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Effective Load Distribution Over Multipath Networks to Control the Delay

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ABSTRACT

An effective model of delay-controlled Load distribution becomes essential to efficiently utilize such parallel paths for multimedia data transmission and real-time applications, which are commonly known to be sensitive to packet delay, packet delay variation, and packet reordering. Recent research on load distribution has focused on load balancing efficiency, bandwidth utilization, and packet order preservation. This paper proposes a new load distribution model aiming to minimize the difference among end- to- end delays, thereby reducing packet delay variation and risk of packet reordering without additional network overhead. Therefore, our model can reduce not only the end-to-end delay but also the packet reordering recovery time.

KEY WORDS—Delay minimization, load distribution, multipath forwarding, packet reordering, packet delay variation.

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1.INTRODUCTION

The heterogeneity and high degree of connectivity of various networks result in potentially multiple paths in establishing network connections. The exploitation of these multiple paths no longer aims only at circumventing single point of failure scenarios, but also focuses on facilitating network provisioning for multimedia data transmission and real-time applications, where its effectiveness is indeed essential to maximize high quality network services and guarantee QoS at high data rates [1], [2]. Bandwidth aggregation and network-load balancing are two major issues that have attracted tremendous amount of research, and a number of load distribution approaches have been proposed.Devices must be equipped to perform traffic forwarding, which splits traffic into multiple paths as illustrated in Fig. 1.

The traffic splitting component splits the input traffic into single packets or flows, each of which independently takes a path determined by the path selection component. If the forwarding processor, which is responsible for transmitting packets, is busy, it will be queued in the corresponding input queue. Network load caused by input traffic with arrival rate λ is shared among the multiple paths, i.e., the load of path p is assigned the traffic rate $\lambda p \leq \lambda$. Therefore, bandwidth demand on each of multiple outgoing paths is likely to be smaller than that on the single outgoing path. Inefficient load distribution.

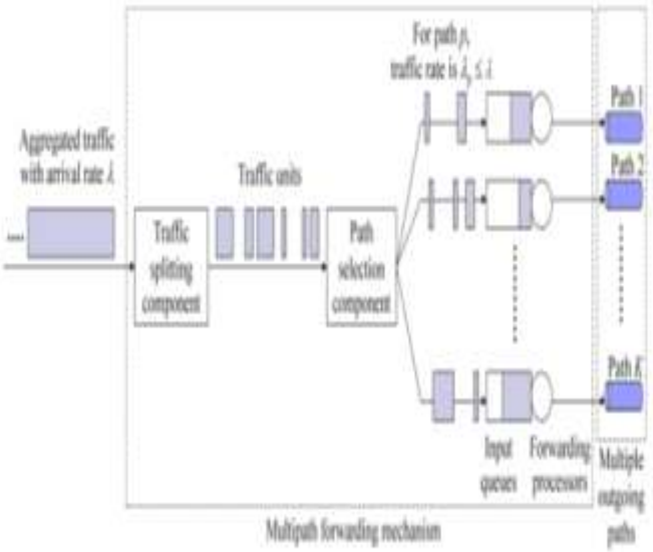

Fig. 1.Functional Components of the Multipath Forwarding Mechanism.

Packets arrived earlier have to wait for late packets in reordering buffers at the receiving destination. If late packets arrive within a receive timeout period, the transmission is successful; however, the waiting time causes packet delay. The packet reordering problem causes additional delay without packet loss. Inefficient load distribution can degrade network performance as a result of a large variation of latency and a large latency to successfully transmitting a packet. The latency in the focus of this paper is the end-to-end delay in transmitting a packet and the additional time required in reordering the packet. End-to-end delay is the time it takes a packet to travel across the network from one end to the other end, consisting of propagation and queuing delays. The load imbalance problem causes a large end to- end delay and a large difference in delay among multiple paths. The large difference in delay brings about a significant variation in packet delay and a high risk of packet reordering (in packet-based models), leading to a large extra time introduced by the packet reordering recovery process. The packet reordering itself, large packet delay, and large variation in packet delay can significantly degrade QoS required for multimedia data transmission as well as real time applications [11], [12], [13].

2. RELATED WORKS

In this section, we briefly describe various load distribution models, each of which exhibits different characteristics and specific advantages (depending upon control objectives), and drawbacks.

Round Robin-Based Schemes

Surplus Round Robin (SRR) [5] is adopted from Deficit Round Robin (DRR) [15] which is a modified model from Weighted Round Robin (WRR)[10]. In SRR, a byte-based deficit counter representing the difference between the desired and actual loads (in bytes) allocated to each path is taken into account in the path selection. At the beginning of each round, the deficit counter is increased by the number of credits (referred to as quantum [5]) assigned for that path. Each time a path is selected for sending a packet, its deficit counter is decreased by the packet size. As long as the deficit counter is positive, the selection result will remain unchanged. If the deficit counters of all paths are non positive, the round is over, and a new round is started. These round robin schemes achieve starvation free and competent load balancing efficiency; however, the major drawback is their inability to maintain packet ordering

Least-Loaded-Based Schemes

Least-Loaded-First (LLF) [7], [8], [9] is one of the most well known load sharing approaches introduced to handle task loads with heavy-tailed distribution, where a task is assigned to the least-loaded server. In load distribution over multiple paths, with this scheme, a path having the smallest load or the.

Flow-Based Schemes

Direct Hashing (DH), Table-based Hashing (TH) [2], [3], [4], and Fast Switching (FS) [6] are examples of well-known flow-based models, which are simple and can completely prevent packet reordering. DH and TH are hash based models by using hashed results of packet identifiers in a path selection. The packet identifier is obtained from the packet header information, which is typically the destination address. The major drawback of these flow based models is the inability to deal with variation of flow size distribution [17], thus leading to the load imbalance problem.

Previous Work

Delay Controlled Load Distribution model (DCLD) [14] uses a traffic splitting vector that determines the distribution of traffic over multiple paths, and is a theoretical idea of load balancing by calculating an optimal traffic splitting vector such that maximum path delay (i.e., maximum end to-end delay) can be minimized. Unless otherwise stated, the terms, “end-to-end delay” and “path delay,” are interchangeable since we assume that end-to-end delay is quasi-equal to path delay. DCLD computes the path delay by using the M/M/1 queuing model, and reduces the difference among path delays by decreasing load assigned to the path with the largest delay and increasing load by the same amount (of the reduced load) to the other path with the smallest delay. Traffic splitting ratios are thereby gradually adjusted until all path delays are equal. However, DCLD was designed for Poisson traffic, and is thus likely not practical for a real network under different traffic conditions.

E-DCLD (Effective DCLD)

In this paper, we propose E-DCLD enhanced from DCLD that can overcome the drawbacks of DCLD and outperform the existing models in solving the delay-related problems. Fig. 2 shows the functional block diagram of EDCLD. EDCLD takes into account of input traffic rate and the instantaneous queue size, which are locally available information, in determining the traffic splitting vector, and thereby properly responding to network condition without additional network overhead.

SRR Algorithm

Let P be a set of multiple paths. For we formulate the cost function of path p, which is a function of the estimated end-to-end delay consisting of the fixed delay and the variable delay,
$Cp(\boldsymbol{\psi} p)=Dp+(1-w)\ 1/(\mu p - \psi p\ \lambda)+w(qp/\mu p)$ (1)

The fixed delay (i.e., propagation delay) of path p is the first term, denoted by Dp. The variable delay focused in our work is the queuing delay which varies according to the input traffic rate (λ), the bandwidth capacity of the path (μp), and the traffic splitting ratio (ψp). With the assumption that input traffic is a combination of Poisson traffic and unknown traffic which cannot be identified, the queuing delay is modeled as a mixture of an M/M/1 queue (which has low complexity as compared to other queuing models) and a measurement Therefore, with a weight factor w, the queuing delay is obtained by averaging the second term which is the average queuing delay derived from the M/M/1 model and the third term which is the waiting time of the current packet at an input queue having queue size of qp with unknown queuing model, thus measured as $qp/\mu p$. With a small value, E-DCLD calculates the queuing delay by using the M/M/1 model, which is similar to the DCLD model and is accurate under the Poisson traffic condition. On the other hand, with a large value, the queuing delay is calculated only from the queue size, which is almost similar to the LLF model that can decrease the average queue size but is likely to increase the risk of packet reordering.

3. ANALYSIS

In this section, we analyze the performance of E-DCLD and present simulation-based verifications, in terms of end to end delay, packet delay variation, risk of packet reordering, and total packet delay.

End-to-End Delay

Let Dp (m) and Qp (m) be propagation delay and queuing delay, respectively. They constitute the end-to-end delay dp (m) $dp\ (m) = Dp\ (m) + Qp\ (m)$

That is experienced by the mth packet sent via path p; dp is the expected value of the path delay averaged over m packets. Theoretically, if the input traffic is Poisson and path p is randomly selected with probability p while at least one packet is being forwarded via the path, with the assumption that $1/\mu p$ is the (expected) service time in sending a packet to its destination and $qp/\mu p$ is the (expected) waiting time of the packet in the queue, the cost value obtained from the cost function Cp in (1) will be close to the (expected) end-to-end delay of path p, i.e., dp. In a long-run system where the rate of input traffic is quasistatic during a short update-period, with the optimal traffic splitting vector ψ^*, all paths have (almost) the same delay. The maximum path delay is minimized and the end-to-end delay is therefore reduced.

Packet Delay Variation

Here, let $\Delta i,j$ be the expected value of $\Delta i,j\ (m)$, i.e., $\Delta i,j\ (m) = di\ (m-1) – dj\ (m)$ Since E-DCLD tries to minimize the difference among path delays of all paths, $|\Delta i,j|$ is thus reduced. As compared to E-DCLD as well as the other packet-based models, flow-based models can cause large variation in packet delay, affected from overload and, consequently, large end-to-end delay on a particular path. E-DCLD aiming to reduce $|\Delta i,j|$ achieves the least delay variation. On the other hand, SRR, LLF, FS, and LBPF having larger $|\Delta i,j|$ are likely to cause larger variation.

Risk of Packet Reordering

Risk of packet reordering affects the number of reordered packets as well as the degree of packet reordering, and thus incurs packet reordering recovery time. In this section, risk of packet reordering will be analyzed. The risk of packet reordering can be presented in terms of the probability of packet reordering, πr. The smaller value of $\Delta i,j\ (m)$, the smaller risk of packet reordering. Therefore, E-DCLD aiming to minimize $\Delta i,j$ strives to maintain a low risk of packet reordering. As compared to E-DCLD, packet-based models such as SRR and LLF can cause a high risk of packet reordering.

Total Packet Delay

The total packet delay is the delay experienced by users. It includes two factors: end-to end delay and additional time delay required for packet ordering recovery. E-DCLD aims to decrease both of the two factors and can thus efficiently reduce the total packet delay. SRR and LLF can cause a high risk of packet reordering, and consequently require long time for packet reordering recovery, whereas FS, LBPF, and FLARE can cause a large end-to-end delay.

4. CONCLUSION

Since the existing models are critical to efficiently utilize multiple available paths for multimedia data transmission and real-time applications which are sensitive to packet delay, packet delay variation, and packet reordering, we used E-DCLD, which aims to minimize the difference among end-to-end delays by using locally available information. By doing so, the packet delay variation can be reduced and thus the risk of packet reordering is minimized, without using additional network overhead. When the risk of packet reordering is small, the extra time required for the packet reordering recovery process is likely small.

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REFERENCES

[1] L. Golubchik, J. Lui, T. Tung, A. Chow, W. Lee, G. Franceschinis, and C. Anglano, “Multi-Path Continuous Media Streaming: What Are the Benefits?” Performance Evaluation, vol. 49, pp. 429-449, Sept. 2002.

[2] C. Villamizar, “OSPF Optimized Multipath (OSPF-OMP),” Internet Draft Draft-Ietf-Ospf-Omp-02.txt, vol. ospt, no. 2, pp. 1-38, Feb. 1999.

[3] D. Thaler and C. Hopps, “Multipath Issues in Unicast and Multicast Next-Hop Selection,” RFC 2991, Nov. 2000.

[4] C. Hopps, “Analysis of an Equal-Cost Multi- Path Algorithm,” RFC 2992, Nov. 2000.

[5] H. Adiseshu, G. Parulkar, and G. Varghese, “A Reliable and Scalable Striping Protocol,” ACM SIGCOMM Computer Comm. Rev., vol. 26, no. 4, pp. 131-141, Oct. 1996.

[6] A. Zinin, Cisco IP Routing, Packet Forwarding and Intra-Domain Routing Protocols. Addison Wesley, 2002.

[7] K.G. Shin and C.J. Hou, “Design and Evaluation of Effective Load Sharing in Distributed Real-Time Systems,” IEEE Trans. Parallel and Distributed Systems, vol. 5, no. 7, pp. 704-719, July 1994.

[8] O. Kremien and J. Kramer, “Methodical Analysis of Adaptive Load Sharing Algorithms,” IEEE Trans. Parallel and Distribution Systems, vol. 3, no. 6, pp. 747-760, Nov. 1992.

[9] C.C. Hui and S.T. Chanson, “Hydrodynamic Load Balancing,” IEEE Trans. Parallel and Distributed Systems, vol. 10, no. 11, pp. 1118- 1137, Nov. 1999.

[10] A.K. Parekh and R.G. Gallager, “A Generalized Processor Sharing Approach to Flow Control in Integrated Services Networks: The Single Node Case,” IEEE/ACM Trans. Networking, vol. 1, no. 3, pp. 344-357, June 1993.

[11] C. Demichelis and P. Chimento, “IP Packet Delay Variation Metric for IP Performance Metrics (IPPM),” RFC 3393, Nov. 2002.

[12] G. Almes, S. Kalidindi, and M. Zekauskas, “A One-Way Delay Metric for IPPM,” RFC 2679, Sept. 1999.

[13] H. Schulzrinne, S. Casner, R. Frederick, and V. Jacobson, “RTP: A Transport Protocol for Real-Time Applications,” RFC 3550, July 2003.

[14] S. Prabhavat, H. Nishiyama, Y. Nemoto, N. Ansari, and N. Kato, “Load Distribution with Queuing Delay Bound over Multipath Networks: Rate Control Using Stochastic Delay Prediction,” Proc. 26th Int’l Comm. Satellite Systems Conf. (ICSSC), June 2008.

[15] M. Shreedhar and G. Varghese, “Efficient FairQueueing Using Deficit Round Robin,” IEEE/ACM Trans. Networking, vol. 4, no. 3, pp. 375-385, June 1996.

[16] N.M. Piratla, A.P. Jayasumana, A.A. Bare, and T. Banka, “Reorder Buffer-Occupancy Density and Its Application for Measurement and Evaluation of Packet Reordering,” Computer Comm., vol. 30, no. 9, pp. 1980-1993, June 2007.

[17] N.M. Piratla and A.P. Jayasumana, “Reordering of Packets Due to Multipath Forwarding—An Analysis,” Proc. IEEE Int’l Conf. Comm. (ICC), pp. 829-834, June 2006.

[18] A. Morton, L. Ciavattone, G. Ramachandran, S. Shalunov, and J. Perser, “Packet Reordering Metrics,” RFC 4737, Nov. 2006.

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