



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

MIMO RADAR STATUS PROJECT RANGER

Dresden, 01.08.18







OUTLINE

Overview System architecture Components Digital hard- and software Outlook

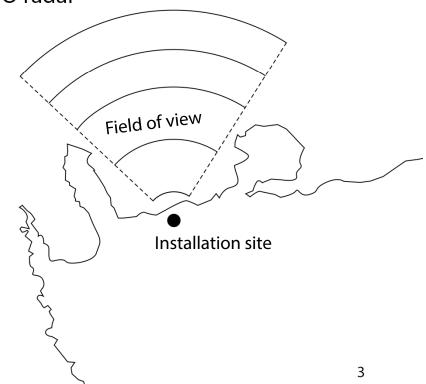




OVERVIEW RANGER

Maritime coastal radar

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



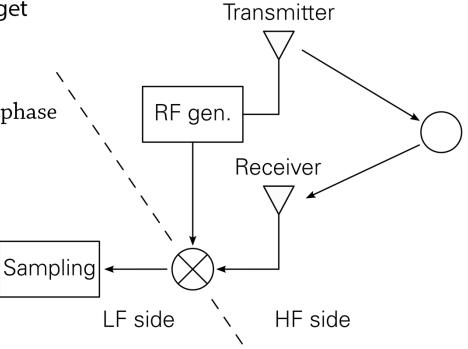




SIDE NOTES FMCW RADAR

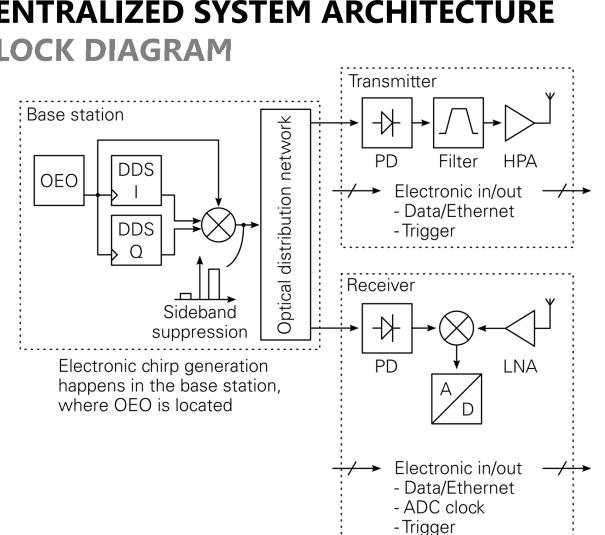
Theory of operation

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









CENTRALIZED SYSTEM ARCHITECTURE BLOCK DIAGRAM





ETH switch Photodiode Ethernet RS 485 RX/TX trigger signal stations Central station Optical system

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)





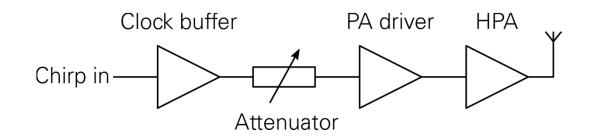
PROTOTYPE TX STATION

- 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** Antenna connectors **RF** Filter TX analog board Mounting mechanism





PROTOTYPE TX ARRAY



HPA with heat sink





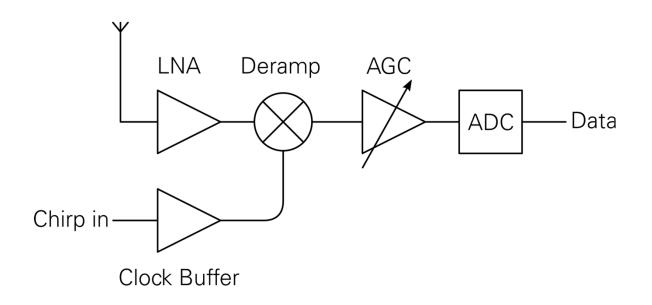
PROTOTYPE RX STATION

- 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





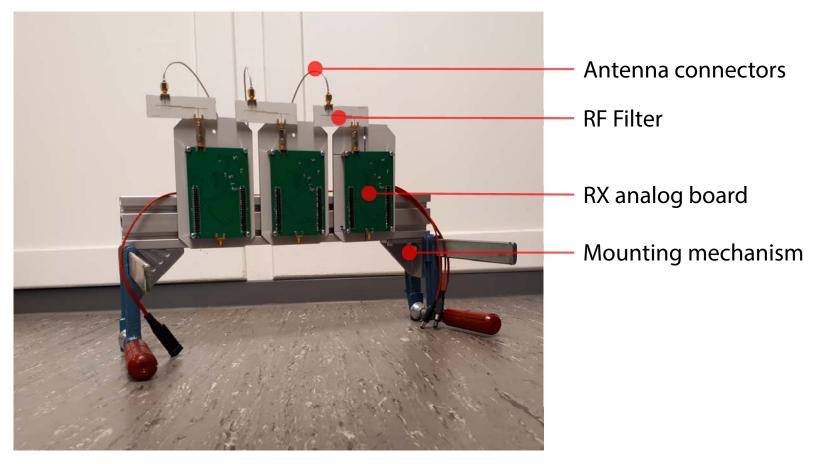
PROTOTYPE RX STATION







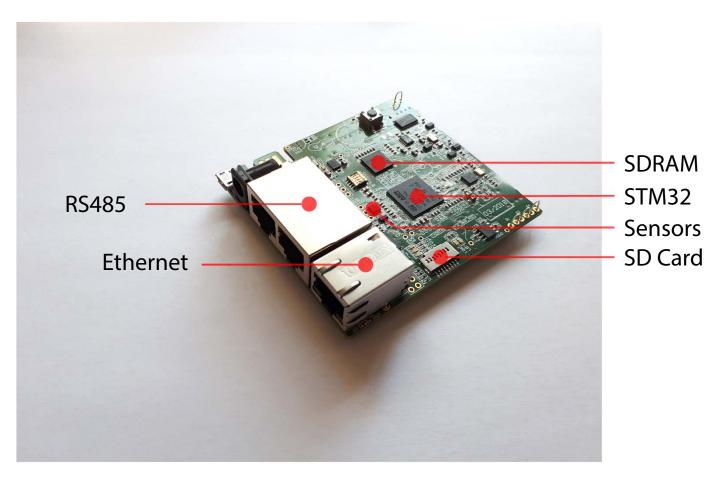
PROTOTYPE RX ARRAY







DIGITAL HARDWARE FINAL VERSION







SOFTWARE OVERVIEW

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

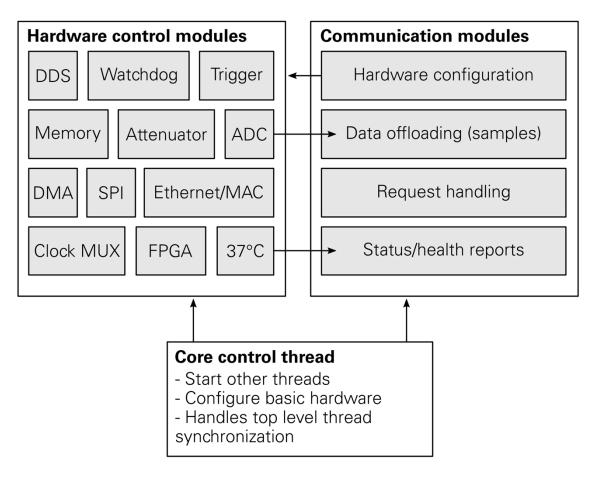
Features

- 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





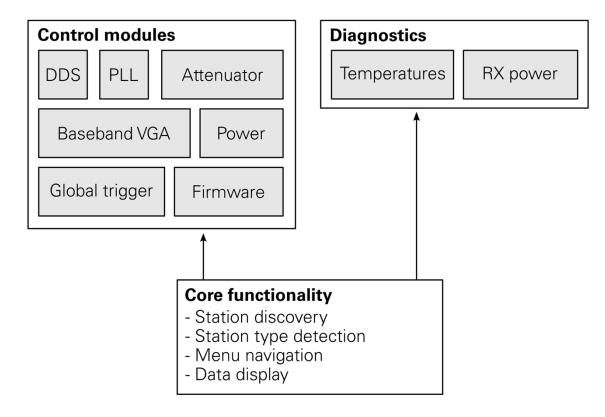
EMBEDDED SOFTWARE ARCHITECTURE (C-BASED)







REMOTE CONTROL SOFTWARE ARCHITECTURE (PYTHON-BASED)







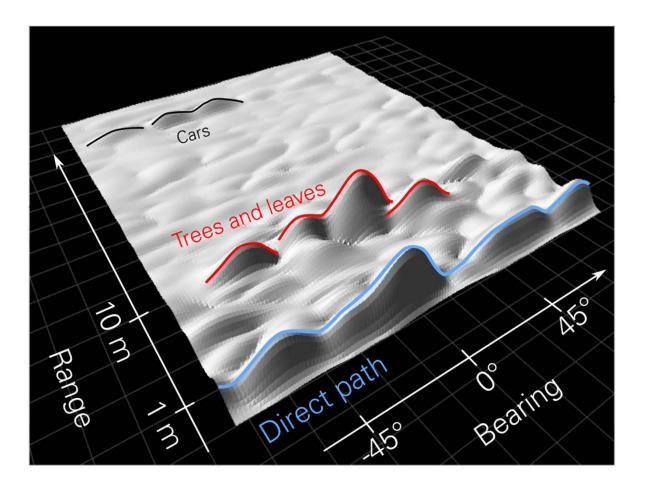
REMOTE CONTROL SOFTWARE GUI

🗈 Radar configurator — 🗆 🗙	🗈 Radar configurator — 🗆 🗙	
Network Configuration Health Display Firmware	Network Configuration Health Display Firmware	🔝 Radar image — 🗆 🗙
This IP range is used to derive station addresses. Enter it before attempting the configuration of stations or refreshing the list below. IP range 10.10.10 Refresh Expand Stations	PLL DDS Baseband Trigger DDS chirp settings Chirp starting frequency (Hz) 3.1e9 Chirp bandwidth (Hz) 100e6 Chirp duration (s) 1e-3 Upconversion frequency (Hz) 3e9	
DDS, Attenuator, Health, Transmitter 10.10.10.105 0x3b0028001851353432393631	Chirp slope (GHz/s) 100.0 Frequency bin (Hz) 10000	
 Carmelo DDS, Sampler, Baseband, Health, Trigger, Receiver 10.10.10.101 	Range bin (m) 1.5	
0x2b003b001851353432393631 Ceo DDS, Sampler, Baseband, Health, Trigger, Receiver 10.10.10.102 0x41003a001851353432393631	Frequency hopping Hops 100 I Enable	
 Niko DDS, Attenuator, Health, Transmitter 10.10.10.103 0x2b0050001851353432393631 	Sync_IN0 3 SYNC_IN1 3 SYNC_OUT 0	
 Luigi DDS, Central, Attenuator, Health, Trigger 10.10.100 0x28001e001851353432393631 Tuomar 	Transmit DDS settings DAC CAL	





DEMO







OUTLOOK

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