World Applied Sciences Journal 7 (Special Issue of Computer & IT): 01-07, 2009
ISSN 1818-4952

Proposing a Dynamic Routing Approach to Improve Performance of Iran Data Network

Hamid Hassanpour and Mehran Mokhtari

Islamic Azad University, Ghaemshahr Branch, P.O. Box: 163, Ghaemshahr, Iran

Abstract: In this paper, a logical three-layer design of Iran data network is presented using the hierarchical model. The results show that by applying the static routing approach to Iran data network, the topology of the network is changed when parameters of the initial configuration vary. In other words, using the static routing may not properly direct the data packets. Consequently, performance of the network can be improved by using dynamic routing approach. In addition, this approach improves reliability and fault tolerance of the network.

Key words: Static routing . dynamic routing . multi-path routing . network performance . queue . hierarchical model . digraph

INTRODUCTION

Routing is required to transfer data packets from a source machine to a destination in networks [1]. Routing is the responsibility of network layer. There are routers at the network layer controlling data packets in networks. Routers direct individual data packets to the destinations.

Routing techniques in network can be categorized in two main groups: static routing and dynamic routing [1, 2]. Routes do not change in static routing. In this approach, the routing table is initialized at the beginning. The routing is not changed unless the network encounters a fault. Since the communication networks often have dynamic behavior, data packets may not be optimally directed using static routing. Hence dynamic routing is preferred. In dynamic routing, the routing table is initially set to a predefined value. Then the table is updated following the network condition using the routing algorithm to determine the optimal route. It needs to be noted that performance of the network is improved by using the optimal routing algorithm. There are many factors influencing performance of the network, for example bandwidth, network utilization, throughput, offered load, delay, response time, cost of the route, safety (reliability and fault tolerance), network traffic [3, 7].

The dynamic or multi routing algorithm can be used for optimal routing in dynamic networks (for example, the Open Shortest Path First algorithm (OSPF)) [4, 5]. Optimized routing includes controlling the traffic of data packets and wisely splitting the traffic between the network routers. This accounted traffic improves the data network structure and increases its performance, throughput and trust factor. The network data traffic problem can be resolved in a Network Operation Centre (NOC) using the optimized routing with an engineering structure. In such a center, the traffic can be monitored to properly control the traffic. Queue of the data packets may have different model, such an RED, Droptail and SFQ; each of which with specific parameters [6, 9]. In this paper, the Droptail queue was used to analyse the network performance simultaneously at three different levels. Different types of TCP, for example Delak, Sack and Fack, were used for sending and receiving data packets in this research [8, 10].

Different scenarios have been designed and performed in this research to determine the optimization rate in multiple or dynamic routing protocol using NS software in Linux operating system. Different scenarios have been considered and their scripts were performed in this research.

The optimized routing on Iran data network is performed using the dynamic routing introduced in this paper. Then the routing results are analysed under different scenarios. These scenarios and their corresponding results are described in Section 3. Finally the conclusion is driven in Section 4.

SIMULATING IRAN DATA NETWORK

Iran data network contains a main router or NOC located in Tehran and eight other routers located in eight other cities. These cities also have routers for their own sub-networks inter-connected via fiber optics.

Corresponding Author: Dr. Hamid Hassanpour, Islamic Azad University, Ghaemshahr Branch, P.O. Box: 163, Ghaemshahr, Iran

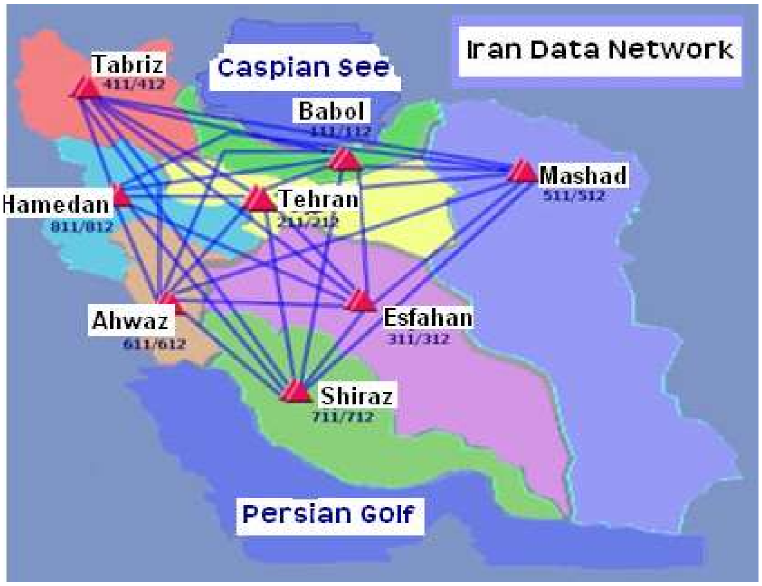

Fig. 1: Structure of Iran data network

Figure 1 shows connections between these routers contain an eight-way path. Iran data network have three layers with hierarchical structure.

The NS simulator can be used to improve the throughput of Iran data network using dynamic routing. This software, with its NAM and Xgraph tools, has strong abilities for analyzing the behaviors of different networks.

In this simulator, the nodes are connected bidirectional using fiber optics. The band width, delay and the queue model have been determines following the individual links in the network. The communication between NOC and NOC-Back is of Droptail queue with length 20 and size 0.5 and bandwidth of 2 m with 10ms delay. The communication between NOC and NOC-Back with any of the octad main routers and their sub-networks (Droptail queue) exist using bandwidth of 4mb and 5ms delay. All communication between the octad region and routers of their sub-networks is configured using band width of 512mb with 15 ms delay. The statistical parameters for routers in layers one to three are computed using the fallowing steps:

- Providing a sink and connecting it with the routers in layers one to three.
- Providing the source traffic on router in layer one and two.
- Connecting a lossmonitor to each of the sinks.

NETWORK PERFORMANCE EVALUATION

Deferent scenarios have been defined in this section to evaluate performance of the network. Each of the scenarios is to evaluate a specific condition for the network. For example, the capability of Iran data network in static routing is evaluated in Scenario 1. In this scenario performance of the network is evaluated by analyzing the statistical parameters of the network using lossmonitor. Scenario 2 is to evaluate Iran data network in dynamic routing (fixed weight and double routing) in terms of performance and bandwidth. Scenario 3 is to evaluate the network in dynamic routing (static weight and mesh routing (di-graph)) in terms of performance and bandwidth. In another scenario, scenario 4, the network is evaluate for its performance, band width and traffic in dynamic routing with unfixed weight and mesh routing.

Scenario 1: Network evaluation in static routing: This scenario was designed to analyse the structure of Iran data network. Statistical parameters of the network for routers in layers 1 and 2 are computed in this scenario by using static routing. Specifications of the route finders, protocols, queue and data packets have been provided in Table 1.

The number or lost-packets during the time in this scenario has been depicted in Fig. 2 As the figure shows, the rate of lost packet is almost zero at the beginning and then the rate is raised in the form of a step-function. This result indicates that the rate of lost packets is increased as traffic of the network increases. In other words, queue of the lost packets is longed as the network works.

The band width used in this scenario by routers in layers 1 and 2 during the time is shown in Fig. 3. This figure shows that the bandwidth used by NOC router

Table 1: Specifications of routers, protocols, queues and packets in Scenario 1

Row	Title	Specification
1	Packet length	600 Bytes
2	Bandwidth of transmission line	2 MBps, 4 MBps, 512 MBps
3	Packet transferring rate	500
4	Queue length	20
5	Transmission time	12 s
6	Transmission Protocol	CBR, Exponential in UDP and ftp in TCP
7	Type of queue for routers in layers 2 and 3	Drop Tail
8	Type of queue for routers in layers 1 and 2	Drop Tail
9	Routing Protocol	Static with identical weight
10	Number of routes	1,2

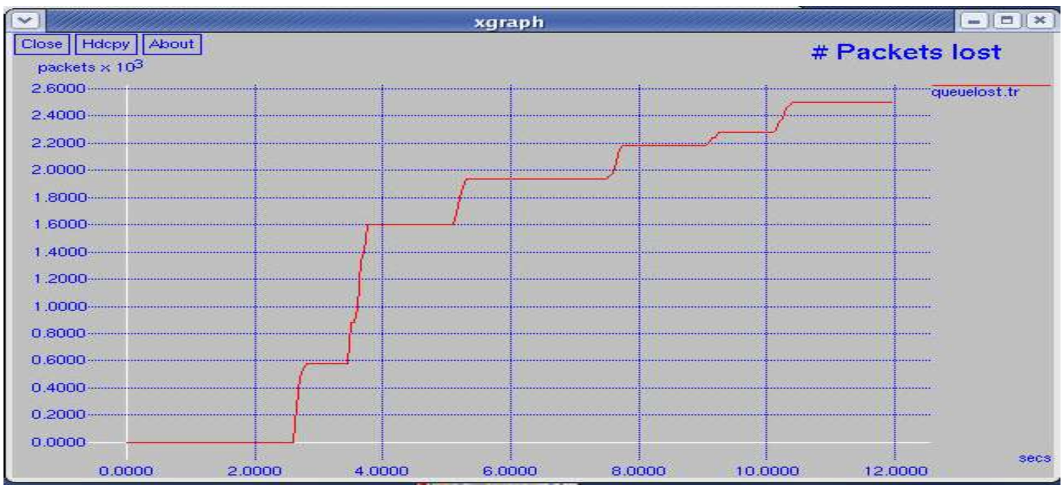

Fig. 2: Lost-packets in Scenario 1

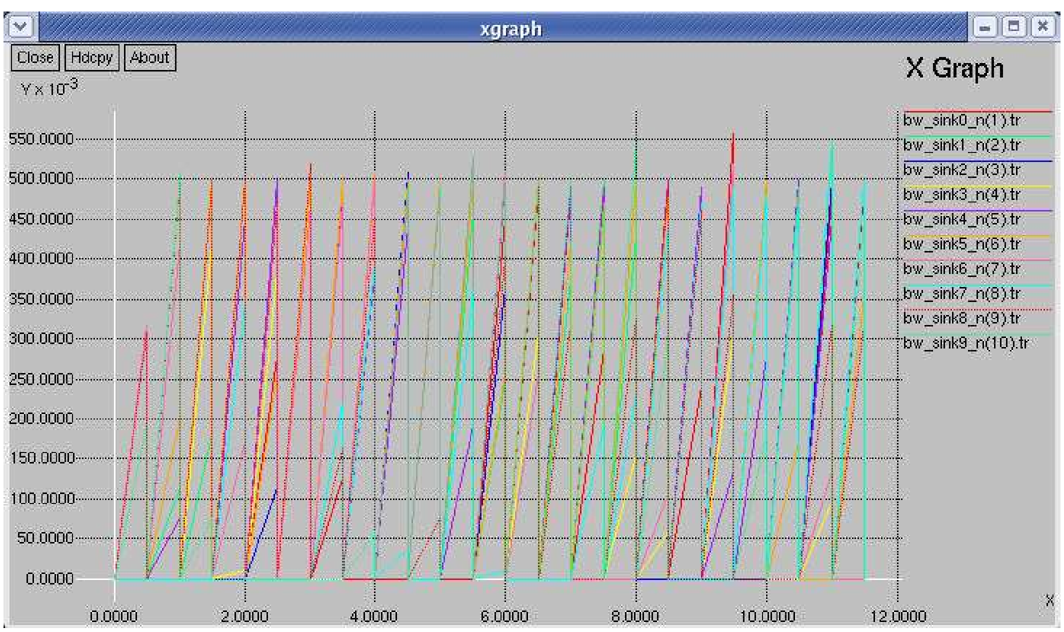

Fig. 3: The consumed bandwidth for routers in Scenario 1

Fig. 4: Variations of bandwidth consuming for the network in Scenario 1

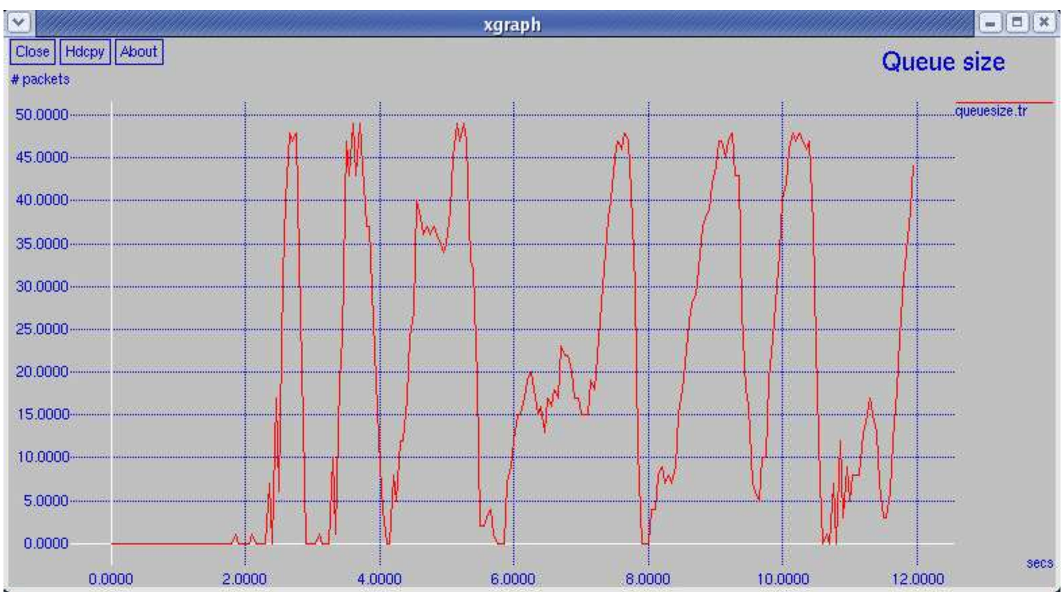

Fig. 5: Length of the queue in Scenario 1

(bw-sink0_n4) variable) is more than the other routers. This parameter was computed by connecting a sink0 to NOC router and a loss-monitor to sink0. In this figure parameters bw_sink1_n(2), bw_sink2_n(3), bw_sink3_n(4), bw_sink4_n(5), bw_sink5_n(6), bw_sink6_n(7), bw_sink7_n(8), bw_sink8_n(9), bw_sink9_n(10) respectively represent the bandwidth consumed by routers in Tehran, Tabriz, Mashad, Hamedan, Esfahan, Shiraz, Babol and Ahwaz.

The consumed bandwidth variations of the network are shown in Fig. 4. As the figure shows, these variations are acceptable at the beginning, but increased up to 4 Mbps after a short while and then stop. As it was mentioned before, rate of lost packed is increased during the time in such a network. In other words, the overall delay for arriving the lost packets in this network is increased as the system keeps running. This causes performance of the network suddenly drop. These results have been obtained as text form in shell environment.

The queue length of the network is shown in Fig. 5. This figure shows that length of queue is zero at beginning; it varies between 0 and 50 packets after about 2.5 seconds. The results obtained at the text environment in Linux in this research indicate that the sum and average transmitting time for packets via Tehran router is higher than via the other routers. The sum and average delay in transmitting the packets via Esfahan router is more than via the other routers. In addition, the delay of transmitting the packets increases as the system run. This causes the consumed bandwidth of the network increase as it was shown in Fig. 3.

Since there is only one route in static routing to transfer data packets, when connection between two routes is lost there would be no other route to transfer data. This issue increases the rate of lost packet and traffic of the network, which indicate unsuitability of static routing. Hence the static routing provides the condition to modify topology of the network. The next scenario discusses the effect of double routing and employing dynamic routing scheme on Iran data network.

Scenario 2: Dynamic routing (Double routing with fixed weight): The main objective of this scenario is to study the effect of dynamic routing on performance and bandwidth of the network. To provide double routing in this scenario, two routers were added in layer 2 from the node in Tabriz to the nodes in Hamedan and Tehran; and similarly two other nodes were added from the node in Mashad to the nodes in Esfahan and Babol. We have analysed behavior of the simulated network by studying the changes in network performance, delay and bandwidth for the TCP protocol and sink traffic in the text environment of Linux and using the Xgraph. Our results indicate that the bandwidth used in this scenario has dropped on two nodes (the bandwidth used in nodes 1 and 2 dropped from 31200 to zero). It needs to be noted that this reduction in bandwidth usage has no considerable effect on the delay, rates and speed of receiving packets. Once speed of transferring packets increases the delay reduces, consequently performance of the network is improved.

Overload traffic increases in dynamic routing because of updating the route table at the beginning of the scenario. But the traffic load is quickly reduced once the shortest pass found. Afterward the traffic load stays fixed unless critical conditions happen. To control traffic of the network and to prevent any critical condition digraph protocol is suggested, which is studied in the next scenario.

Scenario 3: Dynamic routing (Digraph routing with fixed weight): The objective of this scenario is to study the effect of dynamic routing protocol with digraph routing on performance and bandwidth of the network. We have used digraph routing for designing the topology of this network, by keeping the conditions both in Table 1 and Scenario 2. The routing was designed in a ring form for the nodes that are close together in layer 2. In this situation, when the distance between the receiver and transceiver nodes is more than one nut, two main routes and two backup routes are created for each node by applying this routing ($ns ospf run). Consequently, bandwidth of the network improves by increasing the number of routes, in which in low traffic condition the transmission is performed via three passes in a short time. In other words, the network prefers to transmit the packets via a multiple pass simultaneously rather than via a single long pass. This is due to the switching behavior of the routes that gives a higher priority to the availability (free) of the route than the bandwidth of the route. In this situation, the busy time of the route increases by increasing the traffic load. Hence, it is required to choose the optimum pass among the existing ones. Therefore, the value of each route should be determined and the best route with the highest priority be selected. The next scenario discusses on this situation of the network.

Scenario 4: Dynamic routing (Digraph routing with different weight functions): The main idea in this scenario is to study the effect of dynamic routing with different weight functions on performance of the network. There are a number of parameters affecting the costs in this type of protocol as expressed below:

Bandwidth: This parameter varies between 100 and 1000 Mbytes per second. The route with a higher bandwidth has a higher priority.

Distance: Successive nodes are considered to not be far above 1500 Km. It is obvious that the node with a closer distance has a better priority.

Level: The nodes might be in any level from 1 to 3, in which nodes the higher level have a higher priority.

Port: The maximum number of ports (routes) for the simulations performed in this research is 16. The nodes with a less number of connected routes have a higher priority for selection.

Delay: We have assumed that the maximum time required to transfer a data packet between to nodes is less than 16 ms. It is obvious that the routes with a lower transmission delay have a higher priority.

Traffic: The route with lower traffic congestion is more important for routing.

Table 2: The cost of different routes for Iran data network in Scenario 4

Node	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	1,10
Cost	10	32	83	81	51	110	77	89	101
Node	3,5	5,8	8,10	10,7	6,7	4,6	4,9	3,9	
Cost	99	105	110	119	117	117	114	93	

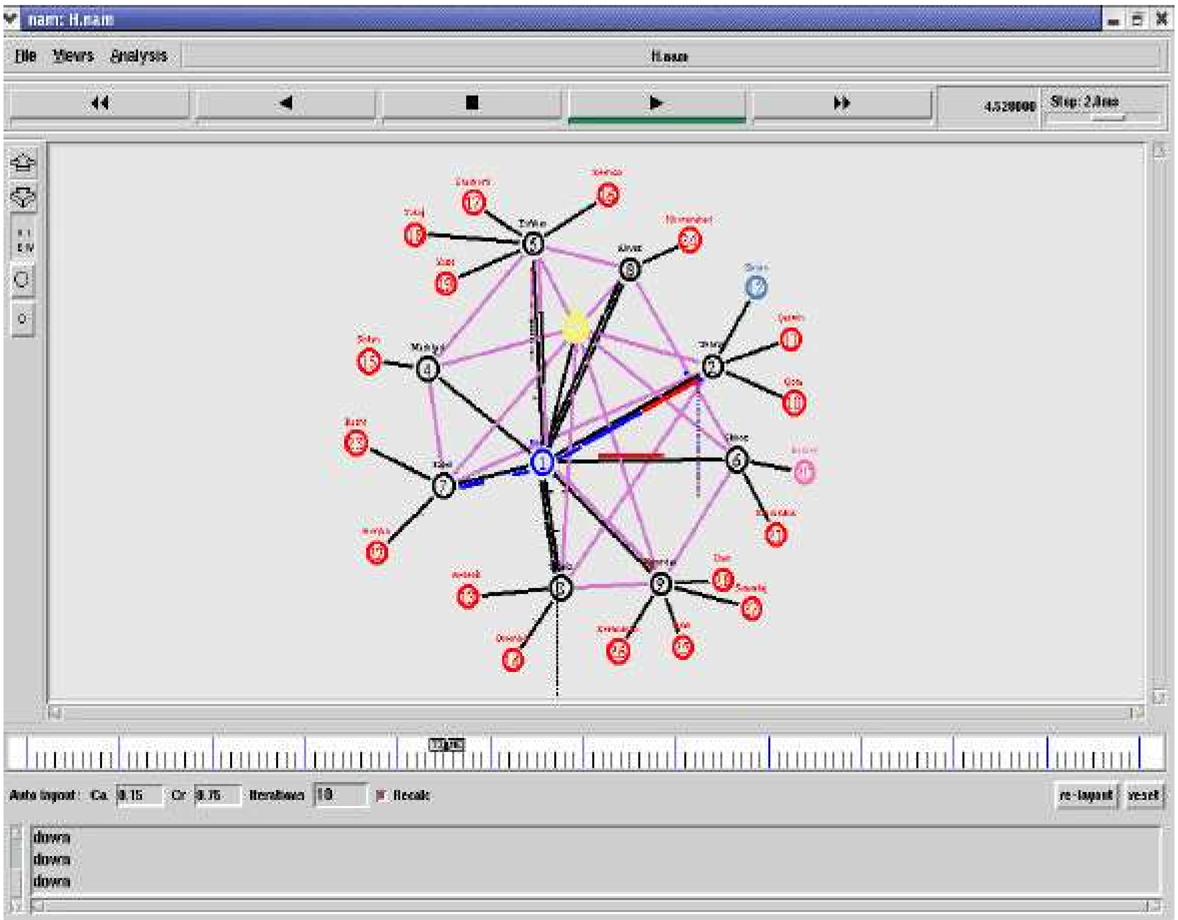

Fig. 6: Dynamic routing for Iran data network in Scenario 4

Reliability: It is assumed that interior data networks have a higher reliability than exterior ones, hence with a higher priority for route selection.

Importance: Usually a route, for some reasons, might be more important for selection in a data network. This consideration has been taken into account in this simulation.

The above mentioned parameters should be defined for all the routes in layer 2. For simplicity, all routes from individual nodes to the NOC and NOC-back in layer 1 are considered to have identical situations. A priority number is assigned to the individual parameter, then they are normalized to have their values between 0 and 255 using the following equation:

$$A = (\text{sign}) \times 256/(\text{up-down})$$

Where (up-down) indicates range of variation for the corresponding parameter. Then the following equation can be used to estimate the cost of a route:

$$C = \left[256 - \left(\frac{256}{N}\right) \times A \times I\right] - 115$$

Where l and N represent the corresponding parameter and the total number of parameter, respectively. In this equation, 115 and 256 are sum and standard deviation of the cost. We have computed the cost for corresponding routes in layer 1 and 2 and the results have been summarized in Table 2.

The estimated cost in Table 2 is assigned to the related routes using commands similar to $NS cost $N (1) $N (2)1. We written a script in Shell environment of Linux to estimate the TCP and Sink parameters in this scenario.

The result of dynamic routing in Scenario 4 has been shown in Fig. 6. If an active route be disconnected for any reason ($ns at 2.1 n2 n1 down) or its cost changes, the system will find the new optimal routes as the situation was changed. As it was mentioned before, the optimal routing scheme may increase the traffic load of the network, however the load is minimum in dynamic routing.

Once a route with a high rate of bandwidth is disrupted, the new route chosen via dynamic routing may have a lower bandwidth. Consequently the overall bandwidth of the network drops in comparison with the previous situation. Although the speed of data transferring reduces in this situation, the data is still transferred via the network. This indicates the high fault tolerance of the network, hence, reliability of the network improves.

CONCLUSION

In this research, the statistical parameters of Iran data network in three layers have been estimated. We have considered a variety of scenarios with different topologies to study on traffic load and performance of the network. The results in this research indicate that static routing has a lower performance as the rate of lost-packets and consequently, the transmission delay are high. This performance is not improved even by widening the network bandwidth. This deficiency of static routing can be compensated first, by providing additional routes between adjacent routers, then using dynamic routing. Dynamic routing may initially increase traffic load of the network, however, it is reduced using digraph protocol although with the cost of increasing transmission delay. Indeed, the fault tolerance and reliability of network improve using this protocol.

ACKNOWLEDGMENT

This study has been supported by the Islamic Azad University, Ghaemshahr Branch, Ghaemshahr, Iran.

REFERENCES

1. Fred Halsall, 2005. Computer networking and the Internet, Addison-Wesley.
2. Sreenivasan, S., R. Cohen, E. Lopez, Z. Toroczkai and H.E. Stanley, 2007. Structural Bottlenecks for Communication in Networks. Phys. Rev. E 75.
3. Jie, Li, Yi Pan and Yang Xiao, 2005. Performance study of multiple route dynamic source routing protocols for mobile ad hoc networks. Journal of Parallel and Distributed Computing, 65 (2): 169-177.
4. Ben-Jye Chang and Ren-Hung Hwang, 2003. Analysis of adaptive cost functions for dynamic update policies for QoS routing in hierarchical networks. Information Sciences, 151: 1-26.
5. Lúcia Martins, José Craveirinha, João N. Clímaco and Teresa Gomes, 2005. On a bi-dimensional dynamic alternative routing method. European Journal of Operational Research, 166 (3): 828-842.
6. Horst, F. Wedde and Muddassar Farooq, 2006. A comprehensive review of nature inspired routing algorithms for fixed telecommunication networks. Journal of Systems Architecture, 52 (8-9): 461-484.
7. Li Layuan, Li Chunlin and Yaun Peiyan, 2007. Performance evaluation and simulations of routing protocols in ad hoc networks. Computer Communications, 30 (8): 1890-1898.
8. Vvedenskaya, N.D and M. Suhov, Yu, 2002. Fast networks with dynamic routing. IEEE International Symposium on Information Theory, pp: 128.
9. Rahman, Md. Arafatur, Azad, Md. Saiful and Anwar Farhat, 2009. Intergating Multiple Metrics to Improve the Performance of a Routing Protocol over Wireless Mesh Network. International Conference on Signal Processing Systems, pp: 784-787.
10. Rookhosh, F., A.T. Haghighat and S. Nickmanesh, 2008. Disjoint categories in low delay and on-demand multipath dynamic source routing adhoc networks. First International Conference on Distributed Framework and Applications, 21-22, pp: 207-213.