Contrail Service Chaining with PANW FW as the VNF

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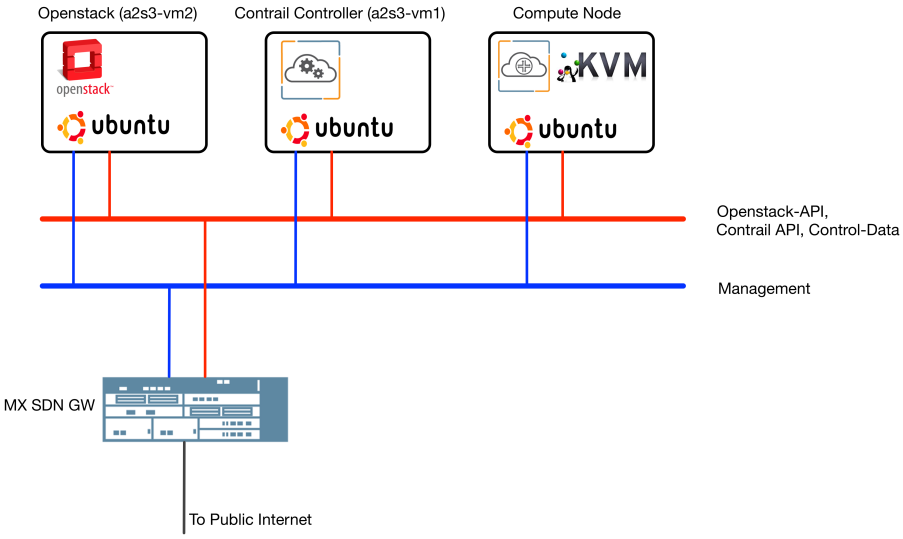
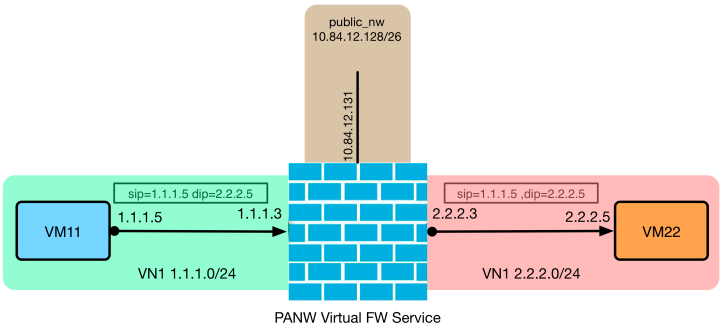
Physical Setup:



Use Case 1: PANW-FW as a Layer 3 firewall using Contrail In-Network service chaining feature.

In this use case PANW-FW is between the two Contrail Virtual Networks VN1 and VN2 and can inspect and filter the traffic that flows between VN1 and VN2 by making use of PANW-FW Zone based firewalls.

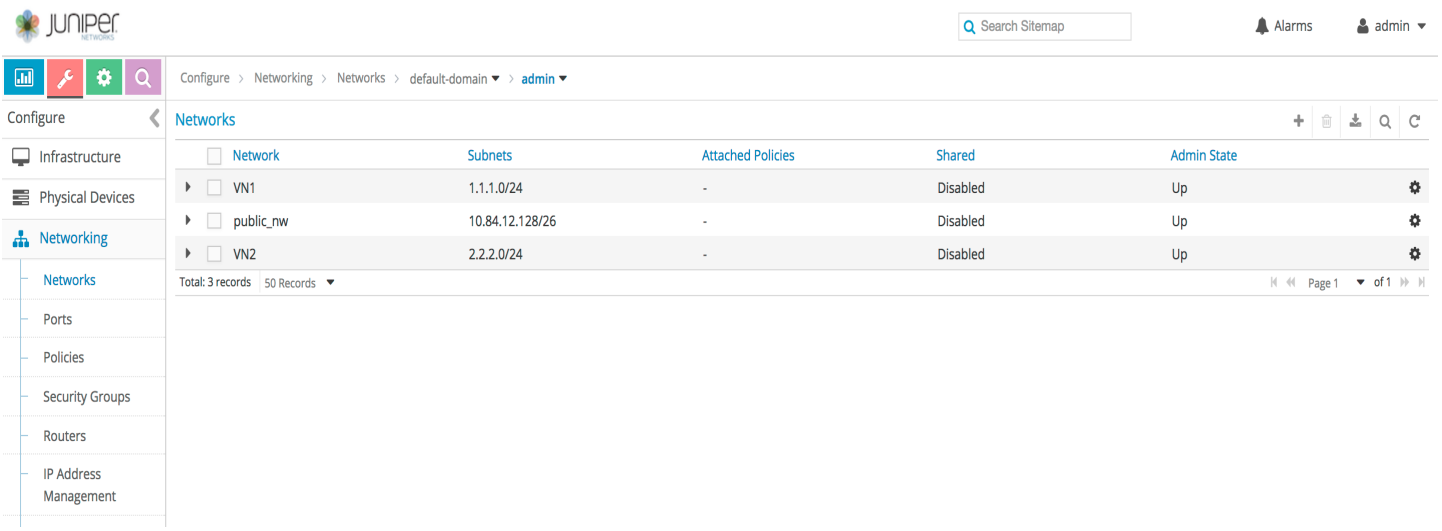
Logical Topology:



Configuration Steps:

Step1: Configure the Contrail Virtual Networks for LEFT, RIGHT and PUBLIC networks on the Contrail WebUI.

Note: Public network needs to be advertised to the MX-SDN GW for external internet since this is required for PANW-FW management WebUI (PANORAMA) access.

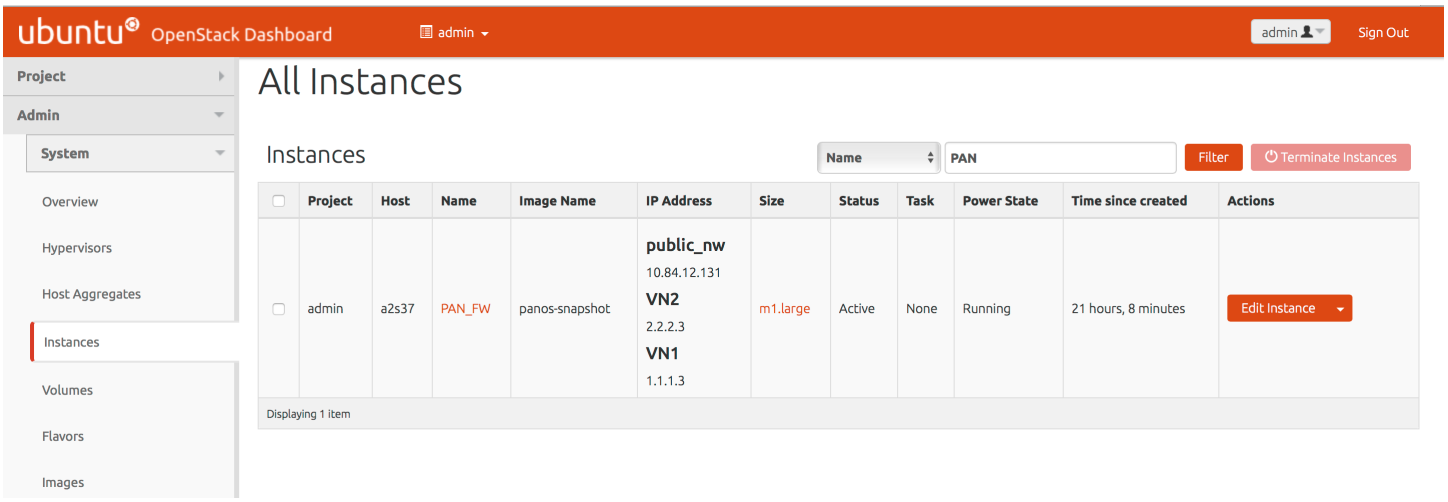


Step2: Create the glance image for PANW FW VM.

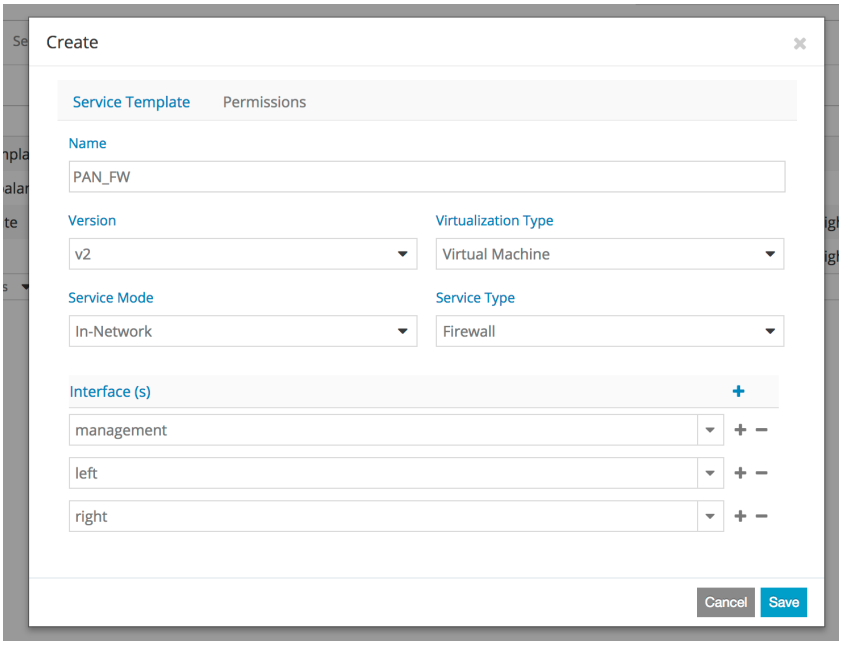
glance image-create --disk-format qcow2 --file PA-VM-KVM-dhcp-enabled-7.1.4.qcow2 --is-public True --container-format bare --name panos-snapshot –progress

Step3: Launch the PANW FW VM using the above created image, nova flavor of m1.large and connected to 3 networks public_nw, VN1 and VN2. Make sure that the nova status shows that the VM is running.

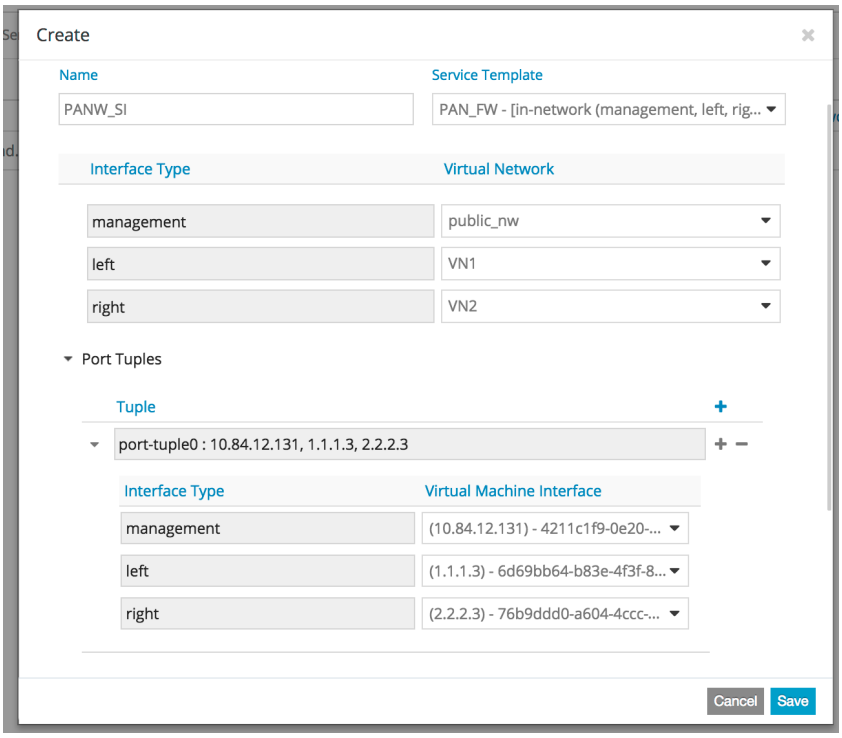
nova boot --image 57cb1b06-ddeb-405b-bf19-6275c2f8261d --flavor m1.large --nic net-id=3af3760f-a323-4d81-aedc-cab9c0fb5e13 --nic net-id=f9fa95310886a364 --nic net-id=d6db9fb4-6609-44bf-bef2-bbd1a1432c98 --availability-zone nova:a2s37 PAN_FW



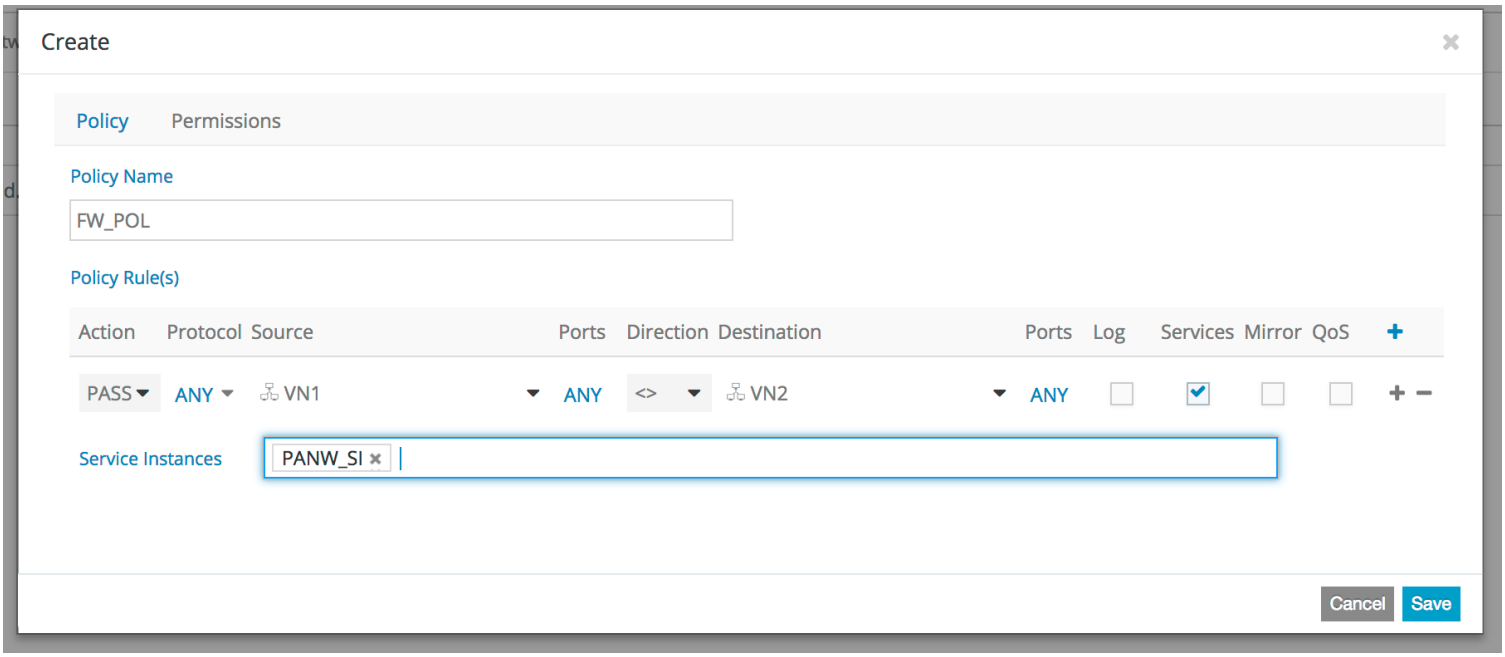
Step 4: Create the V2 service template of the type in-network firewall and virtual machine. Add 3 interfaces namely management, left and right to the service template.



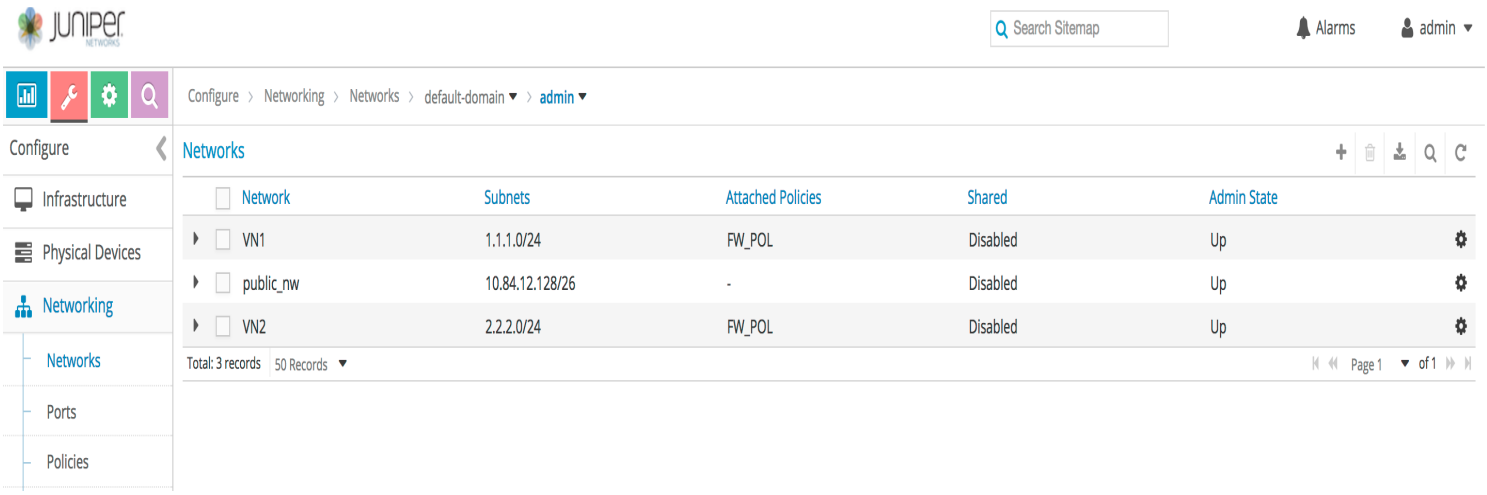
Step 5: Create the v2 service instance using port tuple feature and add the 3 interfaces of the PANW-FW VM to the port-tuple.



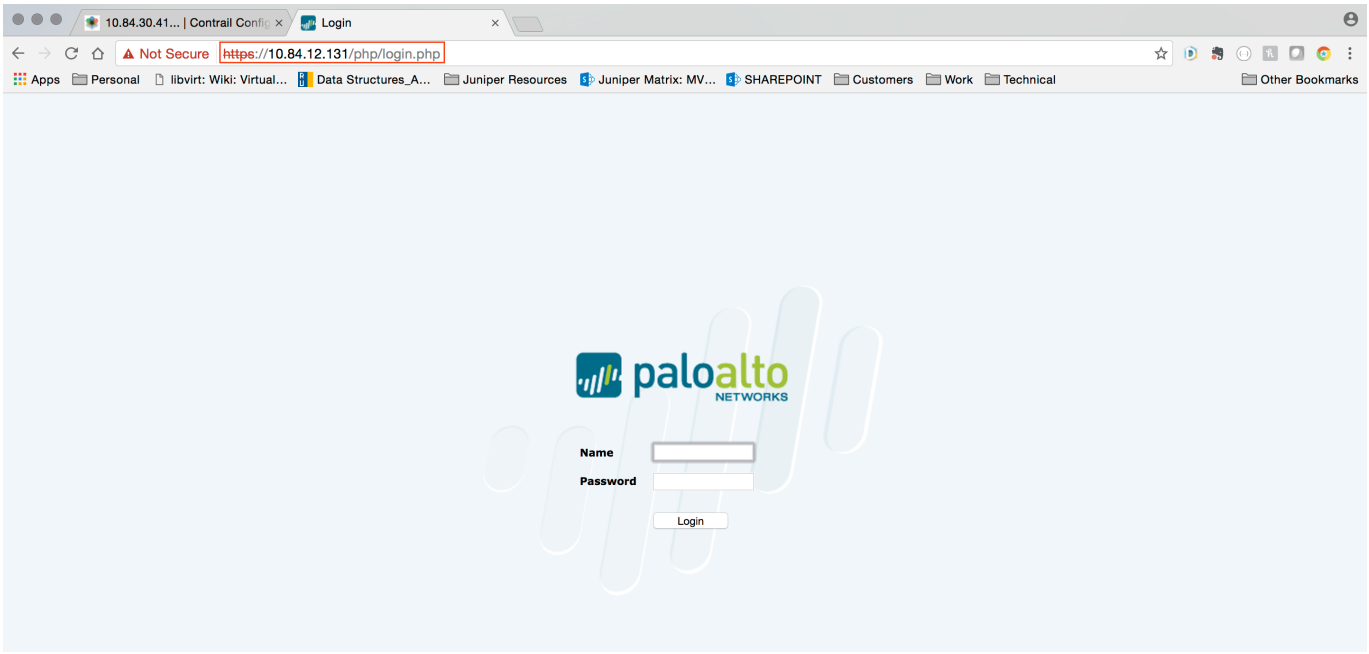
Step 6: Configure a service policy between VN1 and VN2 to match all the application traffic and send it to the PANW_SI created in step 5.



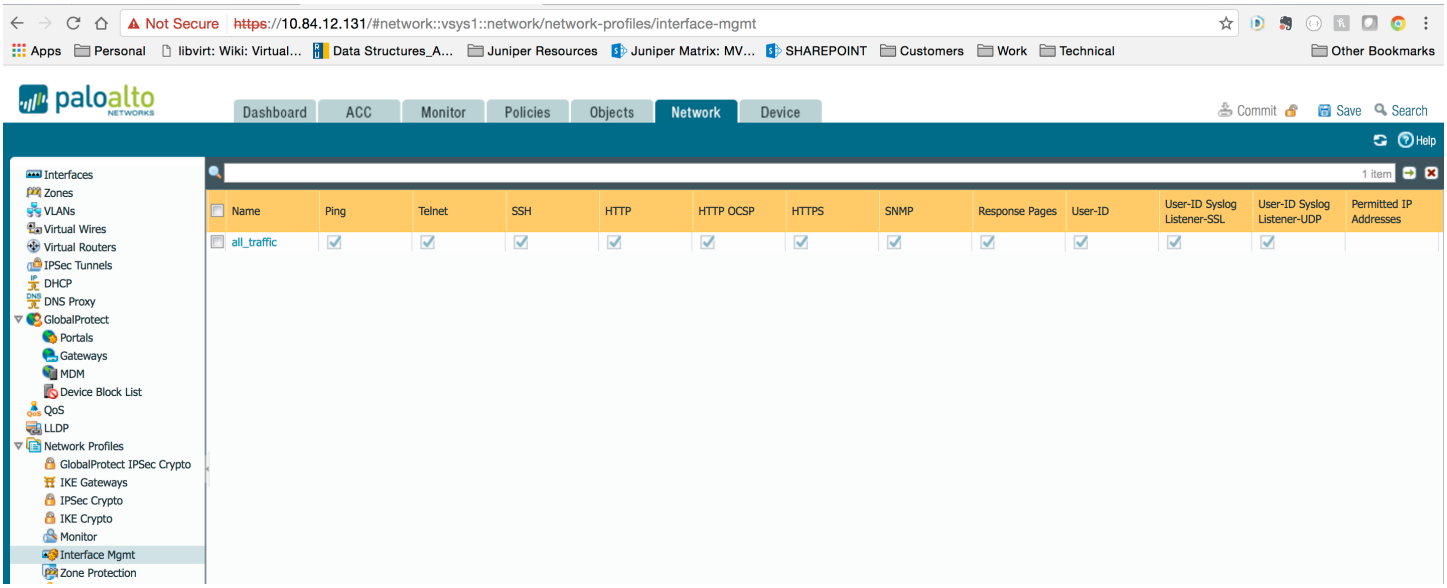
Step 7: Attach the FW_POL to VN1 and VN2.



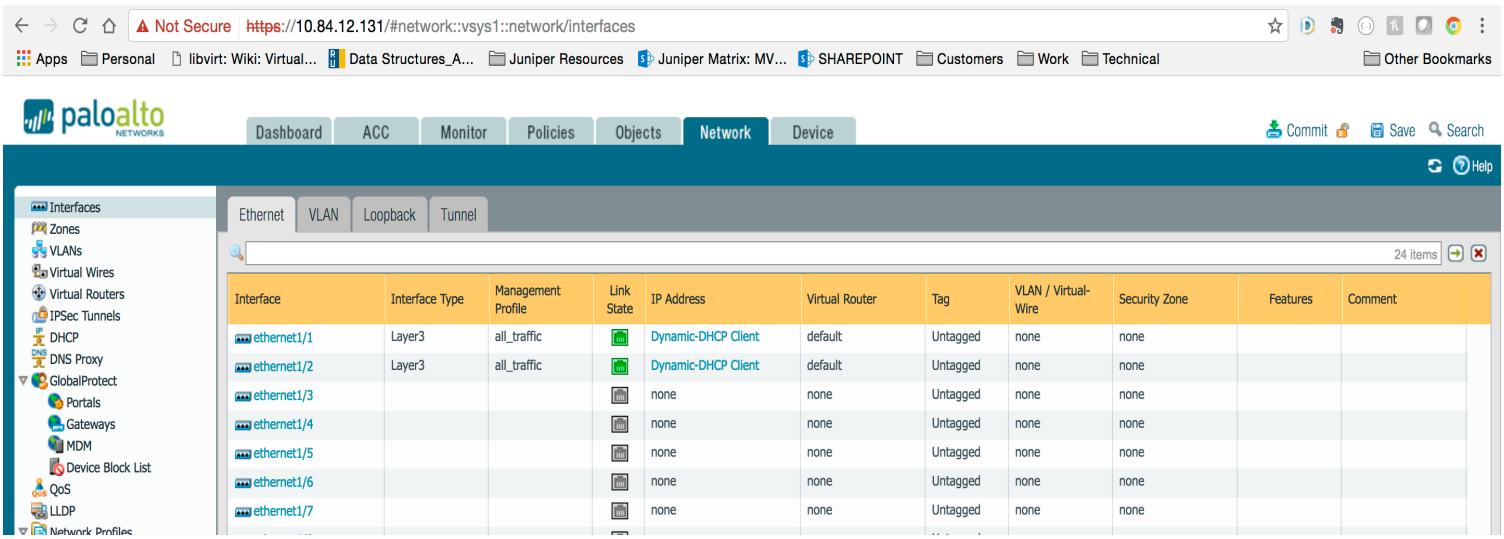
Step8: Login to PANW-FW Panorama management console by doing secure http to management IP address (10.84.12.131) using a web browser.



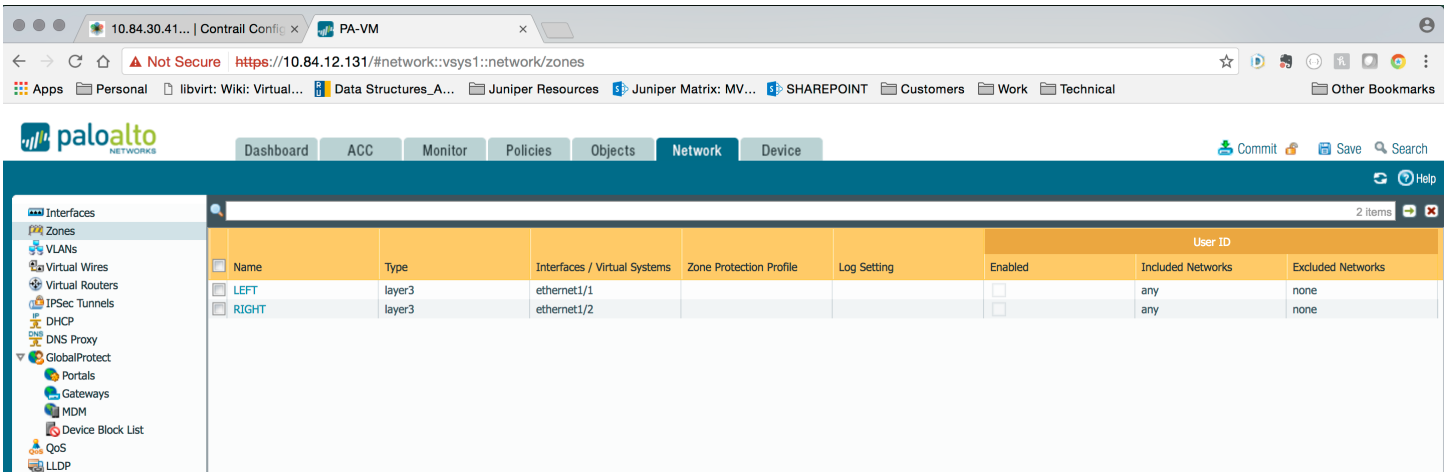
Step 9: Navigate to Network > Interface Management and create a management profile to permit all management / protocol traffic on the interfaces.



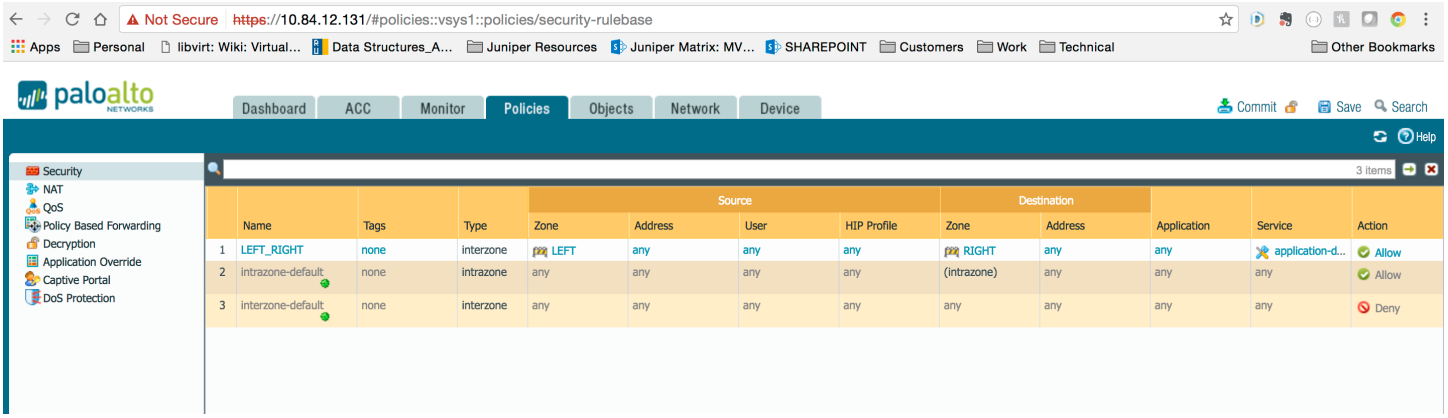
Step 10: Navigate to Network > Interfaces and configure the interfaces eth1/1 and eth1/2 which as per our topology is connected to Contrail virtual-networks VN1 and VN2 respectively. Select interface type as Layer3 and IP address as DHCP Client since our 2 Virtual Networks VN1 and VN2 have DHCP enabled.



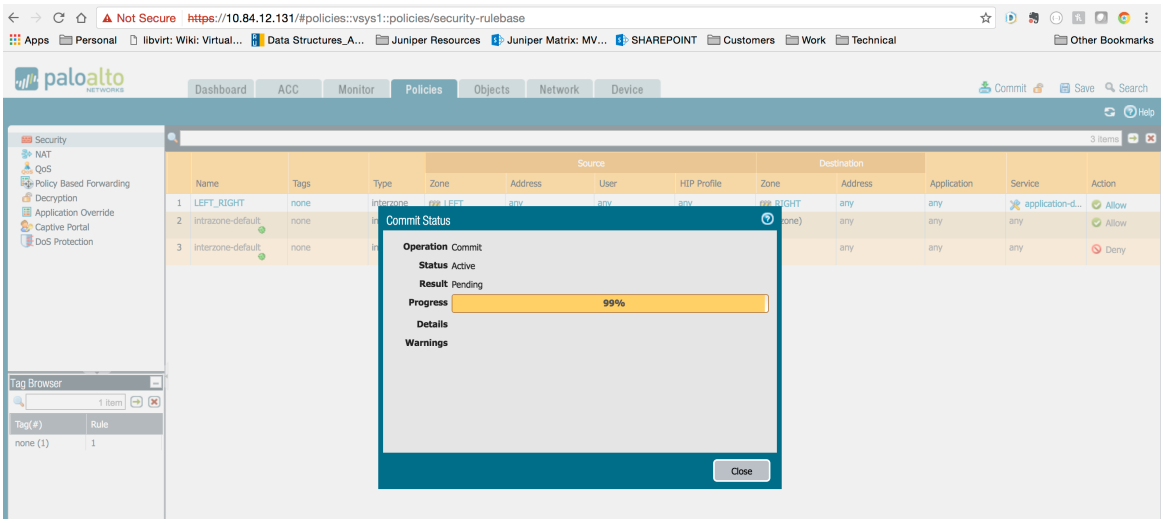
Step 10: Next navigate to Network > Zones and create 2 Security zones Left and Right of the type Layer 3. Attach the zone Left to eth1/1 and zone Right to eth1/2.



Step 11: Next navigate to Policies > Security and create a security policy between the LEFT and the RIGHT zones to permit all the traffic flowing from LEFT to RIGHT.

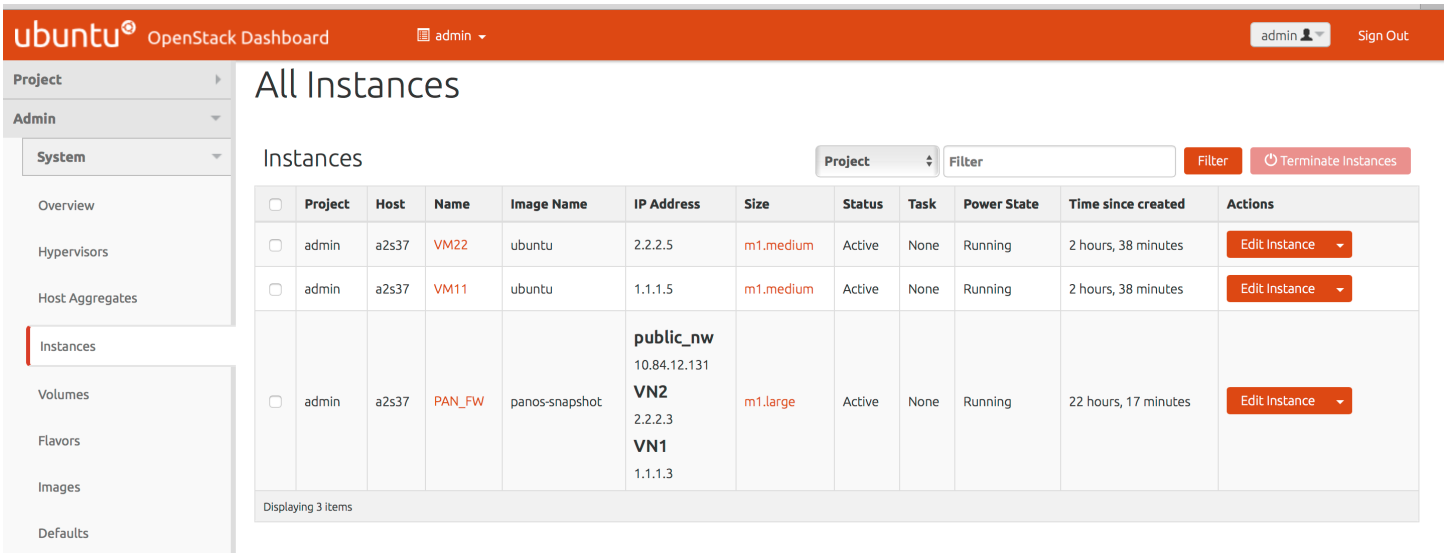


Step 12: Final step is to commit the configuration so that all the above features we have configured on the PANW-FW takes effect.

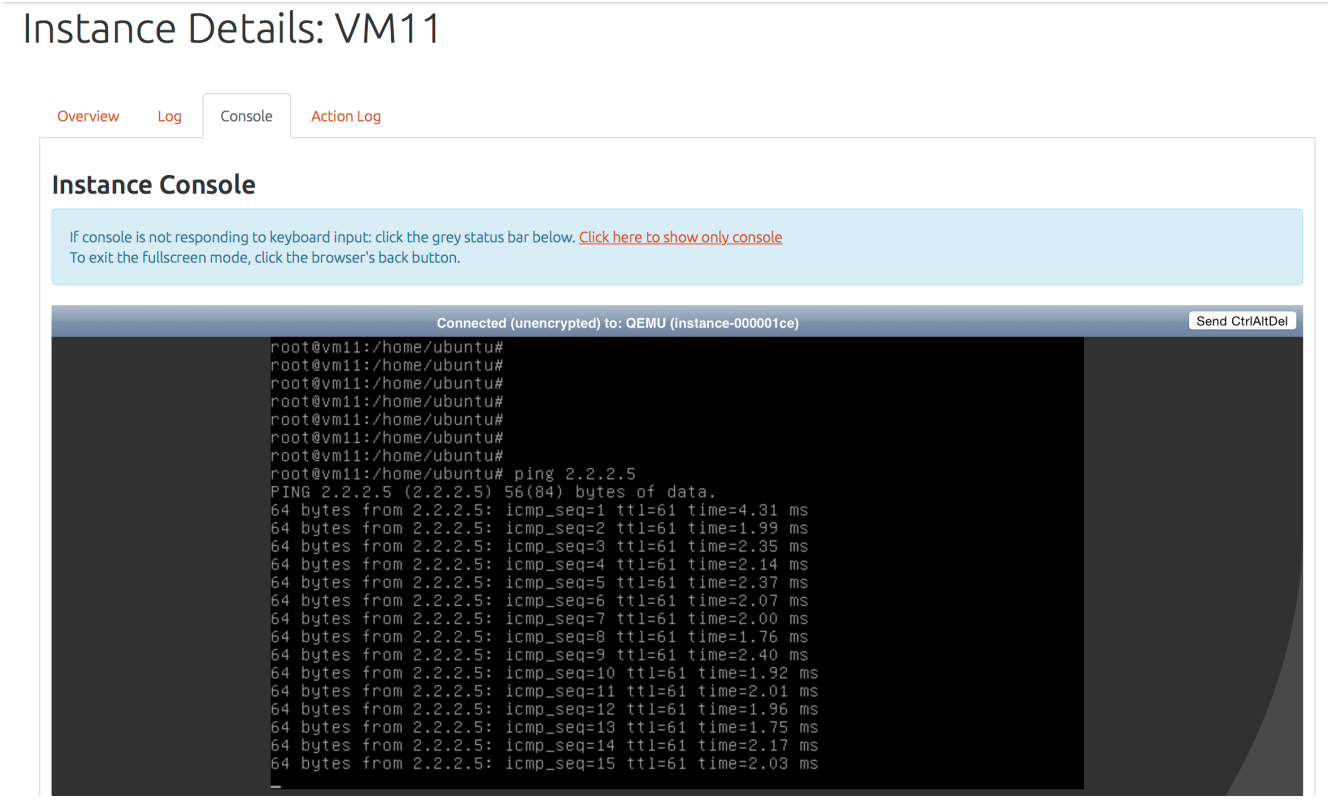


Verification:

Step 13: Launch 2 Ubuntu VM's in VN1 and VN2 which we will use to test the configuration.



Step 14: Verify the working of the service chain by pinging the address of VM22 (2.2.2.5) from VM11.

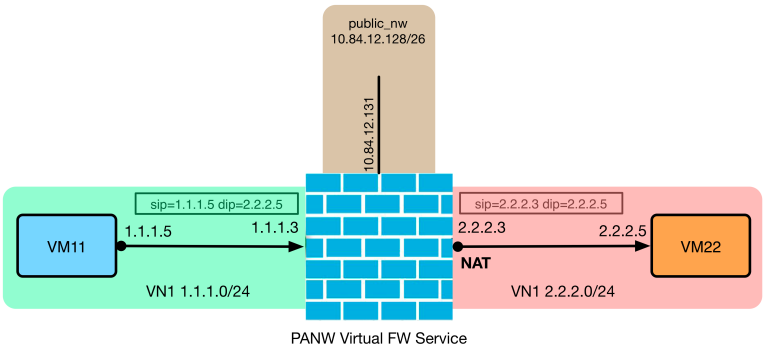


Step 14: We can verify these flows by checking the security sessions on the PANW-FW VM and by checking the vrouter flows on the compute node.

```
[edit]
admin@PA-VM# run show session all

--------------------------------------------------------------------------------
ID          Application    State   Type Flag  Src[Sport]/Zone/Proto (translated IP[Port])
Vsys                                          Dst[Dport]/Zone (translated IP[Port])
--------------------------------------------------------------------------------
1153         ping           ACTIVE  FLOW       1.1.1.5[7851]/LEFT/1  (1.1.1.5[7851])
vsys1                                         2.2.2.5[20]/RIGHT  (2.2.2.5[20])
1154         ping           ACTIVE  FLOW       1.1.1.5[7851]/LEFT/1  (1.1.1.5[7851])
vsys1                                         2.2.2.5[21]/RIGHT  (2.2.2.5[21])
1152         ping           ACTIVE  FLOW       1.1.1.5[7851]/LEFT/1  (1.1.1.5[7851])
vsys1                                         2.2.2.5[19]/RIGHT  (2.2.2.5[19])
1151         ping           ACTIVE  FLOW       1.1.1.5[7851]/LEFT/1  (1.1.1.5[7851])
vsys1                                         2.2.2.5[18]/RIGHT  (2.2.2.5[18])
1155         ping           ACTIVE  FLOW       1.1.1.5[7851]/LEFT/1  (1.1.1.5[7851])
vsys1                                         2.2.2.5[22]/RIGHT  (2.2.2.5[22])
1150         ping           ACTIVE  FLOW       1.1.1.5[7851]/LEFT/1  (1.1.1.5[7851])
vsys1                                         2.2.2.5[17]/RIGHT  (2.2.2.5[17])
[edit]
admin@PA-VM#
```

```
root@a2s37:~# flow -l --match "2.2.2.5"
Flow table(size 80609280, entries 629760)

Entries: Created 1180 Added 1177 Processed 1180 Used Overflow entries 0
(Created Flows/CPU: 65 55 81 74 92 383 17 1 15 5 13 29 50 35 20 77 38 49 4 4 15 38 14 6)(oflows 0)

Action:F=Forward, D=Drop N=NAT(S=SNAT, D=DNAT, Ps=SPAT, Pd=DPAT, L=Link Local Port)
 Other:K(nh)=Key_Nexthop, S(nh)=RPF_Nexthop
 Flags:E=Evicted, Ec=Evict Candidate, N=New Flow, M=Modified Dm=Delete Marked
TCP(r=reverse):S=SYN, F=FIN, R=RST, C=HalfClose, E=Established, D=Dead

Listing flows matching ([2.2.2.5]:*)

    Index               Source:Port/Destination:Port                      Proto(V)
-----------------------------------------------------------------------------------
    71596<=>503080      2.2.2.5:7851                                        1 (2->5)
                        1.1.1.5:0
(Gen: 1, K(nh):46, Action:F, Flags:, QOS:-1, S(nh):46,  Stats:79/7742,  SPort 64906 TTL 0)

   189056<=>435688      2.2.2.5:7851                                        1 (1->4)
                        1.1.1.5:0
(Gen: 1, K(nh):30, Action:F, Flags:, QOS:-1, S(nh):30,  Stats:79/7742,  SPort 62172 TTL 0)

   435688<=>189056      1.1.1.5:7851                                        1 (1->4)
                        2.2.2.5:0
(Gen: 1, K(nh):42, Action:F, Flags:, QOS:-1, S(nh):42,  Stats:79/7742,  SPort 56755 TTL 0)

   503080<=>71596       1.1.1.5:7851                                        1 (2->5)
                        2.2.2.5:0
(Gen: 1, K(nh):34, Action:F, Flags:, QOS:-1, S(nh):34,  Stats:79/7742,  SPort 51356 TTL 0)

root@a2s37:~#
```

Use Case 2: PANW-FW as a Layer 3 firewall along with SNAT policy using Contrail In-Network NAT service chaining feature.

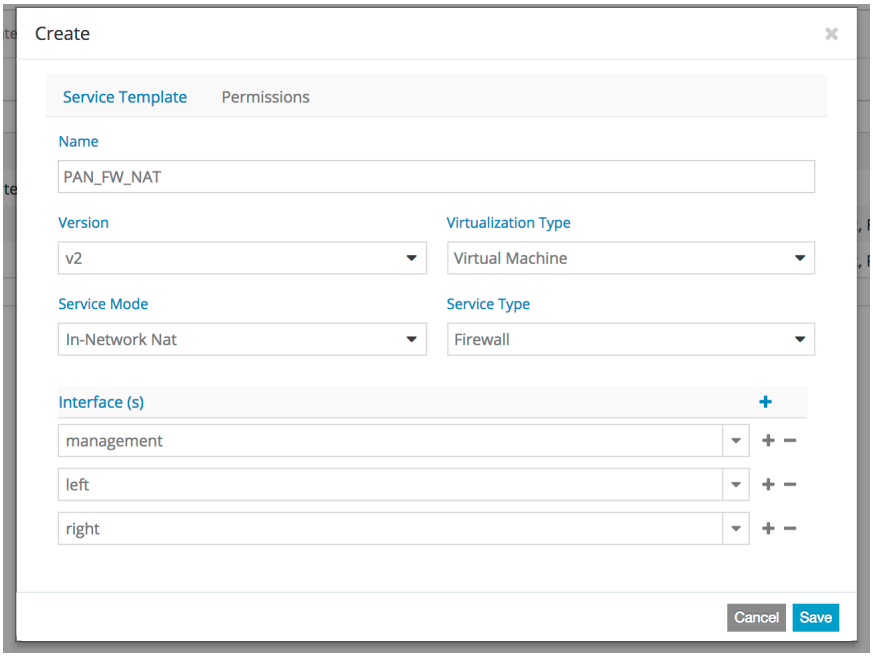


For this use case most of the configuration steps are same as the ones described in use case 1 with couple of differences.

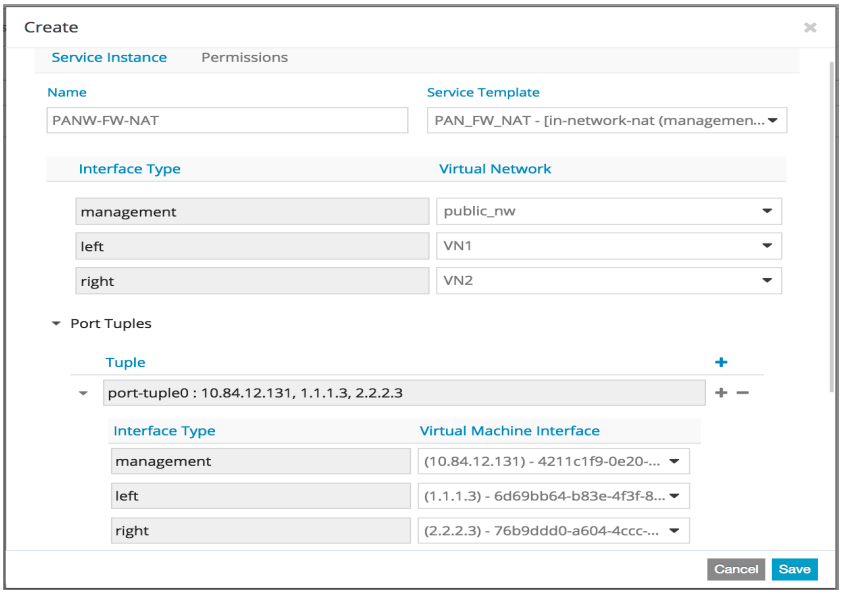
1. On Contrail under Services > service template the service type should be configured as in-network-nat instead of in-network.
2. On PANW-FW a NAT policy has to be configured which should allow all the traffic from zone LEFT to zone RIGHT and the source address should be translated to interface IP address on eth1/2 (2.2.2.3) which is the interface in VN2. (Right Side Network).

Note: The Step 4", 5" and 6" replaces steps 4 , 5 & 6 from use case1. Step 11.1 is in addition to step 11 in use case1. All the other steps are same as the one shown in use case 1.

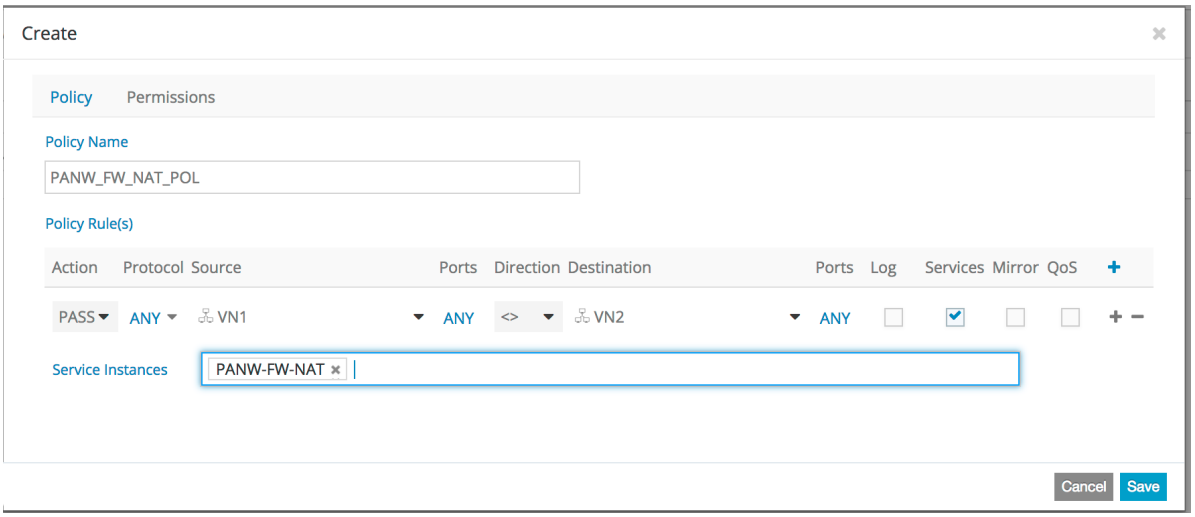
Step 4": On the Contrail Web-UI configure in-network-nat service template.



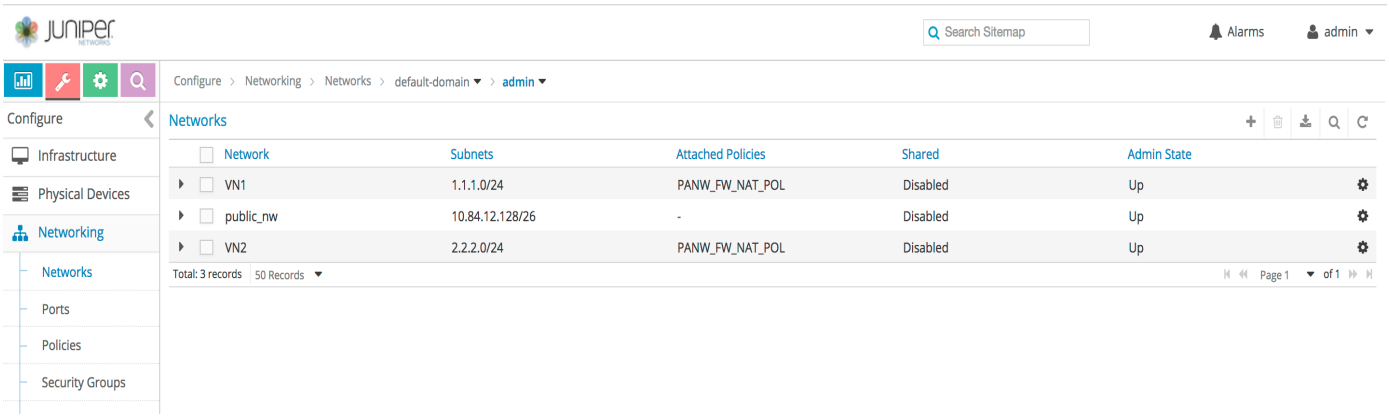
Step 5": Create the v2 service instance for the in-network-nat service template using port tuple feature and add the 3 interfaces of the PANW-FW VM to the port-tuple.



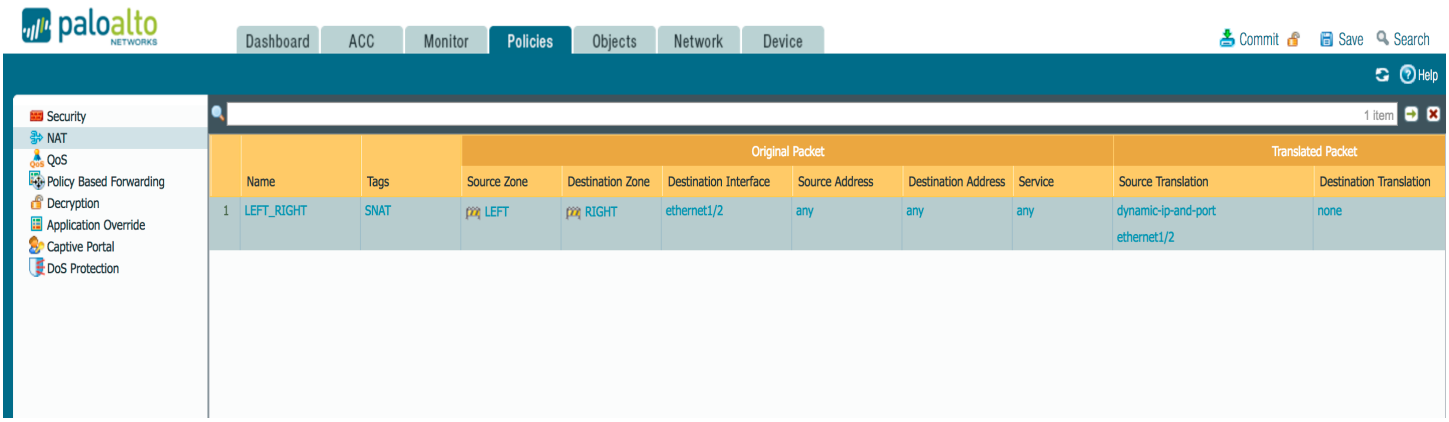
Step 6": Configure a service policy between VN1 and VN2 to match all the application traffic and send it to the PANW-FW-NAT service instance created in step 5".



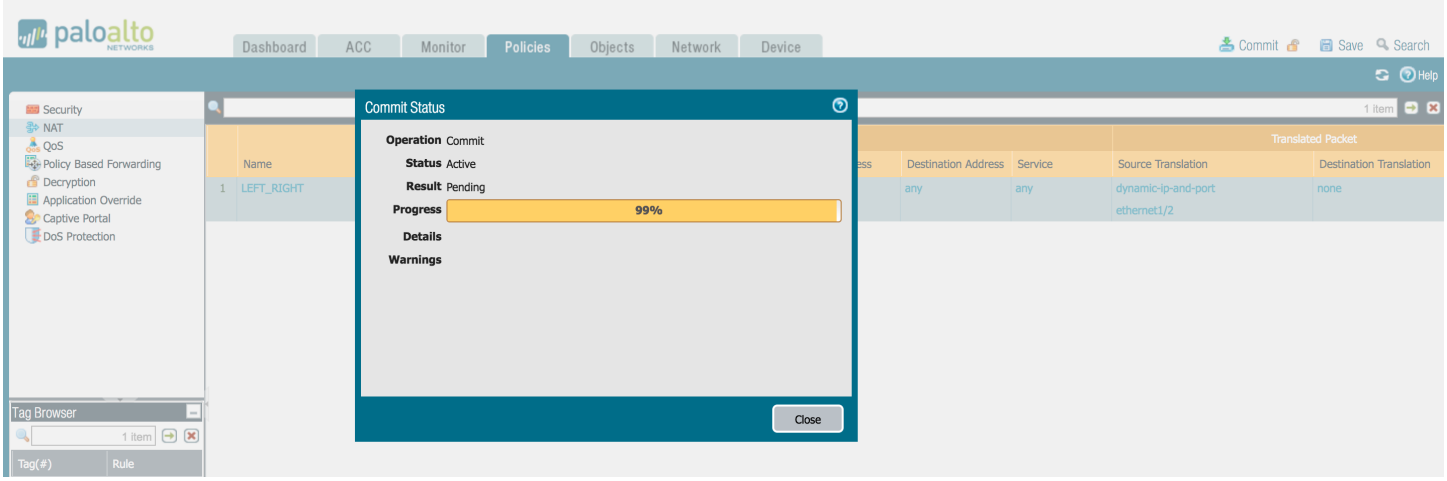
Step 7": Attach the service policy PANW_FW_NAT_POL to VN1 and VN2.



Step 11.1: On the PANW-FW VM configure a SNAT policy between the LEFT and RIGHT zones such that the source address is translated to eth1/2 interface address after SNAT.

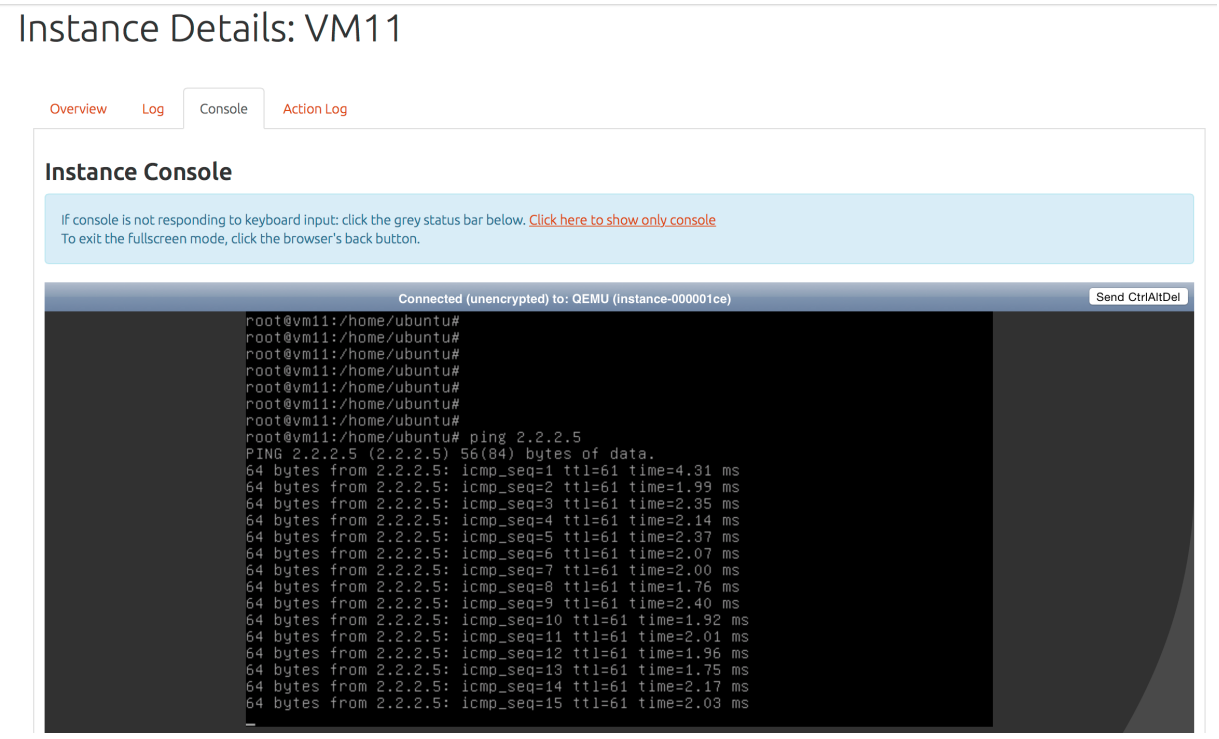


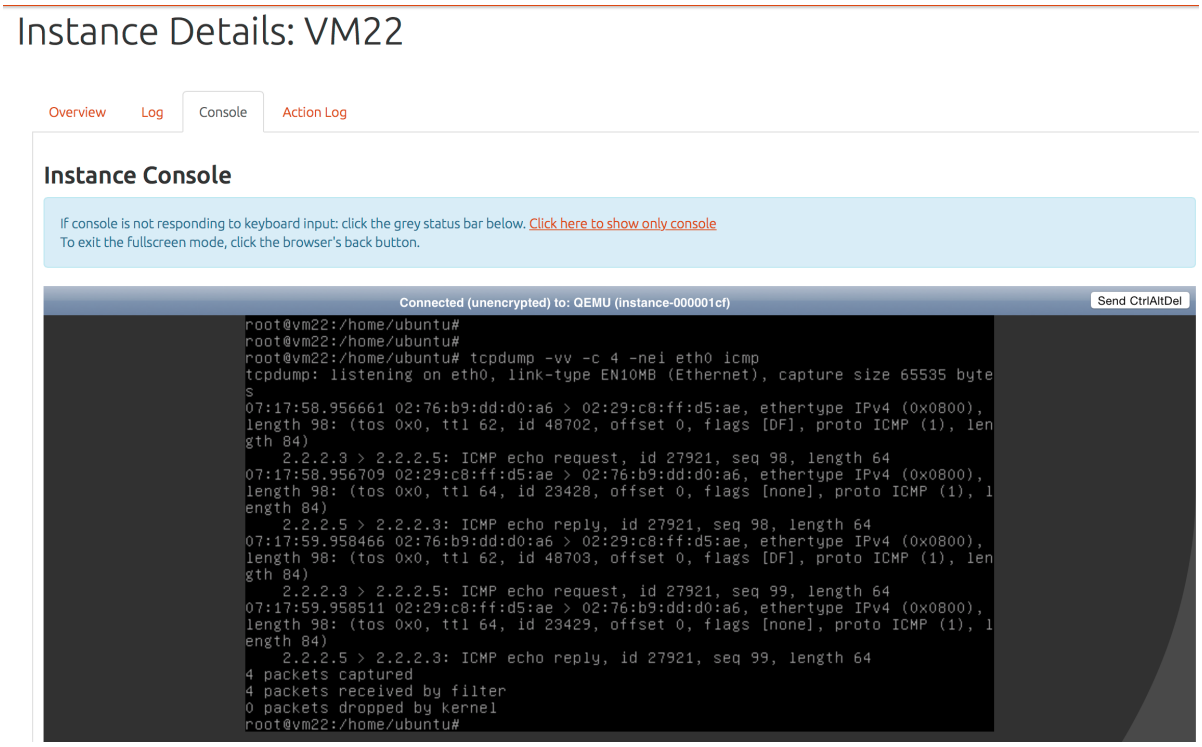
Step 12": Commit the NAT policy on the PANW-FW VM.



Verification:

Step 14": Verify the working of the service chain by pinging the address of VM22 (2.2.2.5) from VM11. While ping is running login to VM22 and run tcpdump on the eth0 interfaces. The source IP address of the ICMP echo requests should be 2.2.2.3 which is the PANW-FW eth1/2 interface IP address. This shows that NAT is working.



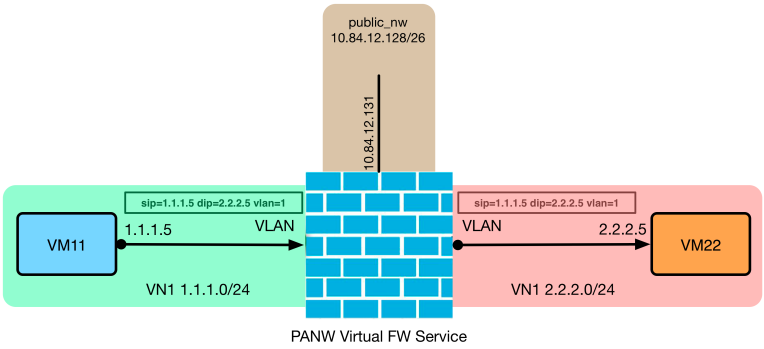


Step 14: We can also verify the NAT flows by checking the security sessions on the PANW-FW VM and by checking the vrouter flows on the compute node.

```
admin@PA-VM# run show session all

--------------------------------------------------------------------------------
ID          Application    State   Type Flag  Src[Sport]/Zone/Proto (translated IP[Port])
Vsys                                          Dst[Dport]/Zone (translated IP[Port])
--------------------------------------------------------------------------------
1119         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[272]/RIGHT  (2.2.2.5[272])
1118         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[271]/RIGHT  (2.2.2.5[271])
1120         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[273]/RIGHT  (2.2.2.5[273])
1117         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[270]/RIGHT  (2.2.2.5[270])
1116         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[269]/RIGHT  (2.2.2.5[269])
1115         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[268]/RIGHT  (2.2.2.5[268])
1114         ping           ACTIVE  FLOW  NS   1.1.1.5[27921]/LEFT/1  (2.2.2.3[27921])
vsys1                                         2.2.2.5[267]/RIGHT  (2.2.2.5[267])
[edit]
admin@PA-VM#
```

```
root@a2s37:~# flow -l --match "2.2.2.5"
Flow table(size 80609280, entries 629760)

Entries: Created 8254 Added 8252 Processed 8254 Used Overflow entries 0
(Created Flows/CPU: 888 1036 1080 1147 1036 1794 17 1 15 5 13 29 156 186 207 182 156 224 4 4 16 38 14 6)(oflows 0)

Action:F=Forward, D=Drop N=NAT(S=SNAT, D=DNAT, Ps=SPAT, Pd=DPAT, L=Link Local Port)
 Other:K(nh)=Key_Nexthop, S(nh)=RPF_Nexthop
 Flags:E=Evicted, Ec=Evict Candidate, N=New Flow, M=Modified Dm=Delete Marked
TCP(r=reverse):S=SYN, F=FIN, R=RST, C=HalfClose, E=Established, D=Dead

Listing flows matching ([2.2.2.5]:*)

    Index                Source:Port/Destination:Port                      Proto(V)
-----------------------------------------------------------------------------------
   286852<=>300324       1.1.1.5:27921                                        1 (1->4)
                         2.2.2.5:0
(Gen: 1, K(nh):42, Action:F, Flags:, QOS:-1, S(nh):42,  Stats:398/39004,  SPort 62936 TTL 0)

   300324<=>286852       2.2.2.5:27921                                        1 (1->4)
                         1.1.1.5:0
(Gen: 1, K(nh):30, Action:F, Flags:, QOS:-1, S(nh):30,  Stats:398/39004,  SPort 63523 TTL 0)

   362872<=>478356       2.2.2.5:27921                                        1 (2)
                         2.2.2.3:0
(Gen: 1, K(nh):46, Action:F, Flags:, QOS:-1, S(nh):46,  Stats:398/39004,  SPort 56227 TTL 0)

   478356<=>362872       2.2.2.3:27921                                        1 (2)
                         2.2.2.5:0
(Gen: 1, K(nh):34, Action:F, Flags:, QOS:-1, S(nh):34,  Stats:398/39004,  SPort 50299 TTL 0)

root@a2s37:~#
```

Use Case 3: PANW-FW as a Layer 2 firewall (Virtual Wire) using Contrail transparent mode service chaining feature.

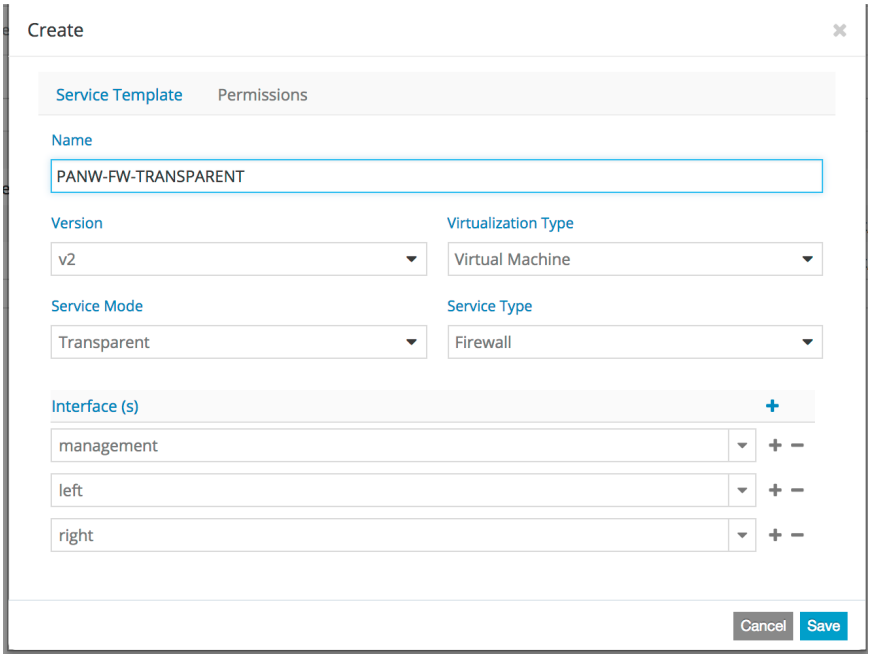


For this use case most of the configuration steps are same as the ones described in use case 1 with couple of differences.

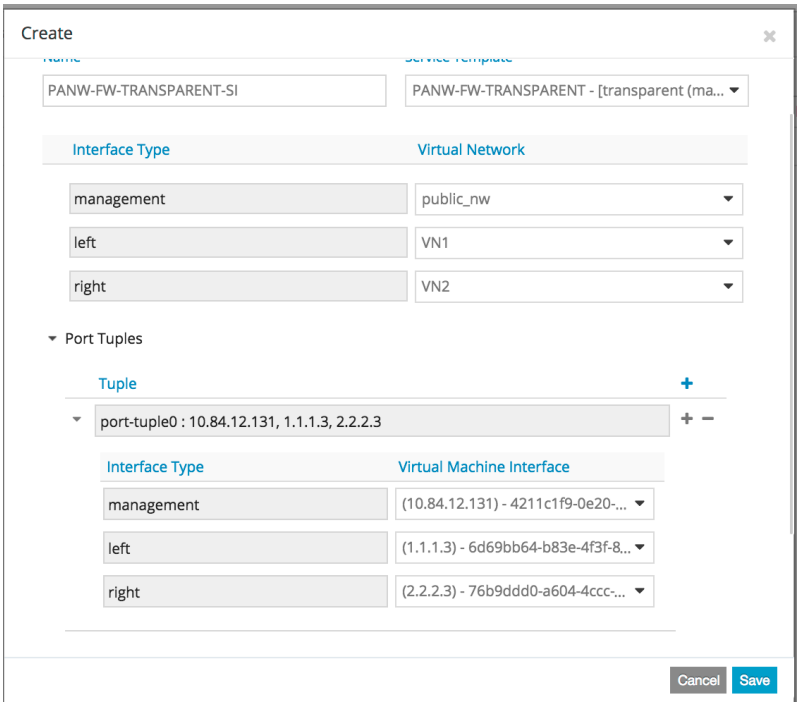
1. On Contrail under Services > service template the service type should be configured as transparent mode instead of in-network.
2. On the PANW-FW for eth1/1 and eth1/2 the interface type should be configured as virtual-wire and these interfaces should be added to the virtual-wire VW1.

Note: The Step 4", 5" and 6" replaces steps 4, 5 & 6 from use case1. Step 11.1 is in addition to step 11 in use case1. All the other steps are same as the one shown in use case 1.

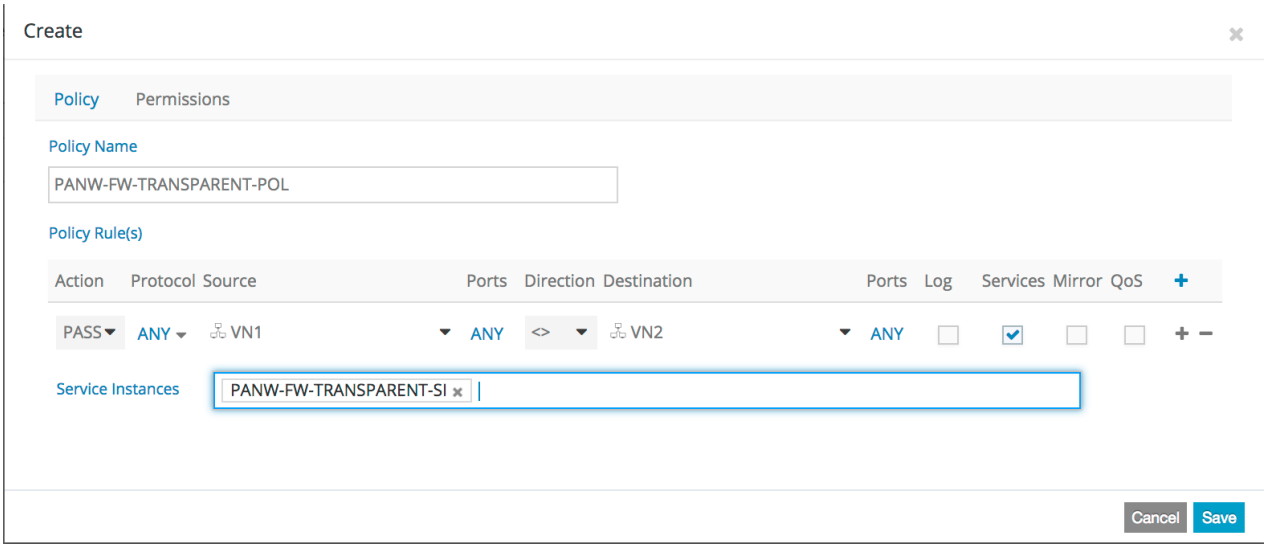
Step 4"': On the Contrail Web-UI configure transparent mode service template.



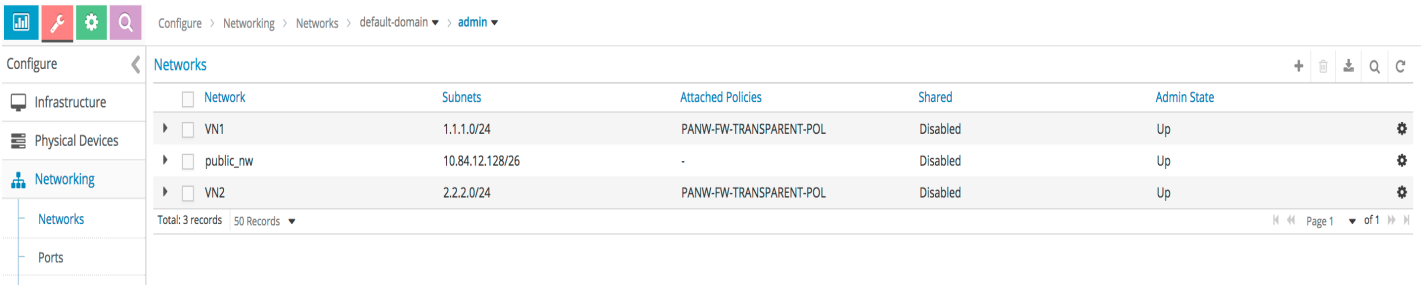
Step 5"': Create the v2 service instance for the transparent mode service using port tuple feature and add the 3 interfaces of the PANW-FW VM to the port-tuple.



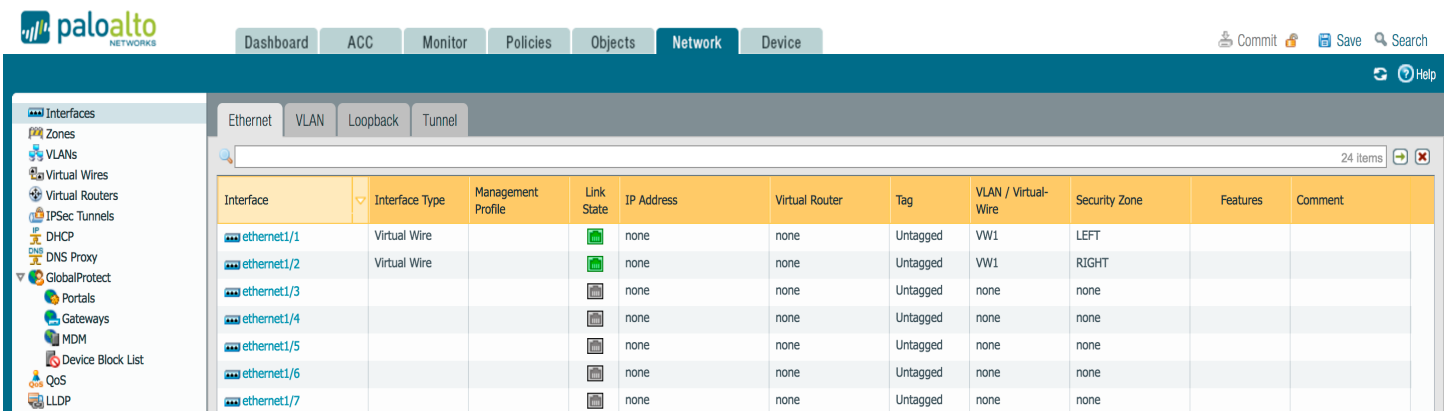
Step 6”’: Configure a service policy between VN1 and VN2 to match all the application traffic and send it to the PANW-FW-TRANSPARENT-SI service instance created in step 5”’.

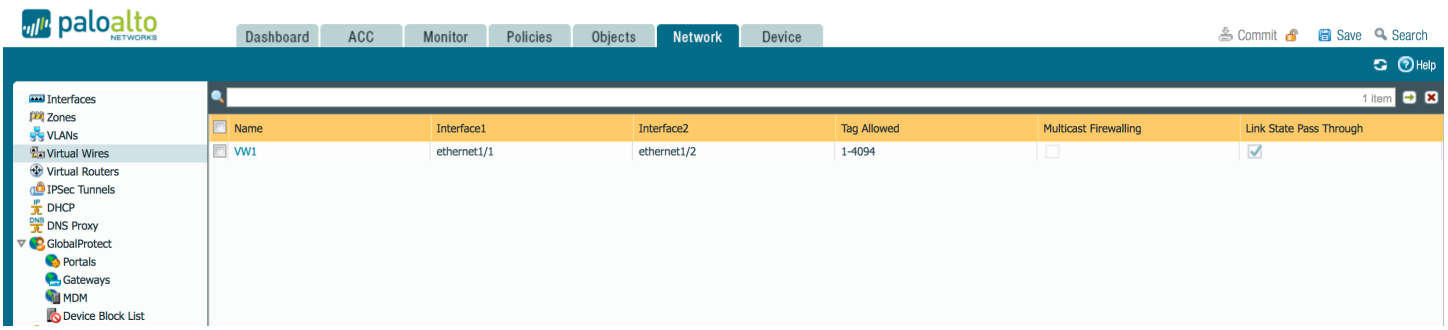


Step 7”’: Attach the service policy PANW-FW-TRANSPARENT-POL to VN1 and VN2.

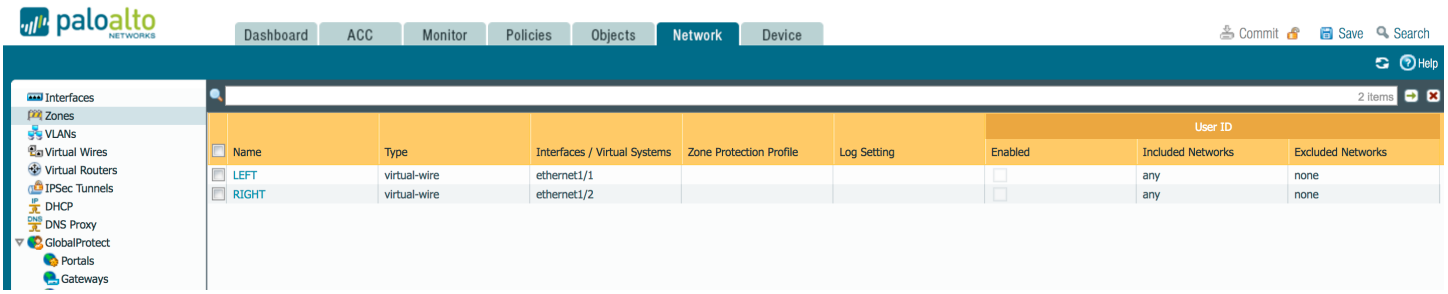


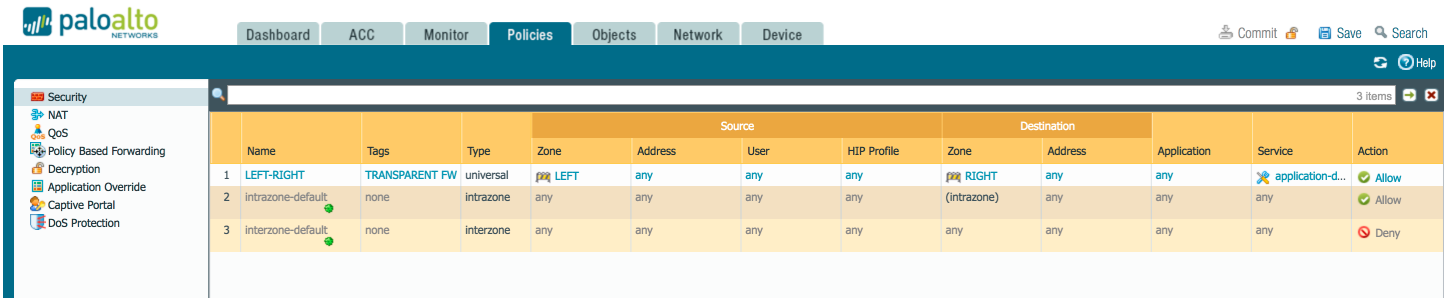
Step 10”’: On the PANW-FW VM navigate to Network > Interfaces and configure the interface type for eth1/1 and eth1/2 as virtual wire from Layer3. Also under Network > Virtual Wires configure a virtual wire VW1 and add the 2 interfaces eth1/1 and eth1/2 to this virtual wire. Allow the complete range of vlan tags 1-4094.





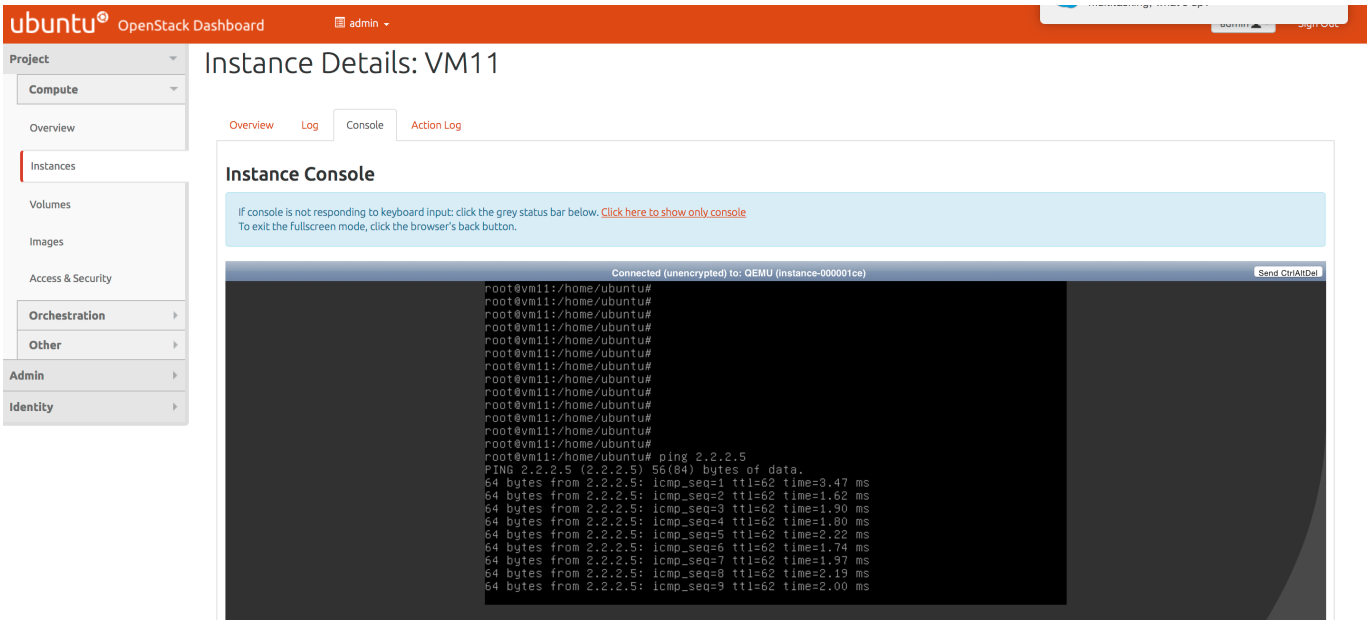
Step 11": Under Network > Zones configure the type for LEFT and RIGHT zones as virtual-wire and add the eth1/1 and eth1/2 interfaces to LEFT and RIGHT zones respectively. Also configure a security policy to allow all the application traffic between the LEFT and the RIGHT zones.





Verification:

Step 14": Verify the working of the service chain by pinging the address of VM22 (2.2.2.5) from VM11. While ping is in progress if we run tcpdump on tap interface that corresponds to eth1/1 or eth1/2 interface of PANW-FW we should see that the ICMP packets should be sent with vlan tags. This is the vlan tag allocated by vrouter for this transparent service. We can also verify the vrouter flows and the security session on the PANW-FW VM.




```
root@a2s37:~# flow -l --match "2.2.2.5"
Flow table(size 80609280, entries 629760)

Entries: Created 40421 Added 40420 Processed 40421 Used Overflow entries 0
(Created Flows/CPU: 5957 5615 6046 6674 5993 7183 17 1 15 5 13 29 302 407 745 498 436 403 4 4 16 38 14 6)(oflows 0)

Action:F=Forward, D=Drop N=NAT(S=SNAT, D=DNAT, Ps=SPAT, Pd=DPAT, L=Link Local Port)
 Other:K(nh)=Key_Nexthop, S(nh)=RPF_Nexthop
 Flags:E=Evicted, Ec=Evict Candidate, N=New Flow, M=Modified Dm=Delete Marked
TCP(r=reverse):S=SYN, F=FIN, R=RST, C=HalfClose, E=Established, D=Dead

Listing flows matching ([2.2.2.5]:*)

    Index                Source:Port/Destination:Port                    Proto(V)
-----------------------------------------------------------------------------
    60284<=>500420       2.2.2.5:27952                                     1 (2->5)
                         1.1.1.5:0
(Gen: 2, K(nh):46, Action:F, Flags:, QOS:-1, S(nh):46,  Stats:2181/213738,  SPort 64751 TTL 0)

   106176<=>153216       1.1.1.5:27952                                     1 (1->4)
                         2.2.2.5:0
(Gen: 215, K(nh):42, Action:F, Flags:, QOS:-1, S(nh):42,  Stats:2181/213738,  SPort 62001 TTL 0)

   153216<=>106176       2.2.2.5:27952                                     1 (4->4)
                         1.1.1.5:0
(Gen: 3, K(nh):36, Action:F, Flags:, QOS:-1, S(nh):36,  Stats:2181/222462,  SPort 59362 TTL 0)

   204956<=>495968       2.2.2.5:27956                                     1 (2->5)
                         1.1.1.5:0
(Gen: 2, K(nh):46, Action:F, Flags:, QOS:-1, S(nh):46,  Stats:58/5684,  SPort 63554 TTL 0)
```

```
admin@PA-VM# run show session all

--------------------------------------------------------------------------------
ID          Application    State   Type Flag  Src[Sport]/Zone/Proto (translated IP[Port])
Vsys                                          Dst[Dport]/Zone (translated IP[Port])
--------------------------------------------------------------------------------
213          ping           ACTIVE  FLOW       1.1.1.5[27956]/LEFT/1  (1.1.1.5[27956])
vsys1                                         2.2.2.5[111]/RIGHT  (2.2.2.5[111])
209          ping           ACTIVE  FLOW       1.1.1.5[27956]/LEFT/1  (1.1.1.5[27956])
vsys1                                         2.2.2.5[107]/RIGHT  (2.2.2.5[107])
211          ping           ACTIVE  FLOW       1.1.1.5[27956]/LEFT/1  (1.1.1.5[27956])
vsys1                                         2.2.2.5[109]/RIGHT  (2.2.2.5[109])
208          ping           ACTIVE  FLOW       1.1.1.5[27956]/LEFT/1  (1.1.1.5[27956])
vsys1                                         2.2.2.5[106]/RIGHT  (2.2.2.5[106])
210          ping           ACTIVE  FLOW       1.1.1.5[27956]/LEFT/1  (1.1.1.5[27956])
vsys1                                         2.2.2.5[108]/RIGHT  (2.2.2.5[108])
212          ping           ACTIVE  FLOW       1.1.1.5[27956]/LEFT/1  (1.1.1.5[27956])
vsys1                                         2.2.2.5[110]/RIGHT  (2.2.2.5[110])
[edit]
admin@PA-VM#
```

```
root@a2s37:~# tcpdump -vv -c 8 -nei tap76b9ddd0-a6
tcpdump: WARNING: tap76b9ddd0-a6: no IPv4 address assigned
tcpdump: listening on tap76b9ddd0-a6, link-type EN10MB (Ethernet), capture size 65535 bytes
09:52:29.971816 02:00:00:00:00:01 > 02:00:00:00:00:02, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 21129, offset)
    1.1.1.5 > 2.2.2.5: ICMP echo request, id 27956, seq 179, length 64
09:52:29.972092 02:00:00:00:00:02 > 02:00:00:00:00:01, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 27710, offset)
    2.2.2.5 > 1.1.1.5: ICMP echo reply, id 27956, seq 179, length 64
09:52:30.973104 02:00:00:00:00:01 > 02:00:00:00:00:02, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 21130, offset)
    1.1.1.5 > 2.2.2.5: ICMP echo request, id 27956, seq 180, length 64
09:52:30.973408 02:00:00:00:00:02 > 02:00:00:00:00:01, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 27711, offset)
    2.2.2.5 > 1.1.1.5: ICMP echo reply, id 27956, seq 180, length 64
09:52:31.974302 02:00:00:00:00:01 > 02:00:00:00:00:02, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 21131, offset)
    1.1.1.5 > 2.2.2.5: ICMP echo request, id 27956, seq 181, length 64
09:52:31.974588 02:00:00:00:00:02 > 02:00:00:00:00:01, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 27712, offset)
    2.2.2.5 > 1.1.1.5: ICMP echo reply, id 27956, seq 181, length 64
09:52:32.975506 02:00:00:00:00:01 > 02:00:00:00:00:02, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 21132, offset)
    1.1.1.5 > 2.2.2.5: ICMP echo request, id 27956, seq 182, length 64
09:52:32.975772 02:00:00:00:00:02 > 02:00:00:00:00:01, ethertype 802.1Q (0x8100), length 102: vlan 1, p 0, ethertype IPv4, (tos 0x0, ttl 63, id 27713, offset)
    2.2.2.5 > 1.1.1.5: ICMP echo reply, id 27956, seq 182, length 64
8 packets captured
8 packets received by filter
0 packets dropped by kernel
root@a2s37:~#
```