Saraswati: A scale-out SDN controller architecture backed by a shared fuzzy log

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OVERVIEW

Current software-defined networking (henceforth SDN) frameworks such as Floodlight, OpenDaylight and ONOS are based on the abstraction of a distributed controller composed of n>1 nodes acting as one logically centralized controller, but the current state-sharing systems for these frameworks are either slow (Paxos, Raft) or only eventually consistent (Cassandra, DynamoDB). The Saraswati project is an attempt to create a scalable, fast distributed SDN controller by using a fuzzy shared log as the state-sharing abstraction.

In order to accomplish this goal, I need some standard way of benchmarking SDN controller performance so I can test the hypothesis that Saraswati will be more performant than current systems. Unfortunately, there is no benchmark for distributed controller performance due to the newness of the field, so as part of this project I will conceptualize and develop an SDN controller benchmark based on a thorough review of literature in the field.

MOTIVATION

Software-defined networking is a nascent but rapidly-growing field of research in distributed systems and networking. In essence, an SDN allows a stateful application to exert fine-grained control over packet routing at the switch level to optimize bandwidth, latency and availability in
large-scale networks. Most SDN frameworks rely on a two-level hierarchy - switches compute routing tables by making calls to functions which reside on an abstract logically-centralized controller, which is in practice implemented as a distributed controller due to latency, locality and bandwidth limitations. Some kind of globally-consistent state-sharing solution is required if you want to scale out this logical controller, since the routing tables are, in theory, calculated based on global state. Current systems often break the abstraction by using Cassandra or some other eventually consistent datastore for metadata and application state, often resulting in undefined or inefficient behaviour and causing massive frustration for application programmers. When global consistency is offered, it is by way of the venerable Paxos and Raft SMR algorithms, which tend to slow things down to an untenable extent.

The Saraswati project is an attempt to build an abstraction-conformant logically centralized controller by storing metadata and application state in a Delos fuzzy shared log store, partitioning across subnetworks, applications and disparate groups of switches.

**THE DELOS FUZZY SHARED LOG**

The Delos Fuzzy Shared Log, which is being developed primarily by Joshua Lockerman (joshua.lockerman@yale.edu) with the assistance of myself and Jose Faleiro (jose.faleiro@yale.edu) under the guidance of Professor Mahesh Balakrishnan with input from Professors James Aspnes and Daniel Abadi, is a multi-chain shared log for use in systems composed of infrequently-interacting subsystems. It builds on Professor Balakrishnan’s Corfu single-chain shared log system, introducing cross-chain happens-before and transaction primitives to enforce some valid total ordering only when needed across disparate parts of a large system’s state. The Delos team intends to use Saraswati as an illustration of Delos’ capabilities as a metadata store for real world systems, in particular for our anticipated paper submission to OSDI this May.
DELIVERABLES

**A benchmark for distributed SDN controller performance**

As previously noted, I will conceptualize and develop an SDN controller benchmark which concentrates on distributed controller performance.

**An implementation of the Saraswati system**

I will design and implement Saraswati against a prototype of the Delos fuzzy shared log system, then publish the code on github.

**Benchmarking of Saraswati against existing solutions**

I will benchmark Saraswati against existing SDN controller solutions for a variety of SDN applications and workloads.

**A presentation on the SDN benchmark and Saraswati**

I will give a presentation on the SDN benchmark and Saraswati at the end of the semester. This talk will be open to anybody who wants to attend and will be advertised through the CS department email list.

**A written exposition and evaluation of the SDN benchmark and the Saraswati system to be included in the Delos OSDI submission**

I will write a report about the motivation behind the SDN benchmark and Saraswati, the details of their specification and implementation respectively, and Saraswati’s performance against other SDN controller solutions based on the benchmark for inclusion in the Delos OSDI submission this May.