재밍 환경에서의
FHSS 위성 통신 링크의 성능 분석

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2003. 10. 10

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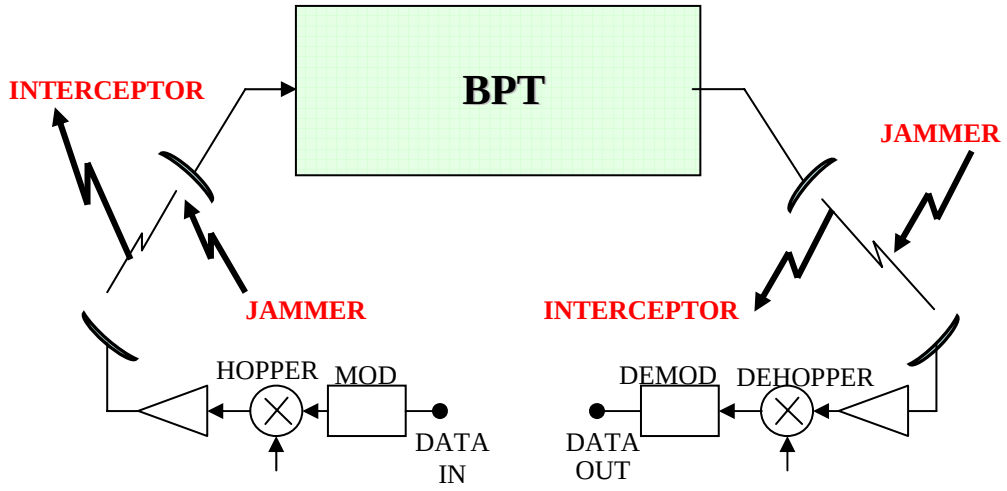
Introduction

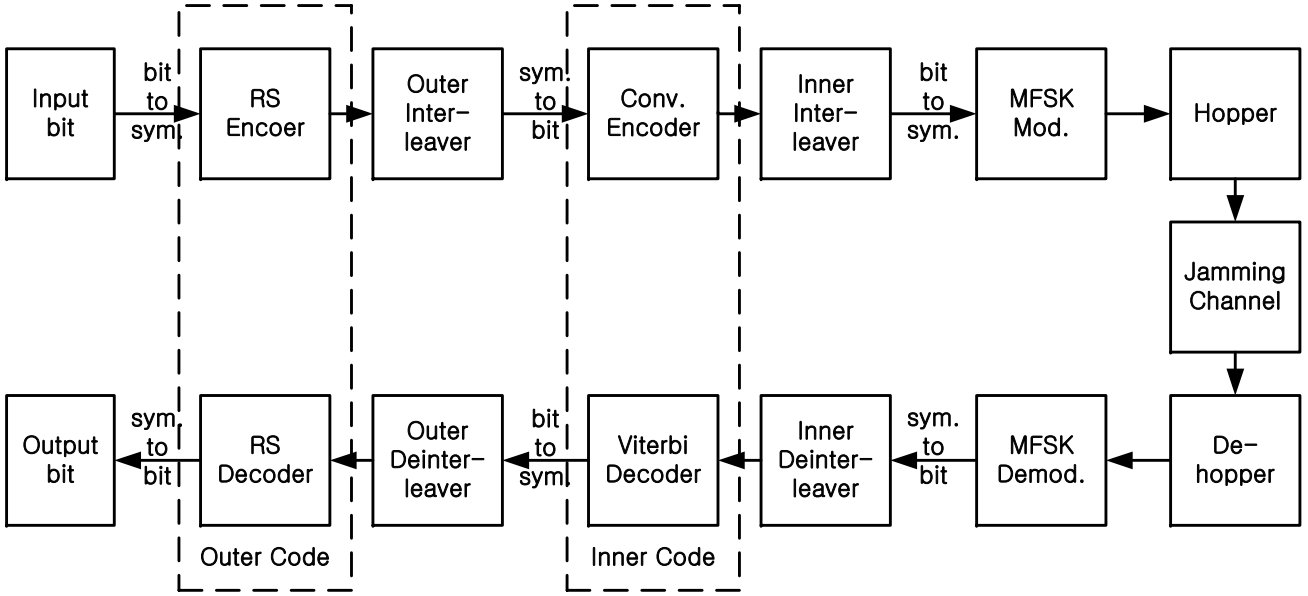
- Satellite Link



- Simple Bent-Pipe Transponder (BPT)
- Intentional Jamming and interceptor
- FFSS communication system

Introduction

- Sysmte Block Diagram



- Consideration
  - The performance improvement according to inner and outer interleaver
  - Soft and Hard Viterbi decoding in jamming environment

Channel Coding

- RS Code
  - Non-binary BCH Code with q(2^m)-ary alphabet
  - (n_r, k_r, d_r) code
    - n_r : the length of code word
    - k_r : the length of information symbol word
    - d_r : the minimum distance
  - Code Rate $R_{out} = k_r/n_r$
- Convolutional Code
  - Constraint length (K)
  - (n_c, k_c) code
    - n_c : output coded bits in shift register
    - k_c : input information bits in shift register
  - Code Rate $R_{in} = k_c / n_c$

Channel Coding

- Serial Concatenated Code
  - If Viterbi decoder is incorrectly decoded, a burst error would be occurred.
  - A burst of errors in the 8 bits results in inner code is only one q-ary symbol error in outer code (q=256)
- Inner Interleaver
  - Make Slow-FHSS system to FHSS system
  - Bit interleaving
  - Avoid burst of bit errors
  - Improve the performance of inner code
- Outer Interleaver
  - Symbol interleaving
  - Avoid bursts of q-ary symbol errors

System Modeling

- Channel Model
  - Full and Partial band jamming
  - Partial overlap of the jammer with the hop bandwidth is ignored
  - AWGN noise is ignored ($N_J >> N_o$)
- System Model
  - SFH/4FSK with non-coherent detection
  - Channel coding
    - Shortened RS code with Symbol q=256(2^8)
    - Binary Convolutional Code with constraint length K=9
    - Soft / Hard decision Viterbi decoder
    - Interleaver

System Modeling

- System parameter
  - Code parameter

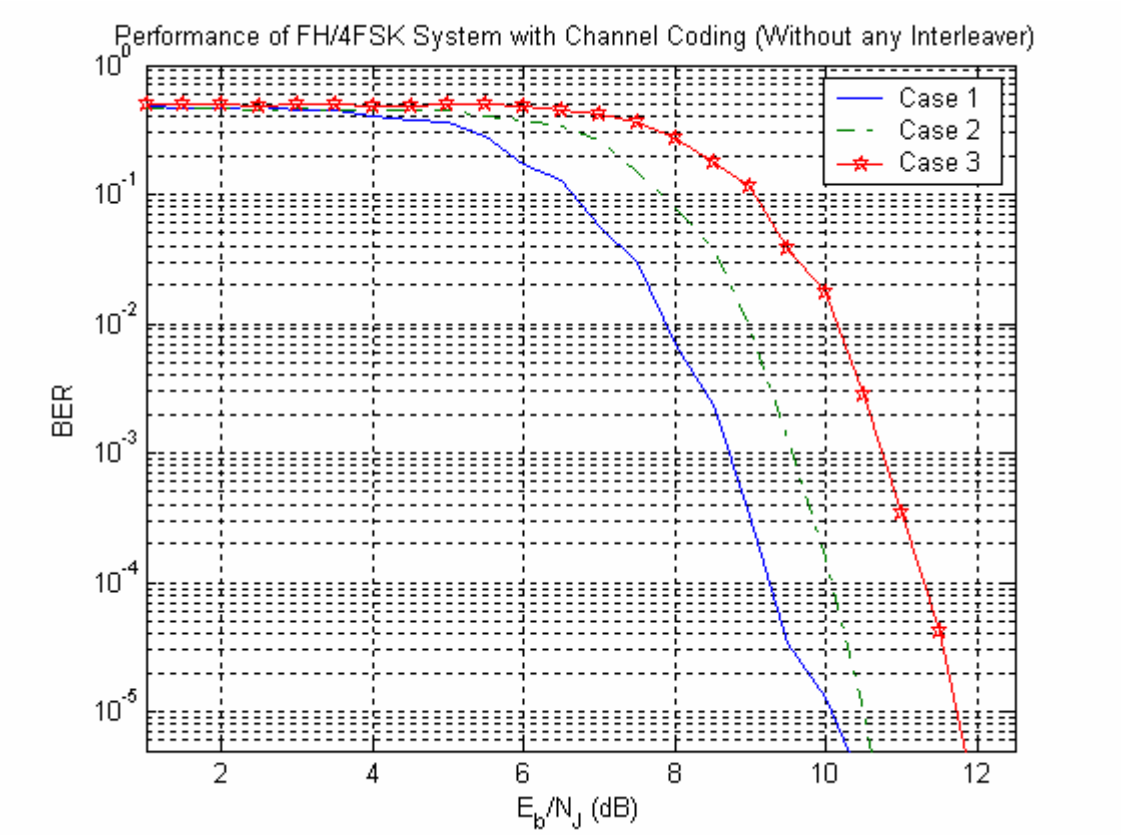
	RS code	Conv. Code	Code Rate
Case 1	(29,25)	1/2	25/58(1/2.3)
Case 2	(19,13)	1/3	13/57(1/4.4)
Case 3	(14,8)	1/4	1/7

  - Interleaver size

	Outer Inter. (Symbol)	Inner Inter. (Bit)
Case 1	28 x 8	480 x 8
Case 2	19 x 8	480 x 8
Case 3	14 x 8	480 x 8

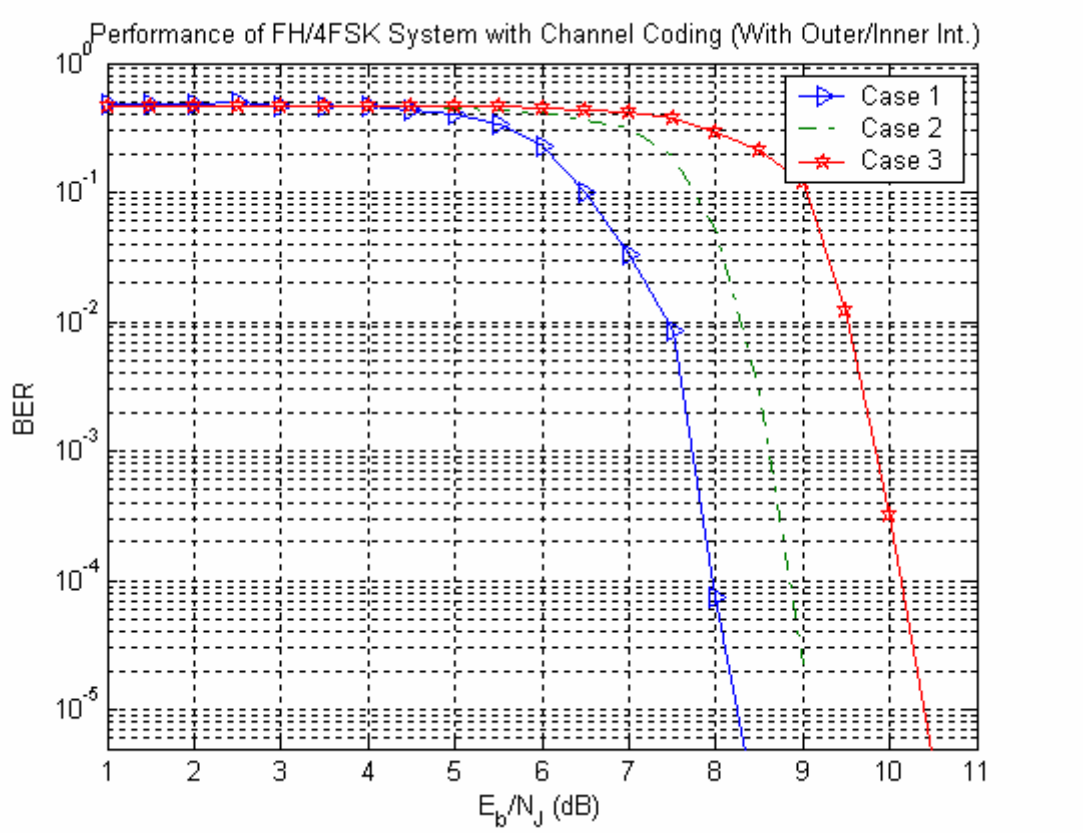
Simulation Result 1

- Full band jamming without any Interleaver



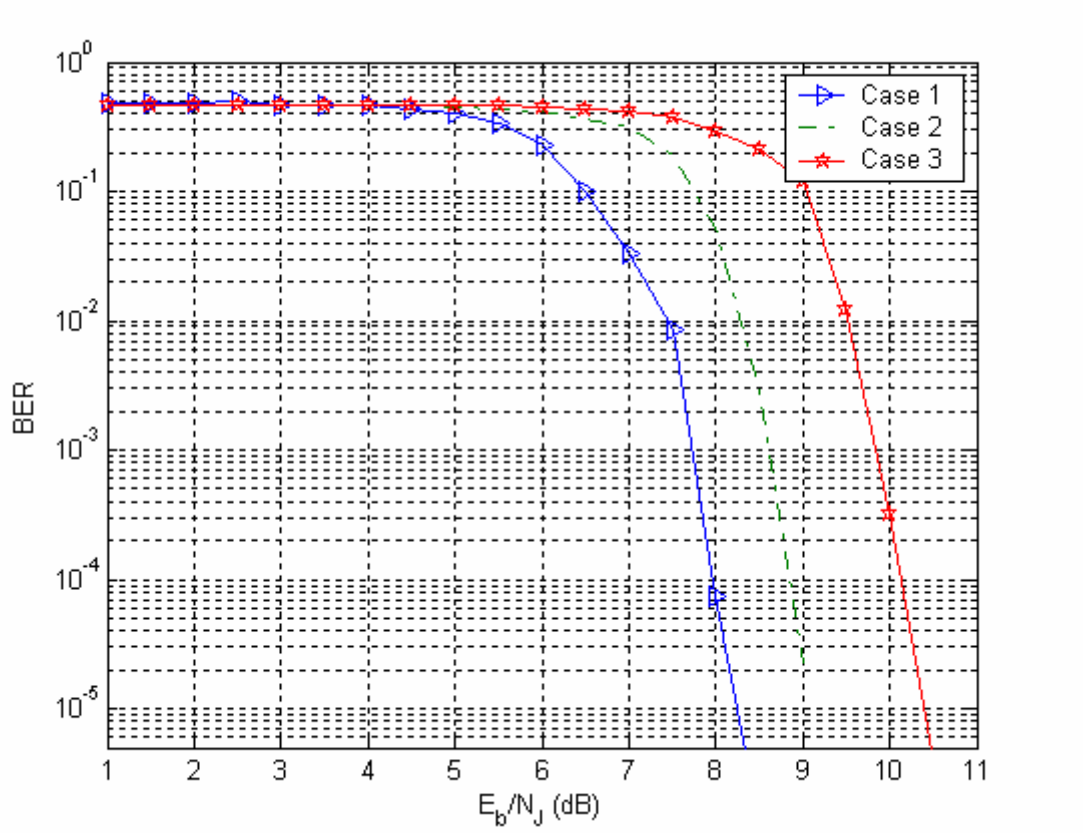
Simulation Result 1

- Full band jamming with only inner interleaver



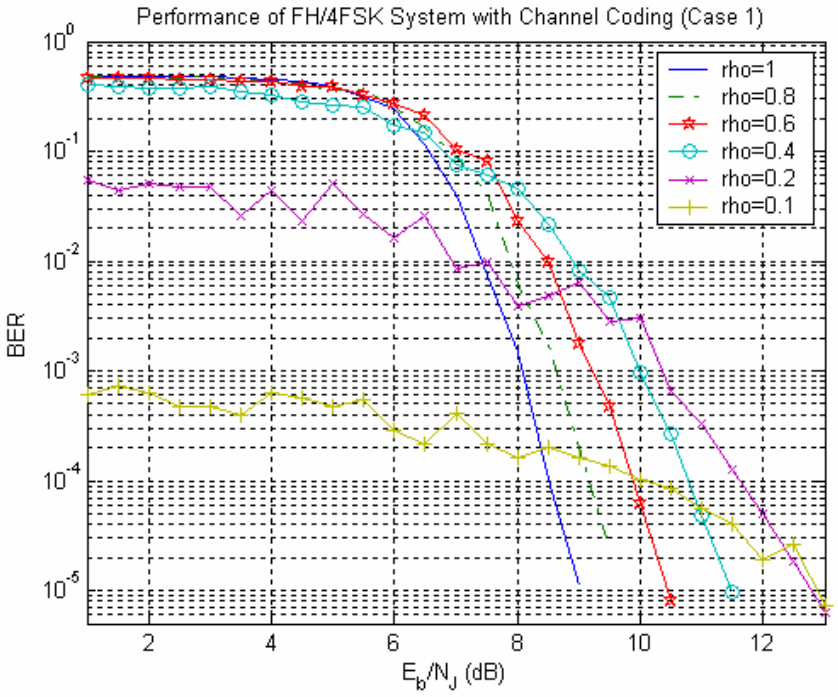
Simulation Result 1

- Full band jamming with both interleavers

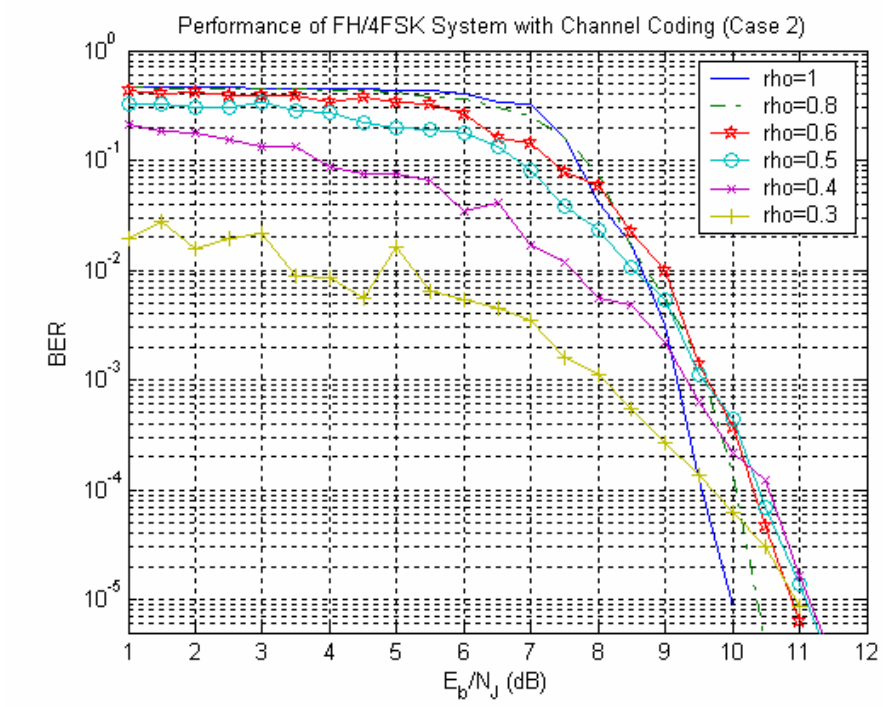


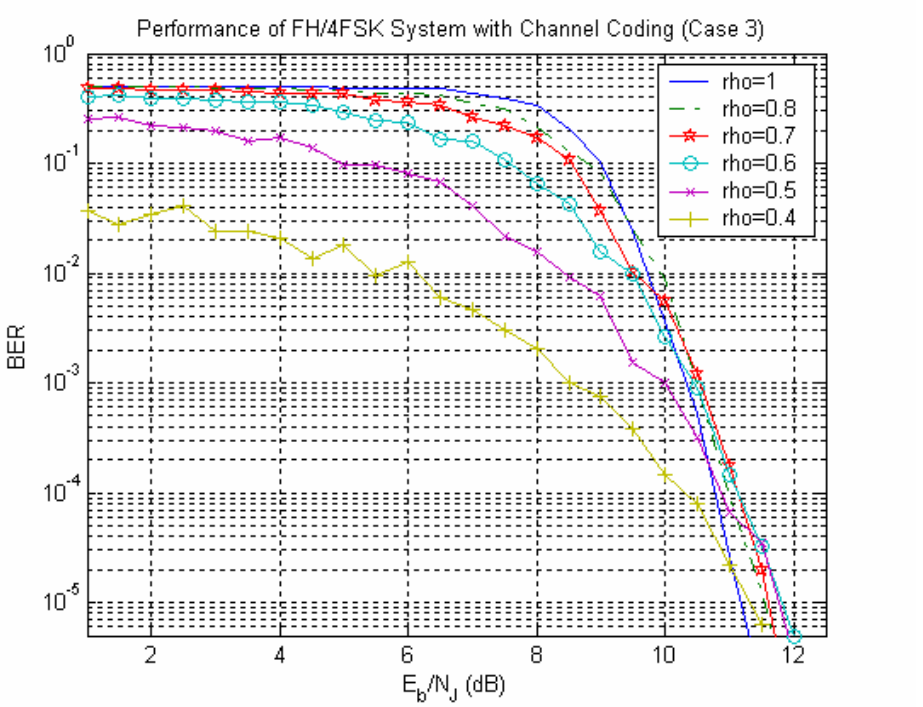
Simulation Result 2

- Partial band jamming
- With inner interleaver
- Without outer interleaver
- Hard decision Viterbi decoding



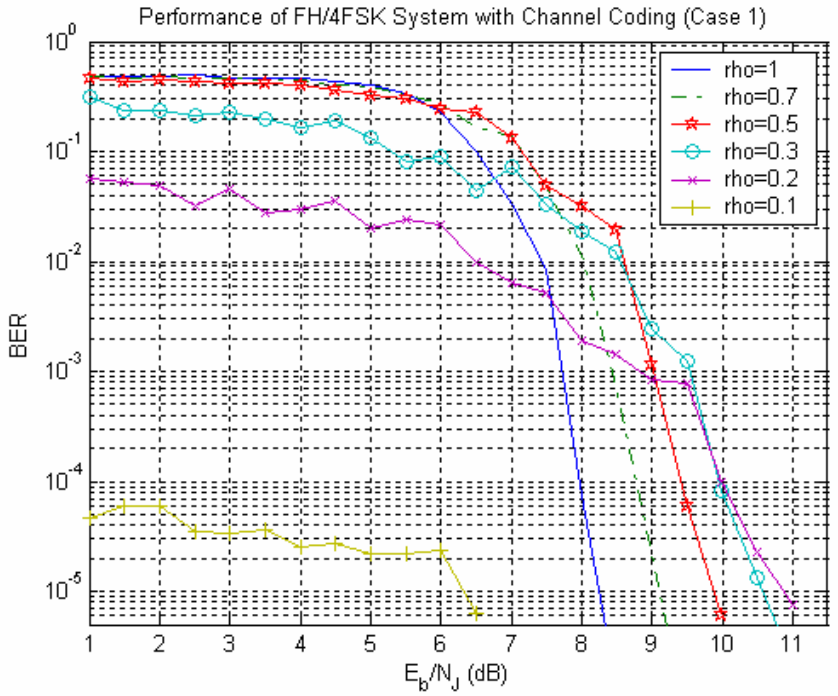
Simulation Result 2



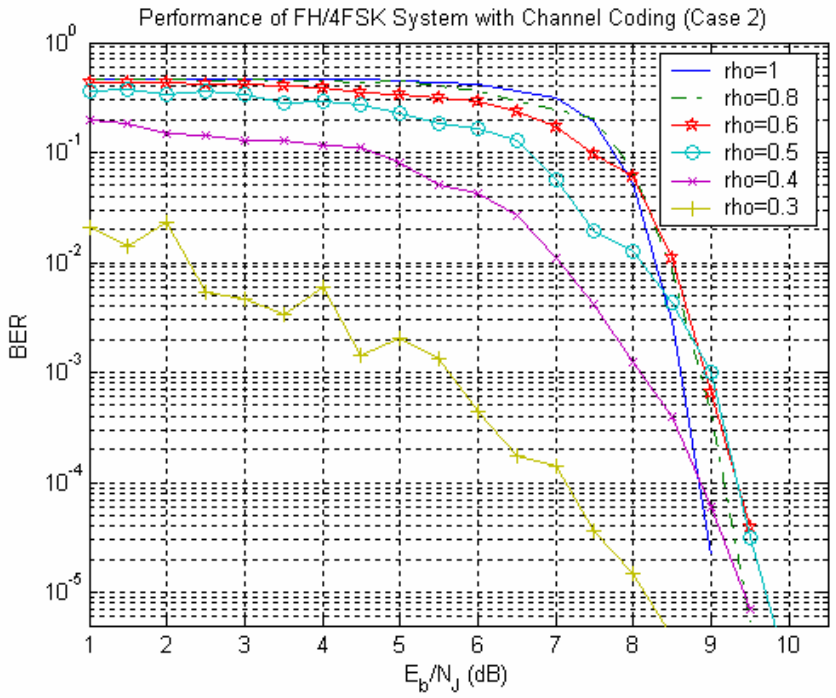


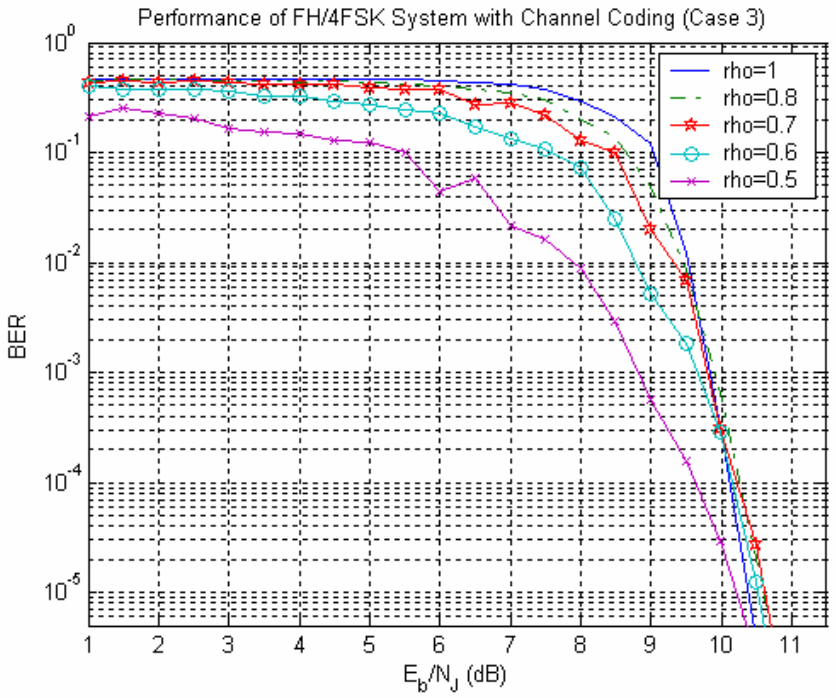
Simulation Result 3

- Partial band jamming
- With inner interleaver
- With outer interleaver
- Hard decision Viterbi decoding



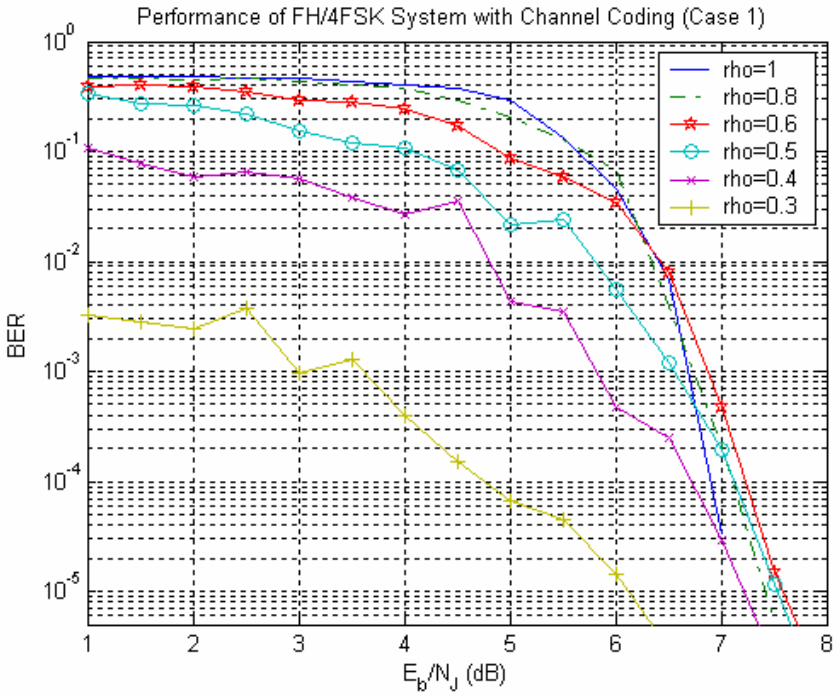
Simulation Result 3



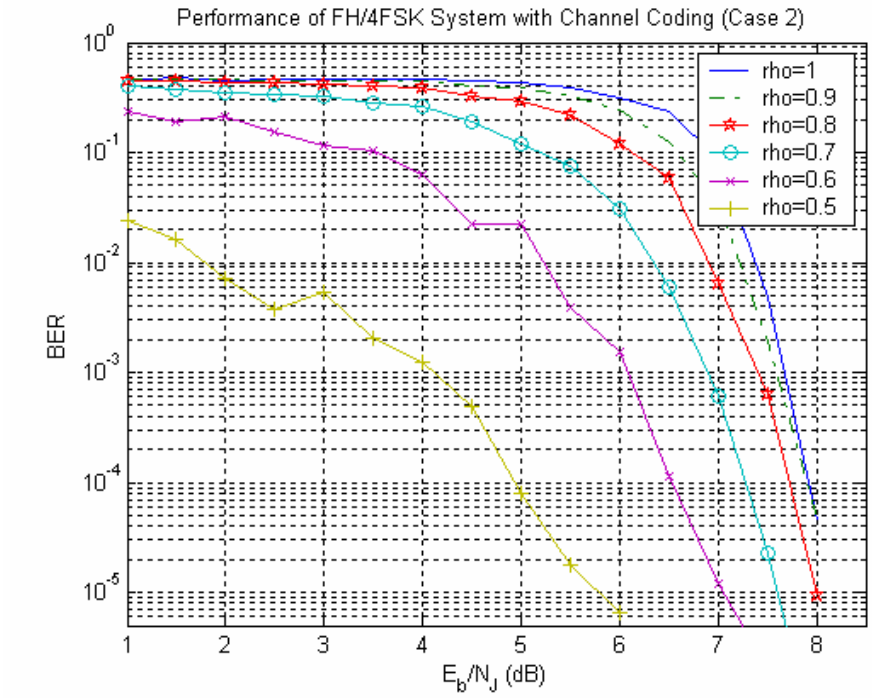


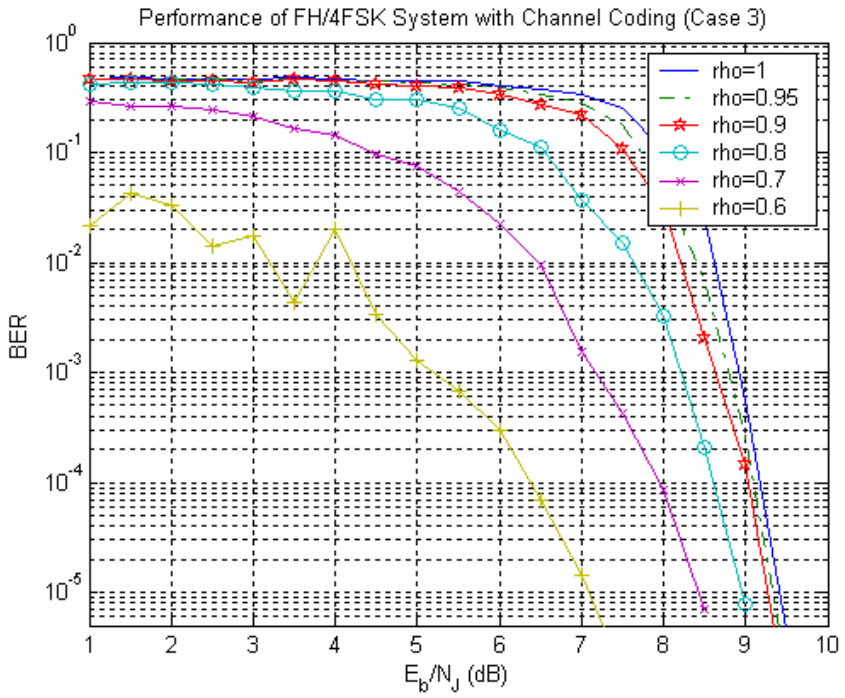
Simulation Result 4

- Partial band jamming
- With inner interleaver
- With outer interleaver
- Soft decision Viterbi decoding



Simulation Result 4





Conclusion

- The performance of satellite communication system is improved by using inner and outer interleavers

- The performance of channel coding (BER=10^{-5})

	Result 1	Result 2	Result 3	Result 4
Best	Case 1	Case 2	Case 2	Case 1
Worst	Case 3	Case 1	Case 1	Case 3