

# 流完成时间实验报告

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## 一、实验题目

流完成时间实验

## 二、实验内容

1. 利用 fct\_exp.py 脚本复现 P25 中的图;  
每个数据点做 5 次实验, 取平均值
2. 调研解释图中的现象;  
TCP 传输协议, 慢启动机制;

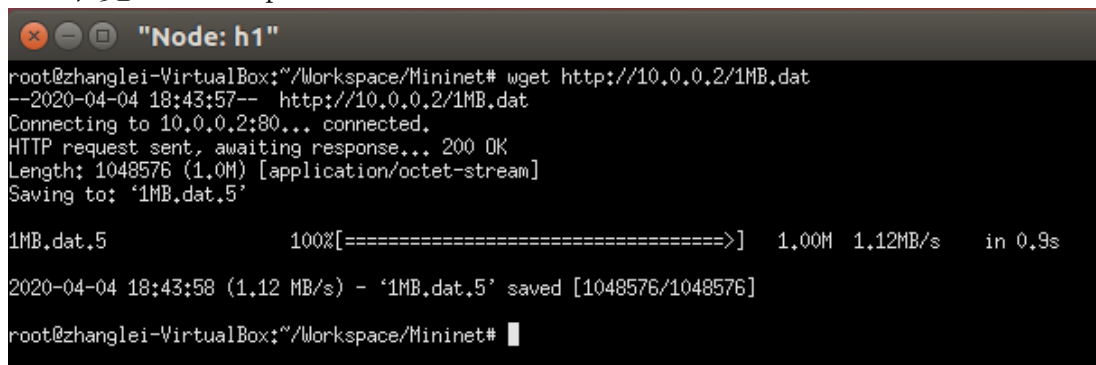
## 三、实验流程

1. 编写 fct\_exp.py 脚本, 设置带宽延迟;
2. 终端输入 python fct\_exp.py 运行脚本, 启动 mininet;
3. 运行 xterm h1 h2 启动两台 host;
4. 在 h2 终端输入 dd if=/dev/zero of="file\_size" MB.dat bs=1M count=1, 其中 file\_size 设置为 1, 10, 100, 生成对应大小的文件;
5. 在 h1 中运行 wget http://10.0.0.2/file\_sizeMB.dat 获取主机 h2 上的文件, 其中 file\_size 对应上一步中的数值;
6. 查看记录 h1 获取完整文件所需要的时间和速度;
7. 根据实验结果复现 P25 中的图, 并调研解释图中的现象;

## 四、实验结果

由于每次实验结果差别不大, 所以每个数据点做 3 次实验, 取平均值

1. 带宽 = 10Mbps:



```
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/1MB.dat
--2020-04-04 18:43:57-- http://10.0.0.2/1MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1048576 (1.0M) [application/octet-stream]
Saving to: '1MB.dat.5'

1MB.dat.5          100%[=====>]  1.00M  1.12MB/s   in 0.9s
2020-04-04 18:43:58 (1.12 MB/s) - '1MB.dat.5' saved [1048576/1048576]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 1MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/10MB.dat
--2020-04-04 18:47:46-- http://10.0.0.2/10MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10485760 (10M) [application/octet-stream]
Saving to: '10MB.dat.5'

10MB.dat.5          100%[=====>] 10.00M  1.14MB/s   in 8.8s

2020-04-04 18:47:54 (1.14 MB/s) - '10MB.dat.5' saved [10485760/10485760]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 10MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/100MB.dat
--2020-04-04 18:50:27-- http://10.0.0.2/100MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 104857600 (100M) [application/octet-stream]
Saving to: '100MB.dat.2'

100MB.dat.2         100%[=====>] 100.00M  1.14MB/s   in 88s

2020-04-04 18:51:55 (1.14 MB/s) - '100MB.dat.2' saved [104857600/104857600]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 100MB

2. 带宽 = 50Mbps:

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/1MB.dat
--2020-04-04 18:58:35-- http://10.0.0.2/1MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1048576 (1.0M) [application/octet-stream]
Saving to: '1MB.dat.3'

1MB.dat.3           100%[=====>] 1.00M  4.22MB/s   in 0.2s

2020-04-04 18:58:35 (4.22 MB/s) - '1MB.dat.3' saved [1048576/1048576]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 1MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/10MB.dat
--2020-04-04 19:00:00-- http://10.0.0.2/10MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10485760 (10M) [application/octet-stream]
Saving to: '10MB.dat.3'

10MB.dat.3          100%[=====>] 10.00M  5.44MB/s   in 1.8s

2020-04-04 19:00:02 (5.44 MB/s) - '10MB.dat.3' saved [10485760/10485760]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 10MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/100MB.dat
--2020-04-04 19:01:19-- http://10.0.0.2/100MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 104857600 (100M) [application/octet-stream]
Saving to: '100MB.dat.2'

100MB.dat.2          100%[=====>] 100.00M  5.61MB/s   in 18s

2020-04-04 19:01:37 (5.58 MB/s) - '100MB.dat.2' saved [104857600/104857600]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 100MB

3. 带宽 = 100Mbps:

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/1MB.dat
--2020-04-04 19:04:22-- http://10.0.0.2/1MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1048576 (1.0M) [application/octet-stream]
Saving to: '1MB.dat.1'

1MB.dat.1            100%[=====>]  1.00M  5.89MB/s   in 0.2s

2020-04-04 19:04:22 (5.89 MB/s) - '1MB.dat.1' saved [1048576/1048576]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 1MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/10MB.dat
--2020-04-04 19:06:25-- http://10.0.0.2/10MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10485760 (10M) [application/octet-stream]
Saving to: '10MB.dat.3'

10MB.dat.3           100%[=====>] 10.00M  9.07MB/s   in 1.1s

2020-04-04 19:06:26 (9.07 MB/s) - '10MB.dat.3' saved [10485760/10485760]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 10MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/100MB.dat
--2020-04-04 19:07:01-- http://10.0.0.2/100MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 104857600 (100M) [application/octet-stream]
Saving to: '100MB.dat.1'

100MB.dat.1          100%[=====>] 100.00M  9.88MB/s   in 10s

2020-04-04 19:07:11 (9.89 MB/s) - '100MB.dat.1' saved [104857600/104857600]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 100MB

#### 4. 带宽 = 500Mbps:

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/1MB.dat
--2020-04-04 19:10:38-- http://10.0.0.2/1MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1048576 (1.0M) [application/octet-stream]
Saving to: '1MB.dat.2'

1MB.dat.2          100%[=====>] 1,00M  --.-KB/s  in 0.1s

2020-04-04 19:10:38 (7.41 MB/s) - '1MB.dat.2' saved [1048576/1048576]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 1MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/10MB.dat
--2020-04-04 19:12:11-- http://10.0.0.2/10MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10485760 (10M) [application/octet-stream]
Saving to: '10MB.dat.3'

10MB.dat.3          100%[=====>] 10,00M  26.5MB/s  in 0.4s

2020-04-04 19:12:11 (26.5 MB/s) - '10MB.dat.3' saved [10485760/10485760]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 10MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/100MB.dat
--2020-04-04 19:12:40-- http://10.0.0.2/100MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 104857600 (100M) [application/octet-stream]
Saving to: '100MB.dat.1'

100MB.dat.1          100%[=====>] 100,00M  40.7MB/s  in 2.5s

2020-04-04 19:12:42 (40.7 MB/s) - '100MB.dat.1' saved [104857600/104857600]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 100MB

#### 5. 带宽 = 1Gbps:

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/1MB.dat
--2020-04-04 19:14:42-- http://10.0.0.2/1MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1048576 (1.0M) [application/octet-stream]
Saving to: '1MB.dat.1'

1MB.dat.1          100%[=====>] 1,00M  --.-KB/s  in 0.1s

2020-04-04 19:14:42 (7.27 MB/s) - '1MB.dat.1' saved [1048576/1048576]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 1MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/10MB.dat
--2020-04-04 19:15:55-- http://10.0.0.2/10MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 10485760 (10M) [application/octet-stream]
Saving to: '10MB.dat.1'

10MB.dat.1          100%[=====>] 10,00M  26.3MB/s   in 0.4s

2020-04-04 19:15:56 (26.3 MB/s) - '10MB.dat.1' saved [10485760/10485760]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

File\_size = 10MB

```
"Node: h1"
root@zhanglei-VirtualBox:~/Workspace/Mininet# wget http://10.0.0.2/100MB.dat
--2020-04-04 19:17:11-- http://10.0.0.2/100MB.dat
Connecting to 10.0.0.2:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 104857600 (100M) [application/octet-stream]
Saving to: '100MB.dat.2'

100MB.dat.2         100%[=====>] 100,00M  72.7MB/s   in 1.4s

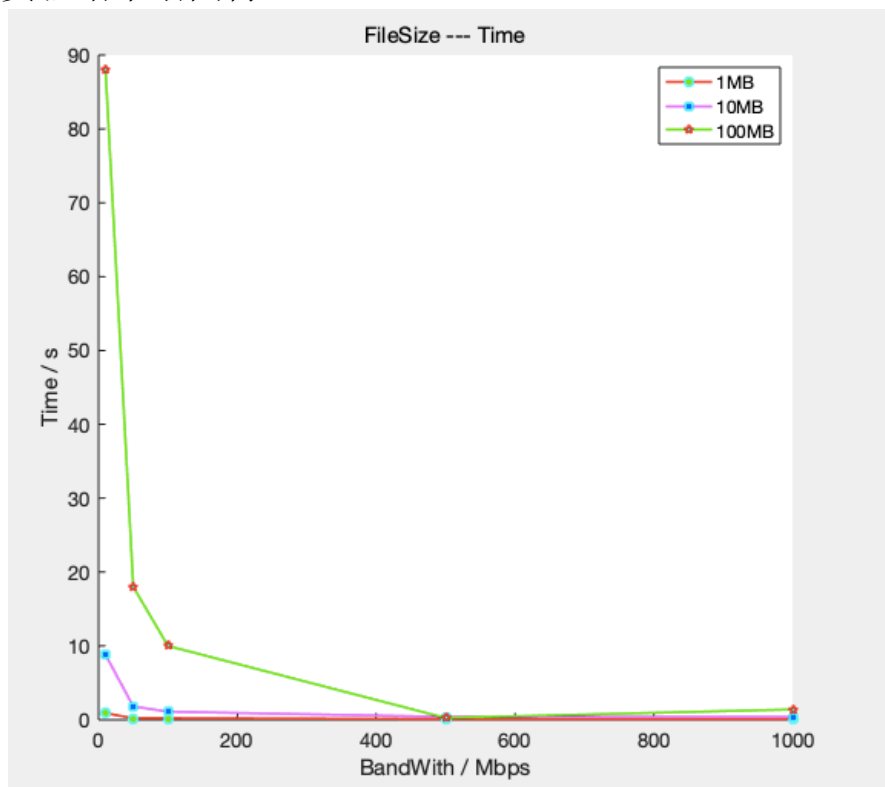
2020-04-04 19:17:13 (72.7 MB/s) - '100MB.dat.2' saved [104857600/104857600]

root@zhanglei-VirtualBox:~/Workspace/Mininet#
```

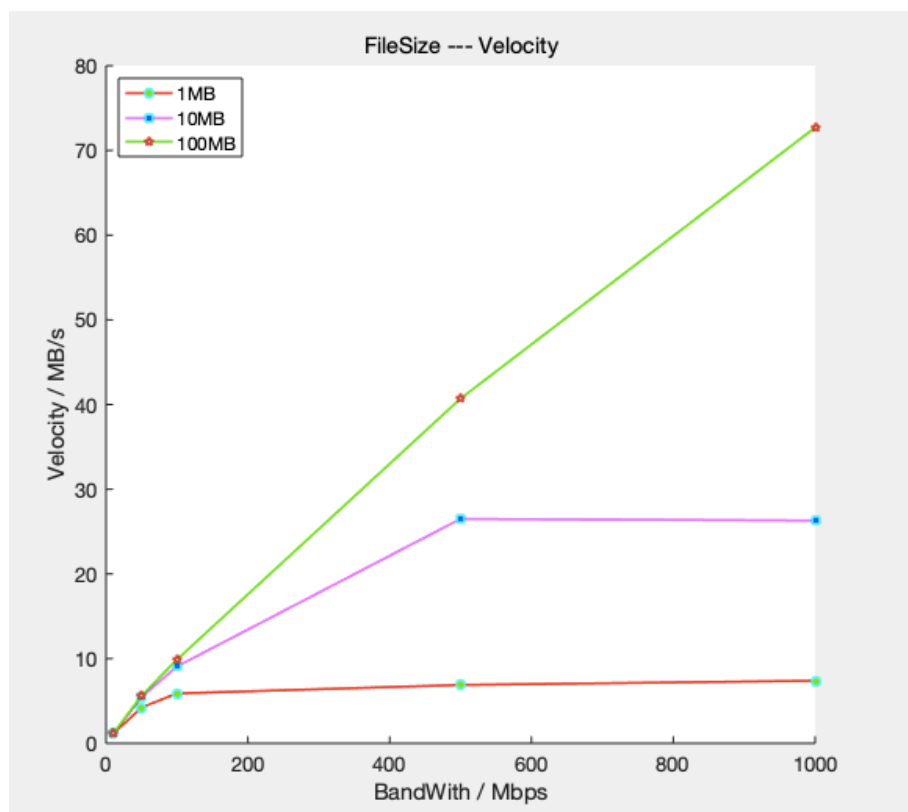
File\_size = 100MB

## 五、 实验分析

1. 由实验结果绘图得：



带宽-文件大小-耗时



带宽-文件大小-速度

2. 当带宽达到 500Mbps 以上后，1MB 大小的文件由于文件太小而无法获得准确速度，为便于作图，特给出估计值；
3. 可以发现，在文件大小给定时，下载速度与带宽并未呈现出良好的线形关系，随着带宽增加，网络传输速率的变化并不令人满意；
4. 当带宽给定时，文件越大，网络传输速率越高，文件越小，网络传输速率越低；
5. 当改变 fct\_exp.py 脚本中的延迟时，随延迟增大，网络传输速率较低，且当延迟增大时，可以明显的观察到，在开始网络传输时的速率很低，经过较短时间后，传输速率迅速升高，开始传输时低速传输的时间长度与延迟时间呈正相关；

## 六、调研解释

### 1. TCP 传输<sup>i</sup>：

对于文件大小相同，但是网速并没有一直随带宽的增加呈现线性关系，我认为可能的原因是：在 TCP 传输协议中，会把传输数据流分割为适当长度的报文段，最大传输段的大小通常受计算机连接的网络数据链路的最大传输单元（MTU）限制；

由于传输数据并非是连续传输整个文件，而是把文件分割成许多分组，所以在传输过程中，各个分组可能会由于排队，丢包等因素造成有效传输时间比连续传输整个文件的时间长，从而引起最终的传输速率的下降；

## 2. 慢启动机制：<sup>ii</sup>

对于小文件，网络传输速率较低的现象，我认为，可能是由于 TCP 传输中的慢启动机制的影响。当建立一个 TCP 连接后，该连接便进入慢启动阶段，TCP 实体将拥塞窗口的大小初始化为 1，此后，每收到一个报文段的确认，窗口大小增加 1 倍；

由于小文件本身数据量很小，所以耗费在慢启动阶段的时间相对于大文件来说就更多，当带宽很高时，也许还没等到慢启动阶段结束，网速达到网络传输的上限就已经传输完毕，所以，导致最终测量得到的网速较低；

## 七、 反思总结

1. 本次实验和调研加深了我对 TCP 传输的认识和理解，对带宽，传输速率，文件大小，延迟，4 者的关系有了更加清楚的理解。改变了以往对于网速就是带宽除以 8 的认知，认识到了网络传输过程中存在的诸多限制。

## 八、 参考文献

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<sup>i</sup> <https://baike.baidu.com/item/TCP/33012>

<sup>ii</sup> <https://baike.baidu.com/item/TCP/33012>