

A Survey on Spatial Reusability-Aware Routing in Multi-hop Wireless Networks

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Abstract: The problem of routing in multi-hop wireless networks, is to achieve high end-to-end throughput. Due to limited capacity of wireless communication media and lossy wireless links, it is extremely important to carefully select the optimal route that can maximize the end-to-end throughput, especially in multi-hop wireless networks. Although a large number of routing protocols have been implemented to find the path with minimum transmission time for sending a single packet, such protocols cannot be guaranteed to achieve high end-to-end throughput. Spatial reusability aware routing in multi hop wireless network is featured by considering spatial reusability of the wireless communication media. To support our argument, we propose spatial reusability-aware single-path routing (SASR) and any path routing (SAAR) protocols for maximize end-to-end throughput.

I. INTRODUCTION

Wireless networks are an emerging new technology that will allow users to access information and services electronically from anywhere. The premise of multi-hop transmission in wireless networks is the deployment of intermediate nodes to relay packets from the source to the destination, in scenarios where direct communication is not possible due to power or interference limitations. In wireless communication network it is important to carefully find the high utility route in multi-hop wireless networks, a large number of routing protocols have been proposed for multi hop wireless networks However, a fundamental problem with existing wireless routing protocols is that minimizing the overall number of transmissions to deliver a single packet from a source node to a destination node does not necessarily maximize the end-to-end throughput.

Originally, most routing algorithms were based on min-hop count metric, which is a metric that assumes perfect wireless links and tends to minimize the number of hops on the path. However, in the face of lossy links in wireless environment, protocols using min-hop metric does not perform well because they may include some poor links with high loss ratios. Most of existing routing protocols, no matter single path routing protocols or any path routing protocols, rely on link-quality aware routing metrics, such as link transmission count-based metrics (e.g., ETX and EATX) and link transmission time-based metrics (e.g., ETT and EATT). They simply select the (any) path that minimizes the overall transmission counts or transmission time for delivering a packet. They need centralized control to realize MAC layer scheduling, and to eliminate transmission contention.

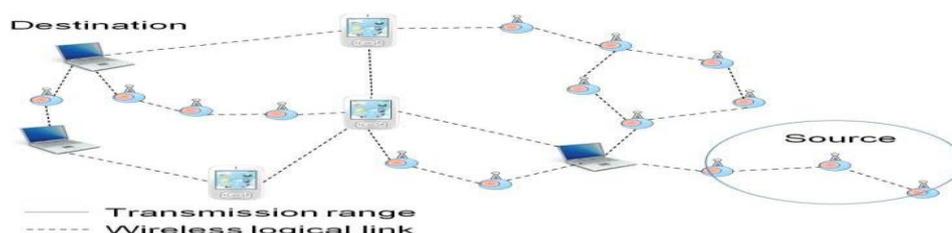


Figure 1. Multi-hop Wireless Network

Routing protocols are generally implemented based on transmission cost minimizing routing metrics, they cannot guarantee maximum end-to-end throughput when spatial reusability need to be considered. An important property of the wireless communication media, which distinguishes it from traditional wired communication media, is the spatial reusability.

We investigate two kinds of routing protocols, including single-path routing and any path routing. In spatial reusability of wireless signals fade during propagation, two links are free of interference if they are far away enough, and thus can transmit at the same time on the same channel. To the best of our knowledge, most of the existing routing protocols do not take spatial reusability of the wireless communication. We consider spatial reusability of the wireless communication media to improve the end-to-end throughput for that we are having two protocols spatial reusability aware single-path routing (SASR) and any path routing (SAAR) protocols. The algorithms proposed in this work do not require any scheduling, and the SASR algorithms can be implemented in a distributed manner. The task of a single-path routing protocol is to select a cost minimizing path, along which the packets are delivered from the source node to the destination node. Any path routing appears as a novel routing technique exploiting the broadcast nature of wireless communication media to improve the end-to-end throughput.

II. LITERATURE SURVEY

1. H. Rahul, H. Hassanieh, and D. Katabi , “Source sync: A distributed wireless architecture for exploiting sender diversity”

This paper presents Source Sync, a distributed architecture for harnessing sender diversity. Source Sync enables concurrent senders to synchronize their transmissions to symbol boundaries, and co-operate to forward packets at higher data rates than they could have achieved by transmitting separately.

2. E. Rozner, M. K. Han, L. Qiu, and Y. Zhang ,”Model-driven optimization of opportunistic routing”.

In this paper, we jointly optimize routes and rate limits for opportunistic communication. We focus on static, 802.11-based, multihop networks, though we believe that the general methodology is applicable to other scenarios. We develop the best opportunistic routing protocol that can accurately optimize IEEE 802.11 end-to-end performance (i.e., the performance derived from optimization can be realized in a real IEEE 802.11 multihop network). This distinctive feature is important given the wide deployment of IEEE 802.11 networks.

3. Y. Yang and J. Wang, “Design guidelines for routing metrics in multihop wireless networks”.

In this paper, we thoroughly study the relationship between routing metrics and routing protocols. Our work provides important guidelines for designing routing metrics and identifies the specific properties that a routing metric must have in order to be combined with certain type of routing protocols.

4. Tong Meng, Fan Wu, ZhengYang, and Athanasios V. Vasilakos, ”Spatial Reusability-Aware Routing in Multi- Hop Wireless Networks”.

This paper presents spatial reusability of the wireless communication media to improve the end-to-end throughput for that they are having two protocols special reusability-aware single-path routing (SASR) and any path routing (SAAR) protocols. Evaluation results show that protocols significantly improve the end-to-end throughput compared with existing protocols. This paper gives one direction to further explore opportunities to improve the performance of routing algorithms by analyzing special underperforming cases identified in the evaluation and optimize system wide performance.

5. A. Adya, P. Bahl, J. Padhye, A. Wolman, and L. Zhou, “A multi radio unification protocol for IEEE 802.11 wireless networks”.

This paper presents a link layer protocol called the Multi-radio Unification Protocol or MUP. On a single node, MUP coordinates the operation of multiple wireless network cards tuned to non-overlapping frequency channels. The goal of MUP is

to optimize local spectrum usage via intelligent channel selection in a multi hop wireless network. It describes the design and implementation of MUP, and analyzes its performance using both simulations and measurements based on implementation. Results show that under dynamic traffic patterns with realistic topologies, MUP significantly improves both TCP throughput and user perceived latency for realistic workloads. They plan to investigate other metrics for channel quality, a more scalable method for sending probes using broadcasts, and the impact of mobile nodes on MUP.

6. J. Broch, D. A. Maltz, D. B. Johnson, Y.-C.Hu, and J. G. Jetcheva, “A performance comparison of multi-hop wireless ad hoc network routing protocols”.

In this paper authors compare performance of different multi-hop routing protocols. They give the results of a detailed packet-level simulation comparing four multi-hop wireless ad hoc network routing protocols that cover a range of design choices: DSDV, TORA, DSR, and AODV. When comparing the number of routing overhead packets sent by each of the protocols, DSR clearly wastes lowest overhead. AODV-LL uses a Route Discovery mechanism based on DSR's, but it creates hop-by-hop routing state in each node along a path in order to eliminate the overhead of source routing from data packets. They have extended network simulator to accurately model the MAC and physical-layer behavior of the IEEE 802.11 wireless LAN standard, including a realistic wireless transmission channel model, and present the results of simulations of networks of 50 mobile nodes.

7. S. Chachulski, M. Jennings, S. Katti, and D. Katabi, “Trading structure for randomness in wireless opportunistic routing”.

Opportunistic routing and network coding are two powerful ideas which may at first sight appear unrelated. This paper combines these ideas in a natural fashion to provide opportunistic routing without node coordination. This paper presents MORE, a MAC-independent opportunistic routing protocol. MORE randomly mixes packets before forwarding them. Authors find opportunistic routing which is recent technique that achieves high throughput in the face of lossy wireless links. The current opportunistic routing protocol, ExOR, ties the MAC with routing, imposing a strict schedule on routers access to the medium. Although the scheduler delivers opportunistic gains, it misses some of the inherent features of the 802.11 MAC. For example, it prevents spatial reuse and thus may underutilize the wireless medium. It also eliminates the layering abstraction, making the protocol less amenable to alternate traffic types such as multicast.

8. D. B. Johnson and D. A. Maltz, “Dynamic source routing in adhoc wireless networks”.

An ad hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. This paper presents a protocol for routing in ad hoc networks that uses dynamic source routing. Unlike routing protocols using distance vector or link state algorithms, this protocol uses dynamic source routing which adapts quickly to routing changes when host movement is frequent, yet requires little or no overhead during periods in which hosts move less frequently. Dynamic source routing protocol is similar in approach to some source routing protocols used in wired networks, such as in the IEEE 802 SRT bridge standard, in FLIP and in SDRP. This paper does not address the security concerns inherent in wireless networks or packet routing.

9. C. E. Perkins and P. Bhagwat, “Highly dynamic destination sequenced distance-vector routing (DSDV) for mobile computers”.

An ad-hoc network is the cooperative engagement of a collection of Mobile Hosts without the required intervention of any centralized Access Point. Proposed routing method allows a collection of mobile computers, which may not be close to any base station and can exchange data along changing and arbitrary paths of interconnection, to afford all computers among their number a (possibly multi-hop) path along which data can be exchanged. They have presented an innovative approach, DSDV, which models the mobile computers as routers, which are cooperating to forward packets as needed to each other. Found that mobile computers, modeled as routers, can effectively cooperate to build ad-hoc networks.

10. R. P. Laufer, H. Dubois-Ferriere, and L. Klein rock, "Multi rate any path routing in wireless mesh networks".

The high loss rate and dynamic quality of links make routing in wireless mesh networks extremely challenging. In this paper, authors present a new routing paradigm that generalizes opportunistic routing in wireless mesh networks. In ultimate any path routing, each node uses both a set of next hops and a selected transmission rate to reach a destination. Any path routing has been recently proposed as a way to circumvent these shortcomings by using multiple next hops for each destination. This approach, albeit straightforward, presents two major drawbacks. First, using a single rate over the entire network underutilizes available bandwidth resource. Secondly, the network may become disconnected at a higher bit rate. They provided a solution to integrating opportunistic routing and multiple transmission rates.

11. N. M. Jones, B. Shrader, and E. Modiano, "Optimal routing and scheduling for a simple network coding scheme".

Network coding, originally introduced in, can increase network throughput by allowing intermediate nodes to combine or encode the data they receive, rather than simply replicating and forwarding it. This paper considers jointly optimal routing, scheduling, and network coding strategies to maximize throughput in wireless networks. It introduces k-tuple coding, a generalization of pairwise coding with next-hop decidability, and fully characterize the region of arrival rates for which the network queues can be stabilized under this coding strategy. Authors evaluated the LCMFrame policy via packet simulation and LP evaluation for pairwise and 3-tuple coding.

III. LIMITATIONS OF EXISTING SYSTEM

1. Energy consumption was bigger challenge to wireless sensor network.
2. In multi hop communication secure data transmission with less cost is ignored.
3. Existing infrastructure is expensive or inconvenient to use, wireless mobile users may still be able to communicate through the formation of an ad hoc network.
4. A fundamental problem with existing wireless routing protocols is that minimizing the overall number (or time) of transmissions to deliver a single packet from a source node to a destination node does not necessarily maximize the end-to-end throughput.
5. Most of the existing routing protocols do not take spatial reusability of the wireless communication media into account.
6. They need centralized control to realize MAC-layer scheduling, and to eliminate transmission contention.

IV. PROPOSED SYSTEM

As most of the other works in routing metrics, we consider a static multi-hop wireless network, in which each of the nodes has a single radio interface and works on the same channel. In this preliminary work, we focus on deterministic single path routing. In our works, we will consider the case of opportunistic any-path routing.

Each of the paths found by an existing source routing protocol (e.g., DSR), SASR algorithm calculates the spatial reusability aware path cost of it. Then, the path with the smallest cost can be selected. . SAAR contrast to the single path routing, which restricts the packets to be forwarded through a predetermined path from the source to the destination, any path routing enables any intermediate node who overhears the packet to participate in packet forwarding. In spatial reusability aware routing scheme novel approach is defined with the spectrum spatial reusability in any path routing, and propose SAAR algorithm for participating node selection, cost calculation, and forwarding list determination.

To show the effect of spatial reusability in wireless routing, let's consider two paths as shown in Fig. 2. In Fig. 2, there're two routes between source node 1 and destination node 6. They are route I with 5 hops and route II with 4 hops. The ETX value of each hop is indicated beside the links in the figure. Note that the first and the last hop on route I can work at the same time

without interfering each other, while there're no such link pair on route II. For convenience, we define such kind of link pair to be a reuse pair. By the ETX metric, route II is preferred because its ETX sum, which is 10.1, is smaller than the value 11.1 of route I. However, considering the fact that link (1-2) and (5-6) can work in the meanwhile, they together do not need to consume as much bandwidth as two consecutive hops. Thus if we subtract the weight of link (5-6) from route I's ETX, it will get smaller ETX than route II instead; and by estimation, route I can achieve a 10% higher throughput than route II because the first four hops on route I have better quality compared with the hops on route II.

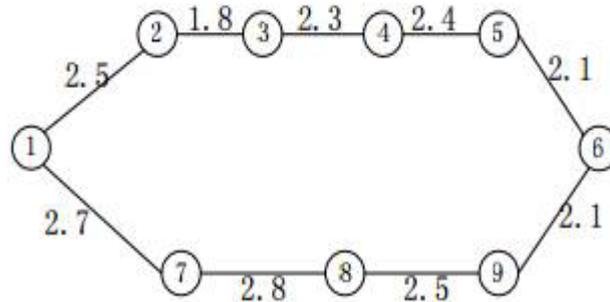


Figure 2. Example of spatial reuse effect

Fig. 2 demonstrates the raw ETX metric's drawback of ignoring the possibility of "spatial reusability" between links. Proposed system formulates data dissemination using multipath routing to reduce packet losses and mitigate delay in packet transmission

ADVANTAGES OF PROPOSED SYSTEM:

1. To the best of our knowledge, we are the first to explicitly consider spatial reusability of the wireless communication media in routing, and design practical spatial reusability-aware single-path routing (SASR) and any path routing (SAAR) protocols.
2. We formulate the problem of spatial reusability aware single-path routing as a binary program, and propose two complementary categories of algorithms for path selection. While one category (SASR-MIN and SASR-FF) tends to exploit the best performance of the paths, the other category (SASR-MAX) evaluates the performance of the paths in the worst case.
3. We further investigate the spectrum spatial reusability in any path routing, and propose SAAR algorithm for participating node selection, cost calculation, and forwarding list determination.
4. We have evaluated SASR algorithms and SAAR algorithm with different data rates.
5. The evaluation results show that our algorithms significantly improve the end-to-end throughput compared with existing ones.

V. CONCLUSION

Spatial reusability aware routing can efficiently improve the source to destination communication with high end throughput in multi-hop wireless networks, by carefully considering spatial reusability of the wireless communication media. This is done by the protocols, SASR and SAAR, for spatial reusability-aware single-path routing and any path routing, respectively. We have also discussed our protocols, and compared them with existing routing protocols. As for the future work, one direction is to further explore opportunities to improve the performance of our routing algorithms by analyzing special underperforming cases identified in our survey.

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