# Telecommunications

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**Goals:** Signal processing for telecommunication, enhanced with deep learning. Physical layer simulations and optimization in wireless (Wi-Fi) networks. Wireless communication mostly relies on model-based statistical signal processing methods that might be suboptimal. Model-based deep learning offers remarkable alternatives with the combination of model-based and data-driven approaches. Further reading: neural network approaches for data estimation [1] and optimal end-to-end learning [2] for wireless communication. Development environment: Python (numpy/pytorch).

**Topics:**

1. **Simulation framework for wireless communications**
   Simulation of orthogonal frequency-division multiplexing networks in Python (numpy), based on the known physical models. Primarily, *unique word* (UW-OFDM) and *cyclic prefix* (CP-OFDM) is in focus. The goal is to develop a flexible and user-friendly framework that simulates the transmission in frequency domain, including the simulation of the transmitter and receiver, symbol generation, channel modelling, model-based data estimation, and optionally channel coding and interleaving.

2. **Physical layer encryption**
   In networking, the usual task of the physical layer is the transmission of the bit data, and the encryption is implemented in the higher layers. However, encryption is also possible in the physical layer as well, which might significantly secure the communication (see e.g. [3]). The task is to encrypt the physical layer of OFDM networks using model-based and deep learning approaches, and the development and study of possible attacks. (Prerequisite: simulation framework)

**References:**

[1] S. Baumgartner, G. Bognár, O. Lang, and M. Huemer. **"Neural Network Based Data Estimation for Unique Word OFDM."** In: *2021 55th Asilomar Conference on Signals, Systems, and Computers*, 2021, 381–388. DOI: `10.1109/IEEECONF53345.2021.9723229`

[2] G. Bognár, S. Baumgartner, O. Lang, and M. Huemer. **"Neural Network Optimal UW-OFDM."** In: *2021 55th Asilomar Conference on Signals, Systems, and Computers*, 2021, 389–394. DOI: `10.1109/IEEECONF53345.2021.9723117`

[3] M. Jacovic, et al. **"Physical Layer Encryption for Wireless OFDM Communication Systems."** In: *J. Hardw. Syst. Secur.* 4 (2020), 230–245. DOI: `10.1007/s41635-020-00097-8`