Implementation of Both High-Speed Transmission and Quality of System for Internet Protocol Multicasting Services

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SUMMARY The paper introduces both high-speed transmission and quality of system to offer the Internet services on a HFC (Hybrid Fiber Coaxial) network. This utilizes modulating the phase and the amplitude to the signal of the IPMS (Internet Protocol Multicasting Service). An IP-cable transmitter, IP-cable modem, and IP-cable management servers that support 30-Mbps IPMS on the HFC were developed. The system provides a 21 Mbps HDTV transporting stream on a cable TV network. It can sustain a clear screen for a long time.

1. Introduction

Since the HFC network uses shared network architecture, undesirable collisions may occur frequently during transmissions of data from cable modems. An alternative network protocol is required to ensure efficient network performance. The Data-Over-Cable Service Interface Specification (DOCSIS) protocol[1],[2] is currently one of the most effective services for resolving these collisions. It utilizes what is known as the Truncated Binary Exponential Back-off (TBEQ) algorithm[3], which is similar to that used in the IEEE 802.3 standard. However, previous studies have shown that the time delay of this algorithm increases rapidly while significantly reducing the network throughput under a heavy network work load[4],[5]. It has been shown that this problem can be mitigated to a certain extent by adjusting the length of the back-off window[4],[5]. Hence, broadcasting-service data provided by a video server to an IP set-top box can be transmitted using the same route. This generates the phenomenon in which the Internet and broadcasting services use the data transmitting quantity provided by CMTS (Cable Modem Termination System). Thus, this result causes a traffic obstacle problem.

2. Problem Description

An example of an existing cable modem is shown in Fig. 1. Upstream channels range from 5 to 42 MHz, and downstream channels range from 88 to 860 MHz.

A DHCP (Dynamic Host Configuration Protocol)[6] server allocates an Internet Protocol (IP) address for a user who connects to the Internet. The L3 switch extracts the requested data for the user among all the data on the Internet and transmits the Internet data to the pertinent CMTS. The CMTS transmits the data as a wave through a wire or by cable TV to thousands of cable modems while managing the cable modem by receiving request signals from the joined computers. Installing an IP set-top box onto the output stream of the cable modem creates the existing IPBS (Internet Protocol Broadcast Service).

As shown in Fig. 1, the CMTS should be a highly efficient system in the existing IPBS to transmit the Internet data and to broadcast system services. This is a main key for broadcasting services. However, the investment cost may increase as the screen resolution determining the broadcasting quality increases, otherwise, the screen resolution is sacrificed under the optimum level when constituting the IPBS using the highly efficient CMTS in as efficient a means as possible, similar to the supply of thousands of broadcasting services. In this way, the investment cost may increase compared to the existing cable TV broadcast or satellite broadcasting services. Finally, it may degrade the broadcasting quality. Thus, there is room for improvement with the current system. Moreover, the existing IPBS causes a serious traffic problem when transmitting data. As mentioned earlier, the existing IPBS is what is allocated among the broadcasting service between video server and IP set-top box. The cable modem provides some data transmission quantity with the installation of the IP set-top box onto the cable modem of the ISS (Internet Service Subscriber).

Figure 2 shows an approximated data traffic graph of the IPBS using the existing transmission system. There are downstream and upstream data provided by the CMTS. In these data streams, the traffic quantity of the Internet service...
is shown as the solid line and the broadcasting service is shown as the dotted line simultaneously in the downstream data. If two services share the same route, it may cause the data to exceed the limit of the existing downstream data.

Figure 3 is a general picture of the DOCSIS downstream channel. Occasionally, the speed of the Internet service drops abruptly in the system. To prevent this falling-off in quality, a CMTS with large capacity in terms of downstream data can be considered. However, increasing the capacity cannot be a solution in terms of technique costs for the reason that IPBS, which broadcasts data at 2 Mbps per second, provides a considerable amount of broadcasting data.

3. The Proposed Method

3.1 System Architecture

To solve these problems, a new system is proposed.

First, the Internet service continues to employ the CMTS. Consequently, the system specifies both high-speed transmission and the quality of system for the IPMS, implying that the system can convey the high-resolution multicasting service data at a low investment cost.

This system provides a HFC based on a high-speed transmission system with the function guaranteeing the Quality of Service (QoS) of the existing Internet network as well as sustaining the smooth traffic of the multicasting service data. Figure 4 shows the high-speed transmission and quality of system for the IPMS.

The proposed system serves IPMS with the existing CMTS in parallel as shown in Fig. 5. The system uses an idle frequency that does not require the intervention of the cable modem.

3.2 The Components

The developed system consists of three distinct parts: an IP-cable transmitter, an IP-cable modem, and an IP-cable management server. The function of each component is described in Table 1.

The system uses an IP-cable transmitter between the L3 switch and the coupler of the ISP in parallel with the CMTS.

The IP-cable transmitter modulates and transmits the phase and the width of the IPMS data that is transmitted. It transmits the data to the IP set-top box after duplicating the IPMS data transmitted from the IP-cable transmitter by equipping the IP-cable modem to that it is parallel in the ISS distributor. It is a better idea to add switches between the cable modem of the ISS and the IP-cable modem. A switch was added to the computer and the LAN-connected IP set-top box by mixing the Ethernet data input-output in the cable modem. By providing an additional IP-cable management server to the ISP, it is possible to monitor the present working state of the IP-cable transmitter and perform emergency operations based on a designated scenario in the case of unexpected events. The IP-cable management either creates
the table of the IPMS service or can be discerned from the remote server. This makes it possible to transmit the ECI. The IP-cable modem has an ECI that is received from the IP-cable cyclically. When the IP set-top box requests IPMS through a video server, it is better to receive the signal of the IP-cable transmitter utilizing the ECI in advance and to create the multicast requested by the IP set-top box.

### 4. Simulation Results

The system was simulated using Smartbit 200 as following Fig. 6 and Table 2. Although the existing local or/and international technologies simply support IPMS at 5 Mbps, this issue has been circumvented. The ability of multicasting services increases sharply to six times its original value. The system can receive data at approximately 32 Mbps without data loss in Smartbit 200. To confirm the ability of the system for an extended time, a video server and IP-cable transmitter were installed to transport HDTV streaming data at approximately 21 Mbps. The HDTV streaming data was received by the modem and a Mac Mini PC (considered here the IP-Set-Top box) then received the data. The Mac Mini PC also decoded the data to display them clearly on the monitor.

The proposed system stably achieves the maximum HDTV streaming data rate of 19.4 Mbps and the Internet data rate of 21.6 Mbps.

Finally, high-speed transmission system with the function that guarantees the QoS and sustains a stable traffic flow of the multicasting service data was achieved as shown in Fig. 7.

### 5. Conclusions

This paper describes the development of an IP-cable transmitter and IP-cable modem based system which supports 30 Mbps IP multicasting services over an HFC network. This system was confirmed using a receiving monitor to support 21 Mbps HDTV transport streaming for an extended period through a cable TV network.

The proposed system creates a new market for bi-directional IPTV and Video on Demand (VOD) but also protect existing users their use of the new IPTV service. Furthermore, it has a financial benefit through its potential for increased ARPU (Average Revenue per User) figures.

### References

1. Cable Television Laboratories, Inc., Data-over-cable Service Interface Specifications in Radio Frequency Interface Specification, April 2004.
2. W.-T. Lee, K.-C. Chung, K.-C. Chu, and J.-Y. Pan, “DOCSIS performance analysis under high traffic conditions in the HFC networks broadcasting,” IEEE Trans. Broadcast., vol.52, no.1, pp.21–30, March 2006.
3. Y. Ling and D. Meng, “Study on improved truncated binary exponential back-off collision resolution algorithm,” IJCSNS International Journal of Computer Science and Network Security, vol.6, no.11, Nov. 2006.
4. Y.D. Lin, C.Y. Huang, and W.M. Yin, “Allocation and scheduling algorithm for IEEE 802.14 and MCNS in hybrid fiber coaxial networks,” IEEE Trans. Broadcast., vol.44, no.4, pp.427–435, Dec. 1998.
5. Y.D. Lin, W.M. Yin, and C.Y. Huang, (2000, Third Quarter) An Investigation into HFC MAC Protocols: Mechanisms, Implementation, and Research Issues. IEE Communication Surveys [Online] Available: http://www.comsoc.org/pubs/surveys
6. R. Droms, “Dynamic host configuration protocol (DHCP),” RFC 2131, March 1997.