TECHNISCHE UNIVERSITÄT
ILMENAU

Prof. (Jun.-Prof.) Dr. Florian Klingler
IoT Engineering
Website: www.tu-ilmenau.de/iot

RESEARCH PROJECT

Approaches to Channel Scheduling in Highly Mobile Networks

Motivation and Background

Wireless communication systems are nowadays prime building blocks of many novel application domains in the context of the Internet of Things (IoT) and Wireless Sensor Networks, Vehicular Networks, as well as our internet. When investigating such wireless networks from a communication layer perspective, the main metrics in form of data rate (throughput and, particularly at application layer, goodput), end-to-end latency, and packet delivery rate (PDR) describe the performance characteristics of such systems. Based on the nature of wireless networks and the use of shared resources – the radio frequency spectrum – those metrics are often a trade-off between them. E.g., when increasing the data rate, the reliability (PDR) can suffer, as higher-order Modulation- and Coding Schemes (MCS) need to be used requiring a better Signal-to-Noise Ratio. Of course, the limited PDR can be combated by proper coding and forward error correction (FEC), yet, they add additional overhead by reducing the maximum achievable data rate. Further, potential re-transmissions necessary at MAC Layer could improve the PDR, but will, however, have a non-negligible impact on the end-to-end latency. In summary, those concepts already have been demonstrated in many works in the literature, originating from **Claude E. Shannon's famous theorem of Channel Capacity** – the Shannon Capacity – of a Additive White Gaussian Noise Channel (AWGN), as it is evident in Wireless Communication Systems. The only possibilities to increase the amount of information transmitted over an AWGN Channel is to increase the transmit power (leading to scalability problems due to interference), or **increasing the amount of RF-Spectrum** – thus adding **more bandwidth** to our communication system.

Research Project Goals

To tackle the challenge of increasing bandwidth of a communication system, channel scheduling systems can be used allowing single-radio and multi-radio systems to use multiple channels. This allows a communication system to increase the used radio spectrum, by taking advantage of multiple channels, in certain configurations even at the same time. However, those multi-channel systems often require tight coordination among systems to address the question of which node should transmit at which time at which channel – consequently similar questions also hold for receiving nodes. In the literature, many works investigate those challenges from a research perspective by giving an overview of potential architectures and protocols for multi-channel scheduling or even proposing dedicated protocols for certain use cases [2, 1, 3, 4], mainly investigating the area of Wireless Sensor Networks.

In this proposed Research Project, multi-channel scheduling approaches for single- and multi-radio systems will be investigated by extending the scope to include also IoT and similar systems as well with potential focus on highly mobile scenarios. By defining certain use-cases from the above communication domains, the concepts will be qualitatively evaluated in terms of their feasibility and performance, as well as systems requirements.

Further, based on simulation studies done within this Research Project, a evaluation of potential candidates for above use-cases will provide quantitative insights to multi-channel scheduling systems.

Required knowledge (or willing to learn)

- C/C++ programming
- Statistical evaluation (e.g., by using R)
- Scientific literature review and writing

References

[1] W. Cheng, X. Cheng, T. Znati, X. Lu, and Z. Lu. The Complexity of Channel Scheduling in Multi-Radio Multi-Channel Wireless Networks. In *28th IEEE Conference on Computer Communications (INFOCOM 2009)*, pages 1512 –1520, Rio de Janeiro, Brazil, 4 2009.

[2] J. Crichigno, M.-Y. Wu, and W. Shu. Protocols and architectures for channel assignment in wireless mesh networks. *Elsevier Ad Hoc Networks*, 6(7):1051–1077, 2008.

[3] B.-J. Ko, V. Misra, J. Padhye, and D. Rubenstein. Distributed Channel Assignment in Multi-Radio 802.11 Mesh Networks. In *IEEE Wireless Communications and Networking Conference (WCNC 2007)*, pages 3978 –3983, Hong Kong, China, 3 2007.

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Contact:
Florian Klingler: <florian.klingler@tu-ilmenau.de>

Website:
www.wnc-labs.org