Aim: Calculation of the performance for the network implemented in experiment-8.

Description:

Bandwidth is the capacity of a wired or wireless network communications link to transmit the maximum amount of data from one point to another over a computer network or internet connection in a given amount of time -- usually one second. Synonymous with capacity, bandwidth describes the data transfer rate.

Network throughput is usually represented as an average and measured in bits per second (bps), or in some cases as data packets per second. Throughput is an important indicator of the performance and quality of a network connection. A high ratio of unsuccessful message delivery will ultimately lead to lower throughput and degraded performance.

 Network devices communicate by exchanging data packets. Throughput indicates the level of successful packet delivery from one point on the network to another. Dropping packets along the way lowers the throughput and the quality of network connections. Throughput has very real consequences for web services. Low throughput or high packet loss during online gaming sessions can lead to entire sections of gameplay being skipped. VoIP calls suffer from low quality and skips.

Goodput is the application-level throughput of a communication; i.e. the number of useful information bits delivered by the network to a certain destination per unit of time. The amount of data considered excludes protocol overhead bits as well as retransmitted data packets. This is related to the amount of time from the first bit of the first packet sent (or delivered) until the last bit of the last packet is delivered.

Turnaround time is the time required to deliver the complete message.Round trip time(RTT) is the length of time it takes for a signal to be sent plus the length of time it takes for an acknowledgement of that signal to be received. This time therefore consists of the propagation times between the two point of signal. On the Internet, an end user can determine the RTT to and from an IP(Internet Protocol) address by pinging that address.

The result depends on various factors :-
 The data rate transfer of the source's internet connection.
The nature of transmission medium.
The physical distance between source and destination.
The number of nodes between source and destination.
The amount of traffic on the LAN(Local Area Network) to which end user is connected.
The number of other requests being handled by intermediate nodes and the remote server.
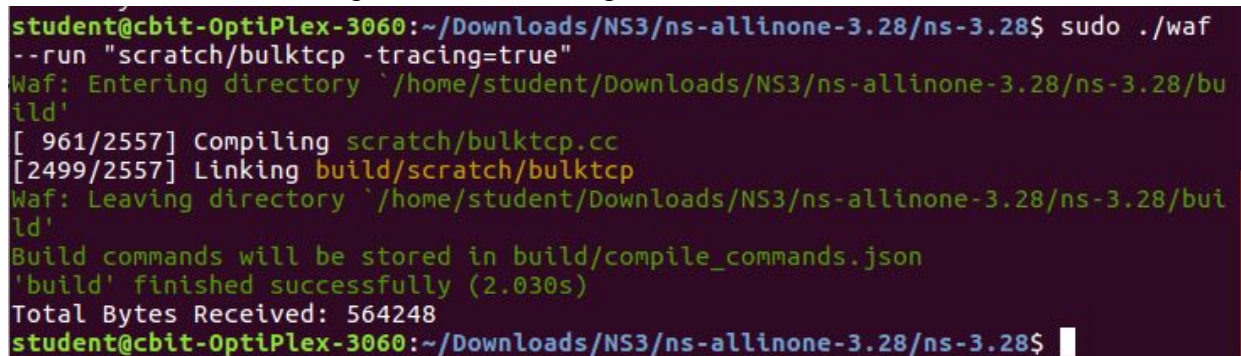The speed with which intermediate node and the remote server function.
The presence of Interference in the circuit.
The average delay of a network specifies how long it takes for a bit of data to travel across the network from one communication endpoint to another by the time taken. It is typically measured in multiples or fractions of seconds.

steps:

1)

Go to ns-allinone-3.xx/ns-3.xx via terminal and give the following command to run
tcp-bulk-send.cc

sudo ./waf --run "scratch/tcp-bulk-send –tracing=true"

```
student@cbit-OptiPlex-3060:~/Downloads/NS3/ns-allinone-3.28/ns-3.28$ sudo ./waf
--run "scratch/bulktcp -tracing=true"
Waf: Entering directory `/home/student/Downloads/NS3/ns-allinone-3.28/ns-3.28/bu
ild'
[ 961/2557] Compiling scratch/bulktcp.cc
[2499/2557] Linking build/scratch/bulktcp
Waf: Leaving directory `/home/student/Downloads/NS3/ns-allinone-3.28/ns-3.28/bui
ld'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (2.030s)
Total Bytes Received: 564248
student@cbit-OptiPlex-3060:~/Downloads/NS3/ns-allinone-3.28/ns-3.28$
```

2)

If the above mentioned command is successful, search for a file named "tcp-bulk-send.tr" in your
ns-allinone-3.xx/ns-3.xx directory.

If you find "tcp-bulk-send.tr", then your trace file is ready for analysis. "tcp-bulk-send.tr" is the
trace file which will be analyzed by TraceMetrics.

3)

Download TraceMetrics from the following link:

**http://sourceforge.net/projects/tracemetrics/**

4)Unzip the downloaded file i.e., tracemetrics-1.3.0.zip.

5)Go in the extracted folder i.e., tracemetrics and open the file named "tracemetrics.jar".Procedure:Procedure:In terminal give following command:

java -jar <filename>.jar

```
student@cbit-OptiPlex-3060:~/Downloads/tracemetrics-1.4.0$ java -jar tracemetri
cs.jar
TCP size: 2
Stream 1
[]
Stream 2
[TcpStreamNode{seqNumber=564249, time=9.98659, flags=[Ljava.lang.String;@403dfa
a9, payload=488, ack=1, signature=Ipv4Header  (tos 0x0 DSCP Default ECN Not-ECT
 id 1070 protocol 6 offset (bytes) 0 flags [none] length: 540 10.1.1.1 > 10.1.1
.2)  TcpHeader  (49153 > 9 [ACK] Seq=564249 Ack=1 Win=32768  TcpOptionTS (7687;
7681)  TcpOptionEnd (EOL)) Payload Fragment [24:512]
}, TcpStreamNode{seqNumber=564737, time=9.99526, flags=[Ljava.lang.String;@307f
11c8, payload=24, ack=1, signature=Ipv4Header  (tos 0x0 DSCP Default ECN Not-EC
T id 1071 protocol 6 offset (bytes) 0 flags [none] length: 588 10.1.1.1 > 10.1.
1.2)  TcpHeader  (49153 > 9 [ACK] Seq=564737 Ack=1 Win=32768  TcpOptionTS (7705
;7700)  TcpOptionEnd (EOL)) Payload (size=512) Payload Fragment [0:24]
}]
student@cbit-OptiPlex-3060:~/Downloads/tracemetrics-1.4.0$
```
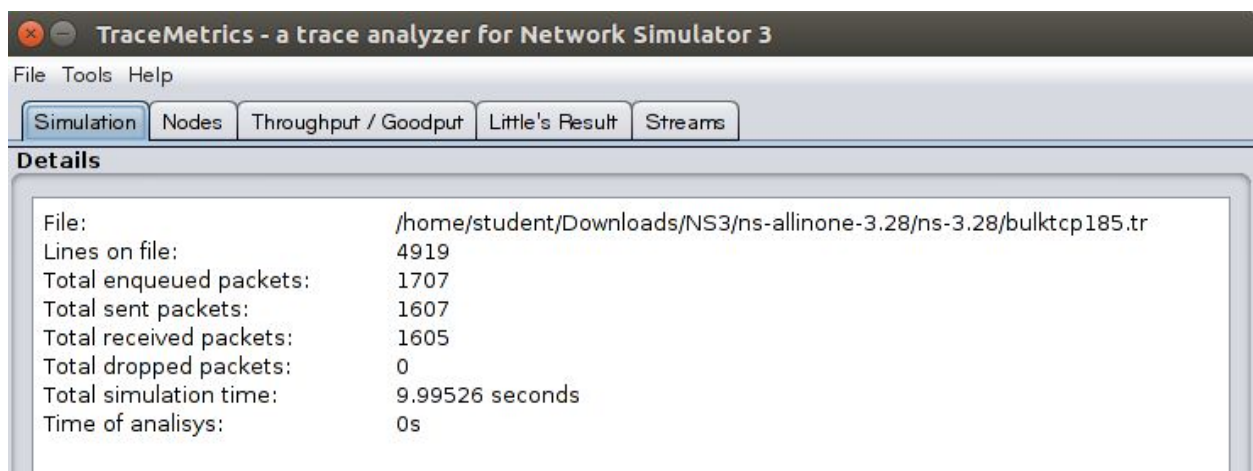
6) Select File -> Choose File and then navigate to the folder where you stored "tcp-bulk-send.tr". Select "tcp-bulk-send.tr"
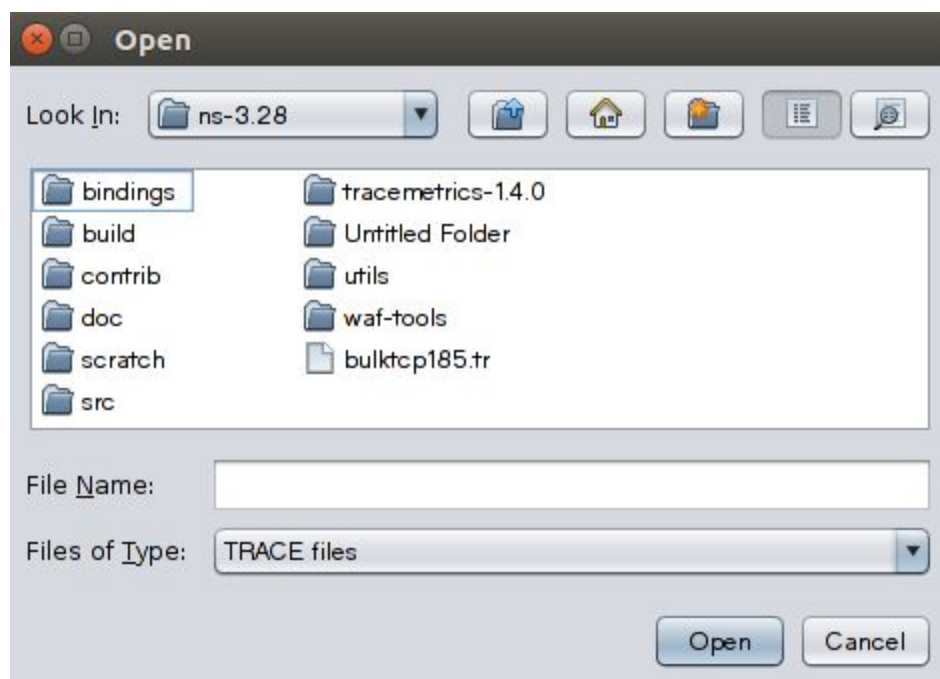
7) The next window that appears will look like the Image shown below:
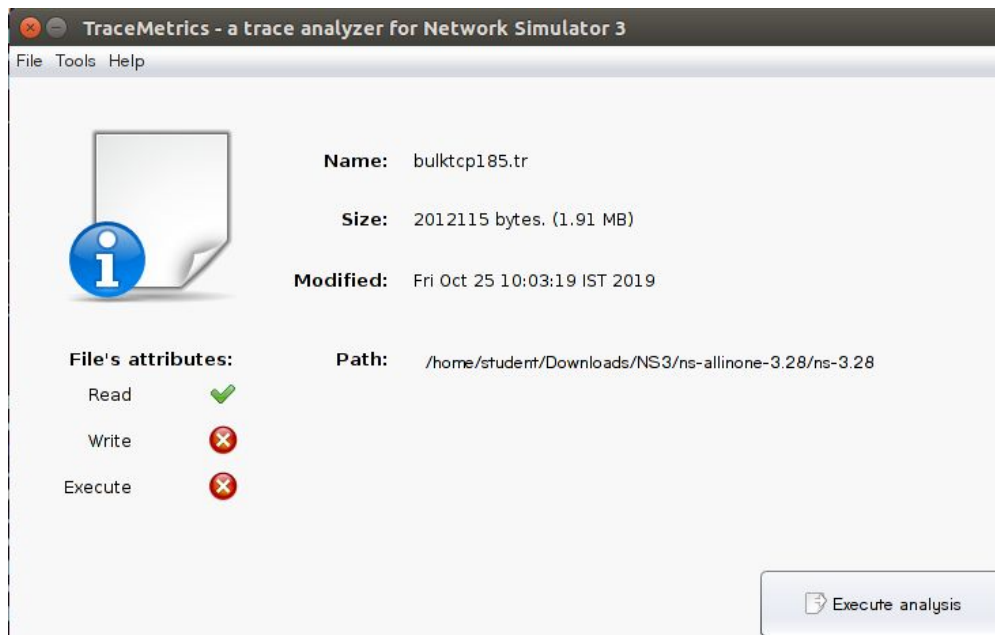
8) Click on "Execute analysis" button on the bottom right corner.

```
Node:               0
Sent packets:   1072
Received packets:       535
Dropped packets:        0
Data sent:              608.55859375 KB
Data received:  28.216796875 KB
Data dropped:   0.0 B
Throughput:             62345.95198123911 B
Goodput:                45745.68345395718 B
Lambda:                 107.25083689668904
EN:             89.77937802518451
EW:             0.8370972257462665
Little's result:
  -> EN:                89.77937802518451
  -> EW*lambda: 89.77937802518372
Average length of:
  -> Sent packets:      581.0 B
  -> Received packets:  54.0 B

Node:               1
Sent packets:   535
Received packets:       1070
Dropped packets:        0
Data sent:              28.216796875 KB
Data received:  607.453125 KB
Data dropped:   0.0 B
Throughput:             2890.770225086691 B
Goodput:                0.0 B
Lambda:                 53.525371025866264
EN:             0.0
EW:             0.0
Little's result:
  -> EN:                0.0
  -> EW*lambda: 0.0
Average length of:
  -> Sent packets:      54.0 B
  -> Received packets:  581.0 B
```

TraceMetrics - a trace analyzer for Network Simulator 3

File Tools Help

| Simulation | Nodes | Throughput / Goodput | Little's Result | Streams |

Node	Throughput	Goodput
0	62345.95198123911	45745.68345395718
1	2890.770225086691	0.0

TraceMetrics - a trace analyzer for Network Simulator 3

File Tools Help

Node	Lambda	E[W]	E[N]	E[W] * Lambda
0	107.25083689668904	0.8370972257462665	89.77937802518451	89.77937802518372
1	53.525371025866264	0.0	0.0	0.0

```
TCP ALL:
------ Stream 0 ------
IPs:            10.1.1.2 --> 10.1.1.1
Ports:          9 --> 49153
Number of packets:      535
Average Delay:  0.0058676186915887635
Delay variance:          2.3285043229737743E-11
Average PDV:    7.618691590341779E-6
PDV variance:   2.32415197844484E-11
Average IPDV:   -1.0861423221007548E-7
IPDV variance:  1.9681086845348262E-11

------ Stream 1 ------
IPs:            10.1.1.1 --> 10.1.1.2
Ports:          49153 --> 9
Number of packets:      1070
Average Delay:  0.014301409345794576
Delay variance:          2.1742118120352208E-7
Average PDV:    0.008437409345794419
PDV variance:   2.1721798383791072E-7
Average IPDV:   7.962581852198739E-6
IPDV variance:  2.688779256346603E-7
```