PicOS First-Look

Whitepaper

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Background

This document serves as first-look whitepaper to guide you on PicOS deployment scenarios where the Agema Systems switch is enabled for Legacy L2/L3, Openflow, or Crossflow operation.

Legacy L2/L3 Mode

This is the default mode when the system is loaded with PicOS for the first time. The system runs as a legacy switching and/or routing device. Open vSwitch isn't enabled.

Open vSwitch (OVS) Mode

In this mode, the PicOS system is optimized for OpenFlow applications. The L2/L3 daemons are not running, and the system is fully dedicated to OpenFlow and OVS.

To enter OVS mode, run the ***picos_boot*** script as a **sudo user** in Linux shell and select "**[2]   PicOS Open vSwitch/OpenFlow**". The PicOS images come with the script included.

To check which mode the system is operating on, execute "**service picos status**" command in Linux shell.

The Openflow versions supported by PicOS image releases can be found at: http://www.pica8.com/wp-content/uploads/2015/09/v2.9/html/ovs-configuration-guide/.

Crossflow (XOVS) Mode

In this mode, the PicOS system can support both legacy L2/L3 and OVS operations. To enable XOVS mode, start the system in L2/L3 mode and then execute the following starting at the Linux shell:

admin@Xorplus$ **cli**
admin@Xorplus> **configure**
admin@Xorplus# **set xovs enable true**
admin@Xorplus# **commit**

Notes:

- Hosts attached to Openflow-enabled ports and hosts connected to Crossflow-enabled ports can exchange traffic once the proper flow entries have been created.

  The following sample configurations would enable Openflow on port he-1/1/1:
  set interface gigabit-ethernet he-1/1/1 crossflow enable true
  set interface gigabit-ethernet he-1/1/1 crossflow local-control false

  The following sample configuration enables Crossflow on port he-1/1/3:
  set interface gigabit-ethernet he-1/1/3 crossflow enable true
  (Optional) set interface gigabit-ethernet he-1/1/1 crossflow local-control true

  Here are examples on creating flow entries between ports he-1/1/1 (enabled with Openflow) and he-1/1/3 (enabled with Crossflow) to allow ARP/IPv4 messages to reach 192.168.10.1. These commands are executed in Linux shell.
  ovs-ofctl add-flow br0 in_port=129,actions=131
  ovs-ofctl add-flow br0 in_port=131,arp,arp_tpa=192.168.10.1,actions=129
  ovs-ofctl add-flow br0 in_port=131,ip,nw_dst=192.168.10.1,actions=129

  In PicOS, port 129 maps to he-1/1/1 and port 131 maps with he-1/1/3.

- Hosts attached to Crossflow-enabled ports and hosts connected to legacy L2/L3 ports can exchange traffic and no flow entry required.

  One of the benefits of Crossflow is to ease up with migrations into SDN. While parts of the network aren't updated with SDN, a port can be enabled with Crossflow to serve both the Openflow network and the legacy network. In this mode, traffic could ingress in Crossflow-enabled port and egresses out onto a legacy L2/L3 port and vice versa so that the legacy networks continue to work. Flow entries can't be created for legacy L2/L3 that's why no flow entry required.

- Hosts attached to Openflow-enabled ports and hosts connected to legacy L2/L3 ports **can't** exchange traffic.

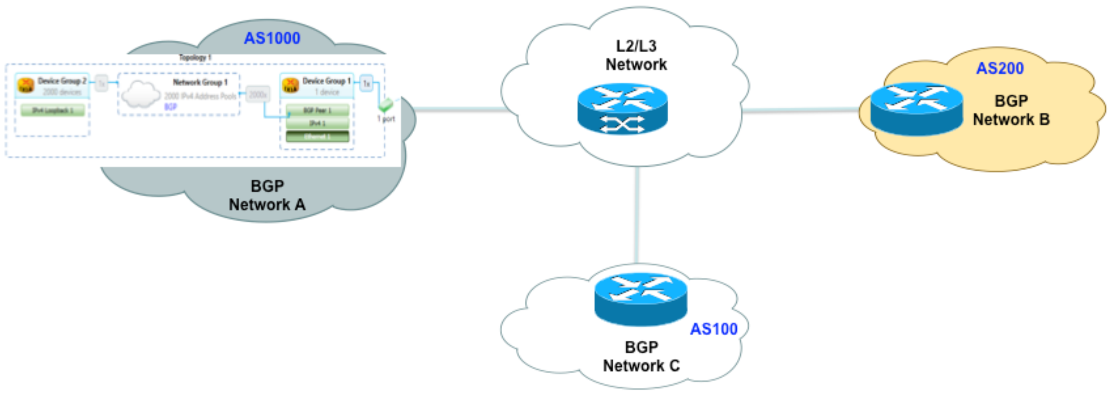
  Once a port is enabled for Openflow, flow entries must be created into the ACL table to allow traffic to pass thru between ports of the switch. However, flow entries can't be created between an Openflow-enabled port and a legacy L2/L3 port. That's why traffic can't be exchanged between them.

Deployment Scenarios

Scenarios covered in this document

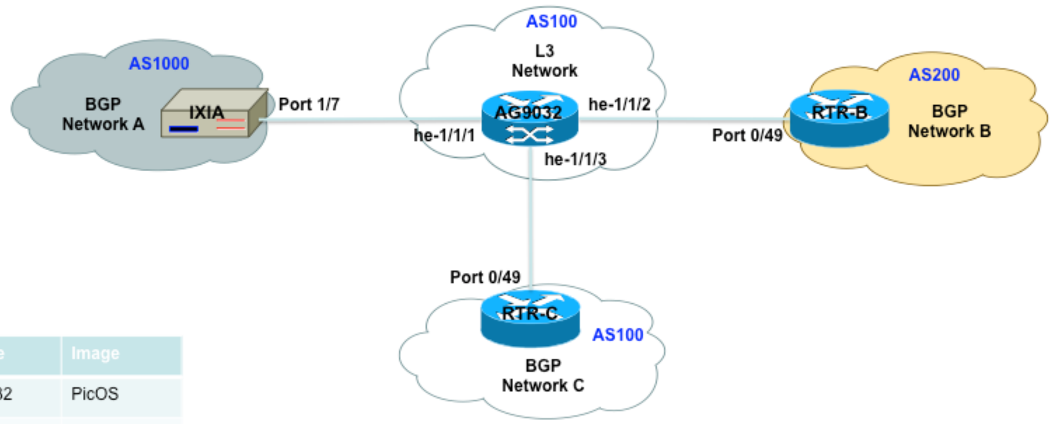
1. PicOS Switch as L3 Device in XOVS Mode
2. PicOS Switch as L2 Device in XOVS Mode
3. PicOS Switch as L2 Device in OVS Mode With ONOS Controller

Logical Topology



1. PicOS Switch as L3 Device in XOVS Mode

Physical Topology



Device	Image
AG9032	PicOS
RTR-B	ICOS
RTR-C	ICOS

Configurations

Refer to the Physical Topology above and load the AG9032, RTR-B, and RTR-C with the following configurations. Setup the Ixia box to simulate 2000 BGP networks in AS 1000. Refer to Appendix section for the sample screen shots of the Ixia setup.

AG9032

 # In Linux shell, execute the following to get to the configuration prompt.

```
admin@Xorplus$ cli
admin@Xorplus> configure
admin@Xorplus#
```

 # Configure native VLANs and associate them to L3 interfaces.

```
set vlans vlan-id 10 l3-interface 10
set vlans vlan-id 20 l3-interface 20
set vlans vlan-id 30 l3-interface 30
set interface gigabit-ethernet he-1/1/1 family ethernet-switching native-vlan-id 10
set interface gigabit-ethernet he-1/1/2 family ethernet-switching native-vlan-id 20
set interface gigabit-ethernet he-1/1/3 family ethernet-switching native-vlan-id 30
set vlan-interface interface 10 vif 10 address 192.168.10.1 prefix-length 24
set vlan-interface interface 20 vif 20 address 192.168.20.1 prefix-length 24
set vlan-interface interface 30 vif 30 address 192.168.30.1 prefix-length 24
set vlan-interface loopback address 100.1.1.1 prefix-length 32
commit
```

 # Configure BGP

```
set protocols bgp bgp-id 100.1.1.1
set protocols bgp local-as 100
set protocols bgp peer 192.168.10.2 as 1000
```

```
set protocols bgp peer 192.168.10.2 local-ip 192.168.10.1
set protocols bgp peer 192.168.10.2 next-hop-self true
set protocols bgp peer 192.168.20.2 as 200
set protocols bgp peer 192.168.20.2 local-ip 192.168.20.1
set protocols bgp peer 192.168.20.2 next-hop-self true
set protocols bgp peer 192.168.30.2 as 100
set protocols bgp peer 192.168.30.2 local-ip 192.168.30.1
set protocols bgp peer 192.168.30.2 next-hop-self true
set protocols bgp network4 100.1.1.1/32
commit

# Enable switch with XOVS and configure Crossflow on the switch ports.
set xovs enable true
set interface gigabit-ethernet he-1/1/1 crossflow enable true
set interface gigabit-ethernet he-1/1/3 crossflow enable true
commit

# The above configurations produce the following running-config:
admin@Xorplus> show run
    interface {
        gigabit-ethernet "he-1/1/1" {
            crossflow {
                enable: true
            }
            family {
                ethernet-switching {
                    native-vlan-id: 10
                }
            }
        }
        gigabit-ethernet "he-1/1/2" {
            family {
                ethernet-switching {
                    native-vlan-id: 20
```

```
            }
        }
    }
    gigabit-ethernet "he-1/1/3" {
        crossflow {
            enable: true
        }
        family {
            ethernet-switching {
                native-vlan-id: 30
            }
        }
    }
}
protocols {
    bgp {
        bgp-id: 100.1.1.1
        local-as: "100"
        peer "192.168.10.2" {
            local-ip: "192.168.10.1"
            as: "1000"
            next-hop-self: true
        }
        peer "192.168.20.2" {
            local-ip: "192.168.20.1"
            as: "200"
            next-hop-self: true
        }
        peer "192.168.30.2" {
            local-ip: "192.168.30.1"
```

```
                as: "100"
                next-hop-self: true
            }
            network4 100.1.1.1/32 {
            }
        }
    }
    vlan-interface {
        loopback {
            address 100.1.1.1 {
                prefix-length: 32
            }
        }
        interface 10 {
            vif 10 {
                address 192.168.10.1 {
                    prefix-length: 24
                }
            }
        }
        interface 20 {
            vif 20 {
                address 192.168.20.1 {
                    prefix-length: 24
                }
            }
        }
        interface 30 {
            vif 30 {
                address 192.168.30.1 {
                    prefix-length: 24
                }
            }
        }
```

```
    }
    vlans {
        vlan-id 10 {
            l3-interface: "10"
        }
        vlan-id 20 {
            l3-interface: "20"
        }
        vlan-id 30 {
            l3-interface: "30"
        }
    }
    xovs {
        enable: true
    }
==========================================================================
```

RTR-B

```
# Configure the following:
vlan database
vlan 20
vlan routing 20 1
!
ip routing
!
interface loopback 0
no shutdown
ip address 121.1.1.1 255.255.255.255
!
```

interface 0/49

no shutdown

switchport mode trunk

switchport trunk native vlan 20

!

interface vlan 20

no shutdown

routing

ip address 192.168.20.2 255.255.255.0

!

router bgp 200

bgp router-id 121.1.1.1

network 121.1.1.1 mask 255.255.255.255

neighbor 192.168.20.1 remote-as 100

exit

==

RTR-C

 # Configure the following:

vlan database

vlan 30

vlan routing 30 1

!

ip routing

!

interface loopback 0

no shutdown

ip address 131.1.1.1 255.255.255.255

!

interface 0/49

no shutdown

switchport mode trunk

```
switchport trunk native vlan 30
!
interface vlan 30
no shutdown
routing
ip address 192.168.30.2 255.255.255.0
!
router bgp 100
bgp router-id 131.1.1.1
network 131.1.1.1 mask 255.255.255.255
neighbor 192.168.30.1 remote-as 100
exit
```

Validations and Observations

1. Start BGP session initiation in Ixia to bring up 2000 sessions.
2. On the PicOS Switch (AG9032), ensure that the 2000 BGP sessions are established.

```
admin@Xorplus> show route table ipv4 unicast ebgp
IPv4 Routing table: 2001 routes
121.1.1.1/32          [ebgp(20)/0]
                        > to 192.168.20.2 via 20/20
200.1.0.1/32          [ebgp(20)/0]
                        > to 192.168.10.2 via 10/10
200.2.0.1/32          [ebgp(20)/0]
                        > to 192.168.10.2 via 10/10
.
.
```

.

3. On the RTR-B, verify that the 2000 prefixes from 'BGP network A' are learned.

   (RTR-B) #
   (RTR-B) #**show ip route summary | include BGP**

   BGP Routes.................................... 2002

4. Ping a host in 'BGP network A' from RTR-B. This is to ensure that the hosts attached to a Crossflow port and the hosts attached to a legacy L3 port can exchange traffic.

   (RTR-B) #
   (RTR-B) #**ping 200.200.0.1**
   Pinging 200.200.0.1 with 0 bytes of data:

   Reply From 200.200.0.1: icmp_seq = 0. time= 12 msec.
   Reply From 200.200.0.1: icmp_seq = 1. time= 12 msec.
   Reply From 200.200.0.1: icmp_seq = 2. time= 4 msec.

   ----200.200.0.1 PING statistics----
   3 packets transmitted, 3 packets received, 0% packet loss
   round-trip (msec) min/avg/max = 4/9/12

   (RTR-B) #

5. On RTR-C, repeat the steps 3 and 4 above. This is to ensure that the hosts attached to a Crossflow port and the hosts attached to another Crossflow port can exchange traffic.

   (RTR-C) #show ip route summary | include BGP

   BGP Routes.................................... 2002

(RTR-C) #
(RTR-C) #**ping 200.200.0.1**
Pinging 200.200.0.1 with 0 bytes of data:

Reply From 200.200.0.1: icmp_seq = 0. time= 4 msec.
Reply From 200.200.0.1: icmp_seq = 1. time= 12 msec.
Reply From 200.200.0.1: icmp_seq = 2. time= 4 msec.

----200.200.0.1 PING statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (msec) min/avg/max = 4/6/12

(RTR-C) #

6. On the AG9032, configure the following to disable Crossflow on he-1/1/1 and limit the IPv4 routes to 1000. This is to allocate part of the route table resources to the legacy ports and the rest of the resources to the Openflow and Crossflow ports.

   set interface gigabit-ethernet he-1/1/1 crossflow enable false
   set interface stm ipv4-route 1000
   commit
   exit
   request system reboot

7. Once the system reboot is completed, he-1/1/1 should not have Crossflow configurations:

   interface {
   stm {

```
        ipv4-route: 1000
    }
    gigabit-ethernet "he-1/1/1" {
        # No crossflow configs
        family {
            ethernet-switching {
                native-vlan-id: 10
            }
        }
    }
```

8. On the Ixia box, re-start the BGP sessions.
9. On the AG9032, ensure that the IPv4 routes are limited to 1000.

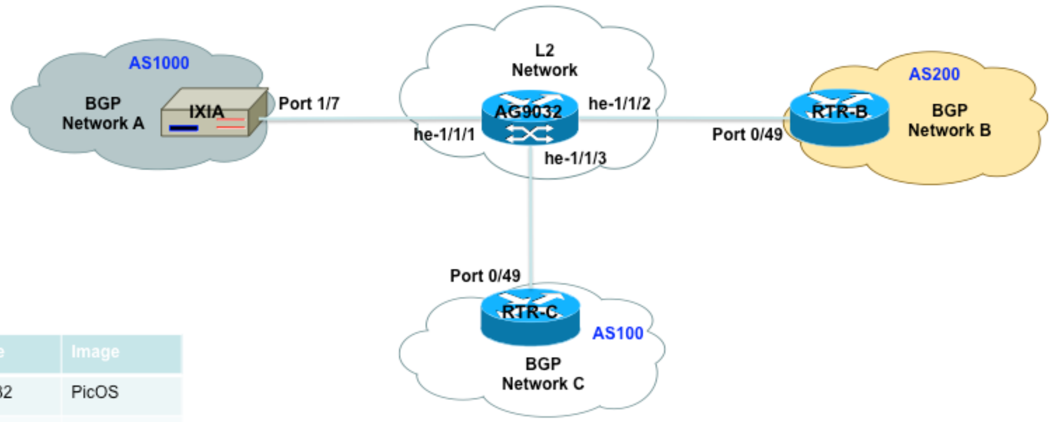
admin@Xorplus> **show route table ipv4 unicast ebgp**

IPv4 Routing table: 2001 routes << should be limited to 1000 routes

```
121.1.1.1/32        [ebgp(20)/0]
                      > to 192.168.20.2 via 20/20
200.1.0.1/32        [ebgp(20)/0]
                      > to 192.168.10.2 via 10/10
```

2. PicOS Switch as L2 Device in XOVS Mode

Physical Topology



Device	Image
AG9032	PicOS
RTR-B	ICOS
RTR-C	ICOS

Configurations

Refer to the Physical Topology above and load the AG9032, RTR-B, and RTR-C with the following configurations. Setup the Ixia box to simulate 200 BGP networks in AS 1000. Refer to Appendix section for the screen shots of the Ixia setup.

AG9032

 # In Linux shell, execute the following to get to the configuration prompt.

admin@Xorplus$ cli

admin@Xorplus$ cli configure

admin@Xorplus#

 # Enable Crossflow mode and create a VLAN.

set xovs enable true

set vlans vlan-id 10

 # Enable the trunk port with Openflow.

```
set interface gigabit-ethernet he-1/1/1 crossflow enable true
set interface gigabit-ethernet he-1/1/1 crossflow local-control false
set interface gigabit-ethernet he-1/1/1 family ethernet-switching port-mode trunk
set interface gigabit-ethernet he-1/1/1 family ethernet-switching vlan members 10

# Keep interface as legacy L2 trunk port.
set interface gigabit-ethernet he-1/1/2 family ethernet-switching port-mode trunk
set interface gigabit-ethernet he-1/1/2 family ethernet-switching vlan members 10

# Enable the trunk port with Crossflow.
set interface gigabit-ethernet he-1/1/3 crossflow enable true
set interface gigabit-ethernet he-1/1/3 family ethernet-switching port-mode trunk
set interface gigabit-ethernet he-1/1/3 family ethernet-switching vlan members 10
commit

# The above configurations produce the following running-config.
admin@Xorplus# run show running-config
    interface {
        gigabit-ethernet "he-1/1/1" {
            crossflow {
                enable: true
                local-control: false
            }
            family {
                ethernet-switching {
                    port-mode: "trunk"
                    vlan {
                        members 10
                    }
                }
            }
        }
        gigabit-ethernet "he-1/1/2" {
            family {
```

```
                ethernet-switching {
                    port-mode: "trunk"
                    vlan {
                        members 10
                    }
                }
            }
        }
        gigabit-ethernet "he-1/1/3" {
            crossflow {
                enable: true
            }
            family {
                ethernet-switching {
                    port-mode: "trunk"
                    vlan {
                        members 10
                    }
                }
            }
        }
    }
    vlans {
        vlan-id 10 {
        }
    }
    xovs {
        enable: true
    }
```

```
# Exit the cli command prompt and go back into the Linux shell.
# Create bridge br0 and then add the Openflow port (he-1/1/1) and Crossflow port (he-1/1/3)
# to the bridge.
ovs-vsctl add-br br0 -- set bridge br0 datapath_type=pica8
ovs-vsctl add-port br0 he-1/1/1 -- set interface he-1/1/1 type=pica8
ovs-vsctl add-port br0 he-1/1/3 -- set interface he-1/1/3 type=crossflow

# Check the size of the ACL table and note that the Max limit is only for 8 flows by default.
admin@Xorplus$ovs-appctl pica/show tables
Pica Tables Statistics:
    Pica Tables            Max Limitation        Current Used
    ---------------------------------------------------------------------
    ICAP Table             8                     1
    ECAP Table             (null)                (null)
    VCAP Table             510                   0
    L2 System Table        (null)                (null)
    L2 FDB Table           (null)                (null)
    L3 Host Table          (null)                (null)
    L3 Route Table         (null)                (null)
    UDF Table              (null)                (null)
admin@Xorplus$

# Increase the size of the ACL table to fit 200 flow entries.
# In cli configuration prompt, configure and commit the following.
set interface stm firewall-table ingress 562   # <<-- adjusts flows limit to 204.
commit
exit
request system reboot   <<-- Reboot is required for the change to take effect

# After system reboot, the ACL table size is 204.
admin@Xorplus$ovs-appctl pica/show tables
Pica Tables Statistics:
    Pica Tables            Max Limitation        Current Used
    ---------------------------------------------------------------------
```

```
    ICAP Table            204          1
    ECAP Table            (null)       (null)
    VCAP Table            510          0
    L2 System Table       (null)       (null)
    L2 FDB Table          (null)       (null)
    L3 Host Table         (null)       (null)
    L3 Route Table        (null)       (null)
    UDF Table             (null)       (null)
admin@Xorplus$

# Ensure that the interfaces are configured properly for Openflow and Crossflow.
admin@Xorplus$ovs-vsctl list pica8
_uuid                   : b81cf833-7b09-41fe-84ef-96cbf122d4cc
.
.
.
hardware_type           : "ag9032"
.
.
.
xovs_crossflow_ports: ["he-1/1/3"]
xovs_openflow_ports : ["he-1/1/1"]
xovs_vlans              : ["1", "10"]
admin@Xorplus$

# Port 129 is the same as he-1/1/1
# Port 131 is the same as he-1/1/3
admin@Xorplus$ovs-ofctl dump-ports br0
OFPST_PORT reply (OF1.4) (xid=0x2): 3 ports
  port 129: rx pkts=59, bytes=15264, drop=0, errs=0, frame=0, over=0, crc=0
```

```
        tx pkts=24215, bytes=2236558, drop=0, errs=0, coll=0
        duration=21263.458s
  port 131: rx pkts=26756, bytes=2466737, drop=2, errs=0, frame=0, over=0, crc=0
        tx pkts=1743, bytes=157915, drop=0, errs=0, coll=0
        duration=21263.453s
  port LOCAL: rx pkts=7, bytes=738, drop=0, errs=0, frame=0, over=0, crc=0
        tx pkts=0, bytes=0, drop=0, errs=0, coll=0
        duration=21263.447s
admin@Xorplus$

# Execute the following in Linux shell to add flows that allow BGP peering across
# Openflow port (he-1/1/1) and Crossflow port (he-1/1/3).
ovs-ofctl add-flow br0 in_port=129,actions=131
ovs-ofctl add-flow br0 in_port=131,arp,arp_tpa=192.168.10.1,actions=129
ovs-ofctl add-flow br0 in_port=131,ip,nw_dst=192.168.10.1,actions=129

# Ensure that the flows are created.
admin@Xorplus$ovs-ofctl dump-flows br0
flowsOFPST_FLOW reply (OF1.4) (xid=0x2):
 flow_id=209, cookie=0x0, duration=77.521s, table=0, n_packets=n/a, n_bytes=0, in_port=129
actions=output:131
 flow_id=211, cookie=0x0, duration=75.402s, table=0, n_packets=n/a, n_bytes=0,
ip,in_port=131,nw_dst=192.168.10.1 actions=output:129
 flow_id=210, cookie=0x0, duration=77.498s, table=0, n_packets=n/a, n_bytes=3672,
arp,in_port=131,arp_tpa=192.168.10.1 actions=output:129

admin@Xorplus$ovs-appctl pica/dump-flows
#206 normal permanent flow_id=211 ip,in_port=131,nw_dst=192.168.10.1, actions:129
#0 normal_d permanent flow_id=2 priority=0, actions:drop
#204 normal permanent flow_id=209 in_port=129, actions:131
#205 normal permanent flow_id=210 arp,in_port=131,arp_tpa=192.168.10.1, actions:129
Total 4 flows in HW.
admin@Xorplus$
```

==

RTR-B

 # Configure the following:

vlan database

vlan 10

vlan routing 10 1

!

ip routing

!

interface loopback 0

no shutdown

ip address 121.1.1.1 255.255.255.255

!

interface 0/49

no shutdown

switchport mode trunk

!

interface vlan 10

no shutdown

routing

ip address 192.168.10.2 255.255.255.0

!

router bgp 200

bgp router-id 121.1.1.1

network 121.1.1.1 mask 255.255.255.255 *neighbor 192.168.10.3 remote-as 100*

address-family vpnv4 unicast

exit

==

RTR-C

 # Configure the following:

```
vlan database
vlan 10
vlan routing 10 1
!
ip routing
!
interface loopback 0
no shutdown
ip address 131.1.1.1 255.255.255.255
!
interface 0/49
no shutdown
switchport mode trunk
!
interface vlan 10
no shutdown
routing
ip address 192.168.10.3 255.255.255.0
!
router bgp 100
bgp router-id 131.1.1.1
network 131.1.1.1 mask 255.255.255.255
neighbor 192.168.10.1 remote-as 1000
neighbor 192.168.10.2 remote-as 200
address-family vpnv4 unicast
```

```
exit
```

Validations and Observations

1. On the Ixia, initiate 200 BGP sessions.
2. At this point, BGP peering will be established with RTR-B and RTR-C. However, pings between the BGP networks in Ixia and RTR-C are expected to fail since there's no flow entry for each of the BGP sessions yet.

(RTR-C) #**show ip route summary | include BGP**

BGP Routes.................................... 201

(RTR-C) #**show ip route bgp**

Route Codes: C - Connected, S - Static
B - BGP Derived
O - OSPF Derived, IA - OSPF Inter Area
E1 - OSPF External Type 1, E2 - OSPF External Type 2
N1 - OSPF NSSA External Type 1, N2 - OSPF NSSA External Type 2
S U - Unnumbered Peer
L - Leaked Route
K - Kernel, P - Net Prototype

B 121.1.1.1/32 [20/0] via 192.168.10.2, 06h:38m:47s, 4/1 <<-- from RTR-B
B 200.1.0.1/32 [20/0] via 192.168.10.1, 00h:32m:01s, 4/1 <<-- from Ixia network

B 200.2.0.1/32 [20/0] via 192.168.10.1, 00h:32m:01s, 4/1
.
.
.

(RTR-C) #**ping 200.1.0.1**
Pinging 200.1.0.1 with 0 bytes of data:

----200.1.0.1 PING statistics----
3 packets transmitted, 0 packets received, **100% packet loss** **<<<-- this is as expected**
round-trip (msec) min/avg/max = <1/<1/<1

3. Add flow entry for each BGP session.

a) On AG9032 Linux shell, execute the following:
ovs-ofctl add-flow br0 in_port=131,ip,nw_dst=200.1.0.1,actions=129
ovs-ofctl add-flow br0 in_port=131,ip,nw_dst=200.2.0.1,actions=129
ovs-ofctl add-flow br0 in_port=131,ip,nw_dst=200.3.0.1,actions=129
.
.
.
ovs-ofctl add-flow br0 in_port=131,ip,nw_dst=200.200.0.1,actions=129

b) The ACL table shows 2004 flow entries.

admin@Xorplus$**ovs-appctl pica/show tables**
Pica Tables Statistics:

Pica Tables	Max Limitation	Current Used
ICAP Table	**204**	**204**
ECAP Table	(null)	(null)

VCAP Table	510	0
L2 System Table	(null)	(null)
L2 FDB Table	(null)	(null)
L3 Host Table	(null)	(null)
L3 Route Table	(null)	(null)
UDF Table	(null)	(null)

admin@Xorplus$**ovs-appctl pica/dump-flows | grep Total**
Total 204 flows in HW.
admin@Xorplus$

4. Pings between RTR-C and the Ixia networks are now successful. he-1/1/1 is an Openflow port while he-1/1/3 is a Crossflow port.

(RTR-C) #**ping 200.1.0.1**
Pinging 200.1.0.1 with 0 bytes of data:

Reply From 200.1.0.1: icmp_seq = 0. time= 4 msec.
Reply From 200.1.0.1: icmp_seq = 1. time= 12 msec.
Reply From 200.1.0.1: icmp_seq = 2. time= 4 msec.

----200.1.0.1 PING statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (msec) min/avg/max = 4/6/12

5. Pings between RTR-B and RTR-C works. he-1/1/2 is a legacy L2 port while he-1/1/3 is a Crossflow port.

(RTR-B) #**ping 131.1.1.1**

Pinging 131.1.1.1 with 0 bytes of data:

Reply From 131.1.1.1: icmp_seq = 0. time= 12 msec.
Reply From 131.1.1.1: icmp_seq = 1. time= 28 msec.
Reply From 131.1.1.1: icmp_seq = 2. time= 12 msec.

----131.1.1.1 PING statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (msec) min/avg/max = 12/17/28

6. Pings between RTR-C and the Ixia networks (even if the prefixes are learned by RTR-C) fails. he-1/1/1 is an Openflow port, while he-1/1/2 is a legacy L2 port.

(RTR-B) #**show ip route summary | include BGP**

BGP Routes.................................... 201

(RTR-B) #**show ip route bgp**

Route Codes: C - Connected, S - Static
B - BGP Derived
O - OSPF Derived, IA - OSPF Inter Area
E1 - OSPF External Type 1, E2 - OSPF External Type 2
N1 - OSPF NSSA External Type 1, N2 - OSPF NSSA External Type 2
S U - Unnumbered Peer
L - Leaked Route
K - Kernel, P - Net Prototype

B 131.1.1.1/32 [20/0] via 192.168.10.3, 06h:27m:25s, 4/1 <<-- from RTR-C

B 200.1.0.1/32 [20/0] via 192.168.10.1, 00h:20m:38s, 4/1 <<-- from Ixia network
B 200.2.0.1/32 [20/0] via 192.168.10.1, 00h:20m:38s, 4/1
B 200.3.0.1/32 [20/0] via 192.168.10.1, 00h:20m:38s, 4/1
.
.
.

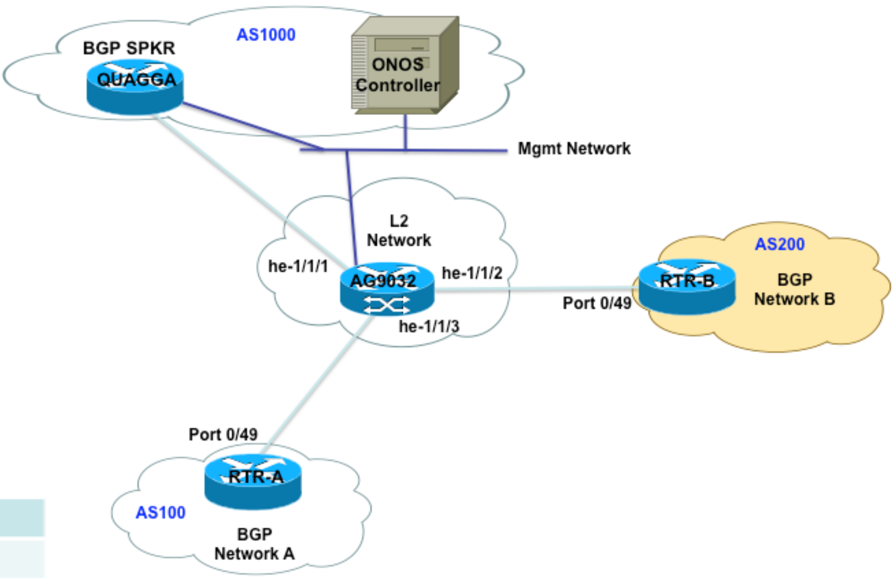
(RTR-B) #**ping 200.1.0.1**
Pinging 200.1.0.1 with 0 bytes of data:

Reply From 192.168.10.2: Destination Unreachable.
Reply From 192.168.10.2: Destination Unreachable.
Reply From 192.168.10.2: Destination Unreachable.

----200.1.0.1 PING statistics----
3 packets transmitted, 0 packets received, 100% packet loss
round-trip (msec) min/avg/max = <1/<1/<1

3. PicOS Switch as L2 Device in OVS Mode With ONOS Controller

Physical Topology



Device	Image
AG9032	PicOS
RTR-A	ICOS
RTR-B	ICOS

NOTE: This deployment doesn't work with PicOS as BGP isn't supported.

Working Scenarios and Limitations

PicOS Switch in XOVS mode

- PicOS Switch as L2 Device
  - In order for BGP peering to work at all, flows must be manually inserted between the Openflow port and crossflow port.
  - Once BGP peering is established between hosts connected to the Openflow port and Crossflow port, additional flow entries must be manually installed for each session to allow traffic to flow between the hosts. These flows

aren't persistent on reload. A script would be required to reinstall all of the flows following a switch restart.
    - Since this is on L2, only TCAM table is used. The max TCAM size is 764 flow entries.
    - Validation was done with 200 BGP sessions.
- PicOS Switch as L3 Device
    - BGP works on legacy and crossflow-enabled ports.
    - Only FIB table is used as there are no Openflow flow entries. Validations was done with 2000 BGP sessions.
    - The configuration to change the route table size ("set interface stm ipv4-route 1000") for legacy ports doesn't work. After changing the value to '1000', the system still allowed 2000 BGP IPv4 routes.
    - There's no CLI to display the size of the FIB table. This was confirmed by Pica8 support team.
- The above scenarios can't verify if the flow table lookup in TCAM and FIB happens for Crossflow since either TCAM only or FIB only can be used.

PicOS Switch in OVS Mode

- The controller (ONOS was used in the validation) can recognize the PicOS switch. The three default controller flows (i.e. ARP, LLDP, and BDDP) are properly inserted into the PicOS switches. However, the BGP messages get dropped at the Openflow ingress ports of the PicOS switches. Per Pica8 support team, BGP isn't supported in OVS mode.
- PicOS isn't suitable for Telco/ISP SDN deployment or in Data Center SDN deployment where the flows get derived and pushed down by ONOS controller based on the dynamic routing changes.

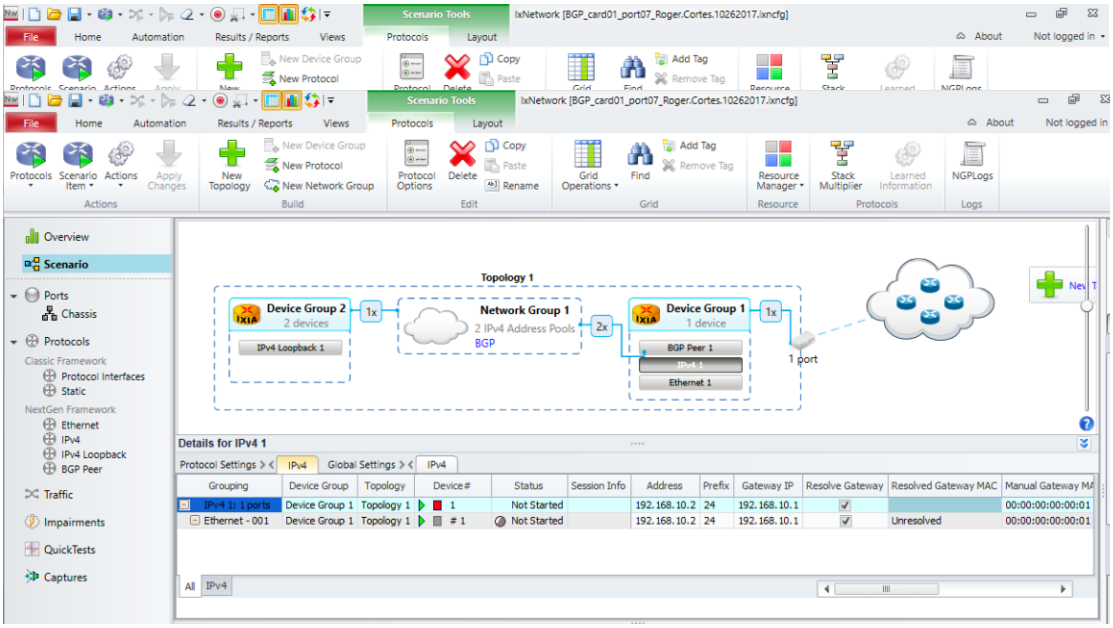
Recommendations

The flows scale limit of PicOS is 744 ingress ACLs. The flows aren’t persistent upon system reboot. A script must be scheduled as part of the post-boot process to re-install all of the desired flows back into the system. With these limitations, PicOS systems should be used in smaller deployments, hence enable only on lower performance switches such as AG6248.

Appendix

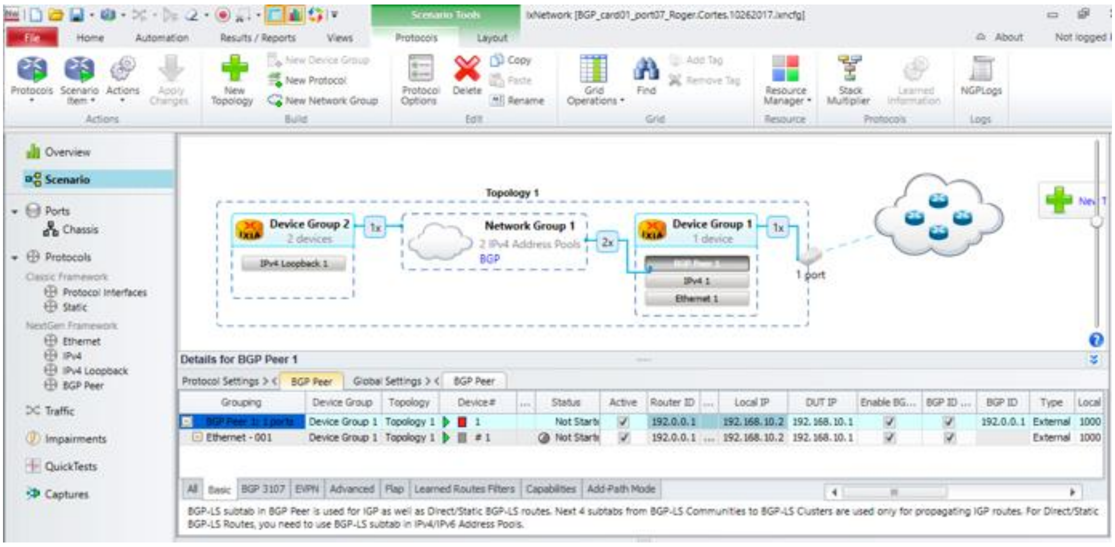
BGP Setup On Ixia

1. Ethernet Setup

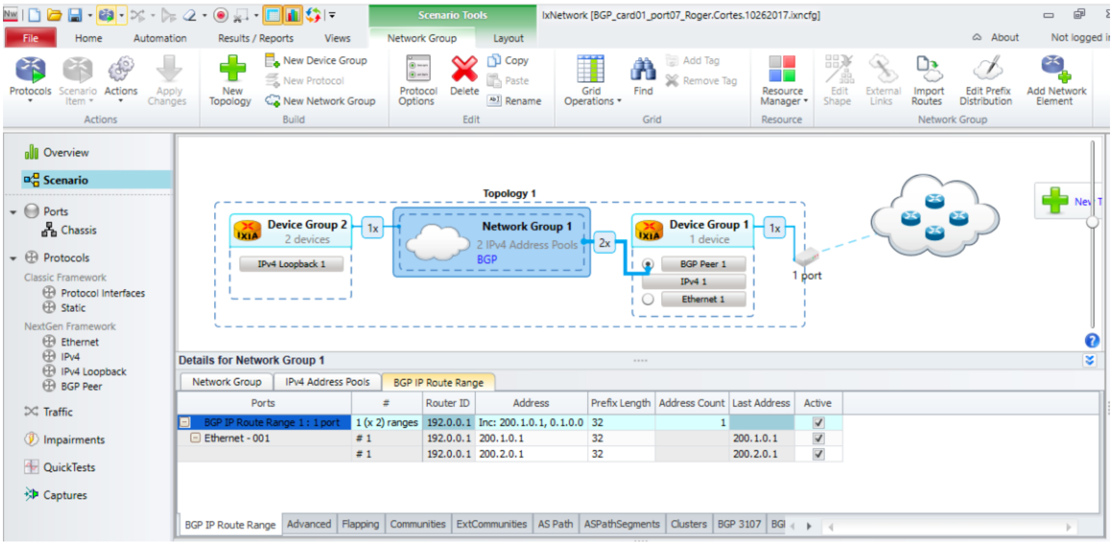


2. IPv4 Setup

3. BGP Peer Setup



4. Network Group Setup



5. IPv4 Loopback Setup