PIM Source Specific Multicast (SSM)

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Agenda

1. Overview
2. Use Cases
3. Details and Caveats
4. Configuration
5. Best Practices
6. Troubleshooting
7. Demo
PIM SSM (Source Specific Multicast) Overview

- 10.9 adds PIM SSM support for non VXLAN deployments
- Allows multicast receivers to request for a multicast stream from a specific source
  - Only (S, G) is used, (*, G) is not used
  - PIM SSM suitable for one source stream to many receivers model/applications
- PIM SSM no longer requires rendezvous points (RPs)
- Both IPv4 and IPv6 SSM are supported
- Requires IGMPv3 (IPv4) or MLDv2 (IPv6) between receivers and LHRs to request for specific multicast source
- Supported platforms:
  - 6200, 6300, 6400, 8320, 8325, 8360, 8400, CX10000

Source: 192.168.2.100/24
fd00:192:168:2::100/64

Receivers
Group: 232.10.10.10
ff32::10

L3 Router (FHR)
L3 Router (LHR)
PIM SSM

(192.168.2.100, 232.10.10.10)

FHR = First Hop Router attached to source subnet

LHR = Last Hop Router attached to receiver subnet
PIM SSM Use Case

- Allows the same multicast group to be used by different sources without interference
- Or when the source IP is known
- Receivers typically join their interested stream via a web page
Multicast Routing and Traffic Forwarding

- Dependent on unicast routing, ensure receiver has L3 connectivity to source
- IGMPv3 or MLDv2 joins are sent from receiver to source connected LHR
- PIM joins are sent upstream towards multicast source/FHR
- Multicast traffic is only forwarded on L3 interfaces towards interested receivers
  - Mroute Outgoing interface list (OILIST) will state this

![Diagram showing multicast routing and traffic forwarding]

**Excerpt from Diagram:**

- I want to join (S,G)
- 192.168.2.100, 232.10.10.10
- fd00:192:168:2::100, ff32::10

**Network Details:**

- Source: 192.168.2.100/24
- L3 Router (FHR): 232.10.10.10
- L3 Router (LHR): fd00:192:168:2::100/64

**Routes:**

- PIM SSM
- IGMPv3 or MLDv2

**OILIST Only on Interfaces Towards Interested Receivers**

**PIM Join Sent Upstream Towards Source**
VSX Support

- VSX is supported on both
  - Switches connected to sources (FHR)
  - Switches connected to receivers (LHR)

VRF Support

- VRFs are supported if required for multi-tenancy
- VRFs with PIM have to be enabled on every link/router between source and receivers
- Sub-interfaces between AOS-CX switches can also be used
PIM SSM ACL support

- Default IPv4 SSM address range = 232.0.0.0/8
- Default IPv6 SSM address range = FF3x::/32

- ACLs can be used together with PIM SSM
  - To allow desired groups to be forwarded
  - To block certain groups from being forwarded
  - To modify the default ssm range to a user defined range
    - e.g. 233.0.0.0/8 or FF4x::/32

PIM SSM and MSDP interaction

- For groups within the SSM range, no MSDP Source-Active (SA) messages within the SSM range will be accepted, generated, or forwarded
  - Applicable for default SSM range and when SSM ACL is modified
PIM SSM Caveats

- It’s not mandatory to only utilize PIM SSM
  - A parallel PIM SM deployment with BSR/RP can be used for non SSM address ranges
    - e.g. both PIM SSM supporting 232.0.0.0/8 and PIM SM supporting 239.0.0.0/8 with BSR/RP can be used on a network

- On VSX switches
  - PIM active-active should be enabled when clients are connected via downstream VSX LAG for faster convergence
  - Applicable to both PIM SSM and PIM SM

- PIM SSM ACL
  - Only “multicast group” parameter in ACL is supported
  - Need to add default SSM range into ACL if those are desired

- Requires IGMPv3 (IPv4) or MLDv2 (IPv6) between receivers and LHRs to request for specific multicast source

- PIM-SSM mapping is not supported today (planned for future AOS-CX release)
  - PIM-SSM mapping will support receivers that are not IGMPv3 or MLDv2 capable

```
access-list ip ssm
  20 permit any any 239.10.10.10
  30 permit any any 232.0.0.0/255.0.0.0
```
Configuration
PIM SSM IPv4 Configuration – FHR example

```
vlan 1,20
!
access-list ip ssm
    20 permit any any 232.10.10.10
!
interface 1/1/49
    no shutdown
    description Downlink to LHR
    ip address 192.168.3.0/31
    ip ospf 1 area 0.0.0.0
    ip pim-sparse enable
!
interface vlan 20
    description Source subnet
    ip address 192.168.2.1/24
    ip ospf 1 area 0.0.0.0
    ip igmp enable
    ip pim-sparse enable
!
routing ospf 1
    area 0.0.0.0
!
routing pim
    enable
    pim-ssm
    pim-ssm range-access-list ssm
```
PIM SSM IPv4 Configuration – Transit router or LHR example

```plaintext
vlan 1,20
!
access-list ip ssm
   20 permit any any 232.10.10.10
!
interface 1/1/49
   no shutdown
   description Uplink to FHR
   ip address 192.168.3.1/31
   ip ospf 1 area 0.0.0.0
   ip pim-sparse enable
!
interface vlan 20
   description Receiver subnet
   ip address 20.1.1.220/24
   active-gateway ip mac 20:00:00:00:20:20
   active-gateway ip 20.1.1.254
   ip ospf 1 area 0.0.0.0
   ip igmp enable
   ip pim-sparse enable
!
router ospf 1
   area 0.0.0.0
!
router pim
   enable
   pim-ssm
   pim-ssm range-access-list ssm
```

IGMPv3 used by default
PIM SSM IPv6 Configuration – FHR example

```
vlan 1, 20
! access-list ipv6 ssm
  20 permit any any ff32::10
! interface 1/1/49
  no shutdown
  description Downlink to LHR
  ipv6 address fd00:192:168:3::/127
  ipv6 ospfv3 1 area 0.0.0.0
  ipv6 pim6-sparse enable
! interface vlan20
  description Source subnet
  ipv6 address fd00:192:168:2::1/64
  ipv6 ospfv3 1 area 0.0.0.0
  ipv6 pim6-sparse enable
  ipv6 mld enable
! router ospfv3 1
  area 0.0.0.0
! router pim6
  enable
  pim-ssm
  pim-ssm range-access-list ssm
```
PIM SSM IPv6 Configuration – Transit router or LHR example

```
vlan 1,20
!
access-list ipv6 ssm
    20 permit any any ff32::10
!
interface 1/1/49
    no shutdown
    description Uplink to FHR
    ipv6 address fd00:192:168:3::1/127
    ipv6 ospfv3 1 area 0.0.0.0
    ipv6 pim6-sparse enable
!
interface vlan 20
    description Receiver subnet
    ipv6 address fd00:20:1:1::220/64
    active-gateway ipv6 mac 20:00:00:00:20:20
    active-gateway ipv6 fd00:20:1:1::254
    ipv6 ospfv3 1 area 0.0.0.0
    ipv6 mld enable
    ipv6 pim6-sparse enable
!
routing ospfv3 1
    area 0.0.0.0
!
routing pim6
    enable
    pim-ssm
    pim-ssm range-access-list ssm
```
Best Practices
Best Practices

- Remember to
  - Enable “pim ssm” under “router pim”
  - Enable “pim sparse mode” between pim routers and on SVIs facing sources and receivers
  - Ensure default SSM address range is used by multicast source
    - ACL needs to be modified if non default is used, need to add default range into ACL if those are desired
Troubleshooting
PIM SSM Troubleshooting

- Have a topology diagram with interface and IP details ready
- Check physical cabling and generate “show tech” when opening a TAC case
- Check network: show LLDP neighbor, ensure unicast network works using ping and traceroute between loopbacks and interfaces, fix any issues found

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Recommended troubleshooting flow

1. Check unicast routing between source and receiver

2. Check PIM SSM configs are correct on LHR, transit routers and FHR

3. Check PIM neighbors are seen between PIM routers

4. Check IGMPv3 or MLDv2 joins are seen on receiver connected LHR

5. Check mroute is seen on LHR, transit routers and FHR
1. Check unicast routing between source and receiver

- In order for PIM SSM to correctly forward traffic from source towards receivers:
  - Ensure source/destination IPs are correctly advertised in the network
    - e.g. “sh ip route”, test pings using between source and receiver IPs
    - Fix connectivity issues if discovered
  - This applies to both IPv4/IPv6 PIM SSM
2. Check PIM SSM configs are correct on LHR, transit routers and FHR

- Refer to config section for LHR, transit and FHR sample configs
3. Check PIM neighbors are seen between PIM routers

- In order for PIM traffic to correctly flow down the multicast tree
  - PIM neighbors should be up on all interfaces between PIM routers
  - This applies to both IPv4/IPv6 PIM SSM

- IPv6 equivalent command

```
SW1A# sh ip pim neighbor

PIM Neighbor
VRF : default
Total number of neighbors : 4

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20.1.1.221</td>
<td>vlan20</td>
<td></td>
<td></td>
<td></td>
<td>00:01:45</td>
<td>1</td>
</tr>
<tr>
<td>30.1.1.221</td>
<td>vlan30</td>
<td></td>
<td></td>
<td></td>
<td>00:01:45</td>
<td>1</td>
</tr>
<tr>
<td>192.168.3.4</td>
<td>1/1/49</td>
<td></td>
<td></td>
<td></td>
<td>00:01:21</td>
<td></td>
</tr>
<tr>
<td>192.168.3.12</td>
<td>1/1/50</td>
<td></td>
<td></td>
<td></td>
<td>00:01:24</td>
<td></td>
</tr>
</tbody>
</table>
```

```
SW1A# sh ipv6 pim6 neighbor

PIM Neighbor
VRF : default
Total number of neighbors : 2

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30.1.1.221</td>
<td>vlan30</td>
<td></td>
<td></td>
<td></td>
<td>00:01:45</td>
</tr>
<tr>
<td>192.168.3.4</td>
<td>1/1/49</td>
<td></td>
<td></td>
<td></td>
<td>00:01:21</td>
</tr>
</tbody>
</table>
```

4. Check IGMPv3 or MLDv2 joins are seen on LHR

- In order for PIM traffic to correctly flow down the multicast tree
  - IGMPv3 or MLDv2 joins should be seen on LHR
  - This applies to both IPv4/IPv6 PIM SSM

- IPv6 equivalent command

```
SW1A# sh ipv6 mld groups
```

---

```
IGMP group information for group 239.255.255.250
Interface Name   : vlan20
VRF Name         : default
Group Address    : 239.255.255.250
Last Reporter    : 20.1.1.21

<table>
<thead>
<tr>
<th>Vers</th>
<th>Mode</th>
<th>Uptime</th>
<th>Expires</th>
<th>V1 Timer</th>
<th>V2 Timer</th>
<th>Sources Forwarded</th>
<th>Sources Blocked</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>EXC</td>
<td>4d 6h</td>
<td>12m 3m 43s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IGMP group information for group 232.10.10.10
Interface Name   : vlan30
VRF Name         : default
Group Address    : 232.10.10.10
Last Reporter    : 30.1.1.21

<table>
<thead>
<tr>
<th>Vers</th>
<th>Mode</th>
<th>Uptime</th>
<th>Expires</th>
<th>V1 Timer</th>
<th>V2 Timer</th>
<th>Sources Forwarded</th>
<th>Sources Blocked</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>INC</td>
<td>52m 28s</td>
<td>3m 36s</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

```

```
Group Address  : 232.10.10.10
Source Address : 192.168.20.22

Mode Uptime | Expire
---- | -------
INC | 52m 28s 3m 34s
```
4. Check IGMPv3 or MLDv2 joins are seen on LHR

- Packet captures might be required to check if receiver sends joins correctly to LHR

<table>
<thead>
<tr>
<th>No.</th>
<th>Timestamp</th>
<th>Source IP</th>
<th>Destination IP</th>
<th>Protocol</th>
<th>Source Port</th>
<th>Destination Port</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>11.571125</td>
<td>30.1.1.21</td>
<td>224.0.0.22</td>
<td>IGMPv3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>11.637364</td>
<td>30.1.1.21</td>
<td>224.0.0.22</td>
<td>IGMPv3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>12.394914</td>
<td>192.168.20.22</td>
<td>232.10.10.10</td>
<td>UDP</td>
<td>1370</td>
<td>65492</td>
<td>5004</td>
</tr>
<tr>
<td>20</td>
<td>12.394916</td>
<td>192.168.20.22</td>
<td>232.10.10.10</td>
<td>UDP</td>
<td>1370</td>
<td>65492</td>
<td>5004</td>
</tr>
<tr>
<td>21</td>
<td>12.390786</td>
<td>192.168.20.22</td>
<td>232.10.10.10</td>
<td>UDP</td>
<td>1370</td>
<td>65492</td>
<td>5004</td>
</tr>
<tr>
<td>22</td>
<td>12.390788</td>
<td>192.168.20.22</td>
<td>232.10.10.10</td>
<td>UDP</td>
<td>1370</td>
<td>65492</td>
<td>5004</td>
</tr>
<tr>
<td>23</td>
<td>12.398932</td>
<td>192.168.20.22</td>
<td>232.10.10.10</td>
<td>UDP</td>
<td>1370</td>
<td>65492</td>
<td>5004</td>
</tr>
<tr>
<td>24</td>
<td>12.398933</td>
<td>192.168.20.22</td>
<td>232.10.10.10</td>
<td>UDP</td>
<td>1370</td>
<td>65492</td>
<td>5004</td>
</tr>
</tbody>
</table>

- Config to mirror traffic

`mirror session 1
enable
destination interface 1/1/40
source interface 1/1/51 both`
5. Check mroute is seen on LHR, transit routers and FHR

- Ensure expected incoming and outgoing interfaces are seen on each router

- **FHR**

```
SW4# sh ip mroute
IP Multicast Route Entries
VRF : default
Total number of entries : 1
Group Address : 232.10.10.10
Source Address : 192.168.20.22
SSM Mroute : True
Neighbor : 
Incoming interface : vlan20
Outgoing Interface List :
Interface       State
----------       -------
1/1/49          forwarding
```

- **Transit router**

```
SW2# sh ip mroute
IP Multicast Route Entries
VRF : default
Total number of entries : 1
Group Address : 232.10.10.10
Source Address : 192.168.20.22
SSM Mroute : True
Neighbor : 192.168.3.0
Incoming interface : 1/1/4
Outgoing Interface List :
Interface       State
----------       -------
1/1/1           forwarding
```

- **LHR**

```
SW1B# sh ip mroute
IP Multicast Route Entries
VRF : default
Total number of entries : 1
Group Address : 232.10.10.10
Source Address : 192.168.20.22
SSM Mroute : True
Neighbor : 192.168.3.2
Incoming interface : 1/1/49
Outgoing Interface List :
Interface       State
----------       -------
vlan30          forwarding
```

- IPv6 equivalent command

```
SW1B# sh ipv6 mroute
```
5. Check mroute is seen on LHR, transit routers and FHR

- On VSX switches, only the DR will state outgoing interface in mroute

<table>
<thead>
<tr>
<th>SW1A# sh ip mroute</th>
<th>SW1B# sh ip mroute</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRF : default</td>
<td>VRF : default</td>
</tr>
<tr>
<td>Total number of entries : 1</td>
<td>Total number of entries : 1</td>
</tr>
<tr>
<td><strong>Group Address</strong> : 232.10.10.10</td>
<td><strong>Group Address</strong> : 232.10.10.10</td>
</tr>
<tr>
<td><strong>Source Address</strong> : 192.168.20.22</td>
<td><strong>Source Address</strong> : 192.168.20.22</td>
</tr>
<tr>
<td><strong>SSM Mroute</strong> : True</td>
<td><strong>SSM Mroute</strong> : True</td>
</tr>
<tr>
<td><strong>Neighbor</strong> :</td>
<td><strong>Neighbor</strong> : 192.168.3.2</td>
</tr>
<tr>
<td><strong>Incoming interface</strong> : vlan30</td>
<td><strong>Incoming interface</strong> : 1/1/49</td>
</tr>
<tr>
<td><strong>Interface</strong> : vlan30</td>
<td><strong>Outgoing Interface List</strong> :</td>
</tr>
<tr>
<td><strong>State</strong> : forwarding</td>
<td><strong>Interface</strong> :</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>

- Method to check which VSX switch is DR for an SVI

<table>
<thead>
<tr>
<th>SW1A# sh ip mroute</th>
<th>SW1B# sh ip mroute</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIM Interfaces</td>
<td>PIM Interfaces</td>
</tr>
<tr>
<td>VRF: default</td>
<td>VRF: default</td>
</tr>
<tr>
<td>Interface : vlan30</td>
<td>Interface : vlan30</td>
</tr>
<tr>
<td>Neighbor count : 1</td>
<td>Neighbor count : 1</td>
</tr>
<tr>
<td><strong>IP Address</strong> : 30.1.1.220/24</td>
<td><strong>IP Address</strong> : 30.1.1.221/24</td>
</tr>
<tr>
<td><strong>Mode</strong> : sparse</td>
<td><strong>Mode</strong> : sparse</td>
</tr>
<tr>
<td><strong>Designated Router</strong> : 30.1.1.221</td>
<td><strong>Designated Router</strong> : 30.1.1.221</td>
</tr>
<tr>
<td><strong>Proxy DR</strong> : false</td>
<td><strong>Proxy DR</strong> : false</td>
</tr>
<tr>
<td><strong>Hello Interval (sec)</strong> : 30</td>
<td><strong>Hello Interval (sec)</strong> : 30</td>
</tr>
<tr>
<td><strong>Hello Delay (sec)</strong> : 5</td>
<td><strong>Hello Delay (sec)</strong> : 5</td>
</tr>
<tr>
<td><strong>Override Interval (msec)</strong> : 2500</td>
<td><strong>Override Interval (msec)</strong> : 2500</td>
</tr>
<tr>
<td><strong>Propagation Delay (msec)</strong> : 500</td>
<td><strong>Propagation Delay (msec)</strong> : 500</td>
</tr>
<tr>
<td><strong>Operational DR Priority</strong> : 1</td>
<td><strong>Operational DR Priority</strong> : 1</td>
</tr>
<tr>
<td><strong>Neighbor Timeout</strong> : 80</td>
<td><strong>Neighbor Timeout</strong> : 100</td>
</tr>
</tbody>
</table>
PIM SSM Demo

- Demo flow
  - Show mroute at FHR
  - Join multicast stream at receiver
  - Show IGMPv3 join at LHR
  - Show updated mroute at LHR, transit router and FHR
  - Show failover of PIM link and impact to receiver
Thank you
daryl.wan@hpe.com