

# CSC/ECE 573 – Internet Protocols

## Project #1

### Report for TASK 1 & 2

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#### Application Message Format:

PEER TO RS/PEER:

1.) **Registering** the Client P2P-DI/1.0 200 OK

Cookie:10.154.36.140:61040

Hostname: 10.154.36.140

OS:Windows

2.) **KEEPALIVE** P2P-DI/1.0 Host:10.155.36.140 cookieNum:10.155.36.140:61042 OS:Windows

Requesting Peer-Index from RS...

3.) **GET PEER-INDEX** P2P-DI/1.0 Host:10.155.36.140 cookieNum:10.155.36.140:61042 OS:Windows

Requesting RFC-Index from Peer 10.154.0.185:40004....

4.) **GET RFC-INDEX** P2P-DI/1.0 Host:10.155.36.140 OS:Windows

RFC-Index successfully downloaded on ('10.155.36.140', 61045)

Searching Merged RFC-Index....

Requesting RFC 8130 from peer 10.154.0.185:40004..

5.) **GET RFC8130** P2P-DI/1.0 Host:10.155.36.140OS:Windows

RFC 8130 successfully downloaded!

Completed searching for all required RFCs

Leave or stay??

Leave

6.) **LEAVE** P2P-DI/1.0 Host:10.155.36.140cookieNum:10.155.36.140:61042OS:Windows

Leaving the P2P network

## TASK 1: Centralized File Distribution

We created 6 peers as P0, P1, P2, P3, P4, P5 and a Registration Server as RS.  
P0 Consisted of 60 RFC Files where as P1, P2, P3, P4 and P5 consisted of no RFC Files.  
P1 to P5 downloaded 50 files each from P0 in all making total downloads as 250 files.

Data in Files created at the client and server folder of P0(emulating as Centralized Server):

Client files:

Cookie File:

P0 cookie : 192.168.0.14:51547

RFC Index File: (Below data is just an instance of RFC index table created in file, it actually has 60 RFC details in below format and all RFC were present locally)

RFC NUMBER	RFC TITLE	HOSTNAME	TTL
8150	MPLS Transport Profile Linear Protection	MIB 192.168.0.14	7200
8151	Use Cases for Data Center Network Virtualization Overlay Networks	192.168.0.14	7200
8152	CBOR Object Signing and Encryption ( COSE )	192.168.0.14	7200
8153	Digital Preservation Considerations for the RFC Series	192.168.0.14	7200
8154	Parallel NFS ( pNFS ) Small Computer System Interface ( SCSI ) Layout	192.168.0.14	7200

Timer : (Time required to download each file)

The cumulative time taken for obtaining all required RFCs: **0.0** (Since no downloads required)

Server Files:

Peer Index:

HOSTNAME	COOKIE	ACTIVE FLAG	TTL	LISTENING PORT	REGISTRATION
192.168.0.14	192.168.0.14:51547	Active	7200	40000 1	Sun Sep 29 01:09:27 2019
192.168.0.8	192.168.0.8:50209	Active	7200	40004 1	Sun Sep 29 01:09:28 2019
192.168.0.6	192.168.0.6:50961	Active	7200	40005 1	Sun Sep 29 01:09:30 2019
192.168.0.9	192.168.0.9:50856	Active	7200	40006 1	Sun Sep 29 01:09:31 2019

192.168.0.12	192.168.0.12:51234	Active	7200	40007	1	Sun Sep 29 01:09:32 2019
192.168.0.22	192.168.0.22:50671	Active	7200	40009	1	Sun Sep 29 01:09:34 2019

### Data in Files created at the client folder of P1:

#### Cookie File:

P1 cookie : 192.168.0.8:50209

RFC Index File: (Below data is just an instance of RFC index table created in file, it actually has 60 RFC details in below format)

RFC NUMBER	RFC TITLE	HOSTNAME	TTL
8170	Planning for Protocol Adoption and Subsequent Transitions	192.168.0.14	7200
8169	Residence Time Measurement in MPLS Networks	192.168.0.14	7200
8168	DHCPv6 Prefix - Length Hint Issues	192.168.0.14	7200
8167	Bidirectional Remote Procedure Call on RPC –over –RDMA	192.168.0.14	7200
8166	Remote Direct Memory Access Transport for Remote Procedure Call Version 1	192.168.0.14	7200

Timer : (Time required to download each file)

The cumulative time taken for obtaining 50 required RFCs at P1: 24.866065281

The time taken for obtaining RFC 8130: 0.485000177383

The time taken for obtaining RFC 8131: 0.314999914169

The time taken for obtaining RFC 8132: 0.23499994278

The time taken for obtaining RFC 8133: 0.334000099182

The time taken for obtaining RFC 8134: 1.22699986458

The time taken for obtaining RFC 8135: 0.1939998626709

The time taken for obtaining RFC 8136: 0.18340003624

The time taken for obtaining RFC 8137: 0.112999916077

The time taken for obtaining RFC 8138: 0.178999908447

The time taken for obtaining RFC 8139: 0.17000091553

The time taken for obtaining RFC 8140: 0.780000267029

The time taken for obtaining RFC 8141: 0.0409998512268

The time taken for obtaining RFC 8142: 0.0509998512268

The time taken for obtaining RFC 8143: 0.0770001316071

The time taken for obtaining RFC 8144: 0.0750000572205  
The time taken for obtaining RFC 8145: 0.09700001316071  
The time taken for obtaining RFC 8146: 0.2345099946594  
The time taken for obtaining RFC 8147: 0.323400047684  
The time taken for obtaining RFC 8148: 2.4560004768  
The time taken for obtaining RFC 8149: 0.1564999952316  
The time taken for obtaining RFC 8150: 0.389000177383  
The time taken for obtaining RFC 8151: 0.214999914169  
The time taken for obtaining RFC 8152: 0.43499994278  
The time taken for obtaining RFC 8153: 0.321000099182  
The time taken for obtaining RFC 8154: 1.11699986458  
The time taken for obtaining RFC 8155: 0.0939998626709  
The time taken for obtaining RFC 8156: 0.18700003624  
The time taken for obtaining RFC 8157: 0.112999916077  
The time taken for obtaining RFC 8158: 0.145999908447  
The time taken for obtaining RFC 8159: 0.104000091553  
The time taken for obtaining RFC 8160: 0.0720000267029  
The time taken for obtaining RFC 8161: 0.0809998512268  
The time taken for obtaining RFC 8162: 0.0809998512268  
The time taken for obtaining RFC 8163: 0.0870001316071  
The time taken for obtaining RFC 8164: 0.0650000572205  
The time taken for obtaining RFC 8165: 0.0870001316071  
The time taken for obtaining RFC 8166: 0.230999946594  
The time taken for obtaining RFC 8167: 0.325000047684  
The time taken for obtaining RFC 8168: 3.82500004768  
The time taken for obtaining RFC 8169: 0.174999952316  
The time taken for obtaining RFC 8170: 0.15700006485  
The time taken for obtaining RFC 8171: 0.21000014169  
The time taken for obtaining RFC 8172: 0.4340094278  
The time taken for obtaining RFC 8173: 0.3256700099182  
The time taken for obtaining RFC 8174: 1.11656986458  
The time taken for obtaining RFC 8175: 0.034598626709  
The time taken for obtaining RFC 8176: 0.200003624  
The time taken for obtaining RFC 8177: 0.452999916077

The time taken for obtaining RFC 8178: 0.6785999908447

The time taken for obtaining RFC 8179: 0.4567000091553

### Data in Files created at the client folder of P2:

#### Cookie File:

P2 cookie : 192.168.0.6:50961

RFC Index File: (Below data is just an instance of RFC index table created in file, it actually has 60 RFC details in below format)

RFC NUMBER	RFC TITLE	HOSTNAME	TTL
8165	Design Considerations for Metadata Insertion	192.168.0.14	7200
8164	Opportunistic Security for HTTP / 2	192.168.0.14	7200
8163	Transmission of IPv6 over Master - Slave / Token - Passing ( MS / TP ) Networks	192.168.0.14	7200
8162	Using Secure DNS to Associate Certificates with Domain Names for S / MIME	192.168.0.14	7200
8161	Benchmarking the Neighbor Discovery Protocol	192.168.0.14	7200

#### Timer : (Time required to download each file)

The cumulative time taken for obtaining 50 required RFCs at P2: 19.41103805

The time taken for obtaining RFC 8130: 0.7234300003052

The time taken for obtaining RFC 8131: 1.22200012207

The time taken for obtaining RFC 8132: 0.259076

The time taken for obtaining RFC 8133: 1.138000011444

The time taken for obtaining RFC 8134: 0.345299990654

The time taken for obtaining RFC 8135: 0.5679999752045

The time taken for obtaining RFC 8136: 0.2234000080109

The time taken for obtaining RFC 8137: 0.231999988556

The time taken for obtaining RFC 8138: 0.1234999950409

The time taken for obtaining RFC 8139: 0.169000005722

The time taken for obtaining RFC 8140: 0.0910001087189

The time taken for obtaining RFC 8141: 1.23446594

The time taken for obtaining RFC 8142: 0.069237061  
The time taken for obtaining RFC 8143: 0.234999990463  
The time taken for obtaining RFC 8144: 0.092001086  
The time taken for obtaining RFC 8145: 0.23447684  
The time taken for obtaining RFC 8146: 0.821999921799  
The time taken for obtaining RFC 8147: 0.2234  
The time taken for obtaining RFC 8148: 0.100085831  
The time taken for obtaining RFC 8149: 0.234600014  
The time taken for obtaining RFC 8150: 3.74300003052  
The time taken for obtaining RFC 8151: 0.22200012207  
The time taken for obtaining RFC 8152: 0.25  
The time taken for obtaining RFC 8153: 0.138000011444  
The time taken for obtaining RFC 8154: 0.12299990654  
The time taken for obtaining RFC 8155: 0.0759999752045  
The time taken for obtaining RFC 8156: 0.216000080109  
The time taken for obtaining RFC 8157: 0.111999988556  
The time taken for obtaining RFC 8158: 0.151999950409  
The time taken for obtaining RFC 8159: 0.069000005722  
The time taken for obtaining RFC 8160: 0.0610001087189  
The time taken for obtaining RFC 8161: 0.105999946594  
The time taken for obtaining RFC 8162: 0.0799999237061  
The time taken for obtaining RFC 8163: 0.134999990463  
The time taken for obtaining RFC 8164: 0.0910000801086  
The time taken for obtaining RFC 8165: 0.700000047684  
The time taken for obtaining RFC 8166: 0.181999921799  
The time taken for obtaining RFC 8167: 0.125  
The time taken for obtaining RFC 8168: 0.160000085831  
The time taken for obtaining RFC 8169: 0.146000146866  
The time taken for obtaining RFC 8170: 0.085000038147  
The time taken for obtaining RFC 8171: 0.22200012207  
The time taken for obtaining RFC 8172: 1.3123097845  
The time taken for obtaining RFC 8173: 1.238000011444  
The time taken for obtaining RFC 8174: 0.02299990654  
The time taken for obtaining RFC 8175: 0.45659999752045

The time taken for obtaining RFC 8176: 0.016000080109

The time taken for obtaining RFC 8177: 0.145999988556

The time taken for obtaining RFC 8178: 2.123999950409

The time taken for obtaining RFC 8179: 0.109000005722

Similarly for the Remaining Peers i.e P3, P4 and P5:

Cookie File:

P3 cookie : 192.168.0.9:50856

P4 cookie : 192.168.0.12:51234

P5 cookie : 192.168.0.22:50671

RFC Index File: (Below data is just an instance of RFC index table created in files at Peer P3, P4 & P5, it actually has 60 RFC details in below format)

RFC NUMBER	RFC TITLE	HOSTNAME	TTL
8165	Design Considerations for Metadata Insertion	192.168.0.14	7200
8164	Opportunistic Security for HTTP / 2	192.168.0.14	7200
8163	Transmission of IPv6 over Master - Slave / Token - Passing ( MS / TP ) Networks	192.168.0.14	7200
8162	Using Secure DNS to Associate Certificates with Domain Names for S / MIME	192.168.0.14	7200
8161	Benchmarking the Neighbor Discovery Protocol	192.168.0.14	7200

Timer : (Cumulative Time required to download all 50 files by P3, P4 & P5)

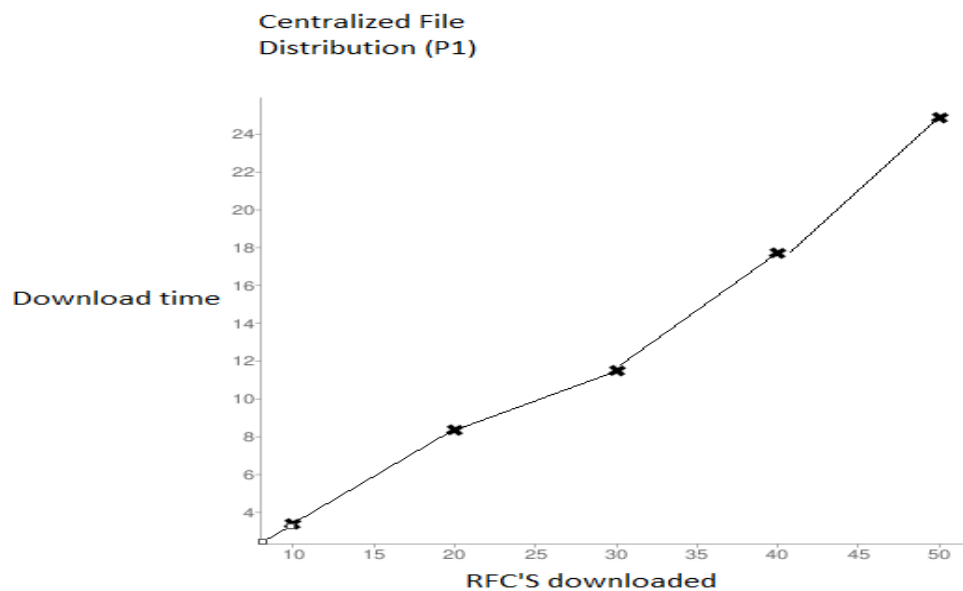
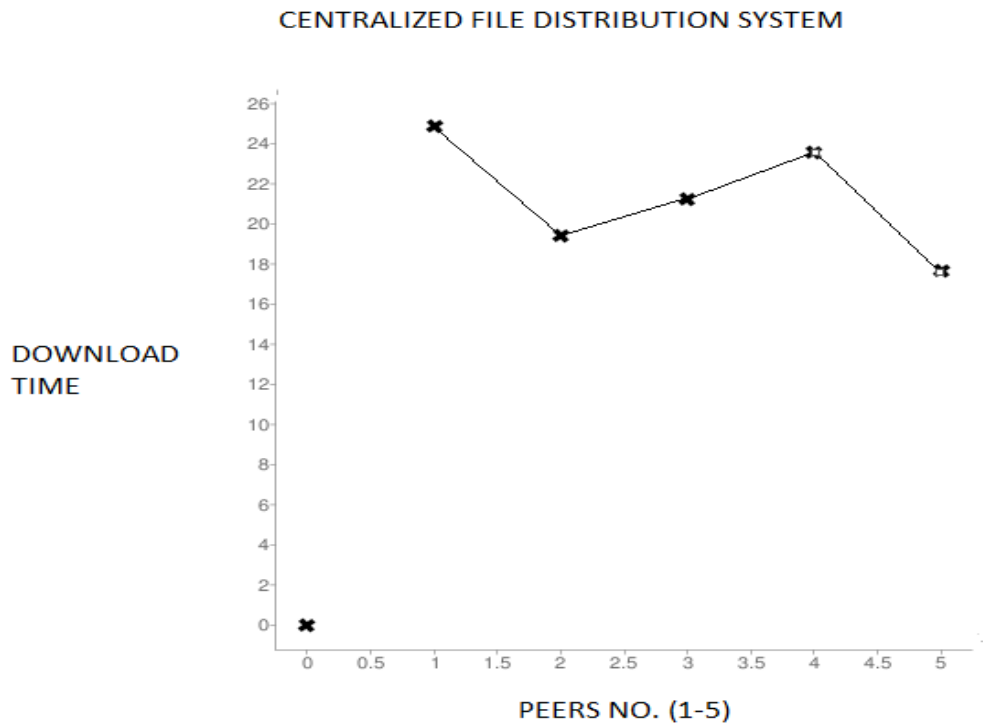
The cumulative time taken for obtaining 50 required RFCs at P3: 21.23495998

The cumulative time taken for obtaining 50 required RFCs at P4: 23.566784

The cumulative time taken for obtaining 50 required RFCs at P5: 17.6789076

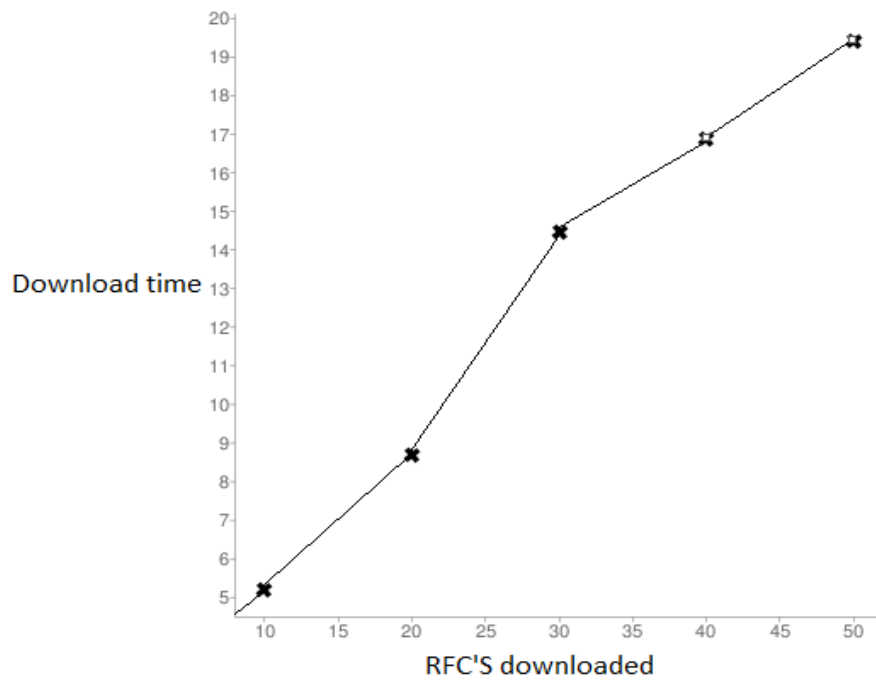
## CUMULATIVE DOWNLOAD time Curves:

- 1.) Combined Cumulative Download time Curve for each peer i.e P1 to P5 for downloading all 50 files each: Download Time for 50 files each against peers.

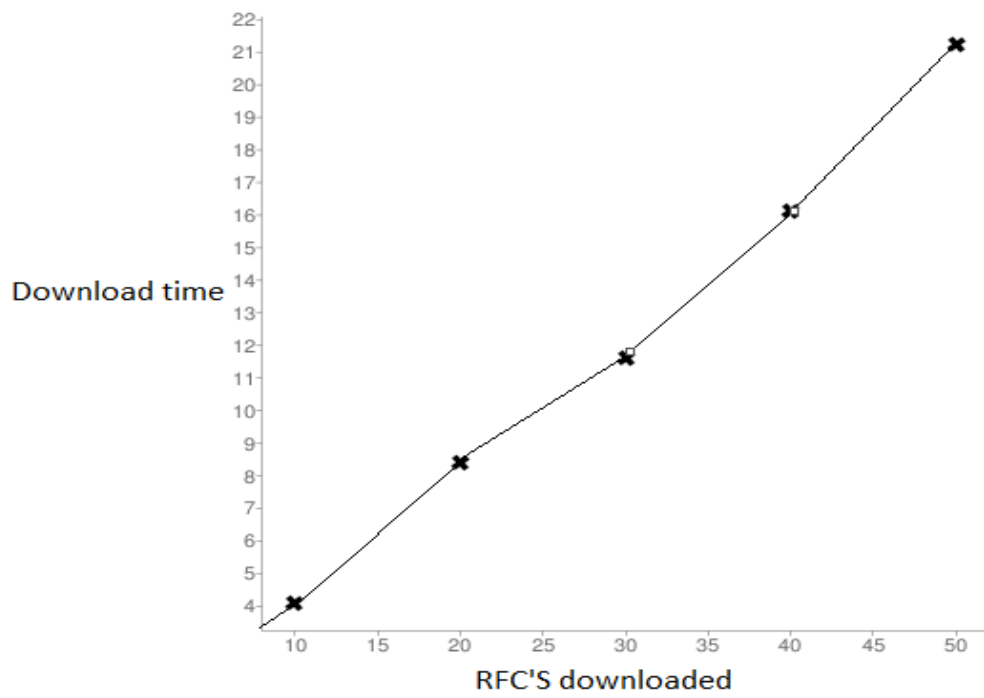




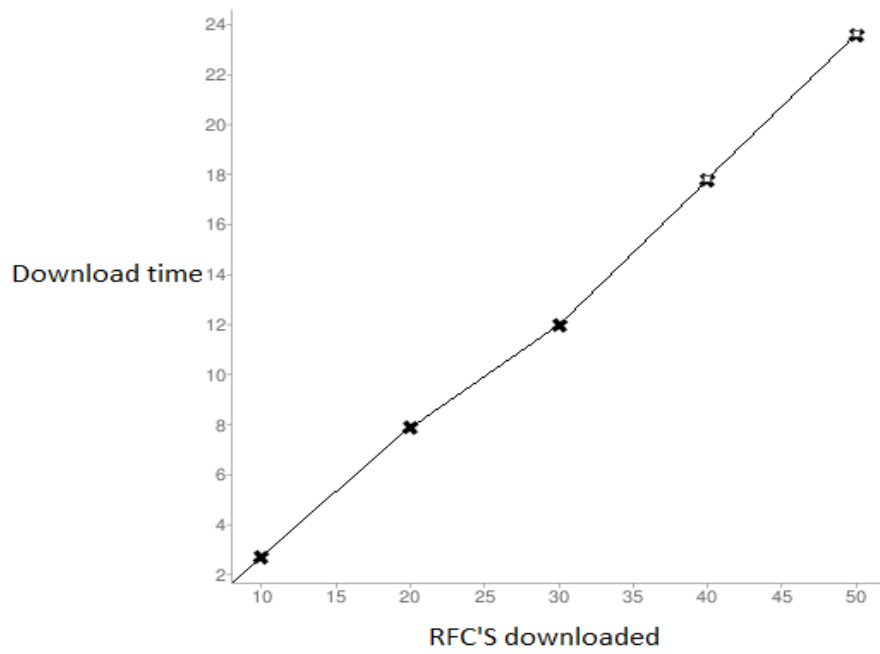
Centralized File  
Distribution (P2)



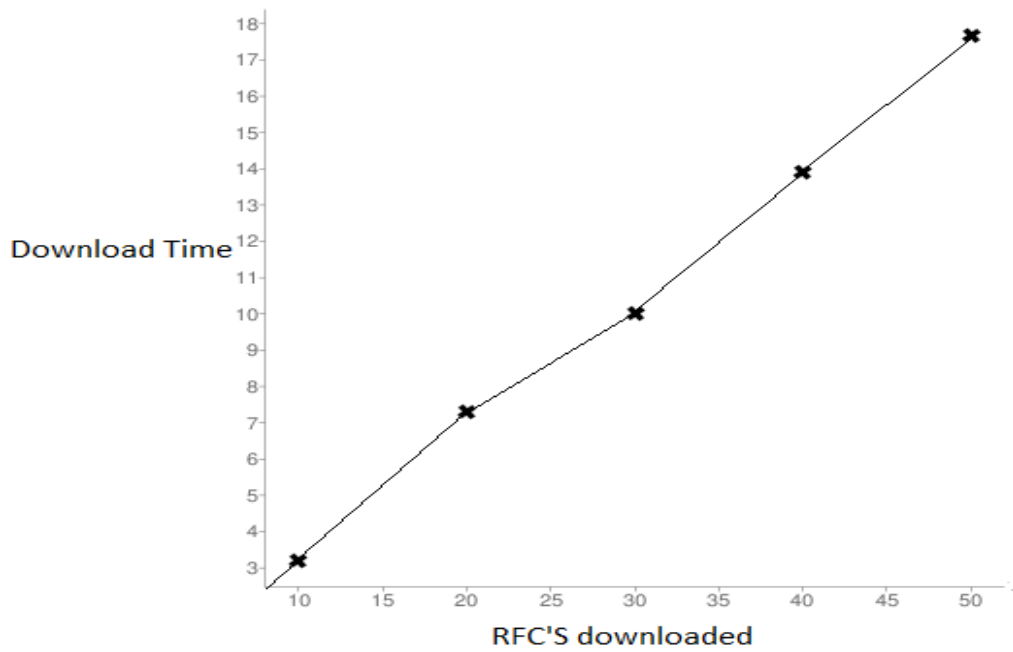
Centralized File  
Distribution (P3)



Centralized File  
Distribution (P4)



Centralized File  
Distribution (P5)



## TASK 2: P2P FILE DISTRIBUTION

We created 6 peers as P0, P1, P2, P3, P4, P5 and a Registration Server as RS.

All the 6 peers in the system P0, P1, P2, P3, P4 and P5 had 10 RFC Files each initially and no two peers in the system had the same RFC files.

Data in Files created at the client folder of P0:

Client files:

Cookie File:

P0 cookie: 192.168.0.14:51564

Timer : (Time required to download each file)

The cumulative time taken for obtaining all required 50 RFCs: 23.095688320954

The time taken for obtaining RFC 8141: 0.0859999656677

The time taken for obtaining RFC 8142: 0.236000061035

The time taken for obtaining RFC 8143: 0.126999855042

The time taken for obtaining RFC 8144: 0.210999965668

The time taken for obtaining RFC 8145: 0.289000034332

The time taken for obtaining RFC 8146: 1.257999897

The time taken for obtaining RFC 8147: 3.49400019646

The time taken for obtaining RFC 8148: 0.148999929428

The time taken for obtaining RFC 8149: 0.085000038147

The time taken for obtaining RFC 8150: 0.0789999961853

The time taken for obtaining RFC 8151: 0.124000072479

The time taken for obtaining RFC 8152: 0.0929999351501

The time taken for obtaining RFC 8153: 0.0750000476837

The time taken for obtaining RFC 8154: 0.73825894287

The time taken for obtaining RFC 8155: 0.2943809218599

The time taken for obtaining RFC 8156: 0.0759352996577

The time taken for obtaining RFC 8157: 0.321342950845

The time taken for obtaining RFC 8158: 0.429375019842

The time taken for obtaining RFC 8159: 0.12367632164

The time taken for obtaining RFC 8160: 0.5682975829848

The time taken for obtaining RFC 8161: 0.0328718417598  
The time taken for obtaining RFC 8162: 0.1435276528725  
The time taken for obtaining RFC 8163: 1.27428954957  
The time taken for obtaining RFC 8164: 0.6735672655999  
The time taken for obtaining RFC 8165: 0.218742389245  
The time taken for obtaining RFC 8166: 0.0378215685914  
The time taken for obtaining RFC 8167: 0.4381278998124  
The time taken for obtaining RFC 8168: 0.138947904564  
The time taken for obtaining RFC 8169: 0.257987006475  
The time taken for obtaining RFC 8170: 0.092487358017  
The time taken for obtaining RFC 8171: 1.283715898457  
The time taken for obtaining RFC 8172: 0.127640082343  
The time taken for obtaining RFC 8173: 0.1897580590175  
The time taken for obtaining RFC 8174: 0.4738253276289  
The time taken for obtaining RFC 8175: 2.2485901983428  
The time taken for obtaining RFC 8176: 0.493283740594  
The time taken for obtaining RFC 8177: 0.29328899857  
The time taken for obtaining RFC 8178: 0.1547299854  
The time taken for obtaining RFC 8179: 0.1892374762708  
The time taken for obtaining RFC 8180: 0.134128548277  
The time taken for obtaining RFC 8181: 0.05912752755  
The time taken for obtaining RFC 8182: 0.0859999656677  
The time taken for obtaining RFC 8183: 0.0838473528  
The time taken for obtaining RFC 8184: 0.3265543  
The time taken for obtaining RFC 8185: 0.0032500452899  
The time taken for obtaining RFC 8186: 1.2458458000035  
The time taken for obtaining RFC 8187: 0.4234875708  
The time taken for obtaining RFC 8188: 0.16934008889  
The time taken for obtaining RFC 8189: 0.1283746985482  
The time taken for obtaining RFC 8190: 0.503999948502

## Data in Files created at the client folder of P1:

Client files:

### Cookie File:

P1 cookie: 192.168.0.8:51321

### Timer : (Time required to download each file)

The cumulative time taken for obtaining all required 50 RFCs: 19.11785687717

The time taken for obtaining RFC 8131: 0.250999927521

The time taken for obtaining RFC 8132: 0.136999845505

The time taken for obtaining RFC 8133: 0.599999904633

The time taken for obtaining RFC 8134: 1.26200008392

The time taken for obtaining RFC 8135: 0.841000080109

The time taken for obtaining RFC 8136: 0.171999931335

The time taken for obtaining RFC 8137: 0.140000104904

The time taken for obtaining RFC 8138: 0.25

The time taken for obtaining RFC 8139: 0.325000047684

The time taken for obtaining RFC 8140: 0.118000030518

The time taken for obtaining RFC 8151: 0.131999969482

The time taken for obtaining RFC 8152: 0.116000175476

The time taken for obtaining RFC 8153: 0.536999940872

The time taken for obtaining RFC 8154: 0.10249385858

The time taken for obtaining RFC 8155: 0.029734897525

The time taken for obtaining RFC 8156: 0.89283009438

The time taken for obtaining RFC 8157: 0.504385978435

The time taken for obtaining RFC 8158: 0.241787848579

The time taken for obtaining RFC 8159: 0.73640045808

The time taken for obtaining RFC 8160: 0.162546108578

The time taken for obtaining RFC 8161: 0.120053850059

The time taken for obtaining RFC 8162: 1.130535179505

The time taken for obtaining RFC 8163: 0.6668471900

The time taken for obtaining RFC 8164: 0.19214766006

The time taken for obtaining RFC 8165: 0.136570005638

The time taken for obtaining RFC 8166: 0.12453057306

The time taken for obtaining RFC 8167: 0.592706453372

The time taken for obtaining RFC 8168: 0.435541205439  
The time taken for obtaining RFC 8169: 0.12408329894  
The time taken for obtaining RFC 8170: 0.140398105838  
The time taken for obtaining RFC 8171: 0.01342823854  
The time taken for obtaining RFC 8172: 0.22300050885  
The time taken for obtaining RFC 8173: 0.41035080109  
The time taken for obtaining RFC 8174: 1.171344431335  
The time taken for obtaining RFC 8175: 0.13212134904  
The time taken for obtaining RFC 8176: 0.423141029298  
The time taken for obtaining RFC 8177: 0.350005898334  
The time taken for obtaining RFC 8178: 0.148312029481  
The time taken for obtaining RFC 8179: 0.125646040495  
The time taken for obtaining RFC 8180: 0.1004384  
The time taken for obtaining RFC 8181: 0.536002399542  
The time taken for obtaining RFC 8182: 0.823404382444  
The time taken for obtaining RFC 8183: 0.085325758303  
The time taken for obtaining RFC 8184: 0.12708085  
The time taken for obtaining RFC 8185: 0.39485  
The time taken for obtaining RFC 8186: 0.102394000476  
The time taken for obtaining RFC 8187: 0.1003485832  
The time taken for obtaining RFC 8188: 0.1999953642  
The time taken for obtaining RFC 8189: 0.161148411941  
The time taken for obtaining RFC 8190: 0.342000007629

Similarly for the Remaining Peers i.e P3, P4 and P5:

Cookie File:

P2 cookie: 192.168.0.6:51453

P3 cookie : 192.168.0.9:51632

P4 cookie : 192.168.0.12:51247

P5 cookie : 192.168.0.22:51642

Timer : (Cumulative Time required to download all 50 files by P2, P3, P4 & P5)

The cumulative time taken for obtaining all required RFCs at P2: 11.49285716857

The cumulative time taken for obtaining 50 required RFCs at P3: 21.598430939031

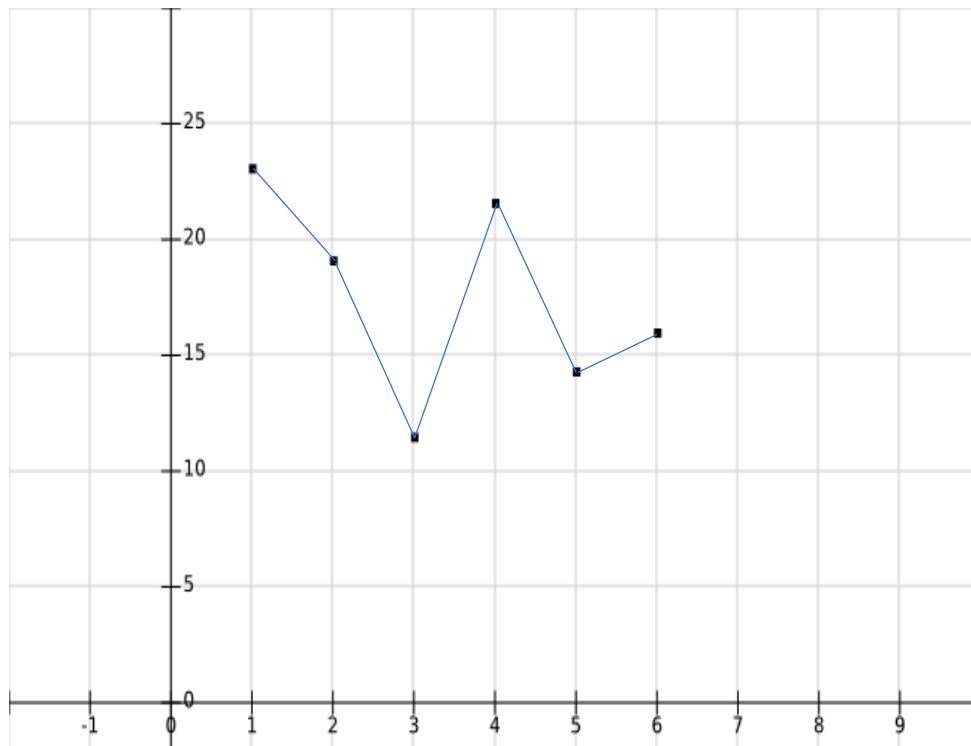
The cumulative time taken for obtaining 50 required RFCs at P4: 14.325403202384

The cumulative time taken for obtaining 50 required RFCs at P5: 16.73045682289

Combined Cumulative Download time curve for each peers P1 to P6 for downloading all 50 files each:

### P2P DISTRIBUTION

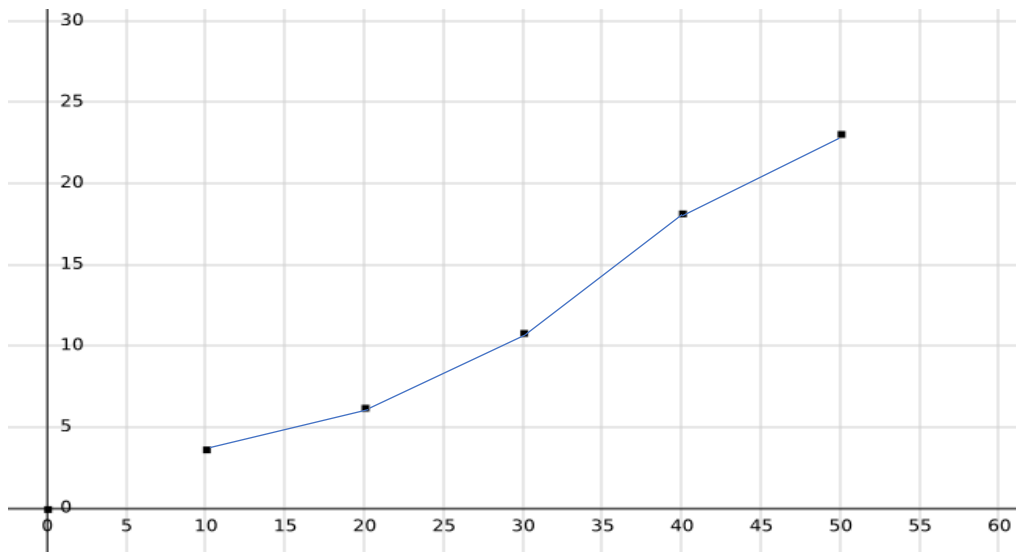
DOWNLOAD TIME



PEER NUMBER (1-6)

P2P DISTRIBUTION GRAPH FOR PEER 0:

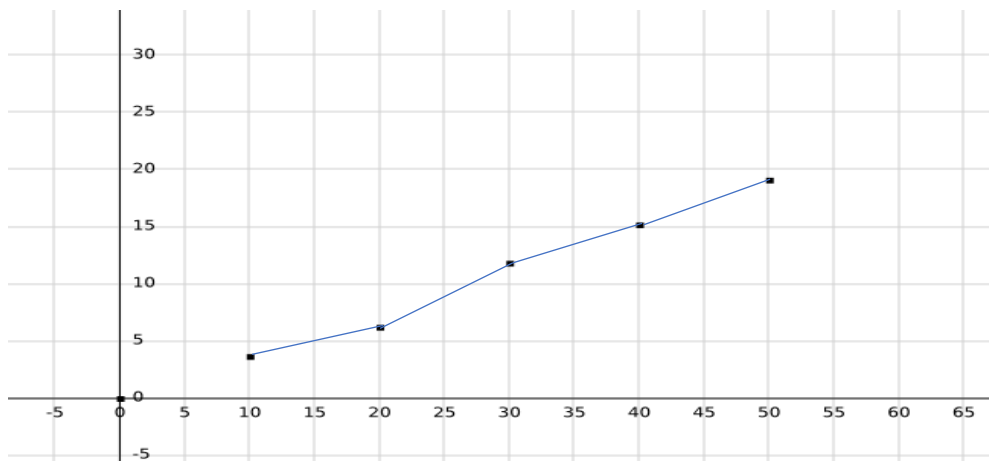
DOWNLOAD TIME



NO OF RFC'S DOWNLOADED

P2P DISTRIBUTION GRAPH FOR PEER 1:

DOWNLOAD TIME

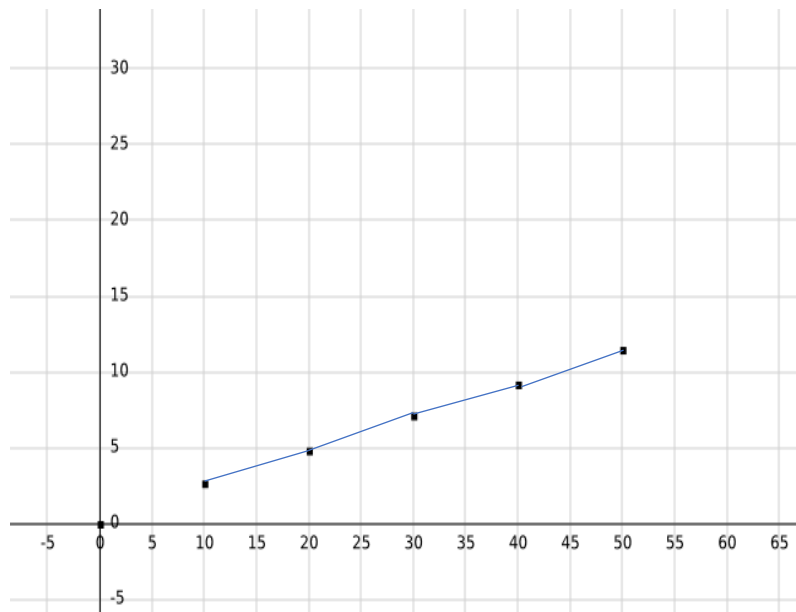


NO OF RFC'S DOWNLOADED



P2P DISTRIBUTION GRAPH FOR PEER 2:

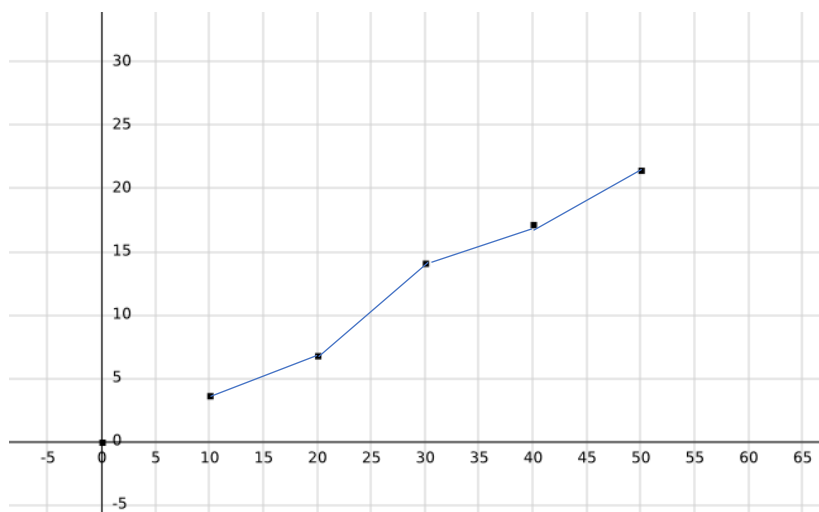
DOWNLOAD TIME



NO OF RFC'S DOWNLOADED

P2P DISTRIBUTION GRAPH FOR PEER 3:

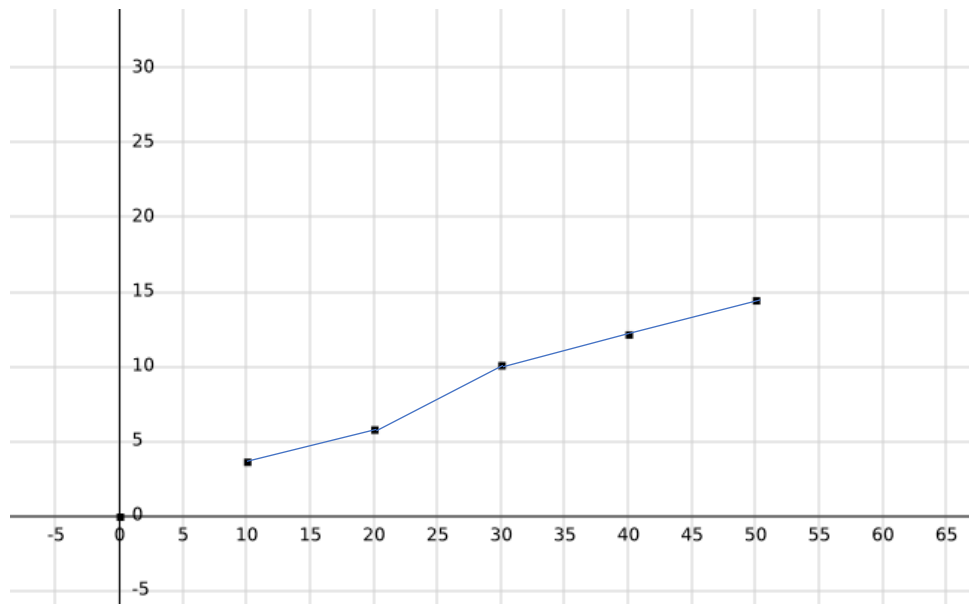
DOWNLOAD TIME



NO OF RFC'S DOWNLOADED

P2P DISTRIBUTION GRAPH FOR PEER 4:

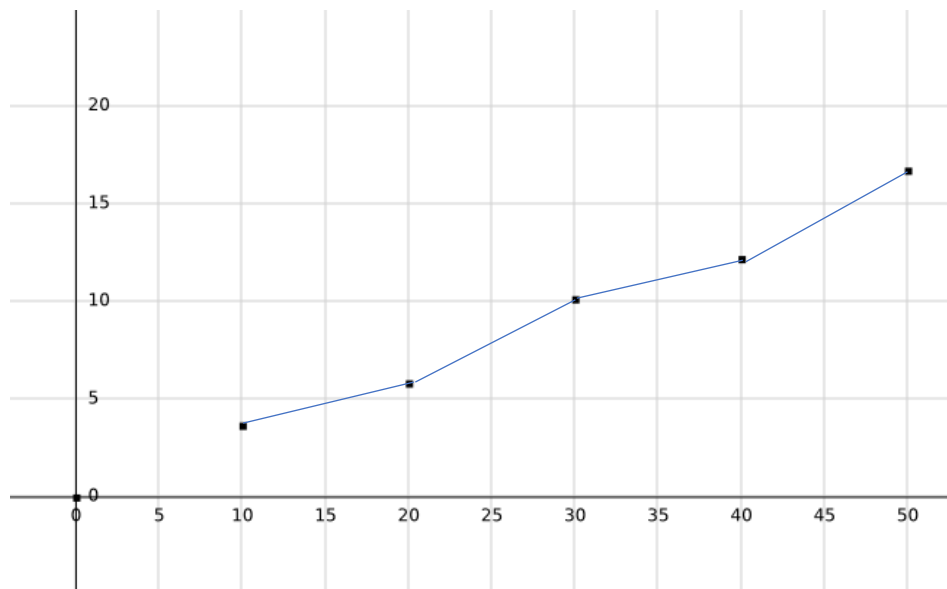
DOWNLOAD TIME



NO OF RFC'S DOWNLOADED

P2P DISTRIBUTION GRAPH FOR PEER 5:

DOWNLOAD TIME



NO OF RFC'S DOWNLOADED

## OBSERVATIONS:

In Task 1, when the centralized system was implemented there was a transfer of 250 RFC files (5 peers x 50 files downloaded from P0) among the peers and the total time taken by all the peers collectively to receive these 250 files was 106.757 seconds which is about 21.34 seconds on an average taken by each peer to download all 50 files.

In Task 2, when the peer to peer system is implemented, there was a transfer of 300 RFC files (6 peers x 50 files from P0 to P5) among the peers and the total time taken by all the peers collectively to receive these files was 106.320 seconds which is about 17.7055 seconds on an average taken by each peer to download all 50 files and this download time decreases as the number of peers in the system increase.

## Conclusion:

### Availability

The most obvious problem that all Centralized File Distribution applications face is that server over here P0 always has to be online and available. In case of any software, network or hardware problem, the service to all clients is affected. Therefore, you need to plan a server high availability solution in advance.

### High Load

Another recurring problem with Centralized file distribution applications is high load. A single powerful client that consumes data faster than the others could consume all the networking, disk operation and server CPU(In this case it was P2 and P5 who downloaded the RFC's faster than others). Since this was a low level deployment, the powerful client didn't make any substantial difference to the network. You want all clients to have access to the server. Therefore you need to limit clients to a certain consumption level, so each of them can get minimal server resources.

## Scalability

Each server needs to be planned for the specific amount of clients it will support. When the number of clients grows, the server CPU, memory, networking, and disk performance need to grow as well, and can eventually reach a point when the server stops operation.

In a nutshell, P2P is always faster. How much faster depends on data size and scale. The larger they are, the bigger the differences.

## References:

1. <https://www.resilio.com/blog/whats-the-difference-between-peer-to-peer-and-client-server>
2. James Kurose, Keith Ross - Computer Networking\_ A Top-Down Approach (7th Edition)-Pearson (2016)