Radio Design Opportunity

Vision:

A Highly-Integrated, Low-Cost, Low-Power (Energy-Efficient), Short-Distance, Networkable Radio

Specifications:

- ~32 Maximum Number of Active Users per “Cell”
- Short Range Transmissions (“Cell” Size ~3-10 meters)
- Low, Scalable Bit Rate (100 b/s – 10k b/s)
- QOS: Uncoded BER 10^{-5} or Better
- Low Power (Operational Power Target: 1mW)
- Flexible Communications (Broadcast, Peer to Peer, etc.)
- Localization Ability
- Small, Simple, Low-Cost

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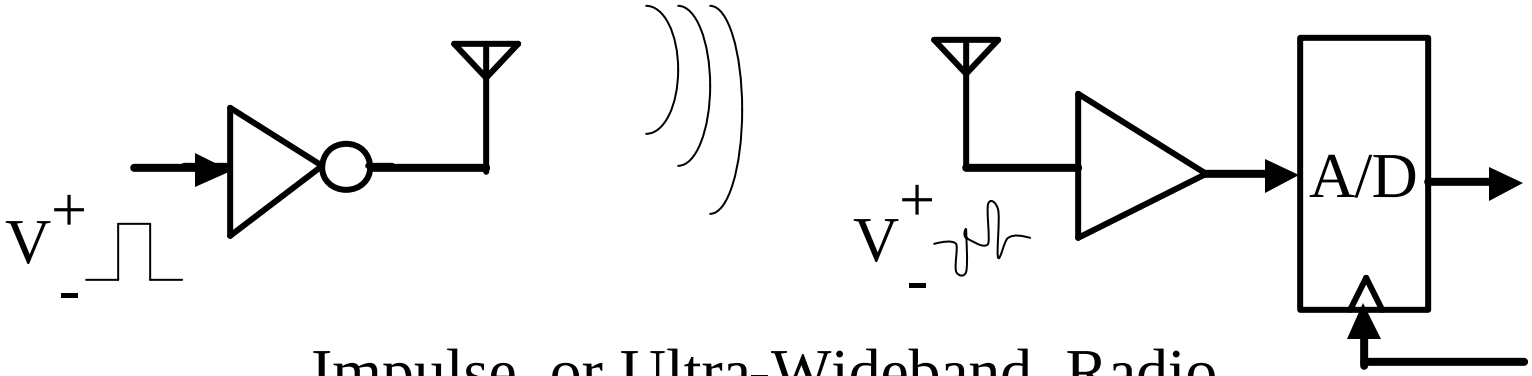
A Digital Pulse-Based Radio

Simpler Digital Architecture: Relax/Remove Analog Req's



Impulse, or Ultra-Wideband, Radio
(Essentially Base-Band Signaling)

- Transmit Only Narrow Pulses (No Carrier Frequency)
- Spread Energy Over Existing Noise Floor
- No Longer Have Narrowband's ADC/DAC Requirements
- Also Narrowband (High-Q) Design is Painful; Usually Requires Extra Components.

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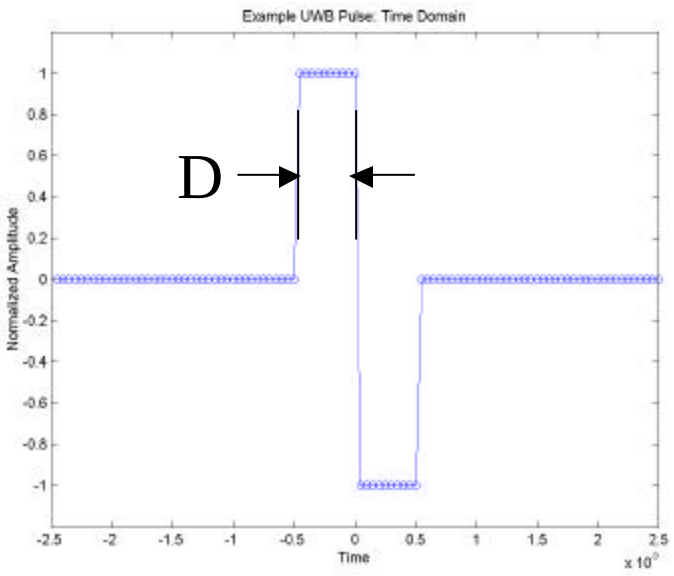
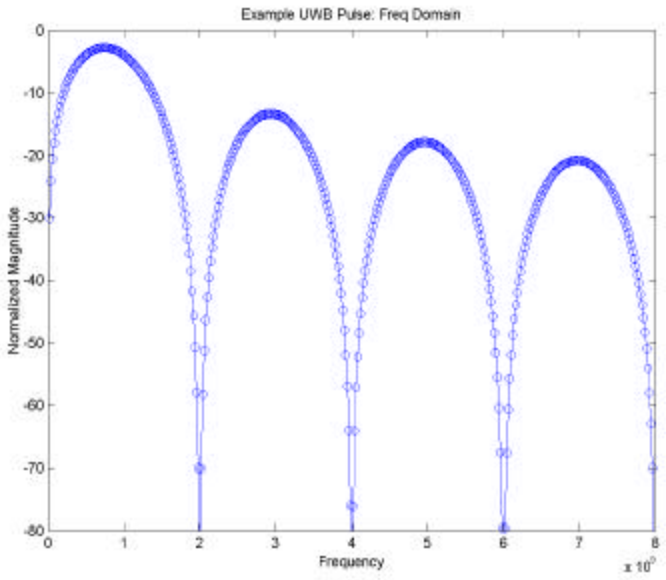
Sending An Impulse



Time Domain



Frequency Domain

- Pulse Energy Spread Over Multiples of 1/D in Frequency
- Use Spread-Spectrum Coding to Whiten (PAM, PPM)

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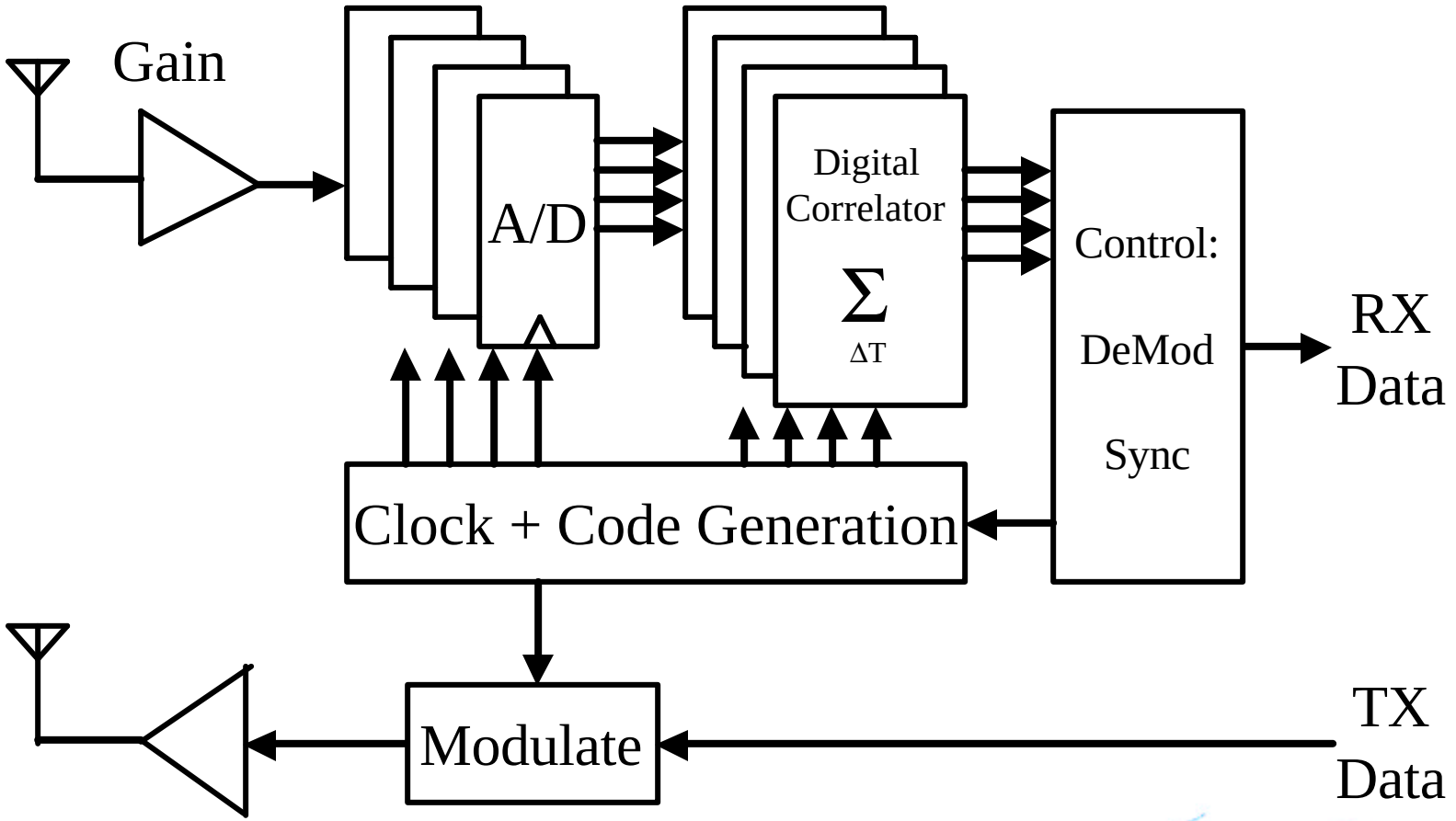
Challenges of UWB

- Noise and Interference
- FCC Compliance
- Power Consumption of Fast/Wideband Front End
- Efficient Pulse Generation
- Pulse Reception (with Dispersion)
- Antenna Design (2D, integrated, cheap)
- Synchronization, Clock Generation
- System Simulation Issues

UWB Transceiver Diagram



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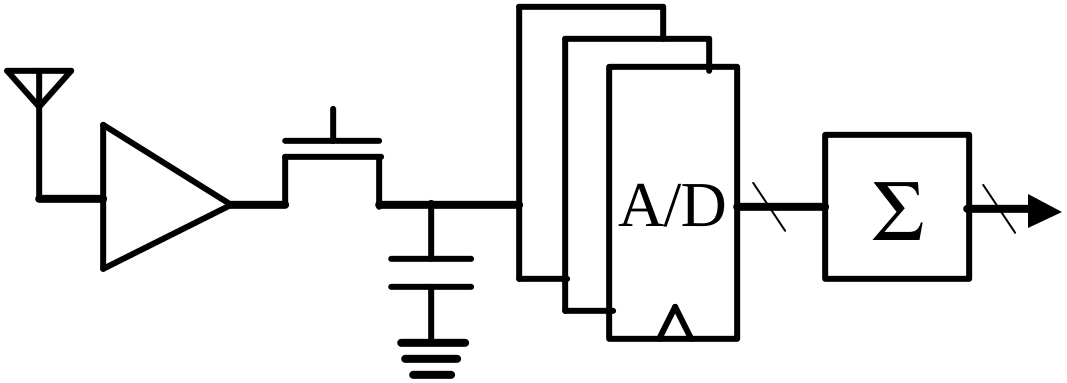
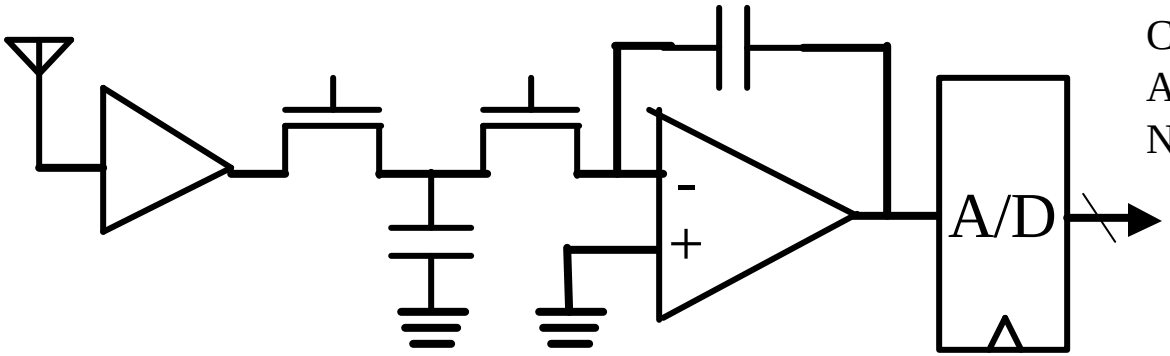
Question: How Soon To Go Digital?

•Correlator Implementation:





Sample Directly --

Need Multiple ADC's Offset in Time, Sampling at Pulse Rep Rate With Lower Resolution. (Note Can Share Offset ADC's With Adjacent Correlation Windows.)

Analog Integrator –

Correlate N Pulses Before ADC. Sample Rate Lower by N, Resolution Larger by Approx. $\log_2(N)$. (Note Could Share Faster ADC Over Several Integrators.)

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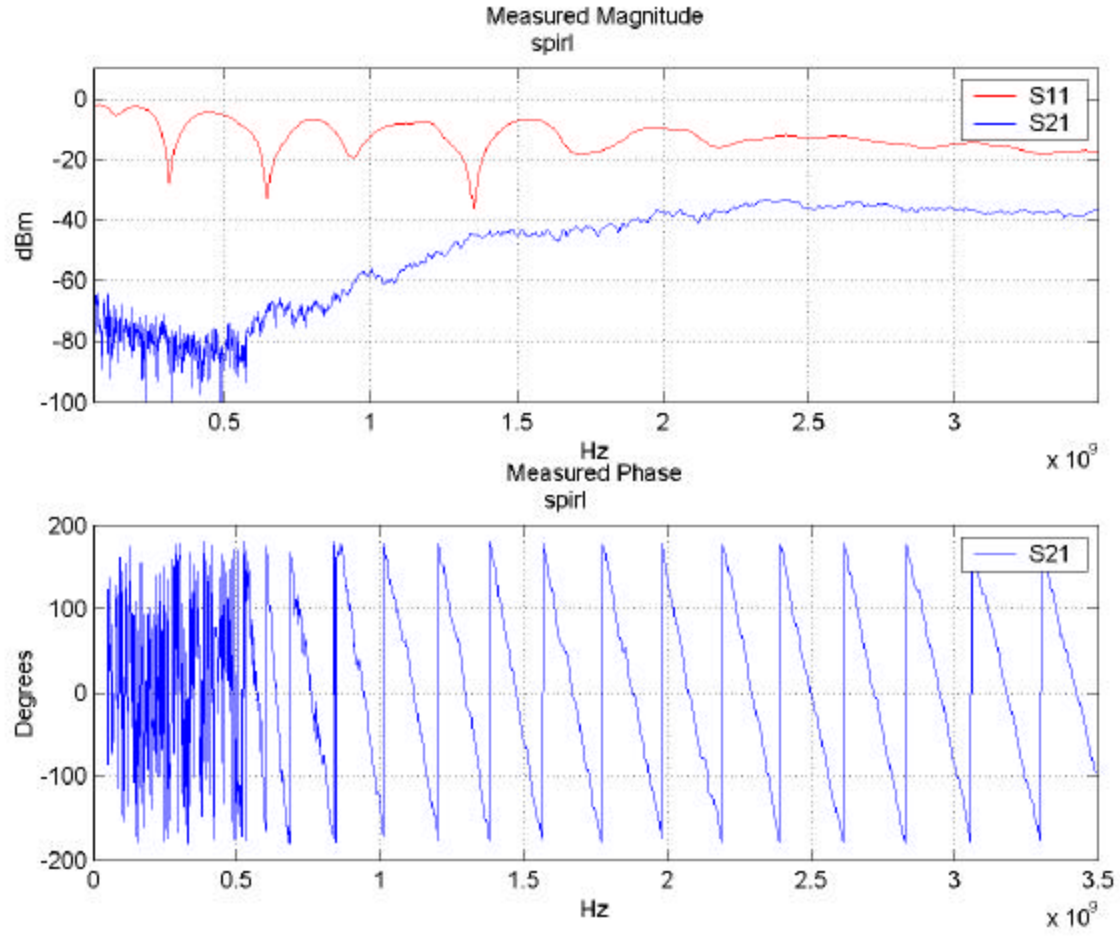
System Simulation

Have to Put Together Several CAD Tools:

- Antenna Design:
  - E&M Field Solver: S-Parameters, Far-Field Gain, Radiation Efficiency, Etc. (HP EEsof, Zeeland IE3D)
- Antenna and Analog Circuit Co-Simulation:
  - Co-Sim: Impedance Matching, Transmit Efficiency, Receive Dispersion, Etc. (HP EEsof, Cadence SpectreRF)
- System:
  - Performance: Link Budget, BER, Power Consumption, etc. (Matlab Simulink)
  - Digital Logic: Standard Cell Synthesis. (Matlab Simulink + In-House Translation Tools)

Recent Antenna Measurement



Spiral Antenna:

+Wideband

+Good 50Ω Z_{in}

+Good Phase

-Bulky, Large

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Coming Soon: More Results

Currently Exploring:

- Link Budget – Use Measured Antenna Data to Solidify Specification for Radio. Preliminary Performance Estimates.
- Antenna Simulation – Get Design ENV Up, Run Preliminary Sim on Measured Antenna Data, Run Sim on Designed Antenna.
- System Simulation – Set up Simulink Framework

Then:

- Analyze Some Circuit Power/Performance Trade-Off's (I.e. Where To Do ADC: Analog Integrator vs. Digital Accumulation)
- Qualifying Exam