Computer Security (COM-301)

Applied cryptography II

ECB properties

To encrypt a series of plaintext blocks p1, p2, . . . pn using a block cipher E operating in electronic code book (ECB) mode, each ciphertext block c1, c2, . . . cn is computed as ci = Ek(pi).

Which of the following is **not** a property of this block cipher mode?

a) Any repeated plaintext blocks will result in identical corresponding ciphertext blocks.
b) Decryption can be fully parallelized.
c) If a ciphertext block is modified or corrupted, then after decryption the corresponding plaintext block and all the following plaintext blocks will be affected.
d) None of the above; that is, (a), (b), and (c) are all properties of the ECB block cipher mode.

ECB properties

To encrypt a series of plaintext blocks $p_1, p_2, \ldots p_n$ using a block cipher E operating in electronic code book (ECB) mode, each ciphertext block $c_1, c_2, \ldots c_n$ is computed as $c_i = E_k(p_i)$.

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Lausanne-Bern Direct line

The police forces in Lausanne and Bern want to build a new messaging system that allows them to exchange reports about crimes in real time so that suspects can no longer escape to the other city to avoid law enforcement. To achieve its goal, the system needs to relay messages without long delays. The police thus decides to build their messaging system based on a symmetric stream cipher: Every morning, the main precinct in Lausanne sends a policeman in disguise to Bern with a fresh secret key. This key is used during the whole day for all messages sent between the two cities.
Messages have the following format and headers:

```
Date: <date of crime>
Crime: <type of crime>
Suspect name: <name>
Case description: <free text describing what happened>
```

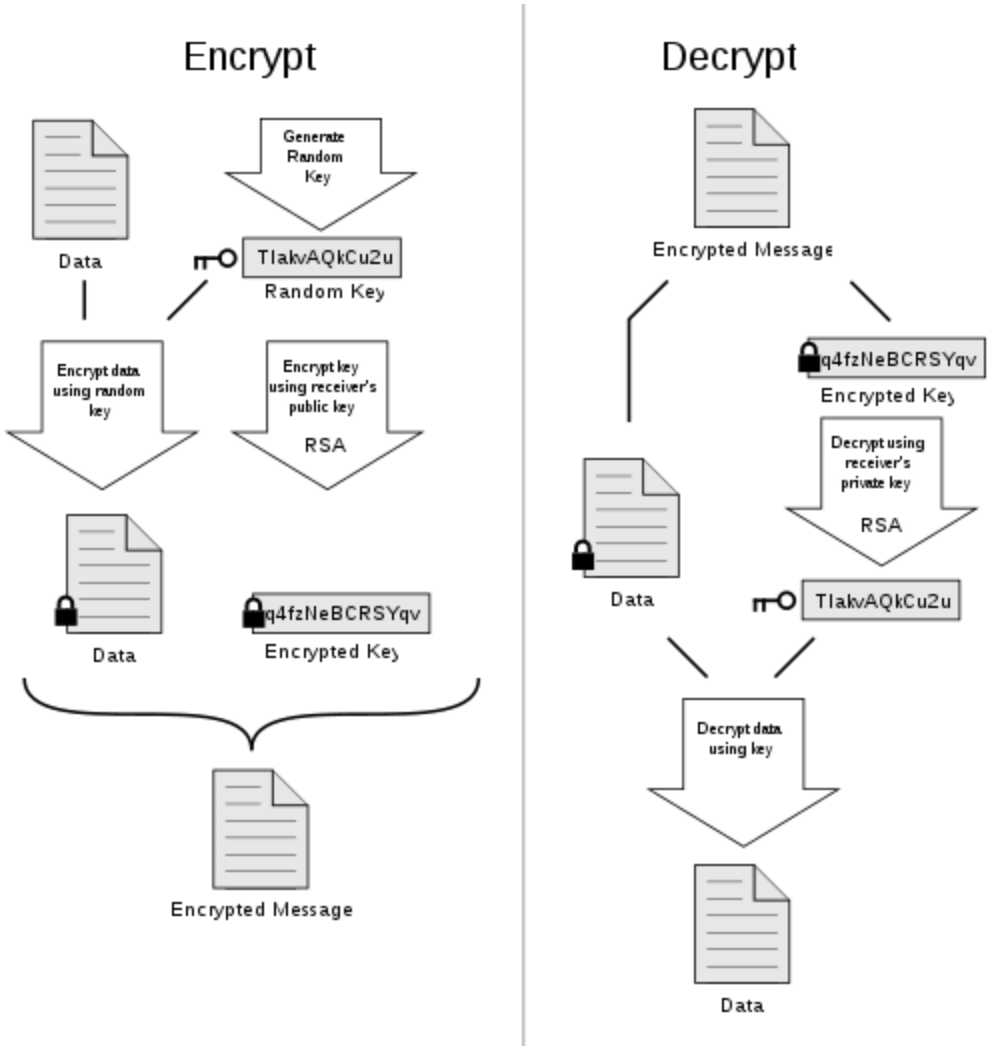
Théo the Thief, that often operates in Lausanne, reads about the new messaging system in the newspaper Le Temps and thinks “Oh no! Now I cannot use my hideout in Bern because the Bern police will have all reports”

Do you agree or disagree with Théo's statement?
If you agree provide a security argument why the new messaging system is secure.
If you disagree, describe a vulnerability in the messaging system and suggest an alternative that would address the problems.

PGP

The following picture explains how PGP (Pretty Good Privacy) is used to encrypt emails.

a) Why does this scheme provide confidentiality?



PGP (class proposals)

b) If you also need to provide integrity of the message, what would you need to add? If you think an option is bad, explain why.

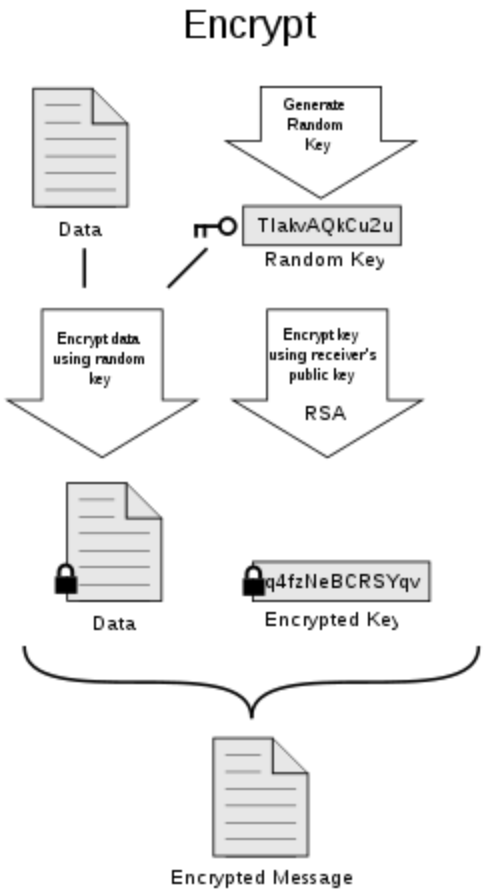
- option 1: Add a hash of the message

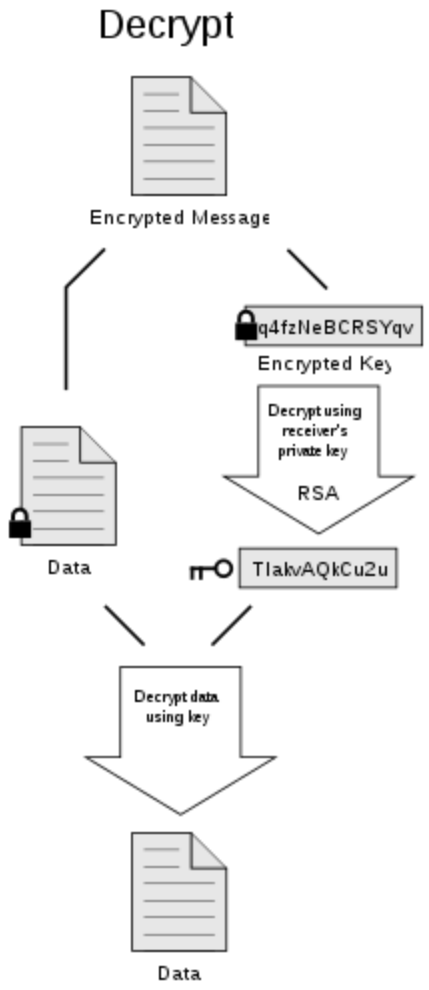
  `Enc(k, data||H(data)), Enc(PKrec, k)`

- option 2: Add a signature of the data and the key

  `Enc(k, data), Enc(PKrec,k),`

  `Sig(SKsen,data||k)`





Destination Fakeland

A group of security researchers traveling to Fakeland learn that, upon arrival at the airport, Fakeland's border authorities will require their laptops for inspection. Fakeland authorities are famous for installing spying software during the inspection, so the researchers decide to take a snapshot of the laptops' state to make sure that they can detect changes.
For this purpose they plan to hash the content of the laptops' hard drive and write this hash on a paper. This way when they receive their laptops back, they can compute the hash of the content again and compare it to the value in their notes.

What property or properties must the hash function have in order to prove that no new software was installed (by comparing the hash on the piece of paper with the hash computed after crossing the border)? (Justify your answer)

Geletram

Alice uses the Geletram application to send messages to Bob. Alice and Bob share a secret symmetric key K. This key K is also known by Geletram.
For each message msg Alice wants to send to Bob through Geletram, Geletram does the following:

It generates a fresh symmetric key KGeletram, it sends
packet = {c = Encrypt(K, msg), m = MAC(KGeletram, c), KGeletram}
to Bob's Geletram to be decoded, where Encrypt is a symmetric encryption scheme, and MAC stands for Message Authentication Code.

Eve is an adversary that controls the channel in between Alice's Geletram and Bob's, i.e., Eve can read and modify any packet before it reaches Bob's Geletram.

Does Geletram provide confidentiality and integrity of the message msg with respect to Eve? If yes, justify; if not, propose a fix.