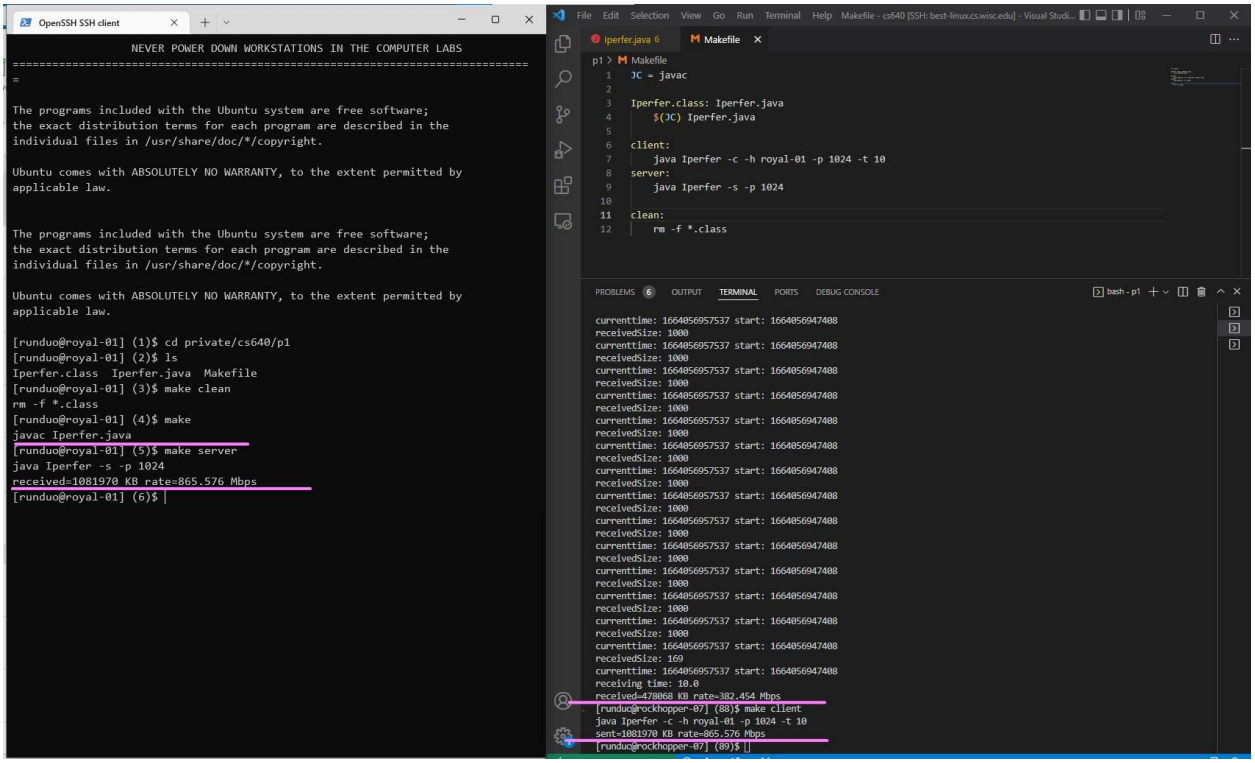
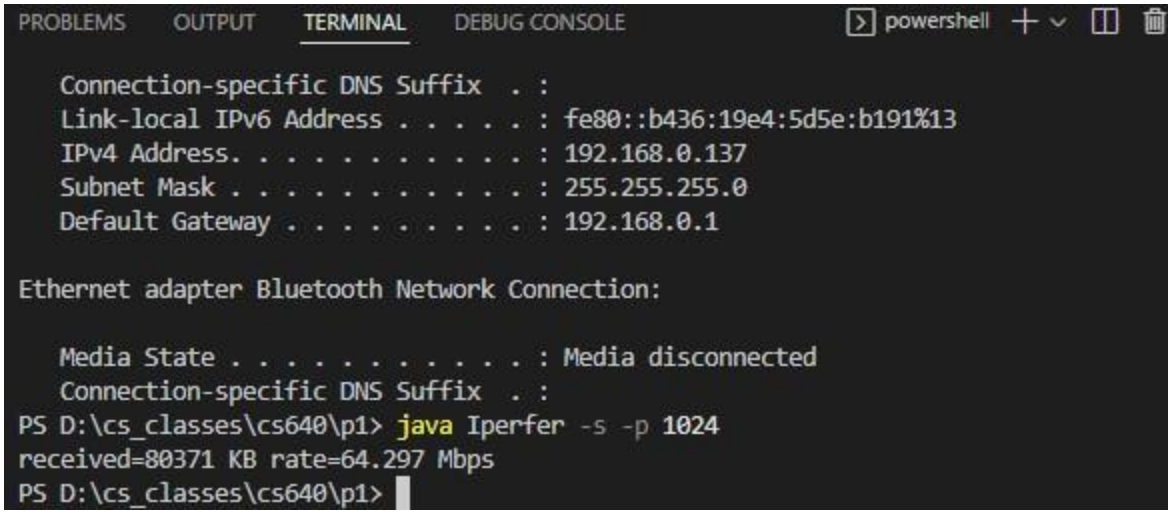
# Part 1 - Wired Environment




# Part 1 - Wireless Environment

I connect two machines to my house wifi. I expected that the throughputs in the wireless environment should be less than in the wired environment. The result met my expectation. Nevertheless, I didn't expect that the throughput would be significantly reduced. I think my house wifi is slow. In a wired network, there are lesser obstacles because all things are in the cable. While in a wireless network, there are so many obstacles in the transient path. For example, I tested on my roommate's computer and my roommate was playing video games.
server




client


## Part 3 - Q2 Predictions

Expected latency and throughput: Latency should be the sum of avg link1+ avg link2+ avg link3 = 80.18ms+20.641ms+40.826ms=**141.647ms**. Throughput should be the min throughput of link1 & link2 & link3 which is around **20.686 Mbps** (the average between results of client and server).

## Part 3 - Q2 Results

The average RTT from h1 to h4 is **142.130ms**. The measured throughput is **20.468 Mbps**. Pretty close to the predictions.

## Part 3 - Q3 Predictions

I predict that the latency for multiple pairs' communication is the same as the single pair's, because latency is the time to transfer a data packet. All pairs use the same link, so the latency of the link is the same. The expected latency for 2 pairs and 3 pairs should be **142.130ms**, the

same as above. The throughput should be divided into each pair. I'm not sure about the algorithm of division, so I simply guess the throughput will be evenly distributed to each pair for the sake of fairness. For 2 pairs, each pair's throughput will be 2**0.686 Mbps/2 =10.234 Mbps**. For the 3 pairs, each pair's throughput will be around **20.686 Mbps/3=6.895 Mbps**.

## Part 3 - Q3 Results

The average RTT for 2 pairs (h1-h4, h7-h9) is **141.983** ms and **143.015 ms**. The result fits my expectation. The latencies are the same for all pairs.
The throughput for 2 pairs (server-client: h1-h4, h7-h9) are **(13.140Mbps|15.330Mpbs)** and **(6.152Mpbs|7.177Mbps)**. Nevertheless, there are time differences in the order of starting client connection to the server, since I have to manually run start each client one by one. If I start h9 as the client and then h4, the result is just the opposite (**13.823Mpbs for h9, 10.147Mpbs for h4**). It seems that the throughput for two pairs is divided into **1.5~2:1**.

The average RTT for 3 pairs (server-client: h8-h10,h1-h4, h7-h9) are **145.168ms, 142.239ms, and 143.305ms**. The result fits my expectation. The latencies are around the same for all pairs.
The throughput for 3 pairs(h8-h10,h1-h4, h7-h9) are **(13.544Mbps|14.898Mbps), (3.181Mbps|3.605Mbps), and (3.009Mbps|3.410Mbps)**. I started the h10, h4, and finally h9. It seems that the throughput for three pairs is divided into around **4:1:1**. There should be some errors caused by time differences.

## Part 3 - Q4 Predictions

The original latency and throughput between h5 and h6 are 82ms and (29.077|31.984Mbps).
The original latency and throughput between h1 and h4 are 141.647ms and (19.340|21.274Mbps).

I guess the latencies remain the same **(h1-h4: 141.647ms, h5-h6:82ms )** for each pair when they communicate simultaneously. For throughput, the throughput of shared link2 might be evenly divided for two pairs (48.865Mbps/2 = 24.43Mbps). Thus, the min throughput between h1 and h4 is min(20.69Mbps, 24.43Mbps, 39.57Mbps) = **20.69Mbps**. The min throughput between h5 and h6 is min(30.232Mbps, 24.43Mbps, 30.62Mbps) = **24.43Mbps**.

## Part 3 - Q4 Results

The average RTT for h1-h4 and h5-h6 are **142.674ms and 83.946ms**. The results meet the expectation.
The measured throughputs for h1-h4 and h5-h6 are **(client: 21.539Mbps|server: 19.053Mbps) and (31.751Mbps | 28.864Mbps)**. I checked the bandwidth in lab1_topo.py and found that the bandwidth of shared link 2 is 50mbps. The throughput of h1-h4 is around 20Mbps, and the

throughput of h5-h6 is around 30 Mbps. Thus, the bandwidth of shared link2 is enough for both pairs. Thus, the throughputs of each pair remind the same (around 20Mbps for h1-h4 and 30Mbps for h5-h6).