

## Output files and Performance evaluation results:

### 1. Deploying at least 5 peers and 1 indexing server in the same virtual machine:

- Ensure you can transfer one file properly: No logs are going to be stored neither a bash script is going to be created. Just some screen captures are going to be shown.

Indexing server:

```
jorge@jorge-VirtualBox:~/Desktop/Advanced/Prog 4/Code/server$ python3 server.py 127.0.0.1 3000
Listening as 127.0.0.1 : 3000

Client ('127.0.0.1', 56988) connected to server. Total connections: 1
Client: ('127.0.0.1', 56988) registered.
Client ('127.0.0.1', 56992) connected to server. Total connections: 2
Client: ('127.0.0.1', 56992) registered.
Client ('127.0.0.1', 56996) connected to server. Total connections: 3
Client: ('127.0.0.1', 56996) registered.
Client ('127.0.0.1', 57000) connected to server. Total connections: 4
Client: ('127.0.0.1', 57000) registered.
Client ('127.0.0.1', 57004) connected to server. Total connections: 5
Client: ('127.0.0.1', 57004) registered.
Client: ('127.0.0.1', 56988) added a file.
```

Sender Peer nodes:

```
jorge@jorge-VirtualBox:~/Desktop/Advanced/Prog 4/Code/peer_2$ python3 peer.py 127.0.0.1 3000 4045 client_files
Connected to INDEXING SERVER: 127.0.0.1 : 3000
Listening as 127.0.0.1 : 4045

Registered for Peer-to-Peer downloads
Client ('127.0.0.1', 37416) connected. Total connections: 2
Client ('127.0.0.1', 37430) connected. Total connections: 3
Sending file to: ('127.0.0.1', 37430)
Chunk size: 262144
Length of chunk to send: 262144
Position of the offset (beginning of chunk): 0
Position of the end (end of chunk): 262144
File specs received
Chunk sent to client ('127.0.0.1', 37430). Size: 262144 with offset: 0

jorge@jorge-VirtualBox:~/Desktop/Advanced/Prog 4/Code/peer_4$ python3 peer.py 127.0.0.1 3000 4025 client_files
Connected to INDEXING SERVER: 127.0.0.1 : 3000
Listening as 127.0.0.1 : 4025

Client ('127.0.0.1', 56612) connected. Total connections: 2
Registered for Peer-to-Peer downloads
Client ('127.0.0.1', 56622) connected. Total connections: 3
Sending file to: ('127.0.0.1', 56622)
Chunk size: 262144
Length of chunk to send: 262144
Position of the offset (beginning of chunk): 524288
Position of the end (end of chunk): 786432
File specs received
Chunk sent to client ('127.0.0.1', 56622). Size: 262144 with offset: 524288

jorge@jorge-VirtualBox:~/Desktop/Advanced/Prog 4/Code/peer_3$ python3 peer.py 127.0.0.1 3000 4015 client_files
Connected to INDEXING SERVER: 127.0.0.1 : 3000
Listening as 127.0.0.1 : 4015

Registered for Peer-to-Peer downloads
Client ('127.0.0.1', 52410) connected. Total connections: 2
Client ('127.0.0.1', 52422) connected. Total connections: 3
Sending file to: ('127.0.0.1', 52422)
Chunk size: 262144
Length of chunk to send: 262144
Position of the offset (beginning of chunk): 262144
Position of the end (end of chunk): 524288
File specs received
Chunk sent to client ('127.0.0.1', 52422). Size: 262144 with offset: 262144
```

```
jorge@jorge-VirtualBox:~/Desktop/Advanced/Prog 4/Code/peer_5$ python3 peer.py 127.0.0.1 3000 4035 client_files
Connected to INDEXING SERVER: 127.0.0.1 : 3000
Listening as 127.0.0.1 : 4035

Registered for Peer-to-Peer downloads
Client ('127.0.0.1', 56976) connected. Total connections: 2
Client ('127.0.0.1', 56984) connected. Total connections: 3
Sending file to: ('127.0.0.1', 56984)
Chunk size: 262144
Length of chunk to send: 262144
Position of the offset (beginning of chunk): 786432
Position of the end (end of chunk): 1048576
File specs received
Chunk sent to client ('127.0.0.1', 56984). Size: 262144 with offset: 786432
```

Receiver peer node:

```
jorge@jorge-VirtualBox:~/Desktop/Advanced/Prog 4/Code/peer_1$ python3 peer.py 127.0.0.1 3000 4010 client_files
Connected to INDEXING SERVER: 127.0.0.1 : 3000
Listening as 127.0.0.1 : 4010

Registered for Peer-to-Peer downloads
Client ('127.0.0.1', 51456) connected. Total connections: 2
get_files_list

Files hosted+size:

8.txt+1048576
9.txt+1048576
5.txt+1048576
7.txt+1048576
1.txt+1048576
6.txt+1048576
10.txt+1048576
4.txt+1048576
2.txt+1048576
3.txt+1048576
query 8.txt

File: 8.txt has been queried for download.
File: 8.txt
File size: 1048576
Peer nodes: ['("127.0.0.1", 56992)', '\4045\']', '["(127.0.0.1", 56996)", \4015\']', '["(127.0.0.1", 57000)', '\4025\']', '["(127.0.0.1", 57004)", \4035\']']
Number of peer nodes: 4
Chunk sizes: 262144
Downloading Chunk 0 from: ["127.0.0.1", "\4045"]. Size: 262144 with offset: 0
Downloading Chunk 1 from: ["127.0.0.1", "\4015"]. Size: 262144 with offset: 262144

Connected to peer: 127.0.0.1 : 4045
Downloading Chunk 2 from: ["127.0.0.1", "\4025"]. Size: 262144 with offset: 524288

Connected to peer: 127.0.0.1 : 4025

Connected to peer: Downloading Chunk 3 from: ["127.0.0.1", "\4035"]. Size: 262144 with offset: 786432
127.0.0.1 : 4015

Connected to peer: 127.0.0.1 : 4035
262144

Chunk from client 4045 of file 8.txt has been correctly downloaded. Length: 262144 , with offset: 0
262144

Chunk from client 4035 of file 8.txt has been correctly downloaded. Length: 262144 , with offset: 786432
262144

Chunk from client 4025 of file 8.txt has been correctly downloaded. Length: 262144 , with offset: 524288
262144

Chunk from client 4015 of file 8.txt has been correctly downloaded. Length: 262144 , with offset: 262144

File 8.txt correctly downloaded from:

--> Client 4045 , chunk 0. At time: 1617846328.7406993
--> Client 4015 , chunk 1. At time: 1617846328.7443287
--> Client 4025 , chunk 2. At time: 1617846328.7443008
--> Client 4035 , chunk 3. At time: 1617846328.7419884

Total time to download all the chunks: 0.039246320724487305 sec.
```

- b) Ensure multiple peer nodes could simultaneously upload and download files:  
The logs of this evaluation are stored in the folder Out/ev 1. In this evaluation, 5 peers were connected to the Indexing server and each one of them requested a different file at the same time. The screenshots of the server and 2 peers logs are shown next:

Indexing server:

```
INFO:root:Listening as 127.0.0.1 : 3000

INFO:root:Client('127.0.0.1', 57076) connected to server. Total connections: 1
INFO:root:Client: ('127.0.0.1', 57076) registered.
INFO:root:Client('127.0.0.1', 57080) connected to server. Total connections: 2
INFO:root:Client: ('127.0.0.1', 57080) registered.
INFO:root:Client('127.0.0.1', 57084) connected to server. Total connections: 3
INFO:root:Client: ('127.0.0.1', 57084) registered.
INFO:root:Client('127.0.0.1', 57088) connected to server. Total connections: 4
INFO:root:Client: ('127.0.0.1', 57088) registered.
INFO:root:Client('127.0.0.1', 57092) connected to server. Total connections: 5
INFO:root:Client: ('127.0.0.1', 57092) registered.
INFO:root:Client: ('127.0.0.1', 57076) added a file.
INFO:root:Client: ('127.0.0.1', 57080) added a file.
INFO:root:Client: ('127.0.0.1', 57092) added a file.
INFO:root:Client: ('127.0.0.1', 57084) added a file.
INFO:root:Client: ('127.0.0.1', 57088) added a file.
```

One peer:

```
INFO:root:
Connected to INDEXING SERVER : 127.0.0.1 : 3000
INFO:root:Listening as 127.0.0.1 : 4010

INFO:root:Registered for Peer-to-Peer downloads
INFO:root:Client('127.0.0.1', 51548) connected. Total connections: 2
INFO:root:Client('127.0.0.1', 51562) connected. Total connections: 3
INFO:root:File specs received
INFO:root:Chunk sent to client ('127.0.0.1', 51562). Size: 262144 with offset: 0
INFO:root:
File: 2.txt has been queried for download.
INFO:root:Downloading Chunk 0 from: ["127.0.0.1", "4000"]. Size: 262144 with offset: 0
INFO:root:
Connected to peer : 127.0.0.1 : 4000
INFO:root:Downloading Chunk 1 from: ["127.0.0.1", "4020"]. Size: 262144 with offset: 262144
INFO:root:
Connected to peer : 127.0.0.1 : 4020
INFO:root:Downloading Chunk 2 from: ["127.0.0.1", "4030"]. Size: 262144 with offset: 524288
INFO:root:
Connected to peer : 127.0.0.1 : 4030
INFO:root:Downloading Chunk 3 from: ["127.0.0.1", "4040"]. Size: 262144 with offset: 786432
INFO:root:
Connected to peer : 127.0.0.1 : 4040
INFO:root:Client('127.0.0.1', 51578) connected. Total connections: 8
INFO:root:Client('127.0.0.1', 51586) connected. Total connections: 9
INFO:root:
Chunk from client 4030 of file 2.txt has been correctly downloaded. Length: 262144 , with offset: 524288
INFO:root:
Chunk from client 4040 of file 2.txt has been correctly downloaded. Length: 262144 , with offset: 786432
INFO:root:Client('127.0.0.1', 51592) connected. Total connections: 8
INFO:root:
Chunk from client 4020 of file 2.txt has been correctly downloaded. Length: 262144 , with offset: 262144
INFO:root:File specs received
INFO:root:File specs received
INFO:root:File specs received
INFO:root:Chunk sent to client ('127.0.0.1', 51592). Size: 262144 with offset: 262144
INFO:root:Chunk sent to client ('127.0.0.1', 51586). Size: 262144 with offset: 262144
INFO:root:
Chunk from client 4000 of file 2.txt has been correctly downloaded. Length: 262144 , with offset: 0
```

```

INFO:root:
File 2.txt correctly downloaded from:

INFO:root:    --> Client 4000 , chunk 0. At time: 1617849325.84992
INFO:root:    --> Client 4020 , chunk 1. At time: 1617849325.8019974
INFO:root:    --> Client 4030 , chunk 2. At time: 1617849325.7858765
INFO:root:    --> Client 4040 , chunk 3. At time: 1617849325.7847447
INFO:root:
Total time to download all the chunks: 0.15447664260864258 sec.
INFO:root:Chunk sent to client ('127.0.0.1', 51578). Size: 262144 with offset: 262144

```

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Another peer:

```

INFO:root:
Connected to INDEXING SERVER : 127.0.0.1 : 3000
INFO:root:Listening as 127.0.0.1 : 4000

INFO:root:Registered for Peer-to-Peer downloads
INFO:root:Client('127.0.0.1', 47568) connected. Total connections: 2
INFO:root:
File: 1.txt has been queried for download.
INFO:root:Downloading Chunk 0 from: ["'127.0.0.1'", "'4010'"]. Size: 262144 with offset: 0
INFO:root:Downloading Chunk 1 from: ["'127.0.0.1'", "'4020'"]. Size: 262144 with offset: 262144
INFO:root:
Connected to peer : 127.0.0.1 : 4010
INFO:root:Downloading Chunk 2 from: ["'127.0.0.1'", "'4030'"]. Size: 262144 with offset: 524288
INFO:root:
Connected to peer : 127.0.0.1 : 4020
INFO:root:Downloading Chunk 3 from: ["'127.0.0.1'", "'4040'"]. Size: 262144 with offset: 786432
INFO:root:
Connected to peer : 127.0.0.1 : 4030
INFO:root:Client('127.0.0.1', 47592) connected. Total connections: 7
INFO:root:
Connected to peer : 127.0.0.1 : 4040
INFO:root:Client('127.0.0.1', 47600) connected. Total connections: 8
INFO:root:
Chunk from client 4010 of file 1.txt has been correctly downloaded. Length: 262144 , with offset: 0
INFO:root:Client('127.0.0.1', 47608) connected. Total connections: 9
INFO:root:
Chunk from client 4020 of file 1.txt has been correctly downloaded. Length: 262144 , with offset: 262144
INFO:root:
Chunk from client 4040 of file 1.txt has been correctly downloaded. Length: 262144 , with offset: 786432
INFO:root:File specs received
INFO:root:Client('127.0.0.1', 47612) connected. Total connections: 7
INFO:root:File specs received
INFO:root:
Chunk from client 4030 of file 1.txt has been correctly downloaded. Length: 262144 , with offset: 524288
INFO:root:
File 1.txt correctly downloaded from:

INFO:root:    --> Client 4010 , chunk 0. At time: 1617849325.7565532
INFO:root:    --> Client 4020 , chunk 1. At time: 1617849325.7565277
INFO:root:    --> Client 4030 , chunk 2. At time: 1617849325.7782643
INFO:root:    --> Client 4040 , chunk 3. At time: 1617849325.8389251
INFO:root:
Total time to download all the chunks: 0.1637592315673828 sec.
INFO:root:File specs received
INFO:root:Chunk sent to client ('127.0.0.1', 47592). Size: 262144 with offset: 0
INFO:root:Chunk sent to client ('127.0.0.1', 47608). Size: 262144 with offset: 0
INFO:root:Chunk sent to client ('127.0.0.1', 47600). Size: 262144 with offset: 0
INFO:root:File specs received
INFO:root:Chunk sent to client ('127.0.0.1', 47612). Size: 262144 with offset: 0

```

As it can be seen in the previous figures, multiple nodes can download and send files between them without any problems.

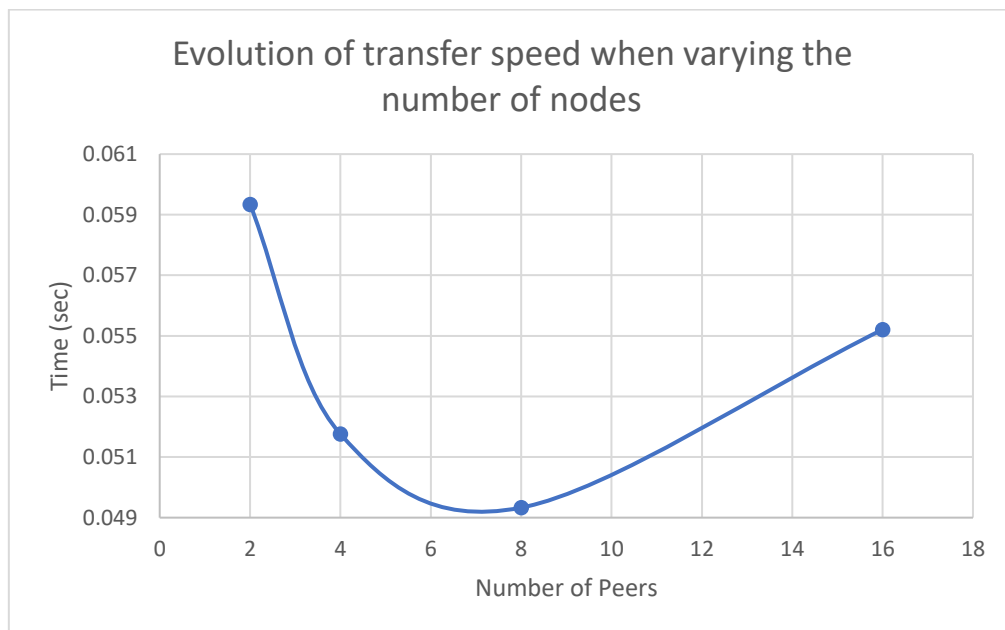
## 2. Measuring how the transfer speed changes when varying the number of nodes that holds the same requested file.

To perform this evaluation, a bash script has been created to automate the process by creating different screens and run the server and all the peers simultaneously:

```
q2.sh <num_peers>
```

The bash script deploys the indexing server, <num\_peers> (2, 4, 8 or 16) peers that will send the files and an additional peer that will request 10 files of 1 MB each (1.txt ... 10.txt) to download from the rest of the peers.

Finally, the results that have been obtained are the following:



As it can be seen in the Figure, the average response time with just 2 peers is the worst of them all and increasing the number of peers improves the transfer time. However, when the number of peers is too large (16) the transfer of the files starts getting slower. It is important to note, that the files transferred are split into the same number of chunks as peers registered for P2P downloads in the Indexing server, and all the chunks are downloaded in parallel.

These results show that using a parallel download with a moderate number of chunks improves the speed and performance of the file transfer. However, if the file is divided into too many small chunks, the transfer gets slower as the actual transfer time of the chunks does not improve as much as the time it takes to handle all those simultaneous connections.