Channelized UWB Digital Receiver

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Frequency Channelized ADC

- Enables the use of a bank of simple, low-resolution, low-frequency ADCs.
  - Each ADC samples at approx. $f_{\text{eff}}/M$, where $M$ is number of subbands.
- Isolates effects of large interferers $\rightarrow$ reduce ADC dynamic range.
  - ADC power decreases exponentially with number of bits.
- Implementation advantages valid regardless of technology improvements.

ADC Dynamic Range Comparison in the Presence of In-Band Interferer

- MMSE receiver SNR with knowledge of channel and noise statistics.
- Interference BW = 0.05 signal BW; worst center frequency.
- CM1 channel; 5 subbands; 4th order LPF; BPSK; 1GSymbol/sec.
ADC Dynamic Range Comparison in the Presence of Out-of-Band Interferer

- MMSE receiver SNR with knowledge of channel and noise statistics.
- Interference BW = 0.05 signal BW; centered outside of signal spectrum.
- CM1 channel; 5 subbands; 4^{th} order LPF; BPSK; 1GSymbol/sec.
TR Channelized Receiver – Detection

- Optimal TR detection obtained by estimating pulse response and correlating in each subband independently.
- Butterworth filters (or other filters) instead of power complementary analysis filters suffers negligible loss (< 0.5dB).

TR Channelized Receiver Performance

- CM1 channel; block of 100 pulses.
• \( S, G, W \) based on FFT/IFFT \( \rightarrow \) computationally efficient.
• Analog front-end and propagation channel vary at different rates.
  – Employ different convergence rates.
• After initial start-up, basically update propagation channel 1-tap equalizer only.
  – Performance similar to full band receiver.

OFDM Simulation Results – Convergence

- 4 subbands; 256 subcarriers; CM1
Comments on Frequency Channelized Receiver

• Channelized receiver not unique to UWB radio.
• Can be used in both narrowband and wideband receivers to relax implementation requirements.
  – ADC dynamic range, linearity, and sampling jitter.
  – Significant reduction in power.
• Frequency channelized serial-link ADC (ISSCC 2005).
  – First frequency channelized receiver implementation.
• Channelized receiver approach effective regardless of advances in ADC technology.