TECHNISCHE UNIVERSITÄT DRESDEN

CCN

Electrical Engineering and Information Technology IEE, Chair for Circuit Design and Network Theory CCN

MIMO RADAR STATUS PROJECT RANGER

Dresden, 01.08.18

FAKULTÄT ELEKTROTECHNIK UND INFORMATIONSTECHNIK

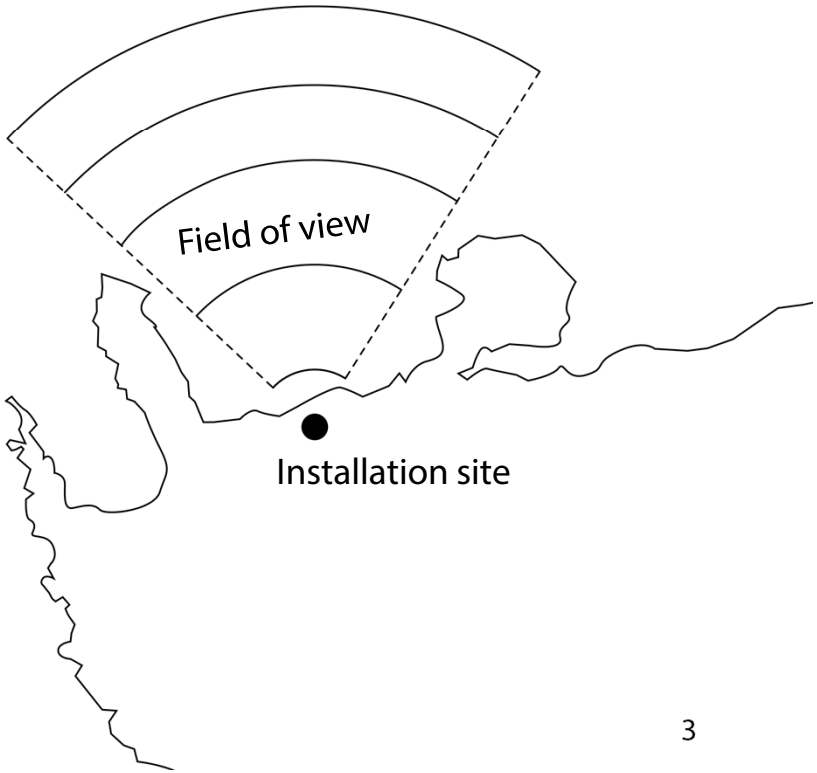
OUTLINE

Overview
System architecture
Components
Digital hard- and software
Outlook

OVERVIEW
RANGER

Maritime coastal radar

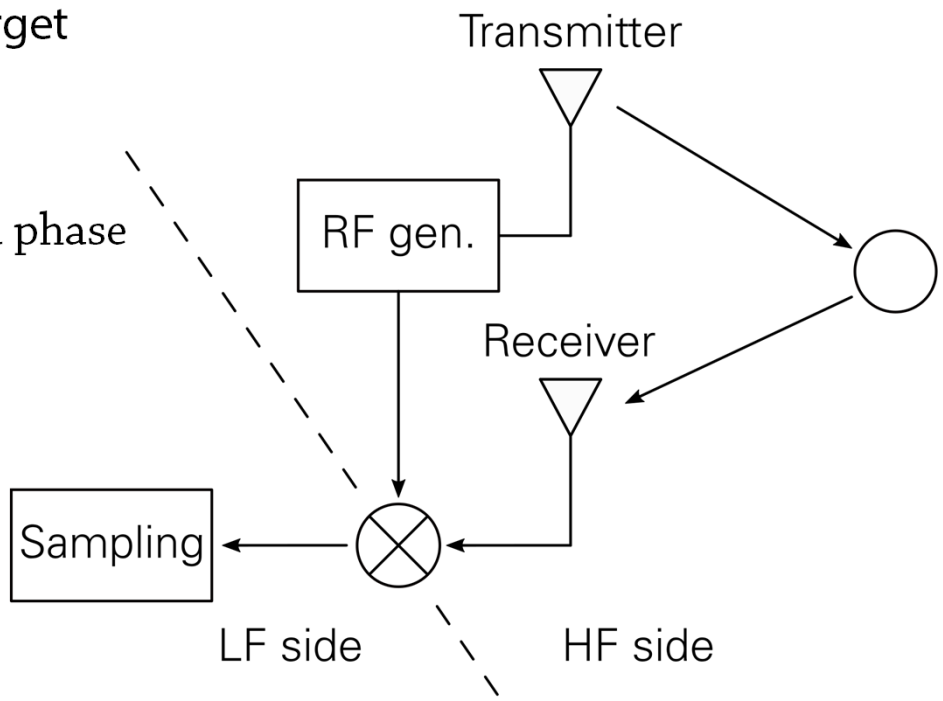
- Development of a complete FMCW MIMO radar
- Design of analog components
- Antenna design
- Design of digital hardware
- Processing and control



SIDE NOTES
FMCW RADAR

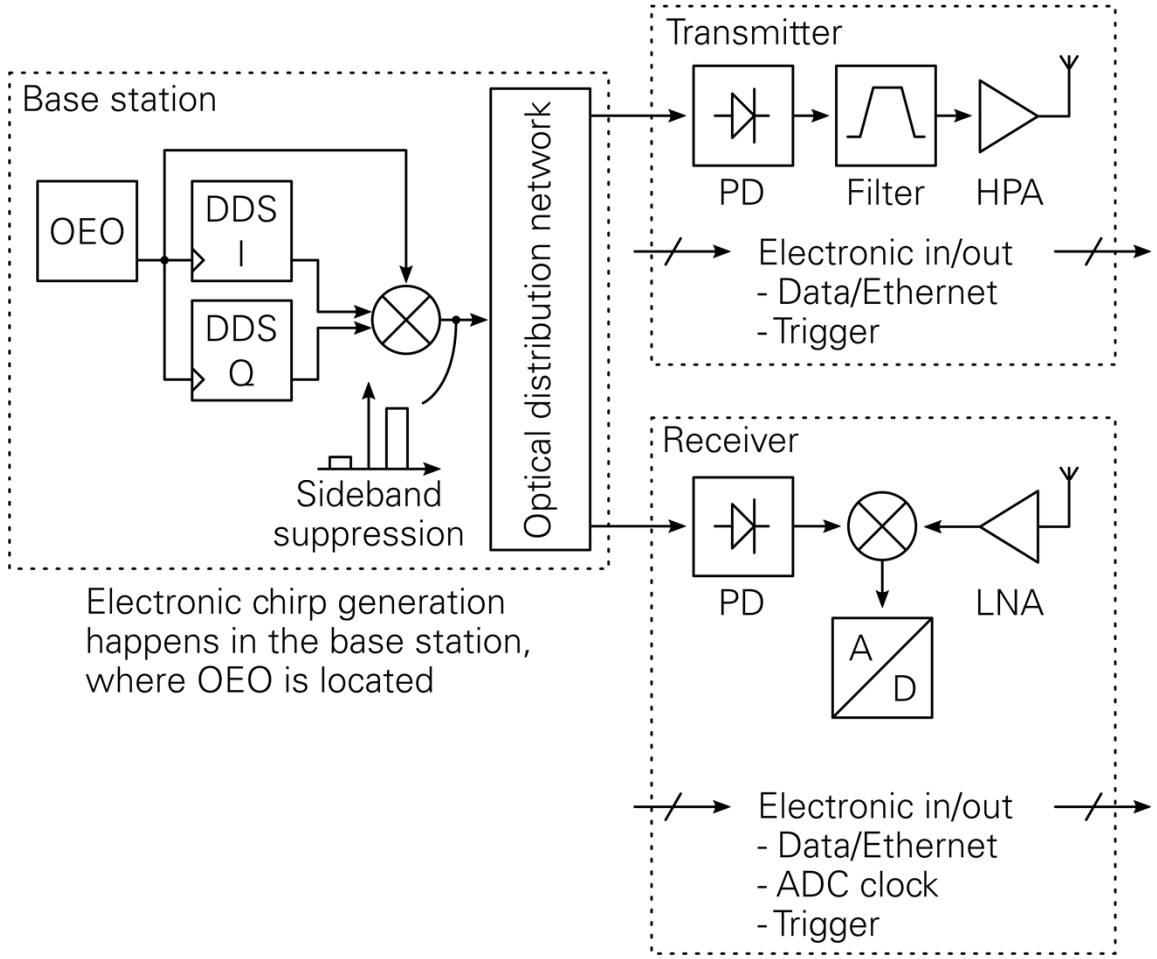
Theory of operation

- RF transmission towards target
- Reception of delayed signal
- Deramping
- Mixer output frequency and phase proportional to range

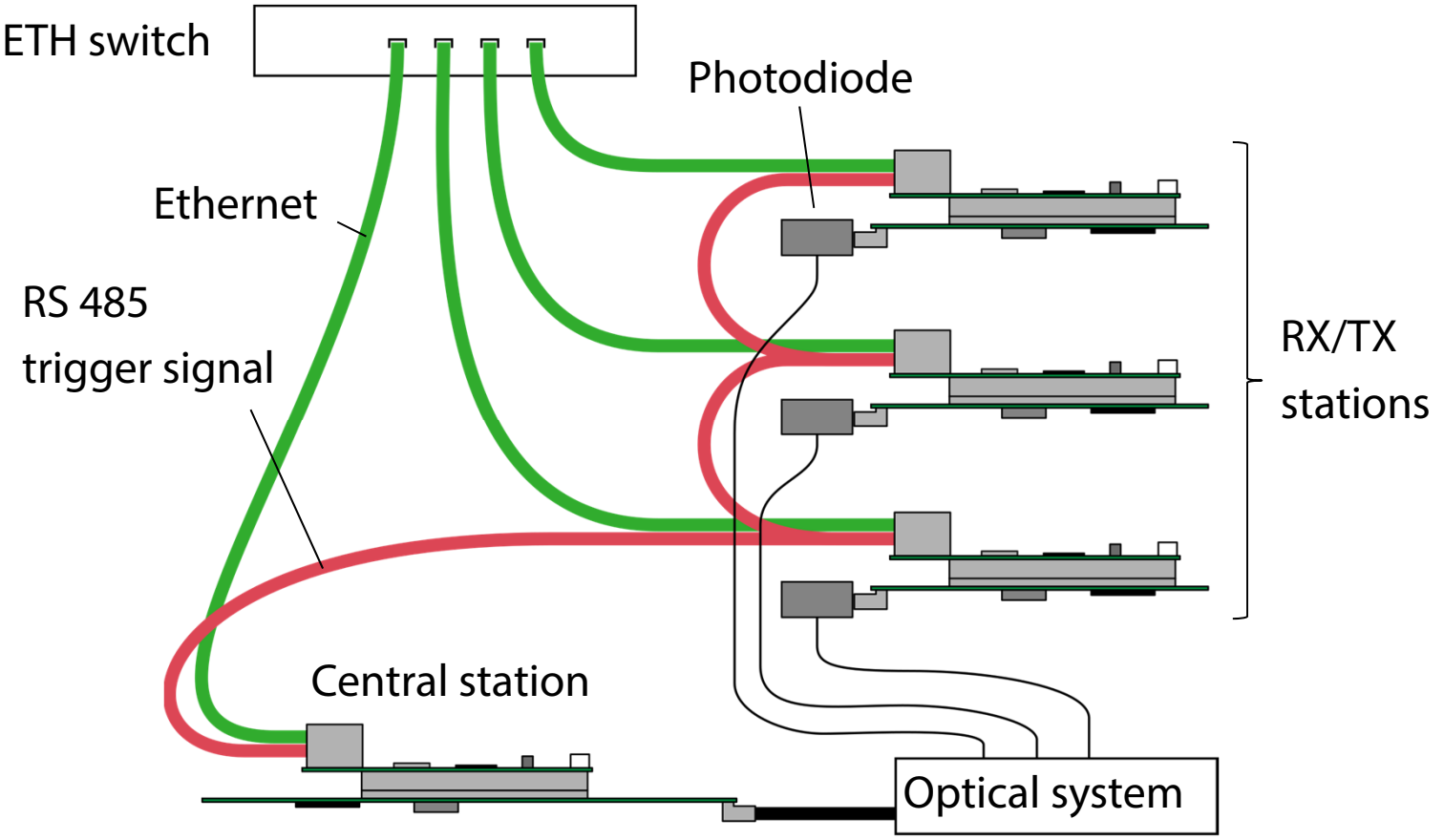


CENTRALIZED SYSTEM ARCHITECTURE

BLOCK DIAGRAM



CENTRALIZED SYSTEM ARCHITECTURE
INTERCONNECTS



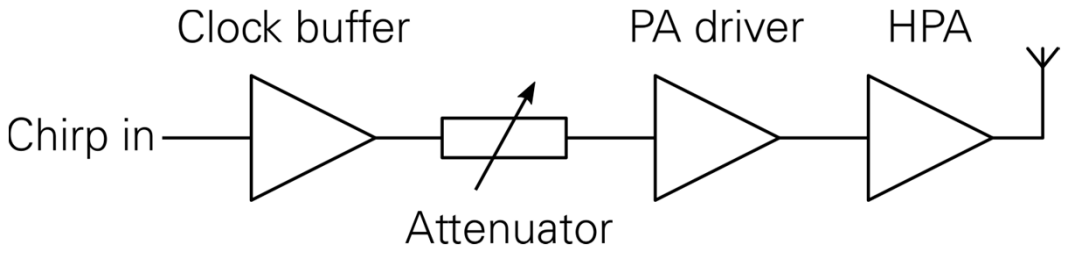
CENTRALIZED SYSTEM ARCHITECTURE
OVERVIEW

- Central station generates chirp signal for use in RX/TX stations
- Signal from central station is distributed to all RX/TX stations over optical fiber
- Configuration and data exchange is done over ethernet (green)
- RS485 daisy-chain transmits trigger signals (red)

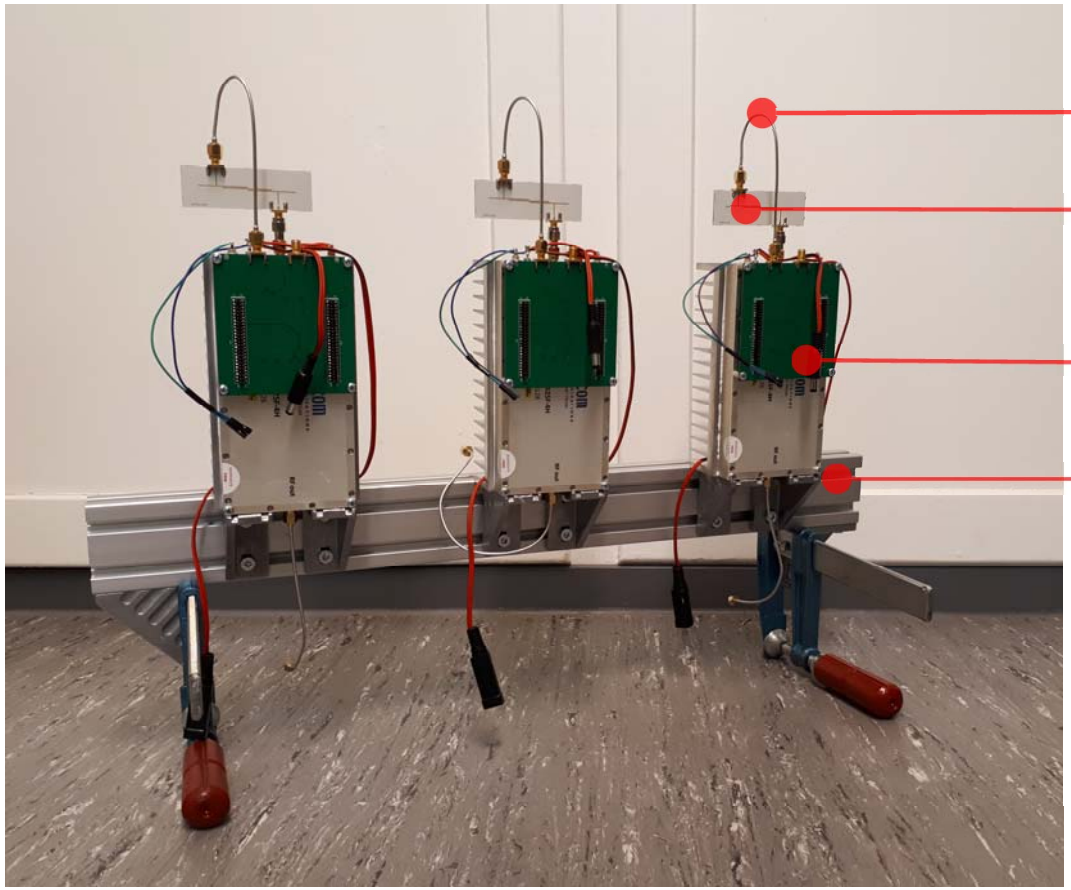
PROTOTYPE
TX STATION

- Receives chirp signal over optical fiber
- Signal amplified with buffer stage
- Attenuation is applied, if required
- Signal is fed into HPA for final amplification
- Full control over Ethernet

PROTOTYPE
TX STATION



PROTOTYPE
TX ARRAY

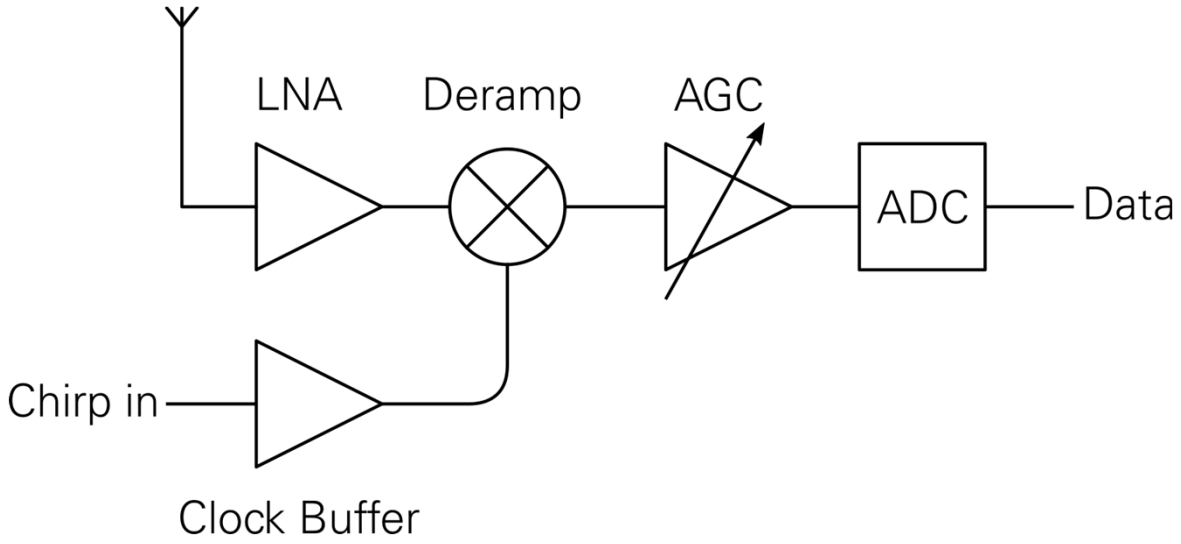


PROTOTYPE
TX ARRAY

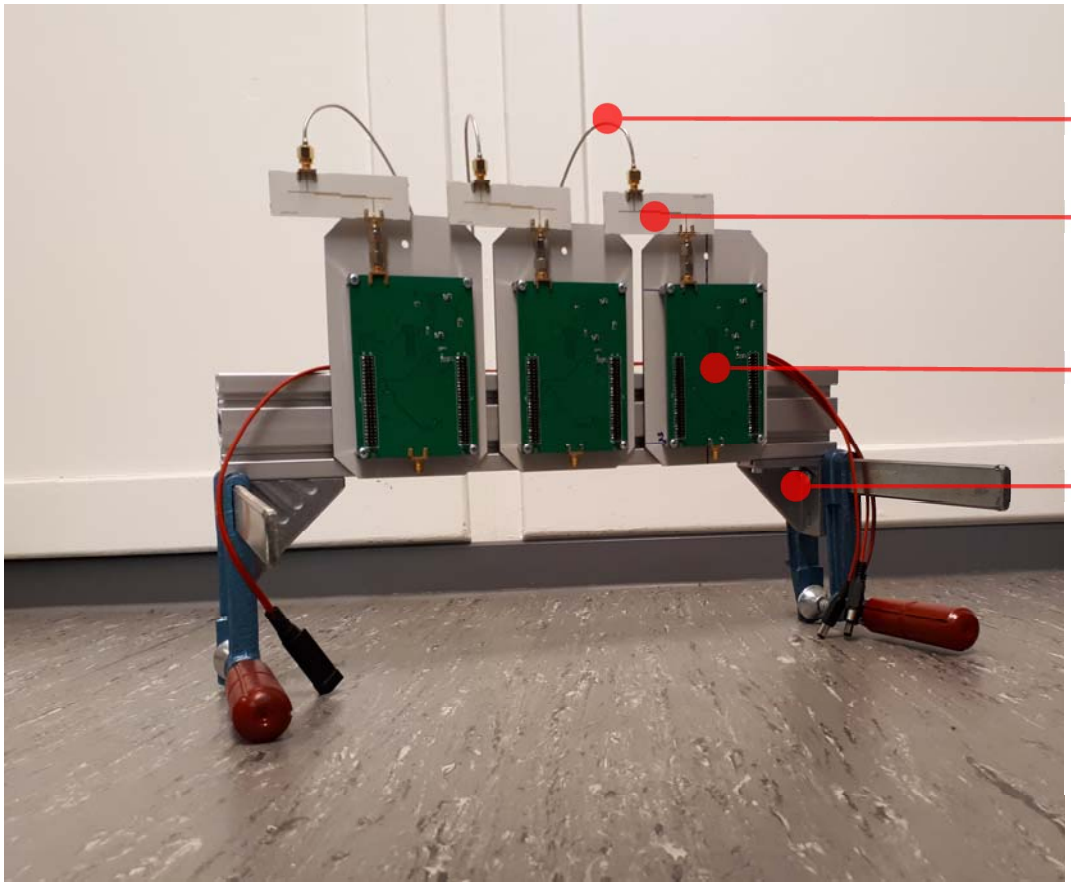
PROTOTYPE
RX STATION

- Downconversion of received signal with input ramp signal that comes over the optical fiber (deramping)
- Applies amplification to the baseband signal with an AGC that can be configured to be free-running or fixed
- Samples the scaled baseband signal
- Data is recorded to SDRAM on digital PCB by means of DMA and transmitted over Ethernet
- Real time data extraction and full control over Ethernet

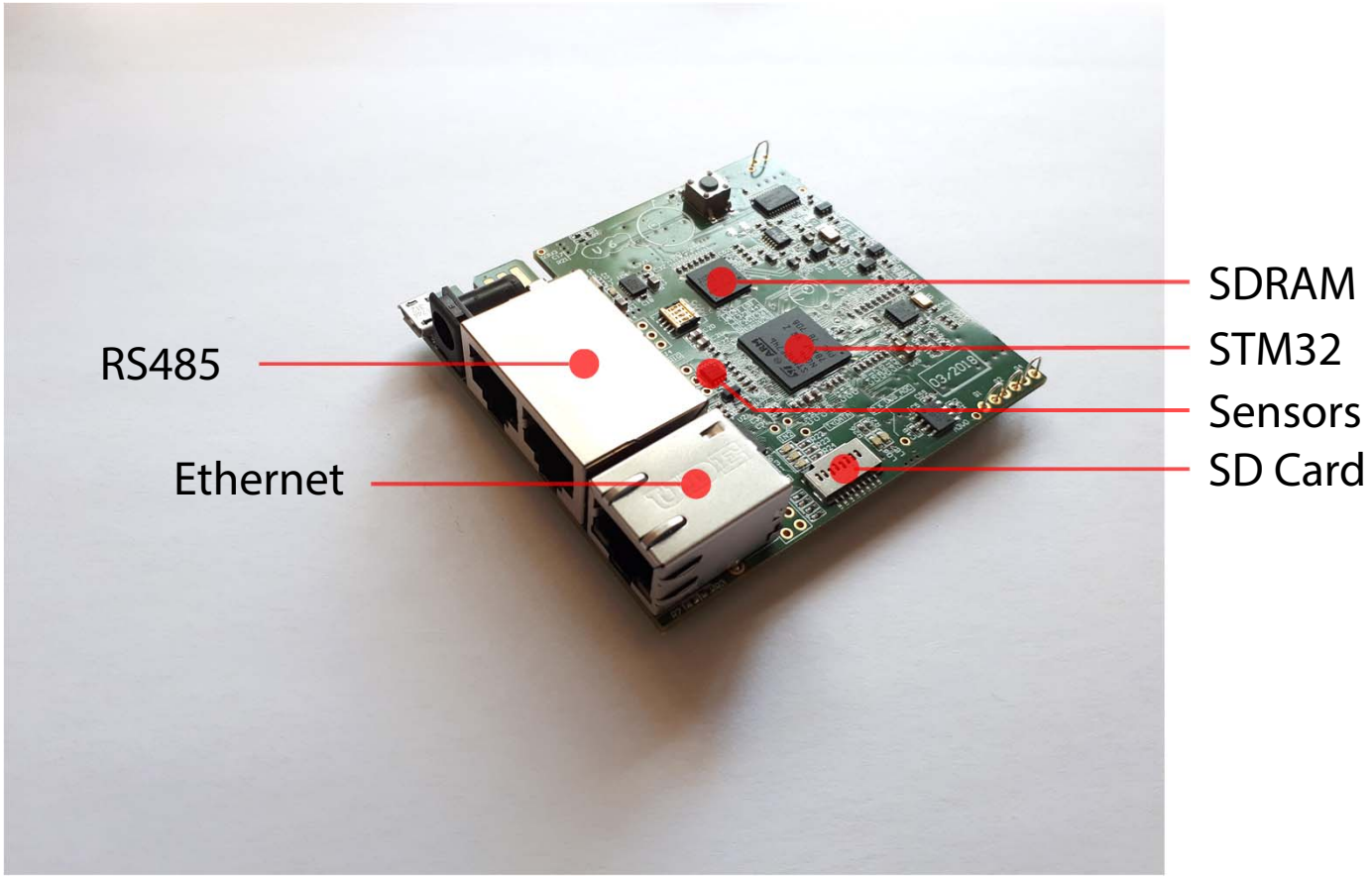
PROTOTYPE
RX STATION



PROTOTYPE
RX ARRAY



DIGITAL HARDWARE
FINAL VERSION



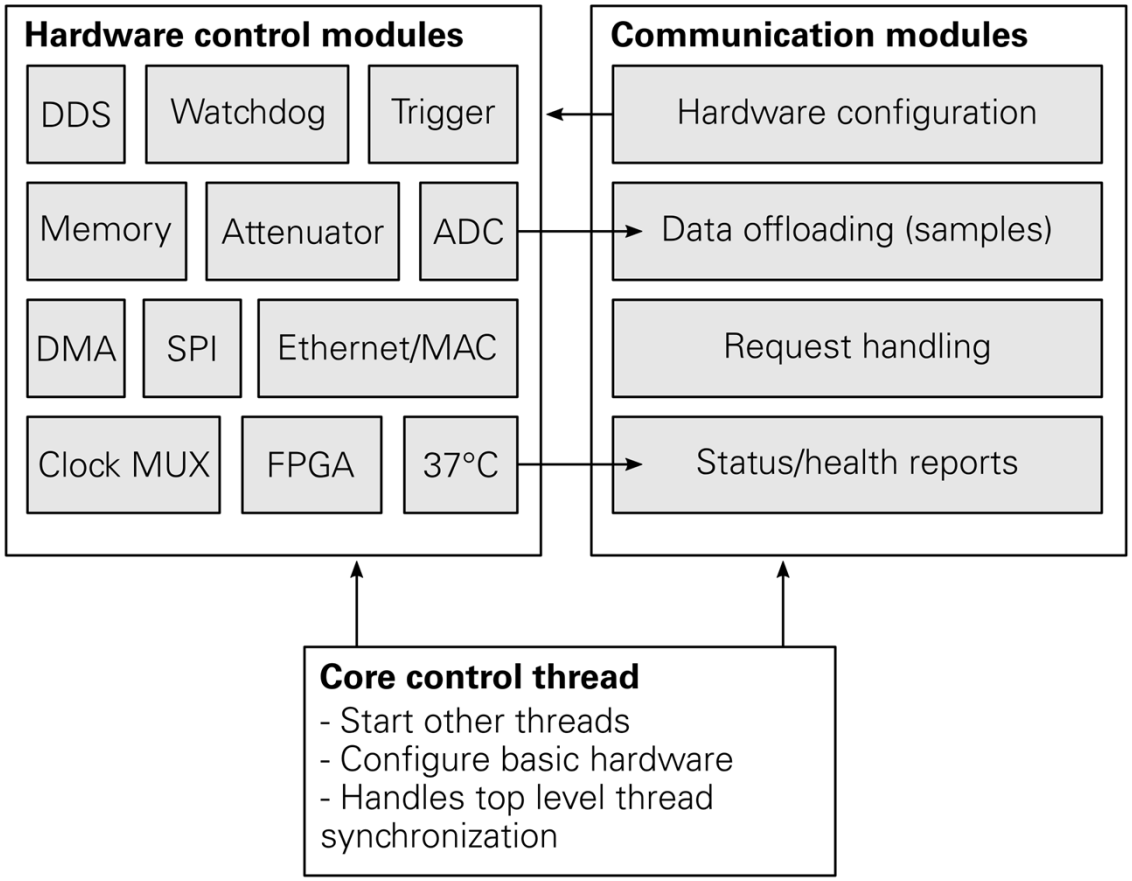
SOFTWARE
OVERVIEW

- Python-based cross-platform user interface
- C-based code (using ChibiOS RT) for digital hardware

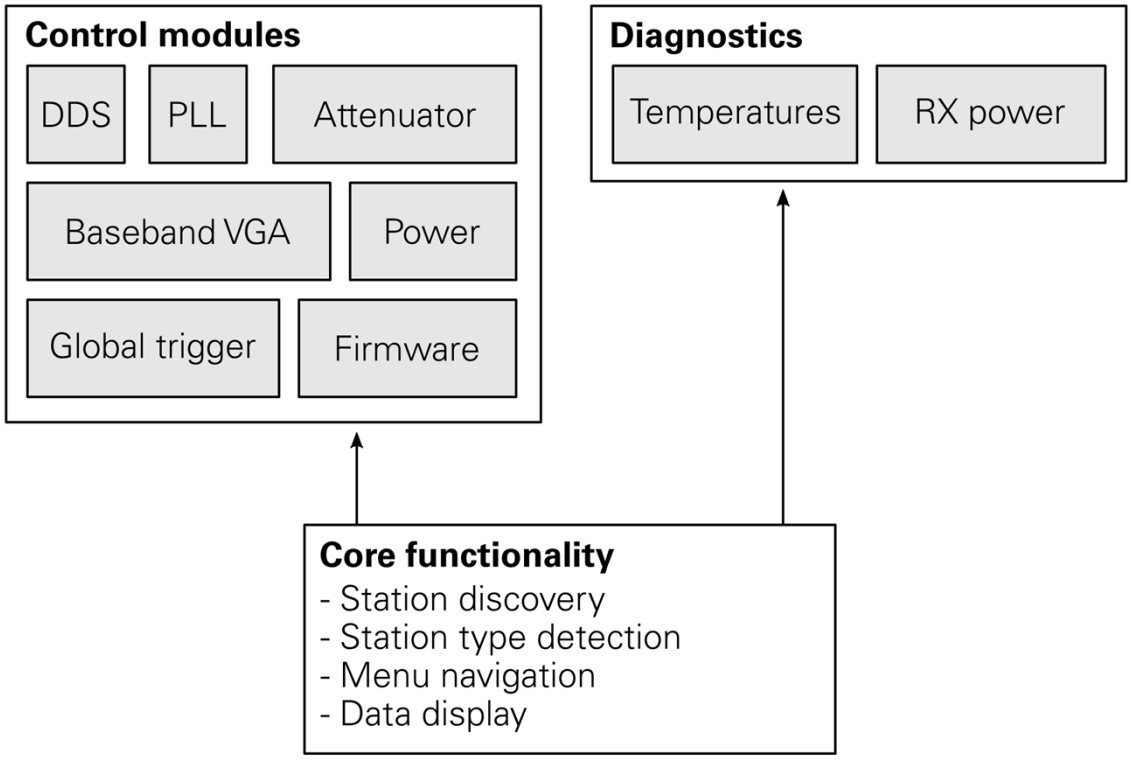
Features

- Station discovery on the network with mode detection
- Firmware update over Ethernet (bootloader)
- Health supervision interface (temperatures and ADC levels)
- Configuration of the global trigger
- Configuration of DDS or PLL based stations

EMBEDDED SOFTWARE
ARCHITECTURE (C-BASED)

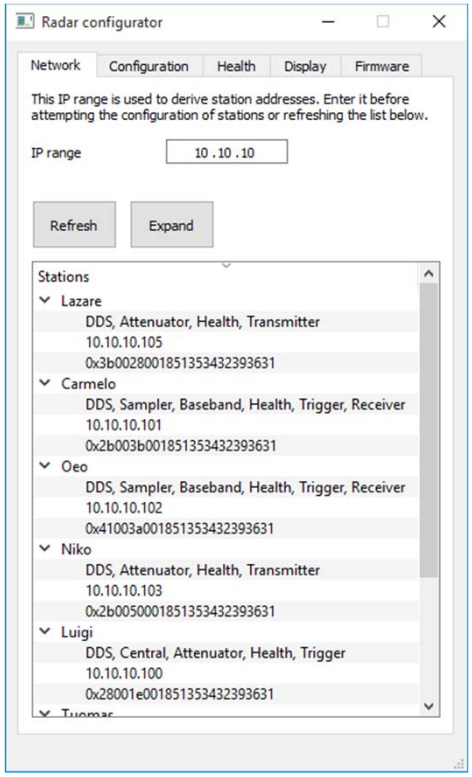


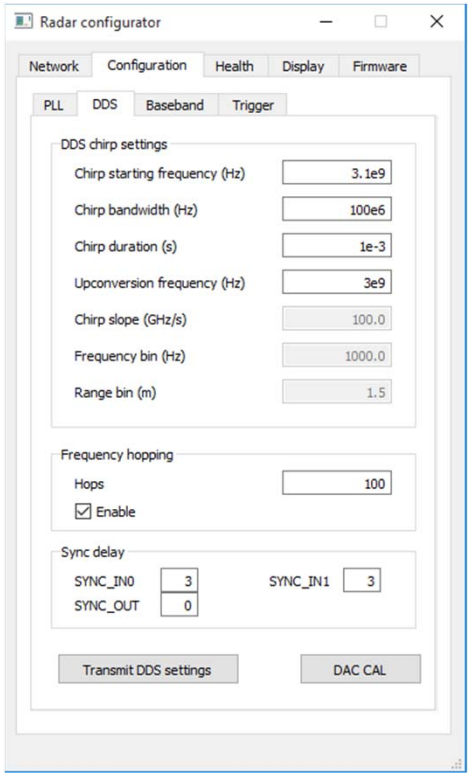
REMOTE CONTROL SOFTWARE
ARCHITECTURE (PYTHON-BASED)

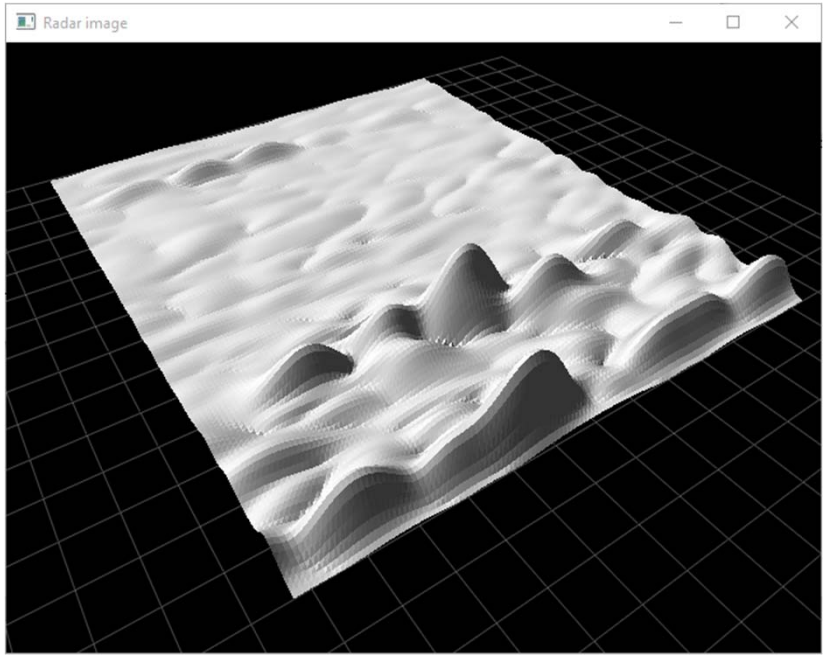


REMOTE CONTROL SOFTWARE

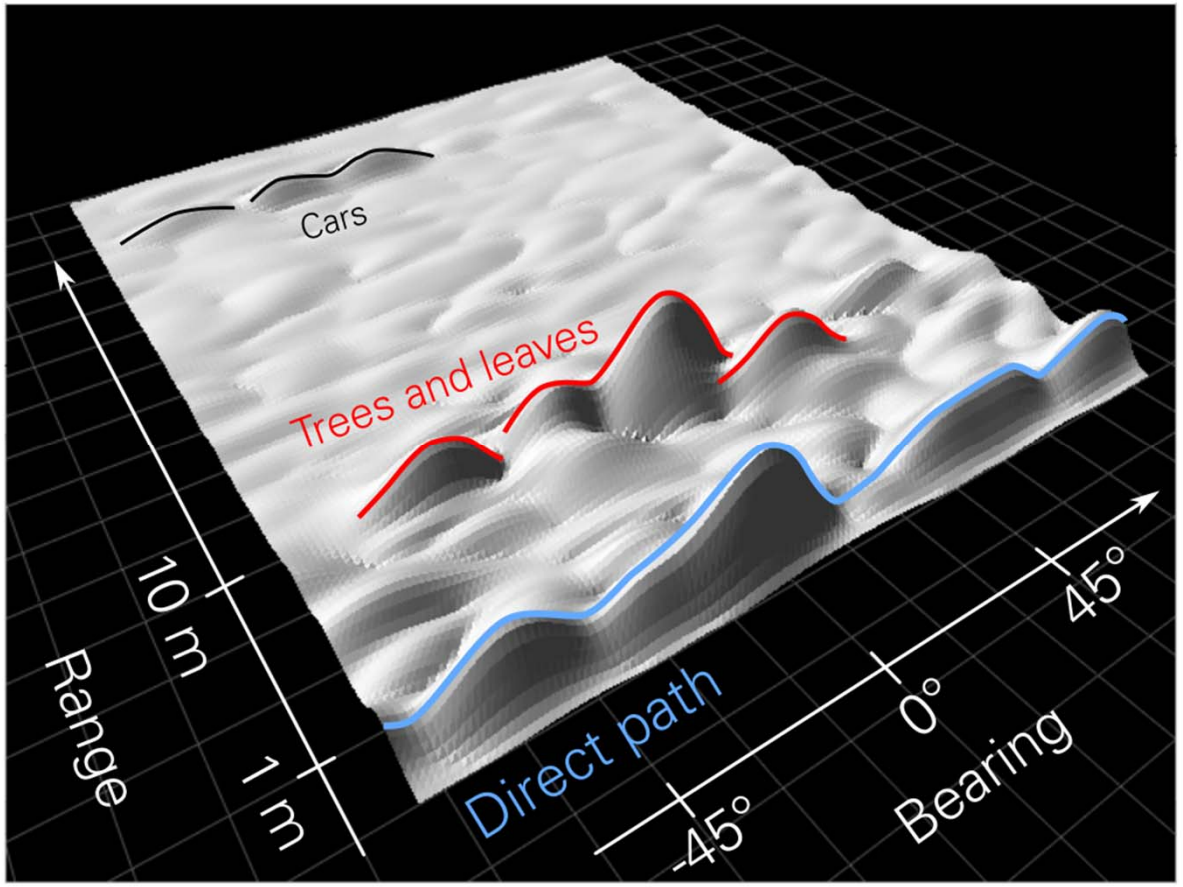
GUI







DEMO


Cars
Trees and leaves
Direct path
Range
10 m
1 m
-45°
0°
45°
Bearing

OUTLOOK

- Test full system with 20 by 20 transceivers
- Perform outdoor evaluation with moving targets
- Fix minor instabilities
- Design target extraction routine