CHAPTER 7
Conclusions and Future Scope

This Chapter presents the conclusions, which have been derived during the design and analysis of the proposed fault-tolerant MINs. Suggestions for future work also have been incorporated.

7.1 Conclusions

In order to design networks for multiprocessor systems optimization of performance and cost are essential for sustained fault-tolerant operation of the network. In view of this, different techniques based on providing redundancy at the network level or providing multiple paths have been employed to improve the fault-tolerance of the existing MINs and to recommend some new networks. This research proposes three irregular MINs (namely IASEN, IFTN and IABN) supporting dynamic routing. The analytical expressions are derived for various performance parameters for the proposed MINs and compared with existing ones, demonstrating the superiority of the proposed networks.

Firstly, a dynamic re-routable fault-tolerant network, named Irregular Augmented Shuffle Exchange Network (IASEN) has been designed using existing ASEN-2 of size 16x16. IASEN has relatively lesser number of switches in the intermediate stage (i.e. stage1). The proposed network IASEN provides eight distinct paths between any of the source-destination pair whereas, ASEN-2 supports four such paths. Therefore, the proposed network supports much larger number of requests simultaneously. Therefore fault-tolerance of IASEN is much better (almost double) in
terms of number of distinct paths than ASEN-2. Besides, it is more cost-effective than ASEN-2.

Analytical results have shown that the comparative performance of proposed IASEN varied desirably. The Permutation Passibility behavior of IASEN is much better than ASEN-2 as it handles much larger number of requests even under faults and that too with reduced average path length. The upper and lower bounds of reliability in terms of MTTF (mean time to failure) of IASEN is better than ASEN-2 (particularly for large sized networks). The bandwidth of IASEN is almost double than ASEN-2. Increase in bandwidth of IASEN is due to availability of more paths between source-destination pairs. As the request generation probability increases, the probability of acceptance decreases in both the networks in a similar fashion. For a given request generation probability, the probability of acceptance is more for ASEN-2 than IASEN. Besides, as increased number of packets is accepted at the destination per unit cycle in IASEN, therefore throughput also shows reasonable improvement. Also, the Processor Utilization has been improved as relatively more requests are being handled by IASEN.

Next, IFTN (Improved Four Tree Network) has been designed by changing the interconnections amongst the stages of FT leading to removal of one stage. An IFTN is an irregular network that supports multiple paths of different path lengths. It resembles to a regular network as the number of switches are the same in all the stages except the first and last stage of this network. The maximum path length of proposed MIN is four, which is lesser than FT by one unit. The number of distinct paths supported by IFTN and FT are eight and two respectively. Hence, IFTN is more fault-tolerant than FT.

Without faults the IFTN has better capability to permeate than FT with slightly increased average path length. With faults permutation passibility of IFTN is much
better than FT due to higher simultaneous request handling capability of IFTN with decreased path length. The reliability in terms of MTTF is comparable for both the networks. Bandwidth of IFTN is slightly lesser than FT. This decrease in bandwidth of IFTN is due to removal of the intermediate stage. Similar, behavior exists for the other parameters of throughput, processor utilization and probability of acceptance.

Finally, Irregular Augmented Baseline Network (IABN) has been designed modifying the structure of the existing fault-tolerant Augmented Baseline Network (ABN). IABN is an Augmented Baseline Network with one additional stage, additional auxiliary links and increased size of demultiplexers. IABN is an irregular MIN and provides multiple paths of varying lengths between any of the pair of source-destination. Topology of IABN has two benefits. Firstly, the network can tolerate the failure of any switch in the network, as there is no critical switch in the network. Secondly, it provides on-line repair and maintainability, as a loop can be removed from any stage of the IABN without disrupting the operation of the network. Since the sub-networks are identical, so the implementation of the network becomes modular and simpler. In IABN there are ten such on entry to primary or secondary sub-network. Hence, there will be twenty such paths in total between any of the source-destination pair. Therefore, the proposed network IABN can cater to much larger number of requests even under faults than the ABN. Thus, IABN is more fault-tolerant.

It has been shown analytically that the comparative performance of proposed IABN varied desirably. It has been shown that the IABN has ability of pass much more number of requests than ABN with increased average path length. The path length has increased due to addition of a new stage. Reliability of IABN in terms of MTTF (both upper and lower bounds) is higher than ABN. This is so because the IABN
provides on-line reparability- maintainability with more paths even under faults than the ABN. IABN (Irregular Augmented Baseline Network) possesses almost double bandwidth for low request generation probabilities (0.1, 0.2). For higher request generation probabilities also, the bandwidth of IABN is much higher than that of ABN. Increase in bandwidth of IABN is due to the addition of one stage in the middle of network, which accepts input from both the first stage and middle stage according to routing tag. As the request generation probability increases, the probability of acceptance decreases for both ABN and IABN. IABN has increased probability of acceptance in comparison to the ABN due to maturity of more requests. Since increased number of packets is accepted at the destination per unit cycle in IABN, throughput also shows considerable improvement. In IABN Processor Utilization is also improved, as more switching elements are being made activated for transfer of data.

In brief, the proposed fault-tolerant MINs offer many desirable features for the use in high-speed, parallel computing environments.
7.2 Future Scope

- Search for new topological design and analysis of static and dynamic, regular and irregular MINs needs further exploration with an aim towards increased improvement in performance and reliability.

- VLSI implementation of the proposed networks needs to be looked into.

- The use of these regular and irregular MINs in ATM applications may be explored.

- Extended MINs using large switching elements can be explored and analyzed.

- Better and customized simulators can be designed to analyze the architecture before hardware implementation.

- MINs can be used in interconnecting the various parallel computing facilities to achieve distributed computing environment.

- Routing in MINs can be improved by designing new algorithms.

- The study can be extended to optical MINs.