## Errors found in distributed protocols

Protocol	Reference	Violation	Counter-example
Raft	[Ong14]	$safety^1$	[AZ15; Ong15]
Raft	[OO14; Ong14]	liveness	[HA20]
Chord	[Sto+03; LBK02]	$liveness^2$	[Zav12; Zav17]
Pastry	[RD01]	safety	[AMW16; AMW18]
Zyzzyva	[Kot+07; Kot+10]	safety	[Abr+17]
FaB Paxos	[MA05; MA06]	liveness	[Abr+17]
EPaxos	[MAK13]	safety	[Sut20]
DPaxos	[NAE18]	safety	[Whi+21]

(Reference list starts on the next page.)

 $<sup>^{1}</sup>$ The single-server membership change algorithm is described in Ongaro's PhD thesis. The paper version of Raft uses joint consensus and does not have this error.

<sup>2</sup>Eventual reachability is Chord's key correctness property.

## References

- [Abr+17] Ittai Abraham et al. "Revisiting Fast Practical Byzantine Fault Tolerance". In: arXiv:1712.01367 [cs] (Dec. 2017). arXiv: 1712.01367. URL: http://arxiv.org/abs/1712.01367 (visited on 2021-09-06).
- [AZ15] Brandon Amos and Huanchen Zhang. 15-812 Term Paper: Specifying and proving cluster membership for the Raft distributed consensus algorithm. Tech. rep. 2015, p. 46. URL: https://www.cs.cmu.edu/~aplatzer/course/pls15/projects/bamos.pdf.
- [AMW16] Noran Azmy, Stephan Merz, and Christoph Weidenbach. "A Rigorous Correctness Proof for Pastry". en. In: Abstract State Machines, Alloy, B, TLA, VDM, and Z. Ed. by Michael Butler et al. Vol. 9675. Series Title: Lecture Notes in Computer Science. Cham: Springer International Publishing, 2016, pp. 86–101. ISBN: 978-3-319-33599-5 978-3-319-33600-8. DOI: 10.1007/978-3-319-33600-8\_5. URL: http://link.springer.com/10.1007/978-3-319-33600-8\_5 (visited on 2021-09-07).
- [AMW18] Noran Azmy, Stephan Merz, and Christoph Weidenbach. "A machine-checked correctness proof for Pastry". en. In: Science of Computer Programming 158 (June 2018), pp. 64-80. ISSN: 01676423. DOI: 10.1016/j.scico.2017.08.003. URL: https://linkinghub.elsevier.com/retrieve/pii/S0167642317301612 (visited on 2021-09-07).
- [HA20] Heidi Howard and Ittai Abraham. Raft does not Guarantee Liveness in the face of Network Faults. Dec. 2020. URL: https://decentralizedthoughts.github.io/2020-12-12-raft-liveness-full-omission/(visited on 2021-05-07).
- [Kot+07] Ramakrishna Kotla et al. "Zyzzyva: Speculative Byzantine Fault Tolerance". In: SIGOPS Oper. Syst. Rev. 41.6 (Oct. 2007), pp. 45–58. ISSN: 0163-5980. DOI: 10.1145/1323293.1294267. URL: https://doi.org/10.1145/1323293.1294267.
- [Kot+10] Ramakrishna Kotla et al. "Zyzzyva: Speculative Byzantine Fault Tolerance". In: *ACM Trans. Comput. Syst.* 27.4 (Jan. 2010). ISSN: 0734-2071. DOI: 10.1145/1658357.1658358. URL: https://doi.org/10.1145/1658357.1658358.
- [LBK02] David Liben-Nowell, Hari Balakrishnan, and David Karger. "Analysis of the Evolution of Peer-to-Peer Systems". In: Proceedings of the Twenty-First Annual Symposium on Principles of Distributed Computing. PODC '02. Monterey, California: Association for Computing Machinery, 2002, pp. 233–242. ISBN: 1581134851. DOI: 10. 1145/571825.571863. URL: https://doi.org/10.1145/571825.571863.

- [MA05] J.-P. Martin and L. Alvisi. "Fast Byzantine Consensus". In: 2005 International Conference on Dependable Systems and Networks (DSN'05).
   ISSN: 2158-3927. June 2005, pp. 402-411. DOI: 10.1109/DSN.2005.
   48.
- [MA06] Jean-Philippe Martin and Lorenzo Alvisi. "Fast Byzantine Consensus". English. In: *IEEE Transactions on Dependable and Secure Computing* 3.3 (Sept. 2006). Num Pages: 202-215 Place: Washington, United States Publisher: IEEE Computer Society, pp. 202-215. ISSN: 15455971. DOI: http://dx.doi.org.libproxy1.nus.edu.sg/10.1109/TDSC.2006.35. URL: http://www.proquest.com/docview/206534931/abstract/A91EECC1018D4A46PQ/1.
- [MAK13] Iulian Moraru, David G. Andersen, and Michael Kaminsky. "There is more consensus in Egalitarian parliaments". In: Proceedings of the Twenty-Fourth ACM Symposium on Operating Systems Principles. SOSP '13. New York, NY, USA: Association for Computing Machinery, Nov. 2013, pp. 358–372. ISBN: 978-1-4503-2388-8. DOI: 10.1145/2517349.2517350. URL: http://doi.org/10.1145/2517349.2517350.
- [NAE18] Faisal Nawab, Divyakant Agrawal, and Amr El Abbadi. "DPaxos: Managing Data Closer to Users for Low-Latency and Mobile Applications". In: Proceedings of the 2018 International Conference on Management of Data. SIGMOD '18. New York, NY, USA: Association for Computing Machinery, May 2018, pp. 1221–1236. ISBN: 978-1-4503-4703-7. DOI: 10.1145/3183713.3196928. URL: https://doi.org/10.1145/3183713.3196928 (visited on 2021-09-07).
- [Ong14] Diego Ongaro. "Consensus: Bridging Theory and Practice". AAI28121474. PhD thesis. Stanford, CA, USA, 2014. ISBN: 9798662514218.
- [Ong15] Diego Ongaro. bug in single-server membership changes. July 2015.

  URL: https://groups.google.com/g/raft-dev/c/t4xj6dJTP6E/
  m/d2D9LrWRza8J (visited on 2021-09-01).
- [OO14] Diego Ongaro and John Ousterhout. "In Search of an Understandable Consensus Algorithm". In: *Proceedings of the 2014 USENIX Conference on USENIX Annual Technical Conference*. USENIX ATC'14. Philadelphia, PA: USENIX Association, 2014, pp. 305–320. ISBN: 9781931971102.
- [RD01] Antony Rowstron and Peter Druschel. "Pastry: Scalable, Decentralized Object Location, and Routing for Large-Scale Peer-to-Peer Systems". en. In: Middleware 2001. Ed. by Rachid Guerraoui. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer, 2001, pp. 329–350. ISBN: 978-3-540-45518-9. DOI: 10.1007/3-540-45518-3\_18.

- [Sto+03] Ion Stoica et al. "Chord: A Scalable Peer-to-Peer Lookup Protocol for Internet Applications". In: IEEE/ACM Trans. Netw. 11.1 (Feb. 2003), pp. 17–32. ISSN: 1063-6692. DOI: 10.1109/TNET.2002. 808407. URL: https://doi.org/10.1109/TNET.2002.808407.
- [Sut20] Pierre Sutra. "On the correctness of Egalitarian Paxos". en. In: Information Processing Letters 156 (Apr. 2020). ISSN: 0020-0190. DOI: 10.1016/j.ipl.2019.105901. URL: https://www.sciencedirect.com/science/article/pii/S002001901930184X (visited on 2021-04-01).
- [Whi+21] Michael Whittaker et al. "Matchmaker Paxos: A Reconfigurable Consensus Protocol". en. In: *Journal of Systems Research* (2021), p. 22.
- [Zav12] Pamela Zave. "Using lightweight modeling to understand chord". en. In: ACM SIGCOMM Computer Communication Review 42.2 (Mar. 2012), pp. 49–57. ISSN: 0146-4833. DOI: 10.1145/2185376. 2185383. URL: https://dl.acm.org/doi/10.1145/2185376. 2185383 (visited on 2021-09-06).
- [Zav17] Pamela Zave. "Reasoning About Identifier Spaces: How to Make Chord Correct". In: *IEEE Transactions on Software Engineering* 43.12 (Dec. 2017). Conference Name: IEEE Transactions on Software Engineering, pp. 1144–1156. ISSN: 1939-3520. DOI: 10.1109/TSE.2017.2655056.