Ultra-wideband, Multifunctional Communications/RADAR System

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Goals

- Build a multifunctional shared-aperture system (Communication and Radar system)
- High range resolution (< 24 in.)
- Moderate Communications Rate
- Potential applications: robotic navigation, military IFF, intelligent highway

Advantages

- Robust communications in multi-path environments
- Maximal radar range-to-power ratio
- UWB ->moderate communication data rate and radar range resolution

Challenges

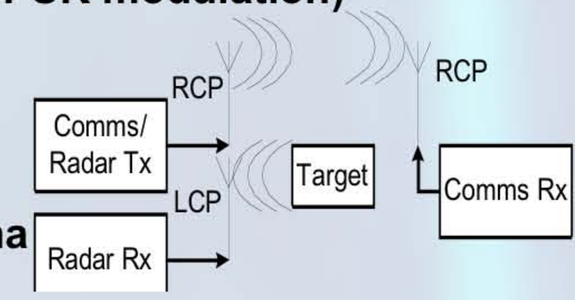
- Balancing Power Levels for each subsystem
- Radar and communication interference
- Determining optimal bit rate

Approach

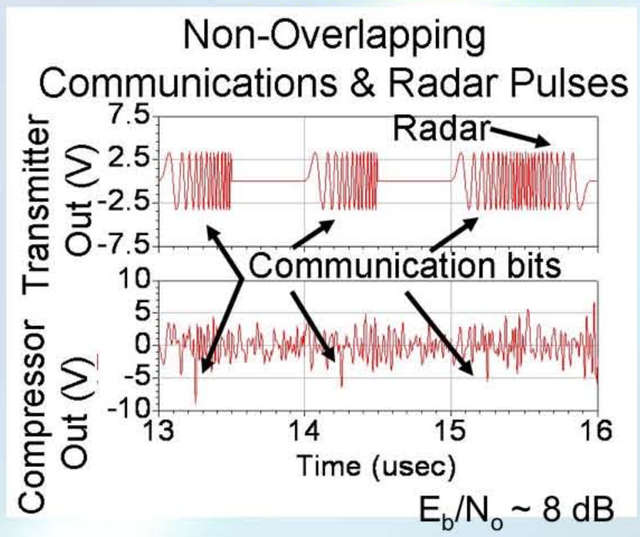
- Ultra-wideband centered at 750 MHz
- Orthogonal Signaling using Chirp Filters & Waveforms
- Simultaneous transmitting through single antenna aperture

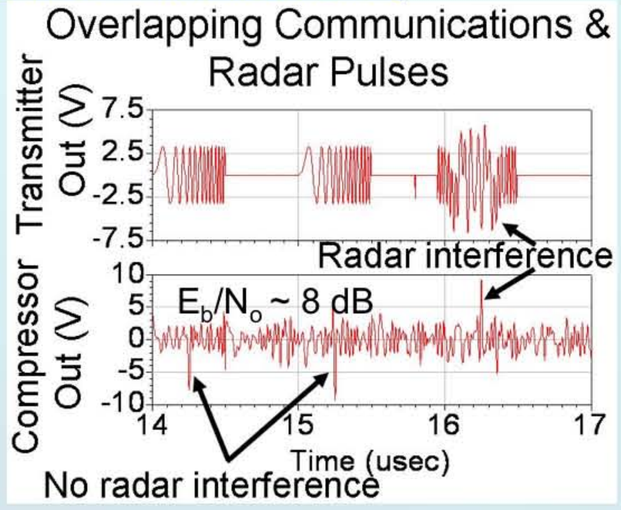
System Architecture

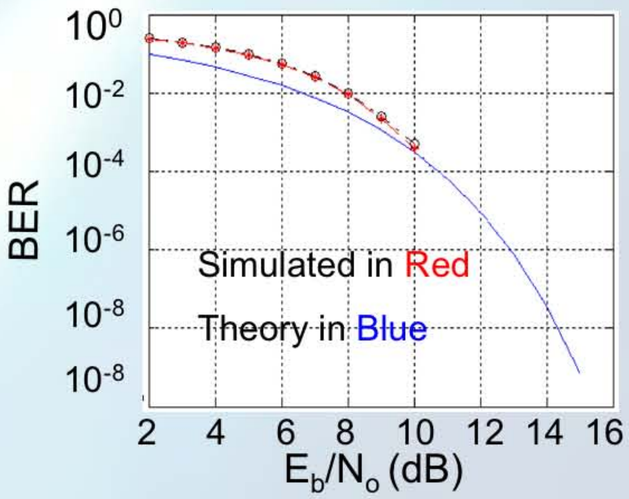
- Chirp Waveforms
  - Up-chirp for communications (BPSK modulation)
  - Down-chirp for radar pulses
- Three Helical Antennas
  - Single, Shared Transmitting
  - Communication Receive Antenna
  - Radar Receive Antenna

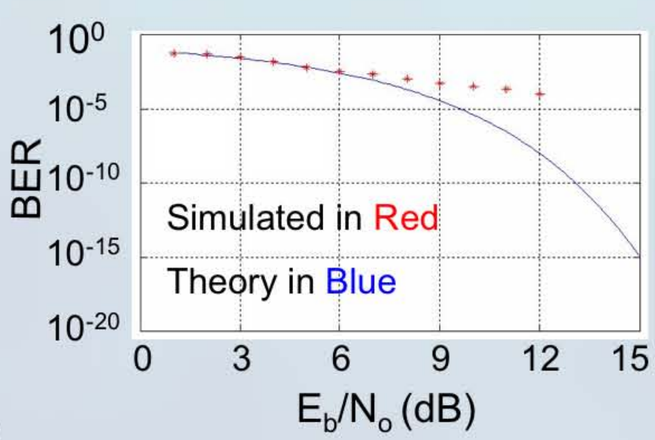


Radar / Communication Simulations





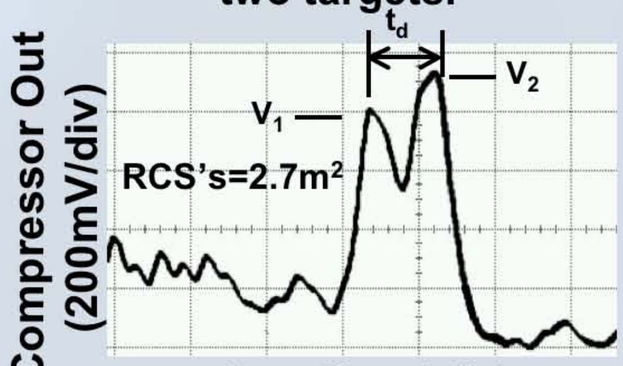




- Best case non-overlap (Left); worst case complete overlap between radar and communication pulses (Right).
- Radar pulse walking BER is -5.2dB drop from Best case non-overlap.

Radar / Communication Experiments

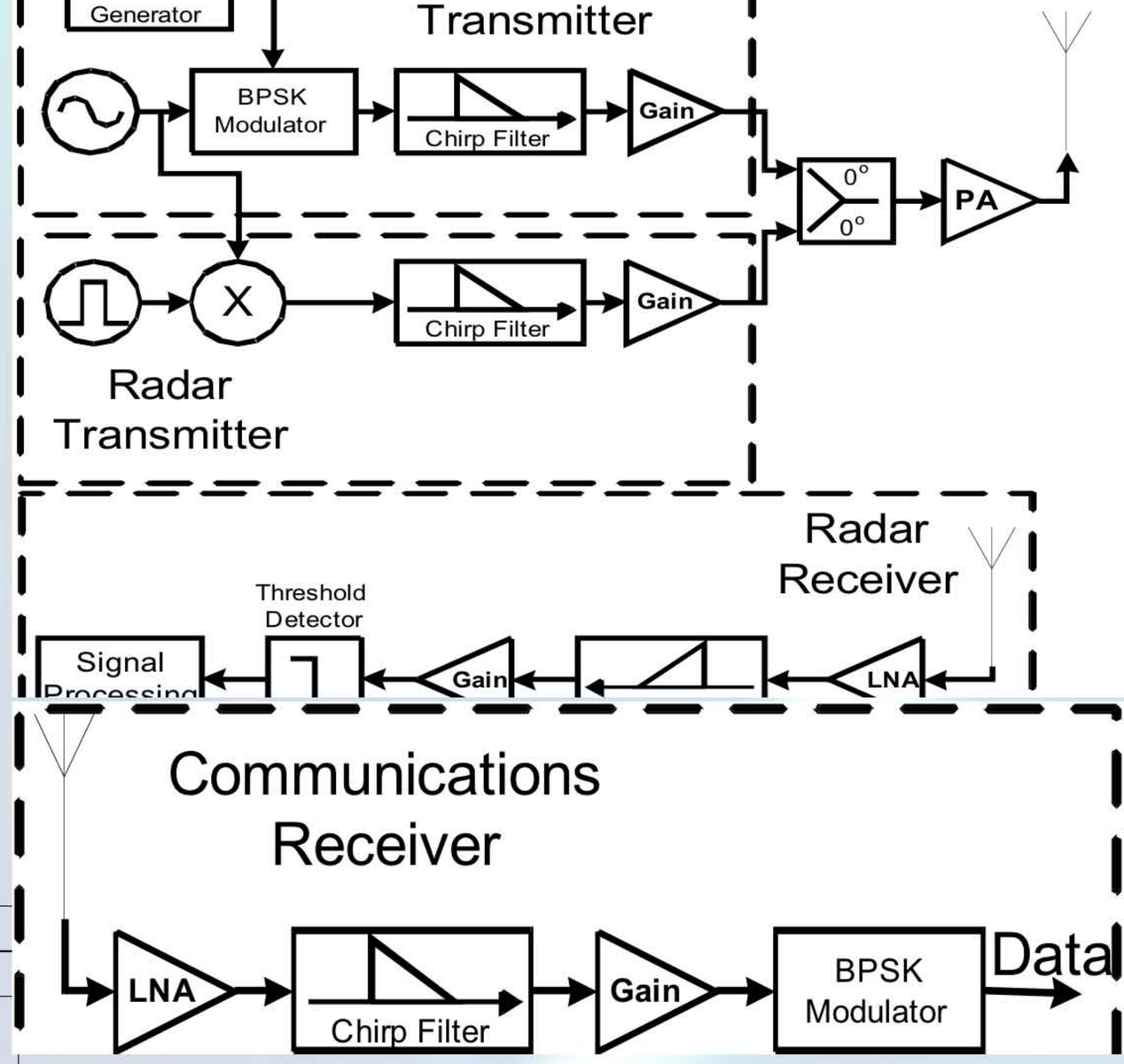
Simultaneous detection of two targets.



V_1 = 600 mV; V_2 = 700 mV; t_d = 3 ns

Table 1: System Performance @ 10 Mb/s	
Parameter	**Value**
Meas. Maximum Range @RCS=2.7 m^2	15.24 m
Meas. Minimum Range Resolution	43 cm
Pulse SNR (no communications)	35 dB
Pulse SNR (with communications)	29 dB
Calculated Free Space Link @15m & RCS=2.7m^2	-87.7 dB
RF Gain	44 dB
Receiver BW	500 MHz
Receiver NF	2 dB
Minimum Receiver level	-73 dBm

- Minimum detectable range resolution is 43 cm.
- Probability of detection (PD) w/o comms 99%; with comms 80%.



- 500 MHz of instantaneous bandwidth (f_0 = 750 MHz)
- P_{out} = 27 dB
- Radar t_p = 1.3 ns
- Communications bit t_p = 2 ns
- Time-bandwidth product = 250

Conclusions and Future Directions

- Higher operating frequency (S band)
- Further investigation of quasi-orthogonality between chirp and impact on operation
- Better Range Resolution

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Multifunctional Adaptive Radio Radar and Sensors