UWB based on Pulsed Multiband

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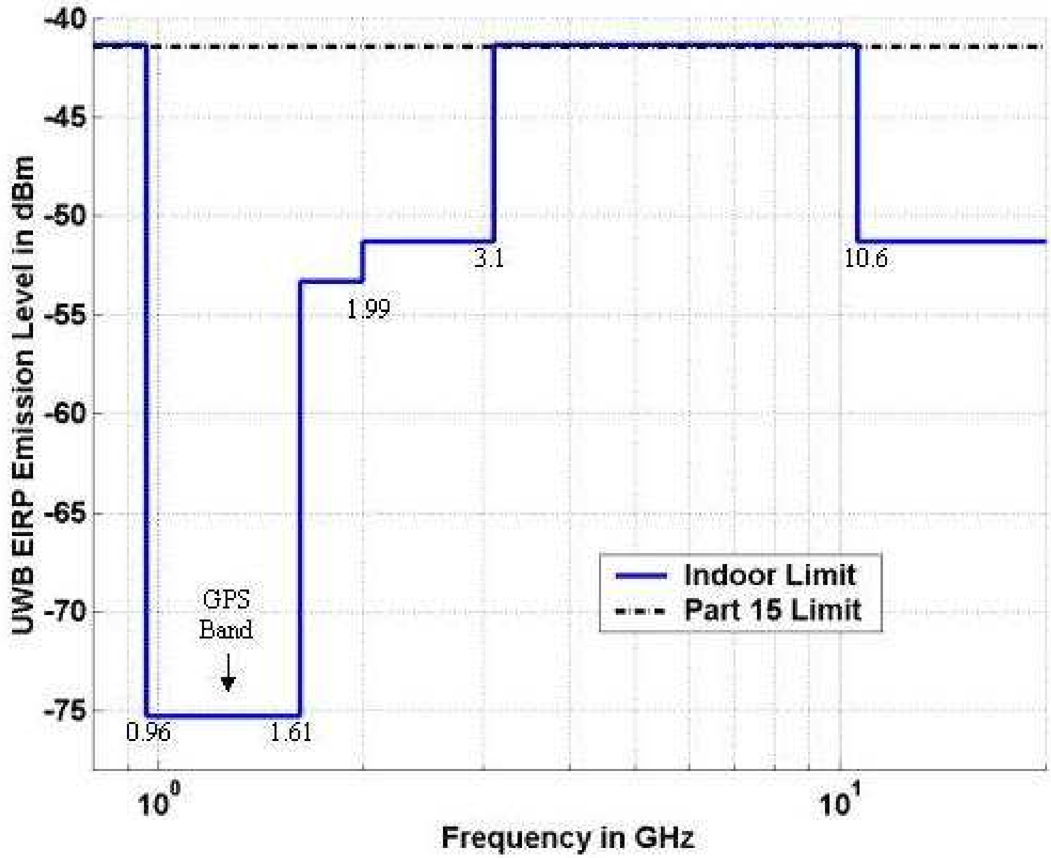
Overview:

- UWB MULTIBAND
- SYSTEM MODEL
- SIMULATION PARAMETERS AND ASSUMPTIONS
- RESULTS
- CONCLUSIONS
- FUTURE WORKS

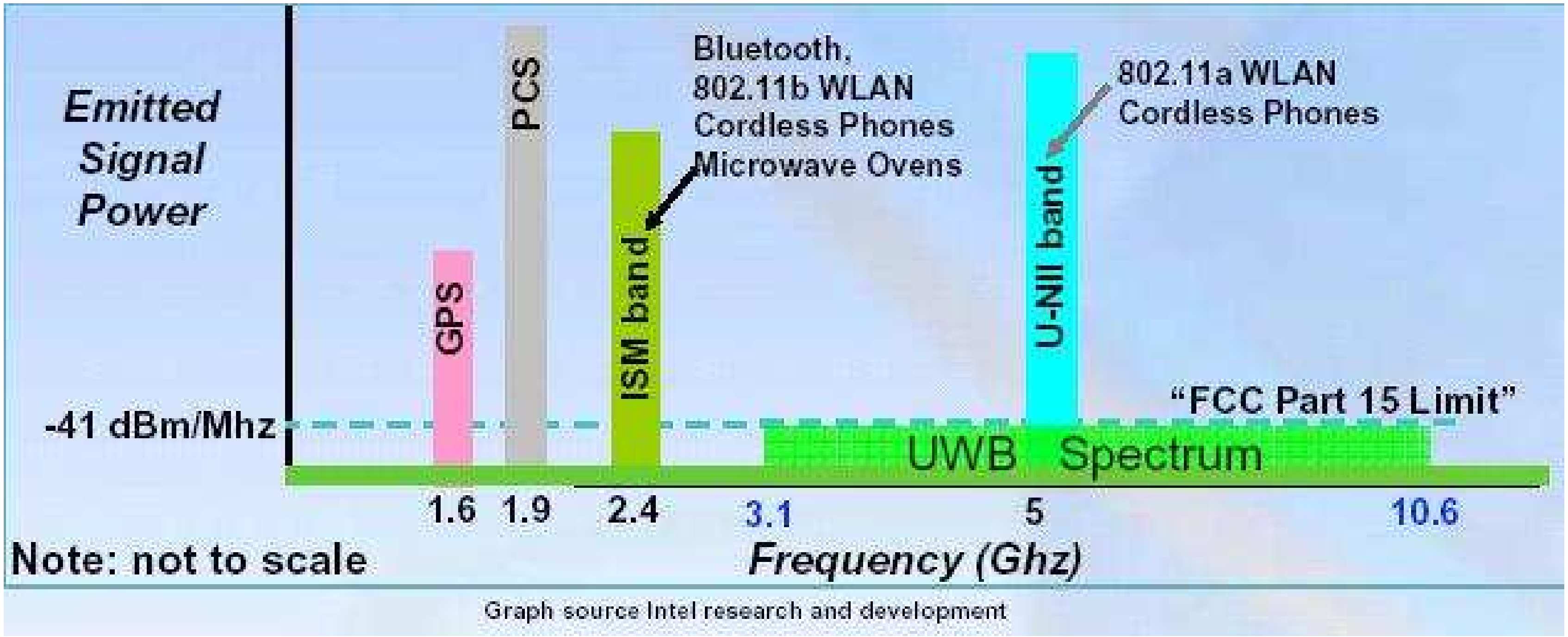
Ultra Wideband (UWB)

- UWB is a wireless technology for transmitting digital data at very high rates over a wide frequency with very low power
- UWB is not a new technology
- February 14, 2002, the FCC defined UWB as any signals that have -10 dB bandwidth at least 500 MHz in unlicensed 3.1 - 10.6 GHz bandwidth frequency and should meet the following spectrum mask

UWB spectral mask for indoor communications system according to FCC



UWB underlay

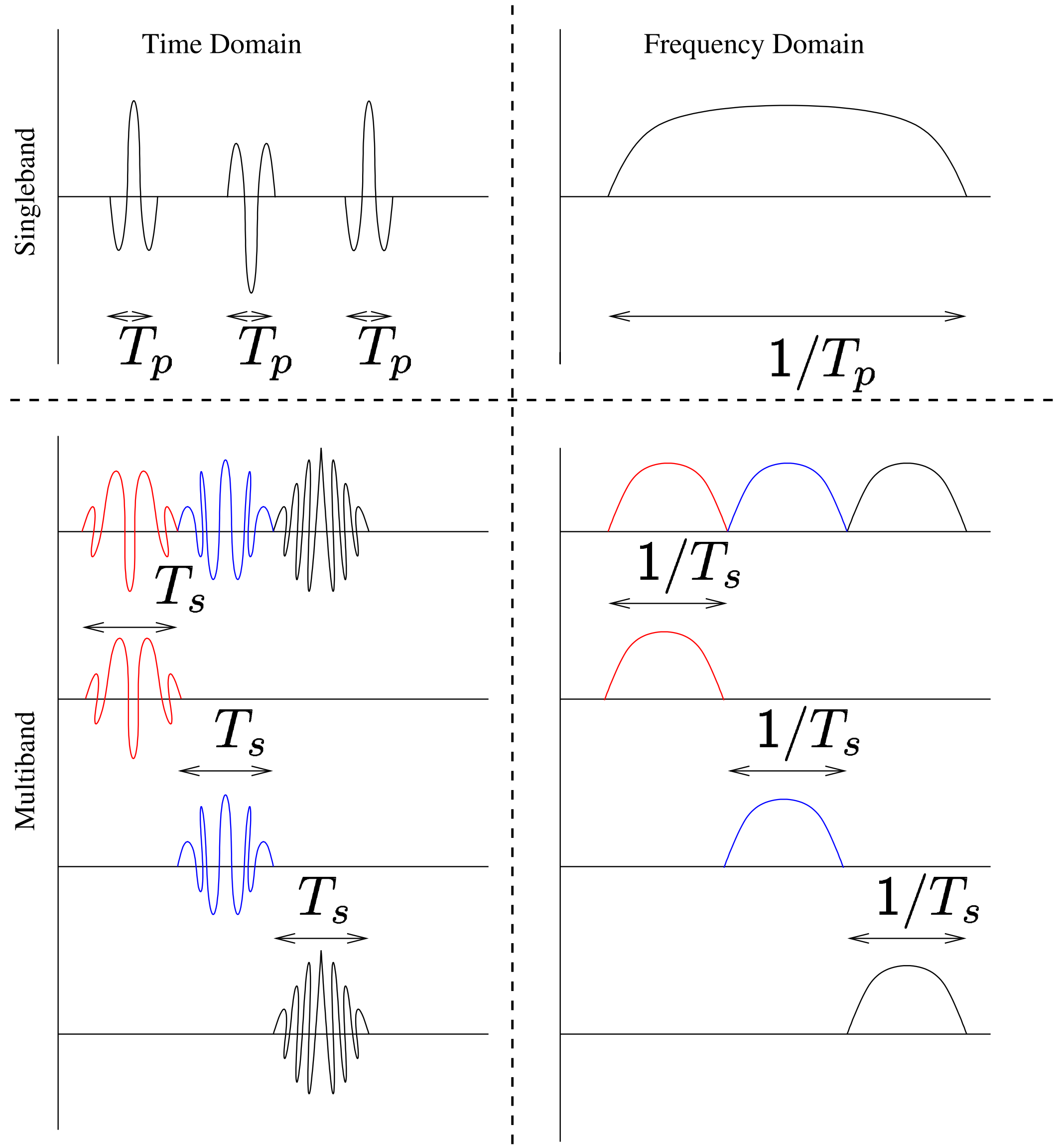


- Wide bandwidth means high channel capacity, high data rate.
  Shannon's capacity limit equation:
  $C = BW * log_2(1 + SNR)$

- Limited power means limited distance (< 10 m)

UWB is suitable for high data rate communications system in a short range

UWB Singleband and Multiband



Why UWB Multiband ?

- Adaptive band selection :
  - UWB coexistence with IEEE 802.11a (WLAN) is improved
  - Compliance with worldwide regulation

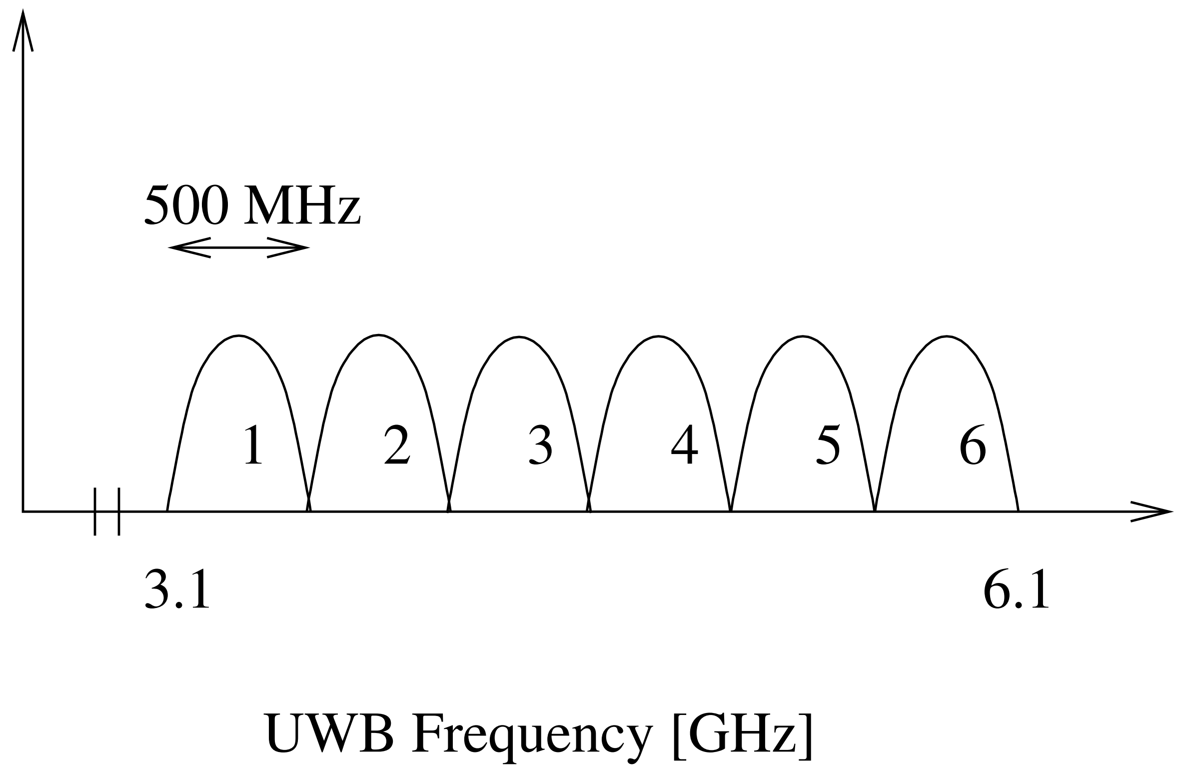
- Flexible in data rate

UWB system based on pulsed multiband in a single user link with data rate 100 Mbps.

SYSTEM MODEL

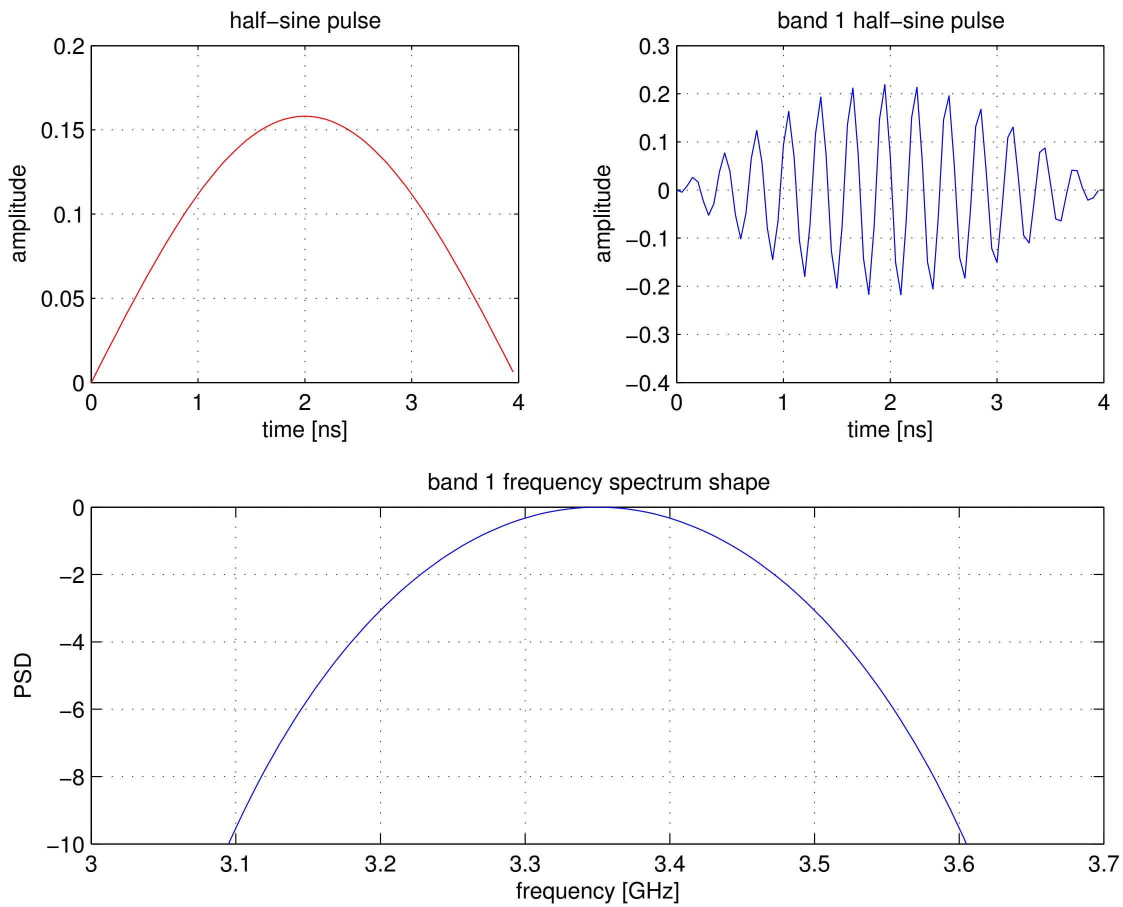
- UWB system based on pulsed multiband
- IEEE UWB channel model
- Coherent receivers
- Channel estimation

Bandplan



- Ease of implementation

Pulse



- Half-sine with duration 4 ns
- -10 dB bandwidth $\approx$ 500 MHz

Data is transmitted sequentially in each band

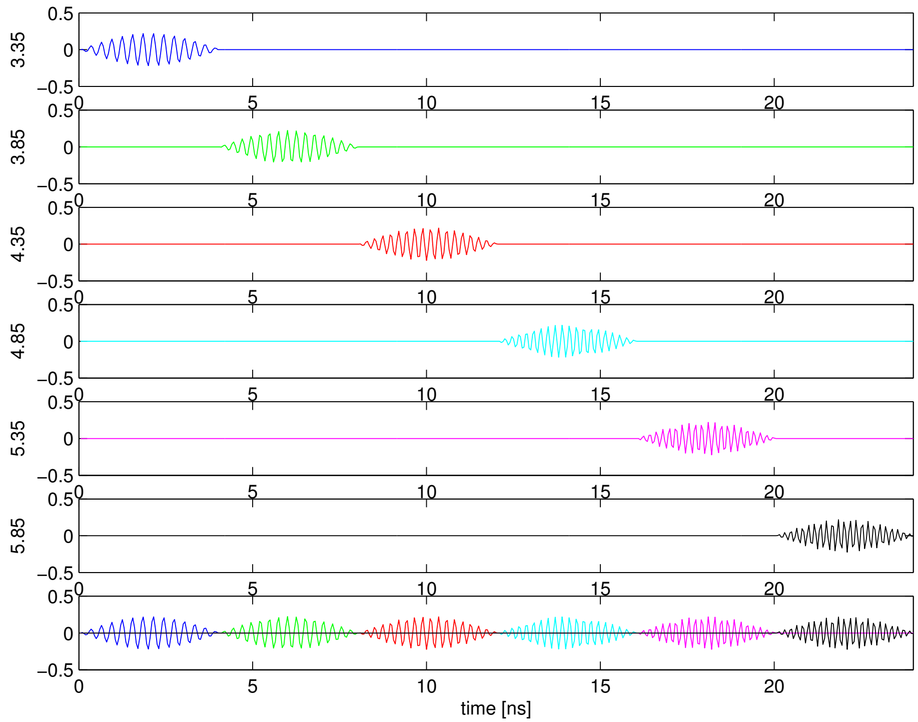


Figure 1: In time domain

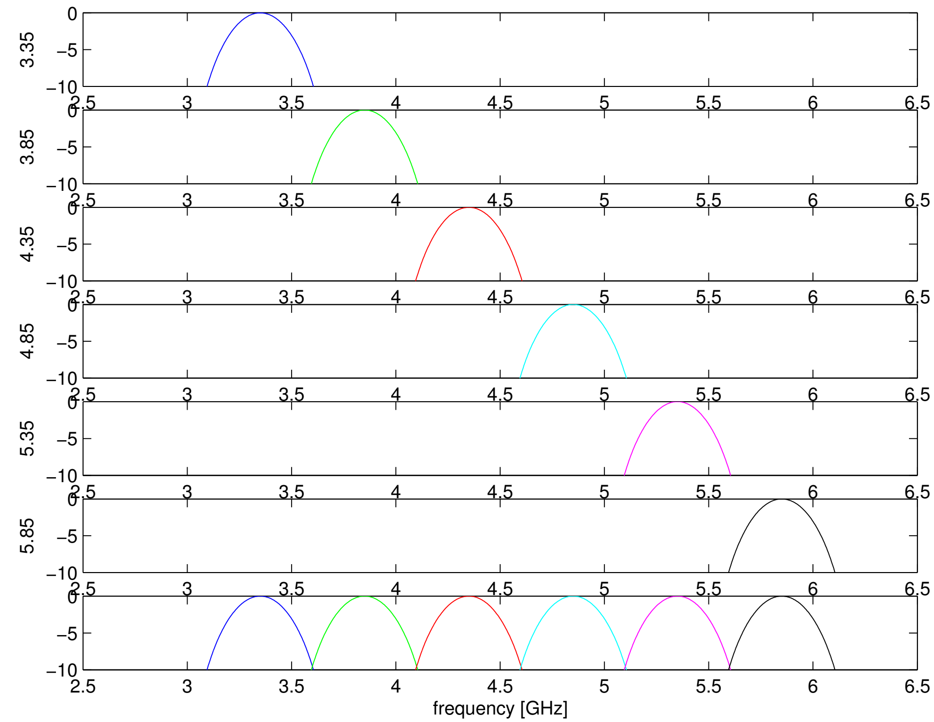


Figure 2: In frequency domain

- Pulse Repetition Frequency (PRF) $= 6 * 4ns = 24ns$
- Pulse rate $= 6 * \frac{1}{6*4ns} = 250Mpps$
- Repetition code 2 pulses/1 bit, Bit rate $= 125Mbps$

IEEE UWB Channel Model

- Based on Saleh-Valenzuela where multipath components arrive in clusters
- Taps has log-normal fading and phase is $\pm$ 1 (equally probable)
- Log-normal shadowing with $\sigma = 3$ dB and $\mu = 0$ dB, with expected energy is 1.2695 or $+1$ dB
- Four different channels models:

CM1:	LOS 0-4 m	CM3:	NLOS 4-10 m
CM2:	NLOS 0-4 m	CM4:	NLOS RMS delay spread 25 ns

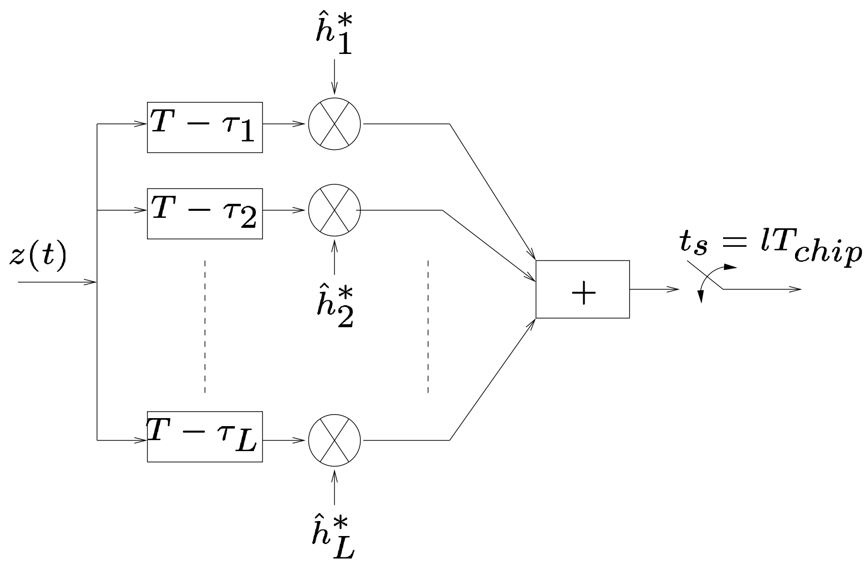
- Interarrival time for clusters and rays follow exponentional distribution

Coherent Receivers

- Coherent receivers need to estimate channel phase, amplitude and delay

- Selective Rake with MRC and pulse matched filter
  - Chip-spaced Rake receiver (pulse or chip rate)
  - Fractional-spaced Rake receiver (Nyquist rate)

Rake receiver



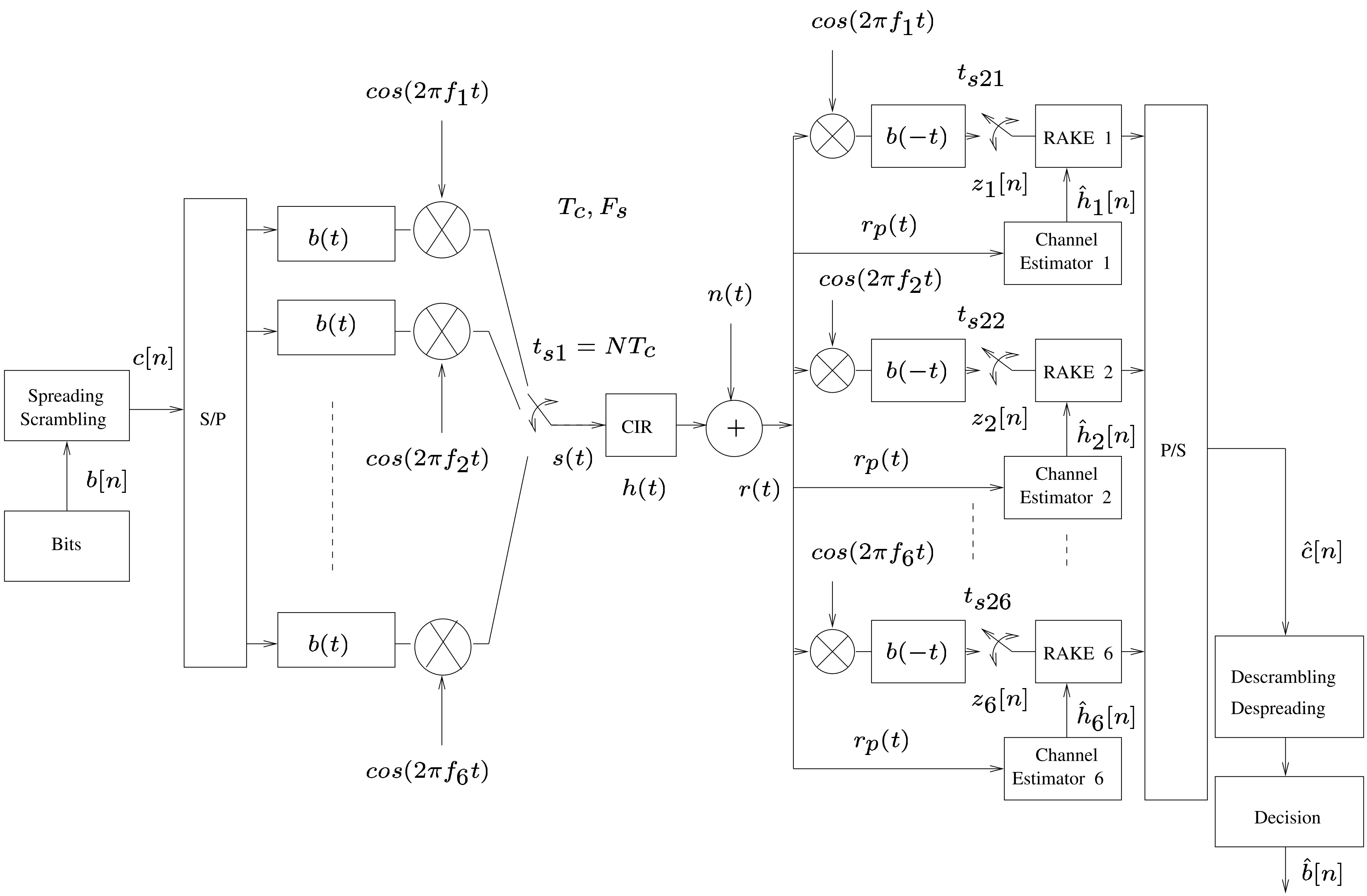


Figure 5: System Model

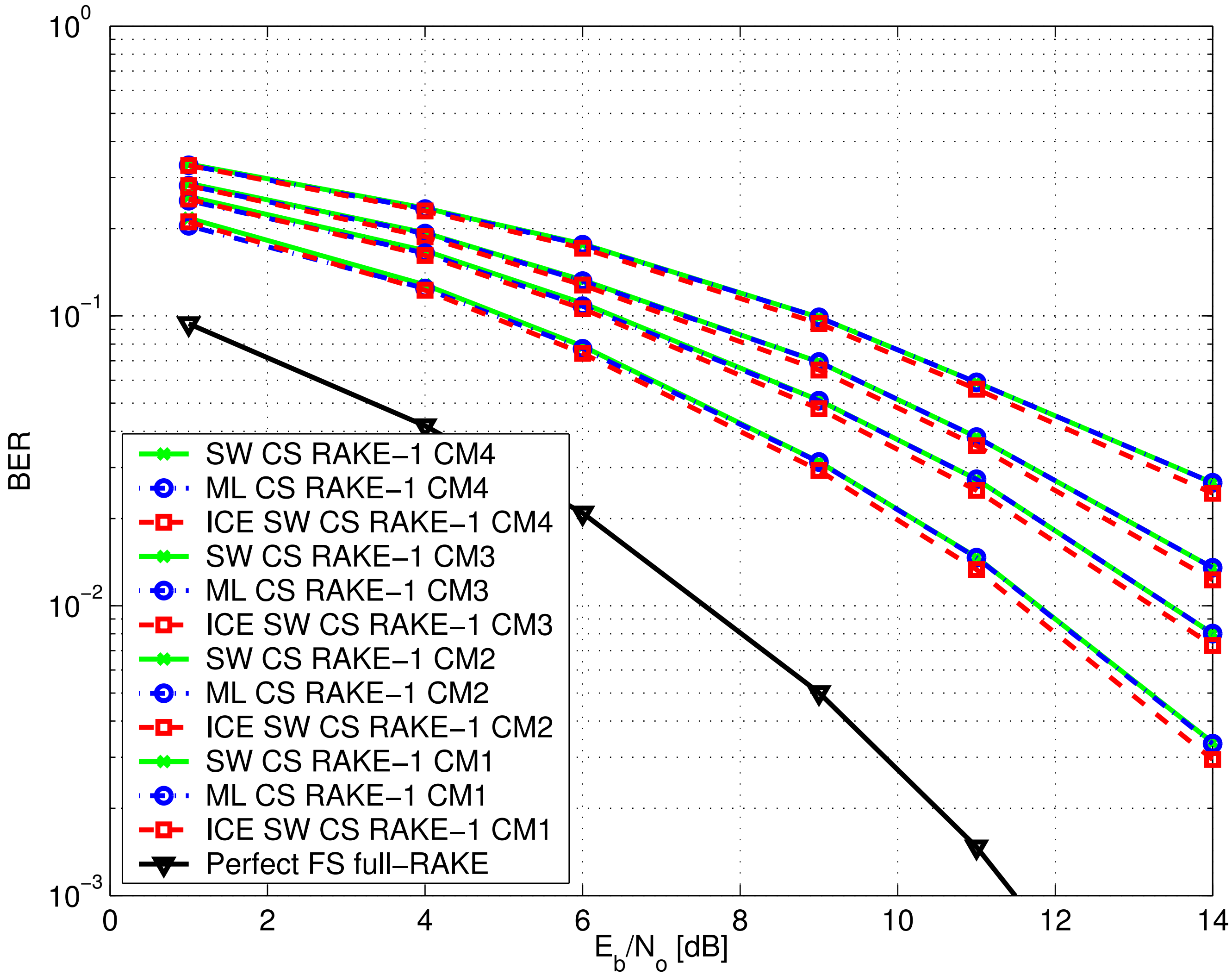
Channel Estimation

- Sliding Window
- Maximum-Likelihood criterion or Least Squares (ML)
- Iterative Channel Estimation

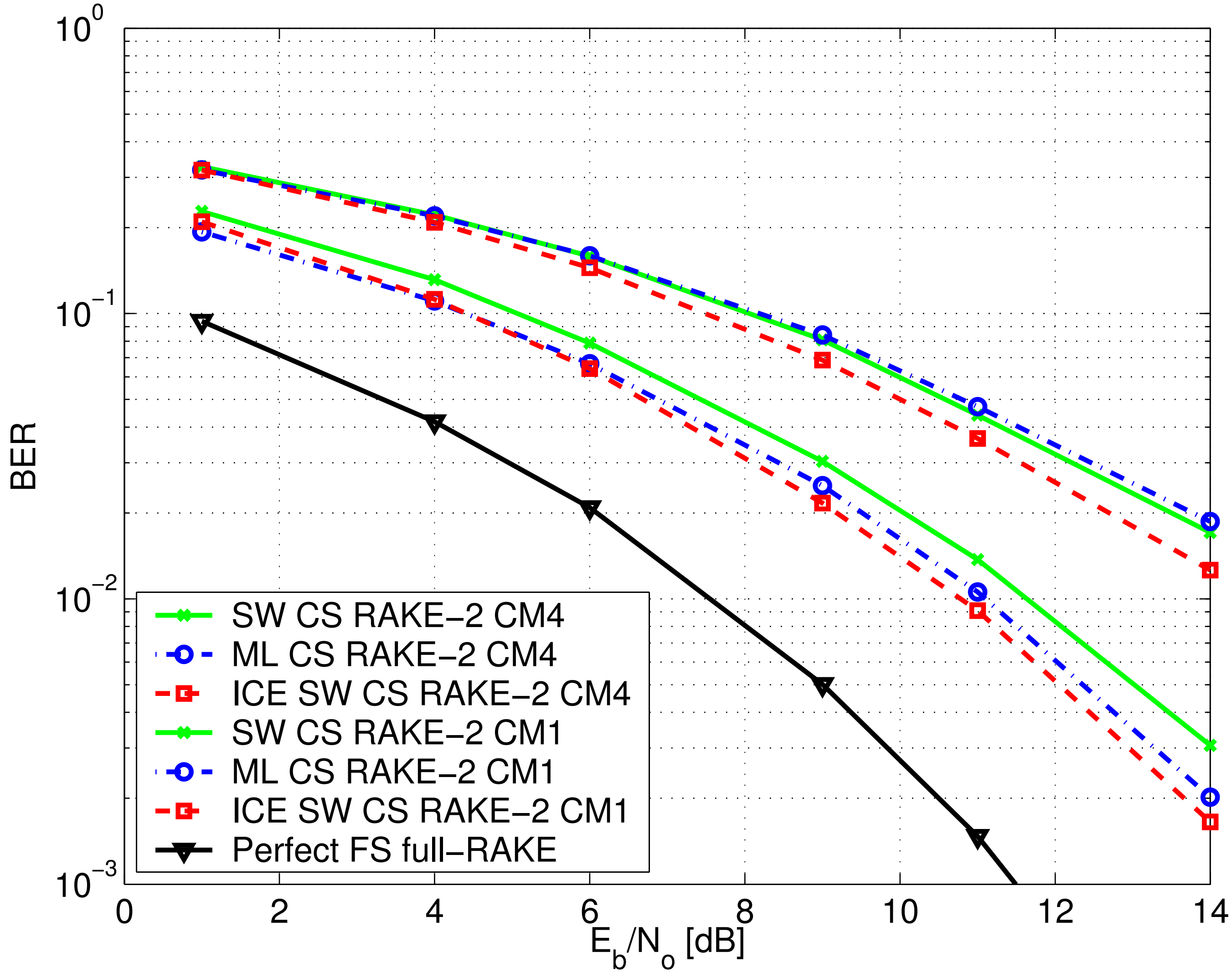
SIMULATION PARAMETERS AND ASSUMPTIONS

- Uncoded data rate is in order of 100 Mbps
- Channel is constant during transmission of 1 packet
- Number of data bit in 1 packet is 2400 bits
- 6 bands 500 MHz from 3.1 to 6.1 GHz
- Sampling rate in the transmitter is 20 GHz
- Half sine pulse with duration 4 ns and -10 dB bandwidth $\approx$ 500 MHz
- BPSK modulation
- Spread the bits in different bands and transmit it sequentially
- Repetition gain 3 dB or 2 pulses per 1 bit
- Long code system with ML sequence period 255
- Perfect synchronization
- Effect from equipment has been neglected

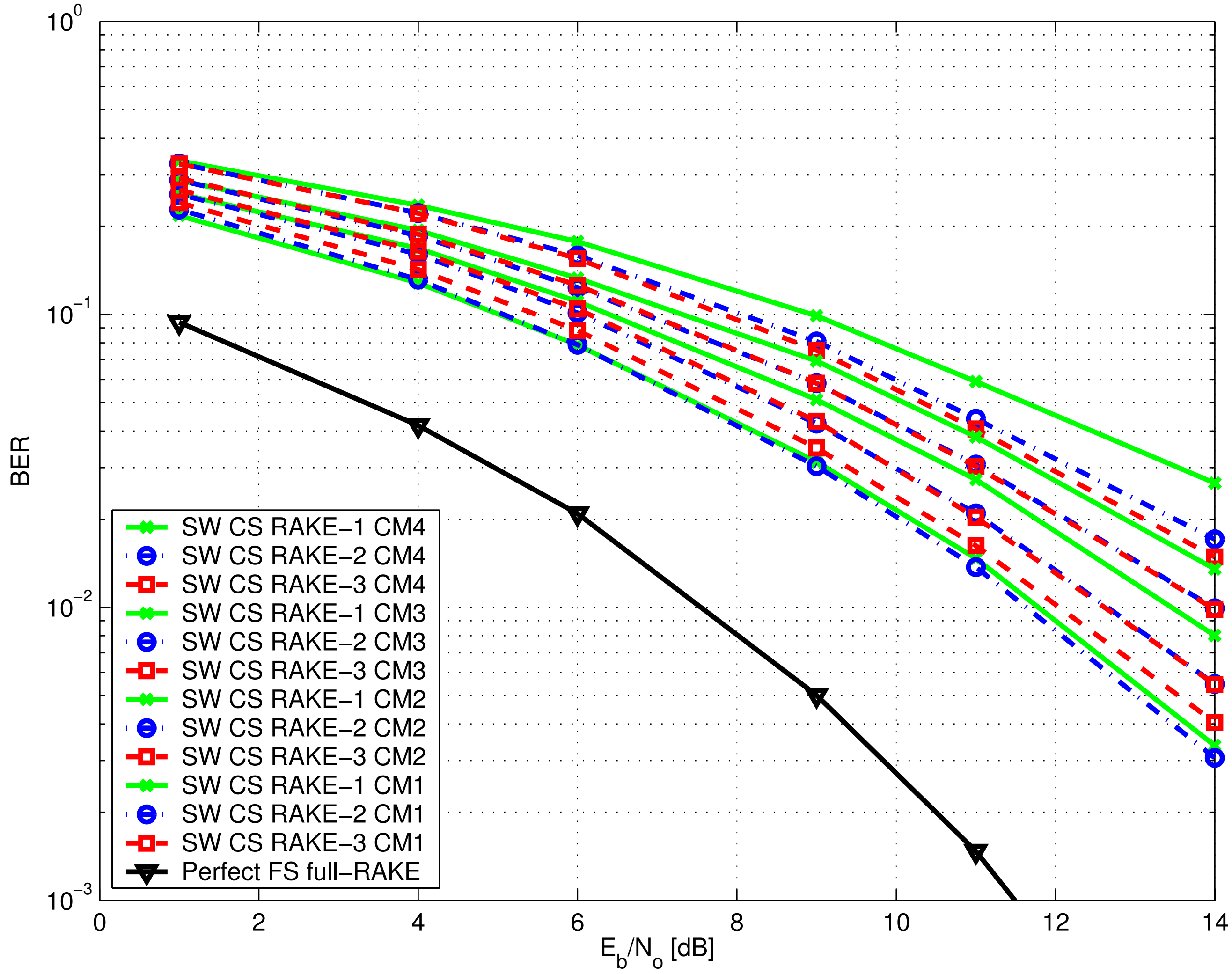
Comparisons Rake 1 finger between SW, ML and ICE SW channel estimation



Comparisons Rake 2 finger between SW, ML and ICE SW channel estimation



Result SW channel estimation



CONCLUSIONS

- Performances of FS and CS Rake are comparable, therefore CS is preferable due to its lower sampling rate

- For Rake 1 finger, ML and SW show the same performance and ICE only gives a small improvement with the cost longer processing time

- Diversity gain is attainable in CM2, CM3 and CM4

- ML estimation needs to know the maximum excess delay time of the channel to determine the optimum sampling point

- Pulse separation gives improvement in CM3 and CM4 but the bit rate is lower

- System proposal: UWB pulsed multiband using sliding window estimation method with chip spaced Rake 1 for CM1 and 2 fingers for CM2, CM3 and CM4