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Balancing Flow Table Occupancy and Link Utilization in Software-Defined Networks

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Abstract

Software-Defined Networking (SDN) employs a centralized control with a global network view and provides great opportunities to improve network performance. However, due to the limitation of flow-table space at the switches and unbalanced traffic allocation on links, an SDN may suffer from flow-table overflow and inefficient bandwidth allocation among flows, increasing the controller's burden and degrading network performance. In this paper, we present a dynamic routing scheme named DIFF that differentiates flows based on their impact on network resource and adaptively selects routing paths for them to mitigate the problems of flow-table overflow and inefficient bandwidth allocation. DIFF pre-generates a set of paths for each pair of source-destination edge switches and intelligently selects the paths from the pre-generated path-sets for new flows with an objective to balance flow-table utilizations. It adaptively reroutes some elephant flows to achieve maximum throughput under the rule of max-min fair bandwidth allocation. Simulation results show that DIFF simultaneously balances the flow-table and link utilizations, reduces the controller's workload and packet delay, while increasing network throughput, compared with baseline schemes.

Index Terms

Software-Defined Networking, OpenFlow, Flow-table Overflow, Max-min Fairness, Routing

I. Introduction

Software-Defined Networking (SDN) offers flexible network operation and control by dynamically realizing network functions based on a global view of the network [1] [2] [3] [4]. The design and implementation of SDN-specific hardware/chips require sophisticated manufacturing techniques and long time testing, and most current SDNs devices are implemented on existing general hardware/chips and support both SDN and conventional protocols. Therefore, the deployment of SDN using those devises (e.g., OpenFlow-compatible switches) becomes the mainstream trend.

In OpenFlow specifications, traditional network functions (e.g., layer 2 forwarding, layer 3 routing, layer 4 packet classification) are abstracted as flow entries [5]. However, most OpenFlow-compatible switches are equipped with