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Link-Disjoint Interference-Aware Admission Control and QoS Routing Protocol for Mobile Adhoc Networks

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Abstract

In Mobile Adhoc Networks (MANETs) interferences diminish the network performances such as data failure, retransmission, conflict and delay. Hence, interferences are main factors that affect the network performances. Sinking interferences on the routing paths are crucial problem to enhance performances of the networks. Here, we proposed a protocol called Link-Disjoint Interference Aware (LDIA) QoS Routing Protocol based on MARIA Protocol. The capacity of networks in rigorously affects by interferences among links and numerous efforts to representation this effects make use of 'Cliques' structure in adhoc graphs. Here, we compared this simulation results in NS2 and analysis made for LDIA QoS Routing protocol and QoS Aware Routing Protocol (QoSAR).

Keywords: Conflict, Link Disjoint, MARIA Protocol, QOSAR

1. Introduction

Interferences reduce the efficiency of mobile adhoc network. Outstanding to the broadcast nature of the wireless medium and the difficulty of wireless promulgation phenomena, it's very hard to spatially separation of wireless medium into obviously disjoint links in wired networks. This, combined with indiscriminate access nature of the IEEE802.11 medium access control protocol give augment to nodes that do broadcast while they eventually should not (hidden nodes) but moreover nodes that do not broadcast while they could (exposed nodes). Both phenomena result in significant diminution of the information rescue capacity of the network. Adding up interference-awareness to routing decisions can considerably improve the network performances.

Due to disagreement for the shared medium, the utilization of capacity of every solitary node is restricted by the raw channel competence, the transmissions in its neighbourhood. Thus, all Multi-hop flood encounters contention not merely as of other flows that pass by neighbourhood that is called inter-flow contention, but moreover from the transmission of itself because the transmission at each hop must argue the channel through the upstream and downstream nodes that is called intra-flow contention. The above mentioned flow contentions may limit the performance of the adhoc networks. So, admission control considers those contentions is needed to overcome this problem and improves the network performance. However, to estimate the contention count for any admission control protocol is very challenging, due to impenetrability to determine all nodes that are positioned

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within carrier-sensing range. In this journal, we analyze the intra-flow contention and evaluate different methods reported in the literature for calculating the contention count.

Modelling of adhoc networks differ considerably from traditional wired networks. In Mobile adhoc network, while a nodule is transmitting to one of its neighbours, other neighbours necessitate to be quiet due to the interferences in channels. This is a well studied characteristic and many researchers deal among some of its aspects specified by an amount of wireless links all within the interference area of each other, only one of these can be active on one occasion. Such a set of links are called Maximal Cliques. Several adhoc algorithms, dealing between the capacities, Quality of Service (QoS) and routing, use cliques.

This paper mainly focuses on the idea of finding multiple paths using Link-Disjoint paths to reduce interference of the networks in MANET environment. In addition to this, the study also targets to evaluate the performances QOSAR[14], LDIA routing protocol based on PDR and throughput. The organization of this paper pursues. Part 2 issues and challenges of MANET to provide QoS. Part 3 briefs about Background and the related work. Part 4 gives a brief discussion about implementation of LDIA, in part 5 Result and Discussion.

2. Issues and Challenges of MANETs to Provide QoS

MANETS have limited resources like limited bandwidth, limited battery life. Adhoc network is an infrastructure less network (i.e.) nodes are dynamic in nature. Due to the characteristics of MANET, it is very difficult to provide QoS. The most important issues are noted below:

2.1 Unpredictable Network Paths

Interferences due to node transmission, signal fluctuation, frequent link failure; Multi-path cancellation signal propagation faces the above problems. Due to these properties of MANETs we can't measure QoS parameters of bandwidth and delay.

2.2 Route Maintenance

MANET has dynamic network topology and not fixed transmission path for source and destination. Due to this property it is very difficult to maintain state of information. In MANET node can join or leave at any time, any place and it creates frequent link failure during data transmission. So that we require routing paths with minimum overhead and low delay, the proposed routing protocol must consider all these problems.

2.3 Node Mobility

MANET has dynamic network topology because of random node movement. Due to this property we can't choose correct path for source to destination. Node mobility makes very difficult to find the amount of residual bandwidth. Bandwidth is an important parameter of QoS.

2.4 Limited Battery Life

MANET devices have limited battery power; battery power is important resource in this network. Because of limited power, it limit the life time of the nodes. So that, the designed protocol with considering the battery powers itself.

2.5 No Centralized Coordination

MANET is an infrastructure less network. Here, all nodes can act as transmitter and receiver. Node movements are random in nature. Due to dynamic topology of network there is no centralized co-ordination.

3. Background and Related Works

In an adhoc networks a bi-directional graphs are represented by G = (V, E) where G - Network Graph, V-Vertices and E-Edges (set of links), nodes are connected by edges and links with limited transmission ranges. In a network interference can be modelled as a conflict graph, $G^C = (V^C, E^C)$[19]. This is entitling connection graphs[1], the interference graphs[2] or the conflict graphs[3].

In network graph all link denoted by a node in the conflict graph. "Vertex" and "Link" are the two important terms used for the network graph, and the same conditions used as 'node' and 'edge' for conflict graph. In conflict graph, 2 nodes can't active at some time ago, but they contain an edge among the nodes. For long time only a single node may be concurrently lively in every complete sub-graph[2,3].

Now, graph theory used to solve above problems. Consider a bidirectional graph among number of nodes and number of edges. An induce sub-graph is a separation of nodes in concert with any edges whose end-points be equally in this separation. An induced sub-graph is a complete graph call clique. A clique is a maximal clique of a graph that it is not enclosed in any other clique. The Figure 1 shows, maximal cliques are ABC, BCFE and CDF.

Many of papers in MANET field to develop the idea of cliques in support of routing, scheduling and to improve QOS within adhoc network. In paper[2], discussed the ideas for finding traffic flow and in[3] they used a cliques to obtain an upper bound on the maximum capacity of adhoc networks. In[4], they used a clique based pricing approach to optimize resource allocation in an adhoc networks. Above papers requires calculation of maximal clique, rather in a trouble-free and scattered approach.

The above algorithms used for Mesh networks and this algorithm used for adhoc network, our exact applications regularly do not need their degree of accuracy and correctness. Thus, we make some key observations with regards to the geographic arrangement of adhoc network and designed computationally easy heuristic approximations.

Figure 2 clearly shows that the model of conflict graph of simple network. From the above figure shows connectivity graph and conflict graph. Let the allocated flow on each connectivity graph of node can be denoted by FA and FB etc.

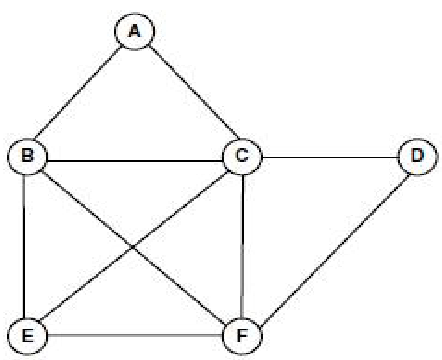

Figure 1. Examples of cliques.

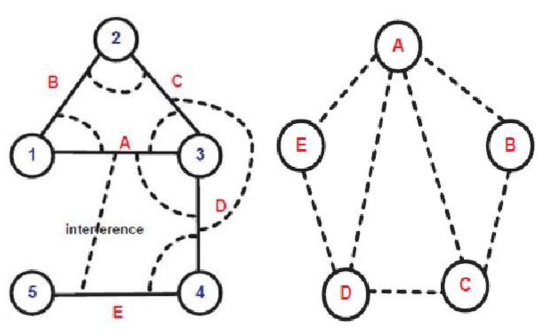

Figure 2. Conflict graph of simple network.

- In the triangle shape of **ABC** then the clique constraints can be written as $\mathbf{F_A + F_B + F_C \leq C}$.
- In the triangle shape of **ACD** then the clique constraints can be written as $\mathbf{F_A + F_C + F_D \leq C}$.
- In the triangle shape of **ADE** then the clique constraints can be written as $\mathbf{F_A + F_D + F_E \leq C}$.

4. Related Works

In[19], the author says that intrusion along with simultaneous transmissions make difficult to provide QoS for multimedia purpose in WMN Networks. Conflict graph based replica use to differentiate interferences into wireless networks. The author's of[15] presented an analytic form for interferences on data reception possibility and designed routing protocol for interferences.

In[16] authors imply a method to create approximate cliques in adhoc networks[16]. In[17], authors discussed a order of formula to calculating node, link, path interferences also proposes an interference aware routing protocols to selects path between source and destination with the least amount average link interference.

5. Protocol Implementation

In LDIA protocol, every node find the data flow information by its interference neighbour node using conflict graph and exchange Hello messages between the nodes. Now we explain how the LDIA protocol makes the local admission with support from QOSAR[13].

5.1 Route Discovery Process and Access Control Process

Route discovery process used to find end-end path with enough resources and small interferences from upcoming flow. Route request (RouteReq) messages are broadcast to the network and create local conflict graph. Initially the source node initiates the data flow and verifies the residual Band Width (BW). If the bandwidth greater than request bandwidth (b), it forward the RouteReq message to its neighbour node. If not, reject the RouteReq due to insufficient bandwidth and inform to initial node. Otherwise, intermediate node receives a non-duplicate RouteReq and it presumes the link with partial route from this neighbour node and again forwards the RouteReq to the next. The RouteReq message contains information about Source ID, Destination ID, and amount of required bandwidth.

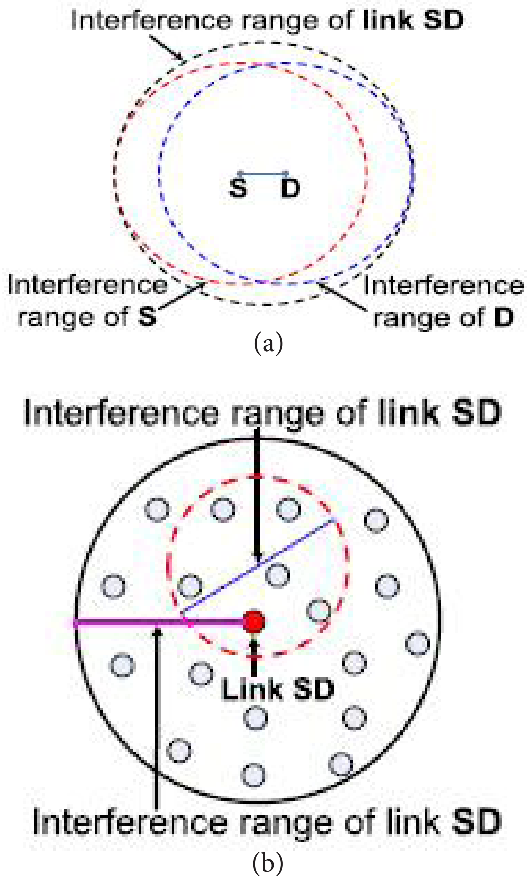

Figure 3. Calculation of maximal cliques. (a) Interfering region of a link. (b) Discovery maximal cliques.

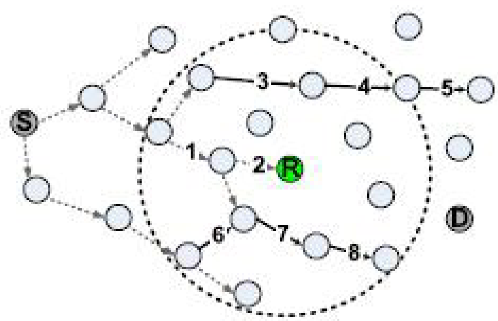

Figure 4. Creation of local conflict graph.

Use of link information it create a link 'Pool', it consists of pending flow accumulated in RouteReq and link of the neighbour flow these all determine from exchange of Hello message between the nodes. Finally, this will make a local conflict graph and update the remaining bandwidth.

'S' denotes source node, 'D' represent destination node and 'R' represent intermediate node. Source node floods RouteReq message to the network to find paths between sources to destination. The outsized circle denotes the interference range of node 'R'. Node 'R' knows 2 previous flow they are {3-4-5} and {6-7-8}. It combine the link of the partial route added in RouteReq, the link of 2 flow in its interfering area and construct a link 'pool' as {1,2,3,4,6,7,8}. It finds the consequent maximal clique constraints to find whether the RouteReq must be transmit. Once nodes receive the RouteReq it chooses the preeminent path and sends route reply (RouteRep) back to the source.

When intermediary nodes receive the RouteRep, it adds all links of this route that are in its interferences area in its link 'pool'. Since the entire routes from 'S' to the 'D' is known to any forwarding node of the ROUTEREP message, the entire access control can be completed at this point. This intermediate node builds up its local conflict graph based on the link pool and computes the maximal cliques. If satisfy the condition of maximal clique constraints, it sends RouteRep to next node. If not, its stops the forwarding of RouteRep. While a node take an admission control resolution, both inter-flows, intra-flow interferences was considered for access control process.

5.2 Route Selection Process

RouteReq takes the least amount of remaining bandwidth of the node. While more the one RouteReq arrive at the end, the preeminent path will be selected chosen and sends RouteRep to the node 'S'. Source node decide the best route, condition is utmost smallest amount of remaining bandwidth, that is smallest amount of interferences. Node 'S' transmits the RouteReq and waiting for particular time period that called as timeout value. If exceeds this timeout value without any RouteRep, it decides admission failed for this flow and discards the requesting flow. Figure 5 is the flowchart model of LDIA protocol.

6. Performance Evaluation

Here, we discussed simulation results of LDIA protocol and analyzed the performance with QOSAR routing protocol.

We used NS-2 simulation software. For simulation we considered 50 nodes with random movement. Table 1 shows simulation parameters. Data flow considered here CBR with 2000 bytes.

The Figure 6 illustrates increased PDR for LDIA com-pared to QOSAR. Due to link interference QOSAR

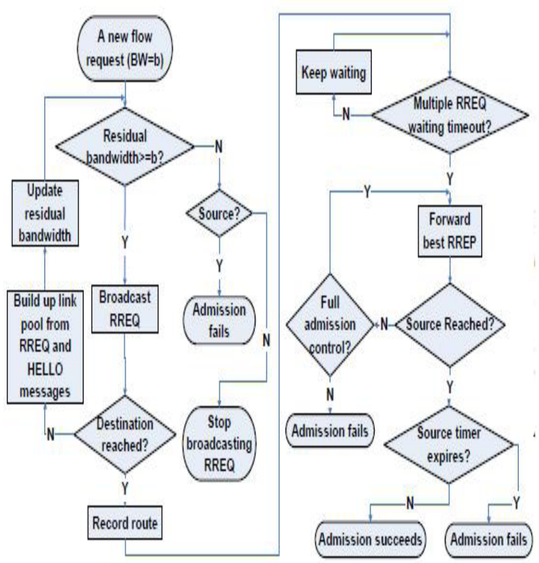

Figure 5. Flowchart model of LDIA protocol.

Table 1. Simulation parameters

Parameters	Value
Simulation area size	1000m×1000m
Number of nodes	50
Node movement	Random
Node Speed when mobile	4-20 m/s
Bandwidth	2MB
Node configuration	Adhoc Routing
Initial Energy	100
Data rate	CBR
Propagation model	Two Ray Ground
Packet size	2000
Maximum Path	3
Source Node	7,14,21
Destination Node	8,12,32
Start Time	15,45,55
End Time	200,200,200

get low PDR and this can be minimized in LDIA by using multiple paths.

Still considering the Figure 7 LDIA not only improves Packet deliverance Ratio and utilization of bandwidth, moreover it decreases Jitter significantly. From Figure 7, LDIA protocol decreases the level of dropping ratio. Here we conclude LDIA protocol provides improved performance compare with QOSAR.

In Figure 8 Interval vs. Control overhead shows that LDIA reduces the control overhead in our proposed

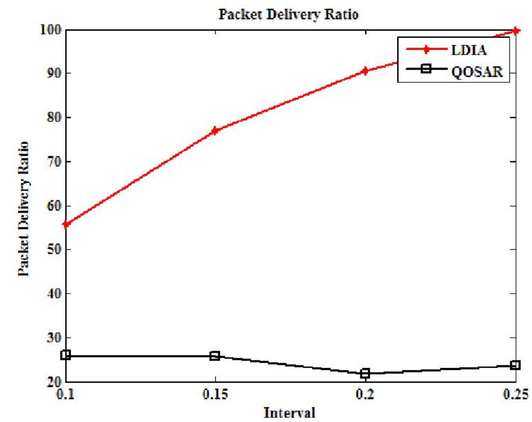

Figure 6. Interval vs. packet delivery ratio.

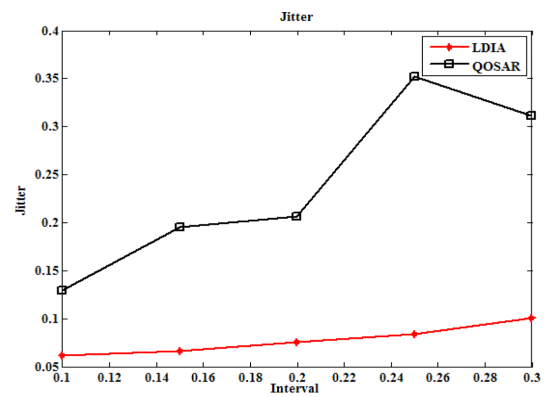

Figure 7. Interval vs. jitter.

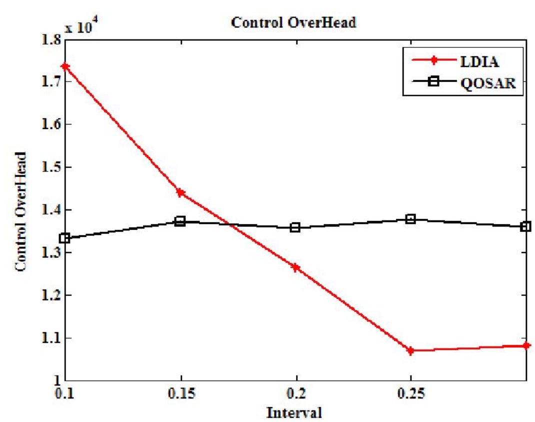

Figure 8. Interval vs. Control overhead.

protocol. In Figure 9 Interval vs. Normalaized overhead shows that LDIA reduces the Normalaized overhead in our proposed protocol.

In Figure 10 shows that the dropping ratio reduced maximum in our proposed protocol Figure 11 assured

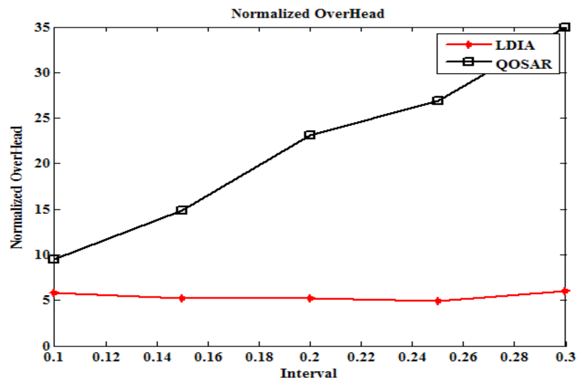

Figure 9. Interval vs. Normalized overhead.

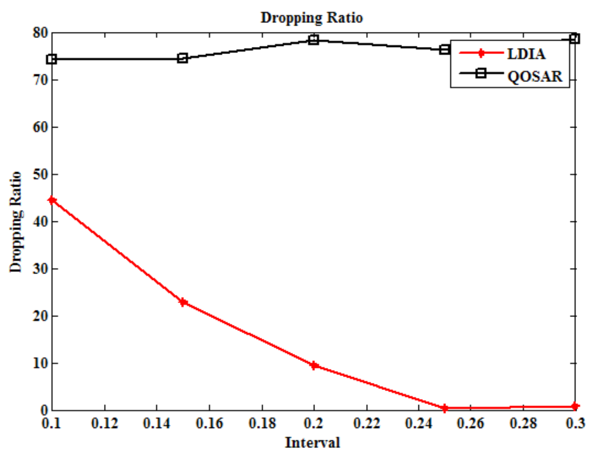

Figure 10. Interval vs. dropping ratio.

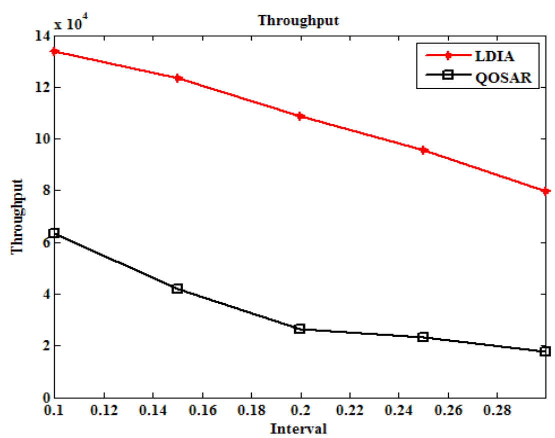

Figure 11. Interval vs. throughput.

that the throughput of the network will increased by LDIA protocol.

The above table shows performance analysis of the proposed protocol and QOSAR protocol.

Table 2. Comparison of QoSAR and LDIA protocol

Parameter	Interval	QOSAR	LDIA
PDR	0.1	25.8560	55.6543
	0.15	25.6175	77.0747
	0.2	21.7166	90.4920
	0.25	23.6708	99.6764
	0.3	21.5752	99.2790
Jitter	0.1	0.128934	0.0613810
	0.15	0.195220	0.0665357
	0.2	0.206555	0.0755441
	0.25	0.352233	0.0835626
	0.3	0.311630	0.1006430
Control Overhead	0.1	13318	17363
	0.15	13727	14393
	0.2	13576	12654
	0.25	13780	10683
	0.3	13598	10819
Normalized Overhead	0.1	9.53329	5.77419
	0.15	14.8722	5.18293
	0.2	23.1278	5.17334
	0.25	26.9141	4.95501
	0.3	34.9563	6.04413
Dropping Ratio	0.1	74.1440	44.3457
	0.15	74.3825	22.9253
	0.2	78.2834	9.50795
	0.25	76.3292	0.323625
	0.3	78.4248	0.721021
Throughput	0.1	63330.7	133644
	0.15	41842.7	123422
	0.2	26610.7	108711
	0.25	23210.7	95822.2
	0.3	17634.7	79555.6

7. Conclusion

In Mobile Adhoc Network (MANET), due to random movement of mobile node, lack of centralized co-ordination, contention for channel access, it's very complicated to avoid interference we use conflict graph model to compute interferences in the network link. Simulation shows that LDIA have high utilization of bandwidth (throughput) and higher Packet Delivery Ratio (PDR) and low overhead and dropping ratio in MANET environs. As the performance analysis of LDIA provide greater performance for MANET environs.

The proposed protocol discovers routes with minimum interference, and maximum throughput and increased QoS performance. While initiate state of information setup, more than one route is counter-productive because of surplus overhead acquired. Primary routes can also find using Link-Disjointness paths. In LDIA QOS routing protocol, we can attain improved QOS in MANET environs.

8. References

1. Puri A. Optimizing traffic flow in fixed wireless networks. Wireless Communications and Networking Conference. 2002 Mar; 2:904–7.
2. Bron C, Kerbosch J. Finding all cliques in an undirected graph. Communications of the ACM. 1973; 16:575–7.
3. Bierstone E. Cliques and generalized cliques in a finite linear graph. 1960.
4. Harary F, Ross IC. A procedure for clique detection using the group matrix. Sociometry. 1957; 20:205–15.
5. Parissidis G, Karaliopoulos M, Spyropoulos T, Plattner B. Interference - Aware Routing in Wireless Multihop Networks. IEEE Transactions on Mobile Computing. 2011 May; 10(5).
6. Suseendran G, Chandrasekaran E. Interference reduction technique in mobile adhoc networks using mathematical prediction filters. International Journal of Computer Applications. 2012 Dec; 60(6):975–8887.
7. Luo H, Lu S, Bhargavan V. A new model for packet scheduling in multihop wireless networks. Proceedings of ACM Mobicom; 2000. p. 76–86.
8. Augustson JG, Minker J. An analysis of some graph theoretical cluster techniques. JACM. 1970 Oct; 17(4):571–88.
9. Jain K, Padhye J, Padmanabhan VN, Qiu L. Impact of interference on multi-hop wireless network performance. ACM Mobicom. San Diego, CA, USA. 2003 Sep.
10. Hanzo L, Tafazolli R. A survey of QoS Routing solutions for mobile adhoc networks. IEEE Communications Surveys and Tutorials. 2007; 9(2):50–70. Available from: http://dx.doi.org/10.1109/COMST.2007.382407
11. Hanzo L, Tafazolli R. QoS-Aware Routing and admission control in shadow-fading environments for multirate manets. IEEE Transactions on Mobile Computing. 2011; 10(5).
12. Gupta R, Walrand J. Approximating maximal cliques in ad-hoc networks. Personal Indoor and Mobile Radio Communications. 2004 Sep; 1:365–9.
13. Saunders S. Antennas and propagation for wireless communication system concept and design. New York, USA: John Wiley and Sons; 1999.
14. Sangeetha T, Venkatesh KK, Rajesh, Manikandan MSK. QoS aware routing protocol to improve packet transmission in shadow-fading environment for mobile ad hoc networks. Communications and Network. 2013; 5:611–7.
15. Chengy X, Mohapatray P, Leez S-J, Banerjee S, MARIA: Interference-Aware Admission Control and QoS Routing in Wireless Mesh Networks. IEEE International Conference on Communications; May 2008. p. 19–23.
16. Zhang X, Liu Q, Shi D, Liu Y, Yu X. An average link interference-aware routing protocol for mobile ad hoc networks. 3rd International Conference on Wireless and Mobile Communication; 2007 Mar. p. 4–9.
17. Luo Y, Wang J, Chen J, et al. Algorithm based on mobility prediction and probability for energy efficient multicasting in ad-hoc networks. Computer Research and Development. 2006; 43(2):231–7.
18. Xue Y, Li B, Nahrstedt K. Price-based resource allocation in wireless ad-hoc networks. Proc IWQoS'2003; Monterey, California. 2003 Jun.
19. Yang Y, Kravets R. Contention-aware admission control for ad hoc networks. IEEE Trans Mobile Comput. 2005; 4:363–77.