MITIGATION OF INTERFERENCE INTO UWB SIGNALS USING WAVELETS

Michael Sablatash, CRC, Ottawa, Canada

- Possible high power signals in the frequency range 3-10 GHz (IEEE 802.11a and 802.15.3a) can cause significant degradation of UWB communication signals

- In the IEEE 802.11a system 8 channels are available in the range 5.15-5.35 GHz.

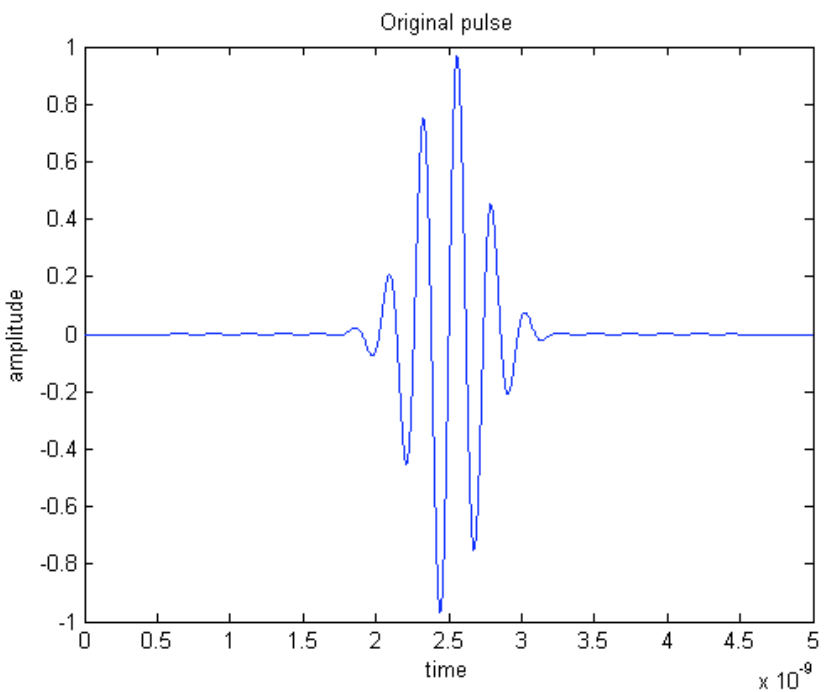
- The OFDM channel at the lowest centre frequency of 5.18 GHz, with 52 subcarriers at 312.5 KHz spacings, interferes with UWB.

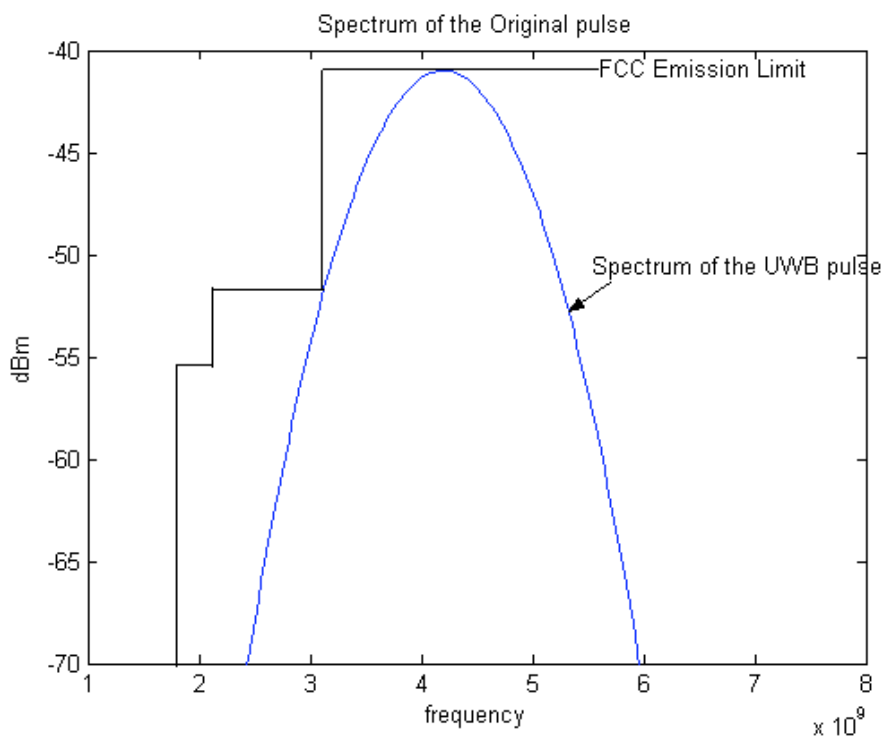
- Can use wavelet-based pulses to reject interference.

- To reduce this interference into the UWB system, the interfering subcarriers are adaptively identified using received power levels.

- Then, as a template for a matched filter receiver a modified wavelet-based UWB pulse is used, a pulse obtained by eliminating the interfering subcarriers.

- Wavelets are used to perform a multiresolution analysis of a transmitted UWB pulse into multiple subband pulses whose frequency responses are centred on distinct subcarriers





Time **Frequency**

- **Original Pulse** $$s_0(t) = \exp(-\frac{At^2}{\tau^2})\sin(2\pi f_0 t)$$

- **Wavelet Pulse**

– Wavelet transform $$W_\psi f(a) = \int_{t=-\infty}^{t=+\infty} \psi\left(\frac{t}{a}\right) s_0(t)\,dt$$

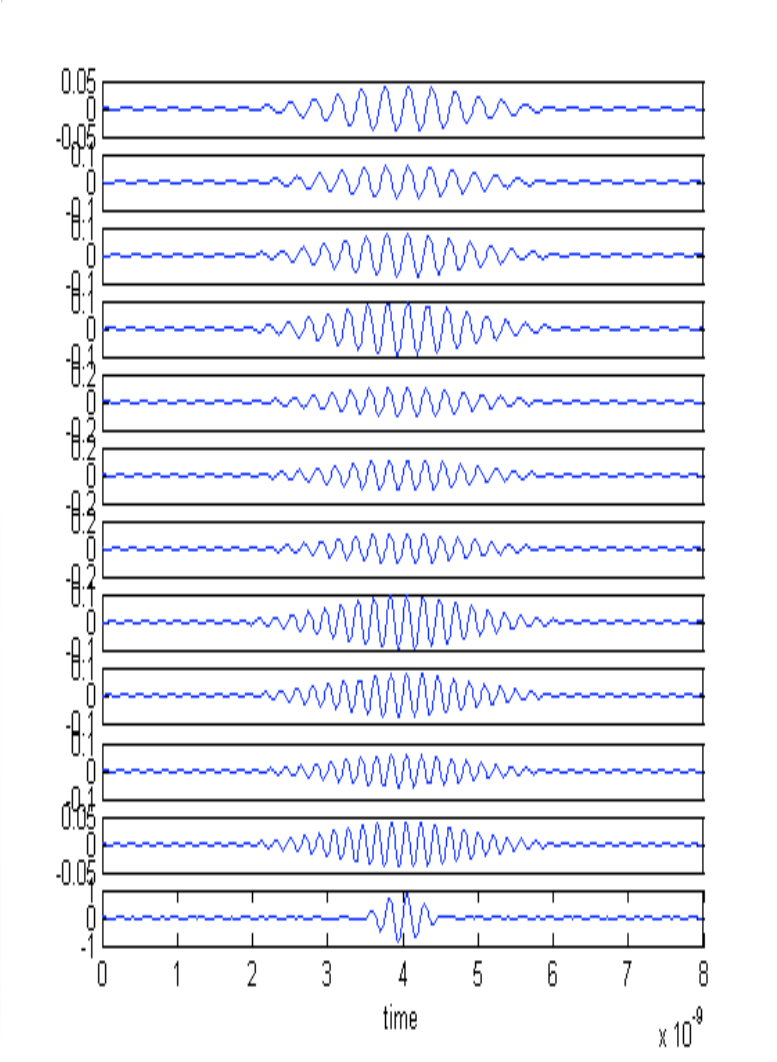
– Subcarriers $$\psi(t/a) = \exp(-At^2/\tau_1^2)\sin(2\pi a t)$$

– Wavelet pulse $$s_0^{'}(t) = \sum_a W_\psi f(a)\psi\left(\frac{t}{a}\right)$$

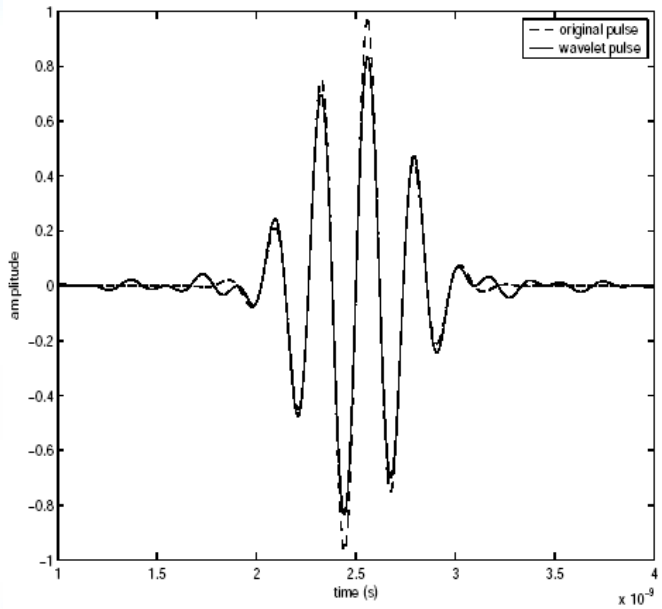
ILLUSTRATIONS OF WAVELET-BASED UWB PULSES

- Example of wavelet-based UWB transmitted pulse: $A = \log_e 10$, τ = 0.5 ns, f_0 = 4.2 GHz, τ_1 = 2 ns, $a = nf_s$, with *n* being an integer and f_s = 200 MHz.

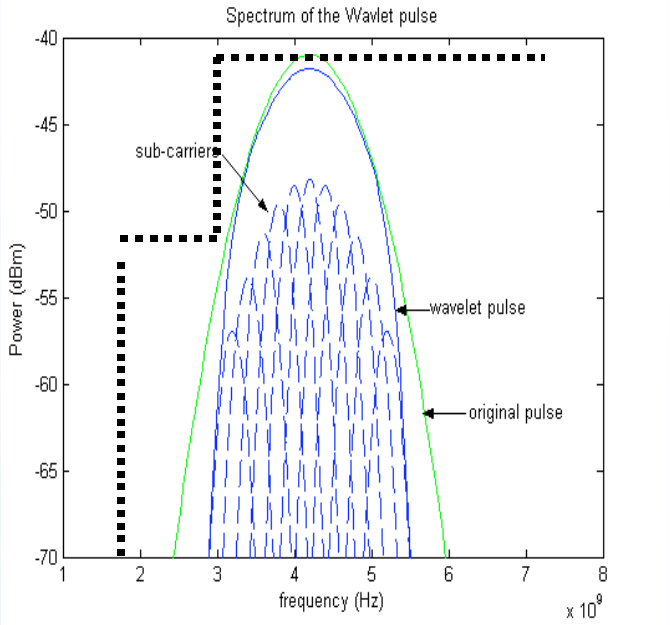
- With these parameters the energy of pulses is concentrated between 3.2 and 5.2 GHz



Subplots 1-11, respectively, show subcarrier waveforms 1-11, and subplot 12 shows the combined UWB pulse.



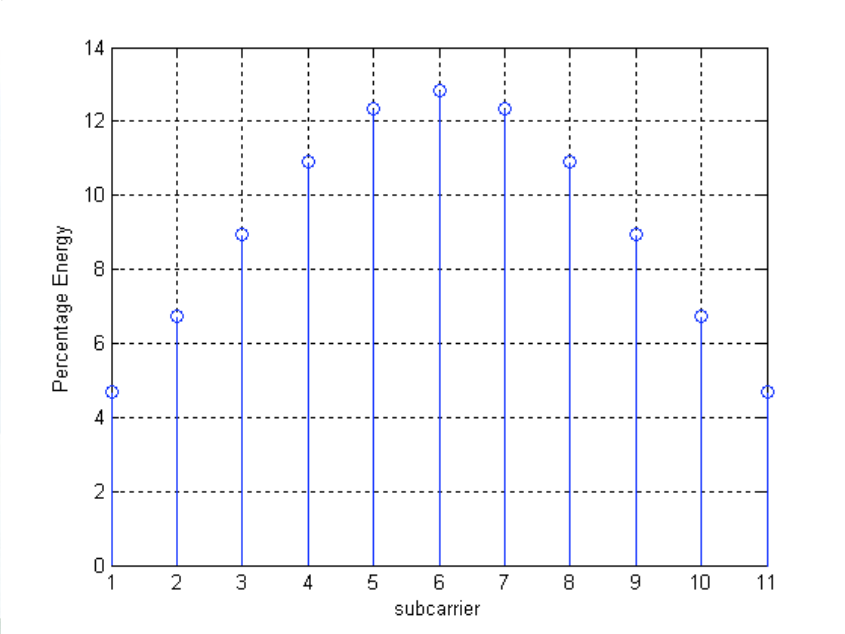
The UWB original pulse (dashed-curve) and wavelet-based UWB pulse (solid-curve).



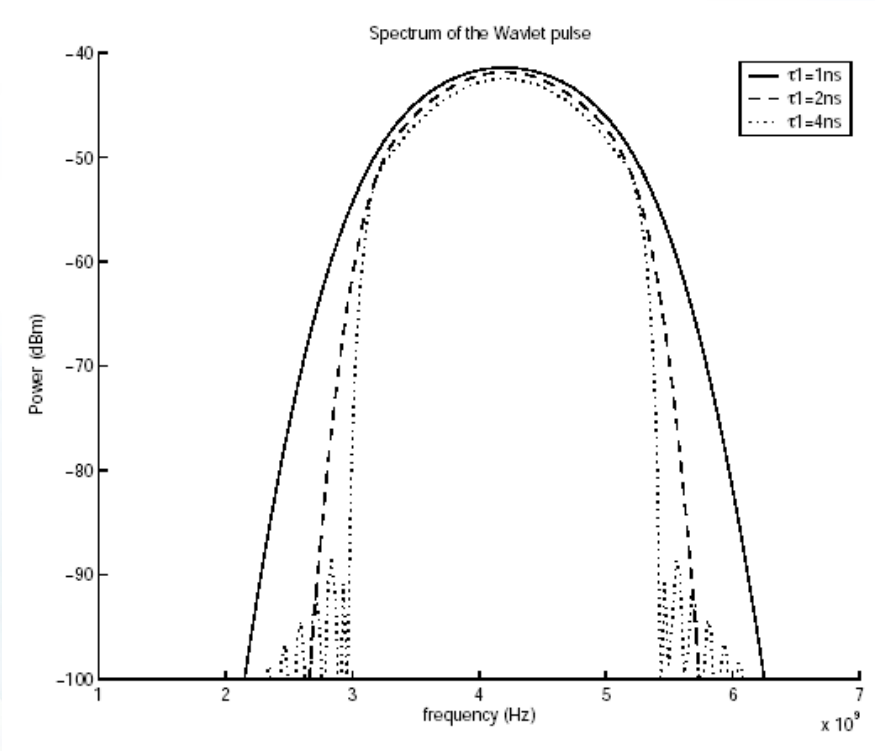
Frequency spectrum of the wavelet-based UWB pulse and the original UWB pulse.

- Eliminate the UWB subcarriers at 3.2, 4.8, 5.0 and 5.2 GHz to mitigate the interference into UWB at these frequencies.

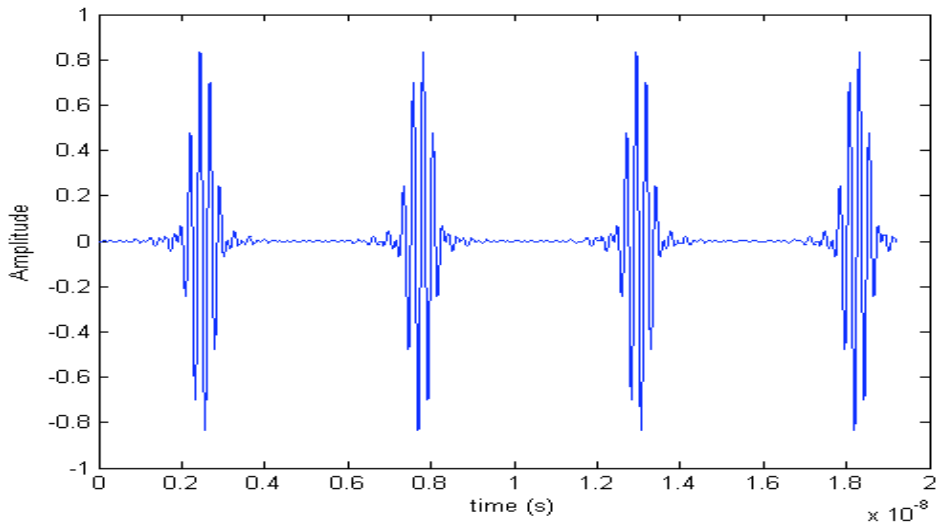
- At the UWB transmitter the modified wavelet-based pulse with 7 subcarriers is used to mitigate interference into the UWB communication system.



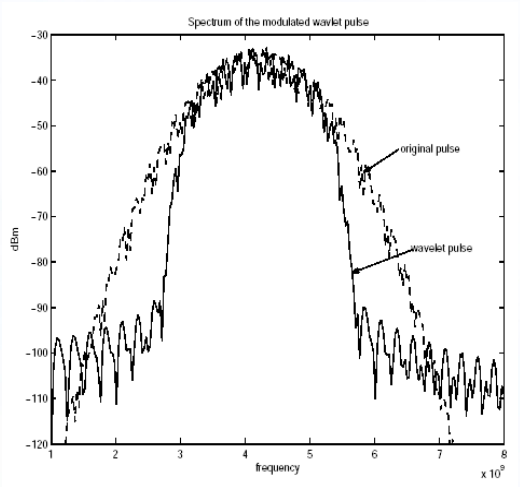
Percentage of energy in each of the 11 subcarriers.



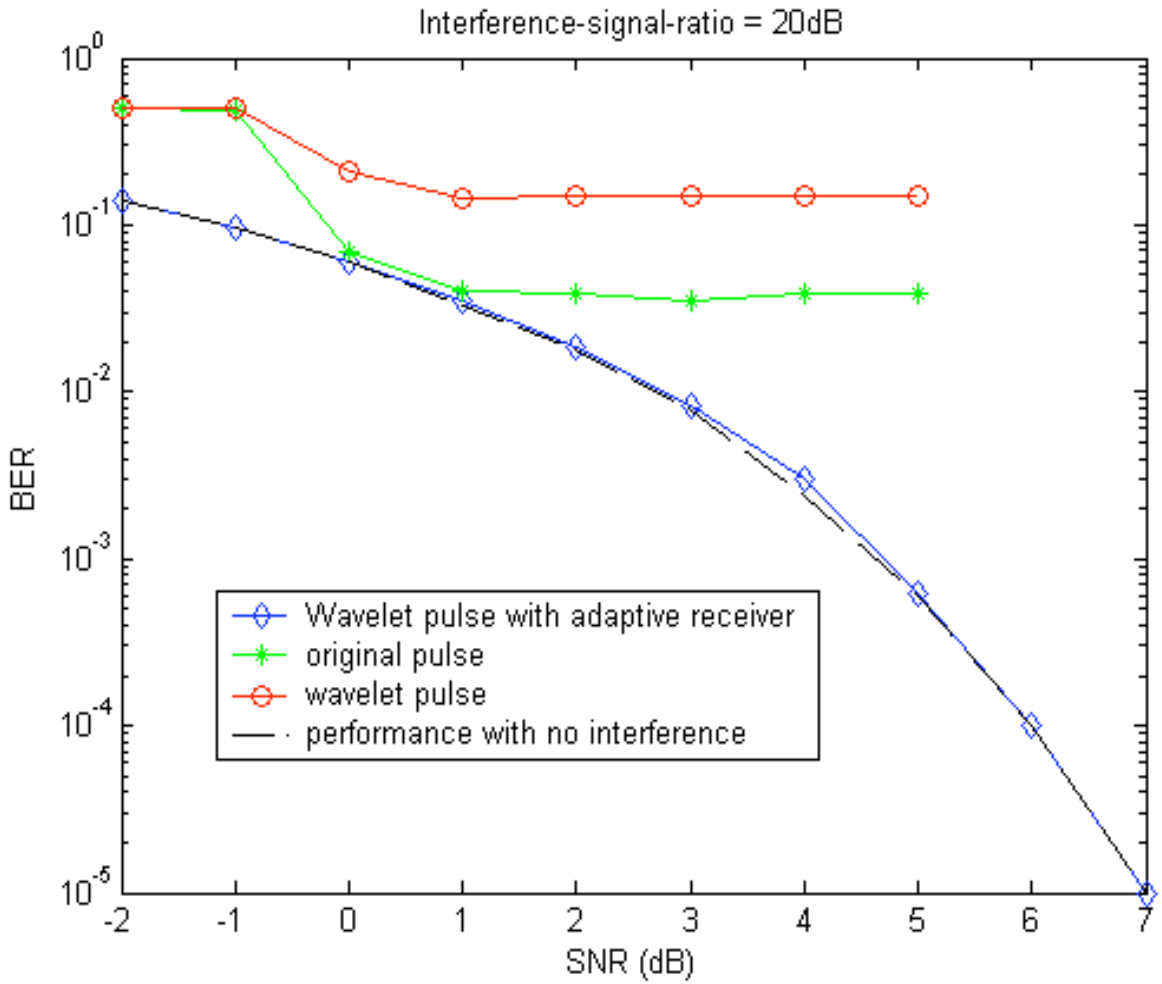
Frequency spectrum of the wavelet-based UWB pulses generated using τ_1=1,2 and 4 ns.



Bi-Phase Modulated (BPM) UWB pulses representing 0 1 0 1 : 1ns pulses trans. every 5 ns.



Frequency spectrum of biphase modulated UWB pulses.



BER performance of the UWB system in the presence of IEEE 802.11a interference and interference below the 3.5 GHz band at ISR=20 dB.

Acknowledgement: Dr. Mathini Sellathurai, formerly at CRC, and now at Cardiff University in Wales, provided much appreciated computational and simulation results.