Abstract

In this thesis we present results of our investigations in several issues pertaining to the use of the star graph as an interconnection topology for parallel computing. We focus on the following key aspects that appear to be important in determining the applicability of the star graph.

1. A scheme for ranking the nodes of the star graph that allows order preserving communication in constant time.
2. Low overhead 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 structures.

All the above issues are dealt with in an integrated manner, with a basic set of tools that consists of an isomorphic transformation and two decomposition schemes for the star graph.

We develop a hierarchical scheme for ranking the nodes and the substars of a star graph. It allows order preserving communication in constant time as is possible in a hypercube. In addition, it is useful in 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. Several other existing algorithms for star graph can also be implemented with lower communication cost using these paradigms.

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, we develop two efficient schemes for processor allocation based on the star cluster concept. These provide a way for efficient utilization of star graph based networks.

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