

Digital signatures

Asymmetric (Block) Ciphers

▷ Use key pairs

- ◆ One private key (personal, not transmittable)
- ◆ One public key, available to all

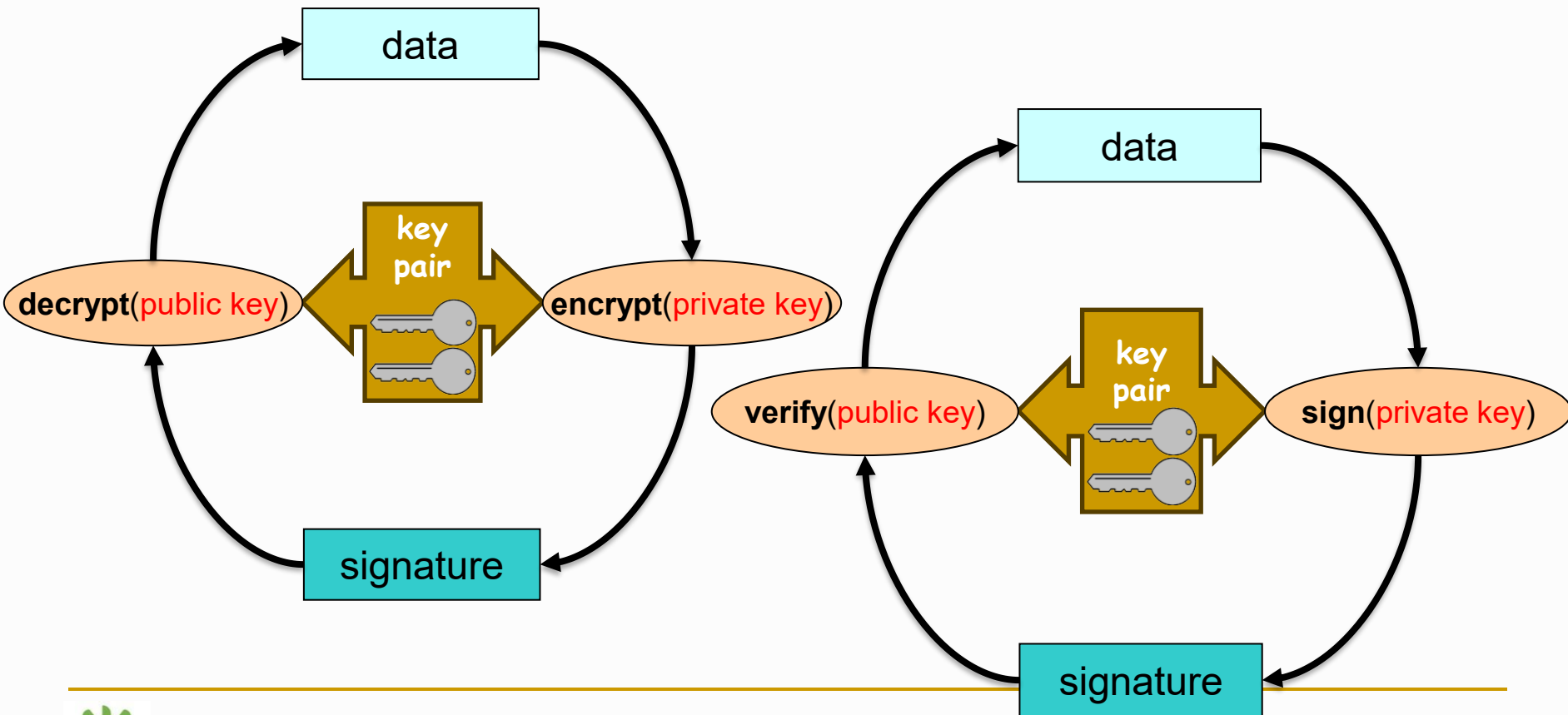
▷ Allow

- ◆ Confidentiality without any previous exchange of secrets
- ◆ Authentication
 - Of contents (data integrity)
 - Of origin (source authentication, or digital signature)

Digital signatures

Encrypt / decrypt (RSA)

Sign / verify (ElGamal, EC)



Digital signatures

- ▷ Authenticate the contents of a document
 - ◆ Ensure its integrity (it was not changed)
- ▷ Authenticate its author
 - ◆ Ensure the identity of the creator/originator
- ▷ Prevent the repudiation of signatures
 - ◆ Non-repudiation
 - ◆ Genuine authors cannot deny authorship
 - Only the identified author could have generated a given signature

Digital Signatures: approaches

- ▷ Asymmetric encryption / decryption
- ▷ Asymmetric signature / verification
- ▷ Digest functions
 - ♦ Only for performance

Signing:

$$A_x(\text{doc}) = \text{info} + \text{Enc}(K_x^{-1}, \text{digest}(\text{doc} + \text{info}))$$

$$A_x(\text{doc}) = \text{info} + \text{Sign}(K_x^{-1}, \text{digest}(\text{doc} + \text{info}))$$

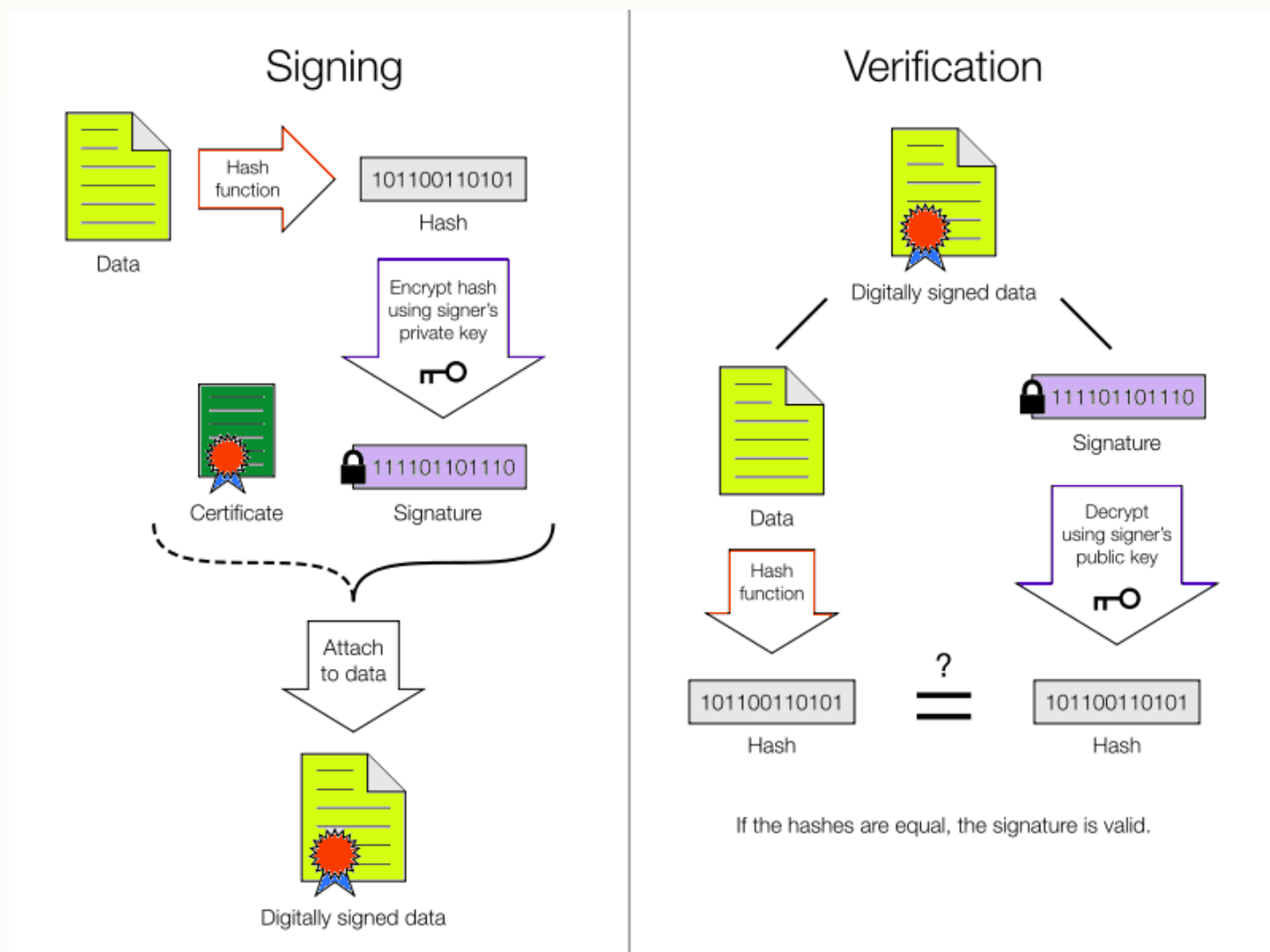
info = signing context, signer identity, K_x

Verification:

$$D(K_x, A_x(\text{doc})) \equiv \text{digest}(\text{doc} + \text{info})$$

$$V(K_x, A_x(\text{doc}), \text{doc}, \text{info}) \rightarrow \text{True} / \text{False}$$

Encryption / decryption signatures



Digital signature on a mail:

Multipart content, signature w/ certificate

```
From - Fri Oct 02 15:37:14 2009
[...]
Date: Fri, 02 Oct 2009 15:35:55 +0100
From: =?ISO-8859-1?Q?Andr=E9_Z=FAquete?= <andre.zuquete@ua.pt>
Reply-To: andre.zuquete@ua.pt
Organization: IEETA / UA
MIME-Version: 1.0
To: =?ISO-8859-1?Q?Andr=E9_Z=FAquete?= <andre.zuquete@ua.pt>
Subject: Teste
Content-Type: multipart/signed; protocol="application/x-pkcs7-signature"; micalg=sha1; boundary="-----ms0504050701010502050101"
```

This is a cryptographically signed message in MIME format.

```
-----ms0504050701010502050101
Content-Type: multipart/mixed;
boundary="-----060802050708070409030504"
```

This is a multi-part message in MIME format.

```
-----060802050708070409030504
Content-Type: text/plain; charset=ISO-8859-1
Content-Transfer-Encoding: quoted-printable
```

Corpo do mail

```
-----060802050708070409030504--
-----ms0504050701010502050101
Content-Type: application/x-pkcs7-signature; name="smime.p7s"
Content-Transfer-Encoding: base64
Content-Disposition: attachment; filename="smime.p7s"
Content-Description: S/MIME Cryptographic Signature
```

```
MIAGCSqGSIb3DQEHAQcAMIAQAQExCzAJBgUrDgMCGGUAMIAGCSqGSIb3DQEHAQAoIIamTCC
BUkwggSyoAMCAQICBAcnIaEwDQYJKoZIhvcNAQEFBQAwdTELMakGA1UEBhMCVVMxGDAWBgNV
[...]
KoZIhvcNAQEBBQAEgYCOfs852BV77NVuwv53vSxO1XtI2JhC1CDlu+tcTPoMD1wq5dc5v40
Tgsaw0N8dqgVLk8aC/CdGMbRBu+J1LKrcVZa+khnjtB66HhDRLrmEGDNttrEjbqvpd2QO2
vxBIPTIU+vCGXo47e6GyRydqTpbq0r49Zqmx+IJ6Z7iigAAAAA==
-----ms0504050701010502050101--
```