Group creation in a collaborative P2P channel allocation protocol

Identifying connected groups of access points

Hans Jørgen Furre Nygårdshaug

Thesis submitted for the degree of
Master in Informatikk: programmering og nettverk
60 credits

Institutt for informatikk
Faculty of mathematics and natural sciences

UNIVERSITY OF OSLO

Spring 2017

Group creation in a collaborative P2P channel allocation protocol

Identifying connected groups of access points

Hans Jørgen Furre Nygårdshaug

© 2017 Hans Jørgen Furre Nygårdshaug

Group creation in a collaborative P2P channel allocation protocol

http://www.duo.uio.no/

Printed: Reprosentralen, University of Oslo

0.1 Disposition

0.1.1 Introduction part

- Introduction to the wifi interference problem
- Taking a step back and looking at other attempts on solving the problem
- Begin presenting Torleiv and Magnus work, the idea, and maybe the p2p protocol.
- End of by showing that there is a problem with creating, limiting and updating groups.

0.1.2 Main thesis part

The problem of data replicaton

- The problem.
- Possible solutions? References.
- Complexity, out of scope for thesis. Assume problem is solved.

The algorithm itself

- Elaborating on the problem, introducing the first algorithm suggestion.
- Explain simulation data creation with stochastic uniform distribution.
- Show how the group creation algorith was created, design decisions (iterations etc).
- Results with visualizations through the visualization tool.
- Evaluate results and consider improvements. How will this work in the wild?
- Introduce SSB data, the data format and why it is relevant. How is the tool made.
- Same procedure with result visualization and result evaluation. Do we still need improvements?
- Introducing Wigle as data source. Show results on map?

0.1.3 Concluding part

- Have we created a meaningful algorithm that can be implemented in hardware?

0.2 Channel allocation

To deal with the problem of channel allocation we will think of an AP as a vertex in a graph. When an AP scans its radio it can hear the strength of all nearby wireless networks measured in dBm (decibel milliwatts). This decibel value will be the value of the edge between one AP to another. With a graph expressing the wireless network topology, the problem of optimally distributing channels between APs boils down to a graph coloring problem. The number of colors in the color problem, represents the number of non-overlapping channels in 802.11. Exactly how an algorithm can be designed to optimally distribute channels within the interfering topology is out of the scope of this thesis. However we can define some invariants that has to be true for such an algorithm to work:

1. All APs has to run the same algorithm
2. All APs must run the algorithm on the same connected group
3. Because of the complexity of the problem the algorthm must solve, the number of APs in the connected group can not be too big

Point 1 is trivial to solve or mitigate, as only APs running the algorithm will actively participate in the channel selection. A simple way to make sure that the same algorithm is used, is by having a software version that is consistently checked with the other APs in the connected group.

Point 2 and point 3 is will be the main focus of the rest of the master thesis, as these are not so easily solved.

We can define a wireless topology graph as a set of wireless APs that are grouped together and share information about their neighbours and interference levels. This set is what will now on be referred to as a *connected group.* All members of the connected group will be considered when running the channel assignment algorithm. For the connected group to have an actual impact on the quality of a network connection, it has to consist of nodes that normally disturbs each other substantially.

An ideal example of a connected group is an apartment builiding. The channel allocation protocol lets APs share information about who-disturbs-who the most in the building. Then each AP can run the channel allocation algorithm. Because they run it on the same graph, every AP will find the same optimal channel distribution throughout the building, and then switch to the correct channel.

Even though an apartment building is most likely an optimal delimination of a connected group, in reality creating such a group is a bigger challenge. As the whole channel allocation protocol is based on decentralized peer-to-peer technology, and no centralized server with access to demographical and geographical divisions exists, the protocol will have to discover suitable connected groups on its own. Moreover, when the group is created the protocol will have to replicate data so that all participants of the group has all the data required to perform channel allocation. It will also need a way to make sure that the image of the current group is consistent within all APs in the connected group.

0.3 The Group Algorithm

0.3.1 Simulation data

Primarily, before beginning to implement and test the group creation algorithm, the task is to create usable data to perform testing on. . Additionally, each node should have a neighbour list, containing the respective interference measured in $-dBi$ for each neighbour. In addition, the following parameters should be variable depending on each test scenario:

- Map size (width of x- and y-axis).
- Number of nodes
- Minimum distance between nodes (in meters)
- Minimum measured $-dBi$ for a neighbour to consider it interfering

The program that generates the data is written in python, and can export the topology data to JSON-format so it can be visualized or used by other applications.

The interference levels between APs is calculated by iterating through each node. For each node N we record its x and y position, and then start a second iteration through the nodes. For each node in the second iteration n we calculate the distance d in meters between N and n using Euclidean distance.