

## 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 and throughput performance on relay links.

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

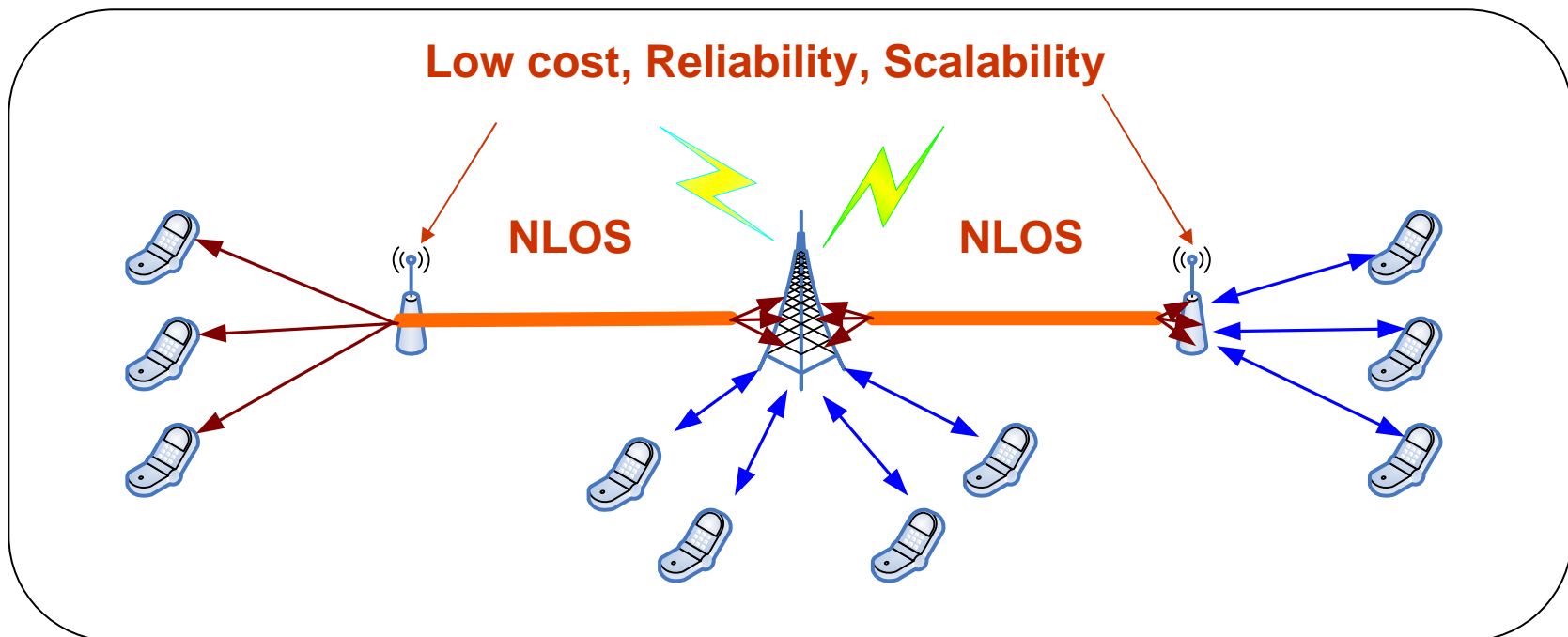
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# Concept of Enhanced Hybrid ARQ (Rate Compatible LDPC)

- The concept of “Enhanced Hybrid ARQ” is to provide **Low cost**, **Reliability** and **Scalability**.



# Motivation –Requested issues

- LDPC codes can provide lower cost hardware than CTC.
- High reliability on low data-rate region. → Expansion of coverage area
- Coexistence of the proposed RC-LDPC codes and the current 802.16e LDPC codes.
  - Minimize of additional circuits for RC-LDPC codes

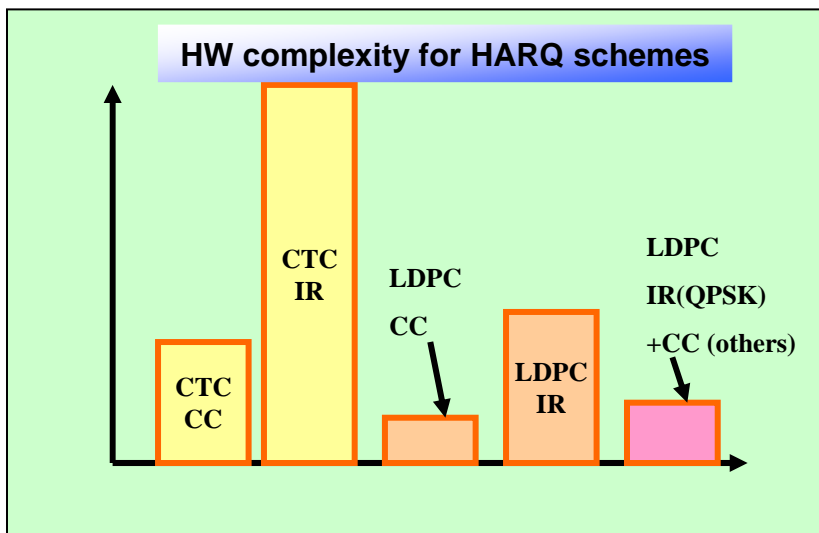


Fig1. Low Cost

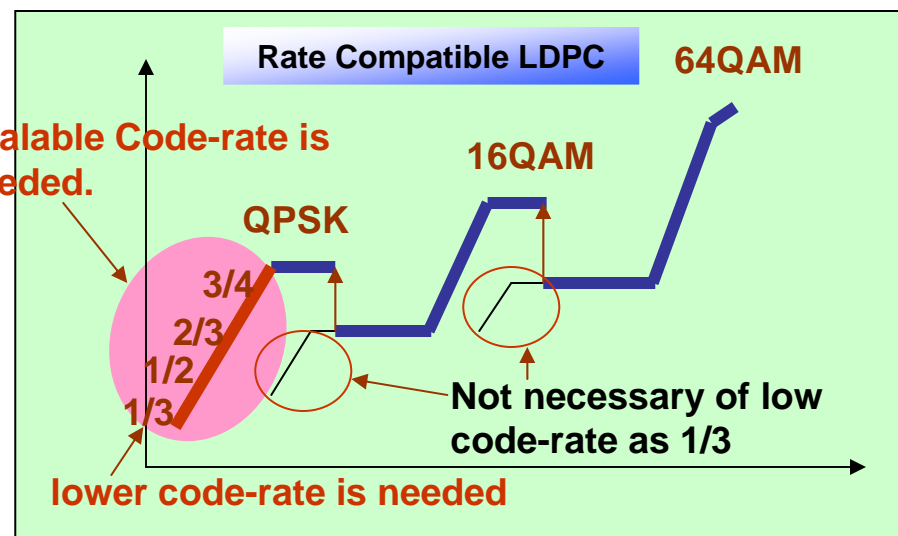


Fig2. Reliability and Scalability

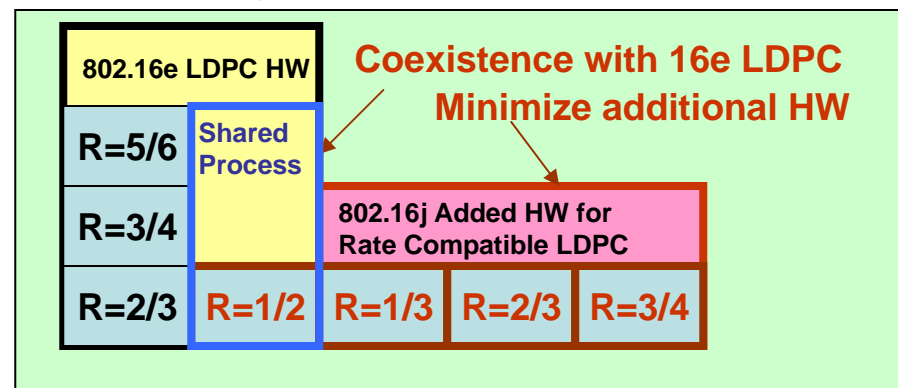
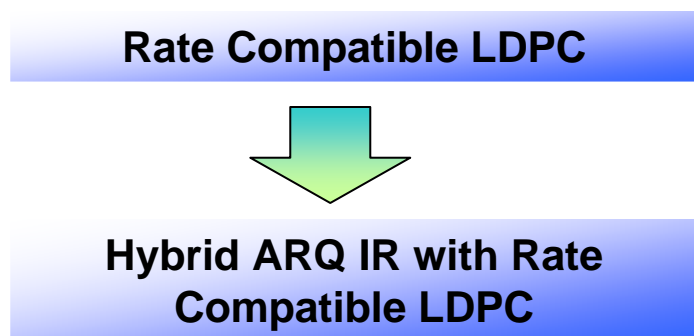


Fig3. coexistence of current LDPC



# Rate-Compatible LDPC codes

IR with Mother Rate=1/3 parity check matrix

Rate > 1/2



Rate = 1/2



Rate < 1/2



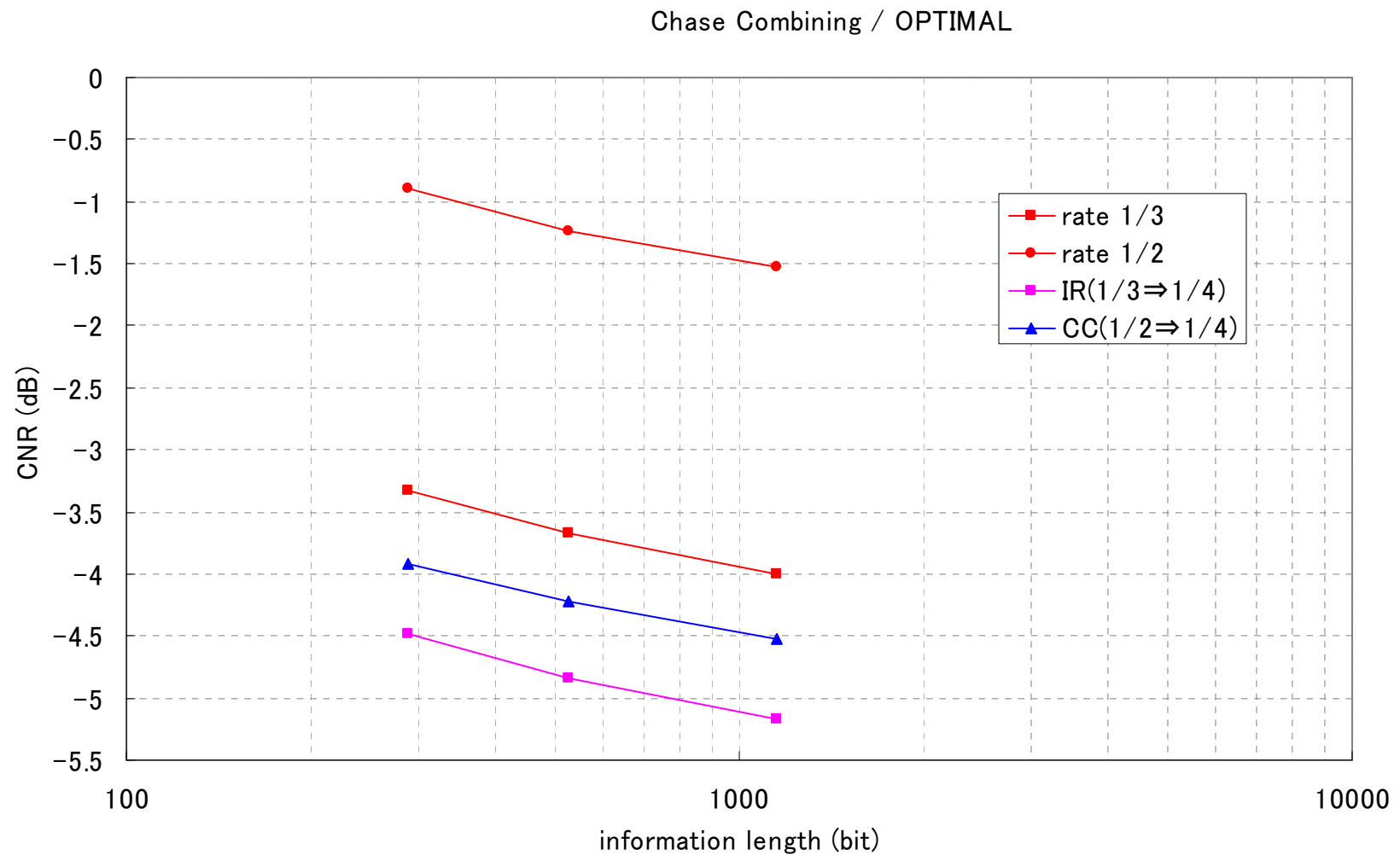
- In addition to puncturing, extended parity matrixes are used to achieve flexible coding rate and rate compatibility

- 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 -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 -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 -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
-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
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-1 -1 95 53 -1 -1 -1 -1 -1 14 18 -1	-1 -1 -1 -1 -1 -1 -1 0 -1 -1 -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 -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
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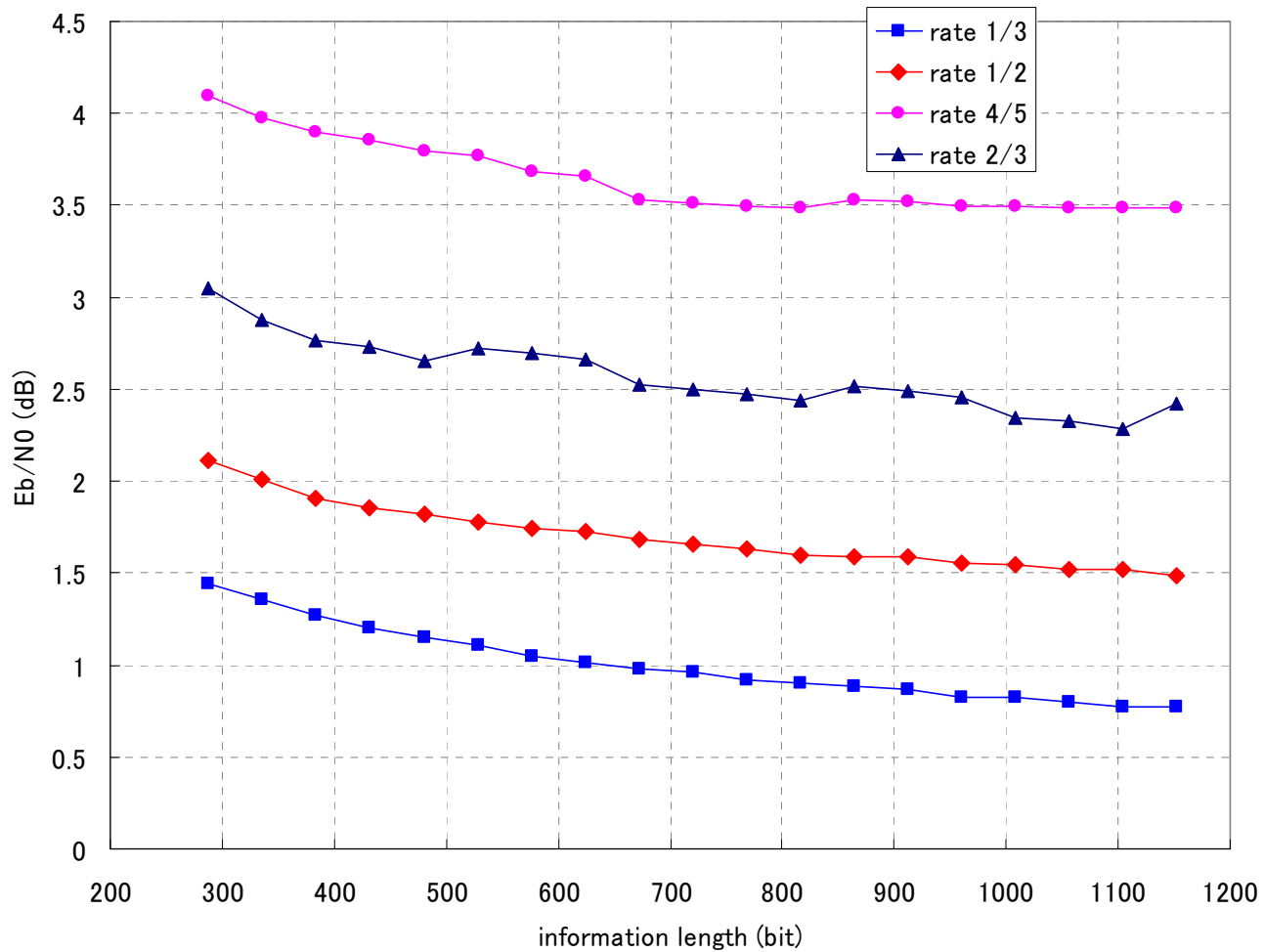
# Performance of RC LDPC

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



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





# Comparison with Turbo

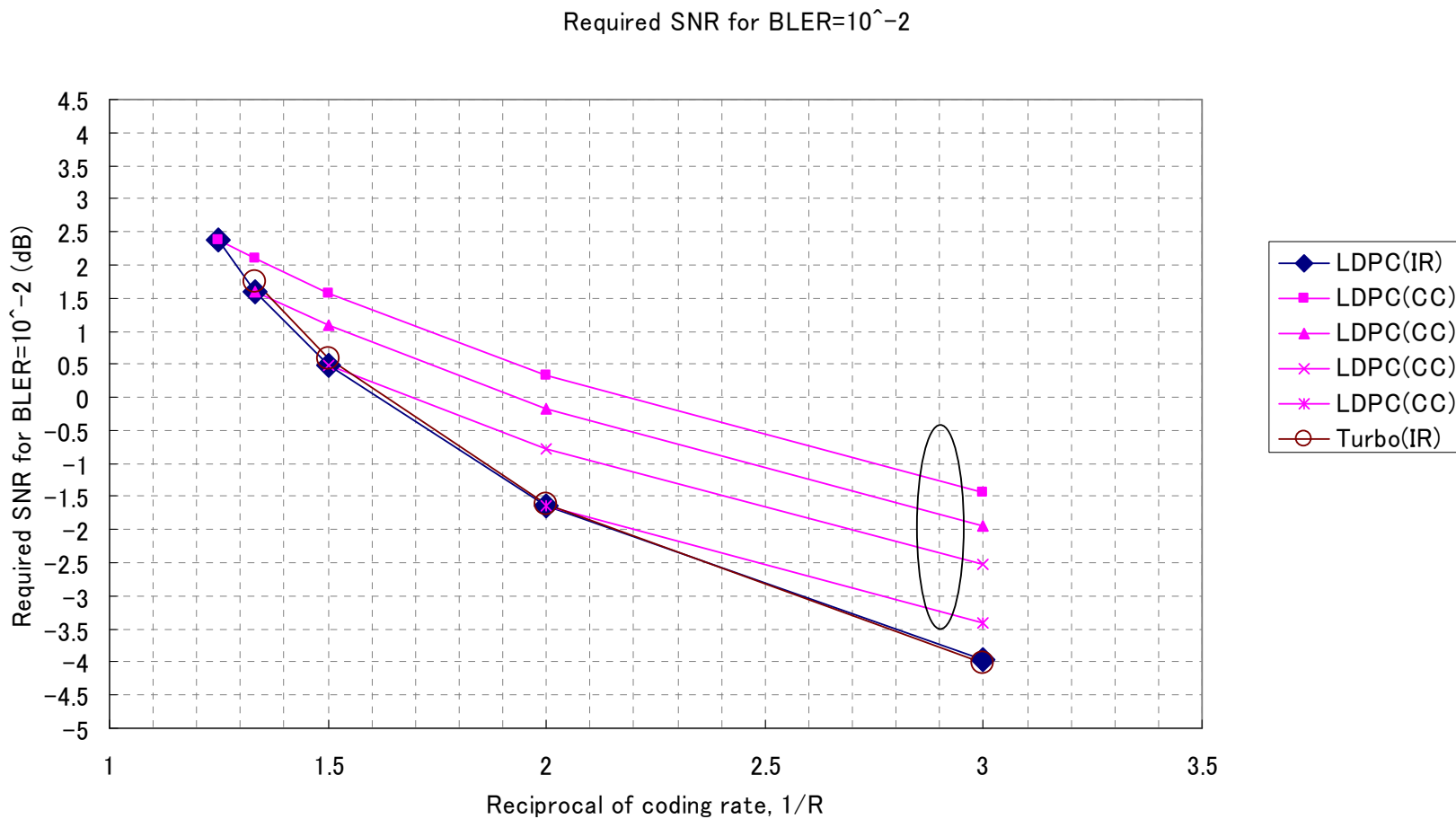
**Table. Operations count comparison of sub-optimal decoders LDPC and TC decoders.**

	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** "

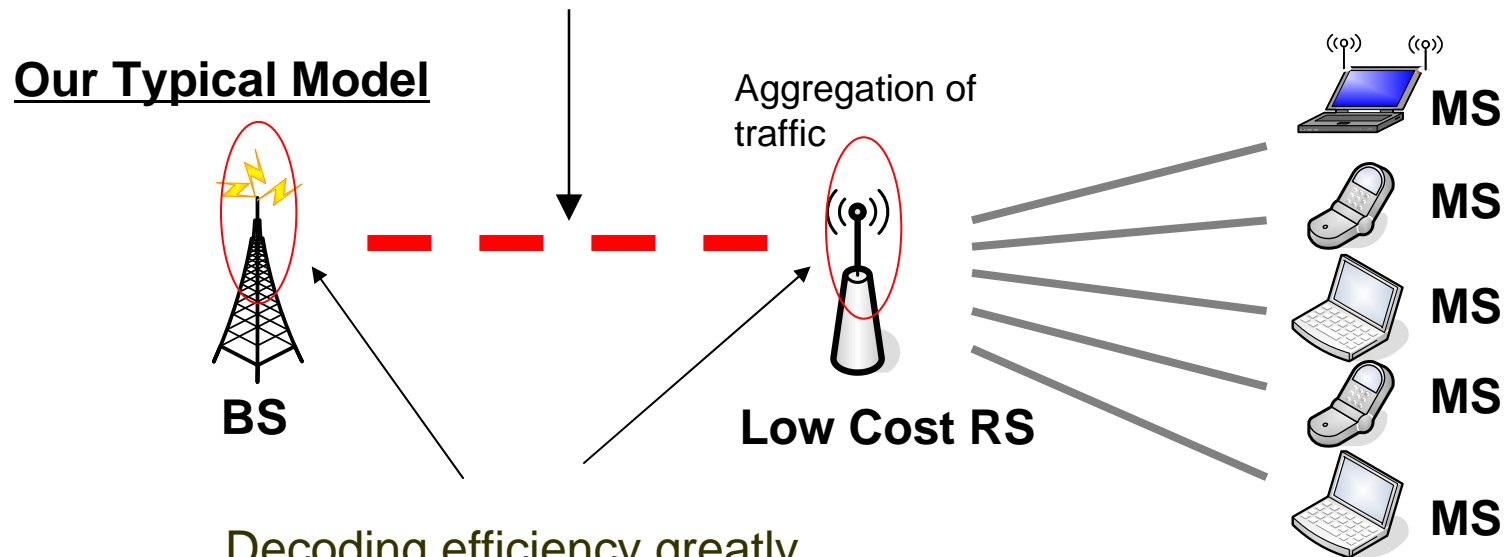
3GPP TSG RAN WG1#44bis, Athens, Greece 27-31 Mar. 2006.

# Throughput Performance of LDPC Chase Combining and IR HARQ



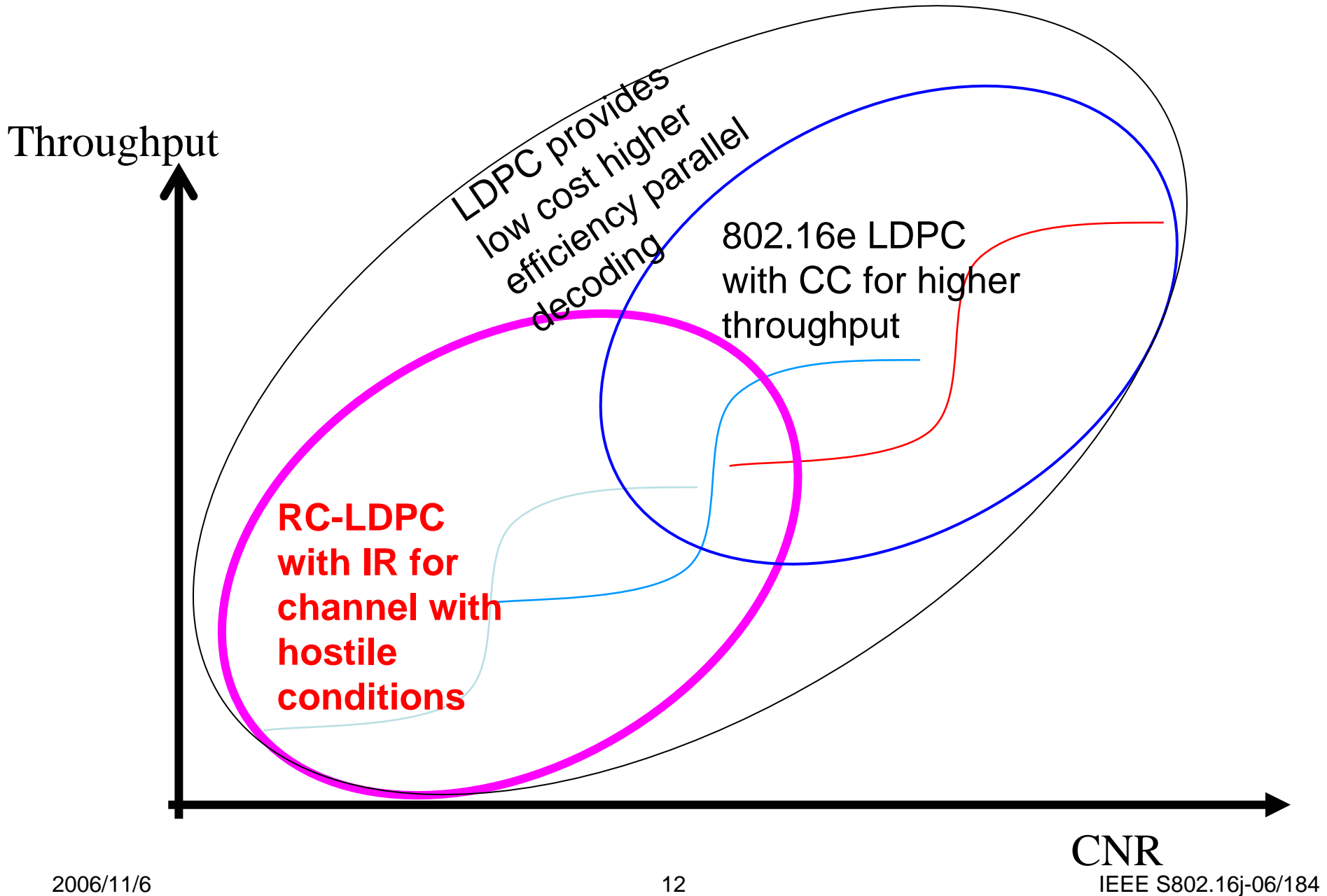
# Merits of RC-LDPC and 802.16e LDPC

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

# RC-LDPC and 802.16e LDPC



# Conclusions

- LDPC support high throughput with less hardware complexity and lower cost compared to Turbo codes
  
- RC-LDPC is an enhanced version of the 802.16e LDPC
  - 802.16e LDPC will be used as a baseline
  - RC-LDPC is rate compatible
  - Backward compatible to 802.16e LDPC
  - 802.16e LDPC with CC HARQ provides support for higher throughput link
  
- RC-LDPC provide improved robustness for channel in hostile conditions with
  - Low code rate such as 1/3 code rate
  - Incremental Redundancy for HARQ