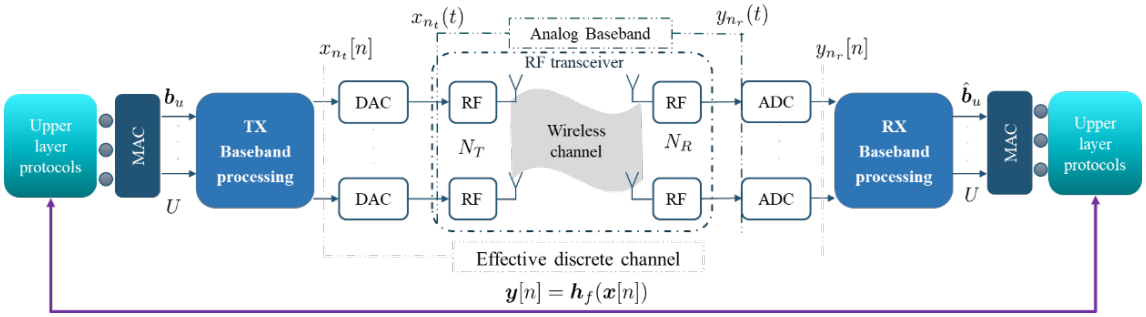
Student assistance

Flexible PHY/MAC implementation and documentation

The physical layer (PHY) is the lowest layer in a communications system. It connects the data source of upper communications layers to the physical medium. It can be split into

- **Baseband module:** is responsible of digital signal processing to encode/decode data to/from digital signals. This module can be implemented with software or hardware depending on the performance requirements in terms of throughput and latency.
- **Medium dependent module:** converts the digital signal at the transmitter (Tx) to signal that can propagate through a medium such as audio, light, and radio frequency (RF) signals, and at the receiver (Rx), it converts the medium signals to digital ones. In RF communications, the Tx hardware consists of analog-to-digital convertors (DACs), low-pass filters (LPFs) and power amplifiers (PAs). The Rx contains low-noise amplifiers (LNAs), LPFs and analog-to-digital converters (ADCs).



The medium access control (MAC) is used to control the access to shared media. In RF communications, the MAC is responsible of allocating and scheduling the radio resources (time, frequency, and spatial).

Most of the RF communications standards employ similar architecture. The differences lie in the operating carrier frequency and bandwidth in addition to the baseband and MAC techniques. Moreover, the communications layer 3 is mostly based on IP, and the standards define protocols in layer 2, which are implemented on software. Standard PHY/MAC design is essential for commercial purposes. However, a device with fixed PHY/MAC implementation on dedicated chip only operates with that standard. Flexible implementation allows devices to be upgradable and reconfigurable to extend their life cycle. Moreover, the flexibility enables the development of private PHY/MAC in a private network, such as industrial networks. Finally, for research purposes, flexible PHY/MAC allows real-time experiments of new innovation in PHY/MAC design under realistic channel conditions instead of simplified simulation.

Tasks

For the implementation of PHY/MAC, NI-USRP that contains a software-defined radio (SDR) module and FPGA module are to be used. Several tasks are available:

- Baseband processing algorithms development and implementations with C/C++, VHDL and LabVIEW
- Experiments and measurements of specific configurations
- MAC protocol design and interfaces with PHY
- Protocol interface with layer 2/3 standards, in particular 5G and WiFi network
- Testing and documentation of available flexible PHY framework implemented with LabVIEW

Requirements

- Good knowledge of the fundamentals of communications engineering and networks
- Good programming skills in one or more programming languages (C/C++, VHDL, Python)
- Familiar with MATLAB/LabVIEW/

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