Public-Key Cryptography

Public-Key Cryptography

Lecture 9

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El Gamal Encryption

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Public-Key Encryption from Trapdoor OWP

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CCA Security

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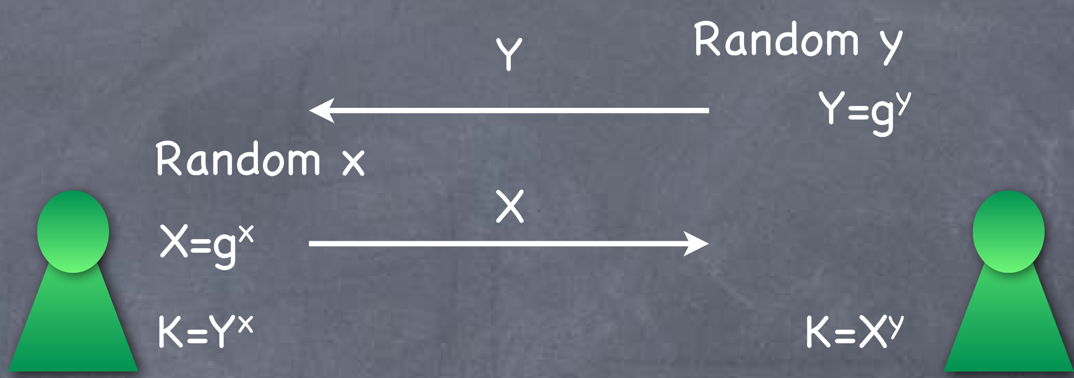

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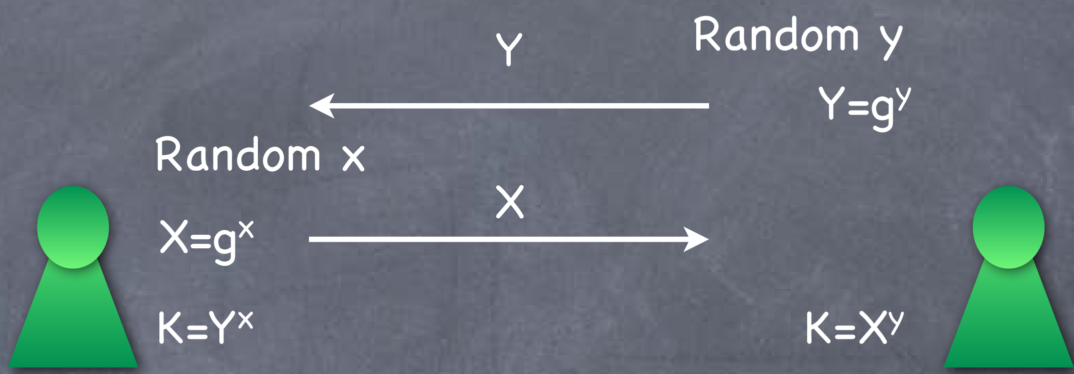

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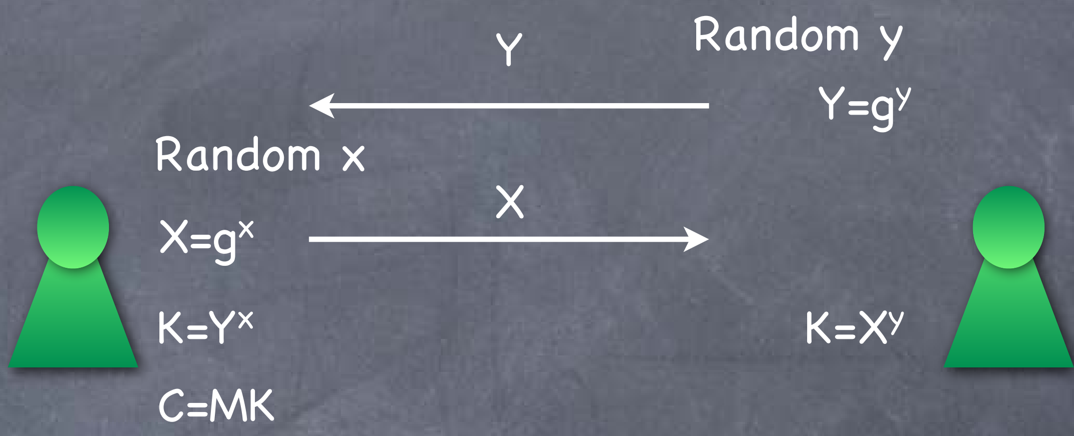

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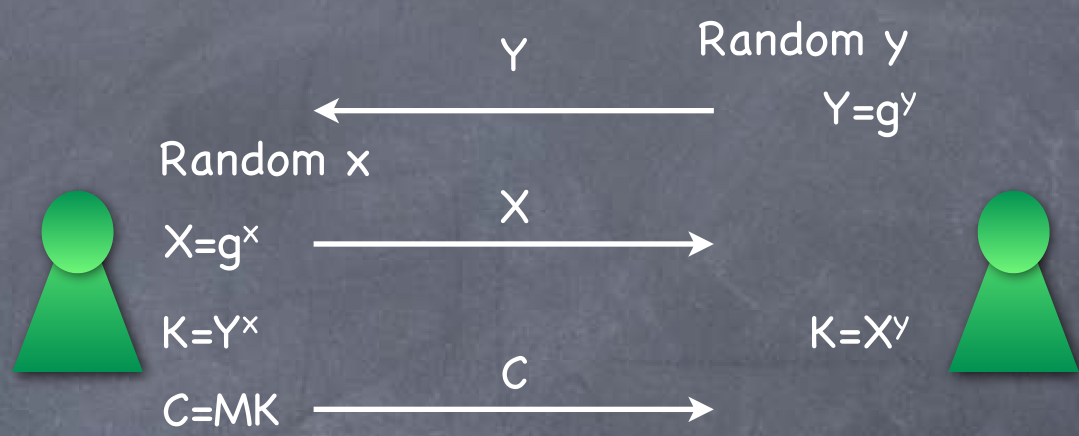

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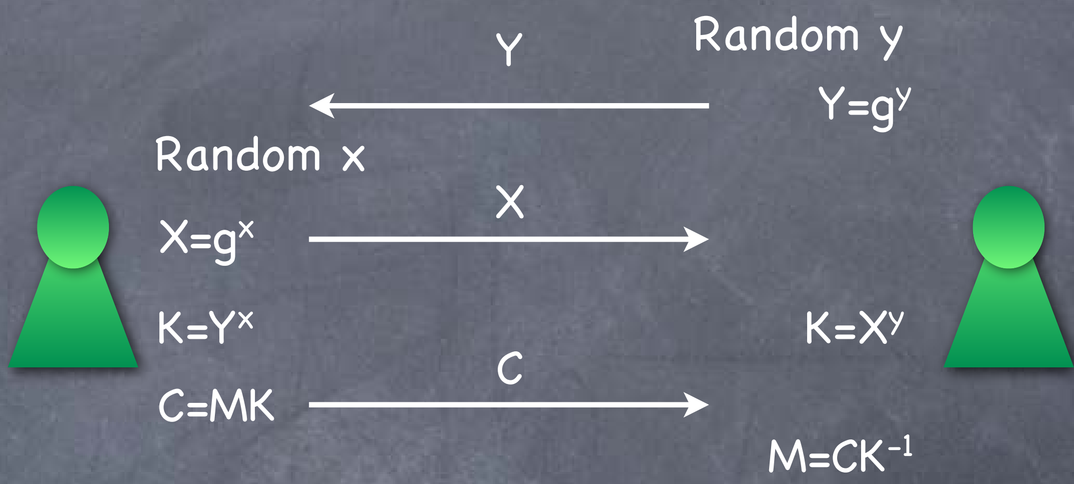

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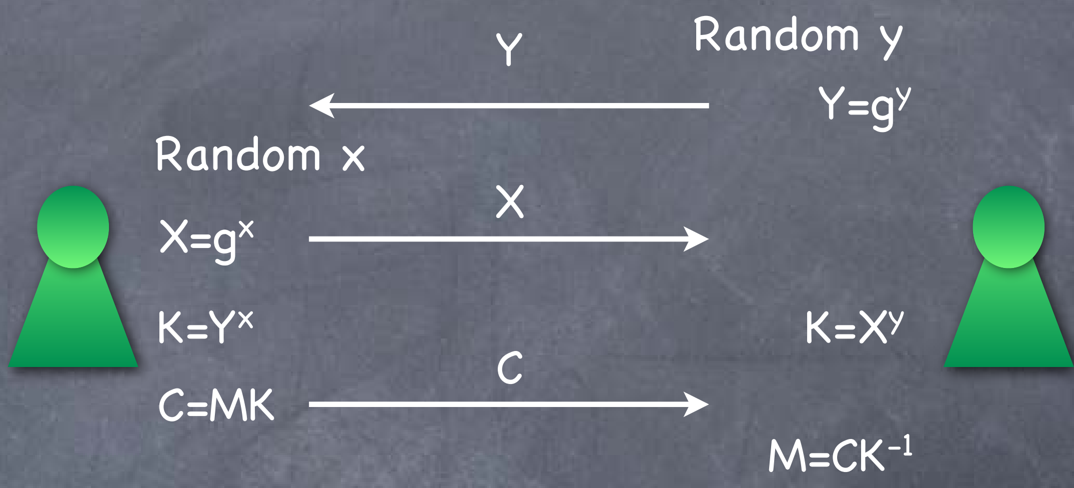

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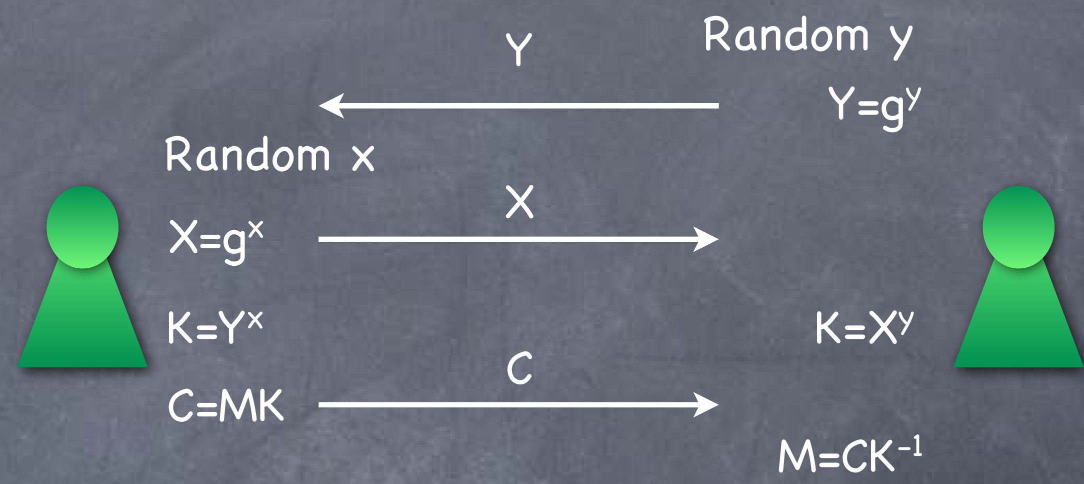

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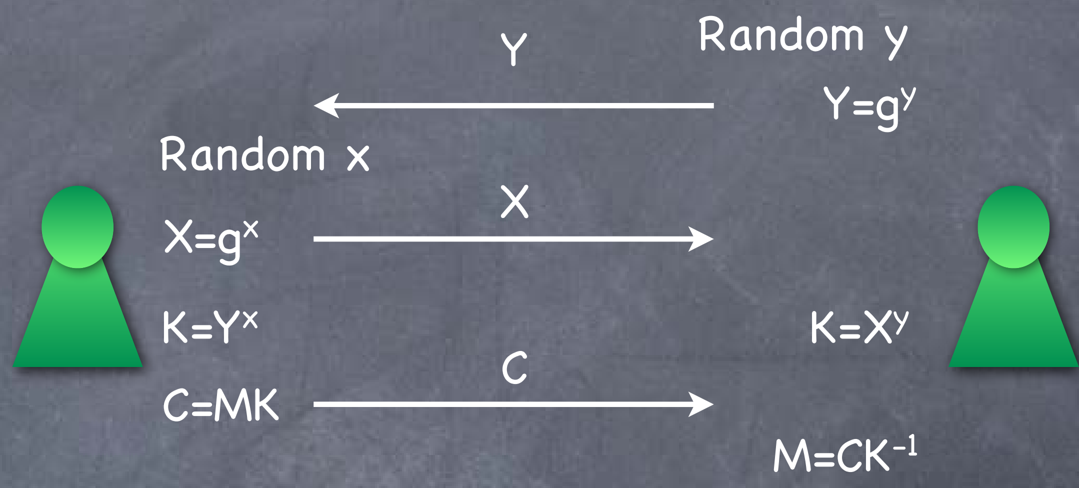

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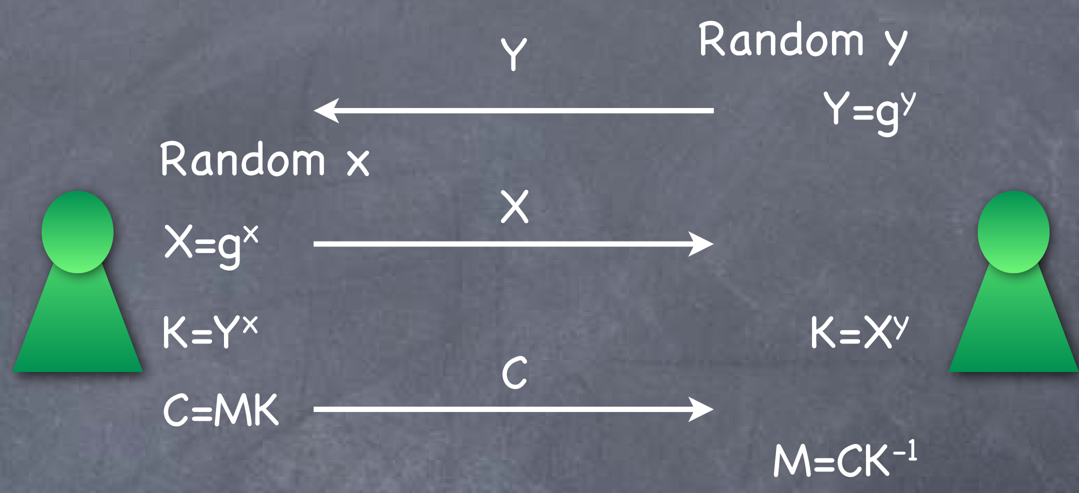

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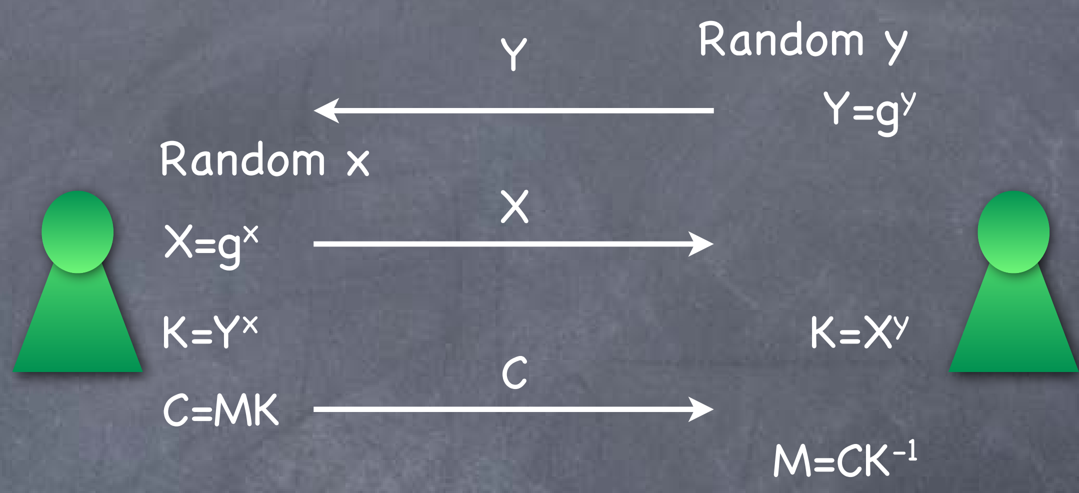

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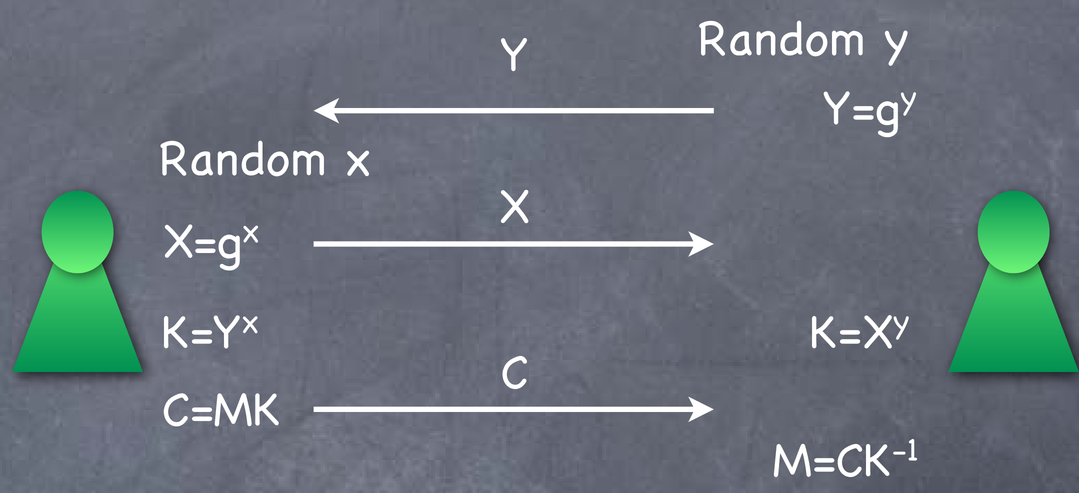

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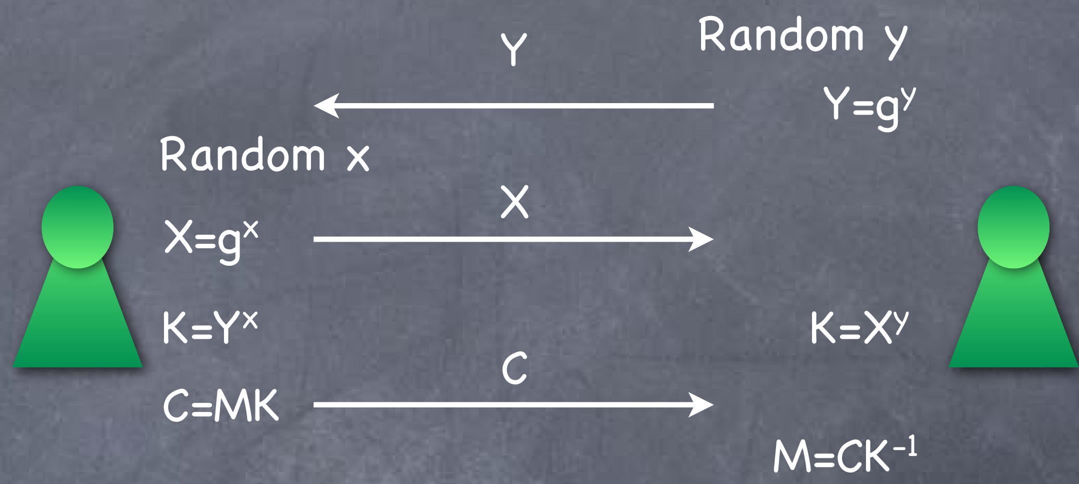

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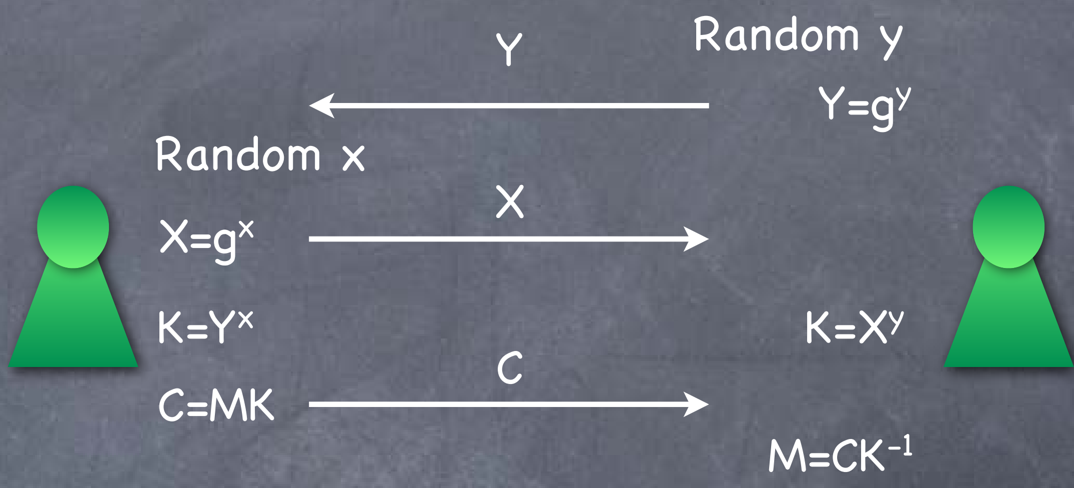

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- KeyGen uses GroupGen to get (G,g)
- x, y uniform from [|G|]
- Message encoded into group element, and decoded

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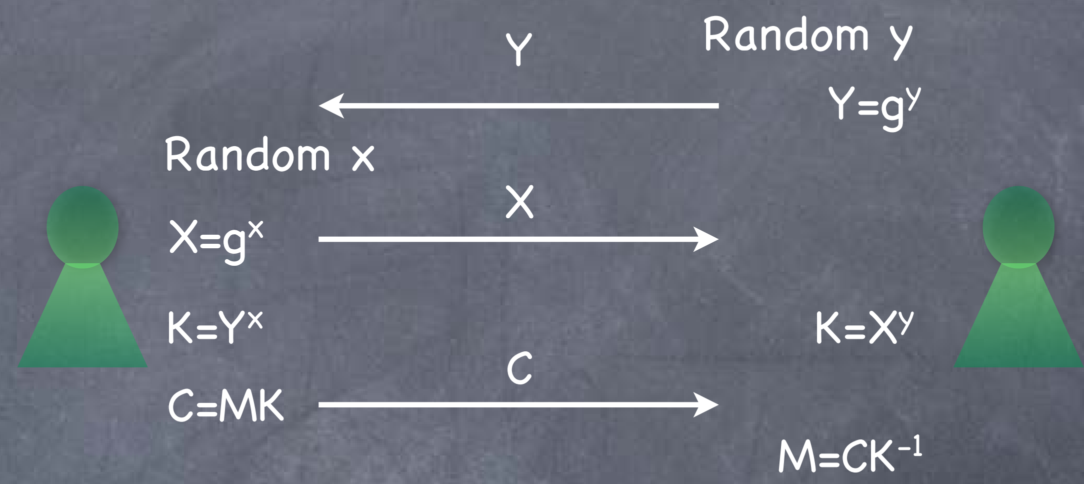
  - When z=random, A* outputs 1 with probability = 1/2
  - When z=xy, exactly IND-CPA experiment: A* outputs 1 with probability = 1/2 + advantage of A.

Abstracting El Gamal



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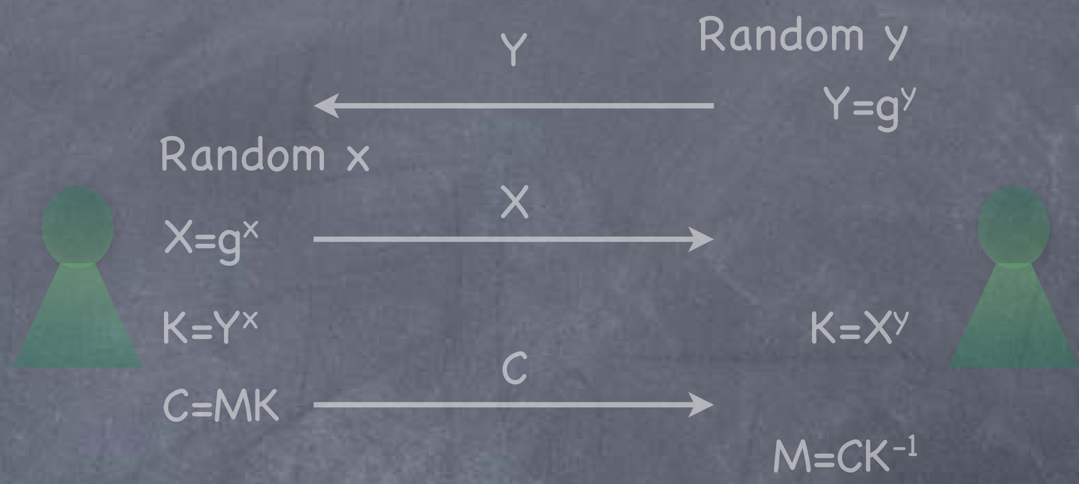

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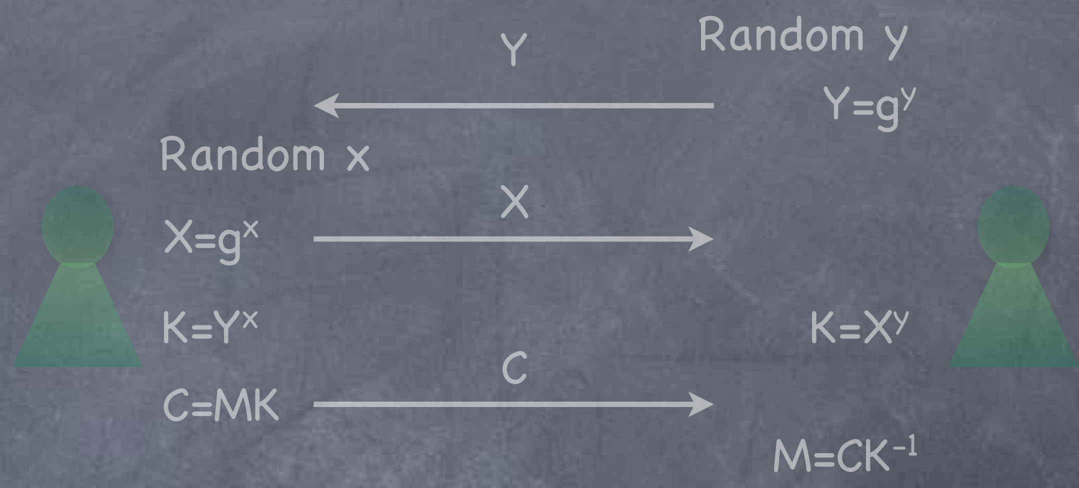

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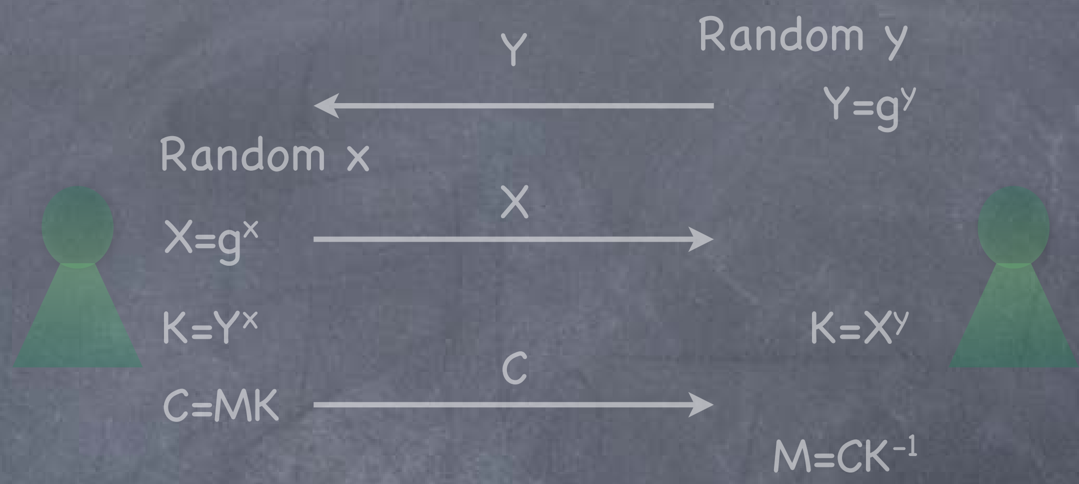

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- Trapdoor PRG:
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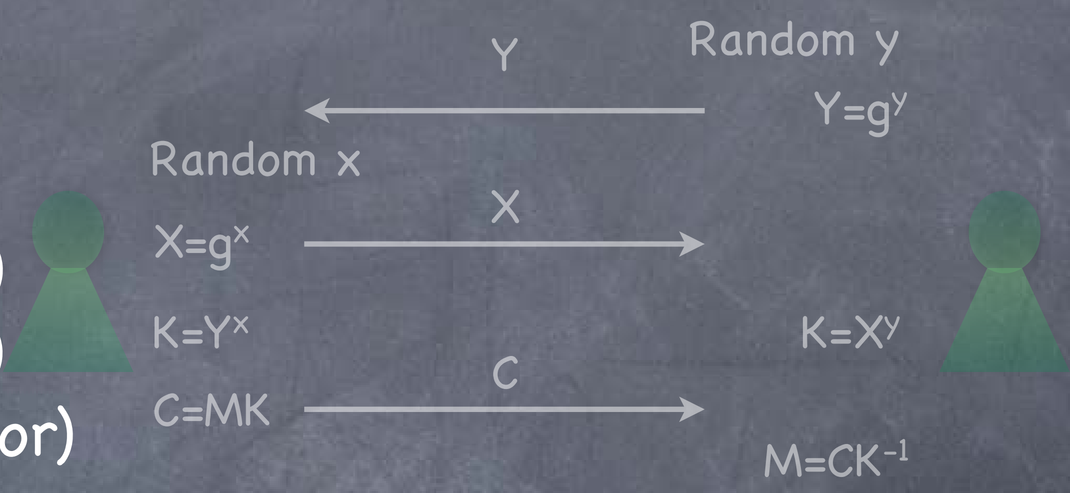

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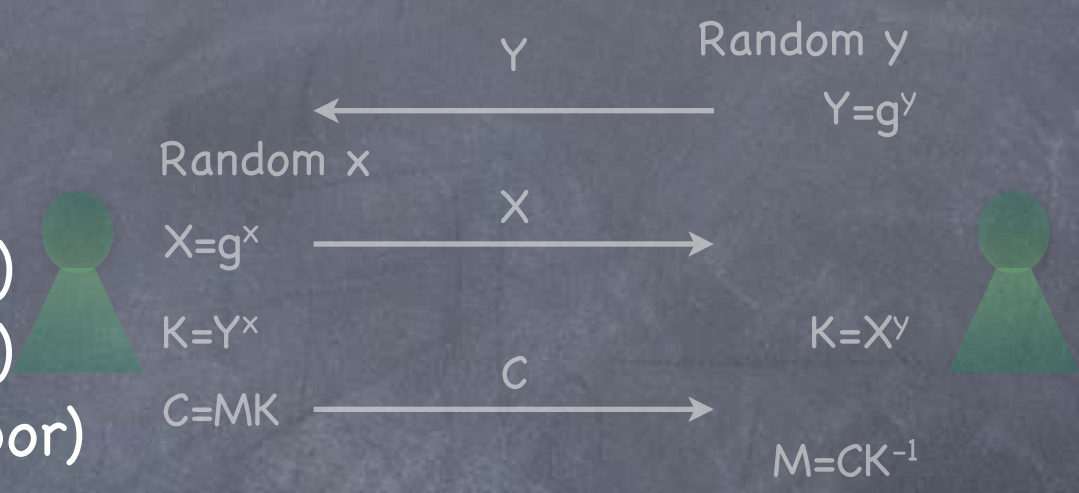

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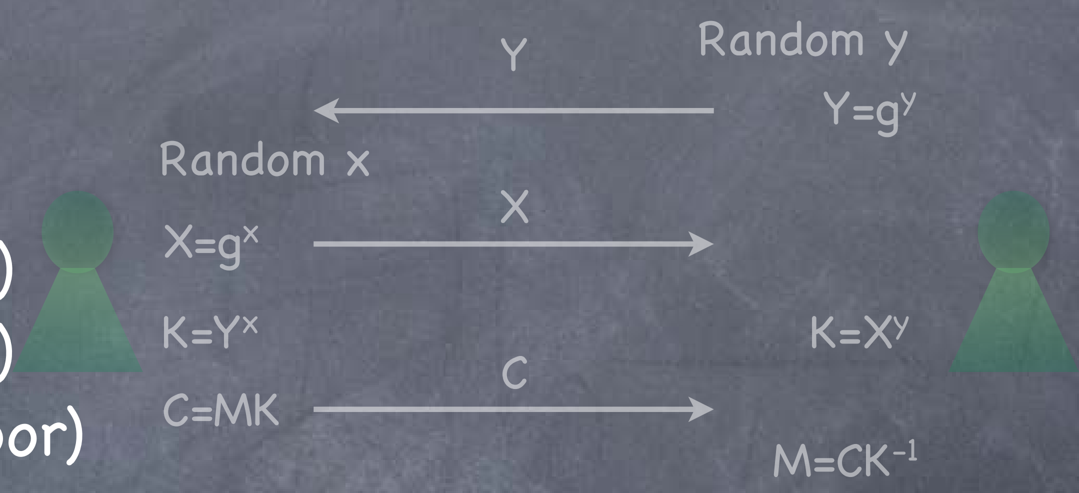

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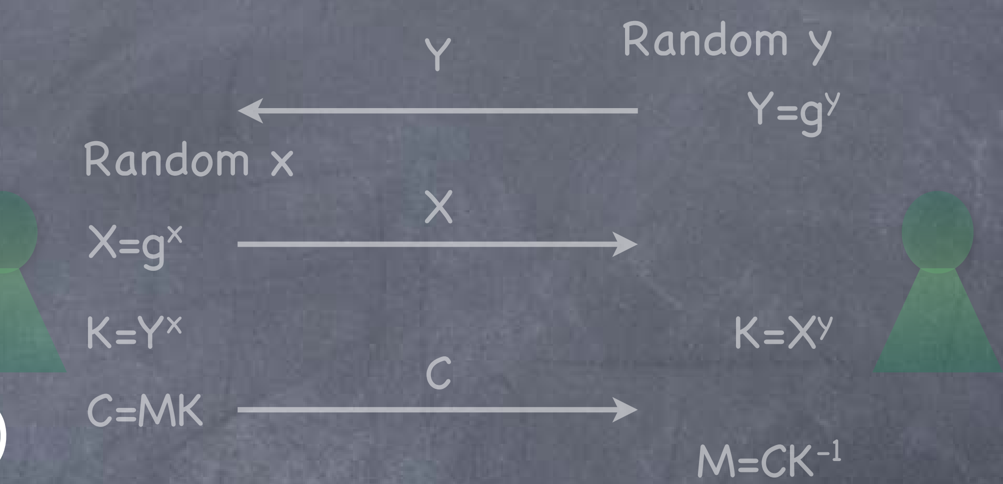

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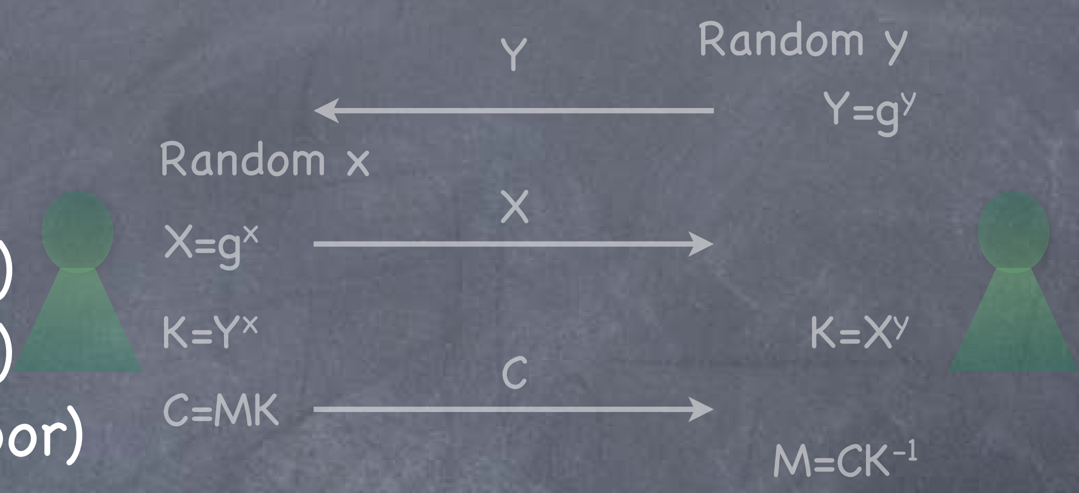

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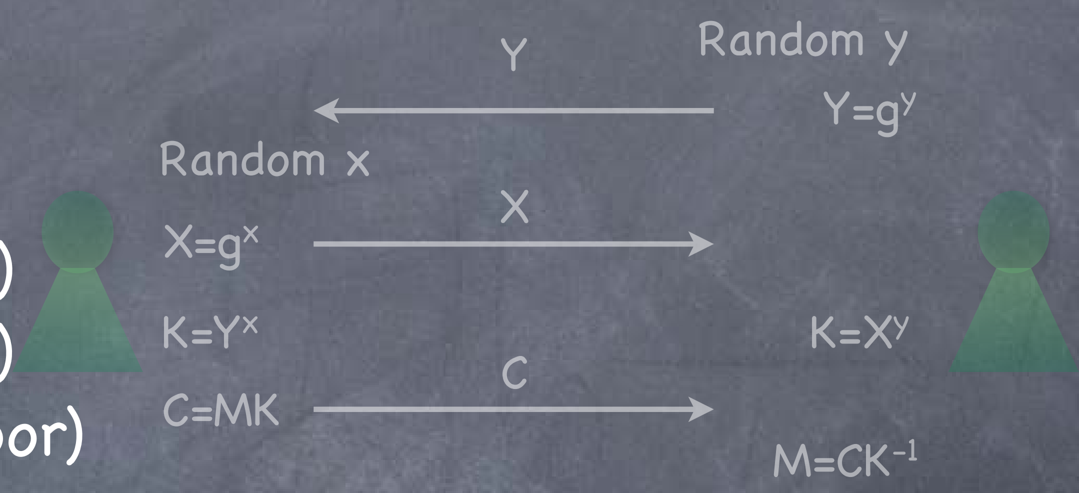

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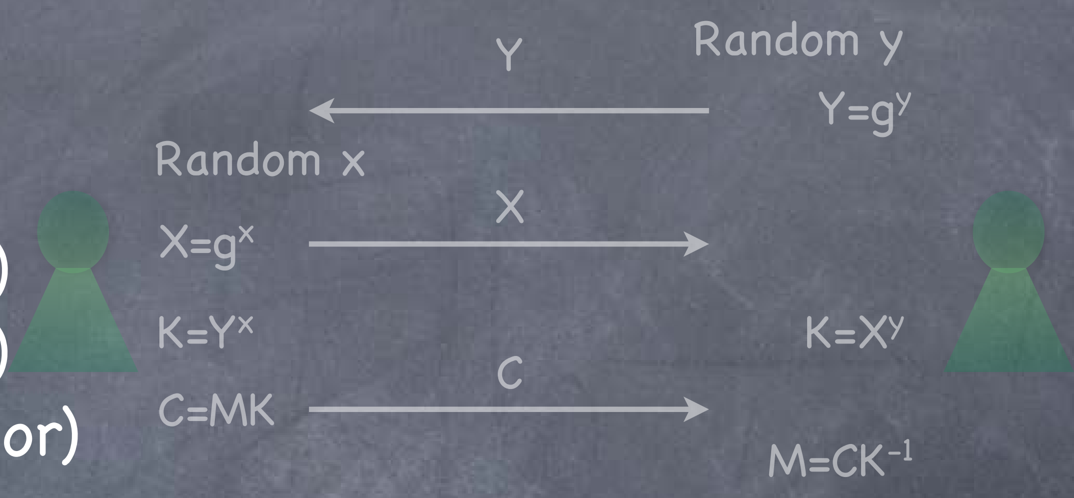

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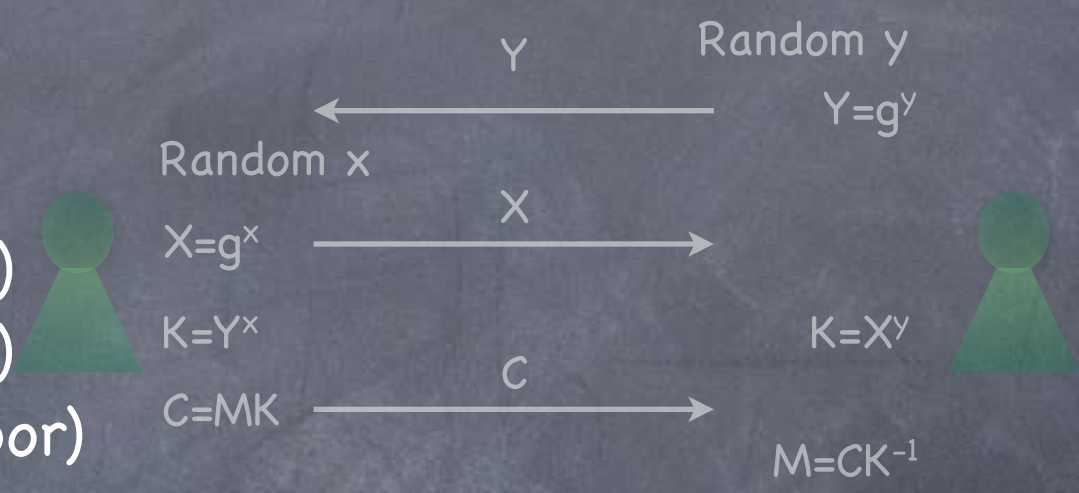

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    - $T_{PK}(x)$ hides $G_{PK}(x)$. SK opens it.
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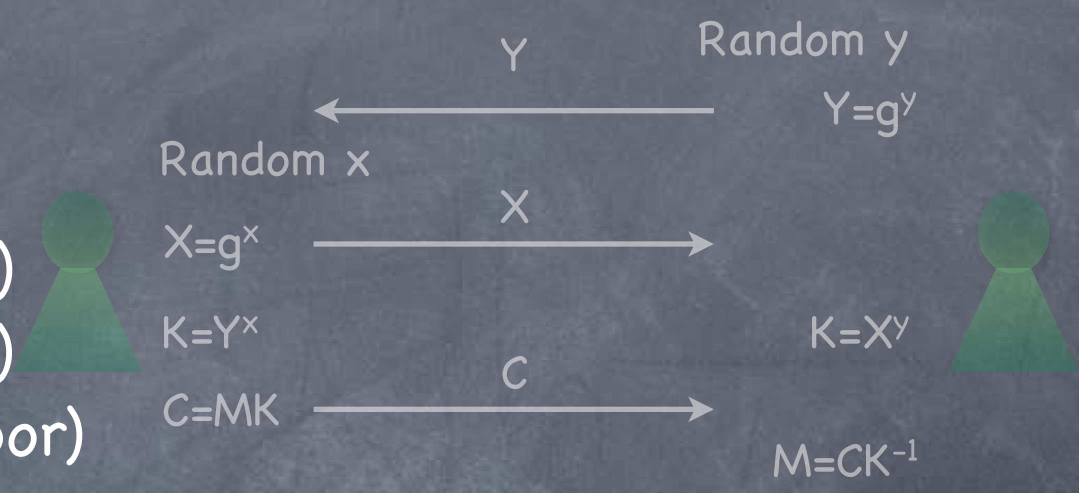
- Enough for an IND-CPA secure PKE scheme (e.g., Security of El Gamal)



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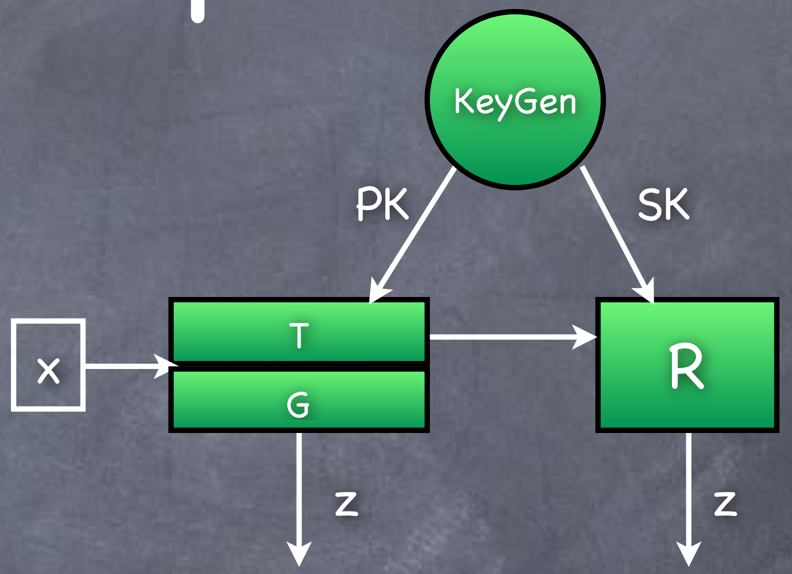
Trapdoor PRG from Generic Assumption?



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Trapdoor PRG from Generic Assumption?

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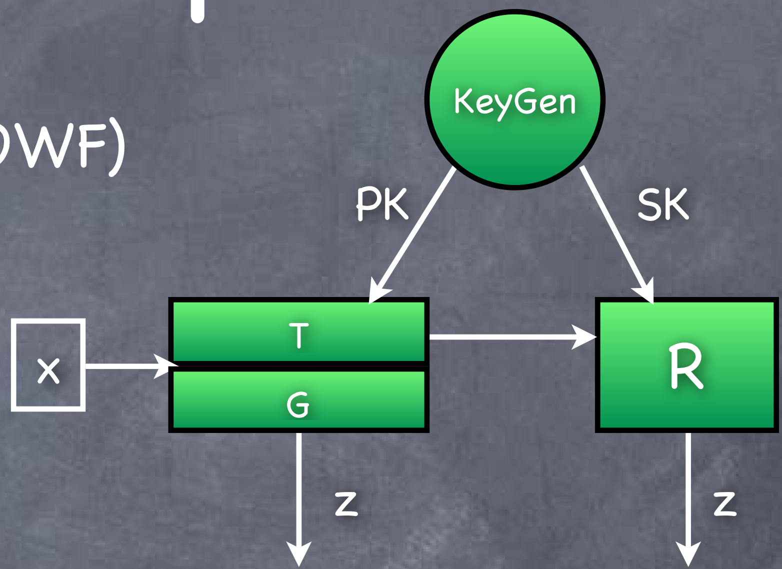

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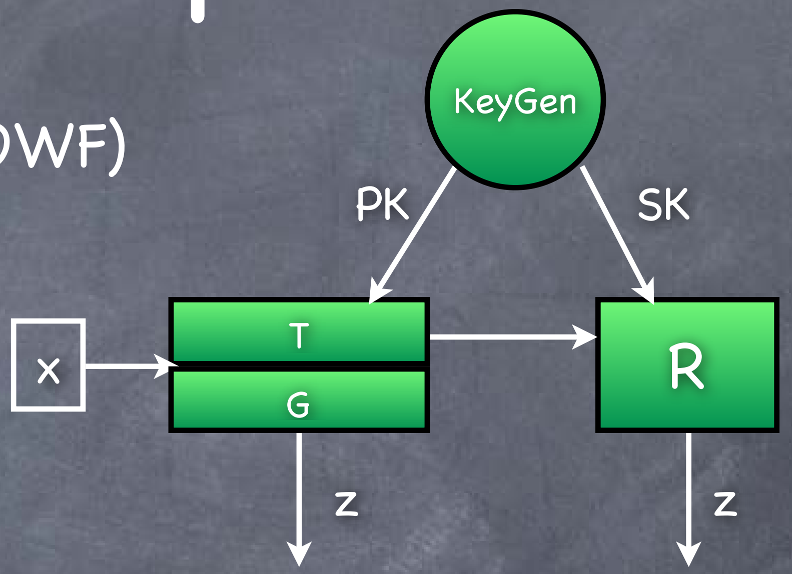
Trapdoor PRG from Generic Assumption?

- PRG constructed from OWP (or OWF)
  - Allows us to instantiate the construction with several candidates



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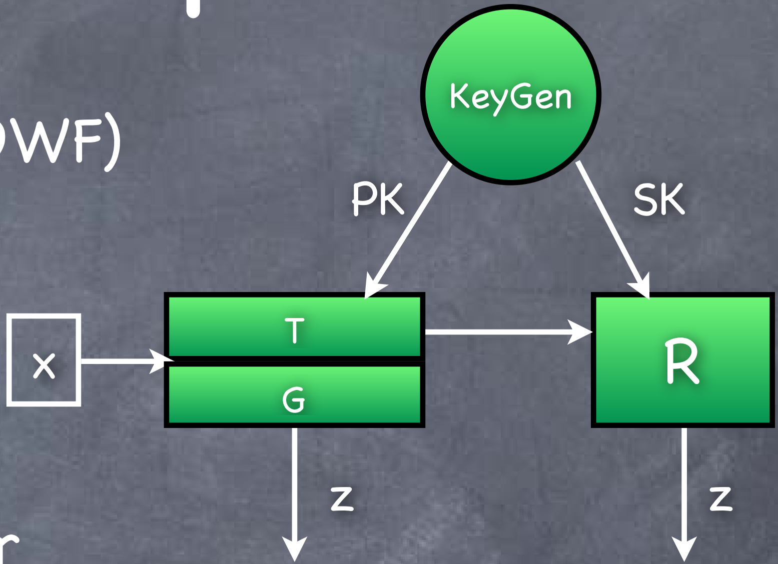

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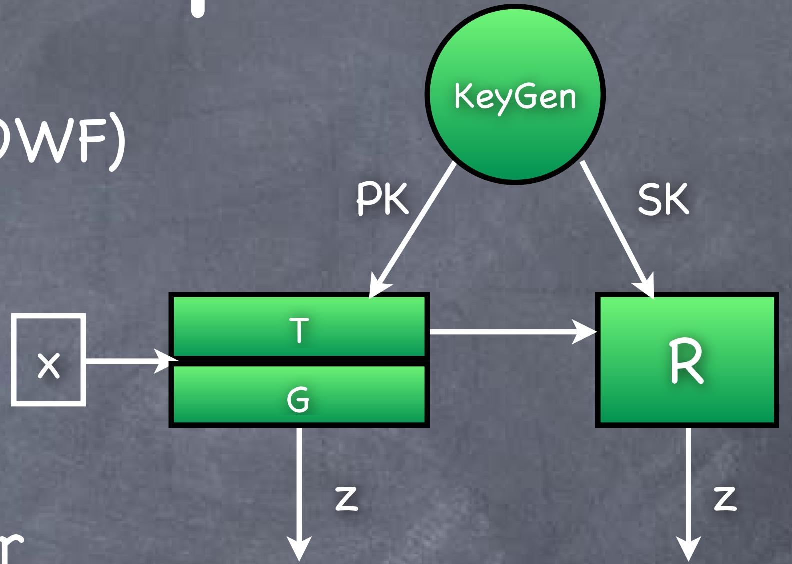

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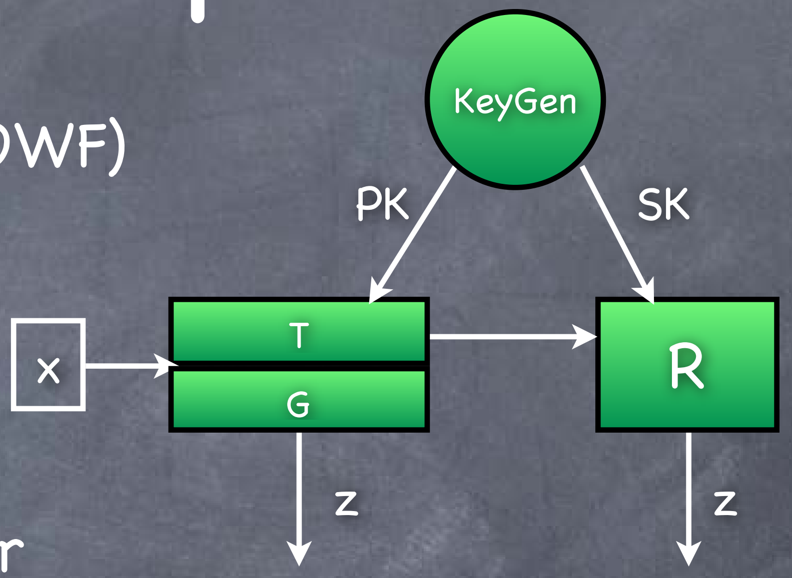

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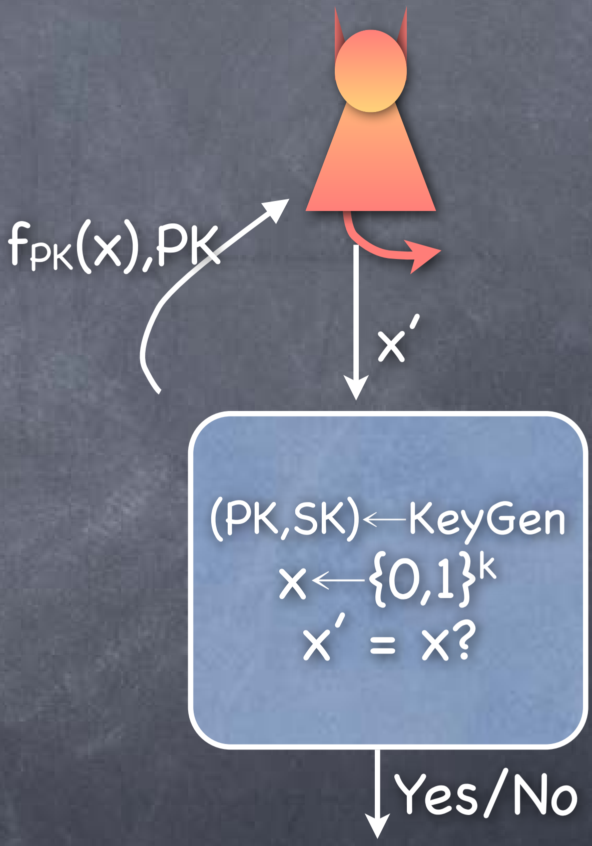

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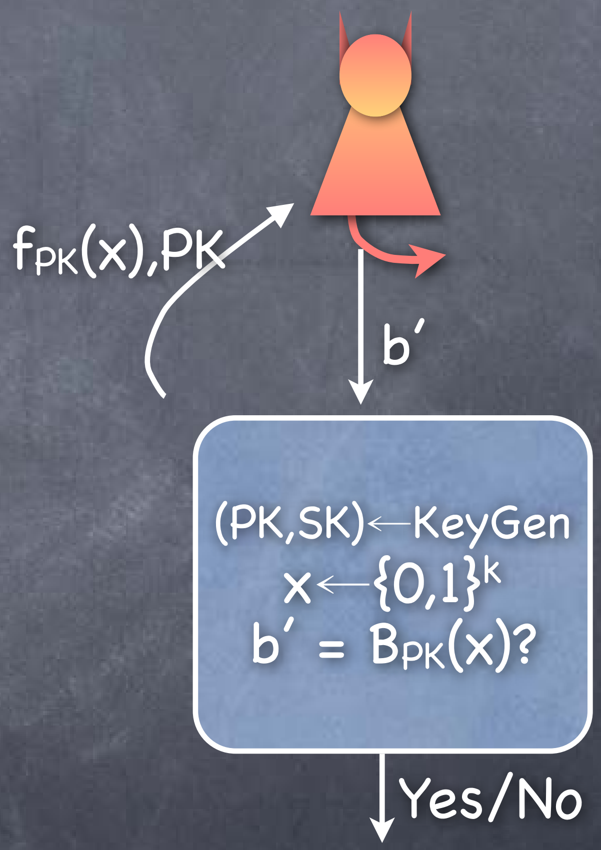

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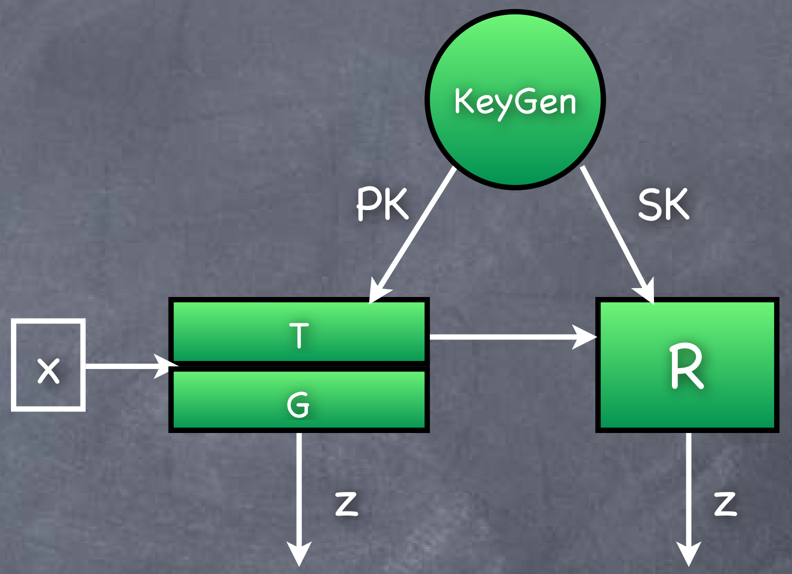

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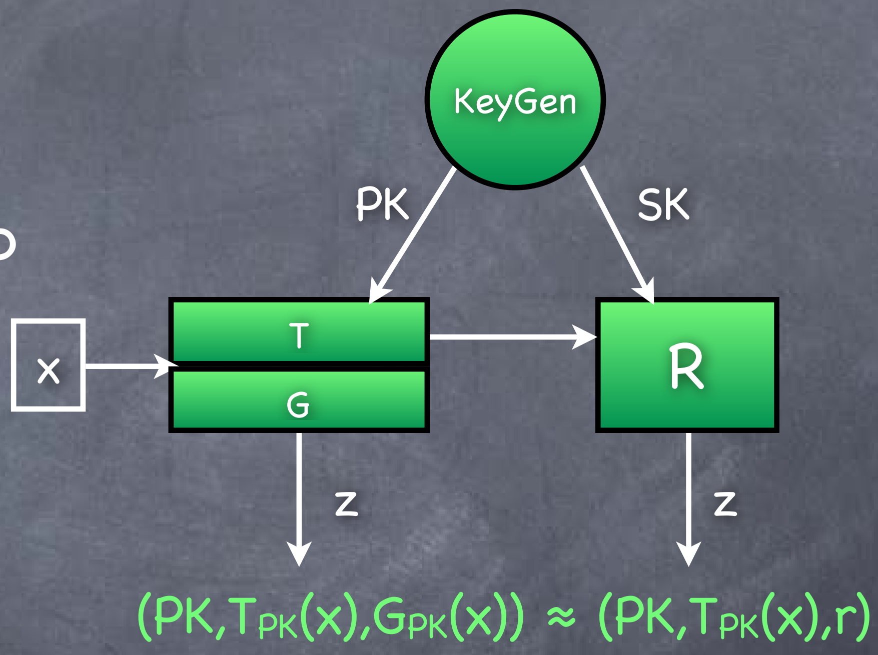

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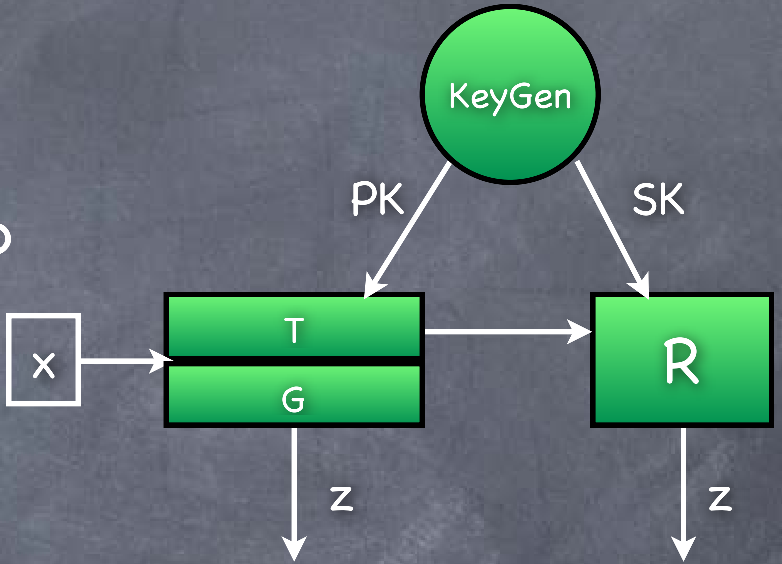

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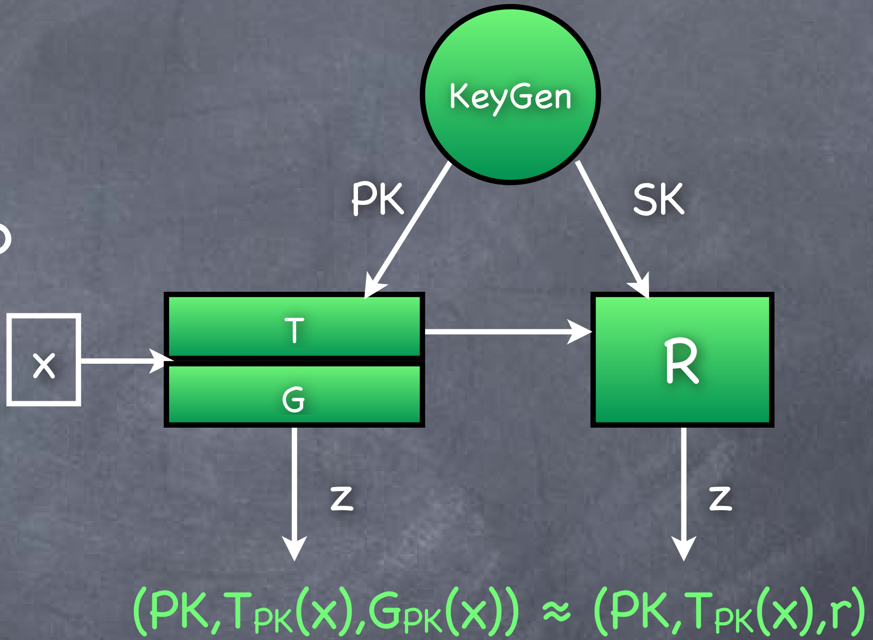

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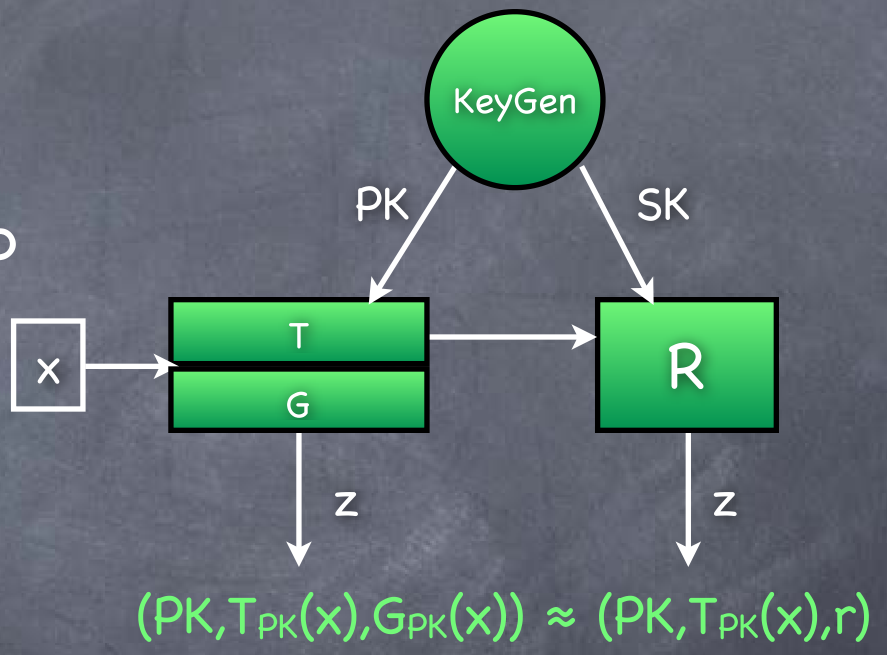

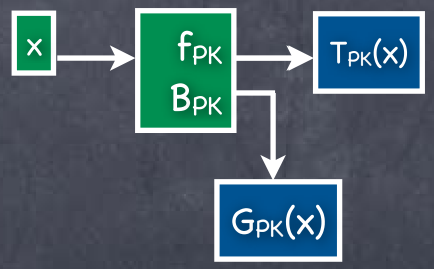

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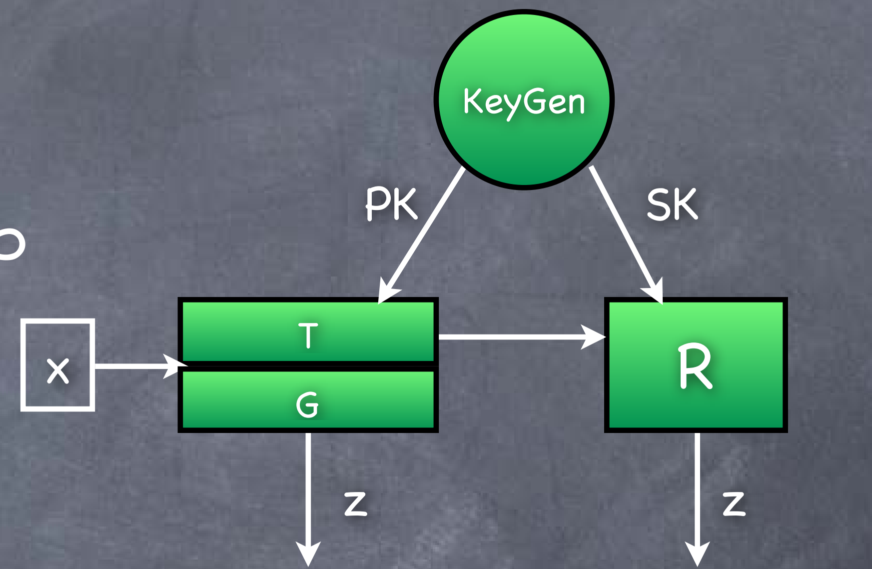

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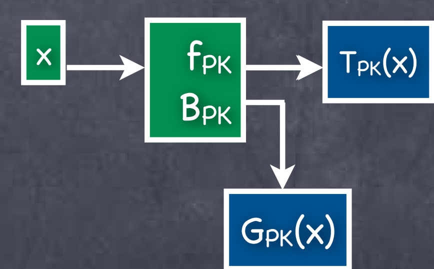

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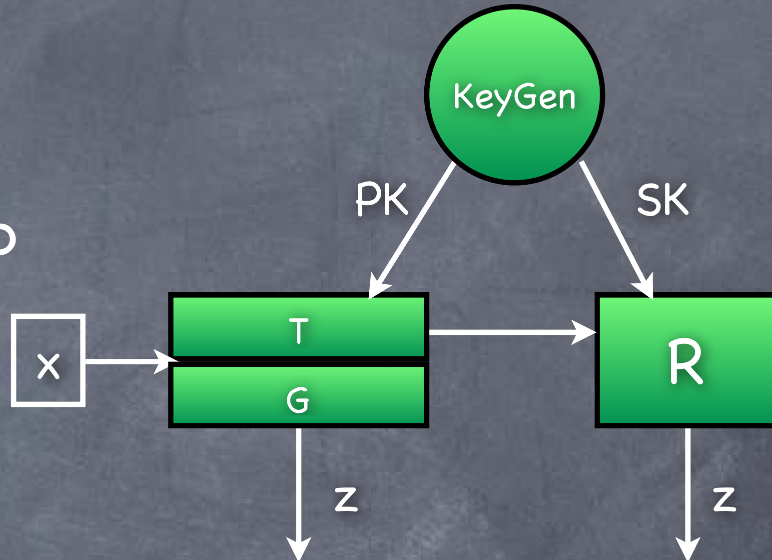

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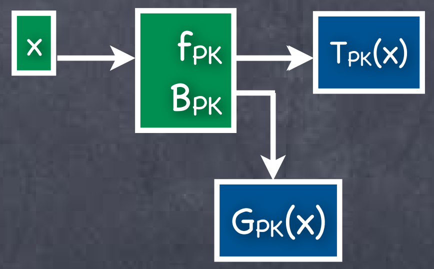

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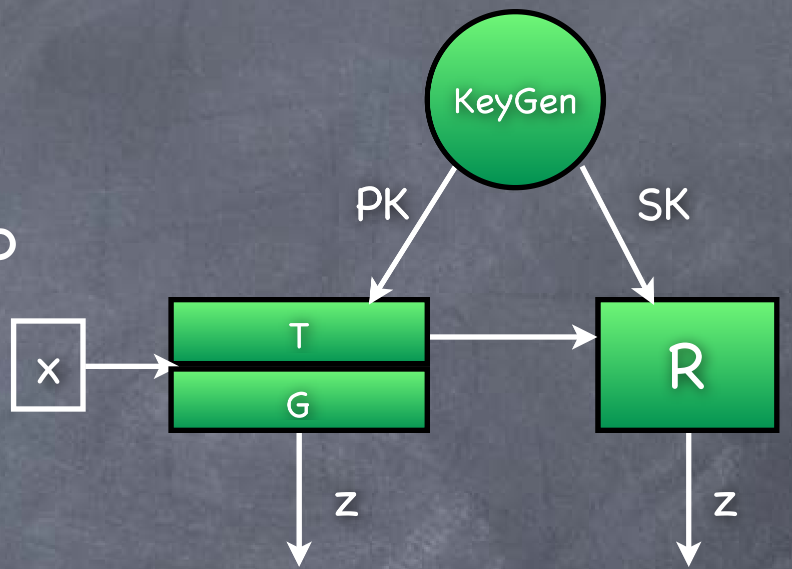

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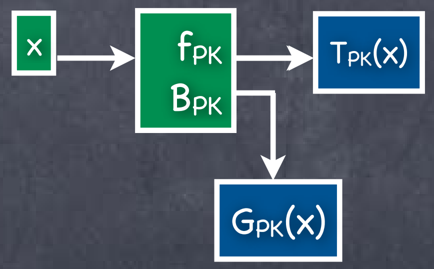

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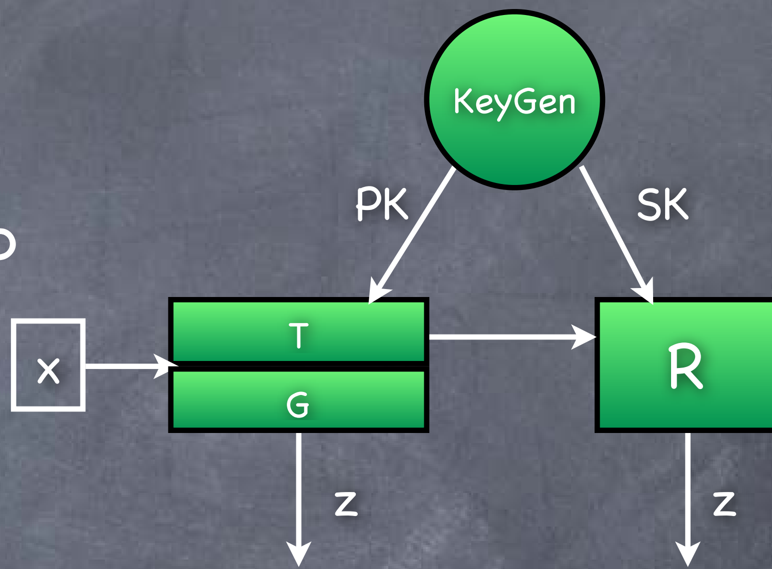

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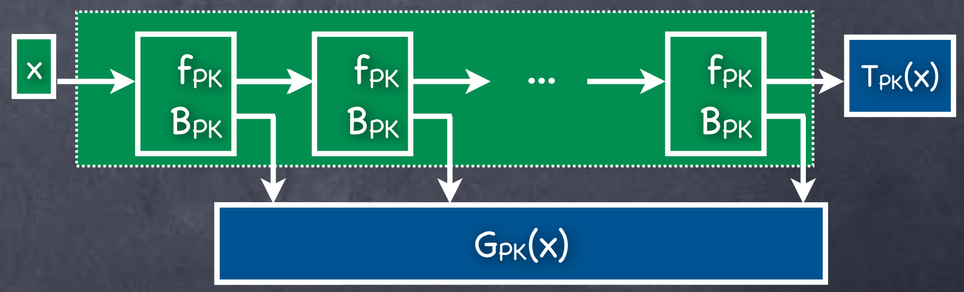

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see handout

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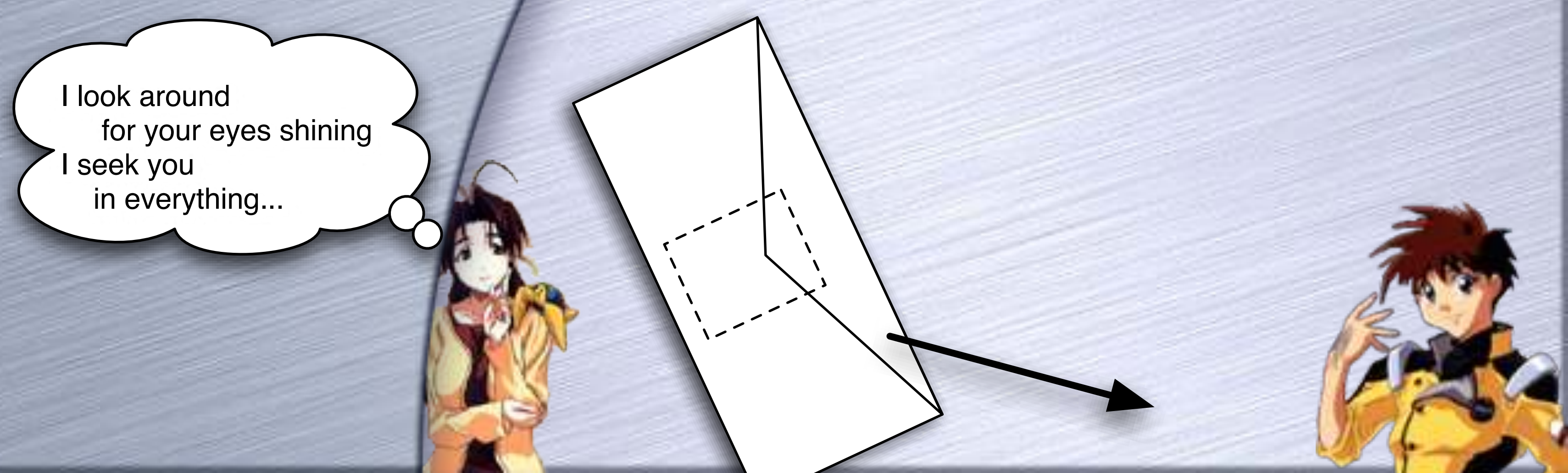

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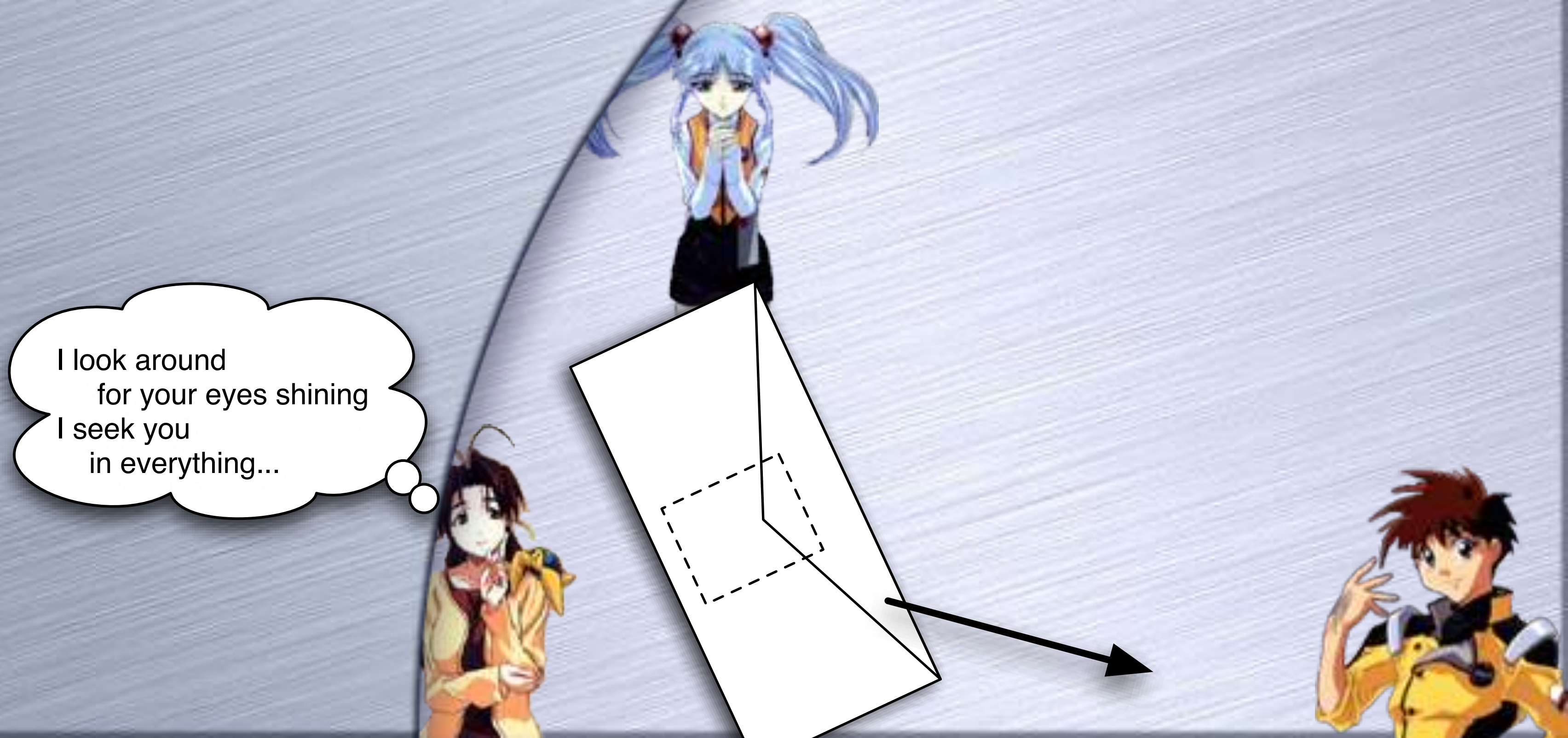

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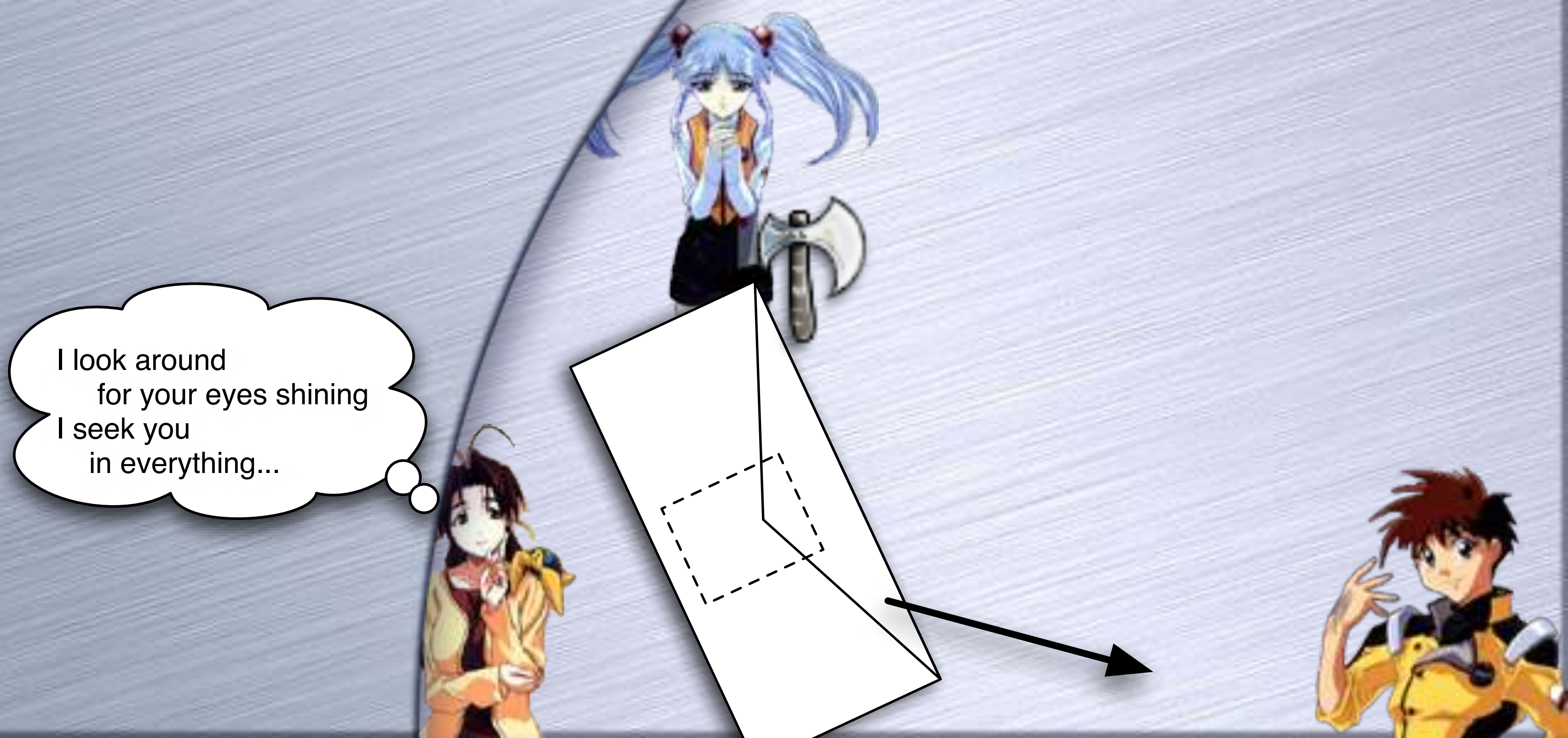

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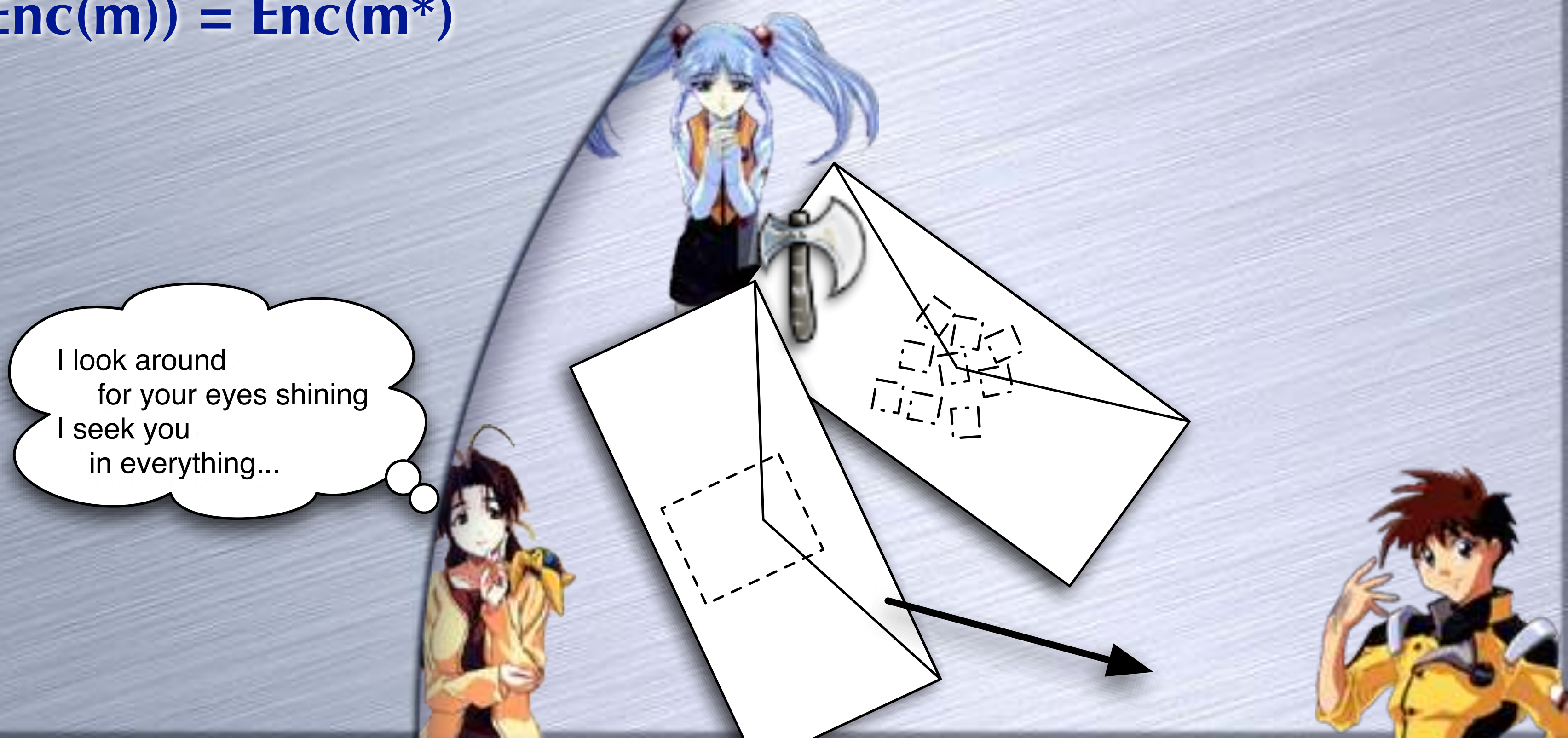

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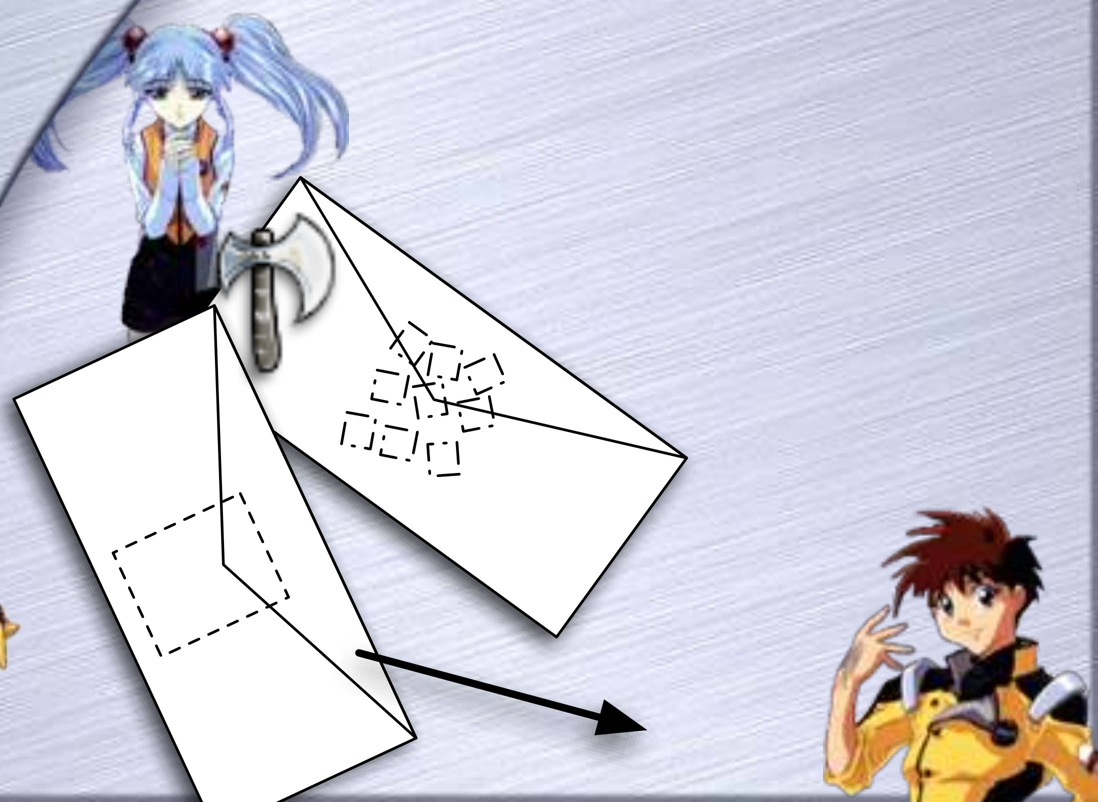

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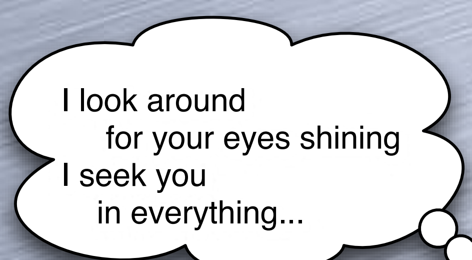

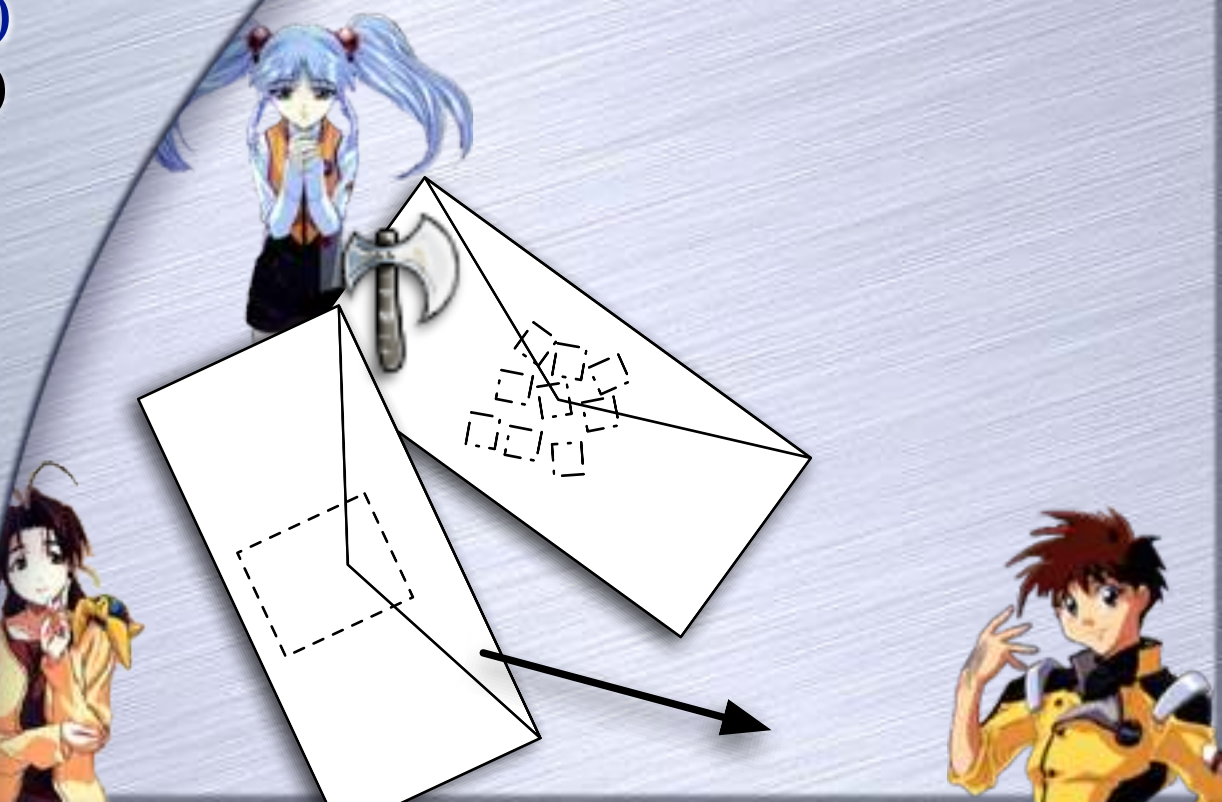

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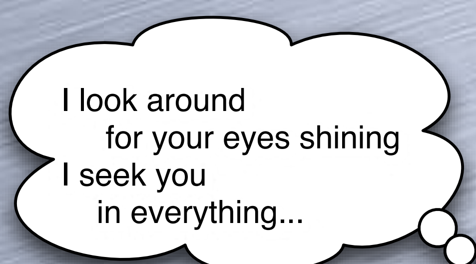

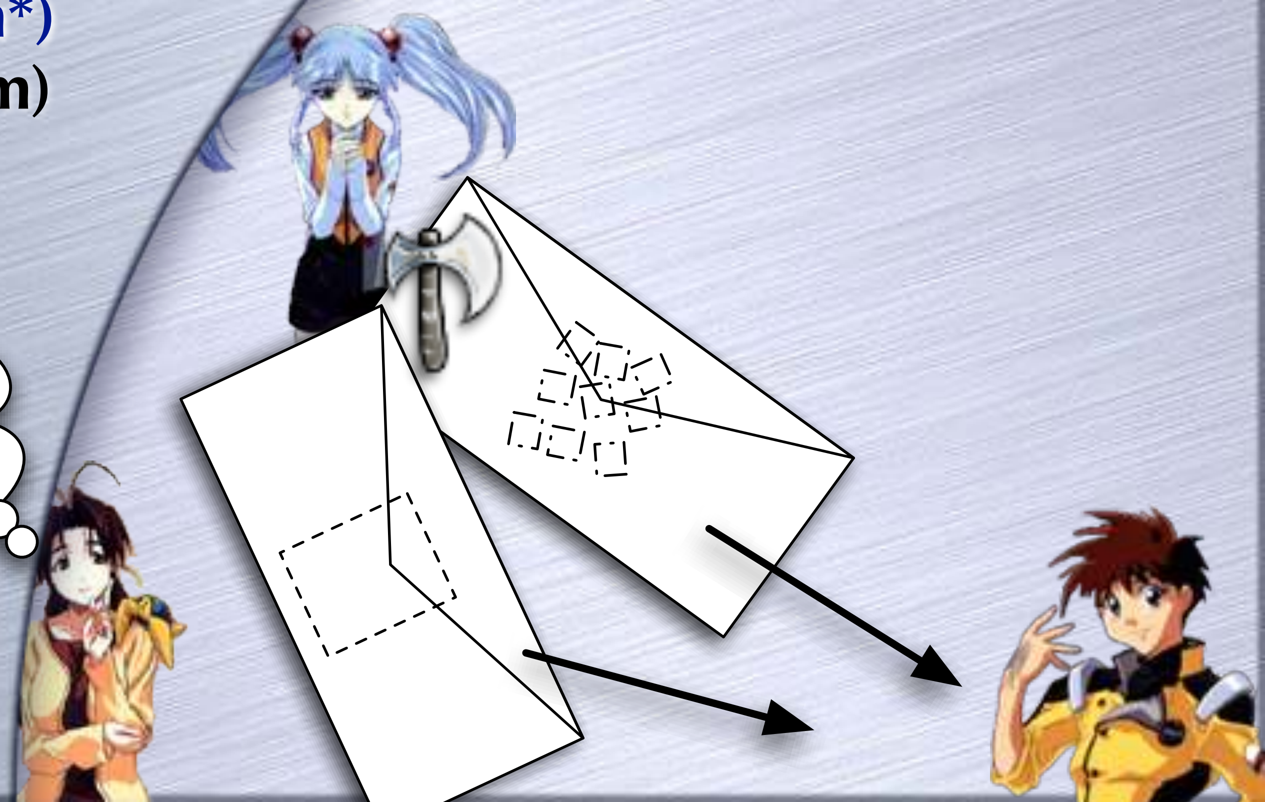

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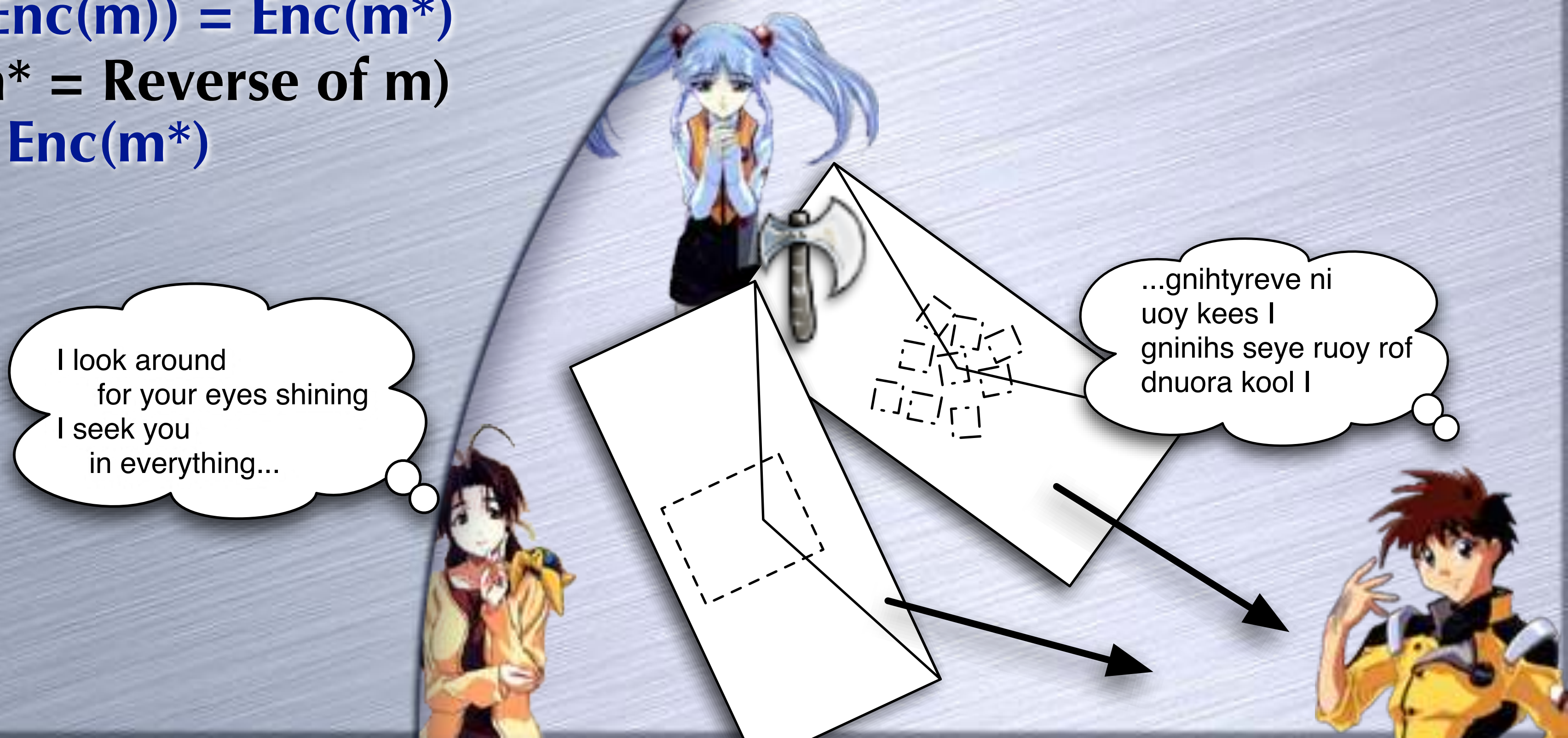

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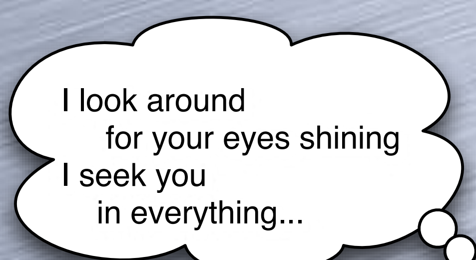
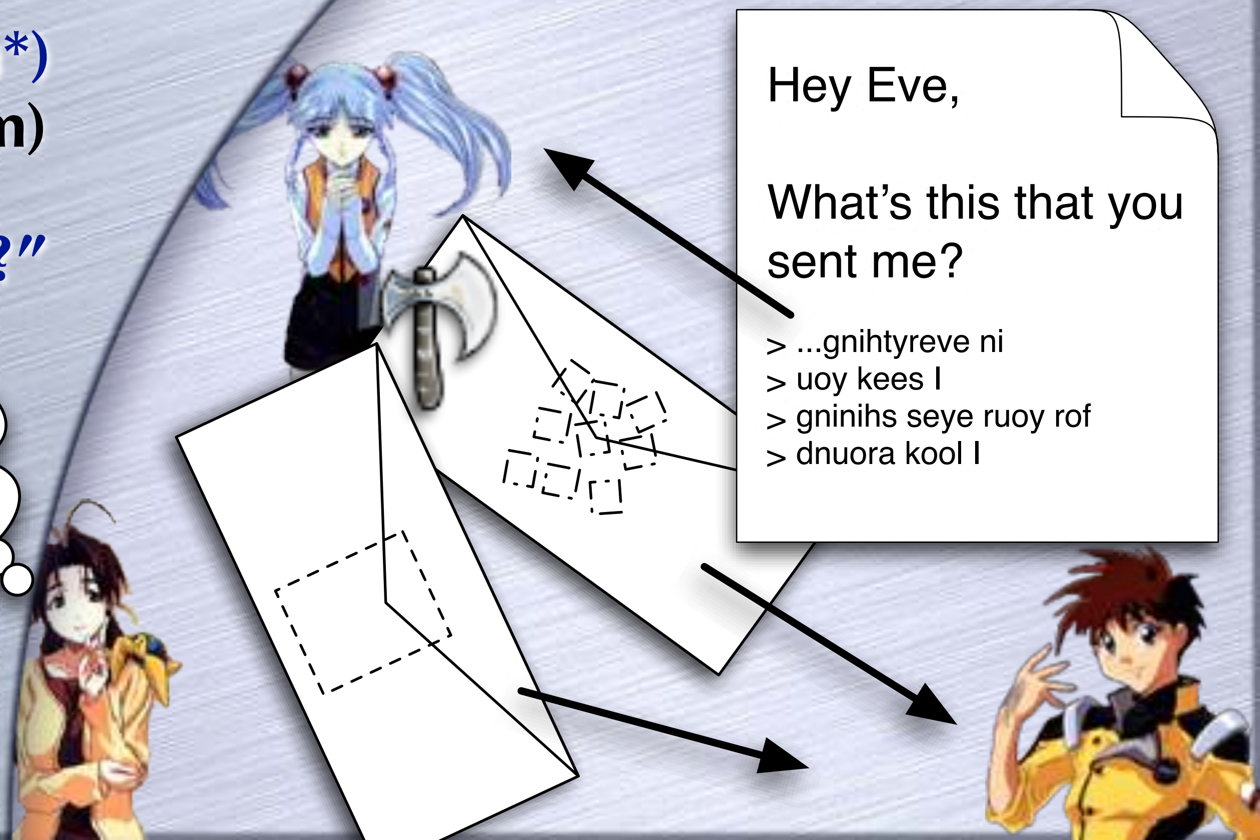


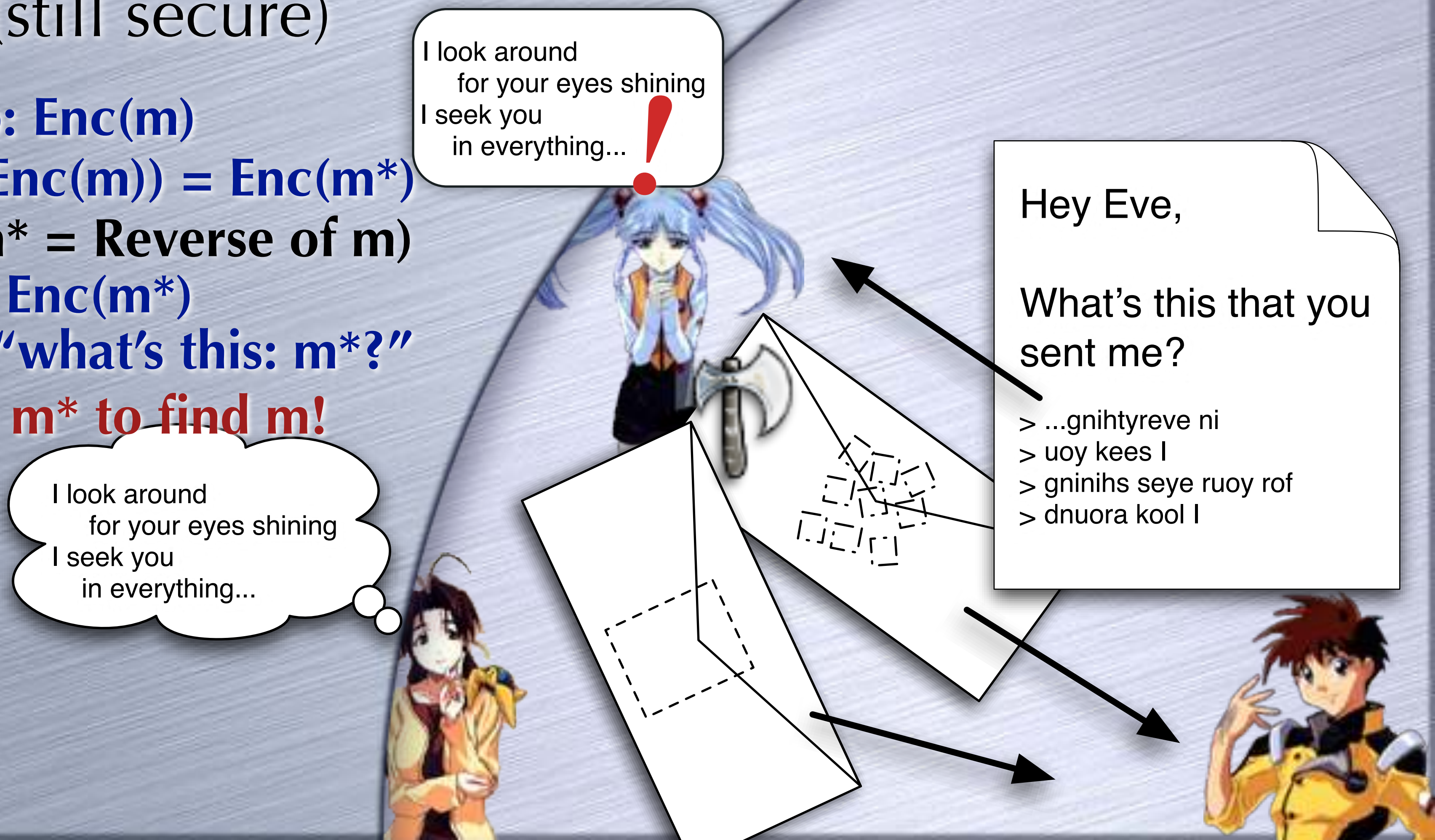


Chosen Ciphertext Attack

- Suppose Enc SIM-CPA secure
  - Suppose encrypts a character at a time (still secure)

A subtle
e-mail attack

Alice → Bob: Enc(m)
Eve: Hack(Enc(m)) = Enc(m*)
(where m* = Reverse of m)
Eve → Bob: Enc(m*)
Bob → Eve: "what's this: m*?"
Eve: Reverse m* to find m!



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More subtly, the 1 bit - valid or invalid - may leak information on message or SK

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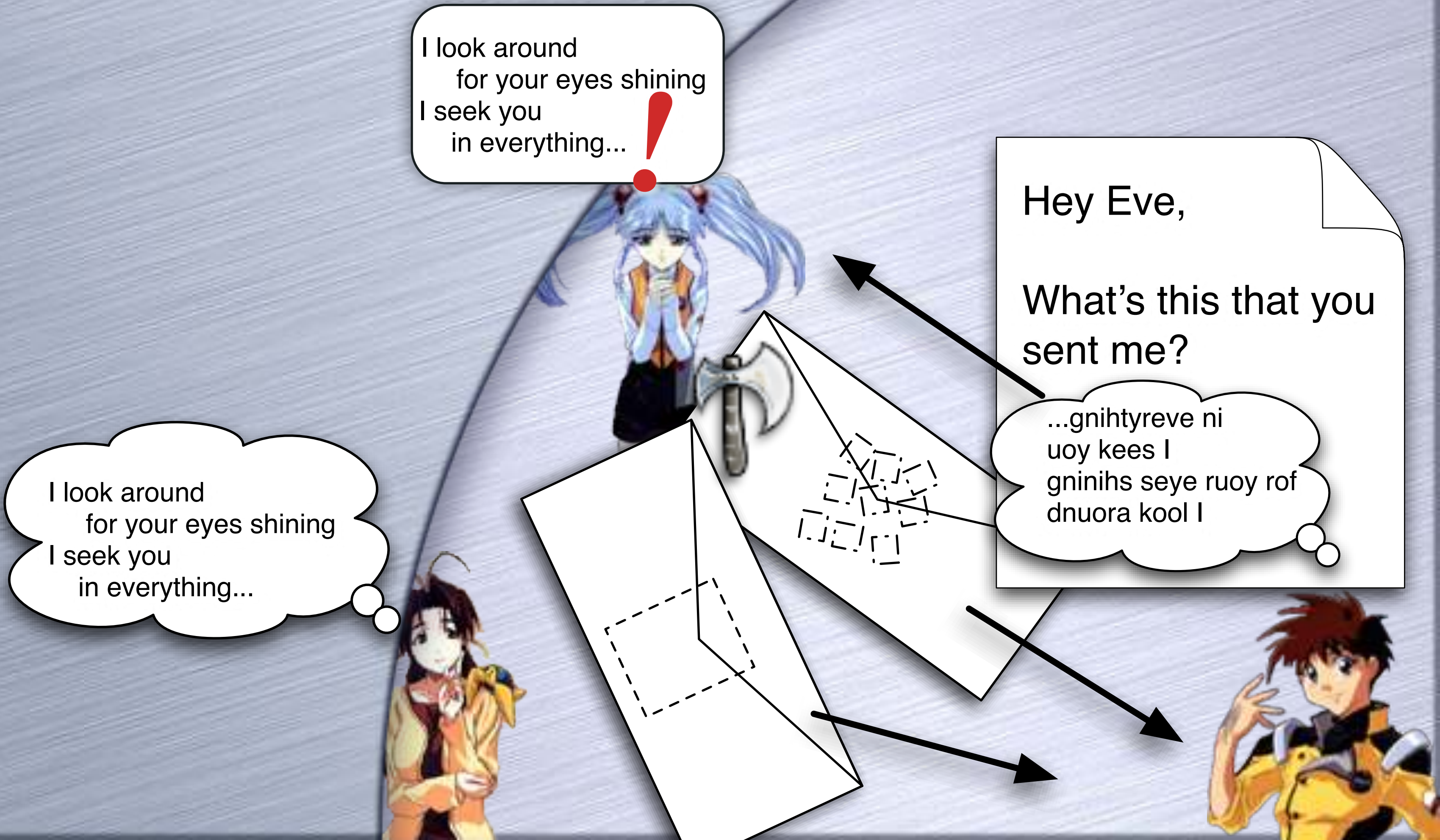

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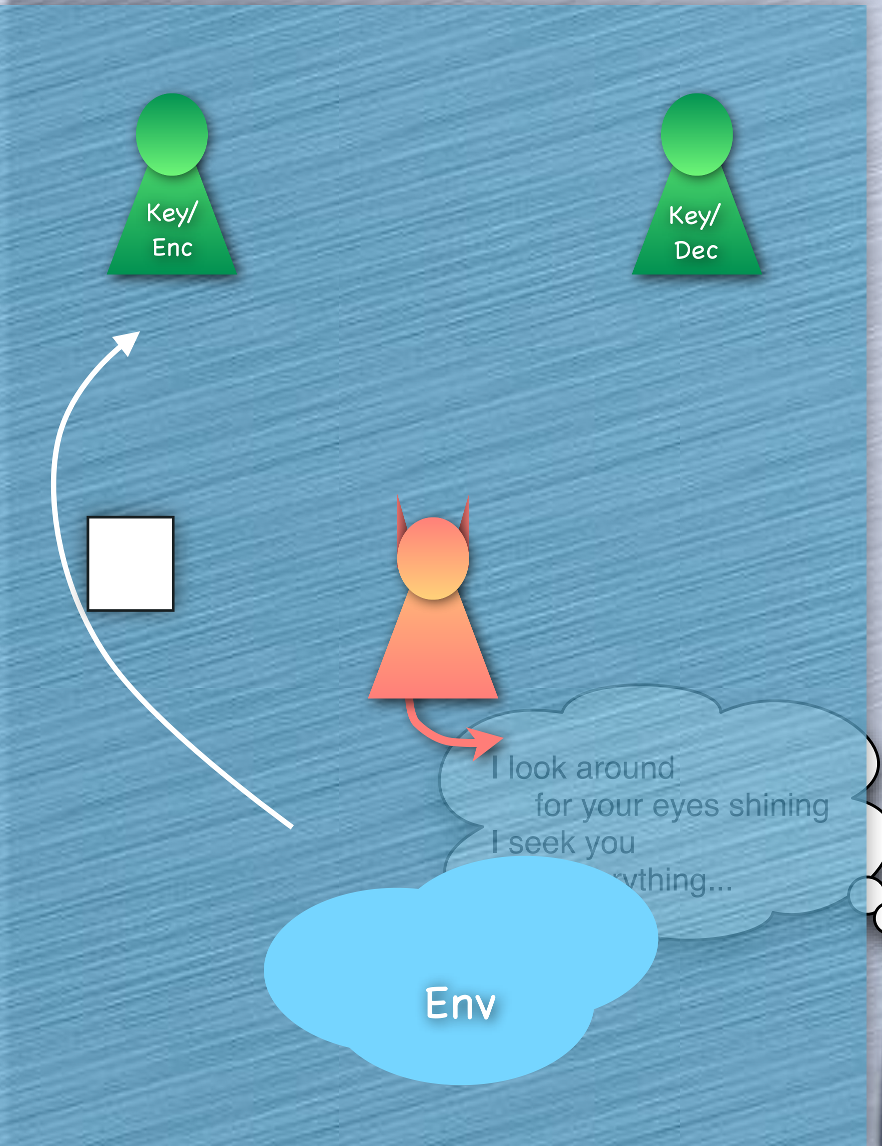

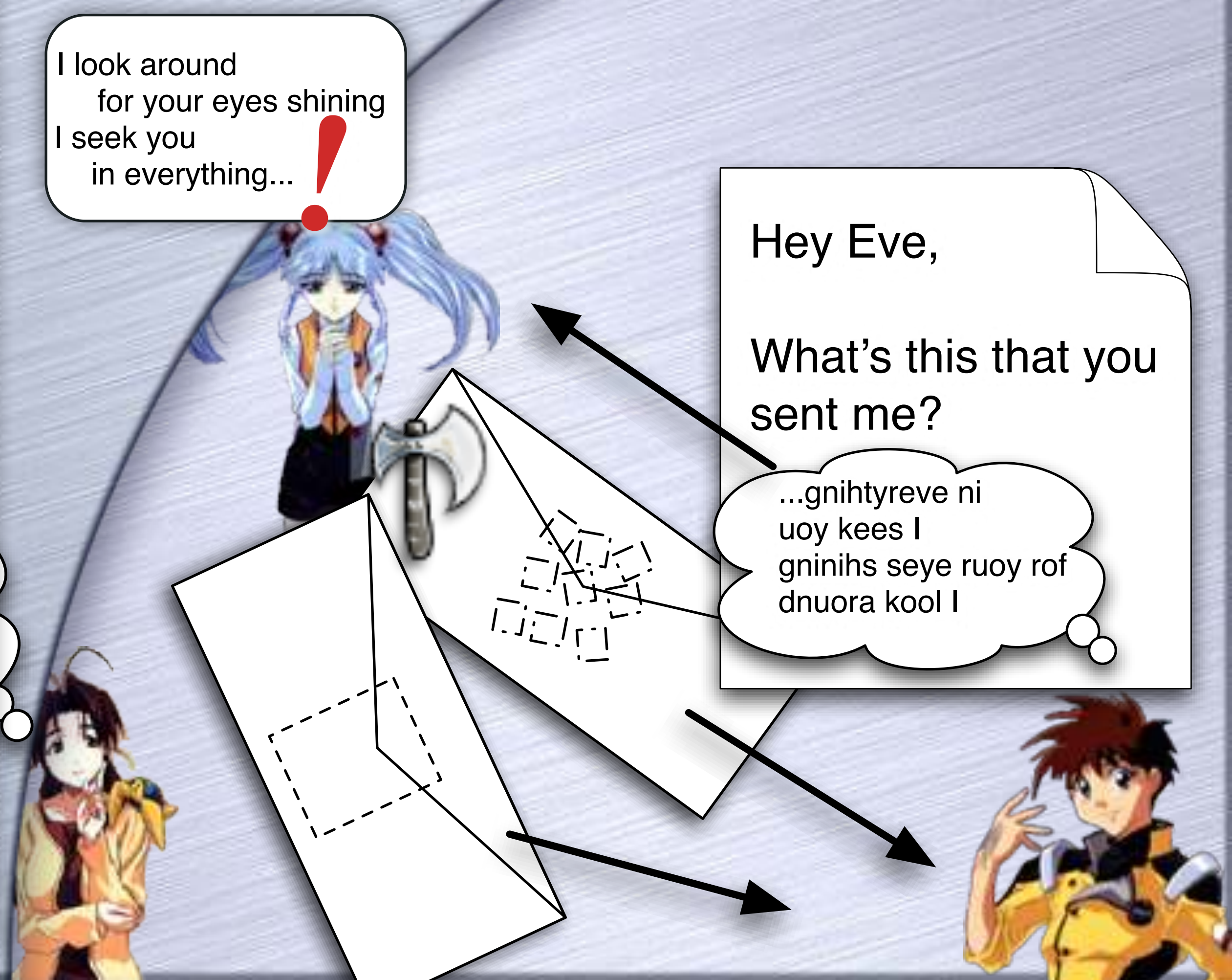

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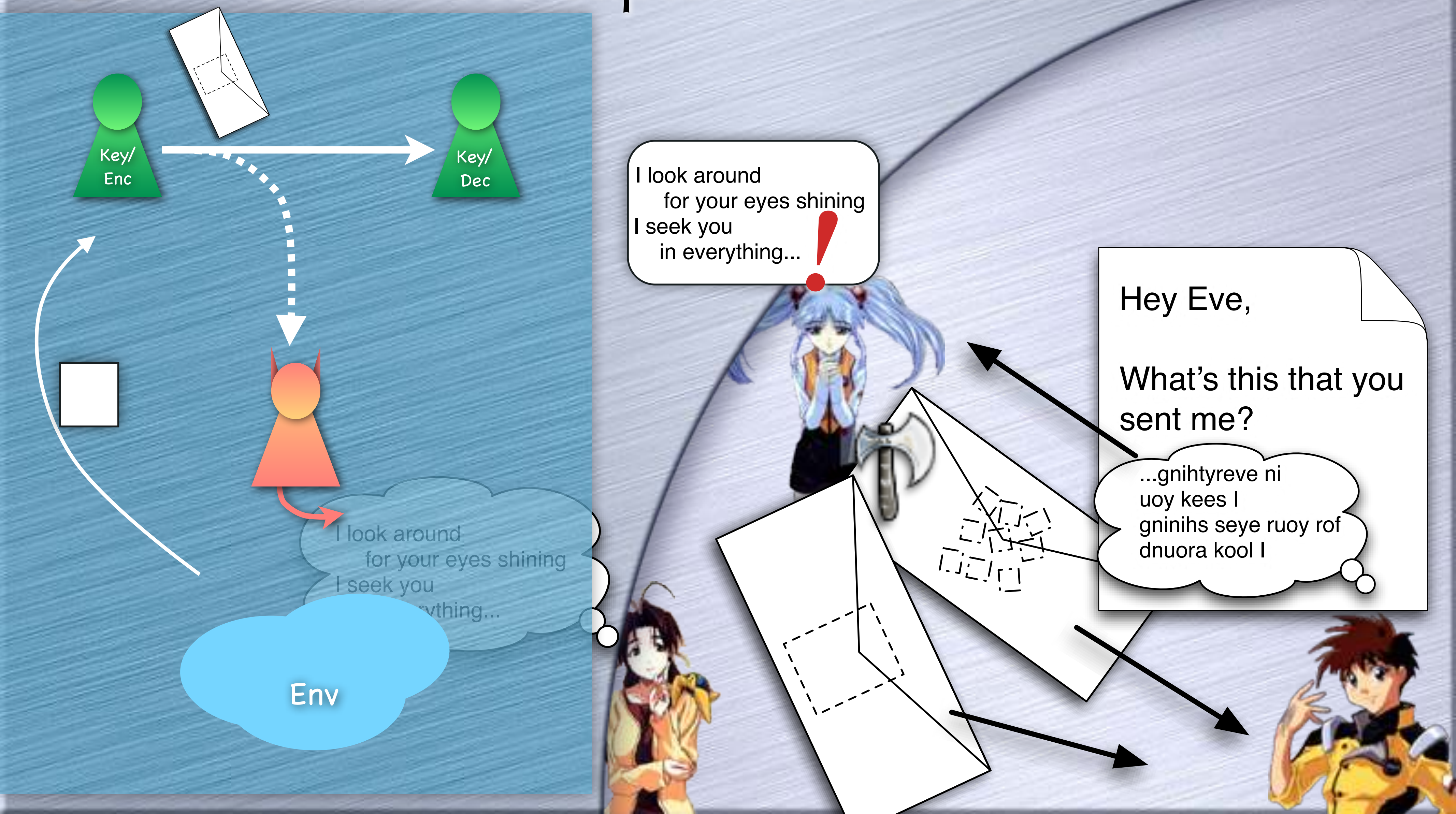

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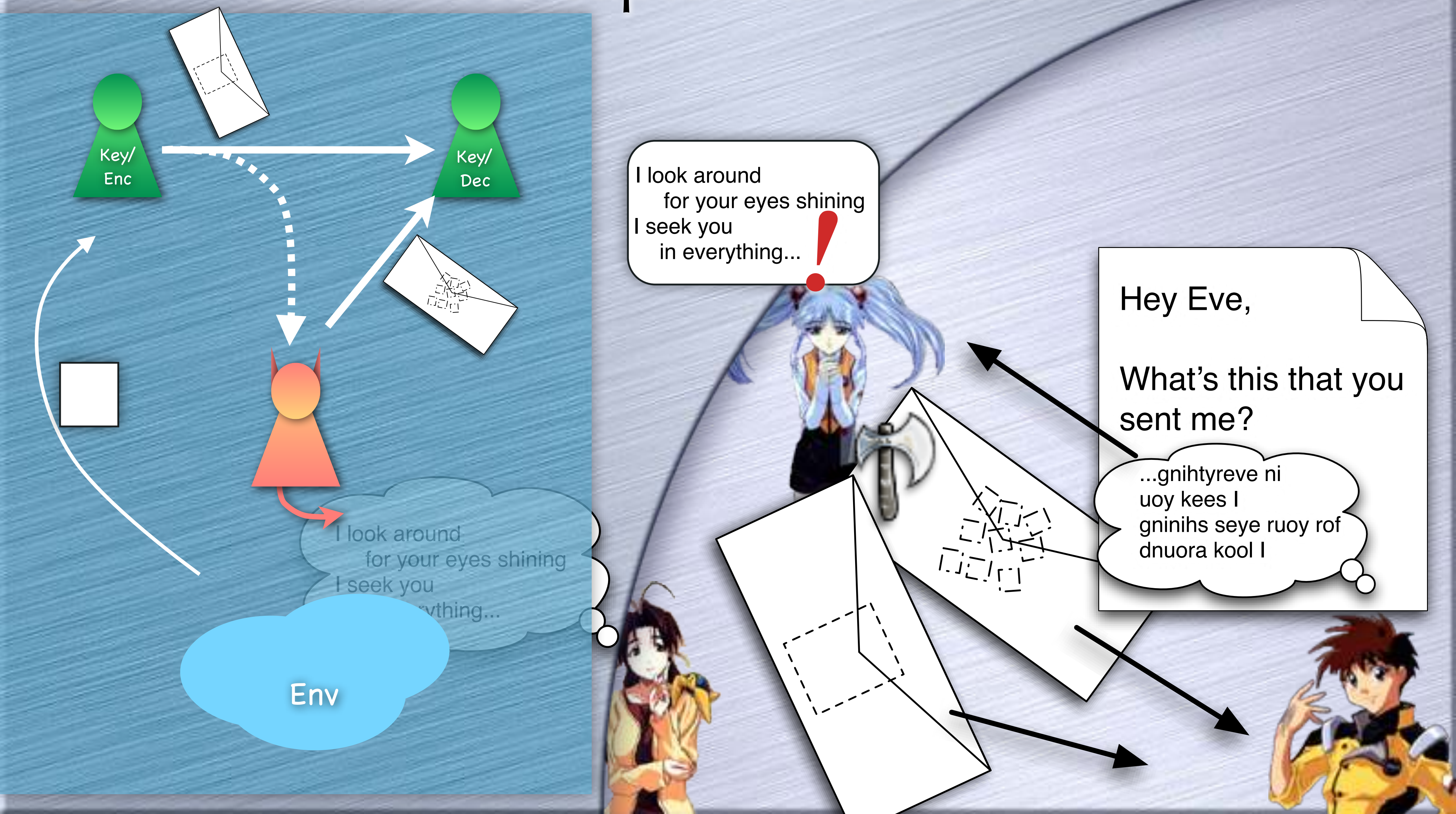

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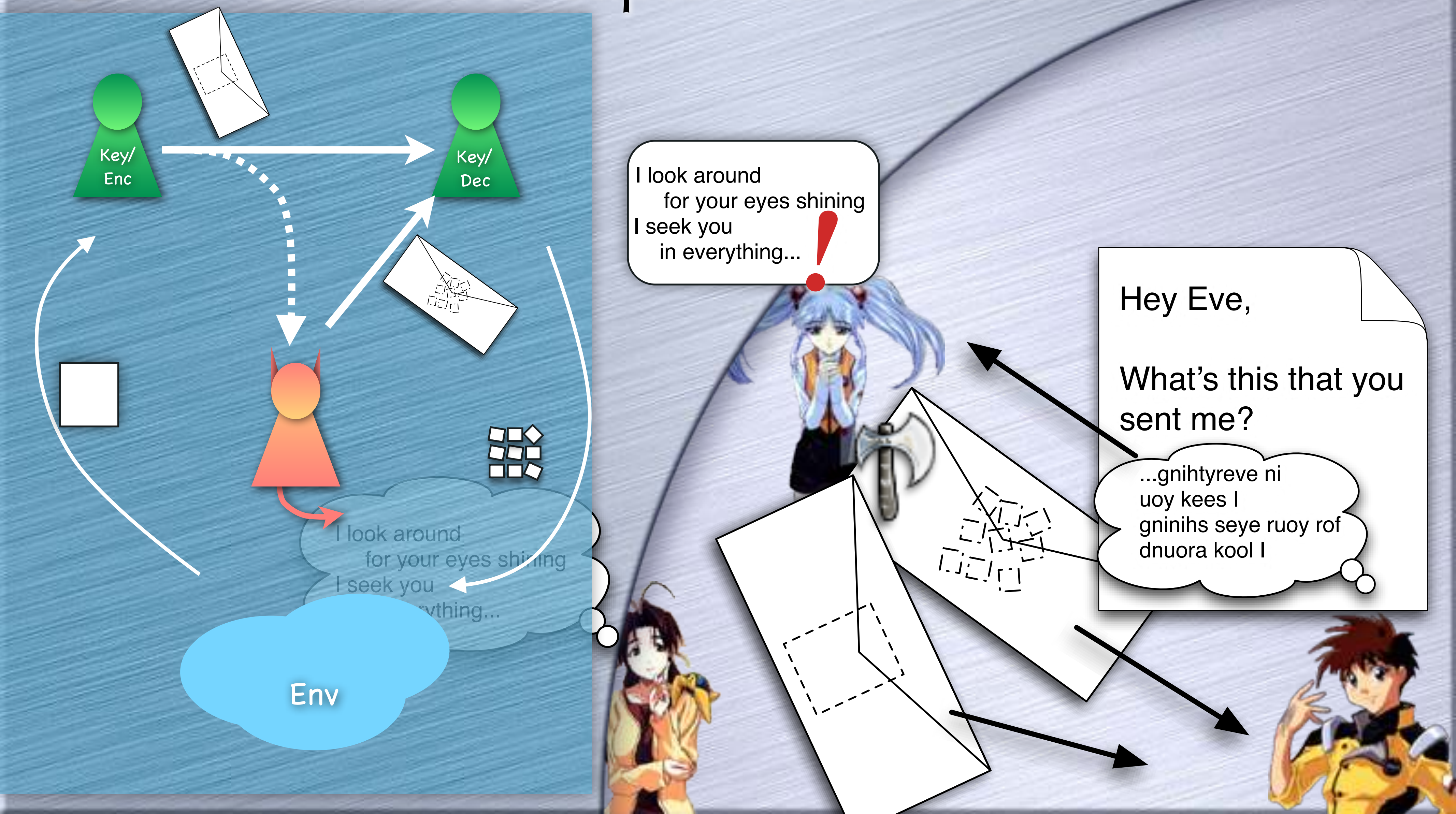

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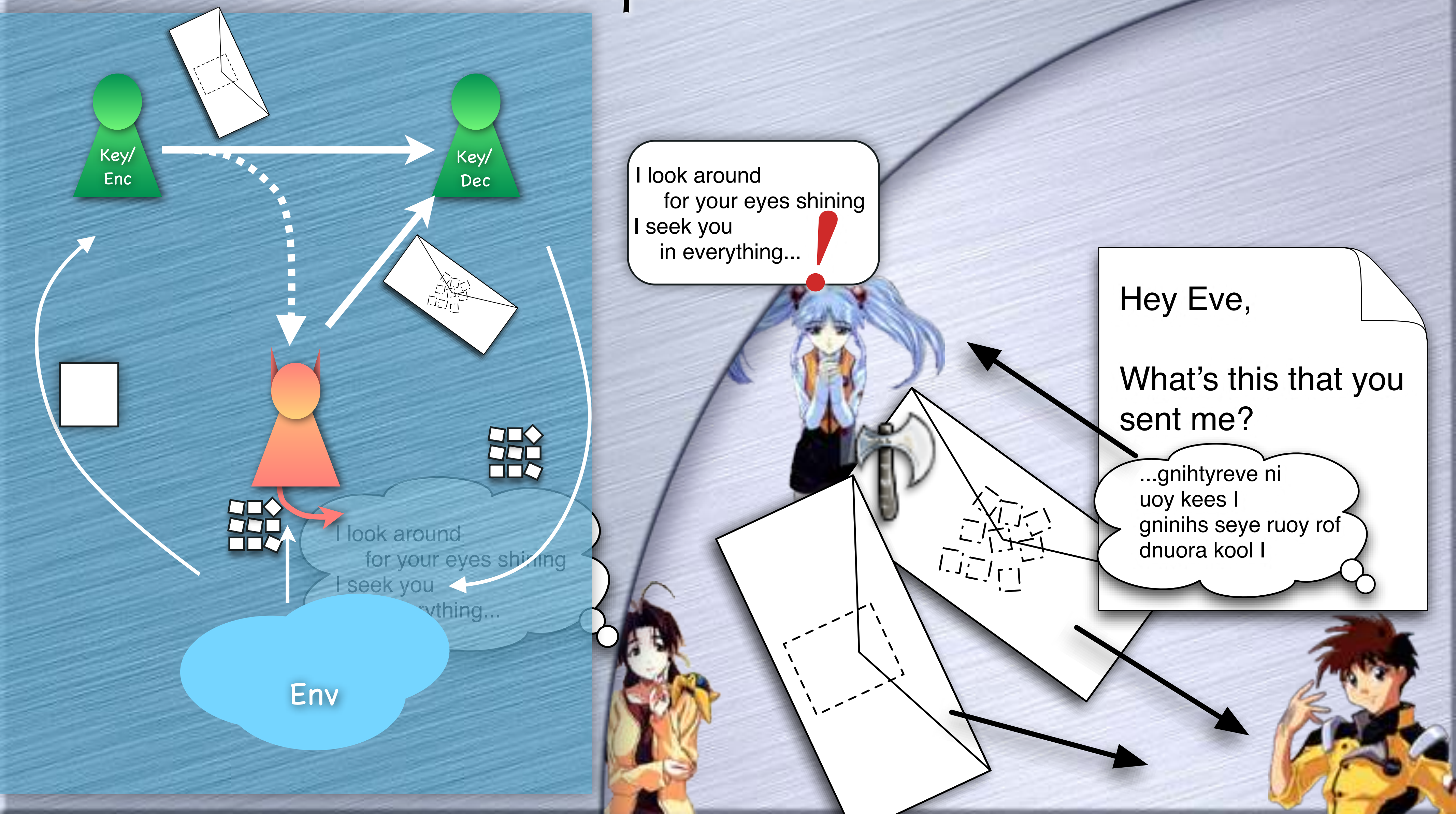

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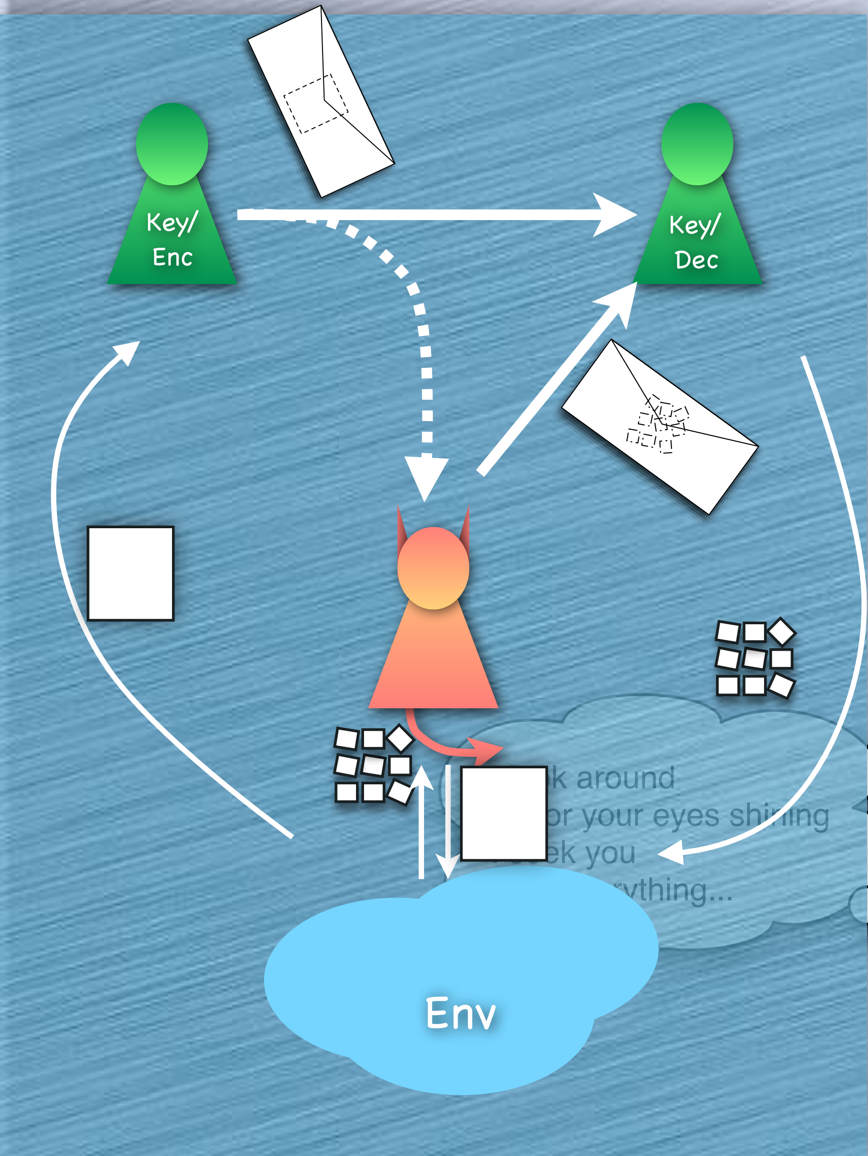

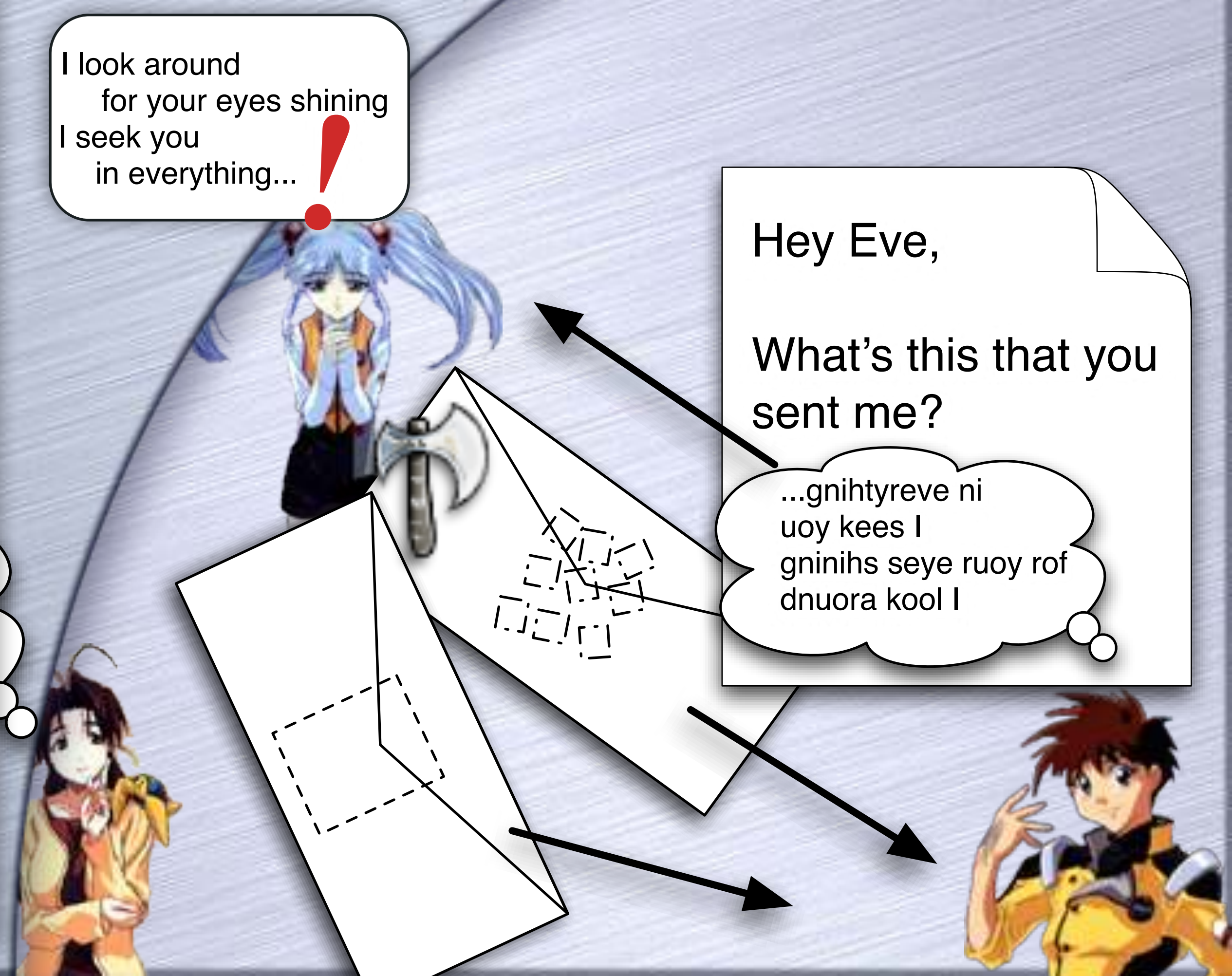

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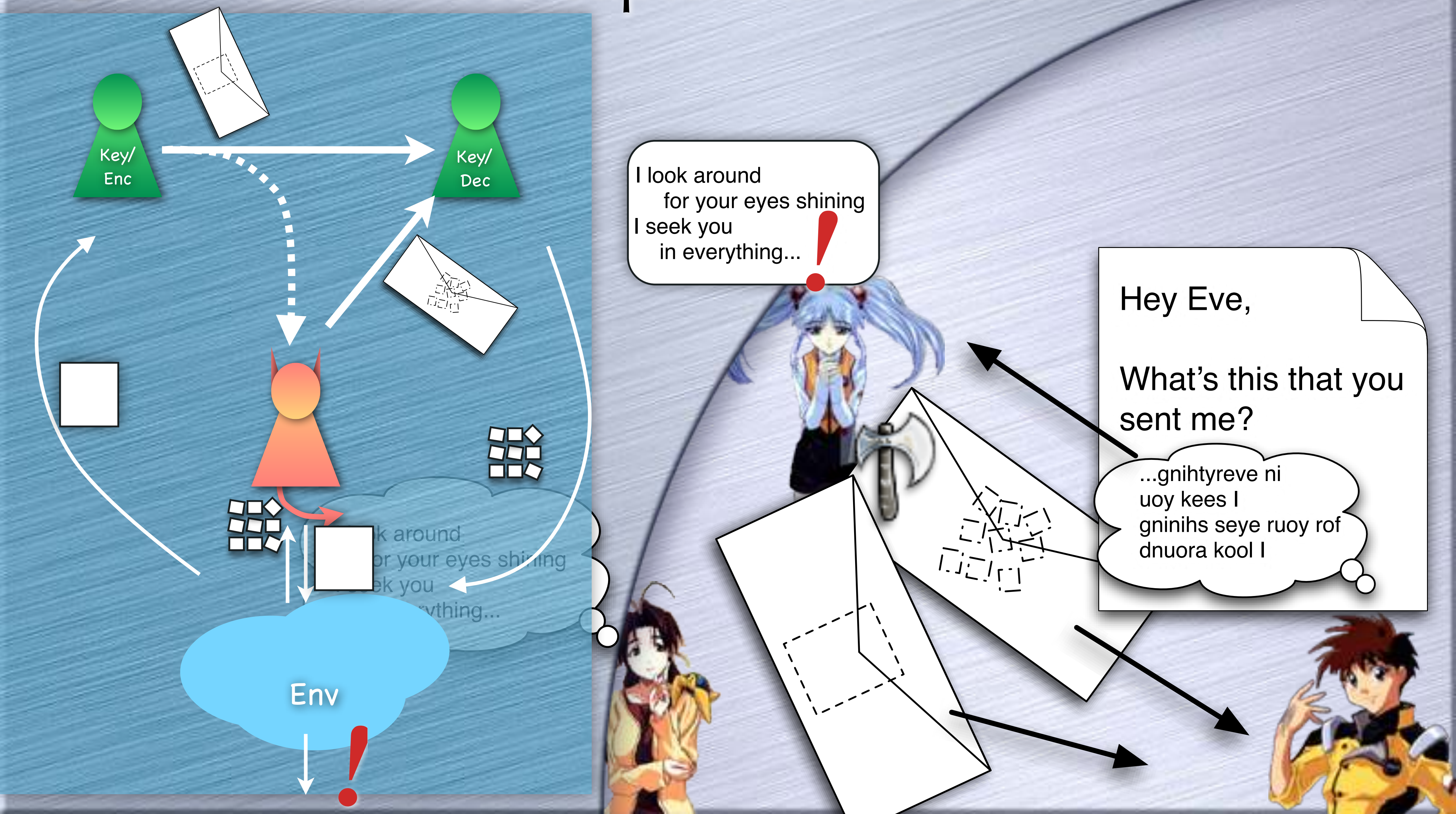
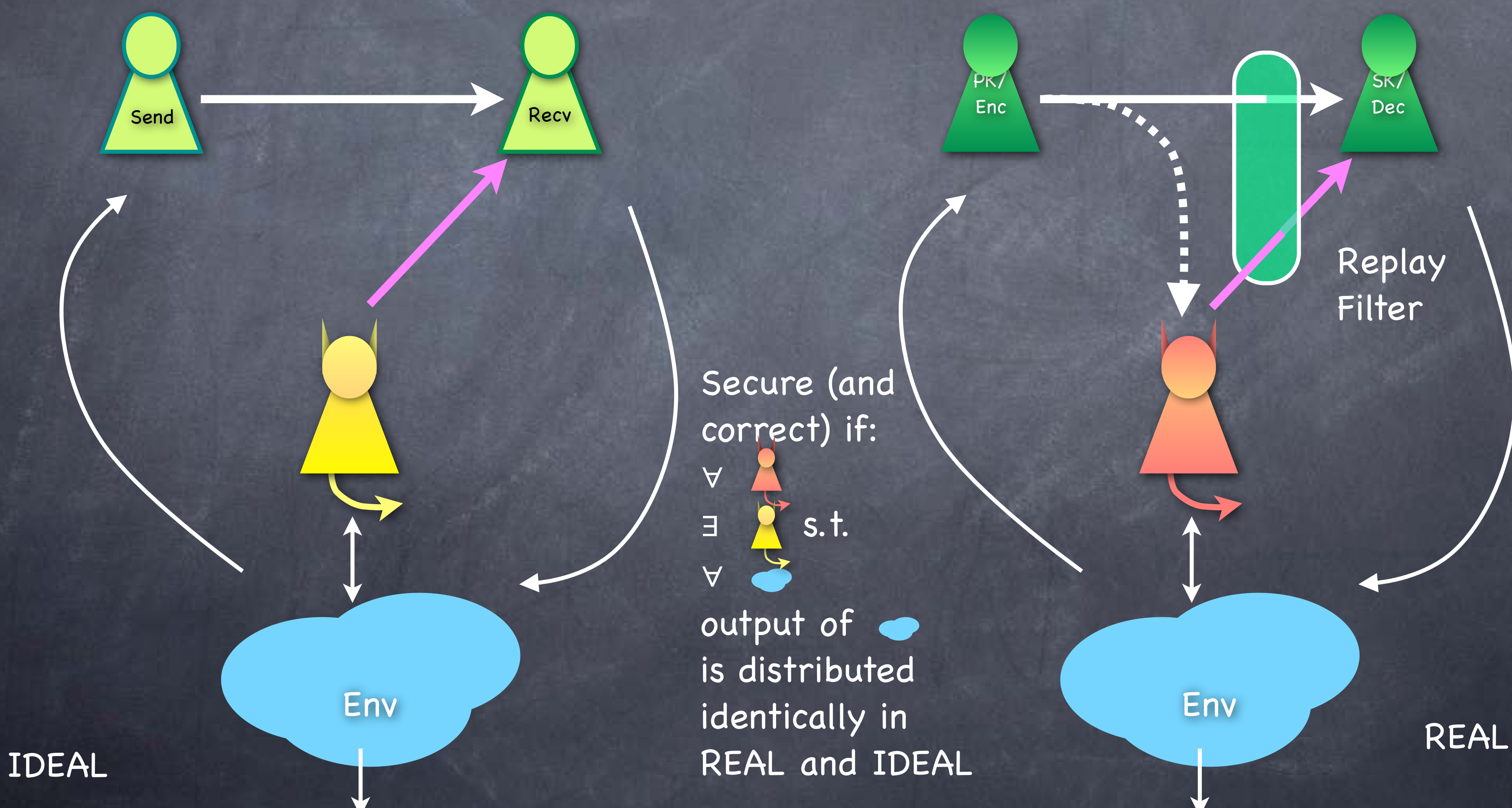
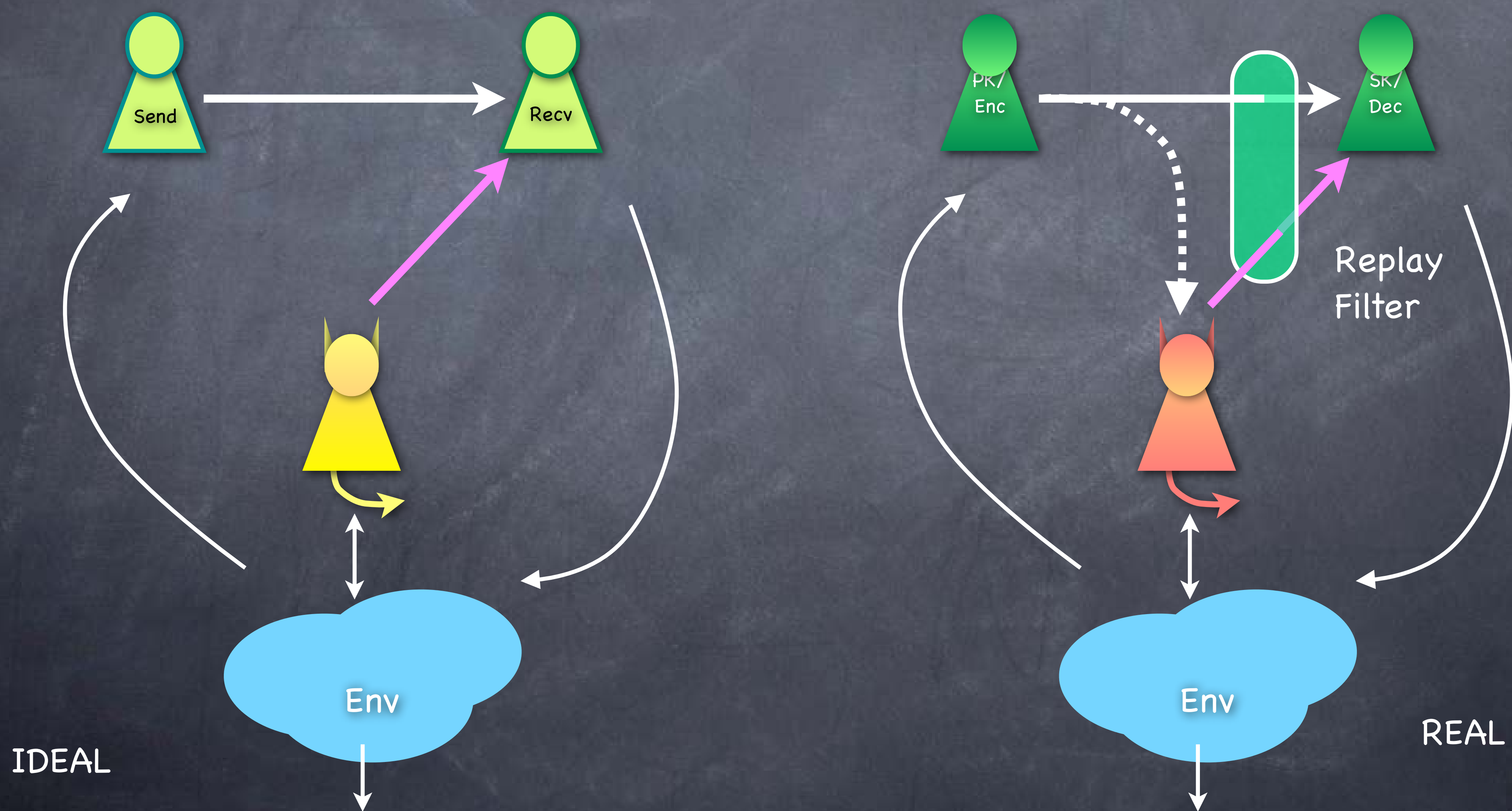


SIM-CCA Security (PKE)



SIM-CCA Security and Malleability



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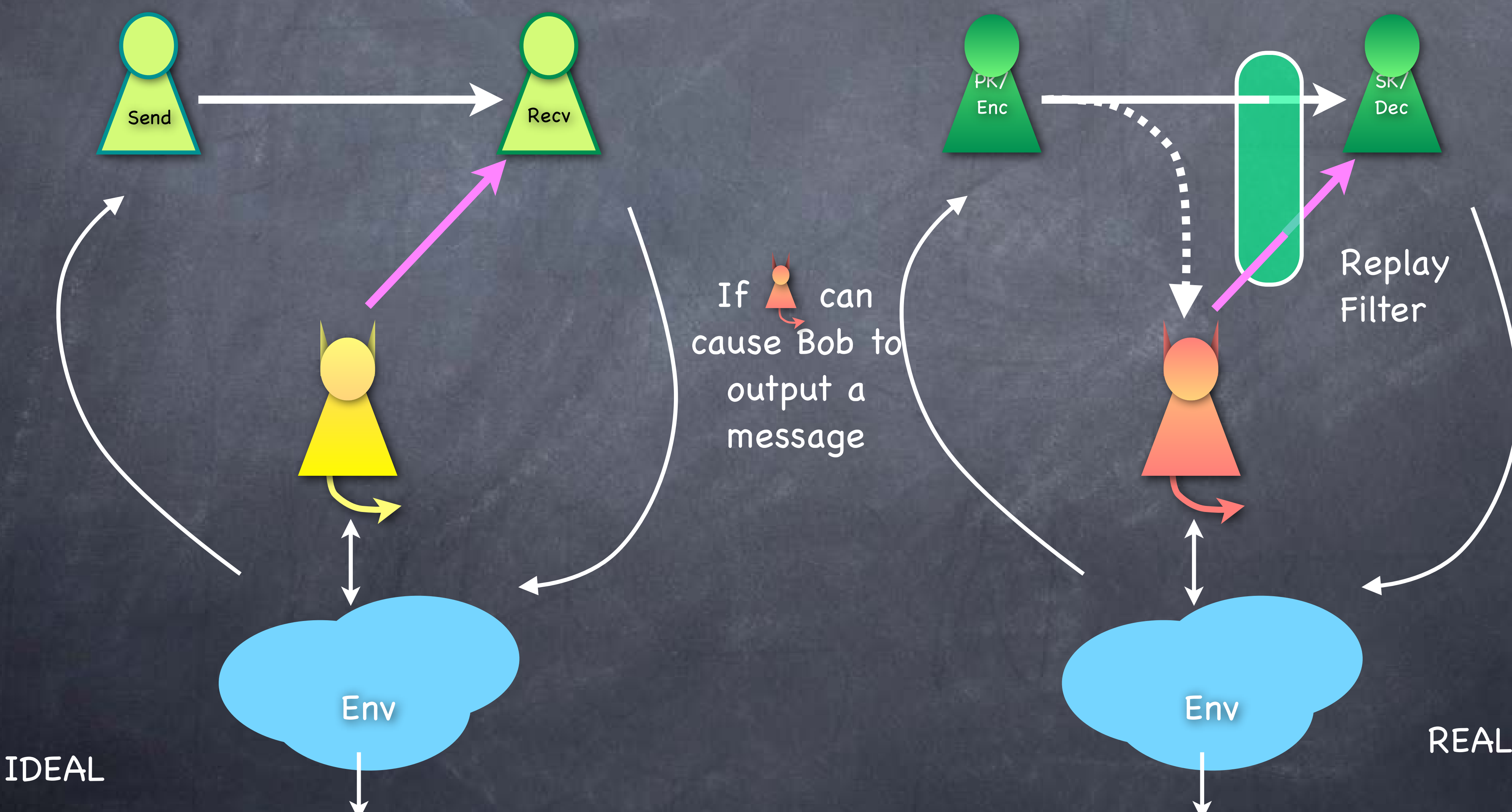

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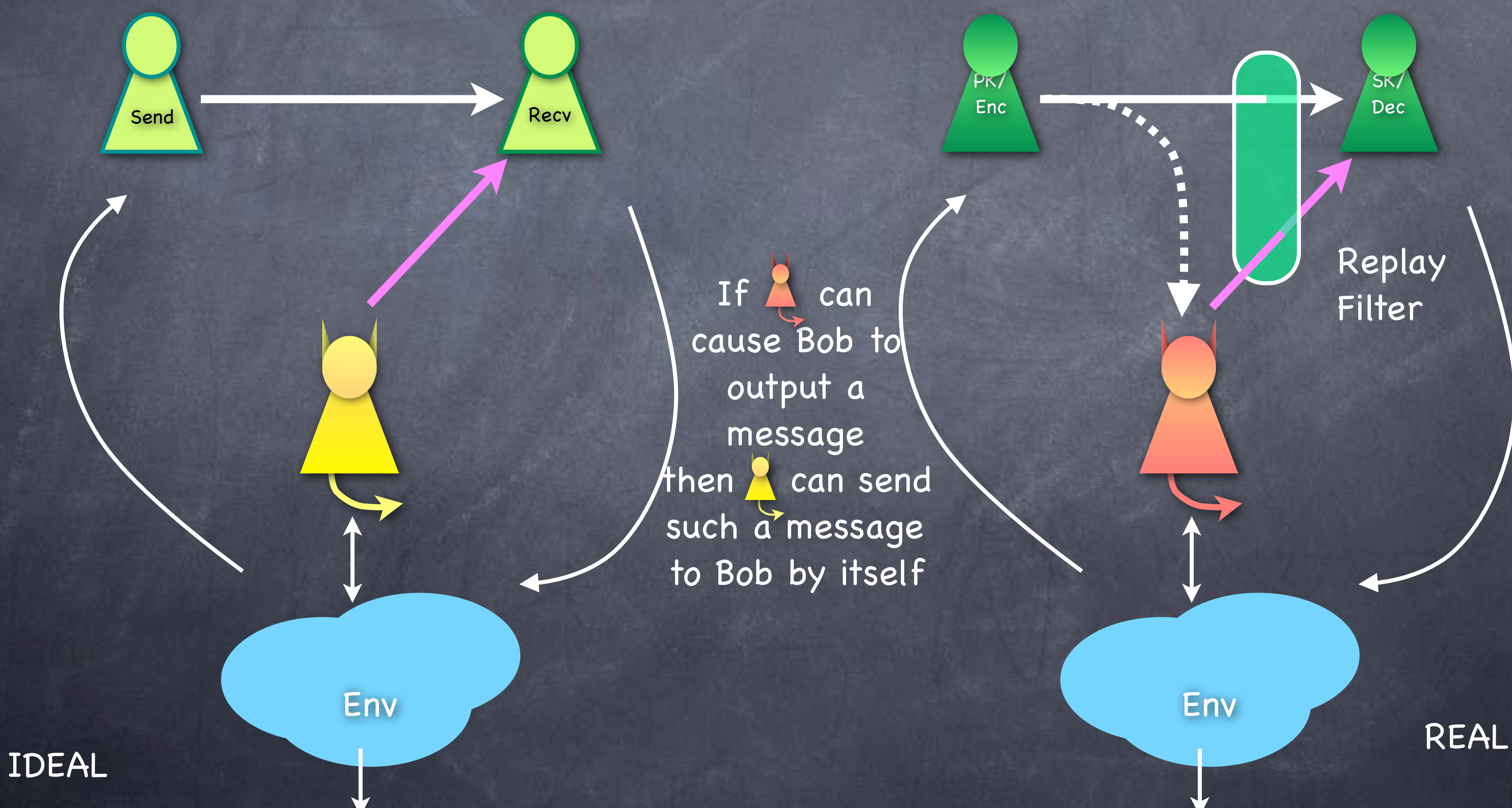

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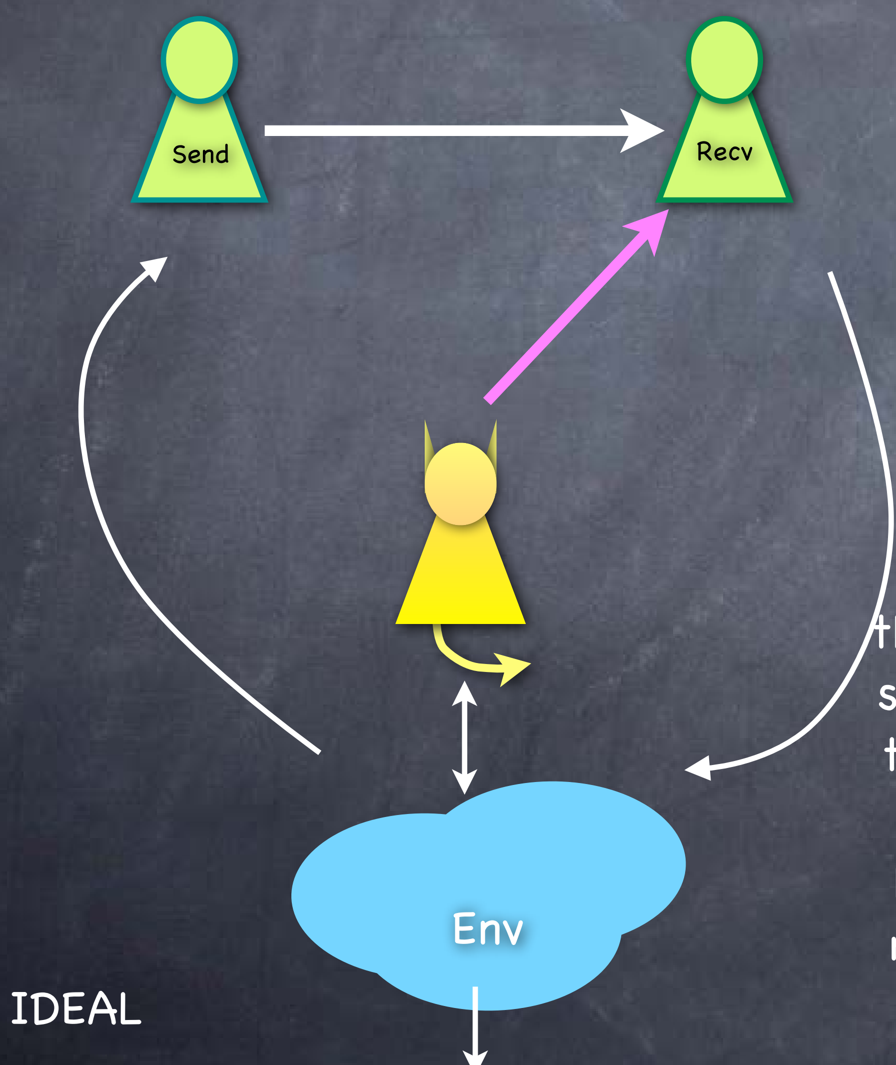
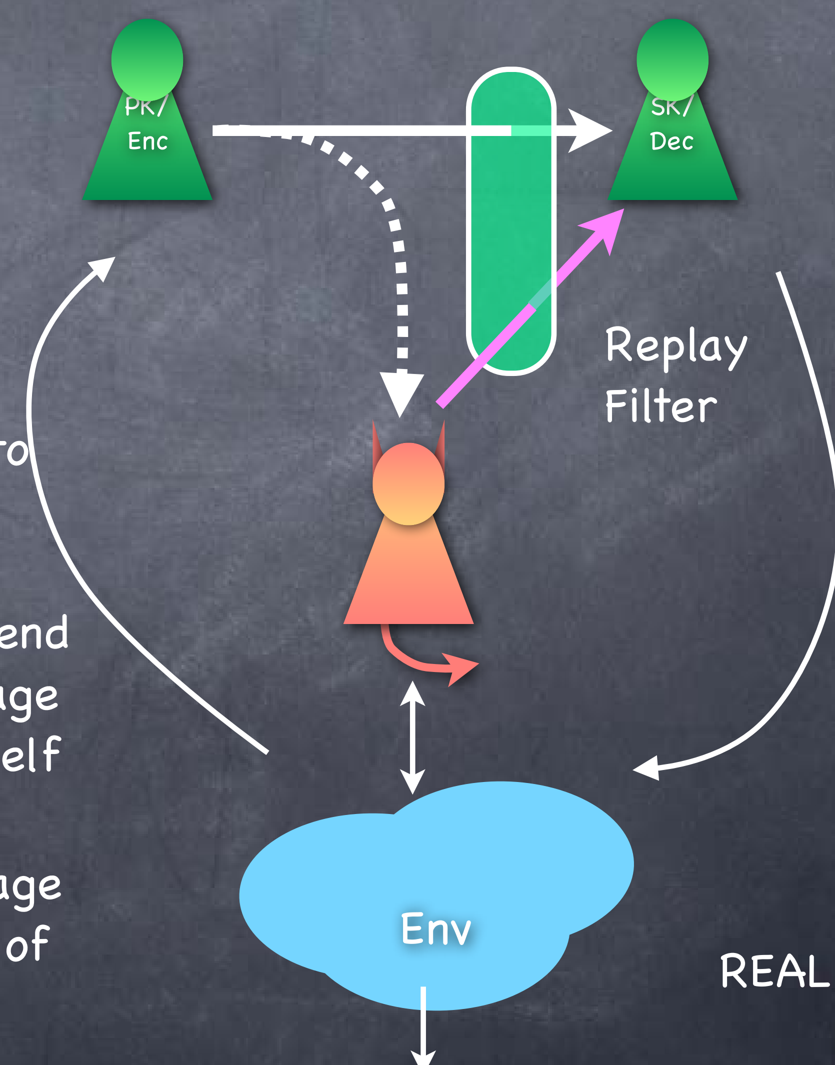


If can cause Bob to output a message then can send such a message to Bob by itself

Hence message not a result of malleating



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    - Relatively low overhead on top of the (fast) SKE encryption

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  - Less security sufficient: KEM used to transfer a random key; DEM uses a new key every time.

Today

Today

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