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SHADOW QUEUE BACK-PRESSURE SCHEDULING BASED PACKET-BY-PACKET ADAPTIVE ROUTING IN COMMUNICATION NETWORKS

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ABSTRACT

In the Back Pressure based adaptive routing algorithm there is the poor delay performance and involve high implementation complexity. After studied Back Pressure algorithm clearly, this paper develops a new shadow queue adaptive routing algorithm that designed probabilistic routing table which is used to route packets to per destination queue to decouple the routing and scheduling components of the algorithm. In the case of wireless networks the scheduling decisions are made using counters called shadow queues. The results are also extended to the case of networks that employ simple forms of network coding and also power consumption and the energy consumption are also reduced in this modified network.

KEYWORDS: Backpressure algorithm, routing, scheduling, shadow queues, power and energy consumption

1 INTRODUCTION

The Back-Pressure algorithm introduced in [1] has been widely studied, in this the ideas behind scheduling using the weights suggested in that paper have been successful in practice in base stations and routers, the adaptive routing algorithm is rarely used. The main reason for this is that the routing algorithm can lead to poor delay performance due to routing loops. Prior work in this area [2] has recognized the importance of doing shortest-path routing to improve delay performance and modified the back-pressure algorithm to bias it toward taking shortest-hop routes. A part of our algorithm has similar motivating ideas. In addition to provably throughput-optimal routing that minimizes the number of hops taken by packets in the network, we decouple routing and scheduling in the network through the use of probabilistic routing tables and the so-called shadow queues.

The min-hop routing idea was studied first in a conference paper [3], and shadow queues were introduced in [4] and [5], but the key step of partially decoupling the routing and scheduling which leads to both significant delay reduction and the use of per-next-hop queueing is original here. In [4], the authors introduced the shadow queue to solve a fixed routing problem. The min-hop routing idea is also studied in [6], but their solution requires even more queues than the original back-pressure algorithm. Compared to [4], the main purpose of this paper is to study if the shadow queue approach extends to the case of scheduling and routing. The first contribution is to come up with a formulation where the number of hops is minimized. It is interesting to contrast this contribution with [6].The important observation in this paper, not found in [4], is that the partial ”decoupling” of shadow back-pressure and real packet transmission allows us to activate more links than a regular back-pressure algorithm would. This idea appears to be essential to reduce delays in the routing case, as shown in the simulations.

In this networks with simple forms of network coding are allowed [7]. In such networks, a relay between two other nodes XORs packets and broadcasts them to decrease the number of transmissions. There is a tradeoff between choosing long routes to possibly increase network coding opportunities .

2 NETWORK MODEL

In the traditional back-pressure algorithm, each node n has to maintain a queue for each destination d: Let |N| and |D| denote the number of nodes and the number of destinations in the network, respectively. Each node maintains queues generally, each pair of nodes can communicate along a path connecting them. Thus, the number of queues maintained at each node can be as high as one less than the number of nodes in the network, i.e., |D| =|D| -1 :

In proposed system, the main purpose of this paper is to study the case of scheduling and routing the shadow queue extends, which brings new invention that the number of hops is minimized. In the antagonism the objectives of the invention is same, the solution involves per hop queue as compared to backpressure algorithm. In this paper, we have used different types of solution. Small number of real queues used as per neighbor, but the number of shadow queues is same as back pressure algorithm. The shadow queue size always upper bounds the real queue size, it follows that the real queue is also assured to be stable. The advantage of this approach is that buildup of the shadow queues can take place to provide a routing “gradient” for the backpressure algorithm without corresponding build up (and so packet delay) of the real queues, but at the cost of compact network capacity. So we brought a new idea which allows the reduction in the number of real queues by routing via probabilistic splitting. One more important observation in this paper to reduce delays in routing case because of partial decoupling of shadow back-pressure and real packet transmit allows us to activate more links as compare to regular back-pressure algorithm. By the modification of our routing algorithm automatically it balances with good performance. This is very good advantage for our proposed system instead of keeping a queue for every destination, each node n maintains a queue nj for every neighbor j; which is called a real queue. Notice that real queues are per-neighbor queues. Let Jn denote the number of neighbors of node n; and let Jmax = max n Jn: The number of queues at each node is no greater than Jmax: Generally, Jmax is much smaller than |N| .Thus, the number of queues at each node is much smaller compared with the case using the traditional back-pressure algorithm. In additional to real queues, each node n also maintains a counter, which is called shadow queue, pnd for each destination d: Unlike the real queues, counters are much easier to maintain even if the number of counters at each node grows linearly with the size of the network. A backpressure algorithm run on the shadow queues is used to decide which links to activate. The statistics of the link activation are further used to route packets to the per-next-hop neighbor queues mention

2.1 Shadow Queue Algorithm

Traditional Back Pressure Algorithm is same as the Shadow algorithm but, the shadow algorithm works on the bases of shadow queuing. Here every node upholds a fictitious queue called shadow queue. These shadow queues are work as counter for every flow. By the movement of fictitious entities called shadow packets the shadow queues are updated. These packets are used for the purpose of schedulingand routing as an exchange of control messages. The shadow queue as counter it is incremented by 1 when packets are arrival, and decremented by 1 when these packets are departure. The packet arrival rate is slightly larger than the real external arrival rate of packets. . Just like real packets, shadow packets arrive from outside the network and eventually exit the network.

The evolution of the shadow queue pnd[t] is

$$p_{nd}\ [t+1] = p_{nd}\ [t] - \sum_{j:(nj)\in L} I_{\{d^*_{nj}\ (t)=d\}}\ \mu_{nj}\ [t] + \sum_{l:(nj)\in L} I_{\{d^*_{ln}\ (t)=d\}}\ \mu_{ln}\ [t] + \sum_{f\in F} I_{\{b(f)=n,e(f)=d\}}\ \alpha_f\ [t]$$
(1)

2.2 Adaptive Routing Algorithms

Now we discuss about packets how it routes once when it arrives at a node. Let us define a variable called $x^d_{nj}\,[t]$ has number of shadow packets, which are transferred from node say n to node j for destination d during time slot t by the show queue algorithm. When shadow queuing process is in a stationary command, the value of is $x^d_{nj}\,[t]$ denoted by $x^d_{nj}\,[t]$ and it estimated at time t. A packet arriving at node n for destination d is inserted in the real queue qnj for next-hop neighbor j with probability Also notice that $x^d_{nj}\,[t]$ is contributed by shadow traffic point-to-point transmission as well as shadow traffic broadcast transmission

$$p^d_{nj}\ [t] = \frac{x^d_{nj}\ [t]}{\sum k:(nk)\in T\, x^d_{nj}\ [t]} \qquad (2)$$

Also notice that $x^d_{nj}\,[t]$ is contributed by shadow traffic point-to-point transmission as well as shadow traffic broadcast transmission,

Destination	(Next-Hop, Probability) pairs
1	(1, pi1(1)), . . . , (j, pi1(j)), . . . (n, pi1(n))
:	:
d	(1, pid(1)), . . . , (j, pid(j)), . . . (N, pid(n))
	:

Fig. 1. Probabilistic routing table

3 IMPLEMENTATION DETAILS

3.1Implementing Backpressure algorithm

During the partitioning of node due to congestion, the node becoming dead is prevented by implementing backpressure algorithm. It is used to maintain a deterministic route. It helps in packet transmission in an efficient manner. So that all packets are routed to their destination node accordingly they determined. It also route packets on shortest hops. Finally the throughput is increased but the delay in transmission is not prevented. However the energy efficiency is also not achieved because congestion is not completely prevented. This is due to it helps only in node becoming dead

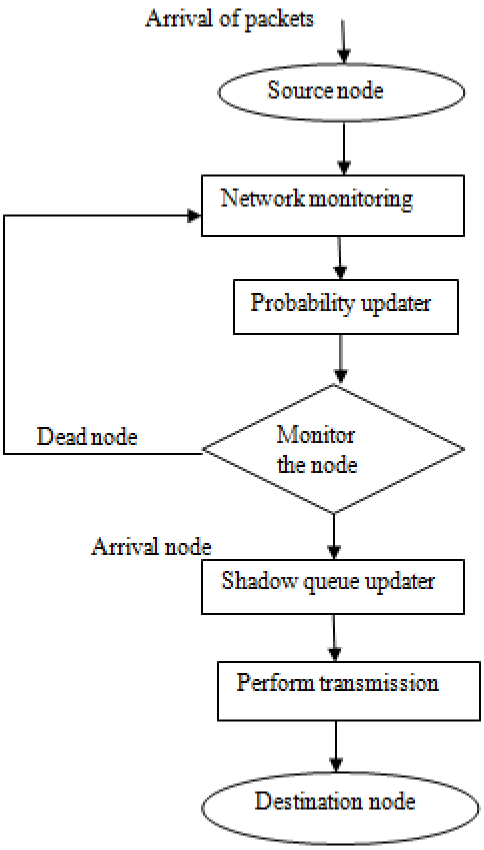

Fig 2 The over all system model

3.2 Exponential Averaging

In this module, using the concept of shadow queues, we partially decouple routing and scheduling. A shadow network is used to up-date a probabilistic routing table that packets use upon arrival at a node. The same shadow network, with back-pres-sure algorithm, is used to activate transmissions between nodes. However, first, actual transmissions send packets from first-in–first-out (FIFO) per-link queues, and second, potentially more links are activated, in addition to those activated by the shadow algorithm [9] To compute $x^d_{nj}\,[t]$ we use the following iterative

Exponential averaging algorithm

$$x^d_{nj}\ [t] = (1-\beta)x^d_{nj}\ [t]\ \ [t-1] + \beta x^d_{nj}\ [t] \qquad (3)$$

Where $0<\beta<1$

3.3 Token Bucket Algorithm

In this unit, the traditional method which compute the average shadow rate $x^d_{nj}\,[t]$ and producing arbitrary numbers for routing packets may impose a computational overhead of routers, which should be avoided if possible. Thus, as substitute, we suggest the following simplealgorithm. At each node n, for each next-hop neighbor j and each destination d, maintain a token bucket r_{nj}^{d} Consider the shadow traffic as a guidance of the real traffic, with tokens removed as shadow packets traverse the link. In detail, the token bucket is decremented by $x_{nj}^{d}[t]$ in each time slot, but cannot below the lower bound 0;

$$r_{nj}^{d} = \max\left\{r_{nj}^{d}[t-1] - x_{nj}^{d}[t], 0\right\} \qquad (4)$$

3.4 Extra Link Activation

Links with backpressure can be activated greater than or equal to parameter only under the shadow back pressure algorithm. This can adequate to condense the real queues. But the delay recital can still be deplorable. Use of unnecessarily long path can be disappointed. So to avoid this we introduce the parameter. The shadow back pressure at a link may be habitually less than this parameter, when light and moderate traffic loads. Because of this the packets are processed after waiting a long time at this links. To cure these circumstances we can establish additional links. With the extra activation, a certain degree of decoupling between routing and scheduling is achieved.

3.5 Extension to the Network Coding Case

In this fragment, we spread out tactic to reflect networks, where network coding is used to progress throughput. We use network coding which reduces the transmission between two nodes. Suppose if a node i wants to send some packets to node j, for this as per traditional back pressure it has transmit i to n and n to j again j to n and n to i. so it requires more transmission . To avoid such kind of transmission we use intermediate relay say n. Here the two of the packets are gets XORed and simultaneously it broadcast two of them to I and j. From this we can reduces the number of transmission. We need to design to build an algorithm to find right adjustment by via possible long routes to arrange for network coding prospects and delay incurred by using long routes.

3.6 Energy Consumption

Energy consumption is becoming an increasingly important issue throughout the community. For network operators in particular it is a concern as networks expand to deliver increasing traffic levels to increasing numbers of customers. An ad hoc network is a group of mobile, wireless hosts which cooperatively form a network independently of any fixed infrastructure. The multi-hop routing problem in ad hoc networks has been widely studied in terms of bandwidth utilization, but energy consumption has received less attention. It is sometimes (incorrectly) assumed that bandwidth utilization and energy consumption are roughly synonymous. Recently, there has been some study of energy-aware ad hoc routing protocols, particularly for distributed sensor networks. In this context, energy is often treated as an abstract “commodity” for purposes of minimizing cost or maximizing time to network partition.

The Energy consumption for the route can be described as well

$$TE = \sum_{i=1}^{l} E_c(i) \qquad (5)$$

$E_c(i)$ - Energy consumption of node i

l – number of links

$$E_c = 2 * E_{tr} + E_{amp}\, d^{\delta}$$

d – distance between the nodes

δ – attenuation factor

$0.1 \leq \delta \leq 1$

3.7 Power Consumption

Energy saving strategies for wired networks have not received much attention, while energy-saving routing protocols in wireless networks have been studied in detail. Energy saving techniques for wireless sensor networks [2], are important because of the limited power availability in networks which operate with batteries or renewable energy sources. “Topology control” (TC) algorithms [3], [4] for wireless networks have been proposed so as to dynamically modify the network graph to maintain or optimize desirable global properties, such as network capacity or user perceived QoS, while reducing energy consumption and wireless interference between nodes. These approaches dynamically adjust the transmission power of each node in order to save energy while guaranteeing connectivity. Another important criterion considered is to limit the ratio of the number of hops traversed by packets from the sources to the destinations, for a given power setting, to the number of hops traversed if all nodes were transmitting at maximum power, and some complex trade-offs occur as the nodes' transmission power levels are varied. While the maximum power can yield the minimum number of hops, higher power levels will adversely affect collisions and interference, lower levels of transmission power potentially lengthen the paths traversed by packets, but reduce collisions and interference on each hop. As the hop count increases, the energy used per packet can also increase and adverse effects such as delay and loss can also increase.

$$Tp = \sum_{i=1}^{l} p_c\,(i) \qquad (6)$$

$p_c\,(i)$ - power consumption of node i

l – number of links

$$p_c = \frac{p_t}{1 + d^{\gamma}}$$

d – distance between the nodes

γ – Environment factor

$0.1 \leq \gamma \leq 1$

4 SIMULATION RESULTS

Wire line and wireless are the two networks. We consider these two networks in our simulation. Her we see the topology of these two and also simulation results shows how the delay was reduced in the backpressure and the modified backpressure algorithm

4.1. Wireline Setting

First we take the wired network having 8 nodes. Here we compare the delay performance of backpressure alogorithm and modified backpressure algorithm i.e, using PARN algorithm and shadow queue which uses the per-neighbour queue concept

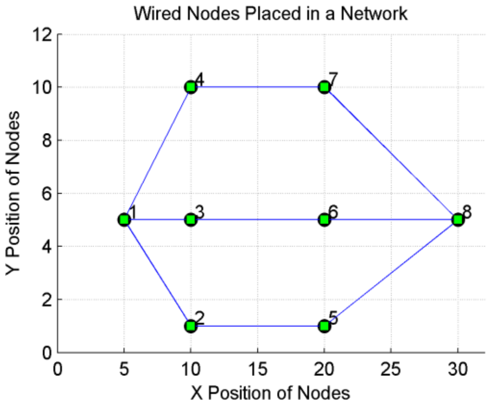

Fig. 3. Wired Network Topology with 8 Nodes

4.2. 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. The packet arrival processes are generated using the same method as in the wireline case. We simulate two cases given the network topology: the backpressure and the modified backpressure In both wireline and wireless simulations, we chose to be, and we use probabilistic splitting algorithm for simulations

4.3 Simulation Results

(a) Wireline Networks: First , we compare the delay performance of the backpressure and the modified backpressure algorithms

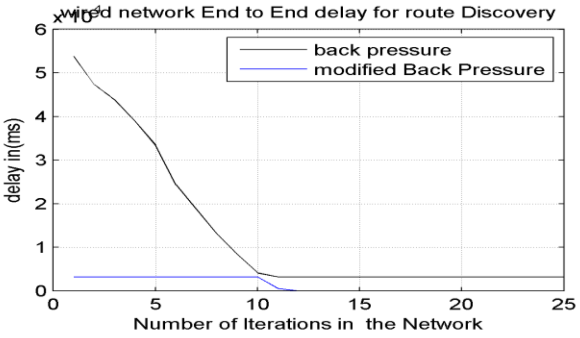

Fig. 4. Wired Network end to end delay

(b) Wireless networks: comparison of the delay performance in the wireless network

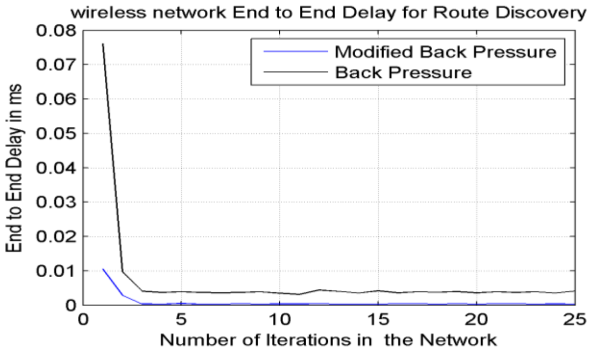

Fig. 5. Wireless Network end to end delay

(c) number of packets delivered from sorce to destination with in a time slot is more in modified backpressure compare to the trdational backpressure algorithm

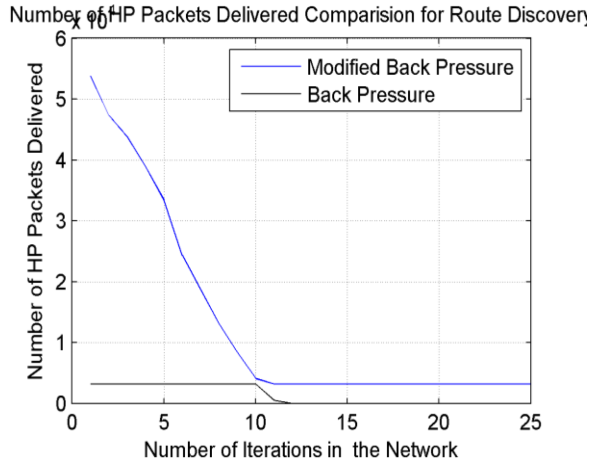

Fig. 6 number of packets delivered

(d) *Energy and power consumption:* The results are also extended to the case of power and energy consumption in modified backpressure compare to the traditional backpressure algorithm

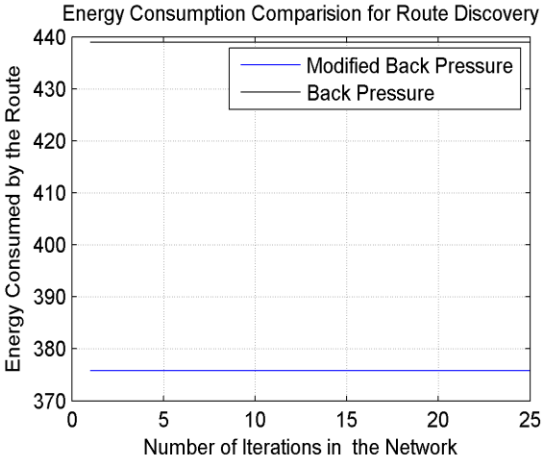

Fig. 7 Energy consumption in the network

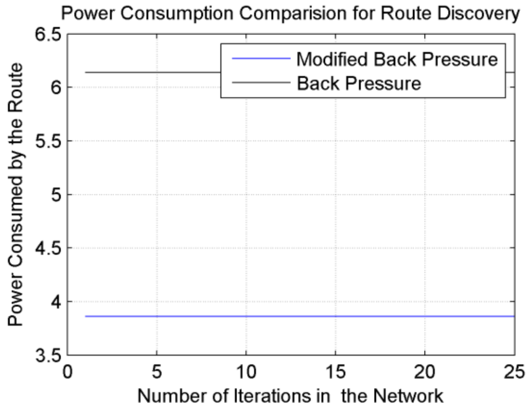

Fig. 8. Power consumption in the network

5 CONCLUSION

The back-pressure algorithm, while being throughput-optimal, is not useful in practice for adaptive routing since the delay performance is really bad. In this paper, an algorithm that routes packets on shortest hops when possible and decouples routing and scheduling using a probabilistic splitting algorithm built on the concept of shadow queues By maintaining a probabilistic routing table that changes slowly over time, real packets do not have to explore long paths to improve throughput; this functionality is performed by the shadow "packets." Our algorithm also allows extra link activation to reduce delays. The algorithm has also been shown to reduce the queuing complexity at each node and can be extended to optimally trade off between routing and network coding.

This paper is extended to the case of energy consumption and the power consumption which shows better results as in the case of both wired and the wireless networks

REFERENCES

[1.] L. Tassiulas and A. Ephremides, "Stability properties of constrained queueing systems and scheduling policies for maximum throughput inmultihop 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.

[6.] L. Ying, S. Shakkottai, and A. Reddy, "On combining shortest-path and back-pressure routing over multihop wireless networks," in Proc. IEEE INFOCOM, Apr. 2009, pp. 1674–1682.

[7.] S. Katti, H. Rahul, W. Hu, D. Katabi, M. Medard, and J. Crowcroft, "XORs in the air: Practical wireless network coding," Comput.Commun. Rev., vol. 36, pp. 243–254, 2006.