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HEURISTIC OVERLAY BACKPRESSURE FOR THROUGHPUT OPTIMAL MULTIPATH ROUTING IN OVERLAY ARCHITECTURE.

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Abstract: A legacy network is generally called as old network, which is not frequently used today and those are designed to operate with single-path routing, like the shortest path, which is known to be throughput suboptimal. On the other hand, previously proposed throughput optimal policies (i.e., backpressure) require every device in the network to make dynamic routing decisions. Overlay Architecture for dynamic routing, such that only a subset of devices (overlay nodes) needs to make the dynamic routing decisions. Identify the essential collection of nodes that must bifurcated traffic for achieving the maximum multi-commodity network throughput. By theoretical study of applying an optimal node placement algorithm to several graphs and the results show that a small fraction of overlay nodes is sufficient for achieving maximum throughput. Finally, novelty of proposed techniques threshold backpressure policy (BP-T) and a heuristic overlay backpressure policy (OBP), which dynamically controls traffic bifurcations at overlay nodes. Policy BP-T is proved to maximize throughput for the case when underlay paths do not overlap. By applying OBP not only achieves full throughput but also reduces delay in comparison to the throughput optimal backpressure routing.

INTRODUCTION

Optimal Routing Design provides the tools and techniques, learned through years of experience with network design and deployment, to build a large-scale or scalable IP-routed network. Optimal routing in networks where some legacy nodes are replaced with overlay nodes. While the legacy nodes perform only forwarding on pre-specified paths, the overlay nodes are able to dynamically route packets. Dynamic backpressure is known to be an optimal routing policy. Backpressure routing is an algorithm for dynamically routing traffic over a multi-hop network by using congestion gradients but it typically requires a homogeneous network, where all nodes participate in control decisions. Instead, let us consider only a subset of the nodes are controllable, these nodes form a network overlay within the legacy network. Backpressure routing is designed to make decisions that (roughly) minimize the sum of squares of queue backlogs in the network from one time slot to the next. It is important to note that the backpressure algorithm does not use any pre-specified paths. Paths are learned dynamically, and may be different for different packets. Delay can be very large, particularly when the system is lightly loaded so that there is not enough pressure to push data towards the destination. As an example, suppose one packet enters the network, and nothing else ever enters. This packet may take a loopy walk through the network and never arrive at its destination because no pressure gradients build up. This does not contradict the throughput optimality or stability properties of backpressure because the network has at most one packet at any time and hence is trivially stable.

EXISTING SYSTEM

Backpressure (BP) routing, first proposed in [1], is a throughput optimal routing policy that has been studied for decades. Its strength lies in discovering multipath routes and utilizing them optimally without knowledge of the network parameters, such as arrival rates, link capacities, mobility, fading, etc. Nevertheless, the adoption of this routing policy has not been embraced for general use on the Internet. This is due to an inability of backpressure routing to coexist with legacy routing protocols. With few exceptions, backpressure routing has been studied in homogeneous networks, where all nodes are dynamically controllable and implement the backpressure policy across all nodes uniformly. There are mainly two types of routing techniques, single path routing and multiple path routing. Single path routing is simple and scalable, but does not efficiently satisfy the requirements of resource constrained WSNs. It is simple because the route between the source node and the destination node can be established in a specific period of time. It is scalable because, even if the network changes from ten nodes to ten thousand nodes, the complexity and the approach to discover the path remains the same. While considering the characteristics of WSNs, single path routing is not efficient for the following reasons. In single path routing, it is easy for the source node to select the intermediate data routing nodes from the same part of the network over and over again. This may cause depletion of power of those sensor nodes and network partition, which shortens the lifetime of WSNs. In WSNs, failures are common because of insufficient power, limited storage space, unreliable wireless communication, or unpredictable environmental interference. If any failure occurs, most single path routing protocols could not successfully deliver sensed data to the sink due to a lack of fault tolerance mechanisms. In single path routing, the presence of a malicious node on the path can manipulate and corrupt the data without catching the attention of the sink node.

Multipath routing is an alternative routing technique, which selects multiple paths to deliver data

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from source to destination. Because of the nature of multipath routing that uses redundant paths, multipath routing can largely address the reliability, security and load balancing issues of single path routing protocols. Thus, multipath routing plays an important role in WSNs and many multipath routing protocols have been proposed in the literary of WSNs research due to the intrinsic features of low-power wireless sensor networks, routing in these networks is much more challenging compared to the traditional wireless networks such as ad hoc networks [4][5]. First of all, according to the high density of sensor nodes, routing protocols should be able to support data transmission over long distances, regardless of the network size. In addition, some of the active nodes may fail during network operation due to energy depletion of the sensor nodes, hardware breakdowns or environmental factors, but this issue should not interrupt the normal network operation. Moreover, as sensor nodes are tightly limited in terms of power supply, processing capability, memory capacity and available bandwidth, routing and data dissemination should be performed with efficient network resource utilization. Furthermore, since the performance demands of the wireless sensor networks are application specific, routing protocols should be able to satisfy the QoS demands of the application for which the network is being deployed. For example, challenges in designing routing protocols for time critical applications (e.g., target tracking and disaster management) are different from issues that should be considered in developing routing protocols for other applications such as habitat monitoring. Delay reduction for BP routing has been studied in a variety of scenarios. While multipath routes are required to support the full throughput region, the exploratory phase of BP can lead to large queues when the offered load is low and single-path routes would suffice. In [6], a hybrid policy combining BP with shortest-path routing is proposed, where flows are biased towards shortest-path routes, yet still support the full throughput region. This hybrid policy is extended in [3] to also include digital fountain codes, and shown to achieve good end-to-end delay performance in the presence of random link failures. The work in [7] develops a policy that achieves a similar shortest-path result by minimizing the average hop count used by flows. In a scenario with multiple clusters that are intermittently connected, [8] combines BP with source routing in a network overlay model to separate the queue dynamics of intra-cluster traffic from longer inter cluster delays. The work in [2] applies shadow queues to allow the use of per-neighbor FIFO queues instead of per commodity queues, as is typical with differential backlog routing, and finds that this can improve network delay. A loop free backpressure policy is developed in [9] that dynamically find acyclic graphs for reducing delay while maintaining throughput optimality. These prior works assume a homogeneous scenario where all nodes use the same control policy and thus differ fundamentally from the approach. Proposed novelty study of algorithms for applying backpressure in overlay networks can help reduce delay by reducing the number of nodes between which differential backpressure is formed. While the original motivation for studying backpressure in overlay networks was not to reduce delay, believe that scheme can be used as part of a delay-reducing solution.

PROPOSED SYSTEM

The proposed system solves the problem of placing the minimum number of overlay (controllable) nodes in a legacy network in order to achieve the full multi commodity throughput region and provide an efficient placement algorithm. By applying placement algorithm to several scenarios of interest including regular and random graphs, showing that in some cases, only a small fraction of overlay nodes is sufficient for maximum throughput. The threshold based control policy and modification of backpressure policy solves the problem. At given any subset of nodes that are controllable, wish to develop an optimal routing policy that operates solely on these nodes. In given graph (G) with nodes N supporting shortest-path routes between each pair of nodes. Identify a minimal set of controllable nodes $V \subseteq N$ such that if only these nodes are allowed to bifurcated traffic, maximum throughput can be achieved. The dynamic network control policies that operate only at controllable nodes V. These controllable nodes are connected by “tunnels” or paths through uncontrollable sections of the network, where the control policy can choose when to inject packets into a tunnel but the tunnel itself is uncontrollable. Develop an overlay control policy that stabilizes all arrival rate vectors in G (V) for the case when tunnels do not overlap. Propose to develop heuristic overlay control policy for use on general topologies, and show through simulation that stability is achieved for all arrival rates considered. The solutions are complementary, in the sense that they can be used together to solve the joint problem of providing maximum throughput when only a subset of nodes are controllable. However, solutions can also be used in isolation, node placement algorithm can be used with other control policies, and the BP extensions can yield maximal stability with any overlay node placement and legacy single-path routing. Proposed study involves

- To formulate the problem of placing the minimum number of overlay (controllable) nodes in a legacy network in order to achieve the full multi commodity throughput region and provide an efficient placement algorithm.
- Propose a Node Placement algorithm for regular and random graphs, showing that in some cases, only a small fraction of overlay nodes is sufficient for maximum throughput.

• Develop the threshold-based control policy (BP-T) as a modification of BP for use at overlay nodes, when tunnels do not overlap.

• Also to develop the heuristic overlay backpressure policy (OBP) for use at overlay nodes on general topologies. OBP can outperform BP when limited to control at overlay nodes and that OBP also has better delay performance compared to BP with control at all nodes.

CONCLUSION

This model captures evolving heterogeneous networks where intelligence is introduced at a fraction of nodes. Finally, proposed dynamic routing policies to be implemented in a network overlay. The threshold based policy that is optimal for overlays with non-overlapping tunnels, and provides alternate policy for general networks that demonstrates superior performance in terms of both throughput and delay.

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