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Priority Based Virtual Channel Flow Control

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1 Introduction

To improve computer performance, parallel computers consisting of many processors interconnected by high performance network attract much attention. To achieve high performance by parallel computers, it is important to reduce communication latency between processors. To researches for reduce communication latency, some researches propose to reduce setup latency that is in before and after transfer, and researches to reduce transfer latency itself.

Wormhole routing, that is one of the transfer methods, transfer a flit that is a pipeline of packet in every clock like as pipeline. The wormhole routing has advantages on transfer time and hardware cost compared to the conventional transfer methods such as store-and-forward and virtual-cut-through. But the wormhole routing often causes packet blocking. Therefore virtual channel is sometimes applied to the wormhole routing. Virtual channel is very useful method since it is can avoid not only deadlock but also packet blocking. However, flow control policy for virtual channel has not been discussed enough.

This paper proposes flow control policies for virtual channel based on appropriate priority, and evaluates performances by simulations. First, we discuss problems of wormhole routing and virtual channel. After then, we propose priority-based virtual channel flow control policy, and evaluate network performance of proposed policy.

2 Priority Based Virtual Channel Flow Control Method

Virtual channel is should be used with appropriate flow control policy. However, only the round-robin policy, one of the simplest policy, has been used for virtual channel flow control policy in most case. Wormhole routing with the round-robin policy causes some blank buffers. To solve this problem, we propose the preempt policy. The preempt policy is a method that each packet has arrival order priority, and a physical link transfer flits with priority order. In this way, one packet uses a link with high priority, and it expects that blanks between flits don't generate frequently.

3 Virtual Channel Flow Control System

In this section, we explain the simulator to evaluate network performance of virtual channel flow control policies. This simulator consists of some sets of a node processor, a send network interface(send NI), a receive network interface(receive NI) and a router. The function of each element is as follows.

1. node processor

   The unit executes instructions.

2. send NI

   The unit generates and sends packets.

3. receive NI

   The unit receives packets and store them.

4. router

   The unit transfers packets by the wormhole routing. Each link of the router has some virtual channels.

This simulator is to transfer many packets, and can measure transfer time of each packet.

4 Performance Evaluation on 2D-Mesh

This section presents the simulation results on 2D-mesh. We evaluate performance by random communication and FFT(First Fourier Transform) with fixed routing, and random communication with adoptive routing; north last method.

The preempt policy should better performance than round robin policy at the random communication with fixed routing on the average transfer time and average throughput. The preempt policy could achieve shorter transfer time than the round-robin policy, but the execution time of FFT was almost same by the both policies. The preempt method could improve the performance of random communication with the north last method when the probability of packet generation was relatively high. Consequently, the preempt policy could improve the network performance than that of round-robin policy.

5 Performance Evaluation on Hierarchical Network:TESH

This section presents the simulation results on a hierarchical network; TESH(Tori connected mESHes). In the hierarchical network, different flow control policy should be used for intra-network communications in the low-level network and for inter-network communications between high-level networks. It mean that the inter-network communications between high-level networks should be given high priority because these communication require many hops. Therefore, we propose a policy that give high priority for inter-network communications between high-level networks. It is names the hierarchical preempt policy. We evaluate average transfer time and average throughput on random communication, and average communication time and execution time on FFT and four-direction communication. The experimental results shows that average transfer time of random communication with preempt policy was faster than that of round-robin policy, and average throughput of random communication with preempt policy was also higher than that of round robin policy. In addition, performance improvement by the preempt policy for TESH was more than the case of 2D mesh. But, the hierarchical preempt policy could not improve the network performance compared with the preempt policy only by the distribution of transfer time. Average communication time of FFT and four-direction communication by the preempt policy were faster than that of the round-robin policy. And execution time of FFT and four-direction communication by the preempt policy were also faster than that of the round robin. But average communication time and execution time on FFT and four direction communication by the hierarchical preempt policy were not improved. Consequently, the preempt policy could improve the network performance of the TESH, but the hierarchical preempt policy could not improve it.

6 Conclusion

In this paper, we proposed the preempt policy and the hierarchical preempt policy as priority-based virtual channel flow control. We showed that the preempt policy could improve communication latency and communication throughput, but hierarchical preempt policy could not improve them.

Improvement of the distribution of communication latency is remained as a future work.