Novel Correlation Parallel Network using Exchanged Cross Cube

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Abstract—In communication networks, Exchanged cross cube network is a new type of data network that makes use of cutting edge technology from several research areas to solve some problems current networks are faced with. The interconnection network plays an important role in large-scale parallel systems, because there is usually a need for one processor to communicate with other processors when a collection of processors execute a program in parallel to solve problems. Much of the computation power is wasted if the processors spend a considerable amount of time in communication, such as routing and broadcasting. Thus, it is necessary for the processors to communicate efficiently with one another, and such efficient inter-processor communication requires the support from a carefully designed interconnection network.

A new and efficient interconnection network called exchanged crossed cube (ECQ) is proposed and implemented in this application for efficient and accurate communication. We prove that ECQ has the better properties than other variations of the basic hypercube in terms of the smaller diameter, fewer links, and lower cost factor, which indicates the reduced communication overhead, lower hardware cost, and more balanced consideration among performance and cost. Furthermore, it maintains several attractive advantages including recursive structure, high partition ability, and strong connectivity. The hypercube has many attractive properties, including regularity, symmetry, small diameter, strong connectivity, recursive construction, partition ability, and relatively small link complexity. Furthermore, we implement the optimal routing and broadcasting algorithms for this new network topology application. The objective is to present a network topology with not only a smaller diameter but also the lower hardware cost. So only we implement, a new interconnection network, called exchanged crossed cube for large-scale parallel computation.

Index Terms——Interconnection networks, hypercube, exchanged crossed cube, inter processor communication, parallel computation

INTRODUCTION

Significant progress has been made in the past decades in developing massively parallel computing architectures. It is well known that the interconnection network plays an important role in large-scale parallel systems because there is usually a need for one processor to communicate with other processors when a collection of processors execute a program in parallel to solve problems. Much of the computation power is wasted if the processors spend a considerable amount of time in communication, such as routing and broadcasting. Thus, it is necessary for the processors to communicate efficiently with one another, and such efficient inter-processor communication requires the support from a carefully designed interconnection network. Among all the topologies proposed in the current literature, the hypercube has received much attention due to its many attractive properties, including regularity, symmetry, small diameter, strong connectivity, recursive construction, partition ability, and relatively small link complexity Variations of this fundamental topology have been proposed in the literature to further enhance some of its features. Among all the features of a network topology, the diameter and the hardware cost are two of the most important factors in determining its performance and cost. Thus, a number of approaches have been suggested to improve the performance of HQ by reducing its diameter. The crossed cube, denoted by CQ, is an excellent example of such a topology. A CQ is derived from an HQ by changing the way of connection of some HQ links. The diameter of a CQ is almost half of that of its corresponding HQ. Specifically, the diameter of an n-dimensional CQ is 1Þ=2e and the diameter of an n-dimensional HQ is n. However, the CQ makes no improvement in the hardware cost compared to the HQ. An n-dimensional HQ is composed of 2n nodes and has n links per node. The number of links of an HQ, which is directly related to the hardware cost, grows more drastically than the number of processors.

This leads to rapid increase of the hardware cost as an HQ scales up. The exchanged hypercube, denoted by EH, is an excellent topology with the lower hardware cost. An EH is based on link removal from an HQ, which makes the network more cost-effective as it scales up. Unfortunately, the availability of rich connectivity in the EH is reduced. The EH offers major reduction in the hardware cost compared to the HQ, but no improvement over the diameter of the HQ. The demand for reduction of the diameter of the HQ as well as its hardware cost motivates our investigation in proposing a new interconnection network.

EXCHANGE HYPERCUBE

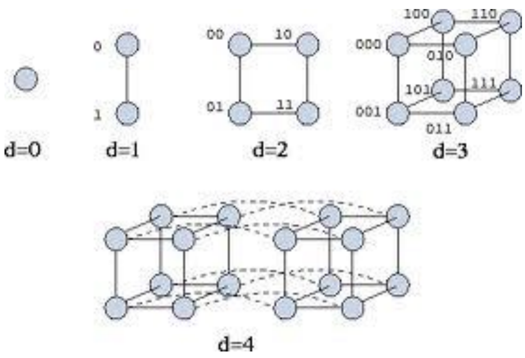
As problem size and complexity increase, corresponding increase in computation power is required in a parallel computer system to maintain acceptable performance. As the interconnection network in the system cannot be implemented directly with commodity components, its design impacts critically the performance and cost effectiveness of upgrading. Topology is one of the most important design issues for these networks. Many have an orthogonal topology, whereby nodes are arranged in an orthogonal n-dimension space. The main advantages of this are simple routing, support for wide application spectrum, and fault tolerance. One of the most widely used is the n-dimensional binary hypercube or n-cube.

A.Network Diameter

The diameter, D, of a network is the shortest distance between its two furthest nodes. It has appreciable influence on communications performance. A network with a large diameter tends to have higher communication overheads than one with a smaller diameter. Advantages of this are simple routing, support for wide application spectrum, and fault tolerance the most widely used is the n-dimensional binary hypercube or n-cube. source authentication security service that can easily scale for large networks is an important capability for the operation and management of the underlying network.

B.Cost Effectiveness

Cost effectiveness measures the product of network diameter achievable and the corresponding network hardware cost. Cost effectiveness, Ceff, is defined as Ceff ¼ 1=ðNCnode þ LClinkÞ D, where D is the diameter achievable for a network of sizeN, Cnode is the unit cost for anode,Clink is the unit cost for a link, and N and L are the number of nodes and links, respectively. Relative cost effectiveness is defined as the ratio of cost effectiveness of network G to cost effectiveness of n-cube. The higher the relative cost effectiveness, the more cost effective is G relative to the n-cube. A cost effective network tends to have a small diameter and low to moderate hardware cost. We let the ratio of node cost to link cost be R ¼ Cnode=Cnode. Without loss of generality, we let Clink ¼.



C.Comparison of Network Diameter.

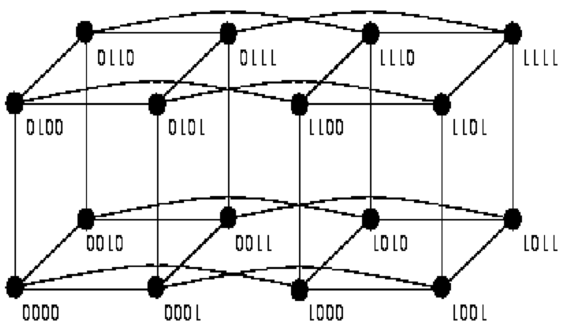
As a basis for comparison, the n-cube has a logarithmic network diameter of n. It is apparent that the link dilution scheme employed influences network diameter significantly. The amount of degradation exhibited varies widely. The Gaussian Cube compromise an approximately M-fold degradation in its diameter. Diameters of Reduced Hypercube and Exchanged Hypercube exhibits minimal degradation, comparatively.

C. Comparison of Cost Effectiveness.

This results show that achievable cost effectiveness depends very much on the link dilution scheme. In fact, an appropriate link dilution scheme is critical to achieving a good balance between communications performance and cost effectiveness. Though the Reduced Hypercube has a shorter network diameter than the Gaussian Cube, its cost effectiveness is at best similar to the n-cube. In the Gaussian Cube, cost effectiveness decreases in inverse logarithmic proportion to increase in network dimension. The major contribution to this is from the approximately linear increase in its diameter in proportion to M. To achieve better cost-effectiveness, Gaussian Cubes should be designed with a small modulus. In the Exchanged Hypercube, the negligible increase in network diameter (from n to n þ 1) acts in concert with the reduced hardware overheads to achieve a progressive improvement in cost effectiveness with logarithmic increase in network size.

EXCHANGE CROSS CUBE

The diameter of an ECQ is almost the same as that of a CQ, but much smaller than that of an EH. Furthermore, the mean distance among the vertices is smaller than that of an EH. . The hardware cost of an ECQ is almost the same as that of an EH, but much lower than that of a CQ. An interconnection network with a large diameter has very low message passing bandwidth but a network with a high node degree is very expensive. The cost factor (i.e., the product of the diameter and the node degree of the ECQ is better than that of the CQ and EH, which indicates that the ECQ is able to offer a better combined consideration between the cost and performance of a parallel computing system. The aforementioned three main advantages of the ECQ reveal that the ECQ is able to achieve the improved performance and scalability compared with all the hyper- cube variations proposed previously in the current literature. The binomial tree is one of the most frequently used spanning tree structures for parallel applications in various systems, especially in the HQ. It has several desirable properties and is applicable in solving many problems, for example, computing prefix sums. Load balancing can also be achieved in this tree structure. The exchanged tree (ET) proposed in is a good method for constructing the spanning tree of an EH. However, by taking the wrong link and the wrong degree of an EH, the exchanged tree is not a spanning tree of an EH. Further explanation and analysis can be found. To overcome this deficiency, we propose the improved exchanged tree and prove that it is a spanning tree of an EH and an ECQ. Furthermore, it offers an efficient way for broadcasting communication in the EH and ECQ.



A. Performance Evaluation

This presents a straightforward comparison among the HQ, CQ, EH, and ECQ in terms of the following properties: the total number of links, node degree, diameter, expand- ability, and decomposition, which have significant impact on the performance of a parallel computing system. In general, for a desirable interconnection structure, the total number of links, the number of links per node, and the diameter should all be as small as possible. A network with a large number of links or a large node degree tends to increase the hardware cost. A smaller diameter means the lower communication overheads. This shows that these networks have their own advantages and disadvantages. For example, the diameter of the CQ is the smallest, i.e., dnþ1 2 ; but it requires much more links than the EH and ECQ. Among these networks, we find that the ECQ offers the best balance among the properties listed. Such balanced performance and cost make the ECQ suitable for large-scale parallel computing systems.

COMMUNICATION IN EXCHANGED CROSSED CUBE

In large-scale parallel and distributed systems, communication is an important problem, which considers how the processors can exchange messages efficiently and reliably. Two most important communication primitives are routing and broadcasting. This will present the routing and broadcasting algorithms we develop for the ECQ.

Routing:

An optimal routing algorithm is to find the shortest path between a source and destination pair, where the source sends a message to the destination. Message exchange takes considerably more time that a computing steps inside a processor. Thus, there is a higher demand for reducing communication than computation time. An interconnection network with a large diameter has very low message passing bandwidth but a network with a high node degree is very expensive. Routes do not dynamically adapt to network topology changes or equipment failures. It does not scale well in large networks

Broadcasting

Broadcasting is a communication pattern in a network where a data set is to be copied from one node to all other nodes. The exchanged tree proposed provides a very good method for constructing a spanning tree for broad- casting. However, there is a serious problem in the ET, which is derived by taking the wrong link and the wrong degree. Thus, the ET is not a spanning tree of the EH.

RELATED WORK

Distributed systems and multi-processor computer architectures (even at the desktop level) clearly show that parallelism is the future of computing. In this same time period, there has been a greater than 1000x increase in supercomputer performance, with no end currently in sight. An optimal routing algorithm is to find the shortest path between a source and destination pair, where the source sends a message to the destination guarantees the shortest path and Broadcasting is a communication pattern in a network where a data set is to be copied from one node to all other nodes are developed. The attractive properties of the ECQ make it applicable to large scale parallel computing systems very well.

CONCLUSIONS

This paper presents a new interconnection topology called exchanged crossed cube. A recursive procedure for constructing an ECQ is proposed. This new topology has many desirable properties such as regularity, expandability, isomorphism, and decomposition. The diameter and node degree of an ECQ have low values, and hence, the cost factor of the ECQ is less than that of other topologies such as the hypercube, crossed cube, and exchanged hypercube. An optimal routing algorithm that guarantees the shortest path and a broadcasting algorithm are developed. The attractive properties of the ECQ make it applicable to large- scale parallel computing systems very well.

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