

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

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Purpose:

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

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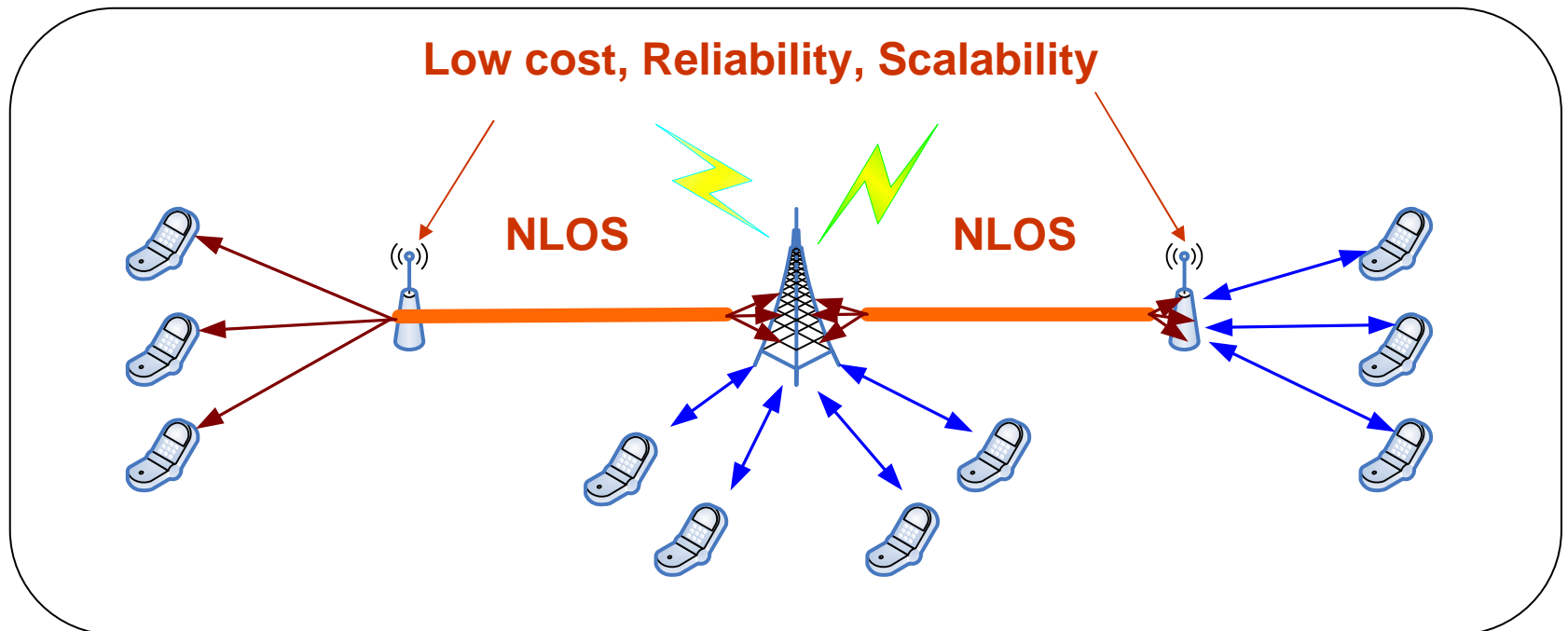
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Concept of Enhanced Hybrid ARQ (Rate Compatible LDPC)

- 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

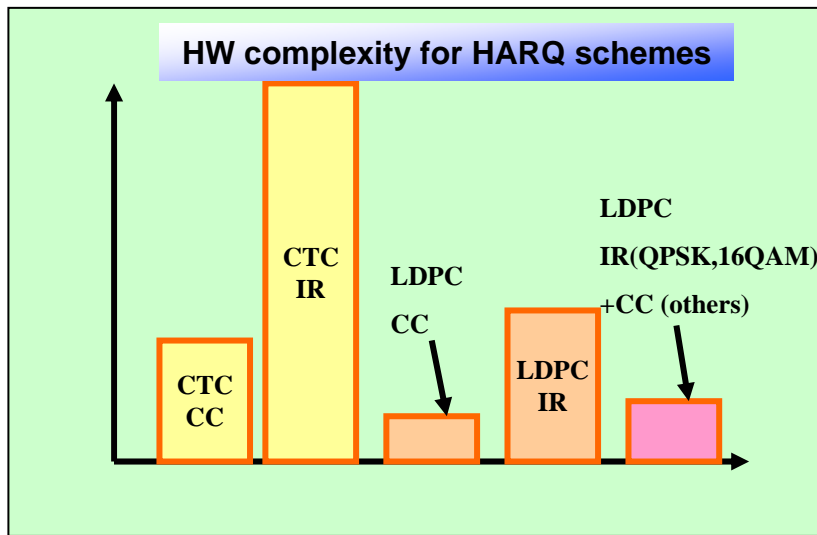


Fig1. Low Cost

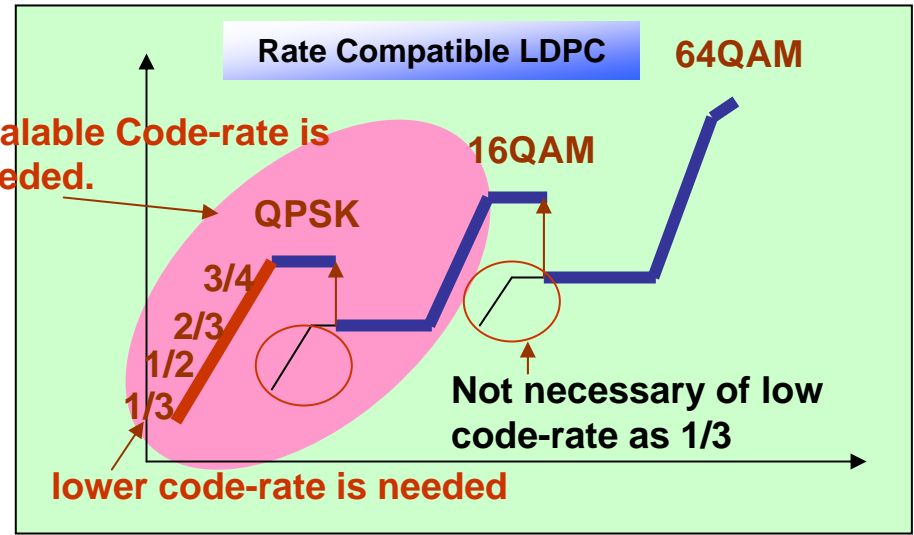


Fig2. Reliability and Scalability

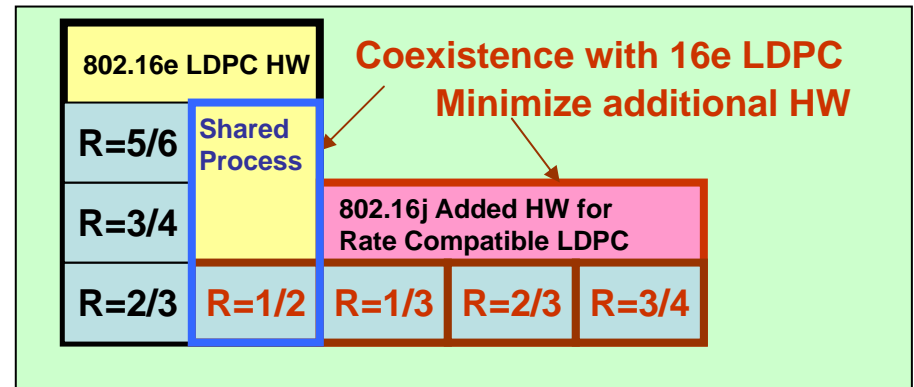
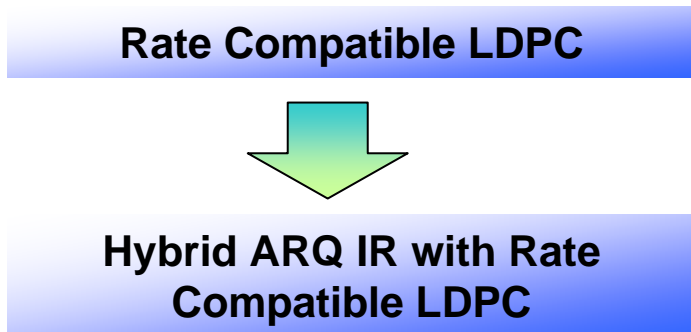


Fig3. coexistence of current LDPC

Comparison with Turbo

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

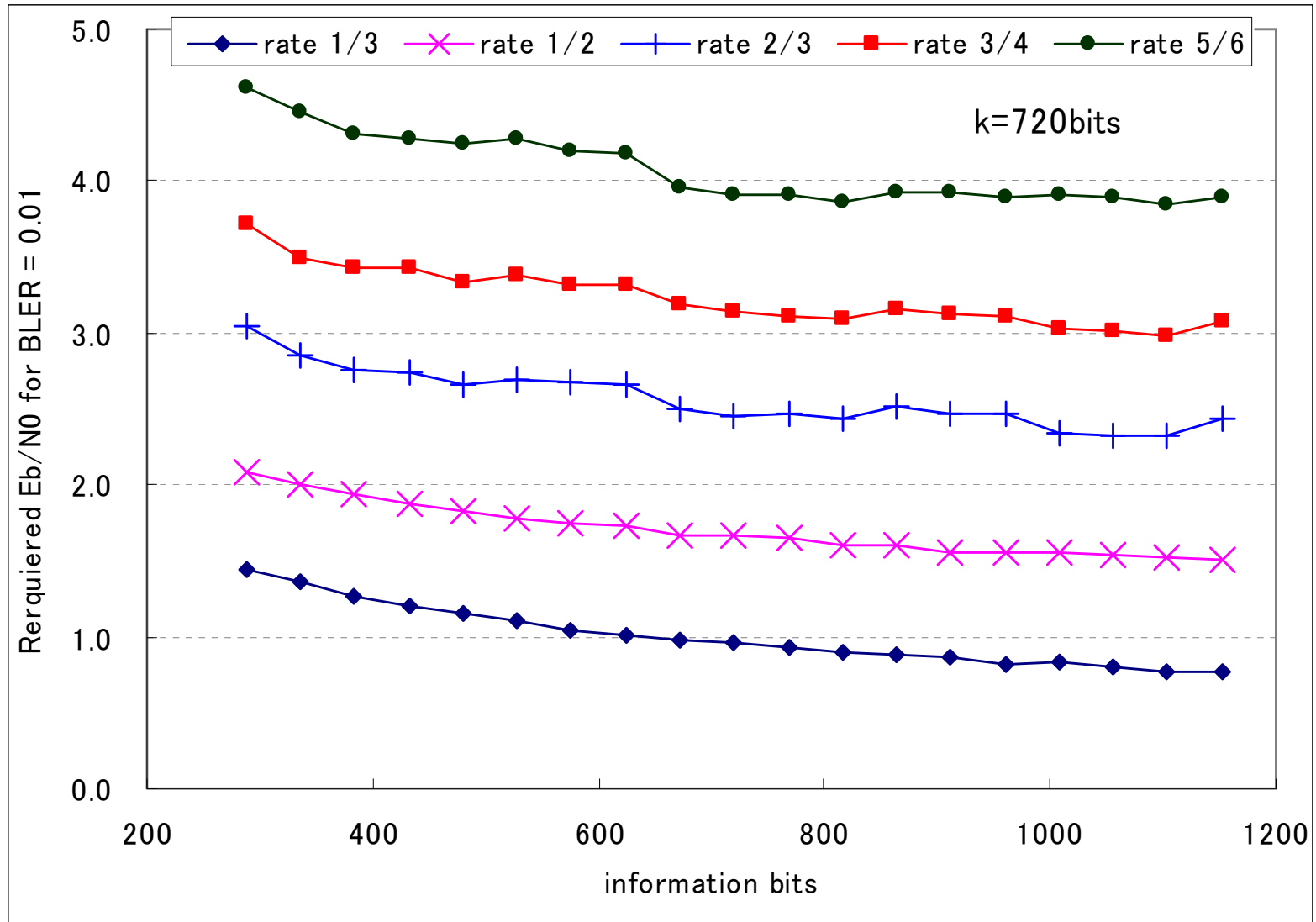
	LDPC	CTC	Complexity of LDPC / Complexity of CTC
Algorithm	LBP Min-Sum+Offset	Max Log Map +extrinsic scaling	
Number of Iterations	20	8	
Total cost (R=1/2)	28.8K x 20 = 576K	171K x 8 x 2 = 2736K	21%
Total cost (R=3/4)	20.6K x 20 = 412K	171K x 8 x 2 = 2736K	15%

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

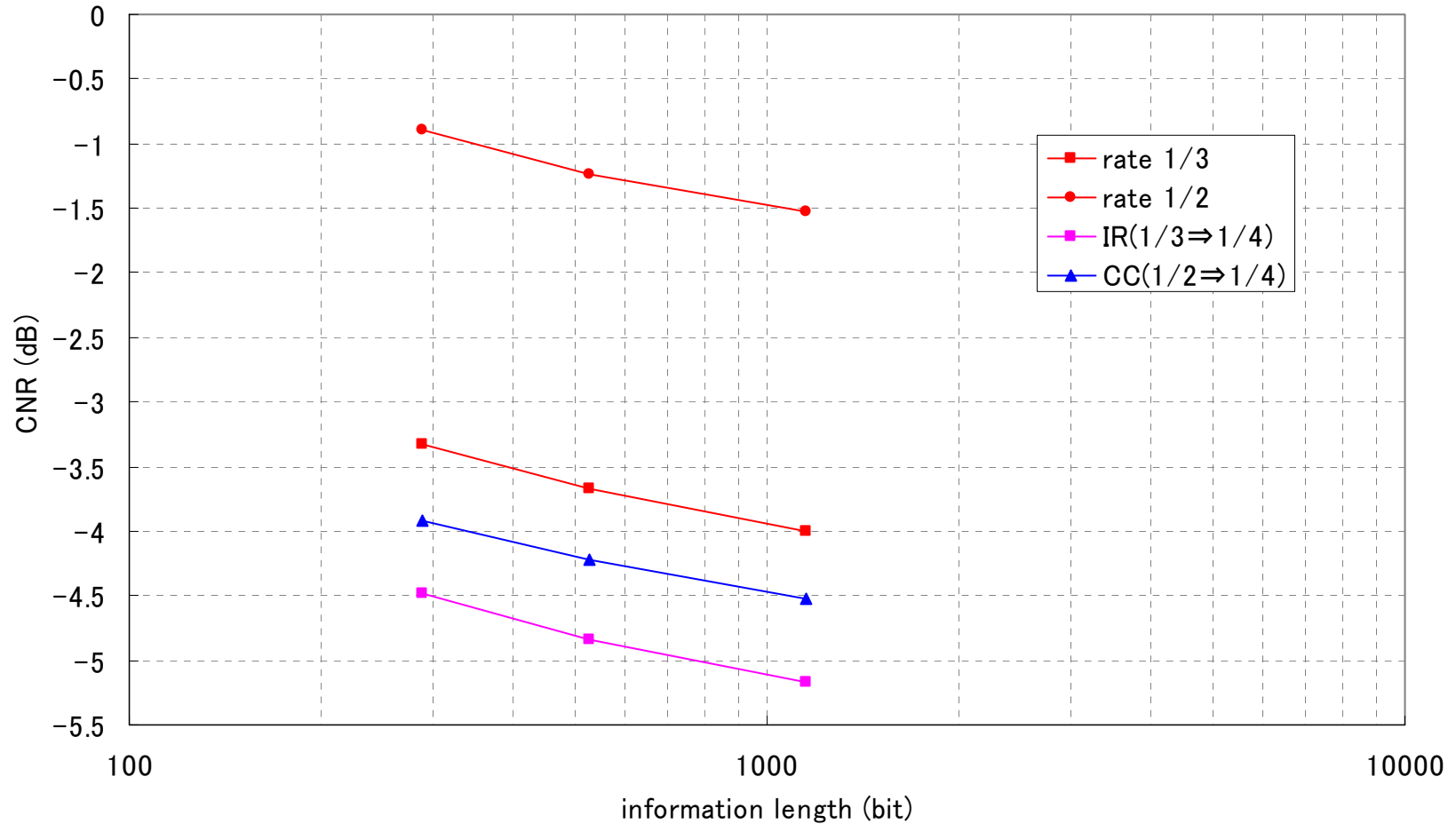
Performance for RC LDPC codes based on the 16e LDPC codes



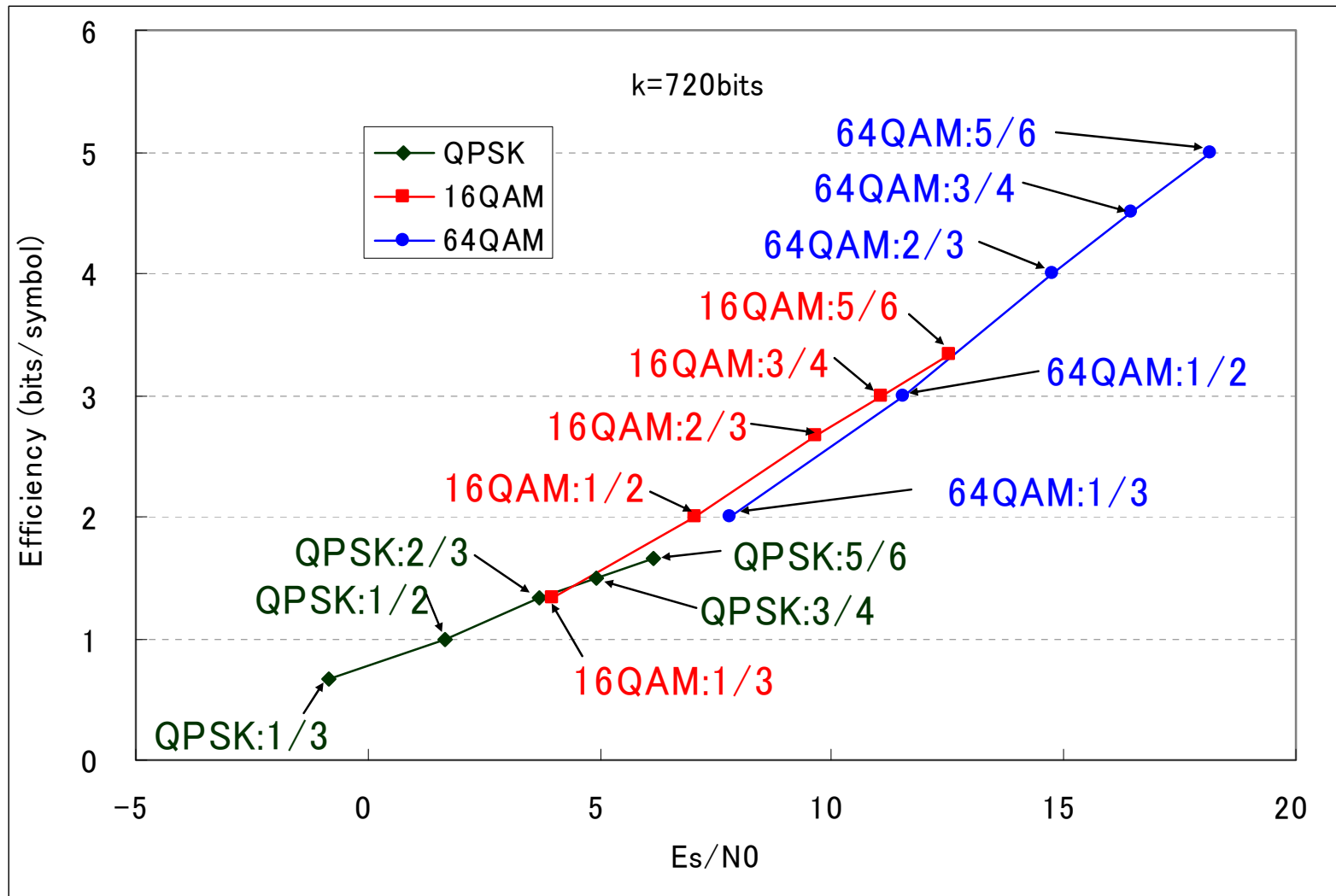
Performance of RC LDPC

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

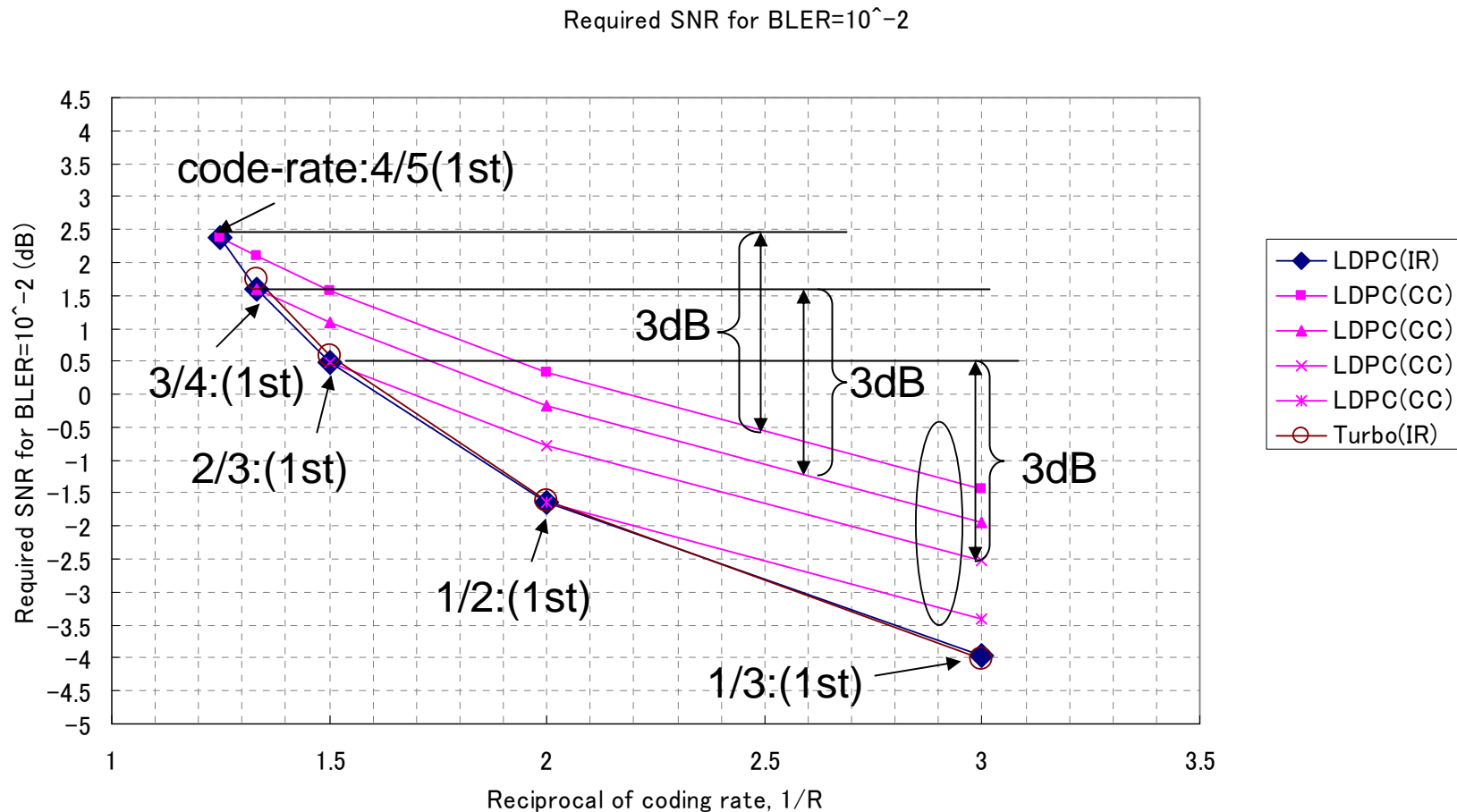
Chase Combining / OPTIMAL



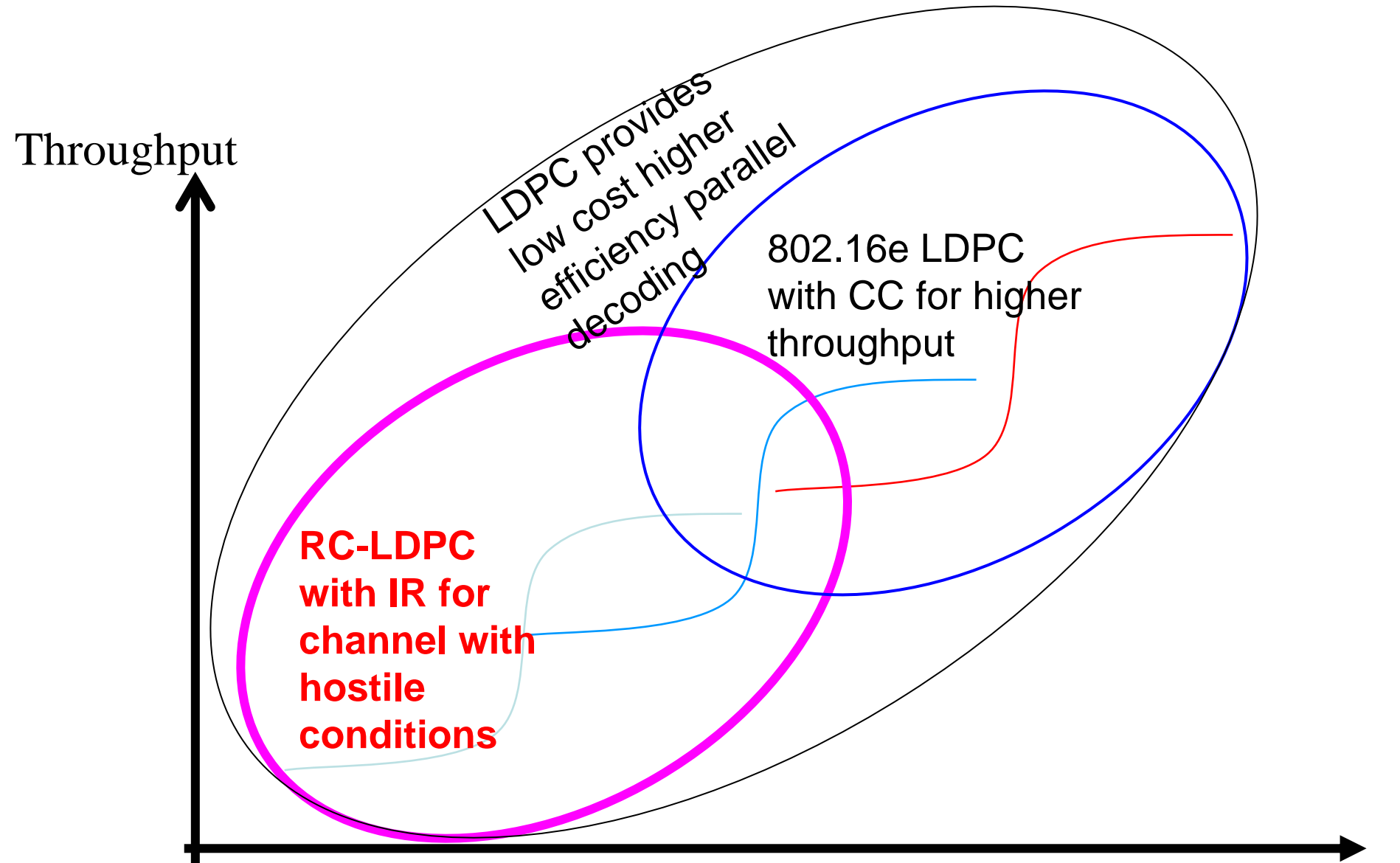
Efficiency Performance of LDPC codes on MCS



Throughput Performance of LDPC Chase Combining and IR HARQ



RC-LDPC and 802.16e LDPC



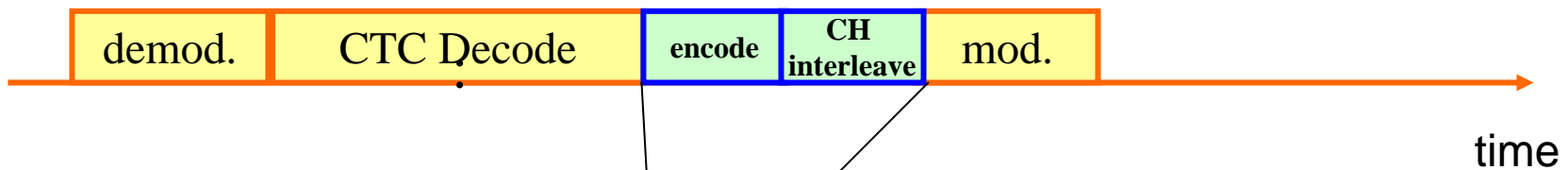
Latency benefit of LDPC codes

➤ In the case of LDPC codes for Relay station

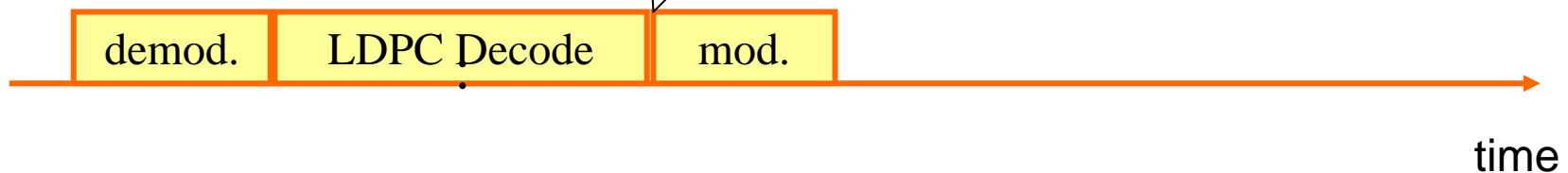
LDPC decoder output LLRs for the whole codeword.

But CTC decoder only output those for the information bits, so CTC have to re-encode to do channel interleaving before modulation.

[Turbo]



[LDPC]

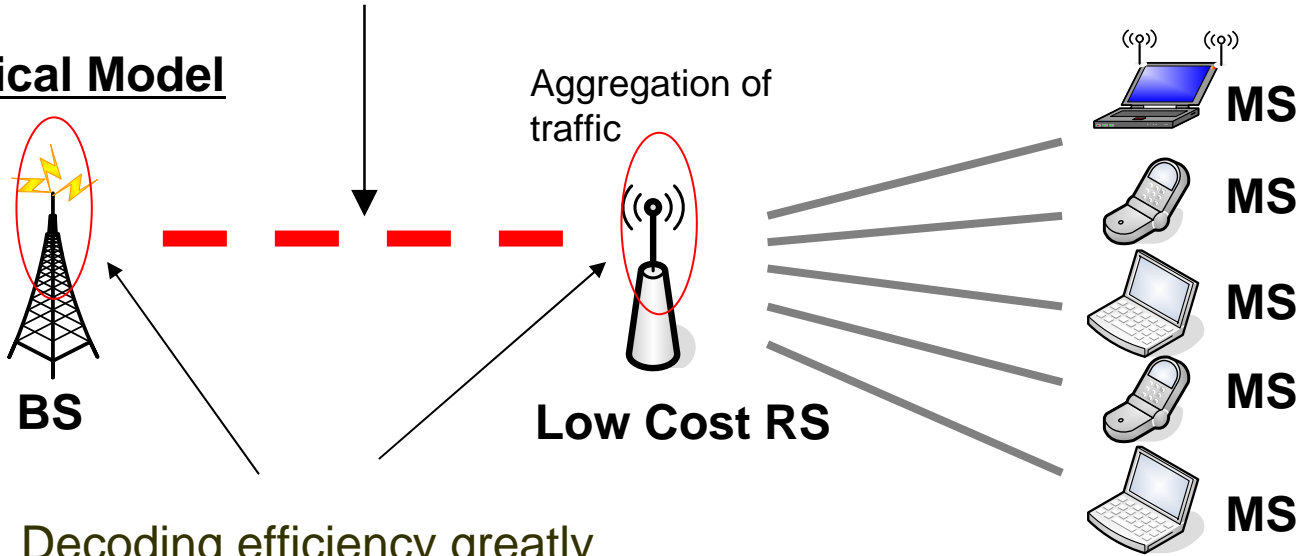


Relay station with LDPC can relay the signal with lower latency.

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

Our Typical Model



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

Conclusions

- LDPC support high throughput with less hardware complexity and lower cost compared to Turbo codes
 - Lower latency 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