WASHINGTON UNIVERSITY IN ST. LOUIS

St. Louis, Missouri

PERFORMANCE EVALUATION REPORT

ON

APACHE WEB SERVER AND MYSQL PERFORMANCE EVALUATION

(CSE 503S RAPID PROTOTYPE DEVELOPMENT AND CREATIVE PROGRAMMING, SPRING 2017)

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1. EXPERIMENTAL SETUP

1.1 INTRODUCTION

Amazon t2 instances don't use the full CPU often or consistently, but occasionally need to burst to higher CPU performance. T2 instances are backed by the latest Intel Xeon processors with clock speed up to 3.3 GHz during burst periods. We selected 2 t2 instances to evaluate Apache web server and MySQL database.

t2.micro has 1 virtual CPU (physical central processing unit (CPU) that is assigned to a virtual machine) and 1 GB memory. On the other hand, t2.xlarge has 4 virtual CPUs and 16GB memory.

Apache Web Server Performance Evaluation:

We used ApacheBench (ab) tool to evaluate the performance of Apache web server on t2.micro and t2.xlarge instances.

ApacheBench is a very handy web server benchmarking tool which can be run from command line. It is extremely simple to use and no complex setup is required. It gets installed automatically with apache. It is a single threaded command line computer program for measuring the performance of HTTP web servers. Originally designed to test the Apache HTTP server, it is generic enough to test any web server.

To test the web server, we created 2 html files. Image.html file displays 6 **images**, whose total size is 3 MB.

```html
<body>
  <div id="main">
    <img id = 'bgimg1' src = "brookings.jpg" alt = "img">
    <img id = 'bgimg2' src = "boston.jpg" alt = "img">
    <img id = 'bgimg3' src = "MIT.jpg" alt = "img">
    <img id = 'bgimg4' src = "NYU.jpg" alt = "img">
    <img id = 'bgimg5' src = "USC.jpg" alt = "img">
    <img id = 'bgimg5' src = "UW.jpg" alt = "img">
  </div>
</body>
```

Video.html plays a **video** (mp4) of size 458 MB.
```html
<body>
```

```html
<div id="main">
    <video width="320" height="500" autoplay>
    <source src="cse330Lecture6.mp4" type="video/mp4">
    Your browser does not support the video tag.
    </video>
</div>
</body>
```

MySQL Database Performance Evaluation:

Sysbench can be used to perform load testing on mysql server. It is a modular, cross-platform and multi-threaded benchmark tool. Sysbench runs a specified number of threads and they all execute requests in parallel. Sysbench OLTP helps to estimate best case scenario MySQL performance. **It is possible to simulate read only workloads, by using select queries or test mixed read and write environments.**

1.2 INSTALLATION AND SETUP

1.2.1 STEPS TO INSTALL SYSBENCH

Execute following commands to install Sysbench in aws instance (both t2.micro and t2.xlarge).
- yum install mysql-devel -y
- wget
http://pkgs.fedoraproject.org/repo/pkgs/sysbench/sysbench-0.4.12.tar.gz/3a6d54fdd3fe002328e4458206392b9d/sysbench-0.4.12.tar.gz
- tar zxvf sysbench-0.4.12.tar.gz
- yum install libtool.x86_64 openssl-devel.x86_64 openssl-static.x86_64
- cd sysbench-0.4.12/
- libtoolize --force –copy
- ./autogen.sh
- ./configure
- make
- sudo make install

1.2.2 SETUP MYSQL DATA REQUIRED FOR SYSBENCH:

Login to MySQL and create a new database.

```
##Create Database
CREATE DATABASE sysbench;
```

Once you have created the test database, run the command below to fill up the database with some data. It creates a database that is about 2GB in size.

sysbench --test=oltp --db-driver=mysql --oltp-table-size=10000000 --mysql-db=sysbench --mysql-user=username --mysql-password=pwd prepare

1.2.3 PERFORMANCE TESTING

Read-only OLTP tests:

Execute below command to run a Read-Only Sysbench OLTP test. This will run OLTP tests at various thread levels to get an idea of how MySQL will perform under certain workloads. This test will start off running a single threaded OLTP read only test, then run a 4 threaded OLTP read only test, and will continue to do that until the 64 threaded test has finished.

for each in 1 4 8 16 32 64; do sysbench --test=oltp --db-driver=mysql --oltp-table-size=10000000 --mysql-db=sysbench --mysql-user=sysbench --mysql-password=password --max-time=240 --max-requests=0 **--oltp-read-only** --num-threads=$each run; done

Mixed Read and write OLTP tests:

Read and Write OLTP Mixed Test. Usually about 70% read (select) and 30% write (insert, update, delete)

for each in 1 4 8 16 32 64; do sysbench --test=oltp --db-driver=mysql --oltp-table-size=10000000 --mysql-db=sysbench --mysql-user=sysbench --mysql-password=password --max-time=240 --max-requests=0 --num-threads=$each run; done

2. EXPERIMENTAL RESULTS CONTAINING MULTIPLE DATA POINTS AND TWO DIFFERENT TYPES OF DATA

2.1 APACHE WEB SERVER
2.1.1 INTRODUCTION

2.2.2 INSTANCES
- t2.micro
- t2.xlarge

2.2.3 DATA
- Images
- Videos

2.2.4 TESTS
- Pages per second
- Mean time per request
- Mean time per request across all concurrent requests

(i) Images
- **On t2.micro**

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 1 -c 1 http://ec2-54-174-181-94.compute-1.amazonaws.com
/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      1
Time taken for tests:   0.165 seconds
Complete requests:      1
Failed requests:        0
Total transferred:      999 bytes
HTML transferred:       725 bytes
Requests per second:    6.07 [#/sec] (mean)
Time per request:       164.762 [ms] (mean)
Time per request:       164.762 [ms] (mean, across all concurrent requests)
Transfer rate:          5.92 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       79   79   0.0     79      79
Processing:    86   86   0.0     86      86
Waiting:       86   86   0.0     86      86
Total:        165  165   0.0    165     165
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 100 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      100
Time taken for tests:   1.130 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      99900 bytes
HTML transferred:       72500 bytes
Requests per second:    88.49 [#/sec] (mean)
Time per request:       1130.062 [ms] (mean)
Time per request:       11.301 [ms] (mean, across all concurrent requests)
Transfer rate:          86.33 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       93  103    5.7     104     112
Processing:    82  479  273.4     490    1018
Waiting:       82  479  273.4     490    1018
Total:        176  582  278.4     594    1129

Percentage of the requests served within a certain time (ms)
  50%    594
  66%    683
  75%    797
  80%    887
  90%   1007
  95%   1048
  98%   1089
  99%   1129
 100%   1129 (longest request)
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 50 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      50
Time taken for tests:   1.010 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      99900 bytes
HTML transferred:       72500 bytes
Requests per second:    98.97 [#/sec] (mean)
Time per request:       505.188 [ms] (mean)
Time per request:       10.104 [ms] (mean, across all concurrent requests)
Transfer rate:          96.56 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       67   99  13.4    104     127
Processing:    82  292  98.2    327     447
Waiting:       82  292  98.2    327     447
Total:        180  391  99.0    416     562

Percentage of the requests served within a certain time (ms)
  50%    416
  66%    442
  75%    454
  80%    461
  90%    491
  95%    523
  98%    561
  99%    562
 100%    562 (longest request)
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 20 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      20
Time taken for tests:   1.055 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      99900 bytes
HTML transferred:       72500 bytes
Requests per second:    94.75 [#/sec] (mean)
Time per request:       211.089 [ms] (mean)
Time per request:       10.554 [ms] (mean, across all concurrent requests)
Transfer rate:          92.43 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   93  15.4     88     126
Processing:    80  101  27.5     84     165
Waiting:       80  101  27.5     84     165
Total:        146  194  36.2    191     284

Percentage of the requests served within a certain time (ms)
  50%    191
  66%    202
  75%    210
  80%    214
  90%    272
  95%    275
  98%    284
  99%    284
 100%    284 (longest request)
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 1 http://ec2-54-174-181-94.compute-1.amazonaws.c
om/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      1
Time taken for tests:   18.275 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      99900 bytes
HTML transferred:       72500 bytes
Requests per second:    5.47 [#/sec] (mean)
Time per request:       182.752 [ms] (mean)
Time per request:       182.752 [ms] (mean, across all concurrent requests)
Transfer rate:          5.34 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       70    92  15.2     89     127
Processing:    78    90  17.1     82     163
Waiting:       78    90  16.8     82     163
Total:        151   183  26.0    172     284

Percentage of the requests served within a certain time (ms)
  50%    172
  66%    193
  75%    199
  80%    206
  90%    218
  95%    240
  98%    250
  99%    284
 100%    284 (longest request)
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 500 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      500
Time taken for tests:   4.311 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    115.97 [#/sec] (mean)
Time per request:       4311.424 [ms] (mean)
Time per request:       8.623 [ms] (mean, across all concurrent requests)
Transfer rate:          113.14 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       68   131   18.8    126     165
Processing:    80  1903 1103.1   1864    4143
Waiting:       80  1903 1102.8   1864    4143
Total:        152  2034 1115.8   2013    4308

Percentage of the requests served within a certain time (ms)
  50%   2013
  66%   2555
  75%   2832
  80%   3004
  90%   3503
  95%   4193
  98%   4234
  99%   4273
 100%   4308 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 300 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      300
Time taken for tests:   4.597 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    108.76 [#/sec] (mean)
Time per request:       2758.262 [ms] (mean)
Time per request:       9.194 [ms] (mean, across all concurrent requests)
Transfer rate:          106.11 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   134 152.5    119    1113
Processing:    77  1725 1378.8   1056    4465
Waiting:       77  1724 1379.1   1056    4465
Total:        147  1859 1384.1   1169    4597

Percentage of the requests served within a certain time (ms)
  50%   1169
  66%   1578
  75%   2838
  80%   3858
  90%   4229
  95%   4394
  98%   4516
  99%   4557
 100%   4597 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 200 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      200
Time taken for tests:   3.752 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    133.26 [#/sec] (mean)
Time per request:       1500.842 [ms] (mean)
Time per request:       7.504 [ms] (mean, across all concurrent requests)
Transfer rate:          130.01 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       72   226 337.7     97    1118
Processing:    69  1015 501.6    947    2642
Waiting:       69  1015 501.6    947    2642
Total:        145  1241 748.4   1051    3752

Percentage of the requests served within a certain time (ms)
  50%   1051
  66%   1182
  75%   1281
  80%   1354
  90%   2132
  95%   3581
  98%   3679
  99%   3687
 100%   3752 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
100%    3732 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 100 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      100
Time taken for tests:   3.774 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    132.49 [#/sec] (mean)
Time per request:       754.767 [ms] (mean)
Time per request:       7.548 [ms] (mean, across all concurrent requests)
Transfer rate:          129.26 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       67    98   17.1     95     130
Processing:    83   587  168.9    608     898
Waiting:       83   585  169.4    608     898
Total:        155   685  167.8    695    1021

Percentage of the requests served within a certain time (ms)
  50%    695
  66%    761
  75%    806
  80%    847
  90%    896
  95%    926
  98%    947
  99%    980
 100%   1021 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 50 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      50
Time taken for tests:   4.114 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    121.53 [#/sec] (mean)
Time per request:       411.420 [ms] (mean)
Time per request:       8.228 [ms] (mean, across all concurrent requests)
Transfer rate:          118.56 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   96   15.8     90    133
Processing:    78  297   88.8    289    488
Waiting:       78  296   88.7    289    488
Total:        168  392   91.3    401    612

Percentage of the requests served within a certain time (ms)
  50%    401
  66%    439
  75%    451
  80%    458
  90%    525
  95%    538
  98%    585
  99%    588
 100%    612 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 20 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      20
Time taken for tests:   4.965 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    100.70 [#/sec] (mean)
Time per request:       198.604 [ms] (mean)
Time per request:       9.930 [ms] (mean, across all concurrent requests)
Transfer rate:          98.24 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       67    96  16.6     89     133
Processing:    77    98  21.1     84     164
Waiting:       77    98  20.8     84     164
Total:        145   194  30.3    196     285

Percentage of the requests served within a certain time (ms)
  50%    196
  66%    204
  75%    211
  80%    215
  90%    243
  95%    248
  98%    255
  99%    277
 100%    285 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 1 http://ec2-54-174-181-94.compute-1.amazonaws.c
om/~nathala/PE/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/image.html
Document Length:        725 bytes

Concurrency Level:      1
Time taken for tests:   94.960 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      499500 bytes
HTML transferred:       362500 bytes
Requests per second:    5.27 [#/sec] (mean)
Time per request:       189.921 [ms] (mean)
Time per request:       189.921 [ms] (mean, across all concurrent requests)
Transfer rate:          5.14 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65   95  16.5     89     130
Processing:    77   95  19.8     82     167
Waiting:       77   94  19.6     82     167
Total:        146  190  29.5    187     280

Percentage of the requests served within a certain time (ms)
  50%    187
  66%    201
  75%    209
  80%    213
  90%    242
  95%    248
  98%    251
  99%    276
 100%    280 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

- **On t2.xlarge**

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 1 -c 1 http://ec2-54-87-180-161.compute-1.amazonaws.com
/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      1
Time taken for tests:   0.170 seconds
Complete requests:      1
Failed requests:        0
Total transferred:      988 bytes
HTML transferred:       725 bytes
Requests per second:    5.87 [#/sec] (mean)
Time per request:       170.352 [ms] (mean)
Time per request:       170.352 [ms] (mean, across all concurrent requests)
Transfer rate:          5.66 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       85   85   0.0     85      85
Processing:    85   85   0.0     85      85
Waiting:       85   85   0.0     85      85
Total:        170  170   0.0    170     170
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 100 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      100
Time taken for tests:   0.897 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      98800 bytes
HTML transferred:       72500 bytes
Requests per second:    111.48 [#/sec] (mean)
Time per request:       896.997 [ms] (mean)
Time per request:       8.970 [ms] (mean, across all concurrent requests)
Transfer rate:          107.56 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       74    84    6.0     84      96
Processing:    73   417  224.9    443     801
Waiting:       73   417  224.9    443     801
Total:        147   501  230.7    527     896

Percentage of the requests served within a certain time (ms)
  50%    527
  66%    626
  75%    712
  80%    724
  90%    809
  95%    886
  98%    896
  99%    896
 100%    896 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 50 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      50
Time taken for tests:   0.896 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      98800 bytes
HTML transferred:       72500 bytes
Requests per second:    111.55 [#/sec] (mean)
Time per request:       448.232 [ms] (mean)
Time per request:       8.965 [ms] (mean, across all concurrent requests)
Transfer rate:          107.63 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    82    6.4     82      95
Processing:    66   268   91.9    301     393
Waiting:       66   268   91.9    301     393
Total:        133   350   96.0    384     488

Percentage of the requests served within a certain time (ms)
  50%    384
  66%    400
  75%    407
  80%    413
  90%    453
  95%    473
  98%    487
  99%    488
 100%    488 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 20 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      20
Time taken for tests:   0.928 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      98800 bytes
HTML transferred:       72500 bytes
Requests per second:    107.73 [#/sec] (mean)
Time per request:       185.645 [ms] (mean)
Time per request:       9.282 [ms] (mean, across all concurrent requests)
Transfer rate:          103.94 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       72    82    6.0     82      93
Processing:    72    91   23.1     85     164
Waiting:       72    91   23.1     85     164
Total:        144   173   26.7    165     255

Percentage of the requests served within a certain time (ms)
  50%    165
  66%    173
  75%    180
  80%    183
  90%    229
  95%    248
  98%    255
  99%    255
 100%    255 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 1 http://ec2-54-87-180-161.compute-1.amazonaws.c
om/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      1
Time taken for tests:   16.382 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      98800 bytes
HTML transferred:       72500 bytes
Requests per second:    6.10 [#/sec] (mean)
Time per request:       163.823 [ms] (mean)
Time per request:       163.823 [ms] (mean, across all concurrent requests)
Transfer rate:          5.89 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    82   6.2     82      94
Processing:    66    82   6.3     82      94
Waiting:       66    82   6.3     82      94
Total:        132   164  12.5    164     187

Percentage of the requests served within a certain time (ms)
  50%    164
  66%    167
  75%    170
  80%    178
  90%    181
  95%    186
  98%    187
  99%    187
 100%    187 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 500 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      500
Time taken for tests:   3.749 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    133.37 [#/sec] (mean)
Time per request:       3748.837 [ms] (mean)
Time per request:       7.498 [ms] (mean, across all concurrent requests)
Transfer rate:          128.69 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       68  100   12.8    100     122
Processing:    67 1800 1027.7   1787    3633
Waiting:       67 1800 1027.7   1787    3633
Total:        138 1900 1038.4   1886    3748

Percentage of the requests served within a certain time (ms)
  50%   1886
  66%   2403
  75%   2762
  80%   3046
  90%   3380
  95%   3567
  98%   3663
  99%   3674
 100%   3748 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 300 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/image.html
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Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      300
Time taken for tests:   5.395 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    92.68 [#/sec] (mean)
Time per request:       3236.957 [ms] (mean)
Time per request:       10.790 [ms] (mean, across all concurrent requests)
Transfer rate:          89.42 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   93   77.4     87    1089
Processing:    66 1494 1044.7   1019    5290
Waiting:       66 1494 1044.7   1019    5290
Total:        133 1586 1049.9   1107    5392

Percentage of the requests served within a certain time (ms)
  50%   1107
  66%   1371
  75%   2850
  80%   3016
  90%   3271
  95%   3382
  98%   3470
  99%   3503
 100%   5392 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 200 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      200
Time taken for tests:   5.089 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    98.26 [#/sec] (mean)
Time per request:       2035.414 [ms] (mean)
Time per request:       10.177 [ms] (mean, across all concurrent requests)
Transfer rate:          94.81 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   105 139.3     85    1082
Processing:    65  1143 1012.5    939    4989
Waiting:       65  1142 1012.5    939    4989
Total:        133  1247 1020.3   1030    5087

Percentage of the requests served within a certain time (ms)
  50%   1030
  66%   1092
  75%   1128
  80%   1161
  90%   1961
  95%   4985
  98%   5079
  99%   5083
 100%   5087 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 1 http://ec2-54-87-180-161.compute-1.amazonaws.c
om/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      1
Time taken for tests:   82.330 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    6.07 [#/sec] (mean)
Time per request:       164.661 [ms] (mean)
Time per request:       164.661 [ms] (mean, across all concurrent requests)
Transfer rate:          5.86 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    82    6.1     82      93
Processing:    66    82    6.1     82      94
Waiting:       66    82    6.1     82      94
Total:        132   165   12.2    164     187

Percentage of the requests served within a certain time (ms)
  50%    164
  66%    169
  75%    170
  80%    177
  90%    181
  95%    186
  98%    187
  99%    187
 100%    187 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 100 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      100
Time taken for tests:   3.193 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    156.61 [#/sec] (mean)
Time per request:       638.538 [ms] (mean)
Time per request:       6.385 [ms] (mean, across all concurrent requests)
Transfer rate:          151.10 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   83   6.2      82      97
Processing:    66  508 142.9     534     787
Waiting:       66  508 142.9     534     787
Total:        135  591 144.5     614     884

Percentage of the requests served within a certain time (ms)
  50%    614
  66%    652
  75%    702
  80%    722
  90%    761
  95%    789
  98%    807
  99%    827
 100%    884 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 50 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      50
Time taken for tests:   3.395 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    147.29 [#/sec] (mean)
Time per request:       339.474 [ms] (mean)
Time per request:       6.789 [ms] (mean, across all concurrent requests)
Transfer rate:          142.11 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    82   6.1     82     105
Processing:    66   243  64.5    240     392
Waiting:       66   243  64.5    240     392
Total:        132   326  66.1    325     487

Percentage of the requests served within a certain time (ms)
  50%    325
  66%    361
  75%    377
  80%    384
  90%    407
  95%    423
  98%    449
  99%    478
 100%    487 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 20 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/image.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/image.html
Document Length:        725 bytes

Concurrency Level:      20
Time taken for tests:   4.232 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      494000 bytes
HTML transferred:       362500 bytes
Requests per second:    118.16 [#/sec] (mean)
Time per request:       169.267 [ms] (mean)
Time per request:       8.463 [ms] (mean, across all concurrent requests)
Transfer rate:          114.00 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65    82   6.6     82      94
Processing:    66    84  12.0     82     162
Waiting:       66    84  12.0     82     162
Total:        130   166  17.1    164     254

Percentage of the requests served within a certain time (ms)
  50%    164
  66%    170
  75%    177
  80%    180
  90%    185
  95%    187
  98%    222
  99%    249
 100%    254 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

(ii) Videos
- **On t2.micro**

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 1 -c 1 http://ec2-54-174-181-94.compute-1.amazonaws.com
/~nathala/PE/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      1
Time taken for tests:   0.235 seconds
Complete requests:      1
Failed requests:        0
Total transferred:      879 bytes
HTML transferred:       605 bytes
Requests per second:    4.26 [#/sec] (mean)
Time per request:       234.836 [ms] (mean)
Time per request:       234.836 [ms] (mean, across all concurrent requests)
Transfer rate:          3.66 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:      113  113    0.0    113     113
Processing:   122  122    0.0    122     122
Waiting:      122  122    0.0    122     122
Total:        235  235    0.0    235     235
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 100 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      100
Time taken for tests:   1.080 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      87900 bytes
HTML transferred:       60500 bytes
Requests per second:    92.58 [#/sec] (mean)
Time per request:       1080.133 [ms] (mean)
Time per request:       10.801 [ms] (mean, across all concurrent requests)
Transfer rate:          79.47 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       87   98   5.4     98     106
Processing:    82  479 264.9    530     974
Waiting:       82  478 264.4    530     974
Total:        169  576 269.5    628    1079

Percentage of the requests served within a certain time (ms)
  50%    628
  66%    718
  75%    799
  80%    828
  90%    958
  95%   1037
  98%   1039
  99%   1079
 100%   1079 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 50 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      50
Time taken for tests:   1.146 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      87900 bytes
HTML transferred:       60500 bytes
Requests per second:    87.26 [#/sec] (mean)
Time per request:       573.012 [ms] (mean)
Time per request:       11.460 [ms] (mean, across all concurrent requests)
Transfer rate:          74.90 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       71    95  13.1     92     128
Processing:    82   343 125.1    406     523
Waiting:       82   343 125.1    406     523
Total:        165   438 129.5    485     624

Percentage of the requests served within a certain time (ms)
  50%    485
  66%    518
  75%    530
  80%    539
  90%    566
  95%    583
  98%    624
  99%    624
 100%    624 (longest request)
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 20 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      20
Time taken for tests:   1.080 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      87900 bytes
HTML transferred:       60500 bytes
Requests per second:    92.61 [#/sec] (mean)
Time per request:       215.953 [ms] (mean)
Time per request:       10.798 [ms] (mean, across all concurrent requests)
Transfer rate:          79.50 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       73   91  13.6     89     127
Processing:    80  104  27.0     85     165
Waiting:       80  104  27.0     85     165
Total:        154  195  33.3    187     266

Percentage of the requests served within a certain time (ms)
  50%    187
  66%    206
  75%    214
  80%    220
  90%    253
  95%    256
  98%    266
  99%    266
 100%    266 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 1 http://ec2-54-174-181-94.compute-1.amazonaws.c
om/~nathala/PE/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      1
Time taken for tests:   18.772 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      87900 bytes
HTML transferred:       60500 bytes
Requests per second:    5.33 [#/sec] (mean)
Time per request:       187.722 [ms] (mean)
Time per request:       187.722 [ms] (mean, across all concurrent requests)
Transfer rate:          4.57 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    94  15.2     90     130
Processing:    77    93  20.0     82     167
Waiting:       77    93  19.8     82     167
Total:        145   188  29.1    183     288

Percentage of the requests served within a certain time (ms)
  50%    183
  66%    199
  75%    203
  80%    211
  90%    224
  95%    244
  98%    284
  99%    288
 100%    288 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 500 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      500
Time taken for tests:   4.244 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    117.80 [#/sec] (mean)
Time per request:       4244.368 [ms] (mean)
Time per request:       8.489 [ms] (mean, across all concurrent requests)
Transfer rate:          101.12 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       86  116   18.6    107     148
Processing:    79 2085 1192.4   2097    4093
Waiting:       79 2085 1192.4   2097    4093
Total:        168 2201 1208.8   2201    4240

Percentage of the requests served within a certain time (ms)
  50%   2201
  66%   2848
  75%   3419
  80%   3583
  90%   3868
  95%   4039
  98%   4159
  99%   4160
 100%   4240 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 300 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/video.html
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      300
Time taken for tests:   4.352 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    114.88 [#/sec] (mean)
Time per request:       2611.475 [ms] (mean)
Time per request:       8.705 [ms] (mean, across all concurrent requests)
Transfer rate:          98.61 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       71  147 191.2    120    1114
Processing:    78 1610 1276.9   1018    4221
Waiting:       78 1609 1275.2   1018    4221
Total:        155 1757 1282.3   1118    4352

Percentage of the requests served within a certain time (ms)
  50%   1118
  66%   1580
  75%   2689
  80%   3658
  90%   3996
  95%   4150
  98%   4272
  99%   4273
 100%   4352 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 200 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/video.html
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      200
Time taken for tests:   3.697 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    135.25 [#/sec] (mean)
Time per request:       1478.711 [ms] (mean)
Time per request:       7.394 [ms] (mean, across all concurrent requests)
Transfer rate:          116.10 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   157 240.1     98    1118
Processing:    81  1060 649.6    983    3584
Waiting:       81  1059 649.6    983    3584
Total:        169  1216 696.4   1101    3694

Percentage of the requests served within a certain time (ms)
  50%   1101
  66%   1180
  75%   1237
  80%   1469
  90%   2131
  95%   2554
  98%   3610
  99%   3649
 100%   3694 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 100 http://ec2-54-174-181-94.compute-1.amazonaws
.com/~nathala/PE/video.html
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      100
Time taken for tests:   3.693 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    135.38 [#/sec] (mean)
Time per request:       738.686 [ms] (mean)
Time per request:       7.387 [ms] (mean, across all concurrent requests)
Transfer rate:          116.21 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       67    96  15.3     93     131
Processing:    82   591 185.2    573    1020
Waiting:       82   590 184.5    573    1020
Total:        174   687 186.9    675    1131

Percentage of the requests served within a certain time (ms)
  50%    675
  66%    745
  75%    802
  80%    884
  90%    949
  95%    987
  98%   1007
  99%   1024
 100%   1131 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 50 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/video.html
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      50
Time taken for tests:   3.651 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    136.94 [#/sec] (mean)
Time per request:       365.134 [ms] (mean)
Time per request:       7.303 [ms] (mean, across all concurrent requests)
Transfer rate:          117.55 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       67    95  15.7     90     129
Processing:    86   257  76.7    246     447
Waiting:       86   257  76.7    246     447
Total:        182   352  79.6    349     560

Percentage of the requests served within a certain time (ms)
  50%    349
  66%    382
  75%    406
  80%    429
  90%    455
  95%    489
  98%    526
  99%    559
 100%    560 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 20 http://ec2-54-174-181-94.compute-1.amazonaws.
com/~nathala/PE/video.html
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      20
Time taken for tests:   4.978 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    100.43 [#/sec] (mean)
Time per request:       199.139 [ms] (mean)
Time per request:       9.957 [ms] (mean, across all concurrent requests)
Transfer rate:          86.21 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65   96  16.7     90     133
Processing:    75   99  22.6     84     166
Waiting:       75   99  22.3     84     166
Total:        145  196  31.9    196     284

Percentage of the requests served within a certain time (ms)
  50%    196
  66%    205
  75%    213
  80%    218
  90%    245
  95%    252
  98%    264
  99%    277
 100%    284 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 1 http://ec2-54-174-181-94.compute-1.amazonaws.c
om/~nathala/PE/video.html
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Benchmarking ec2-54-174-181-94.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-174-181-94.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~nathala/PE/video.html
Document Length:        605 bytes

Concurrency Level:      1
Time taken for tests:   96.354 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      439500 bytes
HTML transferred:       302500 bytes
Requests per second:    5.19 [#/sec] (mean)
Time per request:       192.709 [ms] (mean)
Time per request:       192.709 [ms] (mean, across all concurrent requests)
Transfer rate:          4.45 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    96  16.7     90     130
Processing:    77    96  21.6     83     167
Waiting:       77    96  20.5     83     167
Total:        145   193  31.4    191     288

Percentage of the requests served within a certain time (ms)
  50%    191
  66%    202
  75%    211
  80%    214
  90%    245
  95%    250
  98%    262
  99%    280
 100%    288 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

- **On t2.xlarge**

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 1 -c 1 http://ec2-54-87-180-161.compute-1.amazonaws.com
/~ec2-user/video.html
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      1
Time taken for tests:   0.180 seconds
Complete requests:      1
Failed requests:        0
Total transferred:      868 bytes
HTML transferred:       605 bytes
Requests per second:    5.55 [#/sec] (mean)
Time per request:       180.228 [ms] (mean)
Time per request:       180.228 [ms] (mean, across all concurrent requests)
Transfer rate:          4.70 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       90    90   0.0     90      90
Processing:    90    90   0.0     90      90
Waiting:       90    90   0.0     90      90
Total:        180   180   0.0    180     180
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 100 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/video.html
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      100
Time taken for tests:   0.899 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      86800 bytes
HTML transferred:       60500 bytes
Requests per second:    111.24 [#/sec] (mean)
Time per request:       898.942 [ms] (mean)
Time per request:       8.989 [ms] (mean, across all concurrent requests)
Transfer rate:          94.29 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    84   6.5     84      95
Processing:    66   419 230.1    435     803
Waiting:       66   419 230.1    435     803
Total:        132   503 236.2    519     898

Percentage of the requests served within a certain time (ms)
  50%    519
  66%    626
  75%    710
  80%    772
  90%    812
  95%    884
  98%    894
  99%    898
 100%    898 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 50 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/video.html
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      50
Time taken for tests:   0.934 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      86800 bytes
HTML transferred:       60500 bytes
Requests per second:    107.02 [#/sec] (mean)
Time per request:       467.189 [ms] (mean)
Time per request:       9.344 [ms] (mean, across all concurrent requests)
Transfer rate:          90.72 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    83   6.3     83      95
Processing:    65   284  98.8    328     410
Waiting:       65   284  98.8    328     410
Total:        131   367 102.4    408     505

Percentage of the requests served within a certain time (ms)
  50%    408
  66%    423
  75%    432
  80%    439
  90%    468
  95%    485
  98%    497
  99%    505
 100%    505 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 20 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/video.html
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      20
Time taken for tests:   0.921 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      86800 bytes
HTML transferred:       60500 bytes
Requests per second:    108.60 [#/sec] (mean)
Time per request:       184.161 [ms] (mean)
Time per request:       9.208 [ms] (mean, across all concurrent requests)
Transfer rate:          92.06 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    81   6.1     82      93
Processing:    66    89  23.6     82     163
Waiting:       66    89  23.6     82     163
Total:        132   171  27.6    164     255

Percentage of the requests served within a certain time (ms)
  50%    164
  66%    167
  75%    170
  80%    180
  90%    222
  95%    252
  98%    254
  99%    255
 100%    255 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 100 -c 1 http://ec2-54-87-180-161.compute-1.amazonaws.c
om/~ec2-user/video.html
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient).....done


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      1
Time taken for tests:   17.304 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      86800 bytes
HTML transferred:       60500 bytes
Requests per second:    5.78 [#/sec] (mean)
Time per request:       173.036 [ms] (mean)
Time per request:       173.036 [ms] (mean, across all concurrent requests)
Transfer rate:          4.90 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    91 100.5     82    1084
Processing:    66    82   6.1     82      94
Waiting:       66    82   6.1     82      94
Total:        132   173 101.4    163    1169

Percentage of the requests served within a certain time (ms)
  50%    163
  66%    166
  75%    170
  80%    170
  90%    181
  95%    187
  98%    187
  99%   1169
 100%   1169 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
 100%    1105 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 500 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/video.html
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Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      500
Time taken for tests:   5.487 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    91.12 [#/sec] (mean)
Time per request:       5487.174 [ms] (mean)
Time per request:       10.974 [ms] (mean, across all concurrent requests)
Transfer rate:          77.24 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       67   102  11.0     105     120
Processing:    71  1958 1269.4   1857    5378
Waiting:       71  1958 1269.4   1857    5378
Total:        141  2060 1275.9   1962    5486

Percentage of the requests served within a certain time (ms)
  50%    1962
  66%    2722
  75%    2972
  80%    3069
  90%    3328
  95%    5323
  98%    5419
  99%    5483
 100%    5486 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 300 http://ec2-54-87-180-161.amazonaws
.com/~ec2-user/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      300
Time taken for tests:   3.303 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    151.39 [#/sec] (mean)
Time per request:       1981.678 [ms] (mean)
Time per request:       6.606 [ms] (mean, across all concurrent requests)
Transfer rate:          128.32 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65    92  63.1     89    1079
Processing:    65  1390 967.5    950    3197
Waiting:       65  1390 967.5    950    3197
Total:        134  1482 975.5   1033    3303

Percentage of the requests served within a certain time (ms)
  50%   1033
  66%   1310
  75%   2673
  80%   2846
  90%   3101
  95%   3196
  98%   3290
  99%   3294
 100%   3303 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
 ...%   3303 (tongest request)
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 200 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      200
Time taken for tests:   3.118 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    160.37 [#/sec] (mean)
Time per request:       1247.093 [ms] (mean)
Time per request:       6.235 [ms] (mean, across all concurrent requests)
Transfer rate:          135.94 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66   102 132.5     84    1087
Processing:    66   931 612.5    840    3016
Waiting:       66   931 612.5    839    3016
Total:        138  1033 626.2    931    3116

Percentage of the requests served within a certain time (ms)
  50%    931
  66%    999
  75%   1028
  80%   1066
  90%   1791
  95%   3004
  98%   3087
  99%   3104
 100%   3116 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 100 http://ec2-54-87-180-161.compute-1.amazonaws
.com/~ec2-user/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      100
Time taken for tests:   3.169 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    157.77 [#/sec] (mean)
Time per request:       633.844 [ms] (mean)
Time per request:       6.338 [ms] (mean, across all concurrent requests)
Transfer rate:          133.73 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65    83   6.2     82      97
Processing:    66   504 141.5    533     771
Waiting:       66   504 141.5    533     771
Total:        134   587 143.6    613     867

Percentage of the requests served within a certain time (ms)
  50%    613
  66%    655
  75%    694
  80%    721
  90%    755
  95%    776
  98%    799
  99%    810
 100%    867 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 50 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      50
Time taken for tests:   3.124 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    160.03 [#/sec] (mean)
Time per request:       312.440 [ms] (mean)
Time per request:       6.249 [ms] (mean, across all concurrent requests)
Transfer rate:          135.65 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       66    82   6.2     82      94
Processing:    66   219  60.5    223     393
Waiting:       66   219  60.5    223     393
Total:        134   301  62.3    305     487

Percentage of the requests served within a certain time (ms)
  50%    305
  66%    327
  75%    340
  80%    348
  90%    391
  95%    406
  98%    419
  99%    468
 100%    487 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 20 http://ec2-54-87-180-161.compute-1.amazonaws.
com/~ec2-user/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      20
Time taken for tests:   4.251 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    117.63 [#/sec] (mean)
Time per request:       170.020 [ms] (mean)
Time per request:       8.501 [ms] (mean, across all concurrent requests)
Transfer rate:          99.71 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65    82   6.5     82     107
Processing:    66    84  12.0     82     159
Waiting:       66    84  12.0     82     159
Total:        131   166  16.6    164     251

Percentage of the requests served within a certain time (ms)
  50%    164
  66%    170
  75%    175
  80%    179
  90%    184
  95%    187
  98%    219
  99%    247
 100%    251 (longest request)
[dchaudhary@ip-172-31-23-236 ~]$
```

```
[dchaudhary@ip-172-31-23-236 ~]$ ab -n 500 -c 1 http://ec2-54-87-180-161.compute-1.amazonaws.
om/~ec2-user/video.html
This is ApacheBench, Version 2.3 <$Revision: 1757674 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking ec2-54-87-180-161.compute-1.amazonaws.com (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Finished 500 requests


Server Software:        Apache/2.4.25
Server Hostname:        ec2-54-87-180-161.compute-1.amazonaws.com
Server Port:            80

Document Path:          /~ec2-user/video.html
Document Length:        605 bytes

Concurrency Level:      1
Time taken for tests:   82.514 seconds
Complete requests:      500
Failed requests:        0
Total transferred:      434000 bytes
HTML transferred:       302500 bytes
Requests per second:    6.06 [#/sec] (mean)
Time per request:       165.029 [ms] (mean)
Time per request:       165.029 [ms] (mean, across all concurrent requests)
Transfer rate:          5.14 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       65    82   6.2     82      94
Processing:    65    83   6.2     82      94
Waiting:       65    83   6.2     82      94
Total:        130   165  12.3    164     187

Percentage of the requests served within a certain time (ms)
  50%    164
  66%    169
  75%    170
  80%    178
  90%    182
  95%    186
  98%    187
  99%    187
 100%    187 (longest request)
```

2.2.5 EXPERIMENTAL RESULTS

(i) Images

- **On t2.micro**

S. No.	Requests	Concurrency	Pages/sec	Mean time per request	Mean time per request across all concurrent requests
1.	1	1	6.07	164.762	164.762
2.	100	100	88.49	1130.062	11.301
3.	100	50	98.97	505.188	10.104
4.	100	20	94.75	211.089	10.554
5.	100	1	5.47	182.752	182.752
6.	500	500	115.97	4311.424	8.623
7.	500	300	108.76	2758.262	9.194
8.	500	200	133.26	1500.842	7.504
9.	500	100	132.49	754.767	7.548
10.	500	50	121.53	411.420	8.228
11.	500	20	100.70	198.604	9.930
12.	500	1	5.27	189.921	189.921

- **On t2.xlarge**

S. No.	Requests	Concurrency	Pages/sec	Mean time per request	Mean time per request across all concurrent requests
1.	1	1	5.87	170.352	170.352
2.	100	100	111.48	896.997	8.970
3.	100	50	111.55	448.232	8.965
4.	100	20	107.73	185.645	9.282
5.	100	1	6.10	163.823	163.823
6.	500	500	133.37	3748.837	7.498
7.	500	300	92.68	3236.957	10.790

8.	500	200	98.26	2035.414	10.177
9.	500	100	156.61	638.538	6.385
10.	500	50	147.29	339.474	6.789
11.	500	20	118.16	169.267	8.463
12.	500	1	6.07	164.661	164.661
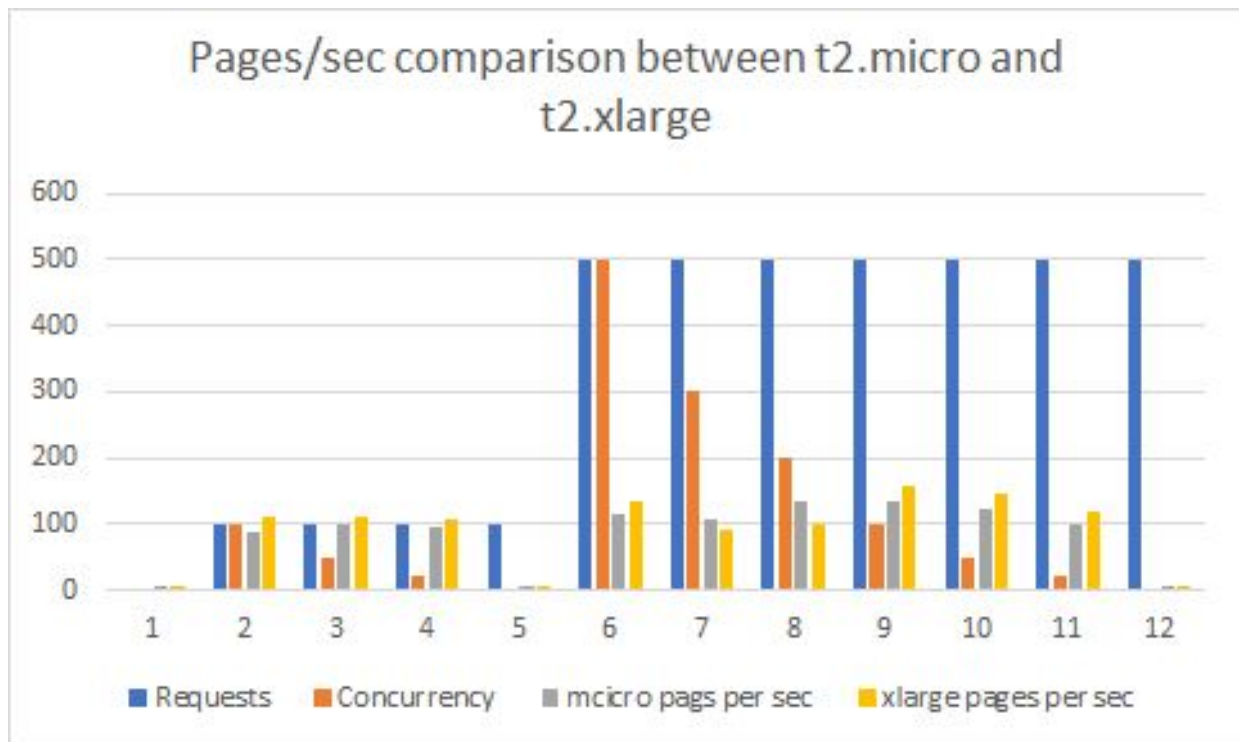
Pages/sec comparison between t2.micro and t2.xlarge for images

Mean time per request comparison between t2.micro and t2.xlarge

Mean time per second across all concurrent requests comparison between t2.micro and t2.xlarge
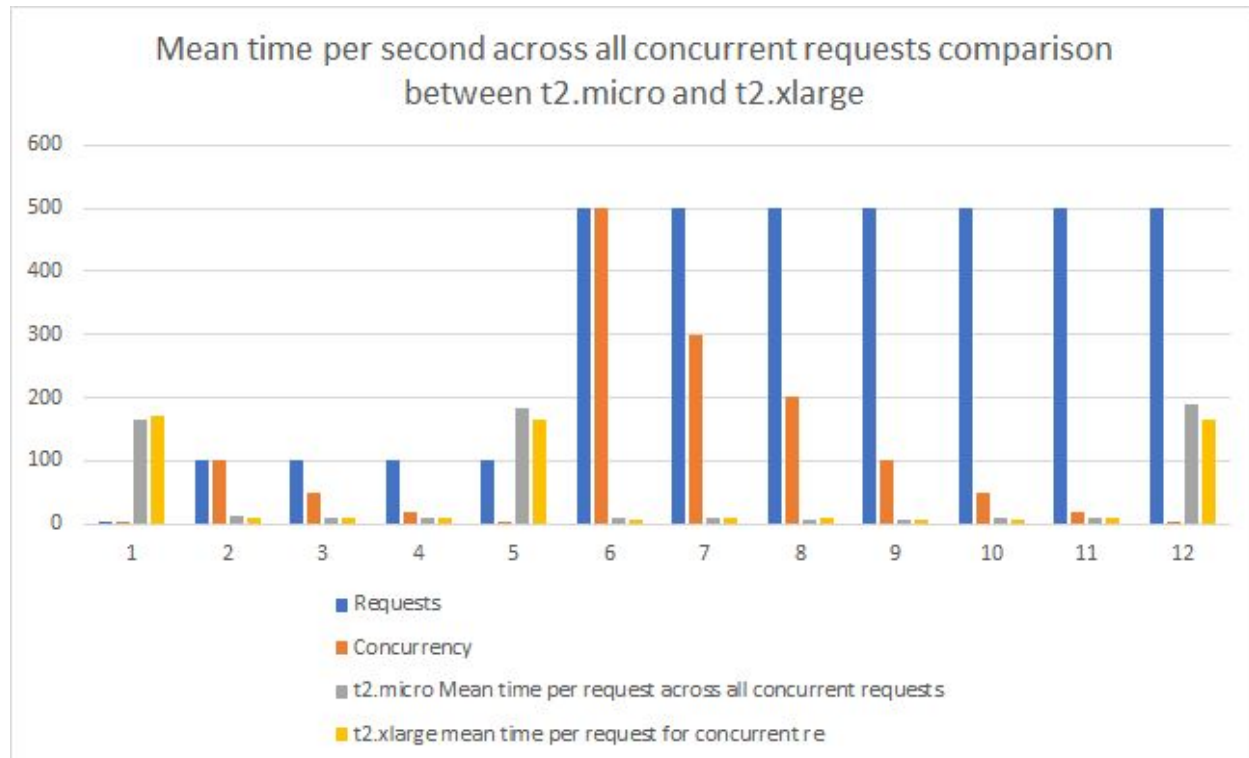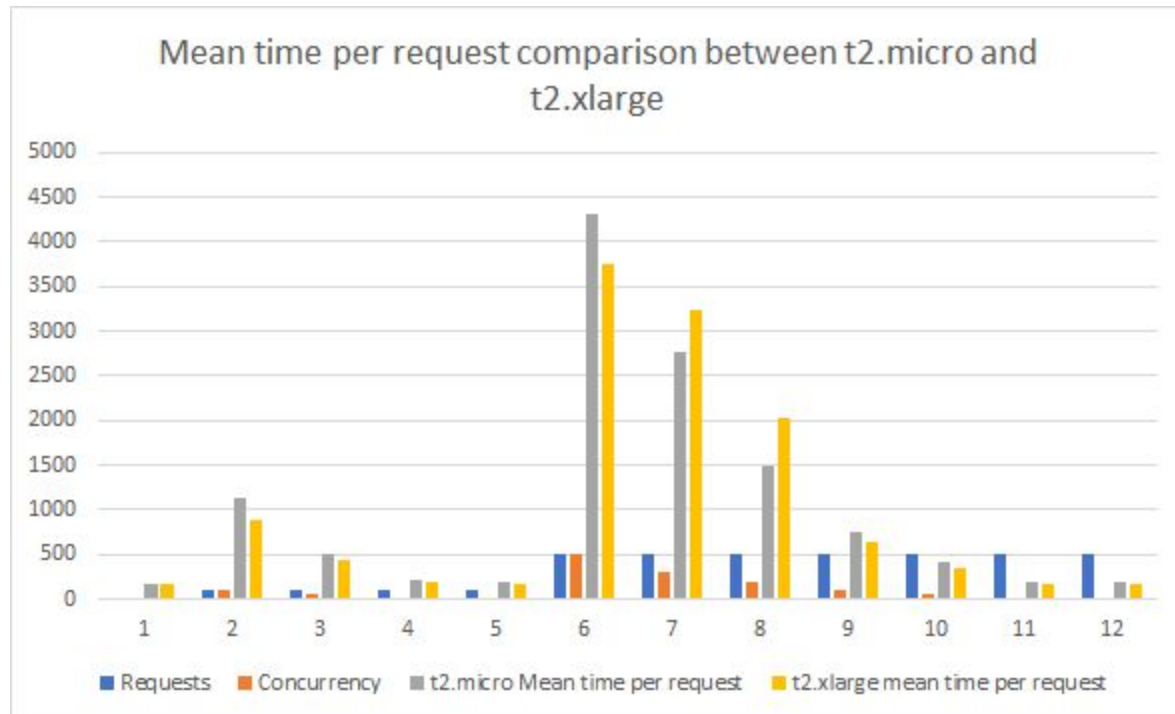
(ii) Videos

- **On t2.micro**

S. No.	Requests	Concurrency	Pages/sec	Mean time per request	Mean time per request across all concurrent requests
1.	1	1	4.26	234.836	234.836
2.	100	100	92.58	1080.133	10.801
3.	100	50	87.26	573.012	11.460
4.	100	20	92.61	215.953	10.789
5.	100	1	5.33	187.722	187.722
6.	500	500	117.80	4244.368	8.489
7.	500	300	114.88	2611.475	8.705
8.	500	200	135.25	1478.711	7.394
9.	500	100	135.38	738.686	7.387
10.	500	50	136.94	365.134	7.303
11.	500	20	11.43	199.139	9.957
12.	500	1	5.19	192.709	192.709

- **On t2.xlarge**

S. No.	Requests	Concurrency	Pages/sec	Mean time per request	Mean time per request across all concurrent requests
1.	1	1	5.55	180.228	180.228

2.	100	100	111.24	898.942	8.989
3.	100	50	107.02	467.189	9.344
4.	100	20	108.60	184.161	9.208
5.	100	1	5.78	173.036	173.036
6.	500	500	91.12	5487.174	10.974
7.	500	300	151.39	1981.678	6.606
8.	500	200	160.37	1247.093	6.235
9.	500	100	157.77	633.844	6.338
10.	500	50	160.03	312.440	6.249
11.	500	20	117.63	170.020	8.501
12.	500	1	6.06	165.029	165.029

Pages/sec comparison between t2.micro and t2.xlarge

Mean time per request comparison between t2.micro and t2.xlarge

Mean time per request across all concurrent requests comparison between t2.micro and t2.xlarge
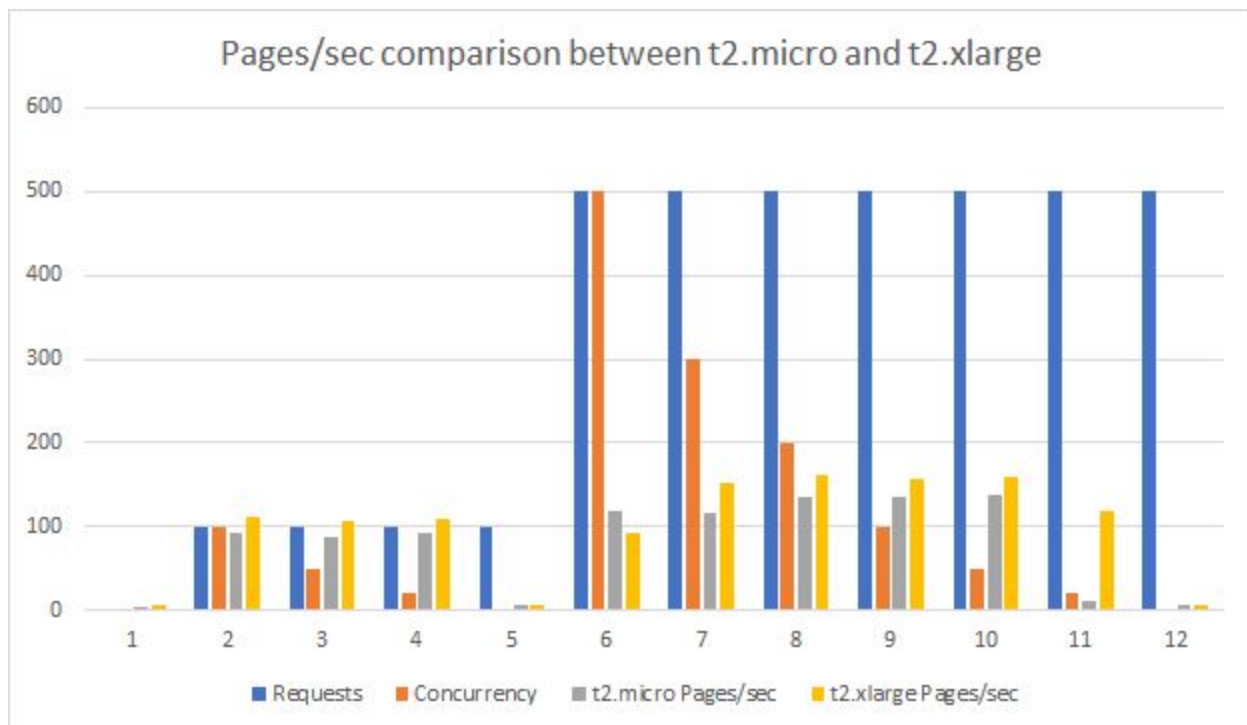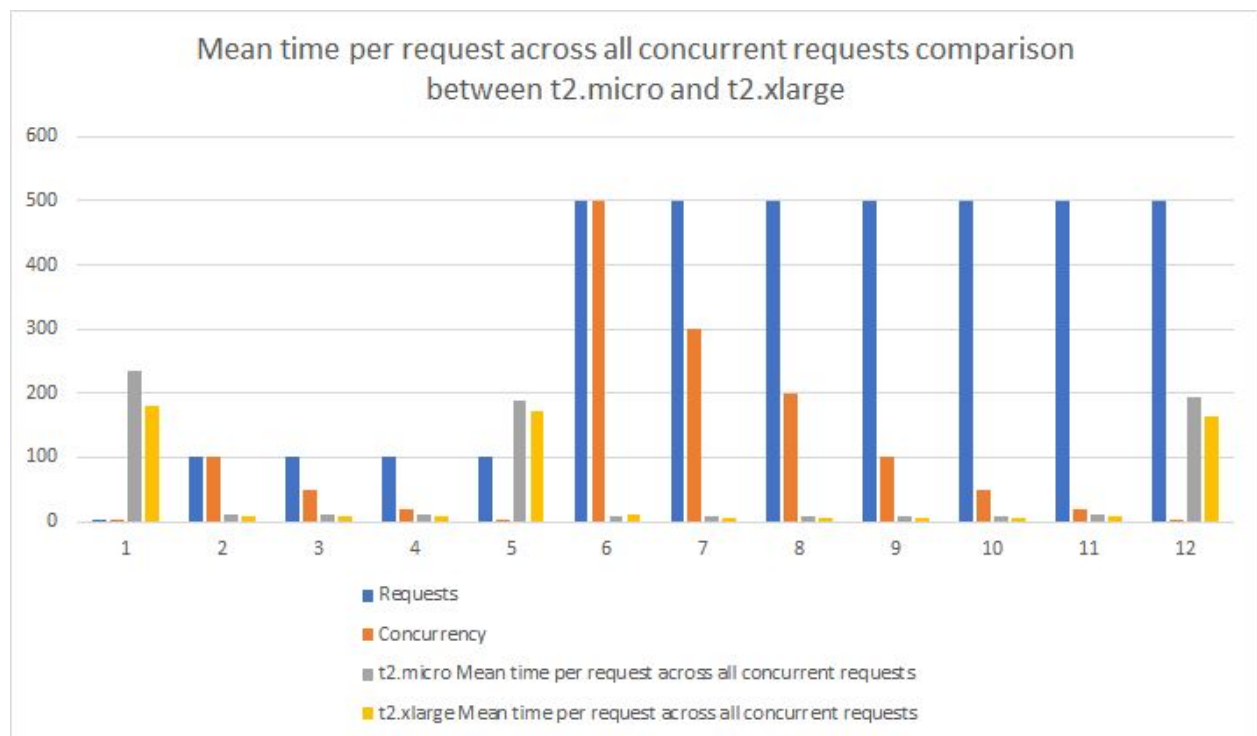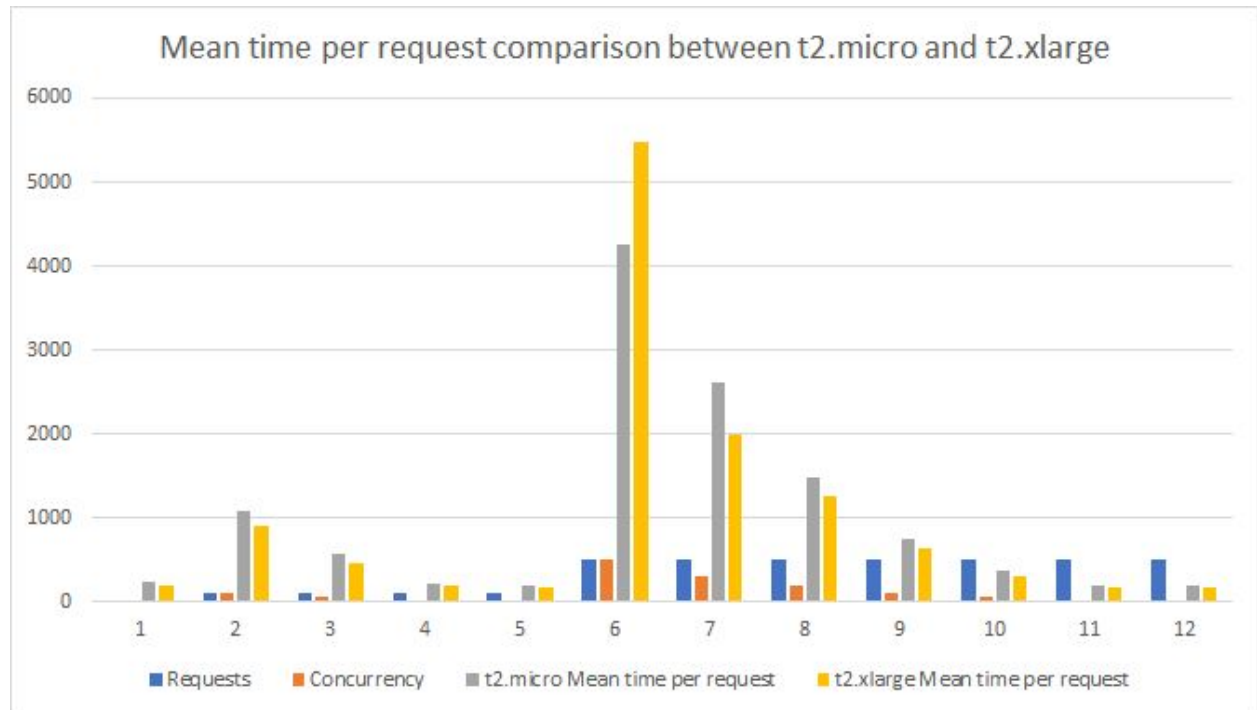
2.2 MySQL Database
2.1.1 INTRODUCTION

2.2.2 INSTANCES
- t2.micro
- t2.xlarge

2.2.3 DATA
- Read only (1, 4, 8, 16, 32 and 64 threads)
- Read and Write (1, 4, 8, 16, 32 and 64 threads)

2.2.4 TESTS
- read/write per second
- Number of transactions per second

(i) Read Only
- **On t2.micro**

Number of threads - 1

```
Running the test with following options:
Number of threads: 1

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
Done.

OLTP test statistics:
    queries performed:
        read:                            58534
        write:                           0
        other:                           0
        total:                           58534
    transactions:                        4181    (17.42 per sec.)
    deadlocks:                           0       (0.00 per sec.)
    read/write requests:                 58534   (243.85 per sec.)
    other operations:                    0       (0.00 per sec.)

Test execution summary:
    total time:                          240.0402s
    total number of events:              4181
    total time taken by event execution: 239.6730
    per-request statistics:
        min:                                      1.02ms
        avg:                                     57.32ms
        max:                                    247.84ms
        approx.  95 percentile:                 122.80ms

Threads fairness:
    events (avg/stddev):           4181.0000/0.00
    execution time (avg/stddev):   239.6730/0.00
```

Number of threads - 4

```
Running the test with following options:
Number of threads: 4

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 3 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            188426
        write:                           0
        other:                           0
        total:                           188426
    transactions:                        13459  (56.07 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 188426 (784.95 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.0484s
    total number of events:              13459
    total time taken by event execution: 958.3586
    per-request statistics:
        min:                                    1.01ms
        avg:                                   71.21ms
        max:                                  454.31ms
        approx.  95 percentile:               201.11ms

Threads fairness:
    events (avg/stddev):           3364.7500/46.82
    execution time (avg/stddev):   239.5896/0.11

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 8

```
Running the test with following options:
Number of threads: 8

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 7 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            221648
        write:                           0
        other:                           0
        total:                           221648
    transactions:                        15832  (65.93 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 221648 (923.08 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.1189s
    total number of events:              15832
    total time taken by event execution: 1917.3765
    per-request statistics:
        min:                                    1.01ms
        avg:                                  121.11ms
        max:                                 1180.42ms
        approx.  95 percentile:               369.60ms

Threads fairness:
    events (avg/stddev):           1979.0000/51.56
    execution time (avg/stddev):   239.6721/0.22

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 16

```
Running the test with following options:
Number of threads: 16

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 15 times)
Done.

OLTP test statistics:
    queries performed:
        read:                        190176
        write:                       0
        other:                       0
        total:                       190176
    transactions:                    13584   (56.53 per sec.)
    deadlocks:                       0       (0.00 per sec.)
    read/write requests:             190176 (791.38 per sec.)
    other operations:                0       (0.00 per sec.)

Test execution summary:
    total time:                      240.3102s
    total number of events:          13584
    total time taken by event execution: 3834.3076
    per-request statistics:
        min:                              1.02ms
        avg:                            282.27ms
        max:                           2555.43ms
        approx.  95 percentile:         889.26ms

Threads fairness:
    events (avg/stddev):          849.0000/22.81
    execution time (avg/stddev):  239.6442/0.40

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 32

```
Running the test with following options:
Number of threads: 32

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 31 times)
Done.

OLTP test statistics:
    queries performed:
        read:                        183470
        write:                       0
        other:                       0
        total:                       183470
    transactions:                    13105   (54.50 per sec.)
    deadlocks:                       0       (0.00 per sec.)
    read/write requests:             183470 (763.06 per sec.)
    other operations:                0       (0.00 per sec.)

Test execution summary:
    total time:                      240.4411s
    total number of events:          13105
    total time taken by event execution: 7670.4037
    per-request statistics:
        min:                              1.07ms
        avg:                            585.30ms
        max:                           4195.13ms
        approx.  95 percentile:        1713.93ms

Threads fairness:
    events (avg/stddev):          409.5312/17.41
    execution time (avg/stddev):  239.7001/0.35

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 64

```
Running the test with following options:
Number of threads: 64

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 63 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            193088
        write:                           0
        other:                           0
        total:                           193088
    transactions:                        13792  (57.32 per sec.)
    deadlocks:                           0       (0.00 per sec.)
    read/write requests:                 193088 (802.41 per sec.)
    other operations:                    0       (0.00 per sec.)

Test execution summary:
    total time:                          240.6340s
    total number of events:              13792
    total time taken by event execution: 15357.3958
    per-request statistics:
        min:                                     1.09ms
        avg:                                  1113.50ms
        max:                                  7458.59ms
        approx.   95 percentile:              2815.36ms

Threads fairness:
    events (avg/stddev):           215.5000/12.06
    execution time (avg/stddev):   239.9593/0.46

[ec2-user@ip-172-31-16-83 ~]$
```

- **On t2.large**

Number of threads - 1

```
Running the test with following options:
Number of threads: 1

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
Done.

OLTP test statistics:
    queries performed:
        read:                            2686222
        write:                           0
        other:                           0
        total:                           2686222
    transactions:                        191873 (799.47 per sec.)
    deadlocks:                           0       (0.00 per sec.)
    read/write requests:                 2686222 (11192.58 per sec.)
    other operations:                    0       (0.00 per sec.)

Test execution summary:
    total time:                          240.0003s
    total number of events:              191873
    total time taken by event execution: 239.4070
    per-request statistics:
        min:                                     0.84ms
        avg:                                     1.25ms
        max:                                     3.31ms
        approx.   95 percentile:                 1.50ms

Threads fairness:
    events (avg/stddev):           191873.0000/0.00
    execution time (avg/stddev):   239.4070/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 4

```
Running the test with following options:
Number of threads: 4

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 3 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            11197732
        write:                           0
        other:                           0
        total:                           11197732
    transactions:                        799838 (3332.64 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 11197732 (46657.00 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.0011s
    total number of events:              799838
    total time taken by event execution: 957.2176
    per-request statistics:
        min:                                  0.89ms
        avg:                                  1.20ms
        max:                                 20.44ms
        approx.  95 percentile:               1.44ms

Threads fairness:
    events (avg/stddev):           199959.5000/301.11
    execution time (avg/stddev):   239.3044/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 8

```
Running the test with following options:
Number of threads: 8

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 7 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            10985548
        write:                           0
        other:                           0
        total:                           10985548
    transactions:                        784682 (3269.48 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 10985548 (45772.79 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.0017s
    total number of events:              784682
    total time taken by event execution: 1917.2461
    per-request statistics:
        min:                                  0.91ms
        avg:                                  2.44ms
        max:                                 35.29ms
        approx.  95 percentile:               3.06ms

Threads fairness:
    events (avg/stddev):           98085.2500/267.16
    execution time (avg/stddev):   239.6558/0.01
```

Number of threads - 16

```
Running the test with following options:
Number of threads: 16

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 15 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            9027158
        write:                           0
        other:                           0
        total:                           9027158
    transactions:                        644797 (2686.61 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 9027158 (37612.59 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.0036s
    total number of events:              644797
    total time taken by event execution: 3837.6068
    per-request statistics:
         min:                                 0.93ms
         avg:                                 5.95ms
         max:                                35.05ms
         approx.  95 percentile:              9.71ms

Threads fairness:
    events (avg/stddev):         40299.8125/65.26
    execution time (avg/stddev):   239.8504/0.01

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 32

```
Running the test with following options:
Number of threads: 32

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 31 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            11072768
        write:                           0
        other:                           0
        total:                           11072768
    transactions:                        790912 (3295.39 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 11072768 (46135.39 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.0059s
    total number of events:              790912
    total time taken by event execution: 7677.2883
    per-request statistics:
         min:                                 0.90ms
         avg:                                 9.71ms
         max:                               182.68ms
         approx.  95 percentile:             32.93ms

Threads fairness:
    events (avg/stddev):         24716.0000/66.70
    execution time (avg/stddev):   239.9153/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 64

```
Running the test with following options:
Number of threads: 64

Doing OLTP test.
Running mixed OLTP test
Doing read-only test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Skipping BEGIN/COMMIT
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 63 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            10998806
        write:                           0
        other:                           0
        total:                           10998806
    transactions:                        785629 (3273.26 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 10998806 (45825.66 per sec.)
    other operations:                    0      (0.00 per sec.)

Test execution summary:
    total time:                          240.0142s
    total number of events:              785629
    total time taken by event execution: 15357.5049
    per-request statistics:
        min:                                  0.89ms
        avg:                                 19.55ms
        max:                                254.68ms
        approx.  95 percentile:              67.00ms

Threads fairness:
    events (avg/stddev):           12275.4531/37.65
    execution time (avg/stddev):   239.9610/0.00
```

(i) Read And Write
- **On t2.micro**

Number of threads - 1

```
Running the test with following options:
Number of threads: 1

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
Done.

OLTP test statistics:
    queries performed:
        read:                            43344
        write:                           15480
        other:                           6192
        total:                           65016
    transactions:                        3096   (12.90 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 58824  (245.09 per sec.)
    other operations:                    6192   (25.80 per sec.)

Test execution summary:
    total time:                          240.0077s
    total number of events:              3096
    total time taken by event execution: 239.7189
    per-request statistics:
        min:                                  3.41ms
        avg:                                 77.43ms
        max:                                525.78ms
        approx.  95 percentile:             125.70ms

Threads fairness:
    events (avg/stddev):           3096.0000/0.00
    execution time (avg/stddev):   239.7189/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 4

```
Running the test with following options:
Number of threads: 4

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 3 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            92764
        write:                           33130
        other:                           13252
        total:                           139146
    transactions:                        6626    (27.60 per sec.)
    deadlocks:                           0       (0.00 per sec.)
    read/write requests:                 125894 (524.31 per sec.)
    other operations:                    13252   (55.19 per sec.)

Test execution summary:
    total time:                          240.1123s
    total number of events:              6626
    total time taken by event execution: 958.4530
    per-request statistics:
         min:                                   2.67ms
         avg:                                 144.65ms
         max:                                5277.37ms
         approx.  95 percentile:              328.58ms

Threads fairness:
    events (avg/stddev):           1656.5000/26.65
    execution time (avg/stddev):   239.6133/0.15
```

Number of threads - 8

```
Running the test with following options:
Number of threads: 8

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 7 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            111048
        write:                           39660
        other:                           15864
        total:                           166572
    transactions:                        7932    (33.03 per sec.)
    deadlocks:                           0       (0.00 per sec.)
    read/write requests:                 150708 (627.52 per sec.)
    other operations:                    15864   (66.05 per sec.)

Test execution summary:
    total time:                          240.1653s
    total number of events:              7932
    total time taken by event execution: 1918.7580
    per-request statistics:
         min:                                   3.01ms
         avg:                                 241.90ms
         max:                                6269.90ms
         approx.  95 percentile:              608.22ms

Threads fairness:
    events (avg/stddev):           991.5000/16.29
    execution time (avg/stddev):   239.8447/0.15

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 16

```
Running the test with following options:
Number of threads: 16

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 15 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            121226
        write:                           43295
        other:                           17318
        total:                           181839
    transactions:                        8659   (36.05 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 164521 (684.91 per sec.)
    other operations:                    17318  (72.10 per sec.)

Test execution summary:
    total time:                          240.2087s
    total number of events:              8659
    total time taken by event execution: 3835.4608
    per-request statistics:
        min:                                    3.49ms
        avg:                                  442.95ms
        max:                                 5822.42ms
        approx.  95 percentile:              1095.24ms

Threads fairness:
    events (avg/stddev):           541.1875/15.33
    execution time (avg/stddev):   239.7163/0.29

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 32

```
Running the test with following options:
Number of threads: 32

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 31 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            148274
        write:                           52955
        other:                           21182
        total:                           222411
    transactions:                        10591  (44.02 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 201229 (836.44 per sec.)
    other operations:                    21182  (88.05 per sec.)

Test execution summary:
    total time:                          240.5772s
    total number of events:              10591
    total time taken by event execution: 7685.3760
    per-request statistics:
        min:                                   32.22ms
        avg:                                  725.65ms
        max:                                 7013.87ms
        approx.  95 percentile:              1596.55ms

Threads fairness:
    events (avg/stddev):           330.9688/10.57
    execution time (avg/stddev):   240.1680/0.28

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 64

```
Running the test with following options:
Number of threads: 64

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 pct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 63 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            119294
        write:                           42605
        other:                           17042
        total:                           178941
    transactions:                        8521   (35.41 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 161899 (672.85 per sec.)
    other operations:                    17042  (70.83 per sec.)

Test execution summary:
    total time:                          240.6180s
    total number of events:              8521
    total time taken by event execution: 15368.3356
    per-request statistics:
        min:                                   34.19ms
        avg:                                 1803.58ms
        max:                                10206.67ms
        approx.  95 percentile:              3385.44ms

Threads fairness:
    events (avg/stddev):           133.1406/5.27
    execution time (avg/stddev):   240.1302/0.34
```

- **On t2.large**

Number of threads - 1

```
Running the test with following options:
Number of threads: 1

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 p
ct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
Done.

OLTP test statistics:
    queries performed:
        read:                            650020
        write:                           232150
        other:                           92860
        total:                           975030
    transactions:                        46430  (193.43 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 882170 (3675.11 per sec.)
    other operations:                    92860  (386.85 per sec.)

Test execution summary:
    total time:                          240.0391s
    total number of events:              46430
    total time taken by event execution: 239.7602
    per-request statistics:
        min:                                  1.74ms
        avg:                                  5.16ms
        max:                                159.37ms
        approx.  95 percentile:              19.35ms

Threads fairness:
    events (avg/stddev):           46430.0000/0.00
    execution time (avg/stddev):   239.7602/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 4

```
Running the test with following options:
Number of threads: 4

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 p
ct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 3 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            1726858
        write:                           616735
        other:                           246694
        total:                           2590287
    transactions:                        123347 (513.90 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 2343593 (9764.04 per sec.)
    other operations:                    246694 (1027.79 per sec.)

Test execution summary:
    total time:                          240.0228s
    total number of events:              123347
    total time taken by event execution: 959.5022
    per-request statistics:
        min:                                  1.82ms
        avg:                                  7.78ms
        max:                                144.37ms
        approx.  95 percentile:              29.18ms

Threads fairness:
    events (avg/stddev):           30836.7500/100.09
    execution time (avg/stddev):   239.8755/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 8

```
Running the test with following options:
Number of threads: 8

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 p
ct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 7 times)
Done.

OLTP test statistics:
    queries performed:
        read:                       2463524
        write:                      879830
        other:                      351932
        total:                      3695286
    transactions:                   175966 (733.13 per sec.)
    deadlocks:                      0      (0.00 per sec.)
    read/write requests:            3343354 (13929.46 per sec.)
    other operations:               351932 (1466.26 per sec.)

Test execution summary:
    total time:                     240.0204s
    total number of events:         175966
    total time taken by event execution: 1919.3198
    per-request statistics:
        min:                                1.91ms
        avg:                               10.91ms
        max:                              422.09ms
        approx.  95 percentile:            39.78ms

Threads fairness:
    events (avg/stddev):           21995.7500/52.20
    execution time (avg/stddev):   239.9150/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 16

```
Running the test with following options:
Number of threads: 32

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 p
ct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 31 times)
Done.

OLTP test statistics:
    queries performed:
        read:                       2915024
        write:                      1041080
        other:                      416432
        total:                      4372536
    transactions:                   208216 (867.54 per sec.)
    deadlocks:                      0      (0.00 per sec.)
    read/write requests:            3956104 (16483.28 per sec.)
    other operations:               416432 (1735.08 per sec.)

Test execution summary:
    total time:                     240.0070s
    total number of events:         208216
    total time taken by event execution: 7679.1412
    per-request statistics:
        min:                                1.89ms
        avg:                               36.88ms
        max:                              479.42ms
        approx.  95 percentile:            99.26ms

Threads fairness:
    events (avg/stddev):           6506.7500/45.84
    execution time (avg/stddev):   239.9732/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 32

```
Running the test with following options:
Number of threads: 32

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 p
ct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 31 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            2915024
        write:                           1041080
        other:                           416432
        total:                           4372536
    transactions:                        208216 (867.54 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 3956104 (16483.28 per sec.)
    other operations:                    416432 (1735.08 per sec.)

Test execution summary:
    total time:                          240.0070s
    total number of events:              208216
    total time taken by event execution: 7679.1412
    per-request statistics:
        min:                                   1.89ms
        avg:                                  36.88ms
        max:                                 479.42ms
        approx.  95 percentile:               99.26ms

Threads fairness:
    events (avg/stddev):           6506.7500/45.84
    execution time (avg/stddev):   239.9732/0.00

sysbench 0.4.12:  multi-threaded system evaluation benchmark
```

Number of threads - 64

```
Running the test with following options:
Number of threads: 64

Doing OLTP test.
Running mixed OLTP test
Using Special distribution (12 iterations,  1 pct of values are returned in 75 p
ct cases)
Using "BEGIN" for starting transactions
Using auto_inc on the id column
Threads started!
Time limit exceeded, exiting...
(last message repeated 63 times)
Done.

OLTP test statistics:
    queries performed:
        read:                            3103562
        write:                           1108415
        other:                           443366
        total:                           4655343
    transactions:                        221683 (923.55 per sec.)
    deadlocks:                           0      (0.00 per sec.)
    read/write requests:                 4211977 (17547.44 per sec.)
    other operations:                    443366 (1847.10 per sec.)

Test execution summary:
    total time:                          240.0337s
    total number of events:              221683
    total time taken by event execution: 15360.7152
    per-request statistics:
        min:                                   2.01ms
        avg:                                  69.29ms
        max:                                 846.14ms
        approx.  95 percentile:              178.95ms

Threads fairness:
    events (avg/stddev):           3463.7969/91.76
    execution time (avg/stddev):   240.0112/0.00
```
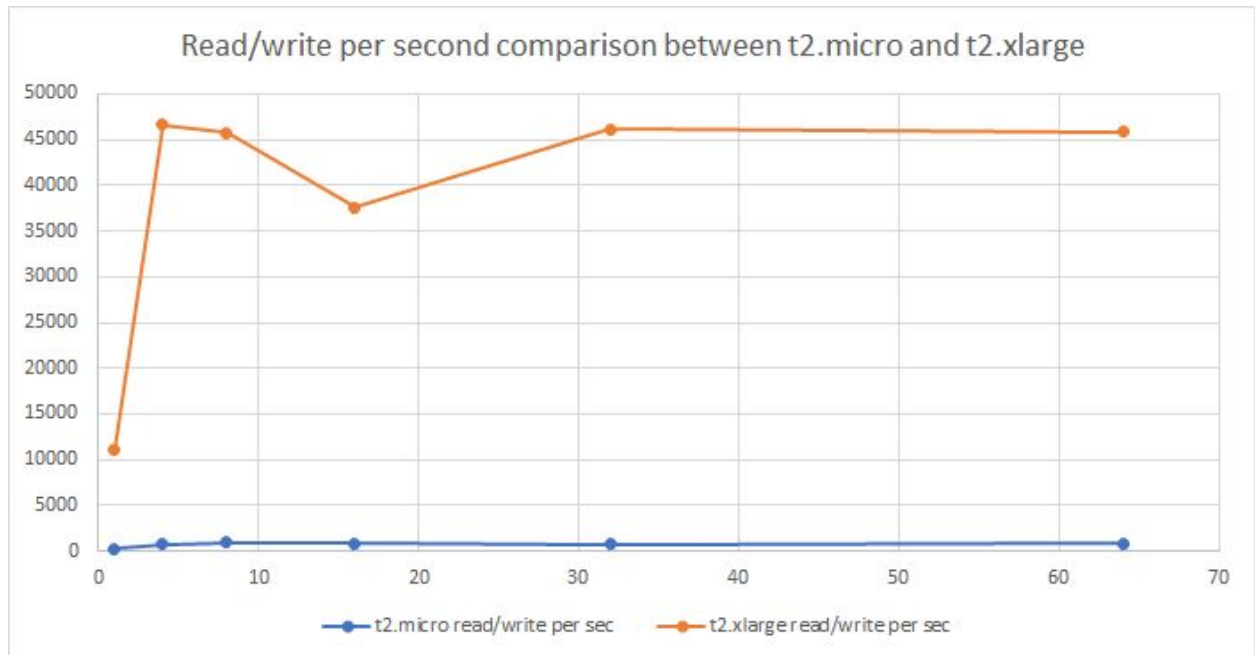
2.2.5 EXPERIMENTAL RESULTS
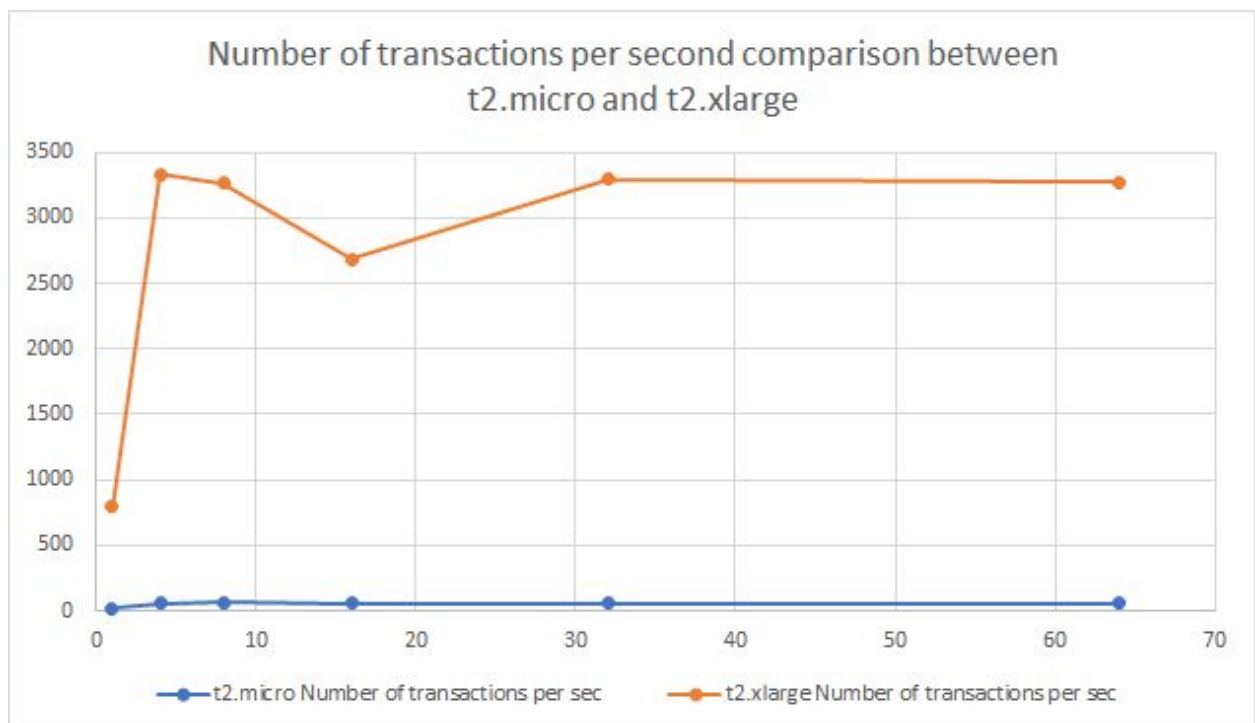
(i) Read Only

- **On t2.micro**

S. No.	Number of threads	read/write per sec	Number of transactions per sec
1.	1	243.85	17.42
2.	4	784.95	56.07
3.	8	923.08	65.93
4.	16	791.38	56.53
5.	32	763.06	54.50
6.	64	802.41	57.32

- **On t2.xlarge**

S. No.	Number of threads	read/write per sec	Number of transactions per sec
1.	1	11192.58	799.47
2.	4	46657.00	3332.64
3.	8	45772.79	3269.48
4.	16	37612.59	2686.61
5.	32	46135.39	3295.39
6.	64	45825.66	3273.26

Read/write per second comparison between t2.micro and t2.xlarge for read only mode

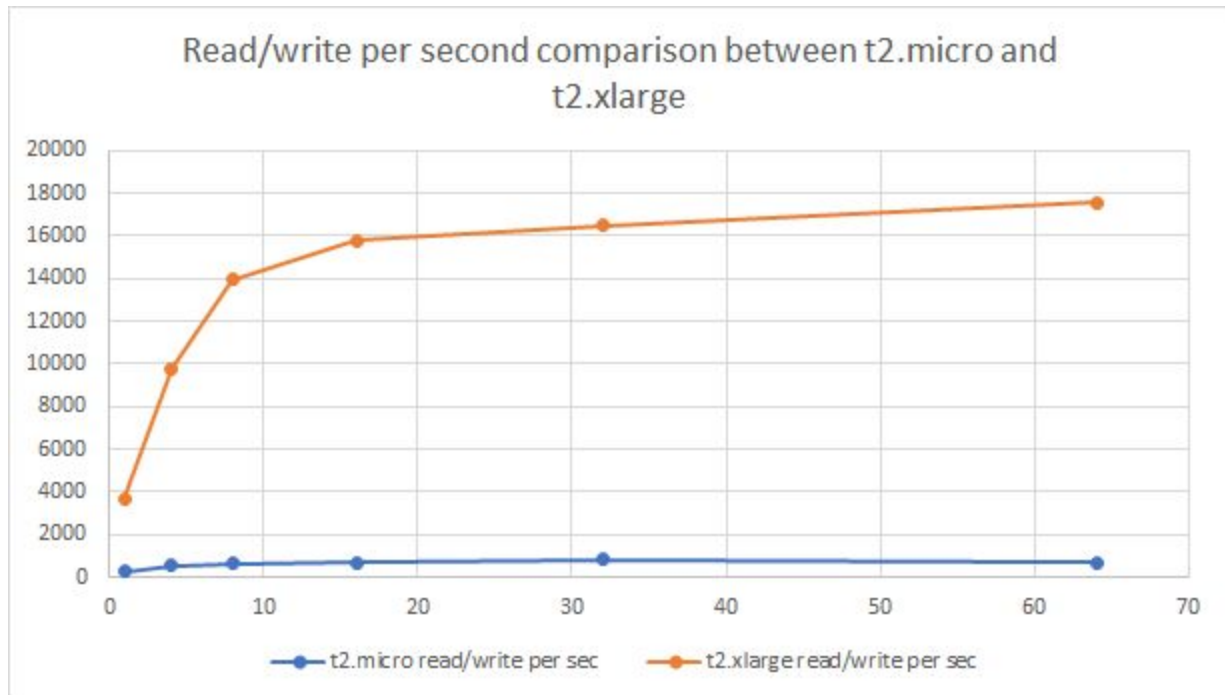**Number of transactions per second comparison between t2.micro and t2.xlarge for read only mode**
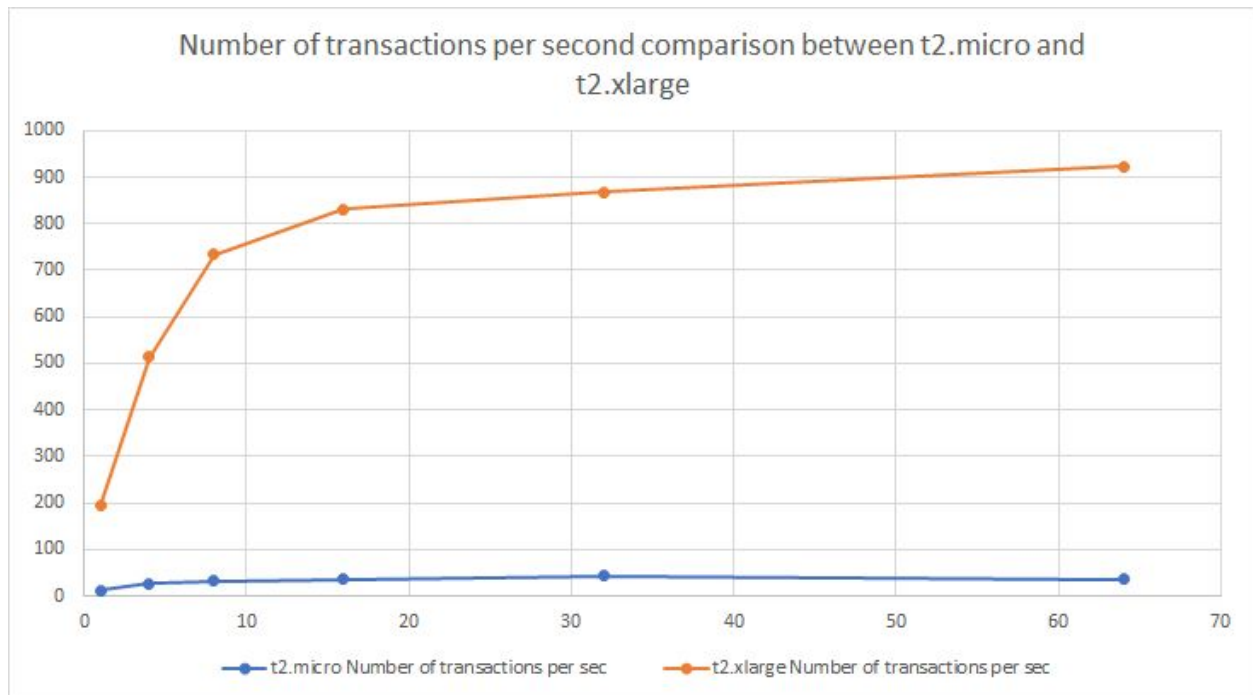
(i) Mixed Mode (Read and Write)

- **On t2.micro**

S. No.	Number of threads	read/write per sec	Number of transactions per sec
1.	1	245.09	12.90
2.	4	524.31	27.60
3.	8	627.52	33.03
4.	16	684.91	36.05
5.	32	836.44	44.02
6.	64	672.85	35.41

- **On t2.xlarge**

S. No.	Number of threads	read/write per sec	Number of transactions per sec
1.	1	3675.11	193.43
2.	4	9764.04	513.90
3.	8	13929.46	733.13
4.	16	15785.78	830.83
5.	32	16483.28	867.54
6.	64	17547.44	923.55

Read/write per second comparison between t2.micro and t2.xlarge for mixed mode (read and write)

Number of transactions per second comparison between t2.micro and t2.xlarge for mixed mode (read and write)

3. RESULTS
4.1 APACHE WEB SERVER
Terms to know:

Time per request (mean) tells you the average amount of time it took for a *concurrent* group of requests to process.

Time per request (mean, across all concurrent requests) tells you the average amount of time it took for a *single* request to process by itself.

After analyzing the performance across 12 different configurations and measuring across three measures, we found that when the number of requests and concurrency are high, the performance starts to degrade because apache spawns one thread for each request. This results in a large number of threads, increasing the context switching time and hence, increasing the mean time per request However, the mean time per request across all concurrent requests is pretty good. So, while increasing concurrency results in better performance, we need to make sure that the context switching time doesn't exceed the actual turn around time using single thread. It also depends upon the type of application you want to build; if the average amount of time to complete a group of requests is a priority, a low concurrency would generally be better. If the average time to process a request is more important for the users, higher concurrency would result in better performance.

2.2 MySQL Database
Terms to know:

Transactions per sec : A transaction is a sequence of operations performed as a single logical unit of work. This measure calculates mean number of transactions that are executed in a sec. It does not reflect the amount of data that is read from or written to a database
read/write per sec: Mean number
We analysed transactions per sec and read/write per sec when data is only read and not updated, using single thread and also multiple threads. We also analysed database performance when data is both read and updated, i.e. mixed mode using single and multiple threads. This analysis was performed on both t2.micro and t2.xlarge instances.
The results show that read operation is faster than write operation. When we increase number of threads, it increases performance initially. But as number of threads increase, due to context switching overhead, performance deteriorates. The same pattern holds when there are more number of CPUs, but both transfer rate and read/write rate is much higher in this configuration.

4. BOTTLENECK OF THE SYSTEM
4.1 APACHE WEB SERVER

The results show that the bottleneck of our system lies with Context Switching. Apache spawns one thread for each request. So, when we have a large number of requests and we increase the concurrency level, the system performance degrades because of the context switching time between the threads.

As the results show, when the number of requests and concurrency are high like in case of 500 requests and 500 concurrency, the performance is the worst. So, while increasing concurrency results in better performance, we would have to make sure that the context switching time doesn't exceed the actual performance using a single thread.

4.2 MySQL Database

In any database, write operation is more expensive than read operation. The results above confirms that this is true for MySQL as well. Results also show that threads increase the performance initially but later it deteriorates. If there are many write requests with large number of threads running concurrently, then the performance deteriorates in a rapid manner.

5. What type of instance or configuration would you recommend

I would recommend using t2.xlarge because overall performance is better in t2.xlarge, for both apache web server and MySQL database. But after selecting the instance, there are many other aspects that a programmer has to take into account to increase the performance, like number of requests that apache server can server concurrently, number of threads in MySQL database. Before deciding the concurrency in both web server and MySQL, we need to estimate the load that is expected in future, i.e. number of requests our application is expected to receive at any given point of time in future.