Abstract

In the field of distributed systems, various topological self-stabilizing Overlay-Networks were introduced in the past. While latest results tend towards logarithmic memory overhead per node (degree), a low latency regarding hops (diameter) is also desirable. A constant diameter already implies a relatively small memory overhead at each process compared to a fully connected topology.

The following thesis has a focus on networks with a diameter of two. In contrast to classical structural approaches, it relies on a stochastic process to manage links between processes in a simple and robust way. The thesis formally defines a randomized version of topological self-stabilization and constant diameter of two. An abstract concept for randomized self-stabilizing protocols aiming at diameter two is presented and analyzed. Let n be the number of participating processes. We show that $\mathcal{O}\left(\sqrt{n \ln n}\right)$ uniformly sampled neighbors at each process suffice to achieve this goal with high probability. Further, we give a lower bound of $\omega\left(\sqrt{n \ln \ln n}\right)$ on the needed degree when using random neighbors. The abstract concept can be implemented in different ways depending on a network size estimation algorithm and a sampling algorithm. It can easily be modified to function as an extension for most self-stabilizing structures. We propose a concrete protocol based on the abstract concept having a degree in $\mathcal{O}\left(\sqrt{n \ln n}\right)$ and converging in $\mathcal{O}(n)$ communication rounds, both with high probability. Furthermore, we present another protocol which has the same bounds on convergence probability and degree while having a convergence time in $\mathcal{O}\left(\log^2 n\right)$ with high probability. A discussion on possible alternatives, improvements, and realization in a general setting is given. Additionally, we present practical evaluations by simulations for the theoretically analyzed relationships and bounds.