Channelized UWB Digital Receiver

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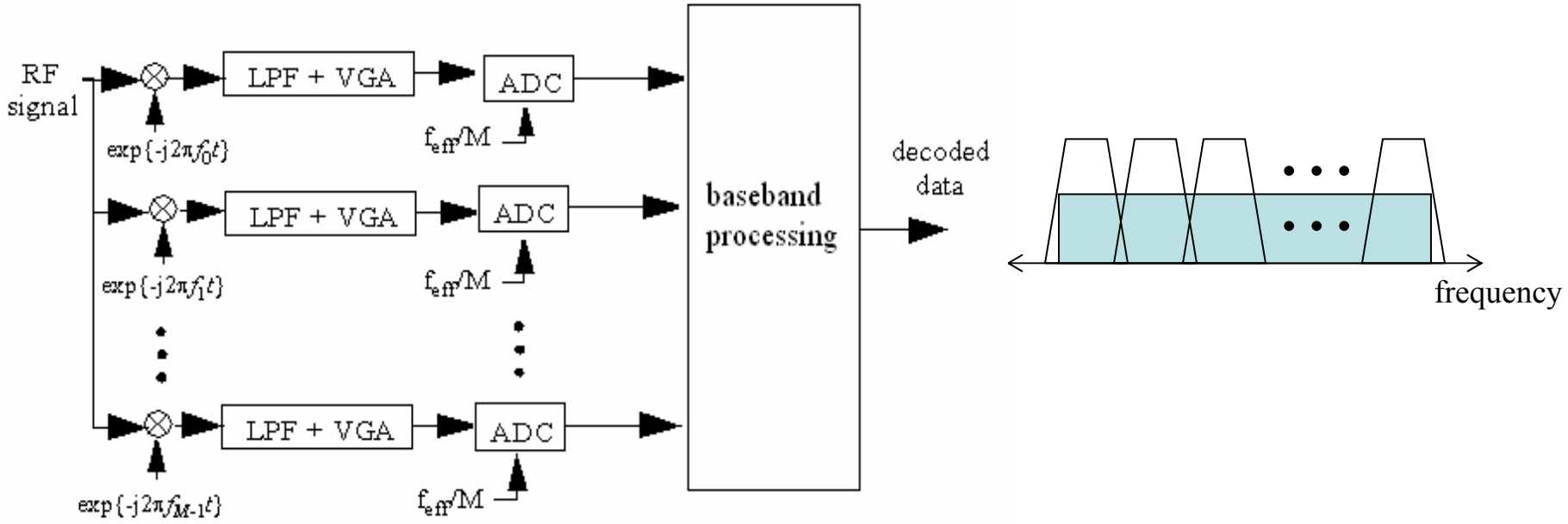
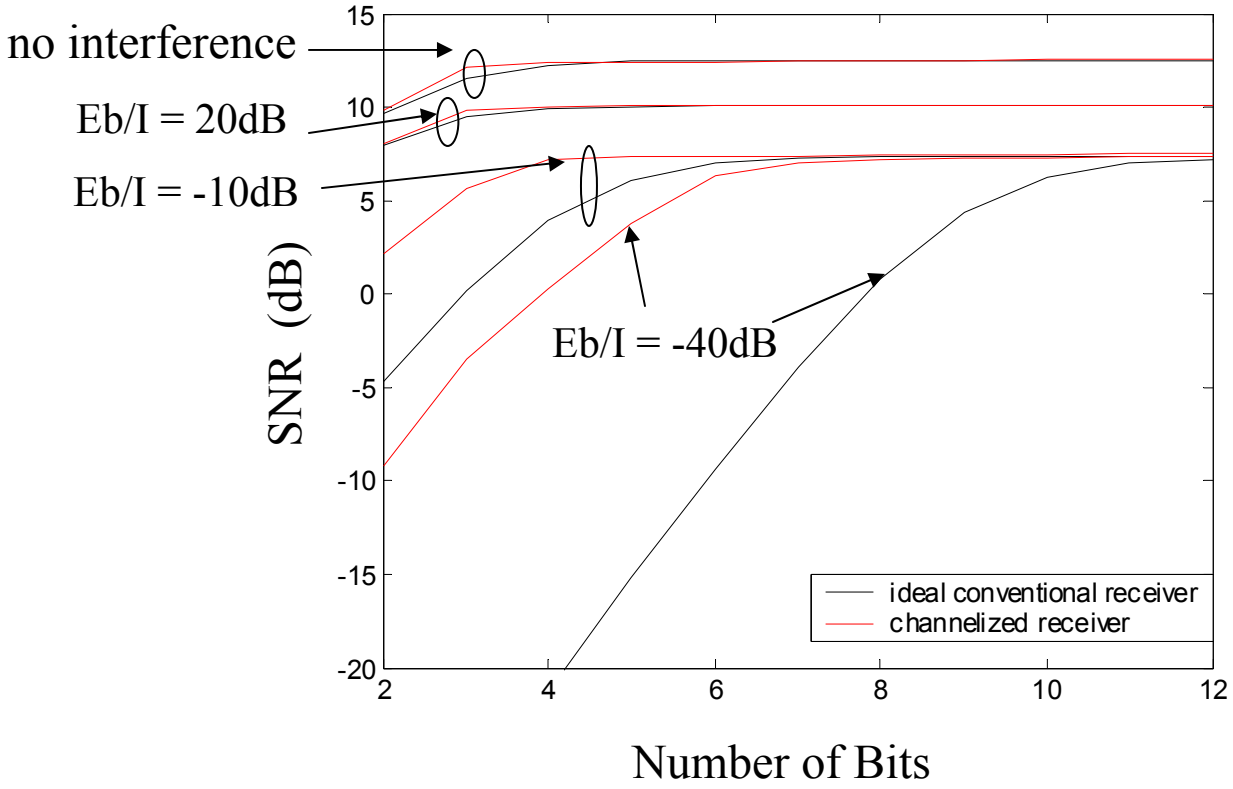
Frequency Channelized ADC



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

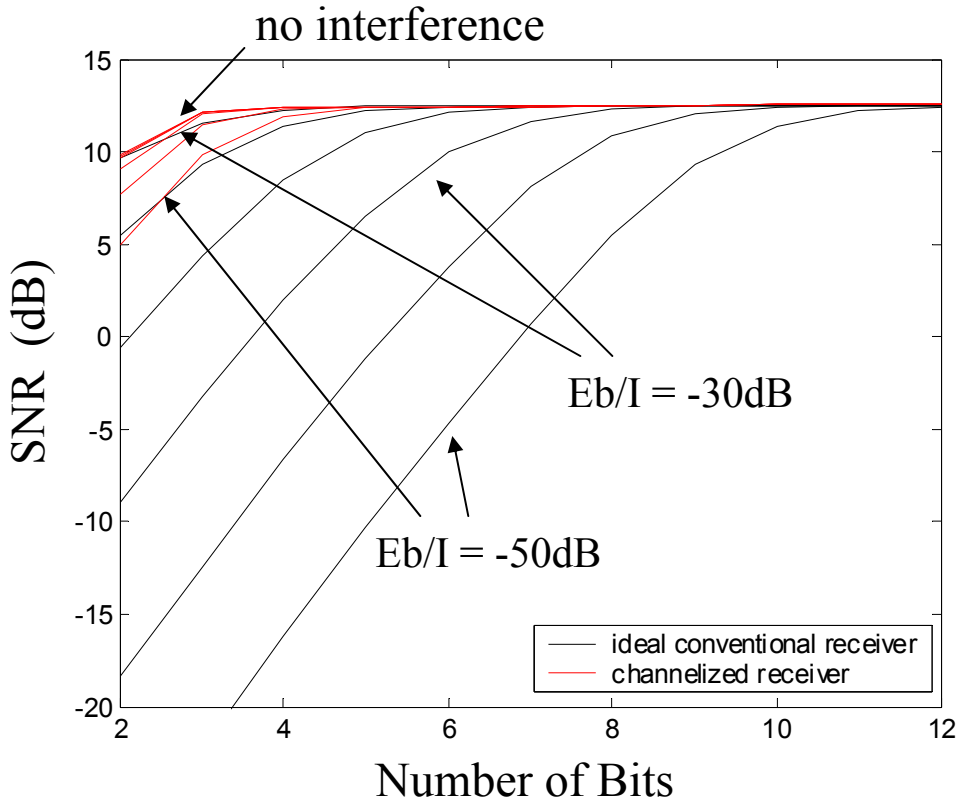
W. Namgoong, "A Channelized Digital Ultra-Wideband Receiver", IEEE Trans. on Wireless Communications, 2003.

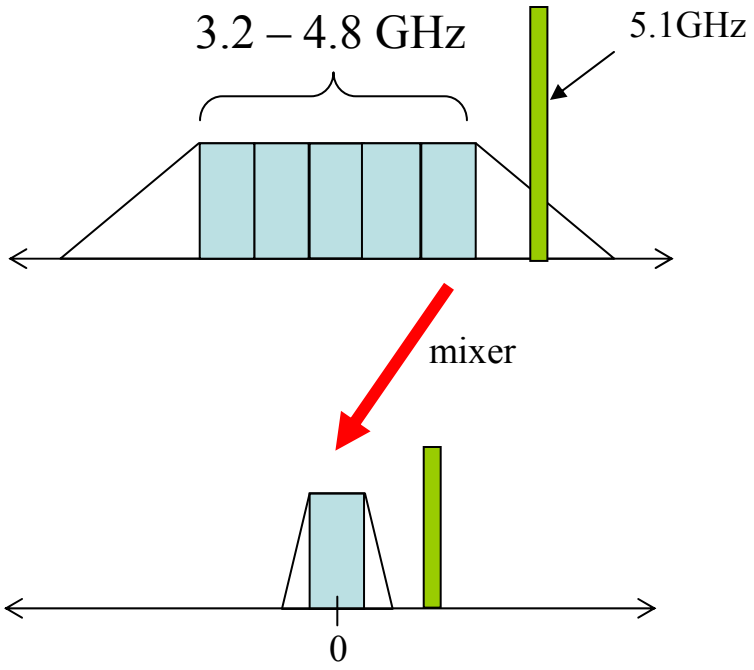
ADC Dynamic Range Comparison in the Presence of In-Band Interferer



- 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

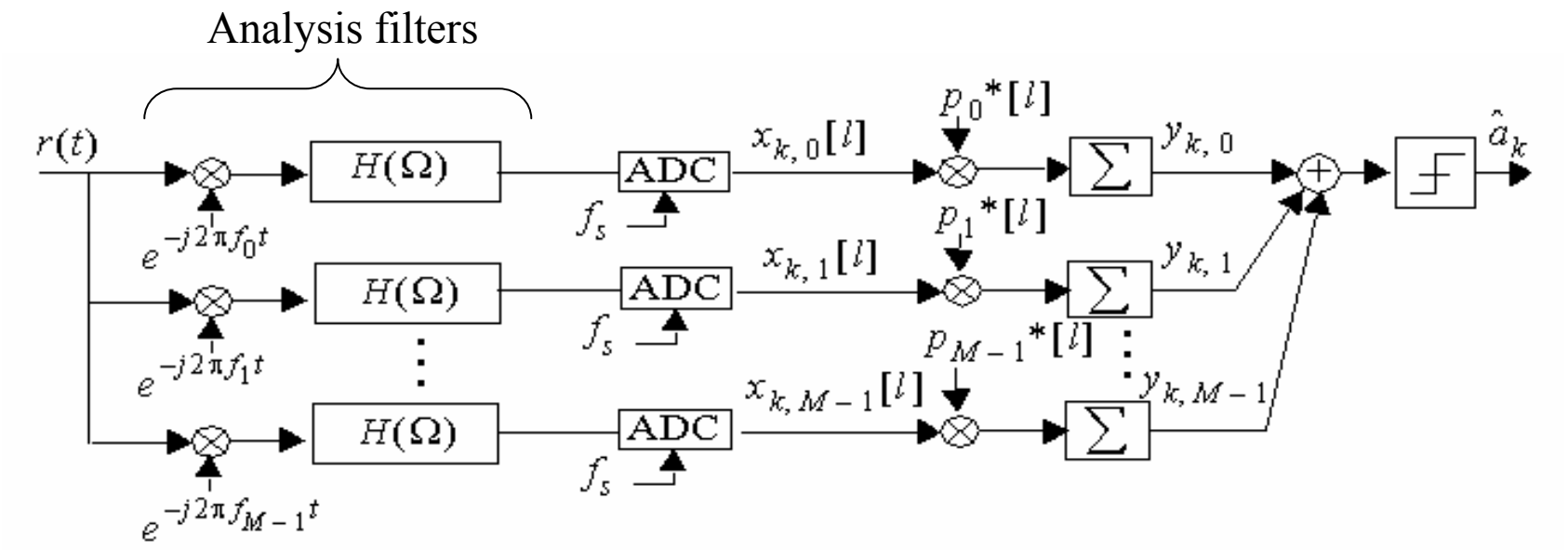




- MMSE receiver SNR with knowledge of channel and noise statistics.
- Interference BW = 0.05 signal BW; centered outside of signal spectrum.
- CM1 channel; 5 subbands; 4th order LPF; BPSK; 1GSymbol/sec.

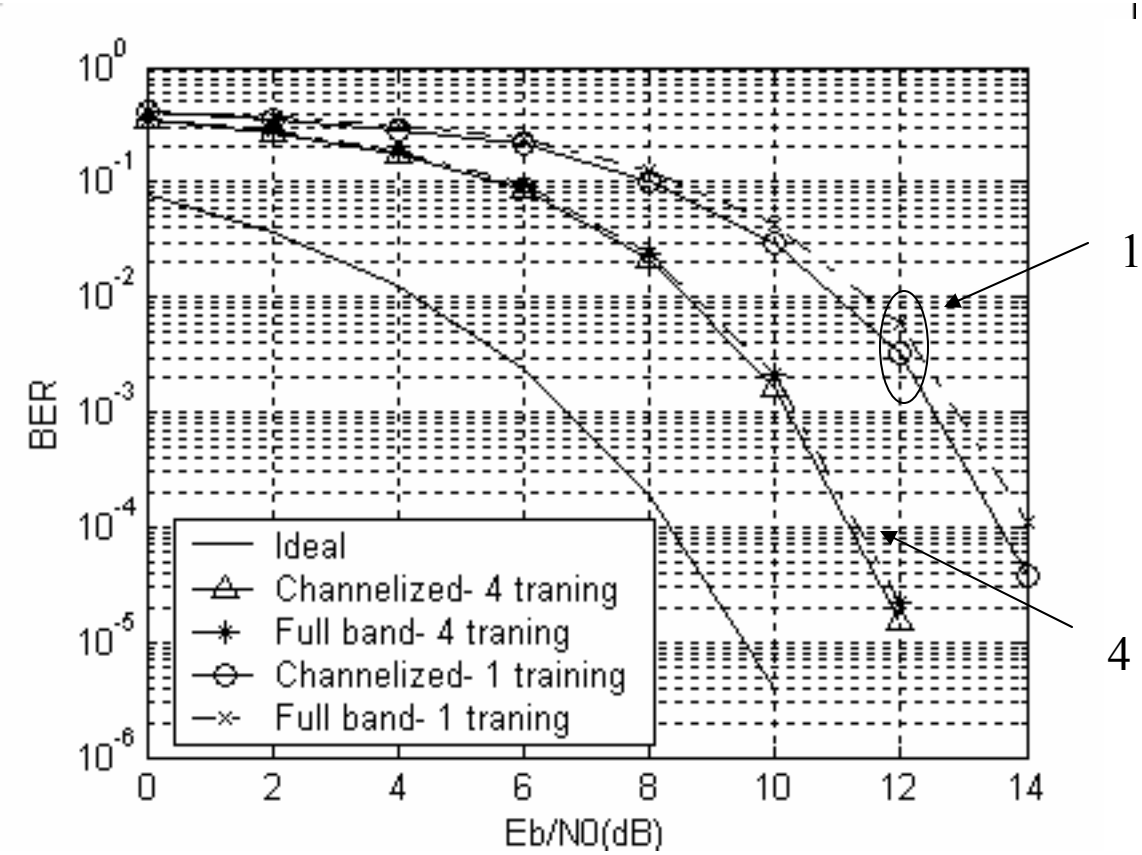
TR Channelized Receiver – Detection

- 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).



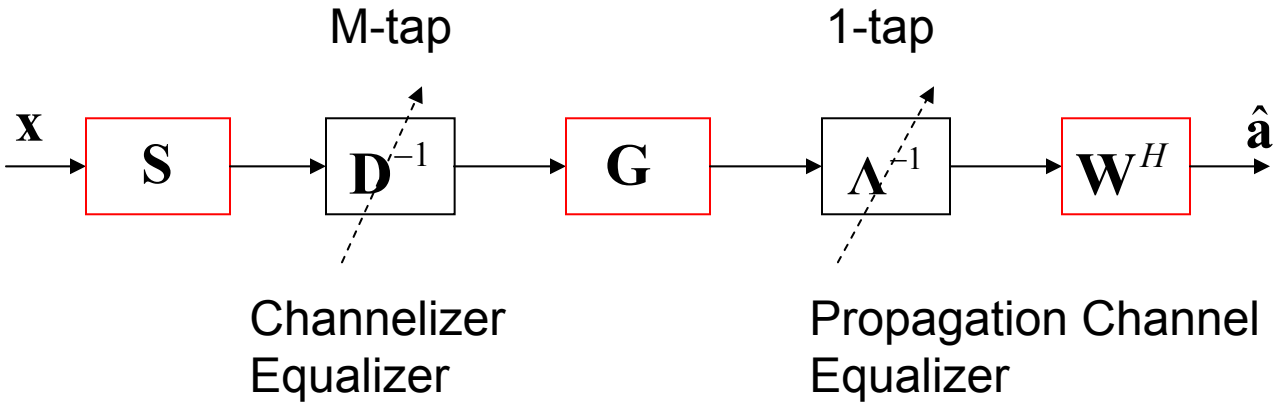
L. Feng, W. Namgoong, "An Oversampled Channelized UWB Receiver with Transmitted Reference Modulation", IEEE Trans. on Wireless Communications, 2006

TR Channelized Receiver Performance



- CM1 channel; block of 100 pulses.

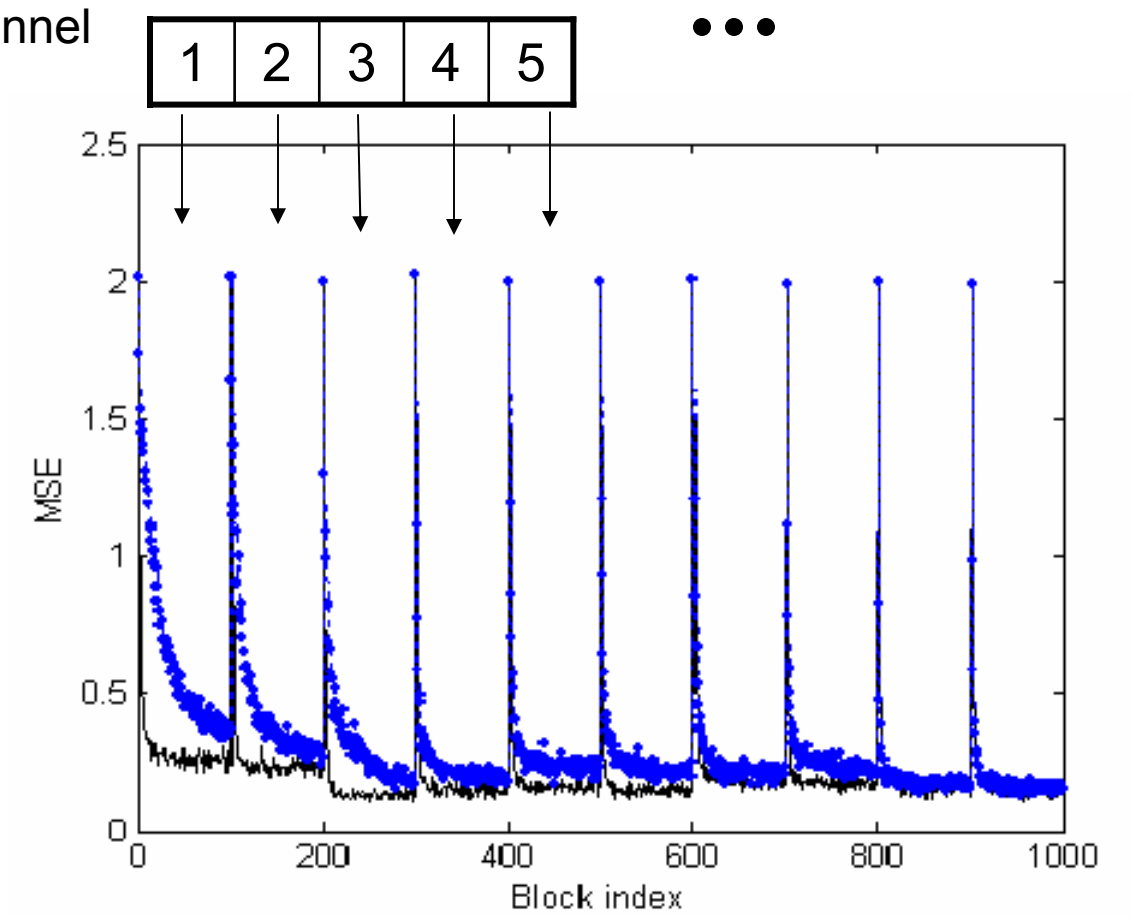
Receiver Structure for Cyclic Prefixed High Data Rate System



- **S**, **G**, **W** based on FFT/IFFT → 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.

L. Feng, W. Namgoong, "An Adaptive Maximally Decimated Channelized UWB Receiver with Cyclic Prefix", IEEE Trans. Circuits and Systems I – Regular Papers, 2005.

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.