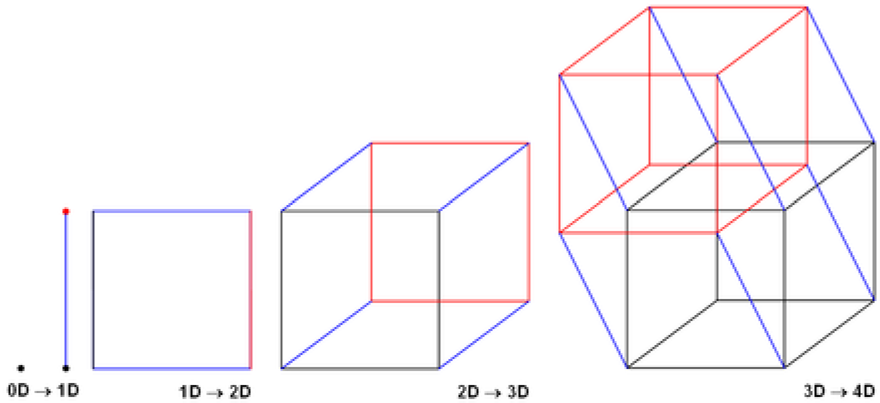
Hypercube Network - Parallel Algorithm



Nature of Hypercube Network

A hypercube network is a processor with only local memory in it. The actives are coordinated by the messages and send between themselves through the processors. The interconnection network corresponds to the edges of an n-dimensional cube with a processor at each vertex.

Hypercube networks are a type of network topology used to connect multiple processors with memory modules and accurately route data. Hypercube networks consists of 2 nodes. These nodes form the vertices of squares to create an internetwork connection. A hypercube is basically a multidimensional mesh network with two nodes in each dimension.

Problems Addressed by Hypercube Network

Transferring of data is very crucial and important in terms of networking, and hypercube networking is one of the parallel computing that gives high speed between multiple high-speed processors and memory modules. With the use of hypercube network, it creates a dimension for the processor to execute an instruction within a set of periods of time which is a multi-stage interconnection network.

Network connections between nodes where each node can be a single processor or a group of processors or memory modules. These connections carry or transport data from one processor to another or from the processor to the memory so that the task is broken down and computed in a parallel algorithm.

An important issue in the design of hypercube network is the scalability. Size-scalability refers to the property that the number of nodes in the network can be increased with negligible effect on the existing configuration and generation-scalability implies that the communication capabilities of a network should be large enough to support the evolution of processing elements through generation.

Objectives of Hypercube Network

The main objective of hypercube network is to connect multiple processors with memory modules and accurately route data. Basically, each processor makes a made of the cube and makes a node of the memory and I/O interface. It directs the communication paths to the n other neighbor processors. These paths are corresponded to the cube edges.

As mentioned in the above problem of hypercube network, one objectives of a hypercube network are the scalable for massive parallel computing. The scalability which refers to the property that the size of the network can be increased with nominal effect on the existing configuration. And also, the time scalability which implies that the communication capabilities of a network should be large enough to support the evolution of processing elements through generations.

Significance of Hypercube Network

The significance of hypercube network is the routing functions which are vertices of n-dimensional cube and labeled with n-bit numbers. Only one bit differs between each pair of adjacent vertices, then n routing functions are defined by the bits in the node vertex address. With hypercube network we can easily identify routing functions that exchange data between nodes with addresses that differ in the least significant, most significant, or middle bit.

Advantages and Disadvantage of Hypercube Network

Hypercube networks are good solution for networks with node counts less than 64, and will consistently outperform 2-D toroid. When the node count of a hypercube networks increases, the node degree of hypercube networks also increases. This is one of the advantages of hypercube network because it increases the performance and reliability of the network.

A significant disadvantage of complete hypercubes is the restrictive node count, as the node count must be a power of two. Incomplete hypercubes alleviate this problem, but can introduce poorly connected nodes, somewhat reducing reliability. However, incomplete hypercubes do gain the versatility of arbitrary node counts. Hypercube network outperforms 3-D toroid at large node counts due to higher node degree.

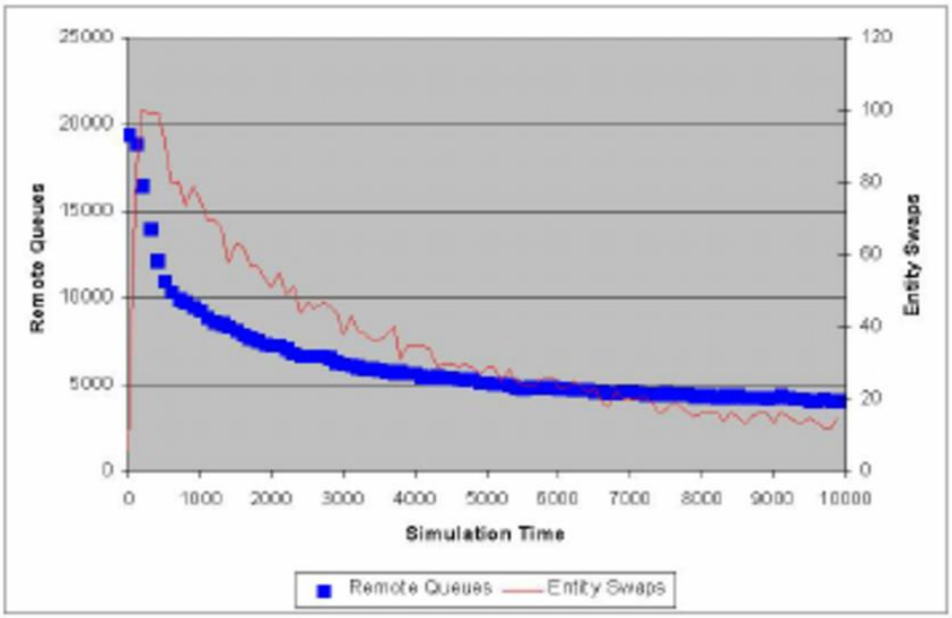
Implementation of Hypercube Network

The optical implementation has totally space-invariant connection patterns at every node, which enables the DLH to be highly amenable to optical implementation using simple and efficient large space-bandwidth product space-invariant optical elements.

A good, reliable performer. Limited choice of network sizes as this topology requires 2d nodes, but the extension to incomplete hypercubes somewhat alleviates this problem. This topology begins to become somewhat complex and costly as node count increases, and as such may be preferred for low-to-medium node counts. However, on the plus side, overall reliability correspondingly increases as well.

An extension to hypercubes that allows arbitrary node count with hypercube-like performance. Performance is only slightly lower than the complete hypercube, but reliability of the incomplete hypercube can vary substantially.

Simulation of Hypercube Network



One of the common applications to run in a supercomputing environment is discrete event simulation (DES). DES is used in a wide variety of applications such as manufacturing models, computer network models, and artificial intelligence research.

Hypercube topology arranges the entities as vertices in a binary hypercube of given dimension n with the dependency set of each entity being the n neighbors in the hypercube structure. These different topologies offer varying amounts of structure to the optimization algorithm.

The optimization clearly shows the ability to reduce the number of remote queues in the event simulation. For simulations with regular structure, such as a torus or hypercube, this reduction can be dramatic. To put the results into perspective, if a parallel event simulator processing a simulation with hypercube topology spends 50% of its time recomputing events due to remote queues, an 88% reduction in remote queues leads to a 400% decrease in overall simulation time.

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