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Chapter 1 IPv4 Multicast Protocol

1.1 IPv4 Multicast Protocol Overview

This chapter will give an introduction to the configuration of IPv4 Multicast Protocol.

1.1.1 Introduction to Multicast

Various transmission modes can be adopted when the destination of packet (including data, sound and video) transmission is the minority users in the network. One way is to use Unicast mode, i.e. to set up a separate data transmission path for each user; or, to use Broadcast mode, which is to send messages to all users in the network, and they will receive the Broadcast messages no matter they need or not. For example, if there are 200 users in a network who want to receive the same packet, then the traditional solution is to send this packet for 200 times separately via Unicast to guarantee the users who need the data can get all data wanted, or send the data in the entire domain via Broadcast. Transferring the data in the whole range of network. The users who need these data can get directly from the network. Both modes waste a great deal of valuable bandwidth resource, and furthermore, Broadcast mode goes against the security and secrecy.

The emergence of IP Multicast technology solved this problem in time. The Multicast source only sends out the message once, Multicast Routing Protocol sets up tree-routing for Multicast data packet, and then the transferred packet just starts to be duplicated and distributed in the bifurcate crossing as far as possible. Thus the packet can be sent to every user who needs it accurately and effectively.

It should be noticed that it is not necessary for Multicast source to join in Multicast group. It sends data to some Multicast groups, but it is not necessarily a receiver of the group itself. There can be more than one source sending packets to a Multicast group simultaneously. There may exist routers in the network which do not support Multicast, but a Multicast router can encapsulate the Multicast packets into Unicast IP packets with tunnel mode to send them to the Multicast router next to it, which will take off the Unicast IP header and continue the Multicast transmission process, thus a big alteration of network structure is avoided. The primary advantages of Multicast are:

1. Enhance efficiency: reduce network traffic, lighten the load of server and CPU
2. Optimize performance: reduce redundant traffic
3. Distributed application: Enable Multipoint Application

1.1.2 Multicast Address

The destination address of Multicast message uses class D IP address with range from 224.0.0.0 to 239.255.255.255. D class address can not appear in the source IP address field of an IP message. In the process of Unicast data transmission, the transmission path of a data packet is from source address routing to destination address, and the transmission is performed with hop-by-hop principle. However, in IP Multicast environment, the destination addresses is a group instead of a single one, they form a group address. All message receivers will join in a group, and once they do, the data flowing to the group address will be sent to the receivers immediately and all members in the group will receive the data packets. The members in a Multicast group are dynamic, the hosts can join and leave the Multicast group at any time.

Multicast group can be permanent or temporary. Some of the Multicast group addresses are assigned officially; they are called Permanent Multicast Group. Permanent Multicast Group keeps its IP address fixed but its member structure can vary within. The member amount of Permanent Multicast Group can be arbitrary, even zero. The IP Multicast addresses which are not kept for use by Permanent Multicast Group can be utilized by temporary Multicast groups.

224.0.0.0 ~ 224.0.0.255 are reserved Multicast addresses (Permanent Group Address), address 224.0.0.0 is reserved but not assigned, and other addresses are used by Routing Protocol; 224.0.1.0 ~ 238.255.255.255 are Multicast addresses available to users (Temporary Group Address) and are valid in the entire domain of the network; 239.0.0.0 ~ 239.255.255.255 are local management Multicast addresses, which are valid only in specific local domain. Frequently used reserved multicast address list is as follows:

- Benchmark address (reserved)
- 224.0.0.1 Address of all hosts
- 224.0.0.2 Address of all Multicast Routers
- 224.0.0.3 Unassigned
- 224.0.0.4 DVMRP Router
- 224.0.0.5 OSPF Router
- 224.0.0.6 OSPF DR
- 224.0.0.7 ST Router
- 224.0.0.8 ST host
- 224.0.0.9 RIP-2 Router
- 224.0.0.10 IGRP Router
- 224.0.0.11 Active Agent
- 224.0.0.12 DHCP Server/Relay Agent
- 224.0.0.13 All PIM Routers
- 224.0.0.14 RSVP Encapsulation
- 224.0.0.15 All CBT Routers
- 224.0.0.16 Specified SBM
- 224.0.0.17 All SBMS

224.0.0.18 VRRP

224.0.0.22 IGMP

When Ethernet transmits Unicast IP messages, the destination MAC address it uses is the receiver's MAC address. But in transmitting Multicast packets, the transmission destination is not a specific receiver any more, but a group with uncertain members, thus Multicast MAC address is used. Multicast MAC address is corresponding to Multicast IP address. It is prescribed in IANA (Internet Assigned Number Authority) that the higher 25 bits in Multicast MAC address is 0x01005e, and the lower 23bits in MAC address is the lower 23bits in Multicast IP address.

Since only 23bits out of the lower 28bits in IP Multicast address are mapped into MAC address, therefore there are 32 IP Multicast addresses which are mapped into the same MAC address.

1.1.3 IP Multicast Packet Transmission

In Multicast mode, the source host sends packets to the host group indicated by the Multicast group address in the destination address field of IP data packet. Unlike Unicast mode, Multicast data packet must be forwarded to a number of external interfaces to be sent to all receiver sites in Multicast mode, thus Multicast transmission procedure is more complicated than Unicast transmission procedure.

In order to guarantee that all Multicast packets get to the router via the shortest path, the receipt interface of the Multicast packet must be checked in some certain way based on Unicast router table; this checking mechanism is the basis for most Multicast Routing Protocol to forward in Multicast mode --- RPF (Reverse Path Forwarding) check. Multicast router makes use of the impressed packet source address to query Unicast Router Table or independent Multicast Router Table to determine if the packet ingress interface is on the shortest path from receipt site to source address. If shortest path Tree is used, then the source address is the address of source host which sends Multicast Data Packets; if Shared Tree is used, then the source address is the address of the root of the Shared-Tree. When Multicast data packet gets to the router, if RPF check passes, then the data packet is forwarded according to Multicast forward item, and the data packet will be discarded else wise.

1.1.4 IP Multicast Application

IP Multicast technology has effectively solved the problem of sending in single point and receiving in multipoint. It has achieved the effective data transmission from a point to multiple points, saved a great deal of network bandwidth and reduced network load. Making use of the Multicast property of network, some new value-added operations can be supplied conveniently. In Information Service areas such as online living broadcast, network TV, remote education, remote medicine, real time video/audio meeting, the following applications may be supplied:

- 1) Application of Multimedia and Streaming Media

- 2) Data repository, finance application (stock) etc
- 3) Any data distribution application of “one point to multiple points”

In the situation of more and more multimedia operations in IP network, Multicast has tremendous market potential and Multicast operation will be generalized and popularized.

1.2 DCSCM

1.2.1 Introduction to DCSCM

DCSCM (Destination control and source control multicast) technology mainly includes three aspects, i.e. Multicast Packet Source Controllable, Multicast User Controllable and Service-Oriented Priority Strategy Multicast.

The Multicast Packet Source Controllable technology of Security Controllable Multicast technology is mainly processed in the following manners:

- 1 . On the edge switch, if source under-control multicast is configured, then only multicast data from specified group of specified source can pass.
- 2 . For RP switch in the core of PIM-SM, for REGISTER information out of specified source and specified group, REGISTER_STOP is transmitted directly and table entry is not allowed to set up. (This task is implemented in PIM-SM model).

The implement of Multicast User Controllable technology of Security Controllable Multicast technology is based on the control over IGMP report message sent out by the user, thus the model being controlled is IGMP snooping and IGMP model, of which the control logic includes the following three, i.e. to take control based on VLAN+MAC address transmitting packets, to take control based on IP address of transmitting packets and to take control based on the port where messages enter, in which IGMP snooping can use the above three methods to take control simultaneously, while since IGMP model is located at layer 3, it only takes control over the IP address transmitting packets.

The Service-Oriented Priority Strategy Multicast of Security Controllable technology adopts the following mode: for multicast data in limit range, set the priority specified by the user at the join-in end so that data can be sent in a higher priority on TRUNK port, consequently guarantee the transmission is processed in user-specified priority in the entire network.

1.2.2 DCSCM Configuration Task List

- 1 . Source Control Configuration
- 2 . Destination Control Configuration
- 3 . Multicast Strategy Configuration

1 . Source Control Configuration

Source Control Configuration has three parts, of which the first is to enable source

control. The command of source control is as follows:

Command	Explanation
Global Configuration Mode	
[no] ip multicast source-control (Required)	Enable source control globally, the “ no ip multicast source-control ” command disables source control globally. It is noticeable that, after enabling source control globally, all multicast packets are discarded by default. All source control configuration can not be processed until that it is enabled globally, while source control can not be disabled until all configured rules are disabled.

The next is to configure the rule of source control. It is configured in the same manner as for ACL, and uses ACL number of 5000-5099, every rule number can be used to configure 10 rules. It is noticeable that these rules are ordered, the front one is the one which is configured the earliest. Once the configured rules are matched, the following rules won't take effect, so rules of globally allow must be put at the end. The commands are as follows:

Command	Explanation
Global Configuration Mode	
[no] access-list <5000-5099> {deny permit} ip {{<source> <source-wildcard>}{host-source <source-host-ip>} any-source} {{<destination> <destination-wildcard>}{host-destination <destination-host-ip>} any-destination}	The rule used to configure source control. This rule does not take effect until it is applied to specified port. Using the NO form of it can delete specified rule.

The last is to configure the configured rule to specified port.

Note: If the rules being configured will occupy the table entries of hardware, configuring too many rules will result in configuration failure caused by bottom table entries being full, so we suggest user to use the simplest rules if possible. The configuration rules are as follows:

Command	Explanation
Port Configuration Mode	
[no] ip multicast source-control access-group <5000-5099>	Used to configure the rules source control uses to port, the NO form cancels the configuration.

2 . Destination Control Configuration

Like source control configuration, destination control configuration also has three steps.

First, enable destination control globally. Since destination control need to prevent unauthorized user from receiving multicast data, the switch won't broadcast the multicast data it received after configuring global destination control. Therefore, It should be avoided to connect two or more other Layer 3 switches in the same VLAN on a switch on which destination control is enabled. The configuration commands are as follows:

Command	Explanation
Global Configuration Mode	
[no] multicast destination-control (required) Globally enable destination control. The no operation of this command will globally disable destination control. All of the other configuration can only take effect after globally enabled. The next is configuring destination control rules, which are similar.	

Next is to configure the multicast destination control profile rule list and use the profile-id number of 1-50.

Command	Explanation
Global Configuration Mode	
profile-id <1-50> {deny permit} {{<source/M> } {host-source <source-host-ip> (range <2-65535>)} any-source} {{<destination/M> } {host-destination <destination-host-ip> (range <2-255>)} any-destination} no profile-id <1-50>	Configure the destination control profile rule. The no command deletes it.

Then is to configure destination control rule. It is similar to source control, except to use ACL No. of 6000-7999.

Command	Explanation
Global Configuration Mode	
[no] access-list <6000-7999> {{{add delete} profile-id WORD} {{deny permit} (ip) {{<source/M> } {host-source <source-host-ip> (range <2-65535>)} any-source} {{<destination/M> } {host-destination <destination-host-ip> (range <2-255>)} any-destination}}}	The rule used to configure destination control. This rule does not take effect until it is applied to source IP or VLAN-MAC and port. Using the NO form of it can delete specified rule.

The last is to configure the rule to specified source IP, source VLAN MAC or specified port. It is noticeable that, due to the above situations, these rules can only be used globally in enabling IGMP-SNOOPING. And if IGMP-SNOOPING is not enabled, then only source IP rule can be used under IGMP Protocol. The configuration commands are as follows:

Command	Explanation
Port Configuration Mode	
[no] ip multicast destination-control access-group <6000-7999>	Used to configure the rules destination control uses to port, the NO form cancels the configuration.
Global Configuration Mode	
[no] ip multicast destination-control <1-4094> <macaddr> access-group <6000-7999>	Used to configure the rules destination control uses to specify VLAN-MAC, the NO form cancels the configuration.
[no] ip multicast destination-control <IPADDRESS/M> access-group <6000-7999>	Used to configure the rules destination control uses to specified IP address/net mask, the NO form cancels the configuration.

3 . Multicast Strategy Configuration

Multicast Strategy uses the manner of specifying priority for specified multicast data to achieve and guarantee the effects the specific user requires. It is noticeable that multicast data can not get a special care all along unless the data are transmitted at TRUNK port. The configuration is very simple, it has only one command, i.e. to set priority for the specified multicast. The commands are as follows:

Command	Explanation
Global Configuration Mode	
[no] ip multicast policy <IPADDRESS/M> <IPADDRESS/M> cos <priority>	Configure multicast strategy, specify priority for sources and groups in specific range, and the range is <0-7>.

1.2.3 DCSCM Configuration Examples

1 . Source Control

In order to prevent an Edge Switch from putting out multicast data ad asbitsium, we configure Edge Switch so that only the switch at port Ethernet1/0/5 is allowed to transmit multicast, and the data group must be 225.1.2.3. Also, switch connected up to port Ethernet1/0/10 can transmit multicast data without any limit, and we can make the following configuration.

```

EC(config)#access-list 5000 permit ip any host 225.1.2.3
EC(config)#access-list 5001 permit ip any any
EC(config)#ip multicast source-control
EC(config)#interface ethernet1/0/5
EC(Config-If-Ethernet1/0/5)#ip multicast source-control access-group 5000
EC(config)#interface ethernet1/0/10
EC(Config-If-Ethernet1/0/10)#ip multicast source-control access-group 5001
    
```


2 . Destination Control

We want to limit users with address in 10.0.0.0/8 network segment from entering the group of 238.0.0.0/8, so we can make the following configuration:

Firstly enable IGMP snooping in the VLAN it is located (Here it is assumed to be in VLAN2)

```
EC(config)#ip igmp snooping
```

```
EC(config)#ip igmp snooping vlan 2
```

After that, configure relative destination control access-list, and configure specified IP address to use that access-list.

```
Switch(config)#access-list 6000 deny ip any 238.0.0.0 0.255.255.255
```

```
Switch(config)#access-list 6000 permit ip any any
```

```
Switch(config)#multicast destination-control
```

```
Switch(config)#ip multicast destination-control 10.0.0.0/8 access-group 6000
```

In this way, users of this network segment can only join groups other than 238.0.0.0/8.

Or configure the destination control access-list by adding the profile list.

```
Switch (config)#profile-id 1 deny ip any 238.0.0.0 0.255.255.255
```

```
Switch (config)#access-list 6000 add profile-id 1
```

```
Switch (config)#multicast destination-control
```

```
Switch (config)#ip multicast destination-control 10.0.0.0/8 access-group 6000
```

3 . Multicast strategy

Server 210.1.1.1 is distributing important multicast data on group 239.1.2.3, we can configure on its join-in switch as follows:

```
Switch(config)#ip multicast policy 210.1.1.1/32 239.1.2.3/32 cos 4
```

In this way, the multicast stream will have a priority of value 4 (Usually this is pretty higher, the higher possible one is protocol data; if higher priority is set, when there is too many multicast data, it might cause abnormal behavior of the switch protocol) when it gets to other switches through this switch.

1.2.4 DCSCM Troubleshooting

The effect of DCSCM module itself is similar to ACL, and the problems occurred are usually related to improper configuration. Please read the descriptions above carefully. If you still can not determine the cause of the problem, please send your configurations and the effects you expect to the after-sale service staff of our company.

1.3 IGMP Snooping

1.3.1 Introduction to IGMP Snooping

IGMP (Internet Group Management Protocol) is a protocol used in IP multicast. IGMP is used by multicast enabled network device (such as a router) for host

membership query, and by hosts that are joining a multicast group to inform the router to accept packets of a certain multicast address. All those operations are done through IGMP message exchange. The router will use a multicast address (224.0.0.1) that can address to all hosts to send an IGMP host membership query message. If a host wants to join a multicast group, it will reply to the multicast address of that a multicast group with an IGMP host membership reports a message.

IGMP Snooping is also referred to as IGMP listening. The switch prevents multicast traffic from flooding through IGMP Snooping, multicast traffic is forwarded to ports associated to multicast devices only. The switch listens to the IGMP messages between the multicast router and hosts, and maintains multicast group forwarding table based on the listening result, and can then decide to forward multicast packets according to the forwarding table.

Switch provides IGMP Snooping and is able to send a query from the switch so that the user can use switch in IP multicast.

1.3.2 IGMP Snooping Configuration Task List

1. Enable IGMP Snooping
2. Configure IGMP Snooping

1. Enable IGMP Snooping

Command	Explanation
Global Mode	
ip igmp snooping no ip igmp snooping	Enables IGMP Snooping. The no operation disables IGMP Snooping function.

2. Configure IGMP Snooping

Command	Explanation
Global Mode	
ip igmp snooping vlan <vlan-id> no ip igmp snooping vlan <vlan-id>	Enables IGMP Snooping for specified VLAN. The no operation disables IGMP Snooping for specified VLAN.
ip igmp snooping proxy no ip igmp snooping proxy	Enable IGMP Snooping proxy function, the no command disables the function.
ip igmp snooping vlan < vlan-id > limit {group <g_limit> source <s_limit>} no ip igmp snooping vlan < vlan-id > limit	Configure the max group count of vlan and the max source count of every group. The “no ip igmp snooping vlan <vlan-id> limit” command cancels this configuration.

<pre>ip igmp snooping vlan <1-4094> interface (ethernet port-channel) IFNAME limit {group <1-65535> source <1-65535>} strategy (replace drop) no ip igmp snooping vlan <1-4094> interface (ethernet port-channel) IFNAME limit group source strategy</pre>	<p>Configure the number of groups which are allowed joining and the maximum of the source in each group under the IGMP Snooping port. Configure the strategy when it is up to the upper limit, including “replace” and “drop”. No command configures as “no limitation”.</p>
<pre>ip igmp snooping vlan <vlan-id> I2- general-querier no ip igmp snooping vlan <vlan-id> I2- general-querier</pre>	<p>Set this vlan to layer 2 general querier. It is recommended to configure a layer 2 general querier on a segment. The “no ip igmp snooping vlan <vlan-id> I2-general-querier” command cancels this configuration.</p>
<pre>ip igmp snooping vlan <vlan-id> I2- general-querier-version <version></pre>	<p>Configure the version number of a general query from a layer 2 general querier.</p>
<pre>ip igmp snooping vlan <vlan-id> I2- general-querier-source <source></pre>	<p>Configure the source address of a general query from a layer 2 general querier.</p>
<pre>ip igmp snooping vlan <vlan-id> mrouter-port interface <interface - name> no ip igmp snooping vlan <vlan-id> mrouter-port interface <interface - name></pre>	<p>Configure static mrouter port of vlan. The no form of the command cancels this configuration.</p>
<pre>ip igmp snooping vlan <vlan-id> mrouter-port learnpim no ip igmp snooping vlan <vlan-id> mrouter-port learnpim</pre>	<p>Enable the function that the specified VLAN learns mrouter-port (according to pim packets), the no command will disable the function.</p>
<pre>ip igmp snooping vlan <vlan-id> mrpt <value > no ip igmp snooping vlan <vlan-id> mrpt</pre>	<p>Configure this survive time of mrouter port. The “no ip igmp snooping vlan <vlan-id> mrpt” command restores the default value.</p>
<pre>ip igmp snooping vlan <vlan-id> query- interval <value> no ip igmp snooping vlan <vlan-id> query-interval</pre>	<p>Configure this query interval. The “no ip igmp snooping vlan <vlan-id> query-interval” command restores the default value.</p>
<pre>ip igmp snooping vlan <vlan-id> immediately-leave no ip igmp snooping vlan <vlan-id> immediately-leave</pre>	<p>Enable the IGMP fast leave function for the specified VLAN: the “no ip igmp snooping vlan <vlan-id> immediate-leave” command disables the IGMP fast leave function.</p>

<pre>ip igmp snooping vlan <vlan-id> query- mrsp <value> no ip igmp snooping vlan <vlan-id> query-mrsp</pre>	<p>Configure the maximum query response period. The “no ip igmp snooping vlan <vlan-id> query-mrsp” command restores to the default value.</p>
<pre>ip igmp snooping vlan <vlan-id> query- robustness <value> no ip igmp snooping vlan <vlan-id> query-robustness</pre>	<p>Configure the query robustness. The “no ip igmp snooping vlan <vlan-id> query-robustness” command restores to the default value.</p>
<pre>ip igmp snooping vlan <vlan-id> suppression-query-time <value> no ip igmp snooping vlan <vlan-id> suppression-query-time</pre>	<p>Configure the suppression query time. The “no ip igmp snooping vlan <vlan-id> suppression-query-time” command restores to the default value.</p>
<pre>ip igmp snooping vlan <vlan-id> static- group <A.B.C.D> [source <A.B.C.D>] interface [ethernet port-channel] <IFNAME> no ip igmp snooping vlan <vlan-id> static-group <A.B.C.D> [source <A.B.C.D>] interface [ethernet port- channel] <IFNAME></pre>	<p>Configure static-group on specified port of the VLAN. The no form of the command cancels this configuration.</p>
<pre>ip igmp snooping vlan <vlan-id> report source-address <A.B.C.D> no ip igmp snooping vlan <vlan-id> report source-address</pre>	<p>Configure forwarding IGMP packet source address, The no operation cancels the packet source address.</p>
<pre>ip igmp snooping vlan <vlan-id> specific-query-mrsp <value> no ip igmp snooping vlan <vlan-id> specific-query-mrspt</pre>	<p>Configure the maximum query response time of the specific group or source, the no command restores the default value.</p>

1.3.3 IGMP Snooping Examples

Scenario 1: IGMP Snooping function

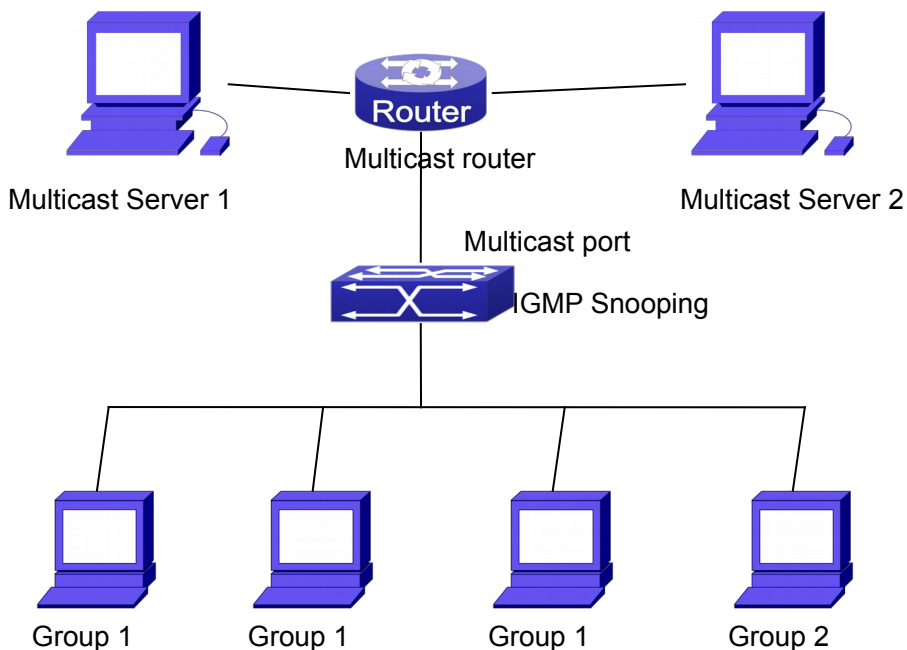


Fig 1-1 Enabling IGMP Snooping function

Example: As shown in the above figure, a VLAN 100 is configured in the switch and includes ports 1, 2, 6, 10 and 12. Four hosts are connected to port 2, 6, 10 and 12 respectively and the multicast router is connected to port 1. As IGMP Snooping is disabled by default either in the switch or in the VLANs, If IGMP Snooping should be enabled in VLAN 100, the IGMP Snooping should be first enabled for the switch in Global Mode and in VLAN 100 and set port 1 of VLAN 100 to be the mrouter port.

The configuration steps are listed below:

```
Switch(config)#ip igmp snooping
Switch(config)#ip igmp snooping vlan 100
Switch(config)#ip igmp snooping vlan 100 mrouter interface ethernet 1/0/1
```

Multicast Configuration

Suppose two programs are provided in the Multicast Server using multicast address Group1 and Group2, three of four hosts running multicast applications are connected to port 2, 6, 10 plays program1, while the host is connected to port 12 plays program 2.

IGMP Snooping listening result:

The multicast table built by IGMP Snooping in VLAN 100 indicates ports 1, 2, 6, 10 in Group1 and ports 1, 12 in Group2.

All the four hosts can receive the program of their choice: ports 2, 6, 10 will not receive the traffic of program 2 and port 12 will not receive the traffic of program 1.

Scenario 2: L2-general-querier

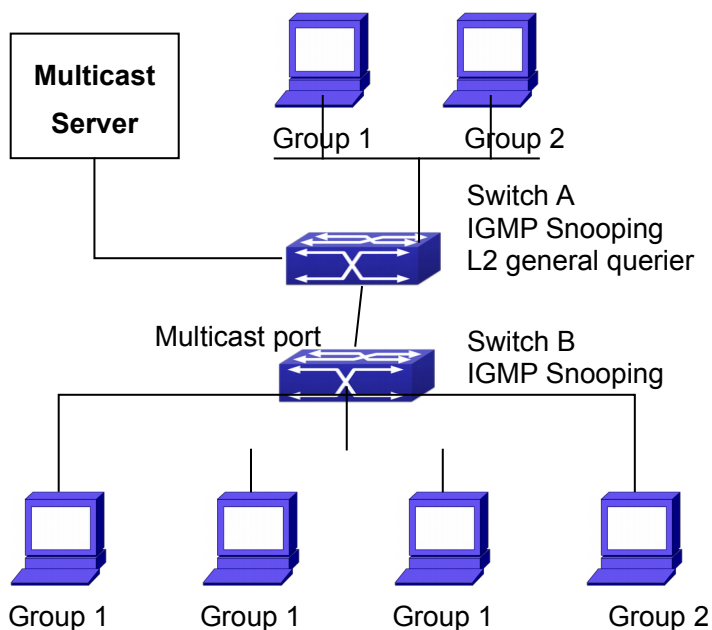


Fig 1-2 The switches as IGMP Queries

The configuration of Switch2 is the same as the switch in scenario 1, SwitchA takes the place of Multicast Router in scenario 1. Let's assume VLAN 60 is configured in SwitchA, including ports 1, 2, 10 and 12. Port 1 connects to the multicast server, and port 2 connects to Switch2. In order to send Query at regular interval, IGMP query must be enabled in Global mode and in VLAN60.

The configuration steps are listed below:

```
SwitchA#config
SwitchA(config)#ip igmp snooping
SwitchA(config)#ip igmp snooping vlan 60
SwitchA(config)#ip igmp snooping vlan 60 L2-general-querier
```

```
SwitchB#config
SwitchB(config)#ip igmp snooping
SwitchB(config)#ip igmp snooping vlan 100
SwitchB(config)#ip igmp snooping vlan 100 mrouter interface ethernet 1/0/1
```

Multicast Configuration

The same as scenario 1

IGMP Snooping listening result:

Similar to scenario 1

1.3.4 IGMP Snooping Troubleshooting

On IGMP Snooping function configuration and usage, IGMP Snooping might not run properly because of physical connection or configuration mistakes. So the users should note that:

- ☞ Make sure correct physical connection
- ☞ Activate IGMP Snooping on whole configuration mode (use **ip igmp snooping**)
- ☞ Configure IGMP Snooping at VLAN on whole configuration mode (use **ip igmp snooping vlan <vlan-id>**)
- ☞ Make sure one VLAN is configured as L2 common checker in same mask, or make sure configured static mrouter
- ☞ Use **show ip igmp snooping vlan <vid>** command check IGMP Snooping information

1.4 IGMP Snooping Authentication

1.4.1 Introduction to IGMP Snooping Authentication

IGMP Snooping Authentication is the authentication of the multicast group of client demanding in IGMP Snooping. Only the multicast group of client demanding passes the authentication, it will be successful and the multicast traffic can be received. Otherwise it will be failed. Currently, the authentication is only based on group, the multicast source information authentication in Igmpv3 is not included.

1.4.2 IGMP Snooping Authentication Task List

1. Enable IGMP Snooping
2. Enable IGMP Snooping Authentication
3. Configure IGMP Snooping Authentication
4. Configure Radius

1. Enable IGMP Snooping

Command	Explanation
Global Mode	
ip igmp snooping no ip igmp snooping	Enable IGMP Snooping function, the no command disables it.

2. Enable IGMP Snooping Authentication

Command	Explanation
Port Mode	
igmp snooping authentication enable no igmp snooping authentication enable	Enable the IGMP authentication function on the port. The no command disables it. After enabled IGMP authentication function, the

	port will conduct authentication for the multicast group of client demanding. Only the multicast group of client demanding passes the authentication, it will be successful. Otherwise it will be failed.
--	---

3. Configure IGMP Snooping Authentication

Command	Explanation
Port Mode	
igmp snooping authentication free-rule access-list <6000-7999> no igmp snooping authentication free-rule access-list <6000-7999>	Configure the authentication free-rule access list of the multicast group. The no command deletes it.
Global Mode	
ip igmp snooping authentication radius none no ip igmp snooping authentication radius none	Configure the switch to work with successful authentication when the radius server has no response. The no command recovers the default authentication method, the switch works with failed authentication.
ip igmp snooping authentication forwarding-first no ip igmp snooping authentication forwarding-first	Configure the process procedure of igmp authentication: issue the multicast table entry to the multicast group of client demanding and then conduct authentication. After the authentication is successful, there is no action, if the authentication failed, the issued table entry will be deleted. The no command recovers to be the default method: conducts the authentication first, and issues the table entry after the authentication result is back.
ip igmp snooping authentication timeout <30-30000> no ip igmp snooping authentication timeout	Configure the timeout of the table entry in igmp authentication. The no command recovers to be the default value of 600 seconds.

4. Configure Radius

Command	Explanation
Global Mode	
aaa enable no aaa enable	Enable or disable AAA function.
radius-server key <word> no radius-server key	Configure or delete RADIUS server key.

radius-server authentication host <A.B.C.D>	Configure or delete RADIUS authentication server address.
no radius-server authentication host <A.B.C.D>	

1.4.3 IGMP Snooping Authentication Examples

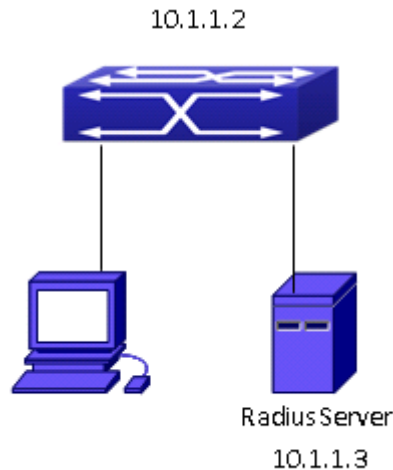


Fig 1-3 IGMP Snooping Authentication

As shown in the above figure, configures VLAN1 including port 1 and VLAN10 including port 2 on the switch. The host is connected to port 1, radius server is connected to port 2. Enables IGMP Snooping on VLAN1, enables igmp authentication on port 1. The switch IP address is configured as 10.1.1.2, and the IP address of radius server is configured as 10.1.1.3.

Configuration steps:

```
Switch#config
Switch(config)#ip igmp snooping
Switch(config)#ip igmp snooping vlan 1
Switch(config)#interface ethernet 1/0/1
Switch(config-if-ethernet1/0/1)#igmp snooping authentication enable
Switch(config-if-ethernet1/0/1)# exit
Switch(config)#ip igmp snooping authentication radius none
Switch(config)#interface vlan 10
Switch(config-if-vlan10)#ip address 10.1.1.2 255.255.255.0
Switch(config-if-vlan10)# exit
Switch(config)#radius-server authentication host 10.1.1.3
Switch(config)#radius-server key test
Switch(config)#aaa enable
```

Chapter 2 IPv6 Multicast Protocol

2.1 MLD Snooping

2.1.1 Introduction to MLD Snooping

MLD, the Multicast Listener Discovery Protocol, is used to realize multicasting in the IPv6. MLD is used by the network equipments such as routers which supports multicast for multicast listener discovery, also used by listeners looking forward to join certain multicast group informing the router to receive data packets from certain multicast address, all of which are done through MLD message exchange. First the router send an MLD Multicast listener Query message through a multicast address which can address all the listeners (namely ff02::1). Once there is a listener who wishes to join the multicast address, it will send a MLD Multicast listener Report back through the multicast address.

MLD Snooping is namely the MLD listening. The switch restricts the multicast traffic from flooding through MLD Snooping, and forward the multicast traffic to ports associated to multicast devices only. The switch listens to the MLD messages between multicast routers and listeners, and maintains the multicast group forwarding list based on the listening result. The switches forwards multicast packets according to the multicast forwarding list

The switch realizes the MLD Snooping function while supporting MLD v2. This way, the user can acquire IPv6 multicast with the switch.

2.1.2 MLD Snooping Configuration Task

1. Enable the MLD Snooping function
2. Configure the MLD Snooping

1. Enable the MLD Snooping function

Command	Explanation
Global Mode	
ipv6 mld snooping no ipv6 mld snooping	Enable global MLD Snooping, the “ no ipv6 mld snooping ” command disables the global MLD snooping.

2. Configure MLD Snooping

Command	Explanation
Global Mode	
ipv6 mld snooping vlan <vlan-id> no ipv6 mld snooping vlan <vlan-id>	Enable MLD Snooping on specific VLAN. The “no” form of this command disables

	MLD Snooping on specific VLAN.
ipv6 mld snooping vlan <vlan-id> limit {group <g_limit> source <s_limit>} no ipv6 mld snooping vlan <vlan-id> limit	Configure the number of the groups in which the MLD Snooping can join, and the maximum number of sources in each group. The “no” form of this command restores to the default.
ipv6 mld snooping vlan <vlan-id> I2-general-querier no ipv6 mld snooping vlan <vlan-id> I2-general-querier	Set the VLAN level 2 general querier, which is recommended on each segment. The “no” form of this command cancels the level 2 general querier configuration.
ipv6 mld snooping vlan <vlan-id> mrouter-port interface <interface - name> no ipv6 mld snooping vlan <vlan-id> mrouter-port interface <interface - name>	Configure the static mrouter port in specific vlan. The “no” form of this command cancels the mrouter port configuration.
ipv6 mld snooping vlan <vlan-id> mrouter-port learnpim6 no ipv6 mld snooping vlan <vlan-id> mrouter-port learnpim6	Enable the function that the specified VLAN learns mrouter-port (according to pimv6 packets), the no command will disable the function.
ipv6 mld snooping vlan <vlan-id> mrpt <value> no ipv6 mld snooping vlan <vlan-id> mrpt	Configure the keep-alive time of the mrouter port. The “no” form of this command restores to the default.
ipv6 mld snooping vlan <vlan-id> query-interval <value> no ipv6 mld snooping vlan <vlan-id> query-interval	Configure the query interval. The “no” form of this command restores to the default.
ipv6 mld snooping vlan <vlan-id> immediate-leave no ipv6 mld snooping vlan <vlan-id> immediate-leave	Configure immediate leave multicast group function for the MLD Snooping of specific VLAN. The “no” form of this command cancels the immediate leave configuration.
ipv6 mld snooping vlan <vlan-id> query-mrsp <value> no ipv6 mld snooping vlan <vlan-id> query-mrsp	Configure the query maximum response period. The “no” form of this command restores to the default.
ipv6 mld snooping vlan <vlan-id> query-robustness <value> no ipv6 mld snooping vlan <vlan-id> query-robustness	Configure the query robustness, the “no” form of this command restores to the default.

<pre> ipv6 mld snooping vlan <vlan-id> suppression-query-time <value> no ipv6 mld snooping vlan <vlan-id> suppression-query-time </pre>	<p>Configure the suppression query time. The “no” form of this command restores to the default</p>
<pre> ipv6 mld snooping vlan <vlan-id> static- group <X:X::X:X> [source <X:X::X:X>] interface [ethernet port-channel] <IFNAME> no ipv6 mld snooping vlan <vlan-id> static-group <X:X::X:X> [source <X:X::X:X>] interface [ethernet port- channel] <IFNAME> </pre>	<p>Configure static-group on specified port of the VLAN. The no form of the command cancels this configuration.</p>

2.1.3 MLD Snooping Examples

Scenario 1: MLD Snooping Function

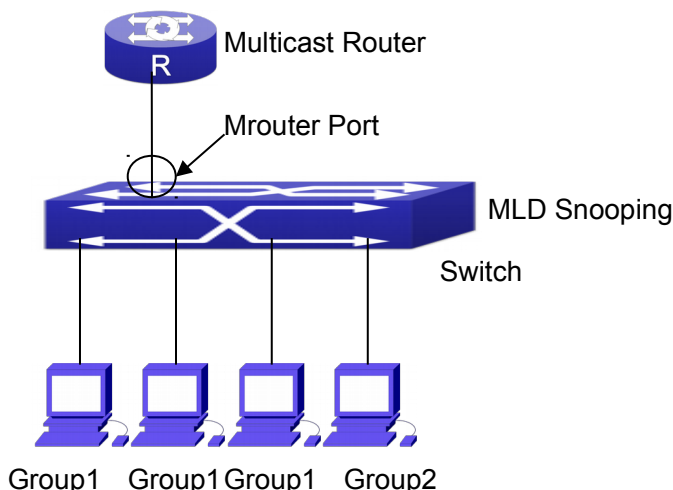


Fig 2-1 Open the switch MLD Snooping Function figure

As shown above, the vlan 100 configured on the switch consists of ports 1, 2, 6, 10 and 12. Four hosts are respectively connected to 2, 6, 10 and 12 while the multicast router on port 1. Suppose we need MLD Snooping on VLAN 100, however by default, the global MLD Snooping as well as the MLD Snooping on each VLAN are, therefore first we have to enable the global MLD Snooping at the same time enable the MLD Snooping on VLAN 100, furthermore we need to set the port 1 of VLAN 100 as a mrouter port.

Configuration procedure is as follows.

```

Switch#config
Switch(config)#ipv6 mld snooping
Switch(config)#ipv6 mld snooping vlan 100
Switch(config)#ipv6 mld snooping vlan 100 mrouter-port interface ethernet 1/0/1
    
```

Multicast configuration:

Assume there are two multicast servers: the Multicast Server 1 and the Multicast

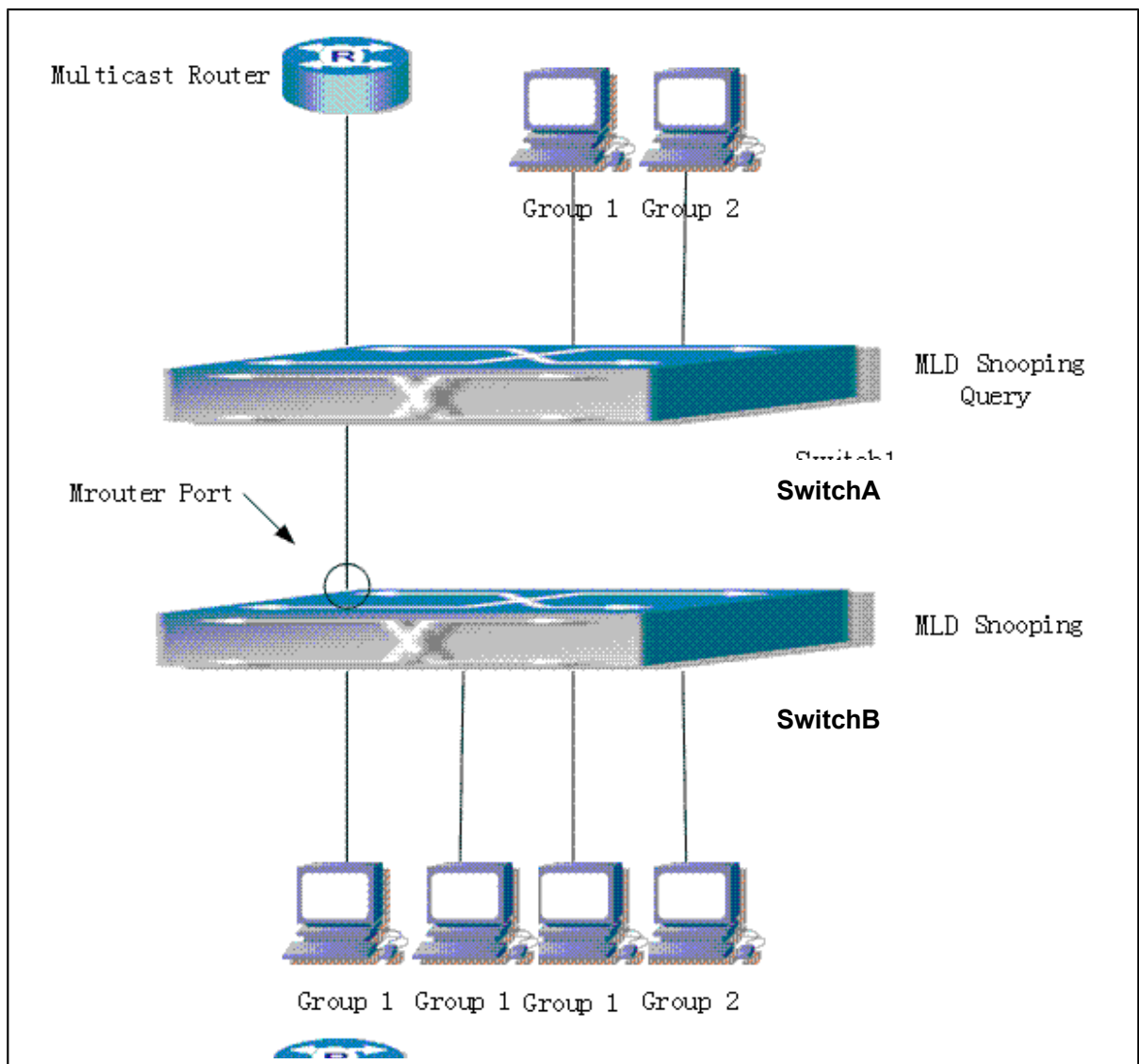
Server 2, amongst program 1 and 2 are supplied on the Multicast Server 1 while program 3 on the Multicast server 2, using group addresses respectively the Group 1, Group 2 and Group 3. Concurrently multicast application is operating on the four hosts. Two hosts connected to port 2, 6 are playing program 1 while the host connected to port 10 playing program 2, and the one to port 12 playing program 3.

MLD Snooping interception results:

The multicast table on vlan 100 shows: port 1, 2, 6 are in (Multicasting Server 1, Group1) , port1, 10 are in (Multicasting Server 1,Group2), and port1, 121, 12 are in (Multicasting Server 2, Group3)

All the four hosts successfully receive programs they are interested in. port2, 6 receives no traffic from program2 and 3; port10 receives no traffic from program 1 and 3, and port12 receives no traffic from program1 and 2.

Scenario 2: MLD L2-general-querier



Configuration of switch B is the same as the switches in case 1, and here the switch 1 replaces the Multicast Router in case 1. Assume the vlan 60 configured on it contains

port 1, 2, 10 and 12, amongst port 1 is connected to multicast server, port 2 to switch2. To send Query periodically, global MLD Snooping has to be enabled while executing the mld snooping vlan 60 l2-general-querier, setting the vlan 60 to a Level 2 General Querier.

Configuration procedure is as follows:

```
SwitchA#config
```

```
SwitchA(config)#ipv6 mld snooping
```

```
SwitchA(config)#ipv6 mld snooping vlan 60
```

```
SwitchA(config)#ipv6 mld snooping vlan 60 l2-general-querier
```

```
SwitchB#config
```

```
SwitchB(config)#ipv6 mld snooping
```

```
SwitchB(config)#ipv6 mld snooping vlan 100
```

```
SwitchB(config)#ipv6 mld snooping vlan 100 mrouter interface ethernet 1/0/1
```

Multicast configuration:

Same as scenario 1

MLD Snooping interception results:

Same as scenario 1

2.1.4 MLD Snooping Troubleshooting

In configuring and using MLD Snooping, the MLD Snooping server may fail to run properly due to physical connection failure, wrong configuration, etc. The user should ensure the following:

- ☞ Ensure the physical connection is correct
- ☞ Ensure the MLD Snooping is enabled under global mode (using `ipv6 mld snooping`)
- ☞ Ensure the MLD Snooping is configured on the vlan under global mode (using `ipv6 mld snooping vlan <vlan-id>`)
- ☞ Ensure there is a vlan configured as a L2 general querier, or there is a static mrouter configured in a segment,
- ☞ Use command to check if the MLD snooping information is correct

Chapter 3 Multicast VLAN

3.1 Introductions to Multicast VLAN

Based on current multicast order method, when orders from users in different VLAN, each VLAN will copy a multicast traffic in this VLAN, which is a great waste of the bandwidth. By configuration of the multicast VLAN, we add the switch port to the multicast VLAN, with the IGMP Snooping/MLD Snooping functions enabled, users from different VLAN will share the same multicast VLAN. The multicast traffic only exists within a multicast VLAN, so the bandwidth is saved. As the multicast VLAN is absolutely separated from the user VLAN, security and bandwidth concerns can be met at the same time, after the multicast VLAN is configured, the multicast traffic will be continuously sent to the users.

3.2 Multicast VLAN Configuration Task List

1. Enable the multicast VLAN function
2. Configure the IGMP Snooping
3. Configure the MLD Snooping

1. Enable the multicast VLAN function

Command	Explanation
VLAN configuration mode	
multicast-vlan no multicast-vlan	Configure a VLAN and enable the multicast VLAN on it. The “ no multicast-vlan ” command disables the multicast function on the VLAN.
multicast-vlan association <vlan-list> no multicast-vlan association <vlan-list>	Associate a multicast VLAN with several VLANs. The no form of this command deletes the related VLANs associated with the multicast VLAN.
multicast-vlan association interface (ethernet port-channel) IFNAME no multicast-vlan association interface (ethernet port-channel) IFNAME	Associate the specified port with the multicast VLAN, so the associated ports are able to receive the multicast flow. The no command cancels the association between the ports and the multicast VLAN.
multicast-vlan mode {dynamic compatible} no multicast-vlan mode {dynamic compatible}	Configure the two modes of multicast vlan. The no command cancels the mode configuration.

compatible}	
--------------------	--

2. Configure the IGMP Snooping

Command	Explanation
Global Mode	
ip igmp snooping vlan <vlan-id> no ip igmp snooping vlan <vlan-id>	Enable the IGMP Snooping function on the multicast VLAN. The no form of this command disables the IGMP Snooping on the multicast VLAN.
ip igmp snooping no ip igmp snooping	Enable the IGMP Snooping function. The no form of this command disables the IGMP snooping function.

3. Configure the MLD Snooping

ipv6 mld snooping vlan <vlan-id> no ipv6 mld snooping vlan <vlan-id>	Enable MLD Snooping on multicast VLAN; the no form of this command disables MLD Snooping on multicast VLAN.
ipv6 mld snooping no ipv6 mld snooping	Enable the MLD Snooping function. The no form of this command disables the MLD snooping function.

3.3 Multicast VLAN Examples

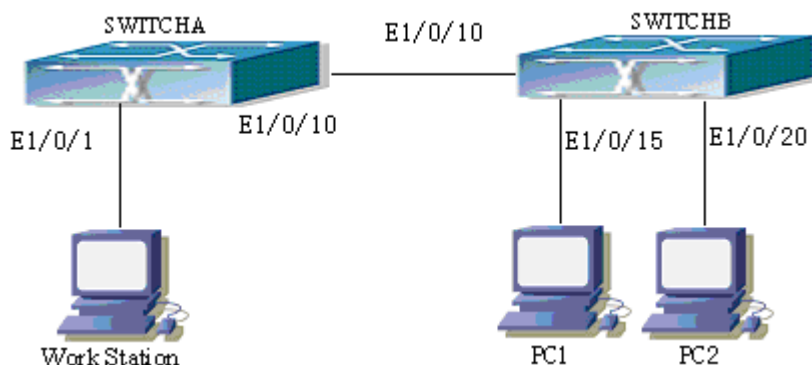


Fig 3-1 Function configuration of the Multicast VLAN

As shown in the figure, the multicast server is connected to the layer 3 switch switchA through port 1/0/1 which belongs to the VLAN10 of the switch. The layer 3 switch switchA is connected with layer 2 switches through the port1/0/10, which configured as trunk port. On the switchB the VLAN100 is configured set to contain port1/0/15, and VLAN101 to contain port1/0/20. PC1 and PC2 are respectively connected to port 1/0/15 and1/0/20. The switchB is connected with the switchA through port1/0/10, which configured as trunk port. VLAN 20 is a multicast VLAN. By configuring multicast vlan, the

PC1 and PC2 will receive the multicast data from the multicast VLAN.

Following configuration is based on the IP address of the switch has been configured and all the equipment are connected correctly.

Configuration procedure

```
SwitchA#config
SwitchA(config)#vlan 10
SwitchA(config-vlan10)#switchport access ethernet 1/0/1
SwitchA(config-vlan10)#exit
SwitchA(config)#interface vlan 10
SwitchA(Config-if-Vlan10)#ip pim dense-mode
SwitchA(Config-if-Vlan10)#exit
SwitchA(config)#vlan 20
SwitchA(config-vlan20)#exit
SwitchA(config)#interface vlan 20
SwitchA(Config-if-Vlan20)#ip pim dense-mode
SwitchA(Config-if-Vlan20)#exit
SwitchA(config)#ip pim multicast
SwitchA(config)# interface ethernet1/0/10
SwitchA(Config-If-Ethernet1/0/10)#switchport mode trunk

SwitchB#config
SwitchB(config)#vlan 100
SwitchB(config-vlan100)#Switchport access ethernet 1/0/15
SwitchB(config-vlan100)#exit
SwitchB(config)#vlan 101
SwitchB(config-vlan101)#Switchport access ethernet 1/0/20
SwitchB(config-vlan101)#exit
SwitchB(config)# interface ethernet 1/0/10
SwitchB(Config-If-Ethernet1/0/10)#switchport mode trunk
SwitchB(Config-If-Ethernet1/0/10)#exit
SwitchB(config)#vlan 20
SwitchB(config-vlan20)#multicast-vlan
SwitchB(config-vlan20)#multicast-vlan association 100,101
SwitchB(config-vlan20)#exit
SwitchB(config)#ip igmp snooping
SwitchB(config)#ip igmp snooping vlan 20
```

When multicast VLAN supports IPv6 multicast, usage is the same with IPv4, but the difference is using with MLD Snooping, so does not give an example.