An Algorithm for locally self-stabilizing a Chord Graph

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The Chord peer-to-peer system is considered, together with CAN, Tapestry and Pastry, as one of the pioneering works on peer-to-peer distributed hash tables (DHT) that inspired a large volume of papers and projects on DHTs as well as peer-to-peer systems in general. Chord, in particular, has been studied thoroughly, and many variants of Chord have been presented that optimize various criteria. Also, several implementations of Chord are available on various platforms. Though Chord is known to be very efficient and scalable and it can handle churn quite well, no protocol is known yet that guarantees that Chord is self-stabilizing, i.e., the Chord network can be recovered from any initial state in which the network is still weakly connected. This is not too surprising since it is known that the Chord network is not locally checkable for its current topology. We present a slight extension of the Chord network, called Re-Chord (reactive Chord), that turns out to be locally checkable, and we present a self-stabilizing distributed protocol for it that can recover the Re-Chord network from any initial, weakly connected state. Our algorithm is based on the process of linearization, where each node of the network sorts its neighbourhood nodes, according to their ids and rearranges the connections. A set of rules, including linearization, is applied costantly to each node, in order to create and preserve the structure of the network. We analyze our algorithm, showing that the convergence to the desired Re-Chord structure can occur in $O(n \log n)$ communication rounds, from any weakly connected state. We also show that our protocol allows a new peer to join or an old peer to leave an already stable Re-Chord network so that within $O((\log n)^2)$ communication rounds the Re-Chord network is stable again. We also run simulations of the protocol, by using the Matlab environment. The simulation results support the theoretical results.