

Chapter 5.19

Insights from Experimental Research on Distributed Channel Assignment in Wireless Testbeds

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ABSTRACT

This article presents the DES-Chan framework for experimental research on distributed channel assignment algorithms in wireless mesh testbeds. The implementation process of channel assignment algorithms is a difficult task for the researcher since common operating systems do not support channel assignment algorithms. DES-Chan provides a set of common services required by distributed channel assignment algorithms and eases the implementation effort. The results of experiments to measure the channel characteristics in terms of intra-path and inter-path interference according to the channel distance on the DES-Testbed are also presented. The DES-Testbed is a multi-radio WMN with more than 100 nodes located on the campus of the Freie Universität Berlin. These measurements are an important input to validate common assumptions of WMNs and derive more realistic, measurement-based interference models in contrast to simplified heuristics.

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INTRODUCTION

Channel assignment for multi-transceiver *wireless mesh networks* (WMNs) attempts to increase the network performance by decreasing the interference of simultaneous transmissions. Multi-transceiver mesh routers allow the communication over several wireless network interfaces at the same time. However, this can result in high interference of the wireless interfaces leading to a low network performance. With channel assignment, the reduction of interference is achieved by exploiting the availability of fully or partially non-overlapping channels. Channel assignment can be applied to all wireless networks based on technologies that provide non-overlapping channels. Currently, wide-spread technologies are IEEE 802.11a/b/g, IEEE 802.11n, and IEEE 802.16 (WiMAX). With the relatively low cost for IEEE 802.11 hardware, the number of deployments based on this technology is increasing and channel assignment algorithms are gaining in importance.

Although channel assignment is still a young research area, many different approaches have already been developed (Si, 2009). These approaches can be distinguished into *centralized* and *distributed* algorithms. Centralized algorithms rely on a central entity, usually called *channel assignment server* (CAS), which calculates the network-wide channel assignment and sends the result to the mesh routers. In distributed approaches, each mesh router calculates its channel assignment based on local information. Distributed approaches can react faster to topology changes due to node failures or mobility and usually introduce less protocol overhead since communication with the CAS is not necessary. As a result, distributed approaches are more suitable once the network is operational and running. Another classification considers the frequency of channel switches on a network node. In *fast channel switching* approaches, channel switches may occur frequently, in the extreme for every subsequent packet a different channel is chosen. The limiting

factor for dynamic algorithms is the long channel switching time with commodity IEEE 802.11 hardware, which is in the order of milliseconds. *Slow channel switching* approaches in contrast, switch the interfaces to a particular channel for a longer period, usually in the order of minutes or hours. *Hybrid* approaches combine both methods.

An important input for channel assignment algorithms are the particular channel characteristics of the used network technology. For instance, IEEE 802.11b/g offers in theory three non-overlapping channels, e.g. {1, 6, 11}, and all available channels in IEEE 802.11a use non-overlapping frequency spectrums. This means, that concurrent transmissions on these channels should not interfere with each other. In practice, experiments and measurement on different experimental platforms have shown, that the non-interfering characteristics do not hold for many reasons (Fuxjager, 2007; Subramaniam, 2008; Draves, 2004), an important one is the insufficient distance of less than 1 m between the antennas on a single network node. Since mesh routers are usually quiet compact, it is almost impossible to design a multi-radio mesh router with sufficient antenna distance. This is also the case with DES-Nodes of the DES-Testbed, on which the three WiFi antennas are mounted with a distance of about 30 cm. Therefore, we also expect to experience side-effects on the theoretical non-interfering channels, which are subject to experimentation in this article.

Next to the channel characteristics of the DES-Testbed, the focus of this article is on the experimentally driven research of distributed, slow channel switching algorithms on wireless testbeds. This process yields several challenges and pitfalls for the researcher. Since common operating systems are not designed to support channel assignment algorithms out of the box. Thus, the researcher has to deal with operating system specifics, drivers for the wireless interfaces, and the capabilities and limitations of the particular hardware. If more than one particular algorithm should be studied, the same problems

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