router 2	Priority= 100	
20	Virtual Router 3	Priority= 150	External Traffic-1 VRRP (10.41.70.226)
	Virtual Router 4	Priority= 100	
30	Virtual Router 3	Priority= 150	External Traffic-2 VRRP (10.41.90.226)
	Virtual Router 4	Priority= 100	