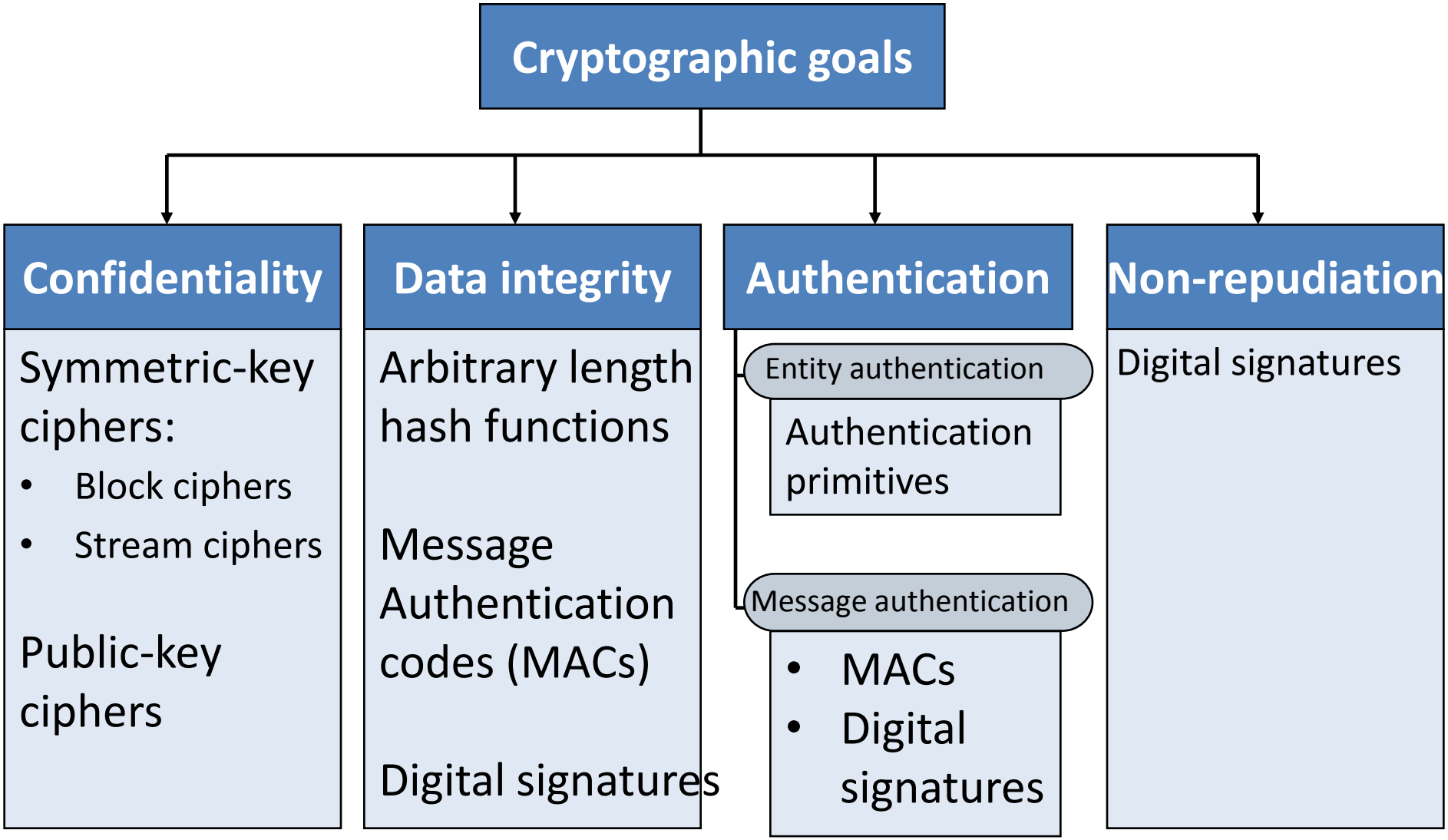
Digital Signature

Outline

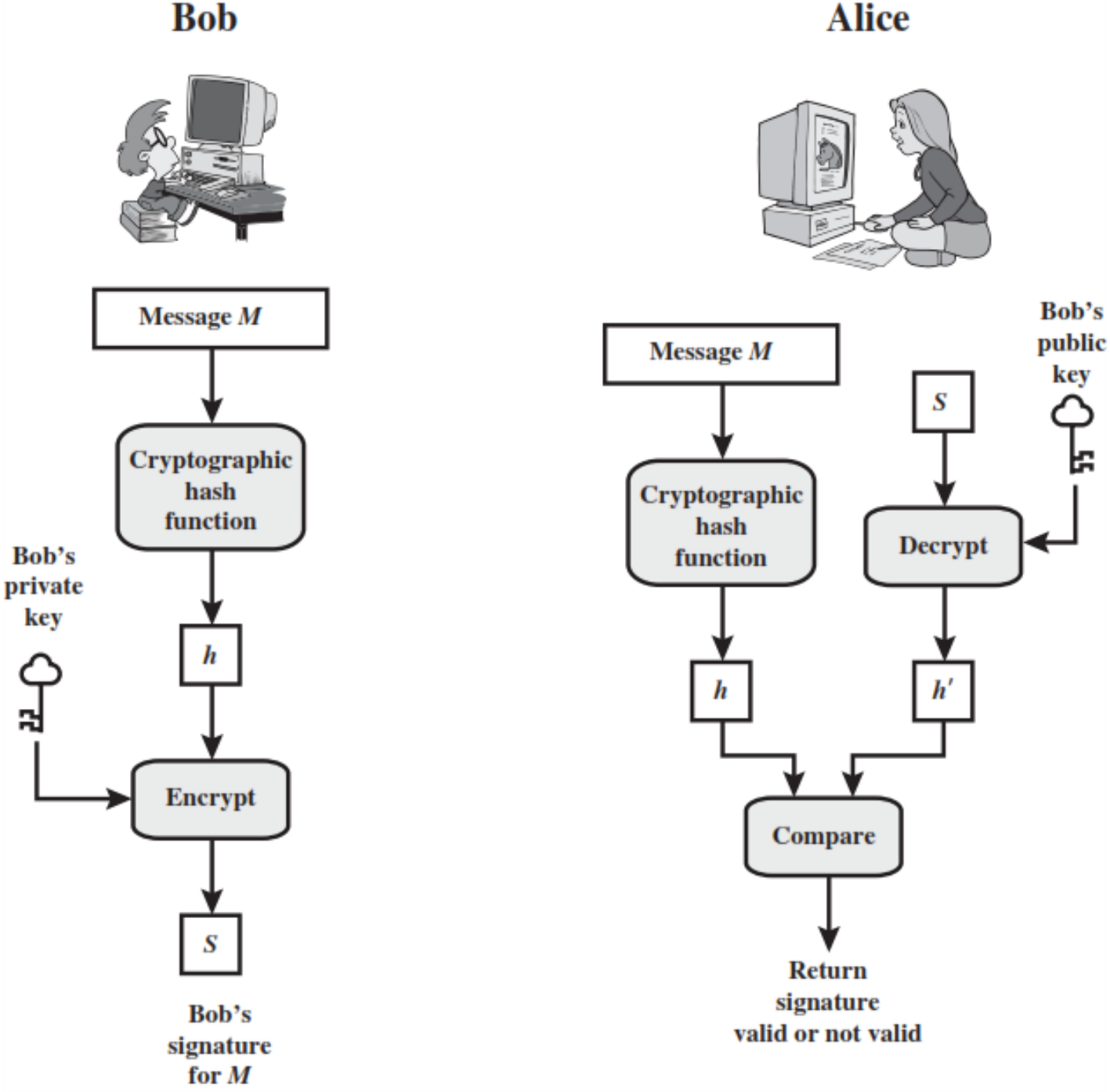
- Digital Signature
- Digital Signature properties
- Requirements and security

Cryptographic Goals



Digital Signature

- A **digital signature** is an authentication mechanism that enables the creator of a message to attach a code that acts as a **signature**.
- Typically the **signature** is formed by taking the hash of the message and encrypting the message with the creator's private key.
- The **signature** guarantees the source and integrity of the message.
- The **digital signature standard (DSS)** is an NIST standard that uses the secure hash algorithm (SHA).


Bob
Alice
Message M
Cryptographic hash function
Bob's private key
h
Encrypt
S
Bob's signature for M
Message M
Cryptographic hash function
S
Bob's public key
Decrypt
h
h'
Compare
Return signature valid or not valid

Hash code, MAC and Digital Signature

Hash Code

- A **hash** of the message, if appended to the message itself, only protects against accidental changes to the message. An attacker can modify the message and can simply calculate a new hash and use it instead of the original one. So this **only gives integrity**.

MAC

- A message authentication code (MAC) (sometimes also known as keyed hash) protects against message forgery by anyone who doesn't know the secret key. Thus, we have both **integrity** and **authentication**, but **not non-repudiation**.

Hash code, MAC and Digital Signature

Digital Signature

- A **digital signature** is created with a private key, and verified with the corresponding public key of an asymmetric key-pair.
- Only the holder of the private key can create this signature, and normally anyone knowing the public key can verify it.

Attacks and Forgeries on Digital Signature

- **Key-only attack:** C only knows A's public key.
- **Known message attack:** C is given access to a set of messages and their signatures.
- **Generic chosen message attack:** C chooses a list of messages before attempting to break A's signature scheme, independent of A's public key. C then obtains from A, valid signatures for the chosen messages. The attack is generic, because it does not depend on A's public key; the same attack is used against everyone.
- **Directed chosen message attack:** Similar to the generic attack, except that the list of messages to be signed is chosen after C knows A's public key but before any signatures are seen.
- **Adaptive chosen message attack:** C is allowed to use A as an "oracle." This means A may request signatures of messages that depend on previously obtained message–signature pairs.

…Attacks and Forgeries on Digital Signature

- **Total break:** C determines A's private key.
- **Universal forgery:** C finds an efficient signing algorithm that provides an equivalent way of constructing signatures on arbitrary messages.
- **Selective forgery:** C forges a signature for a particular message chosen by C.
- **Existential forgery:** C succeeds in forging the signature of one message, not necessarily of his choice

Digital Signature Requirements

1. The signature must be a **bit pattern** that depends on the message being signed.
2. The signature must use some information **unique** to the sender to prevent both forgery and denial.
3. It must be relatively **easy to produce** the digital signature.
4. It must be relatively **easy to recognize** and **verify** the digital signature.
5. It must be computationally **infeasible to forge** a digital signature, either by constructing a new message for an existing digital signature or by constructing a fraudulent digital signature for a given message.
6. It must be **practical to retain a copy** of the digital signature in storage.