

DIGITAL VIDEO STREAMING OVER A HETEROGENEOUS NETWORK

W. G. C. W. Kumara^{1*}, K. Kanchanasut²

^{1*} Corresponding Author, Department of Mechatronics Engineering, Faculty of Engineering, South Asian Institute of Technology and Medicine (SAITM), Sri Lanka. Email: chinthaka.w@saitm.edu.lk

² Internet Research Laboratory (intERLab), Asian Institute of Technology (AIT), Thailand, Email: kanchana@ait.ac.th

ABSTRACT

Digital Video (DV) is a standard by International Electrotechnical Commission (IEC) for high quality video and audio formats. Digital Video Transport System (DVTS) is a technology that uses DV standards to send DV streams as unicast or multicast over Internet. Dvrelays are used to relay streams between different networks where they behave as gateways to accommodate the different properties of the networks. These Dvrelays themselves form an overlay network on the underlying heterogeneous network. Conducting online seminars among members of a multicast group with DVTS and Dvrelay is still a difficult task even within a small member group with a few senders as all Dvrelays must be manually configured. In this paper, we propose to have a system which automatically configures all the Dvrelay nodes in the DV delivery overlay network to serve online talks or seminars according to the given agenda.

The approach being proposed here is to design and implement an overlay system using Dvrelay installed gateways with a centralized controller server for the seminar which distributes the agenda file to all the members and take care of the overall operation of online seminar. Dvrelay gateways on the overlay network exchange their connected link information among neighbors and finally settle down with an identical topology table of overlay at each gateway. After receiving the seminar agenda from the centralized server, gateways now can build the shortest path tree from sender to receivers and can start sending DV stream according to agenda by automatically configuring Dvrelay as required.

Key words: Multicast, Overlay, Digital video streaming

1. INTRODUCTION

The use of Internet has been dramatically increased in recent past in almost all the fields, especially in the communication arena. Video and audio exchange between remote locations can be easily carried out with the help of Internet at present. This facility has been tested and used in many applications such as online multiparty seminars, conferences, medical operations, defense operations etc.

The quality of video and audio plays the most important role in such online communications. Newly developed video and audio compression technologies such as high quality Digital Video (DV) [2] can be used to accomplish the requirement of video and audio quality. Even though DV provides the expected quality it consumed a considerable bandwidth in the Internet around 35 Mbps per stream.

As Internet transmits data between two points using unicast connections, in both, version 4 and 6 flavors of IP addressing, this point to point transmission of high quality data such as DV can overwhelm the available Internet bandwidth. To fill up this drawback of unicast connections, a new technology named multicast has been introduced to the Internet. Multicast can be used to transmit one

stream to the intended recipients limiting the bandwidth used by separate unicast connections [1].

Since introduction of multicast to the existing Internet infrastructure requires new routers capable of handling multicast that causes large investments, the whole Internet infrastructure is not yet fully supported for multicast. This leads to the Internet with isolated multicast capable islands. As a result of that to deploy high quality communication between multi points cannot be solely bared by the multicast. While using the multicast where it is available, unicast can be used to fill the gap of multicast.

Relaying mechanism is required to relay the data between multicast and unicast. Dvrelay that is developed at the Interlab facilitates above need providing relaying of DV between any combination of unicast or multicast of both the IPv4 and IPv6 addressing mechanisms [3]. Even though Dvrelay is capable of relaying between multicast and unicast, it is not capable of auto configuring according to the requirement of the participants of the online communication. Whenever the senders or receivers are changed, Dvrelay has to be configured manually according to the receiving and sending stream type at the Dvrelay.

2. METHODOLOGY

The Internet consists of many isolated multicast enabled backbone networks which are connected to each other using particular technology of tunneling or normal unicast connections. Those islands may use different technologies to run multicast in their networks. A simplified network like in Fig. 1 can be used to model the current complex Internet infrastructure [14].

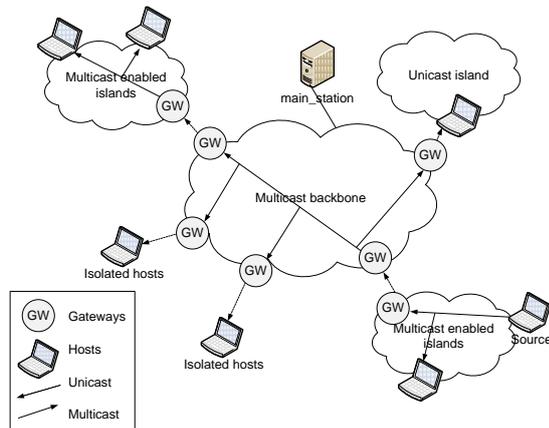


Figure. 1: Simplified online seminar network example

Separate multicast backbones are connected to each other on top of unicast Internet. Isolated unicast islands that want to receive multicast transmissions have to be connected to one multicast backbone using a unicast connection as in Fig. 1. As per this work gateways can be used to connect to multicast networks; the network of gateways is an overlay network over the Internet. So the interested participants can enjoy the multicast streams. Hence with respect to this work the sender sends DV stream using the DVTS and the Dvrelays which are installed on the gateways of the network to relay the stream through out the network to the interested recipients.

A centralized server is used as the main station of the seminar streaming, for all the administration and control of the network and the seminar.

Unicast hosts cannot receive any multicast stream from multicast enabled networks hence Dvrelays have to be used to relay streams at each gateway. As an example when the sender sends a stream and if all hosts in the other networks want to receive that stream the streaming tree is built as stated by arrows. Based on the users' priorities they can configure which type of link connections among available options to be used. If four communication methods available in one link between two gateways as unicast and multicast of IPv4 and IPv6 flavors, user can select to use IPv6 multicast instead of IPv4 unicast.

The overlay network protocol was designed based

on the OSPF IP routing protocol. The ultimate result of the protocol is the topology table with all the link information of the overlay. Eight message types are used in the protocol to exchange information between gateways and the main station. The operation of the proposed system basically consists of four phases as initialization, overlay network setup, tree building and DV streaming.

In the initialization phase seminar administrator creates GatewayList (used to send the neighbor gateway and multicast group information to all the gateways), NodeList (used to introduce new hosts to the overlay) and SeminarAgenda (used to send the agenda to all gateways) files based on the network information and places them in main station. Then the proposed DVRelayNet application is started at the gateways.

In second phase each gateway pulls GatewayList file from the main station and generate the topology table of the overlay network using all the gateways. After topology table stabilize at all gateways main station pushes NodeList file to all gateways and after that overlay network is updated with the newly introduced host addresses.

In third phase main station pushes SeminarAgenda file to all gateways and the shortest path tree building procedure from the source to destinations starts.

In the fourth phase, Dvrelays at each gateway starts according to the agenda and sends used port information back to the main station. Finally it starts sending and receiving of DV at each participating host using DVTS application.

3. RESULTS

The network in Fig. 2 was used for functionality test. After placing the three input files named GatewayList, NodeList and SeminarAgenda at main station the proposed DvrelayNet application at each gateway was started and after some time an identical topology table of complete network setup was built at each gateway. And the topology table was updated with the newly introduced hosts after the main station pushed NodeList file to all gateways. Then the SeminarAgenda file was pushed to the all gateways from the main station.

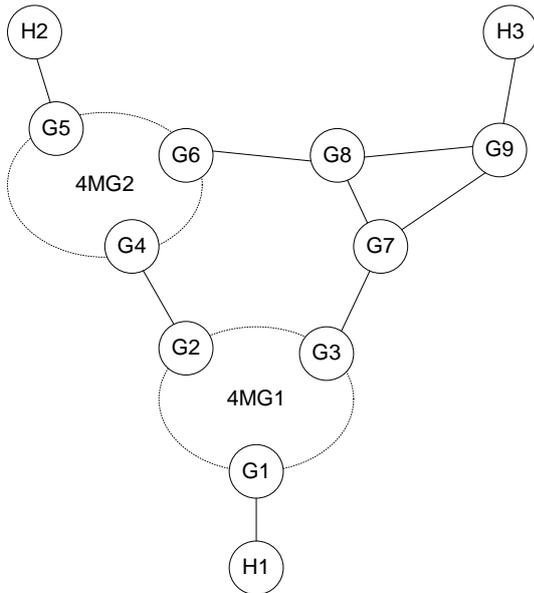


Figure 2: Test bed for functionality test

After building shortest path tree Dvrelays at each gateway was activated based on the up and down links of the tree so that receivers were able to enjoy the stream from sender.

The values of time taken to build the topology table for the given five types of the tests are displays in Table 1.

Table 1: Protocol performance results

Test	Available Interconnection types	Time taken to built the topology database (s)		
		Setup A	Setup B	Setup C
1	Only IPv4	20.1	22.1	28.9
2	IPv4, IPv6	20.6	23.5	41.3
3	IPv4, 4MG1	20.1	22.5	27.0
4	IPv4, IPv6, 4MG1	20.8	26.0	46.2
5	IPv4, IPv6, 4MG1, 6MG1	21.2	29.8	46.6

Test column shows the tested five link type scenarios. Each test was carried out considering three network setups as network setup A, B and C. In network setup A, there were two gateways while network setup B and C having three and four gateways. It shows that in each setup time taken is increases with the complexity of the network. But for test number three times taken is less than the test number two for all network setups. In test number two since there are both IPv4 and IPv6, number of entries in topology table for network setup A is four. But for test number 3, there are only three entries in the topology database.

Table 2: Topology table building time

No. of entries	Topology table build time (s)
2	20.1
3	21.1
4	24.0
5	23.9
6	22.4
7	26.0
8	35.5
9	46.2
10	46.6

Since the number of entries in the topology database actually affects the time taken to build the topology database, data given in Table 1 was simplified as in Table 2. As an example test number 1 on network setup A has only two entries in the topology database since test 1 was done only for IPv4 and network setup A had only two gateways. There are ten entries in the topology database of test number 5 on network setup C. There were four gateways with IPv4 and IPv6, and two multicast groups. Since each gateway have entries for IPv4 and IPv6, and each multicast group has one entry, topology database has ten entries. So Table 2 shows average time taken to build the topology database against the number of entries in the topology database.

As per Fig. 3 it can be concluded that topology building time increases with the number of entries in topology table and following equation represents it mathematically,

$$y = 3.4465 x + 8.8411$$

$$x = (l * m) + n$$

y = Topology table building time (s)

x = Number of entries in topology table

l = Number of gateways

m = Unicast heterogeneity

n = Number of multicast groups

Unicast heterogeneity can take values one or two. If the network has only IPv4 or IPv6 value of m is one, and if the network has both IPv4 and IPv6 value of m is two. As per referred three networks it is assumed that all the gateways have same unicast heterogeneity.

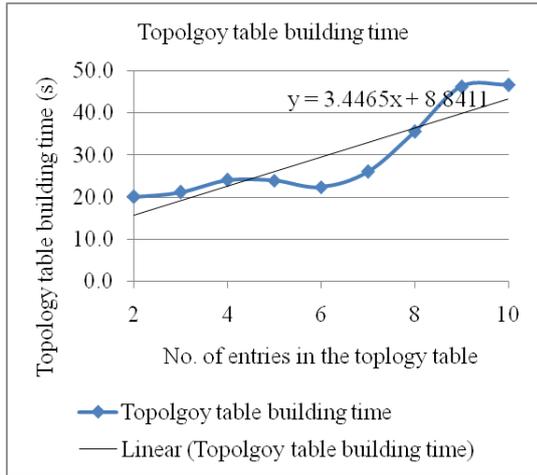


Figure 3: Protocol performance results

4. CONCLUSION

DVTS is used to send and receive DV in internet to conduct multiparty seminars or talks using IPv4 or IPv6 flavors of unicast or multicast. Since current internet is not fully supported for multicasting a relaying mechanism is required to relay between different unicast or multicast and IPv4 or IPv6. Dvrelay is capable of relaying DV between IPv4 and IPv6 flavors of unicast and multicast and further it is capable of thinning out DV stream to suite the existing bandwidth in the link. Different configurations are required at each Dvrelays placed at gateways in the network to facilitate multiparty seminars and it requires a lot of effort to do those configurations manually.

Hence we proposed to implement a system based on the overlay concept using those Dvrelay installed gateways and to automate above said manual configurations at Dvrelays.

According to the results as proposed the automation of an online seminar using a DV steam in a heterogeneous network could be achieved through an overlay mechanism. The test results of the implemented code proved that it can be used to conduct an online multi party seminar or talk in internet with heterogeneous types of interconnections between participants and gateways.

The following points are recommended for further studies of this work,

- i. Refinement of code: It is recommended to introduce the queues to handle messages exchanges between nodes. When the number of nodes participating in the seminar increases, this could increase efficiency by exchanging the most recent messages in the queues.
- ii. Testing the code further with different parameters: The proposed application should be tested with parameters such as generated control message traffic.
- iii. Introduction of neighbor discovery protocol: In this design neighboring information was fed to the system manually by the seminar administrator. This function can be replaced by a neighbor discovery protocol
- iv. Improve Dvrelay as it can handle several streams at a gateway: At present Dvrelay is capable of relaying only one stream at a gateway. This leads to limit only one sender at a time. Effectiveness of proposed system can be further increased if Dvrelay is capable of handling several streams at a time.
- v. Introduction of tree convergence: The proposed system is capable of recovering the topology table upon network disconnectivity like lost of a host or gateway. But it is not capable of reconstructing and resending the DV stream.

5. REFERENCES

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