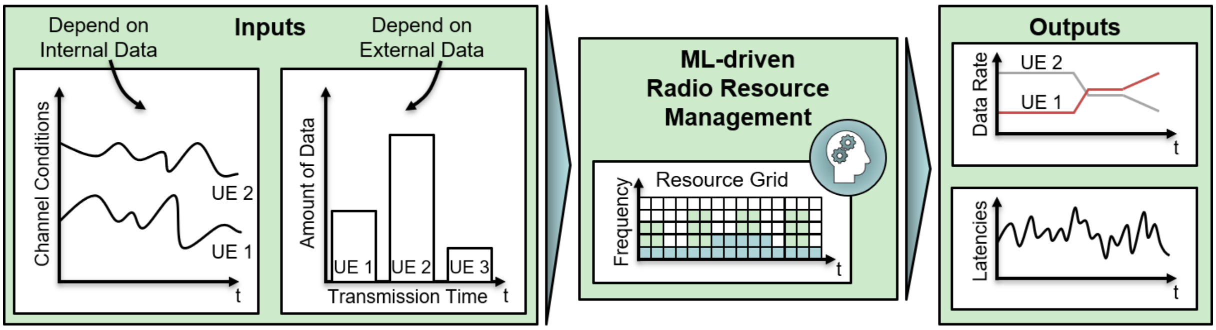
Master Thesis

ML-driven Network Slicing for critical communications

The feed-in behavior of renewable energy sources such as solar and wind energy is characterized by high volatility and strong weather-related fluctuations. In order to still meet the high demands on reliability and grid stability in future intelligent energy grids, so-called "smart grids", a large number of monitoring and control units are required down to the customer level. These in turn require high-performance communication networks that can transmit the resulting data in a timely manner via shared, possibly public 5G infrastructures. This can be addressed with the help of 5G network slicing [1]. However, to provide reliable, efficient resources to each inhabitant of a network slice, sophisticated radio resource management is needed.



Machine-learning enabled Network Slicing for 5G and beyond networks is necessitated by the complexity of efficient resource scheduling, while considering spectral efficiency as well as the highly critical demands e.g. Smart Grid communications pose to a shared communication network [2], [3]. To provide a steady level of data rate and latency to the User Equipments (UEs) of one slice, channel conditions and anticipated data traffic need to be considered. While static resource provisioning is capable of achieving this, unused resources are wasted and thus spectral efficiency for scarce radio spectrum declines [4]. To optimize the trade-off between reliability and efficiency, a ML-driven concept for radio resource management is pursued within the scope of this work.

For this, a ML-model is to be designed and trained on real-world data sets to provide the scheduler with the necessary information to allocate resources proactively. Building on previous works, the interface definition to use this ML-model within the testbed needs to be adapted accordingly [4], [5]. The trained model is then evaluated based on SDR solutions and compared to static slicing as well as regular scheduling approaches in terms of identified KPIs. Finally, the obtained results are optimized from both a technological (e.g. spectral efficiency) and an economic (e.g. trade-offs) point of view.

Proposed working points:

- Familiarization with 5G standard and development of knowledge about srsRAN, scheduling and machine learning
- Data aggregation and extraction for ML-enabled Network Slicing use cases
- Design and setup of an SDR-based experimental setup in the CNI laboratory
- Implementation and training of suitable prediction models
- Identification of Key Performance Indicators
- Validation, evaluation and optimization of the developed solution

Requirements:

- Required: General understanding of communication networks and protocols
- Desirable: Programming skills in C/C++
- Desirable: Knowledge in data visualization (e.g. with Python)
- Optional: Git and Linux knowledge
- Optional: Experience in handling ML-Tools

References:

[1] X. Foukas, G. Patounas, A. Elmokashfi and M. K. Marina, "Network Slicing in 5G: Survey and Challenges," in IEEE Communications Magazine, vol. 55, no. 5, pp. 94-100, May 2017.

[2] M. Elsayed and M. Erol-Kantarci, "AI-Enabled Future Wireless Networks: Challenges, Opportunities, and Open Issues," in IEEE Vehicular Technology Magazine, vol. 14, no. 3, pp. 70-77, Sept. 2019

[3] 3GPP, “3GPP TS 23.501 – 5G; System Architecture for the 5G System” 3rd Generation Partnership Project (3GPP), Tech. Rep. 23.501, Oct. 2020, version 16.6.0

[4] C. Bektas, D. Overbeck, C. Wietfeld, "SAMUS: Slice-Aware Machine Learning-based Ultra-Reliable Scheduling", In 2021 IEEE International Conference on Communications (ICC), Virtual Event, June 2021.

[5] C. Bektas, S. Böcker, F. Kurtz and C. Wietfeld, "Reliable Software-Defined RAN Network Slicing for Mission-Critical 5G Communication Networks," 2019 IEEE Globecom Workshops (GC Wkshps), 2019, pp. 1-6, doi: 10.1109/GCWkshps45667.2019.9024677.