*Impact Factor (SJIF): 3.632*

**International Journal of Advance Research in Engineering, Science & Technology**

*e-ISSN: 2393-9877, p-ISSN: 2394-2444*

***Volume 3, Issue 6, June-2016***

# Optimized Fault Tolerant Routing In Convergent Network: A Genetic Algorithm Approach

**B. S. Malapur, Anusha N. Godi**

*Department of computer science and engineering, Basaveshwar engineering college, Bagalkot*

***Abstract — Now a days to identify the optimal path in a computer network is one of the complex task, that to in a Convergent Network it become more complex because optimization depends upon number of quality of service (QoS) parameters. Especially to transfer variety of data in critical application is one of the big task that to if there occurs fault like link failure while transferring data it become more complicated. So a fault tolerant routing is gaining more importance so that the data can be transferred even in the presence of fault. To overcome this issue proposed method is Genetic Algorithm (GA) which will find the optimal route and transfer the data in a single network. GA starts initially with number of solutions where each solution is represented in the form of chromosomes. The success of GA depends upon the selection, crossover and mutation operators. The performance is measured by a fitness function that includes various QoS parameters such as delay, jitter and transmission success rate.***

***Keywords-convergent network; genetic algorithm; fault tolerant; link failure; optimal route;***

## I. INTRODUCTION

For the information oriented society in this Internet world communication takes place through sending the packet of data in a computer networks which become important in our day-to-day life. Routing is the process of sending a packet of data across the network from one host to another host. It is performed by dedicated device called routers. In this process if it involves single source and single destination it is called unicast routing or point-to-point communication. If it includes more than one source and destination it is called collective communication process. Collective communication process example include multicast (single-to-many), broadcast (single-to-all) and gossip (all-to-all). Routing is complex in large area network due to the numerous potential intermediate destinations a parcel may cross before achieving its destination. There are two different types of routing: Static and Dynamic. In static routing, only the information related to nodes and edges and their related data like bandwidth, buffer space are stored in route information table. In dynamic routing, routes are created on spot whenever required.

The problem of finding optimal route from a particular source to destination is one of the problem in a network communication. To find an optimal path for transferring of data in the computer network by taking care of time and satisfying different quality of service (QoS) parameters. So it become difficult to find the optimal path in a network. As the size of nodes and edges increases in the network there are more chances that failure in the nodes and edges also increases because of which data may not reach the destination. Therefore it become important to design the routing process with capability of fault tolerant so that data can reach the destination even in the presence of fault. A Fault tolerant routing designed in such a way that it can continue its operation, possibly at the reduced level instead of failing completely when some fault occurs in the system. In Fault tolerant routing there occurs the fault like link failure, path failure or node failure. In this work link failure is taken as fault and try to send a data even if link is failed by using algorithm.

Convergence indicates integration of telecommunication, broadcasting and internet as services. It allows a variety of sellers to use different communication network to transfer audio, video and data to home and in business field. In earlier day's communication was restricted through wire line. In the present world, convergent network alludes to the provision of phone, video and data correspondence services inside a single network as shown in Figure 1.1. At the end of the day, one channel is utilized to convey different types of services correspondence. One principle objective of such reconciliation is to convey better services at the lower cost to users.

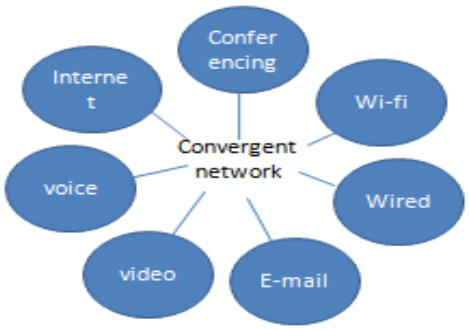


***Figure 1.1 Convergent network***

Genetic Algorithm (GA) has been developed by John Holland, the main goal of author is to discover importance of both natural and artificial science. GA is one of the search technique used to find the optimized solution and problem of searching based on the natural selection and natural evolution. Each individual's candidate arrangement is called chromosomes. Each sub-part of chromosome is called gene. Genes are represented in the form of bits, alphabets, real numbers, integers and rules. GA is one of the evolutionary processing technique and optimization algorithm. GA works with search space called population. Each population are called chromosomes. GA starts by generating the initial population. Each chromosome will indicate one solution, each population fitness is evaluated by using fitness function. The chromosome will undergo survival of fittest, selection, crossover and mutation to find out the new solution. In fitness function different QoS parameters are taken.

## II. LITERATURE SURVEY

A sustainable amount of research work has been done to find optimal and fault free route in convergent network using Genetic algorithm In related work different issues occurred like delay, energy consumption, jitter, link failure, node failure, time complexity, dynamic changes in network .The proposed genetic algorithm is used to find the solution to all these issues and to overcome these problem they have started by initial population, evaluated each population using fitness function which have different quality of service parameters. By applying the genetic algorithm operators like selection, crossover and mutation they have find out optimal path in the network. The different types of issues found after reading many papers are as follows:

- *Energy consumption*: In sensors, power used for replacing nodes which are out of order, batteries used for communication and when re-clustering of data the energy consumption will be more , so balanced energy consumption is necessary to increase network lifetime.
- *Multi-link failure*: In the system at the same time two or more than two link may fail during network operation.
- *Link failure:* Link failure in the network may occur due to power failure, failed blade in switch.
- *Dynamic changes in Network topology:* The network must operate with changing infrastructure and can survive rapid changes in the network topology.
- *Time complexity:* Time complexity increases if communication between the source and destination which depends on number of hops present in between and if the distance between hops is more.
- *Delay:* A variation in the delay of received packet due to network congestion, in-proper queuing and configuration errors.
- *Jitter:* Delay packet arrival time variation due to in-proper queuing.

Among all the issue found out above, we are working out to find the solution to problem like link failure, delay and jitter for which the proposed method is Genetic algorithm. In genetic algorithm we have taken care that delay and jitter time is less. If link has failed while sending the data then that link will be removed from topology and then again genetic algorithm is applied to find optimal and fault free path.

## III. PROBLEM DEFNITION AND PROPOSED METHODOLOGY

In a network topology for a given 'N' number of nodes, finding an optimal path for the convergent network i.e. to transfer data from particular source to destination is one of the complex task because we need to satisfy different quality of service (QoS) parameters. Especially while transferring packet of data if they occurs fault like link failure then data cannot be transferred to destination. The proposed fault tolerant routing system using genetic algorithm, which will find optimal path from source to destination so that data can be transferred even in the presence of fault.

### 3.1 Proposed Methodology

First the packet of data or video or telephone calls is sent as the input to the system. Then Genetic algorithm is applied for finding the optimal path route even in the presence of fault at an edge. Genetic algorithm (GA) starts by generating initial random population as shown in Figure 3.1, say P (t) for generation t. Each individual chromosome is encoded by using binary encoding method, which represented by 0 and 1. Each individual population represents the solution to the problem. Each population fitness value is calculated and evaluated to some measures of fitness. Fitness function used in this system is as shown in equation (1). Then check if an optimization criteria and fault free path is met or not. If it is met means best individual is found so data can be sent to destination through the optimal path found. If it is not met, some fault like link failure might have occurred in the topology so we need to apply again GA, some individual from random initial population is selected based on Roulette wheel selection method. After selection, the individual population will undergo random variable transformation using genetic operator to generate the new individual solution which is optimal and doesn't have any link or node fault. The two types of genetic operators are:

1. Crossover: Crossover will create new individual by combining two parents sub individual. Before applying crossover it will check the probability Pc=0.95, if less than probability then only crossover is applied otherwise crossover is not applied. In this system the single point crossover is used.
2. Mutation: Mutation will create new individual by making changes in single individual. Before applying mutation it will check the probability Pm=0.05, if less than probability then only mutation is applied otherwise it is not applied.

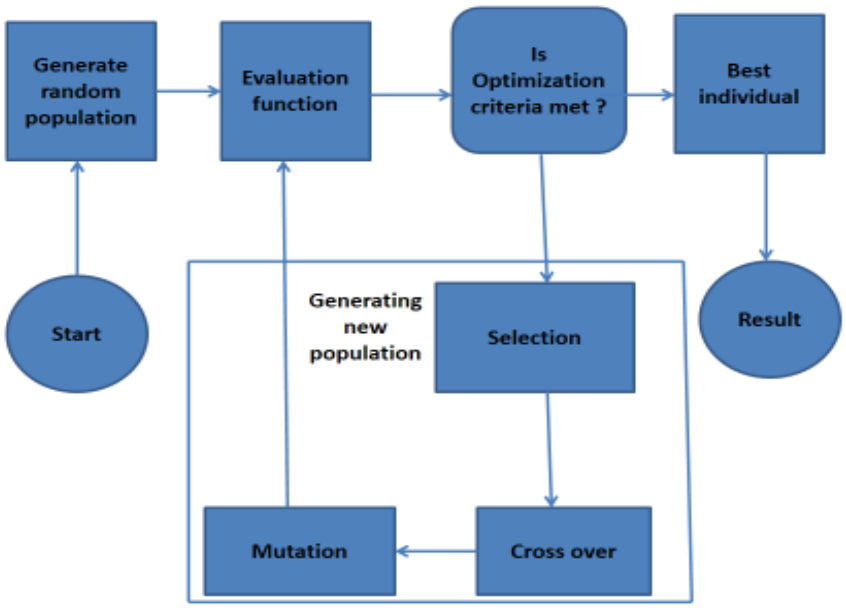


***Figure 3.1 Proposed methodology***

$$\text{Fitness Function (F)} = \left( \frac{\pi TSR}{\sum Dt + \pi Dl + \pi J} \right) * P \longrightarrow \text{(eqn 1)}$$

$$\text{Where Path (P)} = \begin{cases} 1 & \text{If path exist from source to destination} \\ 1000 & \text{Otherwise} \end{cases}$$

TSR= Transmission Success Rate

Dt = Distance

Dl= Delay

J=Jitter

The new population generated will undergo again fitness evaluation after that it will check if optimization criteria is met or not, then if optimization is met which means best individual is found and if optimization is not met means repeat the process from fitness evaluation module. We will stop the execution process, when a termination condition is satisfied.

**3.2 Algorithm**

**Algorithm: Optimized fault tolerant routing using genetic algorithm**

**Input: Number of nodes, source, destination, fault edge.**
**Output: Optimal and fault free path**
Step 1: Give input no_of_nodes, src, dest, fault edge, delay, jitter, distance and transmission success rate (TSR) for each edge.
Step 2: Initialise crossover probability, mutation probability.
Step 3: Generate random initial population based on no_of_edge, population size.
Step 4: Apply genetic algorithm and evaluate fitness of each chromosome using fitness function.
Step 5: for 1: max_no_of_iteration

1. Select the fittest chromosomes for reproduction based on roulette wheel selection method based on their fitness value.

2. Based on the crossover probability, apply crossover to the parents selected which will reproduce offspring's. Here we are using single point crossover.
3. Based on the mutation probability, apply mutation to offspring's
4. Evaluate fitness of new chromosomes generated.
5. If evaluated offspring's fitness value is greater than the lowest fit of population then replace those chromosome with new offspring's.
6. Repeat the procedure from step 4 until no_of_iterations complete

Step 6: End for
Step 7: The chromosome with minimum fitness value is optimal path, gene of this chromosome indicates route from source to destination.
Step 8: If (link which failed belongs to optimal path found)

1. Remove that edge from topology
2. Repeat from step 3 to find the optimal path.

Else
Same path will remain as optimal path
Step 9: End If
Step 10: Stop

**3.3 Implementation**

The Genetic algorithm (GA) is used to find the optimal path from source to destination. The coding language used here is mat lab, in mat lab we are using higher mat lab version because in that some built in library function are present which we are using in coding.
In this we have created some varying static size network (5, 10, 13 and 20 nodes) and in implementation we are applying genetic algorithm for various topologies. They are as shown in Table (3.1).

**Table 3.1. Network Topologies**

| Number of Nodes | Number of Edges |
|---|---|
| 5 | 5 |
| 10 | 14 |
| 13 | 19 |
| 20 | 30 |

After the creation of topology, the nodes and edges are created then the weights are assigned between two nodes and here we are implementing on different QoS parameters like delay, jitter and transmission success rate (TSR). Then in matrix delay and jitter value is assigned for each edges present in topology and then TSR which is randomly generated.

**3.3.1 Selection**

Next step in GA is selection, in selection process we will select two population based on the fitness value. There are many algorithms are present for selection. In our implementation we are using roulette wheel selection method. In roulette wheel selection parents are selected based on probability of selection which depend upon the fitness value. In roulette wheel selection the wheel is spinned so that size of the segments being for every parent is proportional to its fitness. And there is more chances that the element from higher segment is selected most of the time and another advantage of roulette wheel is lowest size segment may also be selected. In roulette wheel selection the cumulative sum of fitness of each individual. Then the selected parents is sent for next step.

**3.3.2 Crossover**

Next step in GA is crossover, in crossover operation crossover is applied to two chromosomes selected. There are various technique for crossover. In our implementation we have considered single point crossover. The crossover probability which we have taken for experiment is 0.95. And crossover is not applied for all chromosomes, it is applied for only those chromosomes which is less than crossover probability. In one point crossover we will select one point and then we will swap the chromosome between that points which will produce two children's. The newly generated children chromosomes are passed to next step. In Figure 3.2 will show a single point crossover.

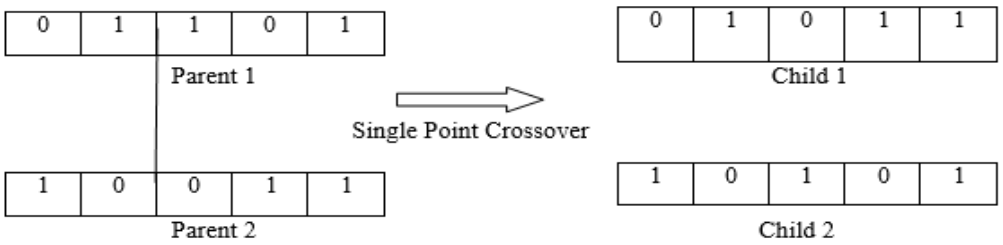


***Figure 3.2 Single Point Crossover***

### 3.3.3 Mutation

Next step in GA is mutation, in mutation process bring randomness in GA. There are various techniques for mutation. In our implementation we have applied mutation at one point only. In mutation we will do bit flipping, we will choose randomly the point and will operates on the chosen genome by inverting the bit. Mutation is not applied to all the population. Mutation will be applied only if chromosome selected has probability less than the mutation probability then only that chromosome will be chosen for mutation. Mutation probability will be always less. Mutation probability which we have implemented is 0.05. In Figure 3.3 will show mutation.

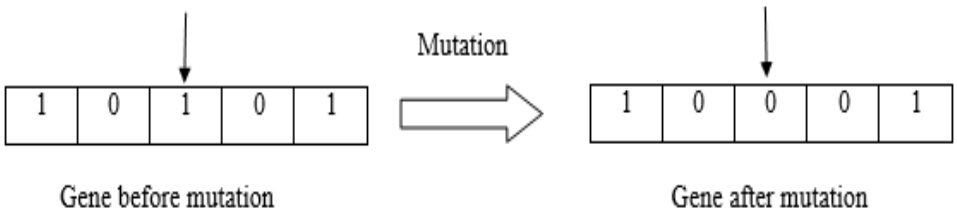


***Figure 3.3 Mutation***

## IV. EXPERIMENTS AND RESULTS

We have created GUI using mat lab, in which user will select the network for which we need to apply genetic algorithm. In GUI, user will be allowed to select the number of nodes, source, destination and even user will select fault. In this link failure is considered as a fault. While sending data if link is failed then it's not possible to send a data to the destination so we need to find optimal and fault free path. After execution of program GUI, the input given are first selecting number of nodes because we have tested for varying static nodes, source node, destination node and then select fault edge then the genetic algorithm is run and after that the output will be displayed and in output part fitness value of solution, chromosome, path and along with this the time taken to find the optimal and fault free path is displayed. Then genetic algorithm is applied for the topology and after finding an optimal path, it will be highlighted in the bio-graph. The fault edge in this implementation is indicated with different color in bio-graph. If the fault link belong to optimal path then that fault link will be removed from the network topology and again genetic algorithm is applied to find optimal path and fault free path. And if fault link doesn't belong to optimal path found then it will not affect the network topology and that optimal path will remain same.

In Figure 4.1 shows the time taken for varying static nodes in our implementation. In our project we have tested for varying number of static nodes like 5, 10, 13, and 20 and then we are testing by using the proposed genetic algorithm. In the output part we have checked how much time will be taken to find the optimal and fault free path. Based on the result we got the graph has been plotted. The graph shows how the time complexity for fault tolerance with varying size of nodes in convergent network. As the size of nodes increases time taken to find out optimal and fault free path will also increase. So in the graph it's clearly show that as size of node increase time taken to find path also goes on increasing.

## CONCLUSION

In our work, genetic algorithm is used to find the path which is optimal in the convergent network from particular source to destination in a network. A chromosome structure used to represent the different solution to find the optimal path in a network. Then genetic algorithm operator's crossover and mutation are used to find better efficient solution. Especially while transferring packet of data in convergent network i.e. transfer any type of data through single network if fault like link failure occurs means data can't reach the destination. So in this work we are removing that edge from a network and then apply again genetic algorithm to find optimal path. Here we have applied genetic algorithm and

tested on variety of network topologies and found out with better optimal paths. The performance of genetic algorithm depends on different quality of service parameters they are delay, jitter, distance and transmission success rate (TSR).

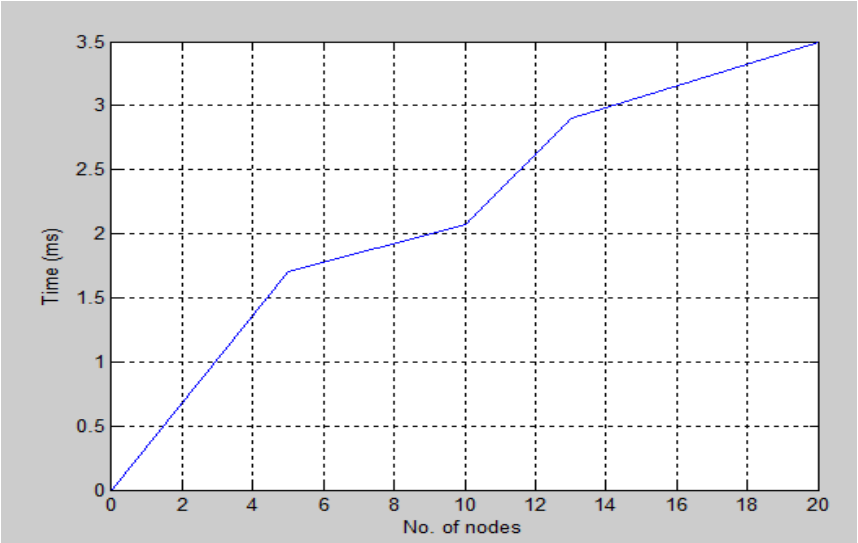


***Figure 4.1 Time complexity vs number of nodes***

**REFERENCES**

[1] Deepak Mehetre and Sanjeev Wagh, 2015,“ Energy Efficient Disjoint Path Routing Using Genetic Algorithm for Wireless Sensor Network”, 2015 International Conference on Computing Communication Control and Automation IEEE, vol. 3, pp. 1305–1310, 2015.

[2] M.Beema Mehraj, 2015 "Genetic Algorithm Based Multicast Routing Used In Mobile Ad Hoc Networks ", International Journal of Innovative Research in Computer and Communication Engineering, ISSN : 0974-6846, 6(S6) 4772-4776, 2015.

[3] Lokesh B. Bhajantri, Nalini. N, 2014, “Genetic Algorithm Based Node Fault Detection and Recovery in Distributed Sensor Networks”, Journal on IEEE I.J. Computer Network and Information Security, 2014, vol 12,pp 37-46, 2014.

[4] Priti Bhardwaj , Rahul Johari, 2013 " Routing In Delay Tolerant Network Using Genetic Algorithm ", IEEE International Journal Of Computer Engineering & Technology (IJCET),vol 26, pp. ISSN 0976 – 6367, 2013.

[5] San jose, 2013 " Cisco Unified Access Technology Overview: Converged Access ", 2013 Cisco and/or its affiliates, 2013.

[6] T.Priyadharshini and Ar.Arunachalam, 2013,” Efficient Genetic Algorithm for Optimal Routing In Ad Hoc Networks”, IEEE International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 2, February 2013 ISSN: 2277 128X, 2013.

[7] Alaa fakri Obeidat and Mohamme ebed ellatief alshalabi ,2012, “the Performance of the Networks Using Genetic Algorithm”, Proc. of the International Conference on Advances in Computer and Information Technology - ACIT 2012, IEEE Transactions on, Volume 33, Issue 3, Page(s):297 -312, 2012.

[8] Yigal Bitran , 2011, “Broadband Data, Video, Voice and Mobile Convergence – Extending the Triple Play”, Texas Instruments Incorporated,2011.

[9] Abdul Kadar Muhammad Masum1, Mohammad Shahjalal, Md. Faisal Faruque and Md. Iqbal Hasan Sarker, 2011, “Solving the Vehicle Routing Problem using Genetic Algorithm”, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 7, 2011

[10] Yousef S. Kavian, Ridha Rejeb, Otto Strobel, 2010, “Dual-Link Failure Covering in DWDM Optical Networks Using Genetic Algorithms”, IEEE Network ICTON 2010, Journal of Lightwave Technology, vol. 25, no. 25, pp. 287-296, 2010.

[11] Jason Peach, 2010, “ Networks First : Qualifying Convergence”, Networks First Limited, 2010.

[12] Dr. Rakesh Kumar, Mahesh Kumar,2010, “Exploring Genetic Algorithm for Shortest Path Optimization in Data Networks”, global journal of computer science and technology, Vol. 10 Issue 11 (Ver. 1.0) October 2010

[13] Gihan Nagib and Wahied G. Ali,2010, “Network Routing Protocol using Genetic Algorithms”, International Journal of Electrical & Computer Sciences IJECS-IJENS Vol:10 No:02,2010.

[14] Elmira Moghaddami Khalilzad , Sanam Hosseini ,2012, “Recovery of Faulty Cluster Head Sensors by Using Genetic Algorithm “, International Conference on Computational Intelligence and Communication Networks, IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 4, No 1, July 2012,IEEE, ISSN (Online): 1694-0814,2012.