CSE 564

Some Crypto Background

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Franziska (Franzi) Roesner
franzi@cs.washington.edu

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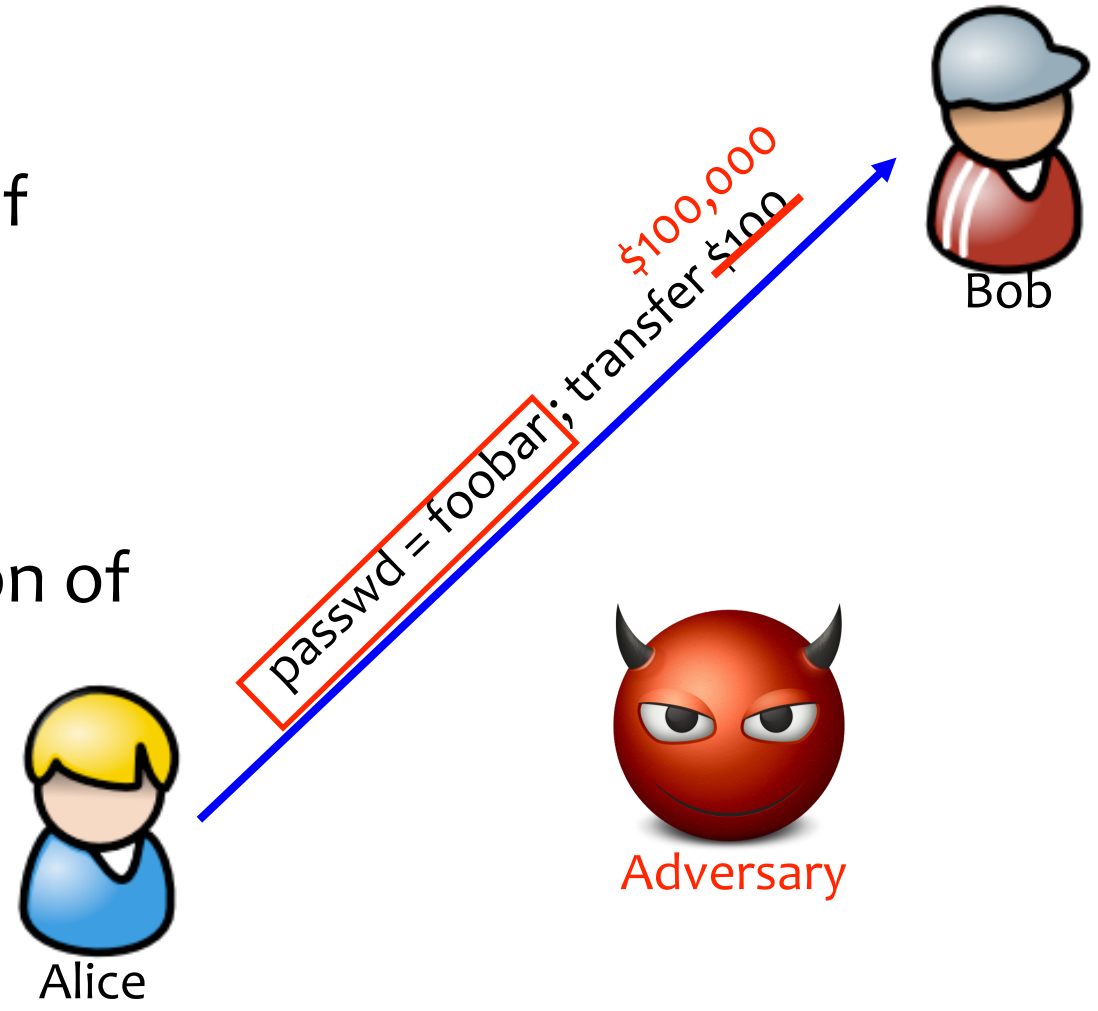
Common Communication Security Goals

Privacy of data:

Prevent exposure of information

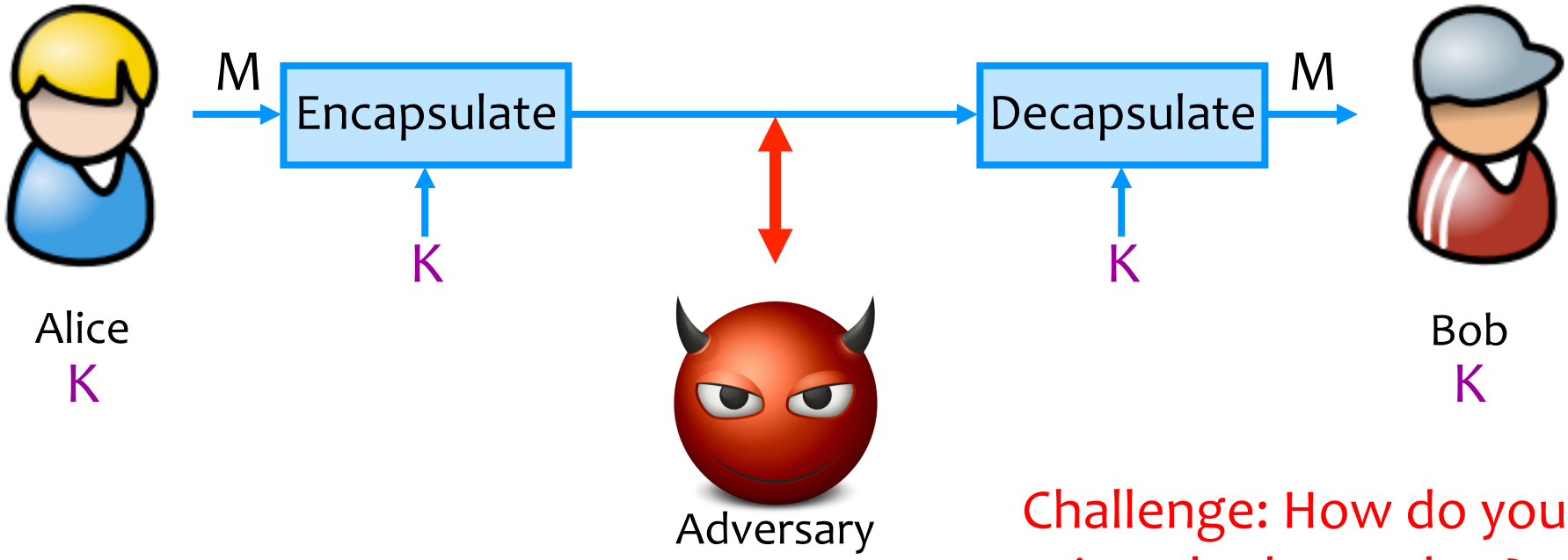
Integrity of data:

Prevent modification of information



Symmetric Setting

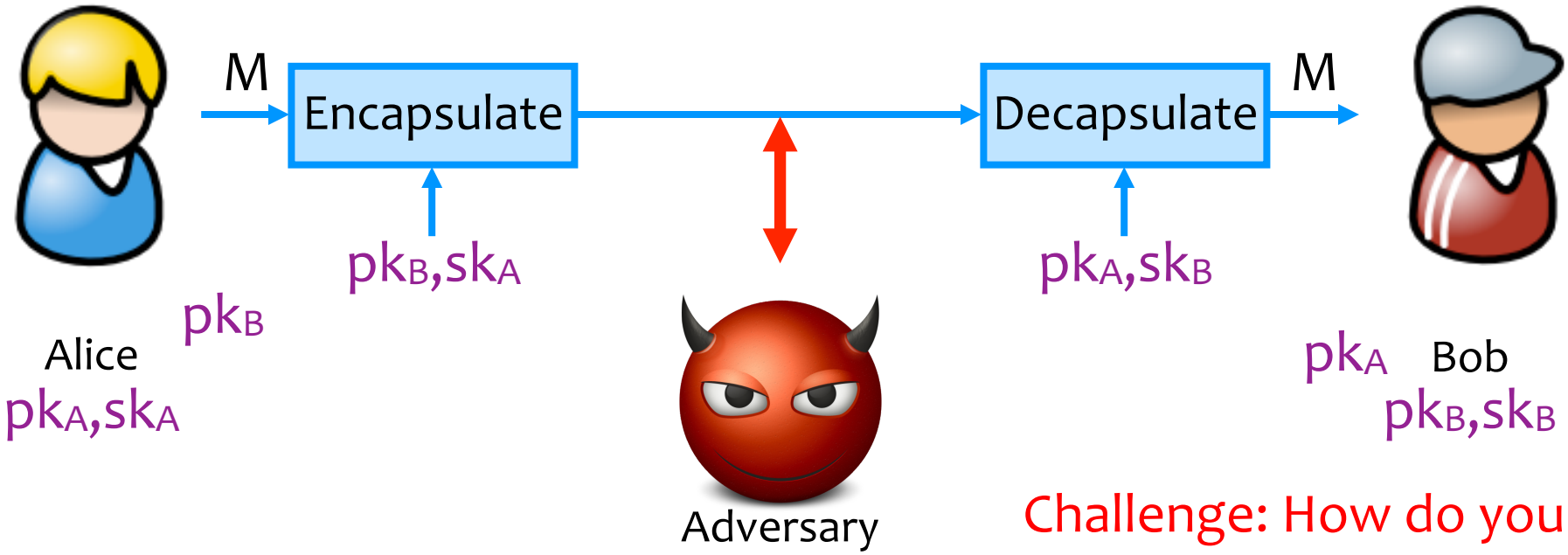
Both communicating parties have access to a shared random string K, called the key.



Challenge: How do you privately share a key?

Asymmetric Setting

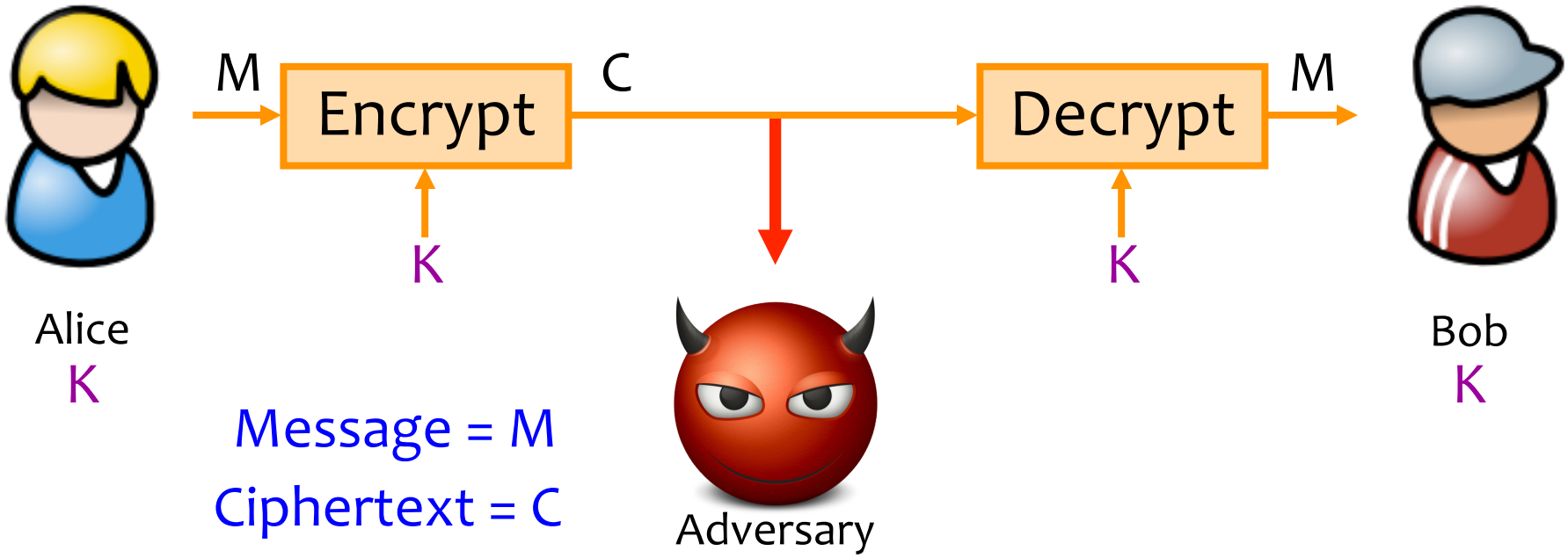
Each party creates a public key pk and a secret key sk.



Challenge: How do you validate a public key?

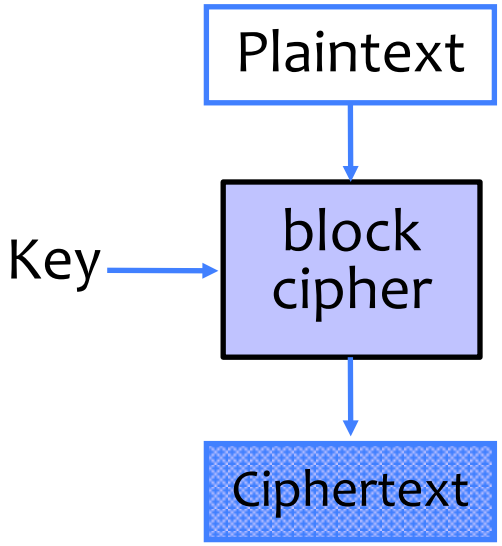
Achieving Privacy (Symmetric)

Encryption schemes: A tool for protecting privacy.



Block Ciphers

- Operates on a single chunk ("block") of plaintext
  - For example, 64 bits for DES, 128 bits for AES
  - Each key defines a different permutation
  - Same key is reused for each block (can use short keys)

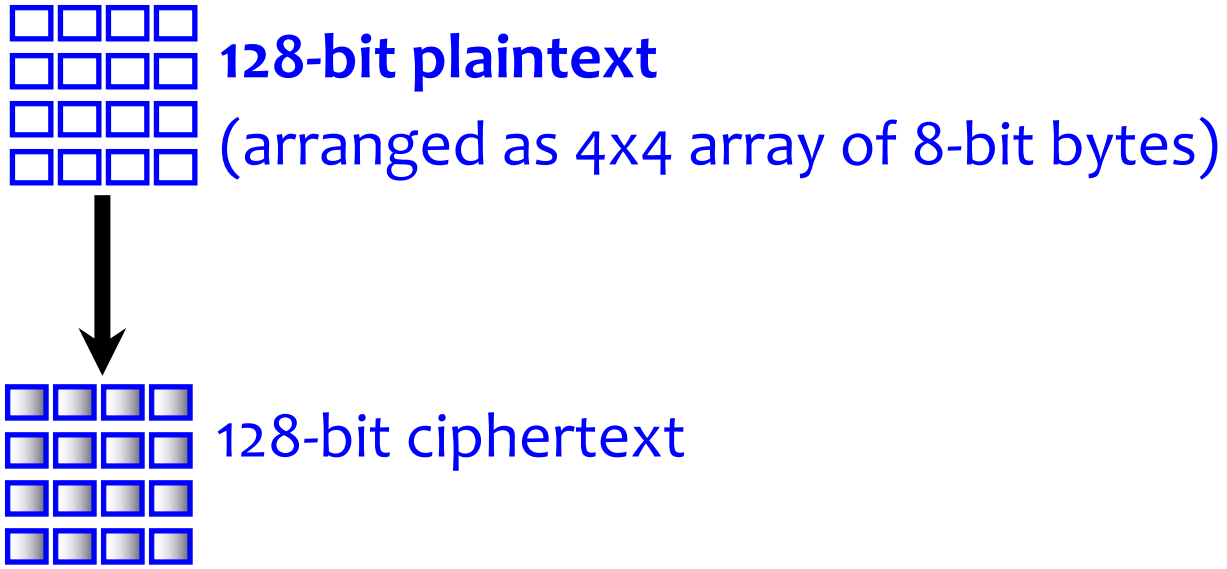


Standard block ciphers:

- DES (deprecated)
- AES

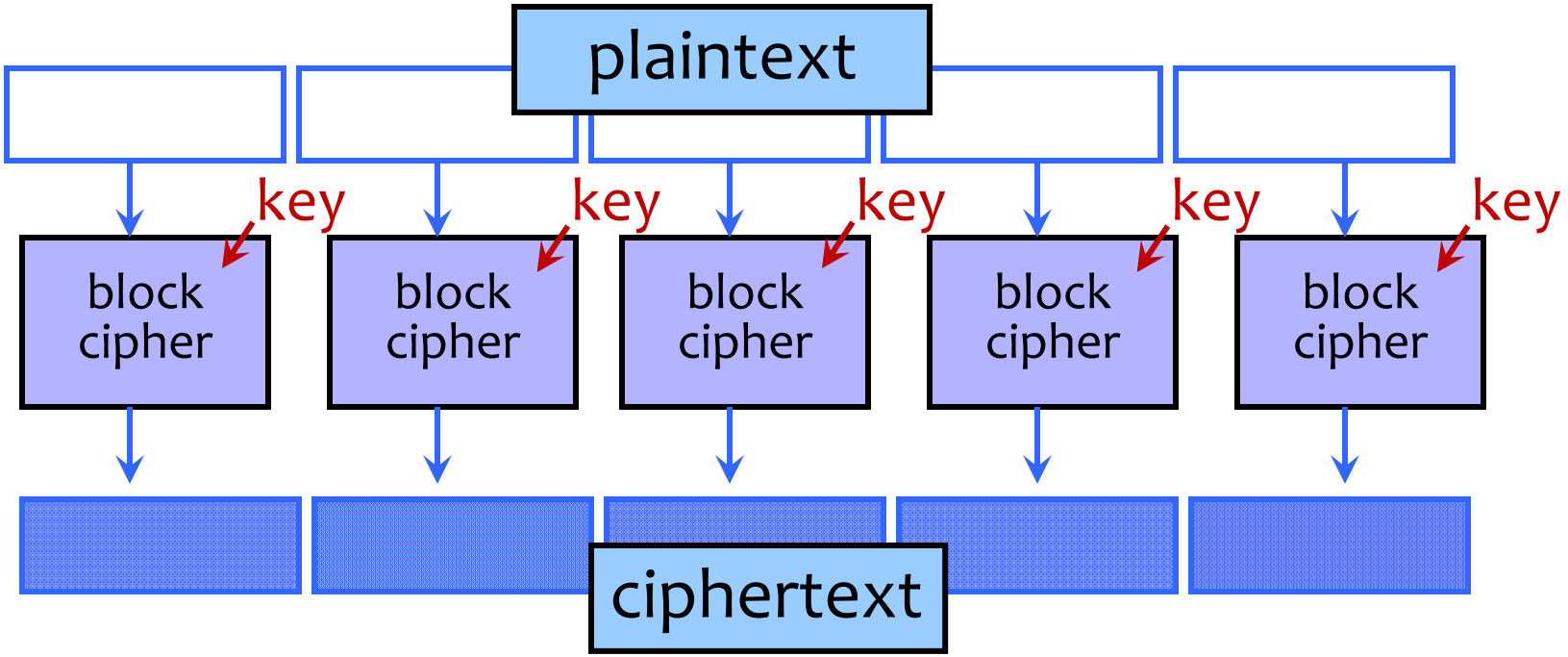
Encrypting a Large Message

- So, we've got a good block cipher, but our plaintext is larger than 128-bit block size



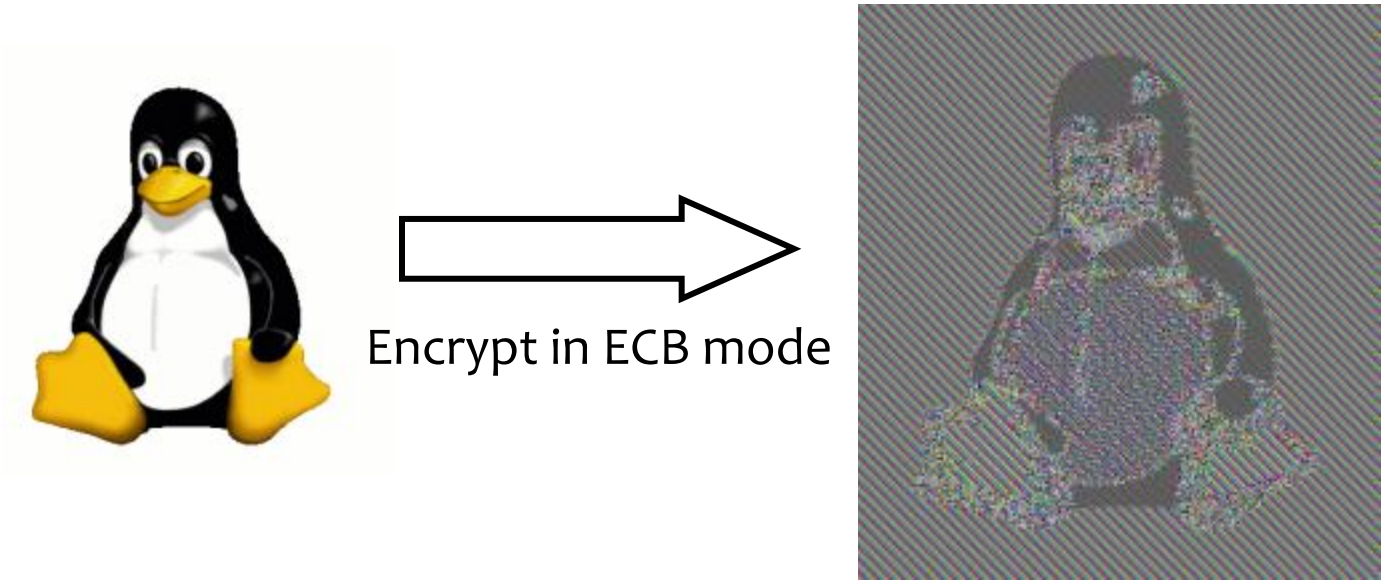
- What should we do?

Electronic Code Book (ECB) Mode



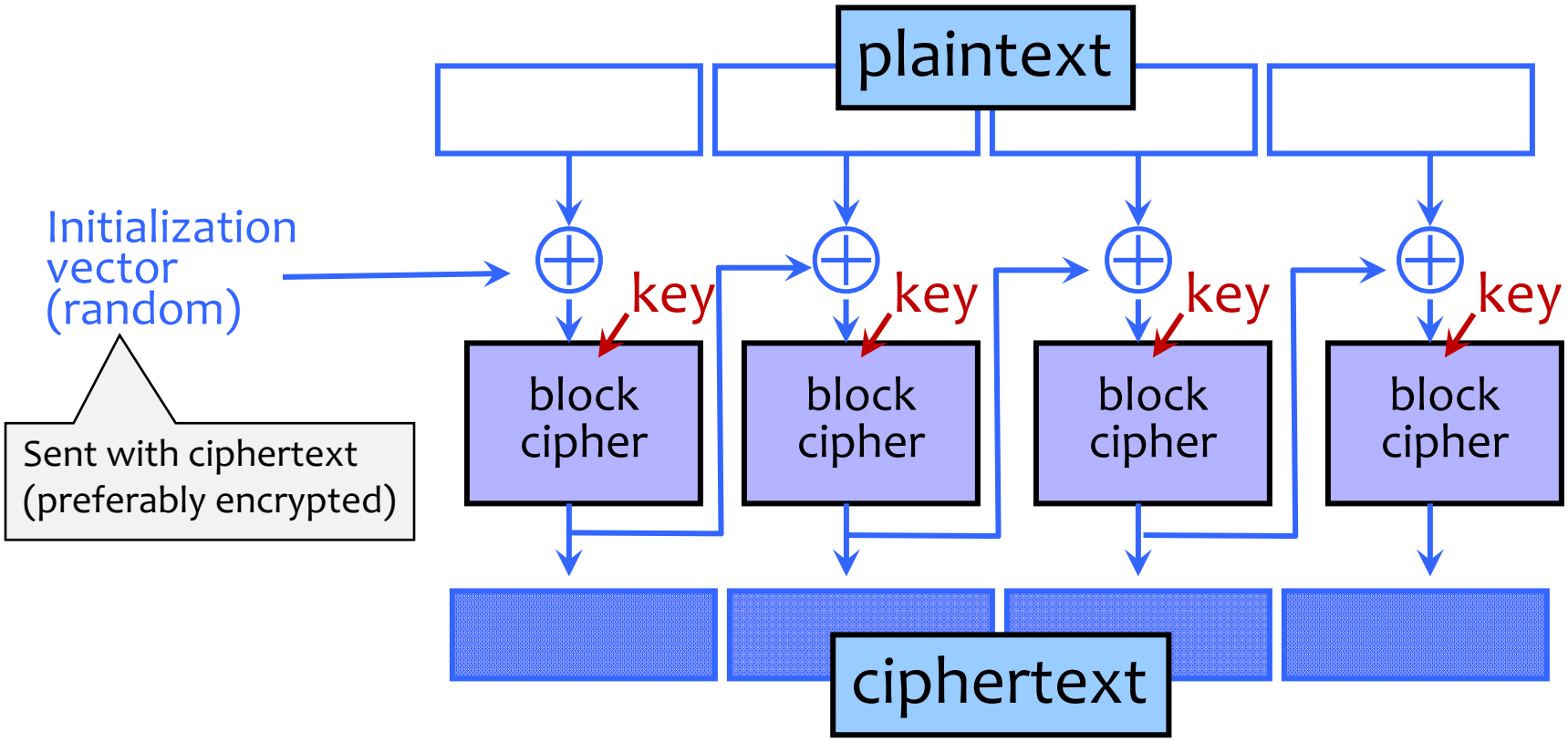
- Identical blocks of plaintext produce identical blocks of ciphertext
- No integrity checks: can mix and match blocks

Information Leakage in ECB Mode



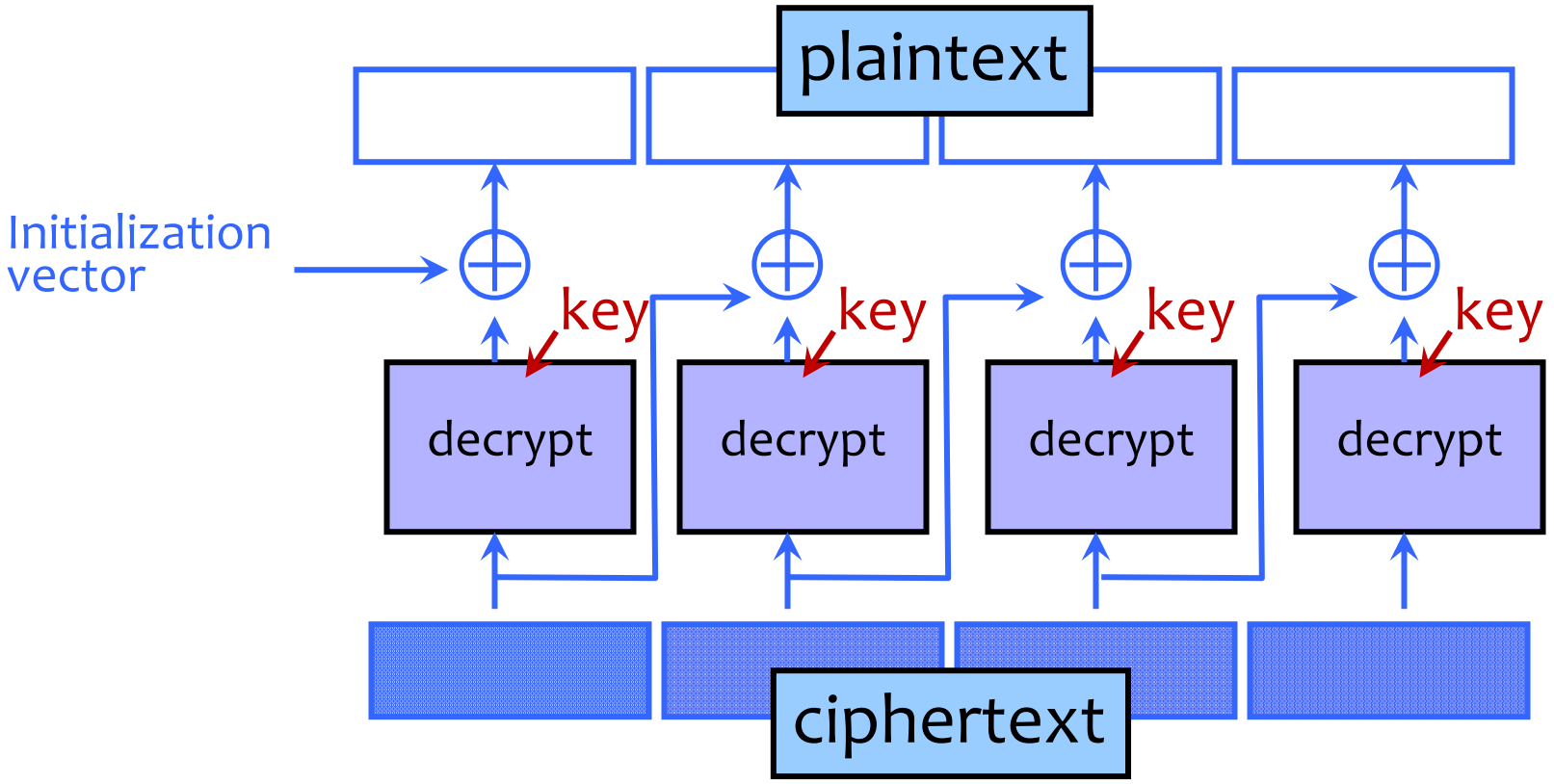
[Wikipedia]

Cipher Block Chaining (CBC) Mode: Encryption

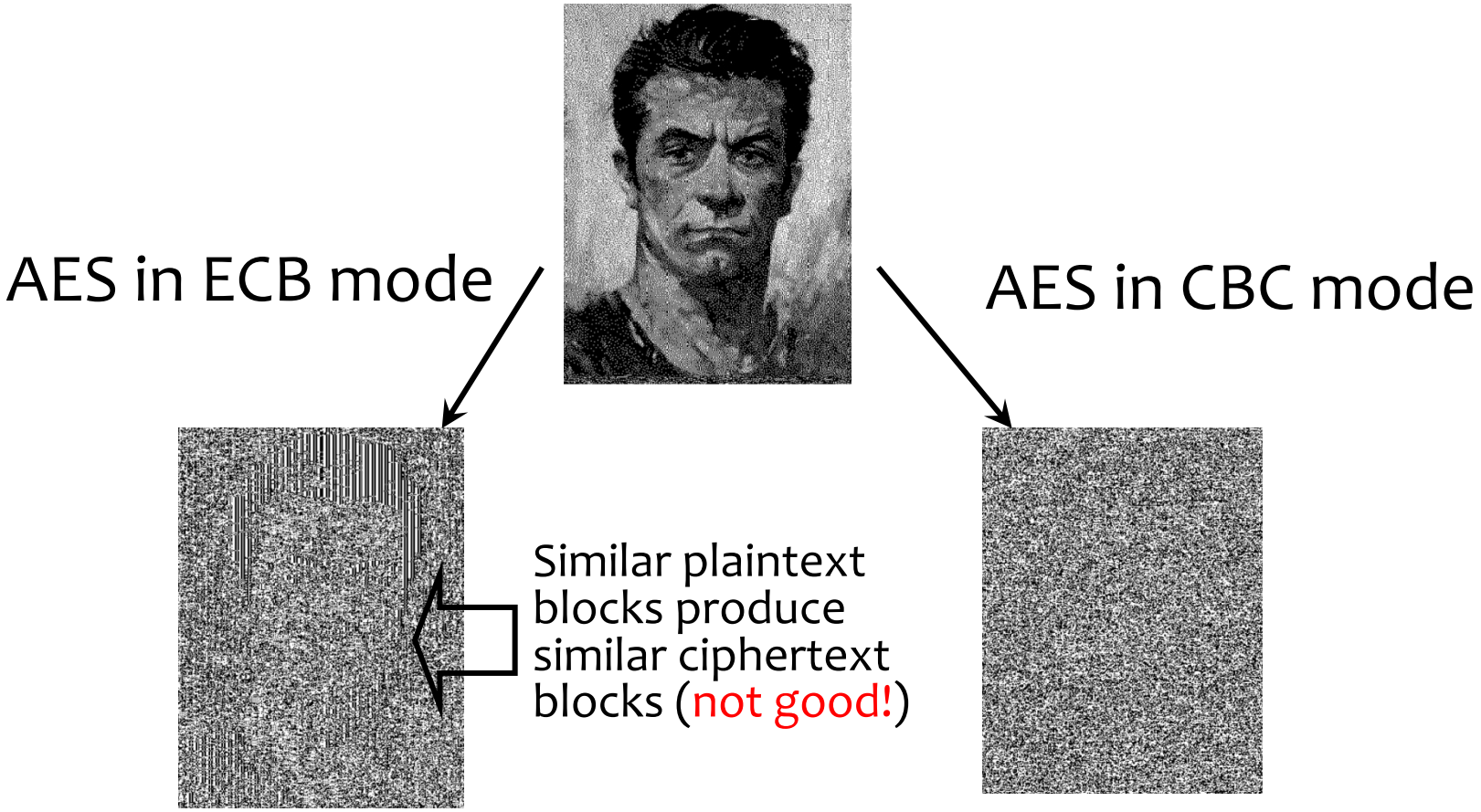


- Identical blocks of plaintext encrypted differently
- Last cipherblock depends on entire plaintext
  - Still does not guarantee integrity

CBC Mode: Decryption

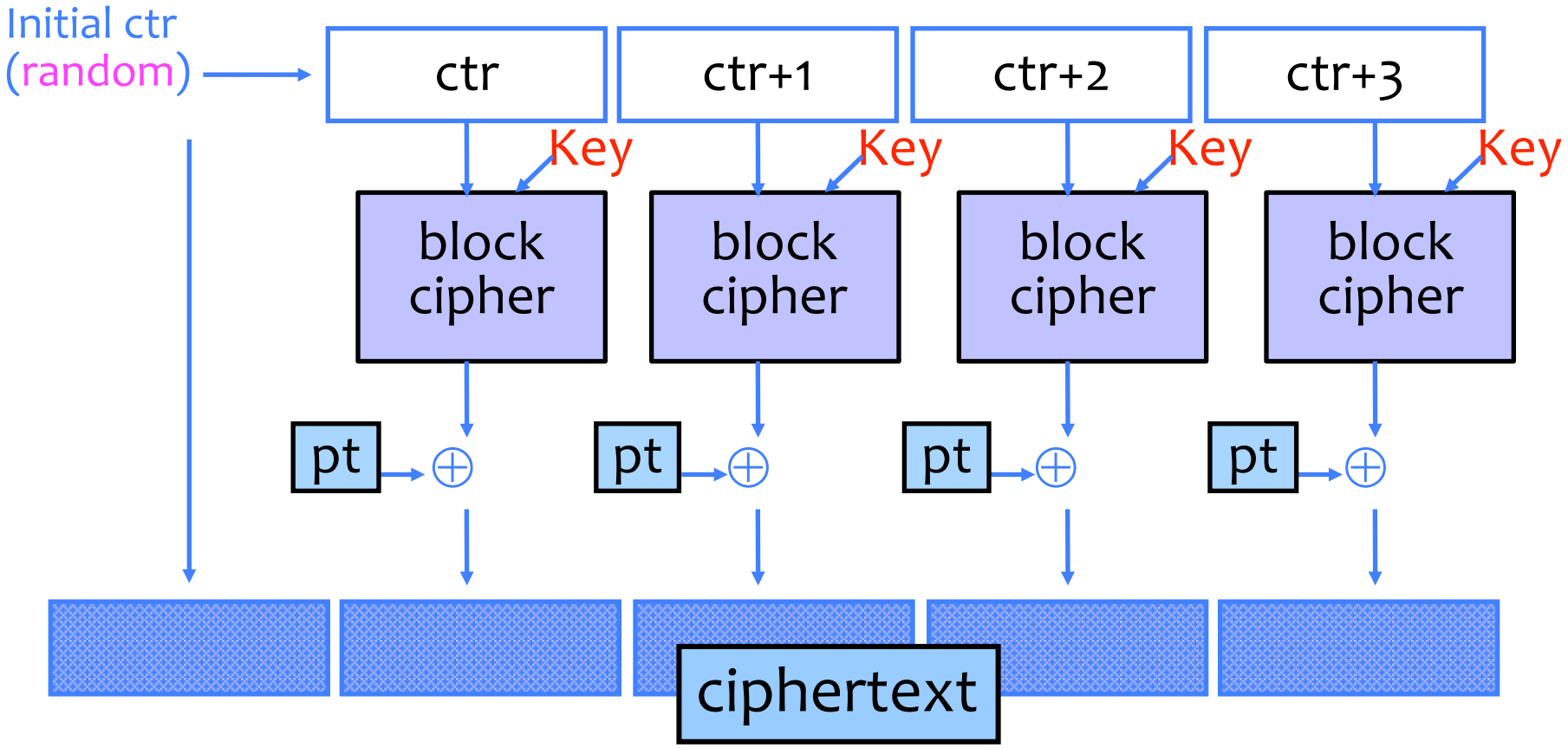


ECB vs. CBC



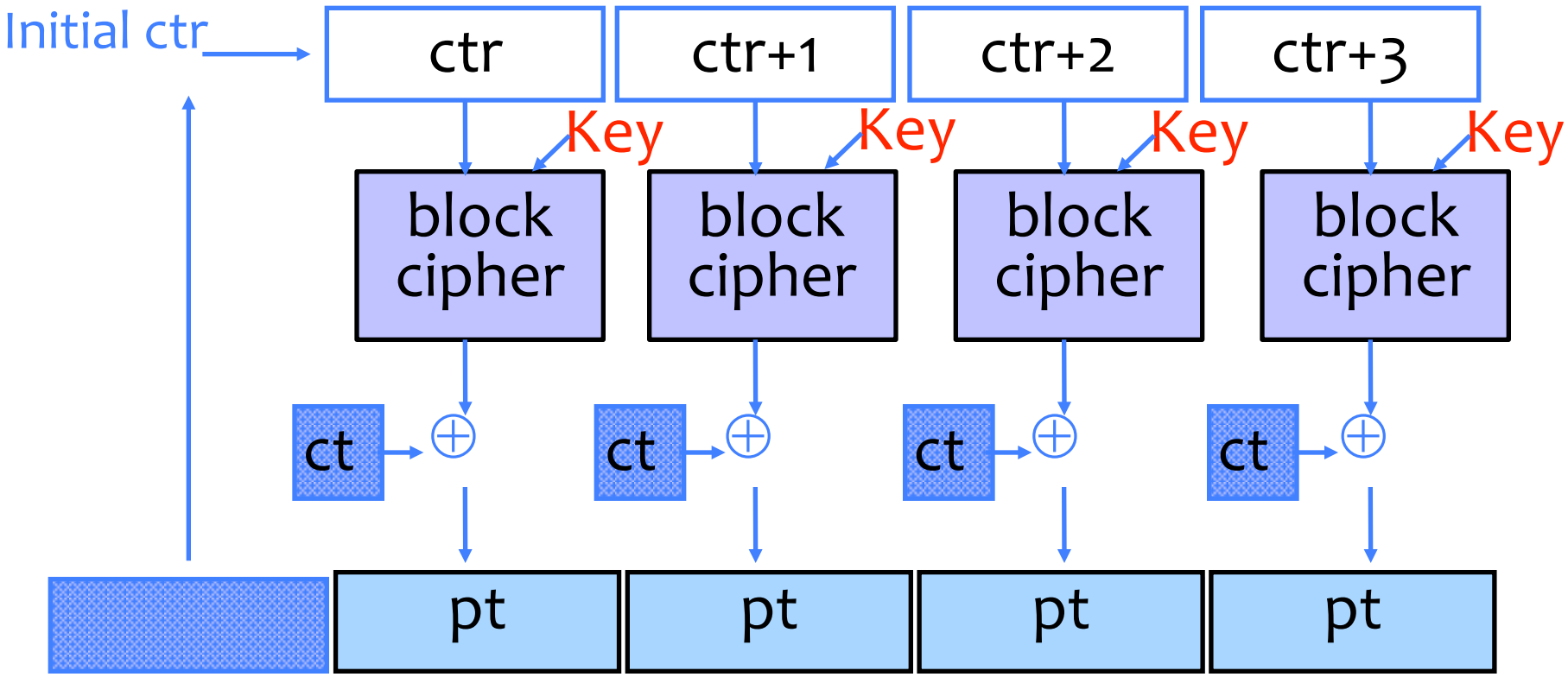
[Picture due to Bart Preneel]

Counter Mode (CTR): Encryption



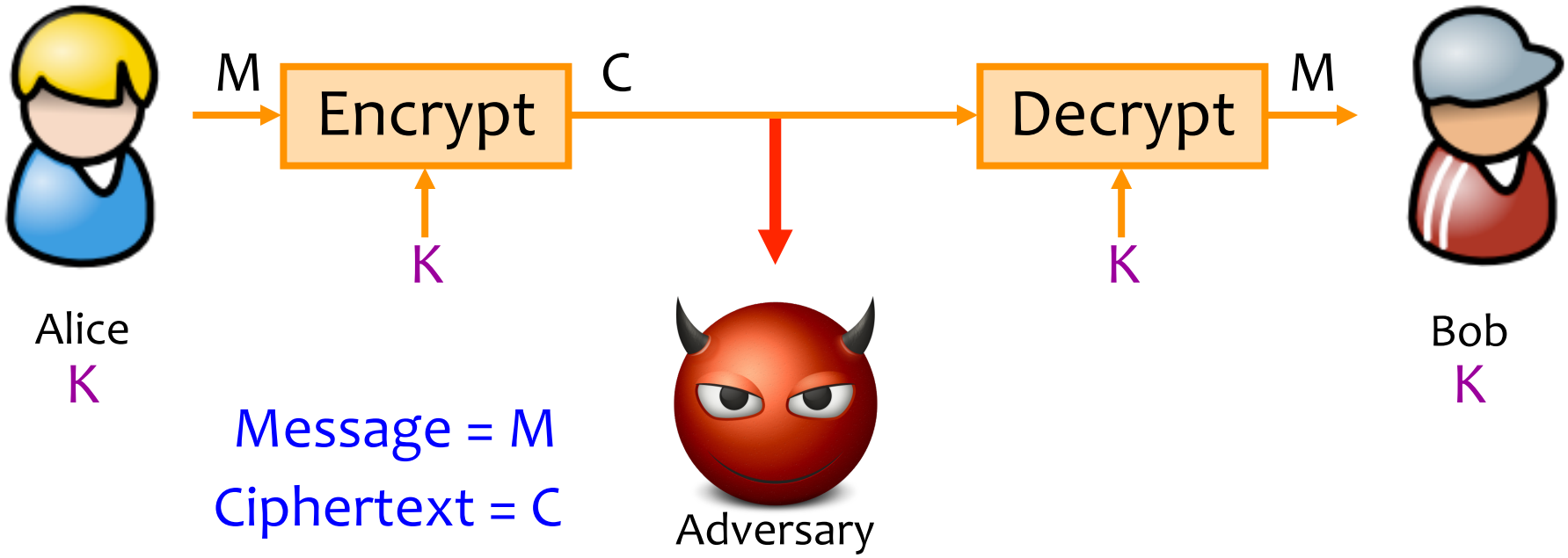
- Identical blocks of plaintext encrypted differently
- Still does not guarantee integrity; Fragile if ctr repeats

Counter Mode (CTR): Decryption



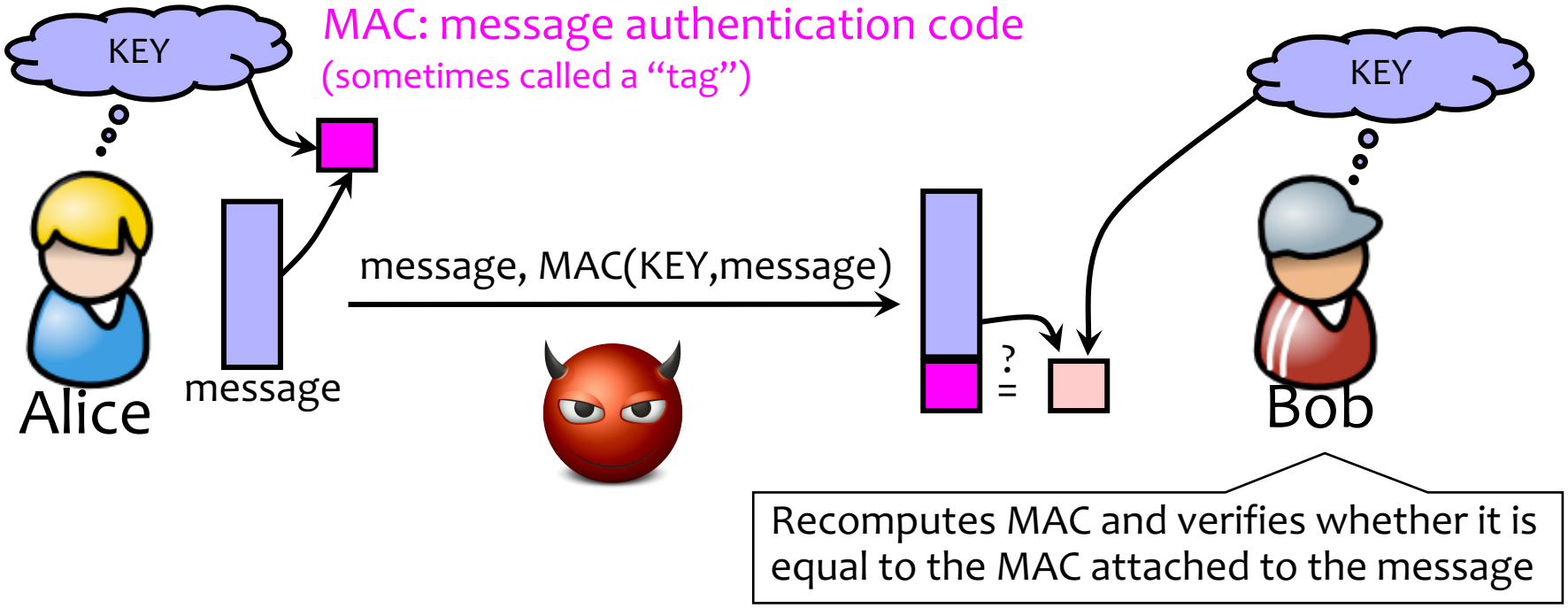
So Far: Achieving Privacy

Encryption schemes: A tool for protecting privacy.



Now: Achieving Integrity

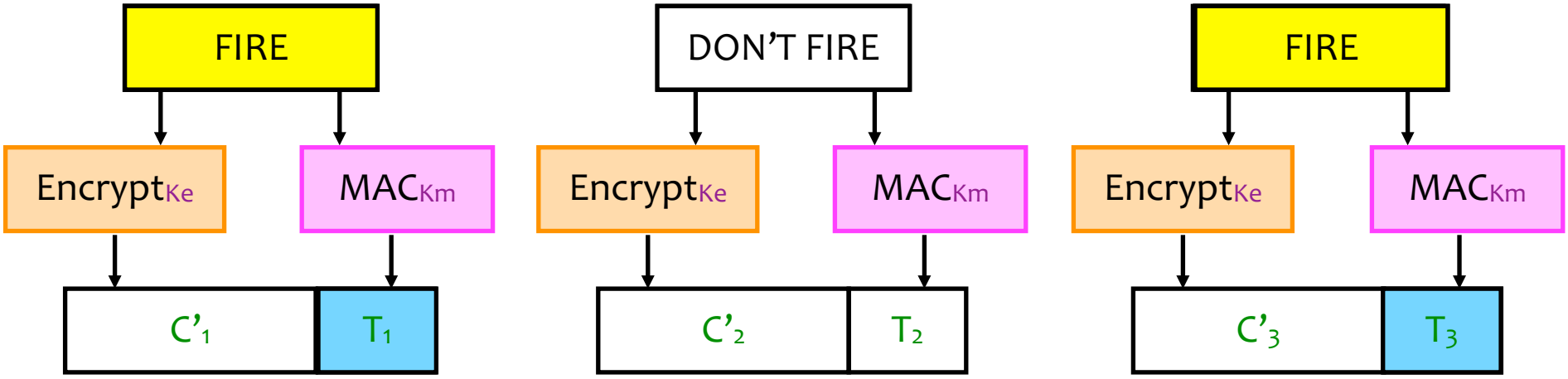
Message authentication schemes: A tool for protecting integrity.



Integrity and authentication: only someone who knows KEY can compute correct MAC for a given message.

Authenticated Encryption

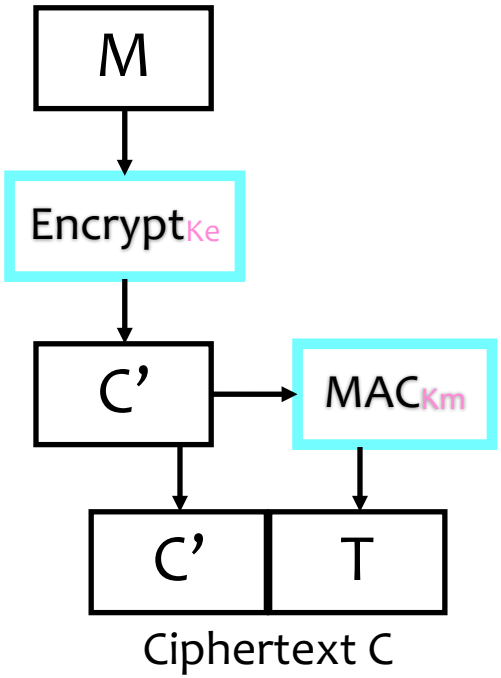
- What if we want <u>both</u> privacy and integrity?
- Natural approach: combine encryption scheme and a MAC.
- But be careful!
  - Obvious approach: Encrypt-and-MAC
  - Problem: MAC is deterministic! same plaintext → same MAC



Authenticated Encryption

- Instead:
  Encrypt *then* MAC.

- (Not as good:
  MAC-then-Encrypt)



Encrypt-then-MAC