Abstract

The processor interconnection network has a strong influence on the efficiency of processing on a parallel computer. The topology of the interconnection network affects cost of building, overhead due to communication and programmability of the computer.

No single topology fully satisfy the requirements of an ideal interconnection topology. The star graph seems to provide a greater number of properties that are desirable in an ideal topology for an interconnection network. As a result it has attracted a lot of interest among researchers. In this thesis we aim to extend our knowledge of the star graph as an interconnection topology for parallel computing. We investigate the following issues related to efficient parallel processing on the star graph.

1. A scheme for ranking the nodes of the star graph that allows development of efficient algorithms.
2. Efficient communication paradigms suitable for a wide variety of algorithms.
3. Addressing problems arising from the extremely rapid rate of expansion of the star graph.
4. Efficient embedding of some important interconnection topologies.

We address these issues in an integrated fashion based on a common set of ideas. These ideas include a fundamental set of isomorphic transformations on the star graph.

We develop a hierarchical scheme for ranking the nodes and the substars of a star graph. This is used in implementing efficient order preserving communication, several embedding schemes and in efficient schemes for processor allocation on star graph based networks.

Based on the hierarchical ranking scheme and suitable decomposition of the star graph we develop four different communication paradigms suitable for a wide variety of algorithms. These communication paradigms have low communication overheads due to path length and edge-congestion. We use these paradigms to develop order preserving ascend/descend algorithms, pipelined algorithms and algorithms for global communication operations.

We introduce a class of subgraphs of the star graph called the *star cluster*. We show that a star cluster retains most of the desirable properties of the star graph. As a result most of the algorithms developed for the star graph can be easily adapted to a star cluster. The advantage of the star cluster is that it provides a way for star graph based interconnection networks to grow in a near linear fashion. Further, the concept of star cluster is also useful in the development of two efficient schemes for processor allocation.

We develop new techniques for efficient embedding of cycles, tori, full binary trees and pyramids on the star graph based on the isomorphic transformations, the hierarchical ranking scheme and the star cluster concept.