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# A Review Paper on Overlay Architecture for throughput Optimal Multipath Routing

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**Abstract:** *Bequest networks are frequently planned to operate with plain single-path routing, like the shortest path, which is known to be throughput suboptimal. On the other hand, earlier proposed throughput optimal policies (i.e., backpressure) need each machine in the network to make active routing decisions. We study overlay architecture for dynamic routing; only a subset of devices (overlay nodes) require to make the dynamic routing decisions. We conclude the necessary compilation of nodes that must bifurcate traffic for achieving the utmost multi-commodity network throughput. We relate our best possible node assignment algorithm to a number of graphs and the consequences demonstrate that a small fraction of overlay nodes is sufficient for achieving highest throughput. Finally, we propose a threshold-based policy (BP-T) and a heuristic policy (OBP), which animatedly control traffic bifurcations at overlay nodes. Policy BP-T is proved to make the most of throughput for the case when underlay paths do not partly cover. In all considered simulation scenarios, OBP not only achieves full throughput but also reduces delay in contrast to the throughput optimal backpressure routing.*

**Keywords:** *Overlay networks, bequest network, network control, backpressure routing*

## I. INTRODUCTION

We study best possible routing in networks where some bequest nodes are replaced with overlay nodes. While the bequest nodes execute only forwarding on pre-specified paths, the overlay nodes are capable to animatedly route packets. *Dynamic backpressure* is known to be an optimal routing policy, but it usually requires a uniform network, where all nodes contribute in organize decisions. As an alternative, we guess that only a division of the nodes are convenient; these nodes form a network overlay inside the bequest network. The option of the overlay nodes is shown to conclude the throughput area of the network.

We estimate our algorithm on numerous classes of usual and random graphs. In the case of random networks with a power-law degree distribution, which is a general model for the Internet. We find that smaller number than 80 out of 1000 nodes are necessary to be convenient to allow the complete throughput area.

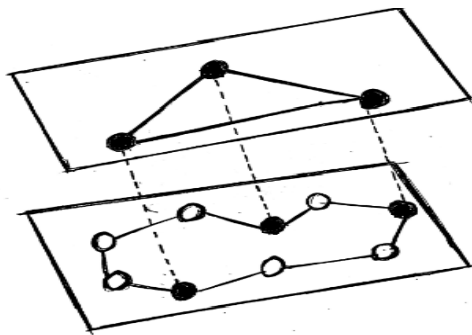


Fig. 1. Pattern of a network overlay. The bottom plane shows the whole network graph, whereas the top plane shows a subset of network nodes and their theoretical overlay connectivity. In this we study network throughput under the statement that overlay nodes apply dynamic routing schemes and underlay nodes forward packets by means of pre-specified paths.

Our first finding is that ring networks need accurately three convenient (overlay) nodes to allow the similar throughput area as when all nodes are convenient, free of the whole number of nodes in the network, Provoked by this, we build up an

algorithm for choosing the smallest amount number of convenient nodes necessary to allow the complete throughput region..

Since usual backpressure routing cannot be explicitly realistic to the overlay situation, we build longer extensions to backpressure routing that conclude how to route packets among overlay nodes. We confirm that highest throughput can be attained with our policies in numerous scenarios, when only a portion of legacy nodes are replaced by convenient nodes. Moreover, we monitor summary delay relative to the case where all nodes are convenient and operate under backpressure routing.

## II. EASE OF USE

### A. Motivation and related work

Backpressure(BP)routing, first projected is a throughput optimal routing rule that has been considered for decades. Its potency lies in discovering multipath routes and utilizing them optimally with no information of the network parameters, such as entrance rates, link capacities, mobility, desertion, etc. however, the acceptance of this routing strategy has not been embraced for common use on the Internet. This is due, in part, to an incapability of backpressure routing to coexist with bequest routing protocols. With not many exceptions, back-pressure routing has been considered in uniform networks, where all nodes are animatedly convenient and execute the backpressure strategy crosswise all nodes consistently. Techniques to offer throughput-optimal multipath routing have been explored in a variety of contexts. The effort considers the difficulty of situation link weights provided to the Open Shortest Path First (OSPF) routing protocol such that, when joined with bifurcating traffic evenly along with shortest paths, the network achieves throughput equivalent to the optimal multi commodity flow. The authors make use of an entropy maximization framework to extend a new throughput optimal link state routing protocol where each router wisely bifurcates traffic for each target among its leaving links. These techniques all need centralized control, universal acceptance by all network nodes, or both; thus none of these techniques could give incremental use of throughput optimal routing to wireless networks. Moreover these techniques cannot be used in mixture with throughput optimal dynamic control schemes. BWe would akin to allow new network control policies to be deployed in accessible networks, beside bequest nodes that are unconscious of the new control policies. There are many reasons to add convenient nodes into mixed networks in a slow manner, not the smallest amount of which is the financial price of replacing all nodes at one time. Other reasons hold a necessitate to uphold compatibility with present applications and particular reason hardware, a need of control to decommission bequest equipment, and a need of administrative freedom to transform accessible software. Theoretically, we sculpt controllable nodes as working in a network overlay on peak of a bequest network. Network overlays are often used to organize new communication architectures in bequest networks. To achieve this, messages from the fresh technology are encapsulated in the bequest format, allowing the two methods to coexist in the bequest network. Nodes making utilize of the new communication methods are then associated in a conceptual network overlay that operates on peak of the bequest network, as shown in Fig. 1. Numerous works have well thought-out the use of network overlays to get better routing in the Internet. The work proposes resilient overlay networks (RON) to find paths in the region of network outages on a quicker timescale than BGP. Similarly, [5] projected a method for choosing placement of overlay nodes to get better path diversity in overlay routes. Whereas both of the foregoing works show that their strategies decide high excellence single-path routes, we go advance and spot multipath routes that present maximum throughput. Setback decrease for BP routing has been measured in a diversity of scenarios. whereas multipath routes are necessary to hold up the complete throughput area, the examining segment of BP can show the way to large queues when the obtainable weight is low and single-path routes would suffice. In [9], a crossbreed procedure combining BP with shortest-path routing is proposed, where flows are biased towards shortest-path routes, however still hold the full throughput area. This crossbreed policy is extended in [8] to also contain digital fountain codes, and revealed to attain good end-to-end delay performance in the existence of accidental link failures. The work in [18] develops a strategy 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, [15] 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 [14] that dynamically finds 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 our approach. Our proposed algorithms for applying backpressure in overlay networks can help reduce delay by reducing the number of nodes between which

differential backpressure is formed. While our original motivation for studying backpressure in overlay networks was not to reduce delay, we believe that our scheme can be used as part of a delay-reducing solution.

### B. Problem Statement and Contributions

We consider two problem areas for control of heterogeneous networks. First, we develop algorithms for choosing the placement of controllable nodes, where our goal here is to allocate the minimum number of controllable nodes such that the full network stability region is available. Second, given any subset of nodes that are controllable, we also wish to develop an optimal routing policy that operates solely on these nodes.

In the second problem area, we consider the design of 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. We develop an overlay control policy that stabilizes all arrival rate vectors in  $\Lambda_G(V)$  for the case when tunnels do not overlap. We also develop a heuristic overlay control policy for use on general topologies, and show through simulation that stability is achieved for all arrival rates considered.

Our solutions for the first and second problem areas 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, our solutions can also be used in isolation; our node placement algorithm can be used with other control policies, and our BP extensions can yield maximal stability with any overlay node placement and legacy single-path routing.

### C. Our Contributions are Summarized Below.

- 1) 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.
- 2) We apply our placement algorithm to numerous 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
- 3) We propose a threshold-based control policy — BP-T — as a modification of BP for use at overlay nodes, and prove this policy to stabilize all arrival rates in  $\Lambda_G(V)$  when tunnels do not overlap
- 4) We propose a heuristic overlay BP policy — OBP — for use at overlay nodes on general topologies. We show via simulation that 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.

## III. EXISTING SYSTEM

- A. Techniques to supply throughput-optimal multipath routing have been explored in various contexts. The work in existing system considers the problem of setting link weights provided to the Open Shortest Path First (OSPF) routing protocol such that, when coupled with bifurcating traffic equally among shortest paths, the network achieves throughput equal to the optimal multi-commodity flow.
- B. The authors of existing system use an entropy maximization framework to develop a new throughput-optimal link state routing protocol where each router intelligently bifurcates traffic for each destination among its outgoing links.
- C. The work in existing system proposes resilient overlay networks (RON) to find paths around network outages on a faster timescale than BGP. Similarly, a other system proposed for choosing placement of overlay nodes to improve path diversity in overlay routes. While both of the preceding works show that their strategies select high quality single path routes, moreover we identify multipath routes that offer maximum throughput.

## IV. DISADVANTAGES OF EXISTING SYSTEM

- A. Existing techniques all require centralized control, universal adoption by all network nodes, or both; thus none of these techniques could provide incremental deployment of throughput optimal routing to wireless networks.
- B. Moreover, these techniques cannot be used in conjunction with throughput optimal dynamic control schemes, such as backpressure.

## V. PROPOSED SYSTEM

- A. We consider two problem areas for control of heterogeneous networks. First, we develop algorithms for choosing the placement of controllable nodes, where our goal here is to allocate the minimum number of controllable nodes such that the full network stability region is available.
- B. Second, given any subset of nodes that are controllable, we also wish to develop an optimal routing policy that operates solely on these nodes.
- C. Our solutions for the first and second problem areas 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, our solutions can also be used in isolation; our node placement algorithm can be used with other control policies, and our BP extensions can yield maximal stability with any overlay node placement and legacy single-path routing.

## VI. ADVANTAGES OF PROPOSED SYSTEM

- A. Our proposed algorithms for applying backpressure in overlay networks can help reduce delay by reducing the number of nodes between which differential backpressure is formed.
- B. We formulate the problem of placing the minimum number of overlay (controllable) nodes in a legacy networking order to achieve the full multi-commodity throughput region and provide an efficient placement algorithm.
- C. We apply our algorithm to several scenarios of regular and random graphs, results that in some cases, only a small fraction of overlay nodes is enough for maximum throughput.
- D. We propose a threshold-based control policy — BP-T — as a modification of BP for use at overlay nodes, and prove this policy to stabilize all arrival rates in  $\Lambda G(V)$  when tunnels do not overlap.
- E. We propose a heuristic overlay BP policy — OBP — for use at overlay nodes on general topologies. We show via simulation that 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.

## VII. CONCLUSION

We study optimal routing in legacy networks where only a subset of nodes can make dynamic routing decisions, while the legacy nodes can forward packets only on pre-specified shortest-paths. This model captures evolving heterogeneous networks where intelligence is introduced at a fraction of  $B_{nodes}$ . We propose a necessary and sufficient condition for the overlay node placement to enable the full multi commodity throughput region. Based on this condition, we devise an algorithm for optimal controllable node placement. We run the algorithm on large random graphs to show that very often a small number of intelligent nodes suffices for full throughput. Finally, we propose dynamic routing policies to be implemented in a network overlay. We provide a threshold based policy that is optimal for overlays with non-overlapping tunnels, and provide an alternate policy for general networks that demonstrates superior performance in terms of both throughput and delay.

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