Peer-to-Peer Networks based on Random Graphs

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Peer-to-peer networks belong to the class of overlay networks, i.e. the network is built on top of a physical network (e.g. the Internet) which is used to realize the communication between the nodes (peers) of the overlay. In contrast to the nodes in a client server architecture, peers have symmetric functionality: every peer acts as a server as well as a client. This property bears the potential of excellent resilience to network failures, since a faulty peer can be replaced by every other peer in the network. Studies of real world peer-to-peer networks reveal that these are highly dynamic. Thus, it is of major importance to take advantage of the potential robustness when designing a peer-to-peer network and it is reasonable to choose a simple network structure that can be maintained in case of strong dynamics and therefore guarantees the functionality of the network. This criterion is met by random networks. In this thesis we present local graph transformations to build and maintain random networks without central coordination mechanisms. They especially allow to maintain properties such as logarithmic diameter and expansion by local "handshake" operations only and are able to recover from any worst case situation. To overcome the lack of efficient query algorithms for random networks, we describe how to use random networks as a building block of a structured peer-to-peer network. For this, we cleverly combine random networks, search trees, and distributed hash tables to overcome their individual shortcomings while keeping their individual strength. The resulting network, called 3nuts, is self-stabilizing and load-balanced, supports range queries, and allows routing with small latency by adapting the structure of the overlay to the underlying physical network.