Key Factors for IPTV Multicasting in Local Area Network with Multiple Hosts

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Abstract — **Considering the standard definition and actual behavior of a snooping switch which transports IPTV in local area network with multiple hosts, we figure out there are some differences between devices in performance, leave procedure, and message forwarding aspects. We integrate the factors into a parameter S_N to estimate the completeness of a switch, which can compare different products simply and clearly.**

BACKGROUND

With the development of broadband network, the multimedia services have become popular. Although the network can provide high-speed access for multimedia service, some of the services such as IPTV rely on multicast scheme for efficient transportation.

Within a local area network, the Internet Group Management Protocol (IGMP) is used by host devices, as set-top box, and by the adjacent multicast router to establish multicast group memberships. IGMPv2 defined three types of messages and five significant events that can cause state transitions on IPv4 network. However, some Ethernet switch with multiple hosts in a local area network would produce wrong multicast group memberships after the state transitions, even though the manufacturers announce they support IGMP and they would work well when there is only one single host in a local area network. That's why we want to figure out the key factors in such situation.

ANALYSIS

For investigating whether a switch supported IPTV multicasting in local area network with N hosts, we should consider of three aspects: performance, leave procedure, and message forwarding.

Firstly, the performance of the switch must be simply able to deal with the IPTV multicast streams. Suppose the traffic throughput of each multicast group is constant and be sorted from high to low: $\{T_1, T_2, T_3, \ldots\ldots\}$; there are two cases we can check the performance of a switch: (1) The N hosts join the N different groups. And the maximum traffic throughput is $T_1 + T_2 + T_3 + \cdots + T_N$, (2) The N hosts join the same group, and the maximum throughput is $N * T_1$. The actual throughput of the switch without any packet loss in the two cases is T_{c1} and T_{c2}, respectively.

Secondly, the leave procedure of the multicast protocol must be strictly observed. To prevent hosts in a local area network from receiving traffic for a multicast group, most of switches used in IPTV support IGMP snooping [1]. IGMP snooping allows a switch to forward multicast traffic to the links that have solicited only by listening the IGMP messages. The "listening" means the switch reads the IGMP messages of multicast routers and hosts without any suppression or modification, and all the schemes must be the same for the joined links. The snooping switch should implement a membership timeout mechanism as the router-side functionality of the IGMP protocol on all non-router ports, rather than relies exclusively on the appearance of IGMP leave messages to determine whether a host leaves a group. If the switch do not follow the membership timeout scheme and stop the multicast stream instantly, the host will suffer a broken service for a short period once a single host leaved. The factor L_l is set to 1 to represent the switch following standard leave procedure properly. Otherwise it is set to 0. Besides the timeout mechanism, there is another scheme which can provide instantly leave for last member which is called IGMP immediate leave [2]. However, to support IGMP immediate leave, the switch should figure out all hosts below a non-router port. The number of hosts that the switch can figure out N_i is finite, and the worst case is 1. The function also affects the next aspect.

Thirdly, the message forwarding of the switch must cooperate with the devices above and below it. Considering the host devices below a switch, IGMP allows a host to leave a group without sending messages to reduce the traffic, if it was not the last member. However, a host is hard to confirm whether it is the last member in the group when leaving. A host can do is: if one host sent the leave message, other hosts don't send it again in a short period. That would break the snooping ability of a switch. So a snooping switch should forward IGMP messages only to those ports where multicast routers are attached. The factor M_b is set to 1 to represent the snooping switch forward IGMP messages properly or the hosts send messages normally. Otherwise it set to 0. And for the device above a switch, if it enables the IGMP immediate leave function but can't figure out all hosts below its non-router port as mentioned, the below switch must support IGMP snooping with proxy reporting to prevent any broken appears. The factor M_a is set to 0 if any above device of the switch enable IGMP immediate leave without sufficient numbers and the switch don't support IGMP snooping with proxy reporting. Otherwise it is set to 0.

Finally, we combine the factors to estimate the completeness of a switch to support IPTV multicasting in local area network with N hosts:

$$S_N = P_N \times L_N \times M \text{ , where } P_N = \left(\frac{T_{c1}}{T_1 + T_2 + T_3 + \cdots + T_N} + \frac{T_{c2}}{N * T_1}\right)/2 \text{ ,}$$
$$L_N = \left(1 + L_l + \frac{N_i}{N}\right)/3 \text{ , } M = (1 + M_b + M_a)/3 \text{ .} \quad (1)$$

S_N is distributed from 0 to 1. The ideal case is $S_N = 1$.

CONCLUSION

For supporting IPTV multicasting with multiple hosts, we consider standard definition and the actual behavior of customer products in practical, and then integrate the factors into a parameter S_N to estimate the completeness of a switch simply and clearly. In contrast between different products for IPTV transportation, the product with the largest S_N is preferable.

REFERENCES

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