AN OVERLAY ARCHITECTURE FOR THROUGHPUT OPTIMAL MULTIPATH ROUTING

ABSTRACT

- Legacy networks are often designed to operate with simple 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.
- In this paper, we study an overlay architecture for dynamic routing, such that only a subset of devices (overlay nodes) need to make the dynamic routing decisions. We determine the essential collection of nodes that must bifurcate traffic for achieving the maximum multi-commodity network throughput.

- We apply our 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, we propose a threshold-based policy (BP-T) and a heuristic policy (OBP), which dynamically control traffic bifurcations at overlay nodes. Policy BP-T is proved to maximize throughput for the case when underlay paths do no overlap. In all studied simulation scenarios, OBP not only achieves full throughput but also reduces delay in comparison to the throughput optimal backpressure routing

Existing System

- Backpressure (BP) routing, first proposed in [16], 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, in part, to an inability of backpressure routing to coexist with legacy routing protocols. With few exceptions, back-pressure routing has been studied in homogeneous networks, where all nodes are dynamically controllable and implement the backpressure policy across all nodes uniformly.

DISADVANTAGES

- End-to-end delay performance in the presence of random link failures
- The legacy nodes perform only forwarding on pre-specified paths, the overlay nodes are able to dynamically route packets.

PROPOSED SYSTEM

- We 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.
- We apply our 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.
- 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.

ADVANTAGES

- Multipath routes are required to support the full throughput region
- Optimal for overlays with non-overlapping tunnels

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 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.