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Design and Evaluation of IEEE 802.11ax Scheduling Methods for Ultra-Reliable Low Latency Communication in ns-3

Motivation and Problem Statement

Reliable wireless connectivity is becoming a more and more crucial aspect for modern industrial applications of all kinds. While current implementations often rely on wired connections to guarantee reliable communications between remote-control systems and operators or between multiple autonomous systems, these come at a cost of low flexibility. With the current rise of the 5th Generation of cellular networks (5G) and the possibility for companies to deploy and manage their own campus network in exclusive frequency bands, the opportunities for reliable wireless connectivity are more present than ever. However, 5G networks come at high financial costs as well as a high requirement of expert knowledge. In contrast to that are Wi-Fi networks, which typically are already deployed in most companies for general network access and can be deployed and extended at relatively low cost as they operate in unlicensed frequency bands. With the recent development of Wi-Fi 6 (IEEE 802.11ax) [1] and its introduction of Orthogonal Frequency Division Multiple Access (OFDMA) to the Wi-Fi Standards Family, Wi-Fi networks promise an improved reliability and efficiency [2, S. 11], making it an attractive contestant for 5G networks in the sense of industrial wireless networks on paper.

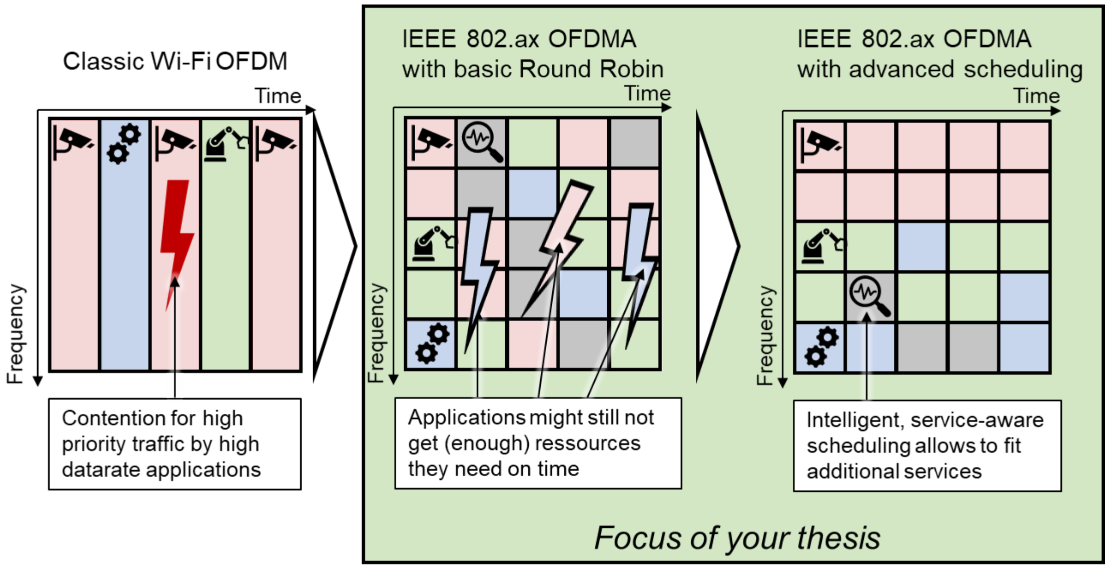

Figure 1: Scope of the thesis: Evaluate scheduling mechanisms in Wi-Fi 6 (IEEE 802.11ax)

In order to provide a reliable, service-aware communication for diverse applications, an intelligent scheduling approach is mandatory. As seen in Figure 1, in classic Wi-Fi networks all stations contend for the same opportunities to access the wireless channel. This can lead to high priority applications not being able to send because another, high data rate application accessed the channel. In Wi-Fi 6, these applications can get resources assigned according to their requirements, allowing heterogeneous services accessing the channel in parallel and due to efficient scheduling even allowing additional best effort services without harming high priority applications.

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However, while Wi-Fi 6 enables such a scheduling by introducing OFDMA, the scheduling itself is not specified and therefor left to the manufacturer and/or operator of the network infrastructure. A simple Round Robin approach poses an easy scheduling implementation, but does not unfold the full potential of the technology, especially for critical application. This thesis therefor aims at the development and analysis of state of the art scheduling approaches for Wi-Fi 6 networks [3] and algorithms previously developed for mobile networks (e.g. Payload-SIze and Deadline-Aware Scheduling, PayDA [4] [5]) and validate their efficiency against a simple round robin implementation. In order to evaluate these, the open source network simulator 3 (ns-3) [6] should be used and extended to support Wi-Fi 6 OFDMA and resource allocation.

Potential Goals:

- Setup and validate a Wi-Fi simulation environment in ns-3

- Adapt existing models to support Wi-Fi 6 OFDMA and Resource Allocation

- Implement and Develop State of the Art Scheduling Algorithms with focus on reliability

- Evaluate the feasibility of Wi-Fi 6 with advanced scheduling for Ultra-Reliable Low Latency Communication (URLLC) Applications

- (Compare Deterministic and Machine Learning Based Scheduling approaches)

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