Performance analysis of the priority queue buffer management mechanism

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Abstract - In order to solve the multimedia communication in computer networks as well as on the quality of service requirements, this paper proposes a buffer management mechanism based on the priority queue. Detailed study of the principles and methods of implementation of the mechanism and performance analysis, and end-to-end multimedia communication system environment, the experiment proved the buffer management mechanism to solve the congestion control of multimedia communication to meet the requirements of the quality of multimedia communication services.

Index Terms - priority queue; buffer management; quality of service; congestion control

1. Introduction

Traditional Internet data transmission services only to ensure the correctness and completeness of the data does not provide the quality of service protection. Multimedia network traffic with real-time and continuous, but also very sensitive to delay and loss, and how to improve the computer network, especially the Internet, end-to-end quality of service for multimedia communications, to obtain good multimedia network transmission quality, multimedia network communication is the most important one of the most pressing problems [1].

Quality and technology in a variety of network services, buffer management is one of the core technologies of network service quality control[2]. Buffer management is the management of the queue buffer memory resources in the network transmission nodes. On the one hand, the transmission node in the computer network usually queue buffer to delay forwarding service to improve the bandwidth utilization of the output link. The buffer management mechanism in the packet arrives at the queue based on some of the strategies and information to decide whether to allow the packet into the buffer queue, is the decision-making of the decision on whether to discard the packet.

Conventional Internet nodes take a simple first in, first out (FIFO) buffer management mechanism that does not distinguish between the type of datagram, the first arrival of data packets is fed into the first buffer, after the arrival of data packets will be discarded when the buffer fills. This buffer management mechanism is easy to implement, but can not meet the quality of service requirements of multimedia communications for low latency, low loss rate, even easily lead to the phenomenon of multimedia network traffic congestion. To solve this problem, you need to take a new buffer management mechanism for multimedia data reported and datagram treated differently in the buffer management process, reducing delay and datagram loss rate of multimedia network communication, multimedia network traffic to meet quality of service requirements [3] [4].

2. Buffer Management Mechanism Based on the Priority Queue

Presented here buffer management mechanism based on the priority queue (PQ). The buffer management mechanism using the idea of dual-queue[5][6]. Its basic realization method is: the system has two buffer queues Q1 and Q2, two buffer queue capacity BH and BL, wherein Q1 is used to store a high-priority, real-time multimedia data packets; Q2 for storing low-priority ordinary datagram. A threshold value TH in the buffer management process, is set in the low priority queue Q2, and the buffer queue Q2 is higher than the threshold value TH as high and low priority data packets shared buffer; low as lower than the threshold value TH priority datagram dedicated buffer. When the high priority queue Q1 occupied, and the available space in the shared buffer in Q2, high-priority real-time multimedia data reported can be stored in the low-priority queue Q2 shared buffer. During forwarding, the datagram in the high priority queue Q1 prior to forward packet in the low priority queue Q2. Its working principle is shown in Figure 1.

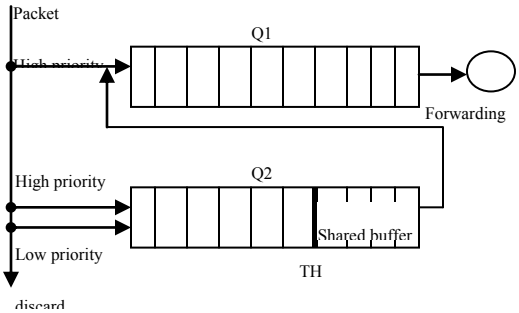

Figure1 mechanism principle of the priority queue buffer

3. Buffer Management Mechanism Analysis

Conducting performance analysis of buffer management mechanisms, the use of queuing theory where Little's Law [7] ().Little's Law when the stabilized state in the queuing system, the relationship between the number of customers N throughput λ and the average delay of each customer T:

$$N = \lambda T \tag{1}$$

Customers where prop theorem as a the datagram buffer queue, can be calculated by the formula (1) the average delay of the data reported.

The Datagram size of the buffer queue for each unit is the same size. Parameter R that the datagram forwarding rate of the buffer that the number of forward packet per second. For the first-in first-out (FIFO) buffer management mechanism, provided the capacity of the buffer queue of as B;-use variable n represents the number of buffer queue data packets of; parameter π-(N) represents the first-in first out buffer management mechanism working process in the datagram number n is the probability. Buffer queue Q1 high first-level data reported that the number of priority queue (PQ)-based buffer management mechanism with variable h said; variable l is the number of buffer queue Q2 low priority data reported of; parameters π (h, l) indicates h and l, respectively probability based on the values of the two variables in the priority queue buffer management mechanism working process.

For the first-in, first-out buffer management mechanism, when the buffer queue is full, there will be a blocking situation, therefore, the data reported blocking probability:

$$P_p = \pi(B) \tag{2}$$

The throughput of the data reported:

$$TP_p = \sum_{n>0} R\pi(n) \tag{3}$$

According to Little's Law, can draw the average delay of the data reported as follows:

$$DL_P = \frac{\sum_{n=1}^{B} n\pi(n)}{TP_P} \tag{4}$$

Buffer management mechanisms based on the priority queue, blocking probability of high priority datagram can be drawn based on the buffer management mechanism works as follows:

$$P_{hb} = \sum_{l \geq BL-TH}^{BL} \pi(BH, l) \tag{5}$$

The blocking probability of the low priority data packets as follows:

$$P_{lb} = \sum_{h=0}^{BH} \pi(h, BL) \tag{6}$$

The throughput of high-priority data reported:

$$TP_h = \sum_{h>0} R\pi(h,l) \tag{7}$$

The throughput of low-priority data reported:

$$TP_l = \sum_{l>0} R\pi(0,l) \tag{8}$$

According to Little's Law, the average delay of high-priority data reported can be drawn as follows:

$$DL_h = \frac{\sum_{h=1}^{BH}\sum_{l=0}^{BL} h\pi(h,l)}{TP_h} \tag{9}$$

Similarly, the low priority packet average delay can be drawn:

$$DL_l = \frac{\sum_{h=0}^{BH}\sum_{l=1}^{BL} l\pi(h,l)}{TP_l} \tag{10}$$

4. Simulation and Analysis

Buffer management mechanism simulation program consists of three parts of the package module, simulation module and analysis module which is used to simulate the network nodes, respectively, using the FIFO buffer management mechanism and based on the PQ buffer management mechanism buffer management process. As shown in Figure 2. Different priority data first into the package module package module, the data is encapsulated into a fixed length of the IP datagram, the IP datagram is then fed into the simulation module, simulation module is used to simulate the first-in first-out buffer management mechanism and the buffer management process based on the priority queue in two ways. Analysis module is used to collect the data reported in the buffer management process blocking rate and average delay data in order to analyze the performance of the two types of buffer management mechanisms.

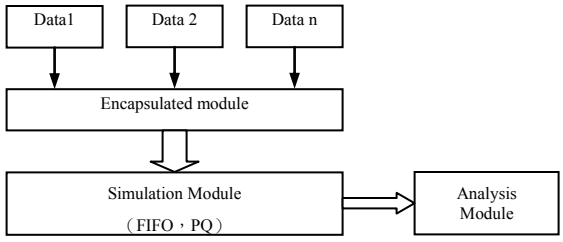

Figure 2 Simulation of buffer management mechanism

Buffer management mechanisms of the simulation, including the following main parameters: datagram forwarding rate R = 20 data reported / sec; first-in-first out buffer management mechanism buffer capacity for B = 2000 units, based on the priority queue buffer management mechanisms inthe buffer capacity BH = BL = 1000 units; simulation time is 20 minutes; DPS reach the number of data packets N = NH + Nl wherein Nh and Nl the number of high-priority and low-priority packet; predetermined Nin order to the random number values in the range between 0-60. Based on the priority queue buffer management mechanism of the threshold value TH is set at 600 units. In addition, the high proportion of the number of low priority packet Nh / Nl different values will be a great impact on the performance of the buffer management mechanism based on the priority queue, therefore, during the simulation, Nh / Nl respectively The value of 0.5, 1, 2, 4 and 8.

Figure 3 shows the FIFO buffer management mechanism based on the PQ buffer management mechanisms under datagram blocking probability contrast.

For FIFO buffer management mechanism can be drawn from the equation (1), the high ratio of the number of the low priority data packets Nh /NL different values have no effect on the blocking probability of the data packets in this manner the blocking probability will remain stable, this is also confirmed by the experimental results in Figure 3.

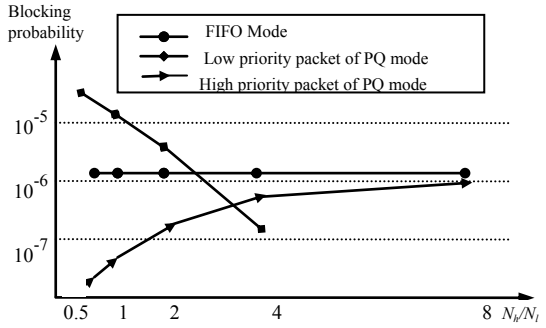

Figure3 blocking probability of different buffer management mechanisms

Buffer management mechanism based on the PQ, from equation(6) can be seen, when the low priority queue is full, the low priority datagram appears blocked. The experimental results are shown in Figure 3, with the high ratio of the number of the low priority data packets NH/NL increases, the blocking probability of the low priority data packets to gradually reduce. Nh/Nl values of 0.5, 1 and 2, the blocking probability of low-priority data reported above the blocking probability of high-priority datagram PQ mode and FIFO mode datagram.; When Nh/Nl values 4:00, the blocking probability of low priority datagram datagram blocking probability will be lower than the the PQ mode high priority the datagram and FIFO mode. Can be seen from the equation (5) can be used due to the high priority data packets to the low priority queue in the shared space, the blocking probability of the high priority data packets related to the value of the threshold value TH, and the smaller the threshold value TH, high lower priority datagram blocking probability. The experimental results are shown in Figure 3, and gradually increase with the high ratio of the number of the low priority data packets NH/NL increases, the blocking probability of the high priority data packets. However, the blocking probability of high-priority data reported is always lower than the blocking probability of the data reported in the FIFO mode.

Figure 4 shows the FIFO buffer management mechanism based on the PQ cache management mechanism datagram average delay of contrast.

Combining two buffer management mode datagram average delay formula and the experimental results in Figure 4 can be seen: the FIFO buffer management mechanism of the datagram average delay is maintained at a substantially constant level, and high, lowthe ratio of the number of priority datagram Nh/Nl different values unrelated. Based on the PQ cache management mechanism, first due to the high-priority datagram be forwarded, therefore, the average delay of the high priority data reported to be lower than the average delay of the low priority pole datagram, if the high-priority data reported that a large number of high-and low-priority data reported average delay will buffer data according to press reports, increased wait time increases, so low priority packet average delay will be with the high-and low-priority data reported the ratio of the number Nh/Nl value increases. However, the the high priority datagram average delay or lower than the FIFO Ecache management mechanism datagram average delay.

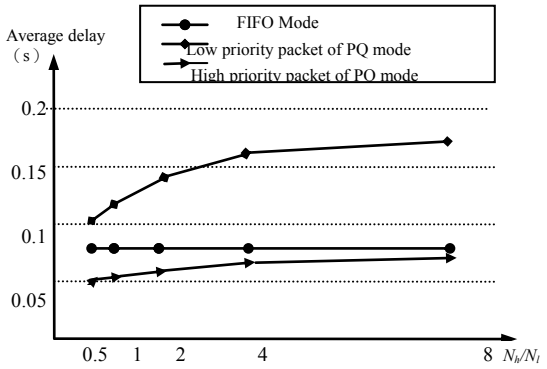

Figure4 Average delay of different buffer management mechanisms

5. Conclusion

With the traditional first-in, first-out buffer management mechanism compared to the treatment of different priority datagram buffer management mechanisms distinction based on the priority queue, and use a threshold to set up a shared buffer space. Blocking probability and average delay of comparative data reported after the performance of the two types of buffer management mechanism analysis and experimental simulation can be drawn based on the priority queue buffer management mechanism to provide better service to high priority data reported quality assurance, and better able to adapt to the needs of the multimedia network communication.

6. References

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