TECHNISCHE UNIVERSITÄT DRESDEN

CCN

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

RANGER STATUS UPDATE
RADAR DIGITAL BACKEND

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FAKULTÄT ELEKTROTECHNIK UND INFORMATIONSTECHNIK

OUTLINE

RANGER summary
Motivation
Digital hardware and system design
System performance
Conclusion

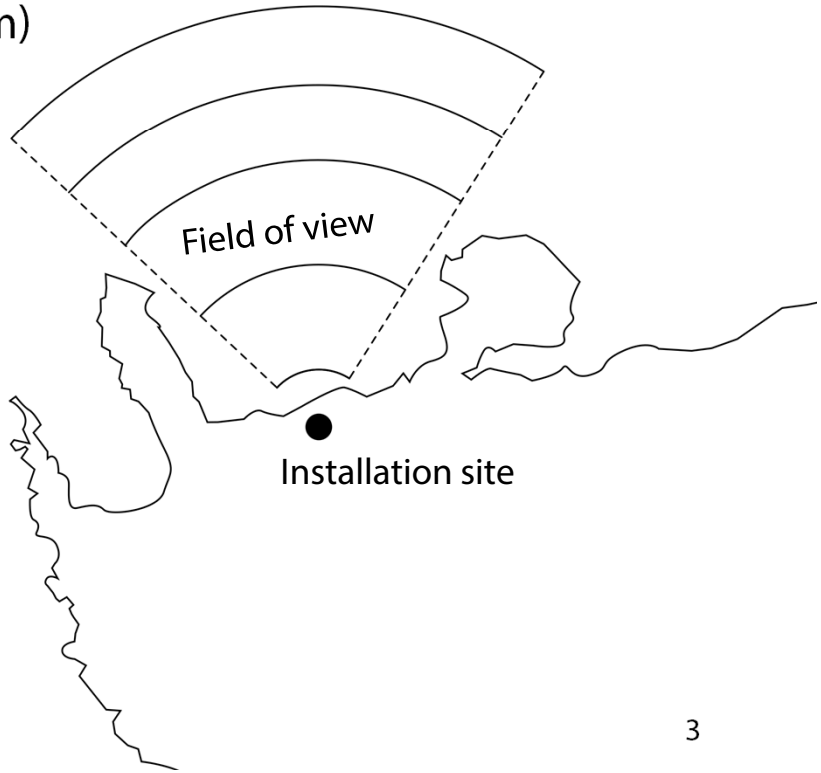
RANGER – SUMMARY

Maritime coastal radar

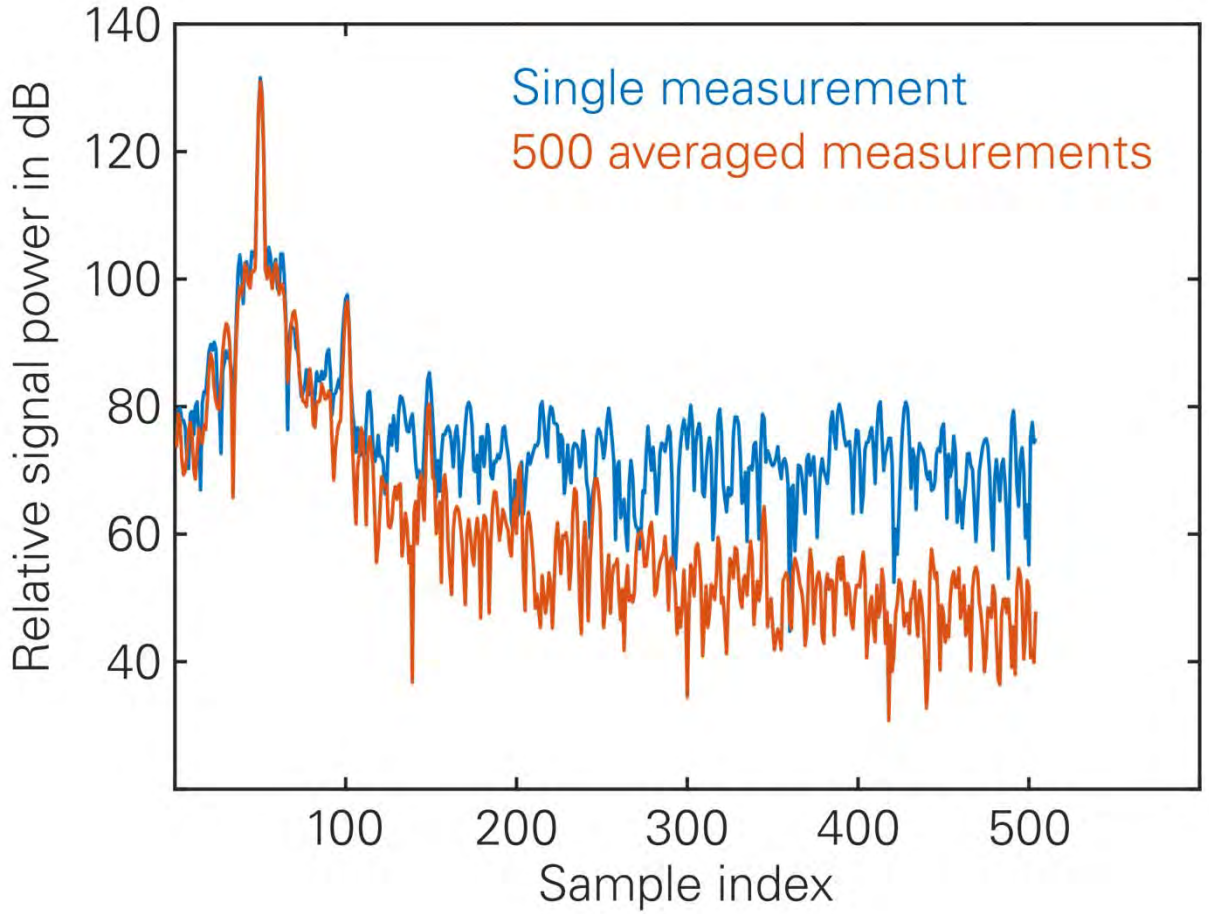
- OTH radar for distant targets (40-350 km)
- (PE-)MIMO radar for close targets (0-15 km)

Tasks of TUD

- System evaluation of MIMO radar
- Design of radar frontend
- Design of output stage
- Antenna design
- Design of digital hardware
- Processing of raw data



MOTIVATION


Single measurement
500 averaged measurements
Relative signal power in dB
140
120
100
80
60
40
100
200
300
400
500
Sample index

MOTIVATION

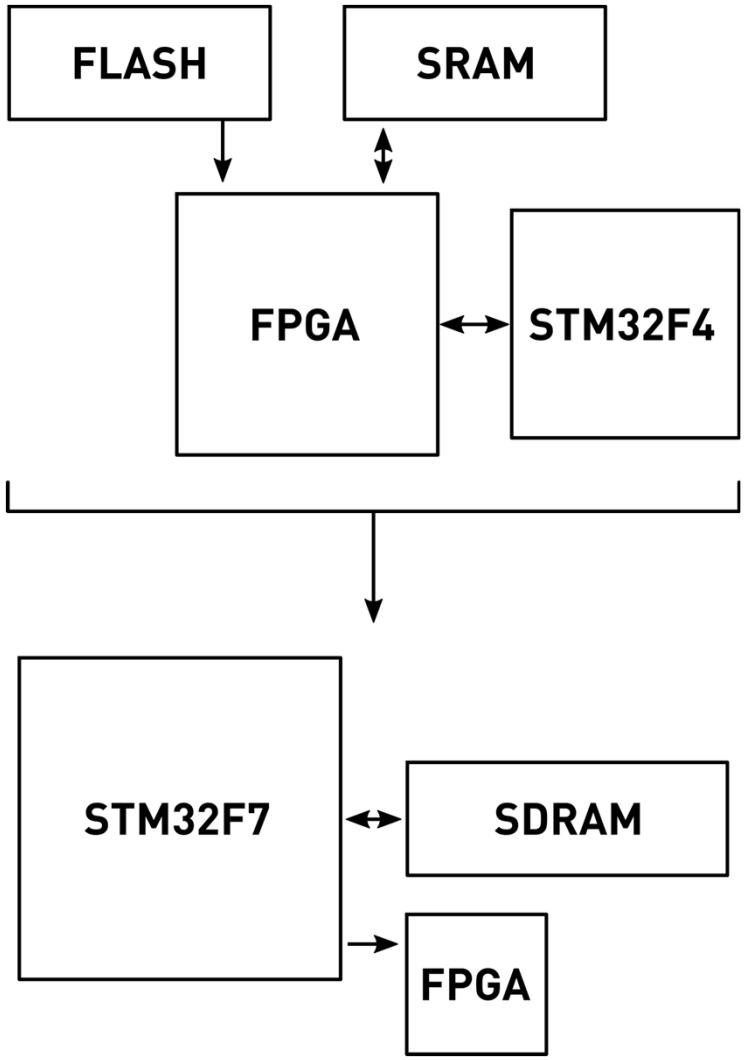
A high speed system is needed

- Current system much too slow (2 Hz)
- SNR is weak without averaging
- Realtime capability is lacking
- Analog hardware is fast enough

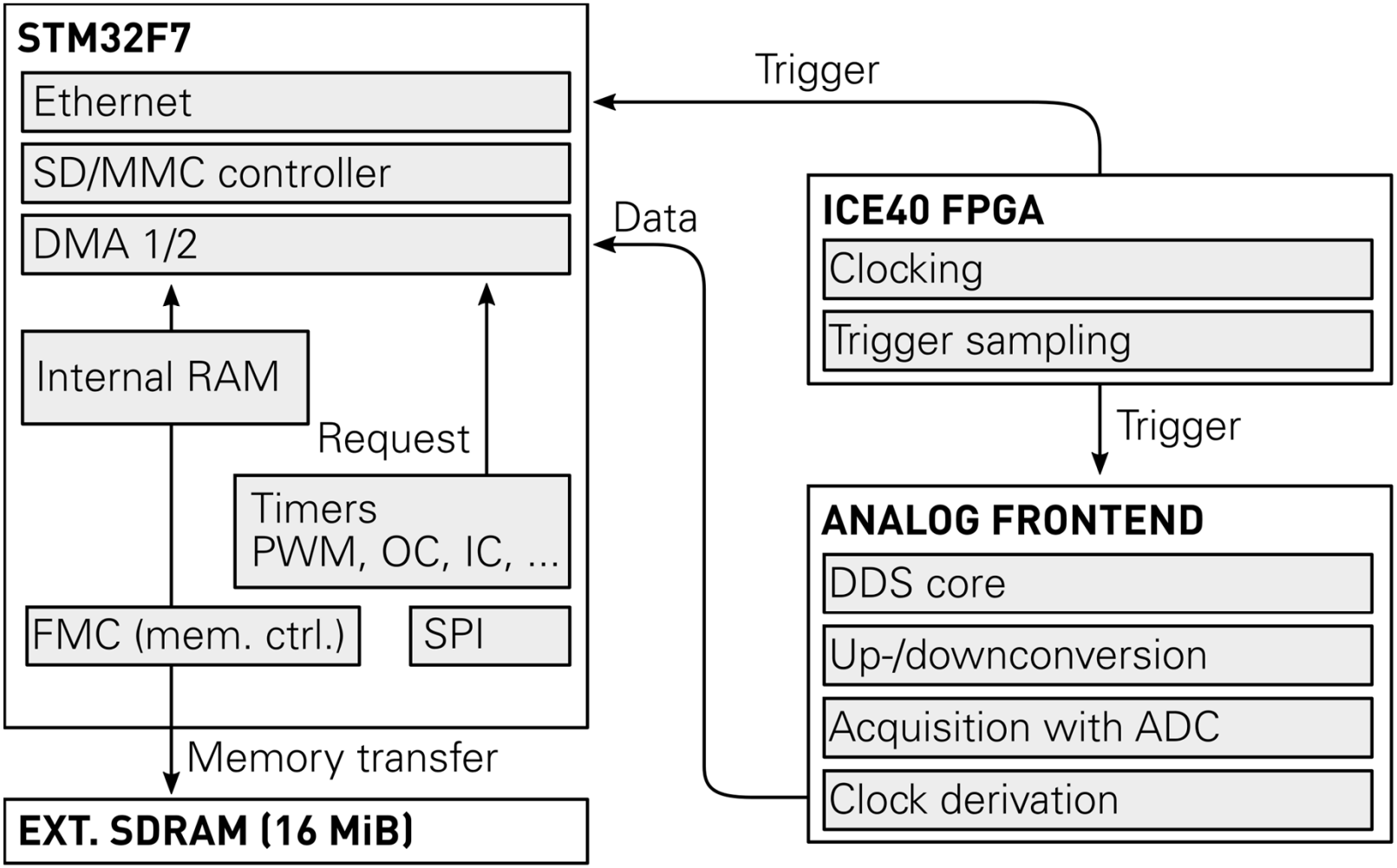
NEW SYSTEM DESIGN

Speedup ingredients

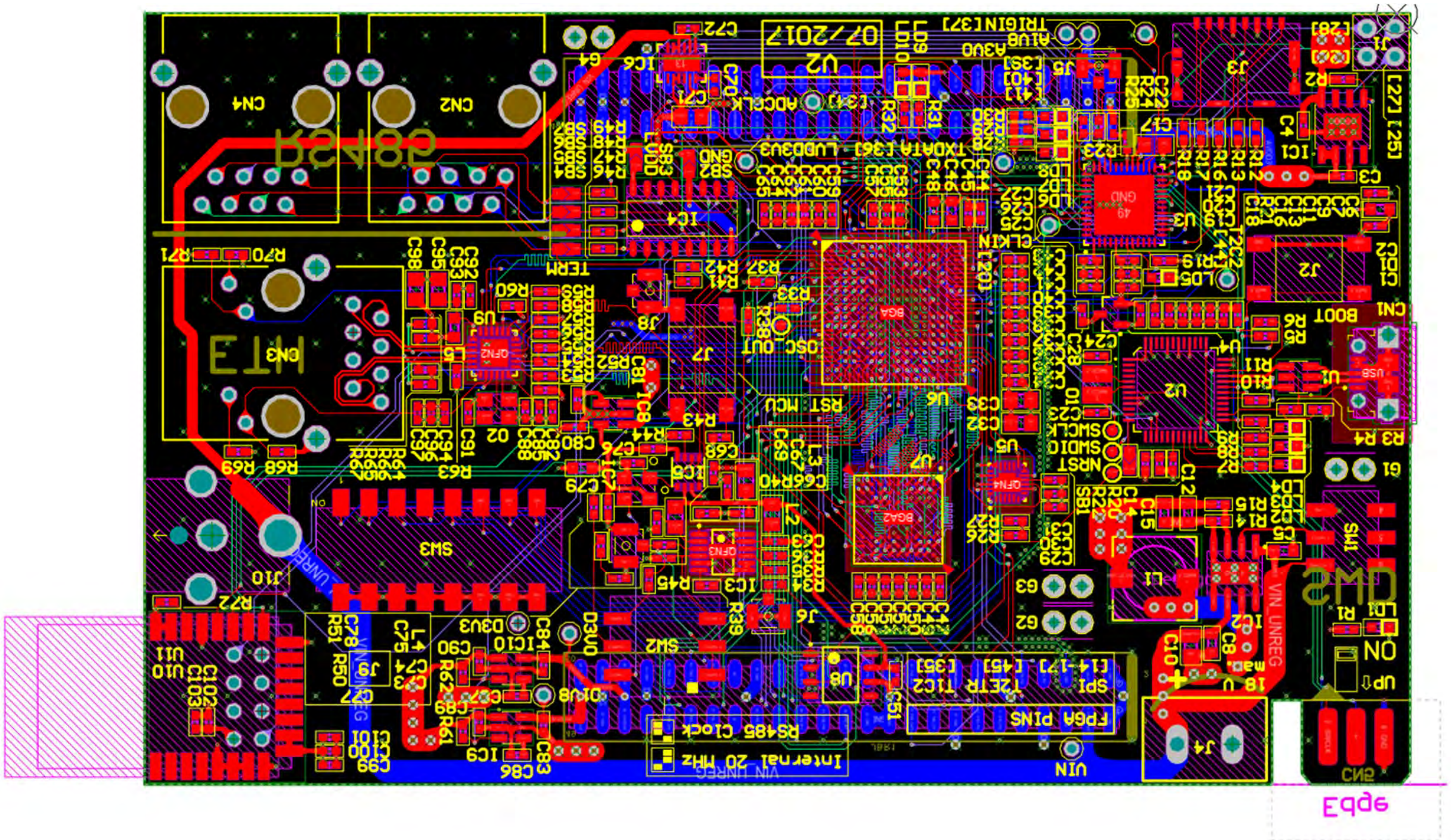
- Use of DMA, interrupts and double buffer memory
- Direct storage to SDRAM
- Ethernet transmission
- Small FPGA for precise clocking



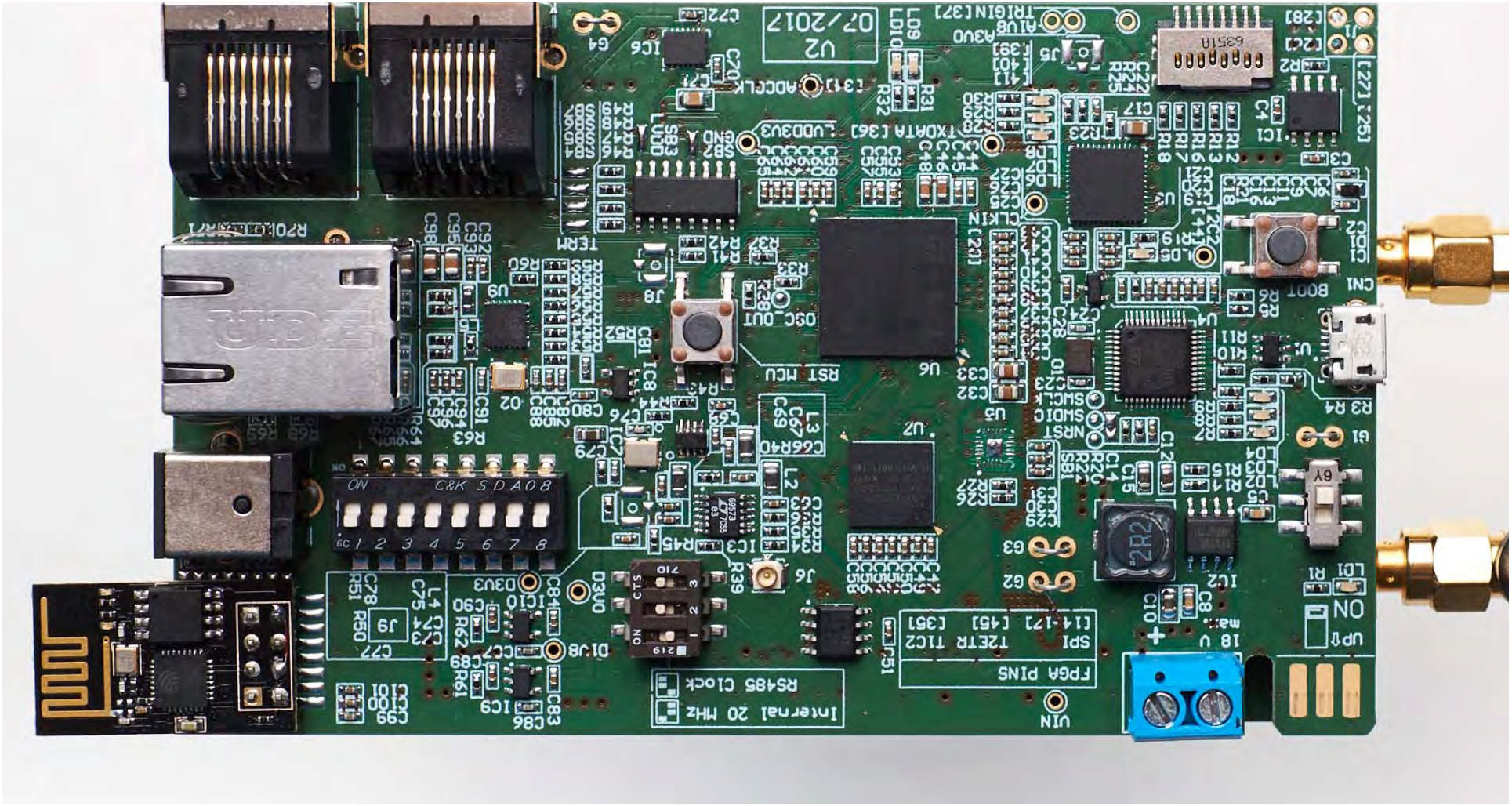
NEW SYSTEM DESIGN – (FUTURE) BLOCK DIAGRAM



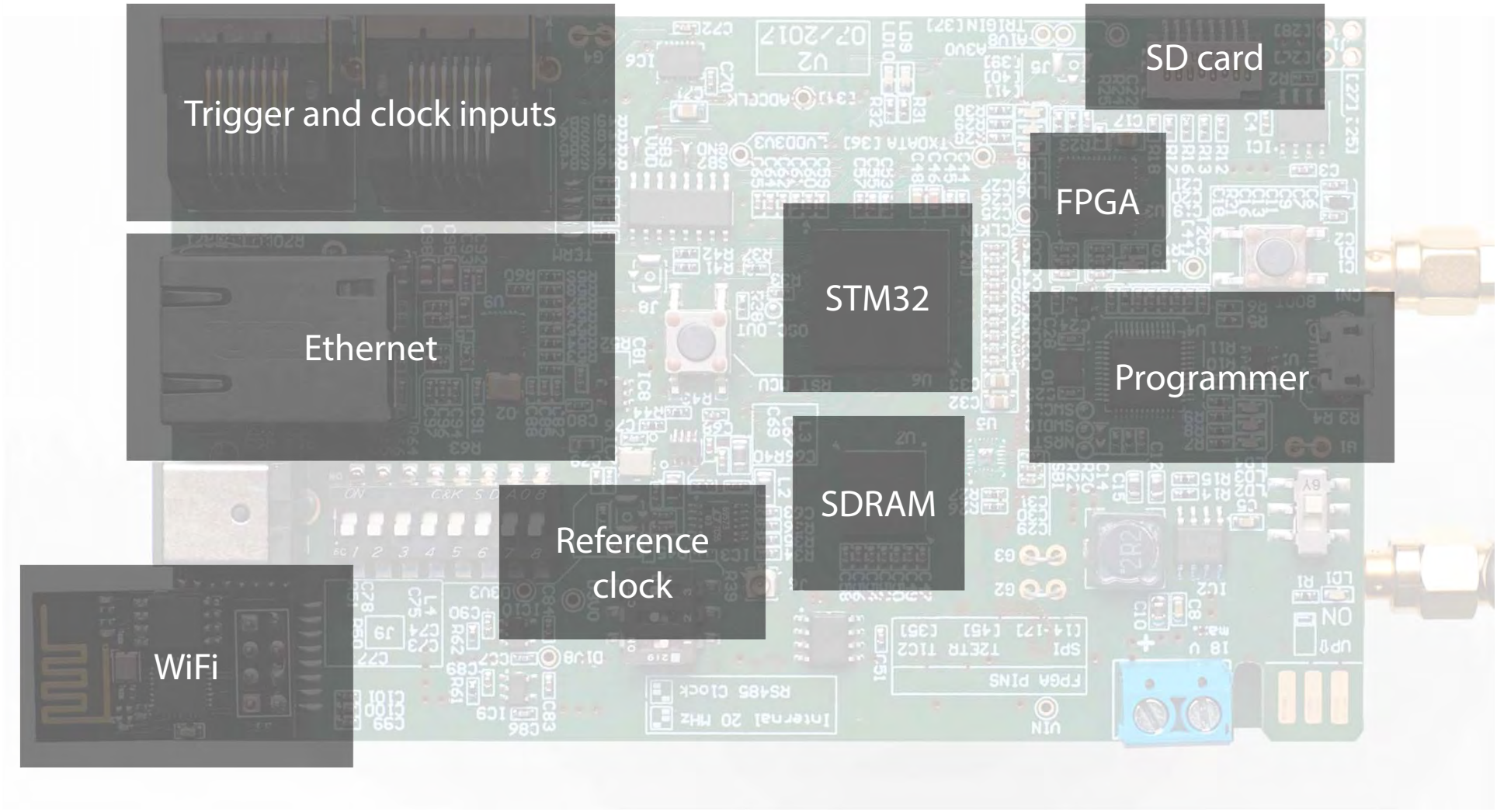
HARDWARE DESIGN – DIGITAL PCB DESIGN



HARDWARE DESIGN – DIGITAL PCB PROTOTYPE



HARDWARE DESIGN – DIGITAL PCB BLOCKS



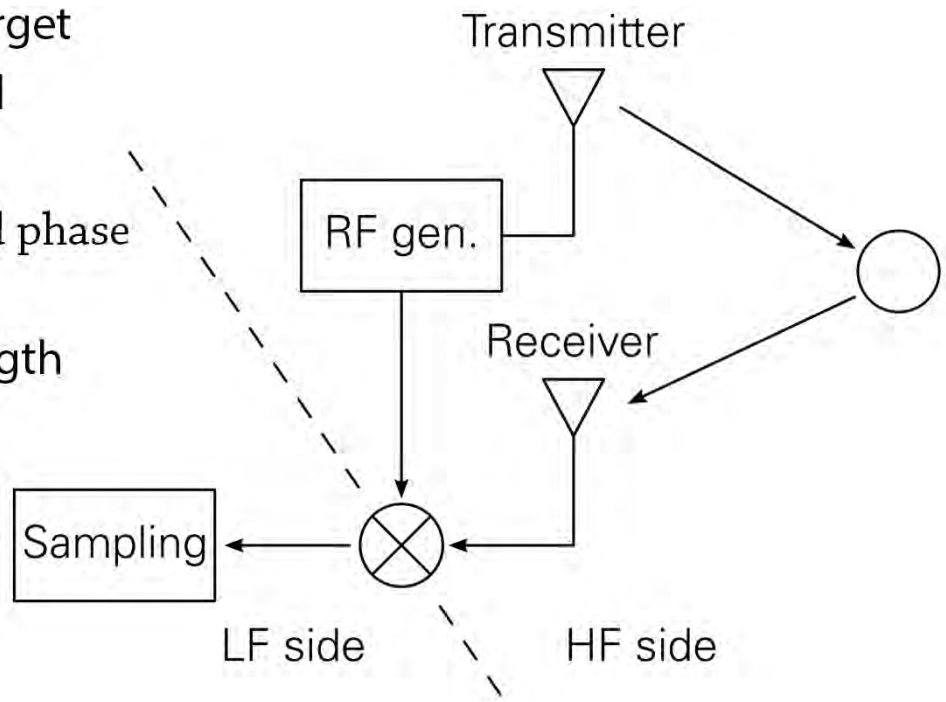
NEW SYSTEM DESIGN – BENEFITS

	NEW DESIGN	PREVIOUS DESIGN
Acquisition rate	Over 1000 Hz	2 Hz
Connectivity	100 Mbit Ethernet, WiFi, Trigger and clock inputs	UART, ZigBee
Cost	Cheaper, mainstream components	Expensive FPGA
Other features	Integrated programmer SD card SDRAM Gyroscope Accelerometer UWB Module	SD card SRAM

SIDE NOTES – FMCW RADAR

Theory of operation

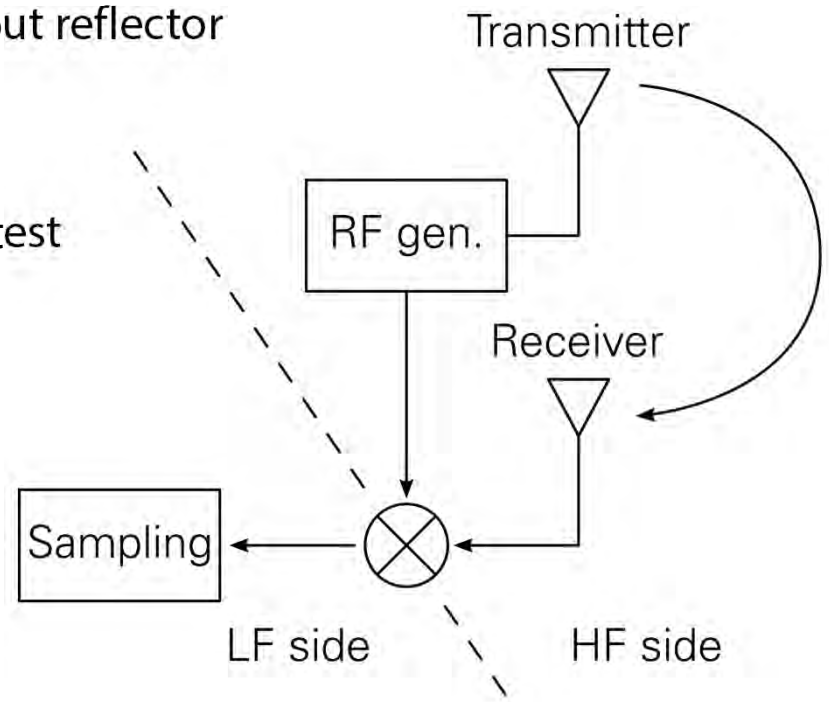
- RF transmission towards target
- Reception of delayed signal
- Deramping
- Mixer output frequency and phase proportional to range
- Phase wraps at RF-wavelength



SIDE NOTES – DEMO

Theory of operation

- Range measurement without reflector
- Secondary radar
- Direct path coupling
- TX and RX separate in this test



DEMO

System settings

- Refresh rate of 25 Hz (limited by Matlab display engine)
- Transfer of data over Ethernet to Matlab TCP-Server
- Display time domain signal after Deramping
- Chirp settings:

  1 ms duration, 150 MHz bandwidth, 2.4 GHz band

Please observe

- Phase change when moving the receiver
- Stability of the time domain signal


Transmitter

ACHIEVEMENTS AND OUTLOOK

Working prototype of digital PCB

- Precise ranging possible
- Very high refresh rate
- Ethernet data connection
- Flexible development platform for other projects

Next steps

- Analog DDS PCB design (Niko Joram)
- Implementation of processing algorithms
- Expand to MIMO