CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The problem of finding efficient optimal design routing algorithm and effective use of traffic networks without congestion has been a fundamental as well as an essential area of research in the field of communication network (Roch 2002).

Communication networks face the problem of deciding how best the data can be transferred from one end of the network to the other with minimum delay, yet without loss of data. Minimum delay is obtained using optimal routing algorithm. Optimal routing algorithm must be capable of selecting the best route, which depends on the metrics and metric weights used to make calculations (Leon 2000).

In communication network, when too many data packets arrive from many input lines and all need the same line to move out, a queue builds up. The data has to wait in queue for transmission to its destination. However, as traffic increases the nodes are no longer able to cope and they begin losing data. At very high traffic, performance collapses completely and almost no packets are delivered and congestion is established. Therefore, congestion prevention is an important problem of packet switching network management in communication network (Lotfi 1993).
Congestion can be brought about by several factors. If there is insufficient memory to hold all of the packets, the packets will be lost. Slow processors can also cause congestion. Congestion tends to feed upon itself and become worse, if a router has no free buffers (Forouzan 2006, Keshav 2000). Congestion control leads to two groups- Open loop and Closed loop. In Open loop congestion control, the solutions attempt to solve the problem by good design to make sure it does not occur in the first place. Once the system is up and running, midcourse corrections are not made. In contrast, closed loop solutions are based on the concept of a feedback loop. The proposed research work addresses the issue of congestion in network using closed loop solution.

1.2 STATEMENT OF THE PROBLEM

The work in this thesis introduces and investigates a new generalized algorithm to obtain optimum path in real time communication network. Its objectives are as follows:

- To develop generalized algorithm to obtain optimal path with minimum number of nodes as metric, which is capable of handling a network of any structure with any number of nodes and any number of satellites verification with Network Simulator (ns).

- To obtain all possible and the best possible multiple paths for the selected communication network from any source to any destination.

- To obtain optimal path using different routing metrics as distance between the hops, number of hops, hop failure, congestion in the network and verification with Network Simulator.
• To analyze network congestion in communication network. The selected model for the analysis of network congestion is single queue single server model. Validation is carried out with a computerized simulation model.

• To develop artificial neural network to solve network congestion in single queue single server model. For this, Back propagation network paradigm is used.

1.3 MOTIVATION FOR THE WORK

During the 20th century, the key technology in computer industry has been information gathering, processing and distribution of programs. Computer areas are rapidly converging, collecting, transporting, storing and processing information data packets between any source to any destination. The merging of computers and communications has a profound influence on the way computer systems are organized.

The total efficiency of the whole computer communication system depends on the very high speed of the movement of information between two points. This can be obtained by routers with different types of routing algorithms. The routing algorithm has to select the best path with minimum communication cost and minimum delay without loss of the data packets. Routing must be designed for flexibility and adaptability with respect to network. The system should operate well under the variety of unexpected conditions as such heavy traffic and node failures.

Basically, there are two types of algorithms such as dynamic and static routing algorithms. In the dynamic routing algorithms, the nodes are dynamically routed depending on the traffic condition, topology and routing
policies. In the static routing algorithm when the load is high traffic and congestion, it does not change the routing path.

Many traditional routing algorithms have been proposed to look for the optimal or multi path routes (Joao 2002, Israel 1999, Almesberger 1997, Xiao 1999, Shavitt 1996). There are several drawbacks in these approaches. Firstly, the computations are massive in finding the optimal or sub optimal routes. Secondly, the speed of computation of binding for new routes does not respond fast enough to the situation, when there is failure of any nodes or components. Thirdly, failure of one node component affect the other nodes. The newly developed algorithm is used to reduce the delay, finding alternative optimal path quickly if there is a failure and aims at reducing network congestion with maximum throughput without loss of the data. Using queuing model analysis of network congestion with capacity of the link is discussed by Cohen. The present work presents the analyses of network congestion using single queue single server model for communication network.

1.4 LITERATURE SURVEY

Communication networks are developed and extended to worldwide level. This development basically needs to design efficient optimal routing algorithm. An ideal routing algorithm should strive to find the optimum path for data transmission within the least communication cost and minimum delay so as to satisfy the user’s demand for fast service. This can be obtained using the shortest-path routing.

The problem with shortest-path routing is that the path computations are performed locally at each node so as to make packets travel over paths that minimize an additive weight function, often with delay-related
developed with the use of link utilization with different quality of service
requirements (Matta 1995).

The short path routing has been developed based on the
performance of a variety of paths related to capacity (Wang 1996). Widest
paths, widest – shortest paths and shortest- widest paths optional routing in
internet networks have been carried but (Ma 1997, Shaikh 1998, Hao 2000,
Apostolopoulos 1999).

The problem of short paths are analyzed by selecting delay or
bandwidth as metric at minimum cost to the network (Roch 2002). Routing
with flow control for computer and communication networks are developed

Tsitsiklis (1986) has proposed Gradient projection for distributed
asynchronous optimal routing. Chang and Wu (1986) have presented an
optimal adaptive routing algorithm. Routing and flow control for computer
and communication network are discussed (Vakil 1987). Simulation study of
routing methods are used in telephone communication (Akselrod 1985).

Mehmet and Joao (2002) have discussed the problem of obtaining
the shortest path computation routing algorithm in computer networks using
Dijkstra algorithm. Implementation of the generalized Dijkstra algorithm to
compute optimal paths with the minimum number of hops is used in
communication network. If one path is preserved, the data has to transmit
with other optimal path. Direct generalized Dijkstra algorithm does not solve
this problem. The present work presents a variant of the generalized Dijkstra
algorithm that computes those paths and has the same computational
complexity as the standard algorithm. Network must be designed for
flexibility and adaptability with respect to access topology and routing. The system should operate well under the various unexpected conditions and node failures (De 2001). There it needs an alternative optimal path within the network. This problem is tackled in multi path routing network.

The performance of multi path routing algorithms that reserve resources, link capacity along the paths are considered for routing (Zappala 1997, Mitra 1991). The reservation message travels to the destination as fast as possible, but the best possible route might not be the one selected. The analysis in this thesis projects that best optimal multipath routing with least communication cost.

Then, a modified algorithm is developed to obtain optimal path by selecting distance between the hops, number of hops, capacity of the link, failure and congestion of the link as metrics in the communication network. All the nodes or links in the path of data transfer fail or become congested and the algorithm shows no possibility of data transfer path for the requested source to destination. All the data packets are saved without loss. However, as the traffic increases the nodes are not able to transmit the data and congestion is established in the network and all the data in line are dropped. Congestion prevention can be interpreted as an important problem in matching the admitted traffic to the network resources.

Communication networks are ‘store and forward’ networks consisting of switching nodes and communication links connecting them according to a certain topology. Each link is characterized by its packet transmission capacity. A node which reaches maximum storing capacity due to the saturation of its processors or one or more of its outgoing transmission links is said to be congested. This leads to a deterioration of the networks throughput and delay performance. Congestion prevention can be interpreted

The concept of credit-based control for available bit rate traffic was first introduced (Kung 1995), which is a link by link back-pressure congestion control scheme. In early implementation, congestion was signaled through a single bit thus providing a binary feedback loop (Barnhart 1994). Single server queues are mostly used to model the network level of data network (Jain 1996, Abrahan 2001).

In general statement that networks performance will increase with increasing the capacity of links in traffic networks or adding links to networks. This plausible belief is now known to be false in several kinds of congested networks when traffic is routed by each individual participant to minimize its own delay given the paths chosen by all other participants (Charny 1996).

A closed loop control algorithm was developed to solve the congestion problem. However, although the approach includes feedback delays, the system performance degrades quickly as feedback delays increase, preventing its applicability to high speed network environments (Cavendish 1995).

The concept of credit based control for available bit rate traffic, which is a link by link back-pressure congestion control scheme is already introduced (Kung 1995, Kolarov 1999, Mascolo 1996). Then the need to use a separate set of parameters for each delay’s values and number of sources in the system is studied (Katabi 2002). A theoretical approach is proposed to control congestion in packet network accounting network buffer capacity (Cavendish 2004). Congestion will be increased resulting in increase in capacity of the link in single server single queuing networks (Cohen 1997).

It follows from this overview that work has been already carried out on network congestion, delay in data packets address with buffer capacity, bandwidth, adding servers and increasing the capacity of existing servers. Single queue single server model is selected and presented for the analysis of network congestion.

In most engineering problems, the parameters need to be of high degree precision for best estimation of various parameters to solve the problems. This is not possible in normal mathematical approaches, and can be obtained using Artificial Neural Network (ANN) (Lippmann 1987). A neural network is a system that is composed of many non-linear computational elements being operated in parallel and exhibiting characteristics such as mapping, generalization, robustness, fault tolerance and high speed information processing. Delay in transmission of data packets are also dependent on arrival rate and service rate distribution along with traffic intensity. These issues for network congestion are tackled in the present study. Analysis of network congestion using neural network single server queuing model is proposed. Performance measures are queue length, delay, waiting time, variance, probability and traffic intensity. Back propagation network has been employed. In the work proposed in this thesis neural networks based single-server queuing models at the network level focus on
long-term average performance, summarizing the complexities of transient congestion through arrival time distribution and service time distribution. This model combines many features, such as a very good convergence and an ability to operate in real time and to adopt changes in network topology and link.

1.5 CONTRIBUTION OF THE WORK

The routing algorithm should not only be efficient in a given state of the network, but also be adaptive to the changes of the network environment such as load levels, traffic patterns and the network topology. The key contributions of this thesis are as follows:

(i) Providing minimum delay for data transfer, for the selected network having selected number of nodes, and any structure, with analytical model and verification obtained using Network Simulator tool.

(ii) Efficiently utilizing data transfer if there is congestion or failure of any node or link

(iii) Reducing network congestion to achieve maximum throughput with maximum traffic intensity using single server queuing model.

(iv) Developing Artificial neural network for single server queuing model.

For ANN, Back propagation network has been employed.
1.6 ORGANISATION OF THE THESIS

The thesis is organized into six chapters. Chapter 1 gives the introduction to the thesis and the motivation to the research work. Need for Routing and its performance are described in Chapter 2. Performance analysis of routing algorithms and design and development of Network Simulator modes are discussed in Chapter 3. A general description of queuing network model for network congestion is given in chapter 4. ANN model for network congestion is discussed in Chapter 5. Summary and conclusions are discussed in Chapter 6.