다양한 부호율로 펑처링된 터보 부호의 성능 비교

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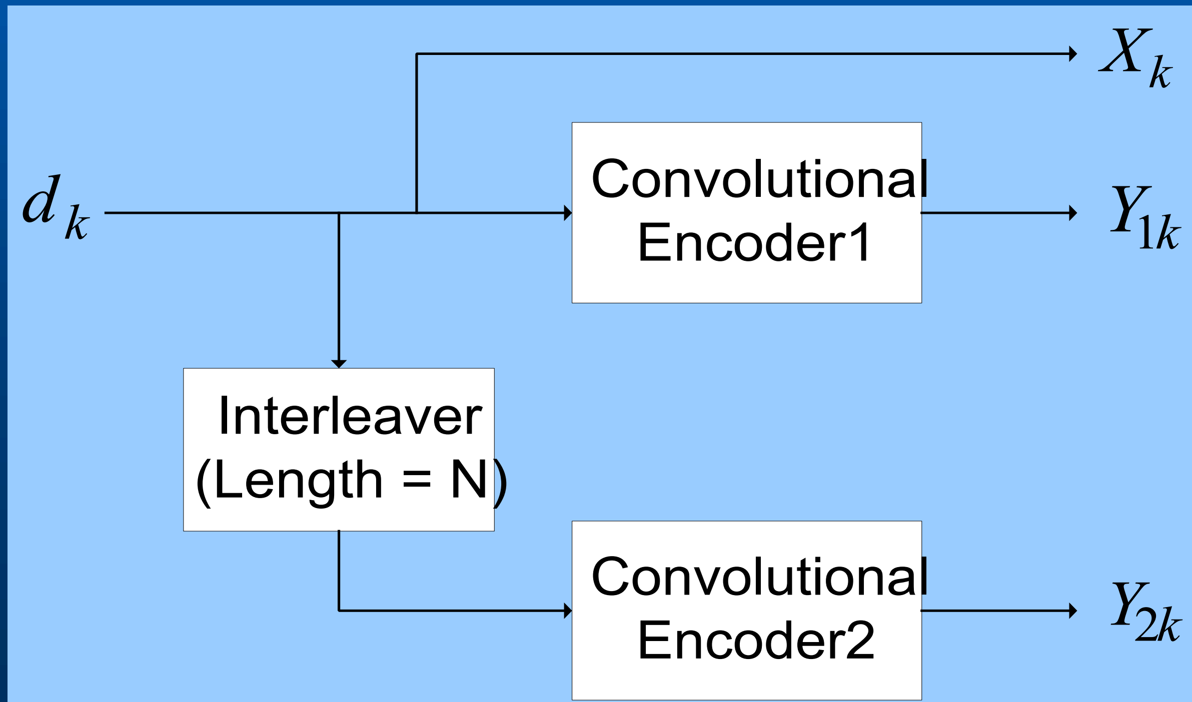
Motivation

- Data communication system provide the ability of changing code rates with communication environment
  - → Various rate codes are needed
  - → Only rate 1/n turbo codes are known
  - → Make turbo codes of various rates to provide general trend of performance

Turbo Code Structure

- Characteristic
  - Encoder : Parallel Concatenation Scheme
  - Decoder : Soft Output decoding + Iterative decoding
- Encoder
  - Rate 1/3 encoder
  - Two component encoder
  - One Interleaver



Decoder

- Viterbi Algorithm
  - Optimal decoding method to minimize sequence error
  - But cannot produce information about each bit

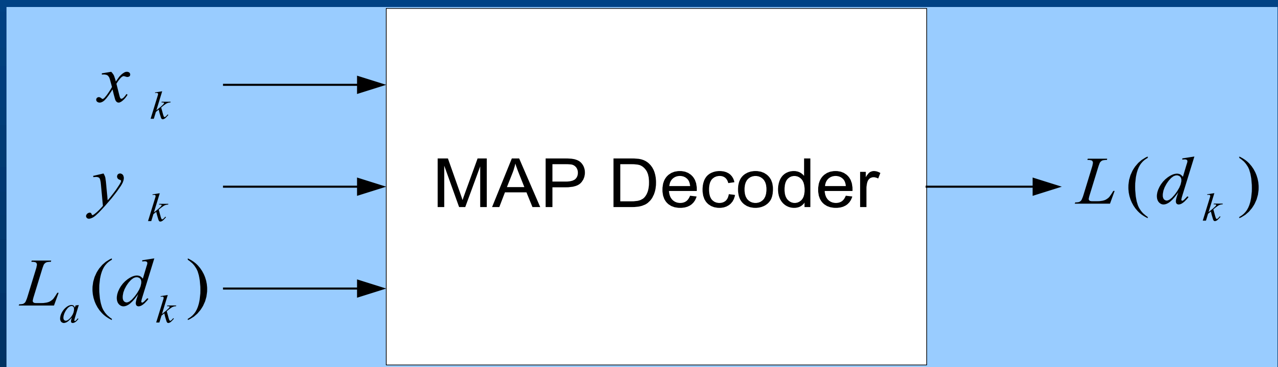
→ MAP(Maximum A Posteriori) Algorithm

- Produce soft information about each bits

Soft Input and Output Decoding

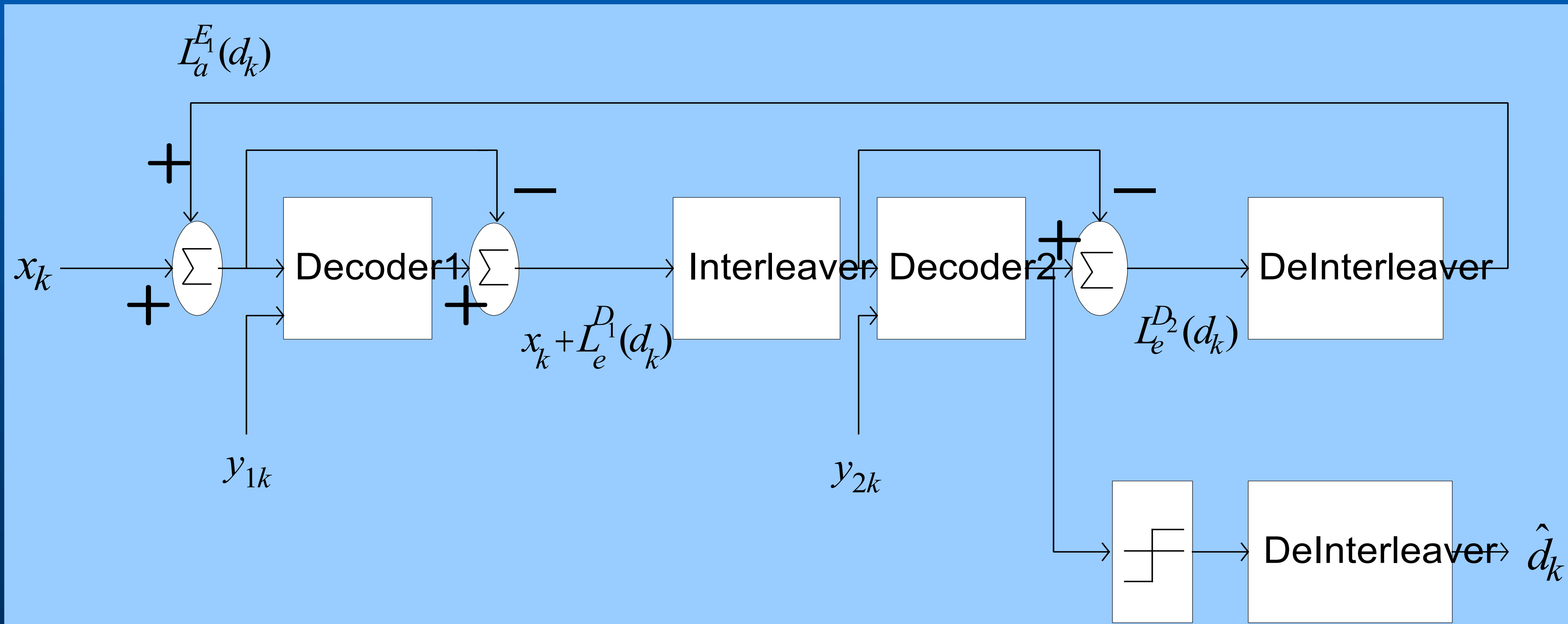
- x_k : systematic information added by noise
- y_k : parity information added by noise
- $L_a(d_k)$: a priori information of d_k
- $L_e(d_k)$: extrinsic information produced by decoder

$$L(d_k) = L_c x_k + L_a(d_k) + L_e(d_k)$$



◆ Iterative Decoding

→ Use extrinsic information $L_e(d_k)$ of previous decoder as an priori information of next decoder



Concept of Puncturing

- Definition

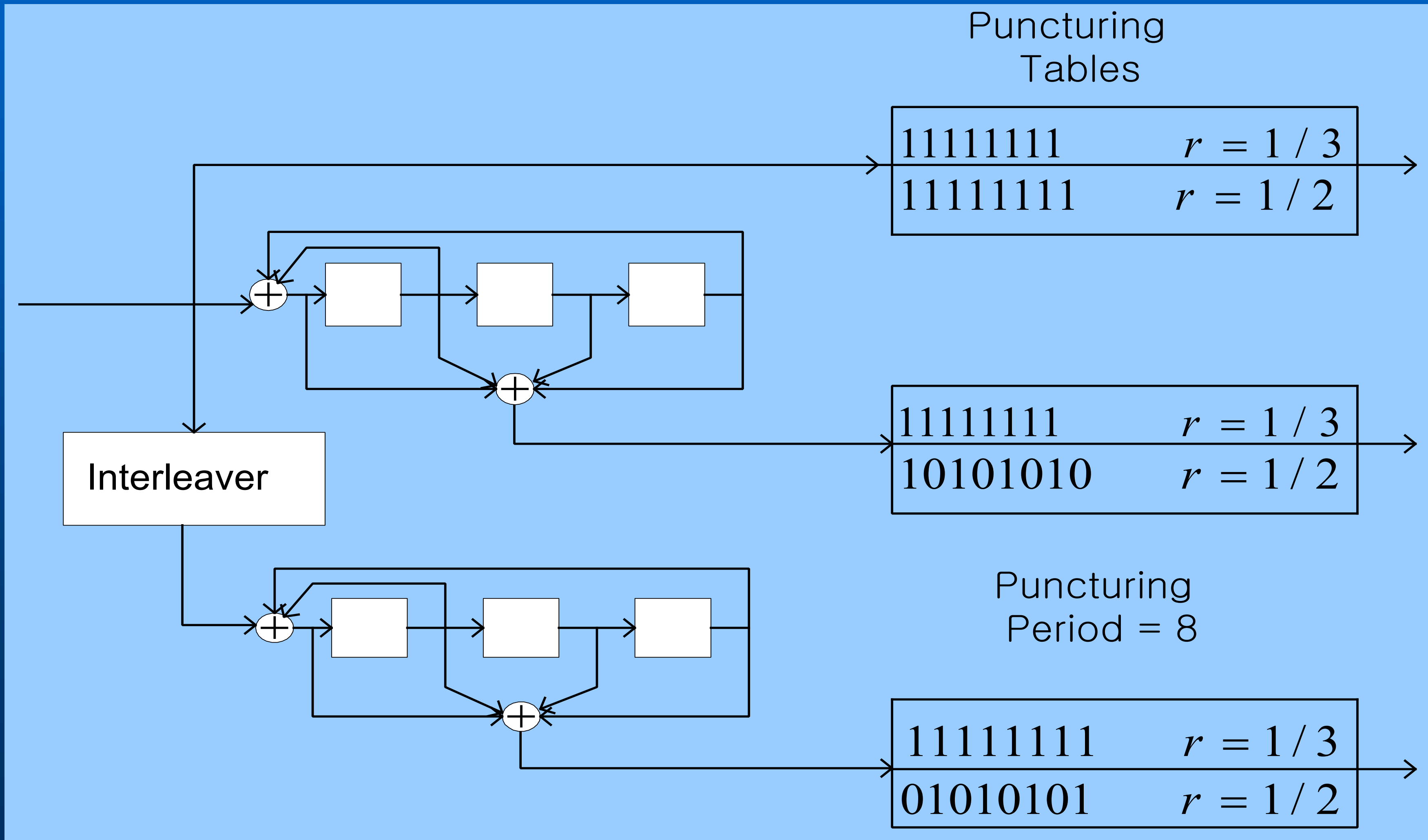
  Systematic deleting of encoded bits using specific rules

  → Higher/change the code rate

- Advantage

  One encoder/decoder pair can produce code of various rates

Turbo Encoder using Puncturing



Application of Puncturing to Turbo Code

- The effect of Puncturing Pattern on punctured turbo code performance
- Various rate turbo code generation using puncturing method

Puncturing Pattern

- The performance of Punctured turbo code vary with puncturing patterns
  - → Provide general rule to choose good puncturing pattern
- Puncturing Pattern of Turbo Code
  - Number of Puncturing bits from each encoder output
  - Distance of puncturing bit
  - Puncturing systematic bit or not

Various Rates Turbo Codes

- Generate puncturing pattern by proposed rule
  → Make the generated code by this puncturing pattern have the best performance in that code rate

- Suggest the performance of codes from rate 1/3 to rate 2/3 with best puncturing pattern
  → Predict the trend of performance variation with code rates

Experimental Results

- System description

Constraint Length (K)	4
Interleaver Type	Random Interleaver
Interleaver Length (N)	1024
Decoder Iteration Number	3 번
Modulation	BPSK, Baseband
Channel	AWGN

  - Programmed by C
  - Simulated in Linux Environment

Punctur P4

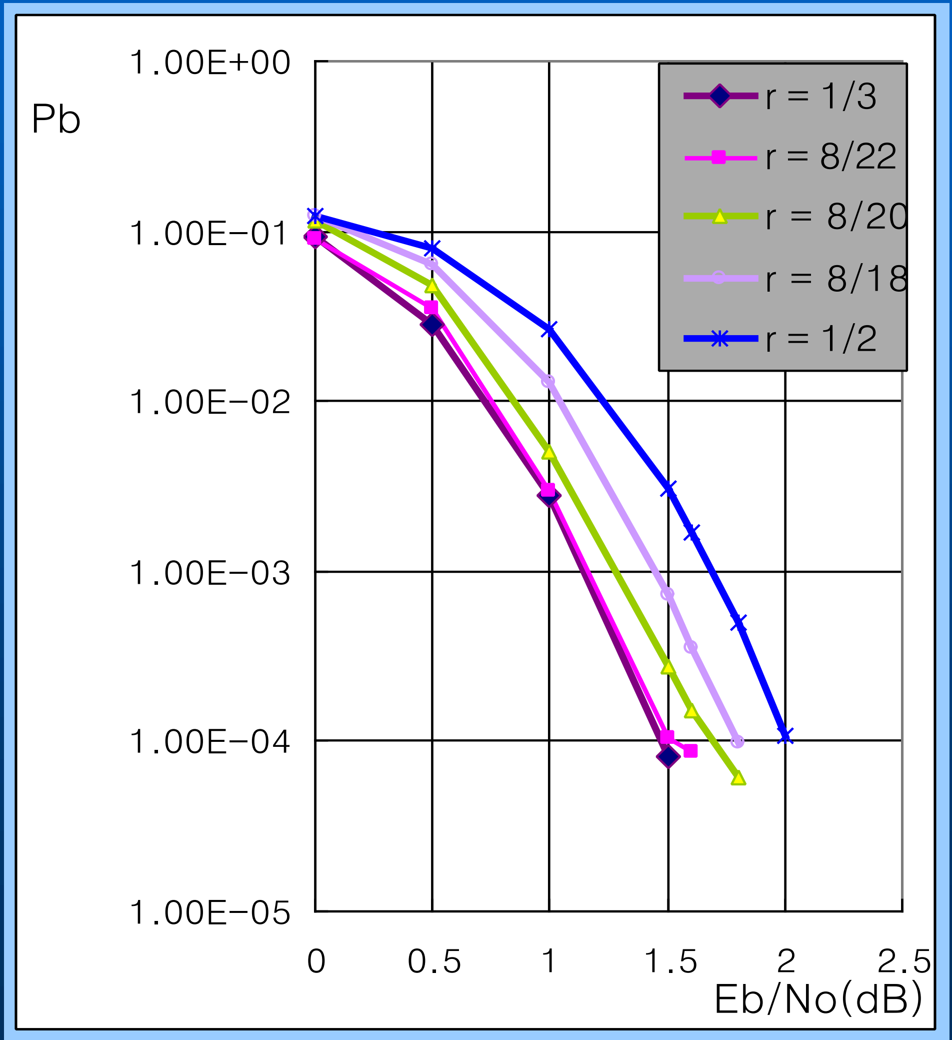
- Rate 1/2 Turbo Codes with Different Puncturing Pattern

Puncturing Matrix

P3

1.
P5 1.
P7 1.

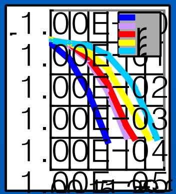
From Rate 1/3 To Rate 1/2 Turbo Codes



부호율 펑처링 행렬

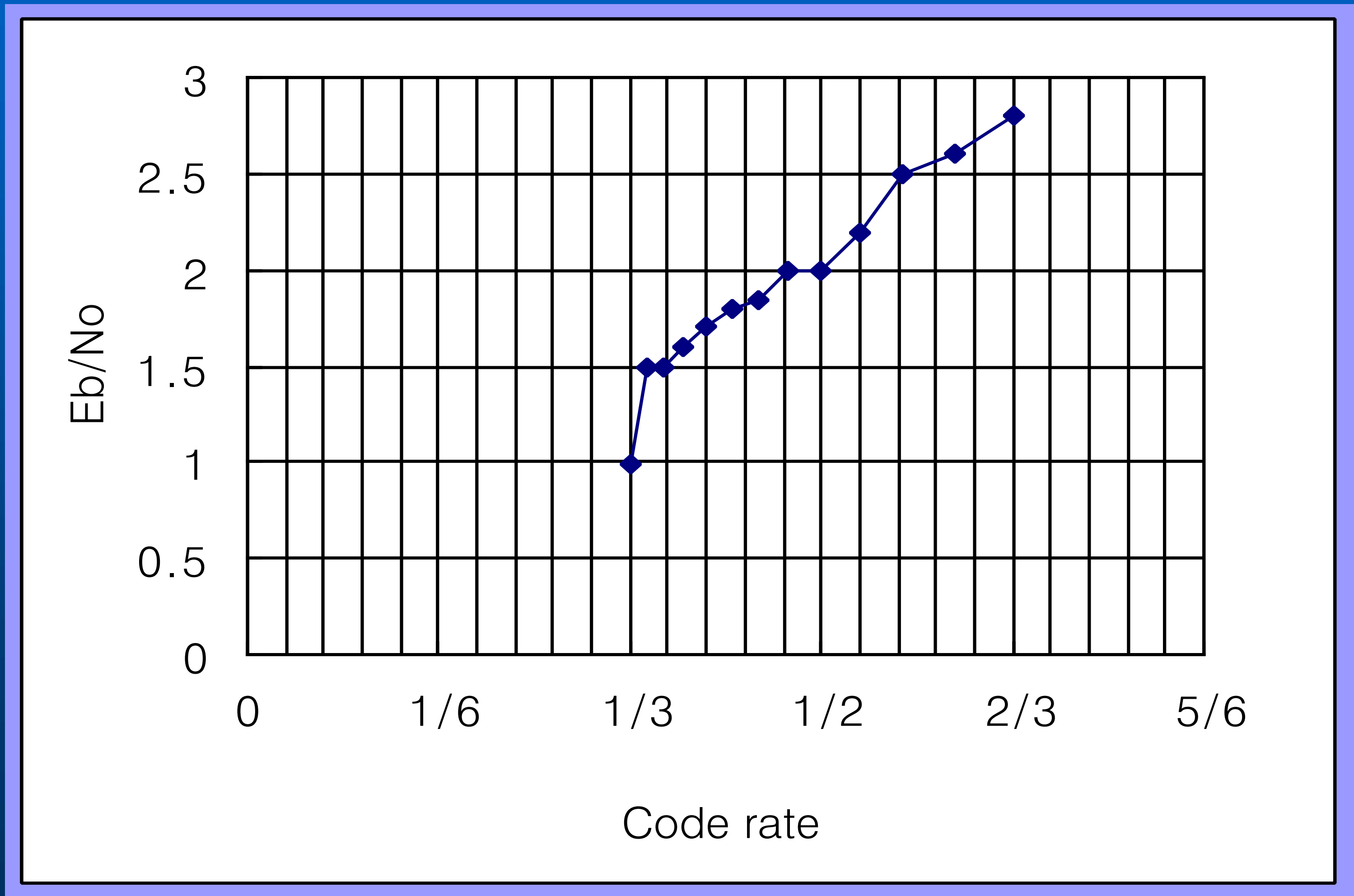
From Rate 1/2 To Rate 2/3 Turbo Codes

		2.2
	P11	2.5
R = 8/13		2.6
	P12	2.8



부호율 펑처링 행렬

- At $P_b = 10^{-4}$, the required Eb/No increase almost linearly with code rate



Conclusion

- Results
  - Suggest puncturing pattern choice guide by experiment
  - Provide the performance of various rate turbo codes

- Future Research
  - Suggested as a channel code in IMT-2000
    - → Fading channel performance research
    - → Performance bound prediction by theoretically
    - → Hardware Implementation