

## Rate-Compatibility and Incremental Redundancy HARQ for 802.16j LDPC codes

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None

Purpose:

Propose a Rate-Compatible and IR HARQ for 802.16j to improve reliability, throughput performance and lower cost for relay links.

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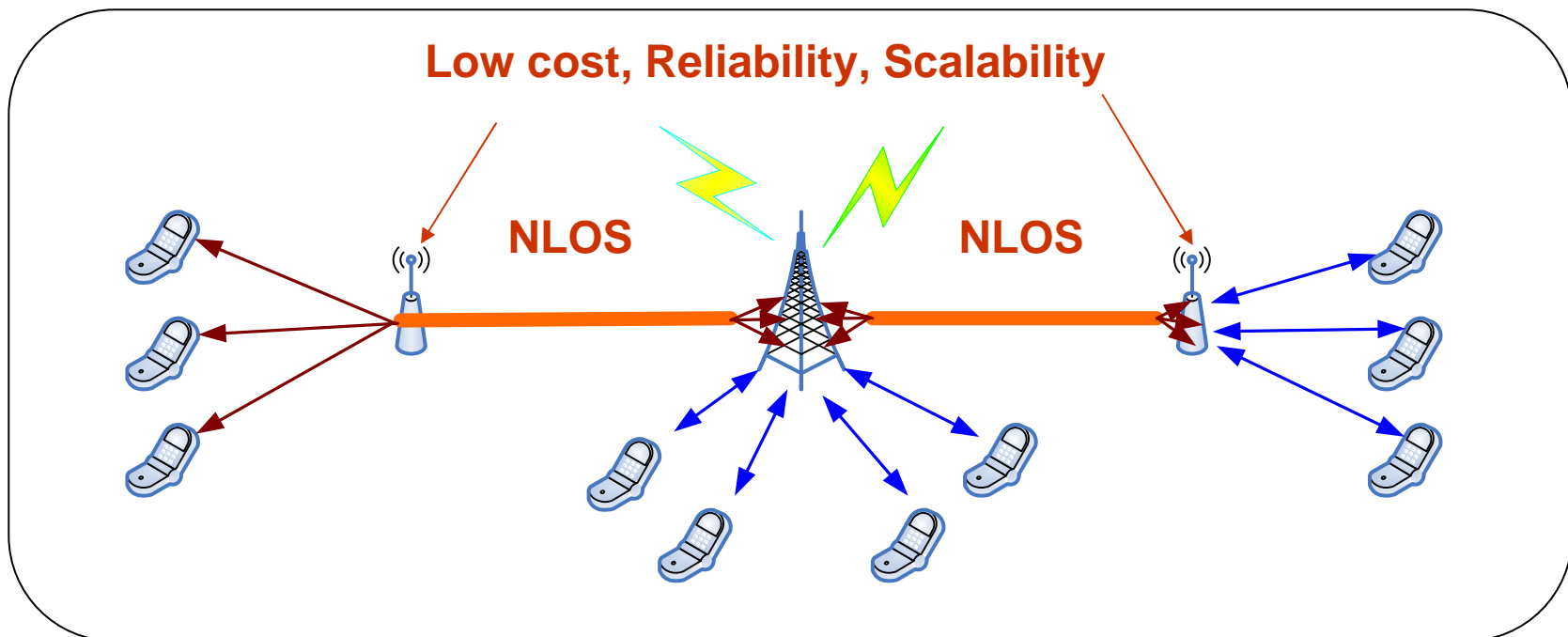
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2006/11/16

# Concept of Enhanced Hybrid ARQ (Rate Compatible LDPC)

- Propose a LDPC scheme which provides the hooks to enhance the current Hybrid ARQ
  - Low cost
  - Reliability
  - Scalability



# Key Features of RC-LDPC

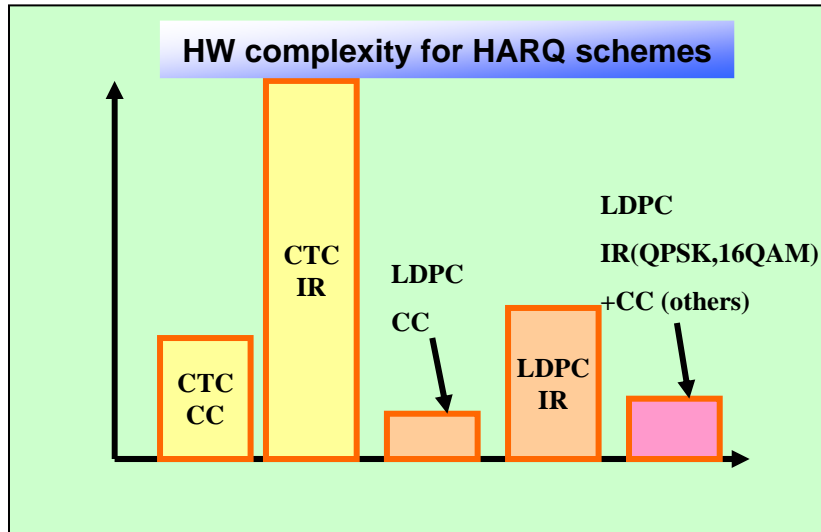


Fig1. Low Cost

- 802.16e LDPC does not support HARQ IR
- IR performs better than Chase Combining
- RC-LDPC supports HARQ IR

- LDPC codes can provide lower cost hardware than CTC.
- High reliability for low to mid data-rate region. → Expansion of coverage area
- RC-LDPC coexists with the 802.16e LDPC → Minimum additional circuits for RC-LDPC codes

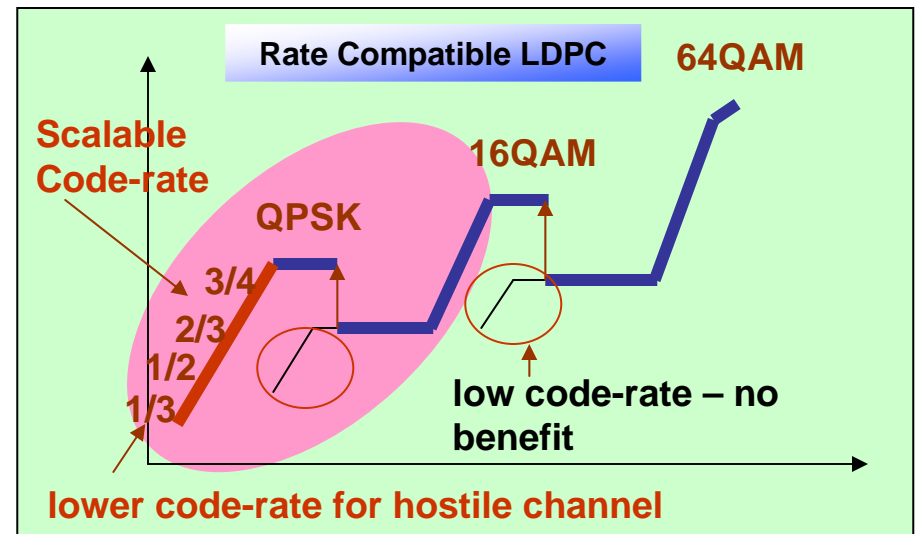


Fig2. Reliability and Scalability



# Conclusions

- LDPC support high throughput with less hardware complexity and lower cost compared to Turbo codes
- RC-LDPC IR HARQ provide improved robustness for channel in hostile conditions for low to mid data rate
- RC-LDPC coexists and is an enhanced version of the 802.16e LDPC

# Rate-Compatible LDPC codes

IR with Mother Rate=1/3 parity check matrix

Rate>1/2

Information bits	Puncturing
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Rate=1/2

Information bits	Parity bits
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Rate<1/2

Information bits	Parity bits	Parity bits	
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- In addition to puncturing, extended parity matrixes are used to achieve flexible coding rate and rate compatibility

- 802.16e LDPC will be used as the baseline for enhancement of the RC-LDPC

-1 94 73 -1 -1 -1 -1 -1 55 83 -1 -1	7 0 -1 -1 -1 -1 -1 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 27 -1 -1 -1 22 79 9 -1 -1 -1 12	-1 0 0 -1 -1 -1 -1 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -1 24 22 81 -1 33 -1 -1 -1 0	-1 -1 0 0 -1 -1 -1 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
61 -1 47 -1 -1 -1 -1 -1 65 25 -1 -1	-1 -1 -1 0 0 -1 -1 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 39 -1 -1 -1 84 -1 -1 41 72 -1	-1 -1 -1 -1 0 0 -1 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -1 -1 4 Z 0 -1 82 -1 -1 -1 79	0 -1 -1 -1 -1 D -1 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 0 -1 -1 -1 -1
-1 -1 95 53 -1 -1 -1 -1 -1 14 18 -1	-1 -1 -1 -1 -1 -1 0 0 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 11 73 -1 -1 -1 2 -1 -1 47 -1 -1	-1 -1 -1 -1 -1 -1 -1 0 0 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
12 -1 -1 -1 83 24 -1 43 -1 -1 -1 51	-1 -1 -1 -1 -1 -1 -1 0 0 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -1 -1 -1 94 -1 59 -1 -1 70 72	-1 -1 -1 -1 -1 -1 -1 -1 0 0 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 -1 7 65 -1 -1 -1 -1 39 49 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 0 0	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
43 -1 -1 -1 -1 66 -1 41 -1 -1 -1 26	7 -1 -1 -1 -1 -1 -1 -1 -1 -1 0	-1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
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-1 -1 36 -1 -1 -1 -1 -1 -1 7 -1 -1	-1 0 -1 -1 -1 -1 -1 -1 -1 -1 -1	-1 0 -1 -1 -1 -1 -1 -1 -1 -1 -1
-1 -1 5 -1 -1 -1 -1 -1 -1 5 -1 -1	-1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1	-1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1
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-1 -1 -1 -1 -1 A -1 23 -1 -1 -1 48	-1 -1 -1 -1 -1 -1 0 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 I -1 -1 -1 -1
-1 -1 -1 -1 -1 29 -1 37 -1 -1 -1 7	-1 -1 -1 -1 -1 -1 0 -1 -1 -1 -1	-1 -1 -1 -1 -1 -1 0 -1 -1 -1 -1
-1 -1 6 -1 -1 -1 -1 -1 -1 3 -1 -1	-1 -1 -1 -1 -1 -1 -1 0 -1 -1 -1	-1 -1 -1 -1 -1 -1 -1 0 -1 -1 -1
-1 -1 1 -1 -1 -1 -1 -1 -1 2 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 0 -1 -1
-1 -1 -1 -1 -1 37 -1 26 -1 -1 -1 8	-1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 0 -1
-1 -1 3 -1 -1 -1 -1 -1 -1 6 -1 -1	-1 -1 -1 -1 -1 -1 -1 -1 -1 0	-1 -1 -1 -1 -1 -1 -1 -1 -1 0

# Comparison with Turbo

**Table. Operations count comparison of sub-optimal decoders LDPC and TC decoders.**

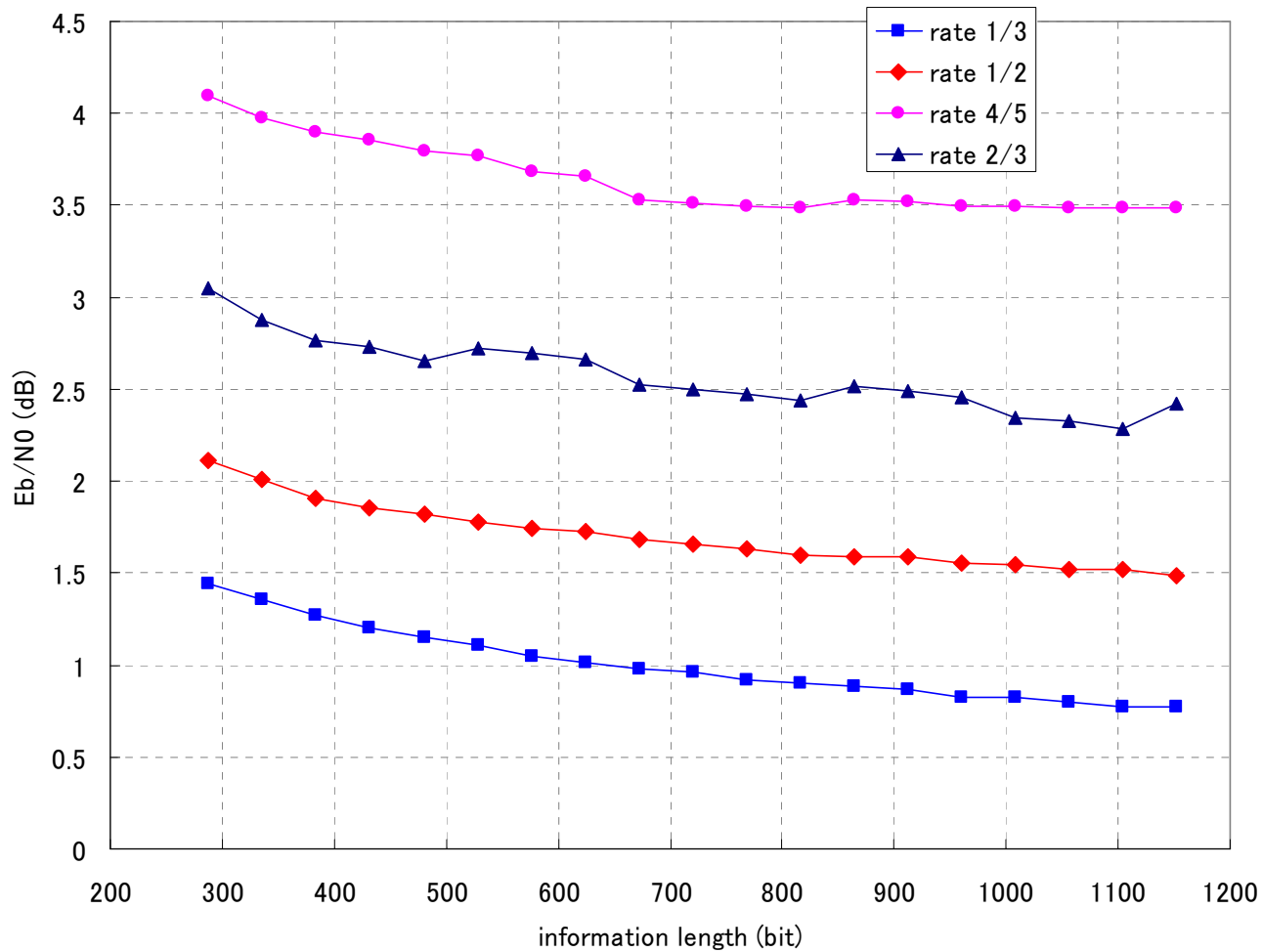
	LDPC	TC	Complexity of LDPC / Complexity of TC
Algorithm	LBP Min-Sum+Offset	Max Log Map +extrinsic scaling	
Number of Iterations	20	8	
Total cost (R=1/3)	38.5K x 20 = 770K	171K x 8 = 1368K	56%
Total cost (R=1/2)	28.8K x 20 = 576K	171K x 8 = 1368K	42%
Total cost (R=3/4)	20.6K x 20 = 412K	171K x 8 = 1368K	30%

Reference: R1-060874, " **Complexity Comparison of LDPC Codes and Turbo Codes** "

3GPP TSG RAN WG1#44bis, Athens, Greece 27-31 Mar. 2006.

# Performance of RC LDPC

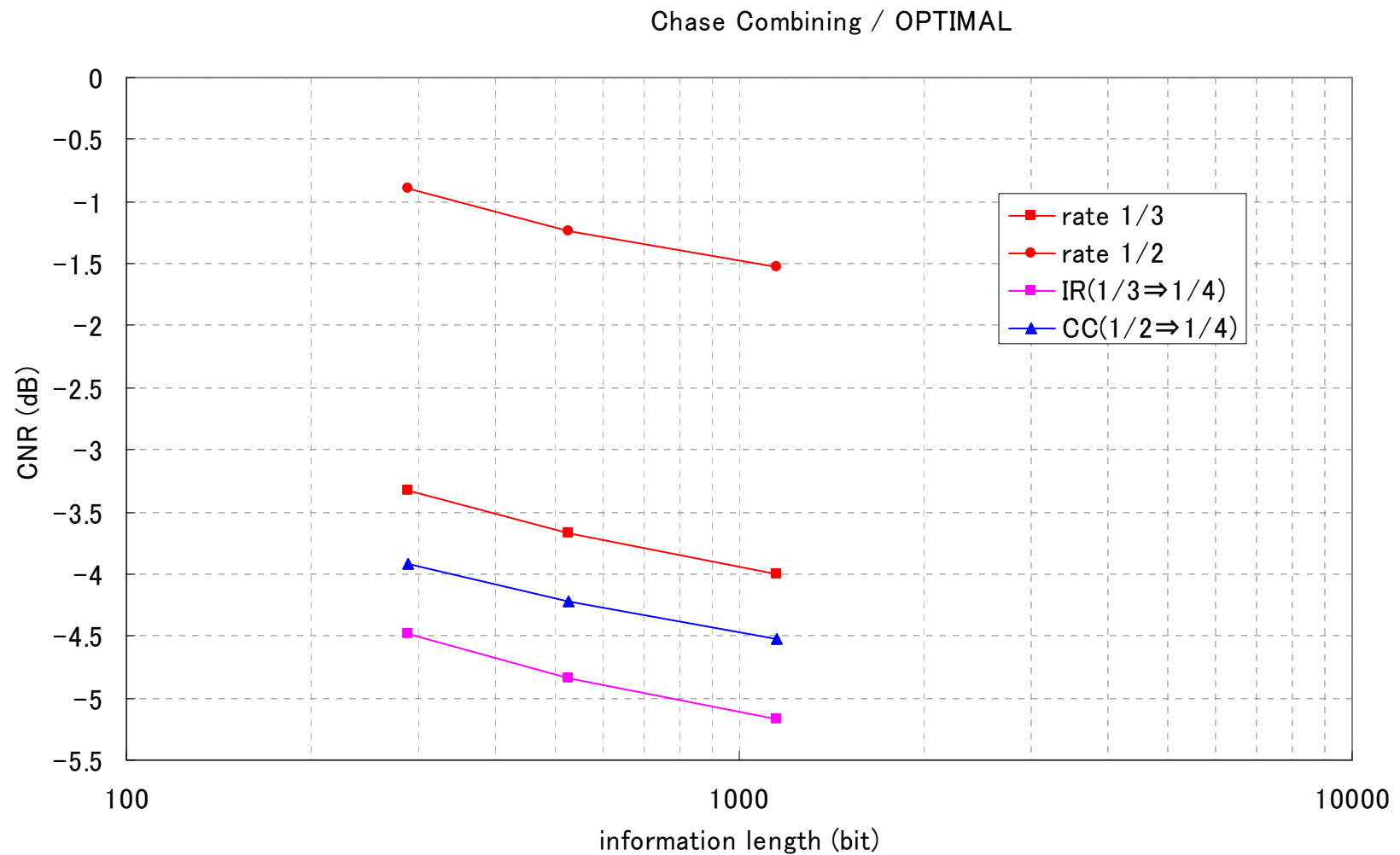
Performance for RC LDPC codes based on the 16e LDPC codes



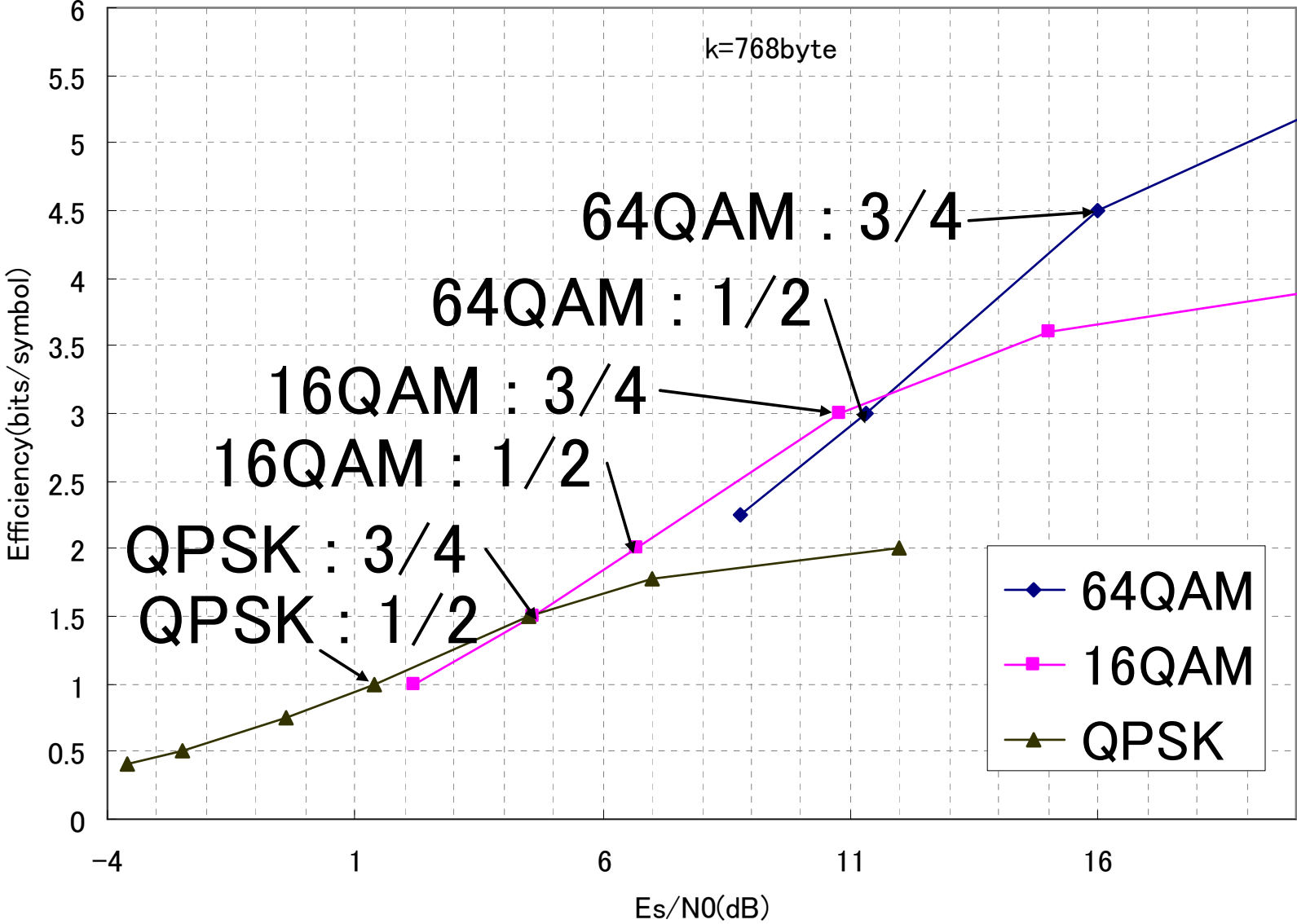


# Performance of RC LDPC

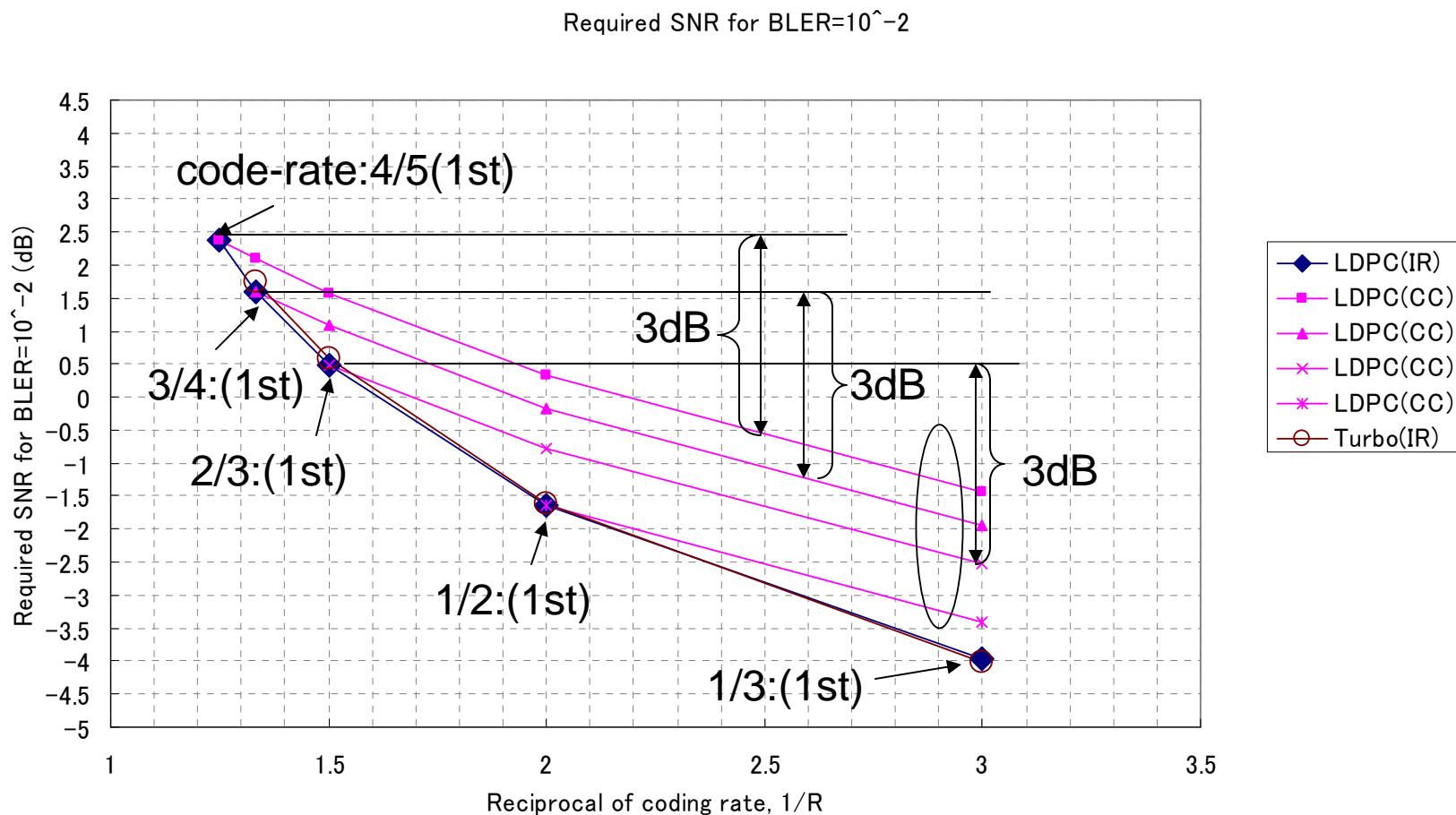
Performance for RC LDPC codes based on the 16e LDPC codes



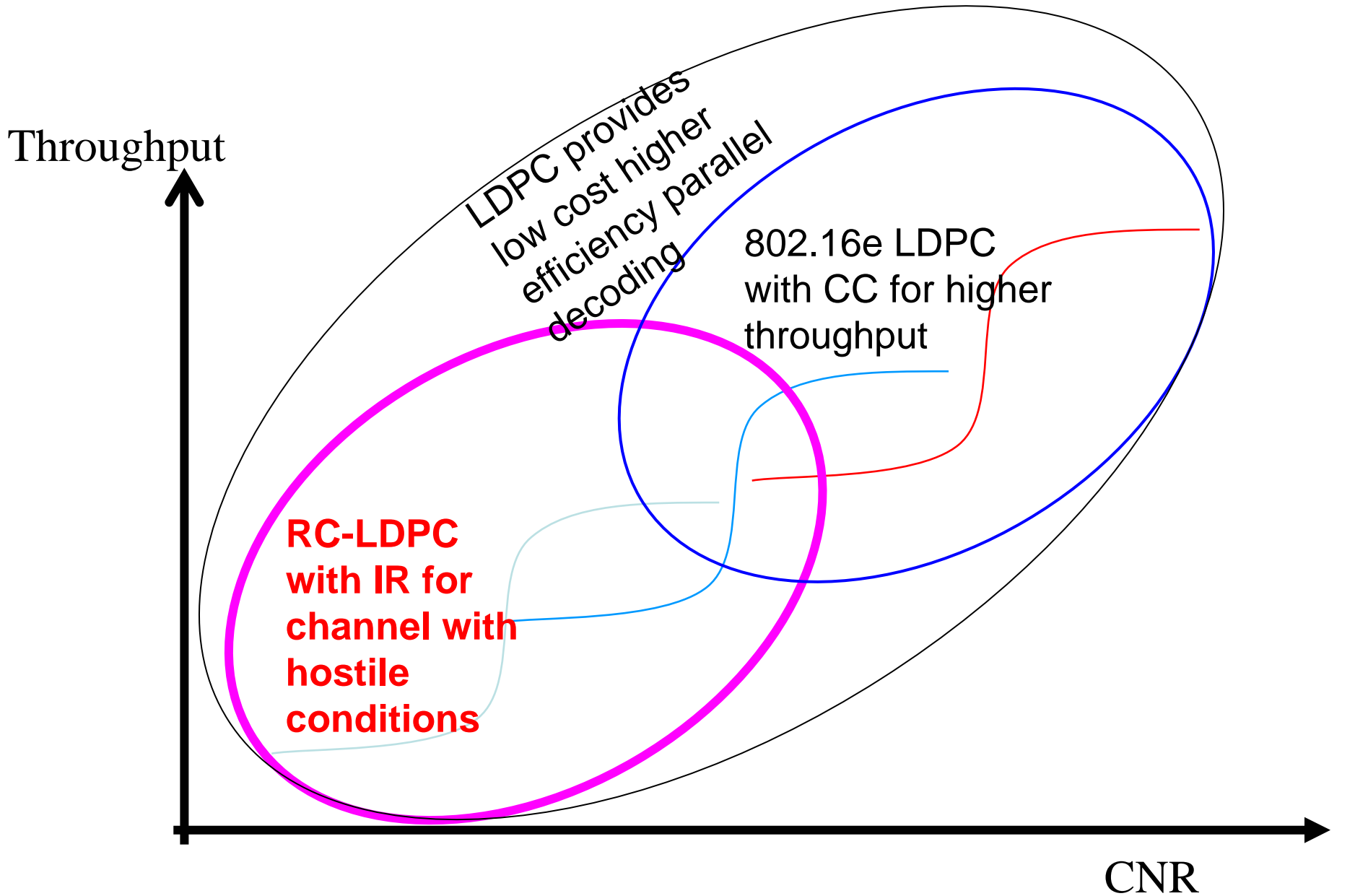
# Efficiency Performance of LDPC codes on MCS



# Throughput Performance of LDPC Chase Combining and IR HARQ

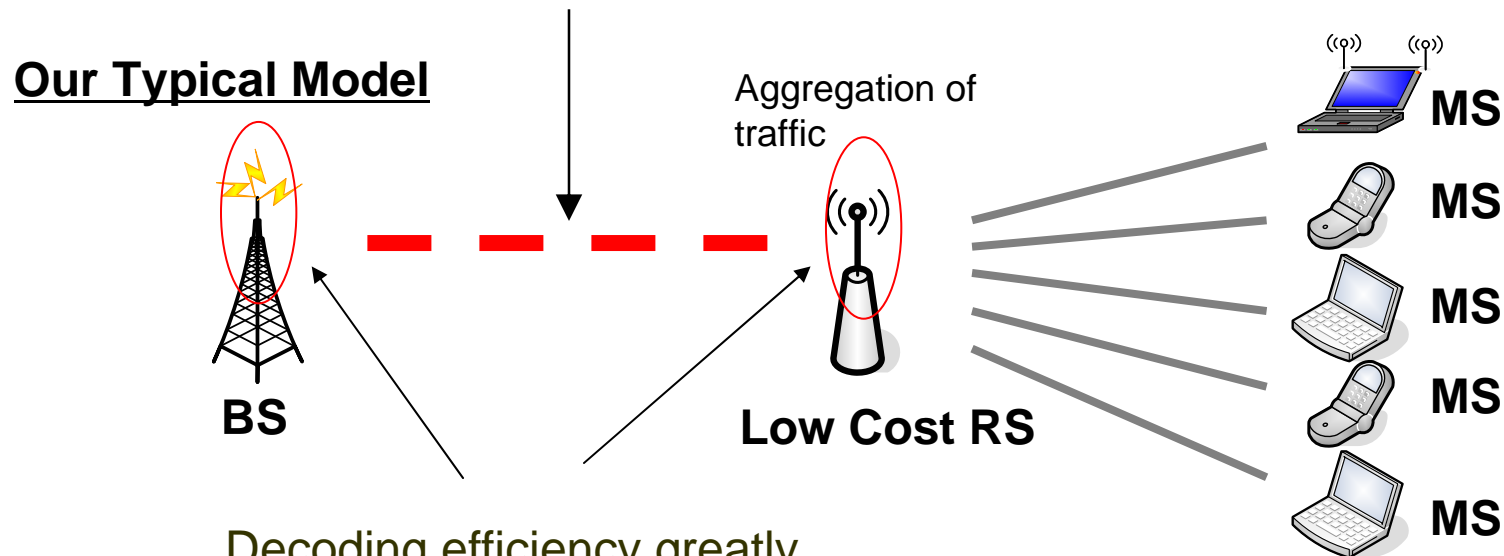


# RC-LDPC and 802.16e LDPC



# Merits of RC-LDPC and 802.16e LDPC

Improved robustness provided by RC-LDPC low code rate and HARQ IR especially for channels with hostile conditions



Decoding efficiency greatly improved by LDPC and making high throughput and low cost RS/BS possible for UL and DL