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Adaptive Routing for Throughput Maximization

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ABSTRACT: Back-pressure natured algorithms are based on the algorithm proposed by Tassiulas and Ephremides in recent times acknowledged much attention for mutually routing and scheduling over multi hop wireless communication networks. However, this approach has a significant weakness in routing because the traditional back-pressure algorithm explores and exploits all feasible paths between each source and destination. While this extensive exploration is essential in order to maintain stability when the network is heavily loaded, under light or moderate loads, packets may be sent over unnecessarily long routes, and the algorithm could be very inefficient in terms of end-to-end delay and routing convergence times. In this paper we propose a novel algorithm to improve the throughput by choosing the shortest paths between the source and destination and it is extended in terms of identifying optimal tradeoff between routing of the packets and network coding.

KEYWORDS: Back Pressure, multi hop, throughput, trade off.

I.INTRODUCTION

Backpressure routing combined with shortest path is throughput-optimal in multi-hop ad hoc networks. Under backpressure routing scheme, a node forwards packets to those next-hop neighbors which have shorter queues. But a forwarding node does not care about how many extra hops may be required to deliver the packet to the destination. This is why, though this property helps avoid the congestion, it does not account for the delay accrued in forwarding packets on long routes when the traffic load is lower. The performance of backpressure with low traffic makes it unattractive to implement in realistic wireless networks. We address this issue by making modifications to the original back pressure routing scheme. Minimum hop routing is a good choice with low traffic while back pressure routing should be chosen for high traffic scenarios.

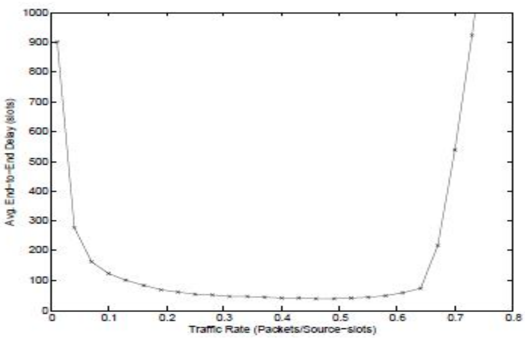

Fig.1 Delay of the performance under light traffic load.

Wireless network operation involves different optimization trade-offs depending on the cross-layer interactions in MAC and network layers. The problem of joint MAC and wireless network coding (or plain routing as a special case) has been

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studied in [1]-[2] for the single source multicasting case. The main performance focus was the multicast throughput rate achievable by all destination nodes, which can be maximized by network coding to the Max-flow Min-cut bound compared to plain routing (originally shown for wired networks in [3]). Energy efficiency has been also introduced in [1]-[2], [4]-[6] to the network coding problem as the performance objective to minimize transmission energy costs per unit multicast rate. The cross-layer design of wireless network coding proposed in [1]-[2] was based on a two-step solution of (a) constructing conflict-free periodic transmission schedules that optimize the multicast rate (or transmission energy per decoded packet) achievable by network coding (or plain routing) and (b) jointly deriving the content of network flows, namely the network codes, to achieve the Max-flow Min-cut rates. However, the common multicast rate does not fully reflect the aggregate throughput performance (even for the single source case), since throughput demands of different destinations can conflict with each other. The average throughput achievable by different destinations has been studied in [7] for a single source node in wired networks. In contrast, we allow multiple source nodes and jointly consider the throughput rates achievable by different source nodes while imposing common throughput condition for destinations of any source node. For that purpose, we need to specify the entire achievable throughput region representing the multicast throughput rates for different source nodes that can strongly conflict with each other because of limited bandwidth resources. We also extend the analysis to broadcast communication by allowing different throughput rates from any source to different destinations. The classical formulation of (wired or wireless) network coding is based on saturated packet queues that guarantee always availability of packets for transmissions without risk of underflow or delay build-up. This is realized by allowing delay nodes to accumulate incoming packets periodically under the assumption that source nodes have always a packet to transmit. If we allow packet queues to empty, we need to specify the stability region as the joint set of stable packet generation rates at source nodes (such that the queue lengths do not grow to infinity). We evaluate the trade-offs between giving higher priorities to relay or source packets (in the case of underflow). Because of the complexity introduced by multiple sources and possibly emptying packet queues, we restrict ourselves to a simple tandem line network. We make realistic wireless network assumptions of omni directional transmissions, destructive interference effects modeled by classical collision channels and single transceiver per node (preventing simultaneous transmission and reception by any node). For the MAC part, we separately consider scheduled and random access, and specify constraints on the achievable throughput and stability region as function of transmission schedules and probabilities (for both network coding and plain routing in network layer). we formally describe our network model. We introduce our proposed schemes and underlying optimization framework in section 3. The simulation model and results are discussed in section 2.3, followed by the conclusion.

II. NETWORK MODEL

Define a graph G = (V;E) representing the network. V is the set of nodes and E is the set of undirected links in the network. For the sake of simplicity, we consider the primary interference model where all disjoint links in the network can be activated simultaneously. This further implies that a node cannot transmit to or receive from more than one node at a time. This interference model is sometimes referred as node exclusive interference model. Every node maintains an internal queue for every known destination in the network to facilitate backpressure-based routing. The complexity of this queuing architecture can be reduced by using suggestions given in [53]. Time is divided into equal slots. All links have equal rate of one packet per slot. Most of these assumptions are for the sake of clarity and ease of the simulation and are not restrictions on our proposed technique.

III. PROPOSED WORK

Backpressure Routing Schemes as discussed before, an optimal scheduling algorithm is computationally intractable for large networks but its approximation exists. For example, it is empirically observed that greedy scheduling performs nearly as well as an optimal scheduling policy [14]. According to greedy backpressure scheduling scheme, we first activate a link with the highest value of maximum differential queue backlog and put it into a schedule. All other links connecting to this link (which are all adjacent links under primary interference model) are not activated and are removed from the link set. We continue this iterative process until the link set is empty. Though greedy scheduling is centralized and impractical to

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implement in distributed systems, it serves our purpose well as the focus of our chapter is on backpressure routing, not scheduling. Though many solutions for distributed scheduling exist in the literature [16{19], they are beyond the scope of this chapter. Our scheme uses a generic routing protocol for route discovery which can accommodate any additive routing metric. We modify original backpressure (Pure BP) approach and propose a scheme where a node forwards a packet to those next hops only which are either on the shortest paths or are equally far from the destination as the forwarding node. Let us denote later type of paths by extended path (EP). We call our scheme modified backpressure (Modified BP). For the sake of exposition, we will consider hop-count based routing, a special case of generic routing. Though the basic idea is to restrict packet forwarding to shorter routes, using the shortest routes only may not be sufficient. Often, the shortest paths for a given source-destination pair may be small in number, and the load balancing obtained.

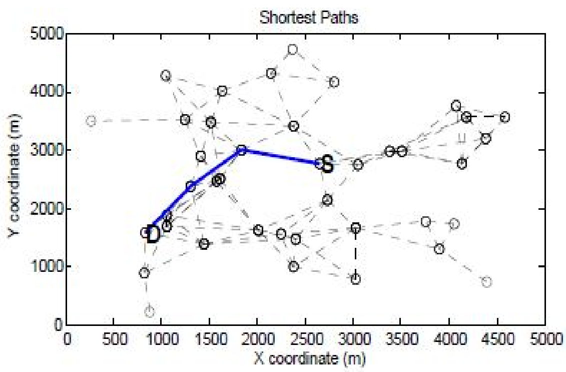

Fig.2 The Shortest and Extended path in random topology

using the shortest paths might not be effective. But the number of extended paths might be large enough to provide sufficient load balancing. This is the main idea behind modified BP. This idea is supported in Figure 2 which shows the shortest and extended paths for a source-destination pair in a random topology. The total number of shortest and extended paths is significantly larger than the number of shortest paths alone. As we can see in the figure, the extended paths allow more node-disjoint routes to be used which is particularly beneficial from a load balancing point of view. The implementation of Modified BP scheme is straightforward. A node runs an additive metric-based routing protocol (the metric is hop count in our case) and fills in the routing table. Backpressure-based packet forwarding algorithm first selects a destination with the highest differential queue backlog, and then it selects a next-hop from routing table to forward packets of that destination. We reiterate that Modified BP can work with any additive metric based routing and hop-count based routing is a special case.

A . End-to-End Delay Performance

Though the average queue backlog plots give some insight into delay properties of the network, the average end-to-end delay performance is still not clear. To plot end-to-end delay performance, we generate traffic for 15000 slots and run the simulation until all packets in the network have been served. At low traffic loads when end-to-end delay due to path traversal supersedes the queuing delay, Pure BP has unnecessary high end-to-end delay because it sends many packets on long routes even when a single shortest path is able to accommodate the traffic load. Other schemes including Modified BP have almost negligible delay in light load conditions because they always use the shortest or slightly longer paths. At higher traffic loads, queueing delay dominates over path traversal delay. Thus, SP and Pure SP have poor delay performance when compared with Pure BP because the queues under these scheme saturate at much less load when compared to Pure BP. But Modified BP manages to perform as well as Pure BP at high traffic loads.

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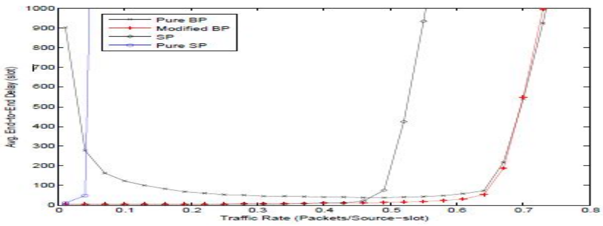

Fig.3 Delay performance for Random topology

Thus the queuing delay in both cases remains almost the same and approximately equal to the average end-to-end delay under high traffic load. Thus across all traffic loads, modified BP has superior end-to-end delay performance compared to other schemes. Under light load it outperforms Pure BP, while under high load it outperforms SP and Pure SP and performs close to Pure BP.

B. Tradeoff's between Routing and Network Coding

In this section, we evaluate the trade-offs involving throughput measures λ_{Σ} (traffic demand) and λ_{min} (minimum traffic) We consider the saturated queue case, although the same optimization results can be approached for the case of non-saturated queues

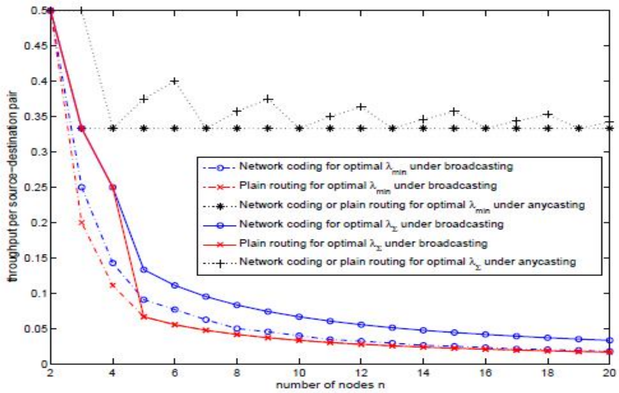

Fig.4 Achievable throughput rates per source-destination pair under broadcast and anycast communication

We have considered both the anycast and broadcast routing for calculating the tradeoff between the routing where Figure 3 depicts the throughput rates per source destination pair that are obtained by separately optimizing λ_{Σ} and λ_{min} and compares the results with the throughput rates achievable under anycast communication.

IV. SIMULATIONS

We consider two types of networks in our simulations: wireline and wireless. Next, we describe the topologies and simulation parameters used in our simulations, and then present our simulation results.

A. Simulation Settings

1) Wireline Setting: The network shown in Fig. has 31 nodes and represents the GMPLS network topology of North America . Each link is assume to be able to transmit one packet in each slot. We assume that the arrival process is a Poisson

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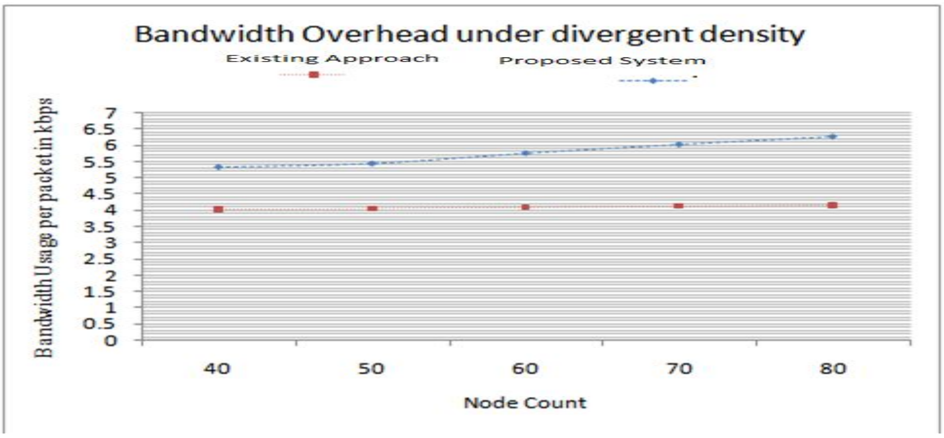
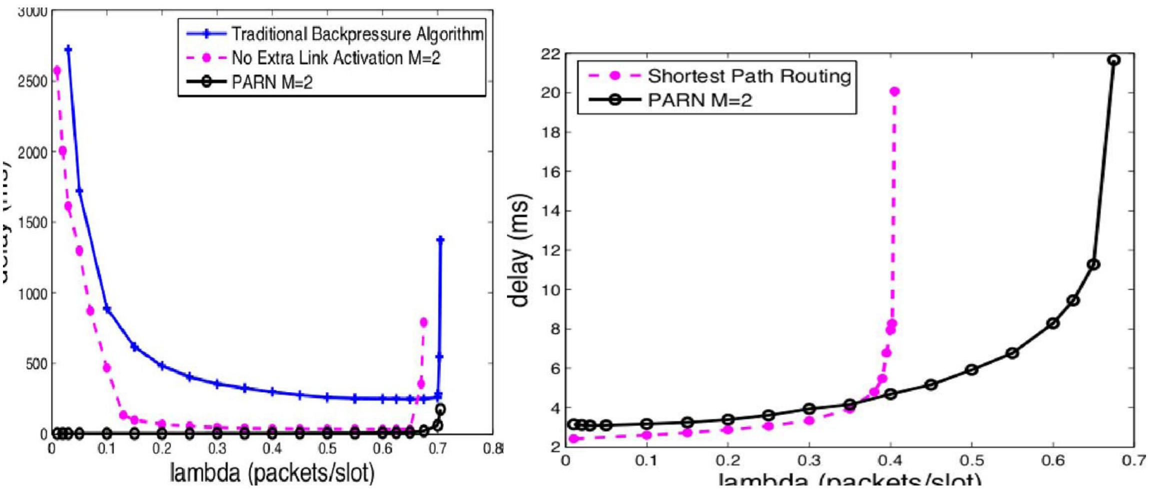
process with parameter , and we consider the arrivals that come within a slot are considered for service at the beginning of the next slot. Once a packet arrives from an external flow at a node .



Fig, Bandwidth overhead under divergent density

Wireless Setting:
We used the following procedure to generate the random network: 30 nodes are placed uniformly at random in a unit square; then starting with a zero transmission range, the transmission range was increased till the network was connected. We assume that each link can transmit one packet per time-slot. We assume a 2-hop interference model in our simulations. By a -hop interference model, we mean a wireless network where a link activation silences all other links that are hops from the activated link.



we make the following observation about network coding, comparing Figs. we noticed that at moderate to high loads (but when the load is within the capacity region of Packet delay as a function of under PARN for in the wireless network under 2-hop interference model with network coding. Packet delay as a function of under PARN for in the wireless network under

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2-hop interference model with network coding. the no coding case), network coding increases delays slightly. We believe that this is due to fact that packets are stored in multiple queues under network coding at each node: For each next-hop neighbor, a queue for each previous-hop neighbor must be maintained. This seems to result in slower convergence of the routing table.
Finally, we study the performance of the probabilistic splitting algorithm versus the token bucket algorithm. In our simulations, the token bucket algorithm runs significantly faster, by a factor of 2. The reason is that many more calculations are needed for the probabilistic splitting algorithm as compared to the token bucket algorithm. This may have some implications for practice. we compare the delay performance of the two algorithms. As can be seen from the figure, the token bucket and probabilistic splitting algorithms result in similar performance. Therefore, in practice, the token bucket algorithm may be preferable.

V.CONCLUSIONS

The back-pressure algorithm, while being throughput-optimal, is not useful in practice for adaptive routing since the delay performance can be really bad. In this paper, we have presented an algorithm that routes packets on shortest hops when possible and decouples routing and scheduling using a queues introduced .By maintaining a probabilistic routing table that changes slowly over time, real packets do not have to explore long paths to improve throughput probabilistic splitting algorithm built on the concept of shadow.

REFERENCES

[1] L. Tassiulas and A. Ephremides, "Stability properties of constrained queueing systems and scheduling policies for maximum throughput in multihop radio networks," *IEEE Trans. Autom. Control*, vol. 37, no. 12, pp. 1936–1948, Dec. 1992.
[2] M. J. Neely, E. Modiano, and C. E. Rohrs, "Dynamic power allocation and routing for time varying wireless networks," *IEEE J. Sel. Areas Commun.*, vol. 23, no. 1, pp. 89–103, Jan. 2005.
[3] L. Bui, R. Srikant, and A. L. Stolyar, "Novel architectures and algorithms for delay reduction in back-pressure scheduling and routing," in *Proc. IEEE INFOCOM Mini-Conf.*, Apr. 2009, pp. 2936–2940.
[4] L. Bui, R. Srikant, and A. L. Stolyar, "A novel architecture for delay reduction in the back-pressure scheduling algorithm," *IEEE/ACM Trans. Netw.*, vol. 19, no. 6, pp. 1597–1609, Dec. 2011.
[5] L. Bui, R. Srikant, and A. L. Stolyar, "Optimal resource allocation for multicast flows in multihop wireless networks," *Phil. Trans. Roy. Soc., Ser. A*, vol. 366, pp. 2059–2074, 2008.

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