Dynamic Self-Configuration of Collocated Wireless Networks

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Our research considers the problem of automatically configuring networks of 802.11 access points (APs) that share common physical spaces. The challenge is to find channel assignments for collocated APs that maximize the global network capacity and satisfy local service demands. The solution must satisfy the capacity constraints of the wireless spectrum and quickly converge to a stable and robust configuration under dynamic network conditions and varying service loads.

This work is motivated by our Personal Router project which envisions wireless environments with a variety of network services offered by a diverse set of providers competing in the same physical spaces. While competing, providers have to cooperate to coexist efficiently. Even in environments without competition between providers, the high density of APs in some areas requires coordinated configurations.

To address this problem we have developed an approach to reliably and effectively configure a collection of access points to provide the maximum possible level of service to users, to allocate capacity among different access points according to user demand, and to quickly respond to demand pattern changes caused by mobile or transient users. Our solution considers both inter-channel allocation to minimize interference between access points, and intra-channel allocation to minimize the competition for a shared channel by different access points when complete isolation is not possible. We address problems such as hidden terminals and interference "ripple effects" by building multi-hop configuration dependency trees and evaluating a "disruption cost" function to choose the most effective configuration as required.

Our algorithm is implemented efficiently as a set of distributed protocols. Each AP participates and locally decides an appropriate channel and estimated load level. An AP maximizes its share of the network capacity but cooperatively observes the algorithmically determined global priorities. By iteratively communicating these decisions, and the disruption cost of making changes, the global network of APs quickly stabilize to an efficient set of channel and capacity assignments.

Absent global coordination mechanisms, networks of APs today most often are statically configured by administrators who carefully consider channel conflicts and predicted service loads. Such static, offline configuration methods cannot react automatically to changing network conditions and place large management burdens on administrators. A few commercial 802.11 products attempt to automatically and dynamically configure themselves by considering the channel assignment of APs within their direct communication range. This single, restrictive configuration criterion ignores user demand, hidden terminals and often results in sub-optimal channel assignments.

We are evaluating our own approach along three fronts, formal analysis of the correctness of our protocols, simulation of large networks of collocated APs, and an implementation. We have proved the correctness of our protocol under reliable message delivery and proved that for all execution sequences our protocol converges to a correct solution. Our simulation results, presented in the poster, demonstrate that the protocol achieves the desired performance objectives. We are in the process of implementing our approach using Linux and the widely available HOSTAP software, which will allow us to evaluate its performance under real-world conditions.