Rate-Adaptive Reconciliation

Grupo de Investigación en
Información y Computación Cuántica

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Facultad de Informática
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QUITEMAD Workshop

Outline

1. Secret Key Agreement
2. Information Reconciliation
3. Rate Adaptive Protocol for Information Reconciliation

Information Theoretic Secret Key Agreement

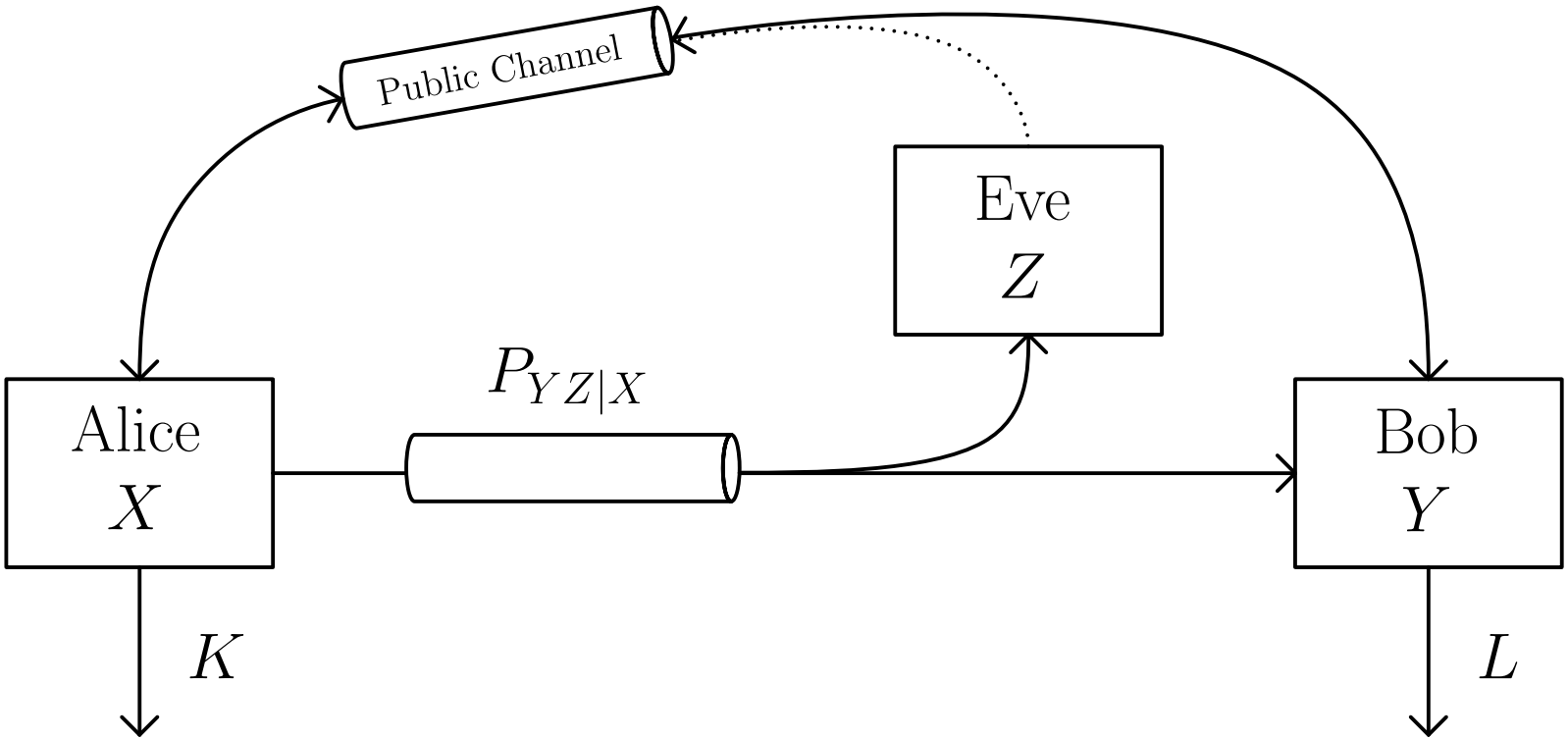


Figure: Channel type model with wiretapper (Ahlswede and Csiszar 1993)

Secret Key Agreement: A two step approach

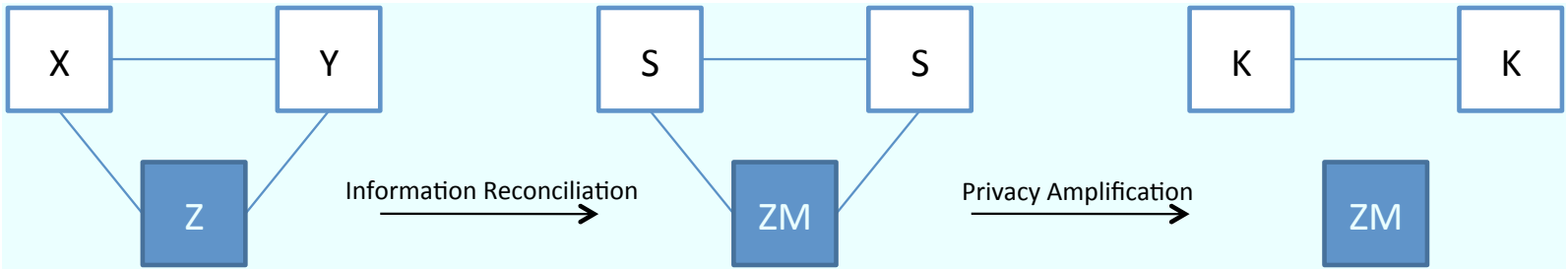


Figure: Variable relations in each step of the key distillation process (Van Assche 2004)

Information Reconciliation as Source Coding with Side Information

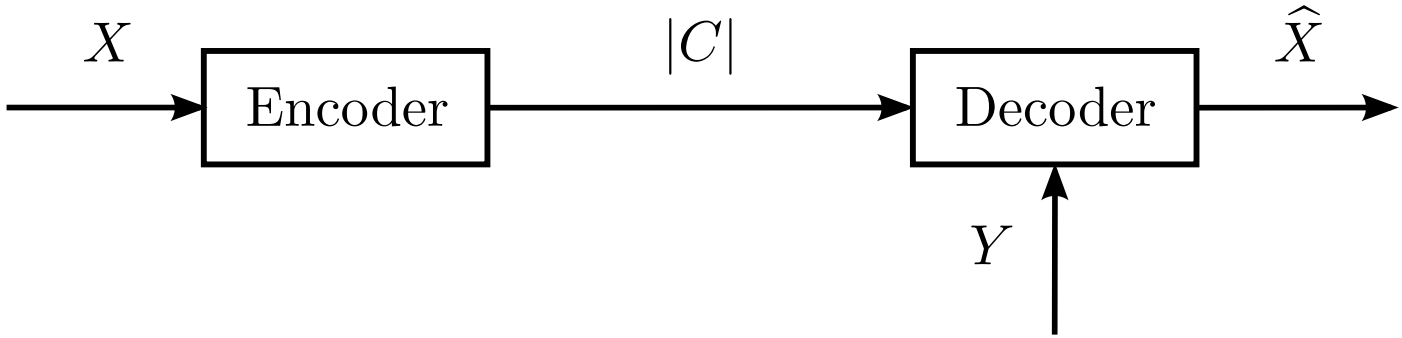


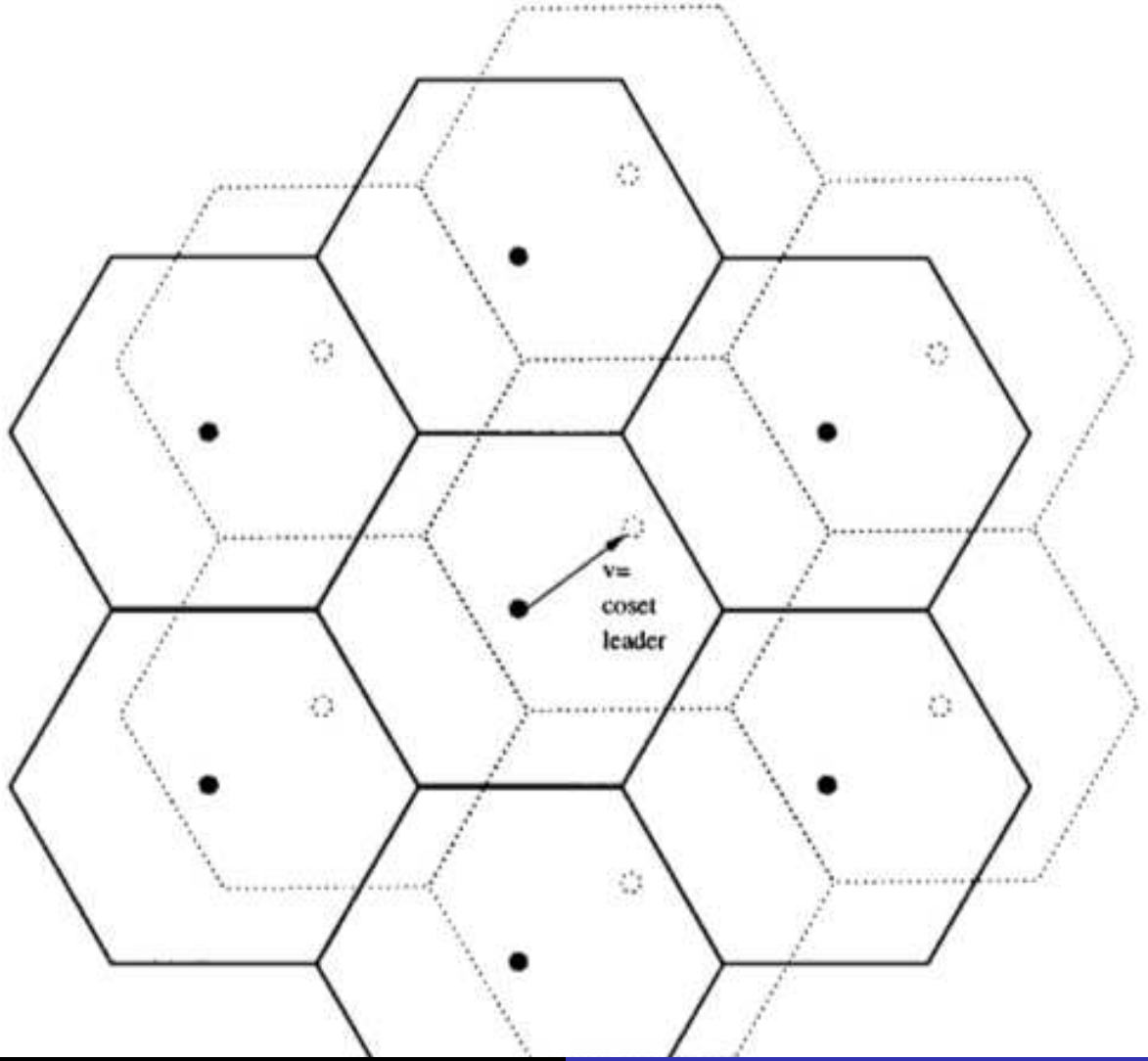
Figure: Source coding with side information.

Definition

Information Reconciliation Efficiency

$$f = \frac{|C|}{H(X|Y)} \geq 1$$

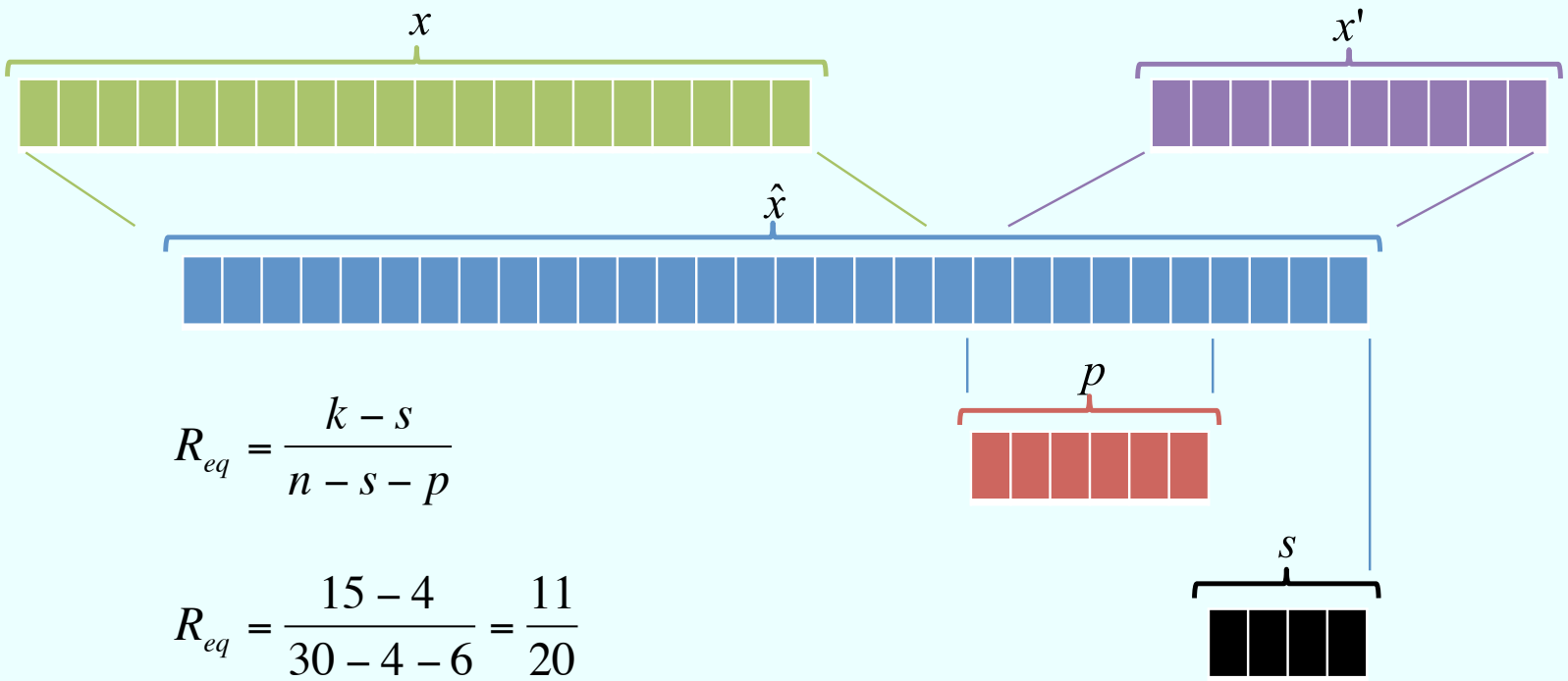
Syndrome Coding



Constraints: no interactivity

- Acts on packets of the same length
- Rate-adaptive with maximum granularity
- Uses one LDPC code
- No interactivity

Solution



$$R_{eq} = \frac{k - s}{n - s - p}$$

$$R_{eq} = \frac{15 - 4}{30 - 4 - 6} = \frac{11}{20}$$

Protocol

Alice and Bob have a code of size $|\widehat{x}|$ and an accurate estimate of p_{err}.

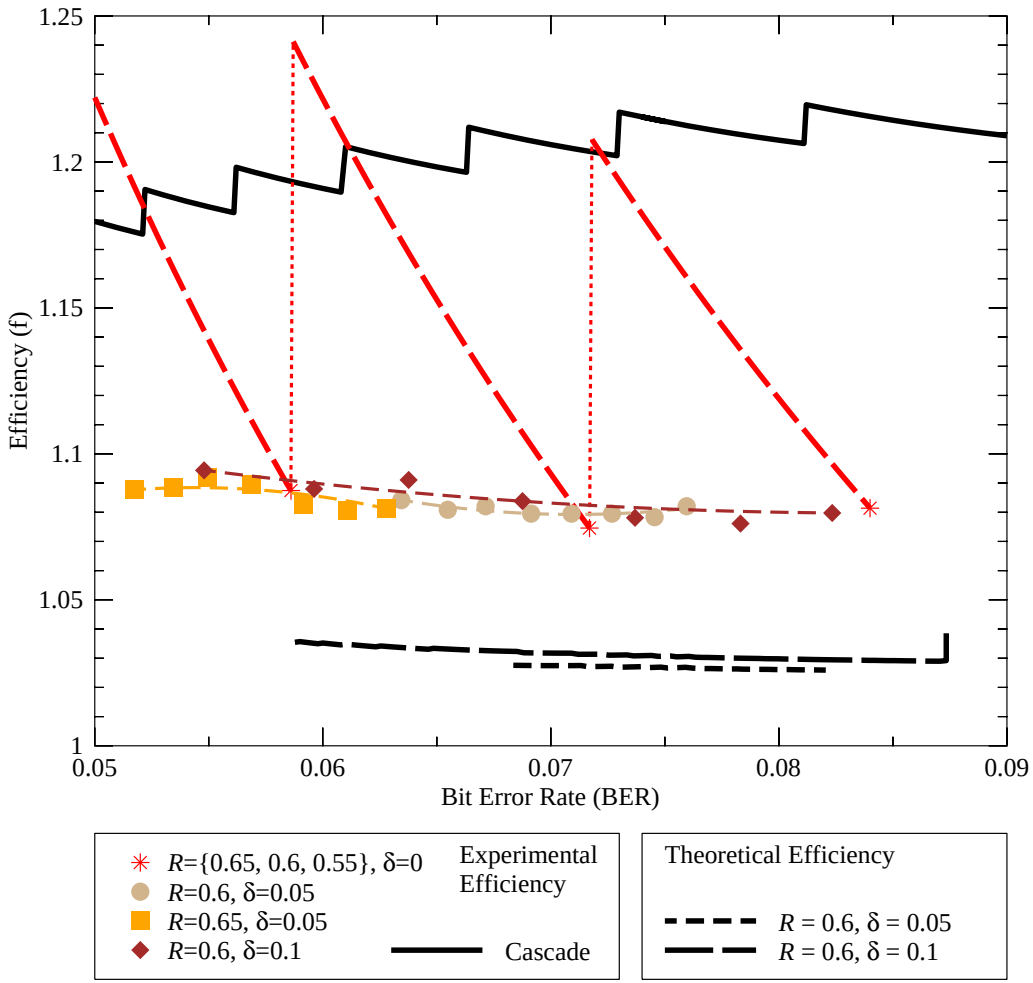
Alice:

1. Creates the extended string $\widehat{x} = x|s|p_A$
2. Transmits $s(\widehat{x})|s$

Bob:

3. Creates the extended string $\widehat{y} = y|s|p_B$
4. Tries to decode $\widehat{x}$

Simulation Results



Bibliography

D. Elkouss, J. Martínez, D. Lancho and V. Martín.
Rate Compatible Protocol for Information Reconciliation: An application to QKD.
IEEE Information Theory Workshop, pp. 145-149, 2010.

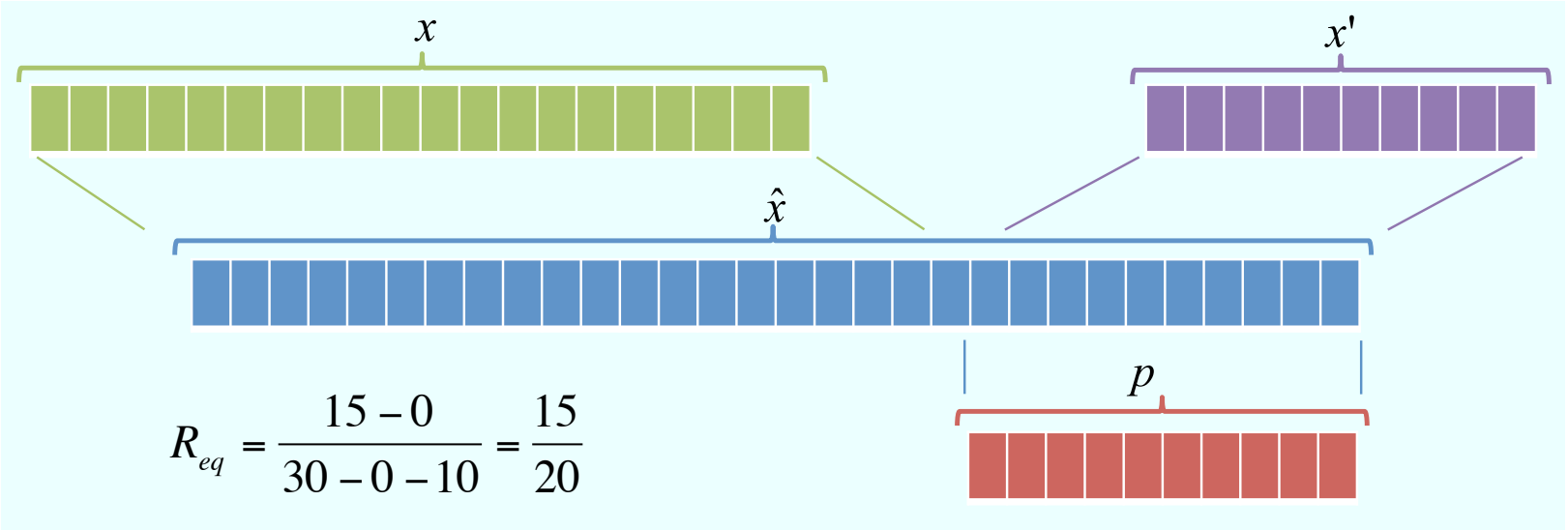
D. Elkouss, J. Martínez, D. Lancho and V. Martín.
Método de reconciliación de información para QKD mediante el uso de códigos LDPC adaptando la tasa de información
Patent P201030099.

D. Elkouss, J. Martínez and V. Martín.
Efficient Reconciliation with Rate Adaptive Codes in Quantum Key Distribution
Quantum Information and Computation, pp. 226-238, 2011.

Constraints: interactivity

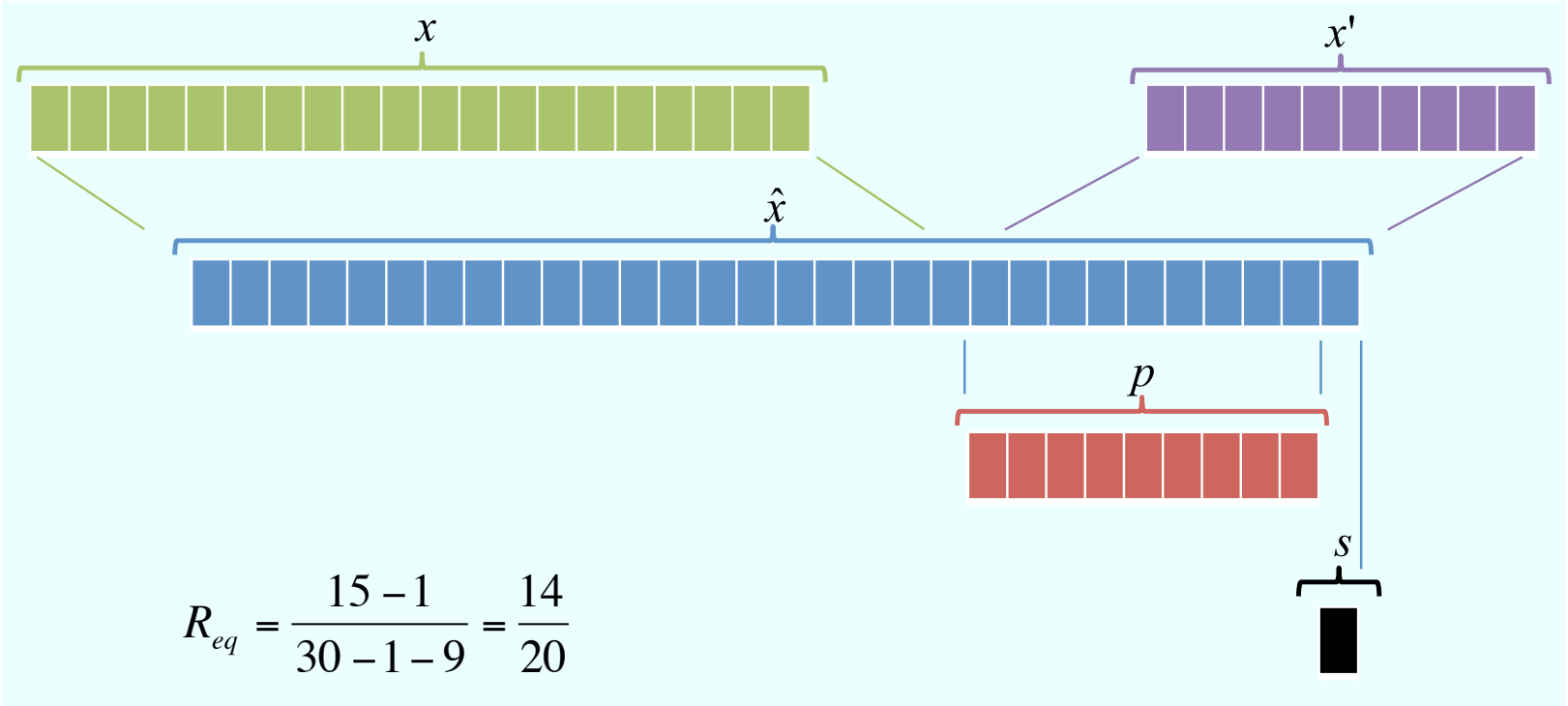
- Acts on packets of the same length
- Rate-adaptive with maximum granularity
- Uses one LDPC code
- Some interactivity allowed

Solution



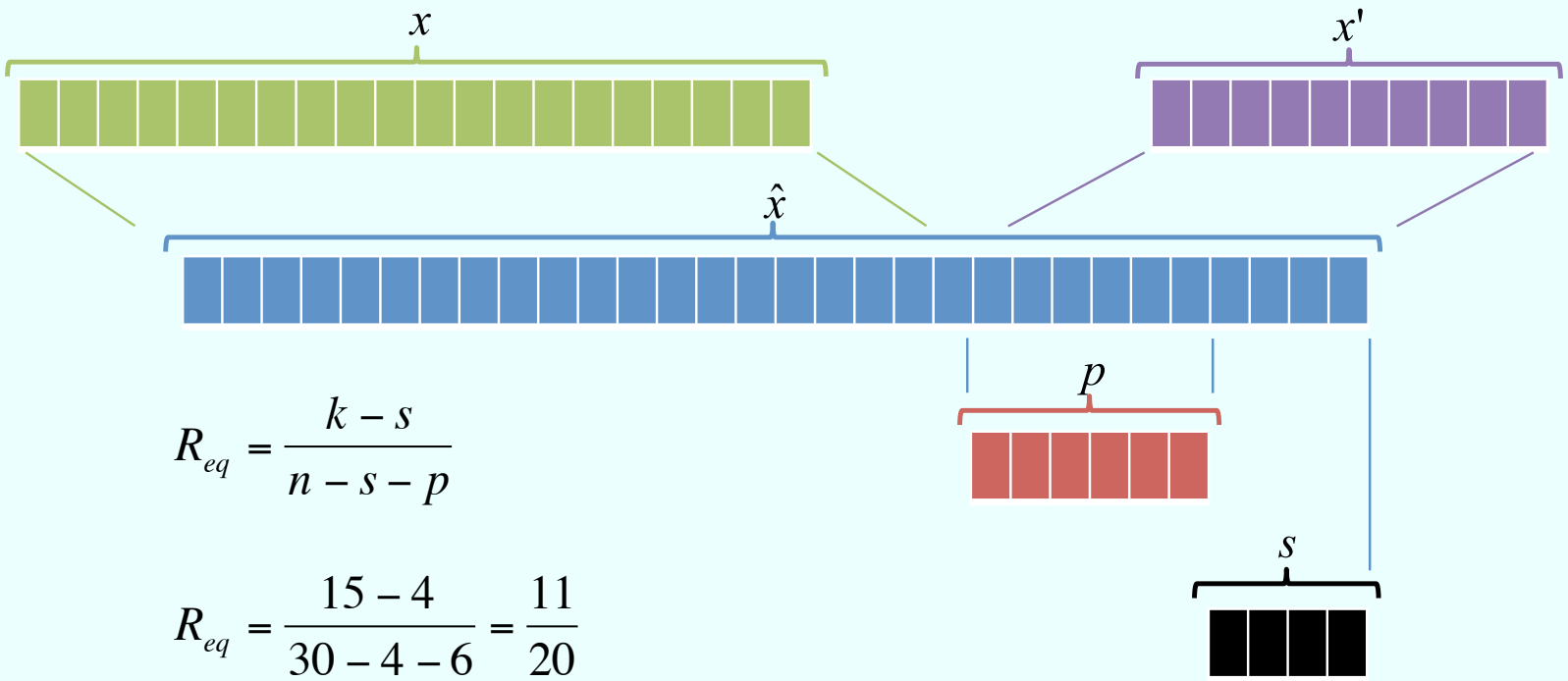
$$R_{eq} = \frac{15-0}{30-0-10} = \frac{15}{20}$$

Solution



$$R_{eq} = \frac{15-1}{30-1-9} = \frac{14}{20}$$

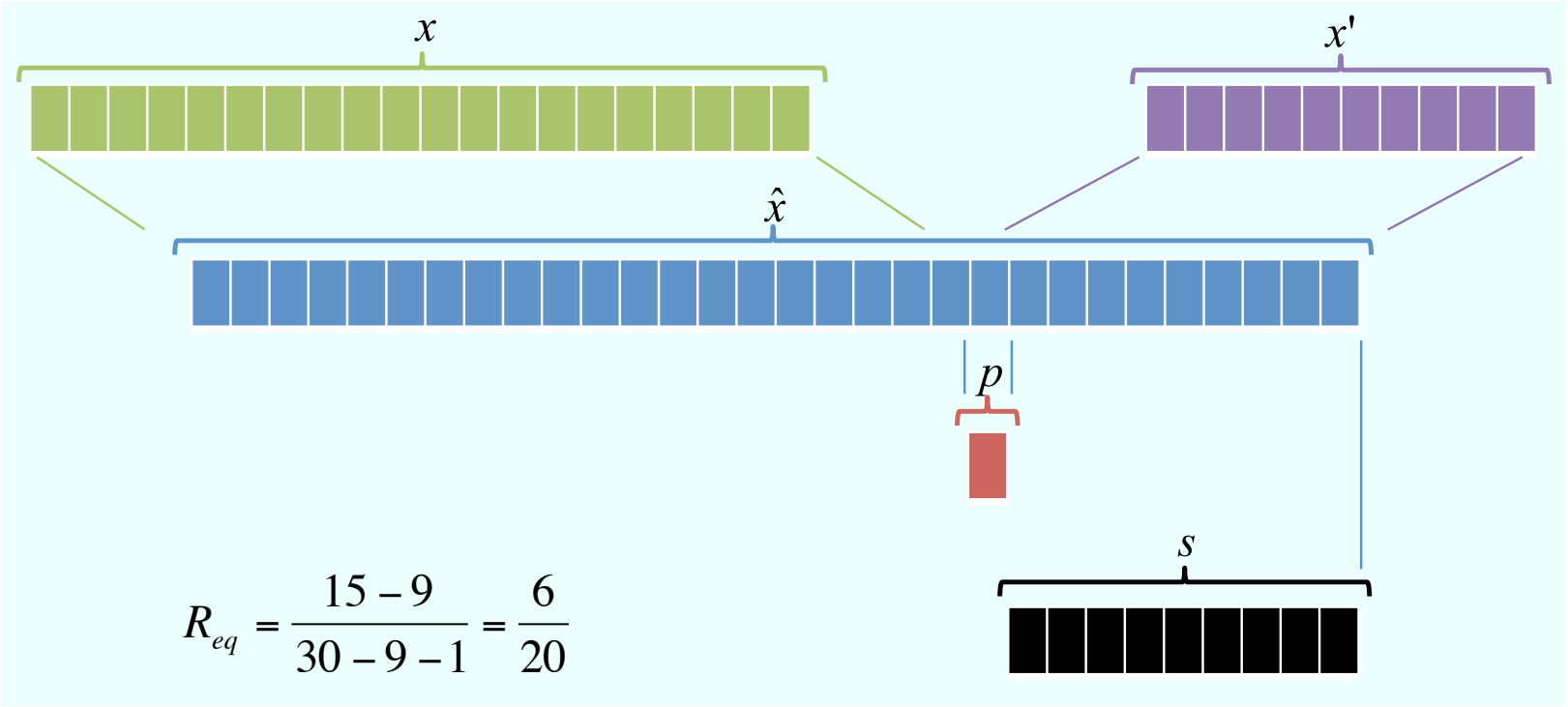
Solution



$$R_{eq} = \frac{k - s}{n - s - p}$$

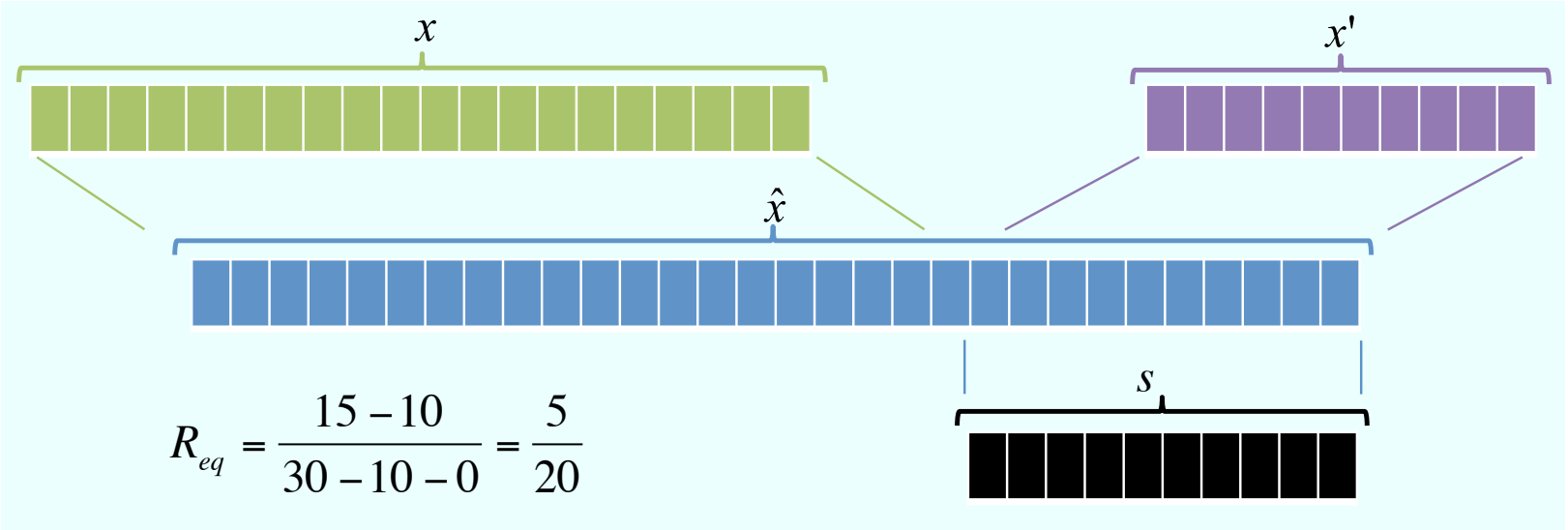
$$R_{eq} = \frac{15 - 4}{30 - 4 - 6} = \frac{11}{20}$$

Solution



$$R_{eq} = \frac{15-9}{30-9-1} = \frac{6}{20}$$

Solution



$$R_{eq} = \frac{15-10}{30-10-0} = \frac{5}{20}$$

Protocol

Bob:

3. Creates the extended string $\widehat{y} = y|s|p_B$
4. Tries to decode $\widehat{x}$
5. Transmits the result to Alice

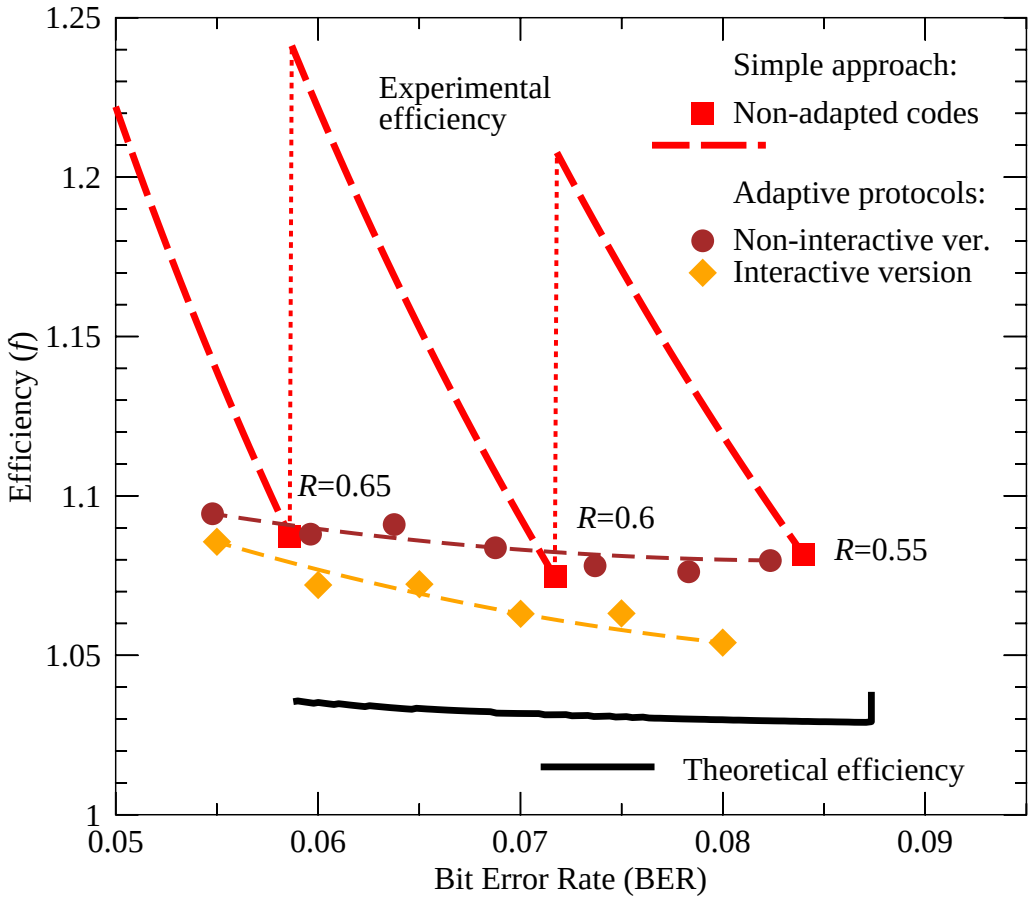
Alice:

6. If successful decoding $\Rightarrow$ end
7. Transmits s'

Bob:

3. Creates the extended string $\widehat{y} = y|s|p_B$
4. ...

Simulation Results



Bibliography

J. Martínez, D. Elkouss and V. Martín.
Interactive Reconciliation with Low-Density Parity-Check Codes.
6th Int. Symposium on Turbo Codes & Iterative Information Processing, pp. 280-284, 2010.

Summary

The efficiency of Information Reconciliation has a strong impact on the size of the final secret key

Error correcting codes are a good solution to the problem

We propose a rate compatible solution with the same efficiency as adapted codes