Australian Journal of Basic and Applied Sciences, 10(1) January 2016, Pages: 443-450

AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178 EISSN: 2309-8414
Journal home page: www.ajbasweb.com

Bandwidth Estimation with Admission Control Scheme for QOS Routing in Mobile Adhoc Networks

[1]John Milton.M, [2]Subhash.J and [3]Premkumar.R

[1,2,3]Electronics and Communication Engineering V.S.B. Engineering College Karur, India.

Address For Correspondence:
John Milton.M, Electronics and Communication Engineering V.S.B. Engineering College Karur, India
E-mail: getjohnmilton@gmail.com

ARTICLE INFO

Article history:
Received 10 December 2015
Accepted 28 January 2016
Available online 10 February 2016

Keywords:
Quality of service; mobile adhoc network; bandwidth reservation; available bandwidth; admission control

ABSTRACT

A mobile Ad hoc Network (MANET) is a collection of mobile nodes (MNs) that cooperatively communicate with each other without any pre-established infrastructures. This paper proposes a new routing approach that combines the residual bandwidth, energy and mobility of the network nodes. The proposed composite metrics selects a more stable MPR set than the QOLSR algorithm. This proposed method also involves a bandwidth reservation model which ensures that the interferences produced by a new flow do not affect the bandwidth granted to the already accepted flows. Once the bandwidth is reserved, then the concept of admission control is introduced to tackle the problem of congestion in the network. By using mathematical analysis and simulations, this new approach is going to be used to calculate different QoS metrics such as routing load, packet delivery fraction, delay and bandwidth utilized by different number of flows.

INTRODUCTION

Due to the nodes mobility, wireless channel and unavailability of centralized control, it is very challenging to guarantee Quality of Service (QoS). To provide QoS we have to fulfill all these requirements including Admission Control (AC), QoS-aware routing (QAR), traffic policing, Resource Reservation, traffic scheduling and possibly QoS aware MAC protocol.

The purpose of AC is to accept data sessions whose QoS requirements can be satisfied without affecting those of previously admitted sessions, otherwise session is rejected. AC must establish if there are any necessary links or availability of node resources. Figure 1 illustrates an example of MANET topology.

Direct communication between devices is shown by arrows.

To Cite This Article: John Milton.M and Subhash.J, Premkumar.R, Bandwidth Estimation with Admission Control Scheme for QOS Routing in Mobile Adhoc Networks. ***Aust. J. Basic & Appl. Sci.,*** *10(1): 443-450, 2016*

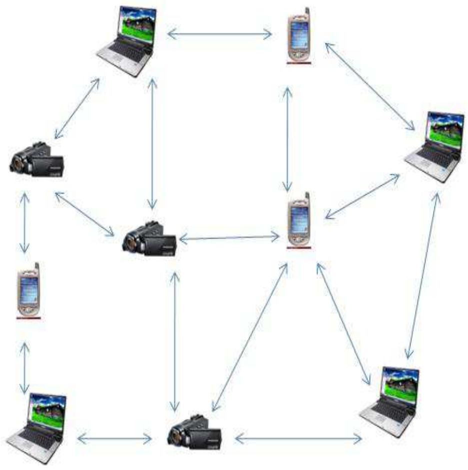

Fig. 1: Example of MANET topology

From the nodes where direct communication is not possible, need to use intermediate nodes to relay messages hop by hop. Due to increase in bandwidth of the wireless channels, variety of services can be provided, such as online games and video conference. These services require the guarantee of a certain bandwidth, otherwise, the quality of services will be degraded. Therefore, Quality of Service (QoS) is an important issue in the MANET (Shih-Lin WuYu-Chee Tseng, 2001).

Optimized Link State Routing (Olsr) Protocol:

A well known proactive link-state protocol developed for mobile ad-hoc networks is the Optimized link state routing (OLSR) protocol (Jacquet, P., T. Clausen, 2003). It exchanges topology information regularly with other nodes of the network. Each participant node selects a set of its neighbor nodes called “multipoint relay” (MPR), which are responsible for forwarding control traffic. An efficient mechanism is provided by MPRs for flooding control traffic by reducing the number of transmissions required (Clausen, T., P. Jacquet, 2003).

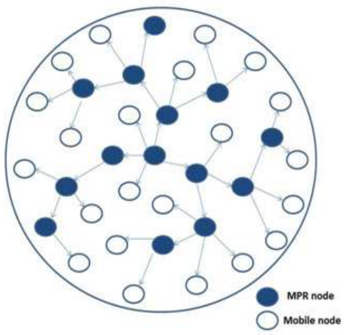

Fig. 2: MPR nodes send the TC Messages

Nodes selected as MPRs have responsibility when declaring link state information in the network. The MPRs relay by some neighbour node(s) announces this information periodically in their control messages. The MPR nodes are shown in the figure 2

The participant node announces to the network, that it has access to the nodes which have selected as it as an MPR. HELLO packet and Topology Control (TC) messages are used by node to discover their neighbours. All nodes do not broadcast the rout packets only MPR nodes broadcast route packets in the network. Routes from the source to the intended destination are built before use and each node in the network keeps a routing table, which makes the routing overheads for OLSR higher than other reactive routing protocols such as DSR or AODV.

The participant node announces to the network, that it has access to the nodes which have selected as it as an MPR. HELLO packet and Topology Control (TC) messages are used by node to discover their neighbours. All nodes do not broadcast the rout packets only MPR nodes broadcast route packets in the network. Routes from the source to the intended destination are built before use and each node in the network keeps a routing table, which makes the routing overheads for OLSR higher than other reactive routing protocols such as DSR or AODV. The above mechanism ensures that the participant nodes have adequate information to route packets to any destination.

Interference Aware OLSR Protocol (I-OLSR):

There are many Researches have been carried out to define an interference model for ad-hoc networks to deal with the network capacity at the physical layer, in the presence of radio interference. In this work, an interference aware bandwidth reservation model operates at the routing level. This simple model computes the bandwidth consumed by flows, considering the interference influence. This model provides the bandwidth reservation with an overestimation of the bandwidth required by flows. It has been observed that the radio transmission spreading is unbounded: radio interferences produced by one single transmission disturb all nodes in the ad-hoc network. Thus, each node is considered as an interference generator by all other nodes.

When a source node S wants to transmit a flow to a destination node D at distance dist from S, measured in number of hops, and requires a bit rate of k bps, the bandwidth amount to be reserved B is:

B = k *dist*q

This quantity of bandwidth, B, is reserved at each node of the network by using a signaling protocol.

In this model, the bandwidth amount for the reservation is equal to the product of the requested amount of bandwidth k by the path length dist and the queue factor q. This can be explained because any node in the path is considered as an interference generator with equal interference level. However, the distance parameter dist is not totally appropriate to provide the reservation mechanism with a good estimation of the interferences generated by flows. There are scenarios where a flow f1 takes a path shorter than a flow f2, but there are more neighbour nodes along the path of the former than of the latter. Thus, the interferences caused by flow f1 affect more nodes than these of flow f2. A more realistic approach to compute the bandwidth to be reserved should take into consideration the number of interfered nodes along the path. Thus the queue factor is added to calculate the near accurate value of bandwidth to be reserved.

Queue factor is more likely a delay value. The multipacket model is used to develop a new technique for link bandwidth measurement. To do so, assume that one packet is send with no queuing and a second packet that queues behind the first packet at a specific link, but not at any later link. Assuming no queuing except at the queuing link, the delay can be splitted into the time to travel to the queuing link, the time spent at the queuing link, and the time spent after the queuing link. With some additional assumptions, this model can be adapted as follows:

$$B = \begin{Bmatrix} k \times dist \times q & if\ dist \leq 5 \\ 5 \times k \times q & if\ dist > 5 \end{Bmatrix}$$

The interference radius is assumed to be equal to 2 times the coverage radius. Moreover, any node is supposed to belong to the interference area of at most 5 nodes such as in a straight line configuration.

The bandwidth reservation model, B = k *dist*q, takes into consideration the path length parameter, dist and the queuing factor q. This is to ensure that all transmitting nodes are counted and the network traffic is also considered. The longer the path is, the more transmitting nodes along that path. Thus, the interference level increases proportionally. As this model considers the traffic in the network, it can measure the more accurate bandwidth value to be reserved by the flow.

OLSR protocol enhanced with bandwidth reservation:

Now the OLSR protocol is enhanced in order to support QoS routing. This QoS routing is based on bandwidth reservation. The OLSR protocol enhanced with bandwidth reservation includes three phases: (1) resource reservation, (2) data/voice/video transfer and (3) resource release. Resource reservation uses the OLSR routing protocol to find the route to the destination, bandwidth is reserved on all nodes of the network according to the model described earlier. Once the bandwidth is reserved, QoS routing ensures that during the transfer phase all packets belonging to that flow follow the same route to the destination.

Admission Control:

Due to the uncertainty in the amount of traffic occurs in the network, now the work is to perform the admission control on the requesting flows. Once the bandwidth reservation is done, admission control is performed to provide the better Quality of Service.

Admission Control QoS-Aware Routing (QAR) Protocols:

The job of AC protocol is either to accept or reject a new session according to available resources in given network (Lajos Hanzo II. and Rahim Tafazolli, 2006).

The role of the AC and QAR protocols may be closely related. In order to perform their functions, both types of protocols must discover certain information about the network at the basic level. The routing protocols must perform network topology discovery and maintain a certain view of this at each node to match application’s requirements for route. The job of both types of protocols is to estimate the residual resources in the network. The routing protocols do this to help in route discovery and selection in order to utilize those nodes used for traffic-forwarding and is most likely to support the application’s requirements. It is the job of AC protocol to know which application data sessions may be admitted into the network without violating the QoS promised to previously-admitted session (Lajos Hanzo II. and Rahim Tafazolli, 2006). QAR protocol provides the achievable QoS on a route to the desired level.

Since the aim of both AC and QAR protocols is to facilitate the provision of the necessary QoS to user applications. A part of AC and QAR protocols also consists of management and utilization of network resources which provide a certain QoS.

The job of AC protocol is either to reject or accept the newly requested session according to available resources (Lajos Hanzo II. and Rahim Tafazolli, 2006). If the available resources are more than the requested resources, the session is granted admission, otherwise it is rejected. It is the duty of the AC protocol that to make sure the newly admitted session does not affect the previous serving data session.

AC protocol during route discovery must establish if there are any links or nodes having necessary available resources. In QAR protocol, it is performed after the routes have been discovered. In QAR protocols the route discovery process can be used for AC decision, if the required resources are unavailable the admission is rejected otherwise the data sessions is granted. However in contention based 802.11 network the session's achievable QoS is not only affected by the nodes on the path but also by the neighbors of the nodes along the path. So it is important to check the available capacity of neighbor nodes whether they can accept or reject the new session without affecting the already admitted data sessions.

In this section, some of the important AC and QAR protocols which have improved the provisioning of QoS for different applications are discussed.

Contention Aware Admission Control Protocol:

The work in (Kleinrock, L and F. Tobagi, 1975) is considered a landmark in the design of Admission control protocols for MANETs. The available network resources are measured by AC protocol and checks whether it can support the new data flow or not, without affecting the existing flow. The proposed protocol is combined with a source routing protocol similar to Dynamic Source Routing (Lajos Hanzo II. and Rahim Tafazolli, 2006). AC in first stage, only partial route of the flow is known to the nodes therefore partial admission is granted to the flow. A route discovery is triggered at that time when a session requesting admission packet arrives at a source node. Nodes monitor the Channel Idle Time Ratio (CITR) and only if their locally available capacity is sufficient then it forwards the Route Request (RReq), considering the intra-route contention. Only local resources are estimated in case of Contention Aware Admission Control protocol-Multi-hop (CACP-Multi-hop) and CACP-Power; during this RReq phase, Carrier Sensing Neighbors (CSN) resources are not checked because it enforces extra overheads on the partial discovered route (Lajos Hanzo II. and Rahim Tafazolli, 2006; Yaling Yang, *et al*., 2005).

The routes in RReq are cashed at the destination. Therefore several routes are cashed due to multiple RReq reaches the destination on different routes. Among the several routes, one route is selected for Route Reply (RRep) on the basis of some criteria, such as the shortest route or first discovered route. Locally available capacity for each intermediate node is again tested by receiving RRep along with the full knowledge of the Intra-route contention. One of the following proposed methods is used by all nodes on the route to check their neighbor's capacity during the RReq.

Adaptive Admission Control (AAC) Protocol:

Adaptive Admission Control (AAC) (Kleinrock, L and F. Tobagi, 1975) a new admission control which deals with all issues regarding QoS provision in MANET (Kleinrock, L and F. Tobagi, 1975).

- It provides accurate low-cost signaling technique to retrieve CS nodes' available bandwidth.
- Robust contention count calculation algorithm which adapts to the path's roughness.
- Efficient adaptation strategy to work against eventual QoS violations.

AAC works better in high traffic load and mobility environment.

Proposed Dynamic Admission Control (Pdac):

In this section, the basic operation model and the algorithm of the proposed dynamic admission control mechanism is discussed. Dynamic admission control (PDAC) allocates the network resources to the requested user flow properly according to the network situation. It means that this algorithm has to react fast to the unexpected traffic pattern changes. The efficient network resource management of the network depends on how fast the entrance ingress edge node can perform the distinct functions according to service classes instead of simple operation in core node. The traffic violation information of network should be gathered immediately by the bandwidth agent and feedback given to the ingress edge node.

In the proposed DAC mechanism, the bandwidth agent initially allocates provisioned bandwidth to each path. The state of a path maintains the amount of bandwidth that has been allocated to the path. When a flow reservation set-up request along a path arrives, the edge node only needs to check the corresponding path whether the amount of bandwidth allocated to the path is sufficient to satisfy the flow's request. If the answer is

Australian Journal of Basic and Applied Sciences, 10(1) January 2016, Pages: 443-450

positive, the flow request is accepted. Only when the allocated bandwidth of the path is less than the requested bandwidth, the entrance edge node requests the additional bandwidth to the bandwidth agent. The amount of the additional bandwidth is calculated in the edge node based on the previous traffic pattern information.

The bandwidth agent will check each link along the path to see whether there is available bandwidth at all the links except already allocated bandwidth for each path. If available bandwidth is sufficient, the bandwidth agent allocates the additional bandwidth to the path and informs each node along the path to change allocated bandwidth information for that path. Therefore, this mechanism simplifies the bandwidth calculation in the bandwidth agent by limiting the resource management to the only path level. That is, the bandwidth agent can minimize the communication between the bandwidth agent and each node in the domain. Also, it has some advantages that the entrance edge node performs the admission control for itself in path level, the estimation of additional bandwidth, and the dynamic bandwidth allocation.

A more formal and detailed description of the algorithm is presented by the pseudo-code below:

Algorithm:

1. Assign reserved bandwidth along the path is equal to the initial bandwidth.
2. If reserved bandwidth is greater than or equal to the sum of used bandwidth along the path and the requested bandwidth, then accept the request.
3. If the reserved bandwidth is less than the requested bandwidth, recompute the required additional bandwidth by subtracting the bandwidth at time ‘i’ (BWi) from bandwidth at time ‘i+1’ (BWi+1).
4. Assign the maximum bandwidth is equal to the requested additional bandwidth.
5. Assign minimum bandwidth is equal to the sum of used bandwidth along the path and requested bandwidth for the new flow subtracting the reserved bandwidth along the path.
6. Check if the new bandwidth satisfies the request, then assign reserved bandwidth along the path is equal to the allocated bandwidth for new flow and also assign used bandwidth along the path is equal to the requested bandwidth for a new flow.
7. If the condition is not satisfied the reject the request.

The above algorithm describes the admission control in the ingress edge node. If the reserved bandwidth is sufficient for new flow setup request, the ingress edge node accepts the flow request. If not, the ingress edge node computes the additional bandwidth considered to be needed in next period and requests bandwidth allocation to the bandwidth agent. That additional bandwidth, BWi+1 denotes the amount of bandwidth that the ingress edge node will request to bandwidth agent in time Ti+1, is estimated based the previous traffic pattern such as follows:

$$BW_{i+1} = \frac{UBW_i - UBW_{i-1}}{T_i - T_{i-1}} . \Delta t$$

BWi is the allocated bandwidth in time Ti , and UBW i is the used bandwidth in time Ti.

Also, Δt means that the average value of time interval fromTi-1 to Ti. Through this Δt the previous traffic patterns to the next bandwidth allocation can be calculated.

$$\Delta t = \frac{\sum_{k=0}^{i} T_k - T_{k-1}}{i - 1}$$

If the minimum available bandwidth among the links along the path is greater or equal to the maximum requested bandwidth from the edge node to the bandwidth agent, then additional bandwidth is allocated. In the case that the available bandwidth in each link along the path is sufficient to satisfy the requested additional bandwidth from the ingress edge node, the bandwidth agent will allocate MAX_BW or min to the ingress edge node as well as to each node in domain. Otherwise, the flow set-up request is rejected.

Simulation Results:

The simulation area used for the network is 800m x 800m.Figure 3 shows the bit rate level for different number of nodes at different times. The fluctuation in the graph is due to as time progresses there are more packets transmitted and hence the bit rate increases. However because of the varying network traffic the bit rate varies for different time intervals.

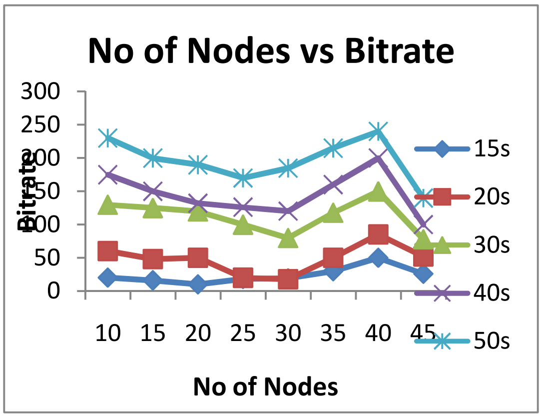

Fig. 3: Bit Rate Graph

Figure 4 shows the throughput comparison for different number of flows. In both the methods there is degradation in throughput due to the congestion in the network. However I-OLSR performs better than the standard OLSR protocol in all the scenarios. Moreover I-OLSR shows significant improvement in throughput for more number of flows.

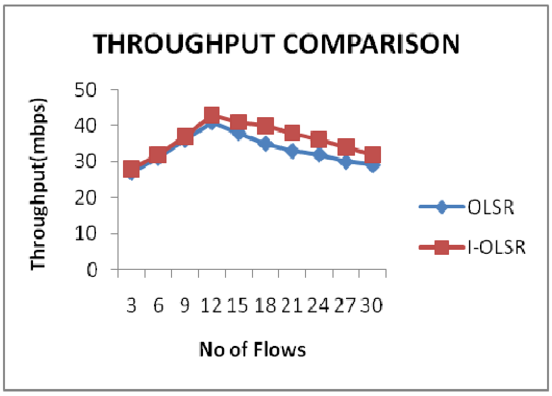

Fig. 4: Throughput Comparison

Figure.5 shows the comparison of packet delivery ratio for different number of flows. In both the cases the packet delivery ratio decreases due to the network traffic. However I-OLSR performs 10% better than the standard OLSR protocol in all the scenarios.

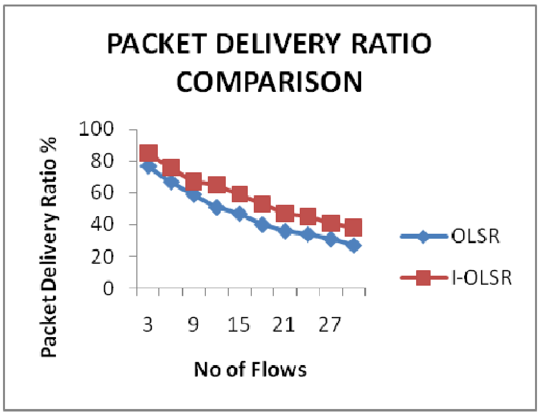

Fig. 5: Packet Delivery Ratio Comparison

Figure.6 shows the comparison of average end to end delay for different number of flows. From the figure it is clear the delay increases as the number of flows increases in both the cases. However in standard OLSR as the traffic increases the delay increases significantly.

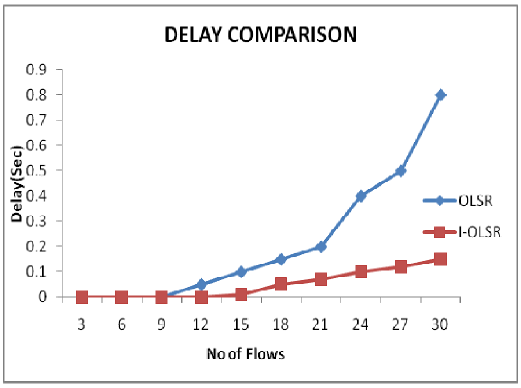

Fig. 6: Average end to end delay comparison

This is due to the fact that OLSR allows all the flows into the network as it doesn't support admission control scheme. But in the case of I-OLSR it admits only the flows satisfying the admission requirements. Thus the delay in I-OLSR is within the tolerable range throughout the entire network.

Figure.7 shows the comparison of average jitter for different number of flows. In I-OLSR with admission control scheme the jitter remains within 3 milliseconds even when the traffic increases. However in standard OLSR without admission control the jitter rises very sharply even with small network traffic.

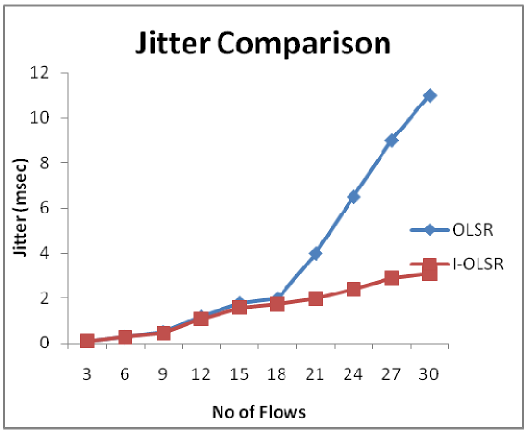

Fig. 7: Average jitter comparison

Conclusion:

Bandwidth is an important QoS parameter in adhoc networks. Bandwidth reserved by already existing flows in the network can be affected by interference and the new flows. The proposed interference aware OLSR (I-OLSR) protocol performs bandwidth reservation in adhoc networks. I-OLSR considers the interference effects before reserving bandwidth for the requested flow and thereby provides improved throughput and packet delivery ratio. I-OLSR provides significant improvement in bandwidth utilization for larger networks. Still there is a problem exists in adhoc networks due to the network traffic. Thus I-OLSR is improved with admission control scheme and thus to provide better quality of service. Simulation results show that I-OLSR performs better than standard OLSR protocol.

REFERENCES

Brahma, M., K.W. Kim, A. Abouaissa, P. Lorenz, University of Haute Alsace, “A new approach for supporting QoS in Mac layer over MANETs”, August 14-August 17. IBN: 0-7695-2422-2. Montreal, Canada.

Chakrabarti, S and A. Mishra, 2001. “QoS Issues in Ad-hoc Wireless Networks”, IEEE Communications magazine, 39(2): 142-148.

Chaudet, C., 2002. Guerin-Lassous.I: BRuIT: Bandwidth Reservation under InTerferences influence, in European Wireless (EW) pp: 466-472, Firenze, Italy.

Clausen, T., P. Jacquet, 2003."Optimized Link State Routing Protocol (OLSR)" Project Hipercom, INRIA, [RFC 3626].

Cristina Cano, Boris Bellalta, Miquel Oliver, "Adaptive Admission Control Mechanism for IEEE 802.11E WLANS", 18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC 07).

Hanzo Lajos II. and R. Tafazoli, 2007. "A Survey of QoS Routing Solutions for MANETs", IEEE Communications Surveys and Tutorials, 9(2): 50-70.

Jacquet, P., T. Clausen, 2003. "Optimized Link State Routing Protocol (OLSR)", IETF Network Working Group Experimental RFC 3626.

Kahn, R., 1997. "The Organization of Computer Resources into a Packet Radio Network", IEEE Transaction Communications, 25(1): 169-178.

Kleinrock, L and F. Tobagi, 1975. "Packet Switching in Radio Channels Part II: The Hidden Terminal problem in Carrier Sense Multiple Access Modes and The Busy-Tone Solution", IEEE Transaction communications, 23(12): 1417-1433.

Lajos Hanzo II. and Rahim Tafazolli, 2006. "Admission Control Schemes for 802.11-Based Multi-Hop Mobile Ad-hoc Networks: A Survey", IEEE Communications Surveys & Tutorials, 11(4).

Lei Chen and Wendi B. Heinzelman, University of Rochester, 2007."A Survey of Routing Protocols that Support QoS in Mobile Ad-hoc Networks", IEEE Network Volume: 21, Issue: 6, Publisher: Citeseer, pp: 30-38, ISSN: 08908044.

Ramanathan, R., J. Redi and B. Technologies, 2002. "A Brief Overview of Ad-hoc Networks: Challenges and Dircetions", IEEE Communications Magazine, 40(5): 20-22.

Shih-Lin WuYu-Chee Tseng, 2001. "Wireless Ad-hoc Networking", chapter 13. Publisher: Taylor & Francis Inc; EAN: 9781420013825-BEPDF.

Shukla, S., L. Chandran-Wadia and S. Iyer, 2003. "Mitigating the Exposed Node problem in IEEE 802.11 Ad-hoc Networks", in Proc. 12th Int. conf. Computer Communications and networks, pp: 157-162.

Vivek Kumar, 2009. "Simulation and Comparison of AODV and DSR routing protocols in MANETs", Computer Science and Engineering Department Thapar University Patiala - 147004.

Yaling Yang, Student Member, IEEE and Robin Kravets, Member, IEEE, 2005. "Contention-Aware Admission Control for Ad-hoc Networks", IEEE transactions on mobile computing,4: 4.

Zhang, J., L. Cheng, I. Marsic, 2003. Models for non-intrusive estimation of wireless link bandwidth, Springer-Verlag Lecture Notes in Computer Science (LNCS) for Personal Wireless Communication, 2775: 334-348.