

# Exercise 3 – SDN Control Plane

## 1. OpenFlow (25P)

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- a) (5P) What are the two main components of OpenFlow?
- b) (5P) Please explain the packet matching process of OpenFlow.
- c) (5P) What is the task of the OpenFlow Channel?
- d) (10P) In the Figure below, the flow tables of a switch are illustrated.
  - i. (5P) Please sketch the way a packet takes through the tables after arriving on ingress port 45.
  - ii. (5P) Please explain what the options of handling a packet that arrives on ingress port 1024 are, depending on the configuration of the switch.

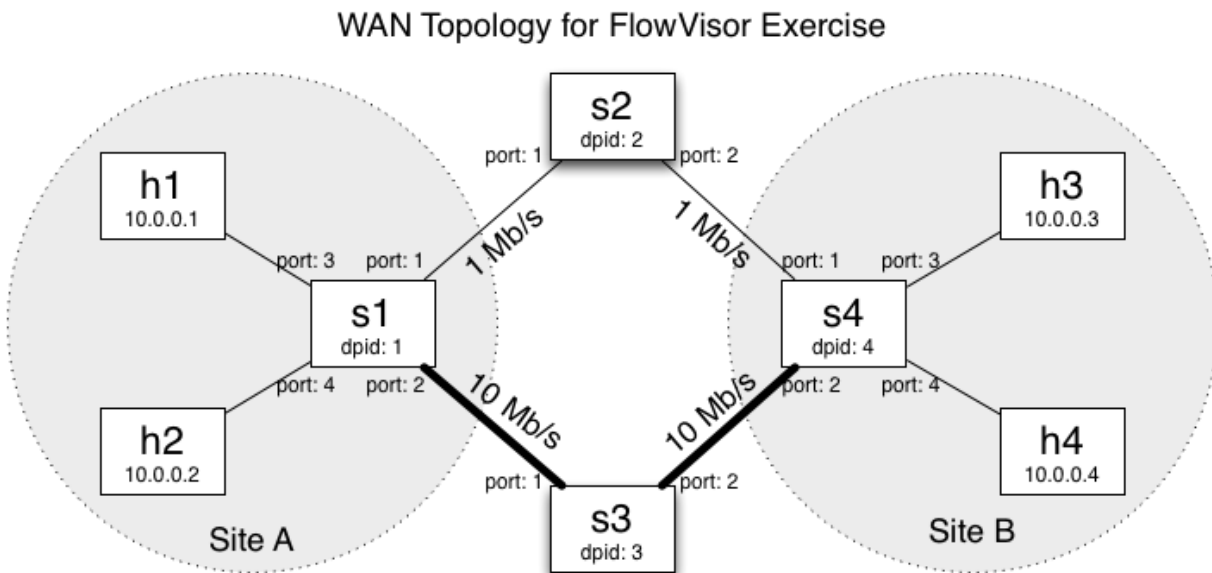
TABLE 0	TABLE 1	TABLE 2
<b>Port   Priority   Instruction</b> 30   100   Table 1 45   50   Table 1 45   100   Table 2 80   500   Table 1 21   0   Drop	<b>Port   Priority   Instruction</b> 30   100   Forward Interface 1 45   50   Forward Interface 1 80   500   Forward Interface 0	<b>Port   Priority   Instruction</b> 45   100   Forward Interface 2

## 2. FlowVisor (50P)

Consider the network topology shown in the figure below. It connects two sites of a Wide Area Network (WAN), where each site is represented by a single OpenFlow switch, s1 and s4, respectively. The sites, s1 and s4, have two paths between them:

- a low bandwidth path via switch s2
- a high bandwidth path via switch s3

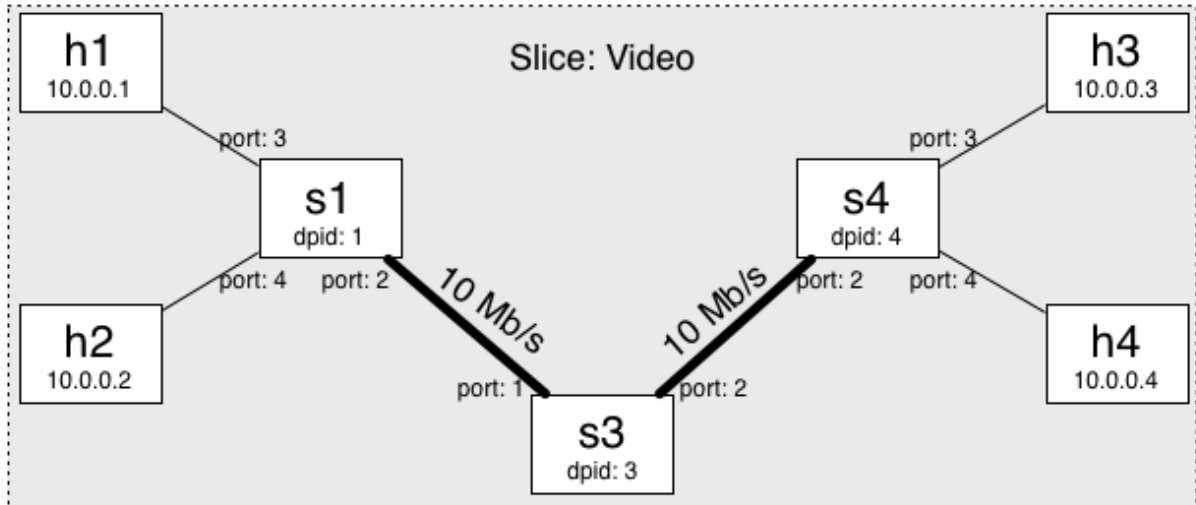
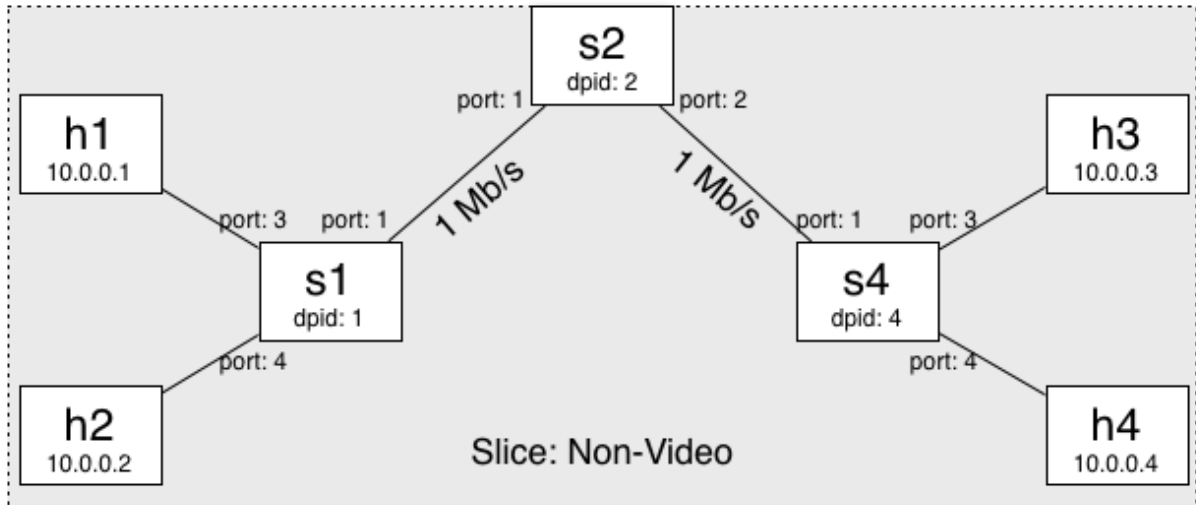
s1 has two hosts attached: h1 and h2. s2 has two hosts attached: h3 and h4.



The provider of the WAN now wants to dedicate certain links to certain applications within the network. In particular, the provider wants to create a *video slice* that handles the video traffic, and a *non-video slice* that handles the remaining, non-video traffic. Each slice will be controlled by a different controller (non-video by controller c1, video by controller c2). The video traffic (sent over TCP port 1234) should be forwarded over the high-bandwidth links, while the non-video traffic (all other ports) should be forwarded over the low-bandwidth links. A visualization of such a slicing is shown in the figure on the next page.

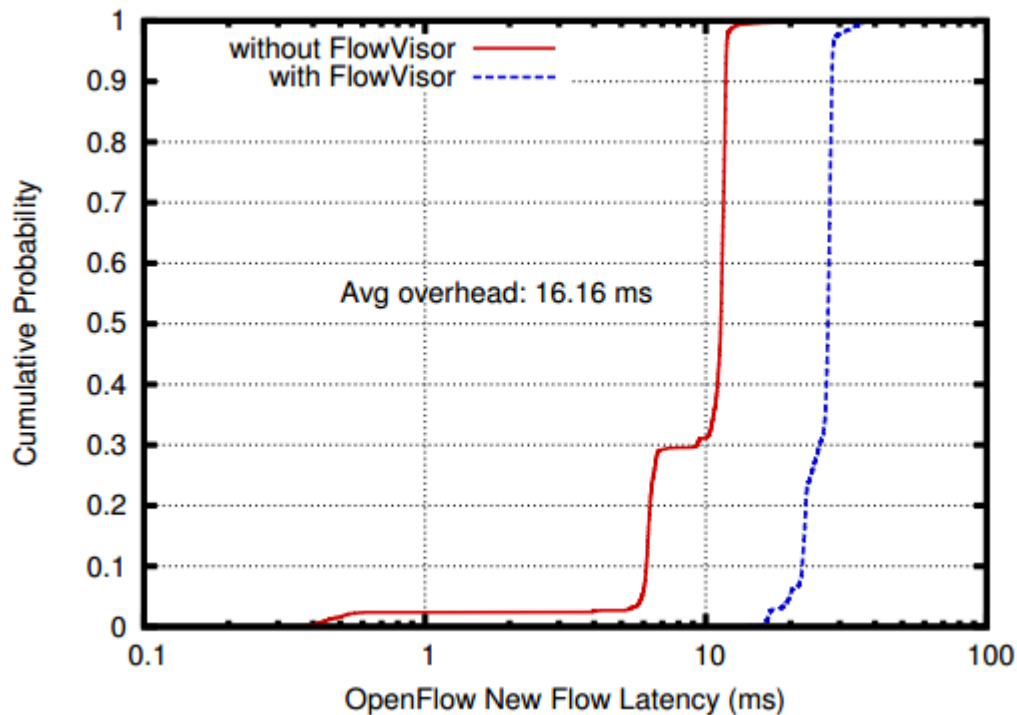
- (10P) Please indicate the flows paces that FlowVisor will set up to realize these slices.
- (25P) Based on the slices created in a, which of the following statements are true? Give reasons for your answer.
  - (5P) Controller c1 is allowed to install the following rule in switch s2: Forward all incoming traffic on port 2 with TCP port 80 and source ip 10.0.0.3 (h3) via port 1
  - (5P) Controller c1 is allowed to install the following rule in switch s3: Forward all incoming traffic on port 2 with TCP port 1234 via port 1.

- c. (5P) If the link s1-s3 is down, video traffic with TCP port 1234 can no longer be forwarded from h1 to h4
- d. (5P) FlowVisor will return an error to controller c2 if c2 tries to setup the rule “forward all traffic with source-IP 10.0.0.4 (h4) via port 2” on switch s4.
- e. (5P) It is impossible to create such a virtualized network with traditional networking techniques.



- c. (15P) FlowVisor has to process the so-called *new flow messages*, i.e., those messages that have to be forwarded to the controller in case of a table-miss at a OpenFlow switch. Here, FlowVisor has to determine the correct recipient controller of these messages before forwarding the new flow message to that controller.

In the figure below, we see that this operation incurs an additional 4 to 5 ms to the latency of these requests in FlowVisor, when compared to an OpenFlow network without FlowVisor. Do you think this amount of overhead is a criterion that could limit the usefulness of FlowVisor? Why?



### 3. OpenFlow Controllers (25P)

Suppose you are the operator of a campus network at the University of Göttingen. You want to set up a SDN infrastructure on this network. Because you are new to the field, you first do some research on the available controller platforms:

- (15P) Please discuss the following properties of the controllers NOX, POX and Floodlight as introduced in the lecture: programming language, advantages and disadvantages, learning curve and type of target network.
- (10P) Which of the controllers would you choose for your network? Give reasons for your answer.