

PRF, Block Ciphers

MAC

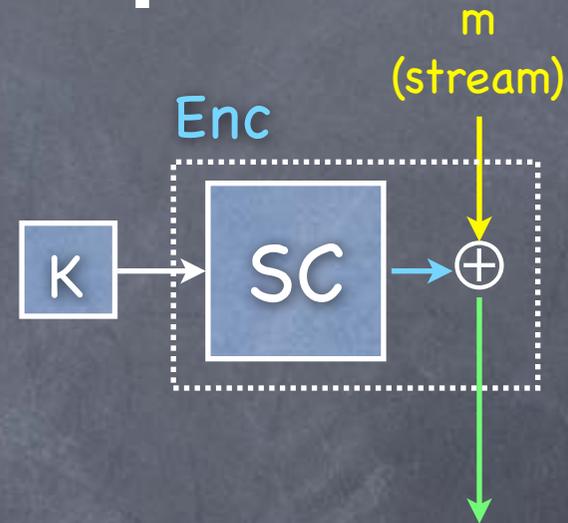
Lecture 6

RECALL

One-time CPA-secure SKE with a Stream-Cipher

- One-time Encryption with a stream-cipher:

- Generate a one-time pad from a short seed
- Can share just the seed as the key
- Mask message with the pseudorandom pad



- Decryption is symmetric: plaintext & ciphertext interchanged
- SC can spit out bits on demand, so the message can arrive bit by bit, and the length of the message doesn't have to be a priori fixed
- Security: indistinguishability from using a truly random pad

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 - Need to define pseudorandomness for a function (not a string)

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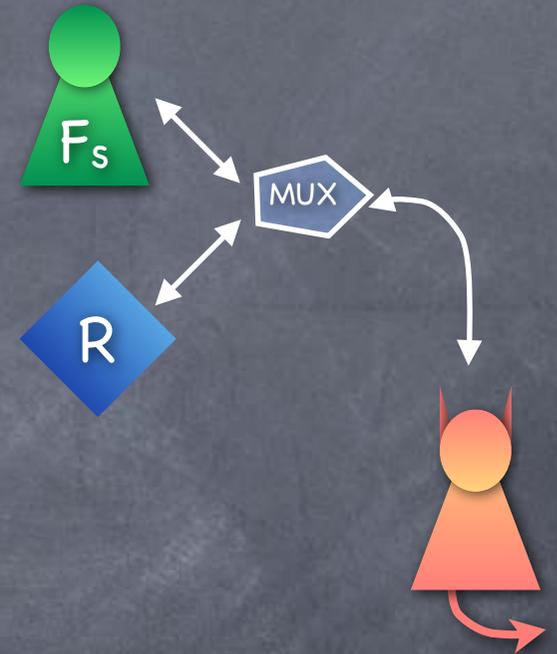
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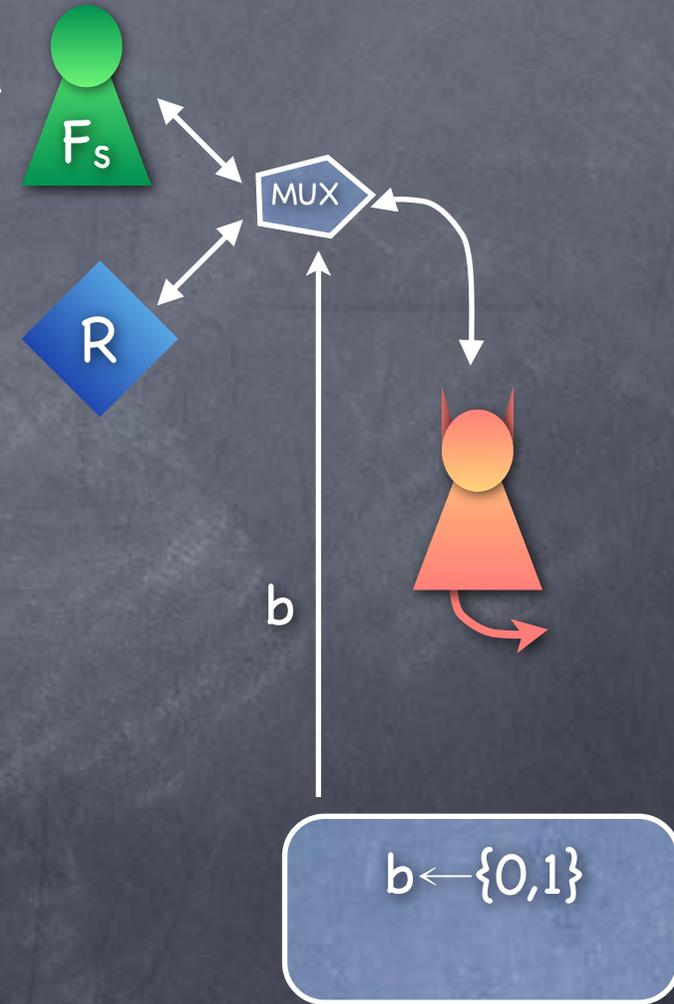
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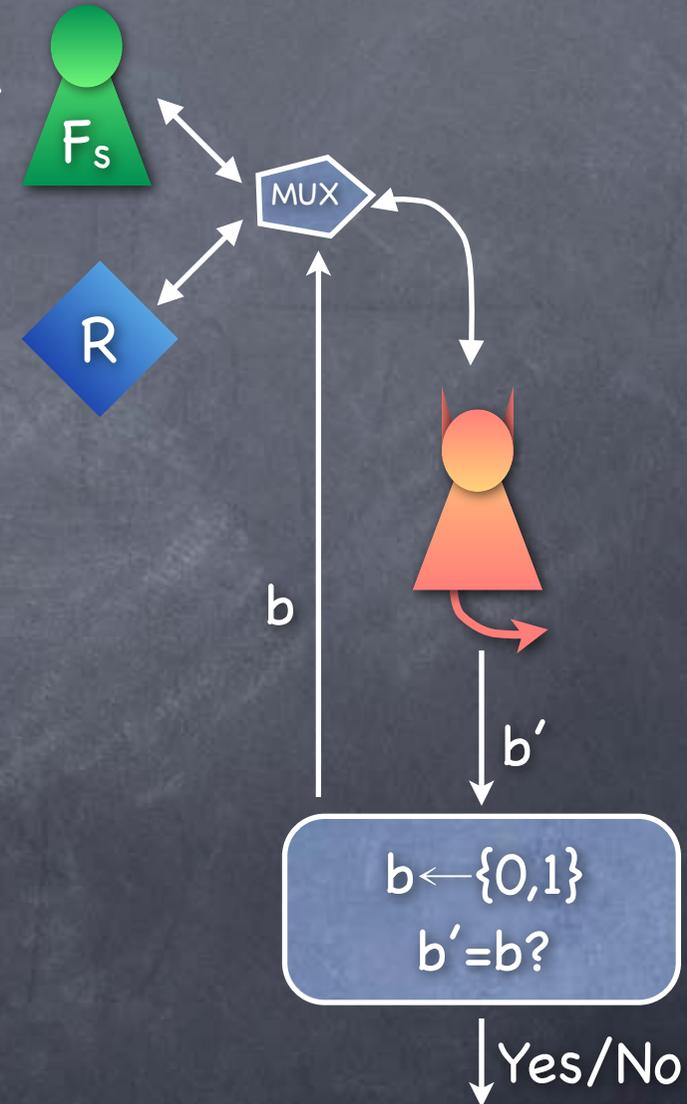
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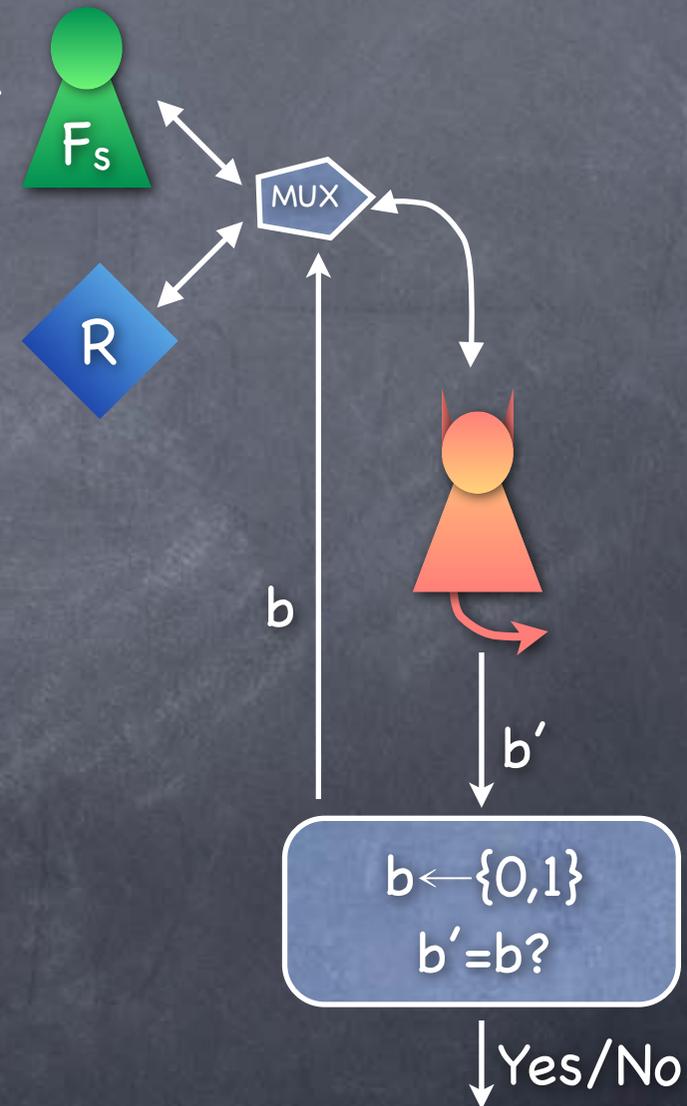


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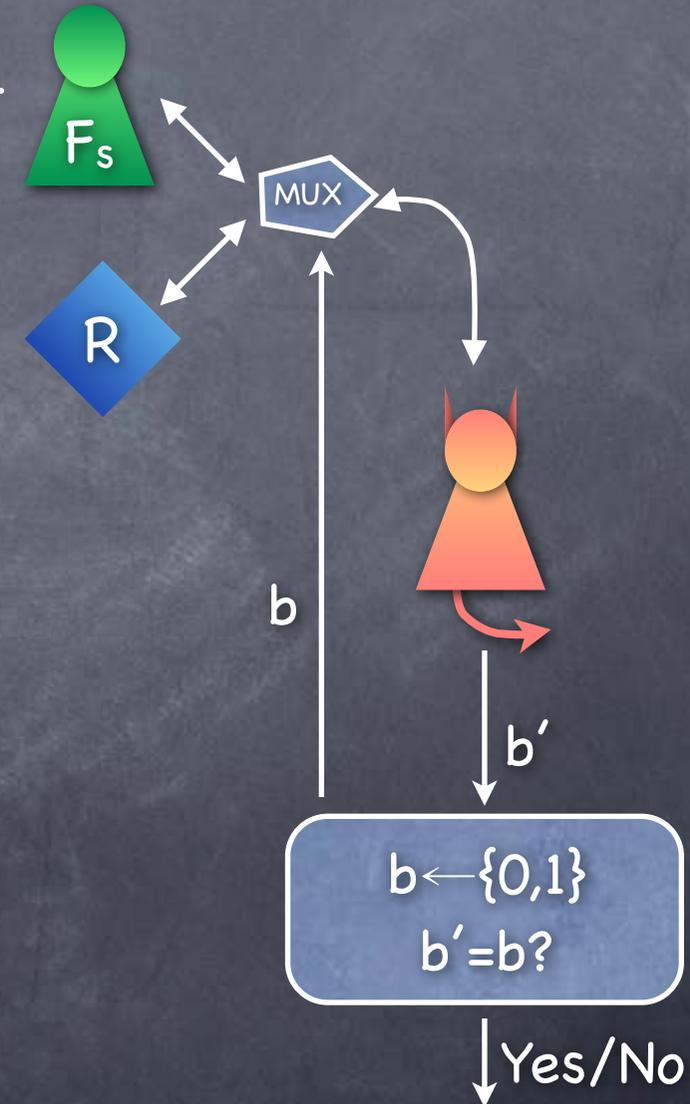
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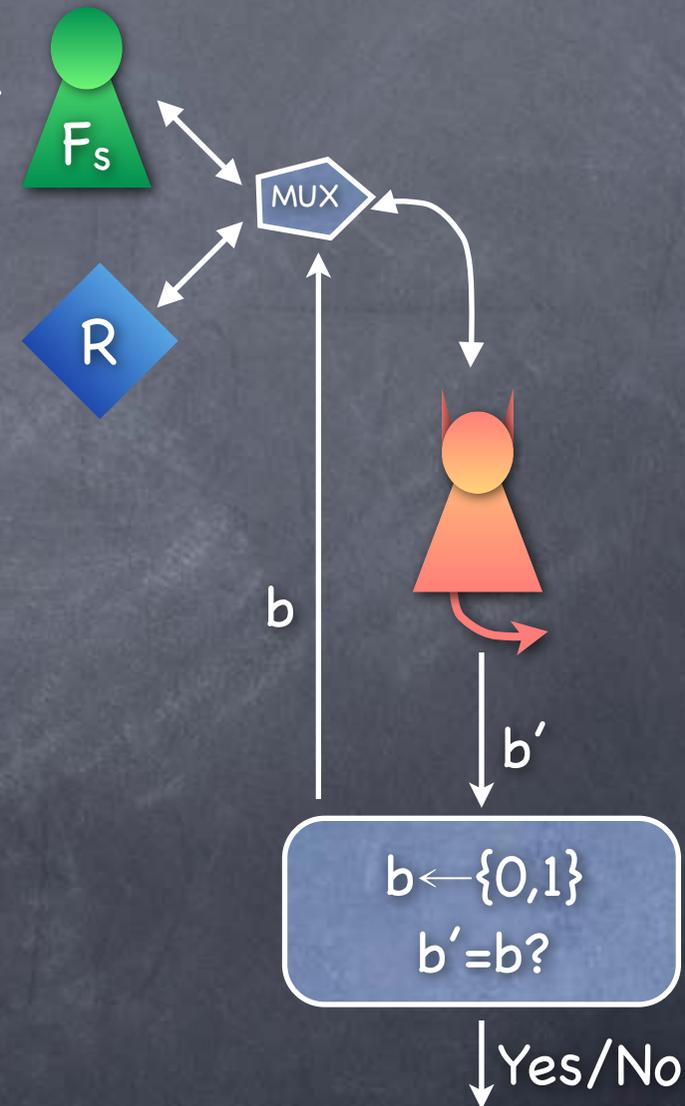
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• PRF stretches k bits to $n2^m$ bits



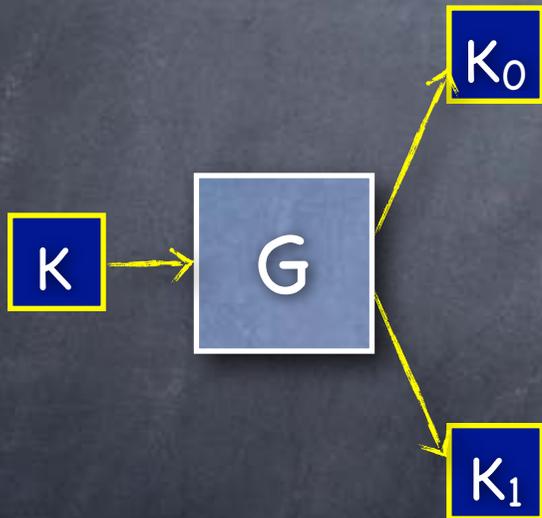
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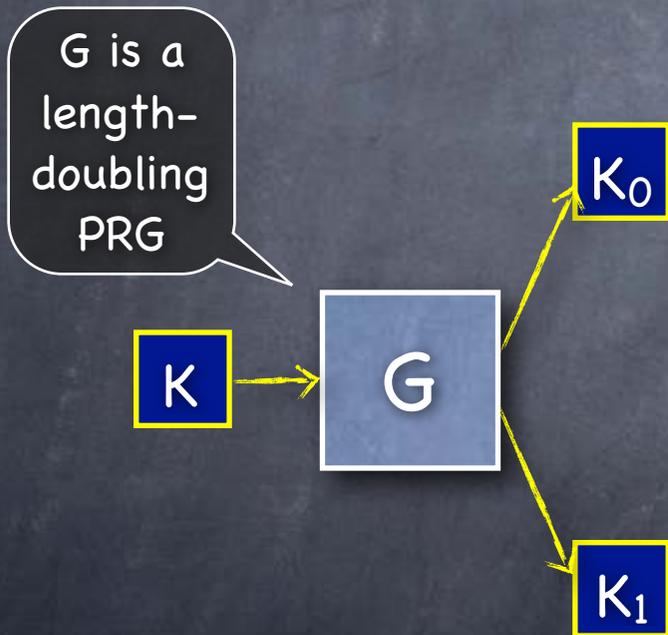
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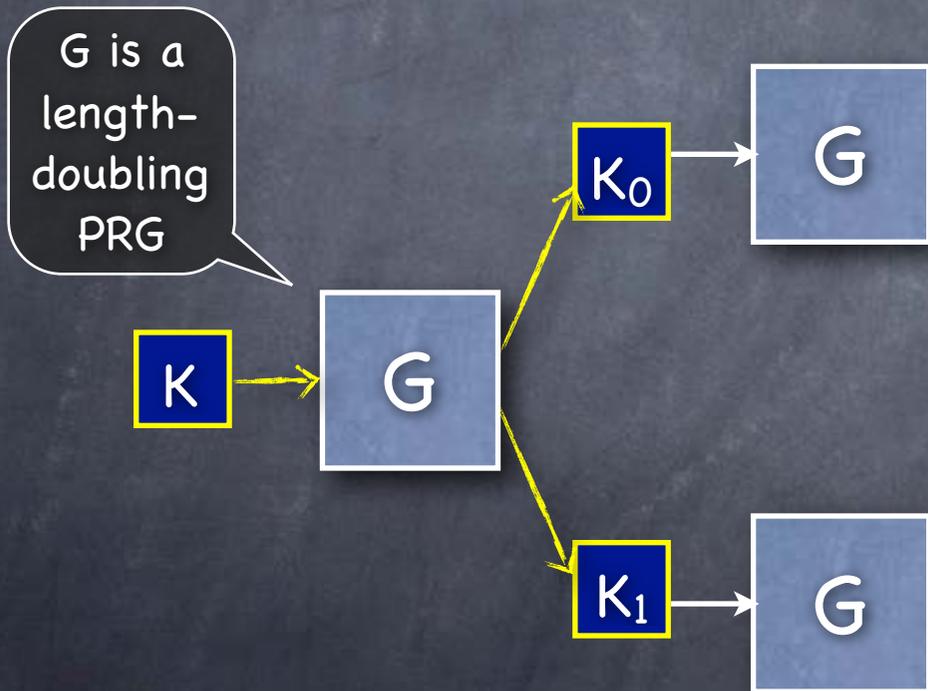
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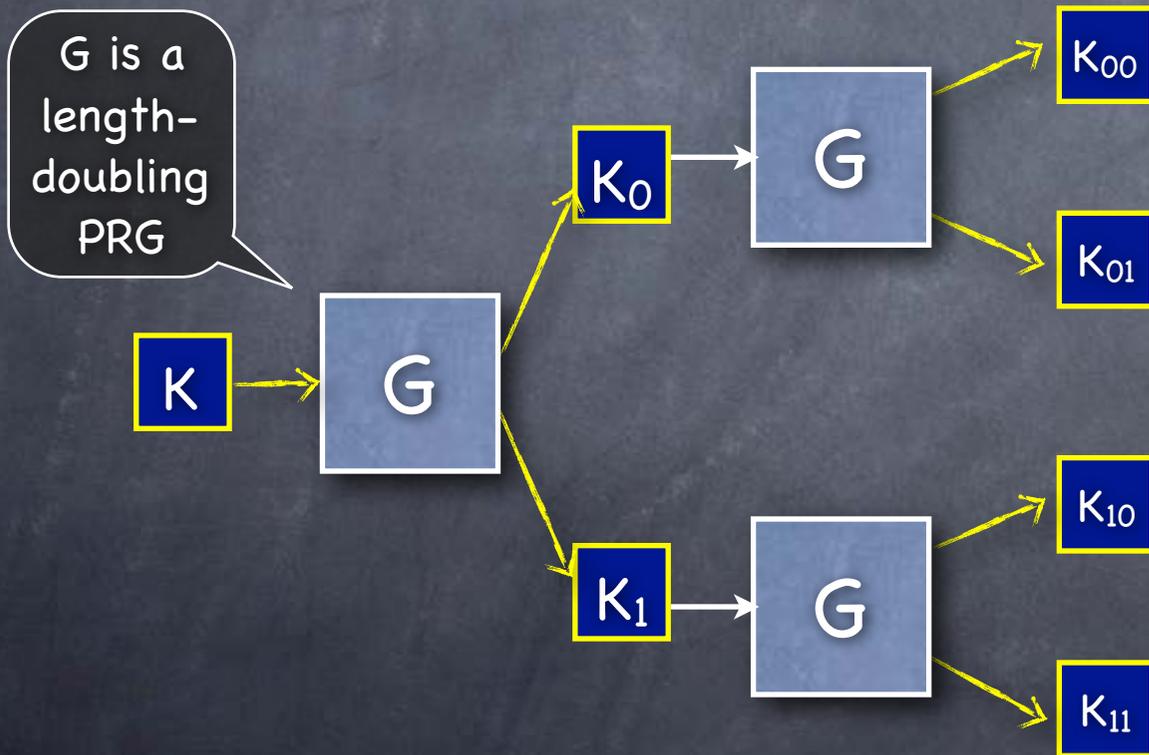
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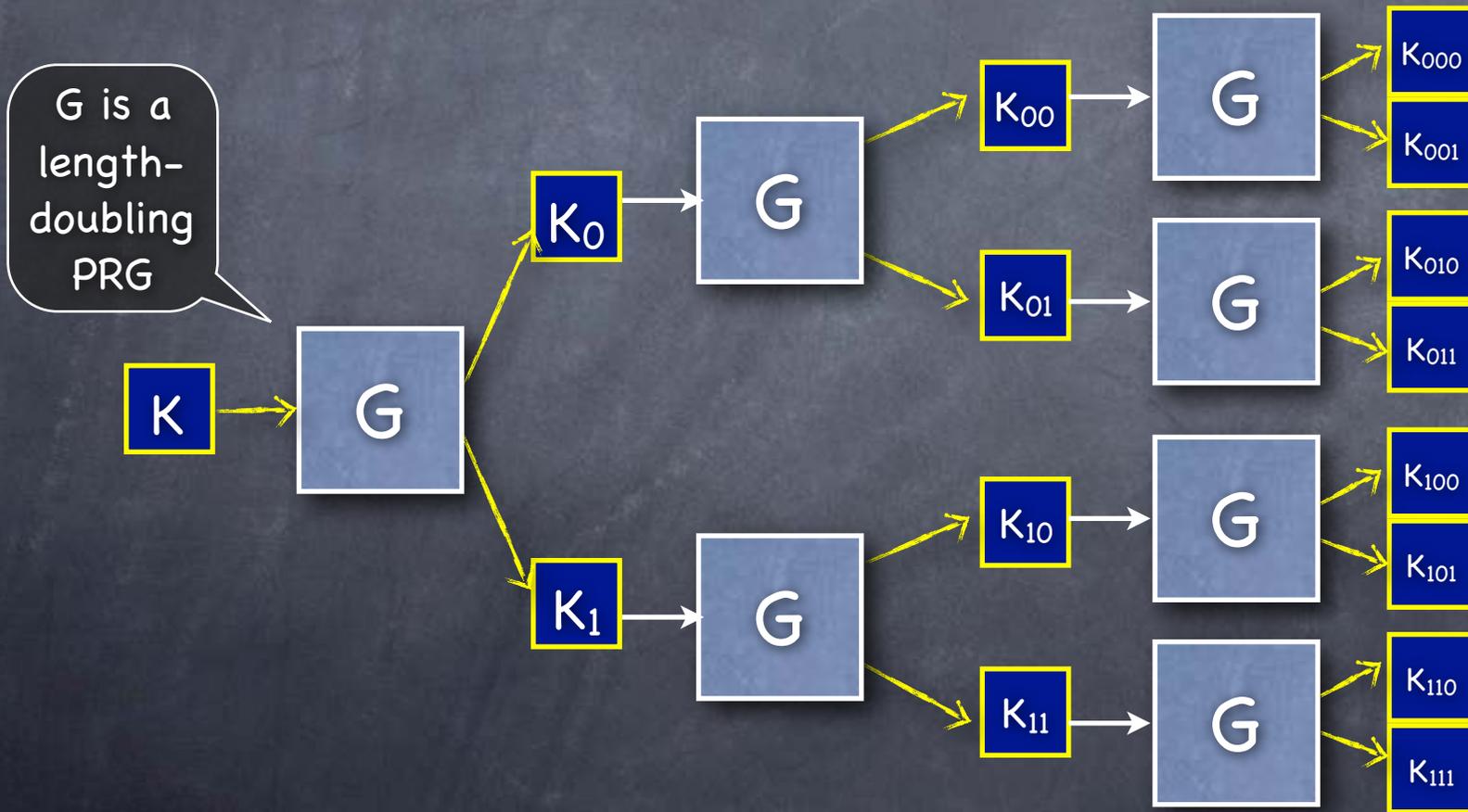
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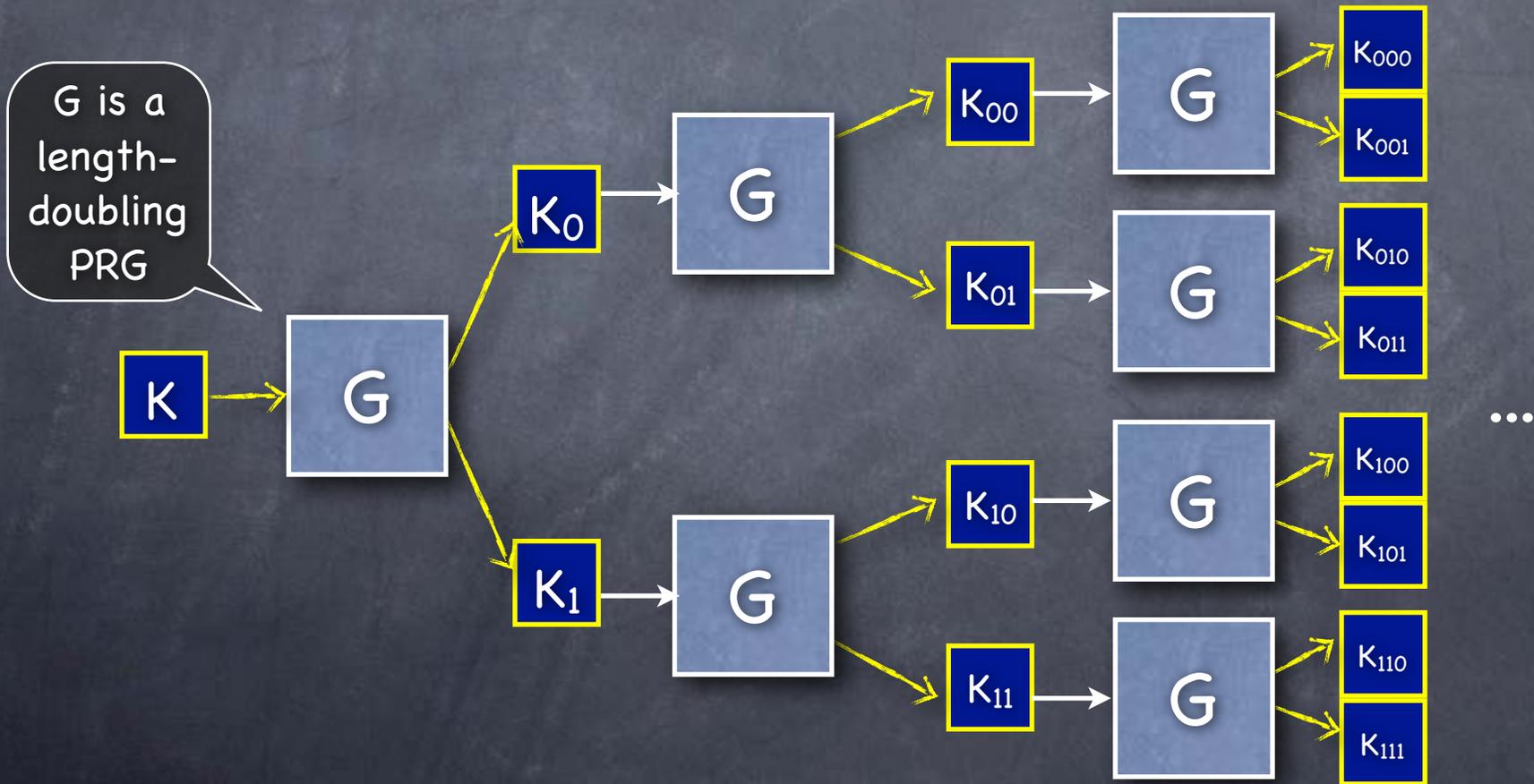
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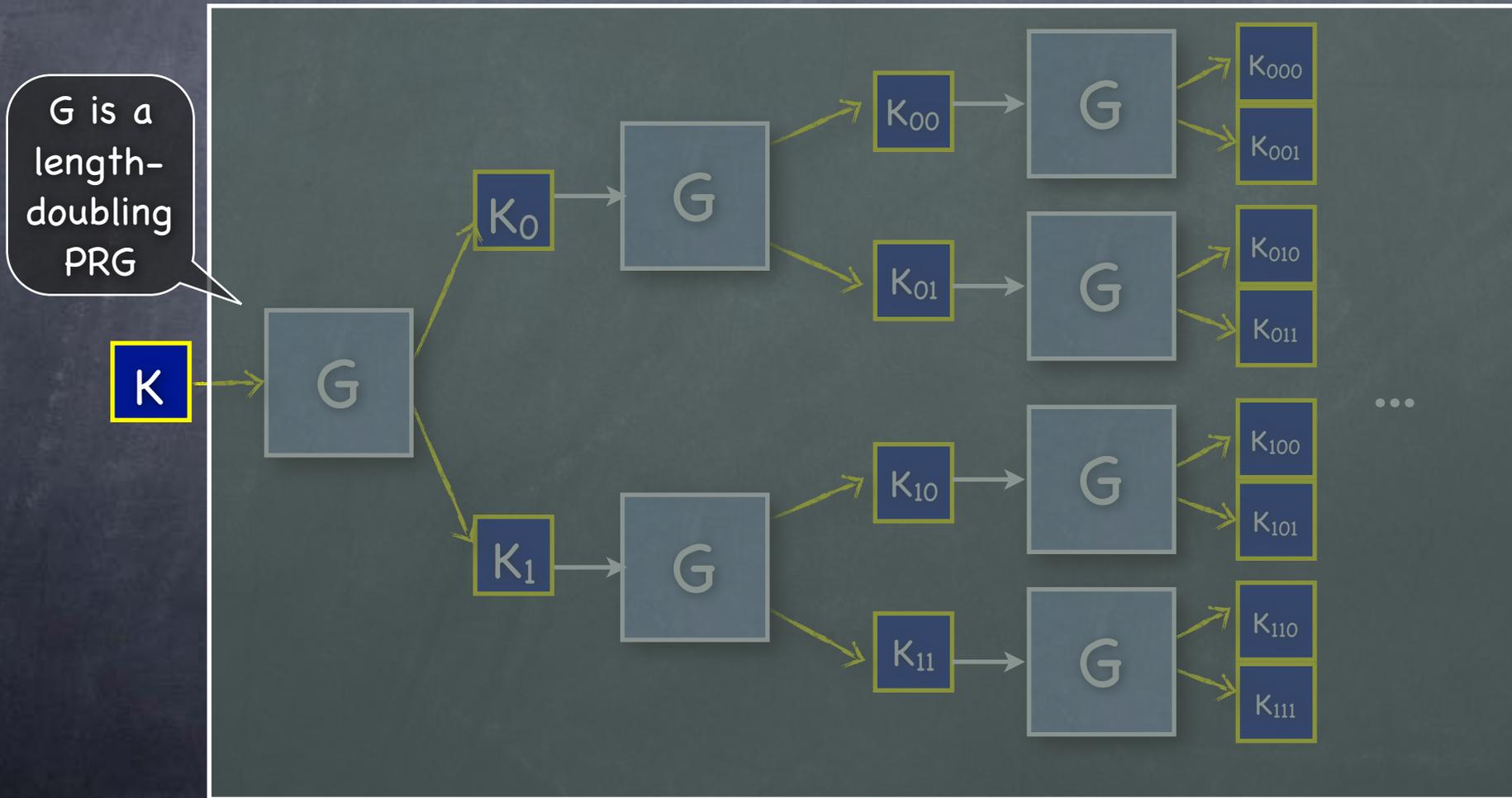
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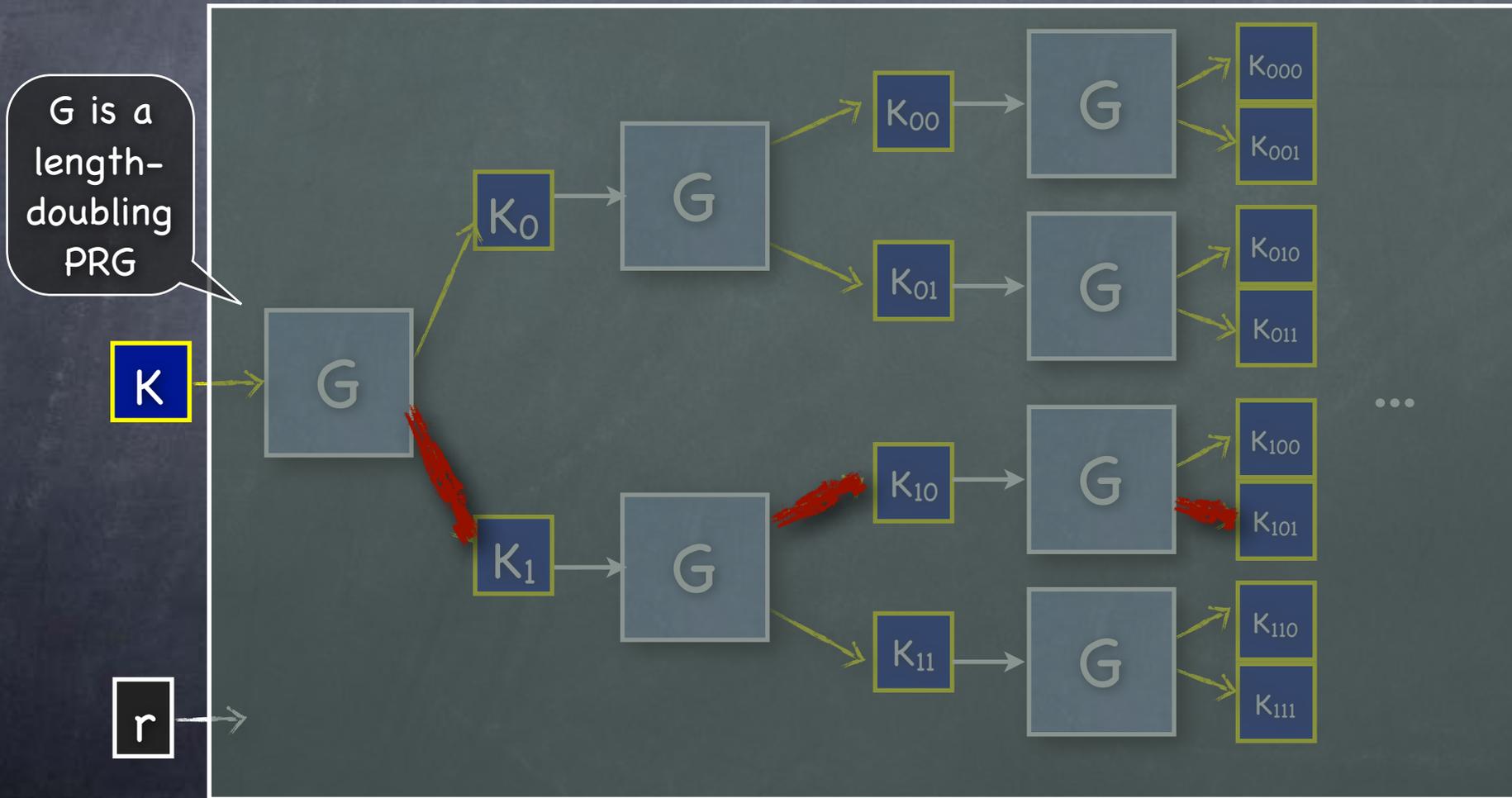
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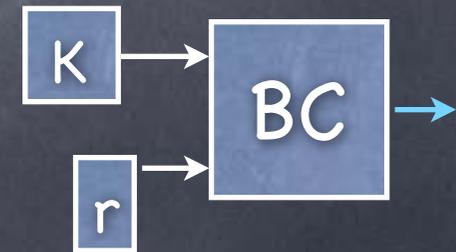
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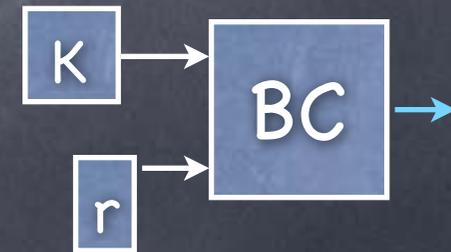
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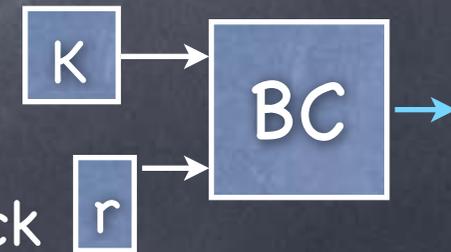
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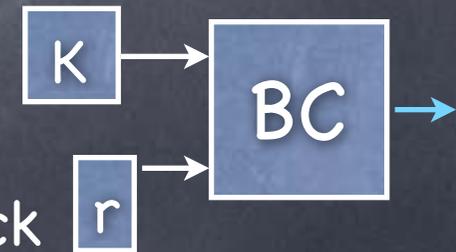
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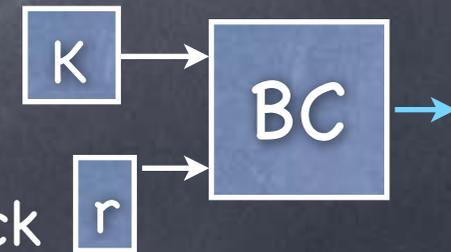
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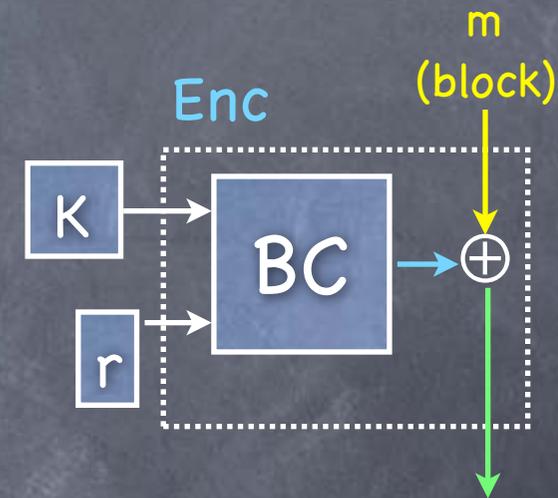
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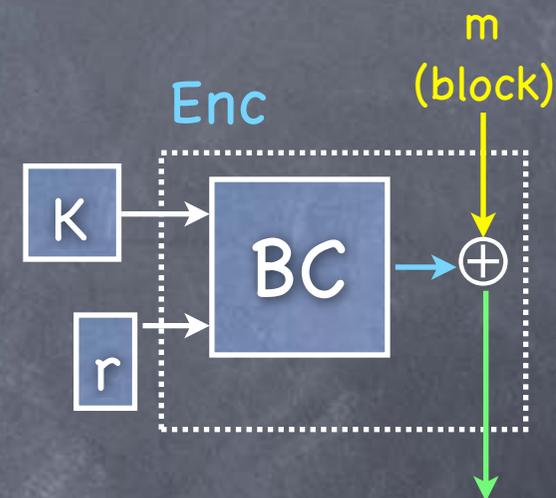
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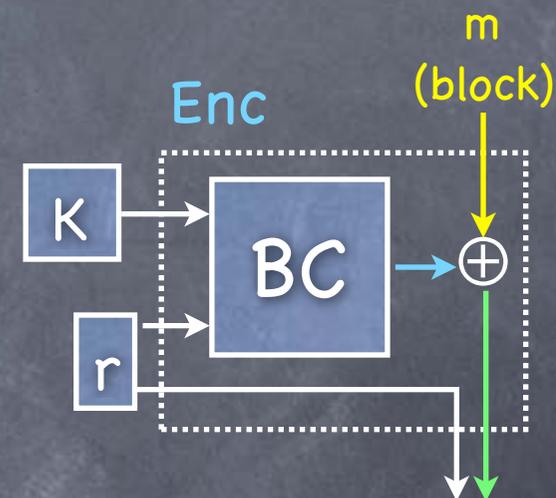
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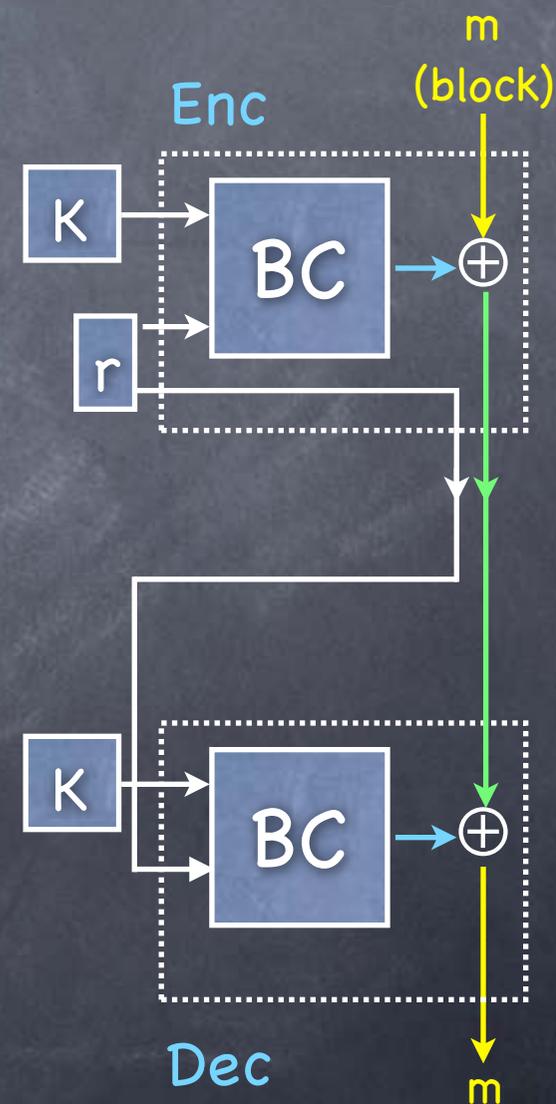
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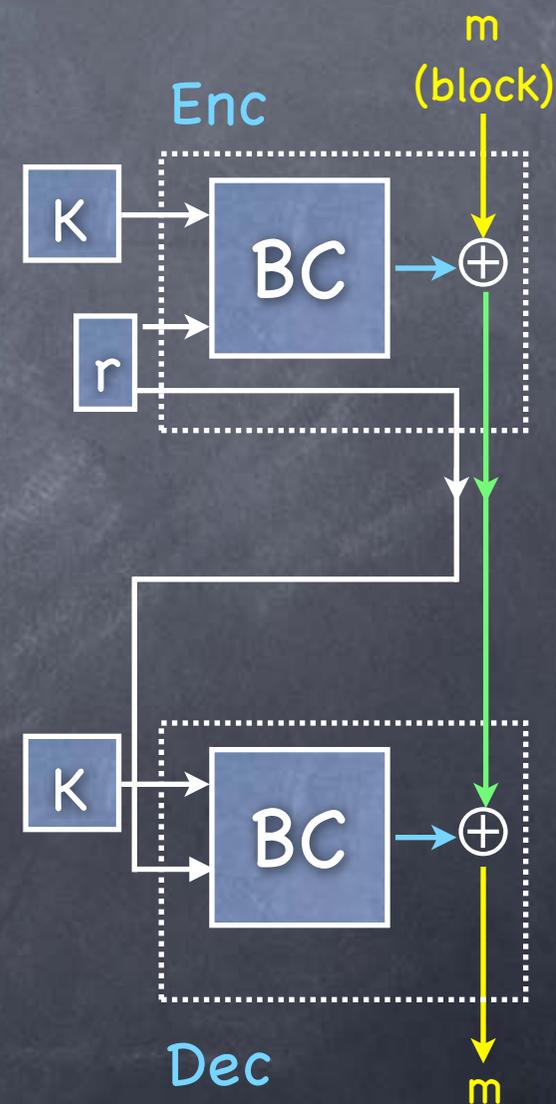
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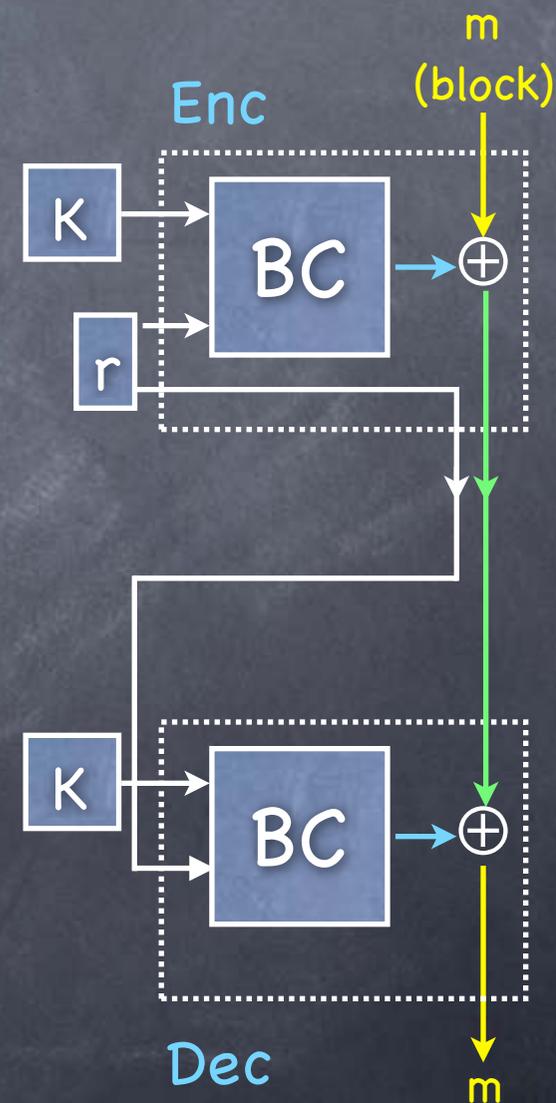
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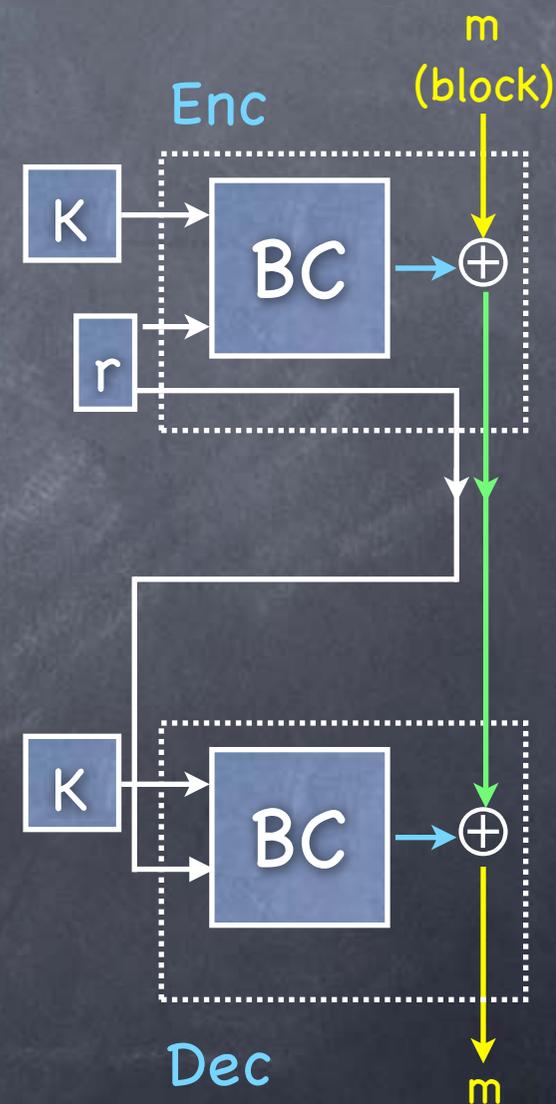
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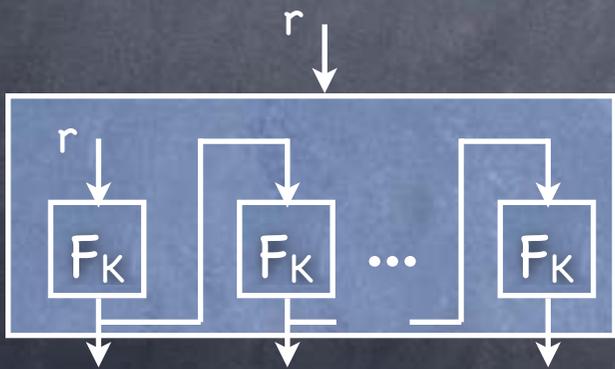
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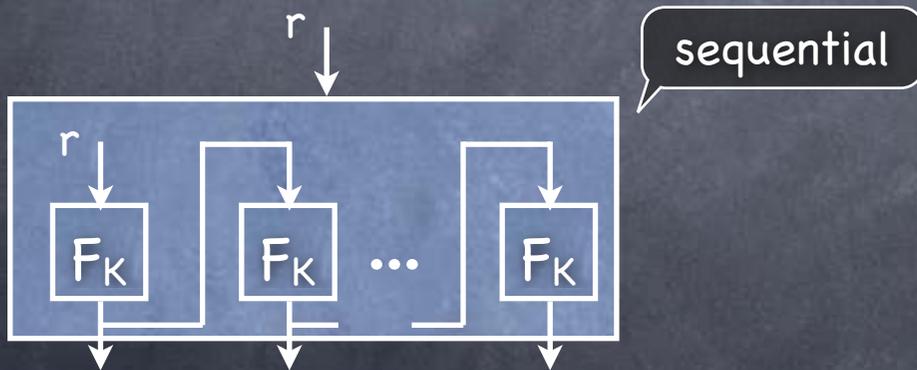
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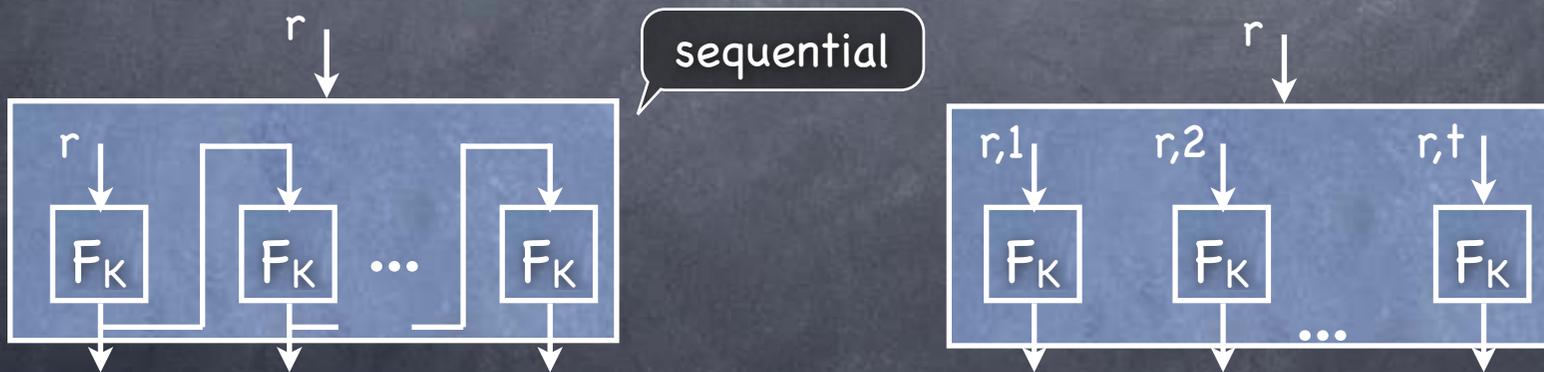
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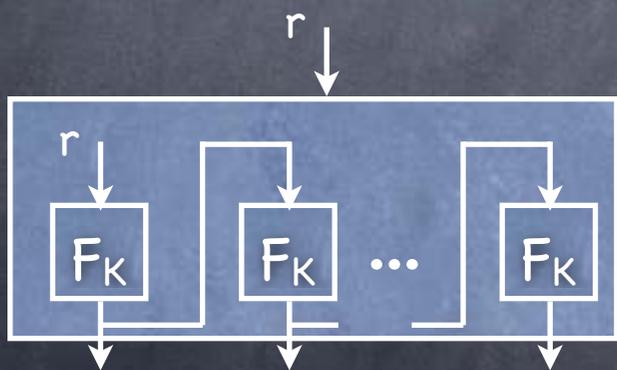
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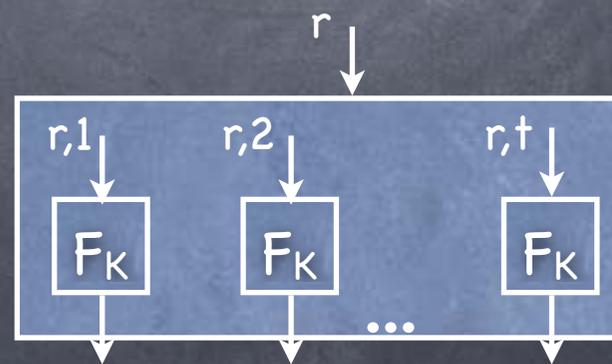


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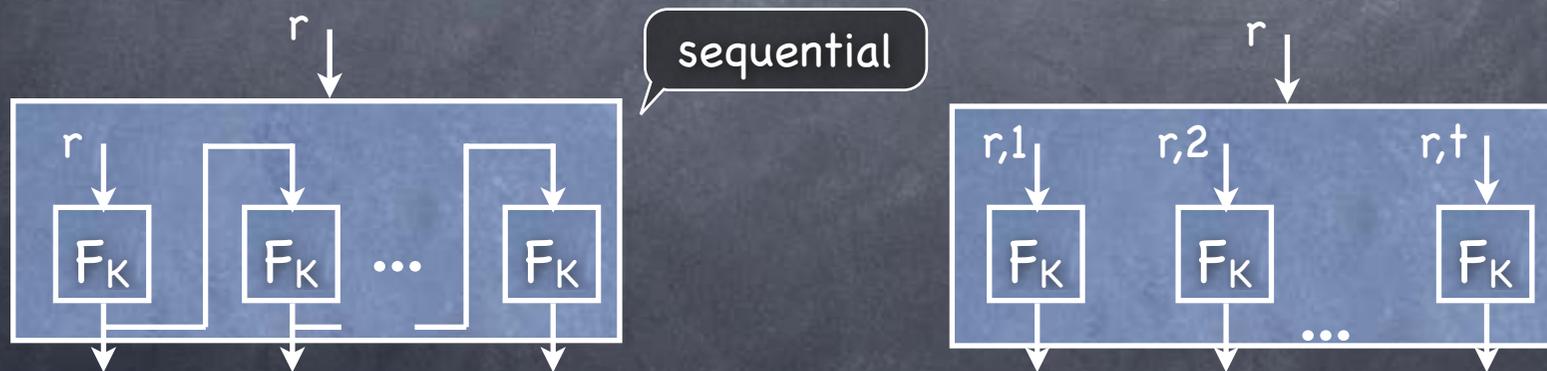
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- Output is indistinguishable from t random blocks (even if input to F_K known/chosen)

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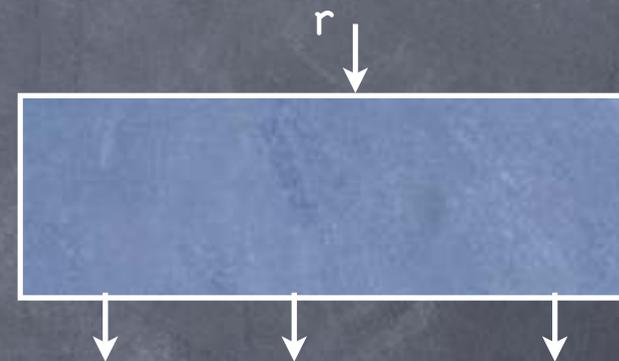
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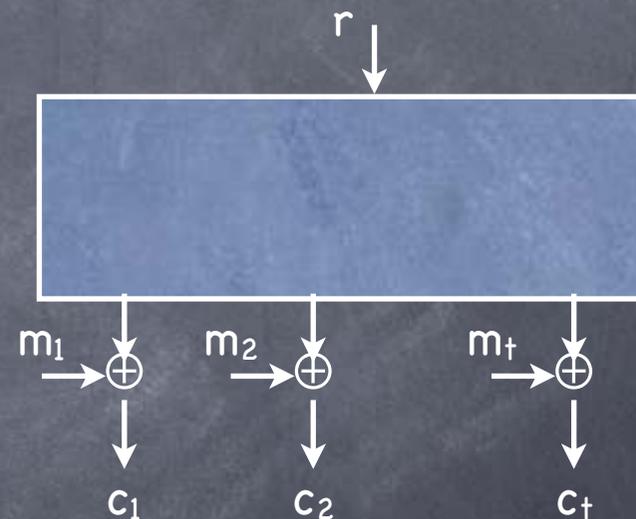
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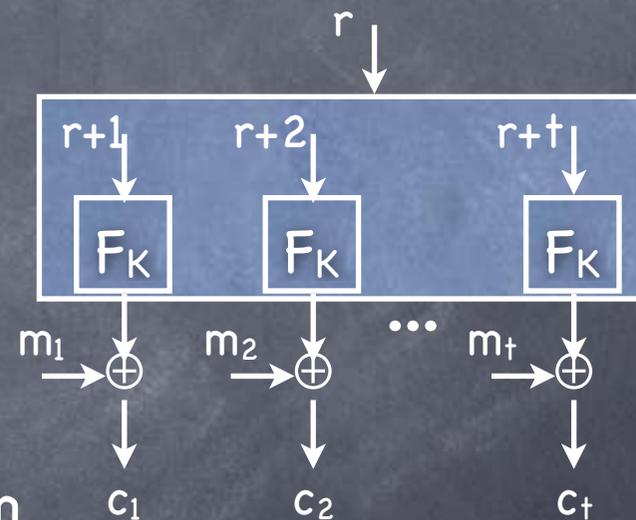


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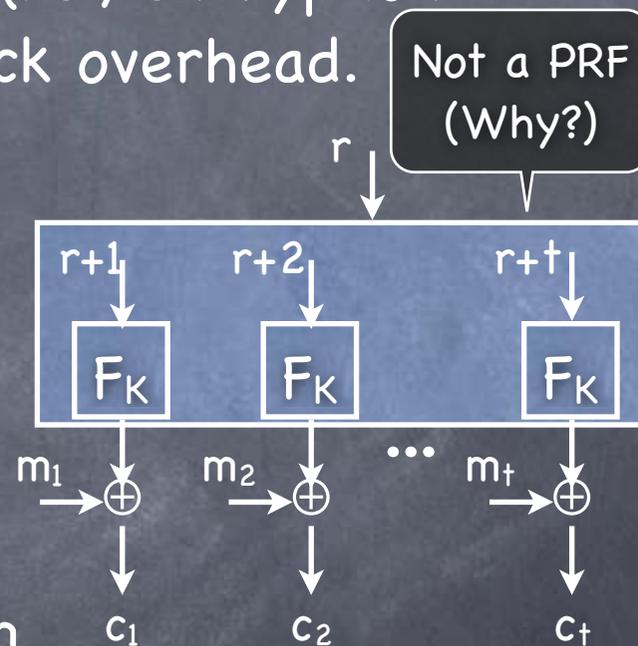


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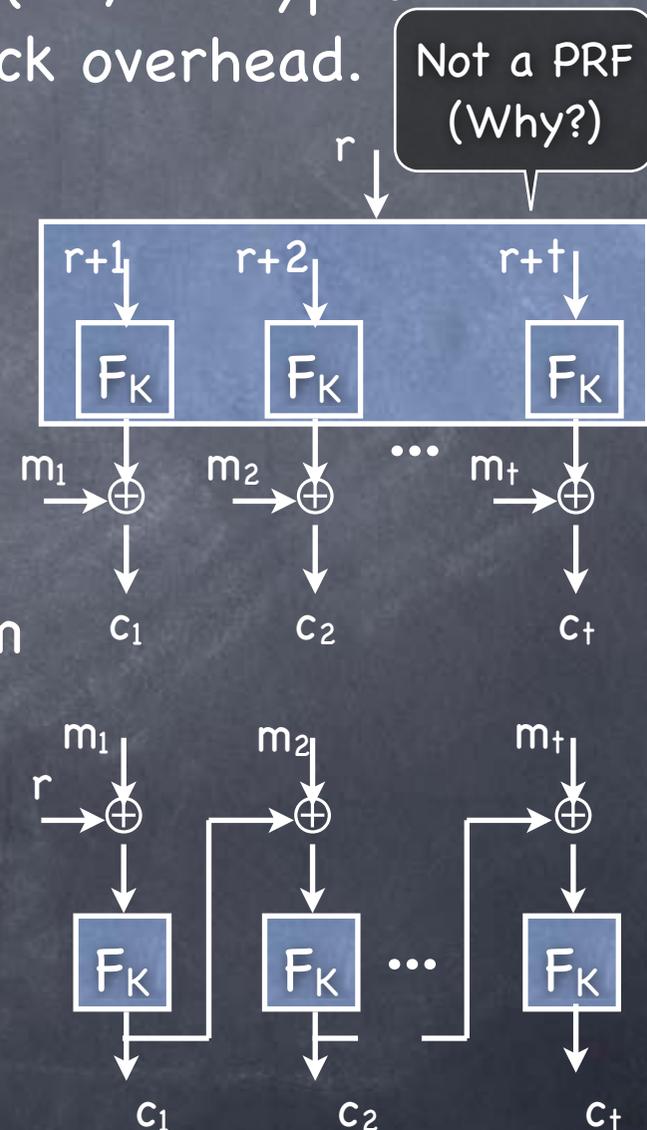
CPA-secure SKE with a Block Cipher

Various "modes" of operation of a Block-cipher (i.e., encryption schemes using a block-cipher). All with one block overhead.

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Cipher Block Chaining (CBC) mode: Sequential encryption. Decryption uses F_K^{-1} . Ciphertext an integral number of blocks.



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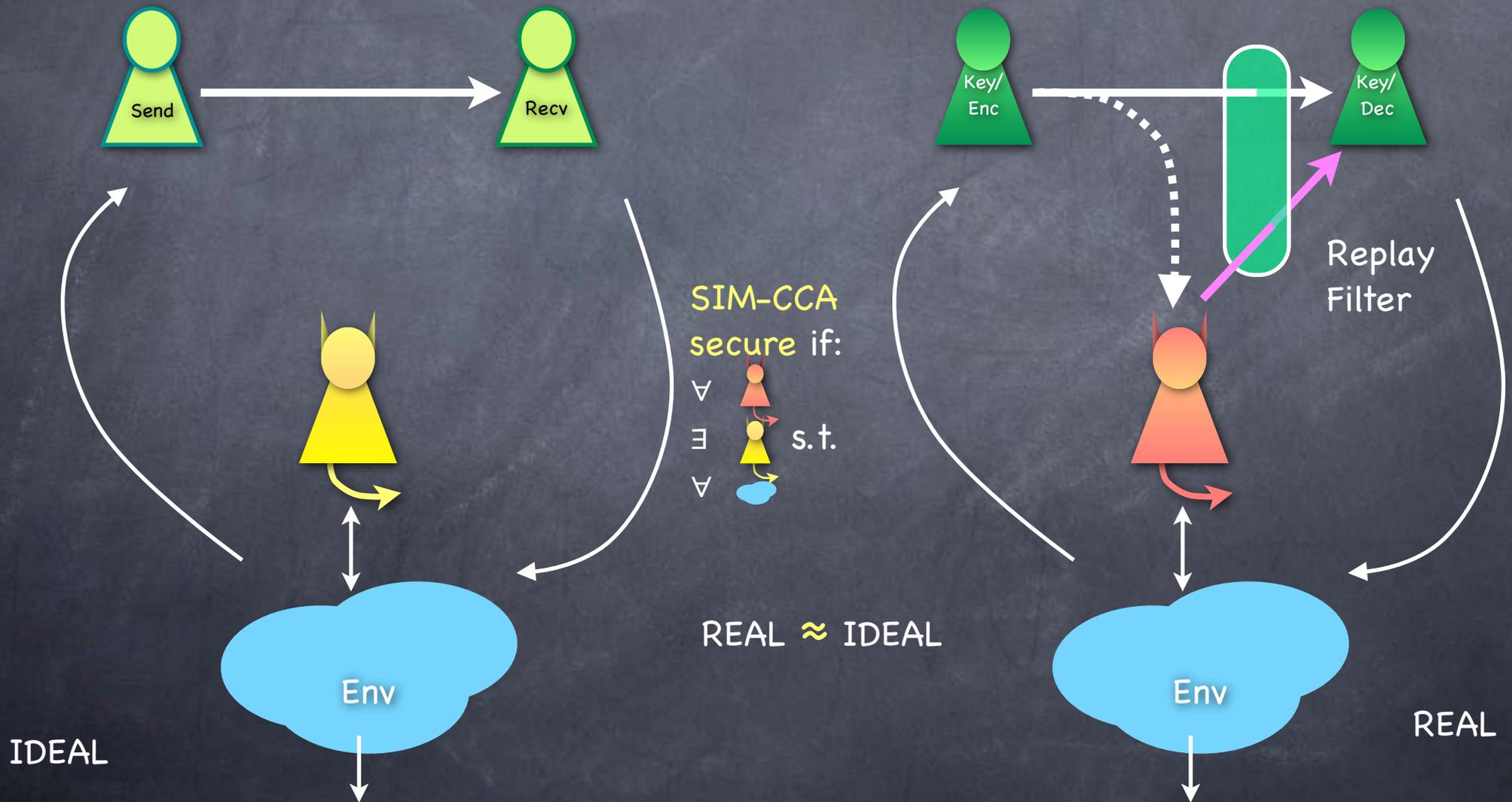
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 - What can Bob do?

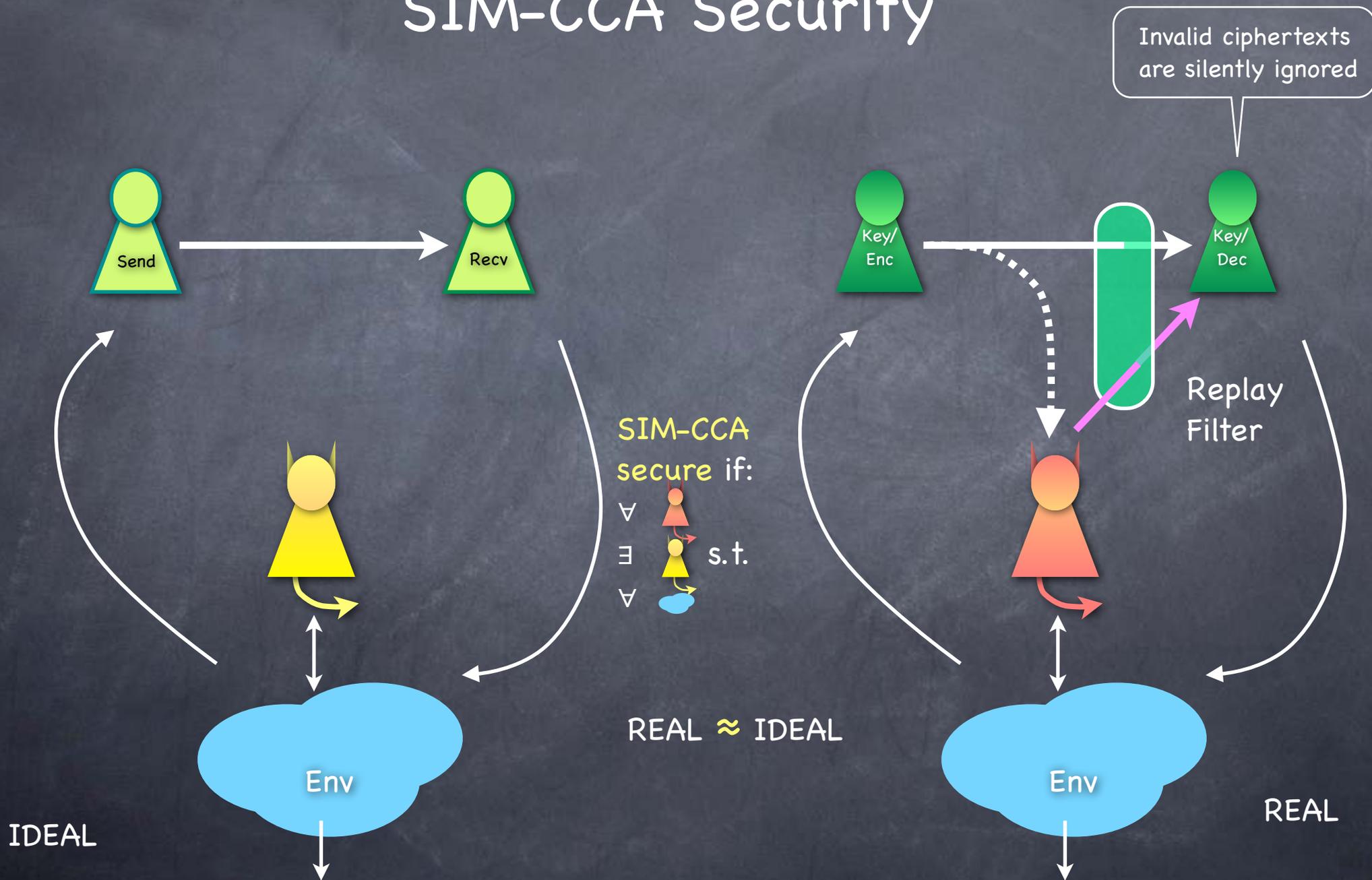
Symmetric-Key Encryption

SIM-CCA Security



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IND-CCA Security

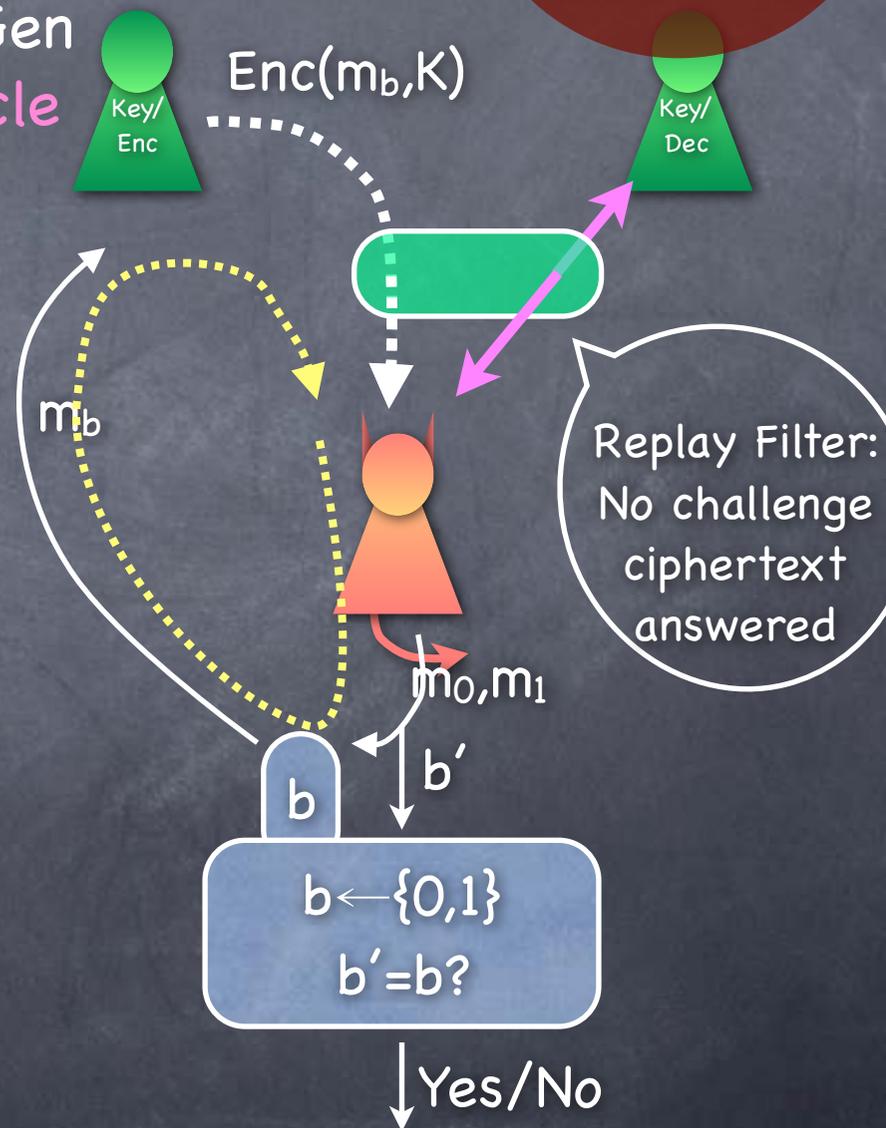
IND-CCA +
~correctness
equivalent to
SIM-CCA

- Experiment picks $b \leftarrow \{0,1\}$ and $K \leftarrow \text{KeyGen}$
Adv gets (guarded) access to Dec_K oracle

For as long as Adversary wants

- Adv sends two messages m_0, m_1 to the experiment
- Expt returns $\text{Enc}(m_b, K)$ to the adversary

- Adversary returns a guess b'
- Experiment outputs 1 iff $b'=b$
- IND-CCA secure if for all feasible adversaries $\Pr[b'=b] \approx 1/2$



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 - **MAC**: Message Authentication Code

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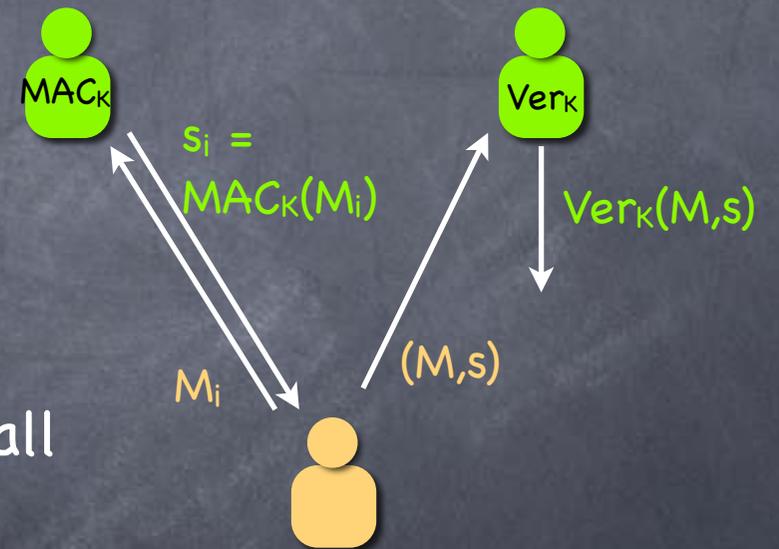
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- A triple (KeyGen, MAC, Verify)
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- Security: probability that an adversary can produce (M,s) s.t. $\text{Verify}_K(M,s)=1$ is negligible unless Alice produced an output $s=\text{MAC}_K(M)$



Advantage

$$= \Pr[\text{Ver}_K(M,s)=1 \text{ and } (M,s) \notin \{(M_i,s_i)\}]$$

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- **SKE in practice entirely based on Block-Ciphers** (next time)
- In principle, PRFs can be constructed (less efficiently) based on any One-Way Permutation or even any One-Way Function