International Journal of Soft Computing 1(4): 239-246, 2006


# Muti Path Routing and Handling of Network Congestion Using Artifical Nerual Network

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**Abstract:** In this study authors are discussed the design and development of a new generalized algorithm to obtain optimal multi path routing for communication network. The selected network for the generalized algorithm is capable of handling network of any structure with any number of nodes. An algorithm is developed to obtain all possible paths from any source to any destination by considering cost of the link in the network. For the selected source and destination with in the network all multi optimal path will be shown on the screen in the text mode. From the listed paths the best any number of the path would be selected and the corresponding structure of the network with the optimal path will appear on the screen in the graphics mode. Link state algorithm is used to obtain the optimal path. The software developed is tested and dealt in this study with a typical example. In communication networks minimizing delays from entry to exit is a major concern of users. In user Optimal routing, each user chooses a path to minimize delay and without loss of the data from entry to exit. Analysis of network congestion using neural network queuing model is proposed. Performance measures of Queuing model are queue length, traffic intensity, total delay and non empty Queue of the data. Many networks especially data networks are commonly modeled as networks of Single Server queuing model. The network performance is analyzed using single server queuing model. Simulation is done with the parameters arrival and service time distribution of data using artificial neural network, Back Propagation Network (BPN) has been employed. The major focus of this work is to provide minimum delay, maximum traffic intensity without loss of the data and better network congestion control in communication network.

**Key words:** Multi path routing, network congestion, queue model, BPN-traffic intensity

## INTRODUCTION

In a packet switched computer network, routing is an important factor that has a significant impact on the networks performance for this reason the area of network routing has been the subject of intensive research for many years[1,2]. The problem of finding efficient routing algorithm has been a fundamental research area in the field of data communication network. An ideal routing algorithm should strive to find the optimum path for data transmission with in a least communication cost so as to satisfy the users demand for a fast service. The optimality of the routing algorithm is a relative attribute which usually implies an efficient use of the network resources so as to optimize a selected performance measure such as network throughput or mean packet delay. This study focuses on the multi optimum short path routing where the goal is to minimize the communication cost in the network.

## LITERATURE SURVEY

**Multi optimal path:** Network must be designed for flexibility and adaptability with respect to access topology and routing. The system should operate well under the variety of unexpected condition and node failures. There it needs alternative optimal path with in the network. This problem is tackled in multi path routing network. Zhang, Deering[3] have dealt reservations for connection oriented traffic along the shortest path between routers. Zappala[4] have dealt reservation can not be made , a new path might be calculated to try and accommodate the requested resources. This study analyzes the performance of multi path routing algorithms that reserve resources, link capacity along the paths considered for routing. The reservation message travel to the destination as fast as possible, but the best possible route might not be the one selected . The analysis in this study shows that best optimal multi-path routing with least communication cost. Shavitt[5] suggested a family of multi path reservation algorithms that use multiple reservation processes concurrently for the same connection.

Isreal Cidon, Raphael tuval a Rom and Shavitt[6] discussed the problem of finding multi-path routing in communication network. In this study we presented an algorithm to obtain all multiple path for the same source and destination and also at the same time any number of best path can also be computed and selected to transfer data in turn reduced minimum delay possible also at the same time

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alternate many number of path also data can select to transfer data.

This algorithm has the following merits as reservation failure in one or more links does not slow down the reservation process in other links and if several routes are available for reservation the one that meets the application requirements the most can be chosen. The performance of multi-path algorithm is presented in this study.

**Network congestion:** Spragins, Hammond and Pawlikowski[7]. Korilis, Lazar and Orda[8] have deat apparent paradoxes in networks consisting entirely of single-server queues. Cohen and Jeffries[9] are proposed congestion resulting from increased capacity in single-server queuing networks.

It follows from this over view that the previous work on network congestion, delay in data packets address with buffer capacity, Band width, adding severs, increasing server's capacity of existing servers. Cohen and Jeffries[9] have dealt network congestion increased with capacity of the link. Cohen[9] deals delay in data transmission with service rate in single Server Queuing model. Cavendish and Gerla[10] are proposed a control theoretical approach to congestion control in packet network accounting network buffer capacity.

A neural network is a system that is composed of many non linear computational elements being operated in parallel and exhibit character tics such as mapping, generalization, robustness, fault tolerance and high speed information processing. Delay in transmission of data packets are also depending on arrival rate and service rate distribution along with traffic intensity. These issues for network congestion are tackled. Analysis of network congestion using neural network Single-Server Queuing model is proposed. Back propagation network has been employed. Obtained results shows minimum delay, maximum traffic intensity with out loss of the data and better network congestion. In the work proposed in this paper 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 .

## ROUTING METRICS

A metric is a standard measurement used to evaluate the best path for a packet to travel. Routing algorithms have used many different metrics to determine the best route. Sophisticated routing algorithms are base route selection on multiple metrics, or combining them in a single metric. The following metrics have been used in the design of routing algorithm. Path length, Reliability, Delay, Bandwidth, Load and communication cost. Path length is the most common routing metric[11,12]. Some routing protocols allow network administrators to assign arbitrary costs to each network link. Path length is the sum of the costs associated with each link traversed. Reliability in the context of routing algorithm refers to the dependability of each network link. Delay refers to the length of time required to move a packet from source to destination through the inter network. Delay depends on many factors. Including the bandwidth of intermediate network links, the port queues, network congestion in the inter network. Band width refers to the available traffic capacity of a link. Load refers to the degree to which a network resource such as a router is busy. Communication cost is another important metric, about operating expenditures.

In this study an algorithm is designed to reduce the communication cost by transmitting data from source to destination, Link state algorithm is used to obtain optimal cost path.

## LINK STATE ROUTING

Distance vector routing was used in the ARPANET, when it was replaced by link state routing. Link state routing is simple and can be stated as five tasks. Each router must.

**Discover its neighbors and learn their network addresses:** When a router is booted its first task is to learn who its neighbors are. It accomplishes this goal by sending a special HELLO packet on each point to point line. The router on the other end is expected to send back a reply telling who it is.

**Measuring line cost:** The link state routing algorithm requires each router to know or at least have a reasonable estimate of the delay to each of its neighbors. The most direct way to determine this delay is to send a social ECHO packet over the line that the other side is required to send back immediately. By measuring the round trip time and dividing it by two , the test can be conducted several times and the average used.

**Building Link state packets:** Once the information needed for the exchange has been collected. The next step is router to build a packet containing all the data. The packet starts with the identity of the sender followed by a sequence number and age and a list of neighbors. For each neighbor the delay to that neighbor is given.

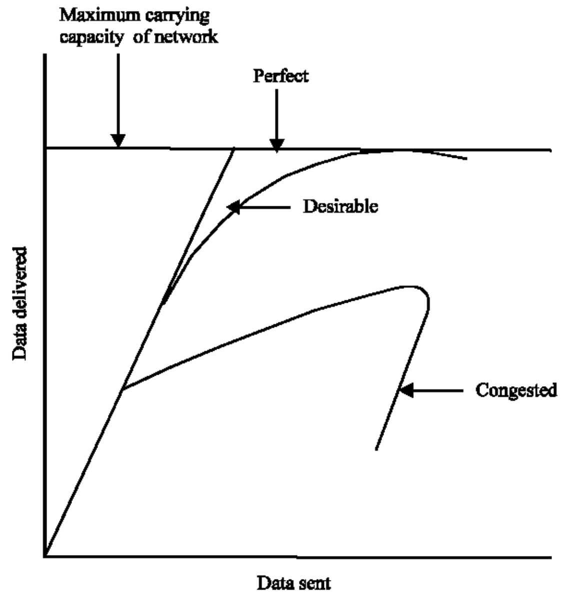


Fig. 1: Performance of network congestion

**Distributing the Link state packets:** The fundamental idea is to use flooding to distribute the link state packets. To keep the flood in check each packet contains a sequence number that is incremented for each packet sent. Routers keep track of all the pairs they see. When a new link state packet comes in, it checked against the list of packet already seen. If it is new it is forwarded on all lines except the one it arrived on. If it is a duplicate it is discarded. If a packet with a sequence number lower than the highest one seen so far ever arrives, it is rejected.

**Compute the shortest path to every other router:** Dijkstra's algorithm can be run locally to construct the shortest path to all possible destinations[1,13].

The Optimal design and efficient use of traffic networks without congestion are important aspects in communication networks. Analysis of queuing model for network congestion has been a fundamental research area in the field of data communication network. When too many data packets arriving from many input lines and all need the same line to move out, a queue will build up.

The data has to wait in the queue for the transmission of the data to destination. However as traffic increases too far the nodes are no longer able to cope and they begin losing data. At very high traffic, performance collapses completely shown in Fig. 1[1,13]. Therefore congestion prevention is an important problem of packet switching network management.

Congestion is a result of mismatch between the network resources, buffers space processing and transmission capacity and the amount of traffic admitted

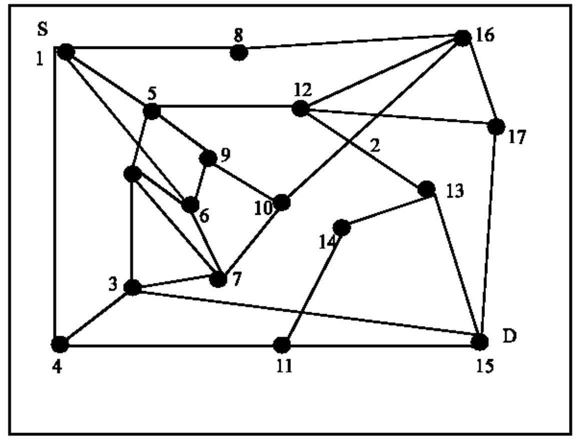


Fig. 2: 17- network node structure. S-source node D-destination node

for transmission. Consequently congestion prevention can be interpreted as the problem of matching the admitted traffic to the network resources. Thus in turn could be viewed as a classical problem of feed back control and indeed has been recognized as such by many researchers[14-16].Congestion will increase with capacity in Single server queuing networks is presented in the paper Transient congestion is also of practical importance at the physical and the data link control layers in data networks like the internet. A rate based equivalent of window scheme was introduced and analyzed in[16].

Network congestion is shown in Fig. 1.

The authors proposed Single Server queuing models at the network level focus on long term average performance, summarizing the complexities of transient congestion through the arrival and service time distribution of data using Neural network BPN algorithm.

## PROBLEM STATEMENT

The objective is to formulate a generalized algorithm to obtain all multiple and best optimal path for any structure with any number of hops and from any source to any destination. Output results of the algorithm are all multiple optimal path in the text mode and required number of best path along with network in graphics mode. A typical 17 node network is considered shown in Fig. 2. To obtain all multiple and best optimal path assuming and processed to further node one as source node and node 15 as destination node. The required best optimal path to be five.

Using Ford-Fulkerson's rule[17,18] nodes in the network are numbered as 1,2,3...17. The links between the nodes are selected as shown in Fig. 2. The cost of each links are assumed as per the demands and requirements for the network considerations. Using Link state algorithm fixing source node and destination node path obtained by adding cost of the link. Same procedure is repeated for all the path from all source nodes to all the destination nodes. Then Dijkstra's algorithm is used to obtain optimal path. Dijkstra's algorithm is used to find the closest node from the source node in the network. Fixing the closest node as permanent node and fixing the same node as source node, further the same processing is carried out. Similarly second permanent node in the network is fixed. The technique is recursive in nature. Same procedure is repeated for all the nodes. Location of all the permanent nodes are listed, Thus the required optimal path is obtained.

## PATH COMPUTATION ALGORITHM

The various steps involved in the algorithm are as follows:

**Step 1:** Initialize the network.
**Step 2:** Initialize the cost of the link.
**Step 3:** Determine path.
**Step 4:** Obtain cost of the path by adding cost of the link.
**Step 5:** Sort the results.
**Step 6:** Print all multi path along with cost in text mode
**Step 7:** Produce best 5 optimal paths for transmission.
**Step 8:** Obtain network with optimal path in Graphics mode.

## SINGLE SERVER QUEUEING MODEL

The essential features of a queuing system of input source queuing process, queue discipline and service process.

Figure 3, 1 represent arrival process, 2 represent queue discipline and 3 represent departure of the data.

Input source is characterized by size, behavior and pattern of arrival of data at the system. Size of data is either to be finite or infinite. Behavior of arrival represent data on arriving at the service system stays in the system until served, no matter how much data has to wait for service. The rate either constant or random at which data arrive at the service facility is determined by the arrival process. Pattern of the arrival distribution can be approximated by Poisson distribution, exponential distribution and Erlang distribution. Poisson distribution is a discrete probability distribution of the number of data arriving in some time interval.

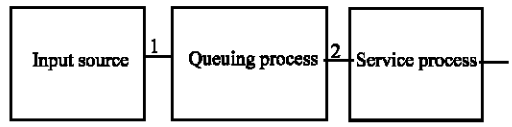


Fig. 3: Queuing system

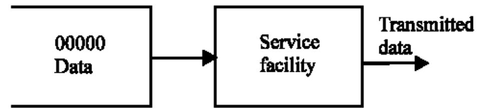


Fig. 4: Single queue, single server model

Data entry in to the service system depends upon the queue conditions. If at the time of data arrival the server is idle, then the data is served immediately. Otherwise the data is asked to join the queue which can have several configurations. The queuing process refers to the number of queues and their respective lengths. The number of queues depends upon the layout of a service system. Thus there may be a single queue or multiple queues.

Figure 4 shows the arrangements of a single queue and single server model.

Data from the queue are selected for service according to certain rules as queue discipline. The queue discipline is the order or manner in which data from the queue are selected for service.

Main types are static and dynamic queue disciplines and this paper focuses on static queue discipline. Static disciplines are as 1. First Come First Served (FCFS) 2. Last Come First Served (LCFS). The service facility may consist of self server, one or more servers arranged in series or parallel. The rate at which service is rendered is as the service process. After the service is rendered the data leaves the system[18,19].

## MATHEMATICAL MODEL

An infinite Buffer Single Server queue with Poisson message packet arrivals takes an exponentially distributed amount of time to service each packet. Packets are processed in first in , First out order[19]. Different models in queuing theory are classified by using standard notations described initially by D.G.Kendall in 1953 in the form a/b/c. Later Am.Lee in 1966 added the symbols d and e to Kendall notation.

In the Literature of queuing theory the standard format used to describe the main characteristics is (a/b/c): (d/e) Where a-arrival of data distribution. b-service of data distribution. c-number of servers. d-maximum of servers of data allowed in the system. e-queue service . Single server model represented as (a/b/1): (8 / FCFS).

- Queue length of the data (Q1) is equal to a*a / b(b-a) 1
- Expected waiting time for a data is in the queue.(Q2) a / b(b-a) 2
- Expected waiting time for a data is in the system (Q3) is 1 / (b-a) 3
- Traffic intensity (Q4) is a/b 4
- Total delay of the data (Q5) is addition of Q2 and Q3. 5
- Probability that the queue is non empty (Q6) is a* a/b * b 6

## NEURAL NETWORK MODEL

Neural network is a mathematical tool to solve different problems. BPN is a systematic method of training multilayer artificial neural networks. It is built on high mathematical foundation and has very good application potential in communication networks.

BPN network is trained for Single Server Queue model performance measurer parameters for network congestion. The three-ayer network was considered as input layer, hidden layer and output layer. Sigmoidal function for activation functions for the hidden layer, output layers and linear activation function for input layer were selected.

Learning rate coefficient determines the size of the weight adjustments made at each iterations and hence influences the rate of convergence. Poor choice of the coefficient can result in a failure in convergence. The coefficient is selected and kept constant through all the iterations for best results. If the learning rate coefficient is too large the search path will oscillate and converges more slowly than a direct descent[20]. If the coefficient is too small the descent will progress in small steps significantly increasing the time to converge.

Adding a momentum term is another way possible to improve the rate of convergence by adding some inertial or momentum to the gradient expression. This can be accomplished by adding a fraction of the previous weight change to the current weight change. The addition of such a term helps to smooth out the descent path by preventing extreme changes in the gradients due to local anomalies. The basic BPN algorithm loop structure is

```
        Initialize the weights
Repeat
        For each training pattern
        Train on that pattern
        End
Until the error is acceptably low.
```

## ALGORITHM

**Step 1:** Normalize the inputs and outputs with respect maximum values.
**Step 2:** Assume number of neurons in the hidden layer.
**Step 3:** Initialize the weights of Synapses connecting neurons and input hidden neurons to small random values usually from -1 to +1.
**Step 4:** For the training data present one set of inputs and outputs.
**Step 5:** Compute the inputs to the hidden layer.
**Step 6:** Compute the inputs to the output layer.
**Step 7:** Calculate the error.
**Step 8:** Repeat steps 4 to 7 until the error rate is less then the tolerance value.

The training of an artificial neural network involves two passes. In the forward pass the input signals propagate from the network input to the output. In the reverse pass the calculated error signals propagate backwards through the network where they are used to adjust the weights.

The calculation of output is carried out layer by layer in the forwarded direction. The output of one layer in the weighted manner will be the input to the next layer in the reverse pass the weights of the output neuron layer are adjusted first since the target value of each output neuron is available to guide the adjustment of associated weights[21]. Neural network is trained until the error converges within the limit.

## SIMULATION AND RESULTS

Figure 2 takeing source node as 1 and destination node as 15, the multiple optimal path is obtained by applying the proposed algorithm. All the multiple path in text mode in Fig. 5. There are 20 different paths available to reach the destination. Here the selected number of paths are five. For the same five optimal path in the increasing order of the cost along with network will appear in graphics mode on the screen. Any problem in any node or link in the network router will select next optimal path with out delay.

**Ann results analysics:** BPN network is trained for single server queue model parameters. Neural network is trained with 2 input neurons, 4 hidden neurons4 output neurons. The learning rate of 0.6 and momentum factor of 0.9 have been used. Number of iterations have been performed till the error rate converges to the tolerance. The training data and testing data have been normalized so that inputs and

Fig. 5: Multi path screen output

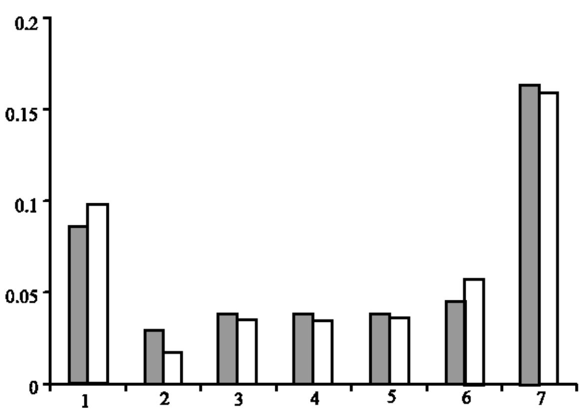


Fig. 6: Comparision of queue length(Q1) X axis- number of sample Y axis-Normalized values of the output Q1,Q4,Q5 and Q6

outputs are with in the range of 0-1[21]. Fig. 6 shows the comparisons of the Queue length the output Q1 actual value and BPN value.

Comparison of actual value Q1 and BPN output.

Figure 7 shows comparisons of traffic intensity output Q4, Figure 8 shows the comparisons of total delay of the data output Q5 and Fig. 9 shows the comparisons

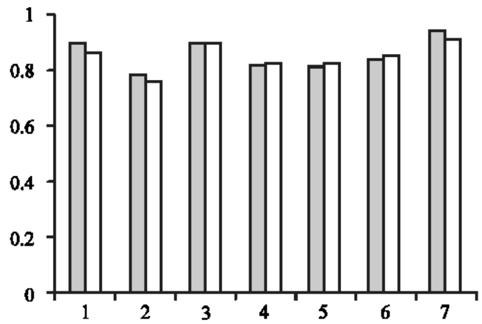


Fig. 7: Output (Q4) Traffic intensity

Table 1: Comparisons of traffic intensity using BPN

| Arrival rate in Mbps | Servi ce rate in Mbps | Actual value | Calculated using BPN |
|---|---|---|---|
| 0.48 | 0.53 | 0.9056 | 0.8734 |
| 0.67 | 0.85 | 0.7882 | 0.7651 |
| 0.73 | 0.89 | 0.8202 | 0.8248 |
| 0.74 | 0.9 | 0.8222 | 0.8287 |
| 0.0.75 | 0.91 | 0.8242 | 0.8325 |
| 0.81 | 0.96 | 0.8474 | 0.8622 |
| 0.87 | 0.92 | 0.9456 | 0.9245 |

Table 2: Comparison of traffic intensity with different arrival data

| Service rate in Mbps | Traffic intensity a/b[1] | Traffic intensity a/b[2] |
|---|---|---|
| 1.7 | 0.8823 | 0.5882 |
| 2 | 0.7500 | 0.5000 |
| 2.3 | 0.6521 | 0.4347 |
| 2.5 | 0.6000 | 0.4000 |
| 2.7 | 0.5555 | 0.3703 |
| 3 | 0.5000 | 0.3333 |
| 3.5 | 0.4285 | 0.2857 |
| 4 | 0.3750 | 0.2500 |
| 4.5 | 0.3333 | 0.2222 |
| 5 | 0.3000 | 0.2000 |

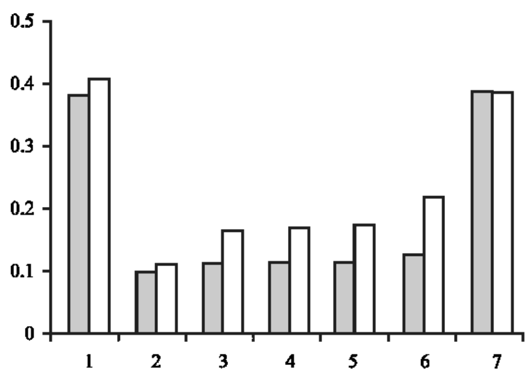


Fig. 8 (Q5) : Output total delay

of the output Q7 nonempty Queue of the data in the network. Table 1 shows all the calculated values using BPN are very close with respect to the actual value. Table 2 shows that the comparisons of traffics for various arrival rate. Traffic intensity[1] obtained with arrival rate of 1.5 Mbps and Traffic intensity[2] obtained with the arrival

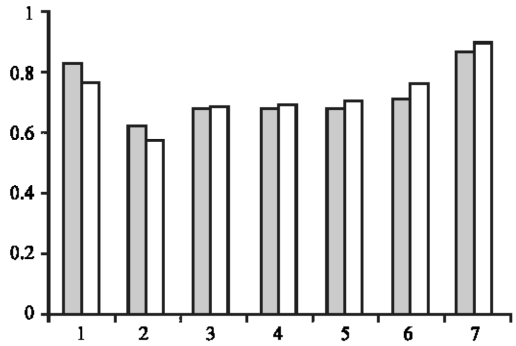


Fig. 9: Output (Q6) non empty queue

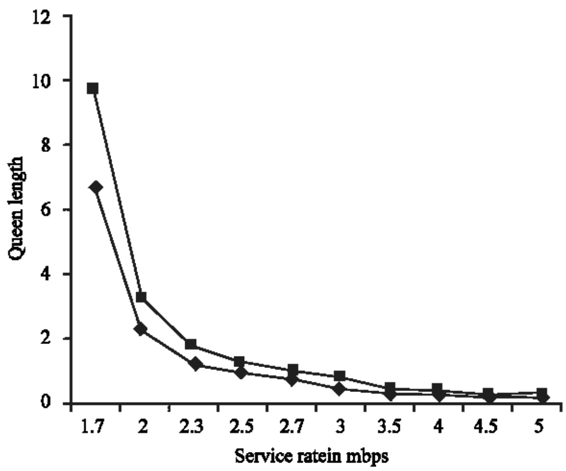


Fig. 10: Comparisons of Queue length with different arrival data

Table 3: Comparison of queue length with different arrival data

| Service rate in MBPS | Queue length Q1[1] | Q1[2] |
|---|---|---|
| 1.7 | 6.617 | 2.941 |
| 2 | 2.25 | 1 |
| 2.3 | 1.222 | 0.543 |
| 2.5 | 0.9 | 0.4 |
| 2.7 | 0.694 | 0.308 |
| 3 | 0.5 | 0.222 |
| 3.5 | 0.321 | 0.142 |
| 4 | 0.225 | 0.1 |
| 4.5 | 0.166 | 0.074 |
| 5 | 0.128 | 0.057 |

rate of 1Mbps with different service rate. Thus the Table 2 shows that the traffic intensity will be reduced with the arrival rate of the data. Total throughput of the system can be increased with optimal selection of the arrival and service rate of the data. Figure 10 and Table 3 shows the variations of Queue length of the data for the various arrival rate. Queue length [1] obtained with arrival rate of 1.5 Mbps and Queue length[2] obtained with the arrival rate of 1Mbps with different service rate. Table 3 shows Queue length will be reduced in turn will reduce the total delay in data transmission. By reducing the delay congestion will reduced in the in the network.

## CONCLUSION

In this study generalized soft ware is discussed for finding an optimal path using link cost as metric. The results are verified for any node as source node and any node as destination node in the network. With in the network any node or link failure or congestion in any node the router will select immediately to next optimal path to reach the destination. Thus the total delay in data transfer will be reduced. This work can be applied to any real world problems, such as Transporting problem, Motion planning and Communication problems. The problem can be extended to obtain optimal routing by considering many different metrics. The congestion analysis discussed in this paper is more efficient to address the problem of the network congestion. Practical designers are well aware that the choice of least delay path takes to account of the delays imposed by congestion. The generalized performance of various parameters in network congestion are analyzed with single server queue model using Artificial Neural network. Obtained maximum traffic intensity without loss of the data, without congestion for the arrival rate and service rate is shown in Table 2. For the above value throughput of the system is increased to the maximum value are shown in Fig. 7, 8 and Table 2. This bringing the phenomenon out of designer frame work in network congestion. Using the above mode the network congestion eliminated completely with maximum throughout. Total delay and loss of the data can also be processed by this model. This can be extended to any number of server system with any network. One can apply this technique to various practical problems, such as network analysis designed to assist in the network planning, network scheduling and controlling of large complex projects.

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