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BeaQoS: Load balancing and deadline management of queues in an OpenFlow SDN switch

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ABSTRACT

Current OpenFlow specification is unable to set the service rate of the queues inside OpenFlow devices. This lack does not allow to apply most algorithms for the satisfaction of Quality of Service requirements to new and established flows. In this paper we propose an alternative solution implemented through some modifications of Beacon, one popular SDN controller. It acts as follows: using 'almost'-real-time statistics from OpenFlow devices, Beacon will re-route flows on different queues to guarantee the observance of deadline requirements (e.g. the flow is still useful if, and only if, is completely received by a given time) and/or an efficient queue balancing in an OpenFlow SDN switch. Differently from the literature, we do not propose any new primitive or modification of the OpenFlow standard: our mechanism, implemented in the controller, works with regular OpenFlow devices. Our changes in the SDN controller will be the base for the design of a class of new re-routing algorithms able to guarantee deadline constraints and queue balancing without any modification of the OpenFlow specification, as well as, of OpenFlow devices.

1. Introduction

Software Defined Networking (SDN) is revolutionizing the networking industry by enabling programmability, easier management and faster innovation [1,2]. These benefits are made possible by its centralized control plane architecture which allows the network to be programmed and controlled by one central entity.

The SDN architecture is composed both of SDN enabled devices (switches/routers)[1] and of a central controller (SDN controller). An SDN device processes and delivers packets according to the rules stored in its flow table (forwarding state), whereas the SDN controller configures the forwarding state of each SDN device by using a standard protocol called OpenFlow (OF) [2]. The SDN controller is responsible also to build the virtual topology representing the physical topology. The virtual topology is used by the application modules that run on top of the SDN controller to implement different control logics and network functions (e.g. routing, traffic engineering, firewall actions).

Currently the Quality of Service (QoS) management in OF is quite limited: in each OF switch one or more queues can be configured for each outgoing interface and used to map flow entries on them. Flow entries mapped to a specific queue will be treated according to the queue's configuration in terms of service rate, but the queue's configuration *takes place outside the OF protocol*. For example, the queue's service rate cannot be modified by OF.

Supposing that a flow is traversing a chain of queues from the source to the destination node, and that the flow data rate increases, a possible consequence is that queues increase their occupancy, and a bottleneck may be generated with consequent network congestion. The impossibility to change the bottleneck queue's service rate through real-time OF directives can lead to a severe performance degradation for the flows traversing that queue because, without a proper rate assignment, it is very difficult to guarantee Quality of Service requirements to the flows [3].

A possible solution to mitigate the performance degradation involves the re-routing of the flows experiencing a violation of deadline constraints (e.g. the flows that are totally received beyond the fixed time constraint) [4] on less congested paths or queues. The underlying idea is that, since we cannot change the service rate of

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[1] In the following we will use the terms: SDN device, OpenFlow device, OpenFlow switch, interchangeably, even if the term "OpenFlows switch" or simply "switch" indicates an SDN enabled device in most SDN literature.

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