

# CS 549: Performance Analysis of Computer Networks

## Lab Assignment 2

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*what to measure ?*

- Network Throughput

*How to measure ?*

- Using the tool **wget**

*Factors*

Factors	Levels
File Size	1B , 1kB, 10kB, 100kB, 500kB , 1MB, 10MB, 100MB, 500MB
Download speed limit	-1 , 1 ( low and high ) ( 1Mb /s , 5Mb /s)
Number of concurrent file downloads running	1, 2, 3
Time of Day	Morning , Day , evening

For simplicity considering :


Levels of File size as 3 ---- 10KB , 1MB, 100 MB

The experimental is conducted as follows:-

A full factorial design is implemented , with 3 repetitions. This implies the total number of experiment to be done are :-

$( 3 \text{ for File size } ) * ( 2 \text{ for Speed Limit } ) * ( 3 \text{ for concurrent downloads } ) * ( 3 \text{ for time of day } ) * ( 3 \text{ for reps } ) = 162 \text{ in total.}$

The data collected by varying all levels of all factors is described in the below table. Note that the data is sorted based on highest value of throughput first. ( That's what we need for good performance).

File Size	Speed Limit	Concurrent Downloads	Time of the day	Throughput ( KB/s) 
10KB	5M	1	Morning	88268.8
10KB	5M	1	Afternoon	66355.2
10KB	100M	2	Afternoon	66201.6
10KB	100M	1	Afternoon	65 433.6
10KB	100M	2	Afternoon	63283.2

10KB	100M	2	Afternoon	61235.2
10KB	5M	2	Morning	59904
10KB	5M	3	Evening	59392
10KB	5M	1	Morning	59187.2
10KB	100M	1	Morning	58880
10KB	100M	2	Morning	58880
10KB	5M	3	Morning	58675.2
10KB	5M	2	Morning	58470.4
10KB	5M	1	Evening	58368
10KB	5M	2	Afternoon	57600
10KB	5M	2	Afternoon	57344
10KB	100M	1	Morning	54988.8
10KB	5M	3	Morning	54272
10KB	5M	1	Evening	53657.6
10KB	5M	3	Afternoon	52053.33
10KB	5M	3	Afternoon	51746.13
10KB	100M	3	Evening	51647.14
10KB	100M	3	Afternoon	51613.01
10KB	100M	1	Evening	51404.8
10KB	5M	1	Morning	50073.6
10KB	100M	1	Afternoon	49664
10KB	5M	3	Afternoon	45813.76
10KB	100M	1	Afternoon	40755.2
10KB	100M	3	Morning	40239.78
10KB	100M	1	Evening	39424
10KB	5M	2	Afternoon	39424
10KB	100M	3	Morning	37246.29
10KB	100M	3	Afternoon	35061.76
10KB	5M	3	Morning	33327.78
10KB	100M	2	Morning	31723.52
10KB	100M	2	Evening	31114.24
10KB	100M	2	Morning	30796.8
10KB	5M	2	Evening	30468.3
10KB	5M	2	Morning	30376.96
10KB	5M	1	Afternoon	28876.8
10KB	5M	3	Evening	22370.98
10KB	100M	3	Evening	20988.58

100MB	100M	3	Afternoon	11605.33
100MB	100M	3	Afternoon	11400.53
1MB	100M	3	Afternoon	10581.33
100MB	100M	3	Afternoon	10018.13
1MB	5M	2	Afternoon	9999.36
1MB	100M	3	Afternoon	9895.25
1MB	100M	1	Morning	9840.64
1MB	100M	3	Afternoon	9359.36
1MB	100M	2	Afternoon	9036.8
1MB	5M	1	Afternoon	8744.96
1MB	5M	1	Morning	8704
1MB	100M	1	Afternoon	8683.52
1MB	5M	3	Afternoon	8622.08
1MB	100M	1	Afternoon	8478.72
1MB	5M	1	Afternoon	8458.24
1MB	5M	2	Morning	8314.88
100MB	100M	1	Afternoon	7905.28
1MB	5M	2	Morning	7838.72
1MB	100M	1	Morning	7833.6
100MB	100M	2	Afternoon	7741.44
100MB	100M	1	Morning	7669.76
1MB	100M	1	Afternoon	7475.2
1MB	5M	3	Afternoon	7464.96
1MB	100M	2	Morning	7408.64
1MB	5M	2	Morning	7408.64
100MB	100M	1	Afternoon	7311.36
1MB	100M	2	Morning	7162.88
100MB	100M	1	Morning	7034.88
100MB	100M	2	Afternoon	6656
1MB	5M	3	Afternoon	6645.76
100MB	100M	1	Afternoon	6574.08
1MB	100M	2	Afternoon	6430.72
1MB	5M	3	Evening	6157.65
100MB	100M	3	Morning	6133.76
1MB	100M	3	Morning	6120.1
1MB	5M	3	Morning	6116.69
100MB	100M	3	Morning	5942.61

1MB	100M	1	Morning	5918.72
100MB	100M	2	Morning	5898.24
100MB	100M	2	Afternoon	5862.4
1MB	100M	2	Morning	5652.48
1MB	5M	1	Afternoon	5601.28
100MB	100M	3	Morning	5434.02
1MB	100M	3	Morning	5379.41
1MB	5M	3	Morning	5212.16
100MB	5M	3	Afternoon	5150.72
100MB	5M	3	Afternoon	5147.3
100MB	5M	1	Afternoon	5130.24
100MB	100M	2	Morning	5120
100MB	5M	1	Afternoon	5109.76
100MB	5M	3	Afternoon	5051.73
100MB	5M	1	Morning	5048.32
100MB	5M	3	Morning	5021.01
100MB	5M	2	Afternoon	5007.36
100MB	100M	2	Morning	4956.16
100MB	5M	1	Morning	4945.92
100MB	5M	2	Morning	4945.92
100MB	5M	2	Afternoon	4904.96
100MB	5M	3	Morning	4898.13
100MB	5M	1	Morning	4812.8
100MB	5M	3	Morning	4795.73
100MB	5M	1	Afternoon	4792.32
1MB	5M	3	Morning	4747.94
100MB	100M	3	Evening	4700.16
100MB	100M	1	Morning	4669.44
100MB	5M	2	Afternoon	4659.2
100MB	5M	2	Morning	4444.16
100MB	5M	2	Morning	4439.04
1MB	5M	1	Morning	4188.16
1MB	5M	2	Afternoon	4147.2
1MB	100M	2	Afternoon	4044.8
1MB	5M	1	Morning	3870.72
1MB	100M	3	Morning	3819.52
1MB	5M	2	Afternoon	3599.36

100MB	100M	3	Evening	3433.02
10KB	5M	2	Evening	3322.88
10KB	5M	2	Evening	3297.28
1MB	100M	2	Evening	2995.2
1MB	100M	3	Evening	2914.98
1MB	5M	3	Evening	2809.17
10KB	100M	3	Morning	2662.4
10KB	5M	1	Afternoon	2560
1MB	100M	2	Evening	2539.52
10KB	100M	1	Morning	2529.28
10KB	100M	2	Evening	2426.88
1MB	100M	3	Evening	2416.64
10KB	100M	3	Evening	2231.48
10KB	100M	3	Afternoon	2194.44
1MB	100M	3	Evening	2174.29
1MB	5M	3	Evening	2131.37
10KB	5M	3	Evening	2104.62
1MB	100M	1	Evening	2048
100MB	5M	1	Evening	2017.28
1MB	5M	1	Evening	1996.8
1MB	100M	1	Evening	1955.84
10KB	100M	2	Evening	1641.96
1MB	5M	2	Evening	1551.36
1MB	5M	2	Evening	1510.4
1MB	5M	1	Evening	1454.08
100MB	100M	3	Evening	1433.6
10KB	5M	1	Evening	1413.12
100MB	5M	3	Evening	1389.41
100MB	5M	1	Evening	1361.92
1MB	100M	2	Evening	1300.48
100MB	5M	2	Evening	1100.8
100MB	100M	2	Evening	1090.3
100MB	5M	3	Evening	1025.93
100MB	5M	3	Evening	944.66
1MB	5M	2	Evening	839
100MB	100M	2	Evening	808.5
1MB	100M	1	Evening	790

100MB	5M	1	Evening	752
100MB	5M	2	Evening	712
100MB	100M	1	Evening	706
1MB	5M	1	Evening	687
100MB	5M	2	Evening	666
100MB	100M	2	Evening	657
100MB	100M	1	Evening	586
100MB	100M	1	Evening	549
10KB	100M	1	Evening	24.9

### Observation / Pattern (Ranking Method) :-

As marked with the Bounding boxed ( green and red ) , We can say :-

- If the file size is smaller ( like 10KB in our case) – we most probably will get a higher throughput ( green box ).
- We are very likely to get very less throughput ( even less than 1MB/sec) if the **time of day** is **evening** ( red box ). Very sad it is :(

### Range Method :-

For this, we need to change our table a little bit ( actually quite many changes )

One more column can be added here which will include all the throughput values for all levels and factors , but to keep the report short I have included the whole tables in appendix.

Factor	Level	Average throughput	Range ( max – min )
File size	10KB	38574.4	34126.78
	1MB	5390.34	
	100MB	4447.62	
Time of the day	Morning	18930.6	11055.66
	Afternoon	20268.7	
	Evening	9213.04	
Number of concurrent Downloads	1	17510.6	2330.3
	2	15721.5	

	3	15180.3	
Speed Limit	5MB	16862	1449.1
	100MB	15412.9	