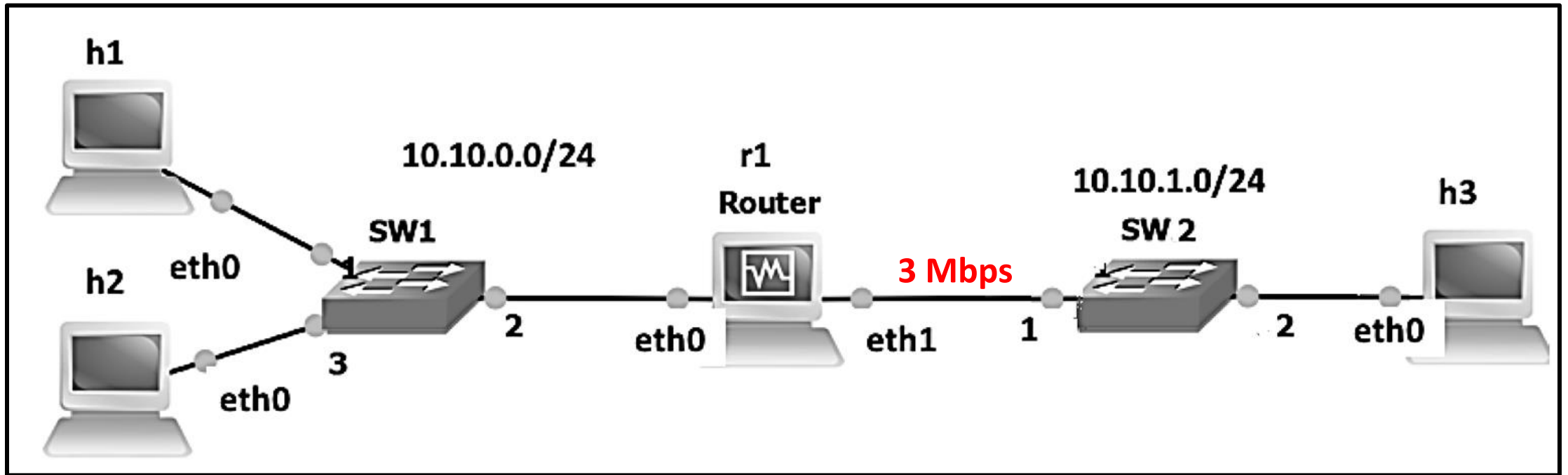


TCP & UDP

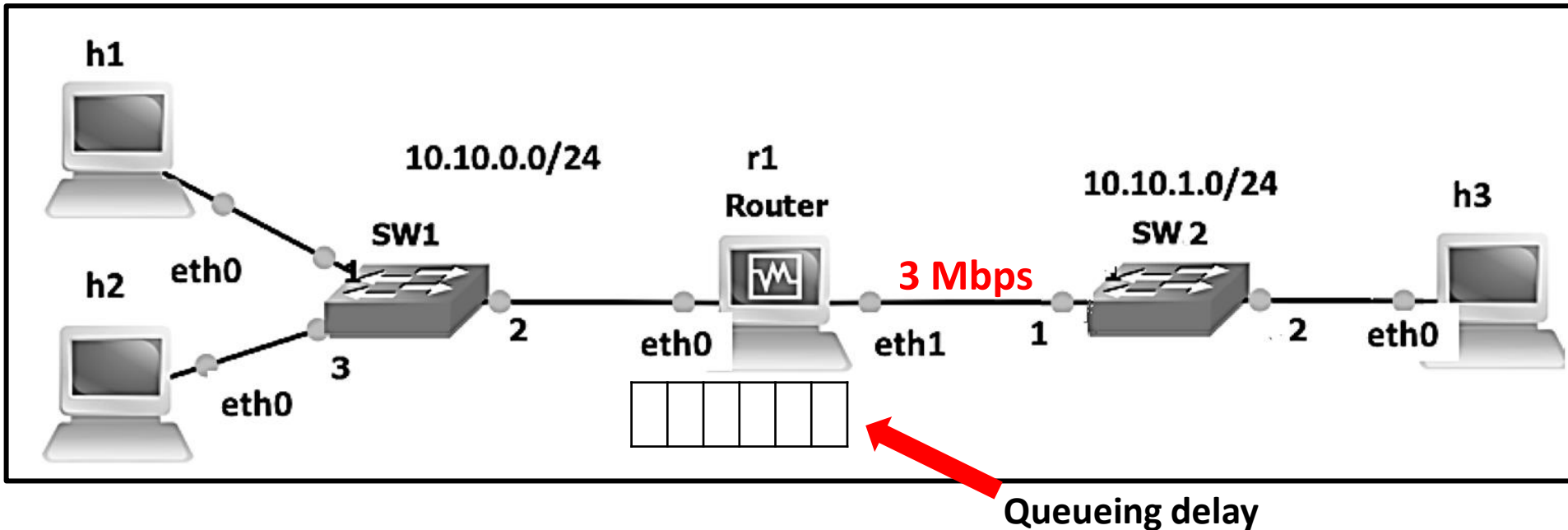
Previous scenario

- `link_r1sw2.intf1.config(bw=3)`



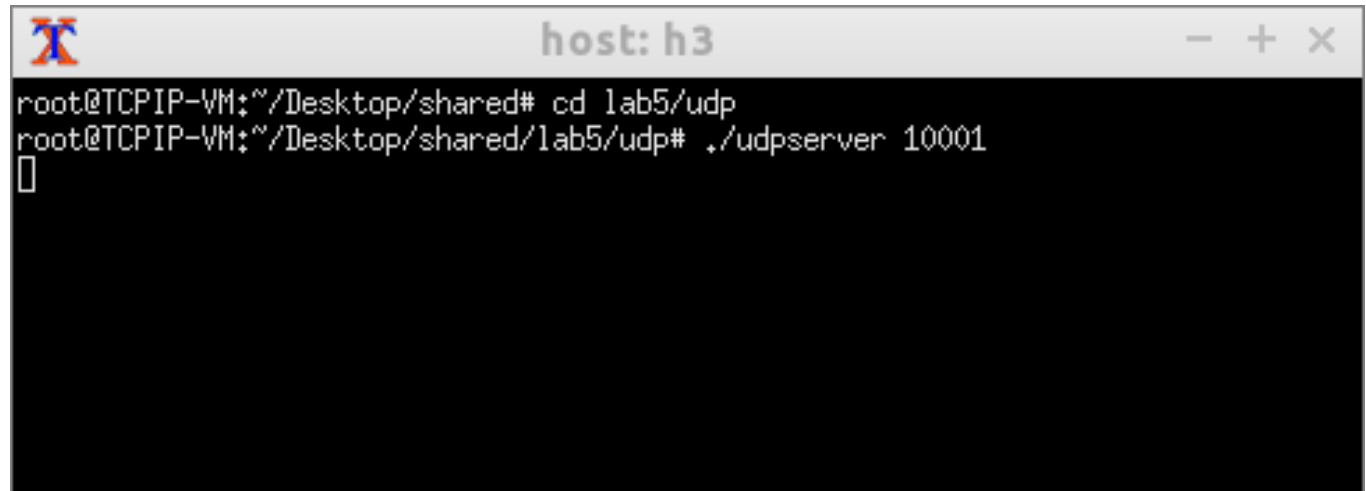
Competing UDP Flows

Scenario	h1 (UDP)	h2 (UDP)
1	1 Mbps	1 Mbps
2	1 Mbps	2 Mbps
3	1 Mbps	4.5 Mbps



Open a new terminal for h3

- mininet> xterm h3

A terminal window titled "host: h3" with a red and blue icon. The prompt is "root@TCPIP-VM:~/Desktop/shared#". The user enters "cd lab5/udp" and the prompt changes to "root@TCPIP-VM:~/Desktop/shared/lab5/udp#". The user then enters "./udpsrvr 10001" and the prompt returns to "root@TCPIP-VM:~/Desktop/shared/lab5/udp#".

```
root@TCPIP-VM:~/Desktop/shared# cd lab5/udp
root@TCPIP-VM:~/Desktop/shared/lab5/udp# ./udpsrvr 10001
root@TCPIP-VM:~/Desktop/shared/lab5/udp#
```

A terminal window titled "Node: h3" with a red and blue icon. The prompt is "root@TCPIP-VM:~/Desktop/shared#". The user enters "cd lab5/udp" and the prompt changes to "root@TCPIP-VM:~/Desktop/shared/lab5/udp#". The user then enters "./udpsrvr 10002" and the prompt returns to "root@TCPIP-VM:~/Desktop/shared/lab5/udp#".

```
root@TCPIP-VM:~/Desktop/shared# cd lab5/udp
root@TCPIP-VM:~/Desktop/shared/lab5/udp# ./udpsrvr 10002
root@TCPIP-VM:~/Desktop/shared/lab5/udp#
```

Competing UDP Flows

Scenario	h1 (UDP)	h2 (UDP)
1	X = 1 Mbps	Y = 1 Mbps
2	X = 1 Mbps	Y = 2 Mbps
3	X = 1 Mbps	Y = 4.5 Mbps

$$goodput_{h1} = \min \left(\left(\frac{X}{X + Y} \right) \times 3 \times \frac{1000}{1042}, X \right) Mbps$$

$$goodput_{h2} = \min \left(\left(\frac{Y}{X + Y} \right) \times 3 \times \frac{1000}{1042}, Y \right) Mbps$$

TCP flows Competing with UDP Flows

Scenario	h1 (UDP)	h2 (UDP)	h2 (TCP)
1	X = 1 Mbps	Y = 1 Mbps	Z
2	X = 1 Mbps	Y = 2 Mbps	Z
3	X = 1 Mbps	Y = 4.5 Mbps	Z

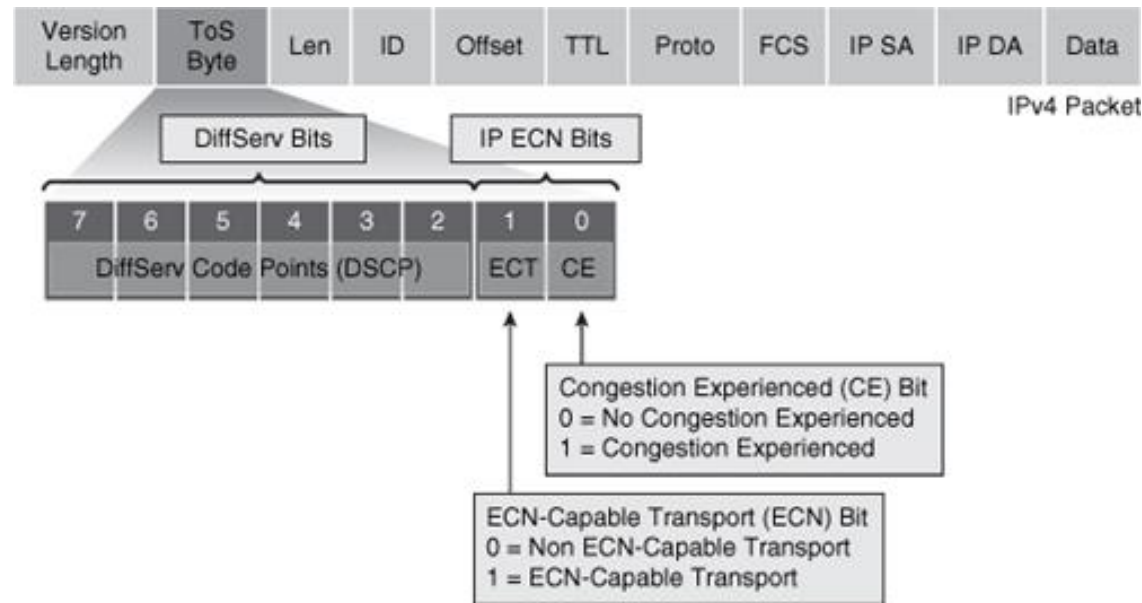
$$goodput_{h1} = \min \left(\left(\frac{X}{X+Y} \right) \times 3 \times \frac{1000}{1042}, X \right) Mbps$$

$$goodput_{h2,UDP} = \min \left(\left(\frac{Y}{X+Y} \right) \times 3 \times \frac{1000}{1042}, Y \right) Mbps$$

$$goodput_{h2,TCP} = \begin{cases} 0 \text{ Mbps,} & X + Y \geq 3 \times \frac{1000}{1042} \\ \left(3 - ((X + Y) \times \frac{1042}{1000}) \right) \times \frac{1448}{1514} \text{ Mbps,} & X + Y < 3 \times \frac{1000}{1042} \end{cases}$$

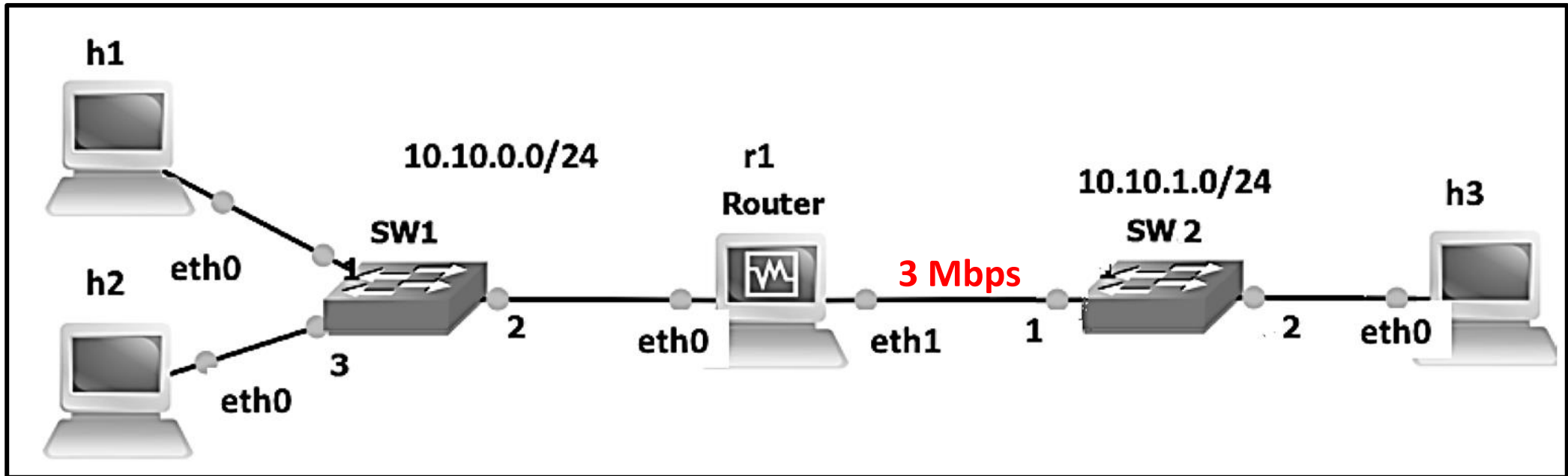
Explicit Congestion Notification (ECN)

- An extension to the Internet Protocol (the network layer protocol)



1. `link_r1sw2.intf1.config(bw=5, max_queue_size=1000, enable_ecn=False)`
2. `link_r1sw2.intf1.config(bw=5, max_queue_size=1000, enable_ecn=True)`

Add delay to all packets going out of an interface



- (h3)# tc qdisc add dev h3-eth0 root netem delay 300ms

Fairness Between TCP Connections and Delay

Scenario	h1 (TCP)	h2 (TCP)	h2 (TCP)	h2 (TCP)
1	X	X	X	X

$$goodput_{h1} = \left(\frac{X}{4X}\right) \times 3 \times \frac{1448}{1514} Mbps$$

$$goodput_{h2} = \left(\frac{3X}{4X}\right) \times 3 \times \frac{1448}{1514} Mbps$$