

Project Proposal: Necessity of Supernodes

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1 Introduction

Our research will investigate searching in P2P networks with the goal of showing that supernodes¹ are necessary for efficient searching. The addition of supernodes form a heterogenous network which requires that certain users carry a large amount of load to provide adequate hit rates for searches. Since few users wish to be supernodes, it would be convenient to remove them from the network. However, anecdotal evidence shows that supernodes are required for P2P networks to allow for efficient search.

We will formulate the problem to show that If we remove supernodes by bounding the maximum degree of the nodes to some small degree, then a lower bound on the search time can be established. The P2P network can be represented by a graph of degree k where k is the maximum degree of any node. We will tackle the problem by showing that for certain graphs and a bound on the degree of any node, there is a lower bound on the search time given some distribution of the documents in the network. The simplest distribution that we will attempt is the adversarial case where the document is placed as far from the search node as possible. Other possible distributions could include variations where the document appears in $p\%$ of the nodes, which can be placed arbitrarily far from the search node or distributed randomly within the network.

Initially, we will look at simple graphs such as trees and k -regular graphs. We will extend this approach to arbitrarily complex graphs in order to show that for all network graphs there is a lower bound on the search that requires supernodes to provide adequate return rates for the documents.

We will be searching the network using a flooding algorithm which propogates a message to all of its neighbours until the time to live has expired. We will be measuring a search in the amount of hops which occur from the initial search node to the node containing the desired document.

To show that supernodes are necessary for a P2P network, it requires showing both the removal of supernodes implies a lower bound on search and that the inclusion of supernodes, by increasing the degree of one or more nodes, does decrease search time in the worst case. We will show that by introducing super nodes, we can reduce the lower bound on searching in the worst case.

We will consider looking at distributed hash tables where increasing the degree of one or more nodes, i.e. the finger table, decreases the search within the DHT.

The main focus of this project is to show that a P2P network without supernodes is not sufficient to provide an efficient search for documents within the network. This project also aims to provide a theoretical foundation for the inclusion of super nodes in a P2P network.

¹nodes with high degree