EVALUATION AND COMPARISON OF INCREMENTAL PERMUTATION PASSABLE OF SAME STAGE CLASS OF MULTISTAGE INTERCONNECTION NETWORKS

***Amardeep Gupta**

Abstract

Multistage Interconnection Networks (MINs) interconnect various processors and memory modules. In this paper the incremental permutation passable of Irregular Fault Tolerant MINs having same number of stages named as Triangle, Theta, Omega and Phi Networks have been analysed and compared.

Keywords Design of Triangle MIN, Routes available in Triangle MIN, Incremental Permutation passable.

***Head, PG Department of Computer Science, D A V College Amritsar, Punjab**

I Introduction

The MINs are used in important applications like ATM Networks, Weather Forecasting and in almost every field where instant response and complex calculations are required[2][7]. The MINs use more than one stage of small interconnection networks like Switching Elements (SEs)[1].If the MIN has same no of SEs in all the stages then it is called as regular MIN, otherwise it is called as irregular MIN. This paper evaluates incremental permutation passable of a new class of Irregular Fault Tolerant MIN named as Triangle MIN and compares the evaluated parameter with same class of MINs like Theta(THN) and PHI(PHN).

II Design of Triangle MIN

The Network is an Irregular Multistage Interconnection Network, of size N*Nwhere N is the number of sources and same number of destinations. The MIN consists of n stages ($n=\log_2 N$). The network Comprises of two identical groups of switching elements (SEs), named as G0 and G1.Each group incorporates N/2 sources and N/2 destinations. Both the groups are connected to the N inputs through N multiplexers, and to the N outputs through N no. of demultiplexers. The switches in all the stages are of size 3*3 except the last one. The switches in the stages n-3,n-2 and n-1 have been connected to each other through links called as express or auxiliary links. These links are used when the SE in the next stage is busy or faulty. This makes the network more fault tolerant and reliable. The Triangle network of size 2^n*2^n consists of (2m-2) stages where $m=\log_2(N/2)$.This network has (2^n -2) no. of switches of size 3*3 and 2^{n-1} no. of switches of size 2*2.

The network of size 16*16 is shown in Fig 1.

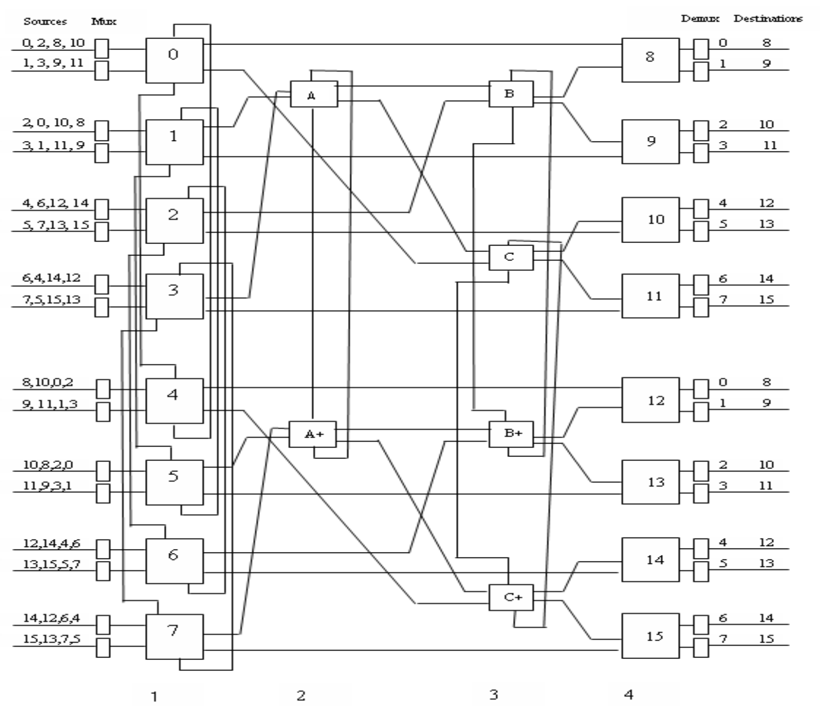

Fig 1Design of Triangle MIN

III Redundancy Graph

The Redundancy Graph is a pictorial representation of the architecture of a MIN. It shows all the possible paths from every source to every destination. [6][3]

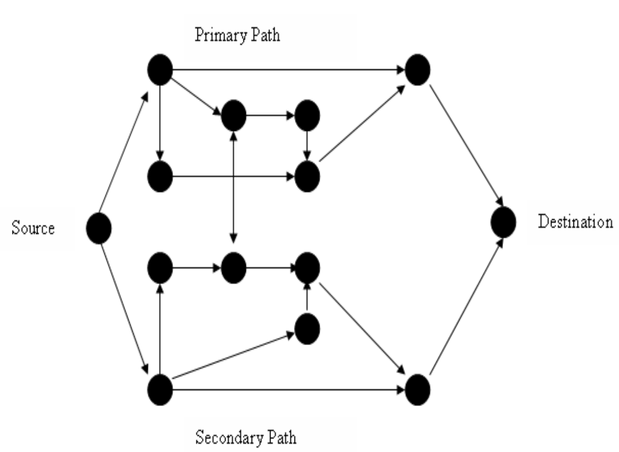

Fig 2: Redundancy Graph of Triangle MIN

IV Permutation passable

It is a set of N data transfers, all of which are performed simultaneously in the network. The $\log_2 N$ stages network allows only some subset of N! passable permutations.

Let the source and destination in binary [4] be represented as

$S=S_{n-1}\ldots\ldots\ldots\ldots S_1S_0$

$D=D_{n-1}\ldots\ldots\ldots D_1D_0$

There are two ways to evaluate the Permutation Passability of the MINs.

Identical Permutation

It is one to one communication between same source and same destination.

$S_{n-1} \rightarrow D_{n-1}$, --------- , $S_o \rightarrow D_o$

Incremental Permutation

Here each source is connected to destination in a circular chain.[16]

Example $S_0 \rightarrow D_4$, ……… , $S_{n-1} \rightarrow D_3$

Two cases have been considered

I Non Critical (N-cr) It is a case when fault is present in a single switch.

II Critical (Cr) It is a case when fault is present in a loop

The proposed Triangle Network has been compared with other popular MINs on the basis of Incremental Permutation for 100% requests.

In the tables and figures discussed below n-cr stands for Non Critical case and cr stands for Critical case in the respective MINs.The incremental permutation of Omega Network has not been discussed because Omega Network is a regular network.It has static routing and has equal path lengths because of same no of switches in all the stages.

The table 1 shows the actual no of requests getting matured and their average path lengths for Triangle MIN.The values have been depicted in Fig 3.

Table 1: Incremental Permutation Passable for Triangle MIN

Fault	Total.Path Length	Total No. of requests matured	Average Path Length	% of requests Matured
No Fault	24	8	3	50
Mux	24	8	3	50
S1 n-cr S1 cr	32 16	8 4	4 4	50 25
S2 n-cr S2 cr	28 20	7 5	4 4	43 31
S3 n-cr S3 cr	28 24	7 6	4 4	43 37
S4	24	8	3	50
DEMUX	24	8	3	50

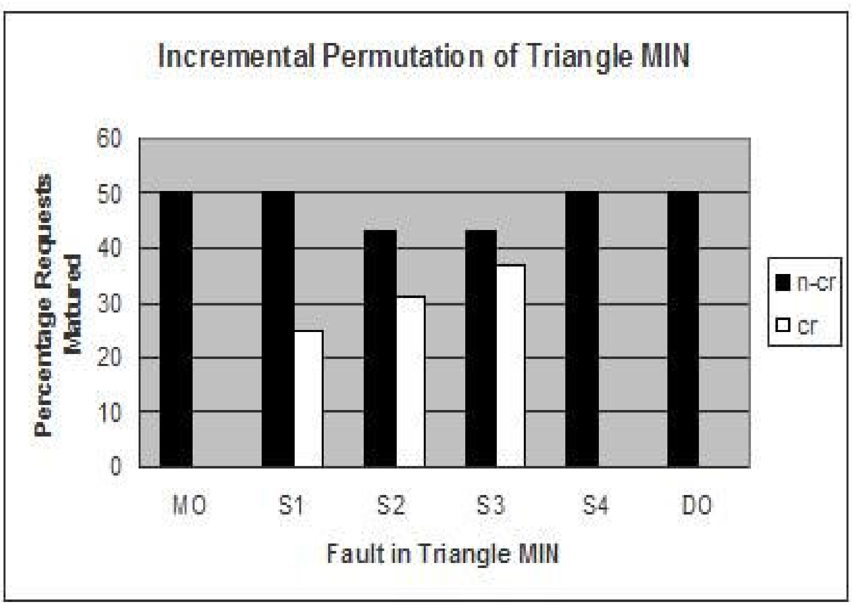

Fig 3: Incremental Permutation Passable for Triangle MIN

Table 2 Incremental Permutation Passable for PHN

Fault	Total Path Length	Total No. of requests matured	Average Path Length	% of request matured
No Fault	32	8	4	50
Mux	32	8	4	50
S1 n-cr S1 cr	24 16	6 4	4 4	37 25
S2 n-cr S2 cr	24 16	6 4	4 4	37 25
S3 n-cr S3 cr	24 16	6 4	4 4	37 25
S4	32	8	4	50
DEMUX	32	8	4	50

Table 3 Incremental Permutation Passable for THN

Fault	Total Path Length	Total No. of request passes	Average Path Length	% passable of requests
No fault	16	4	4	25
Mux	16	4	4	25
S1 n-cr S1 cr	16 12	4 3	4 4	25 18
S2 n-cr S2 cr	16 12	4 3	4 4	25 18
S3 n-cr S3 cr	16 12	4 3	4 4	25 18
S4	16	4	4	25
DEMUX	16	4	4	25

The table 2 shows the actual no of requests getting matured and their average path lengths for Phi (PHN) MIN. The values have been depicted in Fig 4. The table 3 shows the actual no of requests getting matured and their average path lengths for Theta(THN) MIN. The values have been depicted in Fig 5.

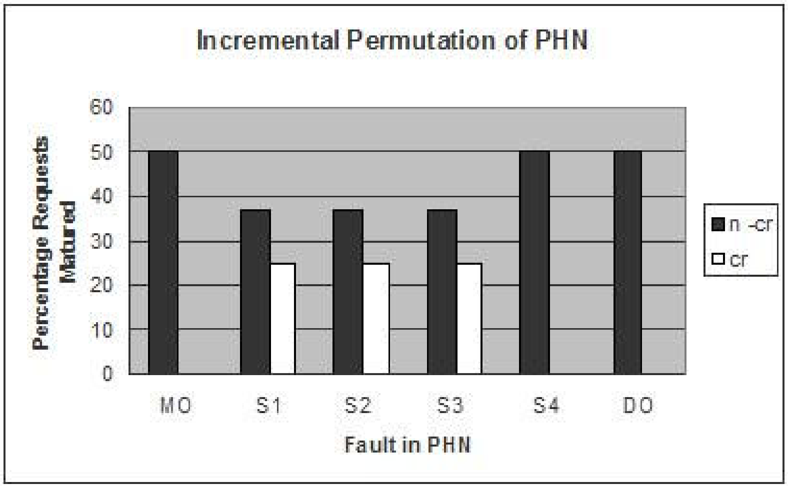

Fig 4: Incremental Permutation Passable for PHN

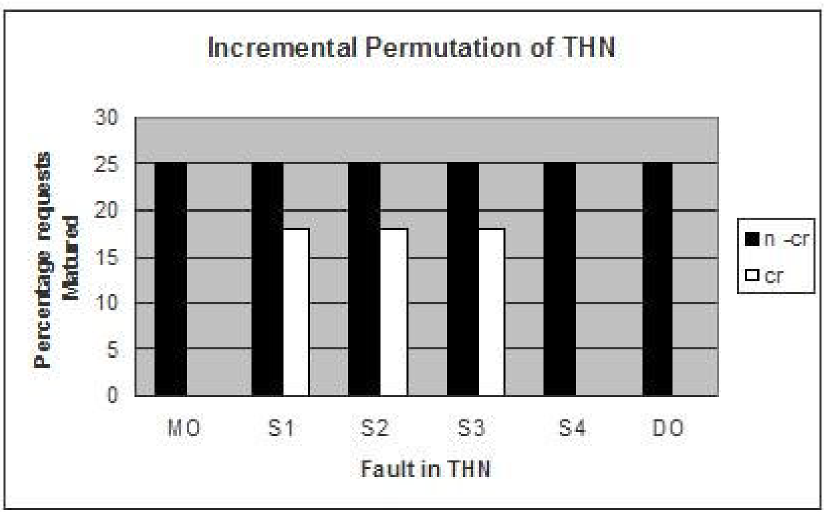

Fig 5: Incremental Permutation Passable for THN

V Conclusion

The proposed Triangle MIN is better as compared to same class of discussed MINs. The Triangle MIN has same no of stages as of Theta and Phi but has more no of requests getting matured in fault free as well as non critical and critical faulty components.

At the same time the proposed network has variable shorter path lengths from source to destination as compared to other discussed networks.

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