Internet Technologies and Applications (ITS 413)

Assignment 2

Group members

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Experiment part

This experiment, we use ubuntu.

*Before you do test in every topic you must set IP of each side by using: **sudo iperf eth0 192.168.1.1(IP of own com) netmask 255.255.255.0 up** and ping both side to test the connection between two computers.

sudo iperf eth0 x.x.x.x netmask 255.255.255.0 up

ping x.x.x.x

1. Application/Protocol Parameters

- **TCP receive buffer/window size**

  You should try to set the window size in each side

  - Set window size at server size

  - First set the command below into client side.

sudo tc qdisc add dev eth0 root tbf rate 500kbit latency 50ms burst 5kb

- After that set the server side with - w

iperf -s -w 5K -t 40

- Then send TCP to server by using " iperf -c 192.168.1.2(IP of server) -t 40 "

iperf -c x.x.x.x -t 40

- You can change the - w to 10,15,20,25…until the window size reach to maximum

iperf -s -w 10K -t 40

iperf -s -w 15K -t 40

- See the throughput and if the throughput reach to maximum window size, throughput will not increase.

-Set window size at client mode

- Same as set at server mode but set – w at client side.

```
iperf -c x.x.x.x  -w 10K -t 40
```

- **Length of Data Written/Read by Application**

• Set length of data at the server side by using

```
iperf -s -l 4K -t 40
```

•After that set length of data at client side by using

```
iperf –c 192.168.1.2 –l 4K –t 40
```

•You can adjust the length of data by change the value of – l.

```
iperf -s -l 8K -t 40

iperf -s -l 16K -t 40
```

2. Network/Link Conditions

2.1 Link Data Rate

- I set the client side with

```
sudo tc qdisc add dev eth0 root tbf rate 500kbit
```

- Then set the client mode with " iperf – c 192.168.1.2(IP of server) –t 40 "

```
iperf – c x.x.x.x –t 40
```

- Set the server mode by using " iperf – s -t 40 "

```
iperf – s  -t 40
```

- After that you can change the data rate in tc command for observe the throughput change.

- **Link Delay**
  - Set “sudo tc qdisc add dev eth0 root netem delay 100ms (←change here) 10ms “ at client side

sudo tc qdisc add dev eth0 root netem delay 100ms 10ms

  - Then set “ iperf -s -t 40 “ for server computer.

iperf -s -t 40

  - Set “ iperf -c 10.10.6.108 (IP at the client)-t 40 “ for client side

iperf -c 10.10.6.108 (IP at the client)-t 40

  - After that you observe the result and you can change the delay in command to see more detail.

sudo tc qdisc add dev eth0 root netem delay 100ms 10ms
sudo tc qdisc add dev eth0 root netem delay 150ms 10ms

- **Packet Drop Rate**
  - Set the rule “ sudo iptables -A INPUT -m statistic --mode random --probability 0.03(←percent delay) -j DROP “ in server computer.

sudo iptables -A INPUT -m statistic --mode random –probability 0.03 -j DROP

  - And set “ iperf -s -t 40 “ in server computer.

iperf -s -t 40

  - Then set “ iperf -c 192.168.1.2 (IP of server)-t 40 “ in client side.

iperf -c x.x.x.x -t 40

- After you finish you can change the percent of delay in rule command.

```
sudo iptables -A INPUT -m statistic --mode random –probability 0.03 -j DROP
sudo iptables -A INPUT -m statistic --mode random –probability 0.02 -j DROP
sudo iptables -A INPUT -m statistic --mode random –probability 0.04 -j DROP
```

3. Multiple TCP Sessions

- 1xTCP (Two TCP Sessions)

- Set the server mode by using " iperf -s -t 60 "

```
iperf -s -t 60
```

- After set server mode, the client side send one TCP by using " iperf -c 192.168.1.2(IP of server) -t 60 " command.

```
iperf -c x.x.x.x -t 60
```

- Then see the throughput result.

- 2xTCP (Two TCP Sessions)

- Set the server side for ready to receive data from client " iperf -s -t 60 ".

```
iperf -s -t 60
```

- After that send 2TCP from client side by using " iperf -c 192.168.1.2 -t 60 -P 2 "(IP of server),(- P 2 means double send TCP automatically).

```
iperf -c x.x.x.x -t 60 -P 2
```

- See the throughput result.

- 3xTCP (Three TCP Sessions)

- Same 2xTCP method but change only – P value (set – P 3).

```
iperf -c x.x.x.x -t 60 -P 3
```

4. Single/Multiple TCP Sessions in Presence of UDP

- **1xTCP + 1xUDP**
  - We want to send TCP and UDP at the same time so you must open 2 terminals.
  - For server side set the first terminal by “iperf -u -s -t 60 ” and second terminal by “iperf -s -t 60 “.

iperf -u -s -t 60

iperf -s -t 60

  - After that open 2 terminals in the client side and set the first terminal by using “iperf -u -c 192.168.1.2 -t 65 (-u means UDP) ” and second “ iperf -c 192.168.1.2 -t 60(this command is send TCP, Default don’t put into command)”.

iperf -u -c x.x.x.x -t 60

iperf -c x.x.x.x -t 60

  - See the throughput at the server side.

- **2xTCP + 2xUDP**
  - Same as 1xTCP + 1xUDP and add the value of -P 2

iperf -u -s -t 60 –P 2

iperf -s -t 60 –P 2

Parameter value

scenarios	Window size	Length	Link data rate	Delay	Drop rate	TCP
Default	85.3	8K	95.3	0	0	93.5 Mbits/sec

Scenarios 1

- Window size

We set the value of w (1, 10, 20, 30…….128) for get real the window size. The window size will double from the value that you set. For example you set the w value is 10K the window size will be 20. Finally you put the value of w equal 128 and you will see the maximum window size equal 256. If you set the value of w more than 128, thought put will not increase more than the throughput of maximum window size.

-Length of data

We set the length value –l (2, 4, 8, 16, 32) for set the length of data and see the effect to throughput from different between short and long length of data.

Scenarios 2

-Link data rate

We set the data rate (100, 500, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 7000, 10000, 15000 Kbit) for see the effect to throughput between many value of data rate.

-Link delay

We set the delay time (10, 20, 50, 100, 150, 200, 250, 300, 350, 500, 700 and 1000. For see the effect that delay time effect to throughput.

-Packet drop

We set the percent of delay equal 0.03 and see the result that effect the throughput. Then I change percent of delay to 0.01, 0.02, 0.05, 0.1 and 0.5. After that see the throughput from the result.

Scenarios 3 Multiple TCP session

We separate the test into 3 set. First we set the client to send one packet with TCP. Second send 2 packets with TCP. Finally send 3 packets with TCP. After that, see the throughput result.

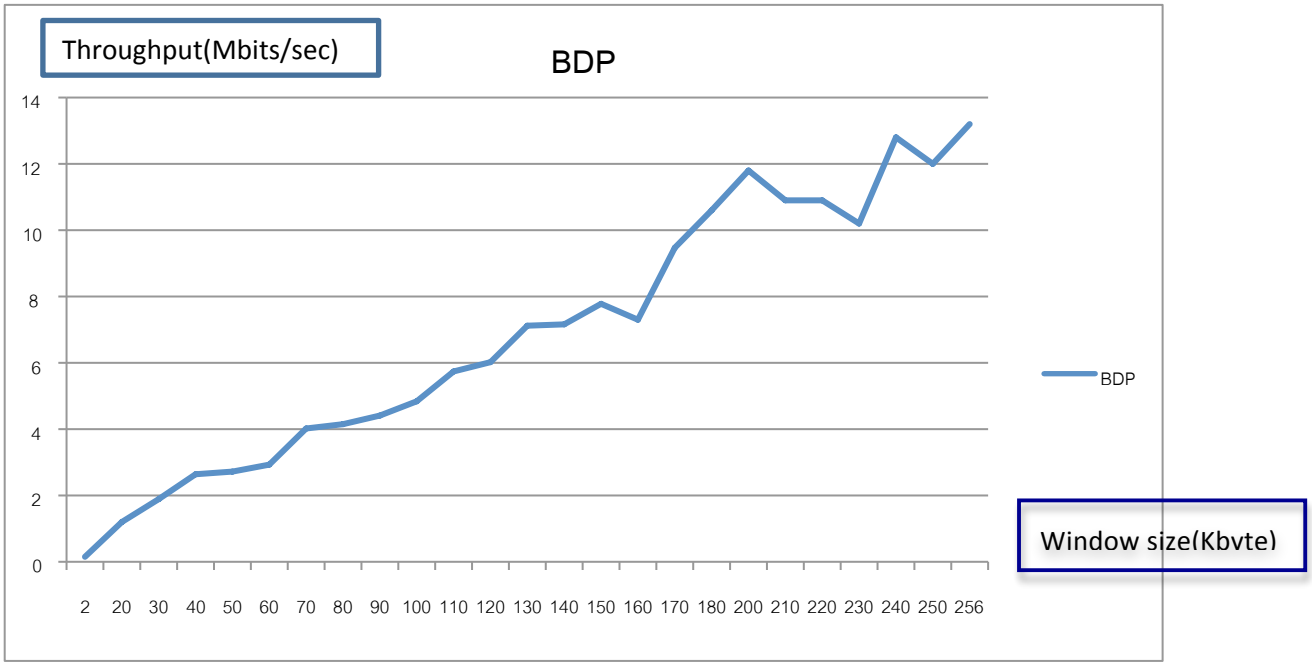
Scenarios 4 Single/Multiple TCP Sessions in Presence of UDP sessions

We separate the test into 2 set. First open 2 terminals into client size and server size because we want to send one packet with TCP and one packet with UDP at the same time. Second, send two packets with TCP and two packets with UDP at the same time. After that, see the different between throughput of UDP and TCP.

Discussion part

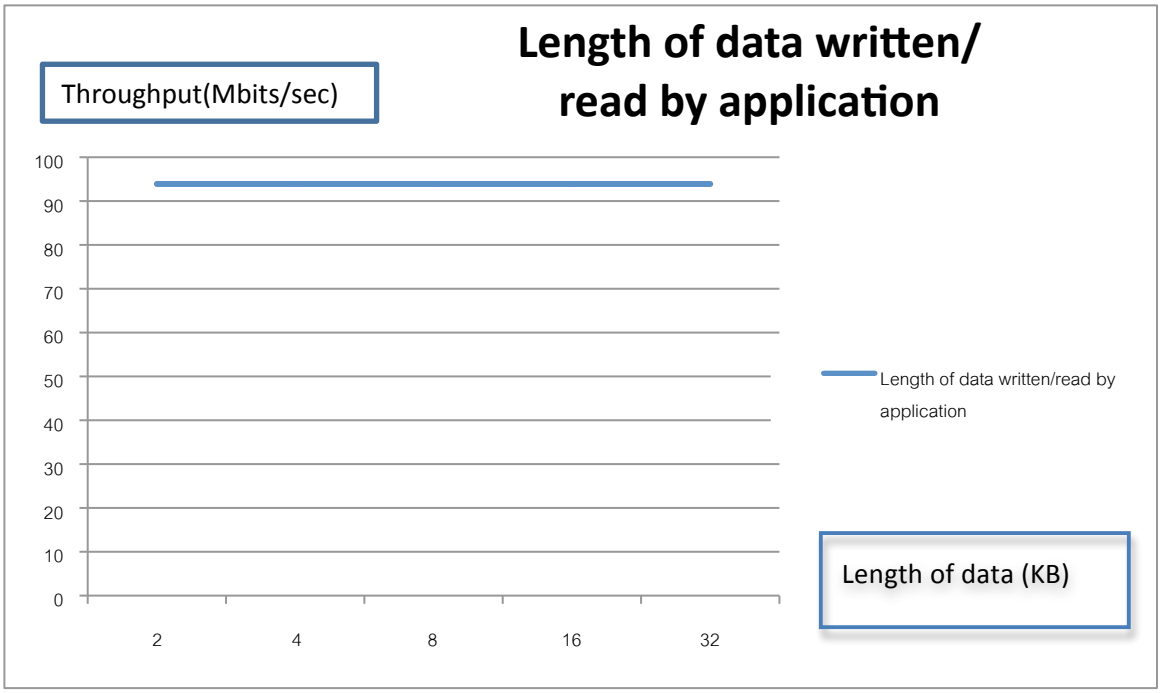
1. Single TCP session; varying application/protocol parameters.

TCP receive buffer/window size



We conclude that if you send data and set the large size of window, it means you can send more data in one time and receiver will send few ACK. Sender not wait a lot of ACK. So throughput will be high. But if you set the small size of window, you cannot send a lot of data in one time and receiver will send ACK a lot. It will be loss a lot of time and affect the throughput. However If you set the w value more than 128 that do the maximum window size, the throughput will not increase.

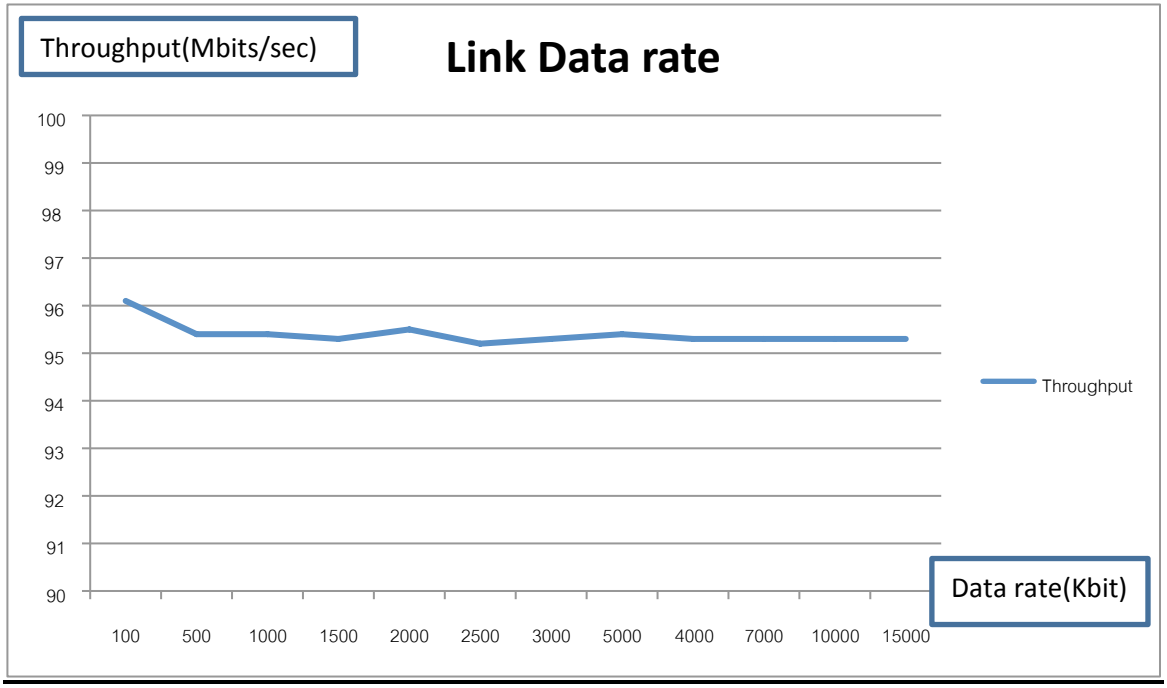
Length of data written/read by application



From the graph, we can conclude that the length of buffer to read or write is having no effect to the throughput because buffer that stores the data in computer and data will send to. Sending the data between computers is not depending on buffer.

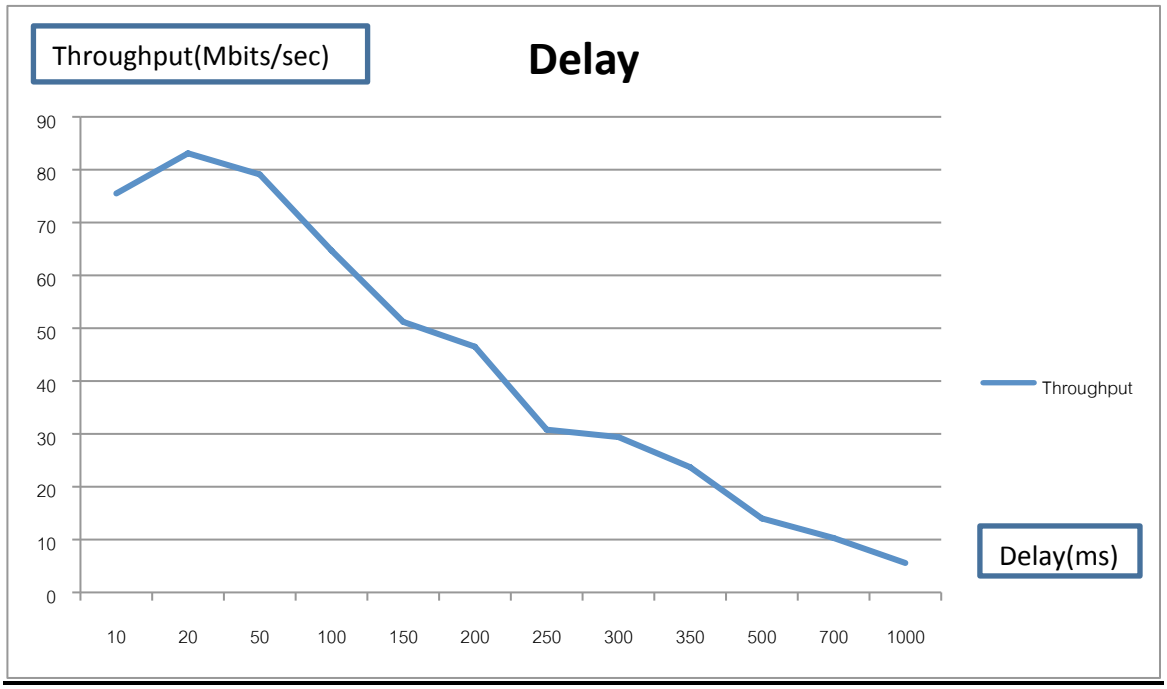
2. Single TCP session; varying network/link conditions.

Link Data Rate



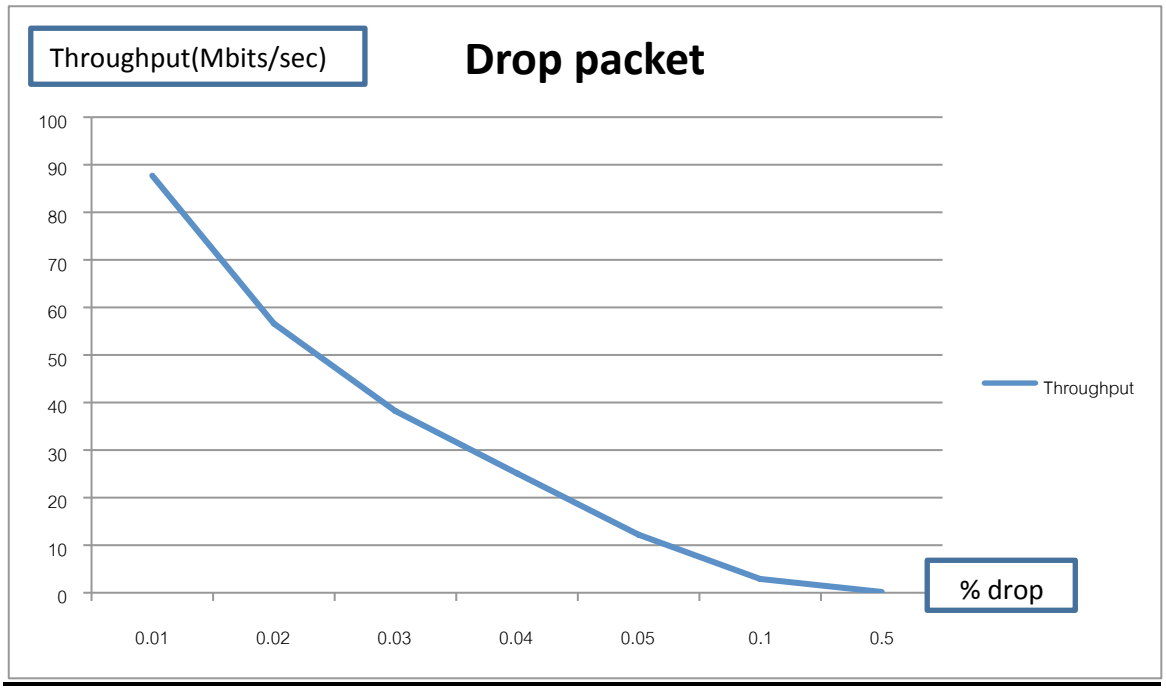
From the graph, we can conclude that data rate not effect to throughput of TCP because link data rate is constant value and depend on the performance of link.

Link delay



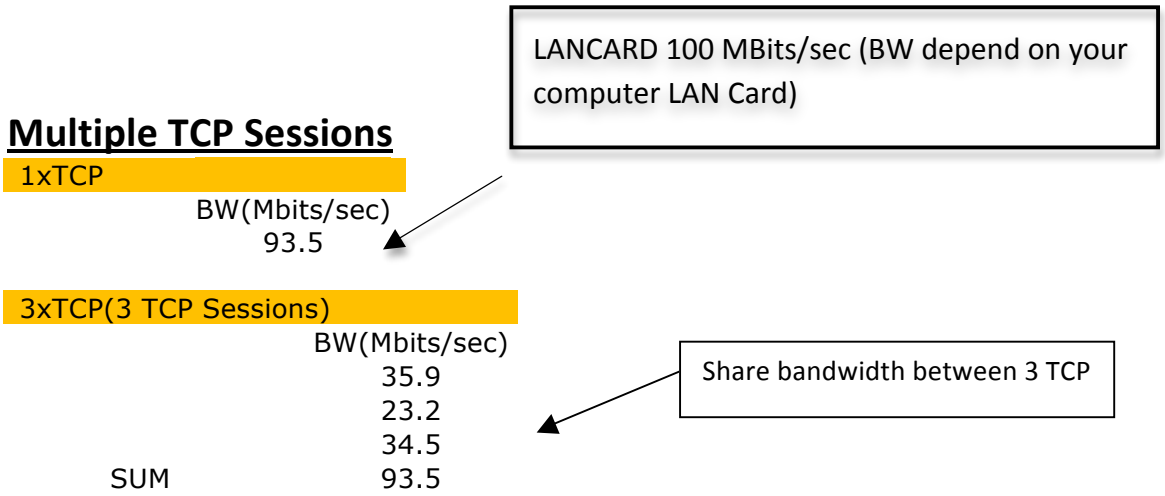
From the graph of delay will show you, the delay will effect to the performance of throughput. If we have more delay so we use more time to send the data it will affect to the throughput is decrease.

Packet drop rate



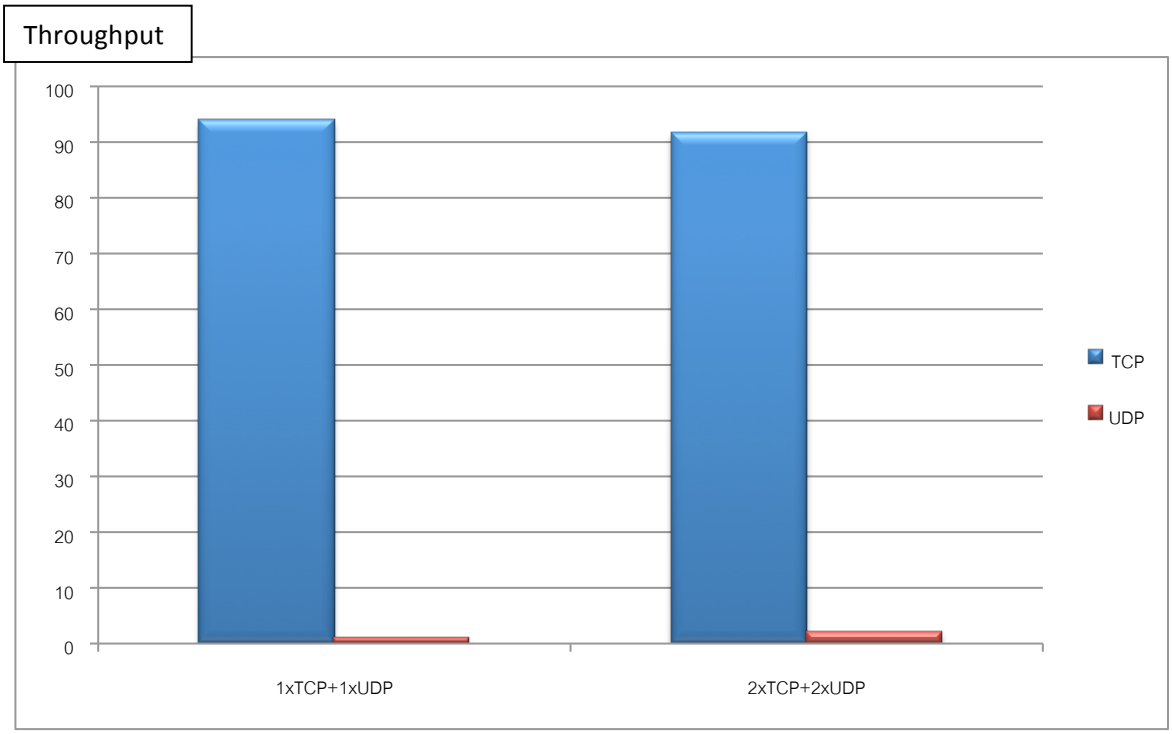
From the graph, we conclude that if percentage of drop is small then the throughput will be big value and also if percentage of drop is big then throughput will be small value because when client send the data to server but some packet loss, so retransmission will need. Before retransmission, the client must wait until the time out. This mean you loss the time to wait. It effect to the throughput rate.

Multiple TCP Sessions



From the result will show you, if you send packet with TCP more than one session, bandwidth will share to each TCP. So throughput will be less than when you send one TCP but still high because TCP is a reliable protocol. Therefore TCP will not allow the packet loss. So you not need to retransmission.

Single/Multiple TCP Sessions in Presence of UDP



If you send TCP with UDP at the same time, throughput is very slow because they share bandwidth to each TCP and UDP. Moreover UDP is not reliable protocol, so the packet will lost a lot. It cause to retransmission.

Appendix

BDP	
receiver window size(Kbyte)	BW(Mbits/sec)
2	0.15
20	1.2
30	1.89
40	2.64
50	2.72
60	2.93
70	4.02
80	4.15
90	4.41
100	4.84
110	5.74
120	6.02
130	7.12
140	7.16
150	7.78
160	7.3
170	9.47
180	10.6
200	11.8
210	10.9
220	10.9
230	10.2
240	12.8
250	12
256	13.2

Length	
Length(K)	BW(Mbits/sec)
2	93.9
4	93.9
8	93.9
16	93.9
32	93.9

Link data rate		
Kbit	BW	%
100	96.1	96.1
500	477	95.4
1000	954	95.4
1500	1.43	95.3
2000	1.91	95.5
2500	2.38	95.2
3000	2.86	95.3
5000	4.77	95.4
4000	3.81	95.25
7000	6.68	95.3
10000	9.53	95.3
15000	14.3	95.3

LINK DELAY	
Delay	BW(Mbits/sec)
10ms	75.5
20ms	83.1
50ms	79.1
100ms	64.7
150ms	51.2
200ms	46.5
250ms	30.8
300ms	29.4
350ms	23.7
500ms	14
700ms	10.3
1000ms	5.57

DROP Rate	
DROP	BW(Mbits/sec)
0.01	87.7
0.02	56.6
0.03	38.2
0.04	25.1
0.05	12.2
0.1	2.9
0.5	0.17

1xTCP	
	BW(Mbits/sec)
	93.5

2xTCP(2 TCP Sessions)	
	BW(Mbits/sec)
	52.5
	41
SUM	93.5

3xTCP(3 TCP Sessions)	
	BW(Mbits/sec)
	35.9
	23.2
	34.5
SUM	93.5

1TCP+1UDP	
UDP	BW(Mbits/sec)
	1.05

TCP	BW(Mbits/sec)
	93.9

2TCP+2UDP	
UDP	BW(Mbits/sec)
	1.05
	1.05
SUM	2.09

TCP	BW(Mbits/sec)
	56.3
	35.3
SUM	91.6