Reducing the Download Time in Stochastic P2P Content Delivery Networks by Improving Peer Selection  
by  
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**What research problem was the reviewed dissertation trying to address?**

The research problem is that Peer-to-Peer (P2P) networks take up enormous portions of the open Internets bandwidth (Zuo & Iamnitchi, 2016). The P2P networks consuming so much bandwidth on the open internet is a problem because of the congestion put on Internet Service Provider’s (ISP’s) networks. (He, et al., 2016) Because open networks get saturated with high bandwidth inefficient P2P traffic, other applications can see reduced performance (Ijaz, Saleem, & Welzl, 2013) The congestion in turn leads to poor user experience through low throughput and intermittent inefficiency. (Brienza, et al., 2016) There have been attempts to solve the bandwidth issues through biased and random based switching techniques (Hsiao, et al., 2011; Pacifici, et al., 2016) The issue with biased based switching is it requires client overhead since connection data about other peers needs to be polled, stored, and analyzed and cannot switch peers if the selected nodes performance degrades. (Wilkins, 2013) The issue with random switching is it only performs switching after the peers have been selected allowing for the potential problem of downloading from a faulty peer before a better one is chosen. ( Chiu & Eun, 2018) Because of the issues mentioned above, the research problem of the reviewed dissertation addresses the attempts to improve P2P networks by addressing how to improve performance of peers before a connection is made and while a file transfer is in progress.

**What was the research goal of the reviewed dissertation?**

The research goal of the reviewed dissertation was to reduce the average download time for individual clients and application loads on the network. The goal was proposed using “advanced knowledge for peer selection, monitoring the performance of the server peer after the connection has been made, and only replacing the worst performing peers.” (This essay) Previous research from Lehrfeld & Simco, 2010 as well as Wilking & Simco, 2013 showed that limiting the amount of time spent with poor performing peers reduces the average download time for the client and that the reviewed dissertation’s goal was achieved based on improved metrics compared to the metrics from the previous research.

**What evidence (literature, data, etc) was presented to support the reviewed dissertation research and achieve the research goal?**

A myriad of research literature was presented as evidence for the dissertation research and the research goal. The literature attempts to cover some of the accomplishments made to the problem of reducing download time in stochastic P2P content delivery networks through five peer selection strategies. The first being from Chiu & Eun, 2008 proposing that the heterogeneity of nodes needs to be considered in P2P download strategies. The second being the literature on random peer selection that has the advantage of having low overhead, being robust, and easy to implement. (Sherman, Neih, & Stein, 2009). Third is literature about advance knowledge peer selection. The advanced peer selection has high overhead and cost but better download times when compared to random seletion. (Xie, et al., 2008). Fourth is ISP based selection, the problem being that cross ISP connections can be expensive and cause bottleknecks. (Varvello & Steiner, 2011) The dissertation proposes that the research goal will need to reduce cross ISP traffic without the cooperation from the ISP’s because of privacy and security concerns. (Varvello & Steiner, 2011; Ijaz, et al., 2013). Last is proximity strategies that use the location of peers to make informed decisions using concepts such as Round Trip Time (RTT), jitter, and number of hops. (Fiorese, et al., 2013)

**What research methodology used and who claim this methodology is valid?**

Set up test environment

Replicated old research first

Created new research data.

**What were the findings of the reviewed dissertation research?**

“This research developed a new peer selection strategy for selecting server peers in a

P2P content delivery network that further reduced the download time by making an

informed decision on which peers to select. “

## **References**

Aiyar, K., Halgamuge, M., & Mohammad, A. (2021). Probability Distribution Model to Analyze the Trade-off between Scalability and Security of Sharding-Based Blockchain Networks. *IEEE 18th Annual Consumer Communications & Networking Conference*, pp. 1-6. <https://doi.org/10.1109/CCNC49032.2021.9369563>

Baird, L., & Luykx, A. (2020). The Hashgraph Protocol: Efficient Asynchronous BFT for High-Throughput Distributed Ledgers. *International Conference on Omni-layer Intelligent Systems*, pp. 1-7. <https://doi.org/10.1109/COINS49042.2020.9191430>

Beikverdi, A., & Song, J. (2015). Trend of centralization in Bitcoin's distributed network. *Proceedings of the 2015* *IEEE/ACIS 16th International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing*, pp. 1-6. <https://doi.org/10.1109/SNPD.2015.7176229>

Duan, S., Reiter, M., & Zhang, H. (2018). BEAT: Asynchronous BFT Made Practical. *In ACM SIGSAC Conference on Computer and Communications Security,* pp. 2028–2041. <https://doi.org/10.1145/3243734.3243812>

Fischer, M., Lynch, N., & Paterson, M. (1985). Impossibility of Distributed Consensus with One   
Faulty Process. *Journal of the ACM*, pp. 374–382.

Hood, K., Oglio, J., Nesterenko, M., & Sharma, G. (2021). Partitionable Asynchronous Cryptocurrency Blockchain. *IEEE International Conference on Blockchain and Cryptocurrency,* pp. 1-9. https://doi.org/10.1109/ICBC51069.2021.9461080

Jia, Y., Xu, C., Wu, Z., Feng, Z., Chen, Y., & Yang, S. (2022) Measuring Decentralization in Emerging Public Blockchains. *International Wireless Communications and Mobile Computing*, pp. 137-141. <https://doi.org/10.1109/IWCMC55113.2022.9825341>

Kaushal, P., Bagga, A., & Sobti, R. (2017). Evolution of Bitcoin and Security Risk in Bitcoin Wallets. *International Conference on Computer, Communications and Electronics*, pp. 172-177. <https://doi.org/10.1109/COMPTELIX.2017.8003959>

Knudsen, H., Li, J., Notland, J., Haro, P., & Ræder, T. (2021). High-Performance Asynchronous Byzantine Fault Tolerance Consensus Protocol. *IEEE International Conference on Blockchain*, pp. 476-483. <https://doi.org/10.1109/Blockchain53845.2021.00073>

Kuo, P., Chung, H., Chao, T., & Cheng, C. (2020). Fair Byzantine Agreements for Blockchains. *IEEE Access*, pp. 70746-70761. <https://doi.org/10.1109/ACCESS.2020.2986824>

Kwon, Y., Liu, J., Kim, M., Song, D., & Kim, Y. (2019). Impossibility of Full Decentralization in Permissionless Blockchains. *Proceedings of ACM Conference on Advances in Financial Technologies*, pp. 110–123. <https://doi.org/10.1145/3318041.3355463>

Lamport, L., Shostak, R., & Pease, M. (1982). The Byzantine Generals Problem. *ACM Transactions on Programming Languages and Systems*, pp. 382-401.

Lin, Q., Li, C., Zhao, X., & Chen, X. (2021). Measuring Decentralization in Bitcoin and Ethereum using Multiple Metrics and Granularities. *IEEE 37th International Conference on Data Engineering Workshops*, pp. 80-87. <https://doi.org/10.1109/ICDEW53142.2021.00022>

Miller, A., Xia, Y., Croman, K., Shi, E., & Song, D. (2016). The Honey Badger of BFT Protocols. *Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security*, pp. 31–42. <https://doi.org/10.1145/2976749.2978399>

Wu, K., Peng, B., Xie, H., & Huang, Z. (2019). An Information Entropy Method to Quantify the Degrees of Decentralization for Blockchain Systems. *International Conference on Electronics Information and Emergency Communication*, pp. 1–6. https://doi.org/10.1109/ICEIEC.2019.8784631

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References

Adler, M., Kumar, R., Ross, K. W., Rubenstein, D., Suel, T., & Yao, D. D. (2005).

Optimal peer selection for P2P downloading and streaming. Proceedings of the

IEEE INFOCOM, 1538 - 1549.

Akella, A., Seshan, S., & Shaikh, A. (2003). An empirical evaluation of wide-area

internet bottlenecks. Proceedings of the 3rd ACM SIGCOMM conference on

Internet measurement, 101-114.

Bernstein, D. S., Feng, Z., Levine, B. N., & Zilberstein, S. (2003). Adaptive peer

selection. Peer-to-Peer Systems II, 2735, 237-246.

Bindal, R., Cao, P., Chan, W., Medved, J., Suwala, G., Bates, T., & Zhang, A. (2006).

Improving traffic locality in BitTorrent via biased neighbor selection. Proceeding

ICDCS ’06 Proceedings on the 26th IEEE International Conference on

Distributed Computing Systems, 66-76.

BitTorrent (2016). Retrieved June 15, 2016, from www.bittorrent.com

Brienza, S., Cebeci, S. E., Masoumzadeh, S. S., Hlavacs, H., Özkasap, Ö., & Anastasi, G.

(2016). A survey on energy efficiency in P2P systems: File distribution, content

streaming, and epidemics. ACM Computing Surveys (CSUR), 48(3), 36.

Chandran, R. M., & Sajeev, G. P. (2015). Intelligent Pollution Controlling Mechanism

for Peer to Peer Caches. CIMSIM '15 Proceedings of the 2015 Seventh

International Conference on Computational Intelligence, Modelling and

Simulation, 141-146.

Cheng, L., Hutchinson, N. C., & Ito, M. R. (2008). RealNet: A topology generator based

on real internet topology. 22nd International Conference on Advanced

Information Networking and Applications-Workshops, 2008. AINAW 2008, 526-

532.

Chiu, Y.-M., & Eun, D. Y. (2008). Minimizing File Download Time in Stochastic Peer-

to-Peer Networks. IEEE/ACM Transactions on Networking, 16(2).

Chiu, Y.-M., & Eun, D. Y. (2010). On the Performance of Content Delivery under

Competition in a Stochastic Unstructured Peer-to-Peer Network. IEEE

Transactions on Parallel and Distributed Systems, 21(10), 1487-1500.

Chougule, A., & Deshmukh, S. (2011). Variable Chunk Based Parallel Switching To

Minimizing File Download Time in P2P Network. IJCSI International Journal of

Computer Science Issues, 8(4).

112

Dischinger, M., Mislove, A., Haeberlen, A., & Gummadi, K. P. (2008). Detecting

bittorrent blocking. Proceedings of the 8th ACM SIGCOMM conference on

Internet measurement, 3-8.

Federal Communications Commission. (2017). Raw Data – Measuring Broadband

America 2014. Retrieved January 1, 2017, from https://www.fcc.gov/general/raw-

data-measuring-broadband-america-2014#block-menu-block-4

Fernando, T., & Keppetiyagama, C. (2013). ISP friendly peer selection in bittorrent. 2013

International Conference on Advances in ICT for Emerging Regions (ICTer),

160-167.

Ferragut, A., & Paganini, F. (2016). Fluid models of population and download progress

in P2P networks. IEEE Transactions on Control of Network Systems, 3(1), 34-45.

Fiorese, A., Simoes, P., & Boavida, F. (2013). Approach for service search and peer

selection in P2P service overlays. 2013 International Conference on Information

Networking (ICOIN), 303-308.

Fuller, V., & Li, T. (2006). Classless inter-domain routing (CIDR): The Internet address

assignment and aggregation plan. IETF RFC 4632.

Gummadi, K. P., Dunn, R. J., Saroiu, S., Gribble, S. D., Levy, H. M., & Zahorjan, J.

(2003). Measurement, modeling, and analysis of a peer-to-peer file-sharing

workload. SIGOPS Oper. Syst. Rev., 37(5), 314-329. Doi:

10.1145/1165389.945475

He, Q., Dong, Q., Zhao, B., Wang, Y., & Qiang, B. (2016). P2P Traffic Optimization

based on Congestion Distance and DHT. Journal of Internet Services and

Information Security (JISIS), 6(2), 53-69.

Hirave, T., Surve, S., & Malgaonkar, S. (2013). Selecting efficient peers in P2P networks

for parallel task computing. 2013 International Conference on Advances in

Technology and Engineering (ICATE), 1-5.

Hsiao, T. H., Hsu, M. H., & Miao, Y. B. (2011). Adaptive and Efficient Peer Selection in

Peer-to-Peer Streaming Networks. 2011 IEEE 17th International Conference on

Parallel and Distributed Systems (ICPADS), 753-758.

Ijaz, H., Saleem, S., & Welzl, M. (2013). Fewest common hops (FCH): an improved peer

selection approach for P2P applications. 2013 21st Euromicro International

Conference on Parallel, Distributed, and Network-Based Processing, 449-453.

Jain, M., & Dovrolis, C. (2005). End-to-end estimation of the available bandwidth

variation range. SIGMETRICS Perform. Eval. Rev., 33(1), 265-276. doi:

10.1145/1071690.1064242

113

Kaune, S., Pussep, K., Leng, C., Kovacevic, A., Tyson, G., & Steinmetz, R. (2009).

Modelling the internet delay space based on geographical locations. 2009 17th

Euromicro International Conference on Parallel, Distributed and Network-based

Processing, 301-310.

Lehrfeld, M. (2009). Peer selection Algorithm in Stochastic Content Delivery Networks

to Reduce File Download Time. Doctor of Philosophy, Nova Southeastern

University, Fort Lauderdale, FL.

Lehrfeld, M., & Simco, G. (2010). Choke-based switching algorithm in stochastic P2P

networks to reduce file download duration. Proceedings of the IEEE

SoutheastCon 2010, 127-130.

Li, J. (2008). On peer-to-peer (P2P) content delivery. Peer-to-Peer Networking and

Applications, 1(1), 45-63.

Li, K. (2012). Probing high-capacity peers to reduce download times in P2P file sharing

systems with stochastic service capacities. International Journal of Foundations

of Computer Science, 23(06), 1341-1369.

Li, K. (2014). On the expected file download time of the random time-based switching

algorithm in P2P networks. Peer-to-Peer Networking and Applications, 7(2), 147-

158.

Li, K. (2015). Analysis of file download time in peer-to-peer networks with stochastic

and time-varying service capacities. Future Generation Computer Systems, 42,

36-43.

Liem, A. T., Hwang, I. S., Nikoukar, A., Yang, C. Z., Ab-Rahman, M. S., & Lu, C. H.

(2016). P2P live-streaming application-aware architecture for QoS enhancement

in the EPON. IEEE Systems Journal, 99, 1-11.

Liu, Y., Wang, H., Lin, Y., & Cheng, S. (2008). Modeling and Quantifying the Impact of

P2P File Sharing Traffic on Traditional Internet Traffic. Proceedings of the

International Conference on Advanced Information Networking and Applications

Workshops, 1428-1433.

LZMA SDK (Software Development Kit) (2017). Retrieved April 19, 2017, from

http://www.7-zip.org/sdk.html

Magharei, N., Rejaie, R., Rimac, I., Hilt, V., & Hofmann, M. (2014). ISP-friendly live

P2P streaming. IEEE/ACM Transactions on Networking, 22(1), 244-256.

114

Mao, Z. M., Rexford, J., Wang, J., & Katz, R. H. (2003). Towards an accurate AS-level

traceroute tool. Proceedings of the 2003 conference on Applications,

technologies, architectures, and protocols for computer communications, 365-

378.

Marchetto, G., Ciminiera, L., Manzillo, M. P., Risso, F., & Torrero, L. (2011). Locating

Equivalent Servants over P2P Networks. IEEE Transactions on Network and

service Management, 8(1), 65-78.

MaxMind. (2017). GeoLite ISP Database. https://www.maxmind.com/en/geoip2-isp-

database#features

National Broadband Map. (2017). Analize. Retrieved January 3, 2017, from

http://www.broadbandmap.gov/analyze

OOKLA. (2017). Speedtest Intelligence from Ookla | Internet performance database.

Retrieved January 6, 2017, from http://www.ookla.com/speedtest-intelligence

Ou, S., Yang, K., & Zhang, Q. (2006). An Efficient runtime offloading approach for

pervasive services. IEEE Wireless Communications and Networking Conference,

4, 2229-2234.

Pacifici, V., Lehrieder, F., & Dán, G. (2016). Cache bandwidth allocation for P2P file-

sharing systems to minimize inter-ISP traffic. IEEE/ACM Transactions on

Networking, 24(1), 437-448.

Ren, S., Liu, Y., Zhou, X., Tang, H., Ci, S., & Wang, M. (2013). A novel peer selection

mechanism in heterogeneous wireless peer-to-peer networks. 2013 19th IEEE

International Conference on Networks (ICON), 1-7.

Scandizzo, P. and Imperiali, A. (2014) Internet as a Growing and Dynamic Network: An

Economic View. Communications and Network, 6, 69-75. doi:

10.4236/cn.2014.62009.

Schulze, H., & Mochalski, K. (2009). Internet study 2008/2009. Ipoque Report, 37, 351-

362.

Sherman, A., Nieh, J., & Sten, C. (2009). FairTorrent: bringing fairness to peer-to-peer

systems. Proceedings of the 5th international conference on Emerging networking

experiments and technologies, 133-144. doi: 10.1145/1658939.1658955

Steiner, M., & Varvello, M. (2011). Peer-to-peer traffic localization as a service.

Proceedings of the IEEE International Conference on Computer Communications

(Demo), Shanghai, China.

115

Traverso, S., Abeni, L., Birke, R., Kiraly, C., Leonardi, E., Lo Cigno, R., & Mellia, M.

(2015). Neighborhood filtering strategies for overlay construction in P2P-TV

systems: design and experimental comparison. IEEE/ACM Transactions on

Networking (TON), 23(3), 741-754.

Varvello, M., & Steiner, M. (2011). Traffic localization for DHT-based BitTorrent

networks. International Conference on Research in Networking, 40-53.

Wilkins, R. (2013). Download Time Reduction Using Recent Performance-Biased Peer

Replacement In Stochastic P2P Content Delivery Networks. Doctor of

Philosophy, Nova Southeastern University, Fort Lauderdale, FL.

Wilkins, R., & Simco, G. (2013). Download Time Reduction Using Recent Performance-

Biased Peer Replacement In Stochastic P2P Content Delivery Networks. 2013

International Conference on Selected Topics in Mobile and Wireless Networking

(MoWNet), 86-91.

Xie, H., Yang, Y. R., Krishnamurthy, A., Liu, Y. G., & Silberschatz, A. (2008). P4P:

Provider Portal for Applications. Proceedings of the ACM SIGCOMM 2008

conference on Data Communication, 351-362.

Yang, C., Zhou, Y., Chen, L., Fu, T. Z., & Chiu, D. M. (2015). Turbocharged video

distribution via P2P. IEEE Transactions on Circuits and Systems for Video

Technology, 25(2), 287-299.

Yang, X., & De Veciana, G. (2004). Service capacity of peer to peer networks.

INFOCOM 2004. Twenty-third AnnualJoint Conference of the IEEE Computer

and Communications Societies, 4, 2242-2252. doi:

10.1109/INFCOM.200401354647

Ying, L., & Basu, A. (2006). Traceroute-based fast peer selection without offline

database. Eighth IEEE International Symposium on Multimedia, 2006. ISM'06.,

609-614.

Zuo, X., & Iamnitchi, A. (2016). A Survey of Socially Aware Peer-to-Peer Systems.

ACM Computing Surveys (CSUR), 49(1), 9.

**Certification of Authorship of Doctoral Course Assignment**

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Submitted to: Dr. Yair Levy

Student’s Name: Eric Webb

Date of Submission: November 27th, 2022

Purpose and Title of Submission: Assignment #2 Pre-Idea Paper “Defending Against Centralization via Asynchronicity.”

Certification of Authorship: I hereby certify that I am the author of this document and that any assistance I received in its preparation is fully acknowledged and disclosed in the document. I have also cited all sources from which I obtained data, ideas, or words that are copied directly or paraphrased in the document. Sources are properly credited according to accepted standards for professional publications. I also certify that this paper was prepared by me for this purpose.

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