ASSIGNMENT 4

Group 9 :-
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Application #2:-

1.Wired Connection:- We implemented the applications using three different agents to make 3 different network flows . The throughput values for different packet sizes and throughput vs packet size graphs for all the agents are shown below:-

a.TCP Westwood:- To simulate wired connection with TCP westwood , we run the wired.cc file. The command is **./waf --run "scratch/wired --agent=Westwood"**
The output of running is shown below:-

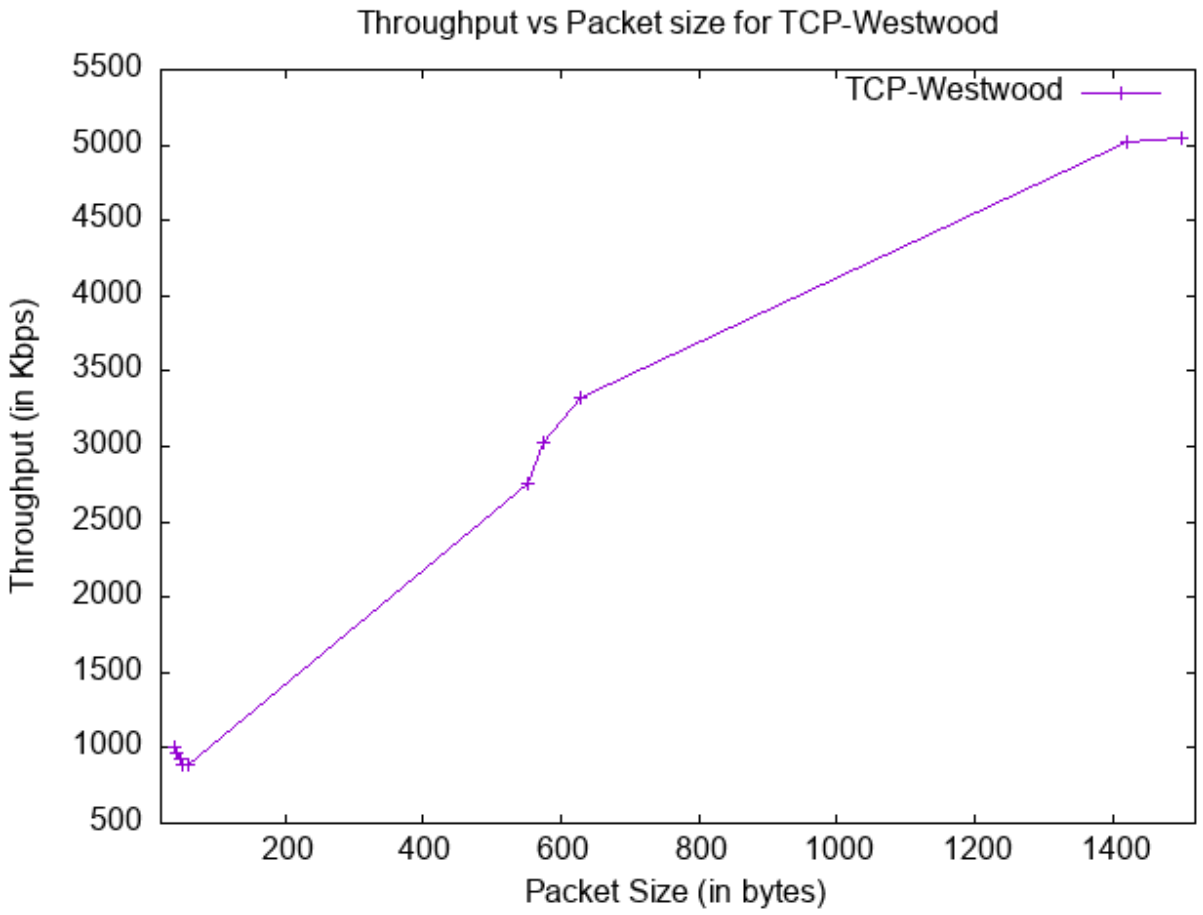
```
~/Doc/ns/ns-3.35 ./waf --run "scratch/wired --agent=Westwood"          ✔ 4s base
Waf: Entering directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
Waf: Leaving directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.500s)
Wired_TCP - Westwood
+-----------------------------------------------+
|Packet Size  |   Throughput   |  Fairness Index|
+-----------------------------------------------+
|    40       |   1003.199725  |    1.000000    |
|    44       |   959.859330   |    1.000000    |
|    48       |   923.768312   |    1.000000    |
|    52       |   893.195379   |    1.000000    |
|    60       |   884.629066   |    1.000000    |
|    552      |   2754.961758  |    1.000000    |
|    576      |   3020.392001  |    1.000000    |
|    628      |   3325.736911  |    1.000000    |
|    1420     |   5023.222710  |    1.000000    |
|    1500     |   5042.341418  |    1.000000    |
+-----------------------------------------------+
~/Doc/ns/ns-3.35                                       ✔ 5s base
```

To create the graph from the plt the command is **gnuplot Wired_TCP_Westwood.plt**
The graph can be seen in **Wired_TCP_Westwood.png**
The observations are as follows:-

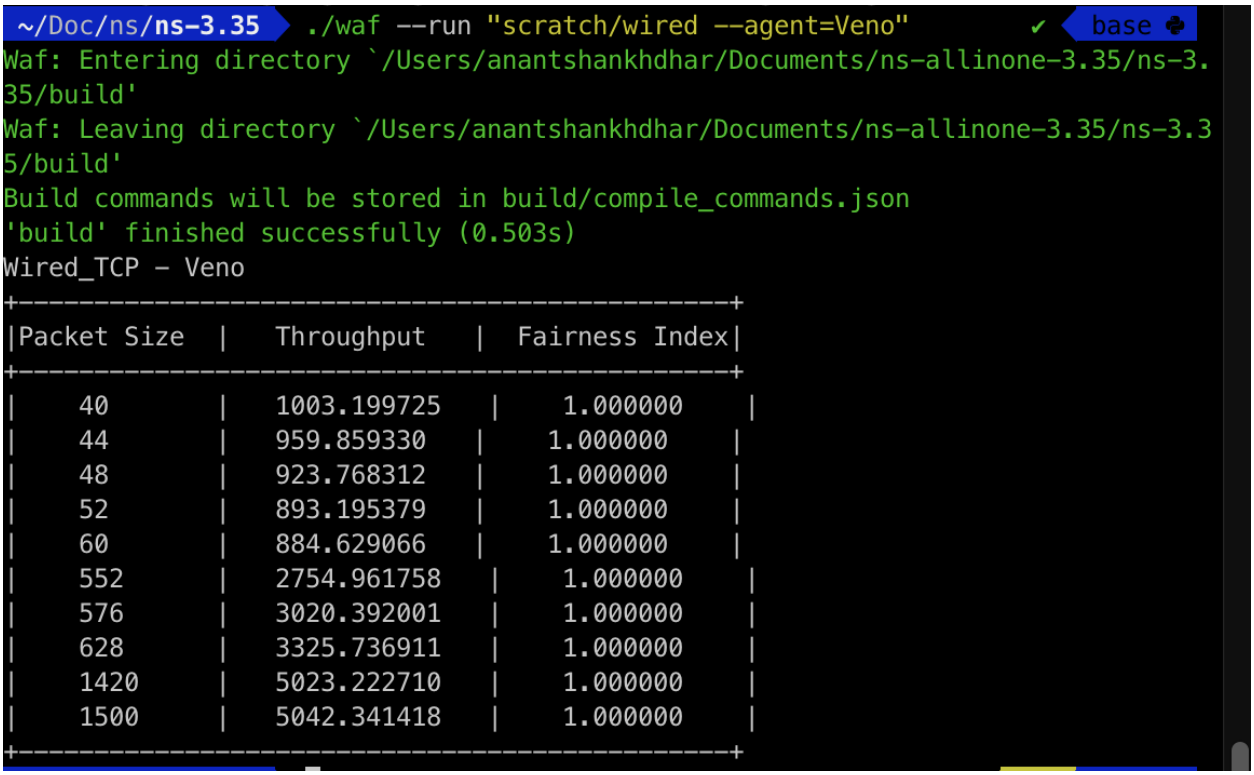
Packet Size	Throughput (kbps)	Fairness Index
40	1003.199725	1.000000
44	959.859330	1.000000
48	923.768312	1.000000
52	893.195379	1.000000

60	884.629066	1.000000
552	2754.961758	1.000000
576	3020.392001	1.000000
628	3325.736911	1.000000
1420	5023.222710	1.000000
1500	5042.341418	1.000000

Throughput vs Packet Size for TCP Westwood



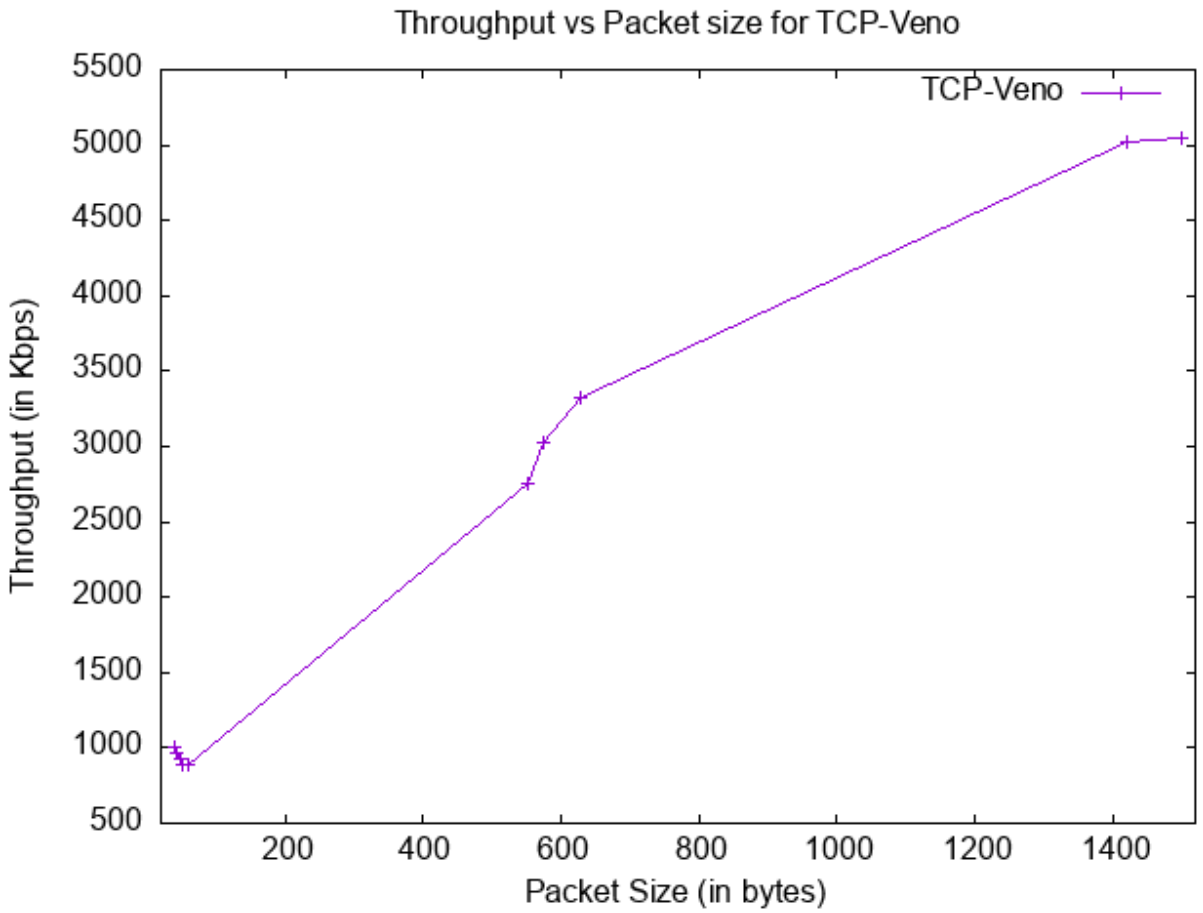
b.TCP Veno:- To simulate wired connection with TCP Veno , we run the wired.cc file.
The command is **./waf --run "scratch/wired --agent=Veno"**
The output of running is as follows:-



To create the graph from the plt the command is **gnuplot Wired_TCP_Veno.plt**
The graph can be seen in **Wired_TCP_Veno.png**
The results are as follows:-

Packet Size	Throughput (kbps)	Fairness Index
40	1003.199725	1.000000
44	959.859330	1.000000
48	923.768312	1.000000
52	893.195379	1.000000
60	884.629066	1.000000
552	2754.961758	1.000000
576	3020.392001	1.000000
628	3325.736911	1.000000
1420	5023.222710	1.000000
1500	5042.341418	1.000000

Throughput vs Packet Size for TCP Veno



c.TCP Vegas:- To simulate wired connection with TCP Vegas , we run the wired.cc file.
The command is **./waf --run "scratch/wired --agent=Vegas".**
The output of running is as follows:-

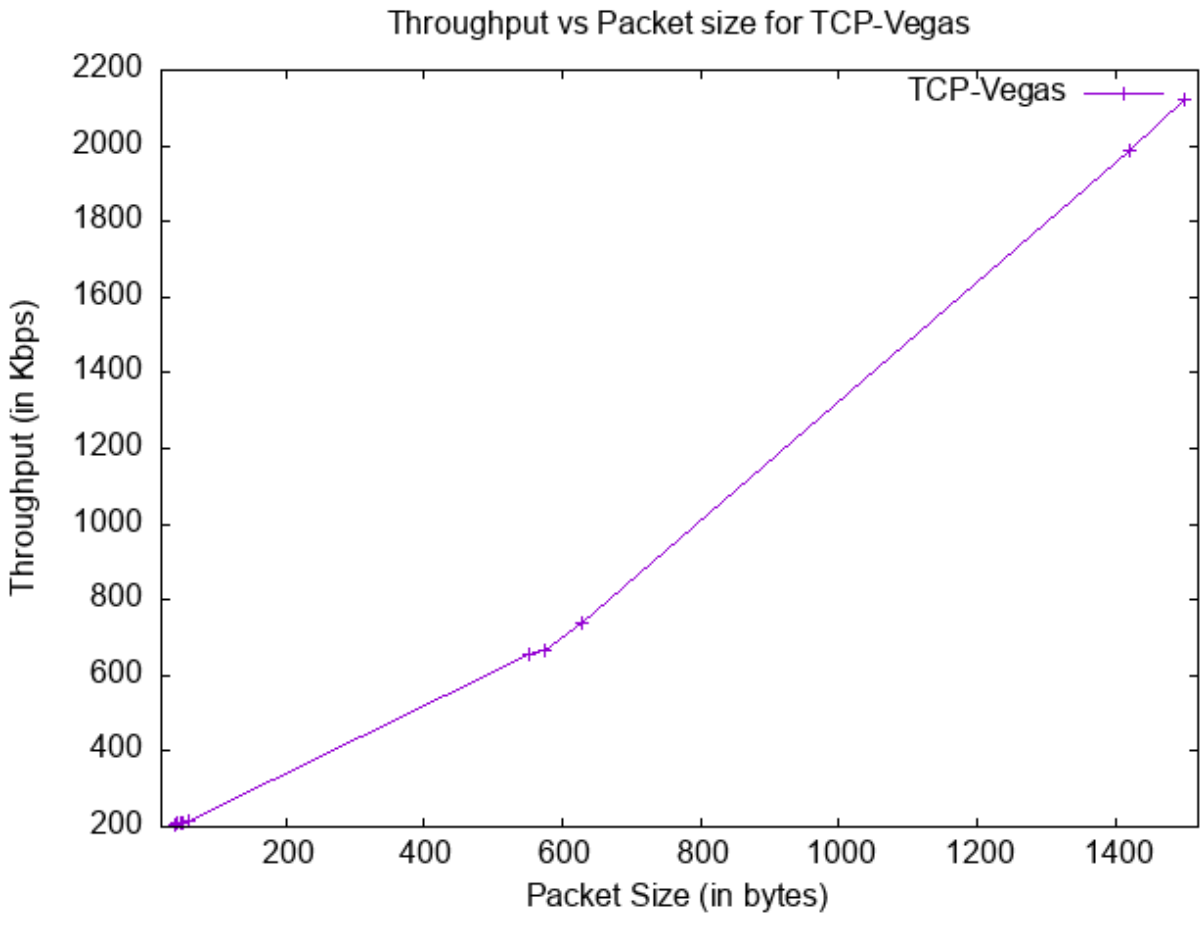
```
~/Doc/ns/ns-3.35  ./waf --run "scratch/wired --agent=Vegas"        base
Waf: Entering directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.
35/build'
Waf: Leaving directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.3
5/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.497s)
Wired_TCP - Vegas
+-----------------------------------------------+
|Packet Size  |   Throughput   |  Fairness Index|
+-----------------------------------------------+
|    40       |   205.891308   |    1.000000    |
|    44       |   208.054941   |    1.000000    |
|    48       |   208.964608   |    1.000000    |
|    52       |   211.511946   |    1.000000    |
|    60       |   212.977341   |    1.000000    |
|    552      |   656.278080   |    1.000000    |
|    576      |   668.547872   |    1.000000    |
|    628      |   736.663984   |    1.000000    |
|    1420     |   1985.596665   |    1.000000    |
|    1500     |   2122.710006   |    1.000000    |
+-----------------------------------------------+
```

To create the graph from the plt the command is **gnuplot Wired_TCP_Vegas.plt**

The graph can be seen in **Wired_TCP_Vegas.png**
The results are as follows:-

Packet Size	Throughput (kbps)	Fairness Index
40	205.891308	1.000000
44	208.054941	1.000000
48	208.964608	1.000000
52	211.511946	1.000000
60	212.977341	1.000000
552	656.278080	1.000000
576	668.547872	1.000000
628	736.663984	1.000000
1420	1985.596665	1.000000
1500	2122.710006	1.000000

Throughput vs Packet Size for TCP Vegas



Important Conclusions:-

1.We can see that in general, the throughput increases with the packet size.
2.The throughput for Westwood and Veno agents is the same whereas it is lower for the agent Vegas
3.The Jain Fairness index for all packet sizes is 1. This is because there is only 1 connection for the entire experiment

2.Wireless Connection:- We implemented the application using three different agents to make 3 different network flows . The throughput values for different packet sizes and throughput vs packet size graphs for all the agents are shown below:-

a.TCP Westwood:- To simulate wireless connection with TCP westwood , we run the wireless.cc file. The command is **./waf --run "scratch/wireless --agent=Westwood"**
The output of running is shown below:-

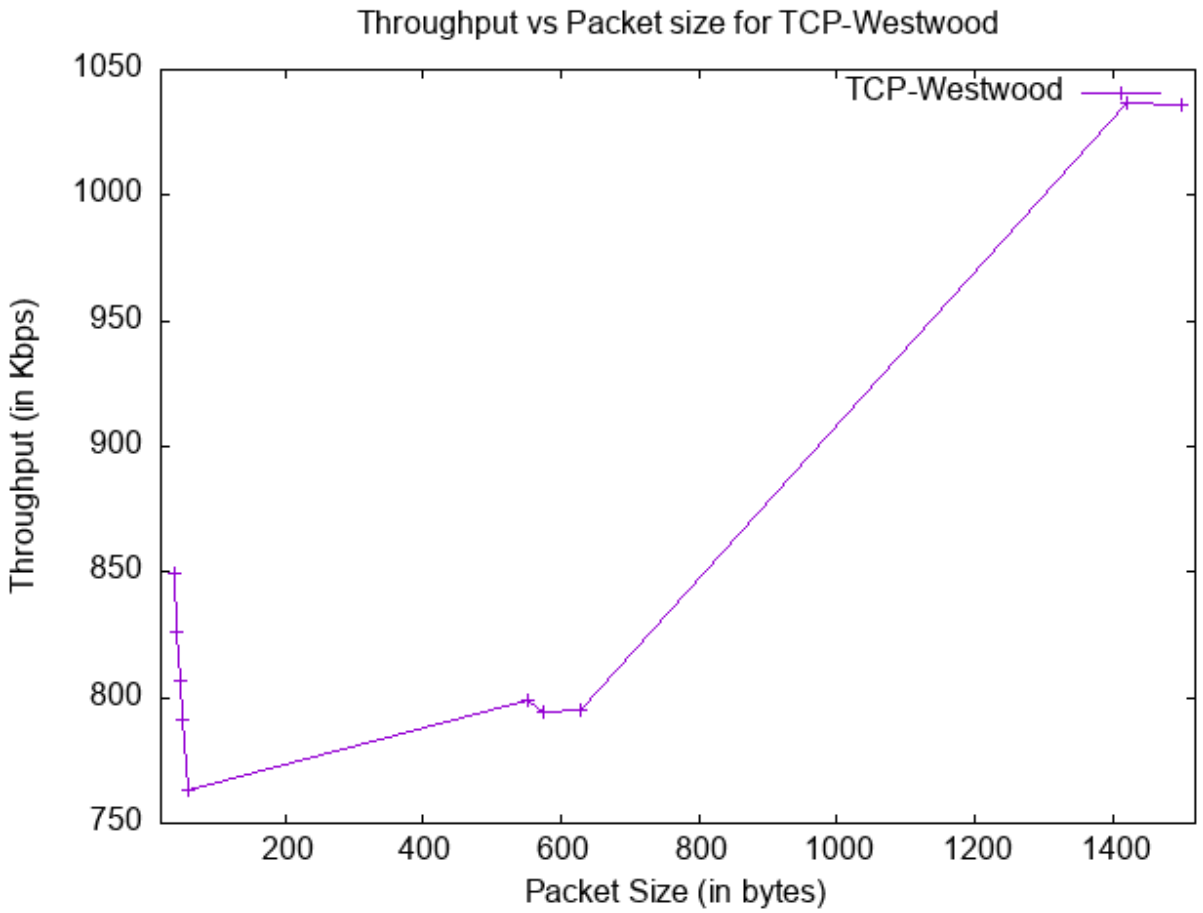
```
~/Doc/ns/ns-3.35 ./waf --run "scratch/wireless --agent=Westwood"

Waf: Entering directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
[2785/2832] Compiling scratch/wireless.cc
[2794/2832] Linking build/scratch/wireless
Waf: Leaving directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (2.472s)
Wireless_TCP - Westwood
+-----------------------------------------------+
|Packet Size  |   Throughput   |  Fairness Index|
+-----------------------------------------------+
|    40       |   849.615448   |    1.000000    |
|    44       |   826.243607   |    1.000000    |
|    48       |   807.118832   |    1.000000    |
|    52       |   791.243088   |    1.000000    |
|    60       |   763.351230   |    1.000000    |
|    552      |   799.106122   |    1.000000    |
|    576      |   794.618591   |    1.000000    |
|    628      |   794.817828   |    1.000000    |
|    1420     |   1036.395463   |    1.000000    |
|    1500     |   1036.239003   |    1.000000    |
+-----------------------------------------------+
```

To create the graph from the plt the command is **gnuplot Wireless_TCP_Westwood.plt**
The graph can be seen in **Wireless_TCP_Westwood.png**
The observations are as follows:-

Packet Size	Throughput (kbps)	Fairness Index
40	849.615448	1.000000
44	826.243607	1.000000
48	807.118832	1.000000
52	791.243088	1.000000

60	763.351230	1.000000
552	799.106122	1.000000
576	794.618591	1.000000
628	794.817828	1.000000
1420	1036.395463	1.000000
1500	1036.239003	1.000000

Throughput vs Packet Size for TCP Westwood



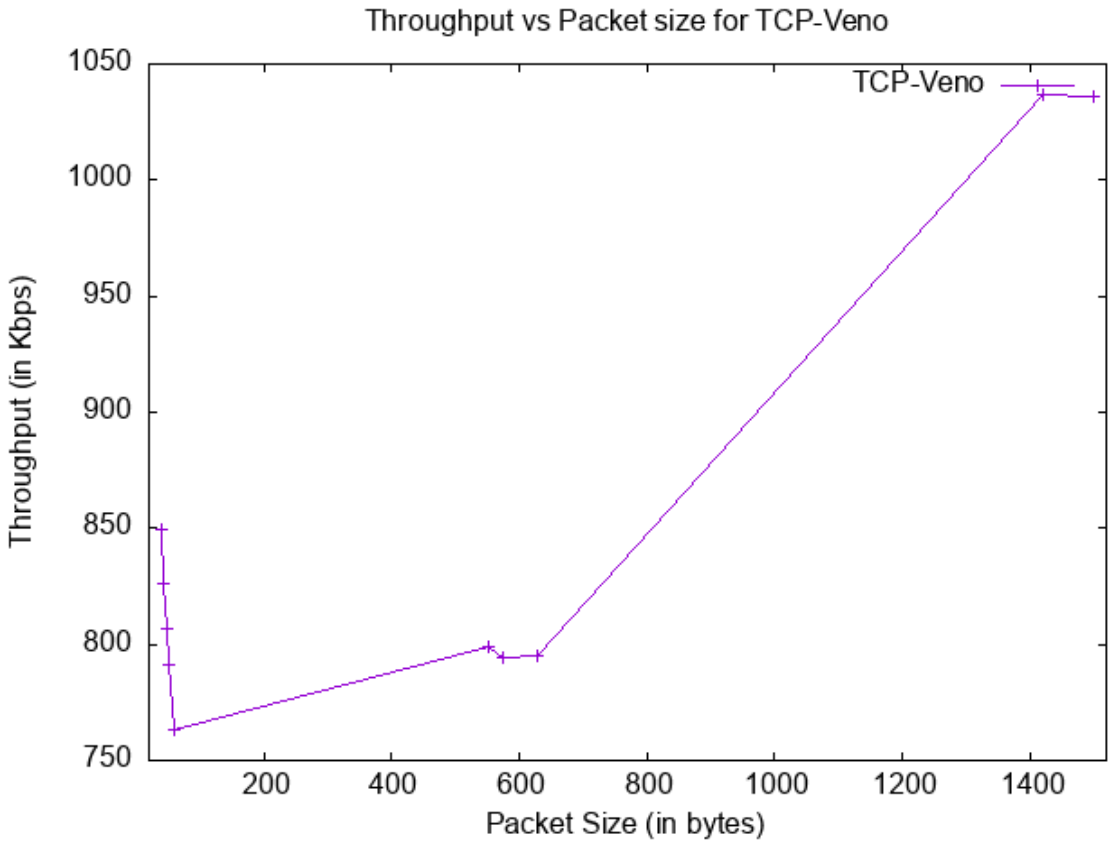
b.TCP Veno:- To simulate wireless connection with TCP Veno , we run the wireless.cc file. The command is **./waf --run "scratch/wireless --agent=Veno"**
The output of running is shown below:-

```
~/Doc/ns/ns-3.35 ./waf --run "scratch/wireless --agent=Veno"                ✔ base
Waf: Entering directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
[2785/2832] Compiling scratch/wireless.cc
[2794/2832] Linking build/scratch/wireless
Waf: Leaving directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (2.446s)
Wireless_TCP - Veno
+-----------------------------------------------+
|Packet Size  |   Throughput   |  Fairness Index|
+-----------------------------------------------+
|    40       |   849.615448   |    1.000000    |
|    44       |   826.243607   |    1.000000    |
|    48       |   807.118832   |    1.000000    |
|    52       |   791.243088   |    1.000000    |
|    60       |   763.351230   |    1.000000    |
|    552      |   799.106122   |    1.000000    |
|    576      |   794.618591   |    1.000000    |
|    628      |   794.817828   |    1.000000    |
|    1420     |   1036.395463  |    1.000000    |
|    1500     |   1036.239003  |    1.000000    |
+-----------------------------------------------+
```

To create the graph from the plt the command is **gnuplot Wireless_TCP_Veno.plt**
The graph can be seen in **Wireless_TCP_Veno.png**
The observations are as follows:-

Packet Size	Throughput (kbps)	Fairness Index
40	849.615448	1.000000
44	826.243607	1.000000
48	807.118832	1.000000
52	791.243088	1.000000
60	763.351230	1.000000
552	799.106122	1.000000
576	794.618591	1.000000
628	794.817828	1.000000
1420	1036.395463	1.000000
1500	1036.239003	1.000000

Throughput vs Packet Size for TCP Veno



c.TCP Vegas:- To simulate wireless connection with TCP Vegas , we run the wireless.cc file. The command is **./waf --run "scratch/wireless --agent=Vegas".** The output of running is as follows:-

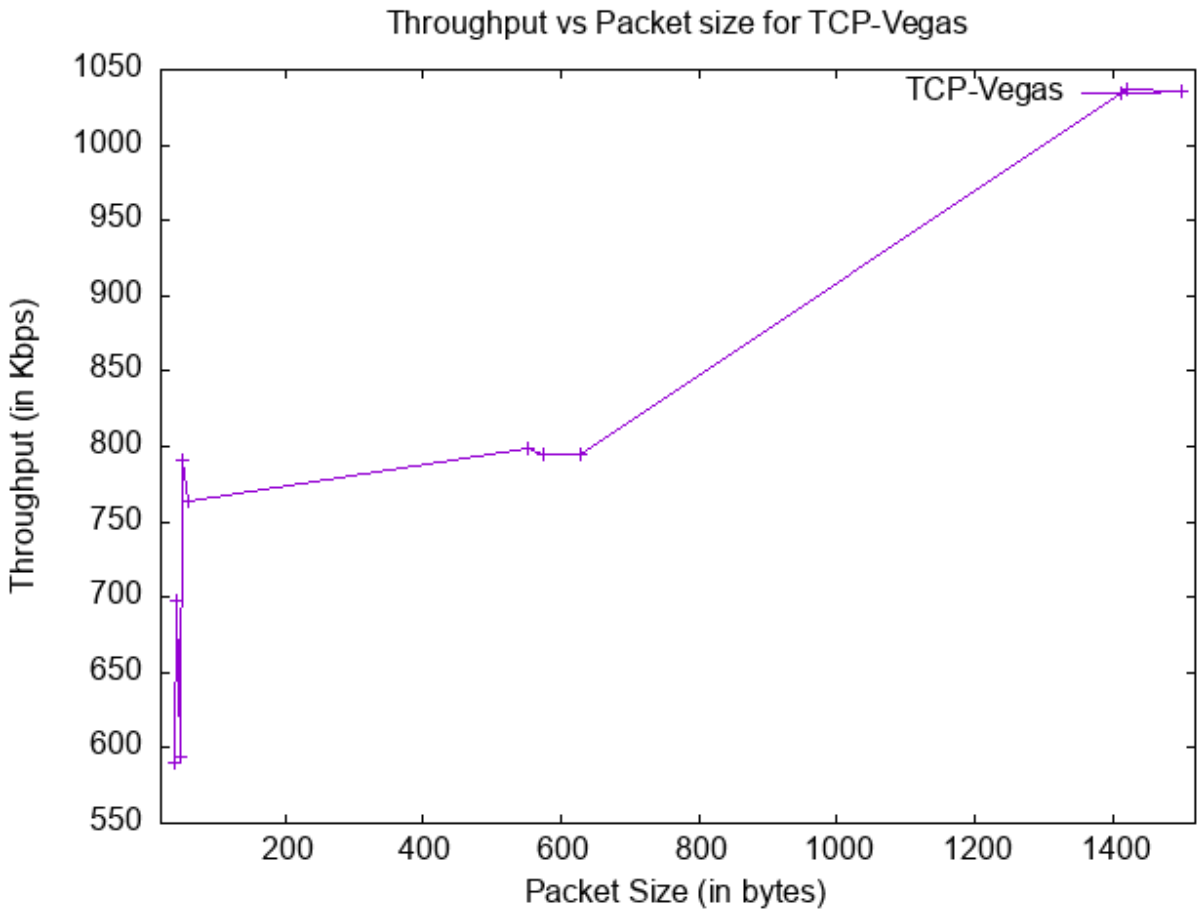
```
~/Doc/ns/ns-3.35 ./waf --run "scratch/wireless --agent=Vegas"          ✔ base
Waf: Entering directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
Waf: Leaving directory `/Users/anantshankhdhar/Documents/ns-allinone-3.35/ns-3.35/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (0.486s)
Wireless_TCP - Vegas
+-----------------------------------------------+
|Packet Size  |   Throughput   |  Fairness Index|
+-----------------------------------------------+
|    40       |   589.619479   |    1.000000    |
|    44       |   697.990273   |    1.000000    |
|    48       |   593.520114   |    1.000000    |
|    52       |   791.243088   |    1.000000    |
|    60       |   763.351230   |    1.000000    |
|    552      |   799.106122   |    1.000000    |
|    576      |   794.618591   |    1.000000    |
|    628      |   794.817828   |    1.000000    |
|    1420     |   1036.395463  |    1.000000    |
|    1500     |   1036.239003  |    1.000000    |
+-----------------------------------------------+
```

To create the graph from the plt the command is **gnuplot Wireless_TCP_Vegas.plt**
The graph can be seen in **Wireless_TCP_Vegas.png**
The results are as follows:-

Packet Size	Throughput (kbps)	Fairness Index

40	589.619479	1.000000
44	697.990273	1.000000
48	593.520114	1.000000
52	791.243088	1.000000
60	763.351230	1.000000
552	799.106122	1.000000
576	794.618591	1.000000
628	794.817828	1.000000
1420	1036.395463	1.000000
1500	1036.239003	1.000000

Throughput vs Packet Size for TCP Vegas



Important Conclusions:-

1.We can see that in general, the throughput increases with the packet size.

2.The throughput for Westwood and Veno agents is the same whereas it is lower for the agent Vegas

3.The Jain Fairness index for all packet sizes is 1. This is because there is only 1 connection for the entire experiment.

Important Points To Note:-

1.Running the .cc files:-

a. Download the files wired.cc and wireless.cc from the submission and move them to the scratch folder inside the ns3 directory
b. To run wired.cc go to the ns3 directory and run **./waf --run "scratch/wired --agent=<agent name>"**
c. To run wireless.cc go to the ns3 directory and run **./waf --run "scratch/wireless --agent=<agent name>"**

2.If there are n users, x_i be the throughput for a connection, then Jain's coefficient is

$$\mathcal{J}(x_1, x_2, \ldots, x_n) = \frac{(\sum_{i=1}^{n} x_i)^2}{n \cdot \sum_{i=1}^{n} {x_i}^2} = \frac{\overline{\mathbf{x}}^2}{\overline{\mathbf{x}^2}} = \frac{1}{1 + \widehat{c_\mathrm{v}}^2}$$

In our case n = 1. Therefore Jain's coefficient = 1 for all experiments.

3. On execution of the .cc files the following files are generated

a. 10 xml files. Each file corresponds to a packet size. The files are named as **<type(wired or wireless)>_TCP_<Agent name>_<packet size>.xml**. For example for wired tcp for agent Westwood the xml file for packet size 44 will be wired_TCP_Westwood_44.xml. These files have been attached in the submission
b. 1 plt file with the name **<type(Wired or Wireless)>_TCP_<Agent name>.plt.** For example for wired Westwood it will be Wired_TCP_Westwood.plt. The command to generate the png plot will be **gnuplot <filename>.plt.** The plt as well as png files have been attached with the submission

3.The throughput calculated has the unit kbps which stands for kilo bits per second.

Assumptions:-

1) Remote station manager for wifi is taken as AarfWifiManager.
2) Active probing for base-stations assumed false.
3) Devices assumed to be stationary and therefore Constant Position mobility model is applied.