International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-2 Issue-4, April 2013

Novel Routing Approaches for Wireless Ad Hoc Networks

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Abstract— ***In wireless ad-hoc networks, a new routing scheme is proposed; it is called Novel Routing Approach-NRA. This method adopts reinforcement learning framework to route the data from source to Destination in the absence of detailed knowledge of entire channel. In this method, an every node itself determines the efficient way to transmit data and utilizes the network opportunity. Also this approach addresses the network congestion problem and improves the throughput that minimizes the delay. This paper examines the traffic flow of a wireless Ad hoc network; Congestion occurs due to elastic traffic that degrades the performance of the entire network. In order to predict the future congestion situation, a relevant estimation is designed for each forwarder node and our proposed algorithm Agent Based Congestion Control(ABCC) Routing Protocol which possess the estimation function. Hence our proposed work can minimize the amount of congestion and delay in opportunistic routing models than the existing ones.***

Keywords— ***maximization, Wireless ad-hoc networks, Agent Based Congestion control Routing Protocol.***

I. INTRODUCTION

AD-HOC wireless networks are defined as an autonomous system of nodes connected by wireless links and communicating in a multichip fashion. The benefits of ad-hoc networks are easy to deployment thereby enabling an inexpensive way to achieve the goal of ubiquitous communications. The possible routing for multichip wireless ad- hoc networks has seen recent research interest to overcome the failure of formal routing [1]–[6] as applied in wireless setting. Motivated by humanistic routing resolution in the Internet, formal routing in ad-hoc networks attempts to find a fixed routing along which the packets are forwarded [7].Such fixed routing schemes fail to take advantage of broad cast nature and opportunities provided by the wireless medium and result in unnecessary packet retransmissions. The possible routing decisions, in contrast, are made in an online manner by choosing the next relay based on the actual transmission outcomes as well as a rank ordering of nearby nodes. The possible routing moderate the impact of low wireless links by exploiting the broadcast nature of wireless transmissions and the path diversity. One of the fundamental tasks that an ad hoc network should often perform is congestion control. Congestion control is the contrivance by which the network bandwidth is distributed across multiple end-to-end communications. Its main goal is to limit the delay and buffer overflow caused by network traffic and provide tradeoffs between efficient and fair resource allocation.

Congestion is an unwanted situation and is disastrous for a data transmission system as it manifests itself as depletion of resources that are critical to the operation of the system. Doing this enables optimal usage of resources for all the nodes in the system with a measurable quality-of- service (QOS). In ad hoc wireless networks the link capacities are “elastic”. Most routing schemes for ad hoc networks select paths that minimize hop count, but it leads to traffic at some block, while other blocks are not fully utilized. To avoid the traffic in wireless ad hoc networks, wireless agent travels through the network, it can select a minimum loaded neighbor node as its next hop and update the routing table according to the node’s congestion status [21]. The opportunistic algorithms proposed in [1]–[6] depend on a precise probabilistic model of wireless connections and local topology of the network. In a feasible setting, however, these opportunistic models have to be “learned” and “maintained.” In other words, a comprehensive study and evaluation of any possible routing scheme requires an integrated approach to the issue of possible estimation. Authors in [8] provide a sensitivity analysis for the opportunistic routing algorithm given in [6]. However, by and large, the question of learning estimating channel statistics in conjunction with opportunistic routing re-mains unexplored. Using a reinforcement learning framework, to propose a distributed adaptive opportunistic routing algorithm (d-Adaptor) that minimizes the expected average per-packet cost for routing a packet from a source node to a destination [22] The reinforcement learning framework allows for a low-complexity, low-overhead, distributed asynchronous implementation. The main contribution of this paper is to provide an opportunistic routing algorithm that: 1) assumes no knowledge about the channel statistics and network, but 2) uses a reinforcement learning framework in order to enable the nodes to adapt their routing strategies, and 3) optimally exploits the statistical opportunities and receiver diversity. In doing so, to build on the Markov decision formulation in [6] and an important theorem in Q-learning proved in [9]. There are many learning-based routing solutions (both heuristic or analytically driven) for conventional routing in wireless or wire [10]–[15]. None of these solutions exploits the receiver diversity gain in the context of opportunistic routing. The authors in [10]–[14] focus on heuristic routing algorithms that adaptively identify the least congested path in a wired network. In wireless network flows can compete even if they don’t share a wireless link in their paths. Thus, in ad hoc wireless networks the contention relations between link-layer flows provide fundamental constraints for resource allocation. In wireless networks the joint design of congestion and media access control is naturally formulated using the network utility maximization framework considering the new constraints that arise from channel contention.

Manuscript published on 30 April 2013.
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In wire line networks with fixed capacities, congestion control is implemented at the transport layer and is often designed separately from functions of other layers. Useful mathematical models and tools based on convex optimization and control theory have been developed, which cast congestion control algorithms as decentralized primal-dual schemes to solve network utility maximization problems. In Section II, discuss the system model and formulate the problem. Section III Formally introduces our proposed ABCC routing protocol algorithm, Section IV discuss the Simulation result Section V Discuses the modeling and preliminaries of congestion control model Finally, conclude the paper and discuss future work in Section VI.

II. SYSTEM MODEL

To consider the problem of routing packets from a source node 0 to a destination node d in a wireless ad hoc network of node k+1 along a sequence of routing packets set denoted as Θ={1,….k}. The time is slotted and indexed by n ≥ 0(this assumption is not technically critical and is only assumed for ease of exposition). A packet is indexed by m ≥ 1 is generated at the source node 0 at time according to an arbitrary distribution with rate. Transmission cost Ci>0 can be retransmitted to the node 'i' considered to model the amount of energy used for transmission, the expected time to transmit a given packet. Consider an opportunistic routing setting with no duplicate copies of the packets. In other words, at a given time only one node is responsible for routing any given packet. Given a successful packet transmission from node to the set of neighbor nodes S, the next (possibly randomized) routing decision includes: 1) retransmission by node 'i'; 2) re-laying the packet by a node jϵS; 3) dropping the packet altogether. Denote the termination action by T and termination time is denoted as τ_T^m be the stopping time when packet is terminated m. The discriminate among the termination events as follows. To assume that upon the termination of a packet at the destination (successful delivery of a packet to the destination), a fixed and given positive delivery reward R is obtained, while no reward is obtained if the packet is terminated before it reaches the destination. Let denote this random reward obtained at the termination time, i.e., either zero if the packet is dropped prior to reaching the destination node or if the packet is received at the destination.

Let $i_{n,m}$is the index of the node at time n and it transmits packet m , and accordingly let $c_{i\,n,m}$ denote the cost of transmission (equal to zero).The routing scheme can be viewed as selecting a (random) sequence of nodes $i_{n,m}$for relaying packets m=1,2…….As such, the expected average per-packet reward associated with routing packets along a sequence of up $\{i_{n,m}\}$to time N is

$$J_N = E\left[\frac{I}{M}\sum_{M=1}^{M_N}\left\{T_m - \sum_{n=\tau_S^m}^{\tau_T^{m-1}} Ci_{n,m}\right\}\right] \quad (1)$$

M_N denote the number of packets terminated up to time m ,and the expectation is taken over the events of transmission decisions, successful packet receptions, and packet generation times.

Problem (A): Choose relay nodes in the absence of knowledge about the network topology such that J_N is maximized as. N→∞ and the performance of the routing protocol are affected by the service types of the traffic carried by the intermediate nodes.

In Section III, proposed the Wireless Agent Based Congestion Control Adaptor routing algorithm, which solves Problem. (A) The nature of the algorithm allows nodes to make routing decisions in distributed, asynchronous, and adaptive manner.

III. ABCC ROUTING ALOGRITHM

First explain the notation that used in the Adaptor algorithm.The notations are follows. Let $N_{(i)}$denote the set of neighbors of node i. Let $\mathfrak{S}^i$ denote the set of potential reception outcomes due to a transmission from node iϵΘ To refer to $\mathfrak{S}^i$ as the state space for node 's transmission. To denote A(S) =SU {T} the space of all allowable actions available to node 'i' upon successful reception at nodes in S. Finally, for each node I and define a reward function on s and potential decisions aϵA(S) as

$$g(S,a) = \begin{cases} c_a & if \quad a \in S \\ R, & if \quad a = T \; and \; d \in S \\ 0, & if \quad a = T \; but \; d \in S \end{cases}$$

TABLE I

NOTATIONS USED IN THE DESCRIPTION OF THE ALGORITHM:

In the scheme makes such decisions in a distributed manner via the following three-way handshake between node and its neighbors 1) at time, node transmits a packet. 2) The set of nodes who have successfully received the packet from node , transmit acknowledgment (ACK) packets to node . In addition to the node's identity, the acknowledgment node , transmit acknowledgment (ACK) packets to node . In addition to the node's identity, the acknowledgment packet of node includes a control message known as estimated best score (EBS). 3) Node announces node as the next transmission announces the termination decision in a forwarding (FO) packet.The routing decision of node at time is based on an adaptive (stored) score vector. The score vector lies in space, where, and is updated obtained from neighbor node using the EBS messages. Furthermore, node uses a set of counting variables and a sequence of positive scalars to update its score vector at time. Table I provides notations used in the ABCC routing protocol algorithm.

B. Detailed Description of ABCC routing

The operation of ABCC Adaptor can be described in terms of initialization and four stages of transmission, reception and acknowledgment, relay, and adaptive computation as shown in Fig. 1. Flow of the algorithm. The algorithm follows a five-stage procedure: transmission, congestion, acknowledgment, relay, and update.

1) Transmission Stage:

Transmission stage occurs at time in which node transmits if it has a packet.

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2) Congestion stage:

Node Agent (NA):

A Node Agent (NA) starts from every node and moves to an adjacent node at every time. A node visited next is selected at the equivalent probability.

Symbol	Definition
S^i_n	Nodes receiving the transmission from node i at time n
a^i_n	Decision taken by node i at time n
$A(S)$	Set of available actions when nodes in S receive a packet
$N(i)$	Neighbors of node i including node i
$g(S,a)$	Reward obtained by taking decision a when set S of nodes receive a packet
$\nu_n(i,S,a)$	Number of times up to time n, nodes S have received a packet from node i and decision a is taken
$N_n(i,S)$	Number of times up to time n, nodes S have received a packet from node i
$\Lambda_n(i,S,a)$	Score for node i at time n, when nodes S have received the packet and decision a is taken
Λ^i_{max}	Estimated best score for node i

The NA brings its own history of movement and updates the routing table of the node it is visiting. Each NA has its own history which consists of its source node S, the current time Tc, the number of hops *NH* from the starting node, the adjacent node *AN* that the NA has last visited and the number of multiple packets *NP* on AN at *Tc* . When an NA visits a node, it puts the information (*S*,*Tc*, *NH*, *AN*, *NP*) in the routing table of that node.Each node has a routing table that stores k fresh routing information records from itself to every node *S*:[*S*,{(*Tci*, *NHi*,*ANi*,*NPi*)L(*Tcm*, *NHm*, *ANm*, *NPm*)}] , where *Tc*1 > *Tc*2 >L> *Tm* . We call m the number of entries. For each *i*(l≤i≤m) , *Tci* is a time of visiting the adjacent node *ANi* , *NHi* is the number of hops and *NPi* is the number of NAs on *ANi* . When NA with the history (*S*,*Tc*, *NH*, *AN*, *NP*) visits a node *N* , the routing information on that node [*S*,{(*Tci*, *NHi*, *ANi*, *NPi*)… (*Tcm*, *NHm*, *ANm*, *NPm*)}] is updated to

[S ;{ Tc, NH; AN, NP), (Tci, NHi, ANi, NPi, NPi .) (Tcm-1, NHm-1, ANm-1, NPm-1)

Queue Length Estimation:

The traffic rate within the network has to be determined to find the level of congestion. The traffic rate is significantly affected by

- the number of new incoming flows
- the number of existing flows
- the density of the nodes in the network
- Communication abilities of nodes

Our goal is to acquire macroscopic network statistics using a heuristic approach. We compute the traffic rate as follows: Let the value *Lo* represent the offered load at the queue of node *i* and it is defined as

$$Loi = \frac{ARi}{SRi} \qquad (1)$$

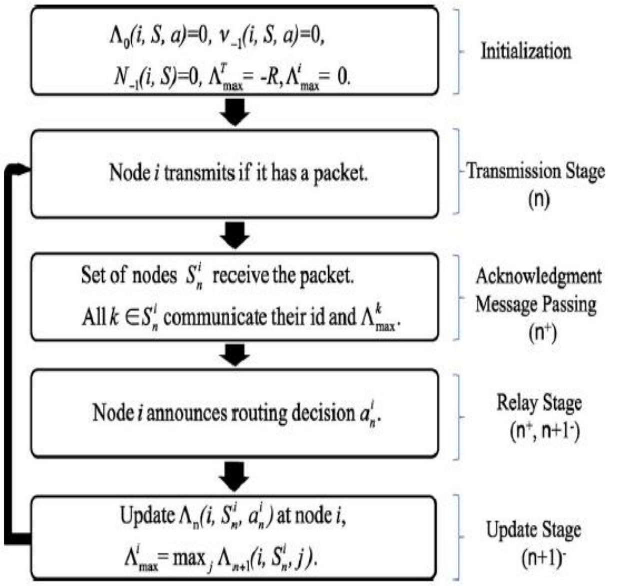

Fig :1 Flow of algorithm

where *ARi* is the aggregate arrival rate of the packets produced and forwarded at node *i* while *SRi* is the service rate at node *i* , i.e., *SRi* = 1/*T* where *T* is the computed exponentially weighted moving average of the packets' waiting time at the head of the service queue. The distribution of the queue length $PR(Q_1)$ (essentially this is the probability that there are Q_l packets in the queue) at the node is computed as

$$PR(Q_1) = (1 - L_{0i})L^1_{oi} \qquad (2)$$

For *N* distinct queues, the joint distribution is the product

$$PR(Q_{11}, Q_{12} \cdot\cdot Q_{1N}) = \Pi^N_{i=0}(1 - L_{0i})L^{l_i}_{oi} \qquad (3)$$

Channel Contention Estimation:

In this network, we consider IEEE 802.11 MAC with the distributed coordination function (DCF). It has the packet sequence as request-to-send (RTS), clear-to-send (CTS), data and acknowledgement (ACK). The amount of time between the receipt of one packet and the transmission of the next is called a short inter frame space (SIFS). Then the channel occupation due to MAC contention will be

$$C_{occ} = t_{RTS} + t_{CTS} + 3t_{SIFS} + t_{acc} \qquad (4)$$

Where t_{RTS} and t_{CTS} are the time consumed on *RTS* and *CTS* , espectively and t_{SIFS} is the *SIFS* period. t_{acc} is the time aken due to access contention.

The channel occupation is mainly dependent upon the medium access contention, and the number of packet collisions. That is, *Cocc* is strongly related to the congestion around a given node. *Cocc* can become relatively large if congestion is incurred and not controlled, and it can dramatically decrease the capacity of a congested link.

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Total Congestion Metric:
The Total Congestion Metric (TCM) can be estimated from the obtained queue length and the channel contention.

$TCM = PR(Q_1) + Cocc$ (5)

Agent Based Congestion Control Routing:
Step 1: The source S checks the number of available one hop neighbors and clones the Node Agent (NA) to that neighbors.
Step 2: The Node Agent selects the shortest path of the route to move towards the destination.
Step 3: The NA1 moves towards the destination in a hop-by-hop manner in the path P1 and NA2 in P2 and NA3 in P3 respectively.

3) Reception and acknowledgment Stage:
Let denote the (random) set of nodes that have received the packet transmitted by node . In the reception and acknowledgment stage, successful reception of the packet transmitted by node is acknowledged to it by all the nodes in. We assume that the delay for the acknowledgment stage is small enough (not more than the duration of the time slot) . For all nodes, the ACK packet of node to node includes the EBS message. Upon reception and acknowledgment, the counting random variable is incremented.

4) Relay Stage:
Before transmission node x announces its routing decision to all its neighbors. The transmission log of x is also updated based on current transmission. Then X is waiting for acknowledgement from destination.

5) Update Stage:
At time, after being done with transmission and relaying, node updates score vector.

TABLE II
OVERHEAD COMPARISONS

	Data Frame	Control packets	Total
802.11	397 μs	40 μs (ACK)	437 μs
Genie-aided opportunistic scheme	400 μs	115 μs + 40 μs (ACK+FO)	555 μs
d-AdaptOR	400 μs	124 μs +40 μs (ACK+FO)	564 μs

IV. SIMULATION RESULTS

Simulation Model and Parameters:
We use NS2 [18] to simulate our proposed technique. In the simulation, the channel capacity of mobile hosts is set to the same value: 11Mbps. In the simulation, mobile nodes move in a 1000 meter x 1000 meter region for 50 seconds simulation time. Initial locations and movements of the nodes are obtained using the random waypoint (RWP) model of NS2. It is assumed that eachnode moves independently with the same average speed. All nodes have the same transmission range of 250 meters. The node speed is 5 m/s. and pause time is 5 seconds. In the simulation, for class1 traffic video is used and for class2 and Class3, CBR and FTP are used respectively.
The simulation settings and parameters are summarized in table 2.

No. of Nodes	50
Area Size	1000 X 1000
Mac	802.11e
Radio Range	250m
Simulation Time	50 sec
Routing Protocol	AODV
Traffic Source	CBR and Video
Video Trace	JurassikH263-256k
Packet Size	512
Mobility Model	Random Way Point
Speed	5m/s
Pause time	5 sec
MSDU	2132
Rate	250kb, 500kb,.....1000Kb
No. of Flows	2,4,6,8 and 10

V. MODELING AND PRELIMINARIES

We consider an ad hoc wireless network represented by an undirected graph G = (N,L), where N is the set of nodesand L is the set of logical links. Each source node s has its utility function Us(xs), which is a function of its transmitting data rate [0,∞) and we assume it is continuously differentiable, increasing, and□xs strictly concave. For its communication, each source uses a subset L(s) of links. Let Lout(n) denote the set of outgoing links from node n,and Lin(n) the set of incoming links to node n. We define S as the set of all sources and S(l) as the subset of sources that are traversing link l. We assume static topology (the nodes are in a fixed position).
Also, each link has finite capacity cl when it is active, i.e. we implicitly assume that the wireless channel is fixed or some underlying mechanism masks the channel variation. Wireless transmissions are interference-limited.

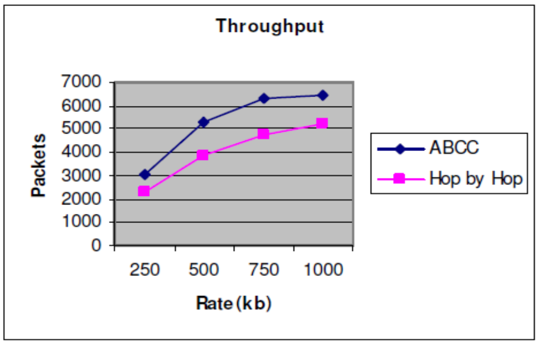

Fig. 2. Rate Vs Throughput

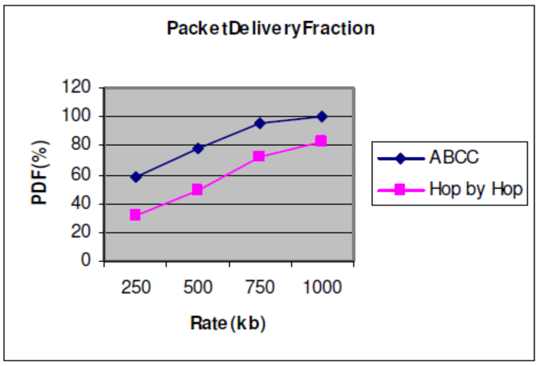

Fig. 3. Rate Vs Packet Delivery Fraction

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All links transmit at rate cl for the duration they hold the channel. Assume that each node cannot transmit or receive simultaneously, and can transmit to or receive from at most one adjacent node at a time. Since each node has a limited transmission range, contention among links for the shared medium is location-dependent. Spatial reuse is possible only when links are sufficiently far apart. Define two types of sets, LI (n) and NI (l), to capture the location dependent contention relations, where LI (n) is the set of links whose receptions are affected adversely by the transmission of node n, excluding outgoing links from node n, and NI (l) is the set of nodes whose transmission fail the reception of link l, excluding the transmit node of NI(l). Time is slotted in LI(n) if and only if n link l. Also note that l intervals of equal unit length and the i'th slot refers to the time interval [i, i + 1), where i = 0, 1. . . i.e., transmission attempts of each node occur at discrete time instances i. In this a MAC protocol is developed based on random access with probabilistic(re-transmissions). At the beginning of a slot, each node n transmits data with probability qn. When it determines to transmit data, it selects one of its Lout(n) with probability pl/qn, where pl is the link outgoing links l persistence probability;1)Where link throughputs given p and q, since the term is the probability that a packet is transmitted over link l and successfully received by its receiver. The problem formulation in (1) entails congestion control at the network layer (finding x), and contention control at the MAC layer (finding p and q). The two layers are coupled through the first constraint in (1), which asserts that for each link l, the aggregate source rate does not exceed the link throughput. The transport layer source rates and the MAC layer transmission probabilities should be jointly optimized to maximize the aggregate source utility.The outgoing link prices for sources involved are adjusted as follows

1) Create a random network.
2) After creating a network, the distance between each node to all other nodes are found by using Euclidean distance method. d=sqrt ((x1-x2) ^2+(y1-y2)^2)
3) Find the neighbor list of each node is used.
4) The neighboring list in order to find the path between each source and destination using DSR routing protocol is implement.
5) Checks for the best optimal path from the various paths obtained in the evaluation of route Algorithm at source s
6) Receives from the network the sum $\lambda^s(t)=\sum_{l\epsilon L(s)\lambda_{ls}}(t)$ of link prices in *s*'s path;
7) Computes the new log rate using

Zs(t + 1)=$\max_{z_s} U_s^1(z_s)$-λ^s(t)z_s)

8) Communicates the new log rate Zs(t + 1) to all links l ϵ L(s) on *s*'s path.

Algorithm at Node n:

9) Receives log rates Zs(t) from all sources s $U_{l\epsilon L_{out(n)}}$S(l) go through the outgoing links of node n
10) Receives pricesλl'(t),Ąl' ϵ$L'(n)$from the neighboring nodes n' where$l'\epsilon L_{out}(n')$
11) Calculate αl_s(t),pl(t),$q_n(t)$,Ąlϵ$L_{out}(n)$,Ą$_s\epsilon L(s)$ according to Proposition 2;
12) Computes new prices

λls(t + 1) = [λls(t) + γ(t)(Zs(λ(t))−logcl − log αls(λ(t))− log pl (λ(t)) −∑NI(l)log(1− qk(λ(t)))]+. For each outgoing link lϵ $L_{out}(n)$ communicates new Prices $\lambda_s(t+1)$ to all sources *s S*(*l*) that use link *l a*nd$\lambda^l(t+1)$to all nodes in $N^i(l)$ For the convergence and optimality of this distributed algorithm, have the following result.

VI. CONCLUSION AND FUTURE WORK

In this paper, we proposed Agent based Congestion Control routing protocol algorithm whose performance is shown to be optimal with zero knowledge regarding network topology and channel statistics. Also solve the congestion problem and improves the throughput that minimizes the delay. Our future work relies in the direction of providing safety and security to the network from the external threats.

REFERENCES

[1] C. Lott and D. Teneketzis, "Stochastic routing in ad hoc wireless networks," in Proc. 39th IEEE Conf. Decision Control, 2000, vol. 3, pp. 2302–2307, vol. 3.
[2] P. Larsson, "Selection diversity forwarding in a multihop packet radio network with fading channel and capture," Mobile Comput. Commun Rev., vol. 2, no. 4, pp. 47–54, Oct. 2001.
[3] M. Zorzi and R. R. Rao, "Geographic random forwarding (GeRaF) for ad hoc and sensor networks: Multihop performance," IEEE Trans. Mobile Comput., vol. 2, no. 4, pp. 337–348, Oct.–Dec. 2003.
[4] S. Biswas and R. Morris, "ExOR: Opportunistic multi-hop routing for wireless networks," Comput. Commun. Rev., vol. 35, pp. 33–44, Oct. 2005.
[5] S. Jain and S. R. Das, "Exploiting path diversity in the link layer in wireless ad hoc networks," in Proc. 6th IEEE WoWMoM, Jun. 2005, pp. 22–30.
[6] C. Lott and D. Teneketzis, "Stochastic routing in ad hoc networks," IEEE Trans. Autom. Control, vol. 51, no. 1, pp. 52–72, Jan. 2006.
[7] E. M. Royer and C. K. Toh, "A review of current routing protocols for ad hoc mobile wireless networks,"IEEEPers. , vol. 6, no. 2, pp. 46–55, Apr. 1999.
[8] T. Javidi and D. Teneketzis, "Sensitivity analysis for optimal routing in wireless ad hoc networks in presence of error in channel quality estimation," IEEE Trans. Autom. Control, vol. 49, no. 8, pp. 1303–1316, Aug. 2004.
[9] J.N.Tsitsiklis, "Asynchronous stochastic approximation and Q-learning," in Proc. 32nd IEEE Conf. Decision Control, Dec. 1993, vol. 1, pp. 395–400.
[10] J. Boyan and M. Littman, "Packet routing in dynamically changing networks: A reinforcement learning approach," in Proc. NIPS, 1994, pp. 671–678.
[11] J. W. Bates, "Packet routing and reinforcement learning: Estimating shortest paths in dynamic graphs," 1995, unpublished.
[12] S. Choi and D. Yeung, "Predictive Q-routing: A memory-based reinforcement learning approach to adaptive traffic control," in Proc. NIPS, 1996, pp. 945–951.
[13] S. Kumar and R. Miikkulainen, "Dual reinforcement Q-routing: An on-line adaptive routing algorithm," in Proc. Smart Eng. Syst., Neural Netw., Fuzzy Logic, Data Mining, Evol. Program., 2000, pp. 231–238.
[14] S. S. Dhillon and P. Van Mieghem, "Performance analysis of the AntNet algorithm," Comput. Netw., vol. 51, no. 8, pp. 2104–2125, 2007.
[15] P. Purkayastha and J. S. Baras, "Convergence of Ant routing algorithm via stochastic approximation and optimization," in Proc. IEEE Conf. Decision Control, 2007, pp. 340–354.
[16] D. P. Bertsekas and J. N. Tsitsiklis, Neuro-Dynamic Programming. Belmont, MA: Athena Scientific, 1996.
[17] S. Chachulski, M. Jennings, S. Katti, and D. Katabi, "Trading structure for randomness in wireless opportunistic routing," in Proc. ACM SIG- COMM, 2007, pp. 169–180.
[18] M. L. Puterman, Markov Decision Processes: Discrete Stochastic Dynamic Programming. New York: Wiley, 1994.

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[19] D. P. Bertsekas and J. N. Tsitsiklis, Parallel and Distributed Computation: Numerical Methods. Belmont, MA: Athena Scientific, 1997.
[20] W. Stallings, Wireless Communications and Networks, 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 2004.
[21] *Performance Analysis on Mobile Agent Based Congestion Control Using AODV Routing Protocol Technique with Hop by Hop Algorithm for Mobile Ad-hoc Network* .Mr.Vishnu Kumar Sharma1 and Dr. Sarita Singh Bhadauria2.
[22] *Adaptive Opportunistic Routing for Wireless Ad Hoc Networks.* Abhijeet A. Bhorkar, Mohammad Naghshvar, *Student Member*, *IEEE*, Tara Javidi, *Member, IEEE*, and Bhaskar D. Rao, *Fellow, IEEE.*

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