Abstract

In this paper, we proposed a testing method to evaluate the system which is developed by IPv6 multicasting for conform the international and industry standards, implementing the functionality as well as meeting business requirements during practical use. The paper also presents a design and implements method for hybrid multiplex integrated network access equipment System by IPv6 multicasting under AN6016-01 system research project context. Moreover, it conducts an IPv6 multicast simulation test on system basic factors through Spirent Testcenter. Testing result shows, it is difficult for instrument ports of Testcenter to meet testing requirements when handle massive users in an application scenario. But long time performance testing among massive users may be conducted via aggregation switch. IPv6 multicast simulation testing may effectively discover problems in system development and application. But this testing method does not suitable for the actual application scenarios (ONU+STB+TV), it is only suitable in laboratory. Finally, the paper proposes a common solution about laboratory testing.

1. IPv6 multicasting

1.1. IPv6 multicast address

Internet Protocol Version 6 (IPv6) is a version of the Internet Protocol. It is designed to succeed Internet Protocol version 4 (IPv4) with improved functionality which is gained from decades experiences of using IPv4 [1]. Developed by IETF, the IPv6 uses a 128-bit address. This expansion gained widespread deployment as an effort to alleviate IPv4 address exhaustion. IPv6 multicast address represents the identification of interface group which commonly consists of interfaces from different nodes. A node may belong to multicast group ranging from 0 to many. All interfaces could receive messages which has multicast address identification. Hence nodes has mobility, a delivery tree then should be structured...
IPv6 benefits IPv4 on a much larger address space and could reduce range overlaps by partitioning multicast domain with range field.

A network node consists of hardware MAC addresses (AKA, unicast MAC) and multicast MAC addresses. Any node will accept the received multicast messages which have destination MAC address (multicast MAC address) equivalent to nodes’ MAC address. Therefore, all members within a LAN group may receive multicast messages which addressed to this group. Likewise IPv4 multicast MAC address, IPv6 achieves its multicast MAC address from multicast IP address mapping but with different rules. A multicast MAC address has 48 bits beginning with 0x3333 while the lower 32 bits stands for the lower 32 bits of IPv6 multicast address.

1.2. IPv6 multicast protocol

Supporting the MLD, MLD Snooping, IPv6 PIM and IPv6 MBGP, the IPv6 multicast protocol forms two parts with host-router at one hand and multicast routing protocol at the other hand.

According to the design and research needs of the project, this paper only concerned with the MLD protocol which dedicates to implement the basic process flow and functionality of multicasting. The key feature of MLD protocol lies on the management of group members sign in and out [4]. Therefore, it is important to analyze the principle of MLD proxying and snooping.

1.2.1. MLD

Multicast Listener Discovery (MLD) is a component of the IPv6 suite. It is used by IPv6 routers to discover multicast listeners on a directly attached link. Multicast Listener is the host node who wishes to receive multicast data. With the MLD protocol, routers could detect any existing IPv6 multicast group listeners and then add them into a database record. Meanwhile, routers also maintain the IPv6 multicasts address relevant timer information. Much as IGMP is used in IPv4, the MLD protocol is embedded in ICMPv6 instead of using a separate protocol. MLDv1 is similar to IGMPv2 and MLDv2 similar to IGMPv3. In fact the protocol shares same behaviors with IGMP except message format. MLDv1 takes the responsibility for IPv6 multicast group member management by a query and response mechanism.

1.2.2. MLD proxy

In fact on some access equipments (e.g. optical line terminal), it is needless to implement such complex three layer protocols as IPv6 multicast routing (IPv6 PIM). MLD proxy enables the router to issue MLD host messages on behalf of hosts that the router discovered through standard MLD interfaces. The router proxy messages from its downstream hosts and maintains multicast forward tables. MLD proxy devices have two types of interfaces: host Interface and router Interface for upstream and downstream network traffic respectively.

By a downstream device (e.g. optical network unit) perspective, MLD proxy devices are substitutions of MLD router. By an upstream device (e.g. router) perspective, MLD proxy devices are not IPv6 PIM neighbors but a proxy server. MLD proxy devices may store downstream interface maintenance information of group members into a group member relational database. The upstream interface behaves rely on this database; it may reply with a current database status report messages when receiving an inquiry message.

On the other hand, the downstream interface behaves as a router to maintain inner group member relationships according to the report message.

1.2.3. MLD snooping

MLD Snooping is the IPv6 multicast constraints on the second layer device for IPv6 multicast group management and control. Such devices may mapping ports and multicast MAC addresses for forwarding IPv6 multicast data by analyzing the received MLD message. Otherwise the IPv6 multicast data message may be broadcast to the second layer once without MLD snooping.

Obviously, MLD snooping benefits IPv6 multicast for reducing broadcast network traffics on the second layer and improving the security as well as managing connected network users.
MLD snooping devices have two types of interfaces: router Interface and member interface for upstream and downstream network traffic respectively.

Once receives MLD membership report messages, the second layer MLD snooping devices (e.g. ONU) may forward those messages via all routers port within a VLAN. It may elicit the IPv6 multicast group address which is potential to hosts address list and furthermore record any member’s port into a MLD snooping forwarding table. Such ports are corresponds to the elicited multicast address. Finally, those devices may forward the downstream multicast program stream to the corresponding hosts via member interfaces in addition to the MLD snooping forwarding table.

2. An AN6061-01 IPv6 multicasting system

2.1 AN6016-01 introduction

AN6061-01 is a hybrid multiplex integrated access device of EPON and WPON. It is based on the research program Low-cost Multi-wavelength Ethernet Integrated Access System (aka. λ-EMD). As a high trustworthy telecommunication open architecture, this system adopts ATCA platform to support hot plug, upstream redundancy backup and uplink 10GE/GE interface. A system’s single frame supports 12 interface boards and each board contains 16 PON interfaces at either 1.25Gbps or 2.5Gbps.

EP16 is the service switchboard to carry traditional EPON (upstream 1490nm, upstream 1310nm) access services. It contains 16 PON interfaces for 1.25Gbps or 2.5Gbps transmission. Each PON interface has 1:64 split ratio and maximum 20KM transmission distance. With such interfaces, the EP16 may access and control such EPON ONU devices as AN5006_09A for example. WE8 is the service switchboard for WPON wavelength division access. Each WE8 contains 8 PON interfaces with 8 different wavelengths which defined through internal tunable optical master. One PON interface of the WE8 has 1:64 split ratio and maximum 20KM transmission distance. The entire OLT constitutes with four WE8 service switchboards therefore may carry 32 different wavelengths ranging from 1574.199nm to 1599.546nm. Colorless ONU (e.g. AN6006_02) connects the WE8 via AWG to perform licensing and service bearing.

Fig. 1 demonstrates the system architecture and the application pattern of AN6016-01 with triple play of IP video, audio and data networks. Thus achieves optical fiber splitting controlled transmission for multicast and unicast services.

![Figure 1 AN6016-01 system architecture and application scenario](image)

2.2. AN6016-01 IPv6 multicast design

In order to achieves IPv6 multicast service control and management, AN6016-01 adopts OLT MLD Proxying at the central office and ONU MLD Snooping at the terminal end. Moreover, both SCB and MLD have been accepted for the multicast services distribution.

Fig. 2 shows the IPv6 multicasting of the entire system in a flowchart manner. TEK3723PON is the key chip on EP16/WE8 to functionalize the MLD Proxying at the central office. TEK3715PON is the key chip to functionalize MLD Snooping at the terminal end.
3. IPv6 multicasting testing

Multicast service is one of the key features that access device should provide. Because it may affects the user experience at business application level. Therefore, it is feasible to test such services.

Generic testing method to verify multicast functionality and performance of the device may be performed by actual VOD experiences on end user terminals (e.g. TV, PC, et al.). However, testing multicast protocols and functionalities in laboratories require simulation on test instrument (multicast sources, upper layer IP networks, end user terminals). Main objectives of IPv6 multicast testing include: functionalities; compliance with international standards or industrial standards; meet the practical business needs [7]. This paper introduces IPv6 multicast on AN6016-01 system via Spirent TestCenter simulation.

3.1. Central office OLT IPv6 multicast configuration

Central office OLT IPv6 multicast configuration consists of four steps include setting up Multicast protocols, multicast mode, multicast VLAN, multicast service stream and uplink VLAN.

3.1.1. Configure IPv6 as the OLT multicast protocol, proxy-snooping as the multicast mode.

Admin\multicast# multicast set protocol ipv6 mode proxy-snooping
Once the configuration activated, it displays MLD as the OLT multicast mode.
Config\igmp# show olt igmp mode
olt igmp mode is MLD
3.1.2. Configure terminal end multicast VLAN

Admin\multicast# multicast set vlan 3998
Once the configuration activated, it displays the multicast VLAN properties.
Admin\multicast# multicast show vlan
multicastmode: proxy-snooping
protocolltype: IPV6
multicastvlan: 3998
Config\igmp# show olt igmp prot vlan
cfg igmp prot Vlan, as below:3998;

3.1.3. Configure OLT multicast service flow. Set C-vlan to multicast Vlan 3998.

traffic add 1 1 1 1 mcast
traffic set cvlan 1 1 1 1 3998 5 3302
traffic apply 1 1 1 1
Once the configuration is activated, it displays multicast vlan 3998 join in the ONU port with the
downstream trip tag.
Config\igmp# show onu igmp port vlan 1 1 1
Index = 01,Vlan=3998
trip tag

3.1.4. Join the multicast vlan into OLT uplink port

Admin\scma# local_vlan set vm servicetype 1 startvid 3998 endvid 3998
uplink 5 tagged
Hitherto, the AN6016-01 IPv6 multicast configuration complete. On one hand, the MLD join message
(untag) sent by upstream user may labels the ONU with a 3998 tag. MLD snooping then creates the
multicast forward table on ONU and further sends a join message to service switchboard EP16/WE8.
Moreover, the OLT may send a join message to up layer multicast source in an MLD proxying form. On
the other hand, the downstream multicast stream may broadcast such message to the ONU NNI port in an
SCB manner. Then, it may forwards the multicast program to relevant hosts interface by referencing
forwarding table.

3.2. Spirent TestCenter simulation test

3.2.1. Networking test

The Spirent TestCenter 9000 3/1 ports may connects to the AN6016-01 uplink port 3/1. Three other
ports 3/2, 3/3 and 3/4 are respectively connect to three user ports on AN5006_09A and AN6006_02 ONU.

![Figure 3 AN6016-01 IPv6 multicast networking](image)

3.2.2. Testcenter configuration

A. Reserve the ports and add IPv6 multicast router.
B. Add simulation user hosts and configure participating multicast groups.

C. Add multicast service stream.

3.2.3. IPv6 simulation test.

A. Enable the multicast service stream to simulate three multicast sources. The destination address may range from ff1e: to ff1e::103. Each program may reserve 30 Mbps during transmission.

B. Three user hosts connect to the service and send join messages for requesting IPv6 multicast programs. The uplink port may analysis join messages with ethereal.
C. During user hosts request a multicast program, the universal group query message periodically sent from up layer router and member relationship report message sent from responded user hosts may be analyzed with ethereal.

D. The MLD proxying chip tek3723 is respond to member relationship report messages replied from universal group query. Hosts are responding to member relationship report messages replied from universal group query.

E. User hosts send leave message and disconnect the multicast group. DONE messages and up layer router queried specific group messages may be analyzed with ethereal.
Once receives NLD done leaving message, the up layer router may request specific group query and it may leave the group once has no replies. User hosts then leave multicast programs.

4. IPv6 multicast performance testing via aggregation switch

Multicast performance directly determines the user experience by concerning figures as join/leave latency, forwarding latency, capacity, throughput, dispensing and stacking as well as packet loss ratio. The 3918 test script of Spirent Testcenter may complete multicast performance testing. However, when testing the multicast performance with large number of user scenarios (1:32 or 1:64, and with multi-port ONU), Testcenter instrument port is insufficient to meet test needs. Thus, aggregation switch is capable to testing longtime multicast performance among large number of users.

The problem defined:
Test instrument port is insufficient to handle large amount users.
The S2300 series HW switches cannot forward the upstream MLD join message by default.

Figure 4 IPv6 multicast performance test via aggregation switch

5. Test process specification.
5.1 Central office OLT configuration.

Central office OLT configuration consists of four steps include setting up Multicast protocols, multicast mode, multicast VLAN, multicast service stream and uplink VLAN. Such configuration is almost similar to OLT IPv6 multicast configuration in this paper. But the differences lie on ONU numbers (e.g. >32), multi-port multicast service stream within a same VLAN.
5.2. HW S2300 switch configuration.
5.2.1. Connect number of ONU IPv6 multicast user ports to 1-48 FE ports on WH Quidway S2300 switch respectively. The 0/1 port on WH Quidway S2300 switch is connects to the simulation user port on Testcenter.
5.2.2. Configure 1-48 FE port trunk-link type as access and PVID as 101-148 respectively on WH Quidway S2300.
5.2.3. Configure the aggregation port 0/1 trunk-link type as trunk and add it to vlan 101-148 on WH Quidway S2300.
5.2.4. Configure the MLD-snooping mode of universal and vlan 101-148 as enable on WH Quidway S2300. (Otherwise, MLD join message will fail to forward through switch)

5.3. Spirent Testcenter configuration
5.3.1. The port connects TestCenter and WH Quidway S2300 switch may added with an MLD access device type. Thus, 48 user hosts can be simulated on this device. Each host interface vlan is set to 101-108 respectively.
5.3.2. Other configuration on Testcenter is exact same with that on Spirent TestCenter simulation test.

Hitherto, the switch may accepts and forwards MLD join messages which contains vlan 101-148 sent from upstream Testcenter simulated 48 hosts. Once leaving the switch, the message may arrives ONU ETH port in an Untag MLD join message form and completes the IPv6 multicasting by referencing MLD protocol on AN6061-01. Similarly, the downstream IPv6 multicast program stream may peel off multicast vlan according to trip tag. Then it receives the PVID of 101-148 and finally arrives at the simulation user host on Testcenter via switch aggregation port to complete multicast program on demand.

Obviously, this network application is capable only to multicast performance test for long time, large user number within laboratory. It is incapable to practical service scenario.

6. Conclusions
High bandwidth multimedia has gained wide application among number of areas. IPv6 multicasting is the core of next generation internet. Therefore, IPv6 multicasting and it's test method is surely reserved the future trend of development among number of areas as CSCW cooperative computing, distance education, AOD/VOD, video conferencing, network video/audio broadcasting and remote consulting. This research introduced a mix reused integrated access device system with IPv6 multicasting. Moreover, it effectively solved the system problems during development and use by simulate testing IPv6 multicast on Spirent TestCenter. However, the research itself hold out hope that it would generate more public discussion among scientists to promote with continuous improvement and innovation.

References