

# **COL334**

## **Assignment 2**

### **Report**

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2019PH10629

## **Part 1**

### **For each Client,**

2TCP connections:

1<sup>st</sup> TCP port is used for initial handshaking and receiving chunks.

2<sup>nd</sup> TCP port is being used for sending requesting missing chunks.

2UDP connections:

1<sup>st</sup> UDP port is for sending chunk request.

2<sup>nd</sup> UDP port for receiving chunk request.

### **For Server,**

2 UDP ports per client for forwarding and receiving requests.

2 TCP connections per client for initial handshaking/sending chunks and receiving chunk packets from clients.

## **Part 2**

Similar methodology is followed for part 2.

### **For each Client,**

2TCP connections:

1<sup>st</sup> TCP port is used for initial handshaking and receiving chunk requests.

2<sup>nd</sup> TCP port is being used for forwarding chunk requests.

2UDP connections:

1<sup>st</sup> UDP port is for sending chunks.

2<sup>nd</sup> UDP port for receiving chunks.

## For Server,

2 UDP ports per client for sending and receiving chunks.

2 TCP connections per client for initial handshaking/requesting chunks and forwarding chunk requests.

## Analysis

### 1. RTT for each chunk a client requests

End time for client 1 : 1663770510.8507168, Total time : 0.2893197536468506

Client 1 --> {0: 0.000453948974609375, 2: 1663770510.7610064, 3:

0.0015718936920166016, 4: 1663770510.7659829, 5: 0.0007770061492919922, 7:

1663770510.772105, 8: 0.004177093505859375, 9: 0.004690885543823242, 10:

0.0015339851379394531, 12: 1663770510.776707, 13: 0.006043195724487305, 14:

0.006938934326171875, 15: 0.0028100013732910156, 17: 0.006379604339599609, 18:

0.10973811149597168, 19: 0.10270094871520996, 20: 0.005743980407714844, 22:

0.20288538932800293, 23: 1663770510.7899008, 24: 1663770510.737601, 25:

0.12991571426391602, 27: 0.12981510162353516, 28: 0.12739205360412598, 29:

1663770510.7262502, 30: 1663770510.7269113, 32: 1663770510.735047, 33:

1663770510.739387, 34: 1663770510.709525, 35: 0.09348082542419434, 37:

0.03325390815734863, 38: 0.03240847587585449, 39: 1663770510.620373, 40:

0.02839207649230957, 42: 1663770510.7470257, 43: 0.032148122787475586, 44:

1663770510.6089754, 45: 0.15002083778381348, 47: 0.017663955688476562, 48:

0.15990710258483887, 49: 1663770510.6690807, 50: 1663770510.8367732, 52:

0.22585749626159668, 53: 1663770510.731006, 54: 0.02025890350341797, 55:

0.03328895568847656, 57: 0.1920909881591797, 58: 1663770510.8189812, 59:

0.10851621627807617, 60: 1663770510.828454, 62: 1663770510.6366622, 63:

1663770510.8400261, 64: 0.2075057029724121, 65: 1663770510.8446996, 67:

0.20732378959655762, 68: 1663770510.850712, 69: 1663770510.6526659, 70:

0.0014510154724121094, 72: 1663770510.6559532, 73: 0.0018498897552490234, 74:

0.04962563514709473, 75: 0.0017850399017333984, 77: 0.0008678436279296875, 78:

0.0010671615600585938, 79: 1663770510.671986, 80: 1663770510.824656, 82:

0.014477014541625977, 83: 0.010539770126342773, 84: 1663770510.6817749, 85:

0.00043129920959472656, 87: 0.004344940185546875, 88: 1663770510.6998262, 89:

8.797645568847656e-05, 90: 1663770510.710672, 92: 0.09502077102661133, 93:

0.11922526359558105, 94: 0.08461713790893555, 95: 0.00012087821960449219, 97:

0.07213497161865234, 98: 0.040993690490722656, 99: 0.0006349086761474609, 100:

0.00015997886657714844, 102: 0.08002686500549316, 103: 1663770510.7604003, 104:

0.05186295509338379, 105: 1.5735626220703125e-05, 107: 0.05567502975463867, 108:

1663770510.780331, 109: 0.026442289352416992, 110: 1663770510.7922182}

End time for client 0 : 1663770510.858602, Total time : 0.297335147857666

Client 0 --> {1: 0.0007269382476806641, 2: 0.000457763671875, 3:

0.0009427070617675781, 4: 0.0014450550079345703, 6: 0.0007791519165039062, 7:  
0.0024869441986083984, 8: 0.0030050277709960938, 9: 0.0032901763916015625, 11:  
0.001199960708618164, 12: 0.0040988922119140625, 13: 0.005178213119506836, 14:  
0.0058879852294921875, 16: 0.0012030601501464844, 17: 0.004956960678100586, 18:  
1663770510.5849085, 19: 0.09159374237060547, 21: 0.005901813507080078, 22:  
1663770510.672353, 23: 0.09898805618286133, 24: 0.10312557220458984, 26:  
1663770510.678526, 27: 0.21799111366271973, 28: 0.11334991455078125, 29:  
0.10677552223205566, 31: 0.11090278625488281, 32: 0.1124117374420166, 33:  
1663770510.7621245, 34: 1663770510.713832, 36: 1663770510.747473, 37:  
1663770510.7541459, 38: 0.02862381935119629, 39: 0.03405189514160156, 41:  
0.02707195281982422, 42: 1663770510.7640967, 43: 1663770510.7413888, 44:  
0.05151009559631348, 46: 1663770510.777666, 47: 0.004746913909912109, 48:  
0.09510469436645508, 49: 0.0059452056884765625, 51: 0.05455303192138672, 52:  
1663770510.6030471, 53: 1663770510.826469, 54: 0.11786293983459473, 56:  
1663770510.6039991, 57: 0.24219083786010742, 58: 0.027570009231567383, 59:  
0.2388160228729248, 61: 1663770510.852274, 62: 0.2369828224182129, 63:  
1663770510.858597, 64: 1663770510.6245449, 66: 1663770510.7662866, 67:  
0.10546207427978516, 68: 1663770510.6476958, 69: 0.01717400550842285, 71:  
0.0011150836944580078, 72: 1663770510.6413581, 73: 0.0006961822509765625, 74:  
1663770510.6475322, 76: 0.002164125442504883, 77: 1663770510.781173, 78:  
1663770510.785268, 79: 1663770510.6609848, 81: 0.0005009174346923828, 82:  
1663770510.6690369, 83: 1663770510.8345838, 84: 1663770510.6719658, 86:  
0.0009760856628417969, 87: 1663770510.752361, 88: 0.17059016227722168, 89:  
1663770510.789509, 91: 0.0008609294891357422, 92: 0.1163032054901123, 93:  
1663770510.7923381, 94: 1663770510.705083, 96: 0.00015473365783691406, 97:  
1663770510.7167242, 98: 1663770510.720595, 99: 1663770510.729101, 101:  
0.00013375282287597656, 102: 1663770510.7399971, 103: 0.017464160919189453, 104:  
1663770510.7833138, 106: 5.2928924560546875e-05, 107: 0.00047206878662109375,  
108: 1663770510.7642508, 109: 1663770510.770978, 111: 1.9311904907226562e-05}

End time for client 2 : 1663770510.931034, Total time : 0.3694419860839844

Client 2 --> {0: 0.0002410411834716797, 1: 0.00015282630920410156, 3:

0.0007708072662353516, 4: 0.0008161067962646484, 5: 0.008477926254272461, 6:  
1663770510.743082, 8: 0.0025658607482910156, 9: 0.014124631881713867, 10:  
0.08965110778808594, 11: 1663770510.6766229, 13: 1663770510.6807969, 14:  
1663770510.6801503, 15: 1663770510.5839498, 16: 1663770510.68517, 18:  
1663770510.701549, 19: 1663770510.7055519, 20: 0.11572885513305664, 21:  
0.00534510612487793, 23: 1663770510.7236447, 24: 1663770510.7152781, 25:  
1663770510.715139, 26: 0.0067059993743896484, 28: 0.10343790054321289, 29:  
1663770510.85365, 30: 1663770510.7439852, 31: 1663770510.843122, 33:  
0.16405892372131348, 34: 1663770510.739532, 35: 0.19722819328308105, 36:  
0.22521734237670898, 38: 0.22473692893981934, 39: 1663770510.7551727, 40:  
1663770510.6514652, 41: 1663770510.813659, 43: 1663770510.8396492, 44:  
1663770510.8074071, 45: 0.18584084510803223, 46: 0.16565513610839844, 48:  
1663770510.6914072, 49: 0.07850313186645508, 50: 1663770510.7632654, 51:

1663770510.7719748, 53: 0.20929956436157227, 54: 1663770510.7692785, 55:  
1663770510.7961214, 56: 0.011806488037109375, 58: 0.15906596183776855, 59:  
0.06171393394470215, 60: 1663770510.7961302, 61: 0.18201971054077148, 63:  
1663770510.8949862, 64: 0.186415433883667, 65: 0.14208340644836426, 66:  
0.14281606674194336, 68: 0.09193992614746094, 69: 1663770510.8190665, 70:  
0.13568711280822754, 71: 1663770510.865087, 73: 1663770510.793874, 74:  
0.07683968544006348, 75: 0.054376840591430664, 76: 0.07018423080444336, 78:  
0.05516362190246582, 79: 1663770510.8799813, 80: 1663770510.8461008, 81:  
1663770510.826084, 83: 1663770510.8197927, 84: 0.1244809627532959, 85:  
1663770510.8435628, 86: 0.016820430755615234, 88: 0.08682894706726074, 89:  
0.015961885452270508, 90: 0.050423622131347656, 91: 1663770510.8722012, 93:  
0.08678293228149414, 94: 0.1065213680267334, 95: 1663770510.8894231, 96:  
1663770510.8923373, 98: 0.08827066421508789, 99: 1663770510.820404, 100:  
1663770510.905858, 101: 1663770510.90993, 103: 0.015923500061035156, 104:  
0.09694385528564453, 105: 1663770510.923356, 106: 1663770510.927027, 108:  
0.01468348503112793, 109: 1663770510.8466604, 110: 2.9325485229492188e-05, 111:  
1663770510.9310322}

End time for client 3 : 1663770510.965127, Total time : 0.4036099910736084  
Client 3 --> {0: 0.00043201446533203125, 1: 0.0006031990051269531, 2:  
0.0007839202880859375, 4: 0.001230001449584961, 5: 0.0022988319396972656, 6:  
0.003045797348022461, 7: 0.001149892807006836, 9: 0.0019960403442382812, 10:  
1663770510.646509, 11: 1663770510.646775, 12: 0.0031707286834716797, 14:  
0.004361867904663086, 15: 1663770510.6003046, 16: 0.06637692451477051, 17:  
0.005706071853637695, 19: 0.07409429550170898, 20: 1663770510.6888304, 21:  
0.07255005836486816, 22: 0.007318973541259766, 24: 1663770510.6827757, 25:  
0.051413774490356445, 26: 1663770510.6891057, 27: 0.05194497108459473, 29:  
1663770510.817029, 30: 0.1602640151977539, 31: 1663770510.701043, 32:  
1663770510.7460544, 34: 0.10008573532104492, 35: 0.11321020126342773, 36:  
1663770510.707715, 37: 0.15879130363464355, 39: 0.12427830696105957, 40:  
0.11292052268981934, 41: 1663770510.8471878, 42: 1663770510.676421, 44:  
1663770510.6602087, 45: 1663770510.676917, 46: 0.053997039794921875, 47:  
0.05934858322143555, 49: 0.13466548919677734, 50: 1663770510.919268, 51:  
1663770510.818425, 52: 0.06525707244873047, 54: 0.09386515617370605, 55:  
0.13685107231140137, 56: 0.19318509101867676, 57: 1663770510.8180661, 59:  
1663770510.707398, 60: 0.12933659553527832, 61: 1663770510.7721694, 62:  
1663770510.9307244, 64: 1663770510.7383528, 65: 0.12608695030212402, 66:  
0.12413883209228516, 67: 1663770510.9491432, 69: 0.05889558792114258, 70:  
1663770510.850285, 71: 1663770510.8509889, 72: 1663770510.858382, 74:  
1663770510.836031, 75: 0.00044918060302734375, 76: 0.0010666847229003906, 77:  
0.12903571128845215, 79: 0.11113190650939941, 80: 1663770510.88577, 81:  
1663770510.8935971, 82: 0.013494014739990234, 84: 1663770510.7939467, 85:  
1663770510.9027271, 86: 1663770510.904793, 87: 1663770510.801293, 89:  
1663770510.8991961, 90: 1663770510.9176643, 91: 1663770510.9250293, 92:  
0.015310287475585938, 94: 0.07536029815673828, 95: 1663770510.936728, 96:  
1663770510.9594092, 97: 0.010969161987304688, 99: 1663770510.82376, 100:  
1663770510.9529002, 101: 0.010913848876953125, 102: 1663770510.9502456, 104:

0.07395505905151367, 105: 1663770510.963892, 106: 1663770510.9552345, 107:  
0.0054357051849365234, 109: 1663770510.890933, 110: 1663770510.9626281, 111:  
1663770510.965125}

End time for client 4 : 1663770510.9855769, Total time : 0.42372870445251465

Client 4 --> {0: 0.0002837181091308594, 1: 0.0009191036224365234, 2:  
0.0015110969543457031, 3: 0.0013430118560791016, 5: 0.004956245422363281, 6:  
1663770510.9468622, 7: 0.0025238990783691406, 8: 0.0036919116973876953, 10:  
0.005609035491943359, 11: 0.055249691009521484, 12: 0.005395174026489258, 13:  
0.006848573684692383, 15: 0.04708409309387207, 16: 0.02446150779724121, 17:  
0.033798933029174805, 18: 0.03562307357788086, 20: 0.054743051528930664, 21:  
0.05119585990905762, 22: 1663770510.680651, 23: 1663770510.6935992, 25:  
0.038825273513793945, 26: 1663770510.7182882, 27: 0.038420915603637695, 28:  
1663770510.7118142, 30: 0.05008864402770996, 31: 1663770510.7983437, 32:  
0.046808481216430664, 33: 0.12317895889282227, 35: 1663770510.730049, 36:  
0.11486959457397461, 37: 1663770510.7343507, 38: 0.2277812957763672, 40:  
0.24619007110595703, 41: 0.2817118167877197, 42: 1663770510.7498238, 43:  
1663770510.7547371, 45: 1663770510.8650038, 46: 1663770510.9648938, 47:  
0.2539682388305664, 48: 0.24767470359802246, 50: 1663770510.7389681, 51:  
0.013478279113769531, 52: 1663770510.737942, 53: 0.06514215469360352, 55:  
1663770510.8025172, 56: 0.04884505271911621, 57: 1663770510.7557418, 58:  
0.01861405372619629, 60: 0.0004649162292480469, 61: 0.0803077220916748, 62:  
1663770510.881785, 63: 0.06061697006225586, 65: 1663770510.8845677, 66:  
1663770510.8593729, 67: 0.08398008346557617, 68: 1663770510.838208, 70:  
0.0015146732330322266, 71: 0.048792123794555664, 72: 1663770510.8219151, 73:  
1663770510.8485389, 75: 0.013124942779541016, 76: 0.012898921966552734, 77:  
1663770510.9387202, 78: 0.014835119247436523, 80: 1663770510.9188967, 81:  
1663770510.916021, 82: 0.12352418899536133, 83: 0.028510093688964844, 85:  
1663770510.932185, 86: 0.040589094161987305, 87: 1663770510.909722, 88:  
1663770510.938611, 90: 1663770510.942852, 91: 1663770510.9457, 92:  
1663770510.849536, 93: 1663770510.8526468, 95: 0.02552199363708496, 96:  
1663770510.9488819, 97: 0.12439703941345215, 98: 0.12529397010803223, 100:  
0.012061119079589844, 101: 1663770510.9711587, 102: 1663770510.8632338, 103:  
1663770510.912119, 105: 1663770510.978119, 106: 1663770510.9802659, 107:  
1663770510.863177, 108: 1663770510.9143596, 110: 0.008407831192016602, 111:  
1663770510.985575}

```

ishaanwatts@Ishaans-MacBook-Pro Code % python3 client2.py
Client 2:Initial Distribution Complete, 22
Client 1:Initial Distribution Complete, 23
Client 3:Initial Distribution Complete, 22
Client 0:Initial Distribution Complete, 23
Requesting missing chunks for Client : 1, 1663769404.458247
Requesting missing chunks for Client : 2, 1663769404.4584188
Requesting missing chunks for Client : 3, 1663769404.458577
Client 4:Initial Distribution Complete, 22
Requesting missing chunks for Client : 0, 1663769404.458648
Requesting missing chunks for Client : 4, 1663769404.459436
End time for client 4 : 1663769404.508488, Total time : 0.04905200004577637
9f9d1c257fe1733f6095a8336372616e 4
End time for client 0 : 1663769404.515454, Total time : 0.056806087493896484
9f9d1c257fe1733f6095a8336372616e 0

```

S. No.	Average RTT (s)
Part 1	0.3556
Part 2	0.052929*

\*only 2 clients completed

RTT is higher for Part 1 as expected because the bulk of data is being transferred via TCP which is slower than UDP. In Part2 the data is being transferred via UDP.

## 2. Average RTT for each chunk

```

{0: 0.00035, 1: 0.0006, 2: 0.00092, 3: 0.00116, 4: 0.00116, 5: 0.00413, 6: 0.00191, 7: 0.00205, 8: 0.00336,
9: 0.00603, 10: 0.03226, 11: 0.02822, 12: 0.00422, 13: 0.00602, 14: 0.00573, 15: 0.02495, 16: 0.03068, 17
: 0.01271, 18: 0.07268, 19: 0.08946, 20: 0.05874, 21: 0.03375, 22: 0.1051, 23: 0.09899, 24: 0.10313, 25: 0
.07338, 26: 0.00671, 27: 0.10954, 28: 0.11473, 29: 0.10678, 30: 0.10518, 31: 0.1109, 32: 0.07961, 33: 0.1
4362, 34: 0.10009, 35: 0.13464, 36: 0.17004, 37: 0.09602, 38: 0.12839, 39: 0.07917, 40: 0.12917, 41: 0.15
439, 43: 0.03215, 44: 0.05151, 45: 0.16793, 46: 0.10983, 47: 0.08393, 48: 0.16756, 49: 0.07304, 51: 0.034
02, 52: 0.14556, 53: 0.13722, 54: 0.07733, 55: 0.08507, 56: 0.08461, 57: 0.21714, 58: 0.06842, 59: 0.1363
5, 60: 0.0649, 61: 0.13116, 62: 0.23698, 63: 0.06062, 64: 0.19696, 65: 0.13409, 66: 0.13348, 67: 0.13226,
68: 0.09194, 69: 0.03803, 70: 0.04622, 71: 0.02495, 73: 0.00127, 74: 0.06323, 75: 0.01743, 76: 0.02158, 7
7: 0.06495, 78: 0.02369, 79: 0.11113, 81: 0.0005, 82: 0.0505, 83: 0.01952, 84: 0.12448, 85: 0.00043, 86: 0
.01946, 87: 0.00434, 88: 0.12871, 89: 0.00802, 90: 0.05042, 91: 0.00086, 92: 0.07554, 93: 0.103, 94: 0.08
883, 95: 0.01282, 96: 0.00015, 97: 0.06917, 98: 0.08485, 99: 0.00063, 100: 0.00611, 101: 0.00552, 102: 0.
08003, 103: 0.01669, 104: 0.07425, 105: 2e-05, 106: 5e-05, 107: 0.02053, 108: 0.01468, 109: 0.02644, 11
0: 0.00422, 111: 2e-05}

```

Chunks with greater average RTT

```

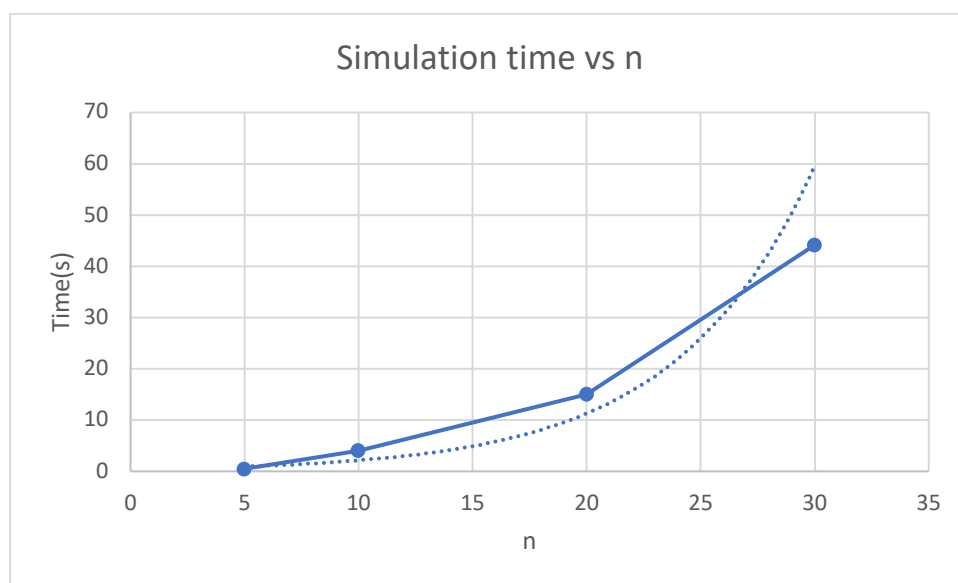
{0: False, 1: False, 2: False, 3: False, 4: False, 5: False, 6: False, 7: False, 8: False, 9: False, 10: False, 11: Fals
e, 12: False, 13: False, 14: False, 15: False, 16: False, 17: False, 18: True, 19: True, 20: False, 21: False, 22:
True, 23: True, 24: True, 25: True, 26: False, 27: True, 28: True, 29: True, 30: True, 31: True, 32: True, 33: T
rue, 34: True, 35: True, 36: True, 37: True, 38: True, 39: True, 40: True, 41: True, 43: False, 44: False, 45: T
rue, 46: True, 47: True, 48: True, 49: True, 51: False, 52: True, 53: True, 54: True, 55: True, 56: True, 57: Tr
ue, 58: True, 59: True, 60: True, 61: True, 62: True, 63: False, 64: True, 65: True, 66: True, 67: True, 68: Tr
ue, 69: False, 70: False, 71: False, 73: False, 74: False, 75: False, 76: False, 77: True, 78: False, 79: True, 81:

```

False, 82: False, 83: False, 84: True, 85: False, 86: False, 87: False, 88: True, 89: False, 90: False, 91: False, 92: True, 93: True, 94: True, 95: False, 96: False, 97: True, 98: True, 99: False, 100: False, 101: False, 102: True, 103: False, 104: True, 105: False, 106: False, 107: False, 108: False, 109: False, 110: False, 111: False}

### 3. Simulation Times

n	Simulation Time(s)
5	0.497669
10	4.051613
20	15.05711
30	44.145929



The time is increasing exponentially as the value of n is increasing.

### 4. Large file experiment

The large file is not able to run on my pc

### 5. Sequential vs Random requests

Since the data is distributed in a circle one by one, every client has  $\text{client\_id}+n$ ,  $\text{client\_id}+2n$  and so on bits. So, if the request is made sequentially then all load would be initially on a one client then to the one having next bit and to the next in a circle. This would take longer time.

But if these requests are made randomly then the load would be distributed among the clients and hence it would be faster.

Random is faster than Sequential requests.

## Food for thought

1. Ideally P2S simulation time decreases with increase in number of clients as opposed to a client-server network where it increases linearly. In our case it was exponential since the requesting was done sequentially.
2. The main advantage would be that in a P2P network there would be  $n^2$  connections between  $n$  clients whereas due to a central server it is limited.
3. Right now we are using a dictionary containing key,value pairs where key is the chunk number and value is the chunk. We can construct a dictionary of dictionary to handle multiple files.

Note: LRUCache code was taken from gfg and edited.