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Adaptive Opportunistic Routing For Wireless AD HOC Networks

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ABSTRACT:

A distributed adaptive opportunistic routing scheme for multihope wireless ad hoc networks is proposed. 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. This scheme is shown to be optimal with respect to an expected average per-packet reward criterion. The proposed routing scheme jointly addresses the issues of learning and routing in an opportunistic context, where the network structure is characterized by the transmission success probabilities. In particular, this learning framework leads to a stochastic routing scheme that optimally "explores" and "exploits" the opportunities in the network.

Keywords:
Adaptive opportunistic routing scheme, Channel statistics, Network model

1. Introduction:

Opportunistic routing for multichip wireless ad hoc networks has seen recent research interest to overcome deficiencies of conventional routing as applied in wireless setting. Motivated by classical routing solutions in the Internet, conventional routing in ad hoc networks attempts to find a fixed path along which the packets are forwarded. Such fixed-path schemes fail to take advantage of broadcast nature and opportunities provided by the wireless medium and result in unnecessary packet retransmissions. The opportunistic 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 neighboring nodes. Opportunistic routing mitigates the impact of poor wireless links by exploiting the broadcast nature of wireless transmissions and the path diversity.The opportunistic algorithms depend on a precise probabilistic model of wireless connections and local topology of the network.

In a practical 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 provide a sensitivity analysis for the opportunistic routing algorithm. However, by and large, the question of learning/estimating channel statistics in conjunction with opportunistic routing remainsunexplored. In this paper, we first investigate the problem of opportunistically routing packets in a wireless multichip 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 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 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, we build on the Markov decision and an important theorem in Q-learning.

1.1 ad-hoc Networks :

The rapid growth of Internet has made communication an integrated and highly important factor of computing. In today's society with the development of mobile devices it has become important to stay online all the time. In order to stay online all the time it must be possible to set up a network fast and cost effective when moving between different infrastructures, ad hoc networks deals with this kinds of issues. Furthermore in military operations or after environment disaster it is important to establish communication fast in addition it is highly probable the existing infrastructure has been destroyed. After the ad hoc network has been established the nodes that connect the network might move, say for example that one military squad is under heavy attack and has to escape. In ad hoc networks nodes should be able to move freely and the information should be routed through new paths after old ones have been broken, the network should also be able to handled clustering. The advent of ad hoc network has given birth to new kinds of routing algorithms and new security threats.More complications arise in ad hoc wireless networks because the components usually have much lower capacity than their wired counterparts, this gives makes congestion and overload common rather than an exception which it is in wired networks. Due to the fact that ad hoc networks should be possible to establish in tough context, factors such as noise and disturbance play a major role in the design.

2. RESEARCH PROBLEM:

Markov decision theoretic formulation for opportunistic routing is developed. It is shown that the optimal routing decision at any epoch is to select the next relay node based on a distance-vector summarizing the expected-cost-to-forward from the neighbors to the destination. This “distance” is shown to be computable in a distributed manner and with low complexity using the probabilistic description of wireless links. A unifying framework for almost all versions of opportunistic routing such as SDF, Geographic Random Forwarding (GeRaF) , and ExOR , where the variations in are due to the choices of cost measures to optimize. For instance, an optimal route in the context of ExOR is computed so as to minimize the expected number of transmissions (ETX), while GeRaF uses the smallest geographical distance from the destination as a criterion for selecting the next-hop.

3. RELATED WORK:

According to the design of routing protocols for wireless adhoc networks is guided by the dual requirements of throughput optimality and minimum delay.Lately, there has been a movement from the traditional routing approach, which identifies a best path to the destination before transmission and routes all the packets through it, to opportunistic approaches which make routing decisions adaptively based on actual transmission outcomes. We compare the stable rate region of both the approaches and find, interestingly, that opportunistic routing schemes do not always support a larger stable-rate region than traditional routing protocols.

Backpressure based schemes are known tobe throughput optimal but compromise on delay performance instead. We study the behavior of various schemes and propose a routing policy that considers both the goals of throughput optimality and minimizing expected delay in its design.

4. PROPOSED SYSTEM:

In this paper 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. Assumes no knowledge about the channel statistics and network. Uses a reinforcement learning framework in order to enable the nodes to adapt their routing strategies, optimally exploits the statistical opportunities and receiver diversity.

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 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.

5. RESULTS:
Creating Node

The following screen shows an input box, we enter the ID of the node in order to create a anode then in the next input box we have enter the value of the cost for each node in the system this step should be repeated as many as we want to create nodes.

In this window we enter the cost for each node, to specify the cost of hoping from one node to another node in order to reach the distination with the as least as possible cost.

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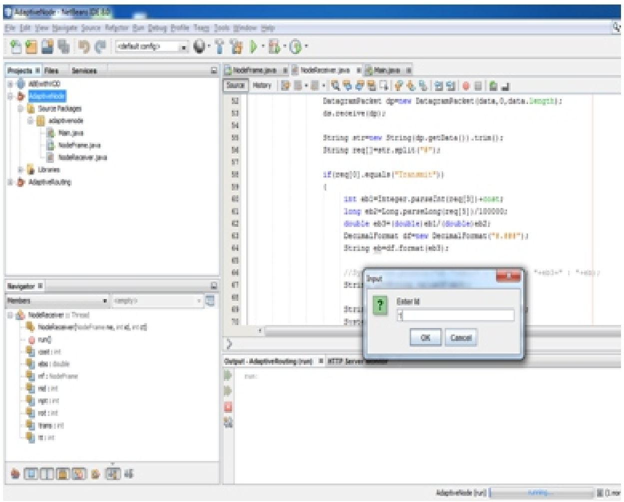

Figure1: Node creating

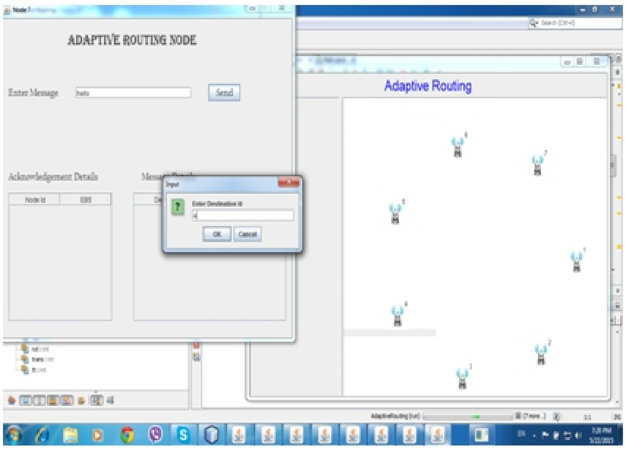

Figure2: node cost

Routing frame:

This screen shows the nodes (wireless routers)after creating it.

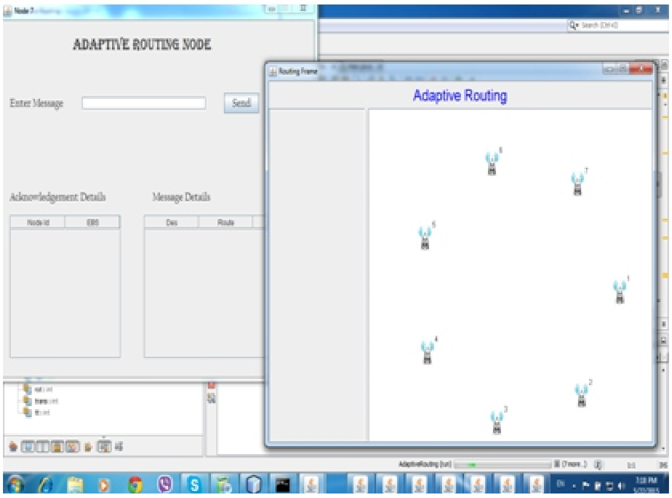

Figure 3: routing frame

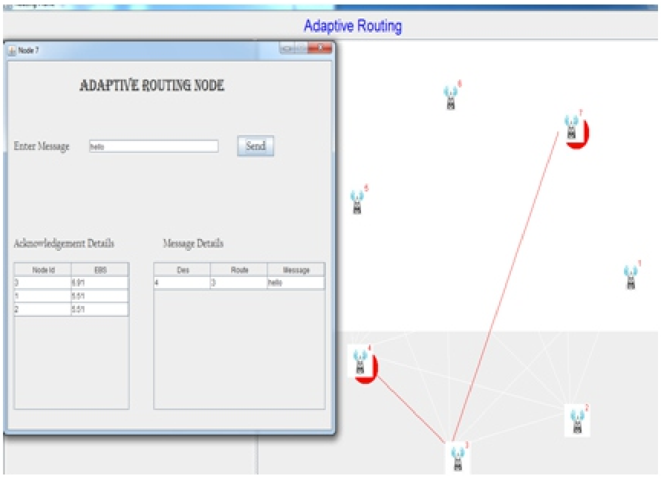

Figure 4: sending message

Sending a message:

In the screen we send a message from one node to another the destination node is specified by entering it's ID, now we are sending a message from node 7 to node 4 . This screen shows that the node 7 takes node 3 for routing because node 3 have the lowest cost.This screen shows the Acknowledgement details and the routing path in the red line.

CONCLUSION:

In this paper, we proposed d-AdaptOR, a distributed, adaptive, 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. Furthermore, we show that d-AdaptOR allows for a practical distributed and asynchronous 802.11 compatible implementation, whose performance was investigated via a detailed set of QualNet simulations under practical and realistic networks. Simulations show that d-AdaptOR consistently outperforms existing adaptive routing algorithms in practical settings. 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. One popular way to study this is via measuring the incurred "regret" over a finite horizon.

Regret is a function of horizon N that quantifies the loss of the performance under a given adaptive algorithm relative to the performance of the topology-aware optimal one. More specifically, our results so far imply that the optimal rate of growth of regret is strictly sublinear in N, 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. The design of routing protocols requires a consideration of congestion control along with the throughput performance. Our work, however, does not consider this closely related issue. Incorporating congestion control in opportunistic routing algorithms to minimize expected delay without the topology and the channel statistics knowledge is an area of future research.

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