IP Project 1
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Task 1:

Task 1 is when the one peer acts as a "Centralized File Server" and all the other peers get a file from that peer. We created an RS server such that the RS server would distribute the "Peer Index" of all the active peers with the requesting peers. Peer0 is the centralized file server in this case.

Screenshot of *nestat -a* to show that connections are being opened:

Screenshots to show Peer Index shared with different peers are shown below:

Peer0:

```
/usr/local/bin/python3.7 /Users/navya/Desktop/Pupul/CFD/CFD_P0.py
Do you want to Register?(Y/N) Y
b'P2P-DI/1.0 200 OK Cookie: 76 '
200
Peer registered with RS

Do you wish to get active peer list? (Y/N)Y
PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 76 Listening port 40001
Peer information received

Details of all peers is as follows:
```

Hostname	Cookie	Active Flag	TTL	Listening_Port	Most Recent Registration
192.168.1.47	76	Active	6174	40001	Tue Oct 1 20:33:53 2019
192.168.1.32	30	Active	6215	40000	Tue Oct 1 20:34:34 2019
192.168.1.199	26	Active	6217	40000	Tue Oct 1 20:34:37 2019
192.168.1.66	45	Active	6254	40000	Tue Oct 1 20:35:14 2019
192.168.1.66	41	Active	6258	40000	Tue Oct 1 20:35:17 2019
192.168.1.199	38	Active	6282	40000	Tue Oct 1 20:35:43 2019
192.168.1.32	61	Active	6904	40000	Tue Oct 1 20:46:13 2019

Peer1:

```
C:\Users\MEENAB\PycharmProjects\untitled\venv\Scripts\python.exe C:/Users/MEENAB/Desktop/CFD.py
Do you want to Register?(Y/N) Y
b'P2P-DI/1.0 200 OK Cookie: 30 '
200
Peer registered with RS

Do you wish to get active peer list? (Y/N)Y
PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 30 Listening port 40000
Peer information received

Details of all peers is as follows:
```

Hostname	Cookie	Active Flag	TTL	Listening_Port	Most Recent Registration
192.168.1.47	76	Active	6787	40001	Tue Oct 1 20:33:53 2019
192.168.1.32	30	Active	6828	40000	Tue Oct 1 20:34:34 2019
192.168.1.199	26	Active	6830	40000	Tue Oct 1 20:34:37 2019
192.168.1.66	45	Active	6867	40000	Tue Oct 1 20:35:14 2019
192.168.1.66	41	Active	6870	40000	Tue Oct 1 20:35:17 2019
192.168.1.199	38	Active	6895	40000	Tue Oct 1 20:35:43 2019

Peer2:

```
Do you want to Register?(Y/N) Y
b'P2P-DI/1.0 200 OK Cookie: 41 '
200
Peer registered with RS

Do you wish to get active peer list? (Y/N)Y
PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 41 Listening port 40000
Peer information received

Details of all peers is as follows:
Hostname         Cookie  Active Flag    TTL      Listening_Port  Most Recent Registration

192.168.1.47     76      Active         6796     40001           Tue Oct  1 20:33:53 2019

192.168.1.32     30      Active         6837     40000           Tue Oct  1 20:34:34 2019

192.168.1.199    26      Active         6839     40000           Tue Oct  1 20:34:37 2019

192.168.1.66     45      Active         6876     40000           Tue Oct  1 20:35:14 2019

192.168.1.66     41      Active         6879     40000           Tue Oct  1 20:35:17 2019

192.168.1.199    38      Active         6904     40000           Tue Oct  1 20:35:43 2019
```

Peer3:

```
Do you want to Register?(Y/N) Y
b'P2P-DI/1.0 200 OK Cookie: 45 '
200
Peer registered with RS

Do you wish to get active peer list? (Y/N)Y
PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 45 Listening port 40000
Peer information received

Details of all peers is as follows:
Hostname         Cookie  Active Flag    TTL      Listening_Port  Most Recent Registration

192.168.1.47     76      Active         6191     40001           Tue Oct  1 20:33:53 2019

192.168.1.32     30      Active         6232     40000           Tue Oct  1 20:34:34 2019

192.168.1.199    26      Active         6234     40000           Tue Oct  1 20:34:37 2019

192.168.1.66     45      Active         6271     40000           Tue Oct  1 20:35:14 2019

192.168.1.66     41      Active         6274     40000           Tue Oct  1 20:35:17 2019

192.168.1.199    38      Active         6299     40000           Tue Oct  1 20:35:43 2019

192.168.1.32     61      Active         6920     40000           Tue Oct  1 20:46:13 2019
```

Peer4:

```
C:\Users\Pranita\Desktop>python CFD.py
Do you want to Register?(Y/N) Y
b'P2P-DI/1.0 200 OK Cookie: 38 '
200
Peer registered with RS

Do you wish to get active peer list? (Y/N)Y
PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 38 Listening port 40000
Peer information received

Details of all peers is as follows:
Hostname         Cookie  Active Flag    TTL      Listening_Port  Most Recent Registration

192.168.1.47     76      Active         7081     40001           Tue Oct  1 20:33:53 2019

192.168.1.32     30      Active         7121     40000           Tue Oct  1 20:34:34 2019

192.168.1.199    26      Active         7124     40000           Tue Oct  1 20:34:37 2019

192.168.1.66     45      Active         7161     40000           Tue Oct  1 20:35:14 2019

192.168.1.66     41      Active         7164     40000           Tue Oct  1 20:35:17 2019

192.168.1.199    38      Active         7189     40000           Tue Oct  1 20:35:43 2019
```

Peer5:

```
C:\Users\Pranita\Desktop>python CFD.py
Do you want to Register?(Y/N) Y
b'P2P-DI/1.0 200 OK Cookie: 26 '
200
Peer registered with RS

Do you wish to get active peer list? (Y/N)Y
PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 26 Listening port 40000
Peer information received

Details of all peers is as follows:
Hostname        Cookie  Active Flag     TTL     Listening_Port  Most Recent Registration

192.168.1.47    76      Active          6911    40001           Tue Oct  1 20:33:53 2019

192.168.1.32    30      Active          6952    40000           Tue Oct  1 20:34:34 2019

192.168.1.199   26      Active          6954    40000           Tue Oct  1 20:34:37 2019

192.168.1.66    45      Active          6991    40000           Tue Oct  1 20:35:14 2019

192.168.1.66    41      Active          6995    40000           Tue Oct  1 20:35:17 2019

192.168.1.199   38      Active          7019    40000           Tue Oct  1 20:35:43 2019
```

We created different folders in two of the laptops to simulate multiple peers such that the download of RFC files would happen to that folder and the Peer0 and registration server would consider them as distinct connections.

Once the "Peer Index" is received, the peers would contact each other to get the "RFC Index" from the other peers. In this case, P0 is the only peer with non-zero RFC Index. Once "RFC Index" is shared between all the active peers, peers have the choice to download all the RFCs. While the RFCs were downloaded, the request response as shared between Peer0 with remaining peers is as shown in the below mentioned screenshots:
The request is a GET RFC and the response is the RFC requested as shown in the below screenshot. It shows all the messages transacted between the *Peer0* and requesting peer.
In the below screenshot, the IP 192.168.1.47 is the IP of *Peer0*. And the time taken here is in the units of 10^{-6} seconds.

```
Do you want to contact the peer for RFC number? (Y/N
GET RFC 8609 P2P-DI/1.0 Host: 192.168.1.47
Individual time  59422.75
GET RFC 8624 P2P-DI/1.0 Host: 192.168.1.47
Individual time  841.5
GET RFC 8600 P2P-DI/1.0 Host: 192.168.1.47
Individual time  5982.25
GET RFC 8602 P2P-DI/1.0 Host: 192.168.1.47
Individual time  14331.25
GET RFC 8641 P2P-DI/1.0 Host: 192.168.1.47
Individual time  9927.75
GET RFC 8606 P2P-DI/1.0 Host: 192.168.1.47
Individual time  2989.5
GET RFC 8635 P2P-DI/1.0 Host: 192.168.1.47
Individual time  2030.0
GET RFC 8630 P2P-DI/1.0 Host: 192.168.1.47
Individual time  3037.0
GET RFC 8603 P2P-DI/1.0 Host: 192.168.1.47
Individual time  2048.0
GET RFC 8632 P2P-DI/1.0 Host: 192.168.1.47
Individual time  8032.0
GET RFC 8629 P2P-DI/1.0 Host: 192.168.1.47
Individual time  3033.5
GET RFC 8589 P2P-DI/1.0 Host: 192.168.1.47
Individual time  5333.0
GET RFC 8597 P2P-DI/1.0 Host: 192.168.1.47
Individual time  3975.5
GET RFC 8594 P2P-DI/1.0 Host: 192.168.1.47
Individual time  5035.25
GET RFC 8586 P2P-DI/1.0 Host: 192.168.1.47
Individual time  2992.5
GET RFC 8607 P2P-DI/1.0 Host: 192.168.1.47
Individual time  6015.25
GET RFC 8599 P2P-DI/1.0 Host: 192.168.1.47
Individual time  7017.0
GET RFC 8590 P2P-DI/1.0 Host: 192.168.1.47
Individual time  6193.75
GET RFC 8604 P2P-DI/1.0 Host: 192.168.1.47
Individual time  1994.0
GET RFC 8611 P2P-DI/1.0 Host: 192.168.1.47
Individual time  3922.0
GET RFC 8619 P2P-DI/1.0 Host: 192.168.1.47
Individual time  4027.0
GET RFC 8615 P2P-DI/1.0 Host: 192.168.1.47
Individual time  4970.5
```

When the RFCs were downloaded, a timer would run to calculate the time taken for each file to be downloaded along with the total time taken to download the file. The graph plotted for cumulative time taken for all RFC files against each peer is shown below (proof is each cumulative time taken by each peer in sequence is also attached):

```
Individual time  15995.0
Received all RFC's
time =  1051502.75
```
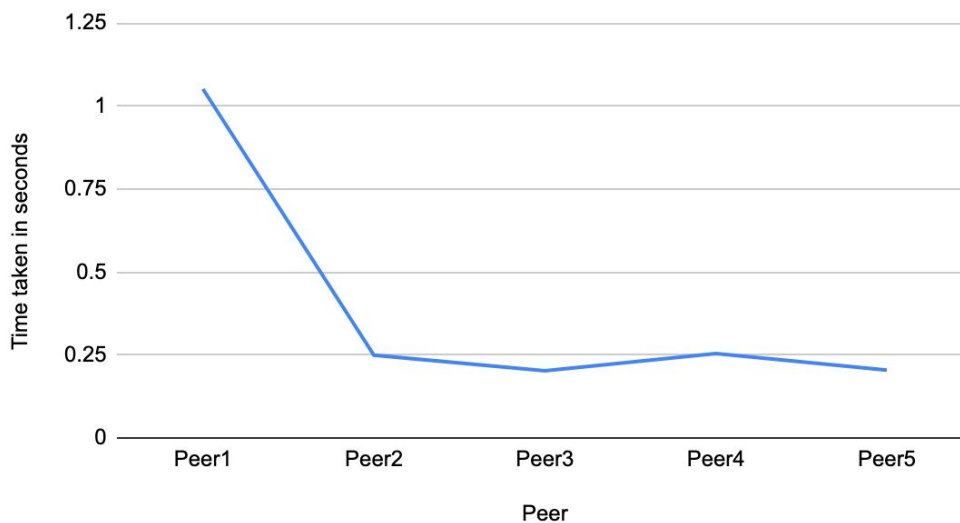
```
Individual time  0.0
Received all RFC's
time =  249808.75
```

```
GET RFC 8634 P2P-DI/1.0 Host: 192.168.1.47
Individual time  0.0
Received all RFC's
time =  202976.75
```

```
GET RFC 8634 P2P-DI/1.0 Host: 192.168.1.47
Individual time  998.0
Received all RFC's
time =  254852.75
```

```
Individual time  0.0
GET RFC 8634 P2P-DI/1.0 Host: 192.168.1.47
Individual time  2006.75
Received all RFC's
time =  204580.5
```

Cumulative download time against each peer

Task2:

The message transaction between peers in Task 2 follows the exact same flow as in Task 1, the only difference being that all the peers have an RFC Index with 10 RFCs each.
After registering with the Registration server, the server had the below list of peers connected and it responded to each peer with the PQuery message as shown in the attached screenshot:.
The Peer Index received by each peer followed the exact same process as it followed in the centralised file distribution. The same peer index shown below were transmitted to each peer on receiving the query.

```
Details of all peers is as follows:

Hostname          Cookie  Active Flag     TTL      Listening_Port  Most Recent Registration

192.168.1.66      76      Active          7196     40000           Wed Oct  2 01:08:52 2019

192.168.1.32      75      Active          7186     40002           Wed Oct  2 01:08:59 2019

192.168.1.199     27      Active          7189     40001           Wed Oct  2 01:08:56 2019

192.168.1.83      18      Active          7196     40004           Wed Oct  2 01:09:03 2019

192.168.1.111     64      Active          7200     40005           Wed Oct  2 01:09:06 2019


Sent Peer-Index Table

Message from peer
b'PQUERY P2P-DI/1.0 Host: 192.168.1.66 Cookie: 76 Listening port 40000 '


Message from peer
b'PQUERY P2P-DI/1.0 Host: 192.168.1.199 Cookie: 27 Listening port 40001 '

Sent Peer-Index Table

Message from peer
b'PQUERY P2P-DI/1.0 Host: 192.168.1.32 Cookie: 75 Listening port 40002 '

Sent Peer-Index Table

Message from peer
b'PQUERY P2P-DI/1.0 Host: 192.168.1.83 Cookie: 18 Listening port 40004 '

Sent Peer-Index Table

Message from peer
b'PQUERY P2P-DI/1.0 Host: 192.168.1.111 Cookie: 64 Listening port 40005 '
```

The time taken for downloading individual set of 10 RFC files from each peer followed messaging as shown in the below mentioned screenshot. We calculated the time taken to download 10 files from individual peers in a loop and all the download of files was a parallel operation. Eg: P0 was transmitting to P1, P2, P3, P4 and P5 at the same time when P1 was transmitting to P0, P2, P3, P4 and P5.

```
Individual time  0.0
GET RFC 8604 P2P-DI/1.0 Host: 192.168.1.199
Individual time  0.0
Received 10 RFCs
46755.0
192.168.1.83
192.168.1.83
40004
GET RFC 8625 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8627 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8628 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8629 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8630 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8631 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8632 P2P-DI/1.0 Host: 192.168.1.83
Individual time  15583.0
GET RFC 8633 P2P-DI/1.0 Host: 192.168.1.83
Individual time  0.0
GET RFC 8634 P2P-DI/1.0 Host: 192.168.1.83
Individual time  15625.0
GET RFC 8635 P2P-DI/1.0 Host: 192.168.1.83
Individual time  15664.25
Received 10 RFCs
93627.25
192.168.1.111
192.168.1.111
40005
GET RFC 8641 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15582.0
GET RFC 8649 P2P-DI/1.0 Host: 192.168.1.111
Individual time  0.0
GET RFC 8637 P2P-DI/1.0 Host: 192.168.1.111
Individual time  0.0
GET RFC 8642 P2P-DI/1.0 Host: 192.168.1.111
Individual time  0.0
GET RFC 8645 P2P-DI/1.0 Host: 192.168.1.111
Individual time  0.0
GET RFC 8638 P2P-DI/1.0 Host: 192.168.1.111
Individual time  0.0
GET RFC 8640 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15551.75
GET RFC 8636 P2P-DI/1.0 Host: 192.168.1.111
Individual time  0.0
GET RFC 8639 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15615.0
GET RFC 8643 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15626.5
Received 10 RFCs
156002.5
Received all RFC's
Total time =  156002.5
```

```
Individual time  15995.75
Received 10 RFCs
135901.5
192.168.1.83
40004
192.168.1.83
40004
GET RFC 8625 P2P-DI/1.0 Host: 192.168.1.83
Individual time  16016.75
GET RFC 8627 P2P-DI/1.0 Host: 192.168.1.83
Individual time  23932.75
GET RFC 8628 P2P-DI/1.0 Host: 192.168.1.83
Individual time  24026.5
GET RFC 8629 P2P-DI/1.0 Host: 192.168.1.83
Individual time  28025.0
GET RFC 8630 P2P-DI/1.0 Host: 192.168.1.83
Individual time  20004.75
GET RFC 8631 P2P-DI/1.0 Host: 192.168.1.83
Individual time  20030.5
GET RFC 8632 P2P-DI/1.0 Host: 192.168.1.83
Individual time  27935.5
GET RFC 8633 P2P-DI/1.0 Host: 192.168.1.83
Individual time  24011.0
GET RFC 8634 P2P-DI/1.0 Host: 192.168.1.83
Individual time  20002.5
GET RFC 8635 P2P-DI/1.0 Host: 192.168.1.83
Individual time  15998.25
Received 10 RFCs
355885.0
192.168.1.111
40005
192.168.1.111
40005
GET RFC 8641 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15933.75
GET RFC 8649 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15933.5
GET RFC 8637 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15989.25
GET RFC 8642 P2P-DI/1.0 Host: 192.168.1.111
Individual time  12021.5
GET RFC 8645 P2P-DI/1.0 Host: 192.168.1.111
Individual time  19951.5
GET RFC 8638 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15999.0
GET RFC 8640 P2P-DI/1.0 Host: 192.168.1.111
Individual time  15996.25
GET RFC 8636 P2P-DI/1.0 Host: 192.168.1.111
Individual time  16001.25
GET RFC 8639 P2P-DI/1.0 Host: 192.168.1.111
Individual time  23990.75
GET RFC 8643 P2P-DI/1.0 Host: 192.168.1.111
Individual time  11986.0
Received 10 RFCs
519687.75
Received all RFC's
Total time =  519687.75
```
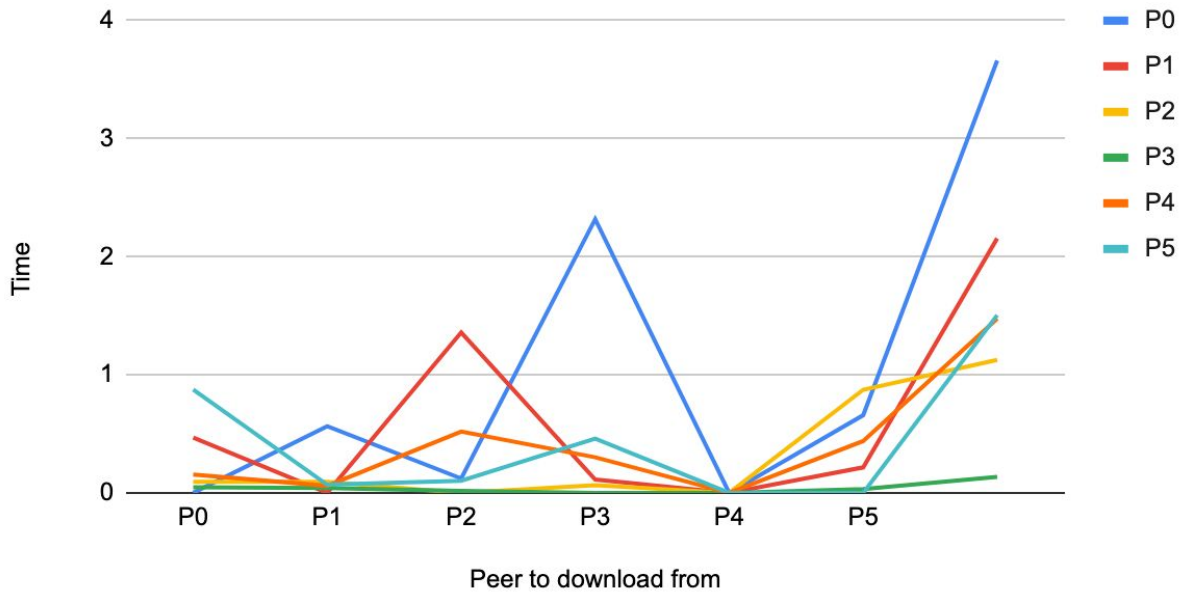
Attached logs files also have the sequence of messages which shows the time taken to download each RFC file and set of 10 RFC files.

Once the files were requested and downloaded, the plot of cumulative time taken to download 10 RFC files against each peer is shown below:

Cumulative Time taken to download RFC Files in distributed environment

The time taken to download RFC files by Peer1 from all the peers is lesser than the time taken by any other peer to download from other peers. In the case of Task , Peer 3 took the least amount of time and for task2, Peer 1 took the least amount of time. We see that the cumulative time taken to download RFC files in a distributed environment is better than the centralised one. This is because multiple peers are sending files simultaneously to receiving peer.

Below tables show the time taken for distributed and centralised environments:

Distributed system(Time taken in seconds):

Time	P0	P1	P2	P3	P4	P5	Total
P0	0	0.46755	0.093627	0.046591	0.156002	0.87549	1.63926
P1	0.56379	0	0.093476	0.040012	0.059761	0.068649	0.825688
P2	0.121964	1.359001	0	0.015998	0.519687	0.102237	2.118887
P3	0.31854	0.113432	0.065399	0	0.301291	0.458912	1.257574
P4	0	0	0	0	0	0	0
P5	0.65827	0.21593	0.87361	0.032772	0.43926	0	2.219842

Centralised System (Time taken in seconds):

Peer	Time
Peer1	1.051502
Peer2	0.249808
Peer3	0.202976
Peer4	0.254852
Peer5	0.20458