



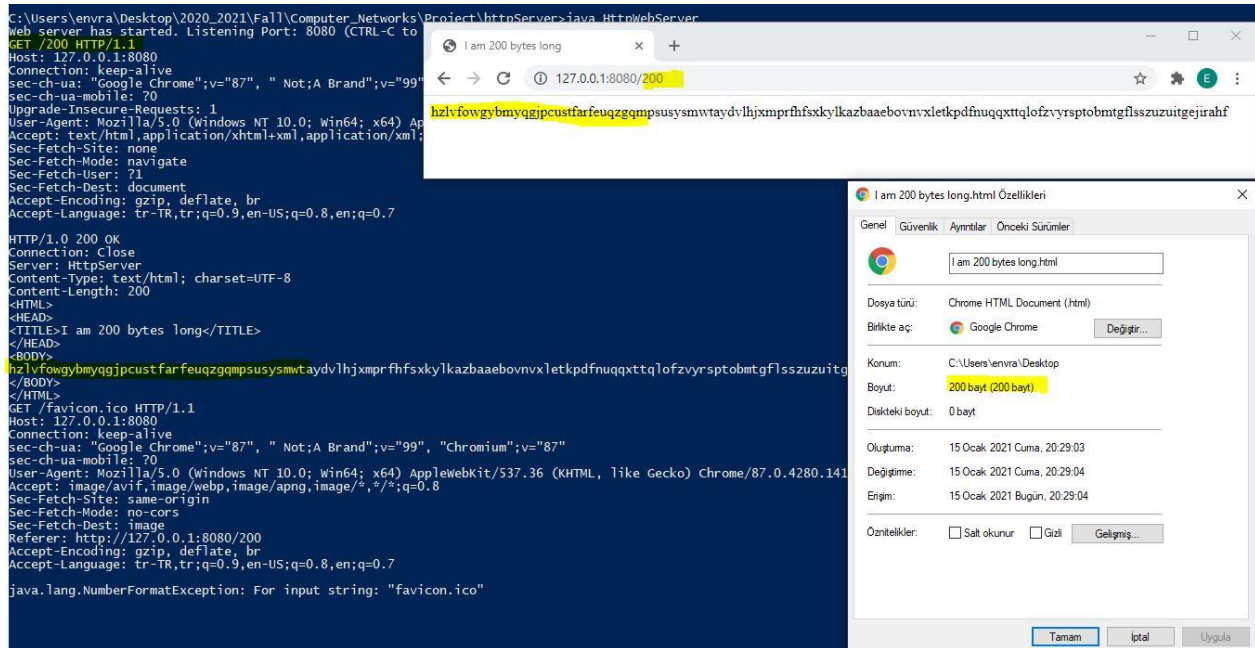
MARMARA UNIVERSITY

**FACULTY OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING
DEPARTMENT**

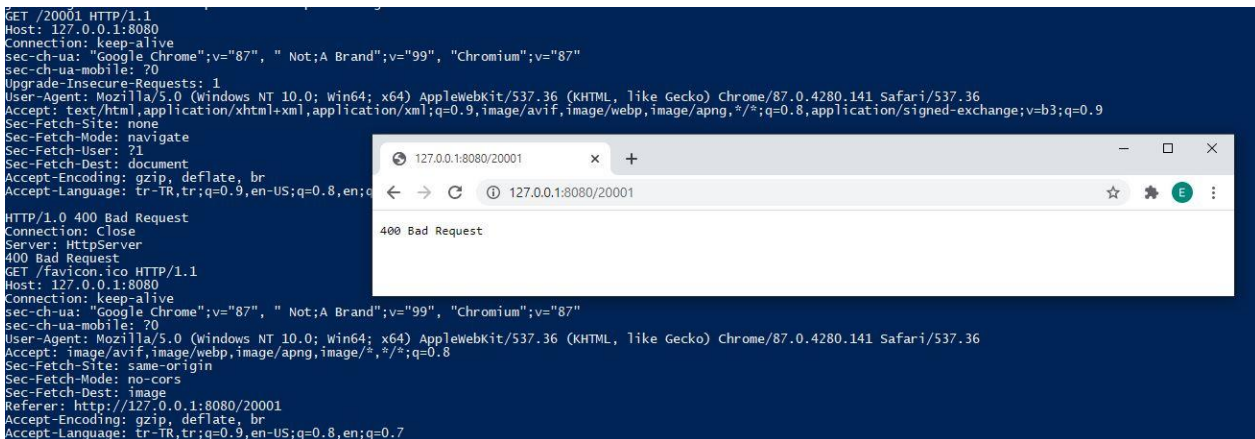
**CSE4074
COMPUTER NETWORKS
Report of Programming Assignment**

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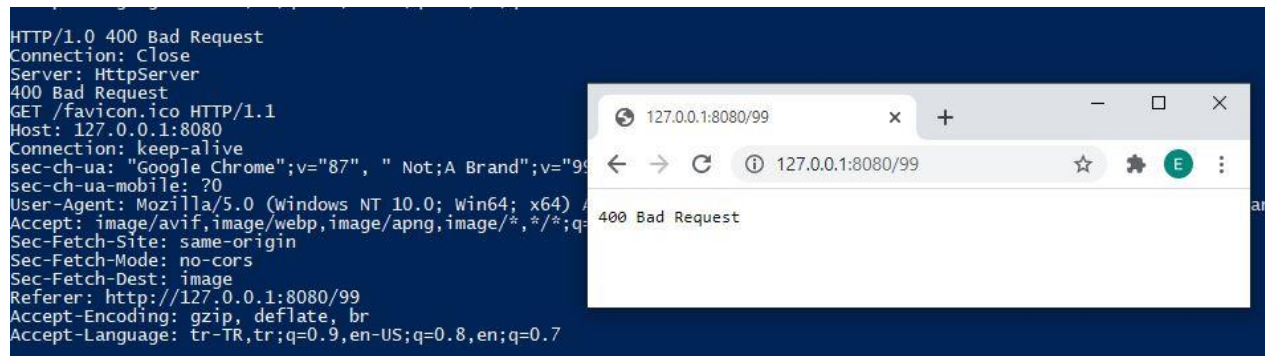
1) Multithreaded Web Server



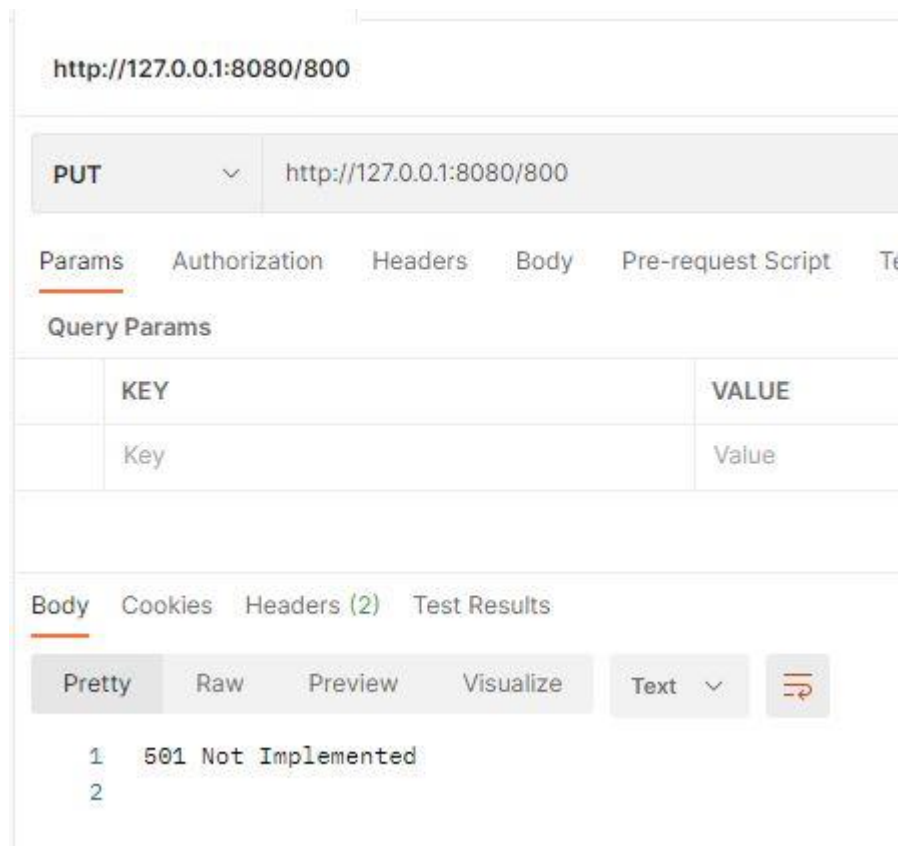
- Based on the requested document size, our Web Server creates a file that has exactly the same requested byte as shown above.
- For default value, we've used 8080 as our Server's port number.



- If the requested file size is greater than 20,000, our server responds to that corresponding request with “400 Bad Request” as shown above.














- If the requested size is below 100, our server also gives a respond with “400 Bad Request” just like it does when it is above 20,000.

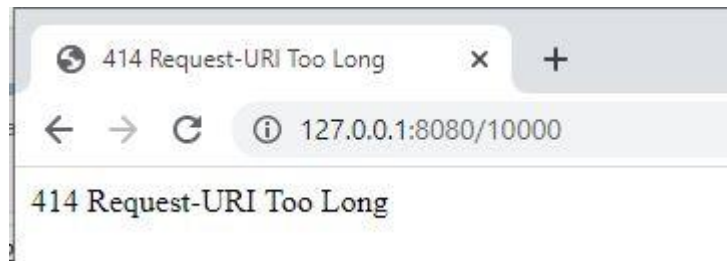


- If the method in request message is not GET, server returns “501 Not Implemented”. We’ve used Postman to create methods that are different than GET.

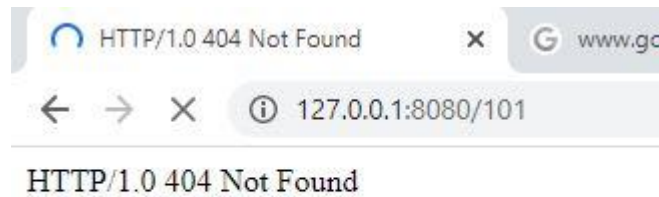
2) Proxy Server

Ad	Değiştirme tarihi	Tür	Boyut
 100.html	15.01.2021 20:40	Chrome HTML Do...	1 KB
 101.html	15.01.2021 20:38	Chrome HTML Do...	1 KB
 200.html	15.01.2021 20:11	Chrome HTML Do...	1 KB
 500.html	15.01.2021 19:48	Chrome HTML Do...	1 KB
 600.html	15.01.2021 20:11	Chrome HTML Do...	1 KB
 7000.html	15.01.2021 20:11	Chrome HTML Do...	7 KB
 cachedSites.txt	15.01.2021 20:46	Metin Belgesi	1 KB
 Proxy.class	15.01.2021 20:09	CLASS Dosyası	6 KB
 Proxy.java	13.01.2021 01:51	IntelliJ IDEA	8 KB
 ProxyServer.class	15.01.2021 20:09	CLASS Dosyası	2 KB
 ProxyServer.java	13.01.2021 00:23	IntelliJ IDEA	1 KB

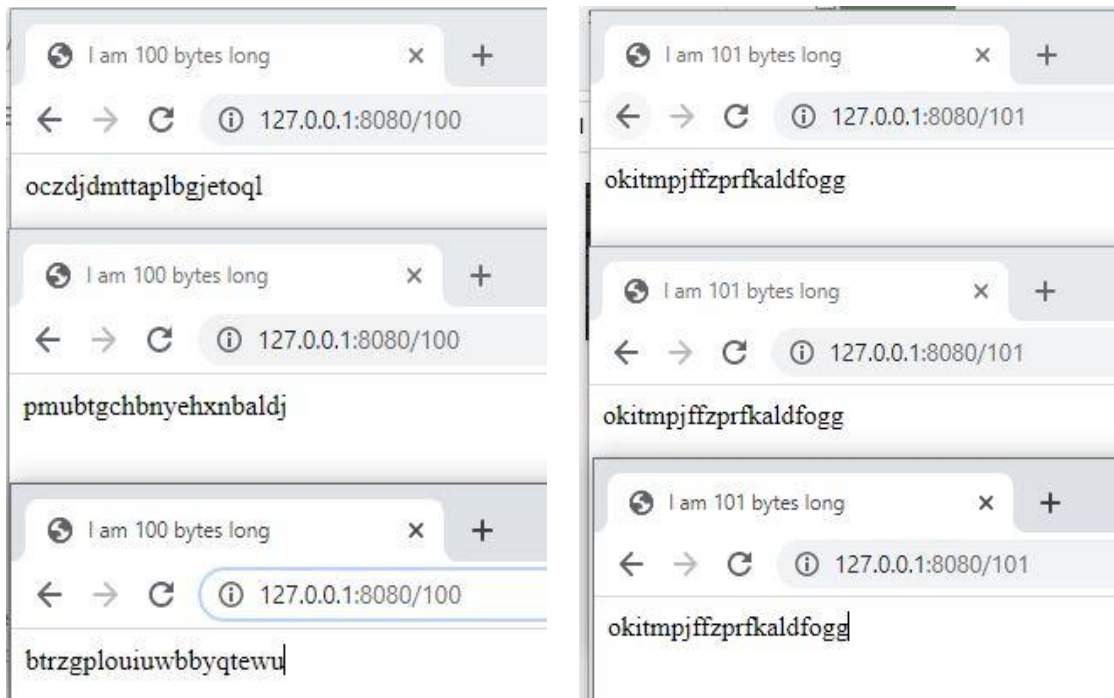
- Our proxy server provides caching mechanism for the requested documents.
- Proxy Server stores cached files in our local directory. When the same request comes to proxy server, it does not redirect that request to the web server, instead, returns the cached file to the client.



- Our proxy server has some restrictions. If the requested file size is greater than 9,999 proxy sends "Request-URI Too Long" message with error code 414.



- When the Web Server is not currently running, our proxy server returns “Not Found” message with status code 404.



- Proxy server also provides Conditional GET mechanism. We assumed that even length files are always modified, on the contrary, odd length files are never modified in the server.

3) Using ApacheBench Program

```
C:\Users\envra>ab -n 10 -c 1 http://ipv4.download.thinkbroadband.com/5MB.zip
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ipv4.download.thinkbroadband.com (be patient).....done

Server Software:      nginx
Server Hostname:      ipv4.download.thinkbroadband.com
Server Port:          80

Document Path:        /5MB.zip
Document Length:      5242880 bytes

Concurrency Level:    1
Time taken for tests:  40.864 seconds
Complete requests:    10
Failed requests:       0
Total transferred:    52431510 bytes
HTML transferred:     52428800 bytes
Requests per second:  0.24 [#/sec] (mean)
Time per request:     4086.385 [ms] (mean)
Time per request:     4086.385 [ms] (mean, across all concurrent requests)
Transfer rate:        1253.01 [Kbytes/sec] received

Connection Times (ms)
      min   mean[+/-sd] median   max
Connect:    59    68   6.6      69    80
Processing: 2486  4018 867.6    4293   5302
Waiting:    65    74   9.9      73    99
Total:      2547  4086 873.4    4364   5382

Percentage of the requests served within a certain time (ms)
 50%    4364
 66%    4450
 75%    4533
 80%    4605
 90%    5382
 95%    5382
 98%    5382
 99%    5382
100%    5382 (longest request)
```

- a) We've sent single request with concurrency level = 1

```

C:\Users\envra>ab -n 10 -c 5 http://ipv4.download.thinkbroadband.com/5MB.zip
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ipv4.download.thinkbroadband.com (be patient).....done


Server Software:      nginx
Server Hostname:      ipv4.download.thinkbroadband.com
Server Port:          80

Document Path:        /5MB.zip
Document Length:       5242880 bytes

Concurrency Level:     5
Time taken for tests:   12.352 seconds
Complete requests:     10
Failed requests:        0
Total transferred:     52431510 bytes
HTML transferred:      52428800 bytes
Requests per second:   0.81 [#/sec] (mean)
Time per request:      6175.992 [ms] (mean)
Time per request:      1235.198 [ms] (mean, across all concurrent requests)
Transfer rate:         4145.30 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        57     64    6.0      64      76
Processing:    4333   5715  1282.6   5933   7680
Waiting:        62     95   39.9      76     189
Total:         4390   5779  1285.4   5991   7756


Percentage of the requests served within a certain time (ms)
 50%    5991
 66%    6791
 75%    7024
 80%    7042
 90%    7756
 95%    7756
 98%    7756
 99%    7756
100%    7756 (longest request)

```

b) We've sent 5 requests at a time (concurrency level = 5)

```

C:\Users\envra>ab -n 10 -c 10 http://ipv4.download.thinkbroadband.com/5MB.zip
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ipv4.download.thinkbroadband.com (be patient).....done


Server Software:      nginx
Server Hostname:      ipv4.download.thinkbroadband.com
Server Port:          80

Document Path:        /5MB.zip
Document Length:       5242880 bytes

Concurrency Level:     10
Time taken for tests:   6.453 seconds
Complete requests:      10
Failed requests:         0
Total transferred:      52431510 bytes
HTML transferred:       52428800 bytes
Requests per second:    1.55 [#/sec] (mean)
Time per request:       6452.983 [ms] (mean)
Time per request:       645.298 [ms] (mean, across all concurrent requests)
Transfer rate:          7934.73 [Kbytes/sec] received


Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        67    70   2.5      69     75
Processing:    3533  4728 803.4    5145   5676
Waiting:        72    270 181.7     280    564
Total:         3605  4798 802.2    5213   5745


Percentage of the requests served within a certain time (ms)
 50%    5213
 66%    5379
 75%    5381
 80%    5484
 90%    5745
 95%    5745
 98%    5745
 99%    5745
100%    5745 (longest request)

```

c) We've sent 10 requests a time (concurrency level = 10)


```

C:\Users\envra>ab -k -n 10 -c 1 http://ipv4.download.thinkbroadband.com/5MB.zip
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ipv4.download.thinkbroadband.com (be patient).....done


Server Software:      nginx
Server Hostname:      ipv4.download.thinkbroadband.com
Server Port:          80

Document Path:        /5MB.zip
Document Length:      5242880 bytes

Concurrency Level:    1
Time taken for tests:  5.406 seconds
Complete requests:    10
Failed requests:      0
Keep-Alive requests:  10
Total transferred:    52431560 bytes
HTML transferred:    52428800 bytes
Requests per second:  1.85 [#/sec] (mean)
Time per request:     540.578 [ms] (mean)
Time per request:     540.578 [ms] (mean, across all concurrent requests)
Transfer rate:        9471.85 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      6   19.0         0     60
Processing:    497    535  100.2        502    819
Waiting:        63     65   2.2         65     69
Total:         497    541  119.1        502    879


Percentage of the requests served within a certain time (ms)
 50%    502
 66%    503
 75%    511
 80%    517
 90%    879
 95%    879
 98%    879
 99%    879
100%    879 (longest request)

```

d) We've repeated part A with using -k argument.

```

C:\Users\envra>ab -k -n 10 -c 5 http://ipv4.download.thinkbroadband.com/5MB.zip
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ipv4.download.thinkbroadband.com (be patient).....done


Server Software:      nginx
Server Hostname:      ipv4.download.thinkbroadband.com
Server Port:          80

Document Path:        /5MB.zip
Document Length:       5242880 bytes

Concurrency Level:    5
Time taken for tests:  10.703 seconds
Complete requests:    10
Failed requests:       0
Keep-Alive requests:  10
Total transferred:    52431560 bytes
HTML transferred:     52428800 bytes
Requests per second:  0.93 [#/sec] (mean)
Time per request:     5351.644 [ms] (mean)
Time per request:     1070.329 [ms] (mean, across all concurrent requests)
Transfer rate:         4783.83 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0    41  44.2      69     95
Processing:    3919  4966  747.0    4795   6436
Waiting:        70   107   55.0     88    247
Total:         3919  5007  780.9    4795   6524


Percentage of the requests served within a certain time (ms)
 50%    4795
 66%    5340
 75%    5675
 80%    5691
 90%    6524
 95%    6524
 98%    6524
 99%    6524
100%    6524 (longest request)

```

e) We've repeated part B with using -k argument.

```

C:\Users\envra>ab -k -n 10 -c 10 http://ipv4.download.thinkbroadband.com/5MB.zip
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ipv4.download.thinkbroadband.com (be patient).....done


Server Software:      nginx
Server Hostname:      ipv4.download.thinkbroadband.com
Server Port:          80

Document Path:        /5MB.zip
Document Length:      5242880 bytes

Concurrency Level:    10
Time taken for tests:  8.278 seconds
Complete requests:    10
Failed requests:       0
Keep-Alive requests:  10
Total transferred:    52431560 bytes
HTML transferred:     52428800 bytes
Requests per second:  1.21 [#/sec] (mean)
Time per request:     8277.813 [ms] (mean)
Time per request:     827.781 [ms] (mean, across all concurrent requests)
Transfer rate:        6185.53 [Kbytes/sec] received


Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        58    72   8.6      73    87
Processing:    4071  6022 1355.4   6090   8200
Waiting:        70    272  183.0    283    576
Total:         4133  6094 1361.7   6163   8278


Percentage of the requests served within a certain time (ms)
 50%    6163
 66%    6664
 75%    6701
 80%    7894
 90%    8278
 95%    8278
 98%    8278
 99%    8278
100%    8278 (longest request)

```

f) We've repeated part C with using -k argument.

How and Why these values change when you use -k argument?

When we look at the screenshots, we examined that the persistent connection optimality increases when concurrency level decreases. We can simply explain it with the concept of TCP's 3-way handshake mechanism. If there is only one client that is sending some requests to server, it is extremely optimal for him/her to use persistent connection because client does not waste his/her time waiting for handshaking for subsequent requests time and time again. On the contrary, if there are multiple clients who are sending requests to server, efficiency of keeping alive option decreases because when one of the clients does not close the connection, the resources needed to keep the connection open on the server will be unavailable for other clients. Also, race condition might occur.

4) Testing your server using ApacheBench (Web Server)

```
C:\Users\envra>ab -n 10000 -c 1 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080

Document Path:        /5000
Document Length:      5002 bytes

Concurrency Level:    1
Time taken for tests:  123.761 seconds
Complete requests:    10000
Failed requests:       0
Total transferred:    51220000 bytes
HTML transferred:     50020000 bytes
Requests per second:  80.80 [#/sec] (mean)
Time per request:     12.376 [ms] (mean)
Time per request:     12.376 [ms] (mean, across all concurrent requests)
Transfer rate:        404.16 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      0    0.4      0      2
Processing:      7     12    4.5     11    112
Waiting:        5      8    2.6      7     84
Total:          7     12    4.5     11    112


Percentage of the requests served within a certain time (ms)
 50%    11
 66%    13
 75%    14
 80%    14
 90%    17
 95%    20
 98%    24
 99%    27
100%   112 (longest request)
```

- We've sent 10,000 requests with concurrency level = 1 to our Web Server


```

C:\Users\envra>ab -n 10000 -c 10 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080


Document Path:         /5000
Document Length:       5002 bytes


Concurrency Level:      10
Time taken for tests:    73.830 seconds
Complete requests:      10000
Failed requests:         0
Total transferred:      51220000 bytes
HTML transferred:       50020000 bytes
Requests per second:    135.45 [#/sec] (mean)
Time per request:       73.830 [ms] (mean)
Time per request:       7.383 [ms] (mean, across all concurrent requests)
Transfer rate:          677.50 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median   max
Connect:        0      0   0.6      0     13
Processing:    11     73  45.2     64    724
Waiting:        6     41  26.6     36    671
Total:         11     74  45.2     64    724


Percentage of the requests served within a certain time (ms)
 50%      64
 66%      76
 75%      86
 80%      93
 90%     116
 95%     148
 98%     203
 99%     238
100%     724 (longest request)

```

- We've sent 10,000 requests with concurrency level = 10 to our Web Server

```

C:\Users\envra>ab -n 10000 -c 100 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
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Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080


Document Path:        /5000
Document Length:      5002 bytes


Concurrency Level:     100
Time taken for tests:  101.602 seconds
Complete requests:     10000
Failed requests:        0
Total transferred:     51220000 bytes
HTML transferred:      50020000 bytes
Requests per second:   98.42 [#/sec] (mean)
Time per request:      1016.023 [ms] (mean)
Time per request:      10.160 [ms] (mean, across all concurrent requests)
Transfer rate:          492.31 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      0   5.1      0      504
Processing:    261 1011 235.6    997    2903
Waiting:         4   352 166.7    295    1526
Total:         262 1012 235.7    998    2903


Percentage of the requests served within a certain time (ms)
 50%    998
 66%   1055
 75%   1128
 80%   1182
 90%   1280
 95%   1427
 98%   1629
 99%   1762
100%   2903 (longest request)

```

- We've sent 10,000 requests with concurrency level = 100 to our Web Server

```

C:\Users\envra>ab -n 10000 -c 1000 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:     127.0.0.1
Server Port:         8080


Document Path:        /5000
Document Length:      5002 bytes


Concurrency Level:    1000
Time taken for tests:  101.463 seconds
Complete requests:    10000
Failed requests:      0
Total transferred:    51220000 bytes
HTML transferred:     50020000 bytes
Requests per second:  98.56 [#/sec] (mean)
Time per request:     10146.263 [ms] (mean)
Time per request:     10.146 [ms] (mean, across all concurrent requests)
Transfer rate:        492.98 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      1    8.9         0     514
Processing:    25 9819 3305.1     9714   27465
Waiting:        8 3577 1998.4     3646   21012
Total:         25 9819 3305.0     9714   27465


Percentage of the requests served within a certain time (ms)
 50%    9714
 66%   11068
 75%   11745
 80%   12226
 90%   14024
 95%   15446
 98%   17372
 99%   18554
100%   27465 (longest request)

```

- We've sent 10,000 requests with concurrency level = 1000 to our Web Server

```

C:\Users\envra>ab -n 10000 -c 10000 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
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Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080

Document Path:        /5000
Document Length:      5002 bytes

Concurrency Level:    10000
Time taken for tests:  104.008 seconds
Complete requests:    10000
Failed requests:       0
Total transferred:    51220000 bytes
HTML transferred:     50020000 bytes
Requests per second:  96.15 [#/sec] (mean)
Time per request:     104007.800 [ms] (mean)
Time per request:     10.401 [ms] (mean, across all concurrent requests)
Transfer rate:        480.92 [Kbytes/sec] received


Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        1  24.3      0    684
Processing: 12414  81580 13274.7  85520 103787
Waiting:        69  37548 20240.0  33621  89133
Total:         12415  81581 13275.0  85521 103788


Percentage of the requests served within a certain time (ms)
 50%  85521
 66%  88198
 75%  89131
 80%  90396
 90%  93817
 95%  95166
 98%  96298
 99%  97006
100% 103788 (longest request)

```

- We've sent 10,000 requests with concurrency level = 10,000 to our Web Server

How do “time per request” and “requests per second” values change by increasing level of concurrency? Maximum of how many concurrent requests do your server handle in a reasonable time?

Request	Concurrency	Time Per Request	Requests Per Second
10000	1	12.376	80.80
10000	10	7.383	135.45
10000	100	10.160	98.42
10000	1000	10.146	98.56
10000	5000	9.984	100.16
10000	10000	10.401	96.15
Average	-	10.075	101.59

Based on the data that has given above, we can say that request per second decreases when time per request increases. If we assume that reasonable time is 100 seconds, our server handles 10000 requests with 10000 concurrency level, approximately.

5) Testing your server using ApacheBench (Proxy Server)

```
C:\Users\envra>ab -n 10000 -c 1 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080

Document Path:        /5000
Document Length:       5002 bytes

Concurrency Level:     1
Time taken for tests:   122.561 seconds
Complete requests:      10000
Failed requests:         0
Total transferred:      51220000 bytes
HTML transferred:       50020000 bytes
Requests per second:    81.59 [#/sec] (mean)
Time per request:       12.256 [ms] (mean)
Time per request:       12.256 [ms] (mean, across all concurrent requests)
Transfer rate:          408.12 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      0    0.4      0      2
Processing:      7     12    4.2     11    124
Waiting:         4      7    2.6      6     87
Total:          7     12    4.2     11    124


Percentage of the requests served within a certain time (ms)
 50%    11
 66%    13
 75%    13
 80%    14
 90%    15
 95%    17
 98%    21
 99%    26
100%   124 (longest request)
```

- We've sent 10,000 requests with concurrency level = 1 to our Proxy Server

```

C:\Users\envra>ab -n 10000 -c 10 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:     127.0.0.1
Server Port:         8080

Document Path:       /5000
Document Length:     5002 bytes

Concurrency Level:    10
Time taken for tests: 75.444 seconds
Complete requests:    10000
Failed requests:      0
Total transferred:    51220000 bytes
HTML transferred:    50020000 bytes
Requests per second:  132.55 [#/sec] (mean)
Time per request:     75.444 [ms] (mean)
Time per request:     7.544 [ms] (mean, across all concurrent requests)
Transfer rate:        663.00 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      0    0.5      0      4
Processing:    13     75   26.4     70   436
Waiting:        7     31   14.0     29   351
Total:         14     75   26.4     71   437


Percentage of the requests served within a certain time (ms)
 50%    71
 66%    82
 75%    90
 80%    95
 90%   108
 95%   121
 98%   134
 99%   148
100%   437 (longest request)

```

- We've sent 10,000 requests with concurrency level = 10 to our Proxy Server

```

C:\Users\envra>ab -n 10000 -c 100 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080

Document Path:        /5000
Document Length:      5002 bytes

Concurrency Level:    100
Time taken for tests:  97.414 seconds
Complete requests:    10000
Failed requests:      0
Total transferred:    51220000 bytes
HTML transferred:    50020000 bytes
Requests per second:  102.65 [#/sec] (mean)
Time per request:     974.138 [ms] (mean)
Time per request:     9.741 [ms] (mean, across all concurrent requests)
Transfer rate:        513.48 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      0   0.5      0      5
Processing:    57    972 315.6    965   3815
Waiting:        7    278 154.9    303   2490
Total:         57    972 315.6    965   3815


Percentage of the requests served within a certain time (ms)
 50%    965
 66%   1041
 75%   1100
 80%   1150
 90%   1313
 95%   1438
 98%   1699
 99%   2169
100%   3815 (longest request)

```

- We've sent 10,000 requests with concurrency level = 100 to our Proxy Server

```

C:\Users\envra>ab -n 10000 -c 1000 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080


Document Path:        /5000
Document Length:      5002 bytes


Concurrency Level:    1000
Time taken for tests:  91.434 seconds
Complete requests:    10000
Failed requests:       0
Total transferred:    51220000 bytes
HTML transferred:     50020000 bytes
Requests per second:  109.37 [#/sec] (mean)
Time per request:     9143.417 [ms] (mean)
Time per request:     9.143 [ms] (mean, across all concurrent requests)
Transfer rate:        547.06 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      0    7.2      0     512
Processing:    18 8918 3346.5    8679   23195
Waiting:        8 2783 1616.4    3049   11242
Total:         19 8918 3346.6    8680   23195


Percentage of the requests served within a certain time (ms)
 50%    8680
 66%   10711
 75%   11436
 80%   11642
 90%   12914
 95%   14824
 98%   15575
 99%   16235
100%   23195 (longest request)

```

- We've sent 10,000 requests with concurrency level = 1000 to our Proxy Server


```

C:\Users\envra>ab -n 10000 -c 5000 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
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Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080

Document Path:        /5000
Document Length:      5002 bytes

Concurrency Level:    5000
Time taken for tests:  89.977 seconds
Complete requests:    10000
Failed requests:       0
Total transferred:    51220000 bytes
HTML transferred:     50020000 bytes
Requests per second:  111.14 [#/sec] (mean)
Time per request:     44988.602 [ms] (mean)
Time per request:     8.998 [ms] (mean, across all concurrent requests)
Transfer rate:        555.91 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      1  16.7      0     618
Processing:    86 38955 12348.8 38335  79706
Waiting:       19 13047  7366.6 12479  33327
Total:         86 38956 12349.1 38336  79706


Percentage of the requests served within a certain time (ms)
 50% 38336
 66% 42820
 75% 46054
 80% 48712
 90% 57547
 95% 61224
 98% 65912
 99% 67175
100% 79706 (longest request)

```

- We've sent 10,000 requests with concurrency level = 5000 to our Proxy Server


```

C:\Users\envra>ab -n 10000 -c 10000 http://127.0.0.1:8080/5000
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
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Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests


Server Software:      HttpServer
Server Hostname:      127.0.0.1
Server Port:          8080

Document Path:        /5000
Document Length:      5002 bytes

Concurrency Level:    10000
Time taken for tests:  87.533 seconds
Complete requests:    10000
Failed requests:       0
Total transferred:    51220000 bytes
HTML transferred:     50020000 bytes
Requests per second:  114.24 [#/sec] (mean)
Time per request:      87532.833 [ms] (mean)
Time per request:      8.753 [ms] (mean, across all concurrent requests)
Transfer rate:         571.44 [Kbytes/sec] received


Connection Times (ms)
              min    mean[+/-sd] median    max
Connect:        0      2   33.2      0     675
Processing:    7092  63169 12916.5  66302  87377
Waiting:        7  27382 10077.6  26646  62548
Total:         7092  63171 12916.6  66304  87377


Percentage of the requests served within a certain time (ms)
 50%   66304
 66%   69413
 75%   70977
 80%   71633
 90%   75339
 95%   77724
 98%   78951
 99%   79356
100%   87377 (longest request)

```

- We've sent 10,000 requests with concurrency level = 10,000 to our Proxy Server

How do “time per request” and “requests per second” values change by increasing level of concurrency? Maximum of how many concurrent requests do your server handle in a reasonable time?

Request	Concurrency	Time Per Request	Requests Per Second
10000	1	12.256	81.59
10000	10	7.544	132.55
10000	100	9.741	102.65
10000	1000	9.143	109.37
10000	5000	8.998	111.14
10000	10000	8.753	114.24
Average	-	9.405	108.59

Based on the data that has given above, we can say that request per second decreases when time per request increases. If we assume that reasonable time is 90 seconds, our proxy server handles 10000 requests with 10000 concurrency level, approximately.

And also, proxy server reduces “time per request” which is a feature that enhances time complexity of our executions.