A Study of QoS-Aware Consistent Updates in a Software Defined Network

The ability to preserve Quality of Service (QoS) requirements at all times is an important ability for enabling Software Defined Networks (SDN) to guarantee performance assurance and consistency. However, ensuring QoS during updates is difficult as the flow rate is dynamically changed according to network conditions (e.g., TCP congestion control), and different update plans may lead to different intermediate states. As these conditions are considerations of the data-plane, predetermined conditions applied to the network can have unforeseen consequences. Existing consistent update approaches fail to account for adaptive rate and QoS requirements, and can lead to QoS violations in real settings.

Software-Defined Networks (SDN) are powerful tools that aim to make networks more agile, flexible and easy to manage. SDN allow users to take control over specific flows in a network, adding, deleting and modifying flows easily. However, implementing these changes on a real network can be a complex challenge. Flow-level operations must be performed efficiently and with no manual ordering from the user. This often requires the use of a scheduler.

Poor scheduling can lead to black holes, loops, and congestion on the network, a problem that has inspired significant work. Much of this work focuses on the problem of parallelizing operations - starting multiple operations at the same time to ensure faster overall completion. Unfortunately, done naively, parallelizing can lead to significant problems as updates can interact and cause congestion or loops in the network.
Additionally, aside from the inherent challenges of scheduling multiple updates, existing work fails to take into the use of each flow. As an example, the behaviour and requirements of video streaming differ greatly from file transfers, and both comprise significant volumes of traffic in daily network usage. Yet current work on scheduling flow operations ignores these application-specific requirements, basing itself on rigid constraints.

In this project, I hope to perform further research on the topic outlined above. I intend to work from a theoretical standpoint to explore and outline (in algorithmic and paper form) ways to implement QoS-Aware updates in the SDN setting.

Initially this will require more in depth understanding of the framework of SDN within which I will be operating. It will then require exploration of the flow-level changes that occur in the network without input from the user. Finally, it will require a novel approach to implementing a scheduler that is QoS-Aware to ensure the paper is applicable without additional user input required.

I hope to submit at least one paper to a conference based on this research. This requires that I will have at least enough novel work to cover 10+ pages in the submission format. I aim to write two papers, one on abstracting network flow-level protocols and another on the scheduler that orders the operations according to these abstractions.

The motivation for this work professionally is outlined above. However, I am also personally interested in pursuing this project as I have developed a working foundational knowledge of a lot of the surrounding topics required to do this project well. It will also be a great way to forward my understanding of SDN, a topic that I will likely be working on post-graduation.
Deliverables:

At least one paper submission to a Networks conference by the end of the year.

A full write-up of all work performed in the semester.