Parallel computing using a multiprocessor has been developed continuously over the past few decades and the demand for even more computing power is ever increasing. Keeping in view the growth of the technological frontiers, there is always a need for the development of cost-effective, reliable and fault tolerant Multistage Interconnection Networks which are the critical part of any multi-processing system. The main objective of this dissertation has been to design new Fault-Tolerant Irregular Multistage Interconnection Networks to enhance the performance of existing networks. Three Fault Tolerant Multistage Interconnection Networks of irregular class named New Four Tree (NFT), Improved Four Tree (IFT) and Improved Irregular Augmented Shuffle Network (IIASN) have been proposed and their performance have been evaluated and compared with existing irregular multipath dynamic Four Tree (FT), Modified Four Tree (MFT), Hybrid Zeta (HZTN-2), PHI and Irregular Augmented Shuffle (IASN) networks. The simulator has been designed on the basis of various proposed algorithms for the analysis and the results are evaluated by varying the size of the network, introducing faults at various levels, by varying the probability of issuing the request and varying the time bounds to evaluate the results for parameters like path length, cost, permutation passable, mean time to failure and bandwidth. A summary of the performance analysis and other characteristics of proposed and existing networks are given below:

- The structural characteristics of proposed NFT and IFT have been improved by reducing the conjugate loop switch of existing FT Network by $\log_2 N - 2$ and $\log_2 N$ respectively. The numbers of interior links of NFT and IFT have been further reduced by $\log_2 N - 4$ and $N/2 + 4$ to improve the interior complexity of FT Network. The 4:1 Mux has been added to IFT network to provide more redundant paths. Similarly, the performance of the proposed IIASN network has been improved by reducing the conjugate loop switch by $\log_2 N$ in comparison to the existing IASN network. The overall analysis shows that IIASN network has better structural characteristics in comparison to other proposed and existing networks.
• The Mean Time to Failure (MTTF) of proposed NFT and IFT networks has been improved by reducing the number of switches of existing FT and MFT networks. The lower bound MTTF of NFT is comparable to FT, but in the case of IFT Network the results have been quite impressive. Similarly, the upper bound MTTF results of both the NFT and IFT networks are comparable to the FT Network. The other evaluated results show that the proposed IIASN Network is not only more reliable than exiting IASN for both upper and lower bounds but it also produces better results as the size of network increases. The cost of proposed NFT network has been reduced by N+2 and 2*N+4 units in comparison to FT and MFT; further the cost of IFT has been reduced by N/4 in comparison to NFT. The cost of IIASN which is based on IASN has been reduced by 2*N-4 units.

• The results in terms of permutation passable indicate that the percentage of requests matured in NFT is comparable to the existing FT and MFT for identical permutations (75% in comparison to 100% of FT and MFT when no fault occurs); the incremental permutation results of NFT are identical to MFT but better than the existing FT (25% requests matured in NFT and MFT in comparison to 0% of FT, when the central switch is faulty in a loop). The IFT network has an edge over existing FT, MFT and proposed NFT. In Identical Permutation the maximum and minimum numbers of requests matured in IFT are 100% and 87.5% (with and without fault) which are enhanced in comparison to 87.5% and 75% in MFT, 75% and 68% in NFT and comparable to FT. On the other hand, the maximum and minimum requests matured during incremental permutations of FT, MFT, NFT and IFT are 25% to 0%, 50% to 25%, 50% to 25% and 50% to 37% respectively. The maximum average path length consumed by IFT is also reduced to 2.6 in comparison to 3.33 in FT, 3.38 in MFT and 3.09 in NFT. The numbers of requests matured during identical permutations of proposed IIASN network are equivalent to IASN but the minimum average path length offered by IIASN is 2.2 which is superior to 2.5 of existing IASN. The incremental permutations result of IIASN is 100% in comparison to 68% of IASN when no fault occurs in network. The maximum to minimum number of requests granted in all the possibilities of IIASN are 100% to 87.5% in comparison to 68% to 62% during IASN in a non critical condition.
• The bandwidth of the proposed NFT network has been improved by 1.4784 in comparison to 1.2 of existing FT when probability of issuing a request is 0.1. The overall result shows that NFT has provided more bandwidth with varying probability of issuing a request. The bandwidth of the other proposed network IFT is comparable to that of FT network. The analysis of the results show that IIASN has 1.4928 bandwidth in comparison to 1.136 of IASN when $p_a=0.1$. The bandwidth of IIASN gradually increases with the increase of probability of issuing a request. The other result shows that the bandwidth of IIASN network is highest among all the considered networks. The result shows that the bandwidth of IIASN remains best even when the size of the network grows.

• The evaluated results show that IFT, IASN and IIASN networks have maximum path length of 3 and minimum path length of 2 which is much less than those of the other irregular networks. An IIASN network has been found to be better among the existing networks in terms of path length. The simulated result shows that from a source to all its destinations it has at least two paths of different path lengths available which are not obtainable in any other considered networks. It is also shown that the proposed networks NFT and IFT are more efficient in terms of path length than existing FT and MFT networks.

In short, the analysis result shows that the proposed networks are better than the existing networks. The proposed network IIASN has better performance than the existing networks which have express links. The other proposed network IFT is the best among all the networks which belong to FT family. The percentage of requests successfully matured in the presence or absence of a single fault or multiple faults in an IIASN, is the highest among all the existing dynamic irregular class of networks.

**Future Scope of Work**

Although the proposed networks and algorithms present a tremendous improvement in the existing networks but still some issues are possible for future research:
• 2x2 switching elements can be replaced by 4x4 or higher switching elements for the designing of network and the switches can be arranged vertically also.

• The expansion of the network is possible in two ways: one either the output of a network is connected to the input of other network by arranging them horizontally, or two by connecting two networks with the help of some selection pins, or MUX.

• The existing analytical models can be improved to provide better performance results.

• An intelligent simulator can be designed to construct a MIN by just suggesting the number of switches, number of links, number of stages and also the number of input and output ports.

• The percentage of requests matured in any source-destination pair combination, for both identical and incremental cases in the presence and absence of faults can be improved by designing better network.

• The reliability, cost and other parameters of the network can be improved by improving the design of the network.

• The scope of interconnection network can also be extended for grid and distributed computing to connect millions of processors to provide intercommunication among them.