Additively Homomorphic UC Commitments With Optimal Amortized Overhead

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Structure

1. Introduction

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2. Our Contributions

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3. A general framework

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4. Open Questions

Commitment Schemes

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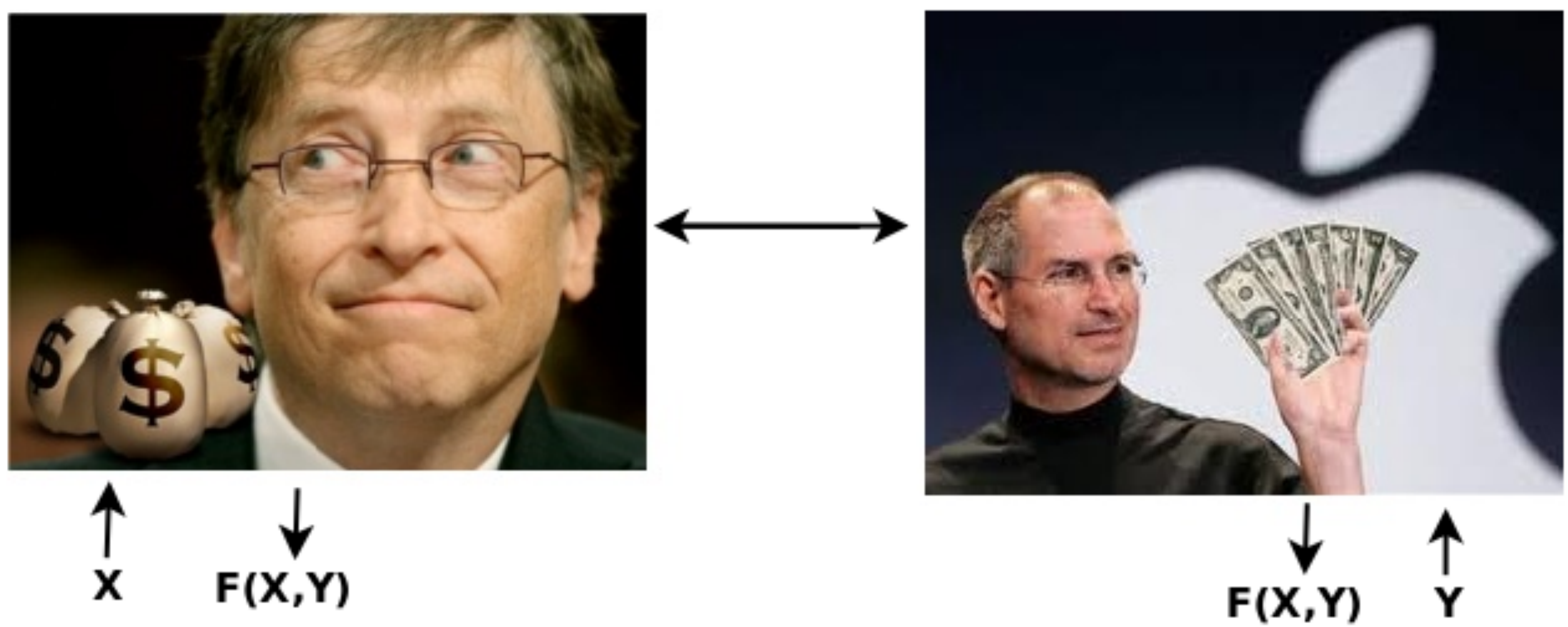
Multiparty Computation

- The Millionaires’ Problem



Universal Composability

- Protocols remain secure in parallel concurrent executions and arbitrary composition.

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- Commitments require setup assumptions [CF01].
- Commitments are complete [CLOS02].

Related Works

- DDH based fast UC commitments: [Lindell11,BCPV13].
  - Use a Common Reference String (CRS).
  - High asymptotic communication and computational complexity.

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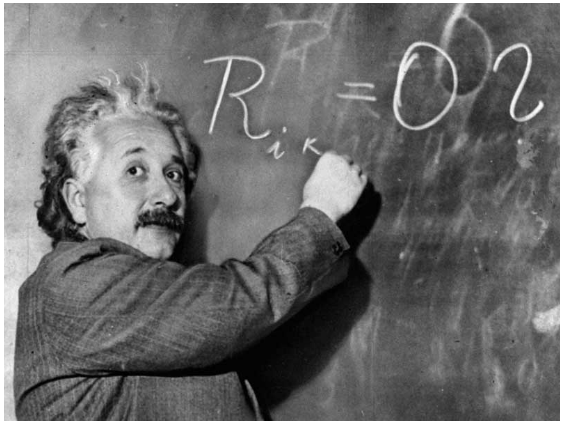
  - Use a Common Reference String (CRS).
  - High asymptotic communication and computational complexity.
- UC commitments with optimal rate: [DDGN14,GIKW14].
  - Use Oblivious Transfer as a setup assumption.
  - Require PRGs and general Linear Secret Sharing.

What do we do in theory?



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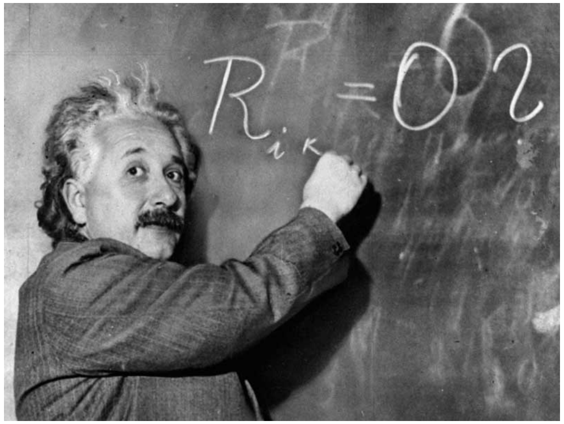

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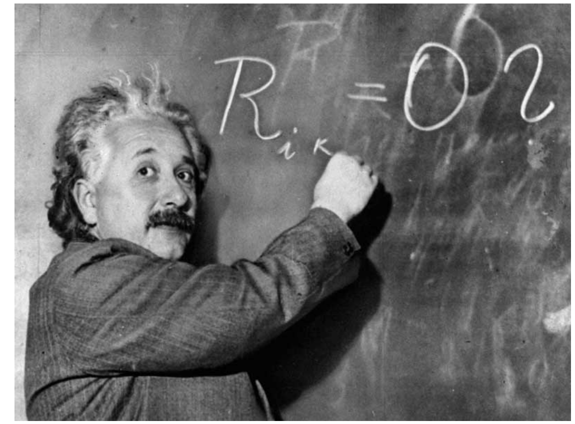
- Optimal communication
- Additively Homomorphic



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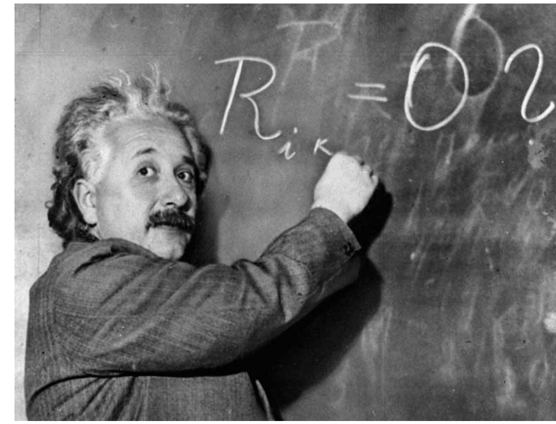

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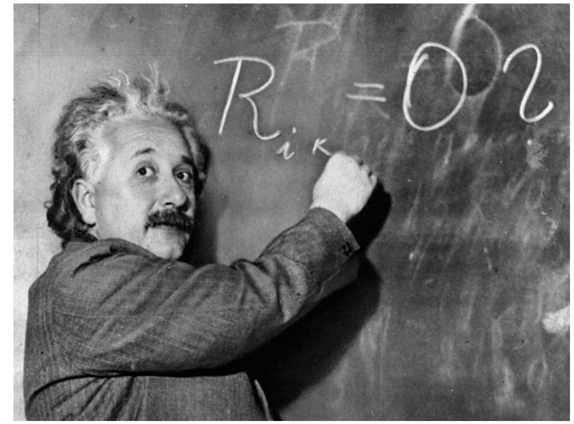

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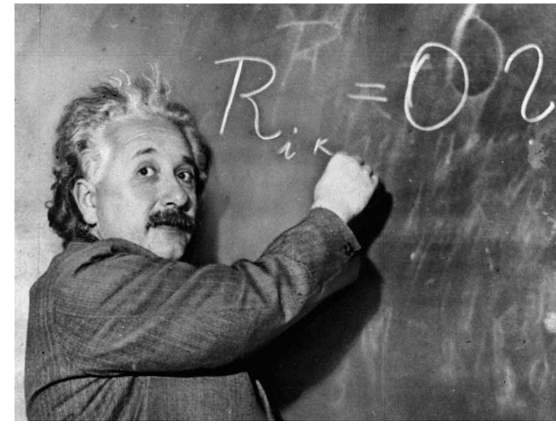
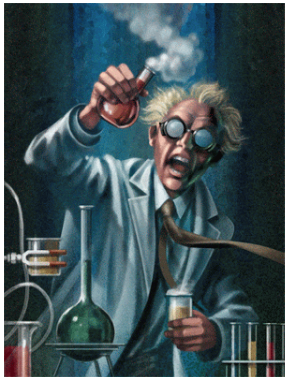


- Optimal communication
- Additively Homomorphic
- Optimal computation NEW!
- No need for general secret sharing NEW!

How do we do it?

ECC + PRG + OT

What do we do in practice?



- Online Phase:

BCH [796,256,>=121] + PRG

2 Encodings: 1.5 μs

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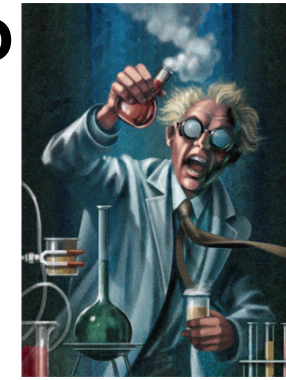

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VS.

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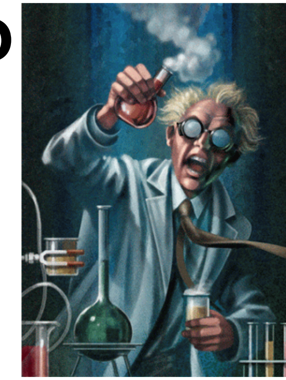

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=

- Practical scheme runs 5500 times faster

Practical Trade Offs…

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- No additive homomorphism.

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- Setup phase cost:

796 OTs

8756 exponentiations using [PVW08]

398 [Lindell11,BCPV13] commitments

Building Blocks

- Error correcting codes:
  - Linear-time encodable codes [GI01,GI02,GI03,GI05,Spi96,DI14].

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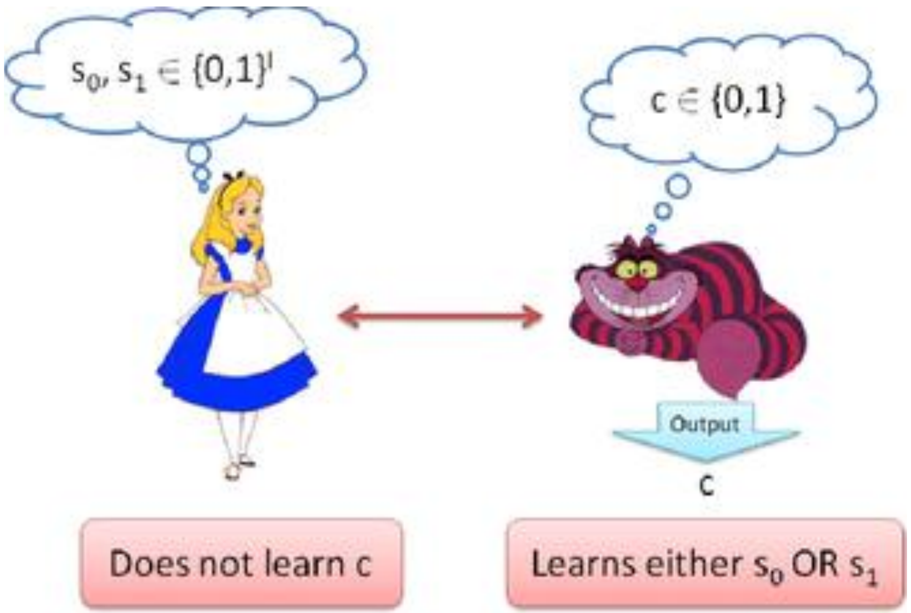
- UC Oblivious Transfer:
  - Any UC Oblivious Transfer protocol, e.g. [PVW08]
- Pseudorandom Generator:
  - Linear-time PRG, e.g. [VZ12]

Oblivious Transfer



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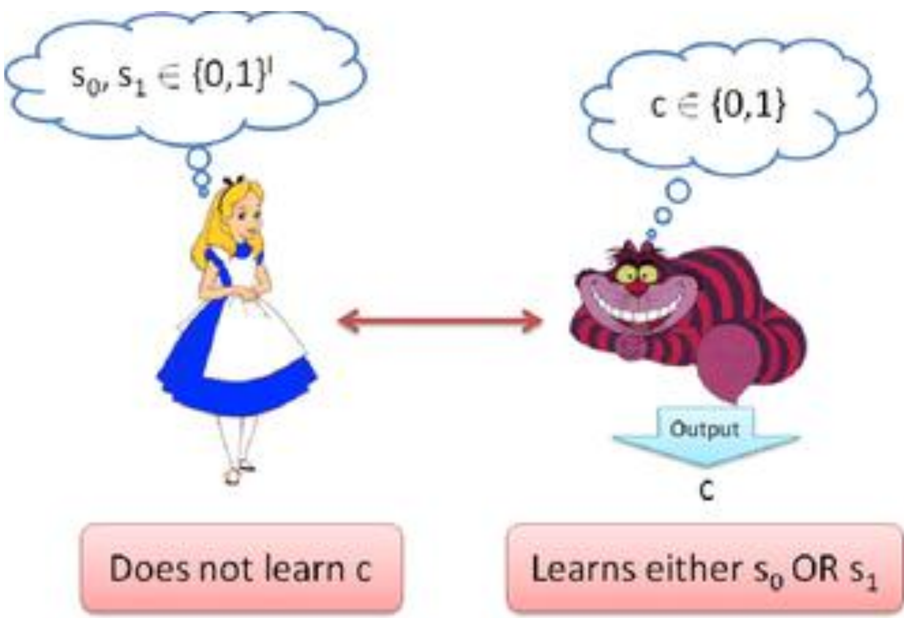
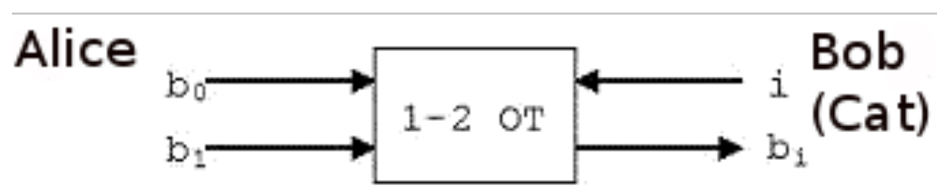
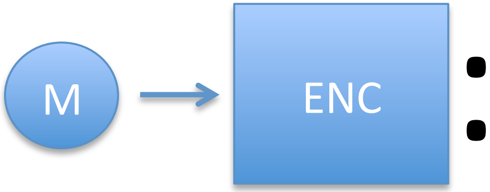




Encoding Scheme



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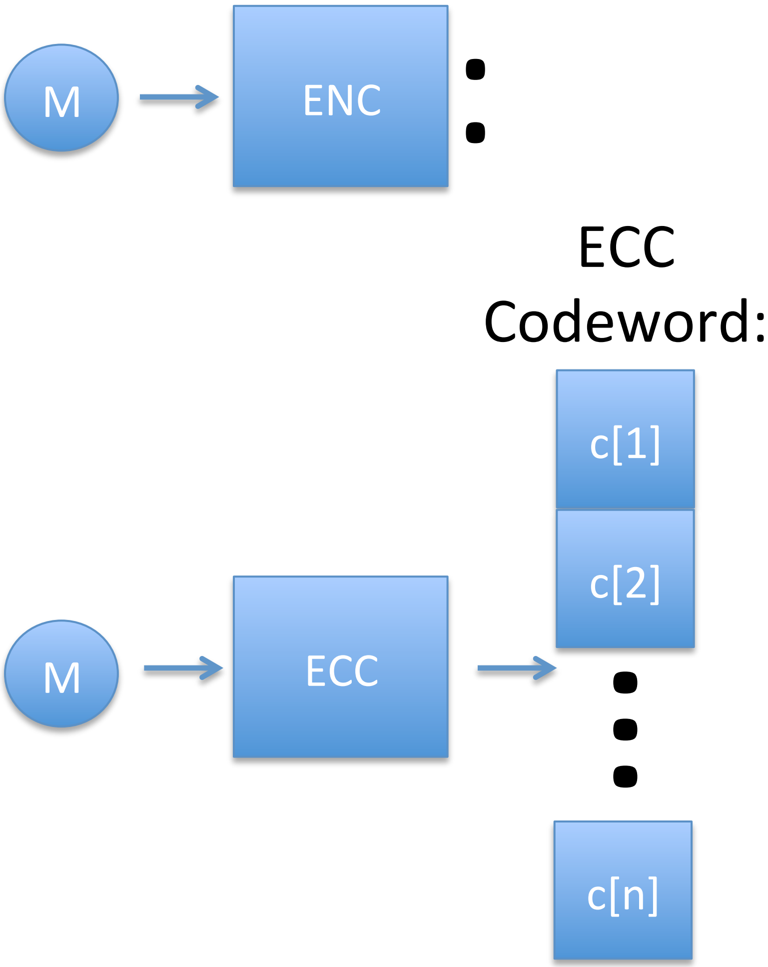

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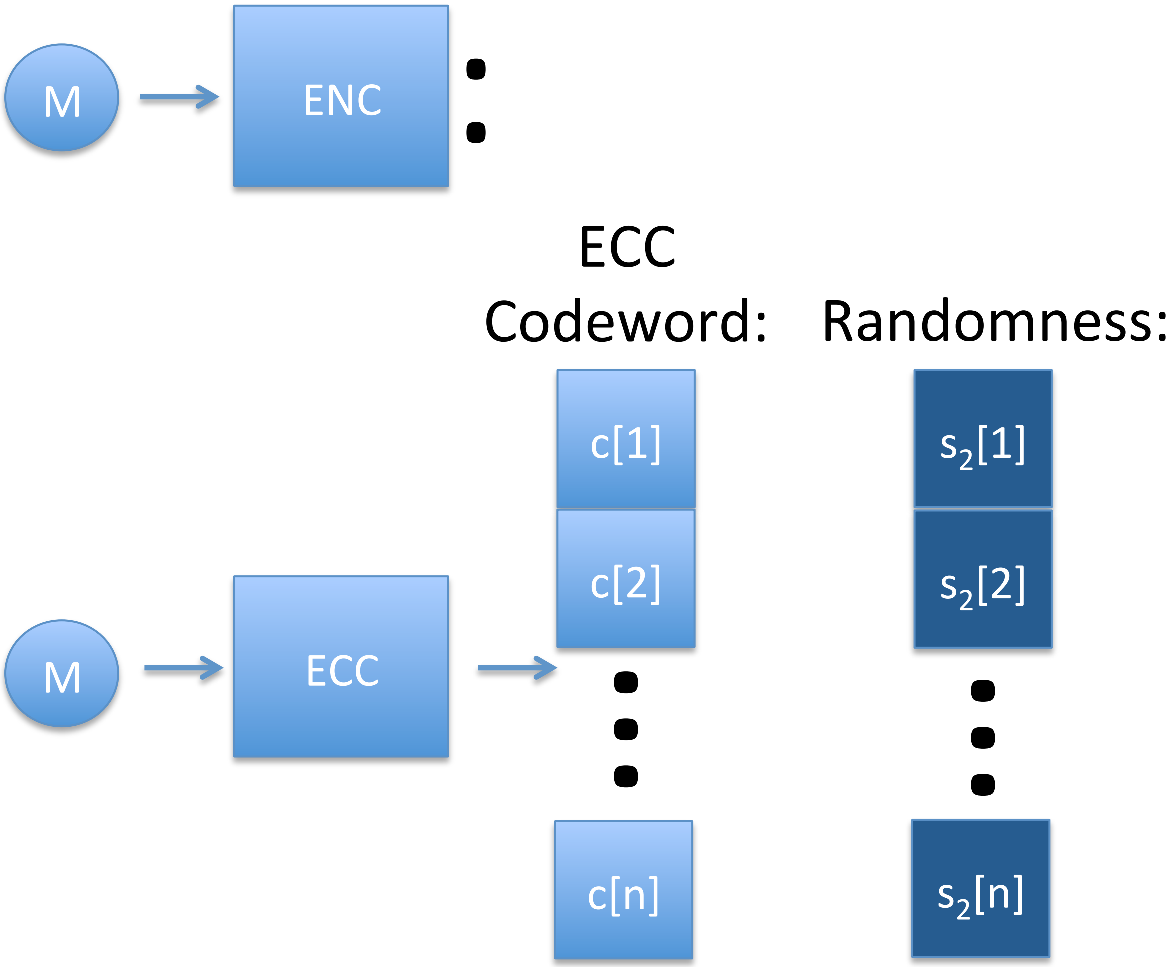

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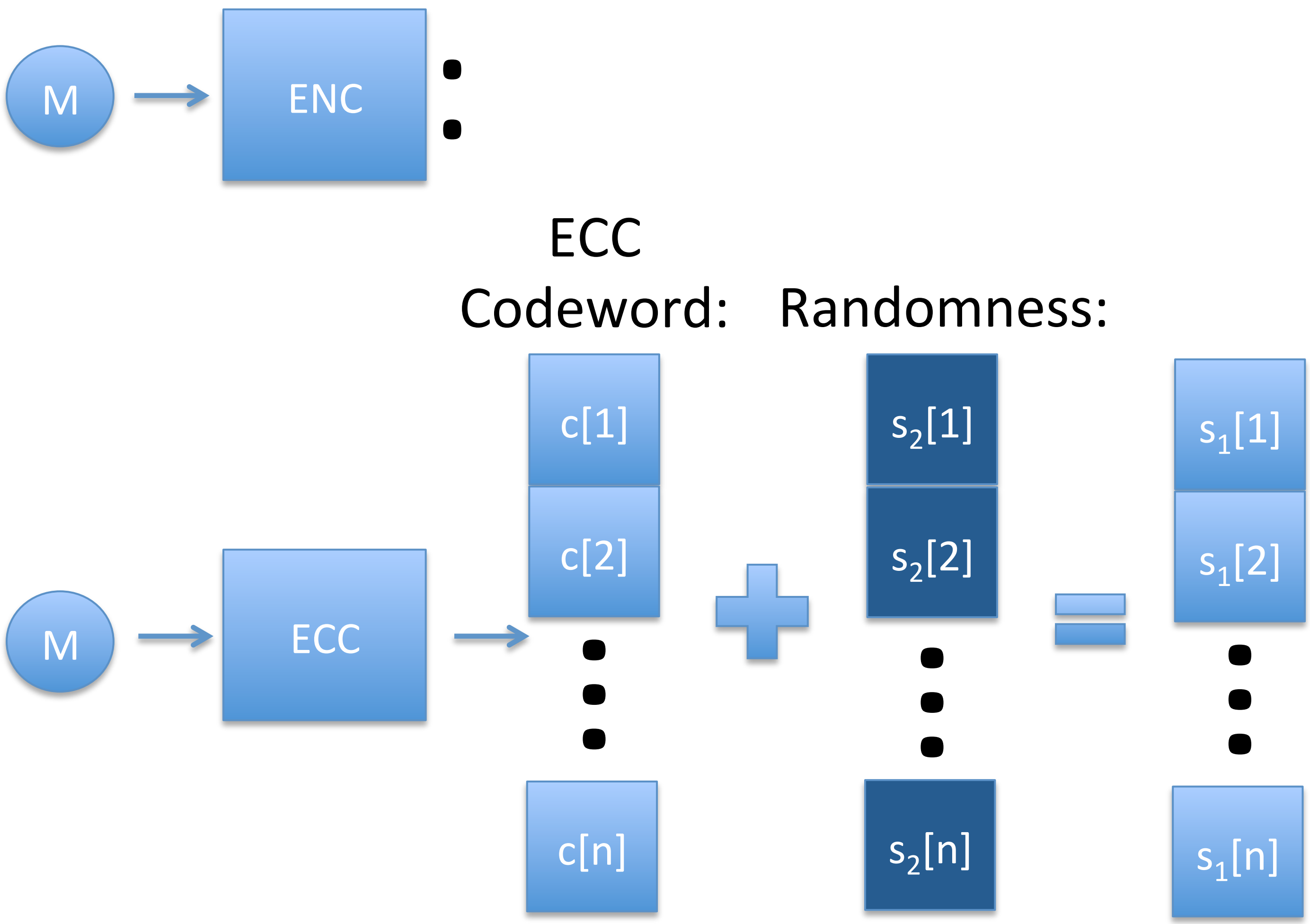

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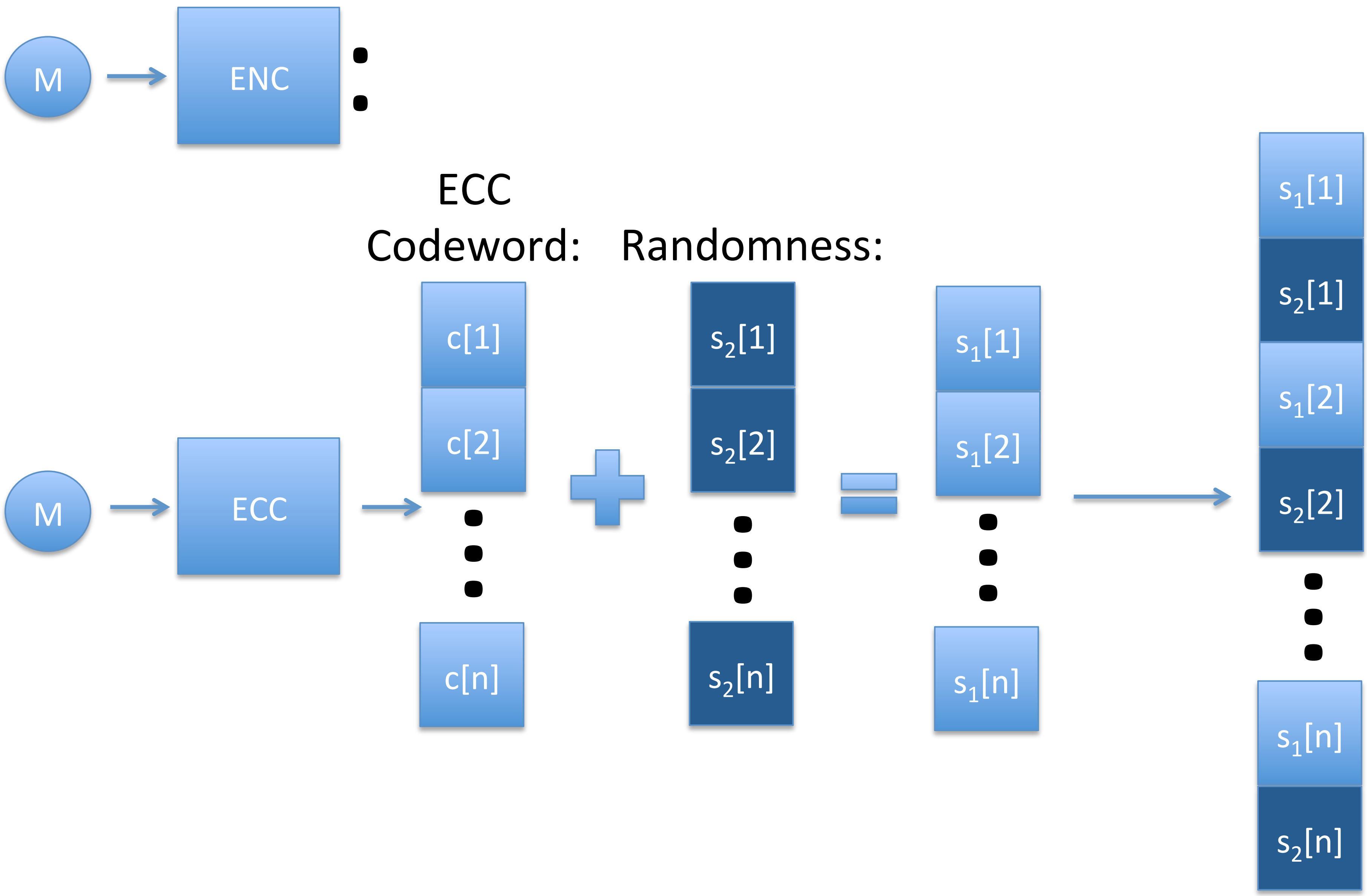

General Framework

- Setup phase:

- Commitment/Open Phases:

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General Framework

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  - Constant number of OTs for unbounded number of commitments.
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- Commitment/Open Phases:
  - Linear communication complexity.
  - Only require a PRG and the encoding scheme.
  - Non interactive.

Setup Phase

Sender

Receiver

Random
Seeds:

Setup Phase

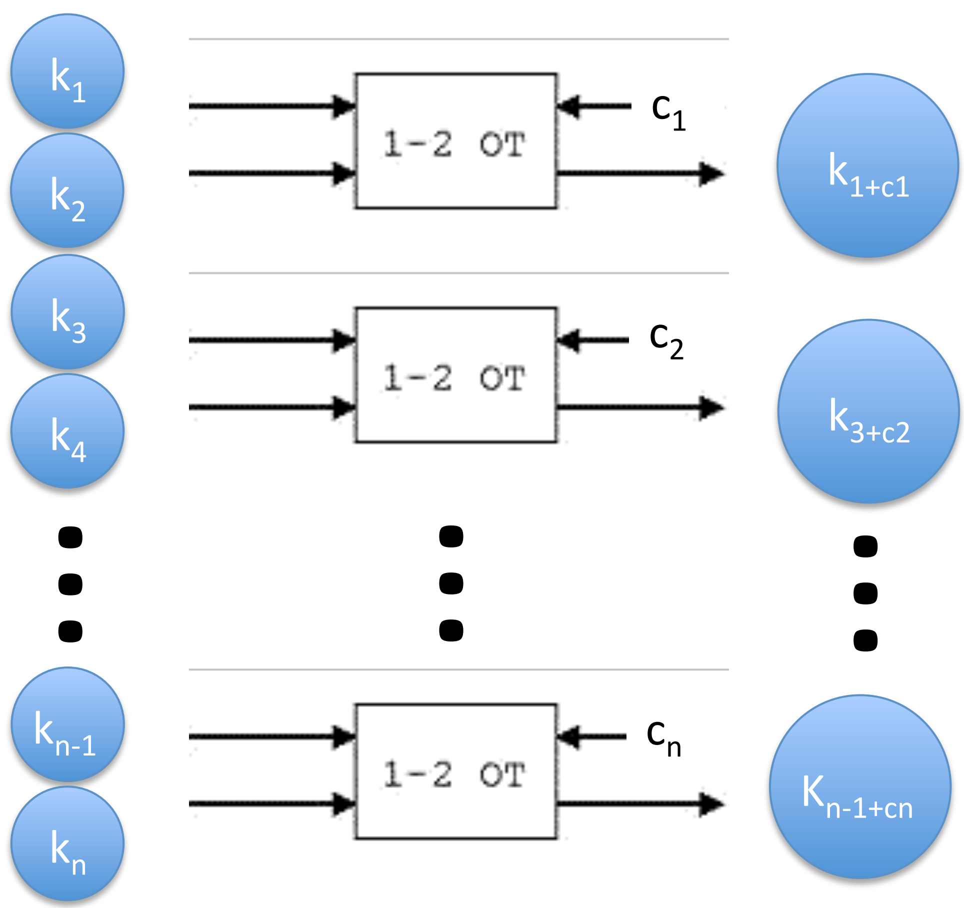
Sender

Receiver

Random Seeds:

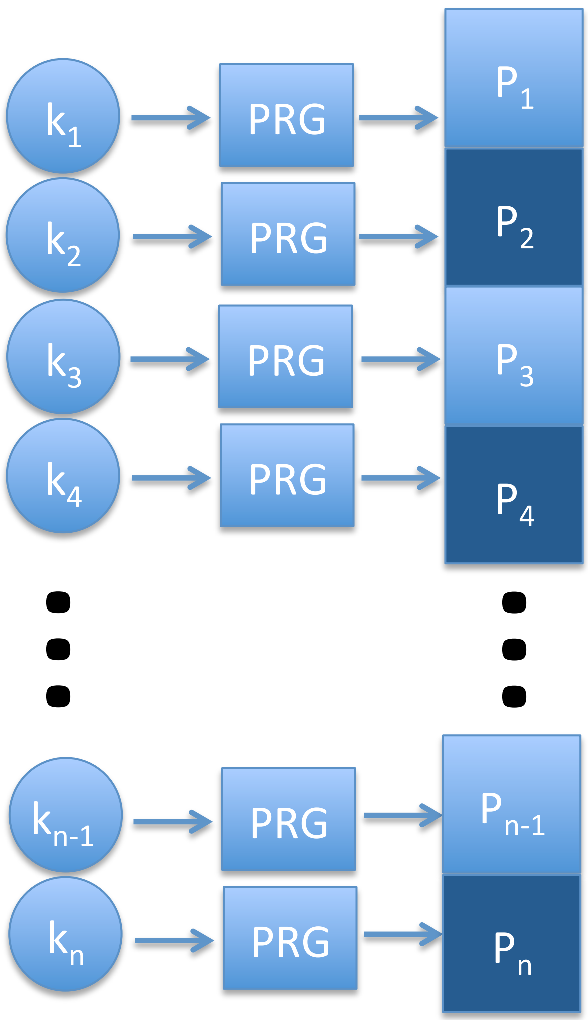
Random Choices:

Received Seeds:



Commitment Phase (Sender)

Generate one-time pads:



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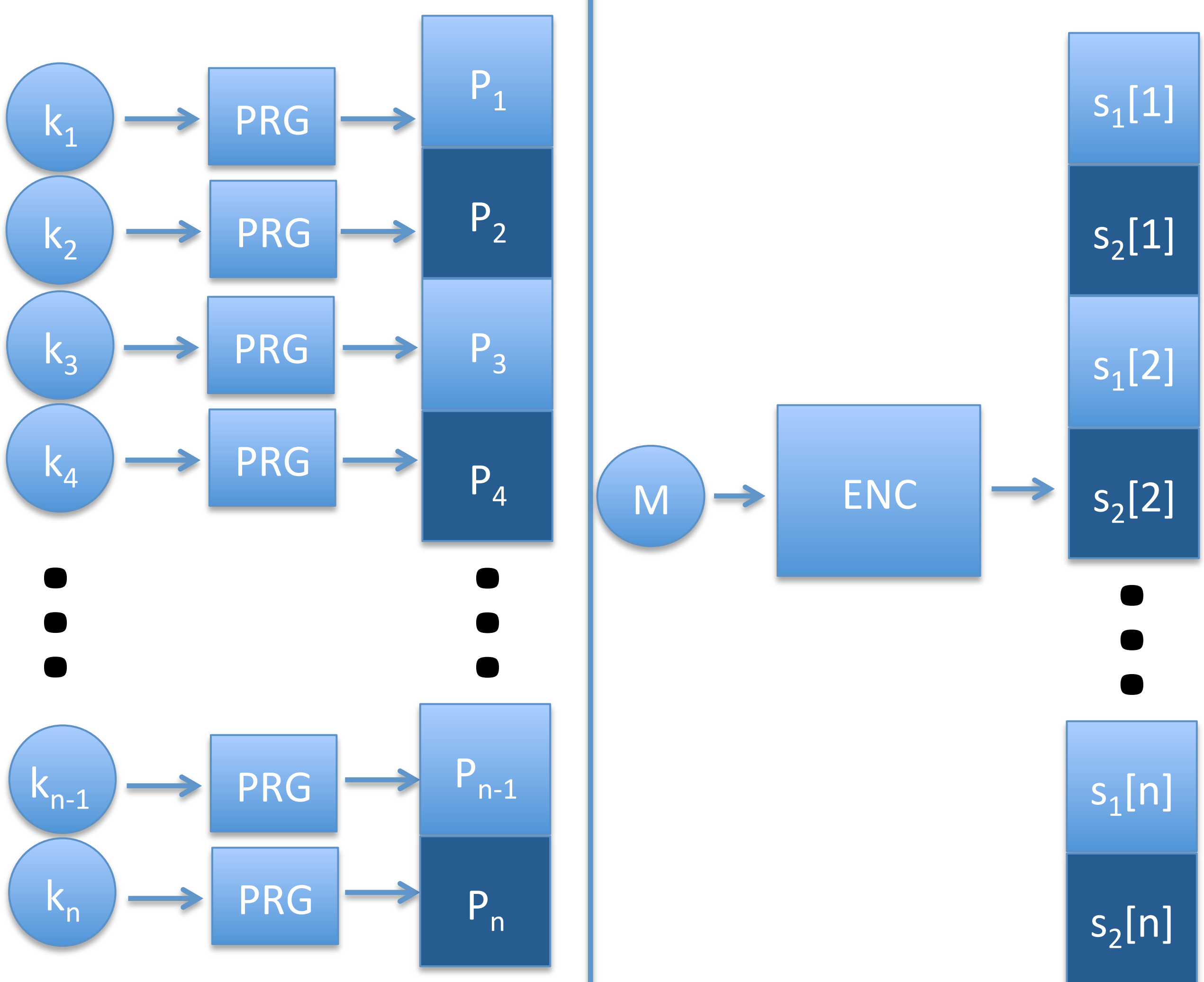
Encode messages and encrypt with one-time pads:



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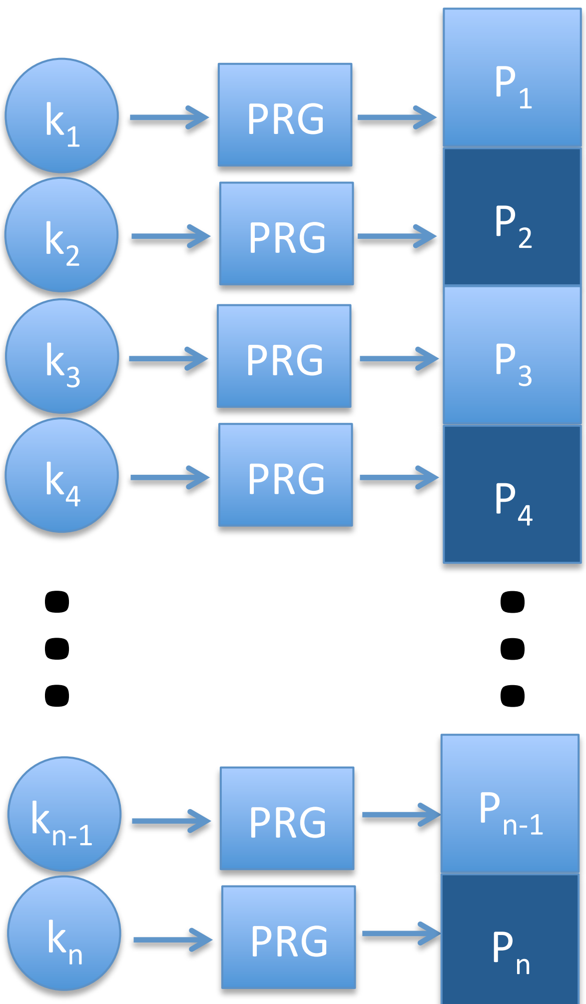

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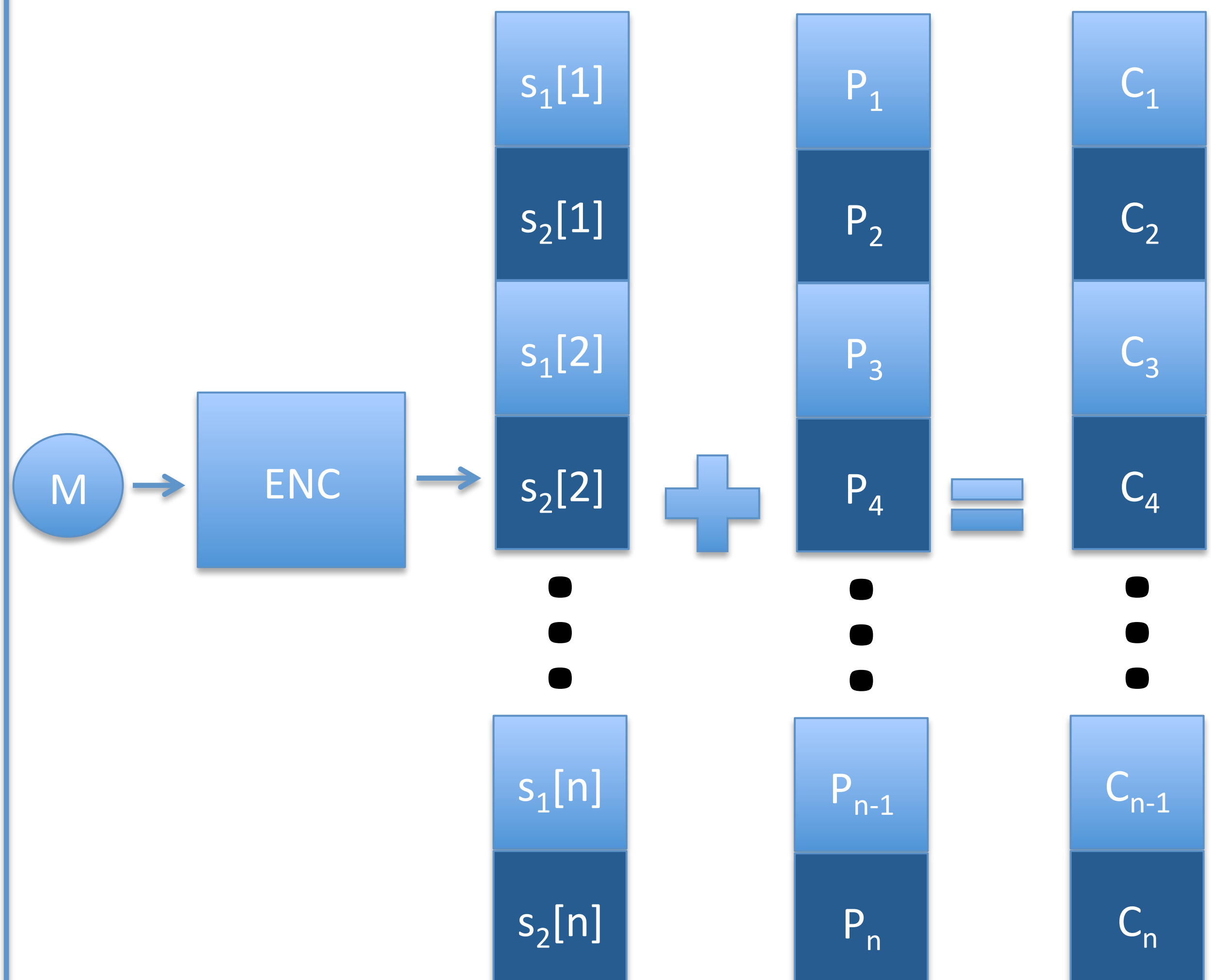

Open Phase (Receiver)

Opening Message:

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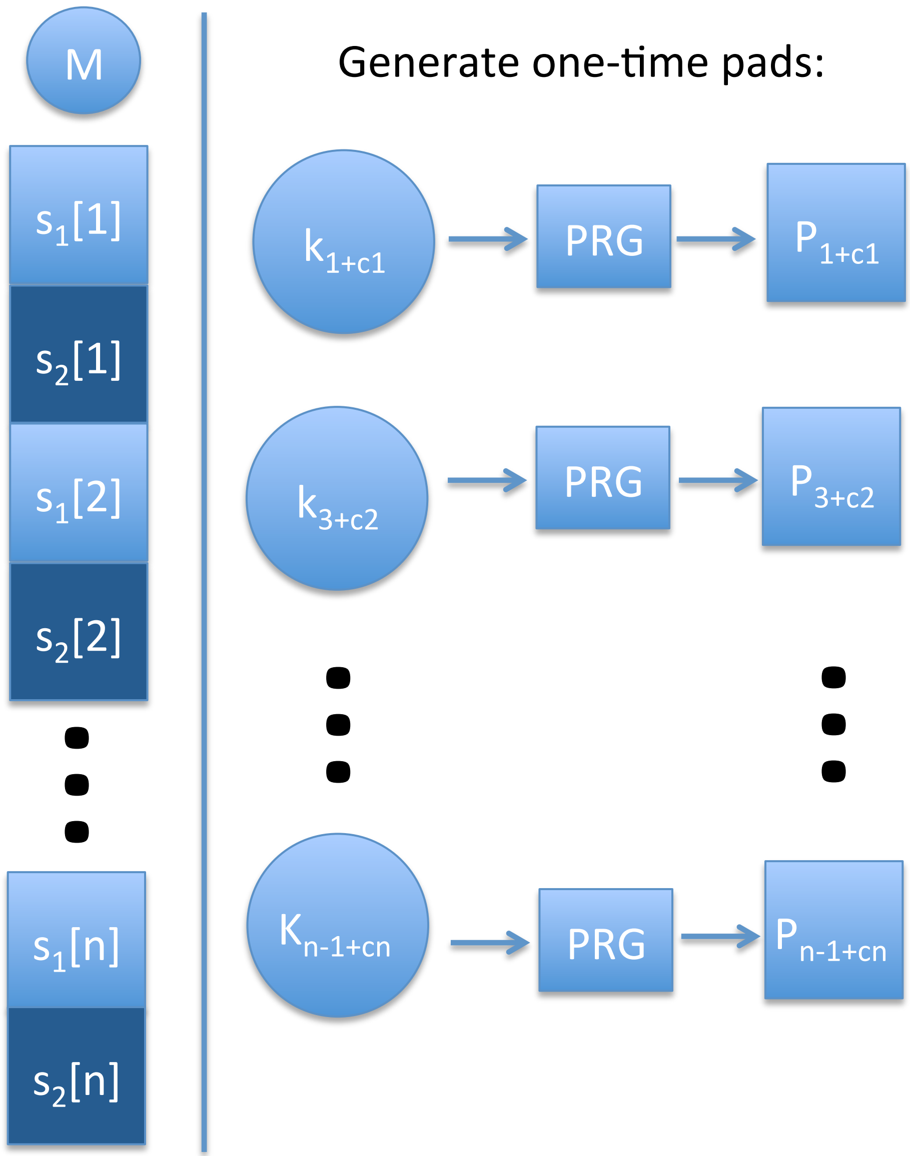

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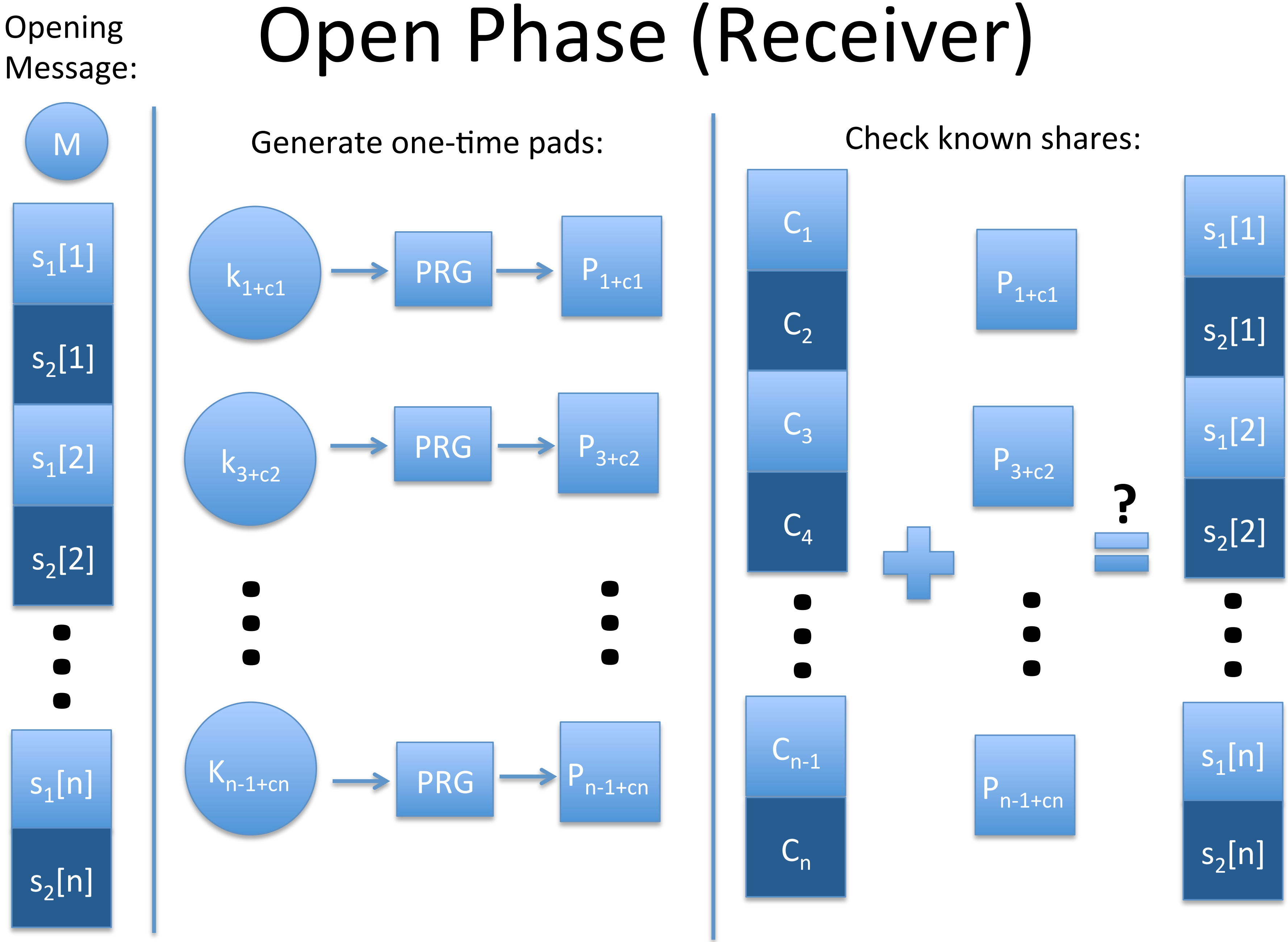
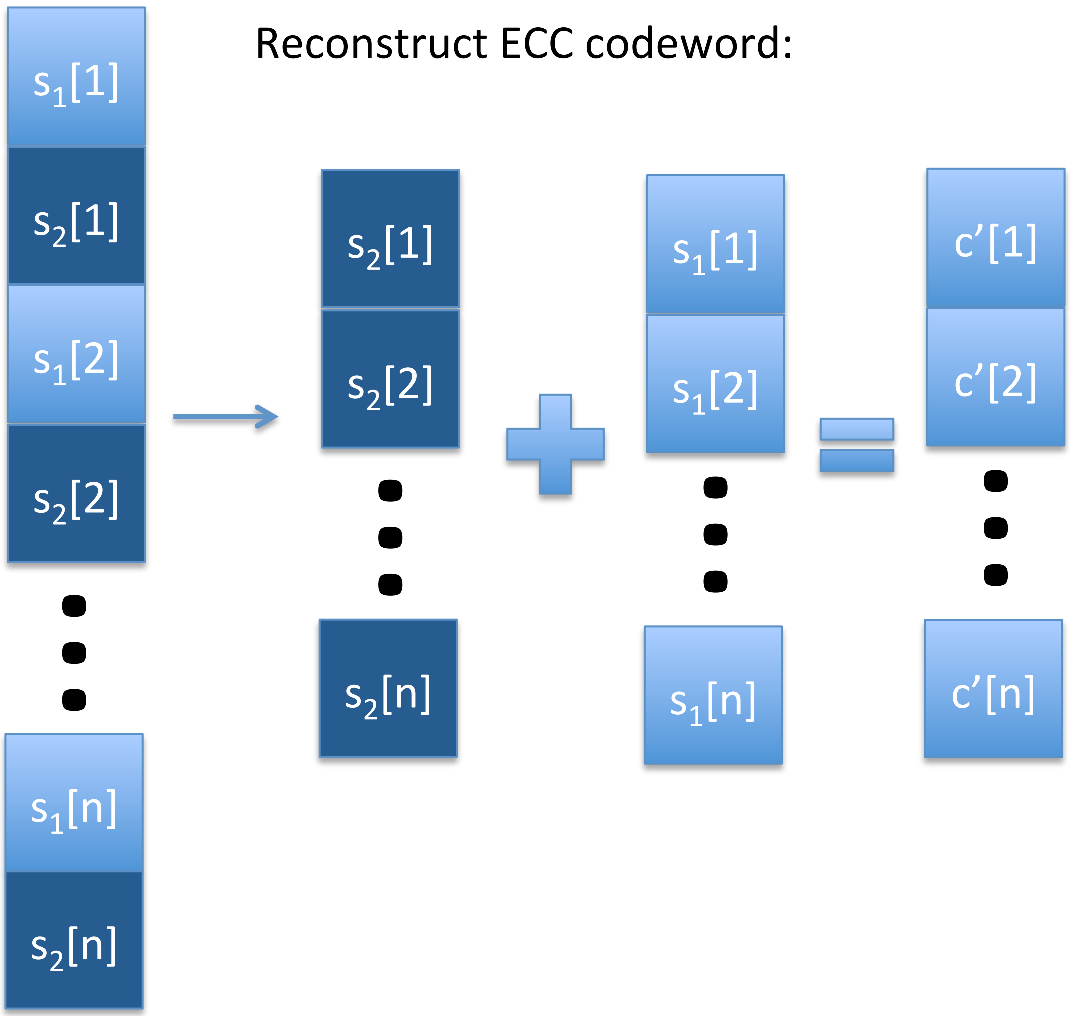
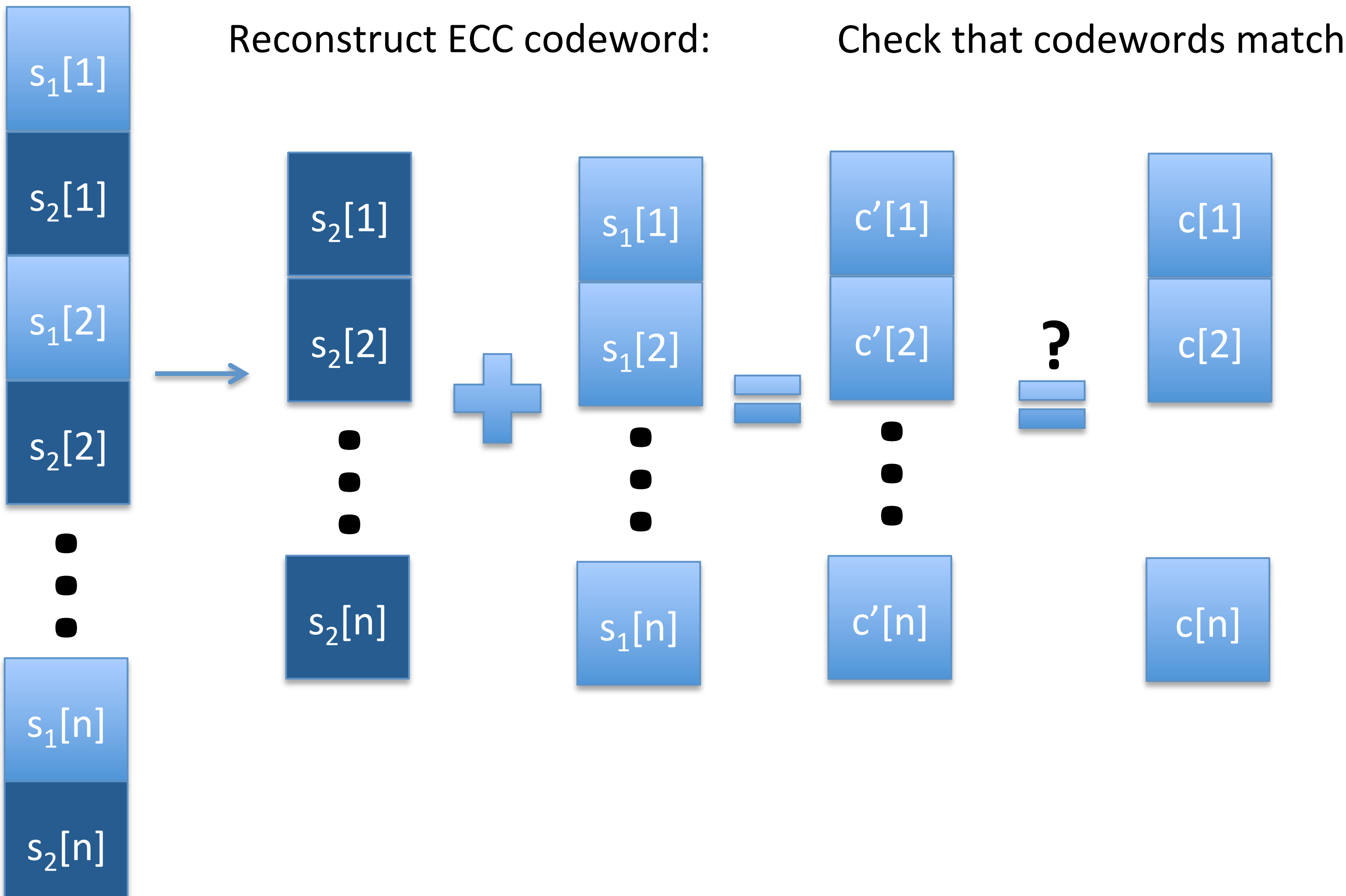


Open Phase (Receiver)

Reconstruct ECC codeword:



Open Phase (Receiver)



Open Problems

- Can we get optimal rate?
- Can optimal fully homomorphic commitments be constructed without general LSSS?
- Can we get additive homomorphism in this construction without VSS?
- Can we increase concrete efficiency in both setup and online phases?

THANK YOU!

READ THE FULL PAPER:

https://eprint.iacr.org/**2014/829**