

LAB2 性能测试报告

计科 1701 瞻前顾后犹豫不决举棋不定进退两难组

组长：贾那热斯.克孜尔别克 组员：许伟杰 张景程 王紫

一. 实验概要

在本实验中，我们将不提供任何基本代码。因此，您应该从头开始实现满足以下要求的 HTTP 服务器（基于 HTTP / 1.1）。

1.HTTP 服务器概述

从网络角度来看，您的 HTTP 服务器应实现以下功能：

- 1).创建一个监听套接字并将其绑定到端口
- 2).等待客户端连接到端口
- 3).接受客户端并获取新的连接套接字
- 4).读入并解析 HTTP 请求
- 5).开始提供服务：1) 处理 HTTP GET / POST 请求，如果发生错误，则返回错误消息。2) 将请求代理到另一个 HTTP 服务器（高级版本可选）。

2.处理 HTTP 请求

在本实验中，您只需要在 HTTP 服务器中实现 GET 方法和 POST 方法。也就是说，如果您的 HTTP 服务器接收到 HTTP 请求，但是请求方法既不是 GET 也不是 POST。HTTP 服务器仅需要返回 501 Not Implemented 错误消息（响应消息的响应行的状态码为 501，请参见 2.2）。不需要处理请求中的标题行（但是您需要识别它，以便您不会将其与下一个请求的起始行混合使用）。另外，您可以随意在 HTTP 响应中填充任何（或零个）标题行。

3.处理 HTTP GET 请求

HTTP 服务器应该能够处理 html 页面的 HTTP GET 请求。

- 1).如果 HTTP 请求的路径与 html 页面文件相对应，则以 200 OK 和文件的完整内容进行响应。例如，如果请求 GET /index.html，并且在文件目录中存在一个名为 index.html 的文件。您还应该能够处理对文件目录子目录中文件的请求（例如 GET /images/hero.jpg）。
- 2).如果 HTTP 请求的路径对应于一个目录，并且该目录包含一个 index.html 文件，则以 200 OK 响应，并在该文件夹中显示 index.html 文件的全部内容。
- 3).如果请求的页面文件不存在，或者请求的目录不包含 index.html 文件，则返回 404 Not Found 响应（HTTP 正文是可选的）。

4.处理 HTTP POST 请求

HTTP 服务器应该能够处理 HTTP POST 请求。在本实验中，处理 HTTP POST 的方法非常简单。

- 1).您应该构造一个 3.1.7.2 包含 2 个键的 HTTP POST 请求（请参阅参考资料）：“名称”和“ID”（请分别填写您的姓名和学生编号），然后将 POST 请求发送至 /Post_show（例如

http://127.0.0.1:8888/Post_show, 服务器的 IP 地址 127.0.0.1 和服务端口) 是 8888)。然后, 如果 HTTP 服务器收到此 POST 请求 (请求 URL 为/Post_show, 且键为“ Name”和“ ID”), 则响应为 200 OK, 并回显已发送的“ Name”-“ ID”对 (请参见 3.1.7.2)。

2).否则 (即请求 URL 不是/Post_show 或键不是“ Name”和“ ID”), 返回 404 Not Found 响应消息。

5.其他要求

对于其他请求方法 (例如 DELETE, PUT 等, 请参见部分 3.1.7.3), 仅返回 501 Not Implemented 错误消息。

二. 性能测试

1: 基础性能测试

完成 GET 命令:

正确 GET

```
jlanaresi@jlanaresi-virtual-machine:~/cloudmath/Lab2$ curl -i -X GET 127.0.0.1:8888/index.html
HTTP/1.1 200 OK
Content-type: text/html
Content-length: 288
Server: My Web Server

<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
<title>CS06142</title>
</head><body>
<h1 align="center">CS06142</h1>
<p align="center">Welcome to Cloud Computing Course.<br />
</p>
<hr>
<address align="center">Http Server at ip-127-0-0-1 Port 8888<address>
</body></html>
```

错误 GET

```
jlanaresi@jlanaresi-virtual-machine:~/cloudmath/Lab2$ curl -i -X GET 127.0.0.1:8888/lnndex.html
HTTP/1.1 404 Not Found
Server: My Server
Content-type: text/html
Content-length: 158

<html><title>404 Not Found</title><body bgcolor="ffffff">
  Not Found
  <p>Couldn't find this file:./lnndex.html</p>
  <hr><em>HTTP Web server</em>
</body></html>
```

完成 POST 命令

正确 POST

```
jlanaresi@jlanaresi-virtual-machine:~/cloudmath/Lab2$ curl -i -X POST --data 'Name=HNU&ID=CS06142' 127.0.0.1:8888/Post_show
HTTP/1.1 200 OK
Server: My Server
Content-type: text/html
Content-length: 124

<html><title>POST method</title><body bgcolor=ffffff>
Your Name: HNU
ID: CS06142
<hr><em>Http Web server</em>
</body></html>
```

错误 POST

```
jlanaresi@jlanaresi-virtual-machine:~/cloudmath/Lab2$ curl -i -X POST --data 'Name=HNU&ID=CS06142' 127.0.0.1:8888/Post_shows
HTTP/1.1 404 Not Found
Server: My Server
Content-type: text/html
Content-length: 113

<html><title>404 Not Found</title><body bgcolor="ffffff">
  Not Found
  <hr><em>HTTP Web server</em>
</body></html>
```

其他请求：
DELETE 命名

```
jianaresi@jianaresi-virtual-machine:~/cloudmath/Lab2$ curl -i -X DELETE 127.0.0.1:8888/index.html
HTTP/1.1 501 Not Implemented
Server: My Server
Content-type: text/html
Content-length: 172

<html><title>501 Not Implemented</title><body bgcolor="ffffff">
  Not Implemented
<p>Doed not implemented this method:DELETE</p>
<hr><em>HTTP Web server</em>
</body></html>
```

分析：

上述测试证明：我们组能完成正常访问服务器并正确返回符合基本要求

2：在各种服务器计算机环境上运行时，测试您的服务器每秒可以处理多少个 HTTP 请求。例如，更改服务器 CPU 内核数，启用/禁用超线程等。

测试环境：

UBUNTU16.04 4 处理器虚拟机，测试工具 ab -Apach benchmark

发送 80000 条请求，并发数 200，根据吞吐量测试每秒可以处理多少 HTTP 请求

变量修改服务器线程池中线程个数从 1 到 8

1 线程

```
Completed 80000 requests
Finished 80000 requests

Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:    200
Time taken for tests:  15.887 seconds
Complete requests:    80000
Failed requests:       0
Total transferred:    30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:  5035.42 [#/sec] (mean)
Time per request:     39.719 [ms] (mean)
Time per request:     0.199 [ms] (mean, across all concurrent requests)
Transfer rate:        1848.94 [Kbytes/sec] received

Connection Times (ms)
  min   mean[+/-sd] median   max
Connect:    0      1    1.6      0    19
Processing:  7     39    6.8     38   245
Waiting:    7     39    6.8     38   245
Total:     12     40    6.6     39   248

Percentage of the requests served within a certain time (ms)
 50%    39
 66%    40
 75%    41
 80%    43
 90%    48
 95%    53
 98%    59
 99%    63
100%   248 (longest request)
```

2 线程

```
Finished 80000 requests

Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:     200
Time taken for tests:  14.567 seconds
Complete requests:     80000
Failed requests:       0
Total transferred:     30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:   5492.04 [#/sec] (mean)
Time per request:      36.416 [ms] (mean)
Time per request:      0.182 [ms] (mean, across all concurrent requests)
Transfer rate:         2016.61 [Kbytes/sec] received

Connection Times (ms)
      min      mean[+/-sd] median   max
Connect:    0       1   10.9      0   1020
Processing:  8      36   13.6     33   174
Waiting:    7      35   13.5     32   173
Total:      14      36   17.4     33  1045

Percentage of the requests served within a certain time (ms)
 50%      33
 66%      35
 75%      36
 80%      38
 90%      46
 95%      55
 98%      71
 99%     107
100%    1045 (longest request)
```

3 线程

```
Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:     200
Time taken for tests:  14.100 seconds
Complete requests:     80000
Failed requests:       0
Total transferred:     30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:   5673.81 [#/sec] (mean)
Time per request:      35.250 [ms] (mean)
Time per request:      0.176 [ms] (mean, across all concurrent requests)
Transfer rate:         2083.35 [Kbytes/sec] received

Connection Times (ms)
      min      mean[+/-sd] median   max
Connect:    0       9   86.2      1  1040
Processing:  2      27    9.4     24   253
Waiting:    2      26    9.4     24   253
Total:      3      35   87.3     26  1278

Percentage of the requests served within a certain time (ms)
 50%      26
 66%      30
 75%      32
 80%      34
 90%      39
 95%      46
 98%      59
 99%      67
100%    1278 (longest request)
```

4 线程

```
Server Software:      My
Server Hostname:     127.0.0.1
Server Port:         8888

Document Path:       /index.html
Document Length:     288 bytes

Concurrency Level:    200
Time taken for tests: 15.189 seconds
Complete requests:    80000
Failed requests:      0
Total transferred:    30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:  5266.93 [#/sec] (mean)
Time per request:     37.973 [ms] (mean)
Time per request:     0.190 [ms] (mean, across all concurrent requests)
Transfer rate:        1933.95 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:      0    1   30.4      0   1034
Processing:    3    3   10.5     35    153
Waiting:       3    3   10.4     34    153
Total:         7    3   32.8     35   1098

Percentage of the requests served within a certain time (ms)
 50%    35
 66%    37
 75%    40
 80%    41
 90%    46
 95%    55
 98%    69
 99%    81
100%   1098 (longest request)
```

5 线程

```
Server Software:      My
Server Hostname:     127.0.0.1
Server Port:         8888

Document Path:       /index.html
Document Length:     288 bytes

Concurrency Level:    200
Time taken for tests: 15.554 seconds
Complete requests:    80000
Failed requests:      0
Total transferred:    30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:  5143.36 [#/sec] (mean)
Time per request:     38.885 [ms] (mean)
Time per request:     0.194 [ms] (mean, across all concurrent requests)
Transfer rate:        1888.58 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:      0    1   29.8      0   1036
Processing:    8    3   10.0     35    111
Waiting:       7    3    9.9     35    111
Total:         8    3   31.4     36   1073

Percentage of the requests served within a certain time (ms)
 50%    36
 66%    39
 75%    41
 80%    42
 90%    48
 95%    58
 98%    71
 99%    80
100%   1073 (longest request)
```

6 线程

```
Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:     200
Time taken for tests:  14.399 seconds
Complete requests:     80000
Failed requests:       0
Total transferred:     30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:   5555.89 [#/sec] (mean)
Time per request:      35.998 [ms] (mean)
Time per request:      0.180 [ms] (mean, across all concurrent requests)
Transfer rate:         2040.05 [Kbytes/sec] received

Connection Times (ms)
  min   mean[+/-sd] median   max
Connect:    0      0   0.6      0    19
Processing:  4     36   8.5     33   107
Waiting:    4     35   8.5     33   107
Total:      15     36   8.6     34   107

Percentage of the requests served within a certain time (ms)
 50%    34
 66%    36
 75%    38
 80%    39
 90%    44
 95%    53
 98%    64
 99%    70
100%   107 (longest request)
```

7 线程

```
Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:     200
Time taken for tests:  15.316 seconds
Complete requests:     80000
Failed requests:       0
Total transferred:     30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:   5223.43 [#/sec] (mean)
Time per request:      38.289 [ms] (mean)
Time per request:      0.191 [ms] (mean, across all concurrent requests)
Transfer rate:         1917.98 [Kbytes/sec] received

Connection Times (ms)
  min   mean[+/-sd] median   max
Connect:    0      0   0.6      0    22
Processing: 10     38  10.3     35   107
Waiting:    10     38  10.2     35   107
Total:      15     38  10.4     36   107

Percentage of the requests served within a certain time (ms)
 50%    36
 66%    38
 75%    40
 80%    42
 90%    48
 95%    62
 98%    73
 99%    82
100%   107 (longest request)
```

8 线程

```
Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

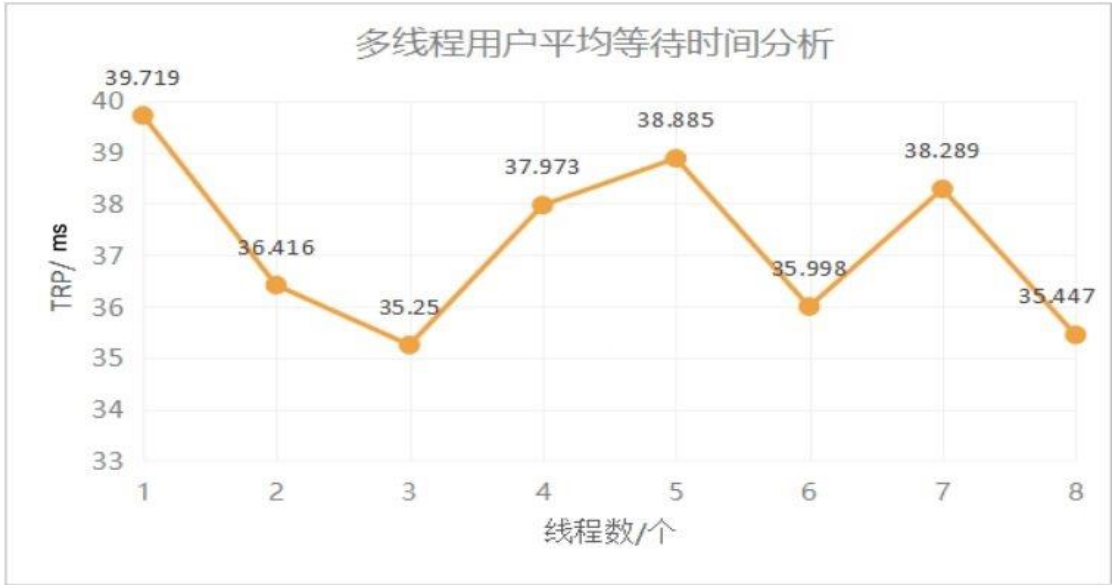
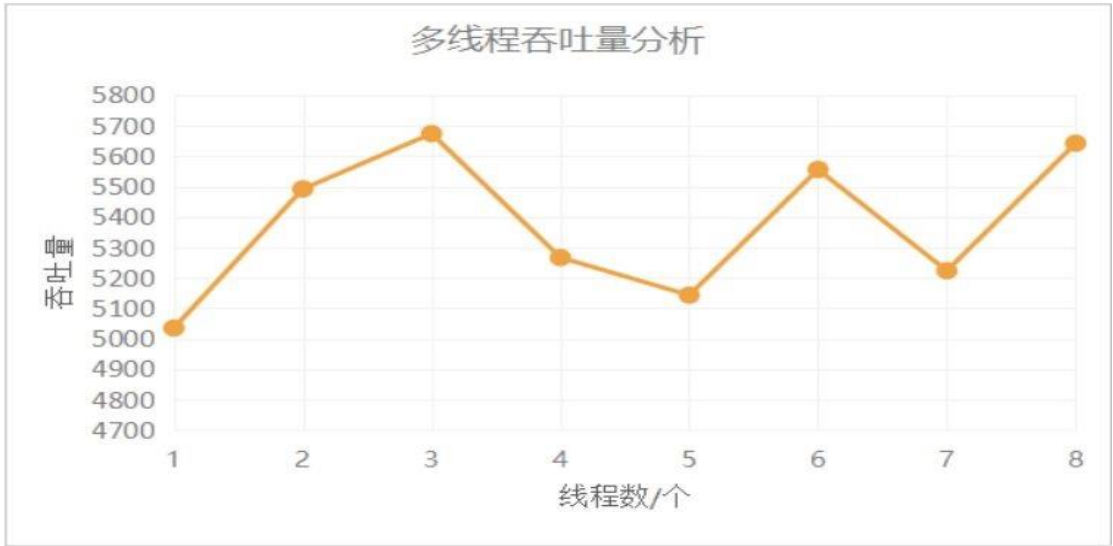
Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:    200
Time taken for tests:  14.179 seconds
Complete requests:    80000
Failed requests:      0
Total transferred:    30080000 bytes
HTML transferred:     23040000 bytes
Requests per second:  5642.20 [#/sec] (mean)
Time per request:     35.447 [ms] (mean)
Time per request:     0.177 [ms] (mean, across all concurrent requests)
Transfer rate:        2071.74 [Kbytes/sec] received

Connection Times (ms)
  min      mean[+/-sd] median    max
Connect:    0         0    0.7      17
Processing:  4        35    7.4      91
Waiting:    3         35    7.4      91
Total:      13        35    7.5      91

Percentage of the requests served within a certain time (ms)
 50%    34
 66%    36
 75%    37
 80%    38
 90%    43
 95%    49
 98%    62
 99%    66
100%    91 (longest request)
```

根据测试结果绘制表格



数据分析:

Requests per second(RPS): **吞吐量**。要清楚吞吐量是与并发数相关的, 即使请求总数相同, 但如果并发数不一样, 吞吐量还是很可能有很大差异的。

计算公式: $\text{Complete requests} / \text{Time taken for tests}$

Time per request(mean): **用户平均请求等待时间**。也就是一次并发总的时间。

计算公式: $\text{Time token for tests} / (\text{Complete requests} / \text{Concurrency Level})$ 。

我们可以

(1) 看到随着线程数 1-4 增加吞吐量上升, 到 4 以后在一定范围内波动, 因为测试设备是 4 核的, 线程数接近 4 性能最佳, 到 4 以后上下波动。

(2) 吞吐量和高低和用户平均等待时间成反比, 对于每个请求花费时间越长, 吞吐量越低。

3: 通过更改同时向服务器发送请求的并发客户端数, 测试您的服务器每秒可以处理多少个 HTTP 请求。一定要改变客户的工作量。例如, 测试客户端何时将新的 TCP 连接用于新请求, 或何时客户端将旧的 TCP 连接重新用于新请求。此外, 如果实施高级版本, 请尝试更改同一客户端的 TCP 连接上的出站请求数。

测试环境:

UBUNTU16.04 4 处理器虚拟机, 测试工具 ab -Apache benchmark

线程池线程数为 4, 发送 80000 条请求, 根据吞吐量测试每秒可以处理多少 HTTP 请求

变量修改请求的并发数, 分别为 1, 2,3,4,10,20,30,40,100,200,300,400,1000

-C 1

```
jlanares@jlanares1-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 1 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Finished 2882 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:    1
Time taken for tests:  1.000 seconds
Complete requests:    2882
Failed requests:       0
Total transferred:    1083632 bytes
HTML transferred:     830016 bytes
Requests per second:  2881.33 [#./sec] (mean)
Time per request:     0.347 [ms] (mean)
Time per request:     0.347 [ms] (mean, across all concurrent requests)
Transfer rate:        1057.99 [Kbytes/sec] received

Connection Times (ms)
  min   mean[+/-sd] median   max
Connect:    0    0   0.1      0    1
Processing:  0    0   0.2      0    4
Waiting:    0    0   0.2      0    3
Total:      0    0   0.2      0    5

Percentage of the requests served within a certain time (ms)
 50%    0
 66%    0
 75%    0
 80%    0
 90%    0
 95%    1
 98%    1
 99%    1
100%    5 (longest request)
```


C2

```
100% 0 (longest request)
jlanarest@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 2 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Finished 3734 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:    2
Time taken for tests:  1.000 seconds
Complete requests:    3734
Failed requests:       0
Total transferred:    1403984 bytes
HTML transferred:     1075392 bytes
Requests per second:  3732.41 [#/sec] (mean)
Time per request:      0.536 [ms] (mean)
Time per request:      0.268 [ms] (mean, across all concurrent requests)
Transfer rate:         1370.50 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd]  median    max
Connect:        0        0  0.1      0      2
Processing:      0        0  0.3      0      6
Waiting:         0        0  0.3      0      6
Total:           0        1  0.3      0      6
ERROR: The median and mean for the total time are more than twice the standard
deviation apart. These results are NOT reliable.

Percentage of the requests served within a certain time (ms)
 50%    0
 66%    0
 75%    1
 80%    1
 90%    1
 95%    1
 98%    1
 99%    2
100%    6 (longest request)
```

C3

```
100% 0 (longest request)
jlanarest@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 3 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Finished 4751 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:    3
Time taken for tests:  1.000 seconds
Complete requests:    4751
Failed requests:       0
Total transferred:    1786376 bytes
HTML transferred:     1368288 bytes
Requests per second:  4750.74 [#/sec] (mean)
Time per request:      0.631 [ms] (mean)
Time per request:      0.210 [ms] (mean, across all concurrent requests)
Transfer rate:         1744.41 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd]  median    max
Connect:        0        0  0.1      0      4
Processing:      0        1  0.5      0     13
Waiting:         0        0  0.5      0     13
Total:           0        1  0.6      1     13
WARNING: The median and mean for the processing time are not within a normal deviation
These results are probably not that reliable.

Percentage of the requests served within a certain time (ms)
 50%    1
 66%    1
 75%    1
 80%    1
 90%    1
 95%    1
 98%    2
 99%    2
100%   13 (longest request)
```

C4

```
jlanares@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 4 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Finished 4684 requests


Server Software:        My
Server Hostname:        127.0.0.1
Server Port:            8888

Document Path:          /index.html
Document Length:        288 bytes

Concurrency Level:      4
Time taken for tests:    1.000 seconds
Complete requests:      4684
Failed requests:         0
Total transferred:      1761184 bytes
HTML transferred:       1348992 bytes
Requests per second:    4683.42 [#/sec] (mean)
Time per request:       0.854 [ms] (mean)
Time per request:       0.214 [ms] (mean, across all concurrent requests)
Transfer rate:          1719.69 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        0  0.1      0       3
Processing:      0        1  0.7      1      14
Waiting:        0        1  0.6      1      14
Total:          0        1  0.7      1      14

Percentage of the requests served within a certain time (ms)
 50%    1
 66%    1
 75%    1
 80%    1
 90%    1
 95%    1
 98%    2
 99%    3
100%   14 (longest request)
```

C 10

```
jlanares@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 10 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5115 requests


Server Software:        My
Server Hostname:        127.0.0.1
Server Port:            8888

Document Path:          /index.html
Document Length:        288 bytes

Concurrency Level:      10
Time taken for tests:    1.001 seconds
Complete requests:      5115
Failed requests:         0
Total transferred:      1923240 bytes
HTML transferred:       1473120 bytes
Requests per second:    5108.84 [#/sec] (mean)
Time per request:       1.957 [ms] (mean)
Time per request:       0.196 [ms] (mean, across all concurrent requests)
Transfer rate:          1875.90 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        0  0.3      0       0
Processing:      0        2  1.1      1      19
Waiting:        0        2  1.0      1      19
Total:          0        2  1.2      2      19

Percentage of the requests served within a certain time (ms)
 50%    2
 66%    2
 75%    2
 80%    2
 90%    3
 95%    3
 98%    6
 99%    8
100%   19 (longest request)
```

C 20

```
jlanares@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 20 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5505 requests


Server Software:        My
Server Hostname:        127.0.0.1
Server Port:            8888

Document Path:          /index.html
Document Length:        288 bytes

Concurrency Level:      20
Time taken for tests:    1.000 seconds
Complete requests:      5505
Failed requests:         0
Total transferred:      2070256 bytes
HTML transferred:       1585728 bytes
Requests per second:    5504.77 [#/sec] (mean)
Time per request:       3.633 [ms] (mean)
Time per request:       0.182 [ms] (mean, across all concurrent requests)
Transfer rate:          2021.65 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        0  0.2      0       4
Processing:      1        3  1.5      3      17
Waiting:        1        3  1.4      3      17
Total:          1        4  1.5      3      17

Percentage of the requests served within a certain time (ms)
 50%    3
 66%    4
 75%    4
 80%    4
 90%    5
 95%    6
 98%    9
 99%   10
100%   17 (longest request)
```

C 30

```
jlanares@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 30 -t 1s 127.0.0.1:8888/index.html
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Benchmarking 127.0.0.1 (be patient)
Finished 4128 requests


Server Software:        My
Server Hostname:        127.0.0.1
Server Port:            8888

Document Path:          /index.html
Document Length:        288 bytes

Concurrency Level:      30
Time taken for tests:    1.000 seconds
Complete requests:      4128
Failed requests:         0
Total transferred:      1552128 bytes
HTML transferred:       1188864 bytes
Requests per second:    4127.94 [#/sec] (mean)
Time per request:       7.268 [ms] (mean)
Time per request:       0.242 [ms] (mean, across all concurrent requests)
Transfer rate:          1515.73 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        0   0.5      0     12
Processing:      1        7   5.5      5     52
Waiting:         1        7   5.4      5     52
Total:          2        7   5.6      6     54

Percentage of the requests served within a certain time (ms)
 50%        6
 66%        6
 75%        7
 80%        8
 90%       13
 95%       16
 98%       26
 99%       29
100%       54 (longest request)
```

C 40

```
jlanares@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 40 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5572 requests


Server Software:        My
Server Hostname:        127.0.0.1
Server Port:            8888

Document Path:          /index.html
Document Length:        288 bytes

Concurrency Level:      40
Time taken for tests:    1.000 seconds
Complete requests:      5572
Failed requests:         0
Total transferred:      2095072 bytes
HTML transferred:       1604736 bytes
Requests per second:    5571.73 [#/sec] (mean)
Time per request:       7.179 [ms] (mean)
Time per request:       0.179 [ms] (mean, across all concurrent requests)
Transfer rate:          2045.87 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        0   0.5      0      5
Processing:      1        7   3.2      6     44
Waiting:         1        7   3.1      6     44
Total:          3        7   3.3      6     45

Percentage of the requests served within a certain time (ms)
 50%        6
 66%        7
 75%        7
 80%        8
 90%        9
 95%       11
 98%       18
 99%       24
100%       45 (longest request)
```

C 100

```
jlanares@jlanarest-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 100 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5418 requests


Server Software:        My
Server Hostname:        127.0.0.1
Server Port:            8888

Document Path:          /index.html
Document Length:        288 bytes

Concurrency Level:      100
Time taken for tests:    1.008 seconds
Complete requests:      5418
Failed requests:         0
Total transferred:      2039048 bytes
HTML transferred:       1561824 bytes
Requests per second:    5372.44 [#/sec] (mean)
Time per request:       18.614 [ms] (mean)
Time per request:       0.186 [ms] (mean, across all concurrent requests)
Transfer rate:          1974.51 [Kbytes/sec] received

Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        1   1.0      1      7
Processing:      5       17   5.6     16     57
Waiting:         5       17   5.6     15     56
Total:          5       18   6.0     17     59

Percentage of the requests served within a certain time (ms)
 50%       17
 66%       17
 75%       18
 80%       19
 90%       24
 95%       26
 98%       38
 99%       50
100%       59 (longest request)
```

C 200

```
jlanaresti@jlanaresti-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 200 -t 1s 127.0.0.1:8888/index.html
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5809 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:       288 bytes

Concurrency Level:     200
Time taken for tests:   1.000 seconds
Complete requests:      5809
Failed requests:         0
Total transferred:      2184184 bytes
HTML transferred:       1672992 bytes
Requests per second:    5808.79 [#/sec] (mean)
Time per request:       34.431 [ms] (mean)
Time per request:       0.172 [ms] (mean, across all concurrent requests)
Transfer rate:          2132.91 [Kbytes/sec] received


Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        1    3.1      0     19
Processing:    10       33    7.3     31     65
Waiting:        9       32    7.3     30     65
Total:         19       34    8.7     31     74


Percentage of the requests served within a certain time (ms)
 50%    31
 66%    33
 75%    34
 80%    35
 90%    42
 95%    62
 98%    65
 99%    65
100%    74 (longest request)
```

C 300

```
jlanaresti@jlanaresti-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 300 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5551 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:       288 bytes

Concurrency Level:     300
Time taken for tests:   1.000 seconds
Complete requests:      5551
Failed requests:         0
Total transferred:      2088304 bytes
HTML transferred:       1599552 bytes
Requests per second:    5550.46 [#/sec] (mean)
Time per request:       54.050 [ms] (mean)
Time per request:       0.180 [ms] (mean, across all concurrent requests)
Transfer rate:          2039.16 [Kbytes/sec] received


Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        3    4.3      0     15
Processing:     7       49   11.9     46    103
Waiting:        6       49   11.8     46     85
Total:          7       52   13.3     48    114


Percentage of the requests served within a certain time (ms)
 50%    48
 66%    52
 75%    55
 80%    58
 90%    77
 95%    88
 98%    91
 99%    92
100%   114 (longest request)
```

C 400

```

jlanaresi@jlanaresi-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 400 -t 1s 127.0.0.1:8888/index.html
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5454 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

Concurrency Level:    400
Time taken for tests:  1.000 seconds
Complete requests:    5454
Failed requests:      0
Total transferred:    2050704 bytes
HTML transferred:     1570752 bytes
Requests per second:  5453.68 [#/sec] (mean)
Time per request:     73.345 [ms] (mean)
Time per request:     0.183 [ms] (mean, across all concurrent requests)
Transfer rate:        2002.52 [Kbytes/sec] received


Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        3   5.2      1      22
Processing:    10       67  12.1     65     106
Waiting:       10       66  11.3     64     103
Total:         25       70  14.4     66     117


Percentage of the requests served within a certain time (ms)
 50%    66
 66%    71
 75%    75
 80%    77
 90%    93
 95%   103
 98%   112
 99%   113
100%   117 (longest request)

```

C 1000

```

jlanaresi@jlanaresi-virtual-machine:~/cloudmath/Lab2$ ab -n 8000 -c 1000 -t 1s 127.0.0.1:8888/index.html
This is ApacheBench, Version 2.3 <$Revision: 1706008 $>
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Benchmarking 127.0.0.1 (be patient)
Completed 5000 requests
Finished 5333 requests


Server Software:      My
Server Hostname:      127.0.0.1
Server Port:          8888

Document Path:        /index.html
Document Length:      288 bytes

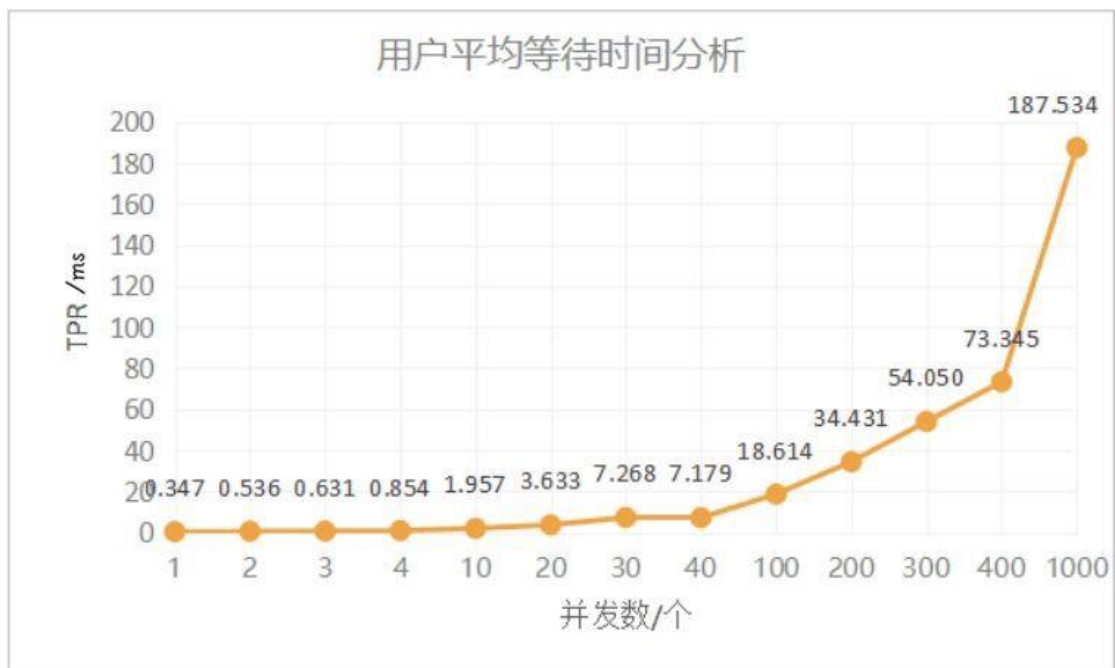
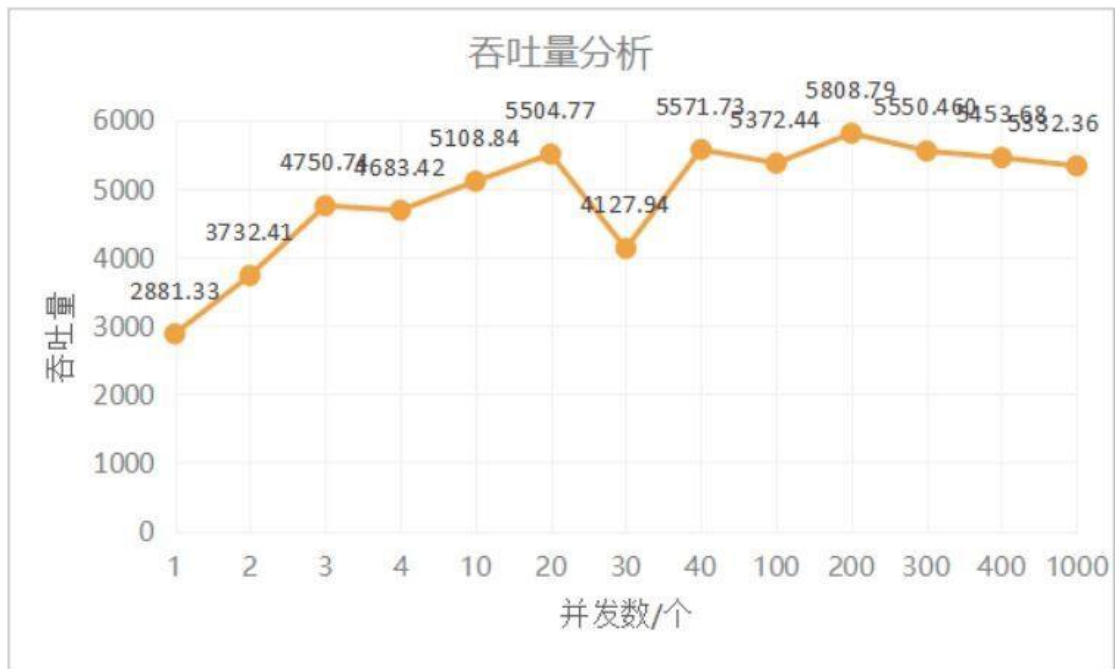
Concurrency Level:    1000
Time taken for tests:  1.000 seconds
Complete requests:    5333
Failed requests:      0
Total transferred:    2005584 bytes
HTML transferred:     1536192 bytes
Requests per second:  5332.36 [#/sec] (mean)
Time per request:     187.534 [ms] (mean)
Time per request:     0.188 [ms] (mean, across all concurrent requests)
Transfer rate:        1958.34 [Kbytes/sec] received


Connection Times (ms)
              min      mean[+/-sd] median   max
Connect:        0        9  14.4      1      59
Processing:    21       100  13.7    100     129
Waiting:       21       98  13.7     98     128
Total:         57       108  17.0    104     157


Percentage of the requests served within a certain time (ms)
 50%   104
 66%   113
 75%   122
 80%   124
 90%   134
 95%   141
 98%   142
 99%   149
100%   157 (longest request)

```

根据测试结合绘制数据图



分析数据

Requests per second(RPS): **吞吐率**。要清楚吞吐率是与并发数相关的，即使请求总数相同，但如果并发数不一样，吞吐率还是很可能有很大差异的。

计算公式: $\text{Complete requests} / \text{Time taken for tests}$

Time per request(mean): **用户平均请求等待时间**。也就是一次并发总的时间。

计算公式: $\text{Time token for tests} / (\text{Complete requests} / \text{Concurrency Level})$ 。

我们根据表格可以看出随着并发数在一定范围内增加 (1-400)，服务器吞吐量上升，用户平均等待请求时间缓慢上升，但是如果并发数过大，吞吐量也会有一定的下降，用户平均等待

请求时间快速上升。

三. 实验总结

我们在之前课程的学习中刚开始接触了 socket 编程, 只对 socket 编程的最简单的阻塞 io 的 tcp 链接和请求进行处理, 这次实验中遇到了很多问题, 为了实现高性能并发的服务器, 我们去了解了使用 Epoll 边沿触发的 IO 多路复用技术, 非阻塞 IO, 使用 Reactor 模式, 对于我们是一个全新的计算和挑战, 我们在 b 站学习了陈硕老师的《linux 多线程网络编程》, 也去阅读很大量简单服务器, 高性能服务器的源码进行学习后, 仿照着实现了我们的实验, 虽然大致的对非阻塞 io 的 epoll 的 io 多路复用技术有了比较简单的理解, 但是为我们打开了新世界的大门, 感觉网络编程有许多方向值得我们学习, 同时高性能编程也有很多方向发展, 这次实验我们由于组员们都比较了解 C++, 使用了 C++11, 实验过程中感觉有点后悔, 因为相比于 JAVA 和 PYTHON 有丰富的网络库, C++ 的很多功能的库函数需要自己封装, 实现比较复杂, 但是也艰难的实现了, 我们觉得所以下次开始实验前要提前做好前期准备工作, 好的工具也是迈向成功的重要途径。