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An Approach for Exploring Combinatorial Properties of *R*-path Omega Interconnection Networks

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Abstract

Multiple path multistage interconnection networks as compared to their parental one path cube-type networks provide better permutation capability and offer such important property as fault-tolerance. In this paper an approach for investigation permuting ability of R-path Omega networks is proposed. The analysis as concerned to arbitrary permutations is done with the help of number theory methods. As to BPC (bit-permute-complement) permutations admissibility check to the aforementioned type of networks, the modified window method is proposed. The aforementioned method reduces drastically the time complexity of admissibility check. The results of computational experiments with applying the technique to some permutations of BPC class are given.

Keywords: *Interconnection networks, R-path Omega network, BPC permutations, window method.*

Introduction

Multistage interconnection networks are of interest for use in large-scale parallel computer systems. The class of multistage, self-routing networks which in its basic form requires $\log_2 N$ stages of 2 x 2 switches to connect N inputs to N outputs with *NI2* switches are needed in each stage is known as a class of cube-type networks. This class includes Omega (Lawrie 1975), Generalized Cube (Siegel and Smith 1978), indirect binary *n*-cube (Pease 1978), delta (Patel 1981), to name but a few. The problem with this topology is that there is only one path from a given network input to a given network output so it is vulnerable to component faults. The fault-tolerance in the case of a multistage network requires multiple disjoint paths for each input-output pair. It can be achieved by either adding one or more stages in front of the original topology (Adams and Siegel 1982; Shen 1995) or by using basic switches with the number of inputs and outputs greater than 2. The authors of the latter approach (Padmanabhan and Lawrie 1983) introduce the concept of a general class of multistage networks that preserves the connection properties of the Omega network and at the same time provides significant tolerance to faults in the form of mlu1tiple disjoint paths for any input-output pair. Padmanabhan and Lawrie (1983) proved that non-faulty multiple path modified Omega network would pass any permutation that one path Omega network passed. In this paper the conditions for blocking occurrence when realizing arbitrary permutations on *R*-path Omega networks are stated. Those conditions are based on congruence notion from number theory. For checking admissibility of regular BPC (bit-permute-complement) permutations the modified window method based rather on symbolic transition sequence than on transition matrix analysis is proposed. The method reduces the time complexity of the check procedure drastically. All work is done in assumption of non-faulty condition of the networks under consideration. This paper is a generalization of research results represented earlier at two international conferences