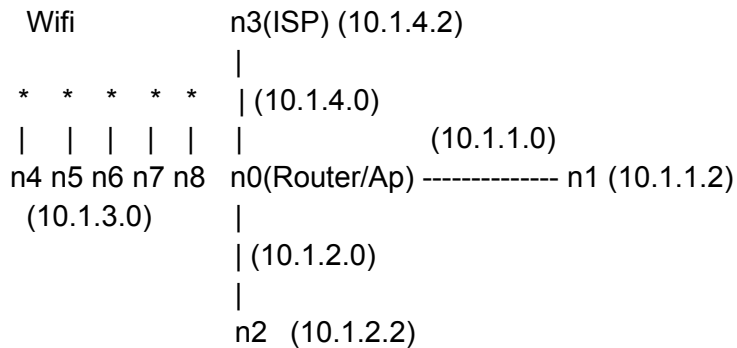


WN Assignment 2 Writeup

Network Topology



The nodes n1 and n2 denote the 2 PCs. The node n0 is the router, and it also serves as the access point for the 5 devices n4-n8 connected via WiFi. The node n3 denotes the ISP server to which the router is connected.

For all the parts, the nodes that are active send their data to node n3 i.e. the ISP server. Thus, the active devices run the TCP app installed on them and the ISP server has a packet sink to receive those packets and send acks. Besides, we have the receive error model specified for the router with an error rate of 0.000001.

The netmask for the wifi nodes is 10.1.3.0, 10.1.1.0 for n0n1, 10.1.2.0 for n0n2 and 10.1.4.0 for n0n3. The point to point links have a bandwidth of 5 Mbps, and a delay of 2ms. We run the simulation for 5 sec for the 4 parts. The TCP app at the nodes attempts to send packets of size 1460 bytes at the data rate of 1000 Mbps, and it sends 1000000 such packets. The rest of the code is explained in the code documentation.

THROUGHPUTS FOR THE 4 SIMULATIONS

part(a)

Here we install the TCP app on the PC n2 and send packets to the ISP server from it.

Throughput at n2 as per the pcap file:

Throughput for PC n2:

Statistics

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	6508	6508 (100.0%)	—
Time span, s	3.999	3.999	—
Average pps	1627.3	1627.3	—
Average packet size, B	403	403	—
Bytes	2620576	2620576 (100.0%)	0
Average bytes/s	655 k	655 k	—
Average bits/s	5,241 k	5,241 k	—

The throughput is 655k bytes/sec

Throughput for router n0:

Statistics

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	6508	6508 (100.0%)	—
Time span, s	3.998	3.998	—
Average pps	1627.9	1627.9	—
Average packet size, B	402	402	—
Bytes	2618992	2618992 (100.0%)	0
Average bytes/s	655 k	655 k	—
Average bits/s	5,240 k	5,240 k	—

The throughput is 655k bytes/sec

Throughput for PC n1, and wifi nodes n4-n8:

0 as there is no traffic directed from them. Their pcap files are empty.

Part (b)

Here we install the TCP app on the PCs n2 and n1 and send packets to the ISP server from them.

Throughput for PC n1: 283k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	2783	2783 (100.0%)	—
Time span, s	3.999	3.999	—
Average pps	695.9	695.9	—
Average packet size, B	407	407	—
Bytes	1132074	1132074 (100.0%)	0
Average bytes/s	283 k	283 k	—
Average bits/s	2,264 k	2,264 k	—

Throughput for PC n2: 283k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	3837	3837 (100.0%)	—
Time span, s	3.998	3.998	—
Average pps	959.6	959.6	—
Average packet size, B	403	403	—
Bytes	1547702	1547702 (100.0%)	0
Average bytes/s	387 k	387 k	—
Average bits/s	3,096 k	3,096 k	—

Throughput at router n0 (to ISP node): 655k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	6520	6520 (100.0%)	—
Time span, s	3.998	3.998	—
Average pps	1630.9	1630.9	—
Average packet size, B	402	402	—
Bytes	2620240	2620240 (100.0%)	0
Average bytes/s	655 k	655 k	—
Average bits/s	5,243 k	5,243 k	—

Throughput for wifi nodes(n4-n8): 1048 bytes/sec (it was the same for all nodes)

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	69	69 (100.0%)	—
Time span, s	4.915	4.915	—
Average pps	14.0	14.0	—
Average packet size, B	75	75	—
Bytes	5152	5152 (100.0%)	0
Average bytes/s	1,048	1,048	—
Average bits/s	8,385	8,385	—

Part (c)

Here we install the TCP app on the PCs n1 and n2 and wifi devices n4,n5,n6 and send packets to the ISP server from them.

PC 1 : 131k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	1309	1309 (100.0%)	—
Time span, s	4.000	4.000	—
Average pps	327.3	327.3	—
Average packet size, B	401	401	—
Bytes	525446	525446 (100.0%)	0
Average bytes/s	131 k	131 k	—
Average bits/s	1,050 k	1,050 k	—

PC 2: 135 bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	1342	1342 (100.0%)	—
Time span, s	3.996	3.996	—
Average pps	335.8	335.8	—
Average packet size, B	402	402	—
Bytes	539924	539924 (100.0%)	0
Average bytes/s	135 k	135 k	—
Average bits/s	1,080 k	1,080 k	—

Wifi node n4: 410 k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	8161	8161 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	1651.1	1651.1	—
Average packet size, B	249	249	—
Bytes	2028081	2028081 (100.0%)	0
Average bytes/s	410 k	410 k	—
Average bits/s	3,282 k	3,282 k	—

Wifi node n5: 410 k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	8160	8160 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	1650.9	1650.9	—
Average packet size, B	248	248	—
Bytes	2027435	2027435 (100.0%)	0
Average bytes/s	410 k	410 k	—
Average bits/s	3,281 k	3,281 k	—

Wifi node n6: 410 k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	8160	8160 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	1650.9	1650.9	—
Average packet size, B	248	248	—
Bytes	2027409	2027409 (100.0%)	0
Average bytes/s	410 k	410 k	—
Average bits/s	3,281 k	3,281 k	—

Wifi node n7: 409k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	8152	8152 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	1649.3	1649.3	—
Average packet size, B	248	248	—
Bytes	2024945	2024945 (100.0%)	0
Average bytes/s	409 k	409 k	—
Average bits/s	3,277 k	3,277 k	—

Wifi node n8: 409 k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	8154	8154 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	1649.7	1649.7	—
Average packet size, B	248	248	—
Bytes	2025177	2025177 (100.0%)	0
Average bytes/s	409 k	409 k	—
Average bits/s	3,277 k	3,277 k	—

Router n0: 656k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	6555	6555 (100.0%)	—
Time span, s	3.995	3.995	—
Average pps	1640.8	1640.8	—
Average packet size, B	400	400	—
Bytes	2622242	2622242 (100.0%)	0
Average bytes/s	656 k	656 k	—
Average bits/s	5,250 k	5,250 k	—

Part (d)

Here we install the TCP app on the PCs n1 and n2 and wifi devices n4,n5,n6,n7,n8 and send packets to the ISP server from them.

PC1 : 111k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	1117	1117 (100.0%)	—
Time span, s	3.999	3.999	—
Average pps	279.3	279.3	—
Average packet size, B	398	398	—
Bytes	445118	445118 (100.0%)	0
Average bytes/s	111 k	111 k	—
Average bits/s	890 k	890 k	—

PC2: 95k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	1011	1011 (100.0%)	—
Time span, s	3.999	3.999	—
Average pps	252.8	252.8	—
Average packet size, B	377	377	—
Bytes	380874	380874 (100.0%)	0
Average bytes/s	95 k	95 k	—
Average bits/s	761 k	761 k	—

Wifi node n4: 491k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	9957	9957 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	2014.5	2014.5	—
Average packet size, B	244	244	—
Bytes	2431389	2431389 (100.0%)	0
Average bytes/s	491 k	491 k	—
Average bits/s	3,935 k	3,935 k	—

Wifi node n5: 492k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	9958	9958 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	2014.7	2014.7	—
Average packet size, B	244	244	—
Bytes	2431999	2431999 (100.0%)	0
Average bytes/s	492 k	492 k	—
Average bits/s	3,936 k	3,936 k	—

Wifi node n6: 492k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	9959	9959 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	2014.9	2014.9	—
Average packet size, B	244	244	—
Bytes	2432851	2432851 (100.0%)	0
Average bytes/s	492 k	492 k	—
Average bits/s	3,937 k	3,937 k	—

Wifi node n7: 492k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	9965	9965 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	2016.1	2016.1	—
Average packet size, B	244	244	—
Bytes	2436149	2436149 (100.0%)	0
Average bytes/s	492 k	492 k	—
Average bits/s	3,943 k	3,943 k	—

Wifi node n8: 493k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	9986	9986 (100.0%)	—
Time span, s	4.943	4.943	—
Average pps	2020.4	2020.4	—
Average packet size, B	244	244	—
Bytes	2437631	2437631 (100.0%)	0
Average bytes/s	493 k	493 k	—
Average bits/s	3,945 k	3,945 k	—

Router n0: 663k bytes/sec

<u>Measurement</u>	<u>Captured</u>	<u>Displayed</u>	<u>Marked</u>
Packets	6843	6843 (100.0%)	—
Time span, s	3.995	3.995	—
Average pps	1712.8	1712.8	—
Average packet size, B	387	387	—
Bytes	2650034	2650034 (100.0%)	0
Average bytes/s	663 k	663 k	—
Average bits/s	5,306 k	5,306 k	—

Analysis:

Initially when only Pc1 is operating we get a throughput of 655k bytes/sec. When we start operating 2 simultaneous PCs on the network the throughput of each decreases by $> 2x$, i.e. to about 283k bytes/sec.

When we start operating 3 additional wifi devices on this network the throughput for the PCs further drops to ~131k bytes/sec. We get a high throughput of about 410k bytes/sec for the Wifi nodes in this case.

Similarly when we operate all the 5 wifi nodes on this network, the throughput for the PC's drops to 111k and 95k bytes/sec and the throughput for the Wifi nodes increases to 492k bytes/sec.

The outgoing throughput at the router stays almost constant throughout.

Code Reference: Third.cc and sixth.cc in ns3 examples