Rate Allocation for Component Codes of Plotkin-Type UEP Codes

Jin Soo Park, Ki-Hyeon Park, Hong-Yeop Song
{js.park09, kh.park, hysong}@yonsei.ac.kr

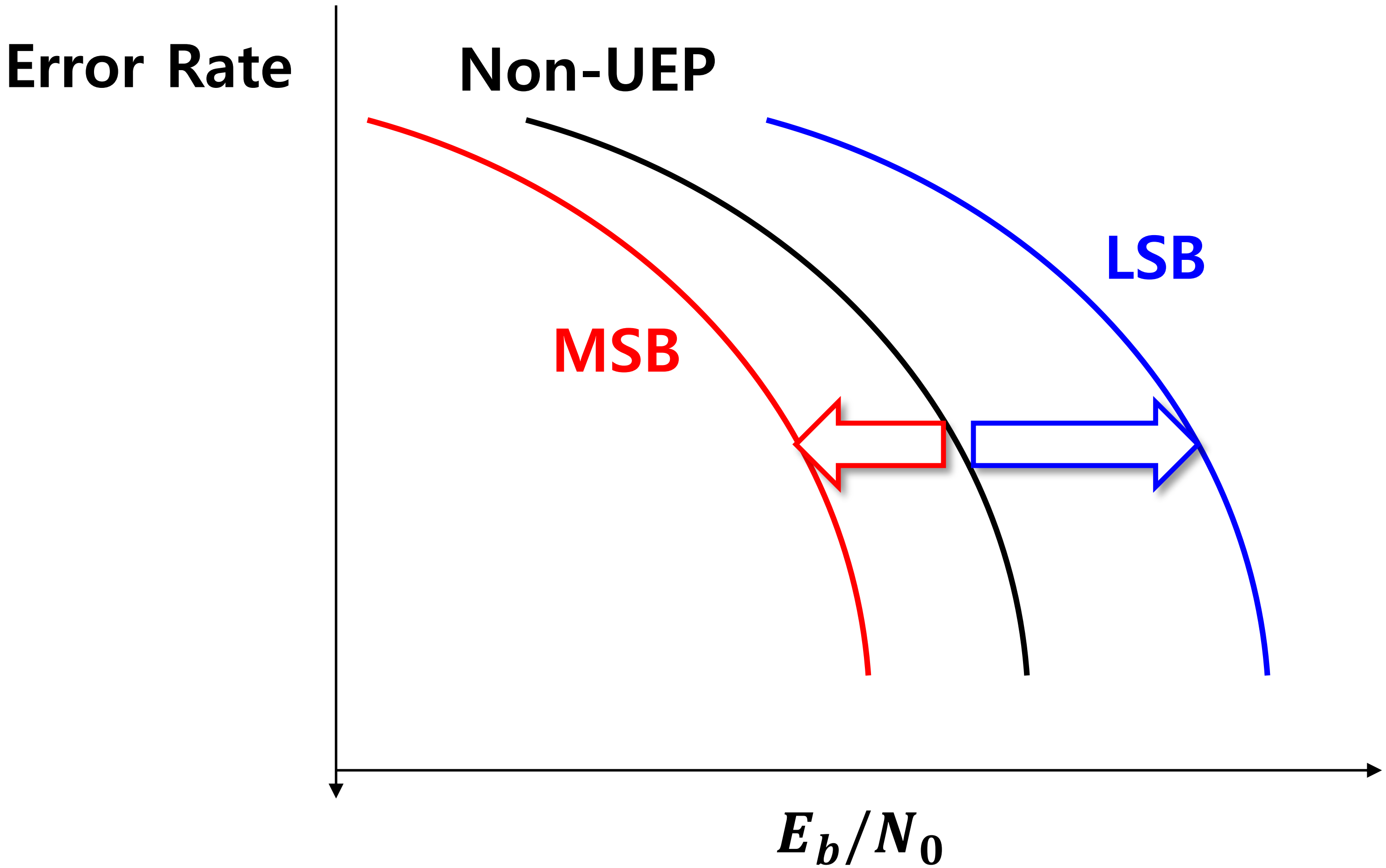
Yonsei University, Seoul, Republic of Korea

IEEE International Symposium on Information Theory
ISIT2012

July 1-6, 2012
Cambridge, MA, USA

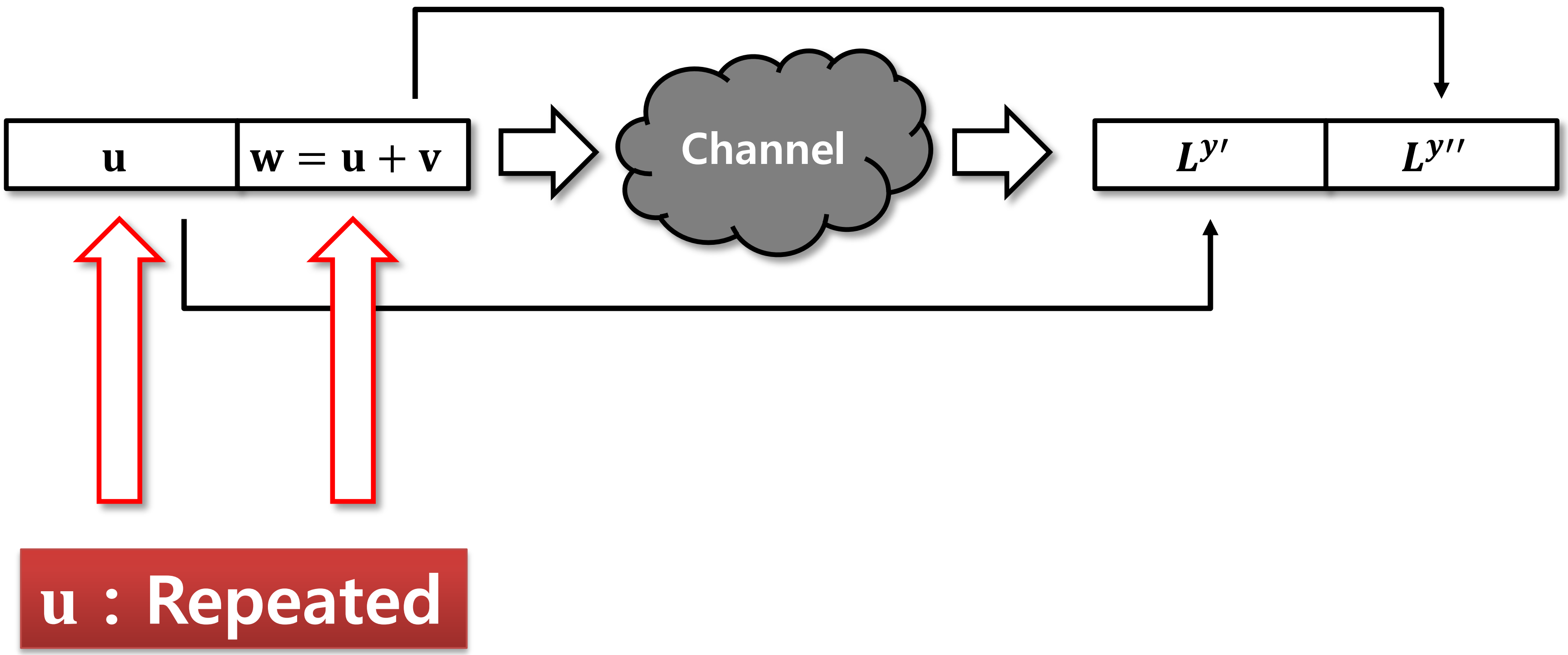
Contents

General UEP Codes



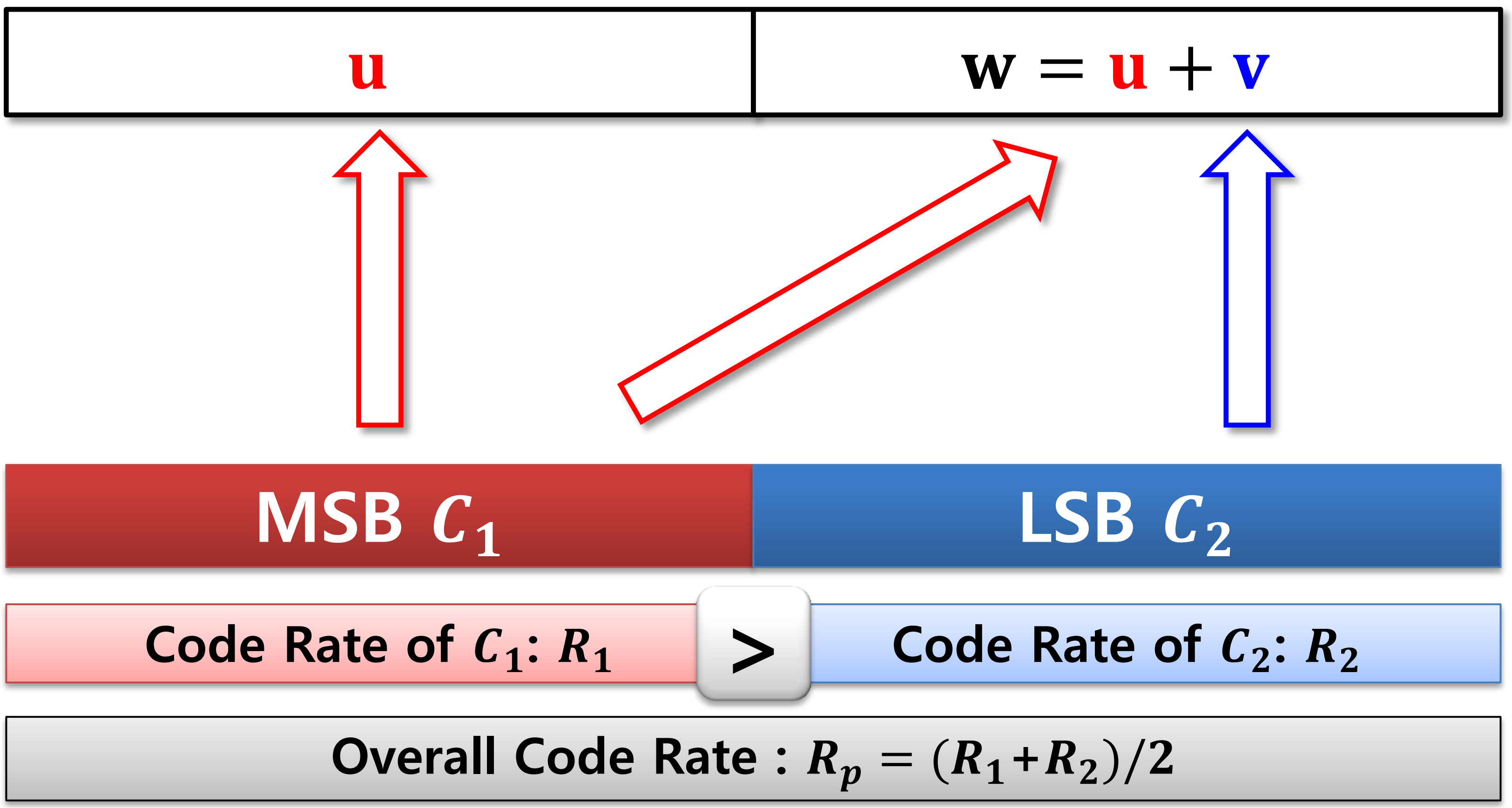
- **Plotkin-type Code**

$$C_p = \{|\mathbf{u}|\mathbf{u}+\mathbf{v}|\,|\,\mathbf{u} \in C_1, \mathbf{v} \in C_2\}$$



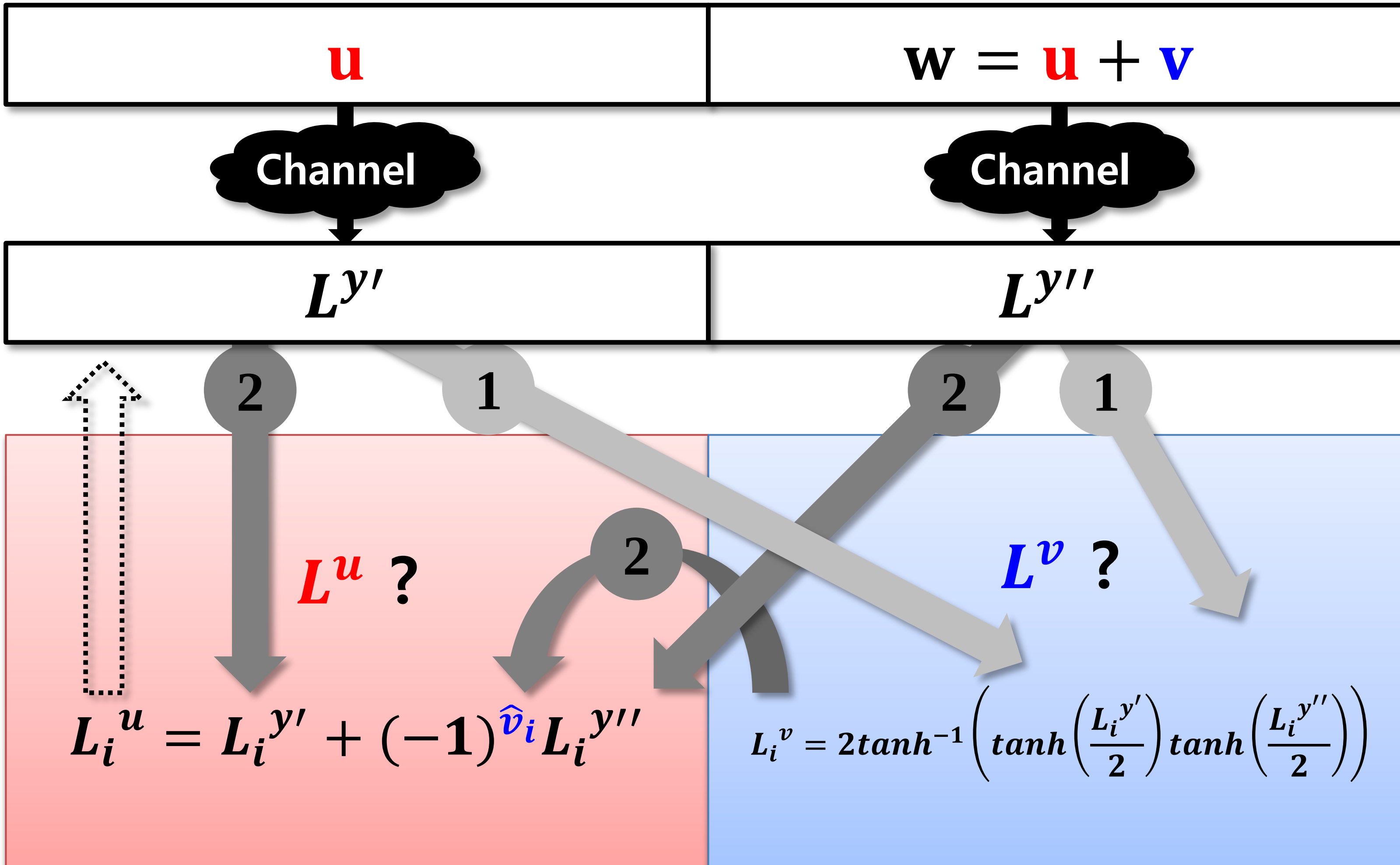
Plotkin-type UEP Codes

- Kumar and Milenkovic, "On Unequal Error Protection LDPC Codes Based on Plotkin-Type Constructions," IEEE Trans. on Comm., 2006



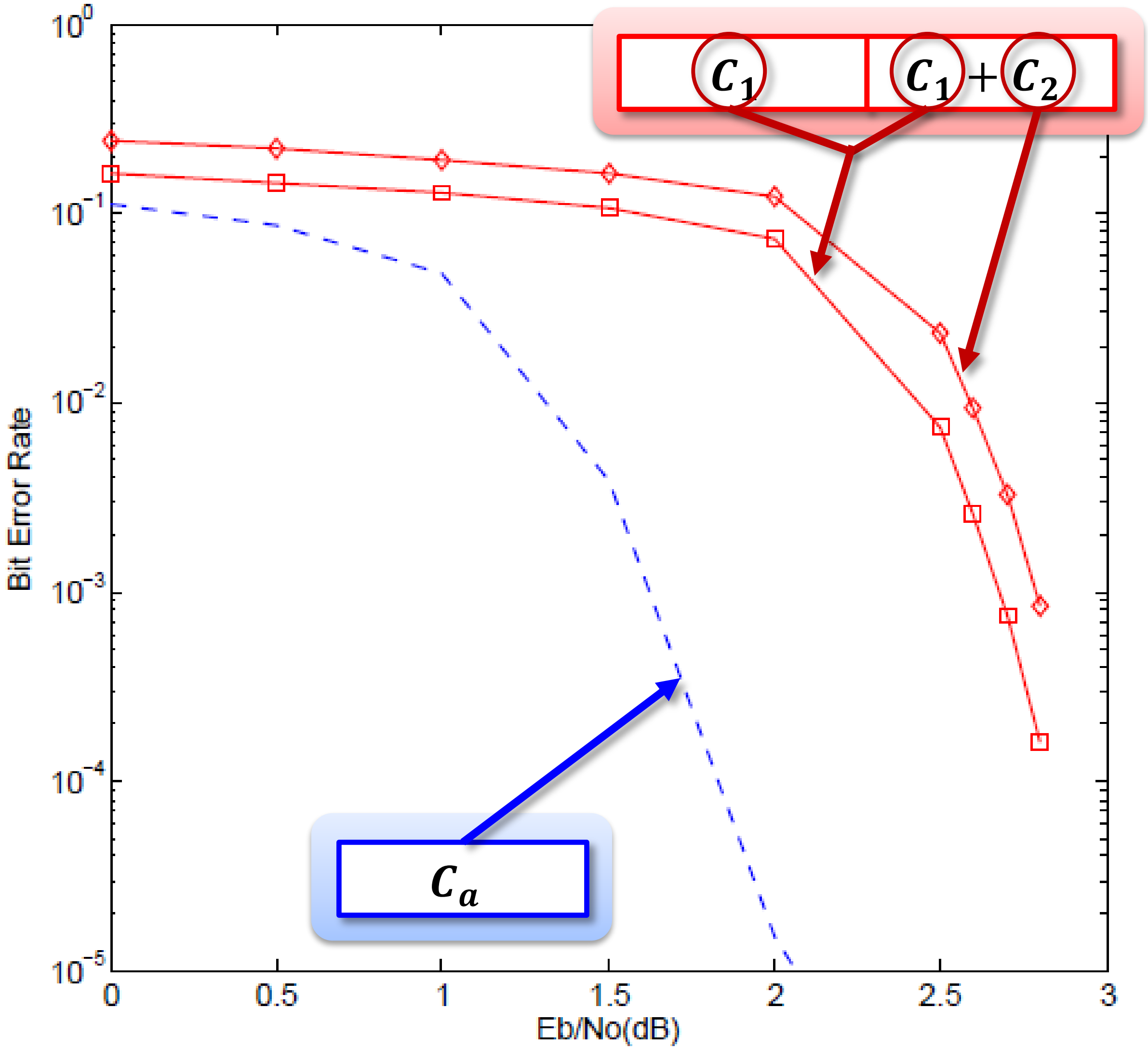
Plotkin-type UEP Codes

- Kumar and Milenkovic, "On Unequal Error Protection LDPC Codes Based on Plotkin-Type Constructions," IEEE Trans. on Comm., 2006



According to their paper (with arbitrary rate allocation I)

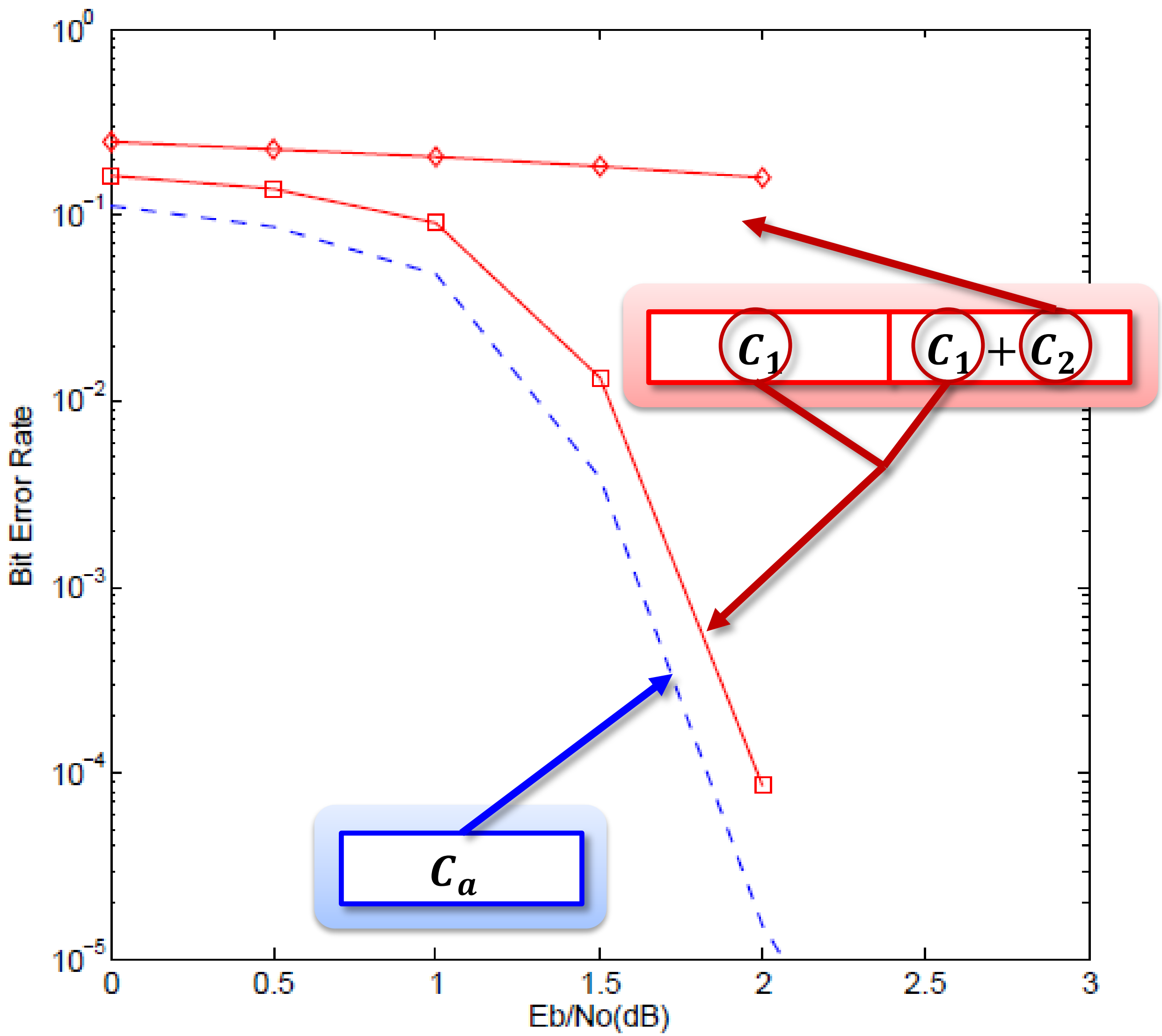
$$\boldsymbol{R_1 = 0.65} \quad \boldsymbol{R_2 = 0.47} \qquad (R_p = 0.56)$$



Plotkin-type UEP Code works MUCH WORSE than Non-UEP Code

According to their paper (with arbitrary rate allocation II)

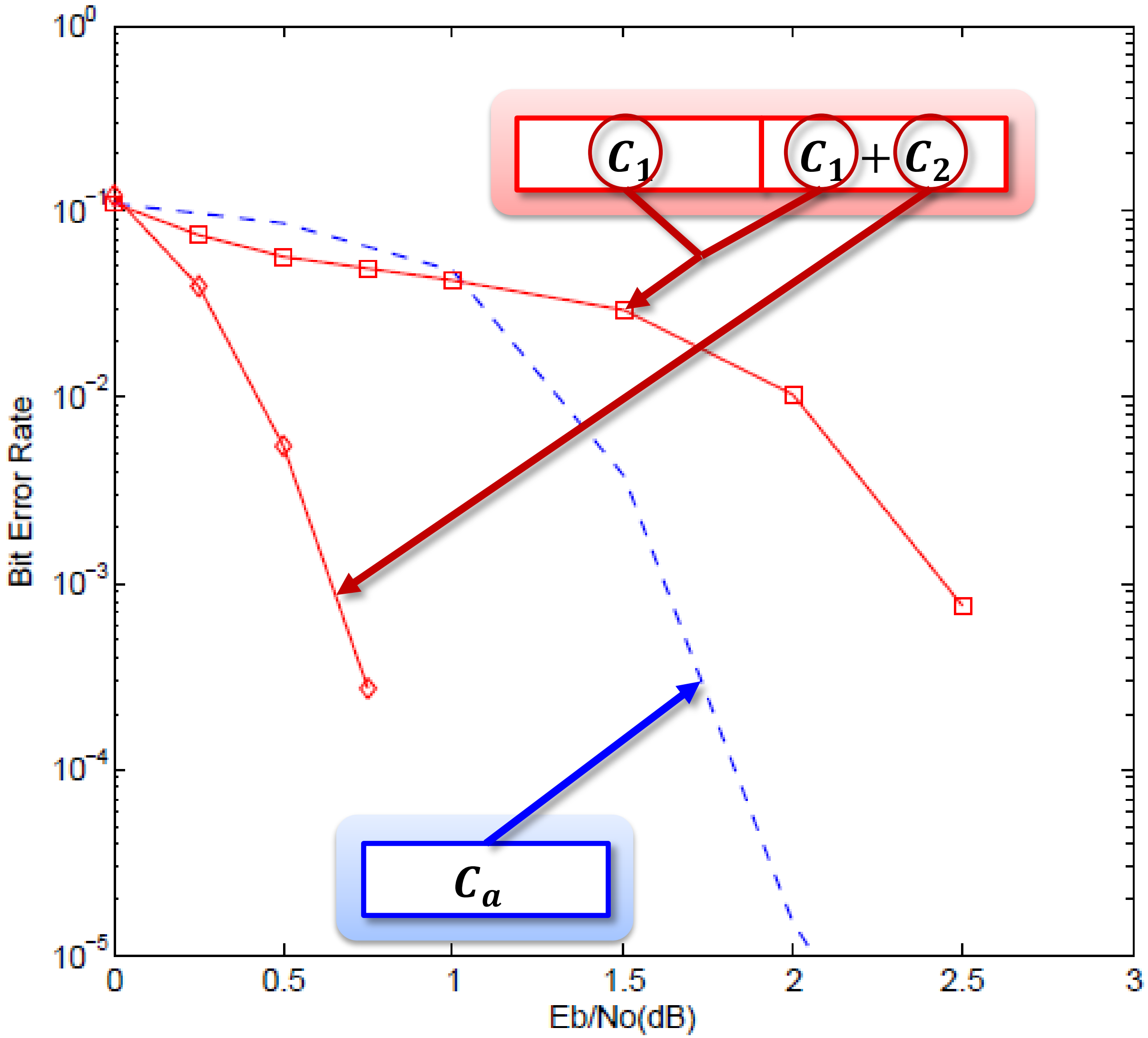
$$R_1 = 0.47 \quad R_2 = 0.65 \qquad (R_p = 0.56)$$



Plotkin-type UEP Code works still WORSE than Non-UEP Code

According to their paper (with arbitrary rate allocation III)

$$\boldsymbol{R_1 = 0.87} \quad \boldsymbol{R_2 = 0.25} \qquad (R_p = 0.56)$$



Plotkin-type UEP code works as "UEP", But MSB and LSB are switched!!

PROBLEM

Why?

How?

We Give the
Reason & Method

Average Code

“(Ideal) Average EEP Code C_a”

- **Ideal** EEP code which **Achieves the Channel Capacity**
- **Code Rate** $R_a = R_p$
- **Threshold** $\sigma_{a,th}{}^2$

Notations

"Plotkin-type UEP Code C_p"

"C_1 in C_p"

Threshold : $\sigma_{1,th}{}^2$
Channel Noise : $\sigma_1{}^2$

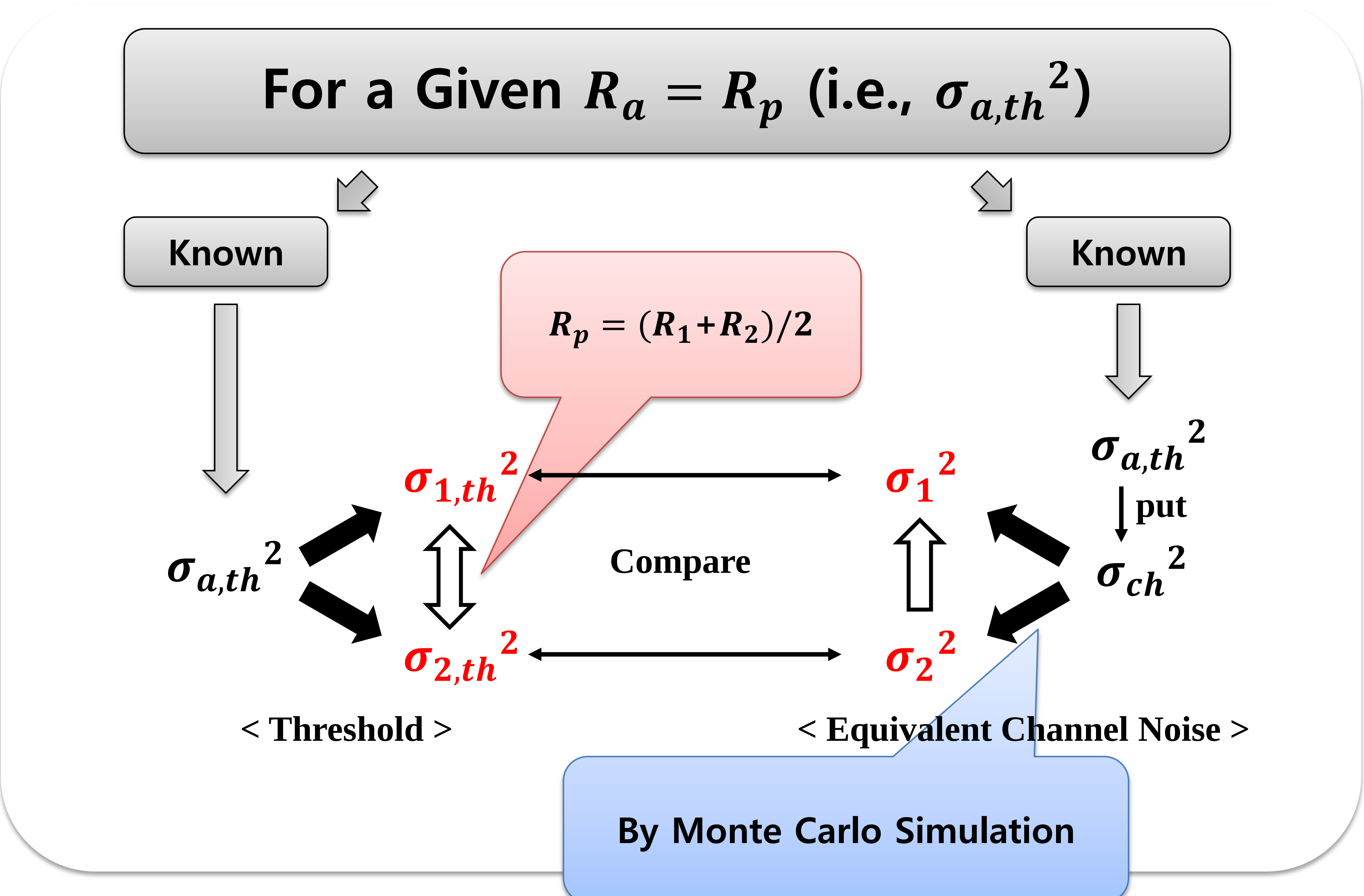
"C_2 in C_p"

Threshold : $\sigma_{2,th}{}^2$
Channel Noise : $\sigma_2{}^2$

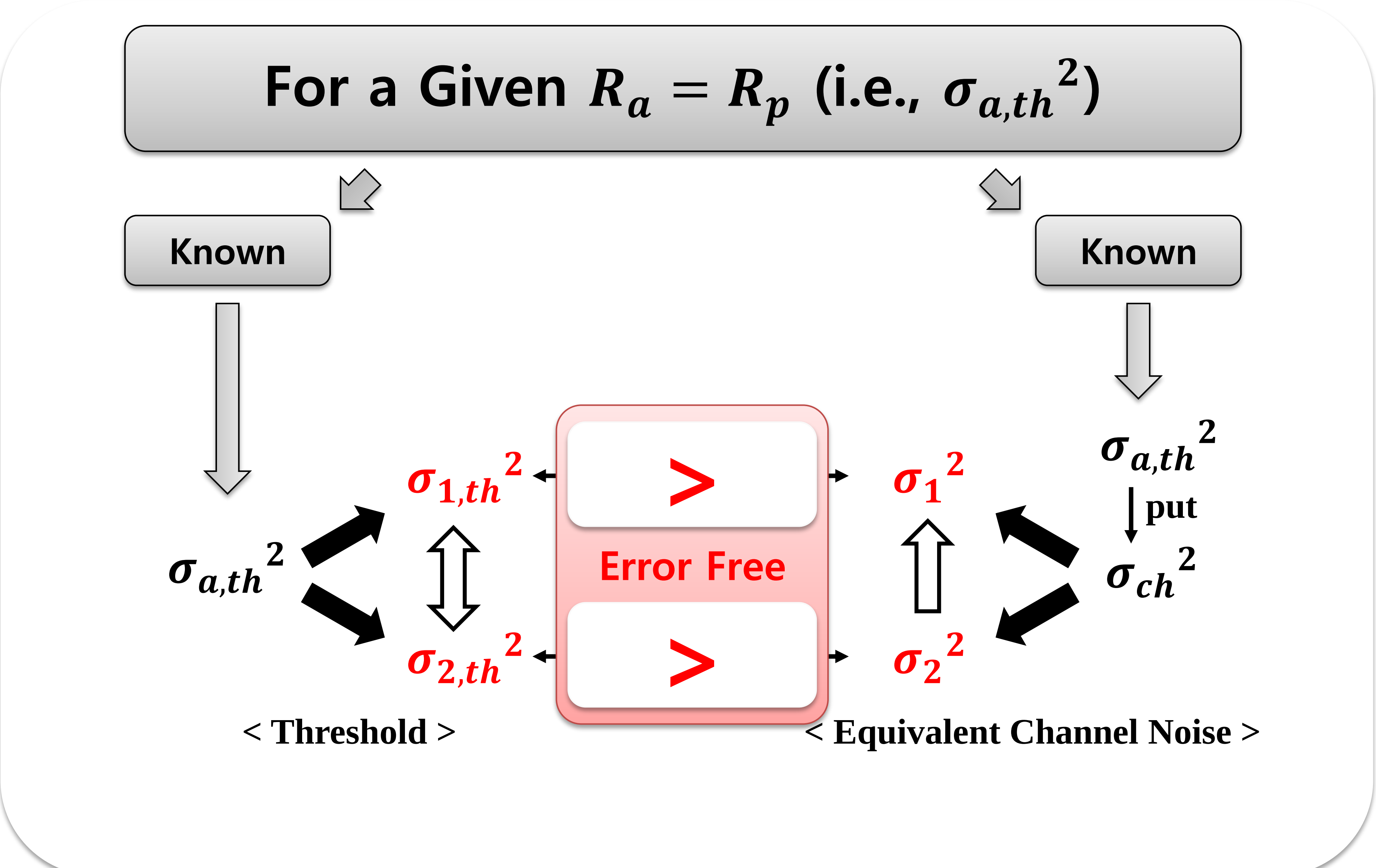
"(Ideal) Average EEP Code C_a"

"C_i $(for\ i = 1,2)$ Only" (EEP)

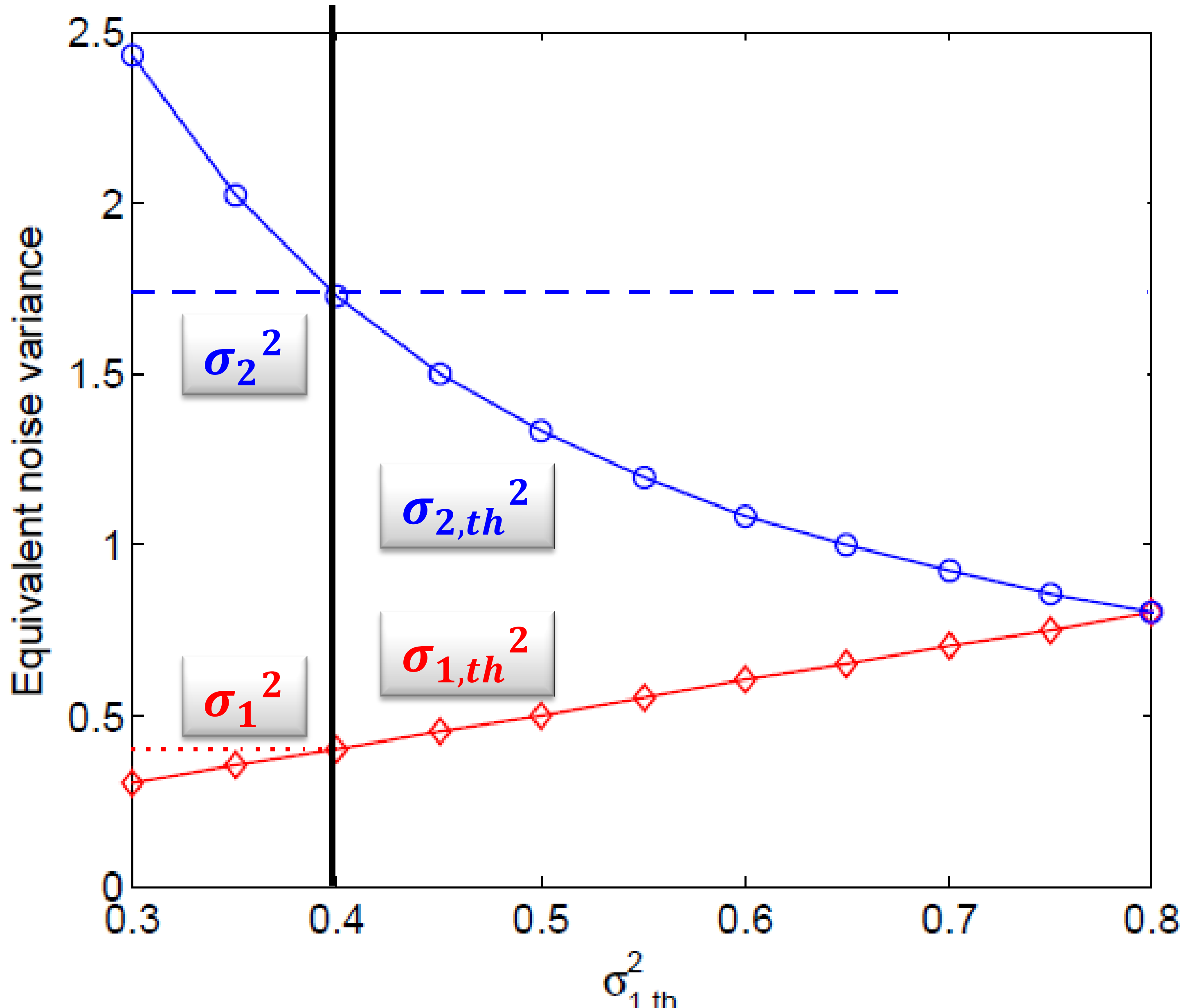
Analysis Diagram



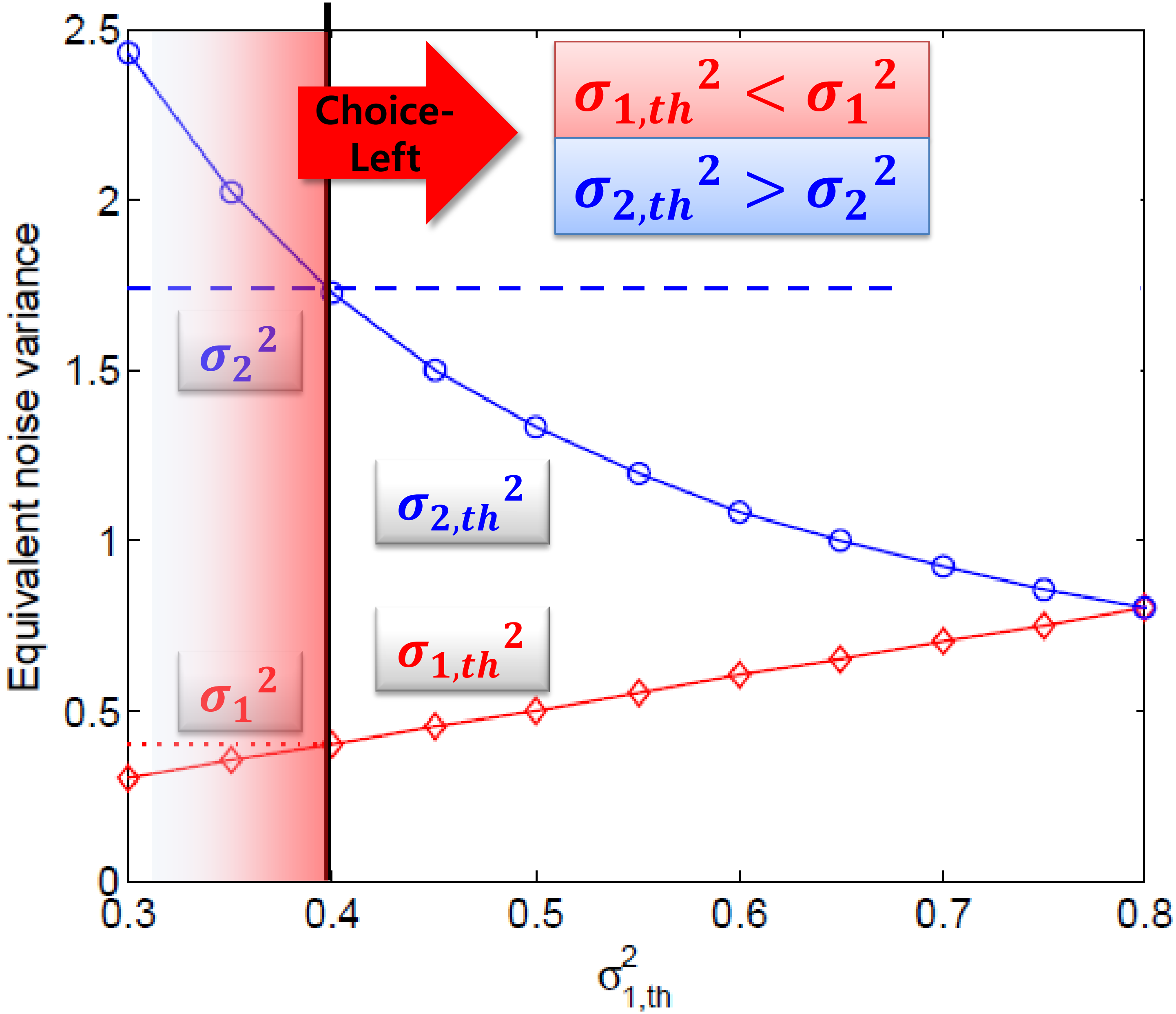
Analysis Diagram



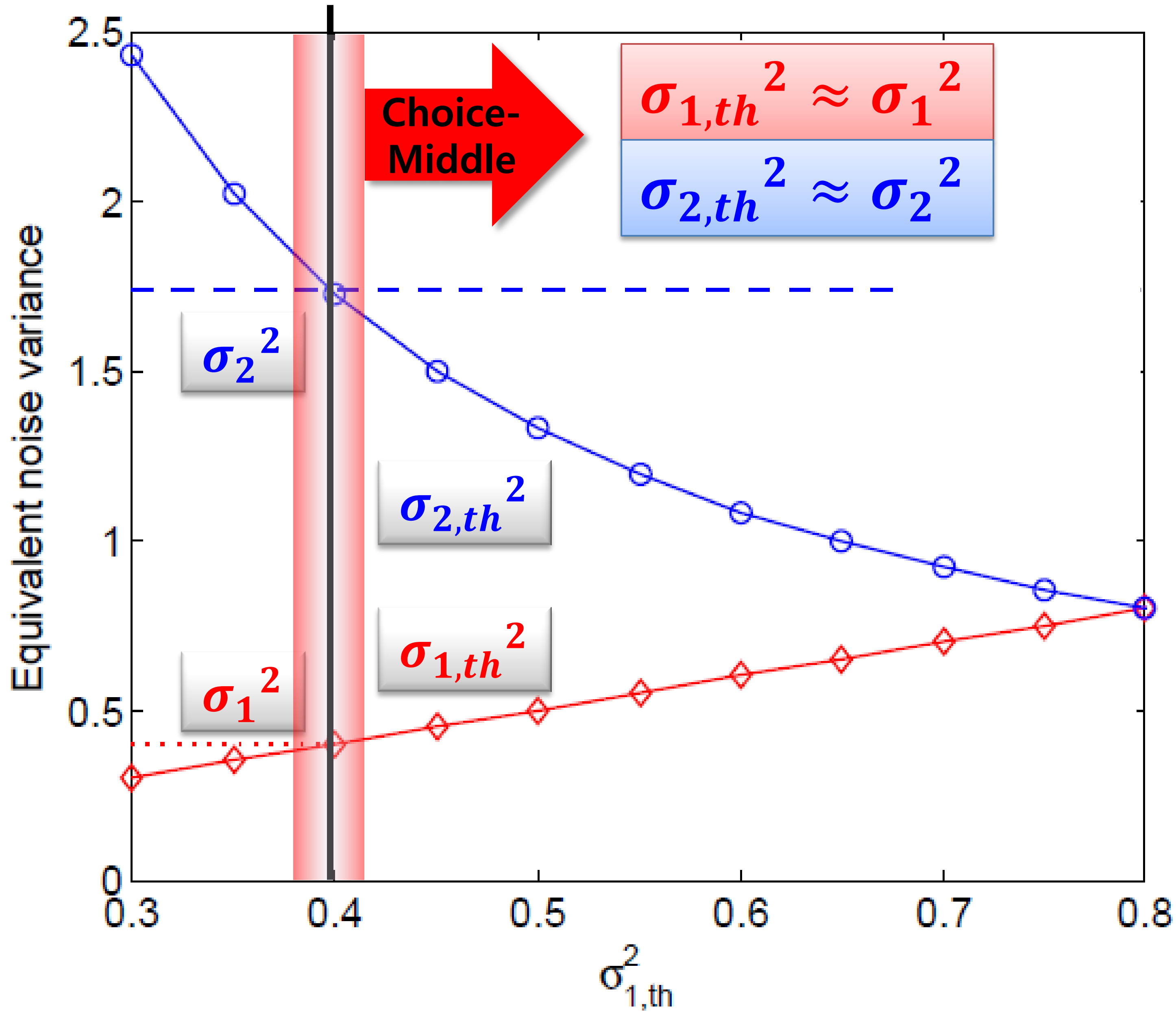
Design Example: ${\sigma_{a,th}}^2 = 0.8$ (i.e., $R_a = 0.5604$)



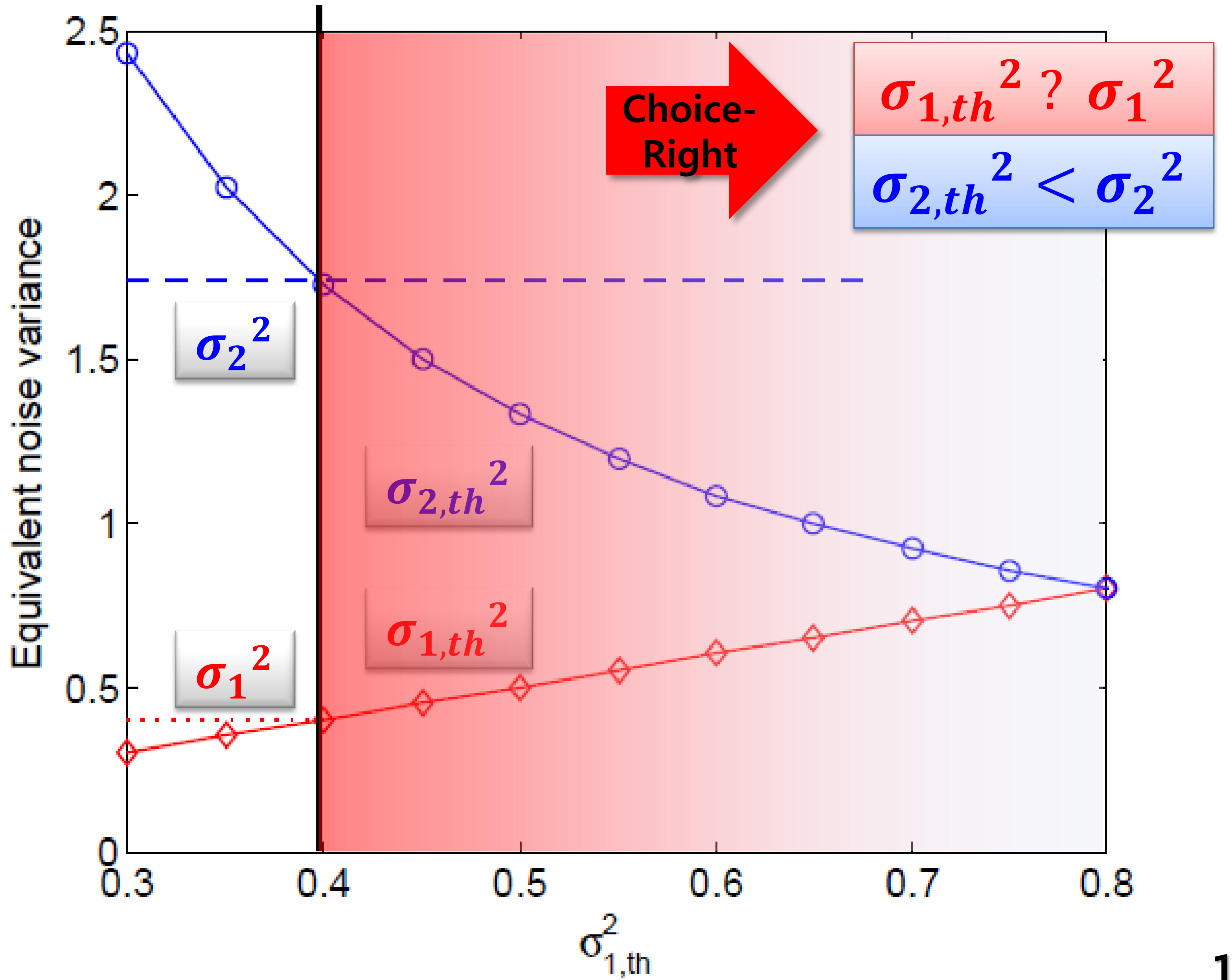
Design Example: ${\sigma_{a,th}}^2 = 0.8$ (i.e., $R_a = 0.5604$)



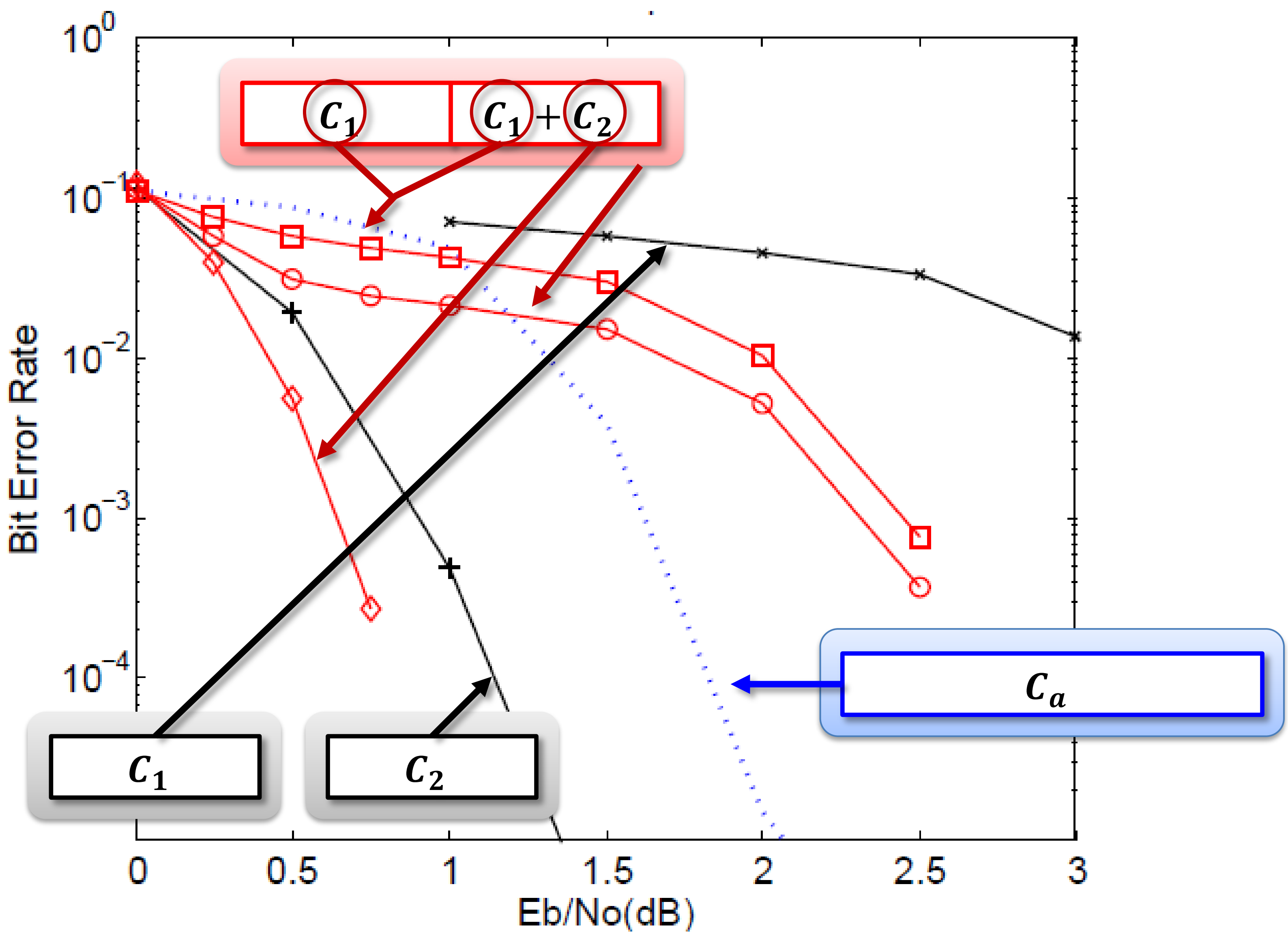
Design Example: $\sigma_{a,th}{}^2 = 0.8$ (i.e., $R_a = 0.5604$)



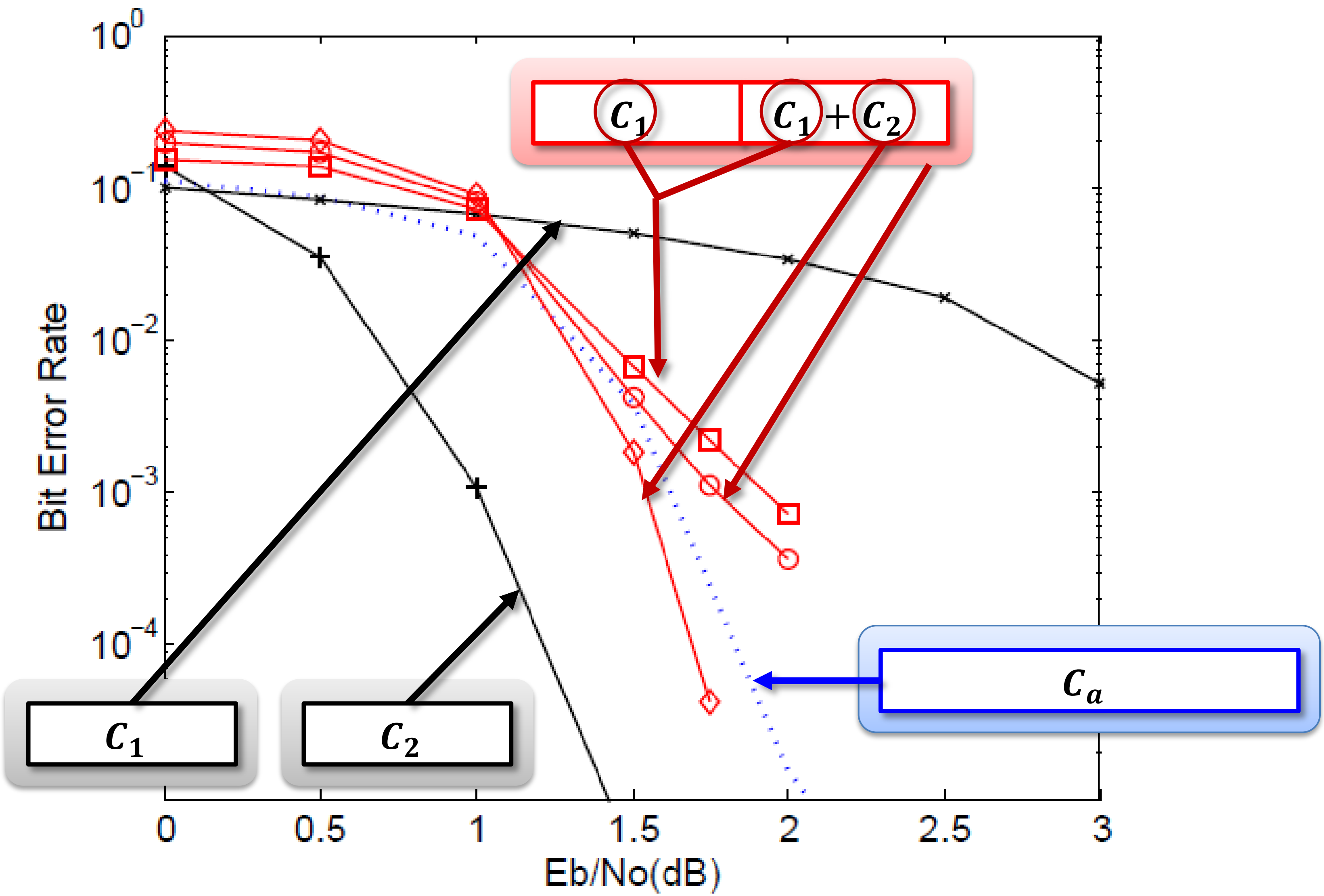
Design Example: $\sigma_{a,th}{}^2 = 0.8$ (i.e., $R_a = 0.5604$)



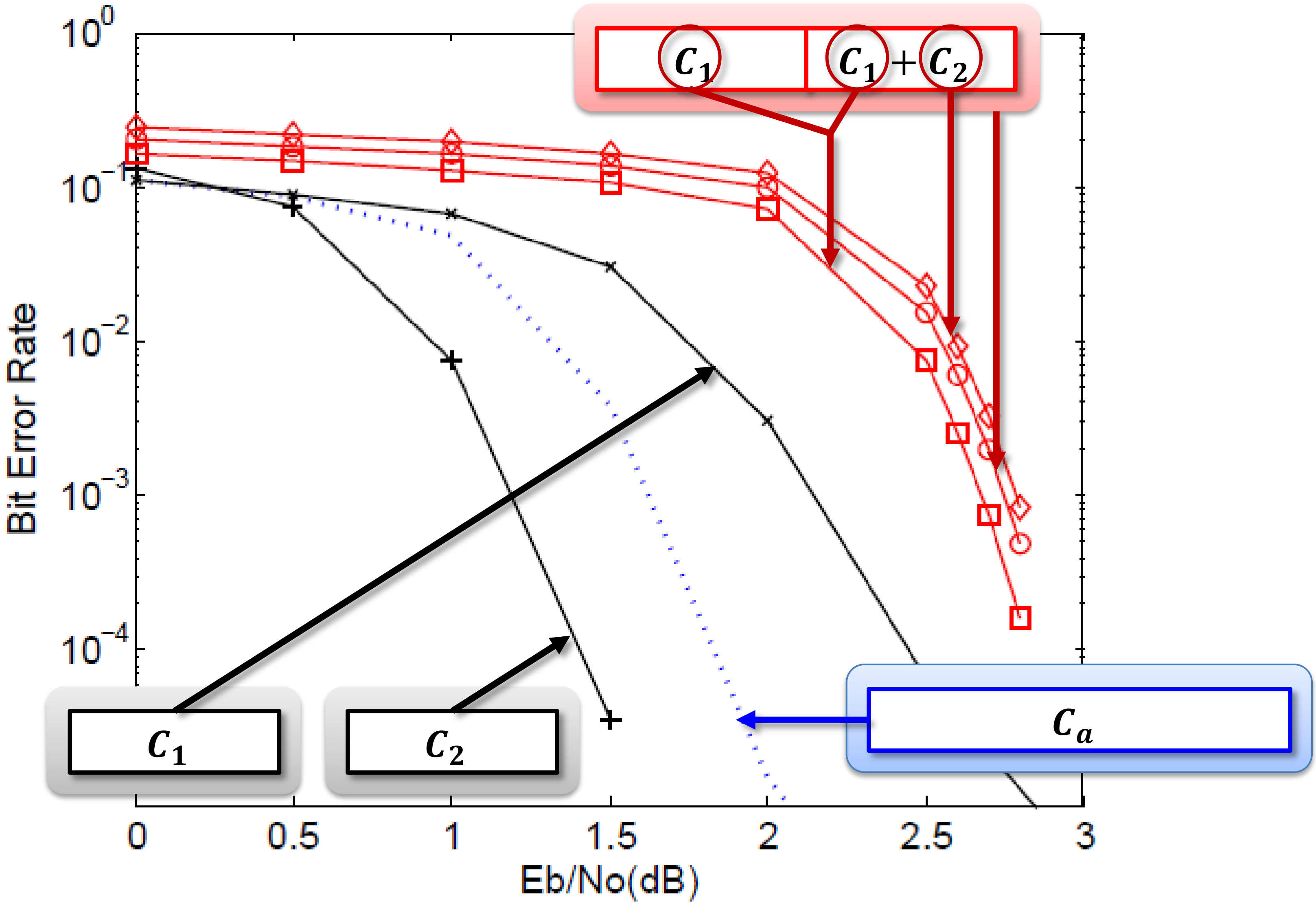
$\color{red}{Choice - Left}\ (\sigma_{1,th}{}^2 = 0.3)$: $R_1 = 0.87, R_2 = 0.25$



$\color{red}{Choice - Middle}$ $(\sigma_{1,th}{}^2 = 0.4)$: $R_1 = 0.79, R_2 = 0.33$



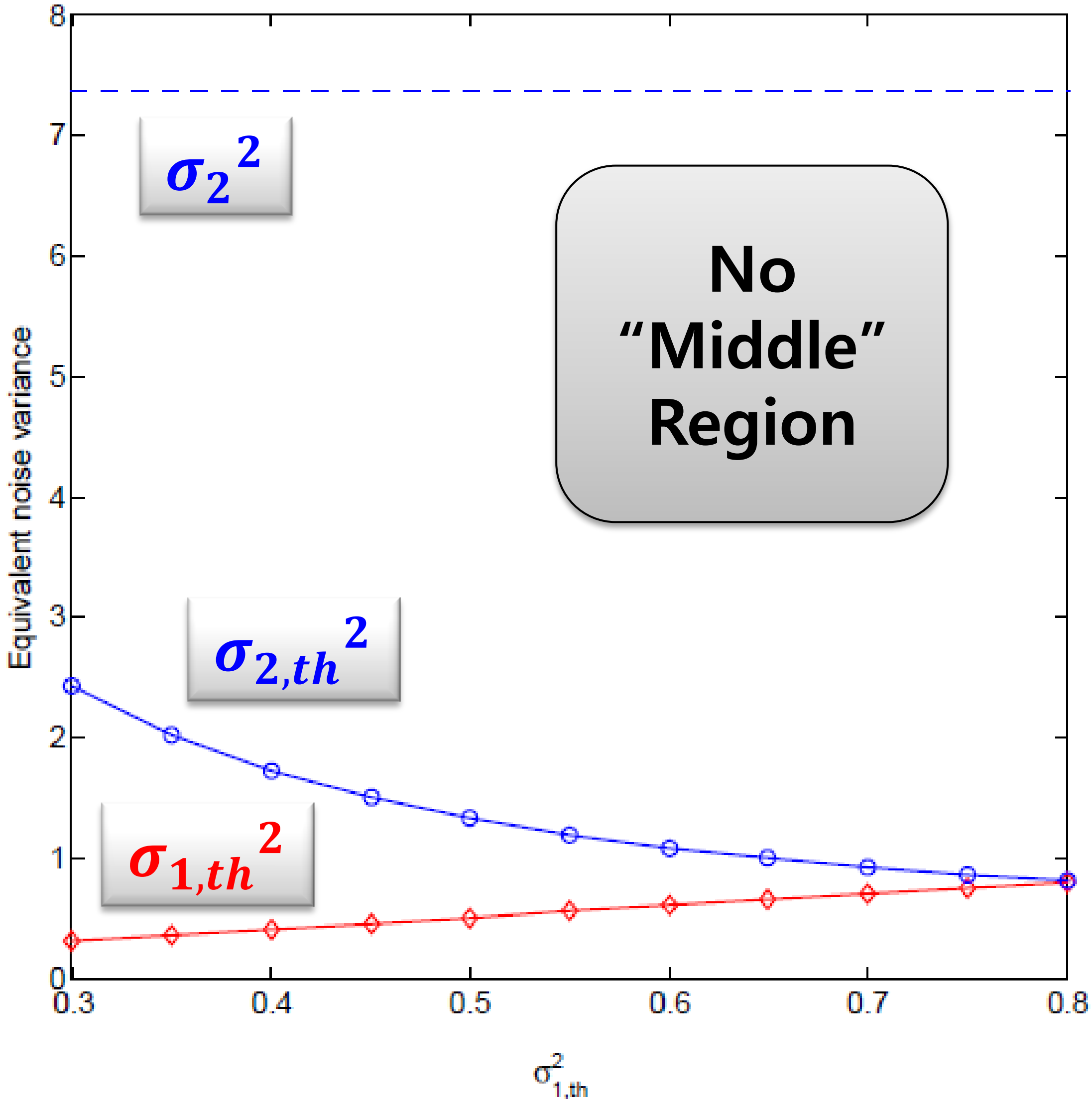
$\boldsymbol{Choice - Right}$ $(\sigma_{1,th}{}^2 = 0.619)$: $R_1 = 0.65, R_2 = 0.47$



Our Design Works as Expected

- '**Choice-Left**' Combination
  - **UEP capability ↑** **- Slightly Worse than C_a**
- '**Choice-Middle**' Combination
  - **UEP capability ↓** **- Comparable to C_a**
- '**Choice-Right**' Combination
  - **UEP capability ?** **- Much Worse than C_a**

Design Example: $\sigma_{a,th}{}^2 = 2.0$ (i.e., $R_a = 0.2905$)



Conclusions

- **Guideline for the rate allocation for the component codes of Plotkin-type UEP codes**.

⇒ We can construct the Plotkin-type codes **without brute force simulation of performance.**

  - For a **good overall performance**, we should select the code rates near the **"middle" region**.
  - For a **good UEP capability**, we suggest that the code rates should be selected in the **"left" region** and use **C_2 as MSB (instead of C_1)**.

Thank You for Listening!