Teaching Computer Networking with Mininet

Session 2: Hands-on Lab -- BufferBloat

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Goals of the Assignment

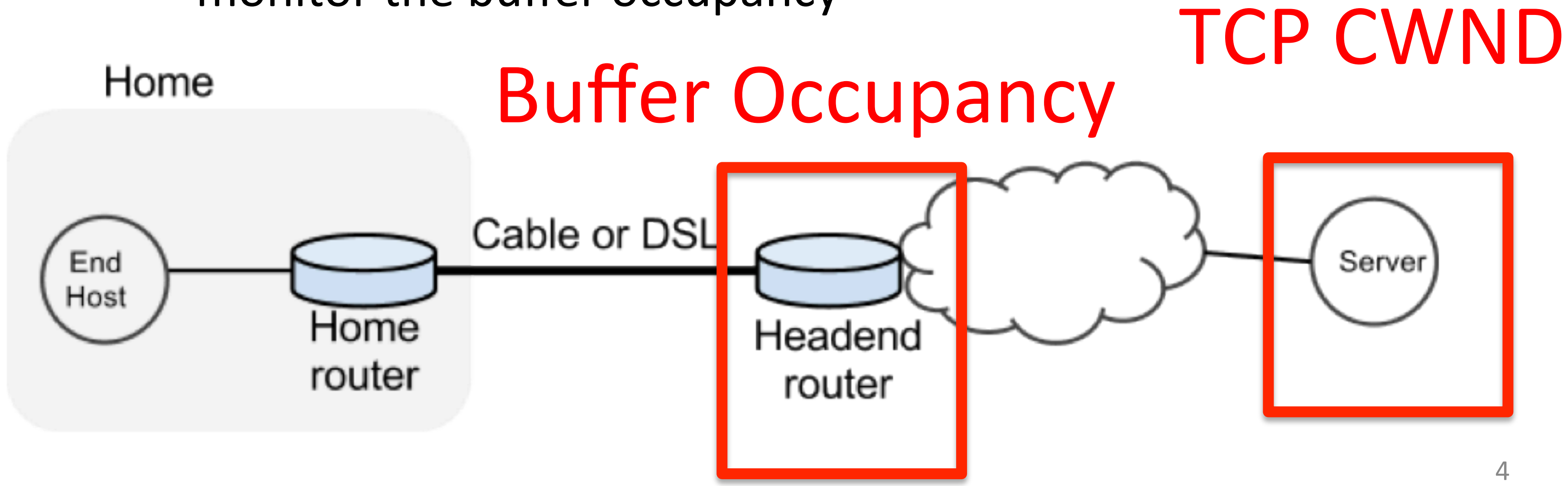
- Understand the dynamics between TCP CWND and router's buffer occupancy
- Understand why large router buffer can lead to poor TCP performance
  - I.e., the buffer bloat problem

Outline of the Session

- Why is Mininet helpful?
- Assignment Overview
- Behind the scene – part 1
  - Architecture
- Time to try it out!
- Behind the scene – part 2
  - The actual code

Why Mininet is Helpful?

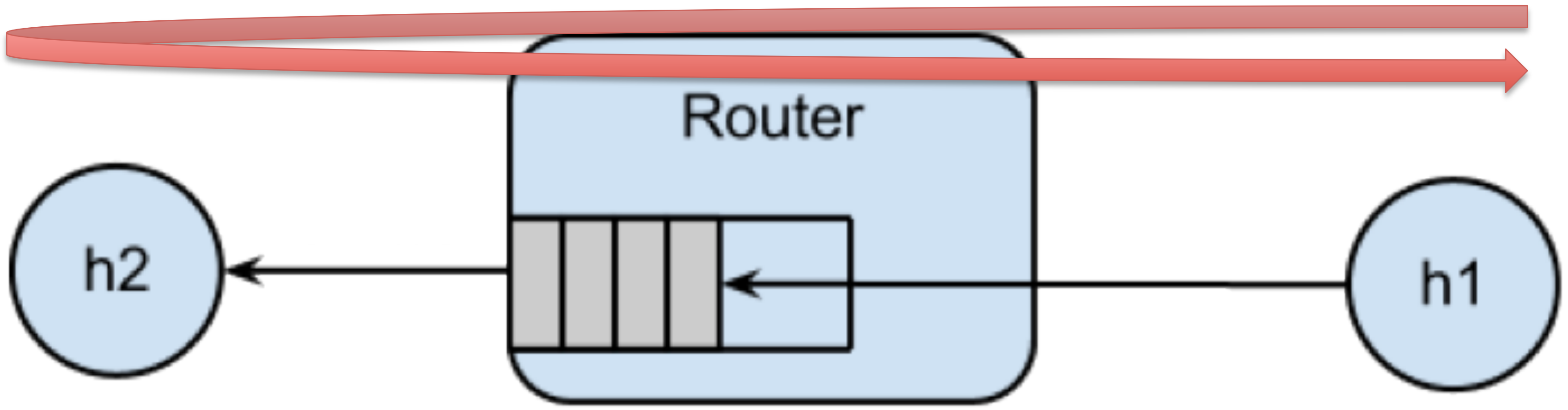
- Easy to setup the environment
- Easy to access the information
  - Use `tcpprobe` to monitor TCP CWND at sender
  - Use `tc` to:
    - control the buffer size
    - monitor the buffer occupancy



Assignment Overview

- Part 1: The setup

RTT of h1 to h2
20ms



End Host

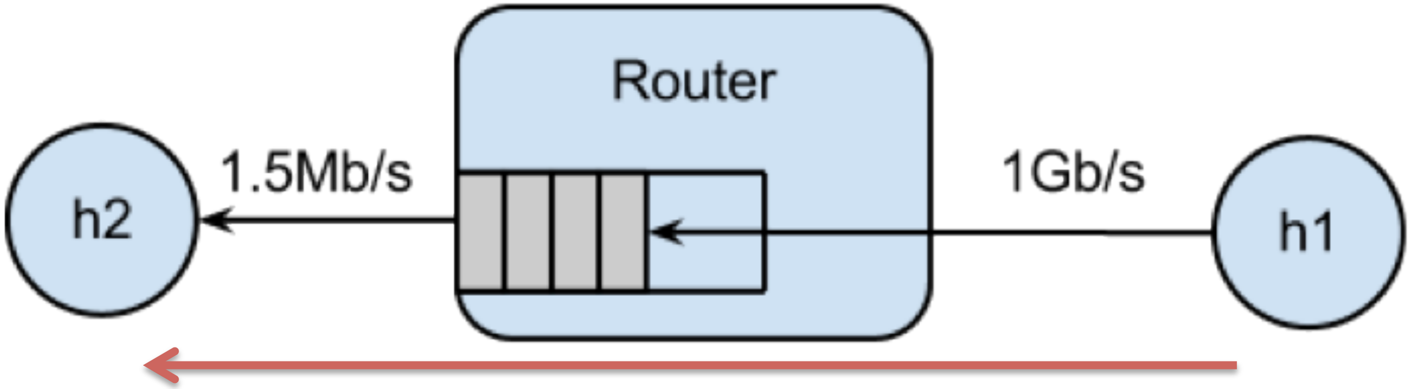
Bottleneck Router

Buffer Size: 150 kB
(100 pkt)

Server

Assignment Overview

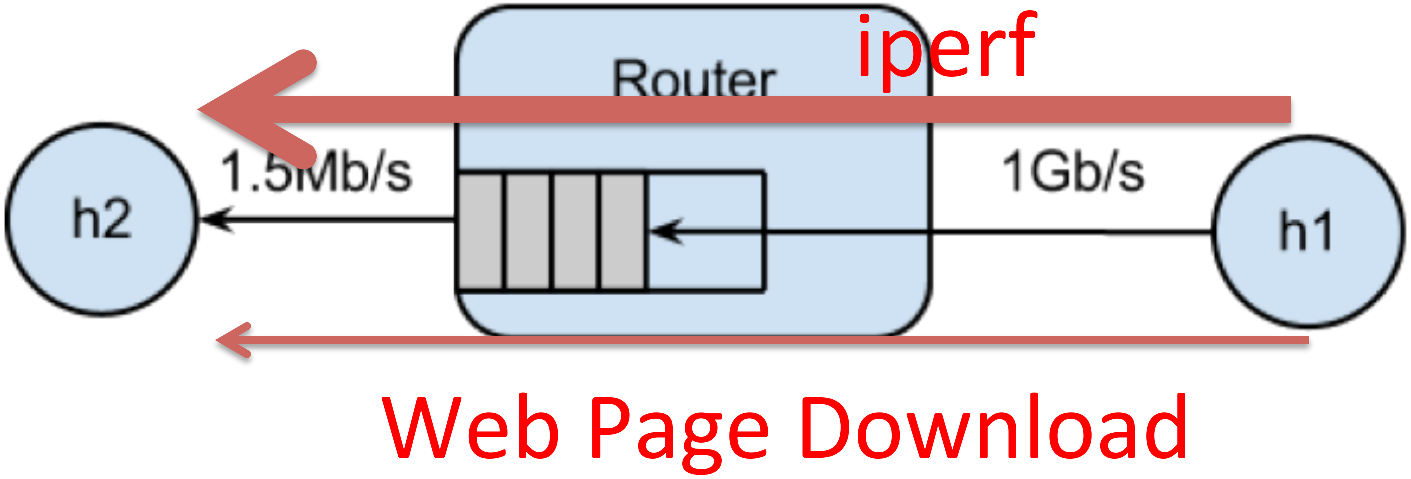
- Part 2: CWND evolution of a **short** TCP flow
  - The TCP flow is created through a web request
  - No competing flow on the network
  - Observe the RTT and flow completion time
  - Think about how the CWND is evolved



Web Page Download

Assignment Overview

- Part 3: CWND evolution of a **long** TCP flow
  – TCP flow is created through iperf
  – Observe the RTT and throughput
  – Think about how the CWND is evolved
  – Observe how the long flow affects the short flow

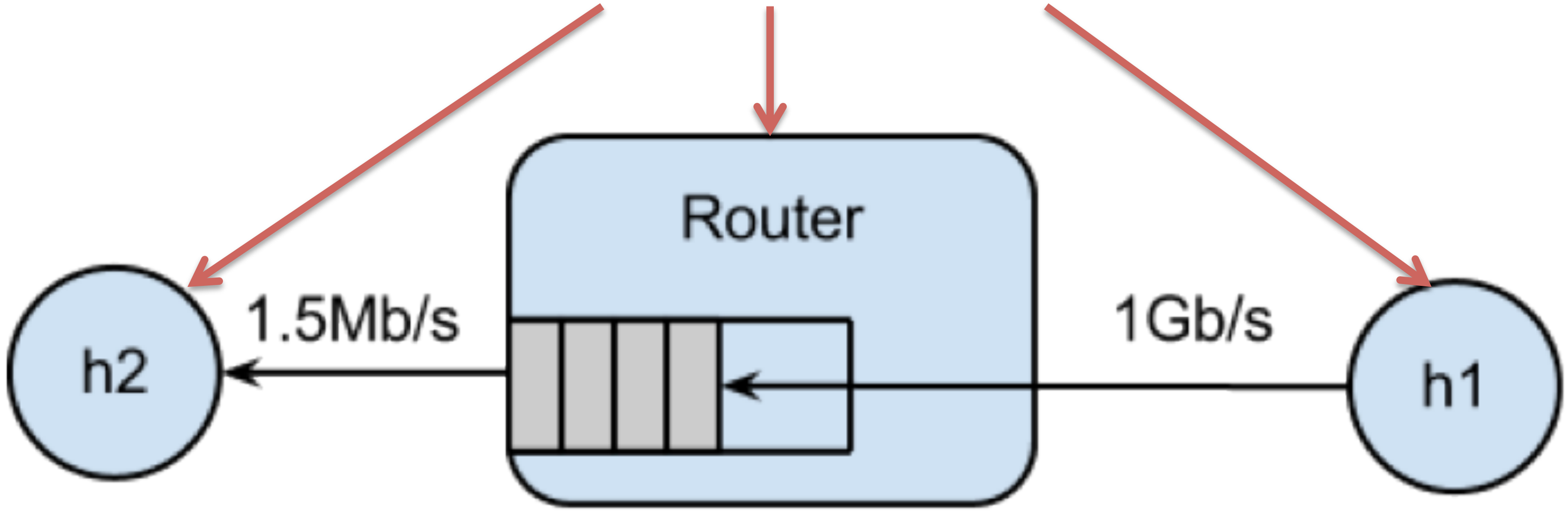


Assignment Overview

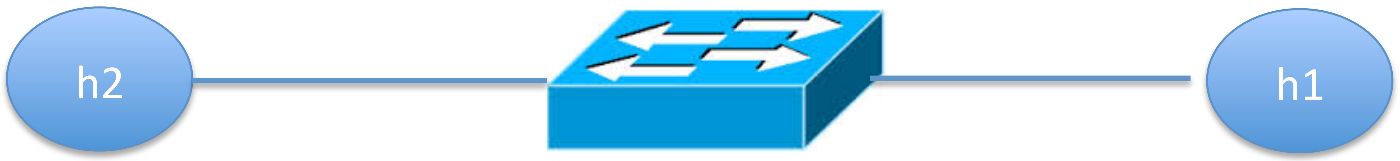
- Part 4: Verify the evolution of CWND through Mininet
- Part 5: Explore a solution: smaller buffer
- Part 6: Explore a solution: separate queue for each flows

Behind the Scene – Part 1

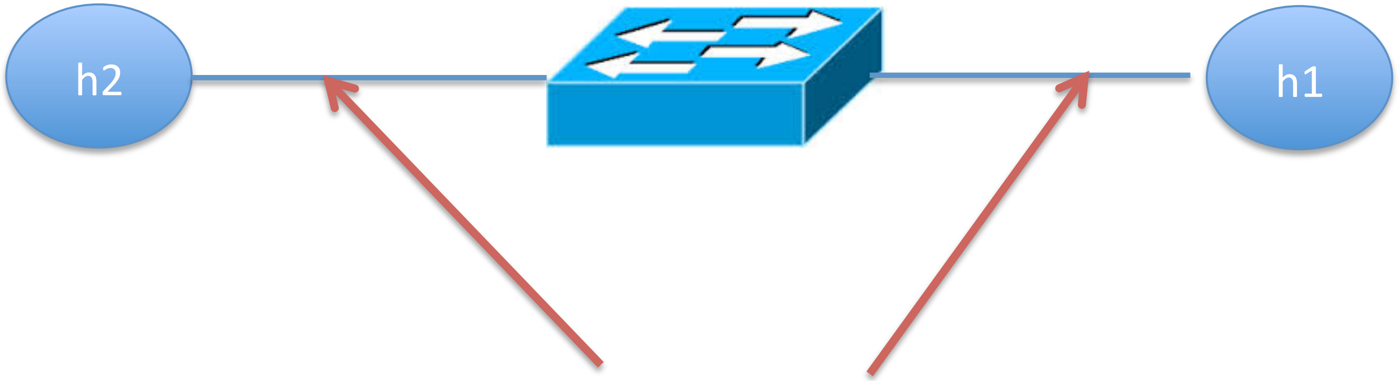
Each runs in a container



Open VSwitch



Behind the Scene – Part 1



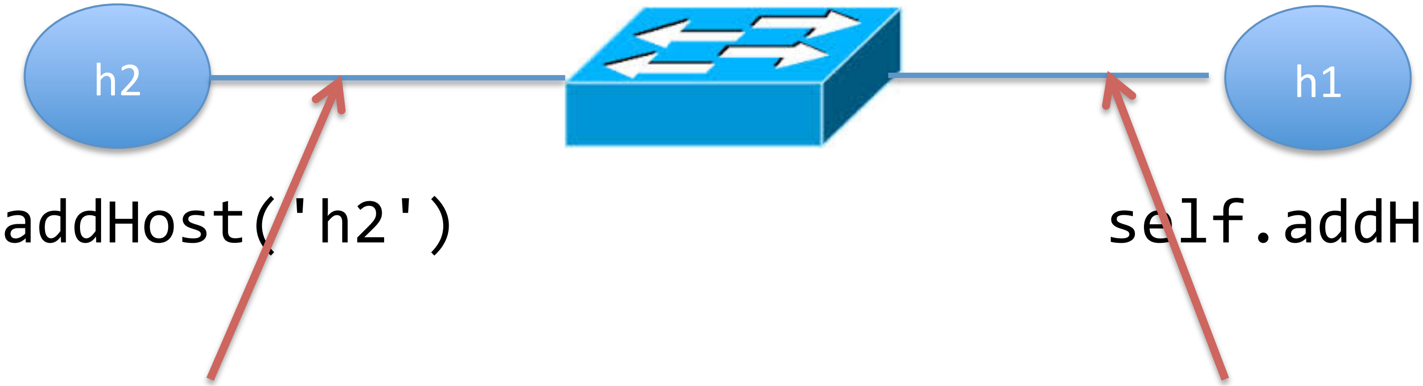
Use 'tc' to control the delay, link rate and queue length

Time to try it out!

Topology

- Defined in bufferbloat.py

```
self.addSwitch('s0')
```

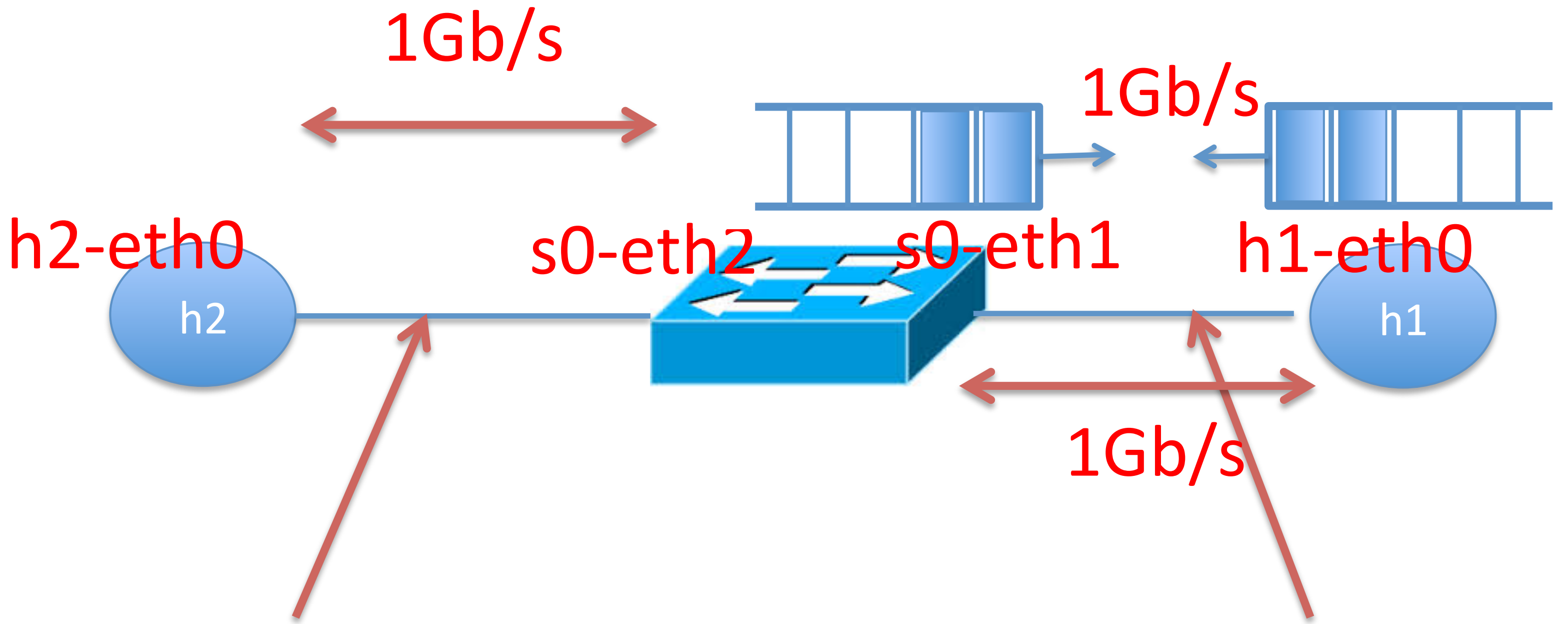


```
self.addHost('h2')                  self.addHost('h1'

self.addLink('h2', 's0')        self.addLink('h1','s0')
```

Link Speed

- Defined in bufferbloat.py

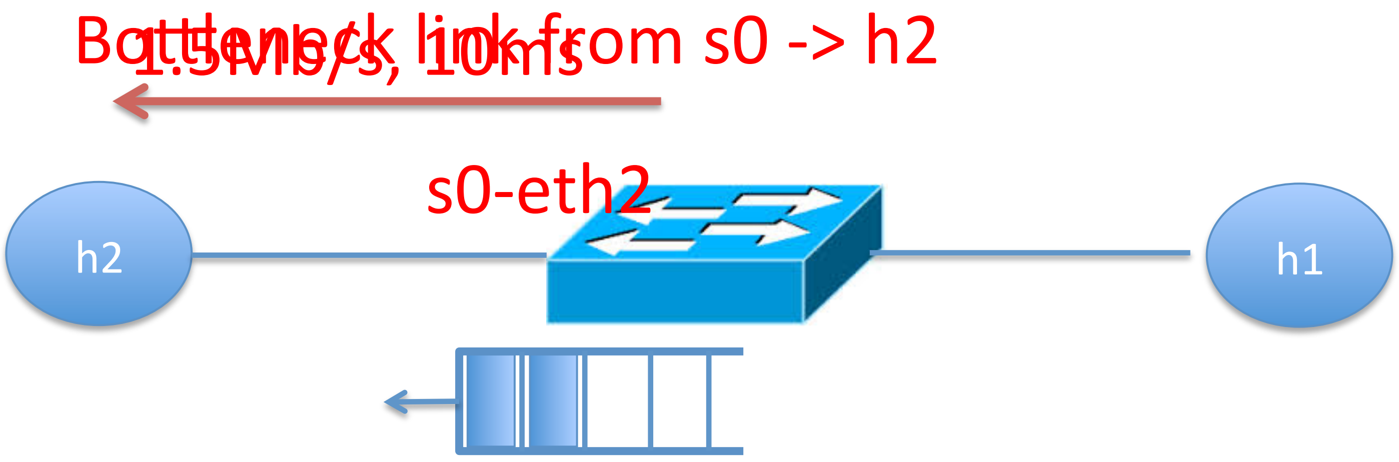


```
self.addLink('h2','s0')
self.addLink('h2','s0',
bw=1000)
```

```
self.addLink('h1','s0')
self.addLink('h1','s0',
bw=1000)
```

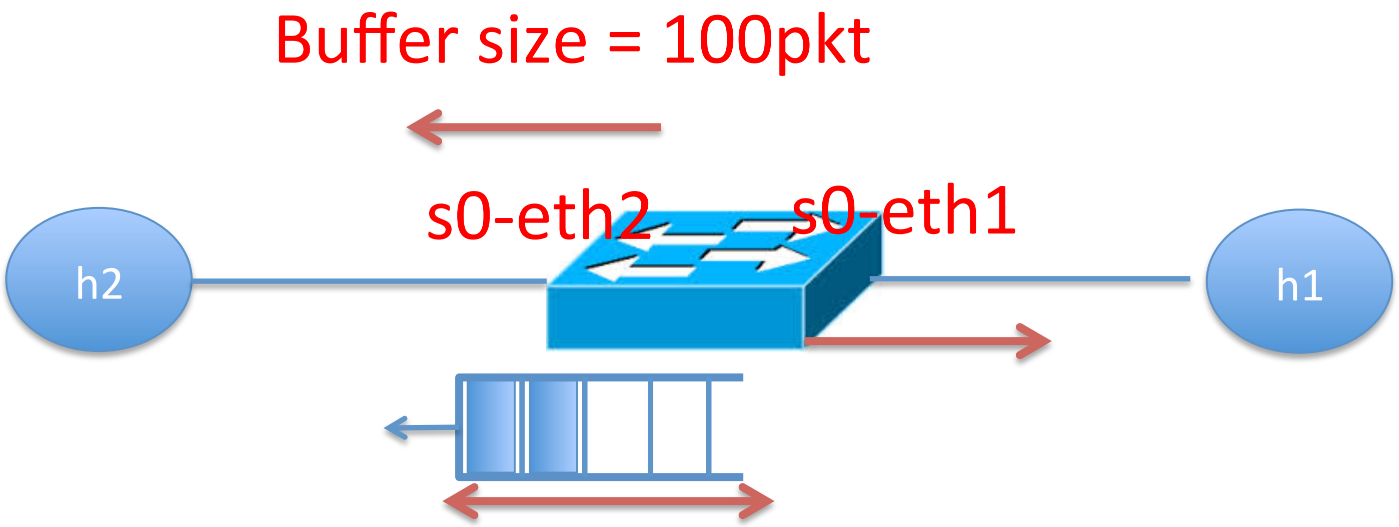
Link Speed

- Add asymmetry into the picture
- Command can be found in tc_cmd.sh



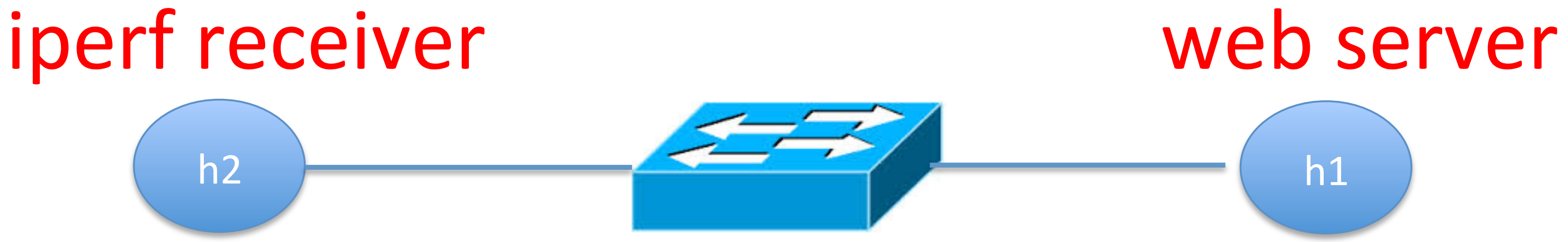
Control Buffer Size

- Command can be found in tc_cmd.sh



Services on Hosts

- Command can be found in bufferbloat.py

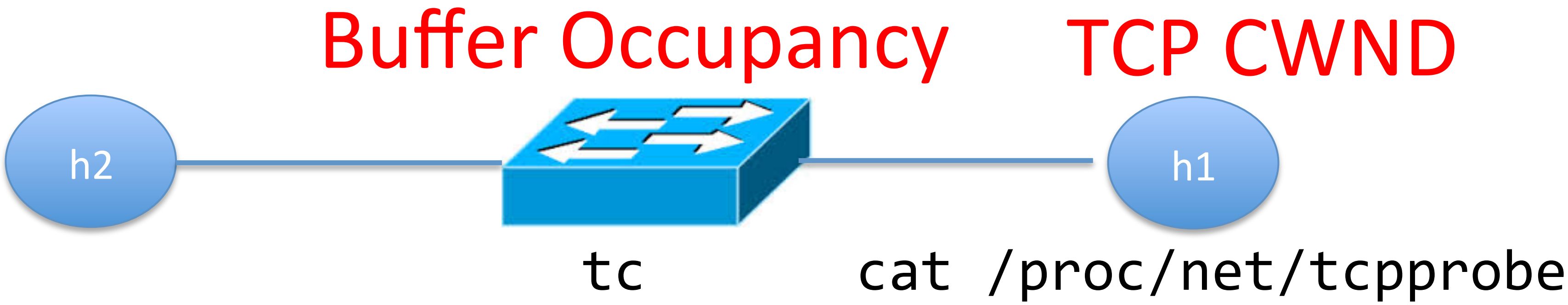


```
h2.cmd('iperf -s')
```

```
h1.cmd('python2.7 webserver.py')
```

Monitor

- Code can be found in exp_monitor.py



```
tc
```

```
cat /proc/net/tcpprobe
```