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Multiport Memory as a Medium for Interprocessor Communication in Multiprocessors

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Abstract

The performance of a multiprocessor greatly depends on the effectiveness of its interprocessor communication. Shared memory and message passing are two major communication architectures for multiprocessors. In shared memory systems, processors communicate by writing to and reading from a common memory. In message passing architectures, nodes communicate by passing messages through an interconnection network using send and receive commands. Both systems have their advantages and disadvantages. This study aims to explore the feasibility of using multiport memories for interprocessor communication based on message passing.

The individual ports of a multiport memory provide independent access to memory cells and can be used as communication links. In the communication structure proposed in this study, several nodes connected to a multiport memory can communicate in parallel without the overhead and delay of the bus architecture, or the interconnection network of a typical shared memory system. The small number of ports on multiport memory is a limiting factor that restricts the number of nodes connected to this structure.

The proposed structure can be scaled by using a hierarchy in which the nodes that are not connected directly can communicate through network controllers and other available multiport memories. In this structure, shared memory is used as a link for message passing. In contrast to other shared memory systems, the small shared memory in this structure is exclusively used for communication purpose.

The first stage in evaluating the proposed structure was the design and implementation of a small multiprocessor called MultiCom. In this prototype system, four nodes were interconnected by a 4-port memory. The memory management of MultiCom could prevent the nodes from interfering with each other using static and dynamic allocations. In particular, dynamic allocation used fewer but larger buffers that could be assigned to any communication on demand, and full memory utilization was possible. It could also handle multicasting and broadcasting very efficiently. As dynamic allocation required a lock mechanism for allocating the buffers, in the absence of hardware locks on multiport memories, two new software locks for controlling the ownership of the multiport memory were designed and successfully tested. Using a basic communication protocol for MultiCom, the measured communication rate was 4.2 times faster than a system using serial links, 11 times faster than a system using dual-port memories, and 14 times better than a bus-based system. In addition, compared to a system using dual-port memories, the system enjoyed a four-fold reduction in cost.

A simulation model was designed to evaluate the performance of the scaled structure. The model showed that the structure was scalable for small systems in which all of the nodes were connected as a group using a single multiport memory. It also confirmed that the structure only required small amount of shared memory for message passing. However, the performance of the cluster structure in the original proposal in which several groups were connected using a network controller was not desirable. The communication rate dropped considerably under high inter-group message transfers because of the overloaded network controller. To overcome this problem, the cluster structure was modified and separate network controllers were used for each group. In addition, an extra multiport memory was used to interconnect the network controllers. With this modification, the performance of a cluster was significantly improved and overloading of the network controllers was considerably reduced. The structure of a network of clusters was also improved to accommodate the modified cluster structure, and other measures were implemented to reduce the load of network controllers. The improved structure can be used for medium to large-scale systems.

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