Chapter 3

Problem Statement and Methodology

The world of communications is moving faster and faster. The continuous growth of network system complexity and the need of reduced design time render the development of effective and efficient optimization strategies to assist the designer. The problem statement for the research is given below:

a) Identification of the various problems in computer network that need optimization.
b) Exploring the possibilities of using intelligent approaches in the problems that need optimization.
c) Exploring the use of evolutionary algorithms in network routing and congestion control.
d) To identify the representation of the problem suitable for evolutionary approaches.
e) To compare the effectiveness of evolutionary approaches with the existing one.

The brief organization of chapter is as follows: Section 3.1 focuses on different areas in computer networks that need optimization. Section 3.2 describes various routing issues. Section 3.3 introduces solution approach. Section 3.4 describes the importance of research and section 3.5 presents the summary.

3.1 Different Areas That Need Optimization

The Major components of a network are, an end system (A Personal Computer or Notebook), communication medium, Intermediate devices like switches, routers and gateways, server systems, a network operating system, network topology and a communication model/architecture. The end system, communication medium, Intermediate devices network topology etc. are already explained in chapter 1 and do not need continuous optimization. Communication architecture has great effect on network performance. For finding the path from
one node to another node for various types of services with efficient utilization of network resources by avoiding congestion, network layer employs the routing protocols. Network protocols use the routing algorithms for finding the best routes. The routing algorithms uses various metrics like hop count, delay, load, reliability to find the efficient path between two nodes. The design and implementation of adequate strategy is a complex issue in today’s networks due to exponentially increment of traffic in network. The good routing strategy makes better utilization of network resources as selection of optimal path is routing algorithm dependent.

As the amount of data that businesses need to process increases, best use of network utilization becomes critical. Every business needs to make sure that every aspect of its physical network is performing as efficiently as possible. The answer to these data problems is not always providing more bandwidth. In view of the increasing scale, complexity, and diversity of networks, optimization for certain objectives such as maximum efficiency, maximum reliability and minimum energy has become an essential critical issue in real-world applications. The design of good routing algorithm is the major issues in a network that affects the performance of a network. Therefore routing issues need continuous optimization to provide acceptable network performance.

Routing is the issue with significant interest across communications network and the whole performance will greatly change with different routing mechanisms. Under such environment, the recognition to dynamics of network is the necessary premise to route in time while the temporary routing often makes sense temporarily instead of the best optimization.

### 3.2 Design Issues of a Routing Algorithm

Routing algorithms often have one or more of the following design goals:

a) Optimality refers to the capability of the routing algorithm to select the best route, which depends on the metrics and metric weightings used to make the calculation.

b) The routing algorithm must offer its functionality efficiently, with a minimum of software and utilization overhead. Efficiency is particularly important when the software
implementing the routing algorithm must run on a computer with limited physical resources.

c) Routing algorithms must be robust, which means that they should perform correctly in the face of unusual or unforeseen circumstances, such as hardware failures, high load conditions, and incorrect implementations.

d) Convergence is the process of agreement, by all routers, on optimal routes. When a network event causes routes to either go down or become available, routers distribute routing update messages that permeate networks, stimulating recalculation of optimal routes and eventually causing all routers to agree on these routes. Routing algorithms that converge slowly can cause routing loops or network outages.

e) Routing algorithms should also be flexible, which means that they should quickly and accurately adapt to a variety of network circumstances.

With the growing importance of telecommunications and the Internet, more complex networked systems are being designed and developed. As networked systems become more complex so are the underlying software and the control rules. The congestion and load balancing directly depends on routing strategies. Therefore the challenges of dealing with the vast complexity of networking tasks such as load balancing, routing and congestion control accentuate the need for more sophisticated (more intelligent) tools to solve these problems.

3.3 Solution Approach/Methodology

An optimization algorithm is one that accepts the search space to the problem as input and processes it by applying different operators considering the specified constraints and returns an optimal solution with minimum cost. The cost is problem dependent. An optimization problem is defined by five tuple \((X, F, G, Op, gpm)\), specifying the problem space-\(X\), objective function-\(F\), search space-\(G\), set of search operations-\(Op\) and genotype to phenotype mapping-\(gpm\). Evolutionary algorithms are generic in this sense and genetic algorithms are most popular optimization technique for multi-objective optimization problems among evolutionary algorithms. Genetic Algorithm uses an initial population called as chromosomes of all feasible solutions of the problem. On basis of fitness function it evaluates each chromosome to select the best pair for crossover and mutation operation by performing a number of iterations to achieve
the optimal solution. GA methodology is most popular technique to solve the complex optimization problem.

3.3.1 Tool to be used

To solve the routing problem a computer simulator is required. Researcher used MATLAB tool to develop the simulator. MATLAB is powerful tool and reduces the simulator design efforts as compared to any other programming language. It provides a lot of inbuilt functions for graph generation etc. and reduces the 60% programming efforts.

3.4 Importance of Research

New usages of communication /Computer networks are in need of quality of service in dealing with numerous daily life problems (airline reservation, e-banking, e-commerce, e-shopping, entertainment, communication, collaboration and research etc.). As computer networks increases rapidly in size, conventional network routing approaches may not work well, because they usually require that each node know the full topology of whole network thus cannot scale to a very large networks. The research will help in providing better solutions to increase the performance of real networks.

3.5 Summary

The problem statement involves Identification of the various problems in computer network that need optimization and exploring the possibilities of using intelligent approaches in the problems that need optimization. Routing and Congestion greatly affects the network performance and needs optimization. An optimization problem is defined by five tuple (X, F, G, Op, gpm), specifying the problem space-X, objective function-F, search space-G, set of search operations-Op and genotype to phenotype mapping-gpm. GA approach is most suitable for solving this problem. MATLAB tool will be used to design the simulator for testing of GA implementation to find the optimal and reliable path for routing of packets in computer network. To compare the effectiveness of evolutionary approaches the implementation will be compared with the existing one.