Masterthesis Proposal

Comprehensive Characterization of Consensus Solvability in Dynamic Networks with Transient Stability

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1 Problem Formulation

Consensus is a fundamental problem in distributed systems. While there are many papers that study this problem in synchronous dynamic networks, "In most existing work in this area, e.g. [1,11,22,23], the message adversary may choose each G^r from the same set of admissible graphs arbitrarily in each round." [WSS19].
The same paper (and several other: [WSS16] [SWS16] [SWS15]) explore a setting of transient Stability (governed by promises of $\diamond$Stability[1]/Sticky[2]) in a inconsistent manner.
My thesis aims for a complete characterization of the solvability/impossibility border by unifying the definitions for $\diamond$Stability/Sticky across the various papers and by providing proofs of solvability/impossibility for previously uncharacterized points of the spectrum.

2 Expected Results

I expect a complete characterization of the chosen spectrum, with proofs of the dividing lines between the areas of impossibility/solvability.

3 Methods

The first step will be unifying the different definitions of $\diamond$Stability/Sticky and a set of proofs allowing the previously stated impossibilities the be retained (in the case that the previous assumptions where stronger than the ones now chosen).
After this I will try to use indistinguishability proofs on the combinations that are yet unknown to either show the impossibility directily or provide a hint to an algorithm that might solve the problem (atleast in this specific setting). Should there exists several disjoint areas of solvability utilizing different algorithms I will aim for a unification of those as well.

[1] $\diamond$Stability(x) is the promise that the omniscient Adversary will eventually allow the the existance of a single-rooted communication graph (with the same root) for atleast x rounds.

[2] Sticky(y) is the promise that the first root that is a root for atleast y rounds will (during it's duration as root) also be a single root for atleast y rounds

4 State of the Art

The state of the art is described in [WSS19] [SWS16] [SWS15] [WSS16]. In [SWS16] an algorithm is shown the solves a consensus in a related setting that manages to solve consensus in the $\diamond$Stability/Sticky setting under some preconditions. In the other papers this algorithm is either further explored, or impossibility proofs exist that for a modified variation of the $\diamond$Stability/Sticky setting.

5 Relation to Logic and Computation

This thesis aims to extend the knowledgepool of computer science by providing a definitive proof to an open problem, while many courses in "Logic and Computation" touch this topic the three courses most aligned with my chosen thesis would be:

- 185.291 Formal Methods in Computer Science
- 182.702 Distributed Algorithms
- 182.703 Problems in Distributed Computing

References

[SWS15] Manfred Schwarz, Kyrill Winkler, and Ulrich Schmid. Fast consensus under eventually stabilizing message adversaries. *CoRR*, abs/1508.00851, 2015.

[SWS16] Manfred Schwarz, Kyrill Winkler, and Ulrich Schmid. Fast consensus under eventually stabilizing message adversaries. In *Proceedings of the 17th International Conference on Distributed Computing and Networking*, ICDCN '16, New York, NY, USA, 2016. Association for Computing Machinery.

[WSS16] Kyrill Winkler, Manfred Schwarz, and Ulrich Schmid. Consensus in directed dynamic networks with short-lived stability. *CoRR*, abs/1602.05852v1, 2016.

[WSS19] Kyrill Winkler, Manfred Schwarz, and Ulrich Schmid. Consensus in rooted dynamic networks with short-lived stability. *Distributed Computing*, 32(5):443–458, Oct 2019.