게임 트래픽 부하에 따른 멀티캐스트 라우팅 전략
Multicast Routing Strategy Based on Game Traffic Overload

이창조, 이광재[*]

우송대학교 게임멀티미디어학과, 서남대학교 전기전자멀티미디어공학부[*]

Chang-Jo Lee(cjlee@wsu.ac.kr), Kwang-Jae Lee(kjlee@seonam.ac.kr)[*]

요약

인터넷에서 게임 트래픽과 같은 대용량 데이터의 부하를 분산하고 안정적인 전송을 위해 멀티캐스트 라우팅 프로토콜을 사용한다. 다양한 멀티캐스트 알고리즘 중 최근 CBT(Core Based Tree) 방식이 널리 사용되고 있으나 코어 라우터로 트래픽 집중되는 병목현상과 코어라우터의 위치에 따라 푸어 코어(Poor core) 현상이 발생한다. 본 논문에서는 코어 라우터의 병목현상을 초래하는 링크 레이트(Link Rate)에 따라 코어 라우터의 상태를 SS(Steady State), NS(Normal State), BS(Bottleneck State)로 구분하였으며, 코어 라우터의 과부하에 따라 멀티캐스트 라우팅 전략을 CBT에서 Anycast로 전환하는 방식을 제안하였다. 온라인 게임에서 교환되는 주요 패킷의 크기에 준하여 두 가지 라우팅 방식을 비교하고 트래픽의 증가에 따라 Anycast 라우팅 방식의 성능개선을 보였다.

■ 중심어 : | 멀티캐스트 라우팅 | 트래픽 부하 | CBT | Anycast |

Abstract

The development of multicast communication services in the Internet is expected to lead a stable packet transfer even though On-Line Games generate heavy traffic. The Core Based Tree scheme among many multicast protocols is the most popular and suggested recently. However, CBT exhibits two major deficiencies traffic concentration or poor core placement problem. Thus, measuring the bottleneck link bandwidth along a path is important to understand the performance of multicast. We propose a method in which the core router's state is classified into SS(Steady State), NS(Normal State) and BS(Bottleneck State) according to the estimated link speed rate, and also the changeover of multicast routing scheme for traffic overload. In addition, we introduce Anycast routing tree, an efficient architecture for constructing shard multicast trees.

■ keyword : | Multicast Routing | Traffic Overload | CBT | Anycast |

I. Introduction

High-speed and generalization of the Internet have created new e-businesses in all areas of society. As this tendency supports the game industry, it tremendously boosts supply and demand of multimedia communication. Thus, communication method follows the interface that

prefers more diverse multimedia communication services and it gets more complicated and varied.

Recently, hundreds of thousands of Internet users are able to be simultaneously connected and the number is expected to increase.

Such radical increment of multimedia communication causes traffic increase to the communication capacity of the restricted Internet and it has a high possibility of leading to insecurity in the connection of the data packet or disconnection from the system.

As for the solution, the studies of multicast communication method are actively making progress under conditions to actualize the reduction of traffic load that is via the Internet.

Multicast communication is a communication method that has both characteristics of unicast – point-to point method and Broadcast – which takes unidirectional Flooding method. It can be one-to-many(1:N) or many-to-many(M:N) communication. Likewise, it has not only flexibility in connection but also decreases traffic load greatly, especially between servers or in cases when users are directly connected with it. For this reason, only one time transmission of packet enables multiple user groups to share data packets.

Thus, Multicast communication becomes a solution to improve the utilization factor of the network source and expands its area of application to video conferencing or Internet broadcasting [1-3].

The methods of multicast communication is classified into the Intra-Domain method and Inter-Domain method according to the constituting domain of routing tree, SBT(Source Based Tree) and ShT (Shared Tree) according to the constituting method of tree[4]. Recently, Anycast that expands the concept of the unicast method as

Multicast is frequently proposed[5][6].

Multiple users use various kinds of information simultaneously like visual conferencing or Internet broadcasting. Once user group, increment tendency in number, and distributed user's location are considered, CBT (Core Based Tree) of the ShT routing method that every information using the groups' member is more effective than the SBT method that sets the shortest source based route for multicast routing method with better use of information[7].

Recently, active studies have been made on CBT. CBT is flexible for expansion and can process traffic of multimedia data packets, which are tremendously appearing recently, more effectively than the existing various multicast routing method. However, the traffic load that deals with the real-time process and multimedia data increases link speed around connected link with core; thus, it causes the Bottleneck phenomena and may induce Link Failure, which is fatal in the whole system flow [8][9].

Chapters 2 and 3 predict traffic load density of link according to the increment of traffic in CBT multicast routing method and stipulates traffic condition of link for the effective traffic control of multimedia data packets and maintenance of stable links. Also, an algorithm that changes multicast routing method according to conditions of link is proposed in order to prevent overload state. The last chapter concludes the study in this paper.

II. CBT and prediction of link speed

1. CBT protocol

CBT protocol is a recently arising multicast routing protocol that is actively proposed and

discussed. It forms a bidirectional shared tree around a core and enables process of traffic by using small numbers of routers than the existing other multicast protocol when the numbers of network node and traffic load are the same. CBT protocol is operated with processes of basic messages as below.

- JOIN_REQUEST : If the presently used protocol is CBT, there exists an optional core router c in the multicast tree. This message is given when a new member x requests to join as a multicast member.
- JOIN_ACK : It is a negative message of JOIN_REQUEST. If a new member x is included in the tree of CBT, multicast service is available right away without going through additional process. However, if a member x is not included in tree of CBT then the shortest route from the Core router c to the member x.
- JOIN_NACK : It is a negative message of JOIN_REQUEST when a new member x fails to join the membership process of the multicast tree.
- QUIT_REQUEST : It is a message of an optional child node in the tree for requesting investigation and closing of child node to parent node to end multicast membership.
- QUIT_ACK : It is a responding message of QUIT_REQUEST. If there is any problem in the parent node or upper parent, a negative answer is given within a time limit.

CBT protocol forms a single tree that is shared by each member with a group; therefore, the biggest merit of it is stability of traffic when there is any change in number of member or source. If number of source is S and number of group member is G, the size of SBT tree such as

DVMRP(Distance Vector Multicast Routing Protocol) or MOSPF(Multicast Open Shortest Path First) is (S*G) whereas the number of CBT tree is the same as G.

Moreover, It does not require periodical information like protocols such as IGMP(Internet Group Management Protocol) for group administration so the assigned bandwidth is used only for multicast traffic. Therefore, it helps to save bandwidth of link and enables to use the whole network sources effectively.
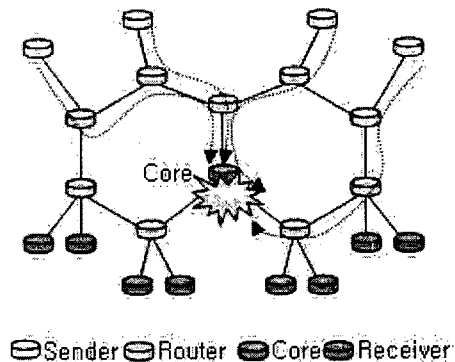

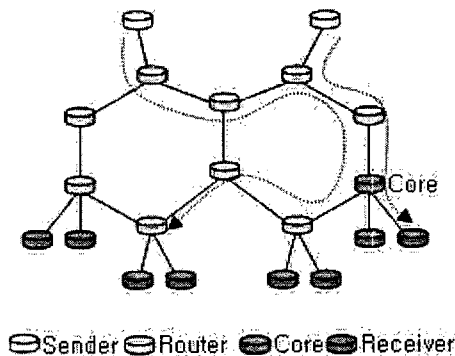Fig. 1. Core Router Congestion

Fig. 2. Poor Core Router

However, routing route of the whole tree is formed around a core and has to go through the core. These characteristics causes increment of

link cost and as [Fig 1] shows, it may induce bottleneck phenomena at the core link because of core congestion.

The link speed that excesses and requests bandwidth of core link causes bottleneck phenomena and leads to blending of core link, at the end it may bring cease of multicast service. In order to resolve traffic congestion to the core link, more than two cores of CBT (Multi Core) can be assigned to decentralize traffic; however, selecting the optimal router would be the major concern like a single multicast using routing method. [Fig 2] shows an example of Poor Core according to the failure of the core's position setting in the multicast network.

2. Algorithm for prediction of link condition

Regardless of the merit of CBT protocol, the weakest point is due to traffic congestion of the router; however, it can be solved by predicting traffic process of core router. There are algorithms to predict Bottleneck: Spectrum analysis, Rate Based Congestion Control Scheme, and so on. But the method of predicting bottleneck link from multi cast tree to reform the multicast tree is often used.

These methods have to have a separate BCS (Bottleneck Calculation Server) or predict the traffic of the whole multicast tree, thus it works as Redundancy from a perspective of the whole multicast.

In this paper, the load density of link traffic in CBT Core predicts bottleneck condition with packet Link Speed Input Ratio to the core. Based on this, an algorithm that decide multicast tree according to the traffic process condition of the core router is suggested. [Fig 3] shows a packet that goes through the Bottleneck link of core
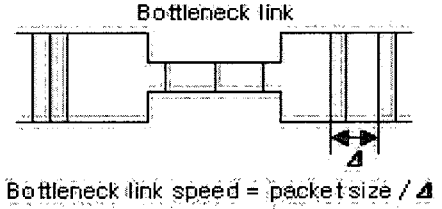
router.

Fig. 3. Bottleneck Link of Core Router

If the size of packet is P (bytes) and the bandwidth of Bottleneck is B (bytes/sec), then the passing time Qb for packet P to go through the Bottleneck link is

$$Q_b = P \ / \ B \qquad (1)$$

The bottleneck condition of the core can be calculated from input link speed of the core router Bin and output link speed Bout under the consideration of the whole multicast traffic, and a single Bottleneck Link Rate Ψ is

$$\Psi_{single} = B_{in} \ / \ B_{out} \qquad (2)$$

In addition, if the connection of CBT Core Router is not single but multi link number of input becomes m and number of output link becomes n; therefore,

$$\Psi_{multi} = \sum_{i=1}^{m} B_{in(i)} \ / \ \sum_{j=1}^{n} B_{out(j)} \qquad (3)$$

If Bottleneck Link Rate Ψ of core router becomes $\Psi>1.0$, packets cannot go through the core router and simply waits or will be decreased. Thus, the condition of the core router is stipulated base on Ψ and [Fig 4] shows the summary of the calculation.

Once a careful observation for the traffic condition of the resent multimedia data packet is made, it shows abrupt increment at a specific period of time. In a case like this, the CBT core where multicast traffic is centralized can be induced as over-load. Therefore, it is necessary to monitor the condition of traffic around the core router inorder to securely support the multimedia data packet with the CBT multicast method.

If present condition of traffic is SS(Steady State), nothing is a problem for the CBT multicast network; however, if it is NS(Normal State) then the network counts its possibility to be BS(Bottleneck State), and a multicast strategy to transfer to a new routing method, that can reduce traffic load of multicast network, has to be made.

Table 1. Definition of Core Router State

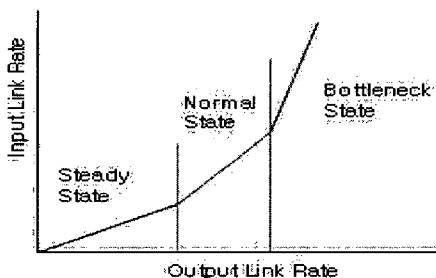| Core Link State	Definition	Link Speed
SS(Steady State)	$0 < \Psi < 1.0$	Input < Output
NS(Normal State)	$\Psi = 1.0$	Input = Output
BS(Bottleneck State)	$\Psi > 1.0$	Input > Output

Fig. 4. State of Core Router

III. Anticipation of effect

In order to decrease traffic of the multicast network, it is very hard to reduce data of game

users therefore; the only ways are to reduce possible elements of packet delay in network, to discard overlapped data, or to simplify information of group administration as much as possible.

Instead of monitoring the traffic condition of the whole multicast tree, it sets BSC to the core that measures link speed of core only for the traffic condition of core. Thus, this paper proposes the Anycast method as a new routing strategy in order to avoid the traffic state of CBT core to be switched from NS to BS based on packet input rate to core and core link speed data that measures output from the core.

The Anycast method supports one-to-multiple communication. However, it is not a method to transmit packet to every member within a group. Rather it transmits data only to the closest router within the multicast group or covalent servers that have optimal conditions from senders like the information provider or game server; therefore, it has the characteristics of unicast.

However, such characteristic corresponds with the attribute of multicast because a network that transmits identical data repeatedly can easily decrease bandwidth. Moreover, it is a Non-core method that does not require any core; thus, the structural problems of the CBT multicast routing method, such as traffic centralization of multicast to the core router, difficulty to select core, and structural matter of poor core, can be solved.

Therefore, transmission delays at core and packet loss are prevented from the origin and various routers in the network. can be used effectively.

IV. Simulation and result

Setting a simulation model is a very sensitive

matter in testing the routing performance of a multicast network. Therefore in this chapter, the model's size, bandwidth of link, and size of applicable data are considered with other important elements for the topology setting.

Because of switch of routing method, network topology is set based on CBT routing. As it is shown
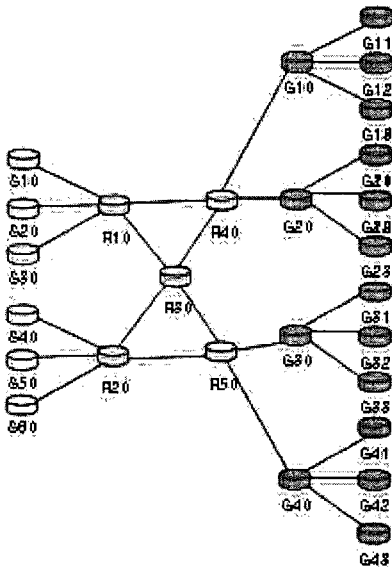

Fig. 5. Simulation Network Topology

in [Fig 5], there are 12 transmitters and 4 groups in order to vary number of transmitter and group. Also, each group has 3 maximum recipients to respond to the number of members on a group.

Each multicast link has fixed bandwidth as 1.5Mbps and wavelength delay as 10ms .The input rate of incoming packets to the router has Poisson distribution and time for packet's arrival and service use exponential distribution. Queueing model M/M/1 is also used for the simulation.

The outer conditions of the simulation are memory capacity 512Mbyte, PC that uses Intel Pentium 4 CPU of system clock 2.0GHz as

platform, operating system being Linux Redhat 7.0, Network Simulator as the simulation tool - ns v2(Version 2) that is a widely used simulator under PC based conditions[10].

By using the simulation model, a packet is generated and transmitted from transmitters to each member of the multicast groups, and also the delay between terminals in the tree is measured. The delay time of the measured result targets the whole system that is connected to the Hop router of group members, thus it is the average delay time between terminals for the whole traffic against the increase in group numbers.

[Fig 6][Fig 7] show results of average delay time between terminals when the game packet size is 210 Bytes, 512 Bytes and 1280 Bytes respectively. With small numbers of groups, the delay characteristics of CBT routing is predominant than Anycast routing; however, as the number of groups increase, Anycast routing does not show any major change when PIM-DM and CBT routing increases delay time gradually in case of increment in group number.

To compare with CBT routing, Anycast routing shows 14.4% of improvement in delay characteristic and the delay time of Anycast according to size change of data packet shows a 3.4% increment on average.

The biggest difference between [Fig 6][Fig 7] is that the performance of Anycast routing improved radically even when the numbers of groups were small. Particularly, when the size of the data packet is 1 Byte, the average delay time between terminals of CBT increases more than PIM-DM and such result indicates serious congestion at link of core because of concentrating traffic to the core router of CBT as the size of multicast data packet gets bigger.
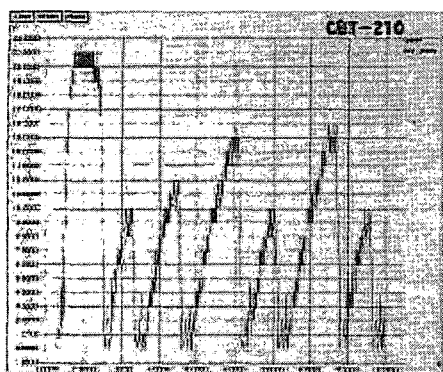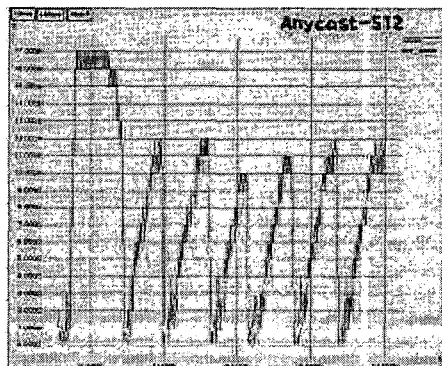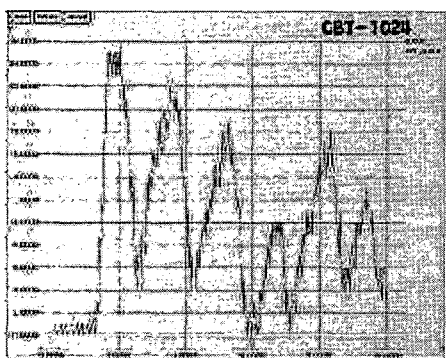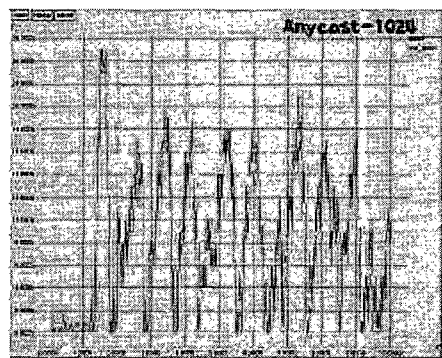
(a) 210 bytes
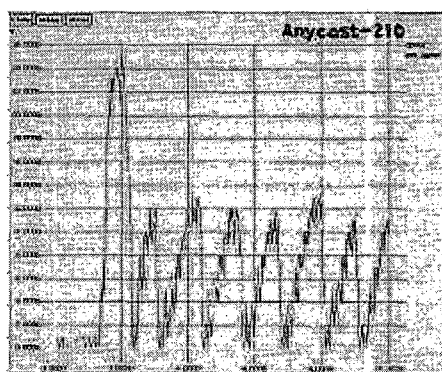
(a) 210 bytes
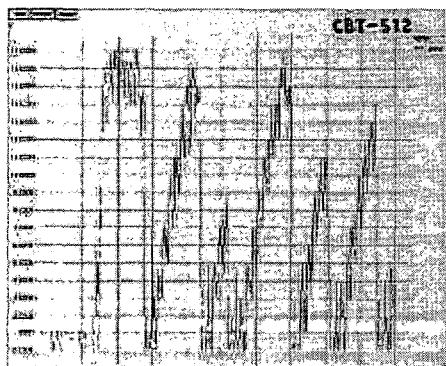
(b) 512 bytes

(b) 512 bytes

(c) 1280 bytes

(c) 1280 bytes

Fig. 6. Packet transmission delays for CBT core   Fig. 7. Packet transmission delays for Anycast

V. Conclusion

In this paper, the CBT multicast routing method that forms a shared tree around the core among multicast routing methods, which are applicable to newly introduced or developing services like video conference, Internet broadcasting, etc. is a carefully studied and proposed algorithm that stipulates link condition of core router by measuring a single input and output link speed.

The proposed algorithm monitors traffic of game data traffic around the core and predicts router's condition to classify its states as SS (Steady State), NS (Normal State), and BS (Bottleneck State).

Also, in order to avoid the entrance of BS that degrades performance of multicast and induces blending of the core router, the multicast routing method that supports the multimedia data packet is suggested to change as the Anycast routing method in CBT. Typical problems of CBT arise from multicast groups that demand large bandwidth; thus proposals in this paper are due to statistical observation. The study estimated stability and proposed the effective change to the Anycast router for decentralization of load from the perspective of the CBT router's communication process according to the increment of traffic load. However, additional studies for overhead of the switching protocol process and analysis of link cost have to be made in order to be applied in the real multicast communication setting.

참 고 문 헌

[1] B. Li and J. Liu, "Multirate video multicast over the Internet: An overview," IEEE Network, Vol.17, No.1, pp.24-29, Jan./Feb., 2003.

[2] W. Yoon, D. Lee, H. Youn, S. Lee, and S. Koh, "A Combined Group/Tree Approach for Many-to-Many Reliable Multicast," IEEE INFOCOM'02, pp.1336-1347, June, 2002.

[3] S. Banerjee, S. Lee, B. Bhattacharjee, and A. Srinivasan, "Resilient Multicast using Overlays," ACM SIGMETRICS'03, pp.102-113, San Diego, California, USA, June, 2003.

[4] B. N. Levine and J. J. Garcia-Luna-Aceves, "A Comparison of Reliable Multicast Protocols," ACM Multimedia Systems, Vol.6, pp.334-348, 1998.

[5] D. Xuan, W. Jia, W. Zhao, and H. Zhu, "A Routing Protocols for Anycast Messages," IEEE Transactions on Parallel and Distributed System, pp.571-588, June, 2000.

[6] C. Carter, S. Yi, P. Ratanchandani, and R. Kravets. "Manycast: exploring the space between anycast and multicast in ad hoc networks," ACM MobiCom'03, pp.273-285, 2003.

[7] T. Billhartz, J. B. Cain, E. Farrey-Goudreau, and D. F. Harris, "Performance and Resource Cost Comparisons for the CBT and PIM Multicast Routing Protocols," IEEE Journal on Selected Areas in Communications, Vol.15, pp.304-315, April, 1997.

[8] S. Ratnasamy and S. McCanne, "Inference of Multicast Routing Trees and Bottleneck Bandwidth using End-to-End Measurements," IEEE INFOCOM'99, pp.353-360, New York, USA, March, 1999.

[9] G. Kwon and J. Byers, "Smooth Multirate Multicast Congestion Control," IEEE INFOCOM'03, No.1, pp.1022-1032, March, 2003.

[10] http://www.isi.edu/nsnam/ns/

저 자 소 개

이 창 조(Chang-Jo Lee)   정회원

- 1989년 2월 : 인하대 전자계산학과
- 1991년 2월 : 인하대 대학원
- 1994년 2월 : 고려대 대학원
- 1990년 11월~1994년 2월 : 한국과학기술연구원/시스템공학 연구소(KIST/SERI) 선임연구원
- 1994년 3월~1996년 2월 : 한국문화예술진흥원 문화정보사업본부 선임연구원
- 1996년 3월~현재 : 우송대학교 게임멀티미디어 학과 교수
- 2004년 7월~현재 : 첨단영상게임산업전문인력양성 (NURI) 사업팀장
- 2005년 8월~현재 : (재)한국게임산업개발원 대전 게임아카데미 원장
- 2006년 1월~현재 : 대전광역시 정보화추진위 위원
  <관심분야> : 게임기획, 모바일게임

이 광 재(Kwang-Jae Lee)   종신회원

- 1986년 2월 : 전북대학교 전자공학과(공학사)
- 1988년 2월 : 한국항공대 전자공학과(공학석사)
- 2002년 2월 : 한국항공대 전자공학과(공학박사)
- 1988년 1월~1996년 2월 : LG(현LS)전선연구소, 중소기업연수원 교수 역임
- 2005년 1월~현재 : 전주게임엑스포 심사위원, (주)다이스넷 엔터테인먼트 사외이사 연구소장
- 1996년 3월~현재 : 서남대학교 전기전자멀티미디어 공학부 교수
  <관심분야> : 게임프로토콜, 게임하드웨어, 협동성증진게임, 게임교육