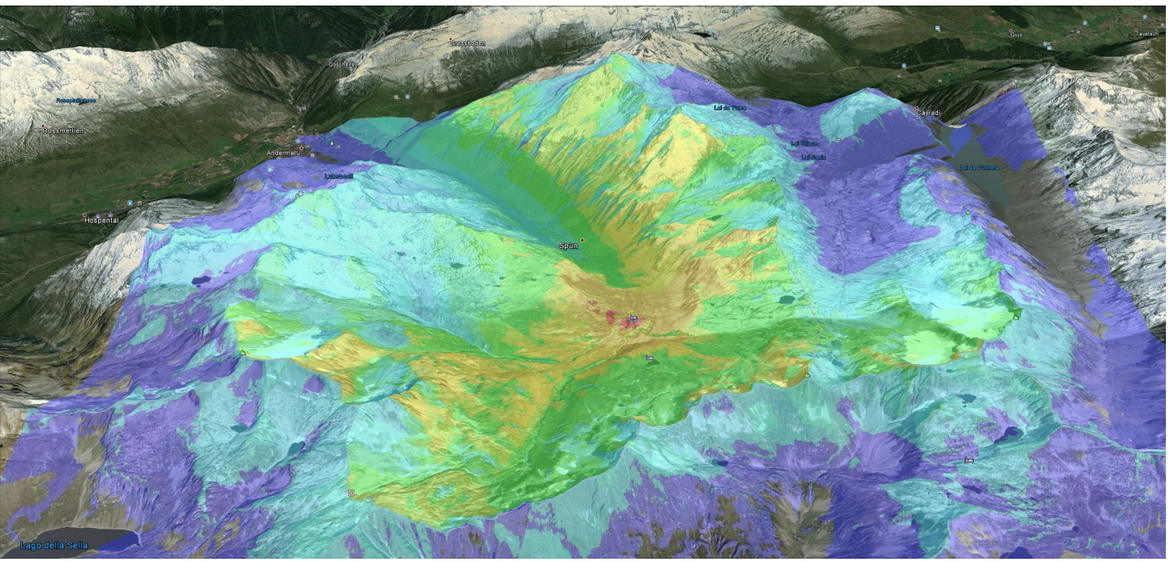
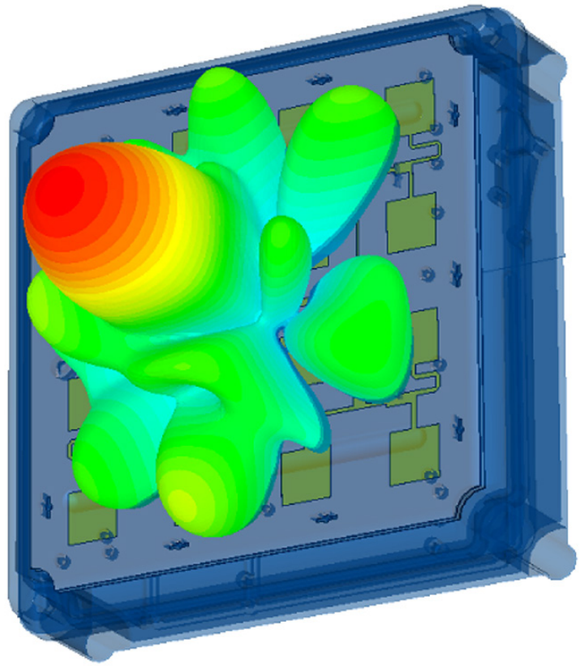
Wireless Communication 1 & 2



Simulated RF propagation and coverage for a LoRa tracking system at 169 MHz.

NOAA wheather satellite data receiver as part of a bachelor thesis in 2022. The receiver was built using a helical antenna with a parabolic reflector, an RTL2832U Software Defined Radio (SDR) and a GNU Radio based decoding algorithm.



4x4 patch antenna array. Multiple antennas are combined in a beamforming system to increase the directivity as indicated with the colored 3D beam. The beam direction can be steered by phase shifting of the antenna feeding signals. Multiple beams can be produced by superpositioning the feeding signals to target different receivers simultaneously. Such smart antenna systems are used in modern mobile communication systems (e.g. 5G/6G).

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WCOM1 - Overview

WCOM1 covers a wide range of topics and areas: from the physics of antennas to signal processing in communications engineering - to information theory for coding and crypto. WCOM1 teaches the basics of wireless communication in both high data rate communication systems (e.g. 5G, WiFi 6) and in lower rate IoT and sensor networks (e.g. BLE, RFID, NFC).

Module Content

- Propagation of radio waves (Free space propagation, propagation models, characteristics of communication channels, antenna systems)
- Transmitter and receiver structures (Superheterodyne receiver, low/zero-IF receiver, Direct Digital Synthesis, Software Defined Radio architectures)
- Analog modulation (Amplitude modulation, frequency modulation, RFID)
- Digital communication in base band (Pulse shaping, Nyquist Filter, Matched Filter, synchronization)
- Digital modulation (Amplitude, phase and frequency shift keying, Quadratur Amplitude modulation) for Bluetooth, WiFi, 4G, 5G
- Introduction to information theory (Source coding (lossless / lossy, Shannon limit), Channel coding), Forward Error Correction (Block codes, convolutional codes, channel capacity), Introduction to cryptography (symmetrical / asymmetrical encryption, electronic signature, authentication)
- Analyse and solve typical problems with modern measurement technology and operation of wireless systems in the WCOM laboratory

Prerequisite Knowledge
Signals and Systems (SISY1): Basic knowledge of system theory (LTI systems, Fourier transformation)

Recommended supplementary modules
Digital Signal Processing 1 + 2 (DSV1/DSV2)
Advanced Electronics (ADEL)

WCOM1 enables the selection of several bachelor thesis in the above mentioned and additional topics.

WCOM2 - Overview

In the WCOM2 module, you learn how modern wireless systems work beyond just protocols (e.g. WiFi 6, 4G (LTE) / 5G (NR), IoT / sensor networks, GPS / GNSS) and also study the most commonly used techniques, such as OFDM, multi-antenna systems (e.g. MIMO) and user separation methods. You will also learn the basics of wireless localisation and wireless sensing (radar). This enables you to select, parameterise and successfully implement a suitable wireless technology for a specific application.

Module Content

- Understanding of the functionality, performance and limitations of modern wireless systems (e.g. WiFi 6, 4G (LTE) / 5G (NR), IoT / sensor networks, GPS / GNSS, Radar), based on the fundamentals of wireless communication
- Propagation of radio waves in multipath environments and suitable modern transmission techniques for high data rates (OFDM)
- Multiplexing methods: Space-, time-, frequency- and code- multiplexing (SDMA, TDMA, FDMA, CDMA), random access, cellular technology, capacity calculation
- Multiantenna-Systems (e.g. MIMO)
- Characteristics of modern wireless systems, e.g. Mobile radio 4G (LTE) and 5G (NR), IoT (LoRa, NB-IoT, LTE-M, 5G), WiFi, DAB, GPS/GNSS, localisation, Radar and DECT
- Flexible receivers and transmitters using Software Defined Radio (SDR) technology
- Analyse and solve typical problems with modern measurement technology and operation of wireless systems in the WCOM laboratory

Prerequisite Knowledge
Wireless Communication 1 (WCOM1): Recommended, but not compulsory.

Signals and Systems (SISY1): Basic knowledge of system theory (LTI systems, Fourier transformation)

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4 ECTS Credits

2 x 45 min lectures per week

2 x 45 min lab training per week

1 written semester exam (20%), 60‘
1 written end of module exam (80%), 90‘

4 ECTS Credits

2 x 45 min lectures per week

2 x 45 min lab training per week

1 written semester exam (20%), 90‘
1 written report (10%)
1 written end of module exam (70%), 90‘