Exercise for Lecture Software Defined Networking

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Problem 2.1 - SDN and OpenFlow Basics

Hint: A 30-minutes version of Scott Shenker's talk on "The Future of networking, and the Past of Protocols" that the lecture was partially based on is available on YouTube: `https://www.youtube.com/watch?v=YHeyuD89n1Y`. It might help you to revisit some of the concepts presented in the lecture.

a) Separation of Concerns: Briefly explain in your own words the different responsibilities of the SDN layers described by Scott Shenker: *Control Program*, *Network Virtualization* layer, and *NOS*.

Control Program:
Gather requirements from operators, such as routing information & ACL, and then use API to design an abstract model with behaviors to meet requirements.
Network Virtualization:
"Compile" the abstract model from Control Program into a global network view(topology), and produce configurations for each hardware in this network.
NOS:
Simply transmit the configuration to the corresponding physical switches remotely. NOS is also responsible to get real-time states of switches in the whole network, so if any one of them is down, the upper Network Virtualization & Control Program could know.

b) Foundation of layers: What are the key abstractions that provide the foundation of SDN? Briefly explain what exactly is abstracted, how the interfaces of the abstractions look like, and who uses them.
Note: This task overlaps with the previous one but requires you to take a more conceptual perspective.

There are 3 key abstractions that provide the foundation of SDN:
1. Distributed state abstraction:
States of all devices in the network are abstracted to a global network view(such as NOS).
The interface is an annotated network graph with programmable API(of NOS).
Control program will use this interface to create a simplified network model.
2. Specification abstraction:
Detailed configurations of distributed devices are abstracted to a network model. This abstraction is often called Network Virtualization.
For upper Control Program, the interface is a configuration model of network. Control Program can use it to modify network behaviors.
For under hardware devices, the interface provide them the detailed hardware configuration and a method to report error or exception to NOS. Based on the configuration, these devices can forward or drop packets.
3. Forwarding abstraction:
Functions of routers and switches are abstracted to 2 parts: Management CPU & Forwarding ASIC. It provides interface to Control plane, so that NOS can get state of all switches; it also provides interface to switches, in order to transmit detailed hardware configurations to them.

c) Briefly explain the concept of a "scale-out router" in the context of network virtualization (slide 42, lecture 2). What is the advantage of using this abstraction in the context of the above discussed abstractions?

Physically a "scale-out router" is a collection of interconnected switches, but it could be abstracted as a single router in the context of Network Virtualization.
The advantage is that complexity of increased number of switches will be limited in the Specification Abstraction. The network model in Distributed State Abstraction stays simple, and Forwarding Abstraction is only responsible to receive configuration and send state.

d) When network engineers start learning about SDN, they often get the impression that the concept introduces a single point of failure to the process of network control. Why is this the case and why is it not true after what you learned in the first lectures? Please briefly explain.

It is easy to have this idea, because instead of a distributed control mechanism, SDN integrates all control functionalities into a centralised control plane. It is quite common to have the concern that a single failure of the centralised control plane will cause the failure of the whole network.
It is not true because in SDN, distributed controller can be used. This clustered state can avoid this problem.