

Mobile Communication

DSSS and FHSS intermediate presentation

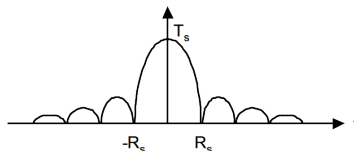
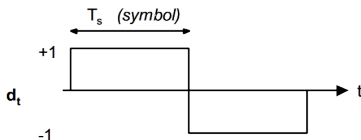
Group 6

November 3, 2014



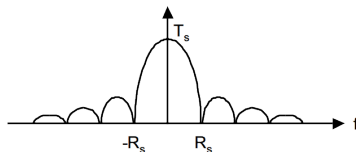
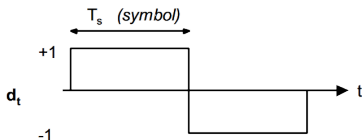
Spread Spectrum

- Transmitting finite sequences requires a frequency *band*
- Spreading this band makes transmission more robust
- Use spreading schemes, that allows using the frequency band for concurrent transmission



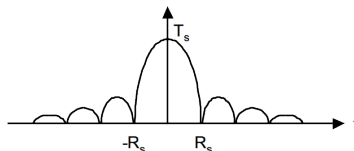
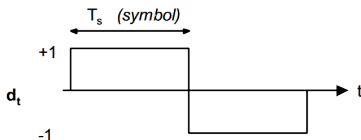
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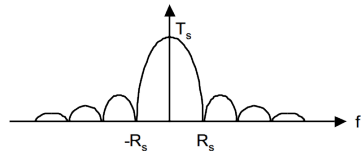
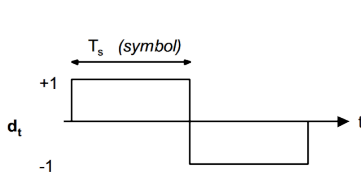
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Direct Sequence Spread Spectrum

Data

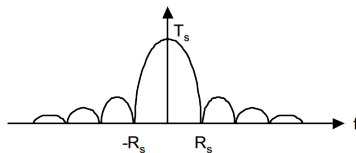
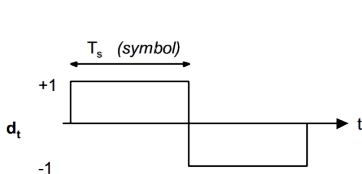
- Let the data $d_t \in \{-1, 1\}^n$ be $d_t = [1, -1]$
- Signal bandwidth R_s



Direct Sequence Spread Spectrum

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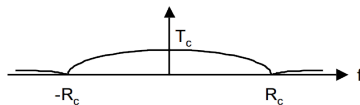
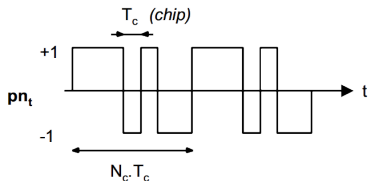
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Direct Sequence Spread Spectrum

Chip Sequence

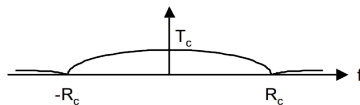
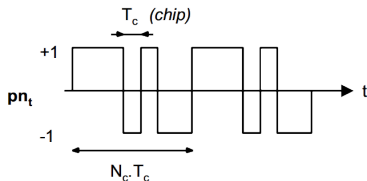
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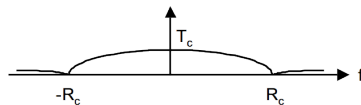
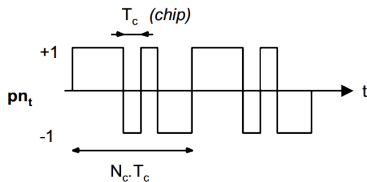
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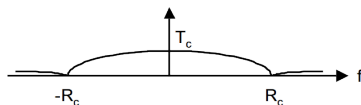
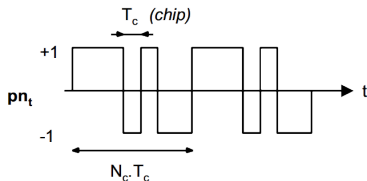
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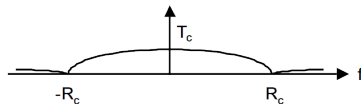
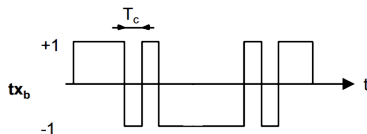
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Direct Sequence Spread Spectrum

Spreading

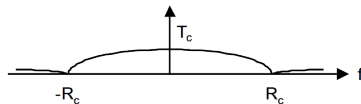
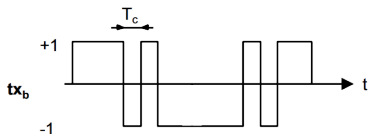
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- Bandwidth of transmitted signal is R_c , the chip sequence's bandwidth.
- For transmission apply some phase modulation



Direct Sequence Spread Spectrum

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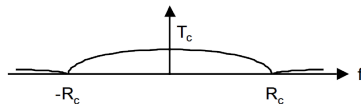
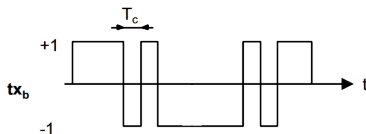
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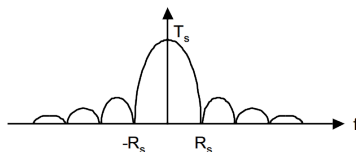
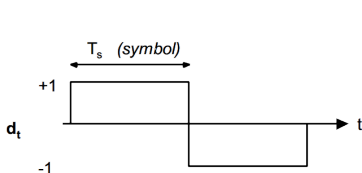
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$$d_r = t_x p_n = d_t p_n p_n = d_t$$

- This returns the original data since $p_n p_n = [1, 1, \dots]$



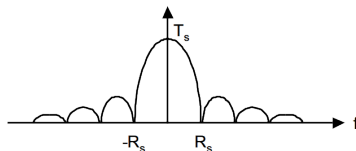
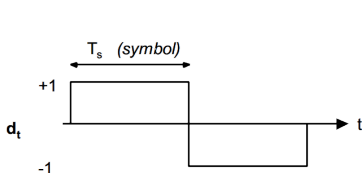
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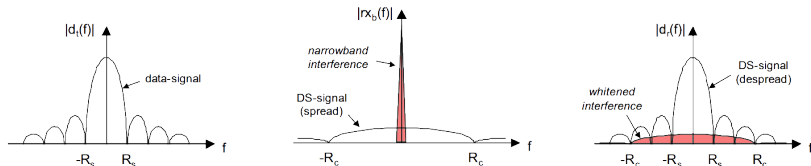
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Interference

Narrow-band Interference

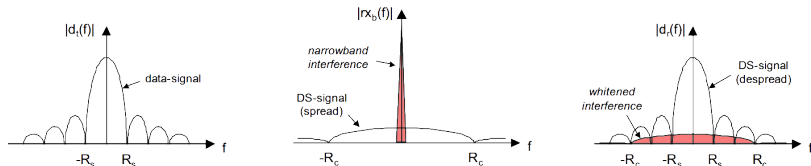
- Narrowband interference is spread in the despreading part
- Remember: spreading and despreading is the same operation
- Does not lower the SNR too much



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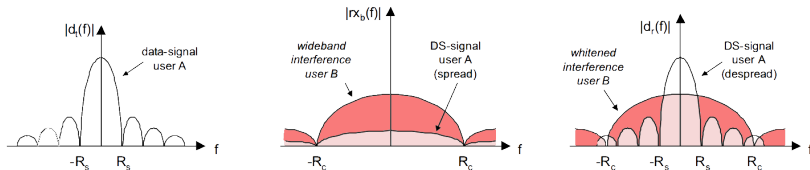
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Broad-band Interference

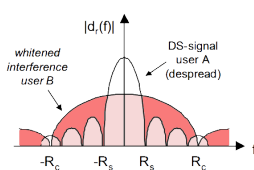
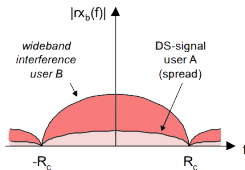
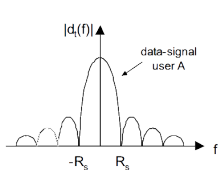
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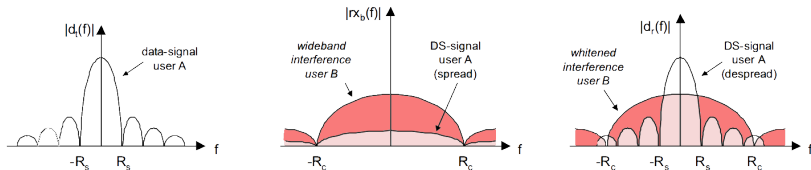
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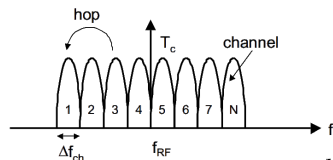
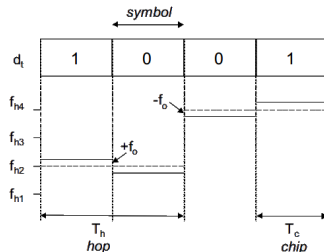
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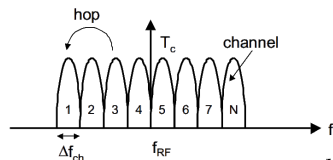
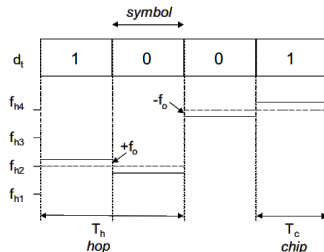
Frequency Hopping Spread Spectrum

- Divide frequency band into N sub-bands
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 $p_n \in [f_1, \dots, f_N]^n$. Let $p_n = [f_2, f_4, \dots]$
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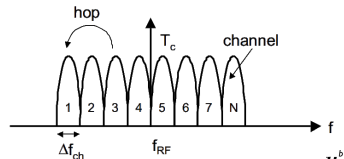
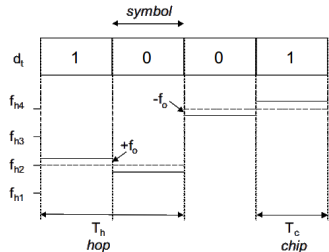
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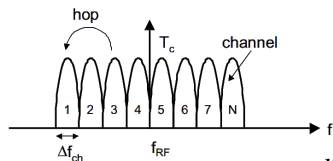
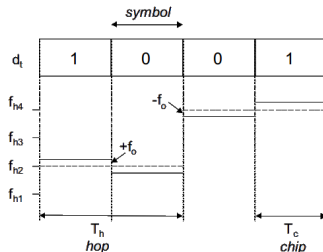
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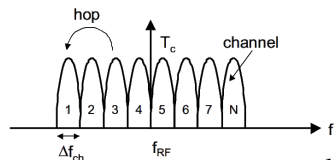
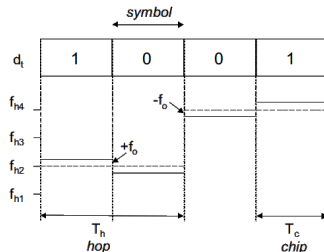
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FHSS

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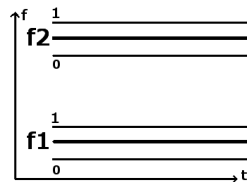
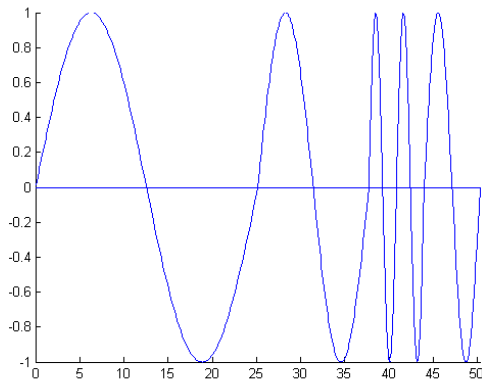
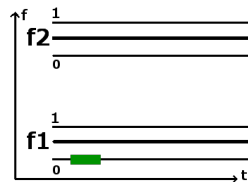
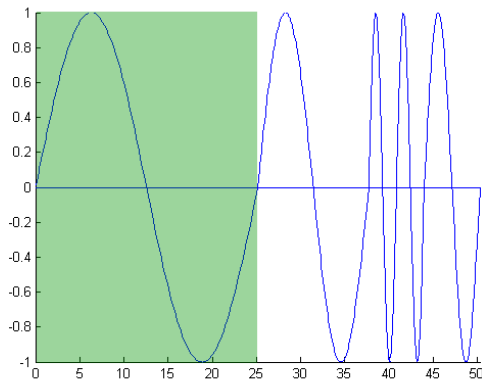


Figure: Frequency = , value =

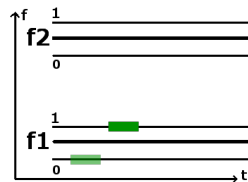
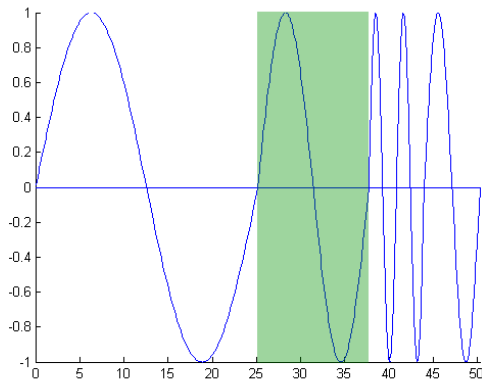
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Figure: Frequency = f_1 , value = 0

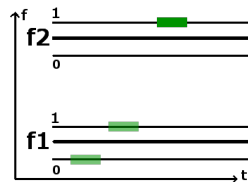
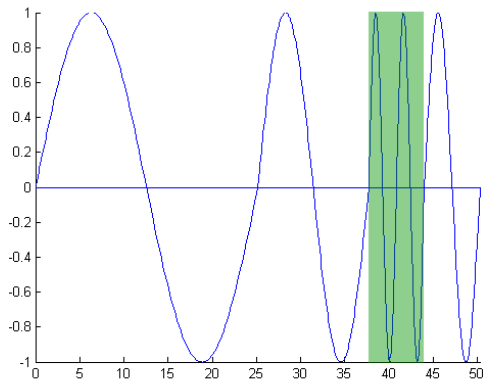
FHSS

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Figure: Frequency = f_1 , value = 1

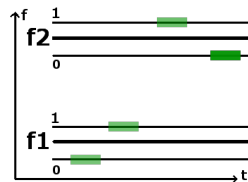
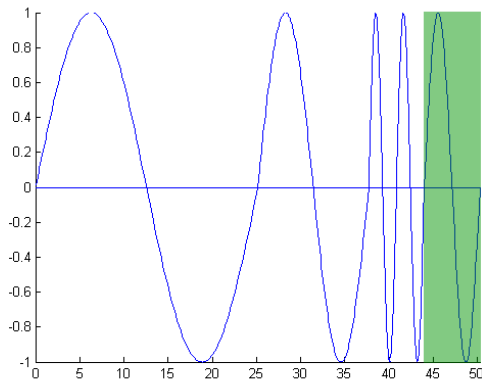
FHSS

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Figure: Frequency = f_2 , value = 1

FHSS

Example

Figure: Frequency = f_2 , value = 0

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- Robust with *narrow-band* interference, since transmission remains only for a few symbols on a frequency
- Problems with *broad-band* interference remain
- Other users will be perceived as narrow-band interference

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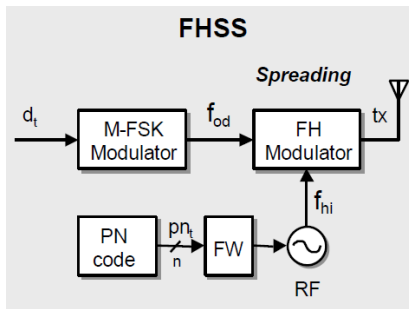
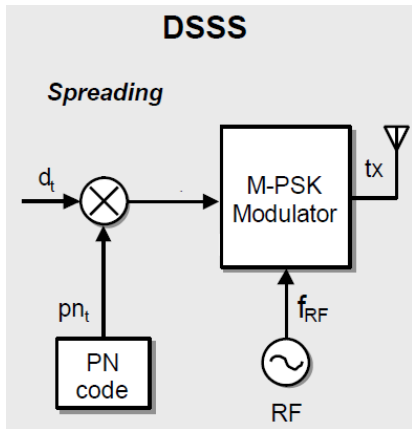
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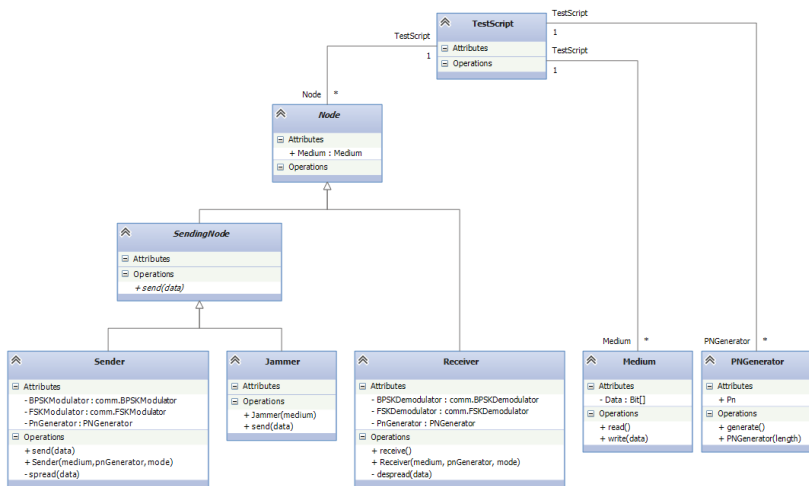
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Architecture

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- Modulation using Communications System Toolbox



UML



Simulation

- DSSS:
 - Phase modulation - BPSK modulation scheme
- FHSS:
 - Frequency modulation - FSK modulation scheme
- Add interferences and noise on the medium
 - Gaussian noise
 - Broadband noise
 - Narrow band noise
- Different chip rates in FHSS - Fast & slow hopping
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- Bit-error rate
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Optional goals

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- Multiple sender/receiver
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- Next steps:
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 - Add noise and interferences
 - Collect & analyze results

GitHub:

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