Chapter 8

Conclusion
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"Enough research will tend to support your conclusions."

Arthur Bloch

8.1 Introduction

This thesis deals with Quality of Service Based Routing Algorithms for High Speed Networks. It presents the concepts involved in QoS Routing and proposes four QoS based Routing Algorithms.

8.2 Contributions

Unwanted noise or jitter may appear in the screen since Video broadcasting requires a constant bandwidth to be assured in the internet. One of the approaches to improve the quality in communication is to reserve the routing resources in the path in which the video data passes. This approach assures quality in a restricted manner. However, in the proposed approach, the communication paths are controlled by increasing the cost to use the free resources in networks according to the state of the current traffic. Since the network resources are limited, this approach improves the quality of communication. This method is called as “The Traffic Sensitive Dynamic QoS Routing” and this is proposed in this thesis. A network is considered and the experiments are done using GNU Zebra Simulator to find the working of the proposed model and the corresponding graph is generated.
A “Fault tolerant QoS Backup Path Routing algorithm” which can recover a single link failure without losing any packet is presented. In the algorithm, a secondary routing table called as the backup table on each router is prepared, and an alternative solution is proposed in case of link failure. The alternate solution if a link fails, is as follows: The router which is directly attached to the link switches its routing table to the backup one, and sets a flag of every packet using the backup table. This operation assures packets to travel to their destination through several backup tables and primary routing tables. A theoretical analysis about backup tables is done. Also, a set of backup tables that recover any single link failure in a network which is represented by a two edge connected symmetric digraph is made. A combinatorial optimization problem on graphs to construct such a set of backup tables and algorithms to solve it in $O(|V|^2)$ time in general case, and $O(|V| + |E|)$ time if all link costs are the same are generated. The proposed “Fault tolerant QoS Backup Path Routing algorithm” method is implemented using Visual Basic. The Screenshots and results of the experiments are given.

Information exchange for the node in a network to acquire link state information is necessary for the nodes to make the routing decisions. The path computation is very important in any information exchange in a network. A path computation algorithm called as the “Off Line Request QoS Routing Algorithm” is proposed. The proposed Algorithm is compared with the existing On Line Request QoS Routing algorithm.

The On Line Request path computation is carried out only on the arrival of a request. Thus, the destination is specified. As to the QoS traffic with bandwidth requirement, the required bandwidth is also known. Hence only one path that fits the QoS requirement to the certain destination is necessary to be computed.
The proposed Off Line Request QoS Routing is as follows. The QoS requirement is unknown and the routing table may have several paths for a specific source destination pair due to different kinds of QoS requirements when computing the paths. One solution is to group the requests into several classes. Those requests in the same class have a similar requirement, and then, for each class in a source destination pair, the route is pre computed and stored in the QoS routing table.

The Comparative analysis investigates the two algorithms with parameters like Blocking Rate and Cost for different periods using NAM (Network Animator) which is a companion of the Network Simulator NS2. The comparative analysis shows that the Blocking rate behaves identically even when the periods are increased, but regarding cost when the periods are increased, the On Line Request Routing catches up with the Off Line Request Routing.

Finally, a “Heuristic QoS Routing Algorithm” is proposed. A comparative study between the existing “Source QoS Routing Algorithm” and the proposed “Heuristic QoS Routing algorithm” is done on the parameters message overhead, response time and path delay. The algorithms are implemented using VC++ and the results are analyzed using tables and graphs.

The results show that the average message overhead of source based routing is always lower than its Heuristic based Routing. When the Bandwidth is increased, the Response time initially shoots up. Later the Response time decreases. The results also show that whenever Source Routing manages to find a path that satisfies the bandwidth requirement, it produces paths of slightly lower delay than the Heuristic based algorithm.
In summary, the following are the major work of this research study.

1. A QoS based Routing Algorithm of changing cost, called as the "Traffic Sensitive Dynamic QoS Routing Algorithm" for Communication Quality is proposed. A network is considered and the evaluations are done using GNU Zebra Simulator to find the working of the proposed model and the corresponding graph is generated.

2. A "Fault Tolerant QoS Backup Path Algorithm" which can recover from any single edge failure without data loss is proposed. A theoretical analysis about backup tables and the existence of the set of backup tables that recover any single link failure in any network which is represented by a two edge connected symmetric digraph is done. A combinatorial optimization problem on graphs to construct a set of backup tables is also given. The proposed method is implemented using Visual Basic. The Screenshots and the evaluations in the experiments are given.

3. An "Off Line Request QoS Routing Algorithm" is proposed. A Comparative analysis between the existing "On Line Request" and the proposed "Off Line Request QoS Routing Algorithms" is done. The Comparison is done between these two algorithms with respect to two parameters, Blocking Rate and Processing Cost using NAM (Network Animator) which is a companion of the Berkeley Network Simulator (NS2). The results and the graphs are displayed to show the comparison between the two algorithms.

4. A "Heuristic QoS Routing Algorithm" is proposed. Also a Comparative Study on the performance between the existing Source and the proposed Heuristic QoS Routing Algorithms with respect to Message overhead, Response time and Path
delay is done using VC++. The results, tables and graphs show the performance of the two algorithms.

8.3 Limitations of the Study

Each of the four QoS Algorithms proposed can be upgraded since they have certain limitations.

In “The Traffic Sensitive Dynamic QoS Routing” there is still some path oscillation in the network, though time delay and changes in cost for one link are considered.

The node failures and multiple link failures are not considered in the proposed “Fault Tolerant QoS Backup Path Algorithm”.

Since Path Caching is used, a table has to be maintained in the proposed “Off Line Request QoS Routing Algorithm” which leads to extra processing and memory requirements.

In “Heuristic QoS Routing”, when the global states at different nodes are inconsistent, loops may occur. A loop can be detected easily when the routing message is received by a node for the second time.

8.4 Recommendations for Future work

The “Traffic Sensitive Dynamic QoS Routing Algorithm” can be extended by making changes in the bandwidth, cost, load and delay. For “Fault Tolerant QoS Backup Path Algorithm”, the proposed work can be analyzed in such a way which optimizes the sum total of the backup path lengths, instead of the longest backup path length. As a future work on “On Line Request and Off Line Request QoS Routing Algorithm”, some of the
factors that might affect the usage of the routing algorithms can be studied like the use of MPLS networks in which the requests may arise frequently or infrequently. The “Source vs Heuristic QoS Routing Algorithms can be extended by including more metrics such as QoS Ratio and Mobility Ratio which can be computed with the help of the client server program is developed using VC++.

8.5 Conclusion

This chapter explains the complete work that has been done in this thesis “QoS Routing Algorithms for High Speed Networks”. The Contributions in this thesis along with the limitations and future directions of this research are also given.