IJETST- Vol.||02||Issue||06||Pages 2625-2632||June||ISSN 2348-9480 2015

Open access Journal International Journal of Emerging Trends in Science and Technology

Trust based Opportunistic Routing Admission Control in Wireless Ad Hoc Networks

Authors
Pallavi Shinde[1], Mr. N. D. Kale[2]
[1]M.E. 2nd year Student, PVPIT, Pune INDIA
Email: *patilpallavi06@gmail.com*
[2]Department of Computer Engineering, PVPIT, Pune INDIA
Email: *navnath1577@yahoo.co.in*

Abstract

For providing QoS in wireless ad hoc networks is difficult task because the network is decentralised network. The multi-hop nature of the network affects QoS in wireless networks. In routing scheme, if one node at the optimal path is down due to lack of available energy the path will be broken, and the source must have to re-route again. Introduced Opportunistics routing to solve this problem which improves performance. It is quite difficult to provide better QoS in Opportunistic Routing due to the uncertainty of forwarding paths in wireless as hoc networks. Most of the existing existing Opportunistic Routing ie OR protocols rarely consider providing service for different types of flows. It uses Admission Control of nodes for the different flows. The ORAC scheme manage a new alternative flow admission control scheme considering the factors bandwidth, backlog traffic and residual energy of nodes to select forwarding candidates. The existing work in OR considered either of QoS and security. So, in the proposed system, security issue in to account while adopting the ORAC scheme and to resolve issues of security we have used the trust value of the nodes

Keywords: *Wireless ad hoc networks routing, traffic, bandwidth, energy.*

1. Introduction

In multi-hop wireless ad hoc networks, packets get forwarded using intermediate nodes from the source to the destination without centralized coordination, So path is not fixed. In traditional routing protocols fail to use the broadcast nature of wireless networks and spatial diversity by choosing a fixed path as similar to wired links networks. When the current path is get broken, the source will re-route again, and then end to end QoS is difficult to guarantee. Opportunistic Routing gives way to utilize the broadcast nature of wireless links to achieve cooperative communication at the link layer and networks layer of static multi-hop wireless networks. Thus the network throughput can be improved and the transmission delay can be reduced by using the OR scheme, because OR has many characteristics, multiple representative works on OR have been proposed.

2. Related Work

To improve the network through put and to reduced the transmission delay by using the OR mechanism. Biswas and Morris [3] firstly explained the ExOR, which integrates routing and MAC protocol to increase the throughput in multi-hop wireless ad hoc networks. ExORs forwarding paths can easily spread from its central point, and the metric which is for selecting candidate nodes only employs Expected Transmission.

Later, MAC-independent Opportunistic Routing and Encoding i.e. MORE, MORE[4] is an intra-session network coding scheme, CCACK adopts a Cumulative Coded Acknowledgment scheme that allows nodes to acknowledge network coded traffic to their upstream nodes. Simple Opportunistic Adaptive Routing ie. SOAR[5] adaptively selects forwarding nodes and uses priority-based timers to service for multiple simultaneous flows in wireless mesh networks.

Wang Bo Hunget. al. [2] TOR gives a new solution to solve security issue by defining a new metric which is called E2TX(trustworthiness and ETX). Using this metric, TOR also considers the two key issues for a new routing protocol called TOR: candidate selection and prioritization of relays in opportunistic routing.

In [7], E Rozner et al. presented an admission control and routing mechanism for multi hope wireless mesh networks, admission control scheme is dependent on available bandwidth estimation. X. Gao F. et al. [8] discussed the multi-rate any path routing scheme, which gives details about a bandwidth reservation for traffics. P. Zhao X. et al. [9] mentioned Bandwidth-aware OR with considering Admission Control named BOR/AC in mesh networks.

In [1] Yang Qin et. al. propose OR scheme joint with admission control for different priority flows in wireless ad hoc networks, named as ORAC (Opportunistic Routing with Admission Control) and it's done by considering the nodes available bandwidth, energy and backlog in buffer before selecting the candidates, ORAC is able to improve the network performance for different traffics.

Proposed Model

Figure shows that proposed trust ORAC considers twomajor factors such as security and admission control inwireless ad hoc networks. It provides security by nodes trustworthiness in network. Initially trust value is get assigned or calculated in every cycle. The admission control is dependent on bandwidth, backlog traffic and energy.

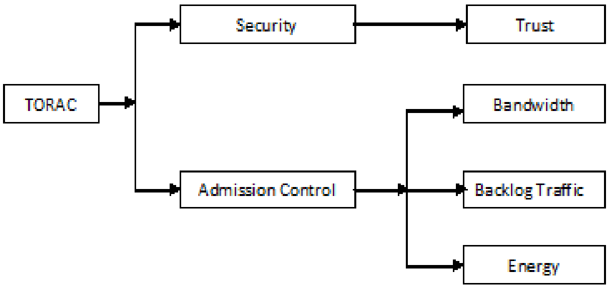

Fig. 1. Proposed TORAC Model

4. Methodology

4.1 Trust Calculation and Updating

Trust value indicates trustworthiness of node in wireless network. Nodes Trust value is calculated using following equation

$$T_j(k,n) = R_{kj}(n)/F_{kj}(n) \qquad (1)$$

Here, $T_j(k,n\,)$Node js trust value assigned or calculated by node k during nth topology cycle. Where $R_{kj}(n)$and $F_{kj}(n)$are the number of packet that have been received by k and forwarded from j at time t respectively and

$$0 \leq T(k; t) \leq 1.$$

Trust value of a node js is updated after every topology change using following equation.

$$T_j(k,n) = \alpha\, T_j(k,n-1) + (1-\alpha).T_j(k,n) \qquad (2)$$

Here, Tj (k; n) is node j's trust value measured during nth topology updating cycle. 0 <α< 1 is a weighting factor used to trade-off between current measurement and previous estimation. The combined routing metric value of node j holds true, only if node j satisfies a precondition

$:T_j \geq T_{Threshold}$

Here,$T_{Threshold}$ is the trust threshold value of the whole network, If the node j is not a trustworthy node, namely, it may be a selfish and malicious node, so, we disregard the node and don't allow its joining in the network.

4.2 Flow Admission Control Model in TORAC

Flow Opportunistic Routing with flow admission control is get introduced to provide method to select forwarding candidates for new incoming flow and it's done by flow admission control during the routing.

1. Nodes current available bandwidth is get compared with requested flow rate to decide whether the new flow get admitted by the node.
2. If node has large backlog traffic then new flow get rejected by node.
3. Node needs energy to receive, forward packets. So energy is needs to consider in multi hop wireless network and it affects admitting of new flow.

Above mentioned factors available bandwidth, backlog traffic required buffer space and energy. Node is participant of routing scheme and become forwarding candidate set.

Here, we consider a wireless ad-hoc network, whose topology is static, denoted by G(V,E) a directed graph, where V is the set of nodes and E is the set of virtual links in wireless ad- hoc networks. Assume there are n nodes in the network and

V = $(n_1;n_2;\, n_3;\, . . . ;\, n_i;n_{i+1}\, ;\, n_{i+2};\, . . . ;\, n_n)$.

4.3 Available Bandwidth

In wireless ad hoc networks, a node has limited bandwidth C to serve to new incoming traffic flow. We are going to denoted incoming flow packet with data rate q_j^k , Where, jis priority class flow and k is number of flow, here are mnumber of classes flow in network and the set of total classesdenoted as (1, 2, . . . ,j, . . ., m). Let's assume that j has pj flows existing with an intermediate node n_j and the class js flow set is denoted as (1, 2, ..., k, ..., pj). Whenever new flow wants access an intermediate forwarding node n_j must haveto satisfy following condition.

$$q_{j+1}^{new} + \sum_{j-1}^{m} \sum_{k-1}^{pj} q_j^k \le C \qquad (3)$$

Where, q_{j+1}^{new}denotes the data rate of the new flow belonging to class j + 1.

$\sum_{j=1}^{m} \sum_{k-1}^{pj} q_j^k$denotes the total data rate of flows that have been admitted by node n_i from different priorities of classes. It considers the bandwidth allocation for the flowsbased on the average rate in wireless ad hoc network.

4.4 Backlog Traffic

In Opportunistic Routing, a node can be congested, ie. Itcan't accept additional incoming flows. It can happened due to lower bandwidth or it can be for lower network performance. So, for providing better QoS we need to consider backlog traffic of nodes. To avoid congestion as well as better delay guarantee. Let's assume at any time, an intermediate node $n_j$contains$\sum_{j=1}^{m} \sum_{k=1}^{pj} w_j^k$ bits in total waiting within its buffer,$w_j^k$is the number of bits waiting in a queue belonging to aflow k of class j. An intermediate node ni, when it admits anew flow, it should satisfy the following inequality.

$$C - \sum_{j=1}^{m} \sum_{k=1}^{pj} \frac{W_j^k}{D_j - T_j^k} \ge 0 \qquad (4)$$

Here, D_j is a soft delay bound parameter of class j in order to ensure more weight given to higher priority traffic,T_j^k is the consumed time that spends on transmitting the flow k of class j from source to intermediate node n_i, which can be expressed.

$$T_j^k = \sum_{\omega=1}^{ni} T_j^k\,(\omega) \qquad (5)$$

Here, $T_j^k(\omega)$ is the successfully transmission time of data flow from node x to next hop x + 1 for flow k of class j, which can be expressed.

$$T_j^k(\omega) = \sum_{l=1}^{L} T_j^k\; (l) \times p_j^k(l) \qquad (6)$$

Here, $l (1 \le l \le L)$ is the number of retry, and L is the retry limit defined in the IEEE 802.11 standard, pk_j^k (l) is successful probability of the l_{th} attempt for flow k of class j, $T_j^k(l)$ is time required for l_{th} attempt of data flow k of class j transmission in node w, which can be expressed.

$$T_j^k(l) = AS_j + T_{boffj}(l) + T_{j-data}^k + R_\omega * T_{ACK} + R_\omega * SS \quad (7)$$

Here, SIFS is the short inter-frame spaces, $AS_j$is the arbitration inter-frame space defined in the IEEE 802.11e EDCA standard, $T_{boffj}(l)$is the average back off time consumed in the l^{th}attempt for the flow of class j, R_ω is the number of candidates of node w, T_j^k-Data is the time for transmit data frame of data flow k within class j, and T_{ACK} is the time for transmit ACK frame.

Let's assume that transmission attempts are independent from each other, and the successful probability for each class of traffic is different because of their different priority. Then, the successful probability of the l^{th} attempt for flow k of class j, denoted by$p_j^k(l)$, which can be calculated as

$$p_j^k(l) = (l - \delta_j^k)^{l-1} \times \delta_j^k \quad (8)$$

Here p_j^k is the success probability of each attempt for flows of class j.

Energy consumption Wireless ad hoc networks are a special kind of wireless networks, which allow a group of nodes to setup and maintain a temporary network by themselves, without the support of any fixed infrastructure. In wireless ad hoc networks, the battery energy of many nodes is limited. Hence, we must consider the energy of these devices, estimating energy consumption of them in packets transmission. We suppose that packet size is the same for different types of flows, and the sending power of nodes is constant, so, the energy consumption that spends on forwarding or receiving packet is also the same for different types of flows. The energy consumption of an intermediate node n_i for successful transmitting one packet to its downstream node, denoted byE_{iC}, which is composed by three parts: the energyE_{iF} is consumed to forward a packet, the energy $E_{iR}$is consumed to receive a packet, and the energy $E_{iACK}$is consumed to send an acknowledgment packet. In this energy module, the main energy consumption of nodes is used to transmit packets, and some other factors, such as energy attenuation of nodes; we do not consider them [1]. Thus, we have

$$E_{ic} = E_{iF} + E_{iR} + E_{iACK} \quad (9)$$

Suppose that E_{iT} denotes the total energy of a node n_i. Moreover, according to the mechanism of OR, node$n_i$should send an acknowledgment to its upstream node when it receives a packet. Hence, the residual energy E_{iR} that the node n_i forwards existing packets belonging to the buffer queue of class j can be expressed.

$$E_{ir} = E_{iT} + \sum_{j-1}^{m} \sum_{k-1}^{\rho j} \frac{w_j^k}{pktsize} (E_{iF} + E_{iR} + z) \quad (10)$$

Here, pktsize denotes the number of bits occupied by a packet size.

$\sum_{j-1}^{m} \sum_{k-1}^{\rho j} \frac{w_j^k}{pktsize}$denotes the number of packets in the buffer queue of class j for node n_i. The above formula expresses the consumed energy that node$n_i$spends to receive and forward existing packets in the buffer.

Suppose that a new flow belonging to class j+1 contains r_{j+1}^{new}packets, hence, the noden_i can admit the new flow, it need to satisfy the following inequality.

$$E_{ir} - r_{j+1}^{new} \times (E_{(j+1)F} + E_{(j+1)R} + E_{(j+1)\_ACK}) \geq 0 \quad (11)$$

Here $r_{j+1}^{new} \times (E_{(j+1)F} + E_{(j+1)R} + E_{(j+1)\_ACK})$ denotes the consumed energy that node n_i spend to receive and forward a new flow of class j +1.

4.5 Flow Admission Control Scheme

Once introducing the available bandwidth, backlog traffic and energy consumption model, we give our admission control scheme from [1]. The key idea is that a node can admit a new flow if it has sufficient bandwidth, energy, and buffer space. And then, we can select it as forwarding nodes in the opportunistic route discovery phase [1]. Thus, any intermediate node n_i admits a new flow of class j+1 which containsr_{j+1}^{new} packets with data rate q_{j+1}^{new} when it satisfies the following inequality.

$$C - \sum_{j=1}^{m} \sum_{k=1}^{\rho j} q_j^k - \sum_{j=1}^{m} \sum_{k=1}^{pj} \frac{W_j^k}{D_j - T_j^k} - q_{j+1}^{new} \geq 0 \quad (12)$$

$$E_{ir} - r_{j+1}^{new} \times (E_{(j+1)F} + E_{(j+1)R} + E_{(j+1)\_ACK)} \geq 0$$

The advantage of this scheme is that it is able to strike a balance indirectly between admitting more flows and facing congestion, and provide better QoS for different requirements.

5. Algorithm

5.1 TORAC Forwarding Scheme

In this, we introduce our forwarding scheme of TORAC for different types of flows in detail. The TORAC scheme contains three components: forwarding candidates set selection, candidate's prioritization, and the opportunistic forwarding scheme. The former two parts determine the methods of selecting forwarding candidates and prioritization policies of forwarding candidates, and the latter gives a forwarding scheme which contains to determine when a node updates its candidates list and how to provide different QoS for different types of flows. We introduce them respectively.

5.1.1 Forwarding Candidate Set Selection

In this we consider how to select proper metrics for determining forwarding candidates set is very important. In TORAC protocol, we propose a new method for selecting the forwarding candidates set, which is based on flow admission control and trust value of the node in candidate set. The details are expressed as follows.

At the beginning of algorithms, the distance between any two nodes in the network should be calculated using location service module. This can be realized easily because the network topology is static. And for node n_i in the network, its one-hop neighbours can be determined when we set the transmission range of nodes. We select the nodes that the distance between them and destination node is shorter than the distance between n_i and destination node within the one-hop neighbors, then, collect these nodes in a set, denoted by temporary set, TSi.

(TSi = {n1; n2; . . . ; nr}). Moreover, we calculate the available bandwidth, backlog traffic, residual energy and trust value of the nodes which are in set TSi. First we check that which nodes are more trustworthy by its trust value in the current network topology cycle.

If $T_j \geq T_{Threshold}$ then add node from TSi to the Si.Then we check that which nodes in set Si have sufficient resources to admit a new flow according to formula .After that, we store the nodes that satisfy formula in set Q_i={n1, n2, ……, nφ}

($Q_i \subseteq S_i \varphi \leq r$)&T(n) ≥ $T_{Threshold}$

Here Q_i is the forwarding candidates set of noden_i .

5.1.2 TORAC Candidate Selection :

1. When node joins the network firstly its trust value is assigned to the 0.5 / calculated, which means node is not a malicious node.
2. After completion of first cycle its trust value is calculated.
3. In every topology cycle trust value is updated.
4. Calculate the distance of each node from other nodes in the network using location service module.
5. After calculation of distance each node will calculate its temporary candidate set TS_i based on trust value of nodes in the range.
6. Then, calculate the available and required bandwidth for incoming flow.
7. Next, calculate the current backlog traffic and incoming traffic for the node.
8. And Calculate required energy and residual energy of the node.

9. Next, check for sufficient resources are available, if node has sufficient resources then add that node to the set S_i.
10. Node from S_i to set Q_i if node in S_i satisfy the

$$T_j \geq T_{Threshold}$$

```
Route_Packet(P){
Receive_Packet9P0;
S <- Get_Src(P);
D <- Get_Dest(P);
If(ID==NodeID) {
 Precoss_Packet(); }
 Else {
 L=Get_NeighborList(NodeID);
 for(all nodes in list L) {
 Calculate_Trust();
 Check_Bandwidth();
 Check_BacklogTraffic();
 CheckAvail_Energy(); }
 Candidate_Selection();
 Candidate_Prioritization();
 Send_Packet(); }}
```

5.1.3 TORAC Candidate Prioritization

Once done with selecting the forwarding candidates set, we give a prioritization policy to determine the priorities for these candidates. In TORAC scheme, we use the priority metric$\delta_i$to decide the priorities of node n_i when it admits a new flow with class j, which can be defined as follows.

$$\delta_i = \alpha \times \frac{C - \sum_{j=1}^{m} \sum_{k=1}^{\rho j} q_j^k - \sum_{j=1}^{m} \sum_{k=1}^{pj} \frac{W_j^k}{D_j - T_j^k} - q_{j+1}^{new}}{C} + \beta \times \frac{E_{ir} - r_{j+1}^{new} \times (E_{(j+1)F} + E_{(j+1)R} + E_{(j+1)\_ACK})}{E_{iT}} + \gamma \times \frac{(p_{if} + p_{ir})}{2} + \varphi \times \frac{d_{SD} - d_{iD}}{d_{SD}} \qquad (13)$$

Here, $p_{if}$is the forward delivery ratio of node n_i, which indicates probability that a data packet successfully arrives at the recipient,$p_{ir}$is the reverse delivery ratio, which is the probability that the ACK packet is successfully received by noden_i, $d_{SD}$is the distance from source to the destination node, $d_{iD}$is the distance from current node $n_i$to the destination node, α,β,γ and φ are the weight factors, which can determine according to the requirements of application, such as, pay more attention to bandwidth, energy, link delivery ratio requirements or the distance to the destination, and satisfying the condition

$$\alpha + \beta + \gamma + \varphi = 1.$$

While computing the node's priority metric within the forwarding candidates set according to above formula, we can obtain a priority queue by sorting the priority metricQ_i in descending order, the larger priority metric Q_i, the higher priority for forwarding packets. And this priority queue is the candidate list.

6. Result

In this section, we evaluate the performance of our TORAC scheme for input as number of nodes 100 and source node 1 and destination node 77, showing routes while fault node entered.

Delay Chart: Figure 2 illustrates the system delay, it shows the delay while fault node entered into the route from source node to destination nodes without resending the packets.

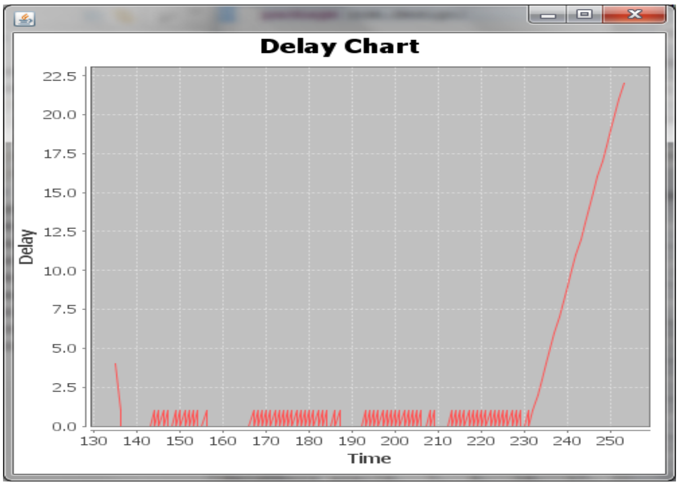

Fig 2: Delay Chart

Throughput Chart: Figure 3 illustrates the throughput of the of TORAC scheme.

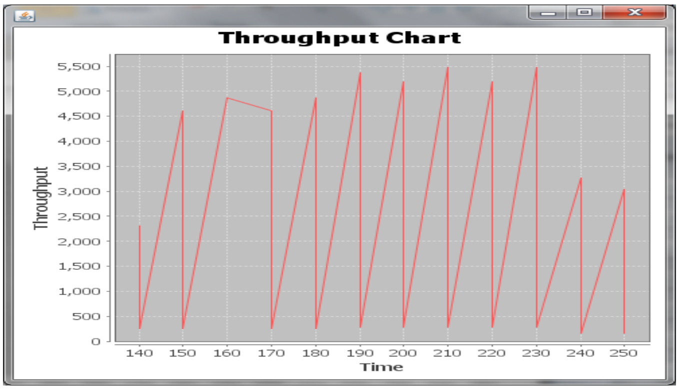

Fig 3: Throughput Chart

Packet Delivery Ratio Chart: Figure 4 illustrates the packet delivery ratio of TORAC scheme.

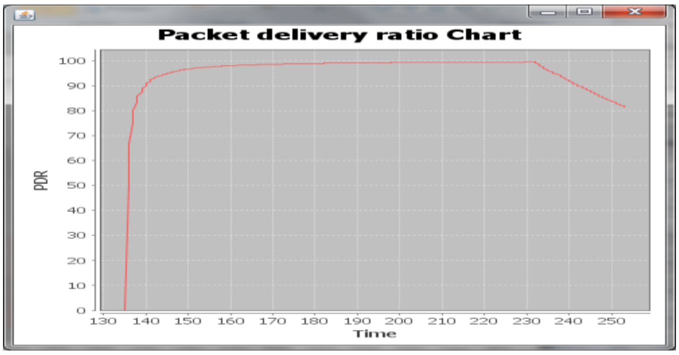

Fig 4 Packet Delivery Ratio Chart

Loss Ratio Chart: Figure 5 illustrates the packet loss ratio chart of the TORAC scheme.

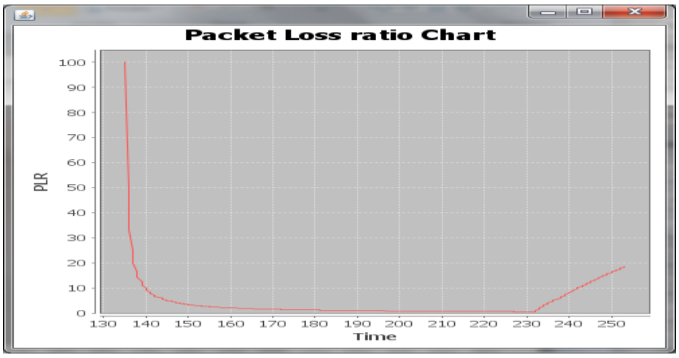

Fig 5: Packet Loss Ratio Chart

Overhead Chart: Figure 6 illustrates the overhead of TORAC scheme.

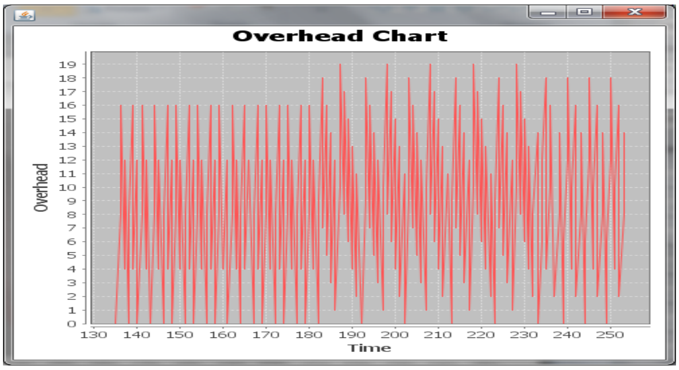

Fig 6: Overhead Chart

Conclusion

In wireless ad hoc networks, providing QoS is very challenging task while one node fails in an optimal path. To provide more efficient routings for packets while one node fails in between the optimal path from source node to destination node without source node need to resend the packet. The proposed TORAC scheme handles the task and provides number of alternative paths for packets from source node to destination node without resending the packets. This provides the QoS solution using forwarding candidate set selection, candidate selection and prioritization and all these depends on the nodes available bandwidth, backlog traffic and energy. By considering each nodes factors the selection and prioritization of node is done for providing alternative route for packets.

Acknowledgement

It is my privilege to acknowledge with deep sense of gratitude to Computer Engineering Department for their support and help and cooperation.

References

1. Yang Qin, Li Li, Xiaoxiong Zhong “Opportunistic routing with admission control in wireless ad hoc networks “ ,0140-3664/2014 Published by Elsevier B.V.
2. WangBoHuangChuanheYangWenzhongWangTong “Trust Opportunistic Routing Protocol in Multi-hop Wireless Networks” 978-1-4244-5849-3/10 ©2010 IEEE
3. S. Biswas, R. Morris, ExOR: Opportunistic multi-hop routing for wireless networks, in: Proceedings of the 2005 Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications SIGCOMM’05), Philadelphia, PA, USA, 2005, pp. 133–144.
4. S. Chachulski, M. Jennings, S. Katti and other., Trading Structure for Randomness in wireless opportunistic routing, in: Proceedings of the 2007 Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications (SIGCOMM’07), Kyoto, Japan, 2007, pp. 169–180.
5. E. Rozner, J. Seshadri, Y.A. Mehta, et al., SOAR: Simple opportunistic adaptive routing protocol for wireless mesh networks, IEEE Trans. Mob. Comput. 8 (2009) 1622–1635.
6. M.A. Ergin, M. Gruteser, L. Luo, et al., Available bandwidth estimation and admission control for QoS routing in wireless mesh networks, Elsevier 31 (2008) 1301–1317.
7. PallaviShinde, and Mr. N. D. Kale “A survey on admission control and trust based opportunistics routing in Wireless ad hoc networks.“ IJERT, (ISSN: 2278-0181), Vol. 3 Issue 12, December-2014.
8. X. Gao, F. Wu, X.F. Gao et al., BREW: A bandwidth reservation protocol for multi rate any path routing in wireless mesh networks, in: Proceedings of IEEE Wireless Communications and Networking Conference (WCNC’13), Shanghai, China, 2013 pp. 1327–1332.
9. P. Zhao, X. Yang, J. Wang et al., BOR/AC: bandwidth-aware opportunistic routing with admission control in wireless mesh networks, in: Proceedings of 31st IEEE INFOCOM, Orlando, FL, USA, 2012, pp. 2701–2705
10. Pallavi Shinde and Mr. N. D. Kale “Admission Control and Trust Based Opportunistics Routing in Wireless Ad Hoc Networks" cPGCON-15, Computer Engineering PG-Conference, Savitribai Phule Pune, University. ACM-2015.

Author Profile

Pallavi Shinde received the B.E. and M.E. degrees in Computer Engineering from PVPIT, Pune.