# ICT Course: Introduction to Cryptography

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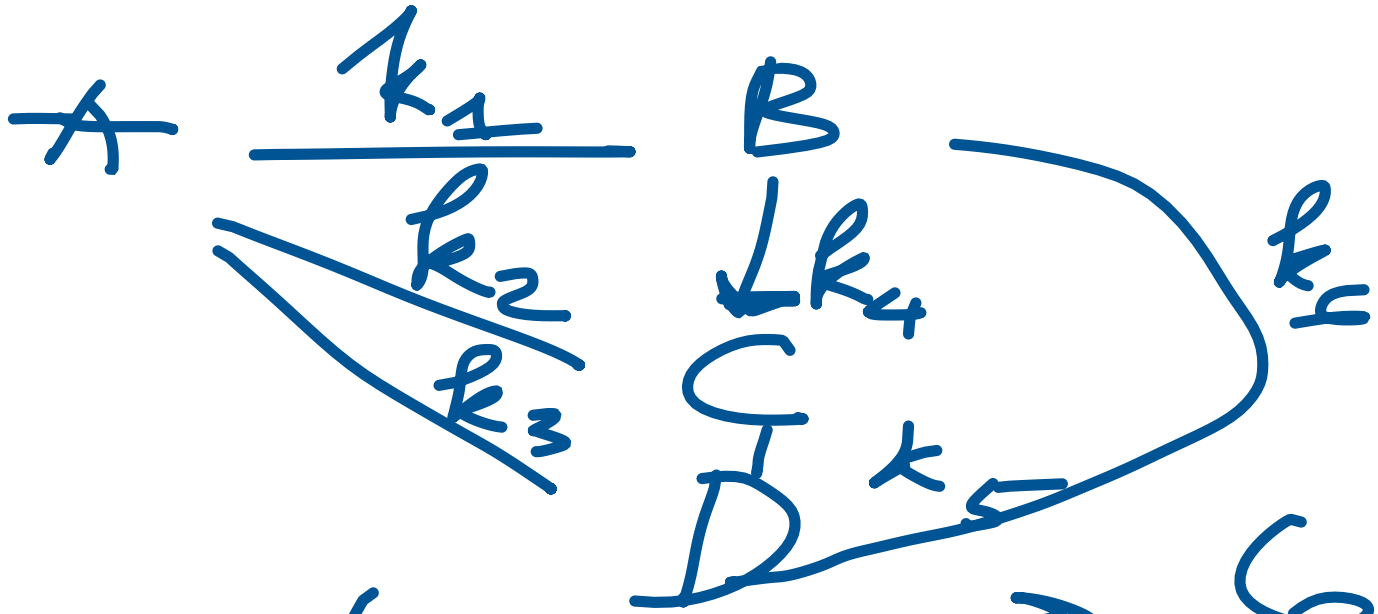
Assymetric ciphers

public key

RSA

A shared key B

- non-identification

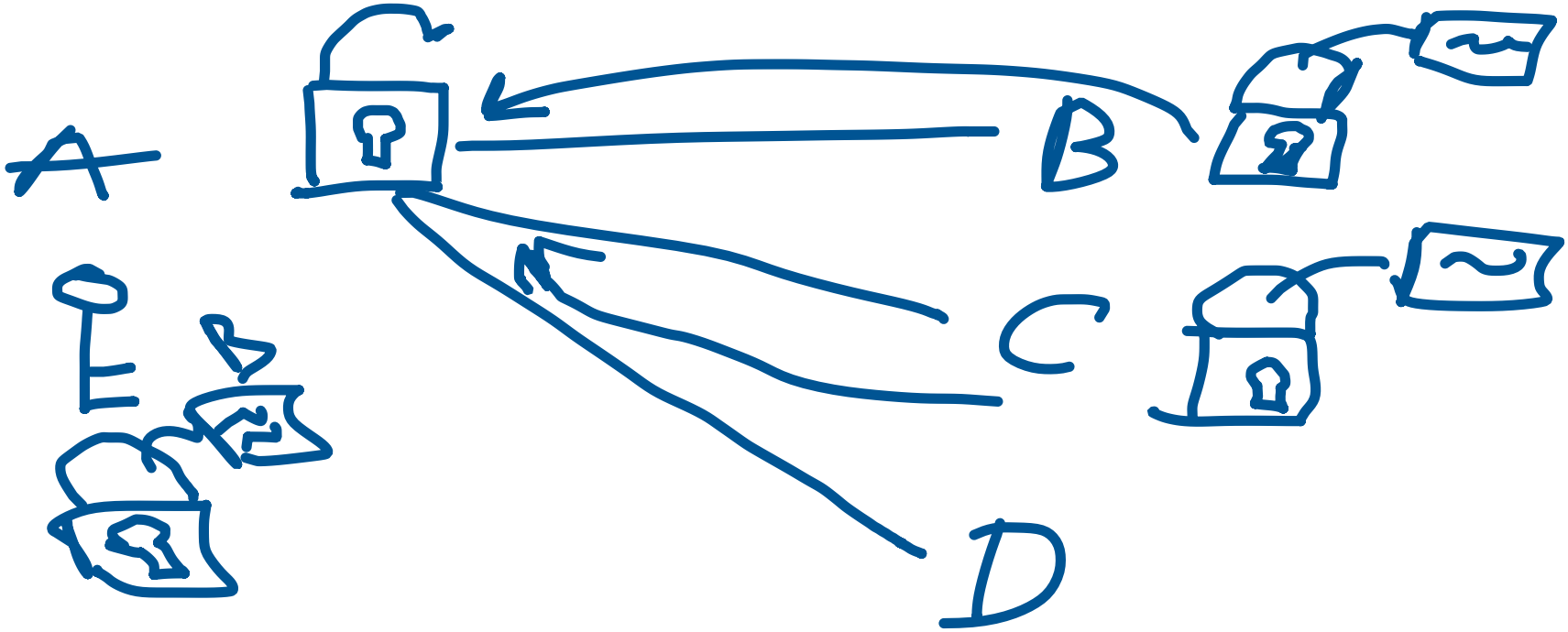



4 users → 6 keys

160 users → ? keys

$$\frac{160 * 159}{2}$$

n users → $\frac{n * (n-1)}{2}$ keys


A
B
C
D

# Session 5: Asymmetric Cryptography - Introductions

1. Introduction to Public Key Cryptography
   - Symmetric cryptography issues
   - Principle of asymmetric cryptography
   - Security mechanisms of Public Key Cryptography

# Symmetric cryptography issues

- Key Distribution: The key must be established between Alice and Bob in secured channel
- Number of keys: a key for each pairs of users
- No protection against cheating of either Alice or Bob

# Principle of asymmetric cryptography

- Trap door one-way function
- A key pair:
  - public key $k_1$: is broadcast to anyone
  - private key $k_2$ :is kept secret
- Algorithm: plaintext M, Ciphertext C

$$C = e_{k_1}(M)$$

$$M = e_{k_2}(C)$$

# Security mechanisms of Public Key Cryptography

- Key Distribution without a pre-shared secret key, e.g, Diffie-Hellman key exchange, RSA
- Digital Signatures
  - providing integrity
  - preventing 'reputation'
  - idetification: using challenge-response protocols
- Encryption, e.g, RSA

# Practical protocols

Most protocol are hybrid protocol, incorporate both symmetric and public-key algorithms:

- Key exchange and digital signature: use asymmetric algorithms (slow)
- Encryption: uses symmetric ciphers (fast)

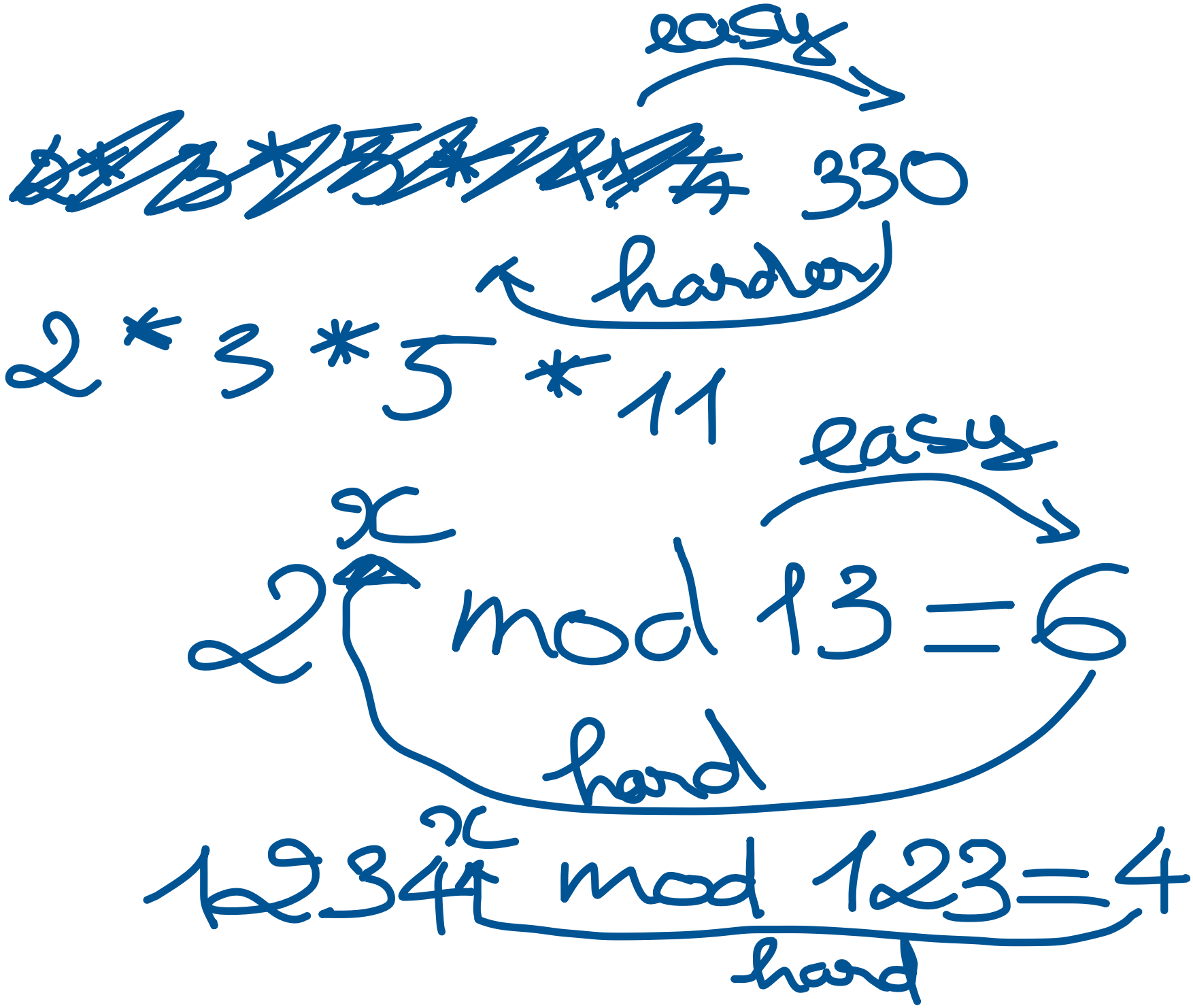
# How to build Public-Key algorithm

Asymmetric schemes are based on **one-way function** $f()$

- Computing $y = f(x)$: easy
- Computing $x = f^{-1}(y)$: infeasible

One-way function are based on mathematically hard problems:

- Factoring integers: given a composite integer $n$, find its prime factors
- Discrete Logarithm: given $a$, $y$, and $m$, find $x$ such that $a^x = y \ mod \ m$
- Elliptic Curves: Generalization of discrete logarithm


easy
330
harder
2 * 3 * 5 * 11
easy
x
2^x mod 13 = 6
hard
x
1234^x mod 123 = 4
hard