Delay Optimization in Wireless Networks Using Packet Deviation Method

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Abstract: ***Back-pressure-based adaptive routing algorithms where each packet is routed along a possibly different path have been extensively studied in the literature. However, such algorithms typically result in poor delay performance and involve high implementation complexity. In this paper, we develop a new adaptive routing algorithm built upon the widely studied back-pressure algorithm. We decouple the routing and scheduling components of the algorithm by designing a probabilistic routing table that is used to route packets to per-destination queues. The scheduling decisions in the case of wireless networks are made using counters called shadow queues. The results are also extended to the case of networks that employ simple forms of network coding. In that case, our algorithm provides a low-complexity solution to optimally exploit the routing–coding tradeoff***

Keywords: Back Pressure Algorithm, Shadow Queues, Per Destination Queues, Packet Deviation

1. Introduction

The back-pressure algorithm introduced has been widely studied in the literature. While 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. Additionally, the implementation of the back-pressure algorithm requires each node to maintain predestination queues which can be burdensome for a wireline or wireless router. Motivated by these considerations, we re-examine the back-pressure routing algorithm in the paper and design a new algorithm which has much superior performance and low implementation complexity.Optimization is a matter of concern in all kinds of network, so optimization mainly deals with minimizing the energy used by the nodes in the network and maximizing the throughput or performance, this includes minimizing or avoiding delay and congestion in networks.

Networking is the word basically relating to computers and their connectivity. It is very often used in the world of computers and their use in different connections. The term networking implies the link between two or more computers and their devices, with the vital purpose of sharing the data stored in the computers, with each other. The networks between the computing devices are very common these days due to the launch of various hardware and computer software which aid in making the activity much more convenient to build and use.

2. Existing System

In the traditional concept, we consider the problem of reducing network delay in stochastic network utility optimization problems. The Existing system uses an algorithm that has a lot of complex probabilistic distribution functions (PDF) that is quite difficult to understand and implement. The algorithm is also outdated in terms of space and time complexity that makes us develop a new concept that is quite effective on implementation, and the one that would consume less space to store and time to run and execute the algorithm. The work starts from studying the recent researches on the concepts related to quadratic functions, since the QLA quadratic lyapunov algorithm. The thesis assumes the fact that says, for each and every stochastic challenge there exists a deterministic problem whose dual optimized solution attracts the network performance exponentially. The goal here is to minimize the average cost of the complete operation, the wireless network in this project uses the time slots to attain stability constraint.

Drawbacks of Existing system

- Generating and Distributing Node Capacities is an Overhead
- Flow Level diversion leads to larger amount of packet loss
- Destination is idle all the way waiting for the packet that were ideally lost during transmission

3. Shadow Queue Algorithm

Here in proposed system, Progress is towards the Deviation of The Packets To Different Neighboring Nodes If and only if the node is experiencing a bottleneck.

Bottleneck: it is a condition that is defined as a hinderance for system by virtue of which the system performance is degraded, because the bottleneck is said to have occurred when two or more sources try to transmit data to the next available neighboring node, the multi-source packet transmission leads to this glitch that has its own consequences based on the reason for packet loss and packet retransmission. Initially all the nodes will generate a Packet that contains it’s own information consisting of the link weight of all the edges to its neighboring nodes and the state of the neighboring node(busy, idle) and multicast it to all the neighboring nodes. This packet needs to be multicasted periodically so that the network is updated with the latest information of all nodes, that helps in better analysis of delay and throughput. .

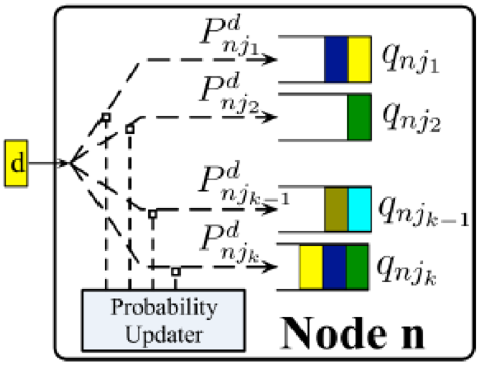

Figure 3.1: Probabilistic Algorithm at node n

4. Shadow Queue Algorithm – M-back-pressure Algorithm

The shadow queues are updated based on the movement of fictitious entities called shadow packets in the network. The movement of the fictitious packets can be thought of as an exchange of control messages for the purposes of routing and schedule. Just like real packets, shadow packets arrive from outside the network and eventually exit the network.

The external shadow packet arrivals are general as follows: when an exogenous packet arrives at node *n* to the destination *d*, the shadow queue *pnd* is incremented by 1, and is further incremented by 1 with probability ε in addition. Thus, if the arrival rate of a flow *f* is *xf* , then the flow generates "shadow traffic" at a rate *xf* (1 + ε). In words, the incoming shadow traffic in the network is (1 + ε) times of the incoming real traffic.

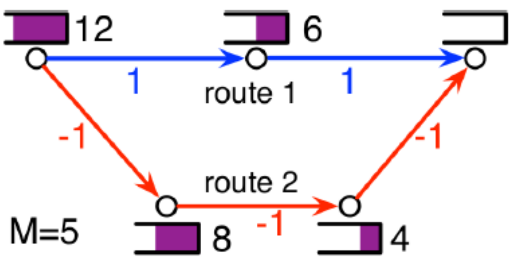

Figure 3.2: Picture illustrating link weights under the M-backpressure algorithm

Figure 3.2 illustrates how the M-back-pressure algorithm works in a simple wireline network. All links can be activate simultaneously without interfering with each other. Notice that the backlog difference of route 1 is 6 and the backlog difference of route 2 is 4.

Because the backlog difference of route 2 is smaller than *M*, route 2 is blocked at current traffic load. The M-back-pressure algorithm will automatically choose route 1 which is shorter. Therefore, a proper *M* can avoid long routes in when the traffic is not close to capacity.

5. Equations

Normally the packet will be transmitted if the neighboring nodes are idle and there is no traffic, but incase there occurs a bottleneck, then the intermediate node will have to decide which packet needs to be deviated to which node based on the packet information that it already has

A flow conservation constraint must be satisfied at each node, i.e., the total rate at which traffic can possibly arrive at each node destined to *d* must be less than or equal to the total rate at which traffic can depart from the node destined to *d* :

$$\sum_{f\in\mathcal{F}} x_f I_{\{b(f)=n,e(f)=d\}} + \sum_{l:(ln)\in\mathcal{L}} \mu^d_{ln} \leq \sum_{j:(nj)\in\mathcal{L}} \mu^d_{nj},$$

where *I* denotes the indicator function. Given a set of arrival rates *x* = {*xf* }*f*∈*F* that can be accommodated by the network, one version of the multi-commodity flow problem is to findthe traffic splits *µd nj* such that (1) is satisfied. However, finding the appropriate traffic split is computationally prohibitive and requires knowledge of the arrival rates. The back-pressure algorithm to be described next is an adaptive solution to the multi-commodity flow problem.

If the capacity of every link has the same value, the chosen schedule maximizes the sum of weights in any schedule.At time *t*, for each activated link (*nj*) ∈ *π∗* [*t*] we remove *cnj* packets from *Qnd∗ nj*[*t*] if possible, and transmit those packets to *Qjd∗ nj*[*t*].

We assume that the departures occur first in a time slot, and external arrivals and packets transmitted over a link (*nj*) in a particular time slot are available to node *j* at the next time slot. Thus the evolution of the queue *Qnd*[*t*] is as follows:

$$\begin{aligned} Q_{nd}[t+1] \;=\; Q_{nd}[t] &- \sum_{j:(nj)\in\mathcal{L}} I_{\{d^*_{nj}[t]=d\}}\, \hat{\mu}_{nj}[t] \\ &+ \sum_{l:(ln)\in\mathcal{L}} I_{\{d^*_{ln}[t]=d\}}\, \hat{\mu}_{ln}[t] \\ &+ \sum_{f\in\mathcal{F}} I_{\{b(f)=n,e(f)=d\}}\, a_f[t], \end{aligned}$$

where ^*µnj*[*t*] is the number of packets transmitted over link (*nj*) in time slot *t* and *af* [*t*] is the number of packets generated by flow *f* at time *t*. It has been shown in [1] that the backpressure algorithm maximizes the throughput of the network. A key feature of the back-pressure algorithm is that packets may not be transferred over a link unless the back-pressure over a link is non-negative and the link is included in the picked schedule

6. Simulation Results

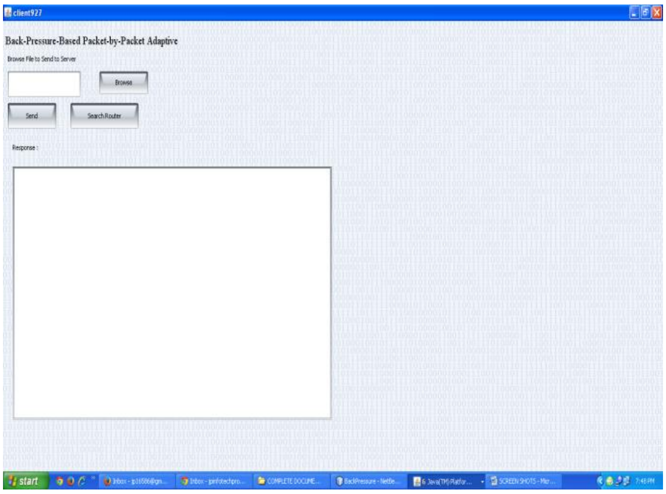

Figure 4.1: Window showing the client interface.

The above interface has a field where in the desired file can be browsed and attached so that it can be sent to the desired destination once the router is invoked. Client sends a request to the router and in response to which receives and ACK as a pop up from router and that is how the transfer is initiated. The router responds back in the form of ping request and which is accepted and returned to the client and the routing process is initiated that continues with packet transfer to successive nodes.

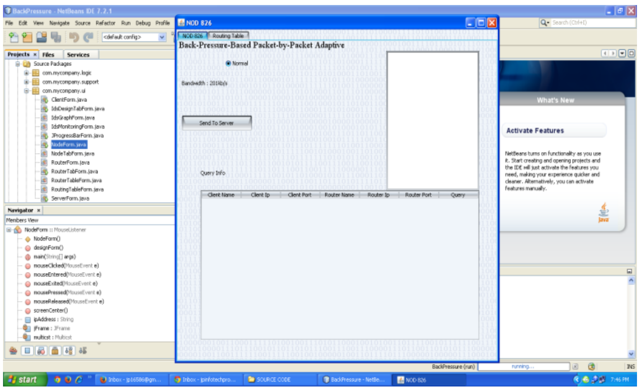

Figure 4.2: Window for the node interface

This window has a display for the type of broadcast and the available broadcast bandwidth after pinging the router. Once the user hits the send query button on node the packed browsed will be sent to the server.

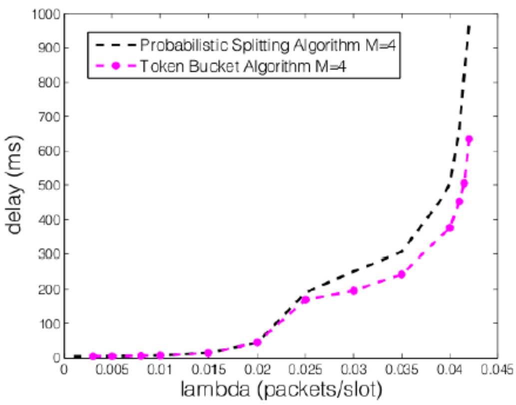

Figure 4.3: Comparison of probabilistic splitting and token bucket algorithms under PARN in the wireless network under 2-hop interference model without network coding.

In this paper, we have presented 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 introduced in [5], [3]. 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 queueing complexity at each node and can be extended to optimally trade off between routing and network coding.

7. Conclusion

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 probabilistic splitting algorithm built on the concept of shadow queues introduced. Here we try to maintain a probabilistic routing table that changes slowly over time, real packets do not have to explore long paths to improve throughput; instead of maintaining real queues at every node this functionality is performed by the shadow "packets." The enhancement also includes the concept of extra link activation to reduce delays. The algorithm has also been shown to reduce the queueing complexity at each node and can be extended to optimally trade off between routing and network coding.

8. Future Enhancement

The future work needs to consider working towards increasing the stability of the shadow queues which is the main theme of our algorithm, also needs to fore look on the concept of enhancing the network performance without network coding.

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