IPv6 Hands-on seminar
IPv6 Multicast

＜Hands-on Text＞

Alcatel-Lucent

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Agenda (Part2: Hands-on)

1. Hands-on environment

2. Configuring IPv6 multicast and checking status

   – Enable IPv6 multicast routing

   – Enable MLD

   – Enable PIM

   – Configuring RP for PIM-ASM

   – Configuring PIM-SSM

   – Configuring MLD Snooping

3. Check the behavior

   – sending stream

   – PIM-ASM behavior

   – PIM-SSM behavior

   – MLD-Snooping behavior

   – PIM Route Failover

4. Advanced course

   – PIM DR behavior

   – Static MLD join

   – SSM mapping

5. Summary

Hands-on environment

Hands-on Topology

Streaming Server

RT-1

RT-2

RT-3

Fiber
Copper

ALU

ALA

RT-20 RT-21 RT-22 RT-23 RT-24 RT-25 RT-26 RT-27

ALU ALU CIS CIS CIS ALA ALA ALA

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Addressing/Port number

Multicast Stream:
(2001:1:10::10, FF18::1:1) for ASM
(2001:1:10::10, FF38::2:1) for SSM
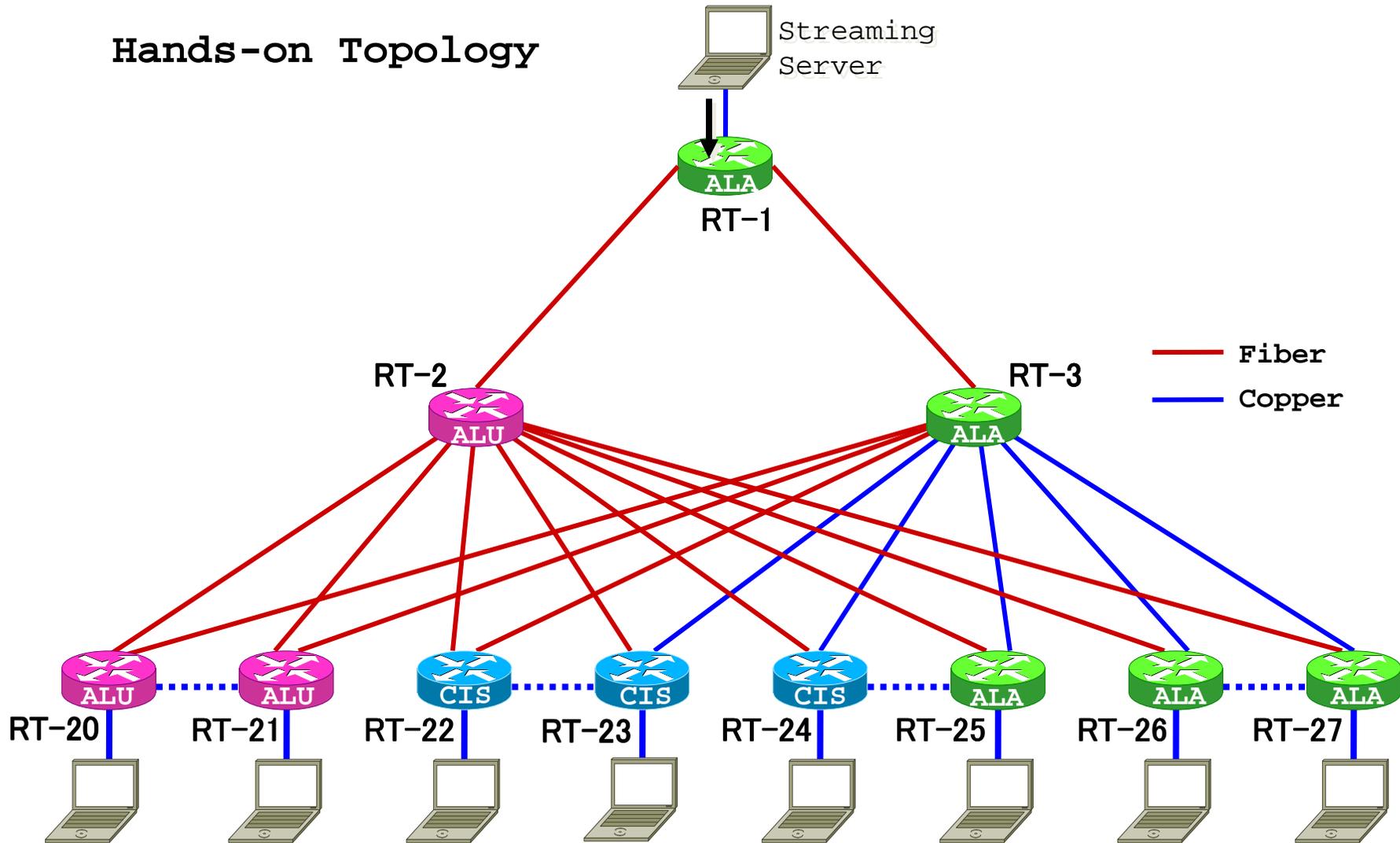
"XX" is your router number : RT-XX
Please use "XX" for your prefix/address.

1/1/1(ge-1/1/1) ALU
0/1(vlan1)   Alaxala
2/1(Gig 2/1)   cisco

Loopback
2001::2/128

OSPFv3

RT-XX

Loopback: 2001::XX/128

::2

RT-2

2001:1:2::/64

2001:2:XX::/64

2001:1:10::/64

::XX
::XX

2001:XX::/64

2001:3:XX::/64

2001:1:3::/64

RT-1

Streaming
Server

1/3/1(e-1/3/1) ALU(L3)
1/3/3(vpls3)   ALU(L2)
0/3(vlan3)   Alaxala
2/3(vlan3)   cisco

::3

RT-3

1/1/2(ge-1/1/2) ALU
0/2(vlan2)   Alaxala
2/2(Gig 2/2)   cisco

L2/L3 internal connection

\<Alcatel\>

RT-2   RT-3

ge-1/1/1   ge-1/1/2

vpls 3(vlan 3)

e-1/3/1   1/3/2   1/3/3   1/3/4

\<Alaxala\>

RT-2   RT-3

0/1(vlan1)   0/2(vlan2)

Vlan3

0/3   0/4

\<Cisco\>

RT-2   RT-3

gig 2/1   gig 2/2

Vlan3

gig 2/3   gig 2/4
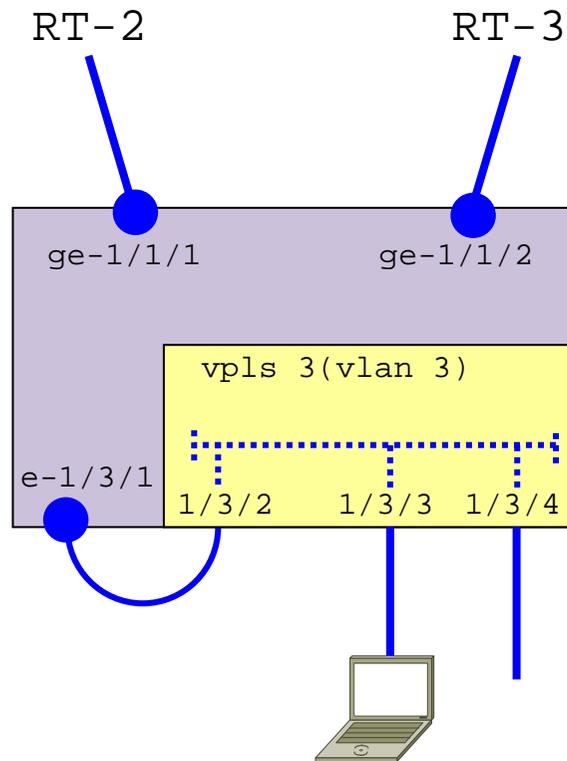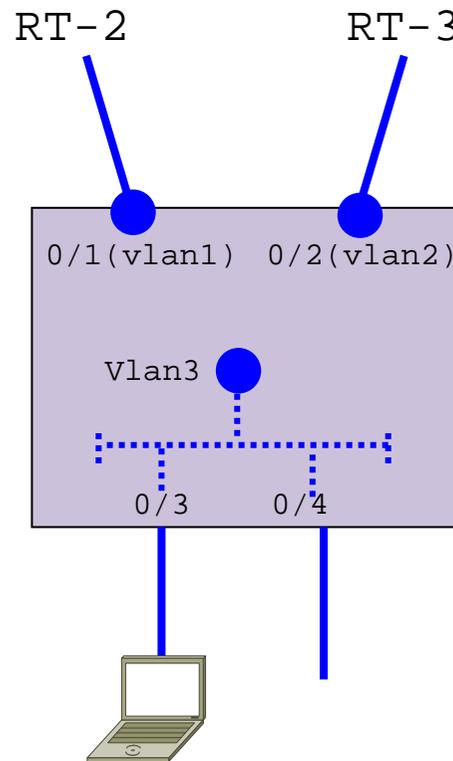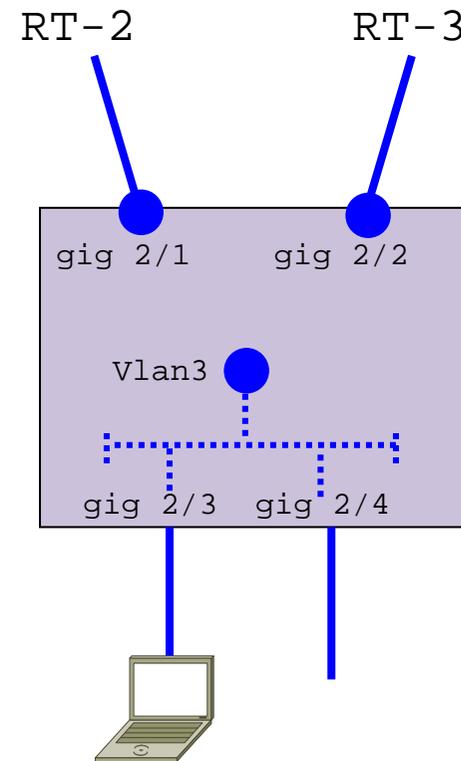
How to access to the router

■ Use "TeraTerm" as terminal software.
telnet to the router's loopback address.
#put the address in parentheses like [2001::XX]

```
Login information:
<ALU>
    user/pass = admin/admin

<Alaxala>
 user = operator
 no enable password

<cisco>
 no login password
 enable password = cisco
```
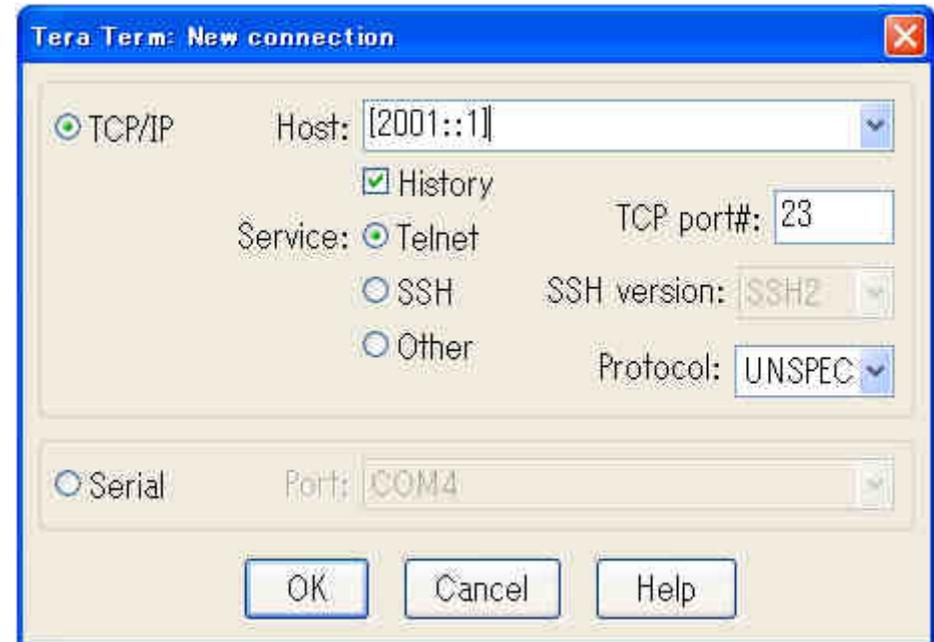
Basic configuration CLI

- Alcatel : directly configuring on Enable mode

```
ALU# configure router pim xxxxxxx
```

- Alaxala : enter to config mode, put configuration, save and exit

```
Alaxala# conf t
Alaxala (config)# ipv6 pim xxxxxxx
! Alaxala (config)# save
Alaxala(config)# exit
Alaxala#
```

- Cisco : enter to config mode, put configuration, and exit

```
cisco#conf t
cisco(config)#ipv6 pim xxxxxxx
cisco(config)#exit
cisco#
```

Saving Configuration

- Alcatel :

```
ALU# admin save
Writing file to cf3:¥v6mcast-training
Saving configuration .... Completed.
```

- Alaxala :

```
! Alaxala (config)# save <saving on config mode>


Alaxala# copy running-config startup-config
Configuration file copy to startup-config? (y/n): y
```

- Cisco :

```
Cisco#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

IPv6 unicast status show commands

- Alcatel :

```
ALU#  show router interface ipv6
ALU#  show router route-table ipv6
ALU#  show router route-table 2001::2
ALU#  show router ospf3 <interface/neighbor/etc..>
ALU#  ping 2001::2
```

- Alaxala :

```
Alaxala#  show ipv6 interface
Alaxala#  show ipv6 route
Alaxala#  show ipv6 route 2001::2
Alaxala#  show ipv6 ospf <interface/neighbor/etc..>
Alaxala#  ping ipv6 2001::2
```

IPv6 unicast status show commands

- Cisco :

```
cisco# show ipv6 interface
cisco# show ipv6 route
cisco# show ipv6 route 2001::2
cisco# show ipv6 ospf <interface/neighbor/etc..>
cisco# ping 2001::2
```

Enabling IPv6 Multicast Routing

Enabling IPv6 multicast routing

- Alcatel : not required

- Alaxala:

```
Alaxala# conf t
Alaxala (config)# swrt_table_resource l3switch-X
<change internal resource allocation to use IPv6 multicast>
Alaxala (config)# swrt_multicast_table
<Enabling both of L2 and L3 multicast feature on the same chassis>
Alaxala (config)# ipv6 multicast-routing
<Enabling ipv6 multicast routing>
```

- Cisco :

```
cisco# conf t
cisco(config)# ipv6 multicast-routing
<Enabling ipv6 multicast routing>
```

Enabling MLD router

Enabling MLD router

- Alcatel :

```
ALU# configure router mld interface "e-1/3/1"
```

- Alaxala :

```
Alaxala (config)# interface vlan 3
Alaxala (config-if)# ipv6 mld router
```

- Cisco : not required

pim/mld is become enable on all interfaces
when "ipv6 multicast-routing" is enabled.

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Check MLD status

- Alcatel :

```
ALU# show router mld status


=======================================================================
MLD Status
=======================================================================
Admin State                            : Up
Oper State                             : Up
Query Interval                         : 125
Last Listener Query Interval           : 1
Query Response Interval                : 10
Robust Count                           : 2
=======================================================================
ALU# show router mld interface


=======================================================================
MLD Interfaces
=======================================================================
Interface              Adm  Oper Cfg/Opr          Num           Policy
   Querier                       Version          Groups
-----------------------------------------------------------------------
e-1/3/1                Up   Up   2/2              0             none
   FE80::216:4DFF:FE56:25DB
-----------------------------------------------------------------------
Interfaces : 1
=======================================================================
```

Check MLD status

- Alaxala :

```
Alaxala# show ipv6 mld interface
Date 2000/02/13 19:30:58 UTC
Total: 1 Interface
Interface        Version  Flags  Querier                          Expires   Group Count
Notice
VLAN0003            2       S       fe80::212:e2ff:fe08:6915         -                 0
```

Check MLD status

- Cisco :

```
cisco#show ipv6 mld interface vlan 3
Vlan3 is up, line protocol is up
  Internet address is FE80::213:5FFF:FE1C:F840/10
  MLD is enabled on interface
  Current MLD version is 2
  MLD query interval is 125 seconds
  MLD querier timeout is 255 seconds
  MLD max query response time is 10 seconds
  Last member query response interval is 1 seconds
  MLD activity: 13 joins, 0 leaves
  MLD querying router is FE80::213:5FFF:FE1C:F840 (this system)
  MLD snooping is globally enabled
  MLD snooping is enabled on this interface
  MLD snooping fast-leave (for v1) is disabled
  MLD snooping querier is disabled.
  MLD snooping explicit-tracking is enabled
  MLD snooping last member query response interval is 1000 ms
  MLD snooping report-suppression is enabled
```

Enabling PIM

Enabling PIM on interface

- Alcatel :

```
ALU # configure router pim
ALU >config>router>pim# no ipv6-multicast-disable
ALU >config>router>pim# interface ge-1/1/1
ALU >config>router>pim>if# exit
ALU >config>router>pim# interface ge-1/1/2
ALU >config>router>pim>if# exit
ALU >config>router>pim# interface e-1/3/1
ALU >config>router>pim>if# exit
```

- Alaxala :

```
Alaxala(config)# interface vlan 1
Alaxala(config-if)# ipv6 pim
Alaxala(config-if)# exit
Alaxala(config)# interface vlan 2
Alaxala(config-if)# ipv6 pim
Alaxala(config-if)# exit
Alaxala(config)# interface vlan 3
Alaxala(config-if)# ipv6 pim
Alaxala(config-if)# exit
```

- Cisco :
  not required

  pim/mld is become
  enable on all interfaces
  when "ipv6 multicast-
  routing" is enabled.

Check PIM interface status

- Alcatel :

```
ALU # show router pim interface ipv6


=====================================================================
PIM Interfaces ipv6
=====================================================================
Interface                     Adm   Opr   DR Prty       Hello Intvl  Mcast Send
    DR
---------------------------------------------------------------------
ge-1/1/1                      Up    Up    1             30           auto
    FE80::216:4DFF:FE56:25DB
ge-1/1/2                      Up    Up    1             30           auto
    FE80::216:4DFF:FE9B:A0FA
e-1/3/1                       Up    Up    1             30           auto
    FE80::216:4DFF:FE56:25DB
---------------------------------------------------------------------
Interfaces : 3
=====================================================================
```

Check PIM Neighbor

- Alcatel :

```
ALU # show router pim neighbor ipv6


===============================================================
PIM Neighbor ipv6
===============================================================
Interface                 Nbr DR Prty    Up Time        Expiry Time      Hold Time
    Nbr Address
---------------------------------------------------------------
ge-1/1/1                      1           0d 06:07:32   0d 00:01:43       105
    FE80::216:4DFF:FE1D:D1B8
ge-1/2/1                      1           0d 05:54:21   0d 00:01:24       105
    FE80::216:4DFF:FE9B:A0FA
---------------------------------------------------------------
Neighbors : 2
===============================================================
```

Check PIM interface

- Alaxala :

```
Alaxala# show ipv6 pim interface
Date 2000/02/13 04:21:02 UTC
Interface       Component   Vif Nbr    Hello DR                        This
                            Count Intvl Address                        System
VLAN0001        PIM-SM       1    1     30 fe80::212:e2ff:fe08:6915 Y
VLAN0002        PIM-SM       2    1     30 fe80::216:4dff:fe9b:a0fa N
VLAN0003        PIM-SM       3    0     30 fe80::212:e2ff:fe08:6915 Y
```

Check PIM Neighbor

- Alaxala :

```
Alaxala# show ipv6 pim neighbor
Date 2000/02/13 04:23:18 UTC
Neighbor Address         Interface        Uptime  Expires
fe80::203:faff:feac:2432 VLAN0001          1hour  01:41
fe80::216:4dff:fe9b:a0fa VLAN0002          1hour  01:41
```

Check PIM interface

- Cisco :

```
cisco#show ipv6 pim interface
Interface          PIM   Nbr    Hello   DR
                         Count  Intvl   Prior

GigabitEthernet2/2 on    1      30      1
    Address: FE80::213:5FFF:FE1C:F840
    DR      : FE80::216:4DFF:FE9B:A0FA
GigabitEthernet2/1 on    1      30      1
    Address: FE80::213:5FFF:FE1C:F840
    DR      : FE80::216:4DFF:FE1D:D1B8
Vlan3              on    0      30      1
    Address: FE80::213:5FFF:FE1C:F840
    DR      : this system
```

Check PIM Neighbor

- Cisco :

```
cisco#show ipv6 pim neighbor detail
Neighbor Address(es)      Interface          Uptime     Expires DR pri Bidir
Address-list Hello option included as type 24 and 65001

FE80::216:4DFF:FE9B:A0FA   GigabitEthernet2/2 3w0d      00:01:21 1 (DR)
2001:3:5::3

FE80::216:4DFF:FE1D:D1B8   GigabitEthernet2/1 3w0d      00:01:43 1 (DR)
2001:2:5::2
```

Configuring RP for PIM-ASM

Configuring RP for PIM-ASM

- ## Alcatel :

```
ALU # configure router pim
ALU >config>router>pim# rp ipv6
ALU >config>router>pim>rp>ipv6# static address 2001::2
<onfiguring "2001::2" as static-RP>
ALU >config>router>pim>rp>ipv6>static>address# override
<add "override" configuration to make static-RP having higher priority than BSR>
ALU >config>router>pim>rp>ipv6>static>address# group-prefix FF18::/16
<configuring group-address range for the RP, 2001::2.>
```

- ## Alaxala :

```
Alaxala(config)# ipv6 access-list asm-group
Alaxala(config-ipv6-acl)# 10 permit ipv6 any ff18::/16
<configuring group-address range in access-list "asm-group" >
Alaxala(config-ipv6-acl)# exit
Alaxala(config)# ipv6 pim rp-address 2001::2 asm-group
<configuring "2001::2" as static-RP and specify group-address range with access-list "asm-group"
>
```

Configuring RP for PIM-ASM

- Cisco :

```
cisco(config)#ipv6 access-list asm-group
cisco(config-ipv6-acl)#permit ipv6 any ff18::/16
```
〈configuring group-address range in access-list "asm-group"〉
```
cisco(config-ipv6-acl)#exit
cisco(config)#ipv6 pim rp-address 2001::2 asm-group
```
〈configuring "2001::2" as static-RP and specify group-address range with access-list "asm-group"〉

Check RP to Group mapping

- Alcatel :

```
ALU # show router pim rp ipv6


===============================================================
PIM RP Set ipv6
===============================================================
Group Address                                   Hold Expiry
  RP Address                          Type     Prio Time Time
---------------------------------------------------------------
FF18::/16
  2001::2                             Static    1   N/A  N/A
---------------------------------------------------------------
Group Prefixes : 1
===============================================================
```

- Alaxala :

```
Alaxala# show ipv6 pim rp-mapping
Date 2000/02/13 19:17:06 UTC
Status : Not Candidate Rendezvous Point
Total: 1 route , 1 group , 1 RP
Group/Masklen                  C-RP Address           Priority Uptime  Expires
ff18::/16                      2001::2                       0 16hours --:--
```

Check RP to Group mapping

- Cisco :

```
cisco#show ipv6 pim group-map <ff18::>
<confirm how that group-address(range) is used (SM or SSM? RP-address?) >

FF18::/16*
    SM, RP: 2001::2
    RPF: Gi2/1,FE80::216:4DFF:FE1D:D1B8
    Info source: Static
    Uptime: 15:51:35, Groups: 1


cisco#show ipv6 pim range-list
<confirm which RP owns what address range, what address range is configured for SSM>
Static SSM Exp: never Learnt from : ::
  FF33::/32 Up: 3w2d
  FF34::/32 Up: 3w2d
  <snip>
  FF3D::/32 Up: 3w2d
  FF3E::/32 Up: 3w2d
  FF3F::/32 Up: 3w2d
Static SM RP: 2001::2 Exp: never Learnt from : ::
  FF18::/16 Up: 15:52:45
```

Configuring PIM-SSM

Configuring PIM-SSM

- Alcatel :

```
ALU # configure router pim
ALU >config>router>pim# ssm-groups
ALU >config>router>pim>ssm# group-range FF38::/16
<configuring "FF38::/16" as group-address range for PIM-SSM>
```

- Alaxala :

```
Alaxala(config)# ipv6 access-list ssm-group
Alaxala (config-ipv6-acl)# permit ipv6 any ff38::/16
<configuring SSM group-address range in access-list "ssm-group" >
Alaxala (config-ipv6-acl)# exit
Alaxala (config)# ipv6 pim ssm range ssm-group
<configuring SSM group-address range with access-list "ssm-group" >

# or you can simply configure "ipv6 pim ssm default". With this command, SSM is enabled for all
standard SSM range "FF3x::/12".
```

- Cisco : not required

  SSM is enabled for all standard SSM range "FF3x::/12" when "ipv6 multicast-routing" is enabled.

Configuring MLD-Snooping

Configuring MLD-Snooping

- ## Alcatel :

```
ALU# configure service vpls 3
ALU >config>service>vpls# mld-snooping no shutdown
<enabling mld-snooing on "vpls 3(VLAN3)">
```

- ## Alaxala :

```
Alaxala# interface vlan 3
Alaxala(config-if)# ipv6 mld snooping
<enabling mld-snooping on "vlan 3">
```

- ## Cisco : not required

  MLD-snooping is enable as default.

Check MLD-snooping status

- Alcatel :

```
ALU # show service id 10 mld-snooping base


===============================================================
MLD Snooping Base info for service 10
===============================================================
Admin State : Up
Querier     : FE80::216:4DFF:FE56:25DB on SAP 1/8/2
---------------------------------------------------------------
Sap/Sdp                   Oper    MRtr  Send      Max Num    MVR        Num
Id                        State   Port  Queries   Groups     From-VPLS  Groups
---------------------------------------------------------------
sap:1/8/2                 Up      Yes   Disabled  No Limit   Local      0
sap:1/8/3                 Up      No    Disabled  No Limit   Local      0
===============================================================
```

Check MLD-snooping status

- Alaxala :

```
Alaxala# show mld-snooping
Date 2000/02/13 20:21:35 UTC
VLAN counts: 1
VLAN: 3
  IP address: fe80::212:e2ff:fe08:6915    Querier: disable
  MLD querying system: fe80::212:e2ff:fe08:6915
  Querier version: V2
  IPv6 Multicast routing: On
  Port(1): 0/3
  Mrouter-port:
  Group Counts: 0
```

- Cisco :

```
cisco#show ipv6 mld snooping mrouter
vlan            ports
-----+-------------------------------------
   3  Router
```

Sending video stream by VLC mediaplayer

Sending video stream by VLC

1. On "Media" menu, select "streaming".

2. Select video source file, and click "stream".
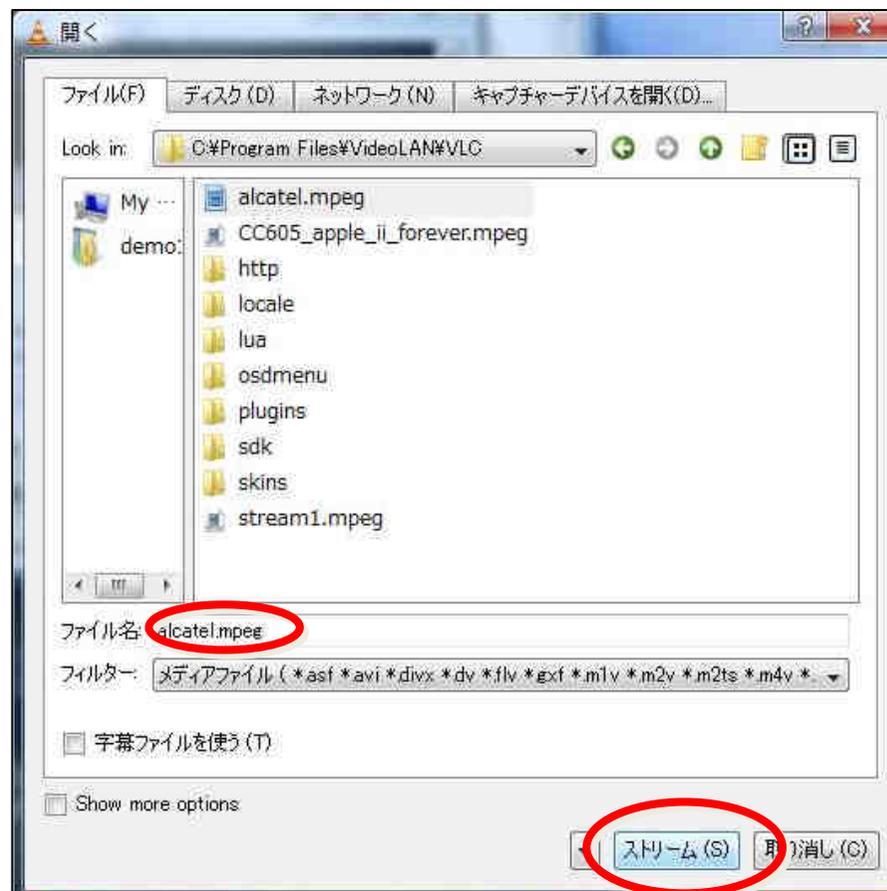
Sending video stream by VLC
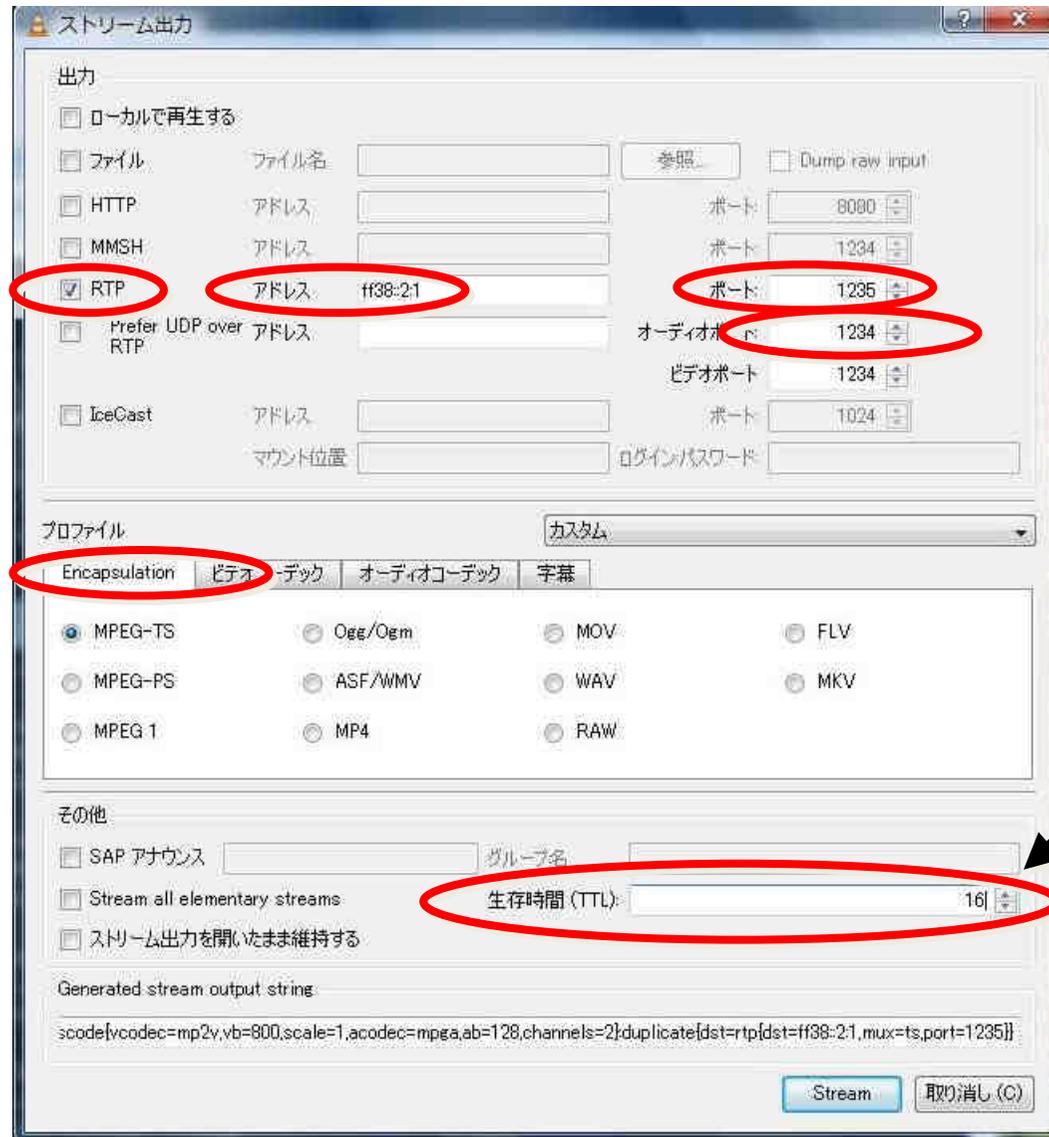
3.Specify
protocol,Encap type,
address/port,TTL.

Be care about Default
TTL is set to 1.

Sending video stream by VLC
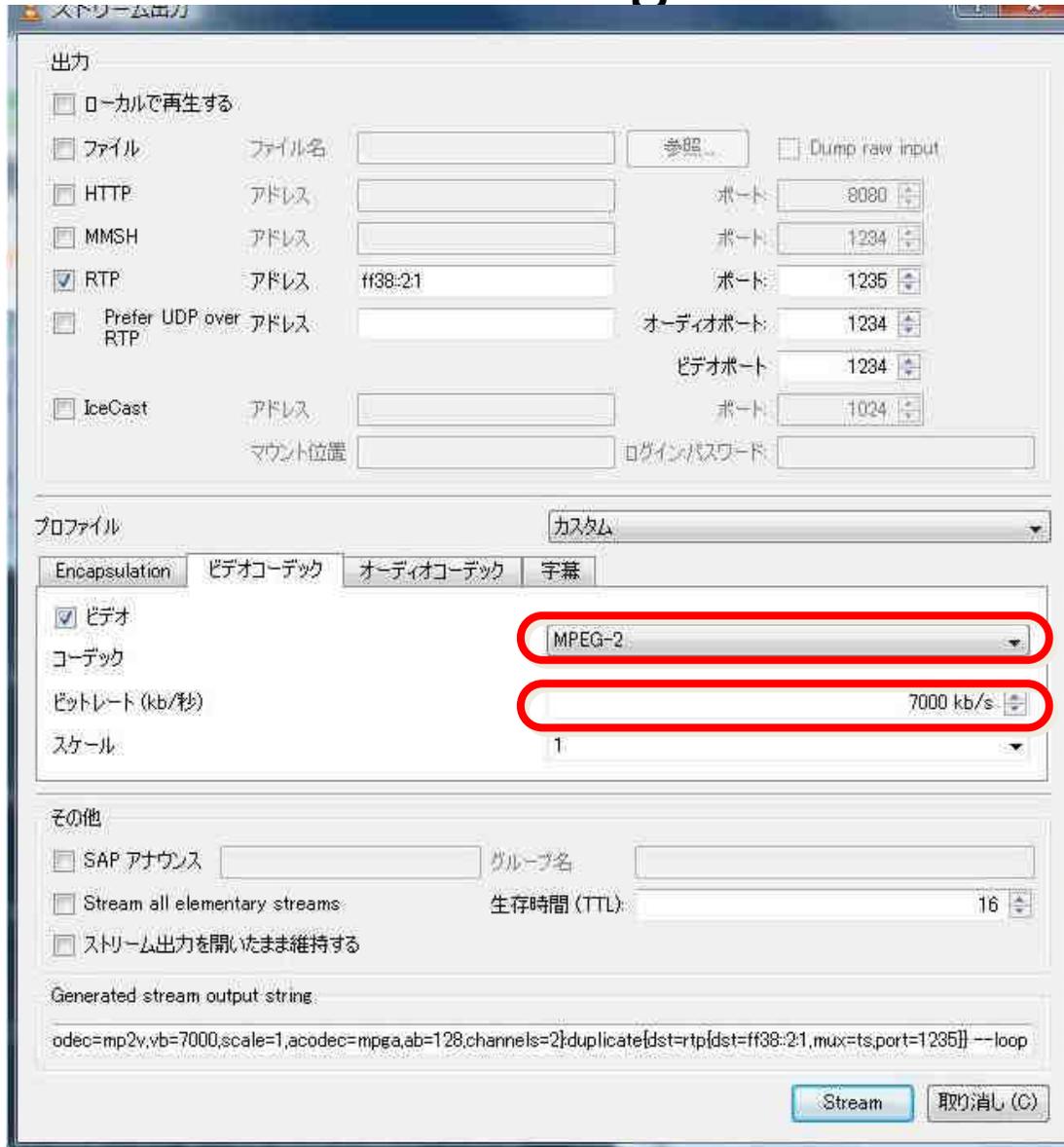

```
4.Specify video/audio
codec,bit rate.
```

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Check PIM-ASM behavior

ASM: Start sending (S,G) traffic

2 (2001:1:10::10, FF18::1:1)

3

RP

RT-2

1

RT-XX

MLD report
Join(*,FF18::1:1)

RT-1

RT-3

(2001:1:10::10, FF18::1:1)
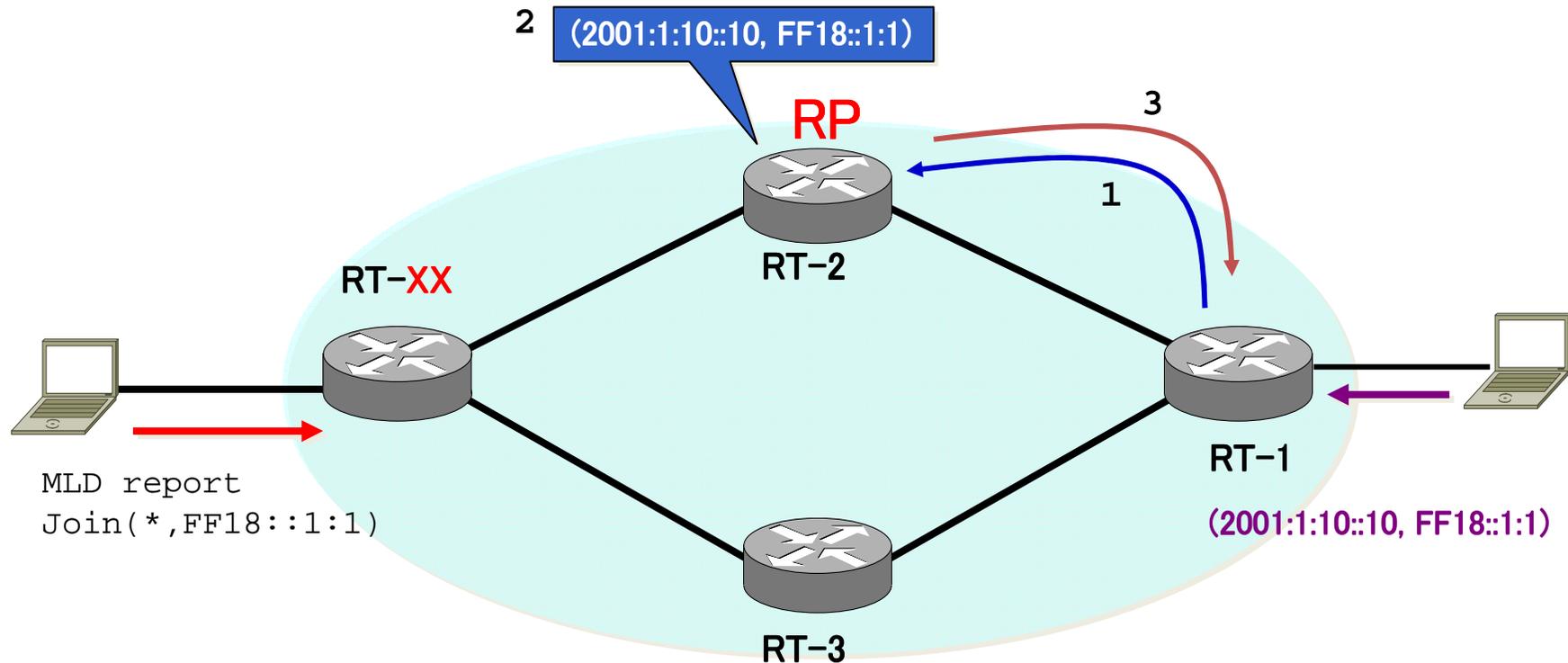
1. FHR starts sending PIM register packets to RP[2001::2] in unicast.
2. By receiving register, RP creates (S,G) entry.
3. RP sends back register stop to FHR, and FHR stops sending register.

Check RP status

```
ALU# show router pim group ipv6

================================================================
PIM Groups ipv6
================================================================
Group Address                       Type     Spt Bit Inc Intf      No.Oifs
   Source Address                   RP
----------------------------------------------------------------
FF18::1:1                           (S,G)            ge-1/1/4         0
   2001:1:10::10                    2001::2
----------------------------------------------------------------
Groups : 1
================================================================
```

ASM: Joining to ASM group
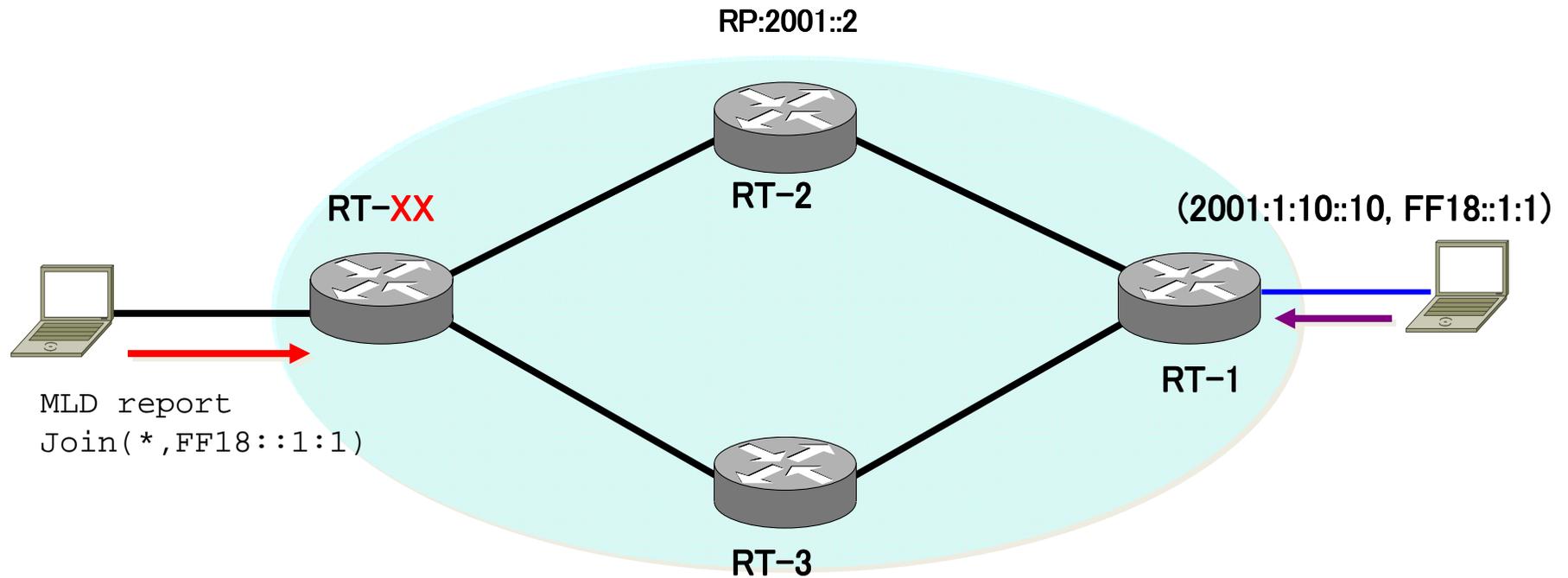
Joining to the group on VLC (ASM)

On "media" menu, select "open network stream"
Set the protocol,address and port, then click "play".
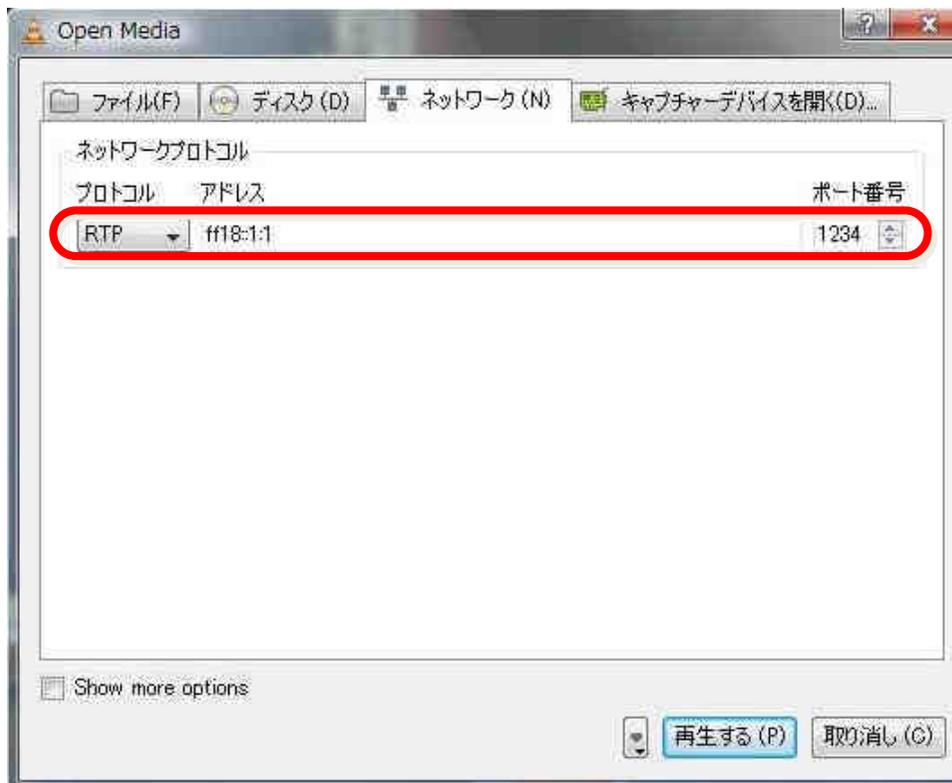
Or execute this command on command prompt.
"**vlc rtp://@[ff18::1:1]:1234**"

Check the status

◆MLD Entry is created correctly ?

◆Check PIM distribution Tree(mroute) status (Forwarding Entry is created correctly ?)

◆Check the RPF interafce(incoming interface) for (*,G) and (S,G) entry. What is the reason of that status ?

Check MLD Entry

- Alcatel :

```
ALU # show router mld group


===============================================================================
MLD Groups
===============================================================================


(*,FF18::1:1)
    Up Time : 0d 00:00:14
    Fwd List  : e-1/8/1
-------------------------------------------------------------------------------
(*,G)/(S,G) Entries : 1
===============================================================================
```

- Alaxala :

```
Alaxala# show ipv6 mld group
Date 2000/02/13 22:16:09 UTC
Total: 1 group
Group Address/Source Address                Interface     Version Mode    Last
Reporter            Uptime  Expires MLDv1
Time MLDv2Time
ff18::1:1                                   VLAN0003        2     EXCLUDE
fe80::7d4c:d2a0:dfed:d2a3 17:50    03:30    --
:--     03:30
```

Check MLD Entry

- Cisco :

```
cisco#show ipv6 mld groups detail
Interface:        Vlan3
Group:            FF18::1:1
Uptime:           00:03:27
Router mode:      EXCLUDE (Expires: 00:03:41)
Host mode:        INCLUDE
Last reporter:    FE80::7D4C:D2A0:DFED:D2A3
Source list is empty
```

Check PIM distribution Tree

- Acatel :

```
ALU # show router pim group ipv6

===============================================================
PIM Groups ipv6
===============================================================
Group Address                         Type      Spt Bit Inc Intf      No.Oifs
    Source Address                    RP
---------------------------------------------------------------
FF18::1:1                             (*,G)             ge-1/1/1       1
    *                                 2001::2
FF18::1:1                             (S,G)     spt     ge-1/2/1       1
    2001:1:10::10                     2001::2
---------------------------------------------------------------
Groups : 2
===============================================================
```

Check PIM distribution Tree

- ## Alaxala :

```
Alaxala# show ipv6 mroute
Date 2000/02/13 22:18:29 UTC
Total: 2 routes, 1 group , 1 source

(S,G) 1 route    -----------------------------------------------
Group Address                        Source Address
ff18::1:1                            2001:1:10::10
    uptime 20:10    expires 03:05    assert 00:00    flags LT  protocol SM
    incoming: VLAN0002      upstream: fe80::216:4dff:fe9b:a0fa
    outgoing: VLAN0003      uptime 20:10    expires --:--

(*,G) 1 route    -----------------------------------------------
Group Address                        RP Address
ff18::1:1                            2001::2
    uptime 20:10    expires --:--    assert 00:00    flags LR  protocol SM
    incoming: VLAN0001      upstream: fe80::203:faff:feac:2432
    outgoing: VLAN0003      uptime 20:10    expires --:--
```

Check PIM distribution Tree

- Cisco :

```
cisco#show ipv6 mroute
Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group,
       C - Connected, L - Local, I - Received Source Specific Host Report,
       P - Pruned, R - RP-bit set, F - Register flag, T - SPT-bit set,
       J - Join SPT
Timers: Uptime/Expires
Interface state: Interface, State

(*, FF18::1:1), 00:03:16/never, RP 2001::2, flags: SCJ
  Incoming interface: GigabitEthernet2/1
  RPF nbr: FE80::216:4DFF:FE1D:D1B8
  Immediate Outgoing interface list:
    Vlan3, Forward, 00:03:16/never

(2001:1:10::10, FF18::1:1), 00:04:05/00:00:13, flags: SJT
  Incoming interface: GigabitEthernet2/2
  RPF nbr: FE80::216:4DFF:FE9B:A0FA
  Inherited Outgoing interface list:
    Vlan3, Forward, 00:03:16/never
```

Check Multicast Forwarding table Entry

- Alcatel : no command

- Alaxala :

```
Alaxala# show ipv6 mcache
Date 2000/02/13 22:21:01 UTC
Total: 1 route
Group Address                              Source Address
ff18::1:1                                  2001:1:10::10
    uptime: 22:45    expires: 03:30
    incoming:
        VLAN0002
    outgoing:
        VLAN0003    <snooping>
```

Check Multicast Forwarding table Entry

- Cisco :

```
cisco#show ipv6 mfib FF18::1:1
<snip>
(*,FF18::1:1) Flags: C
   RP Forwarding: 0/0/0/0, Other: 0/0/0
   LC Forwarding: 0/0/0/0, Other: 0/0/0
   HW Forwd:   0/0/0/0, Other: NA/NA/NA
   GigabitEthernet2/1 Flags: A NS
   Vlan3 Flags: F NS
     Pkts: 0/0/0
(2001:1:10::10,FF18::1:1) Flags:
   RP Forwarding: 9336/0/1376/0, Other: 25/25/0
   LC Forwarding: 0/0/0/0, Other: 0/0/0
   HW Forwd:   265399/707/1376/7602, Other: NA/NA/NA
   GigabitEthernet2/2 Flags: A
   Vlan3 Flags: F NS
     Pkts: 0/9243/9
```

Check RPF interface/neighbor <Alcatel>

```
ALU # show router route-table 2001::2


===============================================================
IPv6 Route Table (Router: Base)
===============================================================
Dest Prefix                            Type     Proto   Age        Pref
      Next Hop[Interface Name]                                  Metric
---------------------------------------------------------------
2001::2/128                            Remote   OSPF3   01d00h39m   10
      FE80::216:4DFF:FE1D:D1B8-"ge-1/1/1"                        101
---------------------------------------------------------------
No. of Routes: 1
===============================================================
ALU# show router route-table 2001:1:10::10


===============================================================
IPv6 Route Table (Router: Base)
===============================================================
Dest Prefix                            Type     Proto   Age        Pref
      Next Hop[Interface Name]                                  Metric
---------------------------------------------------------------
2001:1:10::/64                         Remote   OSPF3   01d00h37m   10
      FE80::216:4DFF:FE9B:A0FA-"ge-1/2/1"                        201
---------------------------------------------------------------
No. of Routes: 1
===============================================================
```

Check RPF interface/neighbor <Alaxala>

```
Alaxala# show ipv6 route 2001::2
<snip>
* NextHop fe80::203:faff:feac:2432%VLAN0001, Interface: VLAN0001
      Protocol <OSPFv3 intra>
      Source Gateway ----
      Metric/2    : 2/-
      Distance/2/3: 110/1/0


Alaxala# show ipv6 route 2001:1:10::10
<snip>
* NextHop fe80::216:4dff:fe9b:a0fa%VLAN0002, Interface: VLAN0002
      Protocol <OSPFv3 intra>
      Source Gateway ----
      Metric/2    : 102/-
      Distance/2/3: 110/1/0

Alaxala# show ipv6 rpf 2001:1:10::10
Date 2000/02/13 22:55:25 UTC
RPF information for ? (2001:1:10::10):
If VLAN0002 NextHop fe80::216:4dff:fe9b:a0fa
```

Check RPF interface/neighbor <Cisco>

```
cisco#show ipv6 rpf 2001::2
RPF information for 2001::2
  RPF interface: GigabitEthernet2/1
  RPF neighbor: FE80::216:4DFF:FE1D:D1B8
  RPF route/mask: 2001::2/128
  RPF type: Unicast
  RPF recursion count: 0
  Metric preference: 110
  Metric: 2

cisco#show ipv6 rpf 2001:1:10::10
RPF information for 2001:1:10::10
  RPF interface: GigabitEthernet2/2
  RPF neighbor: FE80::216:4DFF:FE9B:A0FA
  RPF route/mask: 2001:1:10::/64
  RPF type: Unicast
  RPF recursion count: 0
  Metric preference: 110
  Metric: 102
```

What happens on LHR (Debug sample) - 1

Receives MLD report, and send (*,G)Join to the RPF neighbor towards RP.

```
ALU #
[029 22:22:48.660] MLD interface e-1/8/1
[ifIndex 4] V2 PDU: :: -> FF02::16 pduLen 28
    Type: V2 REPORT maxrespCode 0x0 checkSum 0x6e74
    Num Group Records: 1
        Group Record 0
        Type: CHG_TO_EXCL, AuxDataLen 0, Num Sources 0
        Mcast Addr: FF18::1:1
        Source Address List

51 2009/11/07 16:24:45.49 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSendJoinPrunePdu
pimSendJoinPrunePdu: if 2, adj FE80::216:4DFF:FE1D:D1B8"

52 2009/11/07 16:24:45.49 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: encoding groupset for group FF18::1:1, numJoinedSrcs 1, numPr
unedSrcs 0"

53 2009/11/07 16:24:45.49 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: Encoding Join for (*,G) RP = 2001::2"
```

What happens on LHR (Debug sample) - 2

Send (S,G)Join to the RPF neighbor towards Source.

```
57 2009/11/07 16:24:45.53 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSendJoinPrunePdu
pimSendJoinPrunePdu: if 3, adj FE80::216:4DFF:FE9B:A0FA"

58 2009/11/07 16:24:45.53 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: encoding groupset for group FF18::1:1, numJoinedSrcs 1, numPr
unedSrcs 0"

59 2009/11/07 16:24:45.54 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: Encoding Join for source 2001:1:10::10"

60 2009/11/07 16:24:45.54 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: num joined srcs 1, num pruned srcs 0"
```

What happens on LHR (Debug sample) - 3

Send (S,G)RPT-Prune to the RPF neighbor towards RP.

```
64 2009/11/07 16:24:45.55 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSendJoinPrunePdu
pimSendJoinPrunePdu: if 2, adj FE80::216:4DFF:FE1D:D1B8"

65 2009/11/07 16:24:45.55 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: encoding groupset for group FF18::1:1, numJoinedSrcs 0, numPr
unedSrcs 1"

66 2009/11/07 16:24:45.55 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: Encoding RPT Prune for source 2001:1:10::10"

67 2009/11/07 16:24:45.55 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSGEncodeGroupSet
pimEncodeGroupSet: num joined srcs 0, num pruned srcs 1"

68 2009/11/07 16:24:45.56 JST MINOR: DEBUG #2001 Base PIM[Instance 1 Base]
"PIM[Instance 1 Base]: pimSendJoinPrunePdu
pimSendJoinPrunePdu2: sending JP PDU with 1 groups."
```

PIM distribution Tree after SPT switchover

RP:2001::2

(*,G)Tree

RT-XX

RT-2

（2001:1:10::10, FF18::1:1）

(S,G)Tree

RT-1

Mcast
traffic

MLD report
Join(*,FF18::1:1)

RT-3
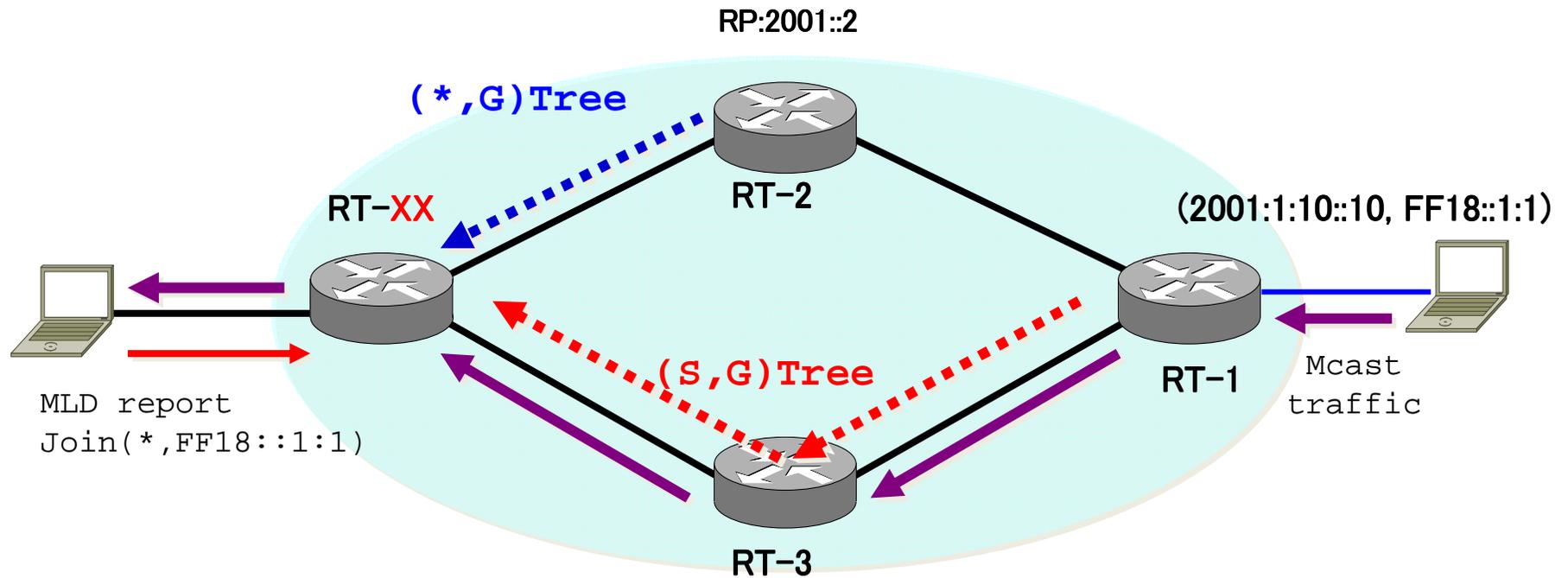
Check PIM-SSM behavior

Joining to SSM group

RT–XX

RT–2

(2001:1:10::10,FF38::2:1)

RT–1

RT–3

MLD report
Join(2001:1:10::10,FF38::2:1)
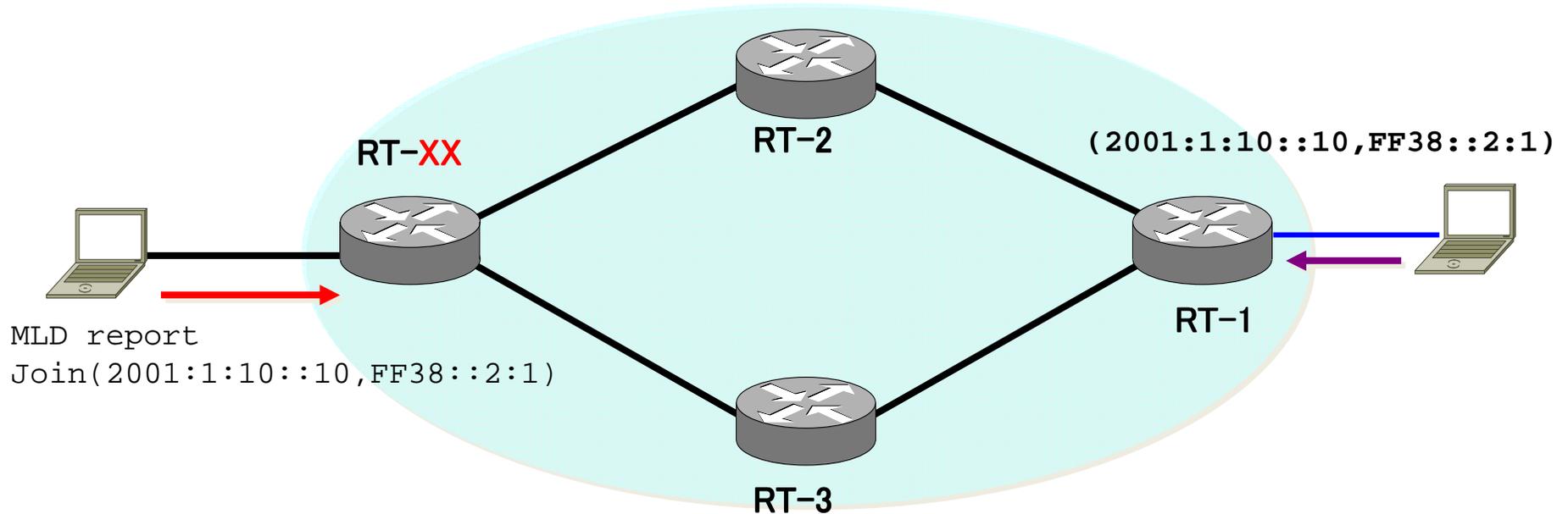
◆please use VLC Client from CLI to join to SSM group
vlc rtp://[2001:1:10::10]@[ff38::2:1]:1235

◆MLD entry is created correctly ?
What's the difference from ASM case ?

◆Check PIM distribution Tree entry.
What's the difference from ASM case ?

Check MLD Entry

- Alcatel :

```
ALU#  show router mld group ff38::2:1


=====================================================================
MLD Groups
=====================================================================


(2001:1:10::10,FF38::2:1)
    Up Time : 0d 00:00:21
    Fwd List  : e-1/8/1
---------------------------------------------------------------------
(*,G)/(S,G) Entries : 1
=====================================================================
```

Check MLD Entry

- Alaxala :

```
Alaxala# show ipv6 mld group ff38::2:1
Total: 1 group
Group Address/Source Address                 Interface      Version Mode      Last
Reporter            Uptime  Expires MLDv1
Time MLDv2Time
ff38::2:1                                    VLAN0003        2     INCLUDE
fe80::7d4c:d2a0:dfed:d2a3 05:04    --:--    --
:--      --:--
   2001:1:10::10                                -              -      -
fe80::7d4c:d2a0:dfed:d2a3 05:04    03:47
-        03:47
```

- Cisco :

```
cisco#show ipv6 mld groups ff38::2:1 detail
Interface:       Vlan3
Group:           FF38::2:1
Uptime:          00:00:22
Router mode:     INCLUDE
Host mode:       INCLUDE
Last reporter:   FE80::7D4C:D2A0:DFED:D2A3
Group source list:
Source Address                    Uptime    Expires  Fwd  Flags
2001:1:10::10                     00:00:22  00:03:57 Yes  Remote 4
```

Check PIM distribution Tree

- Alcatel :

```
ALU # show router pim group ff38::2:1


===========================================================================
PIM Groups ipv6
===========================================================================
Group Address                          Type      Spt Bit Inc Intf      No.Oifs
   Source Address                      RP
---------------------------------------------------------------------------
FF38::2:1                              (S,G)             ge-1/2/1       1
   2001:1:10::10

---------------------------------------------------------------------------
Groups : 1
===========================================================================
```

Check PIM distribution Tree

- Alaxala :

```
Alaxala# show ipv6 mroute ff38::2:1
Date 2000/02/13 23:34:23 UTC
Total: 1 route , 1 group , 1 source

(S,G) 1 route      ------------------------------------------------
Group Address                              Source Address
ff38::2:1                                  2001:1:10::10
    uptime 06:29    expires --:--    assert 00:00     flags L
protocol SSM
    incoming: VLAN0002        upstream: fe80::216:4dff:fe9b:a0fa
    outgoing: VLAN0003        uptime 06:29    expires --:--
```

Check PIM distribution Tree

- Cisco :

```
cisco#show ipv6 mroute ff38::2:1
Multicast Routing Table
Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group,
       C - Connected, L - Local, I - Received Source Specific Host
Report,
       P - Pruned, R - RP-bit set, F - Register flag, T - SPT-bit set,
       J - Join SPT
Timers: Uptime/Expires
Interface state: Interface, State

(2001:1:10::10, FF38::2:1), 00:01:52/never, flags: sTI
  Incoming interface: GigabitEthernet2/2
  RPF nbr: FE80::216:4DFF:FE9B:A0FA
  Immediate Outgoing interface list:
    Vlan3, Forward, 00:01:52/never
```

PIM distribution Tree after joining SSM Group

RT-XX

RT-2

（2001:1:10::10, FF38::2:1)

(S,G)Tree

RT-1

Mcast
traffic

RT-3

MLD report
Join(2001:1:10::10,FF38::2:1)
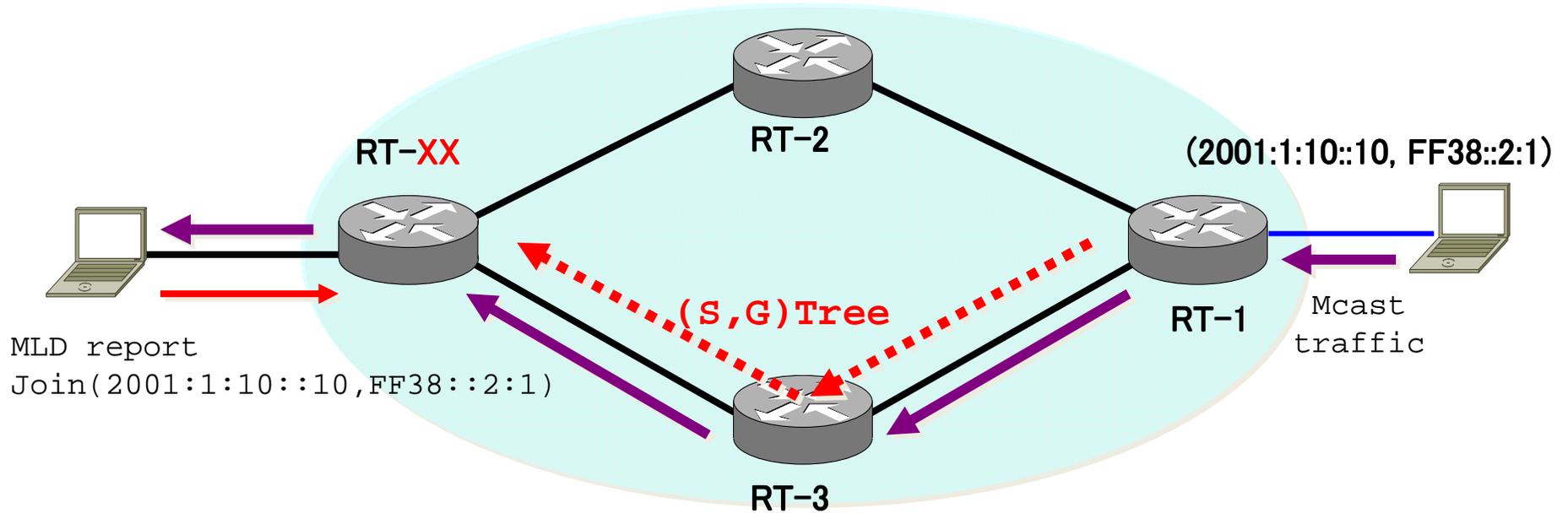
Useful command to check multicast stream rate

- Alcatel :

```
ALU # show router pim group ff38::2:1 detail
<snip>
Group Address       : FF38::2:1
Source Address      : 2001:1:10::10
<snip>
Curr Fwding Rate    : 6920.7 kbps
Forwarded Packets   : 71223           Discarded Packets  : 0
Forwarded Octets    : 98002848        RPF Mismatches     : 0
Spt threshold       : 0 kbps          ECMP opt threshold : 7
Admin bandwidth     : 1 kbps

-------------------------------------------------------------------
Groups : 1
===================================================================
```

- Cisco :

```
cisco#show ipv6 mfib active
Active IPv6 Multicast Sources - sending >= 4 kbps
Group: FF18::1:1
  Source: 2001:1:10::10
   RP Rate: 0 pps/0 kbps(1sec)
   LC Rate: 0 pps/0 kbps(1sec)
   HW Rate: 706 pps/7597 kbps(1sec)
```

Check MLD Snooping behavior

Check MLD status
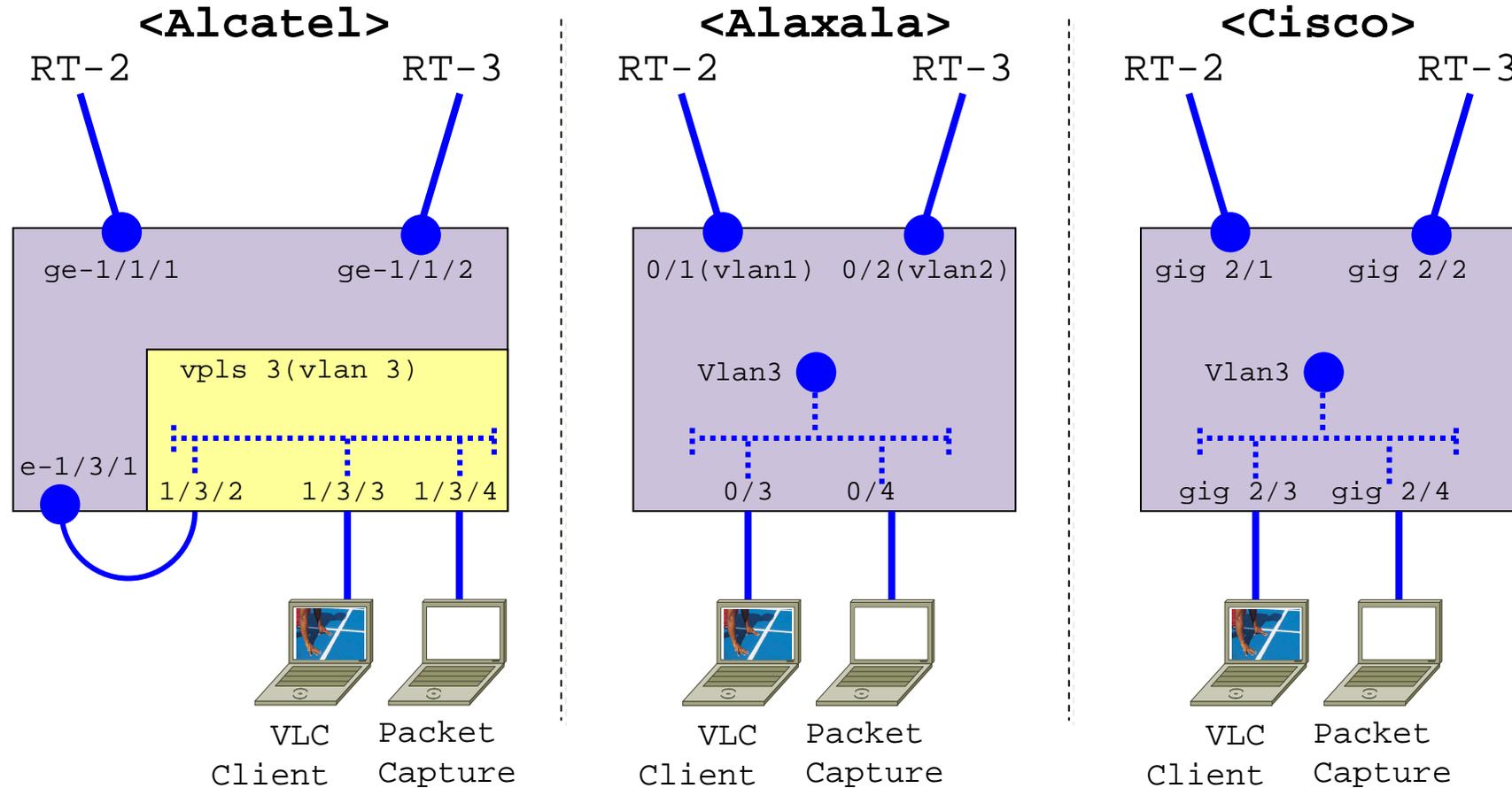
Capture the packets on not-joined port, and confirm no multicast packets are captured.

Check MLD Snooping entry

- Alcatel :

```
ALU # show service id 3 mld-snooping proxy-db
Group Address
                Mode      Up Time          Num Sources
-------------------------------------------------------------------
FF18::1:1
                exclude  0d 00:11:40     0
FF38::2:1
                include  0d 00:11:40     1
-------------------------------------------------------------------
Number of groups: 2
===================================================================

ALU # show service id 3 mld-snooping port-db sap 1/3/3
Group Address
                Mode     Type     From-VPLS  Up Time        Expires  Num   MC
                                                                     Src   Stdby
-------------------------------------------------------------------
FF18::1:1
                exclude dynamic local      0d 00:11:41     143s     0
FF38::2:1
                include dynamic local      0d 00:11:41     0s       1
-------------------------------------------------------------------
Number of groups: 2
===================================================================
```

Check MLD Snooping entry

- Alaxala :

```
Alaxala# show mld-snooping group
Date 2000/02/14 01:02:29 UTC
Total Groups: 2
VLAN counts: 1
VLAN: 3   Group counts: 2   IPv6 Multicast routing: On
  Group Address                              MAC Address       Version     Mode
  ff18::1:1                                  3333.0001.0001    -           -
    Port-list:0/3
  ff38::2:1                                  3333.0002.0001    -           -
    Port-list:0/3

Alaxala# show mld-snooping port 0/3
Date 2000/02/14 01:02:33 UTC
Port  0/3   VLAN counts: 1
  VLAN: 3   Group counts: 2
   Group Address    Last Reporter                  Uptime      Expires
   ff18::1:1        fe80::7d4c:d2a0:dfed:d2a3       00:50       04:01
   ff38::2:1        fe80::7d4c:d2a0:dfed:d2a3       00:50       04:05
```

Check MLD Snooping entry

- Cisco :

```
cisco#show mac-address-table multicast mld-snooping

 vlan    mac address        type    learn qos              ports
-----+----------------+--------+-----+---+------------------------------
    3   3333.0002.0001     static  Yes            -    Gi2/3,Router
    3   3333.0000.000d     static  Yes            -    Gi1/2,Gi2/1,Gi2/2,Gi2/3
                                                        Router,Switch
    3   3333.0000.0001     static  Yes            -    Switch
    3   3333.0001.0003     static  Yes            -    Gi2/3,Router
    3   3333.0001.0001     static  Yes            -    Gi2/3,Router
    3   3333.0000.0016     static  Yes            -    Switch
```

Check MLD Snooping

\<Alcatel\>

RT-2   RT-3

ge-1/1/1   ge-1/1/2

vpls 3(vlan 3)

e-1/3/1   1/3/2   1/3/3   1/3/4

VLC   Packet
Client   Capture

\<Alaxala\>

RT-2   RT-3

0/1(vlan1)   0/2(vlan2)

Vlan3

0/3   0/4

VLC   Packet
Client   Capture

\<Cisco\>

RT-2   RT-3

gig 2/1   gig 2/2

Vlan3

gig 2/3   gig 2/4

VLC   Packet
Client   Capture
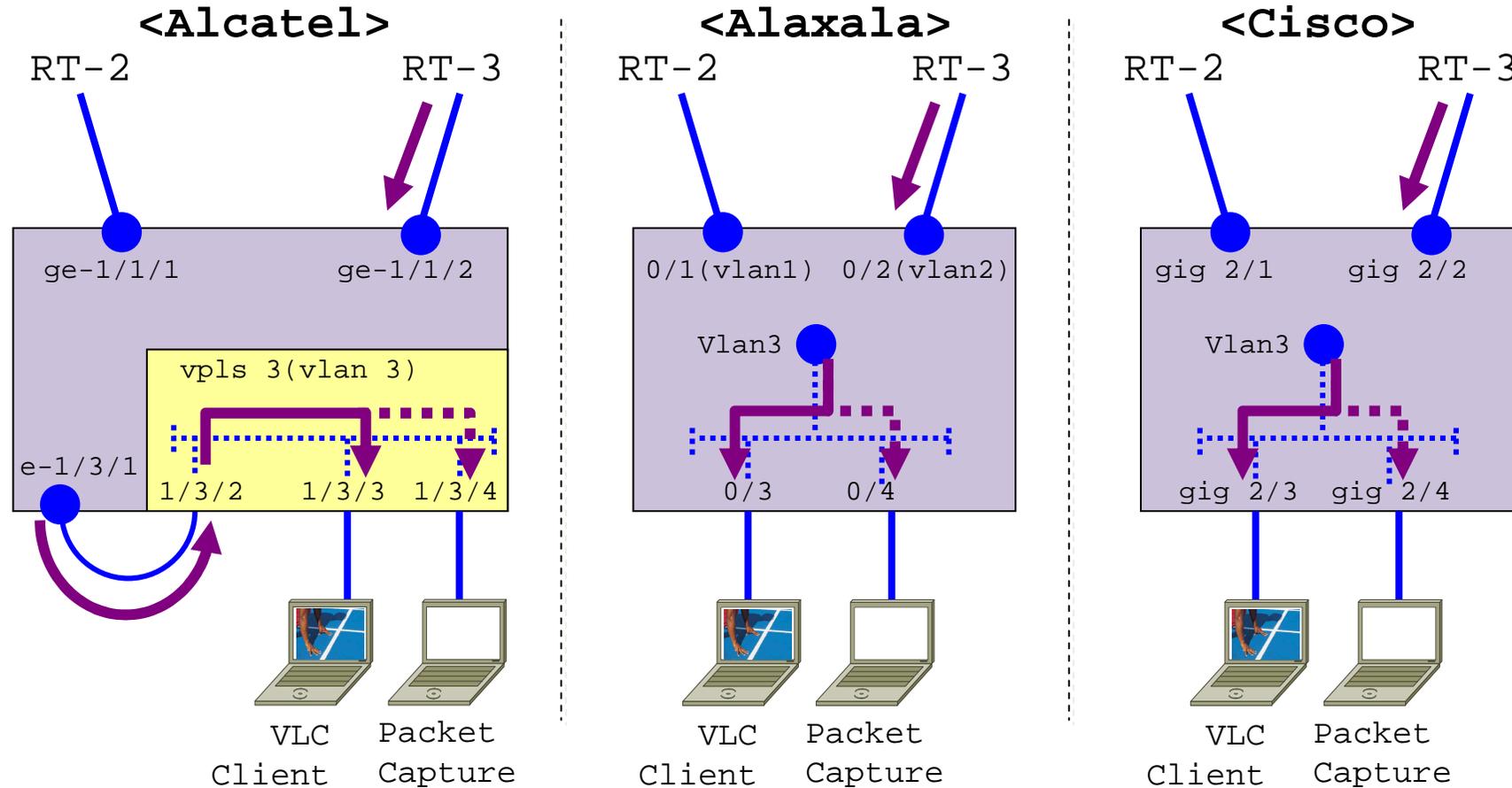
Disable MLD Snooping and confirm multicast packets are flooded.

Disabling/Enabling MLD-Snooping

- ## Alcatel :

```
ALU # configure service vpls 3 mld-snooping shutdown
ALU # configure service vpls 3 mld-snooping no shutdown
```

- ## Alaxala :

```
Alaxala(config)# no ipv6 mld snooping
Alaxala(config)# ipv6 mld snooping
```

- ## Cisco :

```
cisco(config)#no ipv6 mld snooping
cisco(config)#ipv6 mld snooping
```

PIM Route Failover

PIM Route Failover

Shutdown the uplink, and check PIM route failover.

RP:2001::2

(*,G)Tree

RT-XX

RT-2

(2001:1:10::10, FF18::1:1)

(Sx,Gx)Tree

MLD report
Join(*,FF18::1:1)

RT-1

Mcast
traffic

RT-3
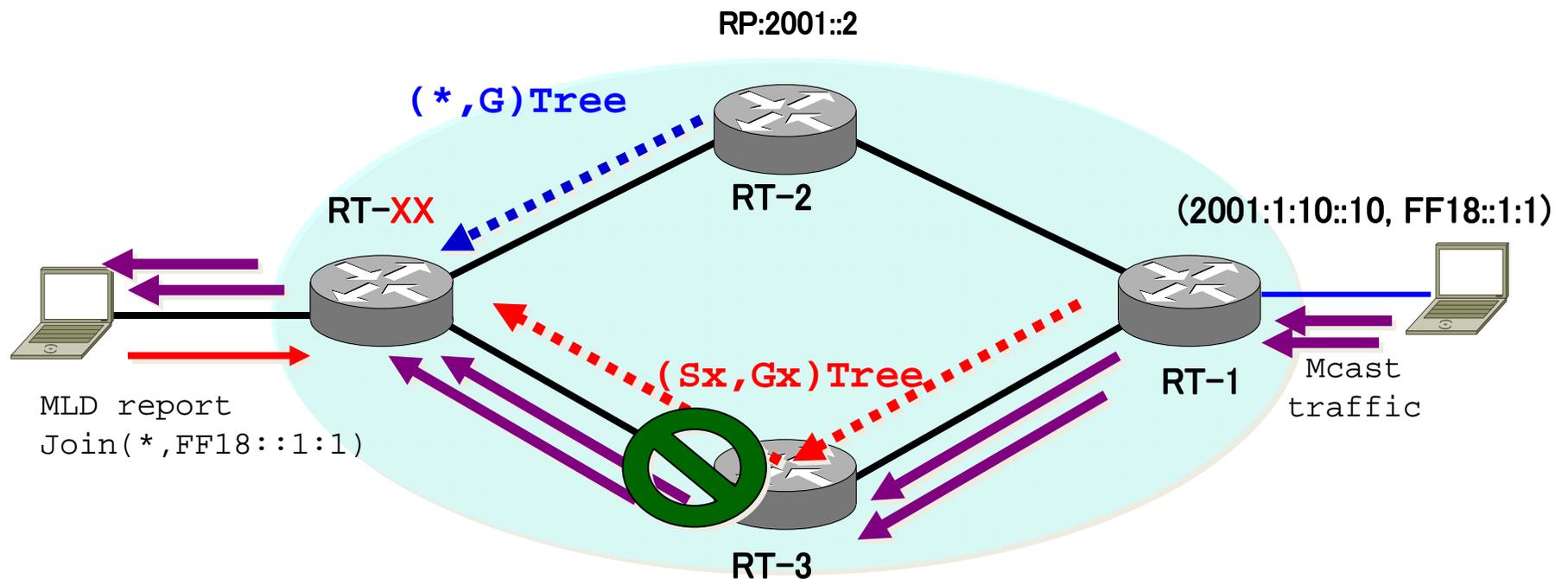
Check how PIM distribution tree has been changed.
"show router pim group ipv6"/ "show ipv6 mroute"

PIM Route Failover process

RP:2001::2

5.(S,G)Join

6.(S,G)Join

RT-2

(2001:1:10::10, FF18::1:1)

7

7

RT-XX

4.(S,G)Prune

Receiver

2.Unicast route change
3.multicast RPF change

RT-1

Mcast
traffic

RT-3

1.Port down

•••► (∗,G) Tree

•••► OLD (S,G) Tree

•••► New (S,G) Tree
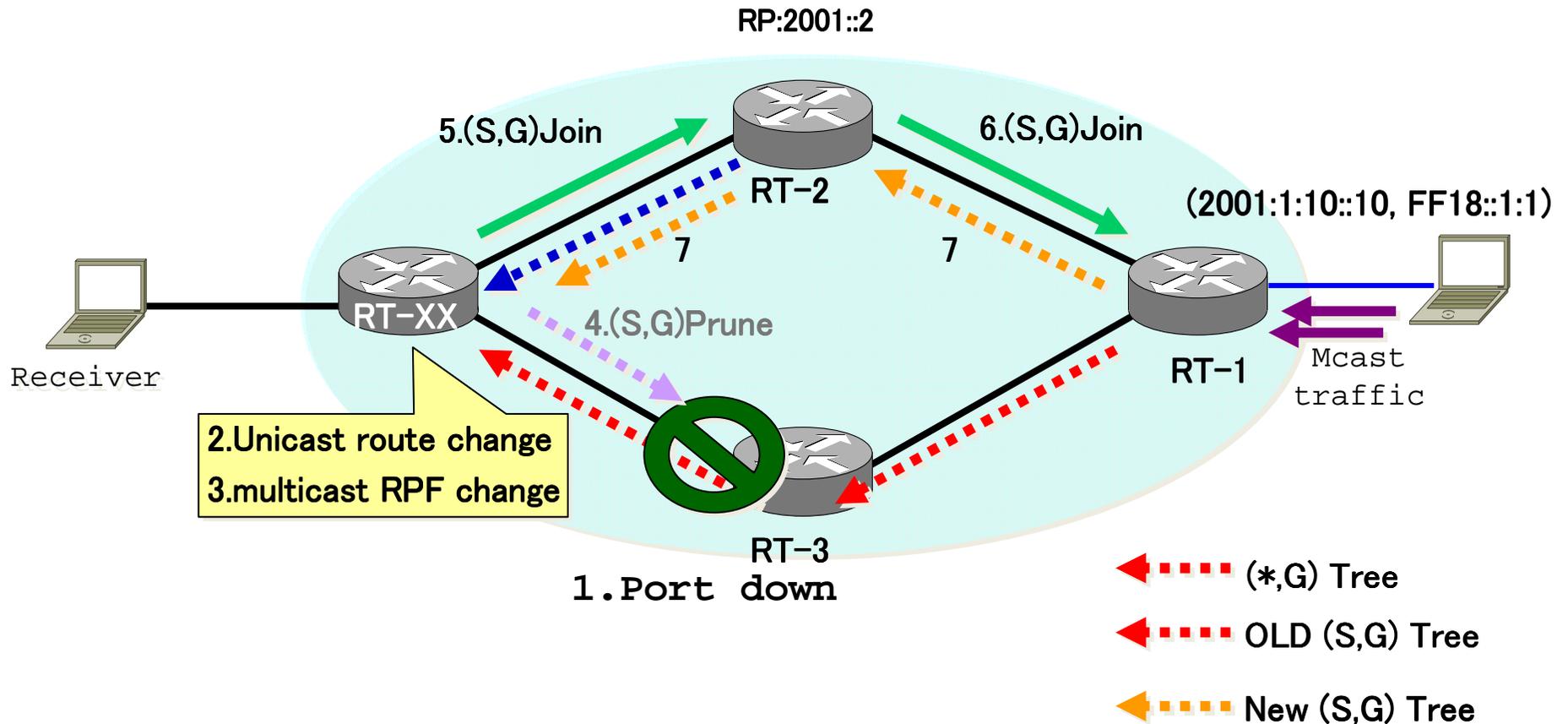
Advanced Course
PIM DR behavior

PIM DR

Enable(no shutdown) the port between RT-XXs, and configure mrouter port on Alaxala.

- ## Alcatel :

```
ALU # configure port 1/3/5 no shutdown
ALU # configure service vpls 3 mld-snooping shutdown
```

- ## Alaxala :

```
Alaxala(config)# interface gigabitethernet 0/5
Alaxala(config-if)# no shutdown
Alaxala(config)# interface vlan 3
Alaxala(config-if)# ipv6 mld snooping mrouter interface gigabitethernet 0/5
```

- ## Cisco :

```
cisco(config)#interface gigabitEthernet 2/5
cisco(config-if)#no shutdown
```

PIM DR

RT-2   RT-3   RT-2   RT-3

0/1(vlan1) 0/2(vlan2)   0/1(vlan1) 0/2(vlan2)

Vlan3   Vlan3
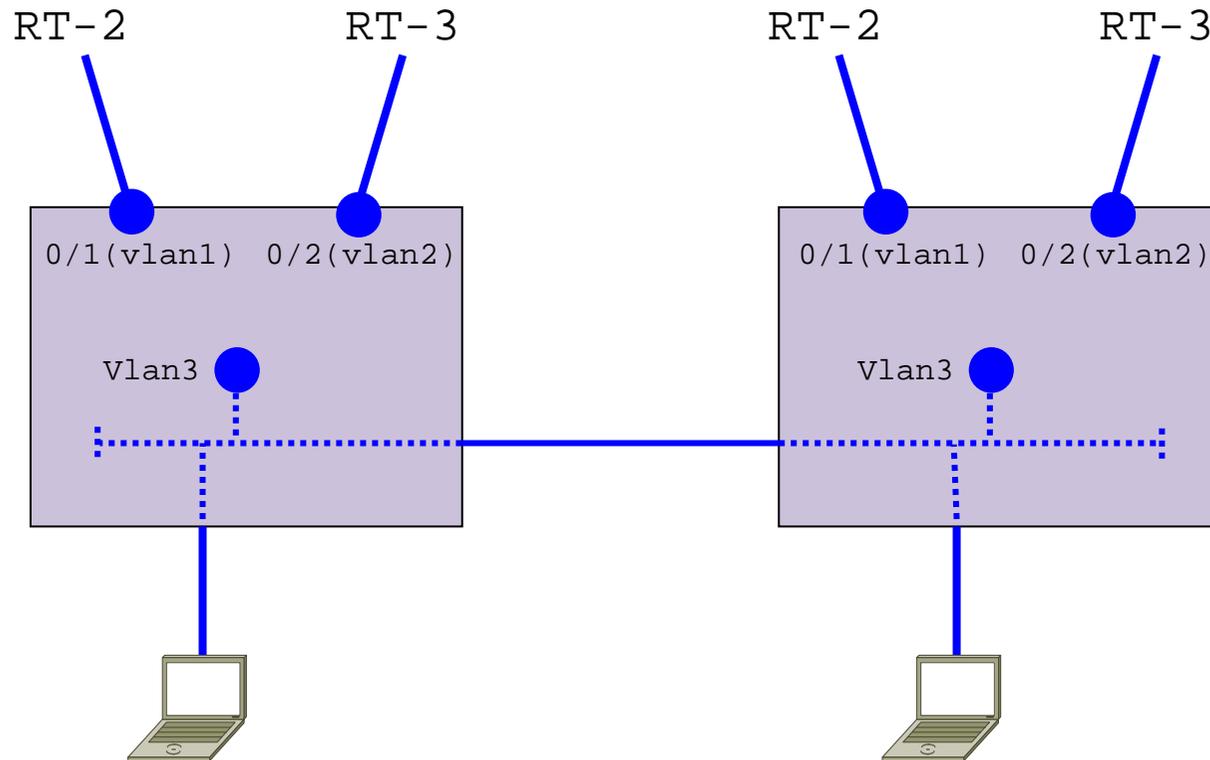
◆Which router become DR ?

◆Which router become MLD Querier ?

◆Which router is forwarding multicast traffic ?

Advanced Course

useful command: Static MLD Join

Emulates joined client even if no real client on the port.

Static MLD Join

- ### Alcatel :

```
ALU # configure router mld
ALU>config>router>mld# interface e-1/3/1
ALU>config>router>mld>if# static group ff18::1:1 starg
<configure emulated joined status for ASM group(FF18::1:1) with "starg" option.(not specify source).>
ALU>config>router>mld>if# static group ff38::2:1 source 2001:1:10::10
<configure emulated joined status for SSM group(2001:1:10::10, FF18::1:1) with specifying source address>
```

- ### Cisco :

```
cisco(config)#interface vlan 3
cisco(config-if)#ipv6 mld static-group ff18::1:1
< configure emulated joined status for ASM group(FF18::1:1) >
cisco(config-if)# ipv6 mld static-group ff38::2:1 2001:1:10::10
< configure emulated joined status for SSM group(2001:1:10::10, FF18::1:1) with specifying source address >
```

Static MLD Join

- Alaxala :

```
Alaxala(config)# ipv6 access-list asm-static
Alaxala(config-ipv6-acl)# permit ipv6 any host ff18::1:1
Alaxala(config-ipv6-acl)# exit
<Configure group address in ACL "asm-static">
Alaxala(config)# interface vlan 3
Alaxala(config-if)# ipv6 mld static-group asm-static
<configure static-group on the interface. >
Alaxala# ipv6 access-list ssm-static
Alaxala(config-ipv6-acl)# permit ipv6 any host ff38::2:1
<Configure group address in ACL "ssm-static">
Alaxala(config)# ipv6 mld ssm-map enable
<enable ssm-mapping>
Alaxala(config)# ipv6 mld ssm-map static ssm-static 2001:1:10::10
<configure group-to-srouce mapping>
Alaxala(config)# interface vlan 3
Alaxala(config-if)# ipv6 mld static-group ssm-static
< configure static-group on the interface. >
```

Advanced Course
SSM mapping

Statically map group-address to source-address

useful to support PIM-SSM in MLDv1-Client only environment.

- ## Alcatel :

```
ALU # configure router mld
ALU >config>router>mld# ssm-translate grp-range ff38::2:1 ff38::2:1 source
2001:1:10::10
<Configure group-address range(start/end address) and mapped source address>
```

- ## Alaxala :

```
Alaxala(config)# ipv6 access-list ssm-static
Alaxala(config-ipv6-acl)# permit ipv6 any host ff38::2:1
<configure group-range in ACL "ssm-static" >
Alaxala(config)# ipv6 mld ssm-map enable
<enable ssm-mapping>
Alaxala(config)# ipv6 mld ssm-map static ssm-static 2001:1:10::10
<configure mapped source-address for the group-range "ssm-static" >
Alaxala(config-if)# exit
```

- ## Cisco :

```
cisco(config)#ipv6 access-list ssm-test
cisco(config-ipv6-acl)#permit ipv6 any host ff38::2:1
< configure group-range in ACL "ssm-test" >
cisco(config)#ipv6 mld ssm-map enable
<enable ssm-mapping>
cisco(config)#ipv6 mld ssm-map static ssm-test 2001:1:10::10
< configure mapped source-address for the group-range "ssm-test" >
```

Useful command: static mroute

Static route only used for multicast to decide RPF neighbor, without any effect for Unicast routing.

It's useful to change multicast RPF without unicast routing change.

RP:2001::2

(*,G)Tree

RT-**XX**

RT-2

(2001:1:10::10, FF18::1:1)

(Sx,Gx)Tree

RT-1

MLD report
Join(*,FF18::1:1)

Mcast
traffic

Configure the mroute(mcast-ipv6 route) for 2001:1:10::10/128 as next-hoop=RT-2(2001:2:XX::2)

RT-3
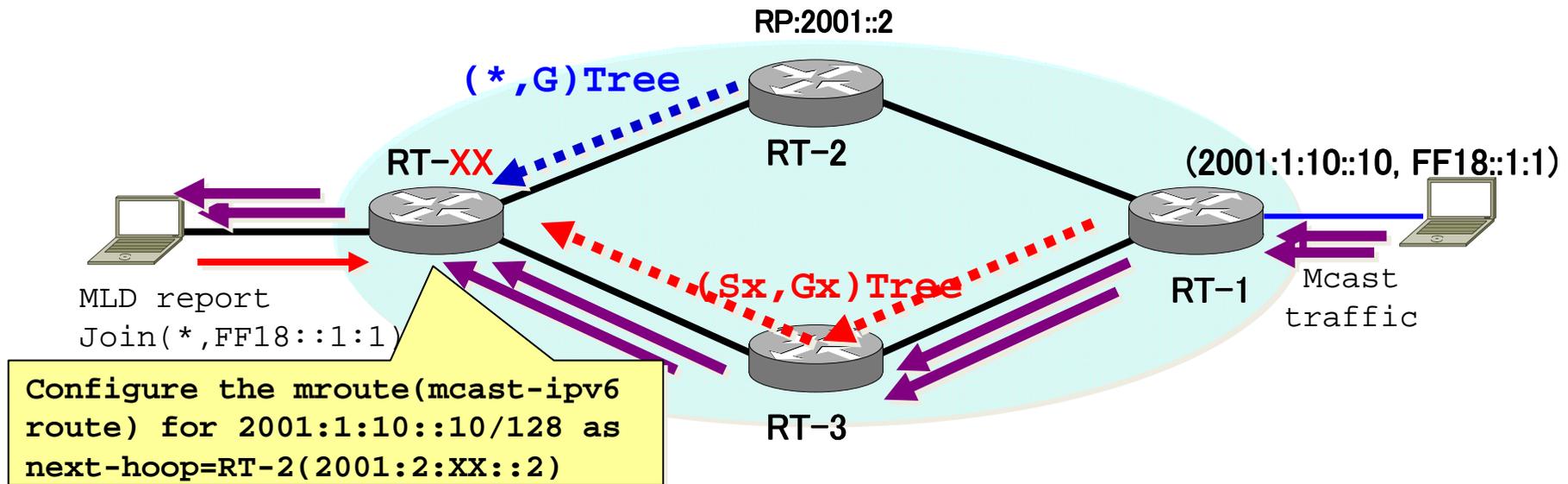
```
ALU # configure router static-route 2001:1:10::10/128 next-hop 2001:2:XX::2
mcast-ipv6

cisco(config)#ipv6 route 2001:1:10::10/128 2001:2:XX::2 multicast
```

How to trouble-shoot multicast

- Check the source sending multicast traffic correctly.
    - It has enough TTL value ?(in some apps, default TTL set to 1)
    - Source/Group Address is correct ?

- Check the status from Receiver side towards Source/RP side.
    - MLD entry is created on LHR correctly ?
    - LHR has PIM Neighbor entry ?
    - PIM entry(mroute) is created on LHR correctly ?
    - RPF Neighbor/Interface is expected one ?
    - LHR is sending Join to RPF Neighbor ?
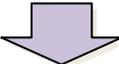
    - PIM entry(mroute) is created on upstream router correctly ?
    - RPF Neighbor/Interface is expected one on upstream router ?
    - Upstream router is sending Join to RPF Neighbor ?
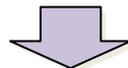
    Repeat the check on each router towards the Source

Debug commands

- ## Alcatel :

```
ALU # debug router pim jp
ALU # debug router pim packet
ALU # debug router pim db
ALU # debug router mld packet
```

- ## Alaxala :

```
Alaxala# show tcpdump interface vlan 3 detail | grep multicast
Alaxala# show tcpdump interface vlan 3 detail | grep pim
Alaxala# show tcpdump interface vlan 3 detail | grep ip6
```

- ## Cisco :

```
cisco#debug ipv6 pim group
cisco#debug ipv6 mrib route
cisco#debug ipv6 mld group
```

www.alcatel-lucent.com