**English summary for Ph.D. thesis titled:**

**“New routing techniques for high message-passing systems performance”**

Most of the advanced research problems require greater computing power at high speeds. Scalable distributed-memory systems are the most favorable architectures to increase the computing power. Efficient communication among the nodes is crucial to the performance of distributed-memory systems. These systems must support communication operations efficiently to achieve good performance. Lower-dimension meshes and tori are the appropriate topologies for current distributed-memory systems. The wormhole routing has been widely used in the design of distributed-memory systems in which the packet is divided into smaller flits.

In this thesis, the multicasting (one-to-many) problem for wormhole-routed 2D multicomputers is studied. Path-based and tree-based wormhole techniques offer a very promising means of achieving extremely efficient multicast routing. New efficient deadlock-free algorithms are introduced to improve the performance of the multicast operations.

First, two new efficient deadlock-free path-based multicast algorithms for wormhole-routed 2D torus multicomputers are introduced. They use the vertical and the horizontal wraparound channels to partition the torus into nearly equal size meshes. A mathematical model for 2D torus is introduced and two new functions are proposed to determine the path routing of the algorithms. Two comparative studies to analyze the network latency and the traffic of the algorithms are introduced. The results show that the introduced algorithms provide low network latency and network traffic, and their performances outperform the other well-known algorithms. The introduced algorithms are efficiently used in case of massively parallel systems especially at large percentage of distensions and the position of the source node is far away from the center of the network.

Second, a new efficient deadlock-free tree-based multicast algorithm for wormhole-routed 2D mesh multicomputers is introduced. The introduced technique can divide the 2D mesh into two and four sub meshes. A mathematical model for 2D mesh multicomputers is introduced. Four mathematical formulas for calculating the network latency and the traffic are presented. A comparative study between path-based and tree-based algorithms in 2D mesh multicomputers is presented. The results show that the introduced technique outperforms other algorithms. The introduced technique is efficiently used in case of massively parallel systems especially at 2D mesh networks with large number of columns, and large percentage of destinations.

This thesis is divided into six chapters:

The first chapter is an introduction to the thesis's topic and a summary of its chapters.

Chapter 2 provides a general introduction to parallel multicomputer systems and their classifications, types of network topologies that connect processors, types of switching methods, and classifications of routing methods.

Chapter 3 presents a review of the most common existing routing methods and their classifications, along with some previous algorithms. It also presents some previous algorithms for the path-based method, the tree-based method, and the unicast-based method.

Chapter 4 presents two new algorithms for the path-based method in two-dimensional torus topologies. The first algorithm uses vertical channels to divide the torus into two equal parts, each forming a mesh. The second algorithm uses horizontal channels to divide the torus into four equal parts, each forming a mesh. New mathematical functions are introduced to determine the message path for both algorithms. At the end of the chapter, the two new algorithms are compared to some previous algorithms, with an explanation of the results.

Chapter 5 presents a new algorithm for the tree-based method in systems with a two-dimensional mesh topology. The algorithm can divide the mesh into two or four meshes. A new method is presented to determine which processors receive the message from the sender. New mathematical theories are presented to calculate the longest path for messages and the total number of channels used to transmit messages. At the end of the chapter, the new algorithm is compared with some previous algorithms, with the results explained. The results show that this algorithm is used efficiently in massively parallel systems, especially in two-dimensional mesh networks with a large number of columns and a large percentage of destinations. The results presented in this chapter were published in [1].

Chapter 6 is a summary of the thesis and suggestions for future work.

1. H. Moharam, M.A. Abd El-Baky, and S.M.M. Nassar "YOMNA: An Efficient Deadlock–Free Multicast Wormhole Algorithm in 2D Mesh Multicomputers," *Journal of systems Architecture*, vol. 46, issue 12, Oct., 2000. DOI: 10.1016/S1383-7621(00)00010-2.