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SENSITIVITY EVALUATION FOR MULTICAST OPPORTUNISTIC ROUTING IN WIRELESS ADHOC NETWORKS

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Abstract

A wireless ad hoc network is a decentralized type of wireless network. If the network is adhoc since it does not rely on a pre accessible infrastructure, such as routers in wired networks and access points in managed wireless networks. As a alternate for, each node contribute in routing by forwarding data for remaining nodes, so the determination of which nodes forward data is made energetically on the basis of network connectivity. In adding together to the characteristic routing, ad hoc networks can use flooding for forwarding the data. A distributed adaptive opportunistic routing design for multihop wireless adhoc networks is projected. The projected scheme makes use of a support learning framework to opportunistically route the packets even in the absence of dependable information about channel statistics and network model. The proposed scheme is to be most select with respect to an expected average per-packet recompense criterion. The proposed routing scheme in cooperation addresses the issues of knowledge and routing in an opportunistic background, where the network structure is characterized by the transmission success probabilities. In exacting, this knowledge framework leads to a stochastic routing scheme that optimally "explores" and "exploits" the opportunities in the network.

Index Terms: *Wireless Ad Hoc Networks, Opportunistic Routing, Reward Maximization, Routing Algorithm*

I. INTRODUCTION

Opportunistic routing for multihop wireless adhoc networks has seen current research interest to overcome absence of conservative routing as applied in wireless background motivated by traditional routing solutions in the internet, conservative routing in ad hoc networks attempts to find a fixed path along which the packets are forwarded. such fixed-path methods fail to take advantage of broadcast nature and chances provided by the wireless medium and result in redundant packet retransmissions. The opportunistic routing conclusions, in disparity, are made in an online manner by choosing the next relay based on the actual transmission results as well as a rank ordering of neighboring nodes. opportunistic routing moderates the impact of poor wireless links by using the broadcast nature of wireless transmissions and the path diversity. The opportunistic algorithms proposed in depend on a precise probabilistic model of wireless connections and local topology of the network. In a realistic setting, however, these probabilistic models have to be "learned" and "maintained." In other words, a comprehensive study and evaluation of any opportunistic routing scheme requires an integrated approach to the issue of probability estimation. Authors in provide a sensitivity analysis for the opportunistic routing algorithm given in. However, by and large, the question of learning/estimating channel statistics in conjunction with opportunistic routing remains unexplored. The optimal routing decision at any period is to select the next communicate node based on a distance-vector shortening the expected cost to forward from the neighbors to the objective. This "distance" is shown to be computable in a dispersed manner and with low complexity using the probabilistic explanation of wireless links.

Fig.1: Multi hop wireless ad hoc networks

Here we have first investigated the problem of opportunistically routing packets in a wireless multihop network when zero or erroneous knowledge of transmission success probabilities and network topology is available. Using a reinforcement knowledge framework, we propose a disseminated 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. This is accomplished by both sufficiently exploring the network with data packets and exploiting the best routing opportunities. Our projected reinforcement learning framework allows for a low-overhead, low- complexity and distributed asynchronous implementation. The important characteristics of d- Adaptor are that it is oblivious to the initial knowledge about the network, it is distributed and asynchronous.

In this article provide an opportunistic routing algorithm that:
1) Assumes no knowledge about the channel statistics and network, but
2) Uses a reinforcement learning framework in organize to enable the nodes to adapt their routing strategies
3) Optimally exploits the statistical opportunities and receiver diversity.
There are a lot of learning-based routing solutions both heuristic and analytically driven for conservative routing in wireless or wired networks. None of these solutions uses the receiver range gain in the context of opportunistic routing. We focus on heuristic routing algorithms that adaptively identify the least congested path in a wired network. If the network congestion, therefore delay, were to be replaced by time-invariant quantities, the heuristics in would become a special case of d-Adaptor in a network with deterministic channels and with no receiver diversity. In, analytic results for ant routing are obtained in wired networks without opportunism. Ant routing make use of ant-like probes to find paths of best possible costs such as expected delay, hop count and packet loss probability. This dependence on ant-like probing corresponds to a stark difference with our move toward where d-Adaptor relies solely on data packet for exploration.

II. RELATED WORK

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. The authors in focus on heuristic routing algorithms that adaptively identify the least congested path in a wired network. If the network congestion, hence delay were to be replaced by time-invariant quantities,
1. The heuristics in would become a special case of d Adaptor in a network with deterministic channels and with no receiver diversity. Ant routing uses ant-like probes to find paths of optimal costs such as expected hop count, expected delay, and packet loss probability.
2. This dependence on ant-like probing represents a stark difference with our approach where d-Adaptor relies solely on data packet for exploration.
The main disadvantages of the existing systems are:

- Ant routing uses ant-like probes to find paths of optimal costs such as expected hop count.
- Expected delay.
- Packet loss.

Stochastic Routing in Ad-Hoc Networks:

In this paper, authors have investigated a network routing problem where a probabilistic local broadcast transmission model is used to determine routing. We discuss this model's key features, and note that the local broadcast transmission model can be viewed as soft handoff for an ad-hoc network. We present results showing that an index policy is optimal for the routing problem. We extend the network model to allow for control of transmission type, and prove that the index nature of the optimal routing policy remains unchanged. We present three distributed algorithms which compute an optimal routing policy, discuss their convergence properties, and demonstrate their performance through simulation.

Selection diversity forwarding in a multi-hop packet radio network with fading channel and capture:

In this paper, forwarding methods for wireless mobile multi hop networking in Rayleigh fading and non-fading channels are examined. An adaptive forwarding scheme denoted Selection Diversity Forwarding (SDF) is introduced and compared with two classical forwarding methods. It is shown that SDF presents significant performance improvements. In particular and in contrast to the reference methods NFP and MFR, the performance of SDF is enhanced under fading channel conditions. It is found that local path adaptation has potential to perform better than routing approaches along a single path. Geographic random forwarding (GeRaF) for ad hoc and sensor networks : Multi-hop performance ExOR: Opportunistic multi-hop routing for wireless networks, A Simplified analysis is given first , some relevant tradeoffs are highlighted ,and parameter optimization is pursued ,further , a semi - Markov model is developed which provides a more accurate performance evaluation . Simulation results supporting the validity of analytical approach are also provided.

Exploiting path diversity in the link layer in wireless ad hoc networks:

An integrated routing and MAC protocol that increases the throughput of large unicast transfers in multi-hop wireless networks. ExOR chooses each hop of a packet's route after the transmission for that hop, so that the choice can react which intermediate nodes actually received the transmission. This deferred choice gives each transmission multiple opportunities to make progress. As a result ExOR can use long radio links with high loss rates , which would be avoided by traditional routing. ExOR in-creases a connection's throughput while using no more net-work capacity than traditional routing.

Stochastic routing in ad hoc networks:

We investigate a network routing problem where a probabilistic local broadcast transmission model is used to determine routing. We discuss this model's key features, and note that the local broadcast transmission model can be viewed as soft handoff for an adhoc network. We present results showing that an index policy is optimal for the routing problem. We extend the network model to allow for control of transmission type, and prove that the index nature of the optimal routing policy remains unchanged. We present three distributed algorithms which compute an optimal routing policy, discuss their convergence properties, and demonstrate their performance through simulation.

Discrete Stochastic Dynamic Programming:

The general discrete-time linear quadratic stochastic control problem. This problem is solved in two steps. Dynamic programming is used to obtain a solution to the stochastic control problem in which perfect measurements of the state are available. Then the stochastic control problem in which only noisy measurements of a linear operator on the state are available is converted into a new stochastic control problem in which perfect measurements of the state are available. This conversion is based upon Kalman filter theory and is valid whenever the disturbances and measurement noises are Gaussian.

III. BACKGROUND

Routing Protocols aim at improving the performance of wireless sensor networks, in terms of the lifetime, the delay and the network throughput. Routing protocols are classified as single hop and multi hop networks, depending on the number of hops to connect the source and target in the network. Based on the network structure routing protocols are classified as flat based, cluster based and location based routing protocols. The establishment of routing path in a wireless sensor network gives reactive and proactive routing protocols. Opportunistic routing is a flat based, reactive, multi-hop routing protocol for wireless sensor networks which applies to both small scale and large scale wireless sensor networks. Opportunistic routing exploits the broadcast nature of wireless sensor networks. The metrics used for forwarder set selection are hop-count, packet delivery ratio and end-to-end delay. Any one or a combination of these metrics can be used in forwarder set selection and for prioritizing the forwarder nodes. Opportunistic routing has potential benefits brought to wireless sensor networks. Challenges faced by opportunistic routing are taken based on network coding coordination, multi-flow rate control, power control with proper bit-rate selection, multi-channel scenario, deployment of nodes and combination of opportunistic routing with selection diversity. Opportunistic routing is analyzed for fixed power model and adjustable power model of wireless sensor network. ExOR [2] multi-hop routing for wireless sensor networks integrates routing and MAC protocol to increase the throughput of multi-hop wireless sensor networks. ExOR uses long radio links with high loss rates for transfer of data in a network, that usually are avoided in traditional routing. With the same network capacity as traditional routing, ExOR results in high throughput in a multi-hop wireless sensor network. AsOR [3] forwards the data from the source to destination through a sequence of intermediate nodes. The assistant nodes are used to provide protection for unsuccessful opportunistic transmissions. Priority is given to conservation of energy in wireless sensor networks in the implementation of AsOR. EEOR [1] allows one of the neighbours to participate in the forwarding of the data packets, from source to destination in multi-hop transmissions in a wireless sensor network. The forwarding node is chosen depending on the cost assigned to each of the nodes. To handle the network traffic efficiently, congestion is controlled in the network dynamically adjusting the flow from each source node in the network. Penalty is imposed on the nodes who choose more than one forwarder nodes in multihop transmission. The protocol computes the expected cost for each node and selecting the forwarder list. From the forwarder list the optimal forwarder list is found by opportunistic routing. The proposed EESOR performs better than the existing EEOR in terms of average End-to-End delay, maximum End-to-End delay and network lifetime

IV. PROPOSED SCHEME FOR OPPORTUNISTIC ROUTING

The proposed scheme utilizes a reinforcement learning framework to opportunistically route the packets even in the absence of reliable knowledge about channel statistics and network model. we first investigate the problem of opportunistically routing packets in a wireless multi-hop network when zero or erroneous knowledge of transmission success probabilities and network topology is available. Using a reinforcement learning framework, we 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. This is achieved by both sufficiently exploring the network using data packets and exploiting the best routing opportunities. Our proposed reinforcement learning framework allows for a lowcomplexity, low-overhead, distributed asynchronous implementation. The significant characteristics of d-AdaptOR are that it is oblivious to the initial knowledge about the network, it is distributed, and it is asynchronous. The advantages of the proposed scheme are: The proposed reinforcement learning framework allows for a low-complexity, low-overhead, distributed asynchronous implementation. The significant characteristics of d-AdaptOR are that it is oblivious to the initial knowledge about the network, it is distributed, and it is asynchronous. The framework allows for a low-complexity, lowoverhead, distributed asynchronous implementation. The significant characteristics of d-AdaptOR are that it is oblivious to the initial knowledge about the network, it is distributed, and it is asynchronous. 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

3) Optimally exploits the statistical opportunities and receiver diversity. In doing so, we build on the Markov decision formulation and an important theorem in Q-learning proved in. There are many learning-based routing solutions (both heuristic or analytically driven) for conventional routing in wireless or wired networks None of these solutions exploits the receiver diversity gain in the context of opportunistic routing. However, for the sake of completeness, we provide a brief overview of the existing approaches. The authors in focus on heuristic routing algorithms that adaptively identify the least congested path in a wired network. If the network congestion, hence delay, were to be replaced by time-invariant quantities, the heuristics in would become a special case of Adaptor in a network with deterministic channels and with no receiver diversity. In this light, it provides analytic guarantees for the heuristics obtained In analytic results for ant routing are obtained in wired networks without opportunism .Ant routing uses ant-like probes to find paths of optimal costs such as expected hop count, expected delay, and packet loss probability. This dependence on ant-like probing represents a stark difference with our approach where Adaptor relies solely on data packet for exploration. The rest of the paper is organized as follows. In , we discuss the system model and formulate the problem. formally introduces our proposed adaptive routing algorithm, d-Adaptor. We then state and prove the optimality theorem ford-Adaptor.

V.PERFORMANCE EVALUATION

5.1 Simulation Setup

Simulator used in the analyzing the wireless sensor network in this paper is NS2. This section provides simulation setup to demonstrate performance of Energy Efficient Selective Opportunistic Routing in the wireless sensor networks. 50 wireless sensor nodes are deployed randomly in a square area of 500m by 500 m, with uniform distribution. The packet generation rate is one packet per second. Packets of 1000 bytes each, are transferred between source and destination pairs for a simulation time of 150 seconds. The acknowledgment packet size is 40 bytes. All the sensor nodes in the network are deposited with an initial energy of 50 Joules. The energy spent by a sensor node in transmission of packet is maximum of 0.38 Joules, in receiving is 0.36 Joules. The node consumes a minimum energy of 0.003 Joules, when it is in idle state.

5.2 Performance Analysis

This section analyzes the performance of the wireless sensor network for Energy Efficient Selective Opportunistic Routing for the parameters Maximum End-to-End delay, average End-to-End delay and network lifetime. Fig. 3 shows the network scenario of the wireless sensor network with 50 nodes randomly deployed in the area of 500 m X 500 m. 250 m is the transmission range of each of the sensor nodes in the network.

5.2.1 Average End-to-End Delay

End-to-End Delay is defined as the time elapsed between the source node sending the packet and the destination node receiving the packet. The average of the End-to-End delay of all the packets transmitted between each of the pairs of source-destinations gives the average End-to-End delay. The average End-to-End delay is plotted against different pairs of source and destinations as shown in Fig. 4. It is observed that for one hop networks, Energy Efficient Selective Opportunistic Routing does not show any improvement, because the time for choosing the set of forwarder list is not needed. As the number of hops increases, the reduction in delay is more. For two-hop and three-hop communications the delay is reduced up to a maximum of 90 ms which is the same as 9% for 10-20 source-destination pair and 295 ms that is approximately equal to 30 %for 11-22 source destination pair, respectively.

5.2.2 Maximum End-to-End Delay

The plot of maximum of End-to-End delay values, for the same 9 pairs of nodes considered for analyzing average End-to-End delay. Once again, single hop communication takes same amount of time in Energy Efficient Selective Opportunistic Routing. Two-hop communication between the nodes 30 and 32 shows the maximum improvement of around 300 ms, or 3 % of total delay for each source destination pair. And more than two-hop communication yields a maximum reduction of delay by approximately 1000 ms, or 50 %, for the source destination pair 11-22. The reason for this reduction is decrease in the size of forwarder list in case of Energy Efficient Selective Opportunistic Routing, by considering only the neighbour nodes that are nearer to destination.

The small size of forwarder list reduces the time taken for prioritizing and sorting the nodes. The time for finding the shortest distance between each node in the forwarder list and the destination is reduced. The analysis of maximum End-to-End delay shows that, as the number of hops increases, the transmission delay increases. The End-to-End delay is lesser in Energy Efficient Selective Opportunistic Routing as compared to Energy Efficient Opportunistic Routing.

5.2.3 Network Lifetime

The lifetime of a sensor node is considered as the time from its deployment to the time till which the node is having more than 10% of its initial energy. The node is said to be alive in this period. Beyond this period the node is said to be dead. Network Lifetime is the time between inception of the network to the time upto which 10% of the sensor nodes are alive. Fig. 6 shows the network lifetime for both Energy Efficient Opportunistic Routing and Energy Efficient Selective Opportunistic Routing protocols plotted against different network sizes. Network size is considered as 25 nodes, 50 nodes, 75 nodes and 100 nodes for comparing the performance of Energy Efficient Opportunistic Routing and Energy Efficient Selective Opportunistic Routing. The network performance is analyzed for the network sizes 25, 50,75 and 100 nodes for network lifetime. The graph shows that the network lifetime increases for all the networks considered, irrespective of the network size. The reason is Energy Efficient Selective Opportunistic Routing uses lesser number of hops to reach destination from the source and the acknowledgment packet traverses a path that may not be the same as the data path as compared to Energy Efficient Opportunistic Routing.

VI.CONCLUSION

We proposed d-Adaptor, a distributed and opportunistic routing algorithm whose performance is shown to be optimal with zero knowledge regarding network topology and channel statistics. More precisely, under idealized assumptions, d-Adaptor is shown to achieve the performance of an optimal routing with perfect and centralized knowledge about network topology, where the performance is measured in terms of the expected per-packet reward The long-term average reward criterion investigated in this paper inherently ignores the short-term performance. To capture the performance of various adaptive schemes, however, it is desirable to study the performance of the algorithms over a finite horizon. Regret is a function of horizon that quantifies the loss of the performance under a given adaptive algorithm relative to the performance of the topology-aware optimal one. More specially results so far implies that the optimal rate of growth of regret is strictly sub linear in, but fails to provide a conclusive understanding of the short-term behavior of d-Adaptor. An important area of future work comprises developing adaptive algorithms that ensure optimal growth rate of regret.

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