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SVC 멀티캐스트 메커니즘에 관한 설계

고 휘*, 이형옥*, 곽용완*, 남지승*

*전남대학교 전자컴퓨터공학과
e-mail : ghuier@hanmail.net

A Design of SVC Multicast Mechanism

Hui Gao*, Hyung-ok Lee *, Young-wan Kwag *, Ji-seung Nam*
*Dept. of Electronics and Computer Engineering, Chonnam National University

요 약

Research on 4A(Any-time, Any-where, Any-device, Any-contents) services for the next-generation multimedia services is developed with the trend of the integration of wire and wireless networks and the convergence of telecommunications and broadcasting. In this paper we proposed a design of SVC(Scalable Video Coding) overlay multicast mechanism which can provide typical next-generation multimedia services such as SVC streaming. A novel overlay multicast algorithm called ACK-Flow tree optimization algorithm is proposed to guarantee SVC streaming with high efficiency.

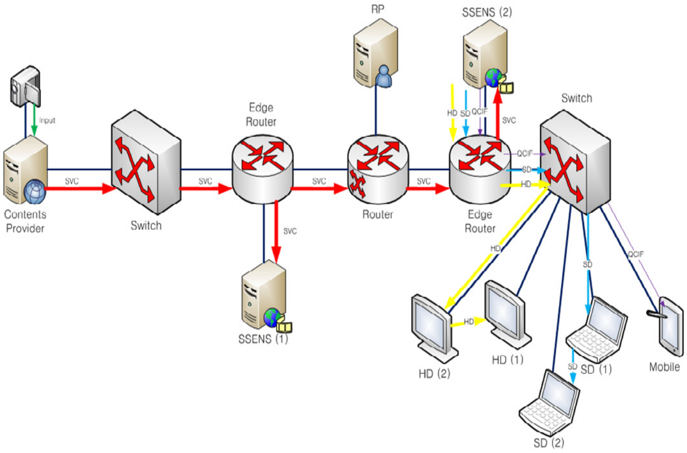
1. Introduction

Hybrid data delivery is utilized in wire and wireless integration networks which combine the existing network infrastructure with the latest network infrastructure. Multicast and overlay multicast are used to make the delivery efficient [2]. By SVC (Scalable Video Coding) streaming through multicast routing and overlay multicast routing, users can enjoy the N-Screen service via the different devices anywhere and at any time [3][4][5]. In this paper, we propose a new generation multimedia system called context-awareness based SVC multimedia broadcasting system that guarantees both real time service and QoS [1]. At the same time a novel overlay multicast algorithm called ACK-Flow is proposed and applied in delivering SVC streaming. Context-awareness based SVC multimedia broadcasting system is described in section 2 and ACK-Flow overlay multicast algorithm is explained in section 3. The simulation result is described in section 4 and the conclusion is given in section 5.

2. SVC Multimedia Broadcasting Service

Fig.1. shows the basic structure of the system which is comprised of CP (Contents Provider), RPS (Rendezvous Point Server) acting as service-supervising server, SSENS (SVC Stream Exchange Network Server) that delivers the channels provided by CP and users of diverse devices.

As the contents provider, CP provides streaming for the system via diverse input methods and SVC encoder. At this time CP starts broadcasting by registering the channels it will provide at RP server. RPS is in charge of broadcasting service and CP and SSENS collect and provide information for the audience. SSENS can control broadcasting contents provider and is embedded with high performance server or network device like router. CP locates SSENS at the high efficiency networks like the backbone. Supervised under RPS, SSENS sets up the path via multicast routing. The function of SSENS is to receive SVC bit streaming from CP, route it to other SSENS and perform extraction with stability and continuity in real time. The audience evaluates the network context between the connected SSENS and the local device environment and then selects the layer for SVC streaming of the channel which will deliver the data. Since then data is transmitted at RPS and the extracted layer streaming received from SSENS can be played. Also the overlay multicast delivery method is applied, the streaming is transferred to the audience who receives the layer data of the same channel and the overlay network is constructed.



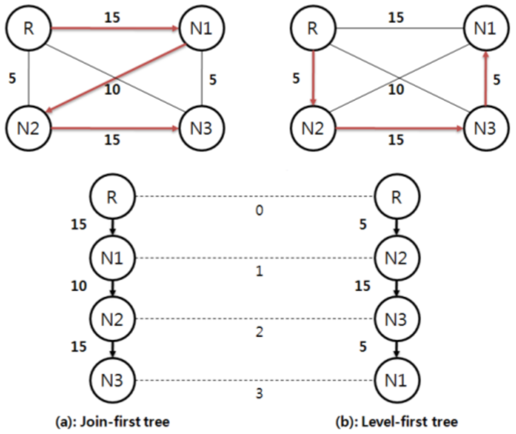
(Fig. 1) Structure of SVC multimedia broadcasting system

In order to deliver SVC streaming of a diversity of the channels there are groups for SSENS Network that is located at the backbone with large scale transfer lines and the layer of each channel located under SSENS [6]. The clients take their position by joining a group which can be treated as overlay network and perform overlay multicast service. Service provider locates RPS and SSENS efficiently and stands by for the access from CP and Clients. CP connects RPS, gets the SSENS list, tests the costs from SSENS on the list and selects the optimum SSENS [9]. And CP connects the selected SSENS and registers the channel. Then the channel is registered at the SSENS connected with RPS. A channel ID is assigned from RPS and SVC streaming is transferred at SSENS [10].

3. ACK-Flow Overlay Algorithm

There are several issues that should be resolved for overlay multicast when it is applied in real time multimedia broadcast service. Firstly the quality and the transfer time of the multimedia streaming is directly affected by the delay of the new node joining and the tree-recovering delay caused by the leave of the existing member of the multicast group [11]. Secondly delay arises when the data has to be sent to the destination via many overlay nodes. These issues seriously become an obstacle to multimedia streaming [12]. Therefore the procedure of new node joining and tree recovery should be fast and the delay needs to be minimized to meet the requirements of real time streaming.

Tree optimization method improves the existing tree-based overlay algorithm. In the physical network environment overlay multicast tree should be constituted according to the rule of shortest distance instead of the joining order of the nodes [7]. Fig.2 (a) gives a join-first tree topology constituted according to the joining order. Fig.2 (b) shows a tree topology constituted by the rule of the link cost from the source node.



(a): Join-first tree (b): Level-first tree

(Fig. 2) Join-first tree and level-first tree

In Fig.2 (a) total cost of the tree is 40 and in (b) the total cost is 25. In the case of the level-first tree, when a new node is joining the tree it calculates the cost between the root node and itself and obtain the value of its level. Then it compares the level value of itself with that of the existing nodes of the tree and selects a position in the tree. That means the node with the shorter distance is located at the lower level of the tree [8].

In the case of TBCP and HTMP which are of tree-based structure, when the new node joins the multicast group, it receives a list of the candidate parent from the root node or its parent node and finds out the nearest node by measuring the delay time from all nodes in the list to itself in order to find out the parent node. But during the process of constructing and recovering the tree, measuring and evaluating the delay time from all the nodes in the list takes a lot of time and cases a problem.

In this paper we proposed a method for new node to join the multicast group without measuring the delay time from all the nodes in the candidate parent list. The parent nodes ask their children to send ACK message to the new node that is joining the group [13]. When the new node receives these ACK messages, it finds out the node that sent the firstly arriving ACK message and takes this node as its candidate parent with minimum delay. The tree constituting steps of ACK-Flow is described in the following.

1. In order to join the multicast group, the new node N selects its temporary parent node N from the nodes it could find including the root node and other nodes in the multicasting group.
2. Node R as the temporary parent sends the node N the delay time between them and N decides at which level to locate itself.
3. Node N sends the join message including the value of its level.
4. If the number of the children of the node R is less than its out-degree, N is permitted to join the group as the child of R.
5. If the number of the children of R is equal to its out-degree, R will send its children Cx the ACK message including N's level and IP.
6. Those who received the message mentioned in step 5 will send the node N the ACK message which includes the difference between the level of the N and the level of itself.
7. Node C1 whose ACK message arrived at N firstly will be chosen as the candidate parent and the value of the level difference will be analyzed by N. If the value is negative, it means that the delay time from R to C1 is less than that from R to N, and N will send join requirement to C1. And then C1 will return to step 4.
8. If the value of the difference is larger or equal to 0, N sends the switching requirement to its temporary parent R and C1 so that N becomes the child of R and C1 becomes the child of N.

According to the traditional tree-constructing method, the delay from each nodes of the group to N should be tested. While according to step 5 and step 6 which feature our novel method, the ACK messages are delivered only between the nodes involved in the join process of the new node N. The node whose ACK message firstly arrives at N will be selected as the parent node of N. The delay time for the new node N to join the group will be shortened. The switching mechanism mentioned in step 8 can optimize the tree structure efficiently. Therefore it is possible to minimize the delay time of delivering the streaming from the root node to each member of the group, which is also helpful in solving the problem of QoS.

Tree recovering procedure of ACK-Flow is described in the following.

If the node C1 tends to leave the group, it will send leave message to its parent node P and its children nodes C1~4. When C1 leaves without sending the leave message, node C2~4 will realize the absence of C1 since they receive nothing from C1 for a certain interval.

If the nodes C2~4 know depart of C1, they will send join message to P who acts as their temporary parent and then start a new round of join procedure.

When C2~4 find their new parent, they will inform their children nodes and then substitute their temporary parent node. Also the new parent node of C2~4 will ask them to replace their temporary parent.

4. Simulation

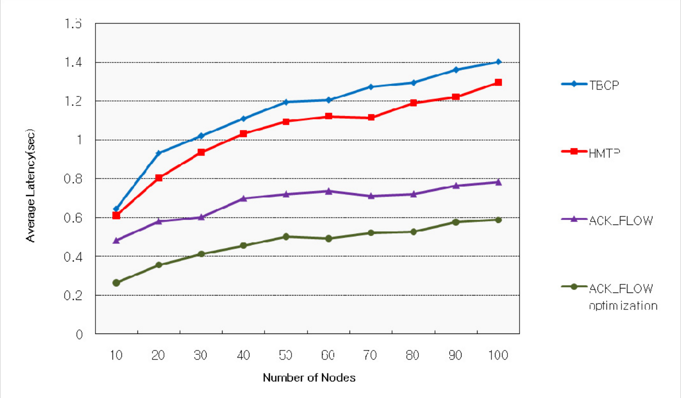
It is known that from the aspect of channel capacity SVC raises 20~30 percent overhead more than AVC (Advanced Video Coding) does. SVC streaming coded with most efficiency will raise 10 percent overlay and raise 20~30 percent generally. Therefore the disadvantage of SVC is the requirement for a higher compression ratio in order to obtain the same video streaming quality with AVC.

The proposed network structure is designed to deliver SVC streaming adaptively and efficiently along the diverse terminals existing in IP network. Streaming resolutions in H.264/AVC are CIF (0.256Mbps), SDTV (2Mbps) and HDTV (8Mbps). As *simulcast* is the combination of *simultaneous* and *broadcast*, it means that the streaming with multiple bit rates can be delivered in one channel and broadcasting request can be applied at the diverse terminals. In the case of Simulcast AVC streaming encoded with different bit rate are delivered and the total serving bit rate is the sum of the bit rate for each layer.

Generally speaking SVC streaming raise more overhead than simple AVC streaming does and requires the network to provide higher delivery rate. For delivering the simple-layer streaming, SVC not only spends time in encoding, decoding and extraction but also allocates network resource in inefficient way. However in the case of streaming with multi-layer along multi-channel, SVC performs more efficient than AVC does. Furthermore providing the services combining IP multicast with overlay multicast, the proposed method can also work efficiently in the existing network. Finally with the increasing of the number of the channels, the gap between the required bandwidth of simulcast and that of SVC will be widened. That is to say that SVC encoded with the maximum efficiency will work well in the context-awareness based adaptive multimedia broadcasting service.

The proposed ACK-Flow tree-optimizing algorithm is compared with the existing tree-based overlay method. GT-ITM is used to generate network topology where the link bandwidth is 10Mbps and the maximum number of the multicast group is 1000 nodes. Ns-2 simulator is used to evaluate the constituted topology in the same environment. 3 experiments are performed in simulation and only the result of the first experiment is showed in this paper. The first experiment and the second experiment show the tree-constructing time and the overhead when the number of the tree is increasing by 5 each time from 10 to 100 given that the out-degree of each node is 3. In the third experiment the out-degree of each node increases from 2 to 5 with 100 nodes participating in multicasting. In each experiment, tree-based TBCP and HMTP, ACK-Flow and ACK-flow with tree optimization are evaluated and analyzed.

The first simulation shows the average tree-constructing time with the group size increasing by 5 each time from 10 to 100 in Fig.3. It is confirmed that TBCP and HMTP spend more time in constructing tree than the proposed method because they have to test delay time from the candidate parents. And ACK-Flow with tree optimization spent more time in constructing the tree than ACK-Flow without tree optimization did. The proposed method that finds out the parent node by ACK-Flow is proved to be more efficient than these existing methods by testing delay times. So the delay time for the new node to join the group can be minimized in the real overlay multicast service.



(Fig. 3) Average tree constituting time against the number of the nodes

5. Conclusions

In this paper, we proposed a design of SVC(Scalable Video Coding) overlay multicast system which can provide typical next-generation multimedia services such as SVC streaming. The system aims to provide N-Screen service to different users equipped with diverse networking terminal devices. In order to meet the requirement of real time service and QoS, we developed the existing tree based overlay algorithm and prosed a novel overlay multicast algorithm called ACK-Flow which perform efficiently in delivering SVC streaming.

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