Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: NICT-YNU-Meiji UWB Phy Proposal: Some aspects of Chirp Pulse Based IR-UWB Physical Layer

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Abstract: Chirp Pulse Based UWB Physical Layer Proposal for Body Area Networks

Purpose: Response to “TG6 Call for Proposals” (IEEE P802.15-08-0811-02-0006)

NICT-YNU-Meiji UWB Phy Proposal: Some aspects of Chirp Pulse Based IR-UWB Physical Layer

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Outline

- Goal
- System principles
- System performance
- Conclusions

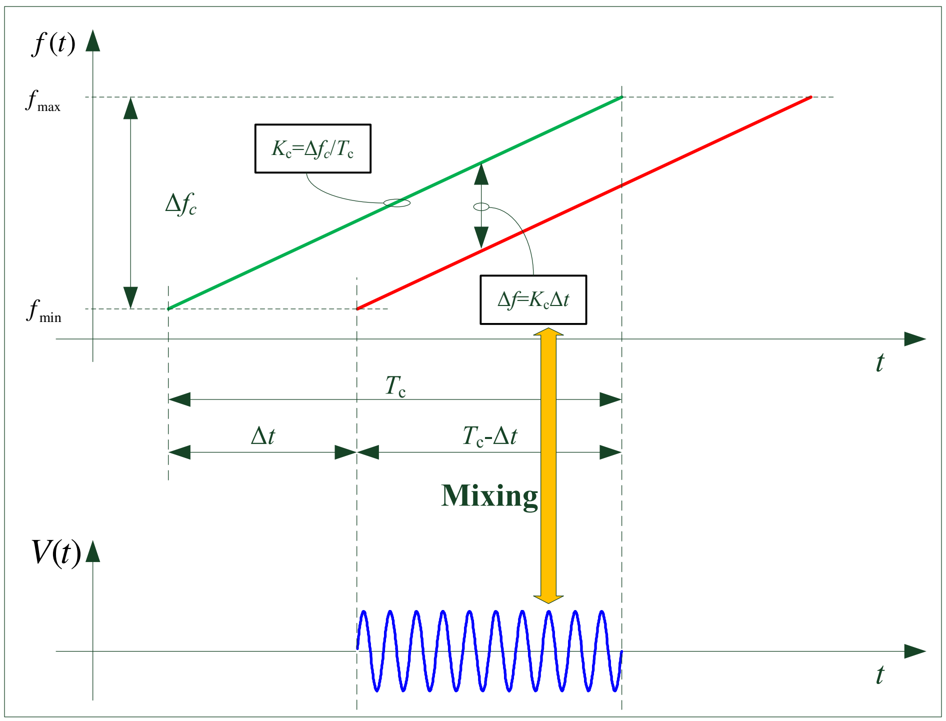
Goal

- To clarify principles of Chirp IR-UWB.
- To show performance and requirements diagrams not shown before.

SYSTEM PRINCIPLES

Why is linear chirp pulse signal like no other?

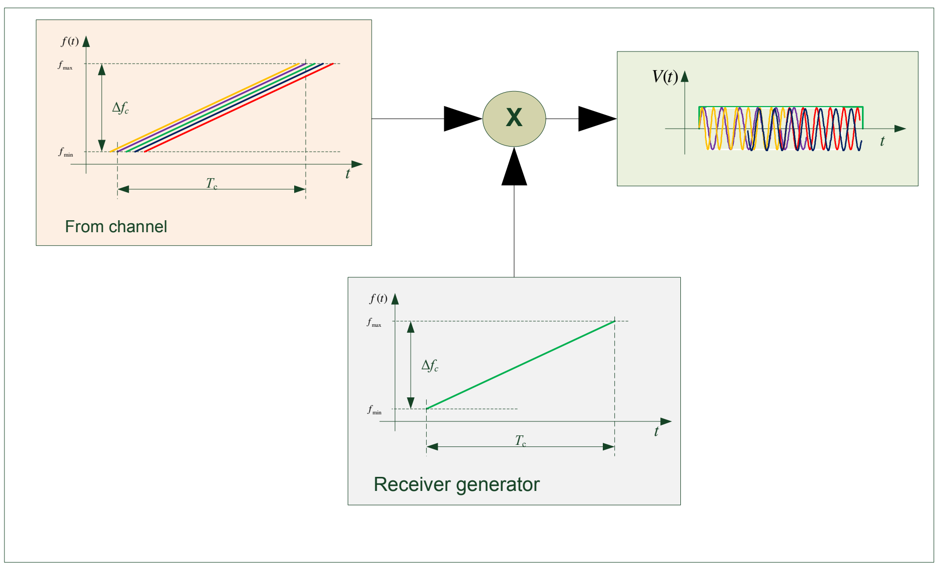
Mixing two linear chirp pulses:

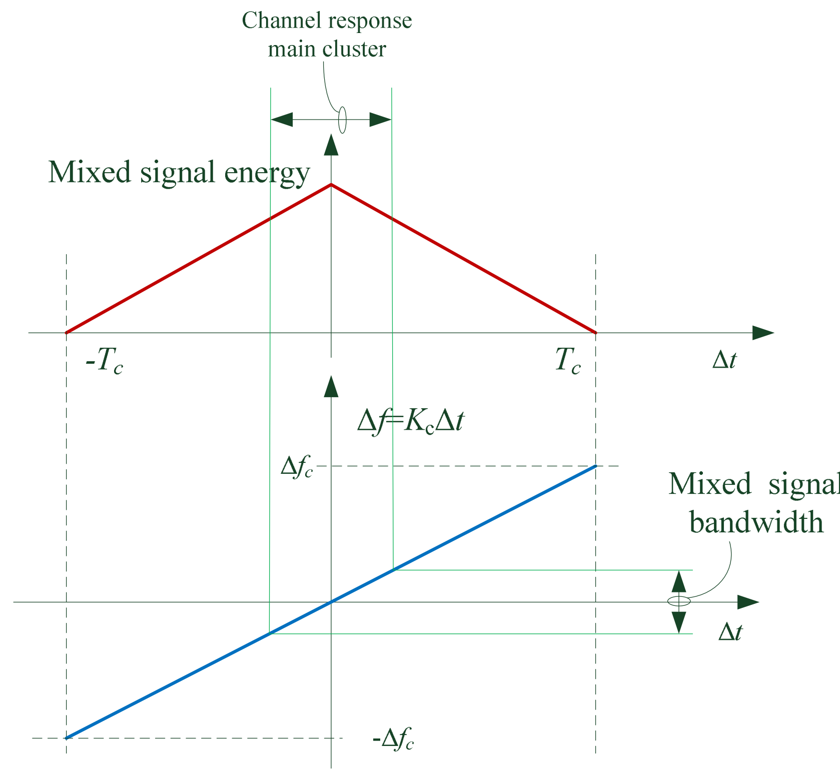


- **It de-spreads the chirp in frequency without de-spreading it in time.**
- Timing does not to be matched well in order to get low-pass signal that contains most of the energy.

Why is linear chirp pulse signal like no other? (cont.)

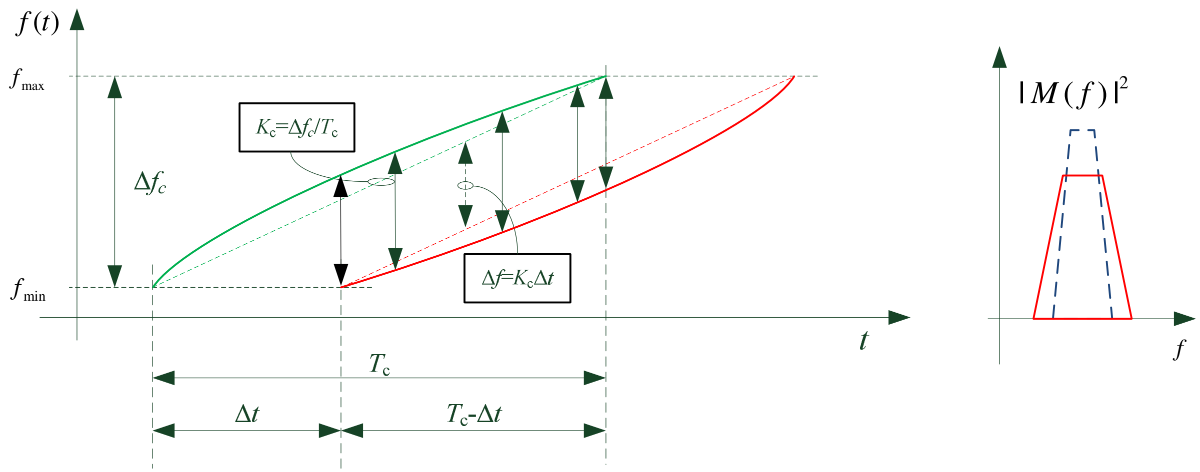
Effects on multipath:





With proper choice of chirp parameters, for a given channel and optimum timing, energy of the multipath signal will be mostly preserved after mixing and concentrated in low frequencies where it ca be conveniently sampled.

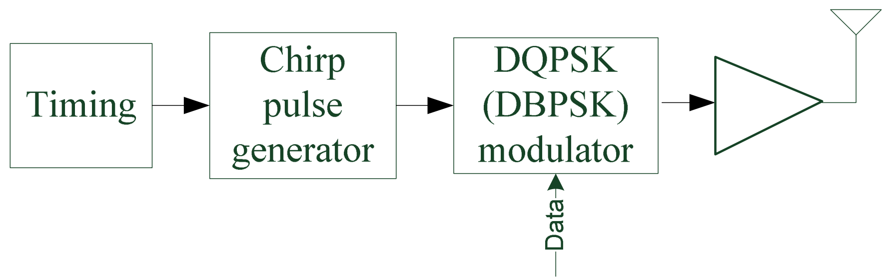
Chirp pulse generation non-idealities robustness rationale



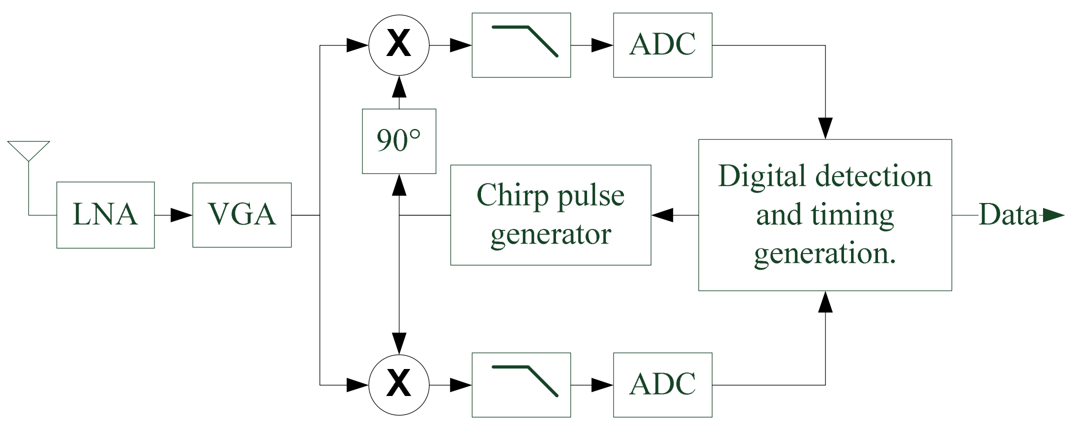
- Non-idealities in chirp generation:
  - Non-linearity and offset in chirp slope (Kc), carrier frequency offset, as well as phase and amplitude modulations encountered in the channel widen the spectra of tones after mixing.

System block diagram

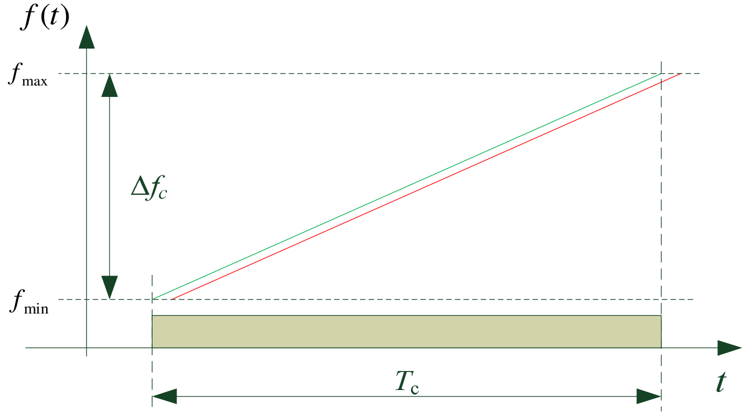
- Tx:

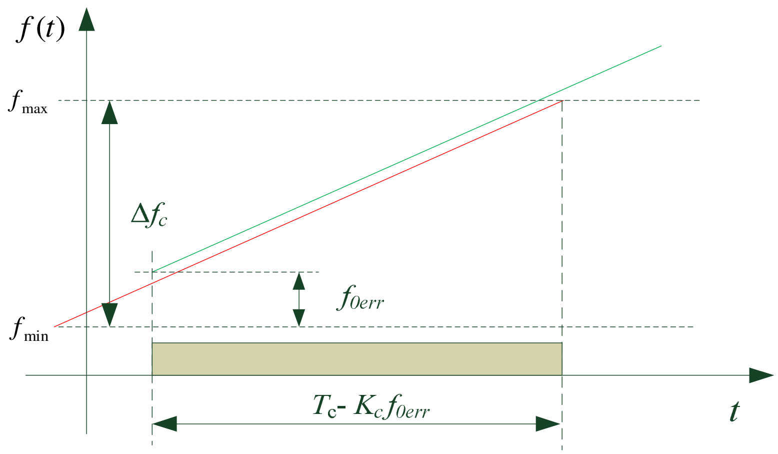


- Rx:

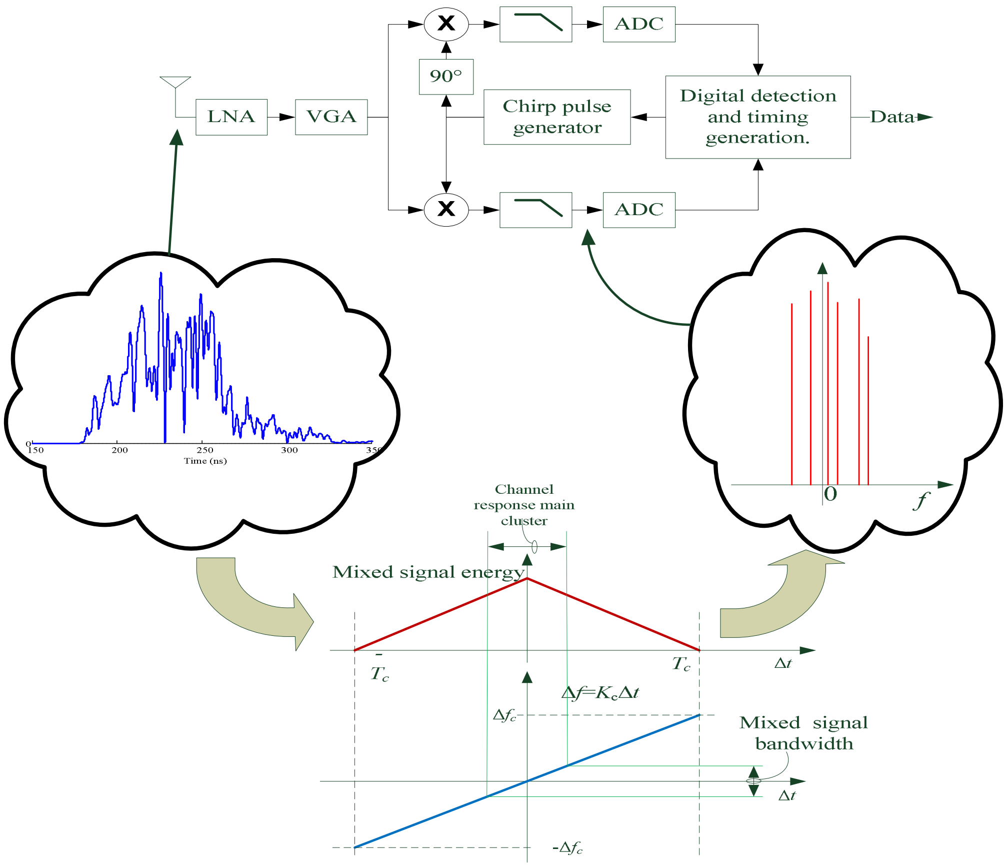


Chirp pulse generation non-idealities robustness rationale





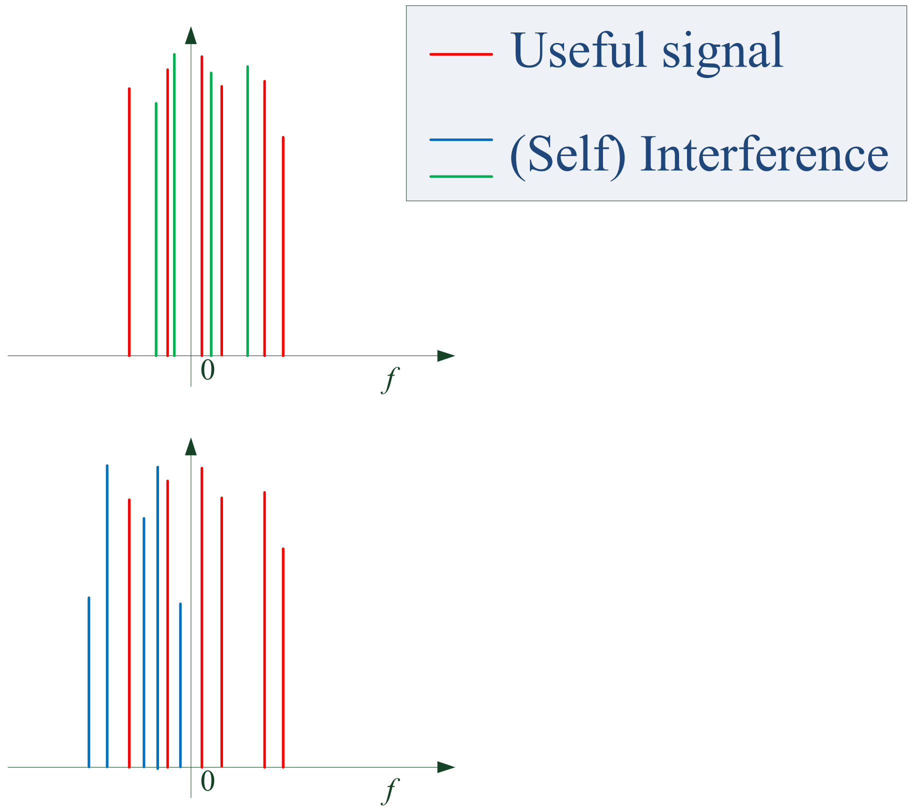
IPI and ISI resistance of the system rationale



MUI and ISI resistance of the system rationale (cont’d.)

Current symbol:

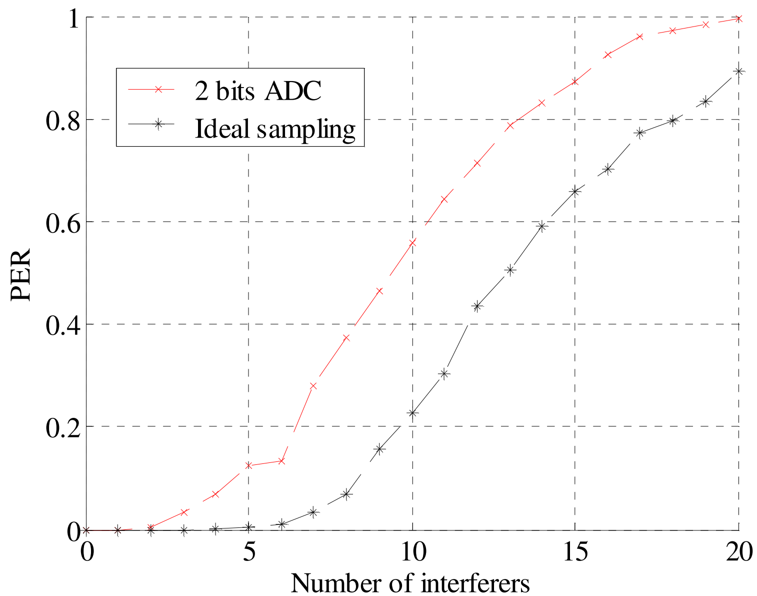
Previous symbol:



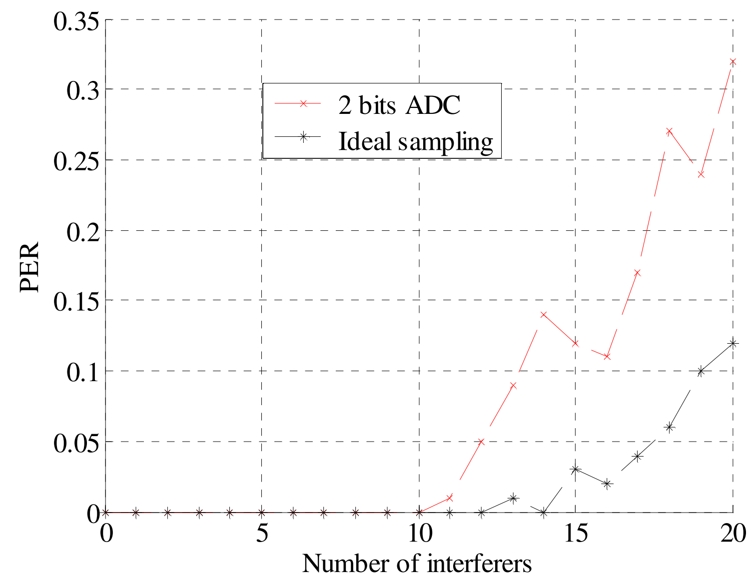
Spectra of signals after mixing and LPF

After correlation, only power of useful signal is high

Intra-Piconet Interference (IPI) resistance of the system



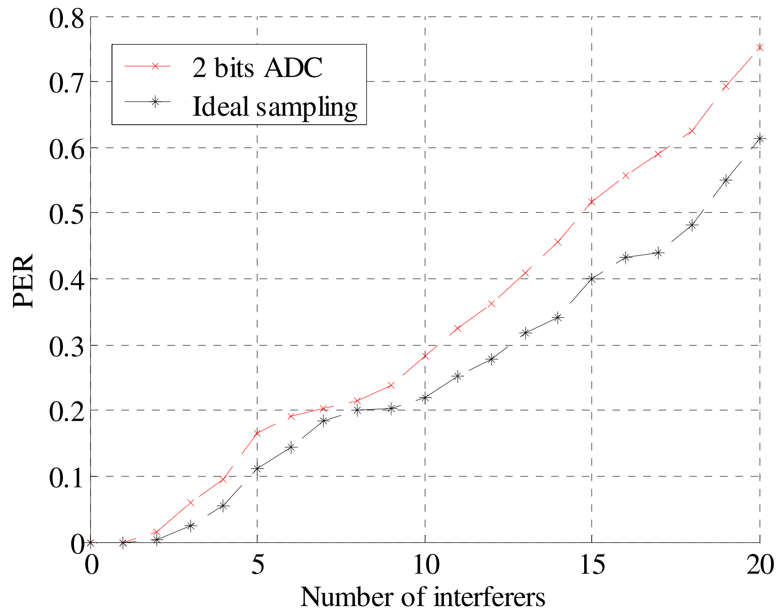
Near-far 1:2 power ratio



Near-far 1:1 power ratio

- Interferers are located on the same IEEE 802.15.4a channel.
- All interferers radiate packages continuously.
- 0.98 Mbps $RS_6(63,55)$ coded DDBPSK.

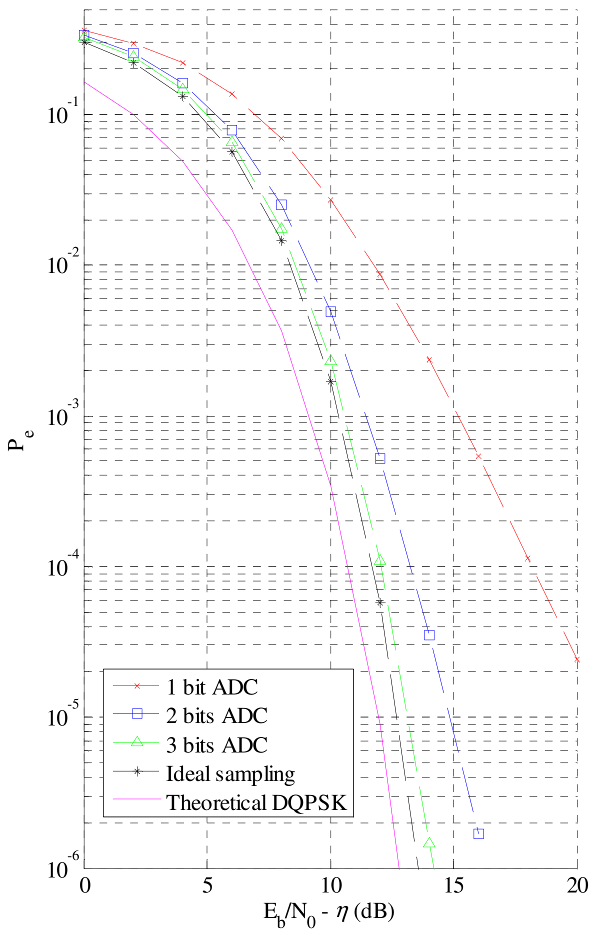
Intra-Piconet Interference (IPI) resistance of the system (cont.)



1.96 Mbps $RS_6(63,55)$ coded DDBPSK.

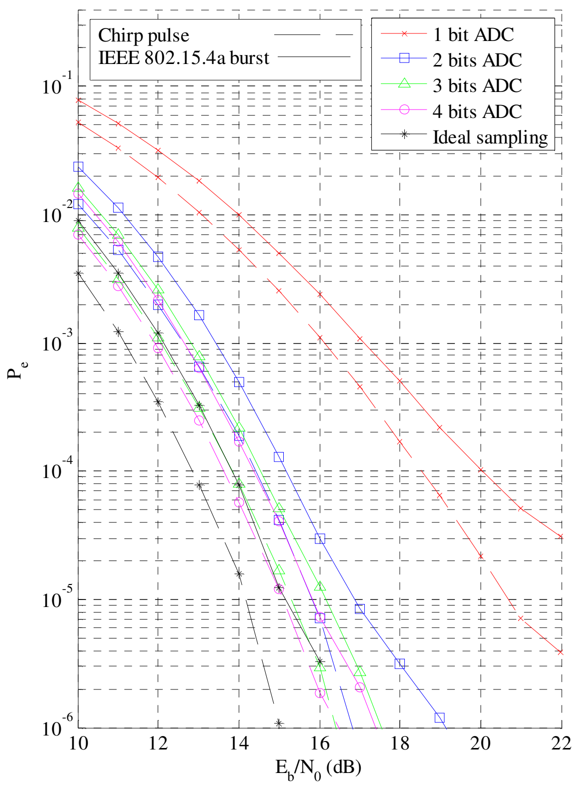
•Interferers are located on the same IEEE 802.15.4a channel.
•All interferers have equal power at the receiver to the one of user of interest.

Inter Symbol Interference (ISI) resistance of the system



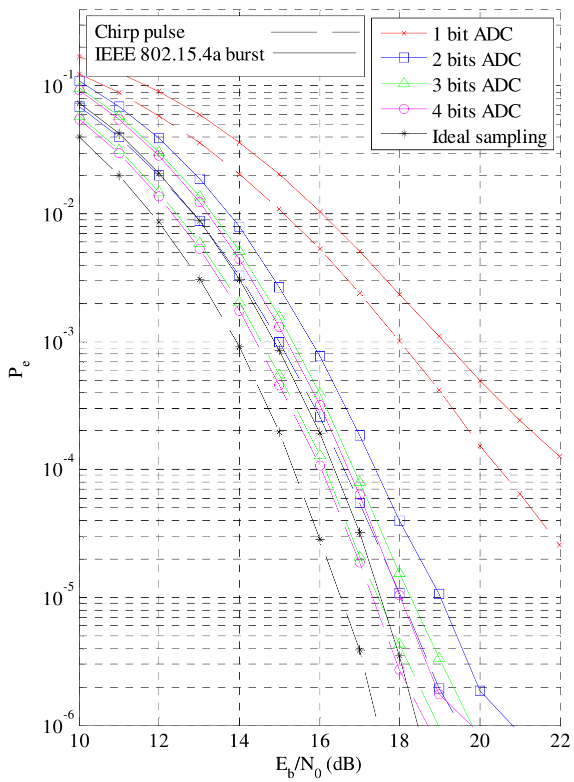
- 10.4 Mbps (5.2 Msps DDQPSK) at IEEE 802.15.6 CM4
- Time hopping is used without guard interval.

Comparison between IEEE 802.15.4a burst waveform and Chirp waveform



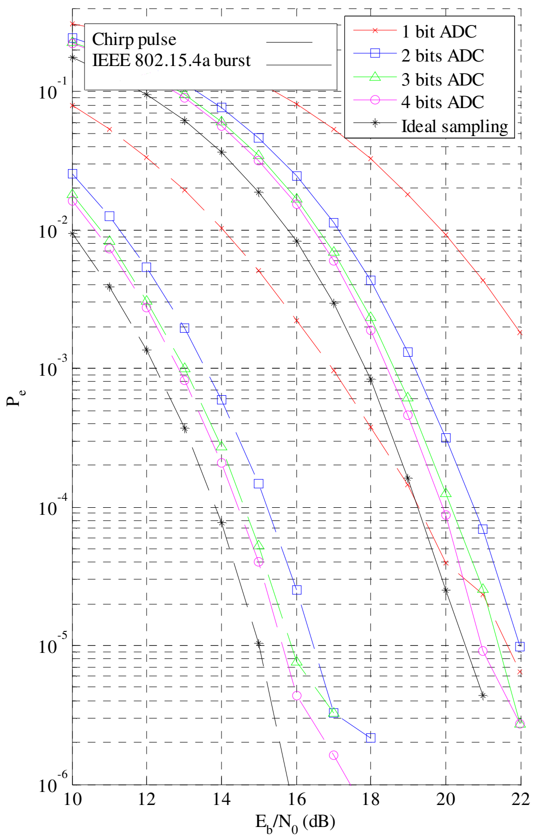
DBPSK (with channel estimation)

- •Both waveforms have IEEE 802.15.4a mandatory burst duration of 32ns.
- •2 Mbps data rate.
- •Both systems use 16 samples per pulse.
- •Receiver for Chirp pulse is uses our Chirp receiver.
- •Receiver for burst waveform uses 500 MHz sampling receiver.



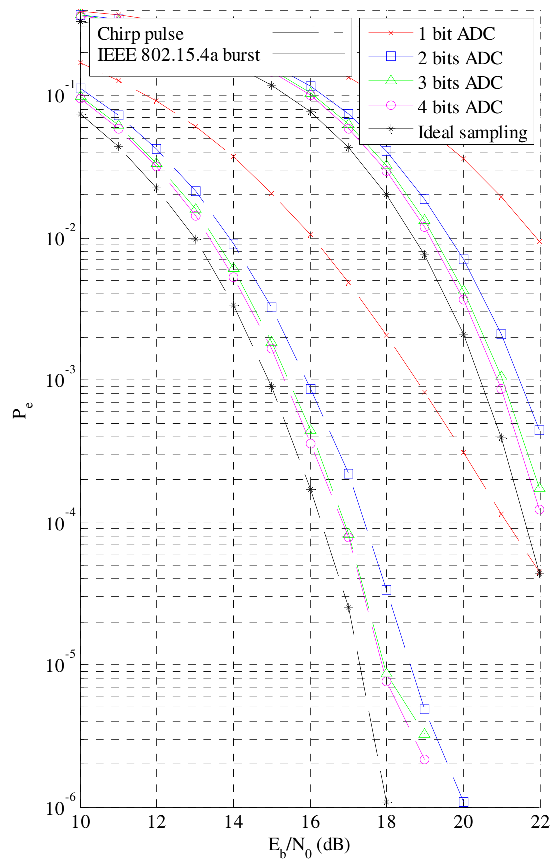
DDBPSK (no channel estimation)

Comparison between IEEE 802.15.4a burst waveform and Chirp waveform (cont.)



DBPSK (with channel estimation)

- Both waveforms have IEEE 802.15.4a burst duration of 256ns.
- 0.12 Mbps data rate.
- Both systems use 16 samples per pulse.
- Receiver for Chirp pulse is uses our chirp receiver.
- Receiver for burst waveform uses 500 MHz sampling receiver.



DDBPSK (no channel estimation)

Conclusions

- System resistivity to ISI is high up to 10 Mbps without channel estimation.
- System resistivity to IPI approximately drops by half when data rate is increased from 1 Mbps to 2 Mbps.
- Near-far resistance of the system is as expected.
- When same level of digital backend complexity is considered, system shows improvement in performance compared to classic Nyqist sampling approach in the baseband.

Backup slides

Oscillator phase noise requirements of the system