I J C T A, 9(11) 2016, pp. 5521-5528
© International Science Press

A TUNING-BASED APPROACH FOR THE MULTI-CONSTRAINED DATA-PATH TRANSMISSION

Ashutosh Sharma*, Rajiv Kumar and Poonam Koundal*****

Abstract: This paper examines the problem of transmitting data from designated source to destination in acyclic network so that the reliability, delay and capacity play the significant role to the transmission of data. In this routing problem path chosen should be optimal. Path chosen by the network is controlled by the tunable factor to consider the all three factors. We implemented the tunable performance extensions and examine their usefulness in routing of traffic. Tunable factor gives the better results with all parameter consideration viz. reliability, delay and capacity.

Key Words: Tuning factor, reliability, capacity, delay, data transmission, tuned data path selection.

Acronyms:

MRDPT	→	most reliable data path transmission
MRTDPT	→	most reliable tuned data path transmission

Notation:

G	→	(V, E); directed acyclic graph or without self-loops
P	→	(V, E, c, d, r, s, t): network
V	→	set of nodes with integer label
(u, v)	→	directed edges
r (u, v)	→	reliability of directed edges
d (u, v)	→	delay of directed edges
c (u, v)	→	capacity of directed edges
s	→	source node
t	→	destination node
σ	→	units of data to be transmitted through s to t along a path.

1. INTRODUCTION

Although wired network is bulky, rigid and immobile, it can be capable of accomplish various applications, such as emergency alarm, telephony surgery, telemedicine, habitat monitoring and many more [1]. Depending on the requirement of application one can set parameter as their usefulness. Like if anyone wants to do skyping, needs to be less delay and same as in telephony

* Department of Electronics and Communications Engineering Jaypee University of Information Technology, Solan, India Email: sharmaashutosh1326@gmail.com,

** Email: rjv.ece@gmail.com

*** Email: poonam5koundal@gmail.com

surgery and if someone wants to transfer huge data requires high capacity. So optimal routing plays an important role in selecting a most reliable path for data transmission [2].

Consider a directed acyclic network with the precomputed edges with reliability, delay and capacity values [3]. This paper examines the problem of selecting a path from designated source to designated destination, so that path tuned for the routing should be most reliable path with consideration of reliability, delay and capacity. Delay, reliability and capacity need to be satisfied in different manners. If path selected has much longer delay than required, that path is not feasible. Same as if path chosen for end to end transmission has not much capacity for transmission of data then that path is not reliable. Many schemes have been proposed to improve reliability, capacity and delay of the transmission path. An effort to reduce the delay and enhance the capacity and reliability of the chosen data transmission path leads to give the most reliable path for the various real time applications and hence we proposed a user-tunable mechanism for selecting router based on factors viz. reliability, delay and capacity known as MRTDPT.

Similar reliability problem on path have been studied. The MRDPT problems consider a simplified problem formulation where each edge considers the reliability, capacity and delay in such a fashion so that delay and capacity are the powers of reliability [4]. The given idea does depend mainly on reliability and poorly on delay and capacity. The MRDPT problem was solved with the well-studied shortest path first algorithm in networks. To make the path chosen for transmission totally dependable on reliability capacity and delay we have proposed MRTDPT which is more realistic than MRDPT. MRTDPT can be solved optimally by modifying well studied shortest path first algorithm [5-6].

The problem in MRDPT occurs here is that it takes account in cost which is the sum of individual but with respect to reliability, it is the product of individual one. But the path chosen is not so optimal so that tuning factor is introduced with gives the best optimal path for routing. The MRTDPT formulation does not only depend on the reliability, capacity and delay but also on the data units to be transmitted through the network [7].

The MRTDPT can be used in number of applications with different size of data units routed from source to sink. Due to the precomputed paths, it guarantees the most reliable path [8].

The rest of the paper is organized as follows. Section II preliminaries, discusses previous work on related topics Section III problem formulation, describes the proposed methodology and section IV illustrate the simulations and discuss the simulation results. Section V concludes the paper.

2. PRELIMINARIES

Number of papers has been proposed to target reliable path for data transmission problems. Spyros Tragoudas [4] gives the most reliable data path transmission formulating problem based on reliability, capacity and delay constraints. As given that σ units of data are to be transmitted from source s to destination t with the routing cost consideration of all three factors reliability, capacity and delay to give MRTDPT though (u,v), the reliability is shown as:

$$E(u,v) = -\ln r(uv)e^{-\left[d(u,v)+\frac{\sigma}{c(u,v)}\right]} \tag{1}$$

The above equation has been proposed on the equation given below as MRDPT problem.

$$\alpha(u,v) = -\ln r(uv)^{\left[d(u,v)+\frac{\sigma}{c(u,v)}\right]} \tag{2}$$

Equation 2 gives most reliable path from source to destination but that depends more on reliability and less on capacity and delay.

Let's consider a topology of 8 nodes with traffic size σ=5 units with given set of values of reliability (r), capacity (c) and delay (d). When data is transmitted from source to destination the path chosen is 0-2-7-6-1-5 which has reliability 0.31 delay 29 sec and capacity 0.80.

Here in this problem more concern is more on reliable path chosen for transmission and less on delay and capacity.

Table 1
Given set of data for topology G (s, t)

Edge (u,v)	*Edge Reliability r(u,v)*	*Edge Delay d(u,v)*	*Edge Capacity C(u,v)*
(0,2)	0.7	7	0.80
(0,4)	0.7	5	0.50
(1,5)	0.7	4	0.95
(2,4)	0.8	5	1.00
(2,7)	0.9	7	1.50
(3,1)	0.8	3	0.70
(3,5)	0.7	6	0.76
(4,6)	0.6	6	0.80
(6,1)	0.9	5	0.85
(6,3)	0.7	6	0.75
(7,6)	0.8	6	0.90

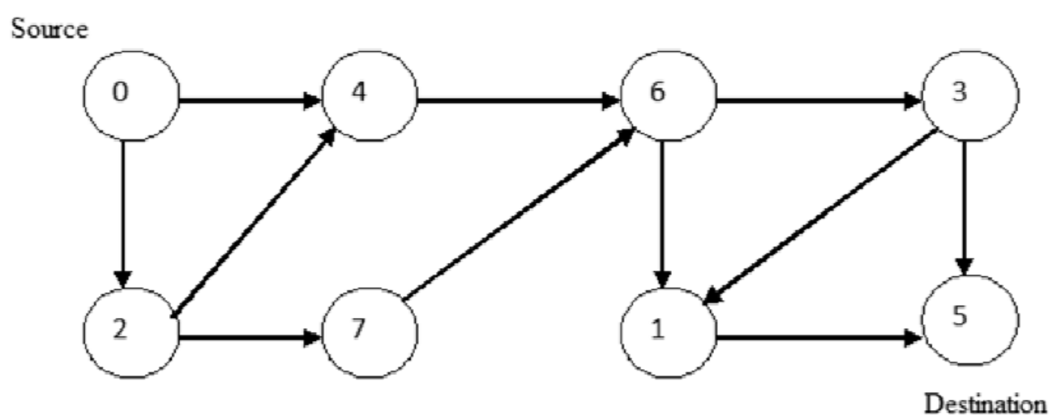

Figure 1 Topology G (s, t)

Let: P is the path chosen from s to t with other vertex consideration P(s, v1, v2... t)

Protocol used here is shortest path first so that it takes the smallest value of cost first.

$$c(P) = \min_{(u,v)\in P}\{\alpha(u,v)\}; \quad (3)$$

Numbers of multiple paths are routed and best shortest path has been chosen for data transmission.

For the path with data size 5 reliability capacities, delay and new weight are given as

Table 2
Values of the reliability, capacity and delay for the edges of routed path

Path	*Reliability*	*Capacity*	*Delay*
0-2	0.7	0.80	7
2-7	0.9	1.50	7
7-6	0.8	0.90	6
6-1	0.9	0.85	5
1-5	0.7	0.95	4

Reliability is multiplicative, capacity is minimum and delay is additive in nature and give as:

$$R(u,v) = \prod_{s}^{t} r(u,v) \tag{4}$$

$$C(u,v) = \prod_{s}^{t} c(u,v) \tag{5}$$

$$D(u,v) = \prod_{s}^{t} d(u,v) \tag{6}$$

So reliability here is .31, delay is 29 and capacity is .80.

But here not so much focus on delay and capacity so to do this we have introduce a new formula called as MRTDPT.

3. PROBLEM FORMULATION

Any route chosen can give an optimal path with the feasibility of reliability, capacity and delay. However , if some constraint so aggressive so that no single path or route alone is capable of giving optimal path so to make it optimal tuning factor has been introduced to set up the route optimal with considered factors [9]. For depending on the requirement of application, tuning factor settle down optimally. For delay constraint, if constraint value, say d1, associated with application which is more depending of delay, chosen a route which has delay more than requirement can be controlled by tuning factor. Same tuning is done in case of capacity and reliability [10].

Idea of MRTDPT leads us to take the data transmission depend on all three factors viz. reliability, capacity and delay. The MRTDPT formula uses Dijkstra’s shortest path first algorithm to compute the data transmission path from source to destination.

The MRTDPT formula is given as below from equation 1:

$$E(u,v) = -\ln r(u,v) e^{-\left[d(u,v) + \frac{\sigma}{c(u,v)}\right]}$$

This can further described as follows:

$$E(u,v) = -\ln r(u,v) + [d(u,v) + \sigma / c(u,v)] \tag{7}$$

$$E(u,v) = K + \alpha L \tag{8}$$

Where α is the tuning factor.

The Tuning factor α helps to take control on three fundamental factors as per requirement of application.

The formula proposed here gives main three factors explained below:

2.1 Optimum routing

The idea MRTDPT associate with optimum routing due to dependency on factors viz. reliability, capacity and delay. These factors can be tuned with the help of tuning factor. As per the application is so sensitive to delay that tuning factor tuned to give that path which has less delay. Optimum routing gives the best QoS services which are helpful in optimal routing.

2.2 Single Link Weight

Depending on the minimum cost, shortest path is selected using Dijkstra's shortest path first algorithm. Single link weight for routing leads to control optimized traffic form source to destination by considering three major factors for optimization into single link weight of combined effect of all three together.

2.3 Offline and Online Tuning approach

Tuning approach for the optimization of reliability, capacity and delay helps to take care of requirements of the user. Tuning leads to give best QoS services provided by the network. Due to tuning factor real time applications perform well. Tuning is done either by offline or online. Offline tuning is done user by manually as per requirement of user and it takes care of the cost value used for routing by routing protocol. For online tuning, SDN can be used for online tuning approach [11].

4. SIMULATION RESULTS AND DISCUSSION

For simulations of MRTDPT we have considered traffic size of 5 units and weight factor is based on the value of tuning factor consisting of reliability, capacity and delay. The routing protocol is used Dijkstra's shortest path first algorithm. All these simulation with tuning factor has been done in NS2 simulation tool [12-13].

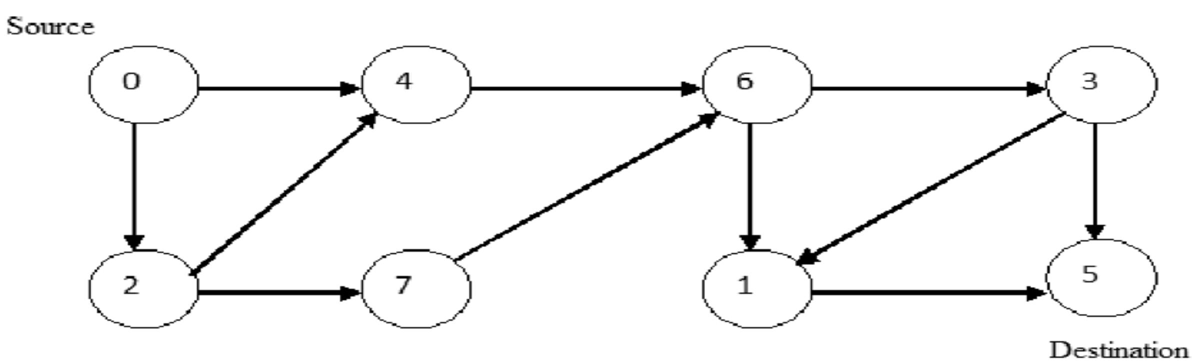

Figure 2 Topology G (s, t)

As we know that reliability and link delays always changes suddenly at any transmission instant and are not predictable [14]. Our interest is to examine the feasibility of our approximate method of probabilistic modeling of unknown link delay and reliability in wired network. If it achieves well performance for the given values then it will work for well-defined models too. The performance comparison between two methods MRDPT and MRTDPT is that MRDPT only depends on the reliability and cannot be adjusted as per requirement by application but MRTDPT gives the path selection as per requirement of application.

The network chosen for experiment consist of 7 nodes and 11 edges assigned with different values of reliability, capacity and delay.

The table for the equation 1 has been given below so that routing is done from source to destination. Numbers of different paths are there available there from source node to destination.

The formula from equation 7 and 8 has been given with tuning factor as below:

$$E(u,v) = -\ln r(u,v) + [d(u,v) + \sigma / c(u,v)]$$

$$E(u,v) = K + \alpha L$$

Let P(s, t) donate the path set of P possible path from a source node s to t. Each path is associated with delay d(u, v), reliability r(u, v) and capacity c(u, v). As the combined values of these three factors gives optimal path for routing with the tuning factor alpha (α).

The value of alpha has been controlled the different values of reliability, capacity and delay are given. With variation of value of alpha path from source node to destination node also changes to give the optimized route with respect to reliability, delay and capacity.

The different values taken for alpha are: 1, ½. 1/3, ¼, 1/10, 1/20, 1/30, 1/40 and 1/100.

The table for the different values of link weight with the different values of alpha has been shown below.

Table 3
Values of cost calculated depending on the tuning factor

α =1	α =1/2	α =1/3	α =1/4	α =1/10	α =1/20	α =1/30	α =1/40	α =1/100
13.60	6.97	4.76	3.66	1.67	1.01	0.79	0.68	0.48
15.35	7.85	5.35	4.10	1.85	1.1	0.85	0.72	0.5
9.61	4.98	3.43	2.66	1.27	0.81	0.65	0.58	0.44
10.22	5.22	3.55	2.72	1.22	0.72	0.55	0.47	0.32
1.43	5.26	3.54	2.68	1.13	0.61	0.44	0.35	0.20
10.36	5.29	3.60	2.75	1.23	0.72	0.55	0.47	0.32
12.92	6.63	4.54	3.49	1.6	0.27	0.76	0.66	0.47
12.76	6.63	4.59	3.57	1.73	1.12	0.91	0.82	0.64
10.98	5.54	3.92	2.82	1.18	0.64	0.46	0.37	0.21
13.01	6.68	4.5	3.5	1.61	0.98	0.77	0.66	0.48
11.77	5.99	4.07	3.10	1.37	0.79	0.60	0.50	0.34
Path chosen for different values of alpha								
0-4-6-1-5	0-4-6-1-5	0-4-6-1-5	0-4-6-1-5	0-4-6-1-5	0-4-6-1-5	0-4-6-1-5	0-2-7-6-1-5	0-2-7-6-1-5

As the different values of cost is given with respect to different values of alpha α so that routes are chosen as per requirement of application.

For the path chosen for routing 0-4-6-1-5 has reliability value 0.26, capacity value .50 and delay value 20 sec.

Table 4
Values of the reliability, capacity and delay for the edges of routed path

Path	*Reliability*	*Capacity*	*Delay*
0-2	0.7	0.80	7
2-7	0.9	1.50	7
7-6	0.8	0.90	6
6-1	0.9	0.85	5
1-5	0.7	0.95	4

Path chosen for routing 0-2-7-6-1-5 has reliability value 0.31, capacity value .80 and delay value 29 sec.

Table 5
Values of the reliability, capacity and delay for the edges of tuned routed path

Path	*Reliability*	*Capacity*	*Delay*
0-2	0.7	0.80	7
2-7	0.9	1.50	7
7-6	0.8	0.90	6
6-1	0.9	0.85	5
1-5	0.7	0.95	4

So as per requirement of application, user can set value of tuning factor. Such as for real time application user can set alpha value such that delay is minimum, so that user can select path 0-4-6-1-5 and for traffic network where user needs of high bandwidth, can use path 0-2-7-6-1-5 to get high capacity and reliability.

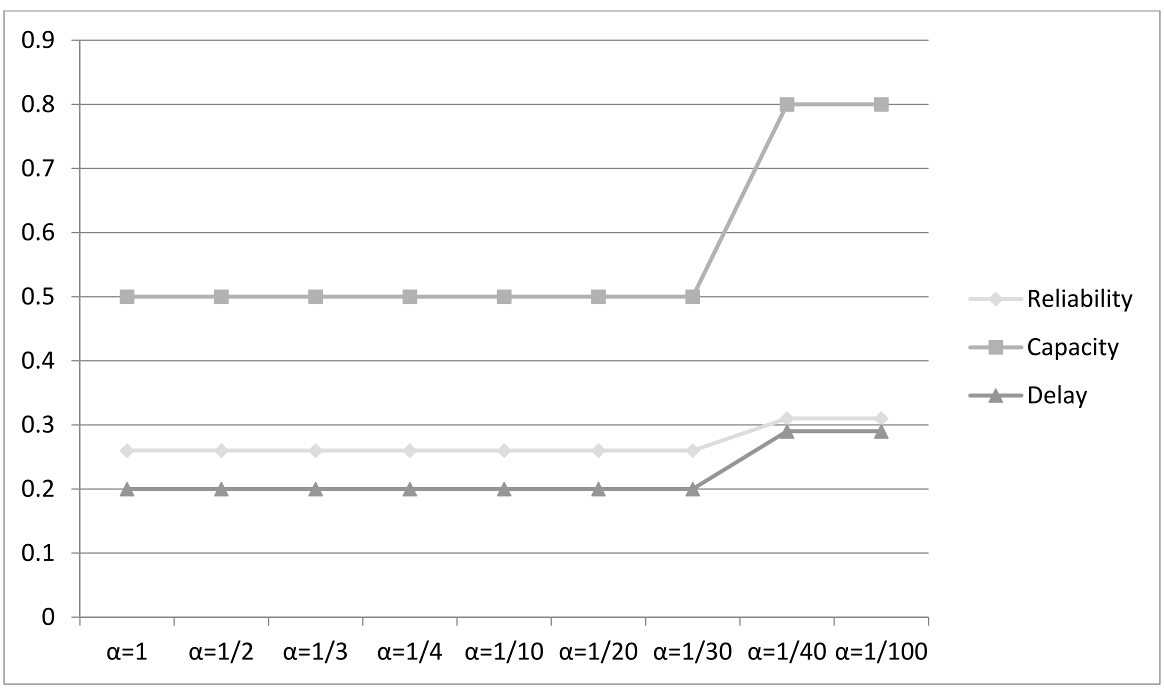

Figure 3 Graph for different values of alpha

5. CONCLUSION AND FUTURE DIRECTION

In this paper, we proposed a formula MRTDPT which computes the link routes on three main constraints viz. reliability, capacity and delay. The existing formula MRDPT, just consider one constraint namely reliability and not holds on capacity and delay as MRTDPT does flexible approach to reliability, capacity and delay. A simulation result carried here are depend on the given set of values of reliability, capacity and delay and shows its feasibility towards the optimality of routes give the optimal results with the application requirements. Further also tuning done here is offline but one can do the tuning online using Software Defined Network.

References

[1] M. Liotine, Mission-Crritical Network Planning, Artech House, Inc., London, 2003.

[2] Soh S., Rai S., “An Efficient Approach for Evaluating Communication-Network Reliability with Heterogeneous Link-Capacities," IEEE Trans. on Rel., vol. 54, no.1, pp. 133-142, March 2005.

[3] Jeff Doyle, Jennifer DeHaven Carroll Routing TCP/IP, Volume II (CCIE Professional Development) Published Apr 11, 2001 by Cisco Press.

[4] Tragdous S., “The Most Reliable Data-Path Transmission," IEEE Trans. Reliability, vol. 50, no. 3, pp. 281-285,Sept. 2001

[5] Ashutosh Sharma, Rajiv Kumar, “Realistic Comparison of Performance Parameters of Static and Dynamic Unicast Routing over Mesh Topology,” International Journal of Scientific & Engineering Research (IJSER), Volume 6, Issue 12,Dec 2015.

[6] Cormen, T. H., C. E. Leiserson, R. L. Rivest, and C. Stien, Introduction to Algorithms, Prantice-Hall of India Pvt. Ltd., N. Delhi, 2002.

[7] F.Kuiper, T.Korkmaz and M. Krunz, " An Overview of Constraint-Based Path Selection Algorithms for QoS Routing", IEEE Communication Magazine, Dec. 2002, pp 5055.

[8] G. Xue, "End-to-End Data Paths: Quickest or Most Reliable?", IEEE Communications Letters, Vol. 2, No.6, pp. 156-158, 1998.

[9] Huang, Xiaoxia, and Yuguang Fang. "Multiconstrained QoS multipath routing in wireless sensor networks." *Wireless Networks* 14.4 (2008): 465-478.

[10] M. Pioro and D. Medhi, Routing, Flow, and Capacity Design in Communication and Computer Network, Morgan Kaufinann Publishers, N. Delhi, 2005.

[11] Mendiola, Alaitz, et al. "DynPaC: a path computation framework for SDN."Software Defined Networks (EWSDN), 2015 Fourth European Workshop on. IEEE, 2015.

[12] Issariyakul, T., & Hossain, E. (2012). An introduction to network simulator NS2. New York: Springer.

[13] The Network Simulator vers.2.26 (NS2) Home Page www.isi.edu/nsnam/ns

[14] JD. McCABE, Network analysis, architecture and design, 2ndedition, Morgan Kaufmann Publication, 2003