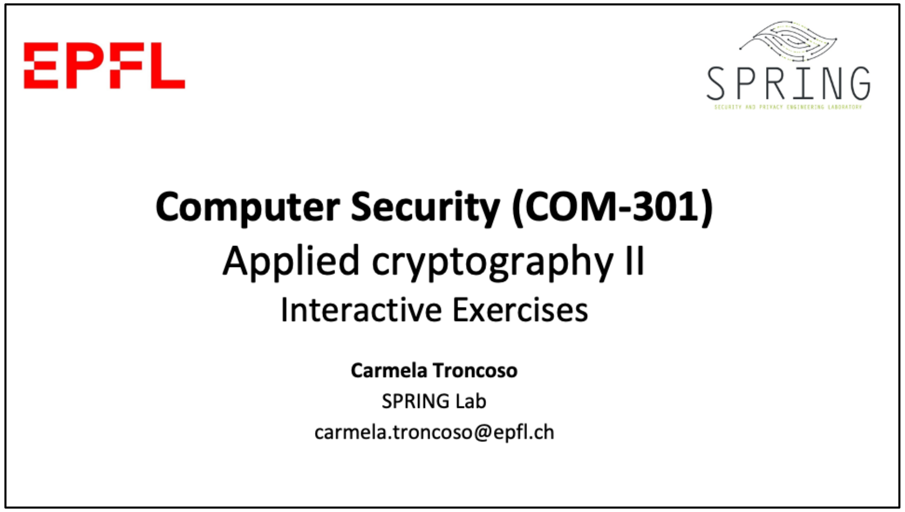

Computer Security (COM-301)

Applied cryptography II

Interactive Exercises

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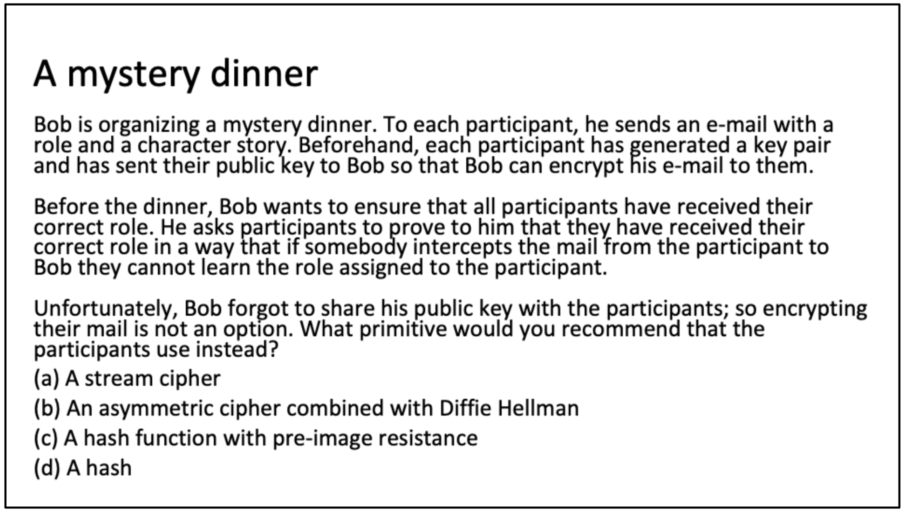


A mystery dinner

Bob is organizing a mystery dinner. To each participant, he sends an e-mail with a role and a character story. Beforehand, each participant has generated a key pair and has sent their public key to Bob so that Bob can encrypt his e-mail to them.

Before the dinner, Bob wants to ensure that all participants have received their correct role. He asks participants to prove to him that they have received their correct role in a way that if somebody intercepts the mail from the participant to Bob they cannot learn the role assigned to the participant.

Unfortunately, Bob forgot to share his public key with the participants; so encrypting their mail is not an option. What primitive would you recommend that the participants use instead?

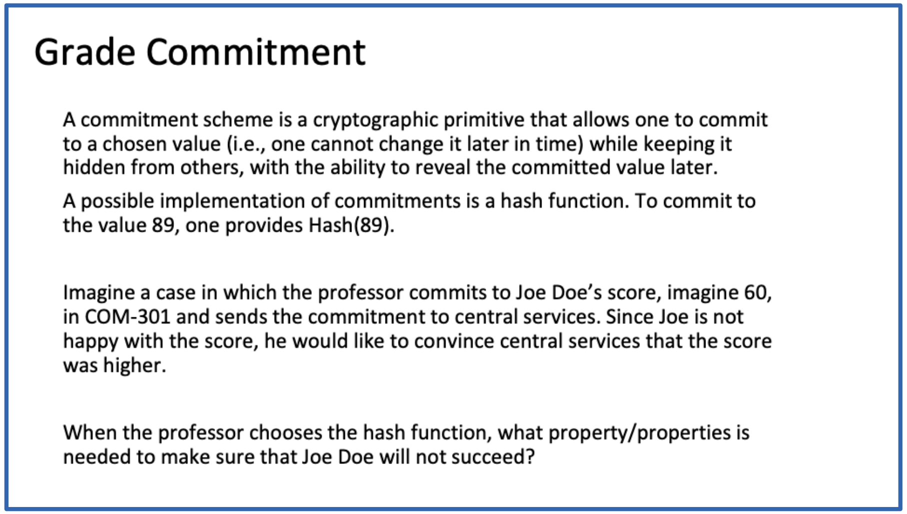
(a) A stream cipher

(b) An asymmetric cipher combined with Diffie Hellman

(c) A hash function with pre-image resistance

(d) A hash

(c) Only if the participants know the role they will be able to produce the right hash. And pre-image resistance is needed to avoid that anyone intercepting the message learns the role.



Grade Commitment

A commitment scheme is a cryptographic primitive that allows one to commit to a chosen value (i.e., one cannot change it later in time) while keeping it hidden from others, with the ability to reveal the committed value later.

A possible implementation of commitments is a hash function. To commit to the value 89, one provides Hash(89).

Imagine a case in which the professor commits to Joe Doe's score, imagine 60, in COM-301 and sends the commitment to central services. Since Joe is not happy with the score, he would like to convince central services that the score was higher.

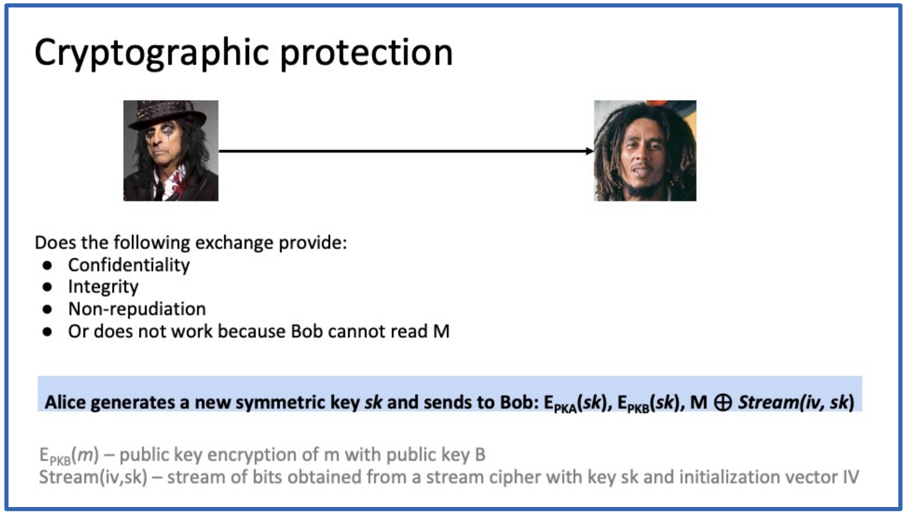
When the professor chooses the hash function, what property/properties is needed to make sure that Joe Doe will not succeed?

Towards central service:

- You could argue pre-image resistance, but SAC will know the grades at the end, so not having it is also fine.
- You could argue second pre-image resistance, if you argue that SAC may want to modify Joe's grade
- Collision resistance does not offer any advantage, the professor already commits to one value

Towards Joe:

- Joe already knows his grade. You cannot argue the need for pre-image resistance
- You **need** second pre-image resistance, to ensure that Joe cannot claim having any other grade
- Collision resistance does not offer any advantage, the professor already commits to one value



Cryptographic protection

Does the following exchange provide:

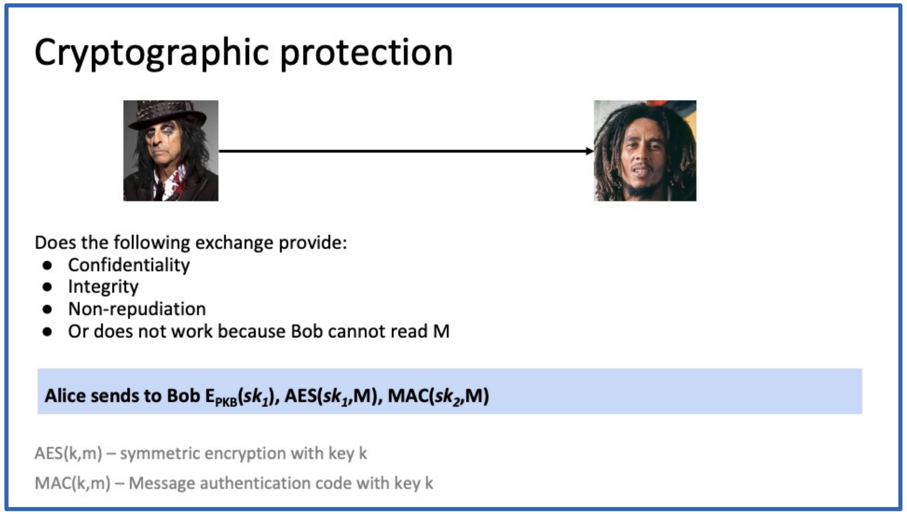
- Confidentiality
- Integrity
- Non-repudiation
- Or does not work because Bob cannot read M

Alice generates a new symmetric key *sk* and sends to Bob: $E_{PKA}(sk)$, $E_{PKB}(sk)$, $M \oplus Stream(iv, sk)$

$E_{PKB}(m)$ – public key encryption of m with public key B
Stream(iv,sk) – stream of bits obtained from a stream cipher with key sk and initialization vector IV

The message provides confidentiality: only Bob can read the message, as only Bob can obtain the sk from E_{PKB}(sk) and compute again the stream(sk) to decrypt M.
(The part $E_{PKA}(sk)$ does not provide information to anyone… can only be decrypted by Alice)

The message does not provide integrity. There is no part of the exchange that cannot be produced by an adversary.
For instance, an adversary could send to Bob:
$E_{PKA}(sk')$, $E_{PKB}(sk')$, $M' \oplus Stream(sk')$
And Bob would not have a way to know whether the original message was M’



Cryptographic protection

Does the following exchange provide:

- Confidentiality
- Integrity
- Non-repudiation
- Or does not work because Bob cannot read M

Alice sends to Bob $E_{PKB}(sk_1)$, AES(sk_1,M), MAC(sk_2,M)

AES(k,m) – symmetric encryption with key k

MAC(k,m) – Message authentication code with key k

The exchange would provide confidentiality (Bob can obtain sk1), but not integrity: Bob has no access to the key k2 to check the MAC.

Even if Bob had access to sk2, this exchange would not provide integrity either. As in all previous cases, the adversary could completely produce a new message: $E_{PKB}(sk_3)$, AES($sk_{3,}$M’), MAC(sk_3,M’)