Public-key Cryptography
Theory and Practice

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Chapter 1: Overview

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- Maintaining security and privacy is an ancient and primitive need.
- Particularly relevant for military and diplomatic applications.
- Wide deployment of the Internet makes everybody a user of cryptographic tools.

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- An eavesdropper (intruder, attacker, adversary, opponent, enemy) cannot decrypt C.

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- If there are many communicating pairs, the key storage requirement is high.

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- Algorithms are slow, in general.

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Asymmetric encryption

- Alice presses a self-locking padlock in order to lock the box. The locking process does not require a real key.
- Bob has the key to open the padlock.

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- Alice sends (C, L) to Bob.

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- Bob recovers K as $K = f_D(L, K_d)$.

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- Bob decrypts C as $M = f_d(C, K)$.

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- Alice puts K in a box, locks the box by L_A using K_A, and sends the box to Bob.
- Bob locks the box by L_B using K_B, and sends the doubly-locked box back to Alice.

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- Alice unlocks L_A by K_A and sends the box again to Bob.

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- Alice unlocks L_A by K_A and sends the box again to Bob.
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- A third party always finds the box locked either by L_A or L_B or both.

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- Alice computes $K_{AB} = f(A_e, A_d, B_e)$.

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- Bob computes $K_{BA} = f(B_e, B_d, A_e)$.
- The protocol insures $K_{AB} = K_{BA}$ to be used by Alice and Bob as a shared secret.
- An intruder cannot compute this secret using A_e and B_e only.

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- Signature generation $\equiv$ Decryption (uses private key), and Signature verification $\equiv$ Encryption (uses public key).
- **Non-repudiation:** An entity should not be allowed to deny valid signatures made by him.

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Drawback

- Algorithms are slow, not suitable for long messages.

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Forging

- Verification is expected to fail if a key $K'_d \neq K_d$ is used to generate s.

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  - Weak authentication

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- If Bob receives satisfactory response in every iteration, he accepts Alice's identity.

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- Alice does not reveal her secret directly to Bob.
- Bob generates a challenge C and sends C to Alice.
- Alice responds to C by sending a response R back to Bob.
- Bob determines whether the response R is satisfactory.
- Generating R from C requires the knowledge of the secret.
- Absence of the knowledge of the secret fails to generate a satisfactory response with a good probability p.
- The above protocol may be repeated more than once.
- If Bob receives satisfactory response in every iteration, he accepts Alice's identity.

Drawback

- C and R may reveal to Bob or an eavesdropper some knowledge about Alice's secret.

Zero-knowledge Protocol

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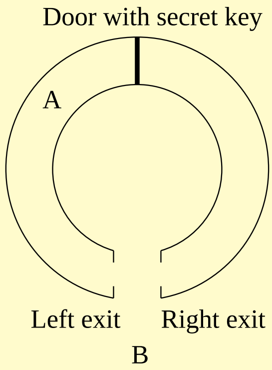
A real-life example



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Message authentication code (MAC)

- A keyed hash function is used to authenticate the source of messages.

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- If a certificate is not in the CRL, and the signature of the CA on the certificate is verified, one gains the desired confidence of treating the public-key as authentic.

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