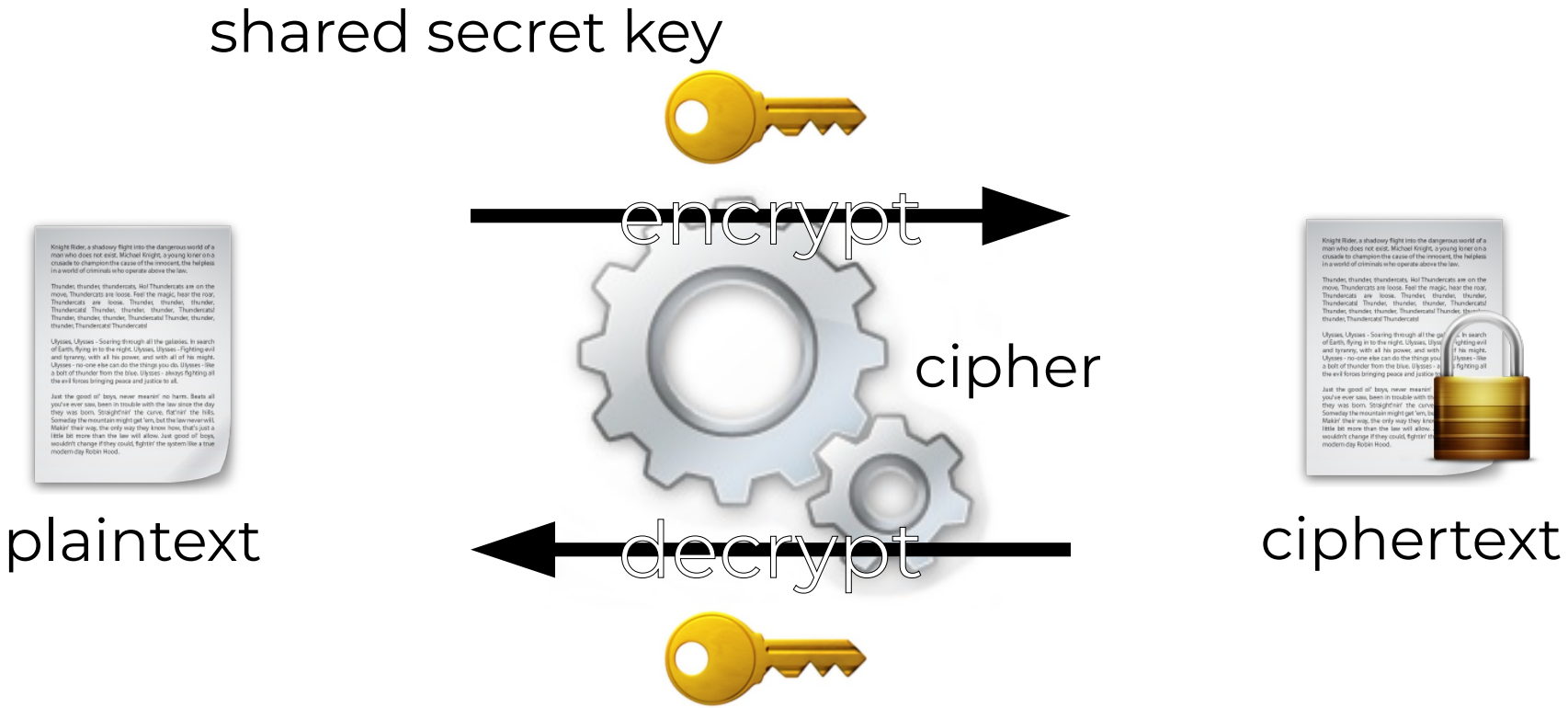
Public Key Cryptography, OpenPGP, and Enigmail

Cryptography is the art and science of transforming (encrypting) a message so only the intended recipient can read it

Symmetric Cryptography



Symmetric Cryptography

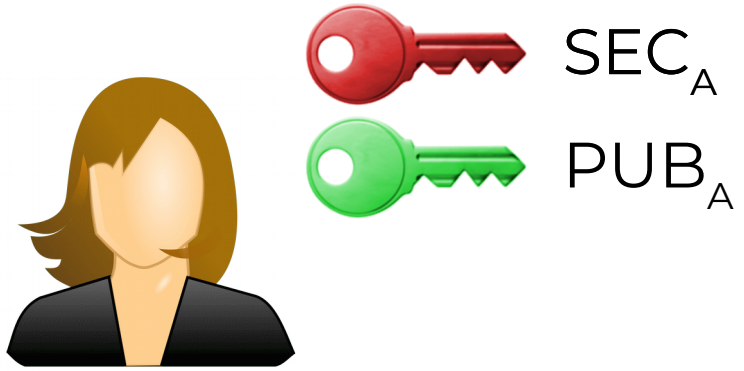
Examples of **symmetric ciphers**:

- Caesar (I cent. BCE)
- substitution (IV cent.)
- Vigenère (XVI cent.)
- Beaufort (XIX cent.)
- DES (1975)
- 3DES (1998)
- AES (1998)
- etc.

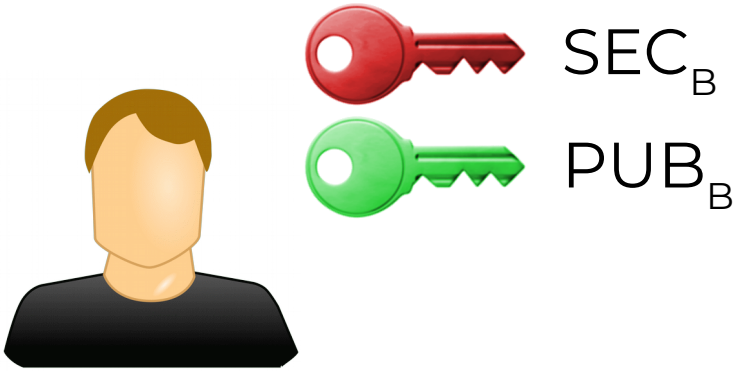
Symmetric Cryptography

Problem: deliver the key to the recipient!

Public Key Cryptography
(Asymmetric Cryptography)



Alice

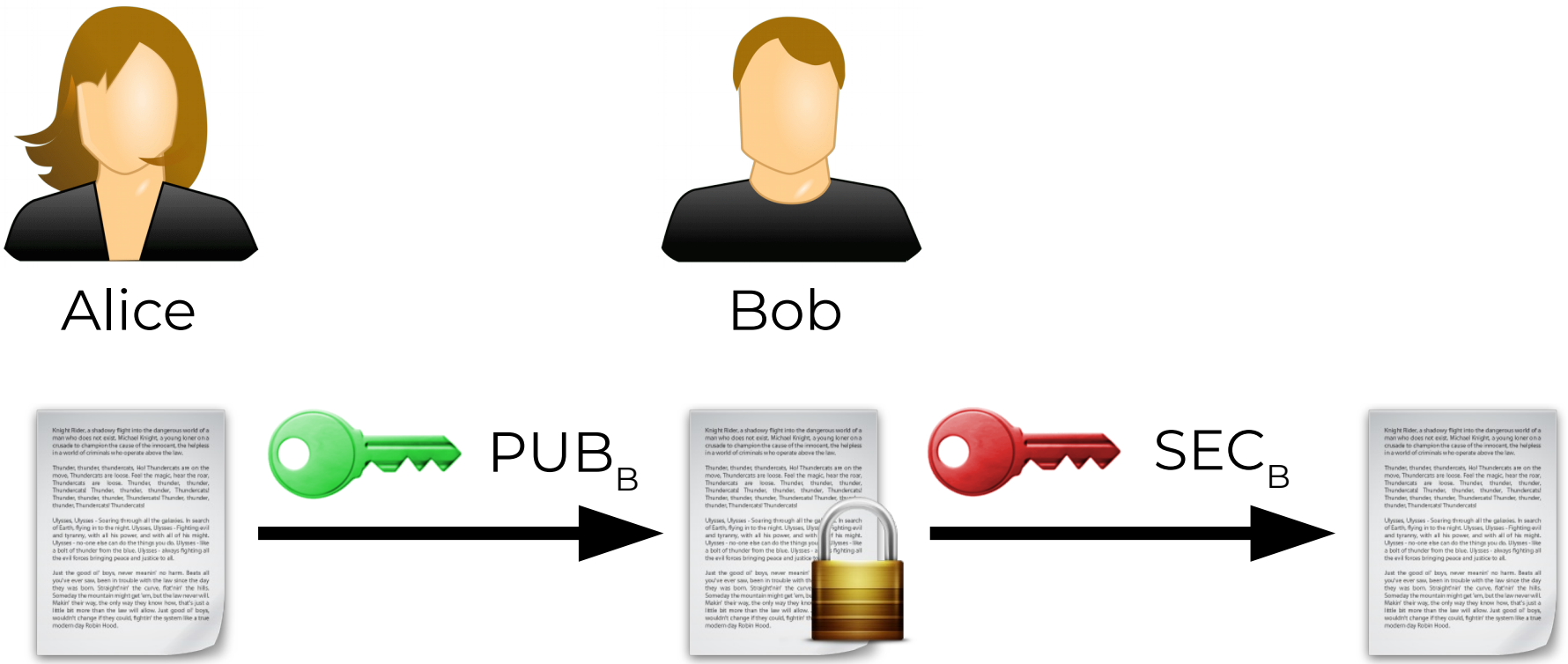


Bob

First, each participant generates a **key pair** composed of a **private key** and a **public key**

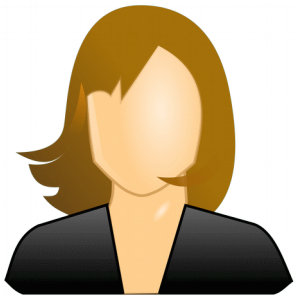
Public Key Cryptography

Encryption/Decryption
(for confidentiality)

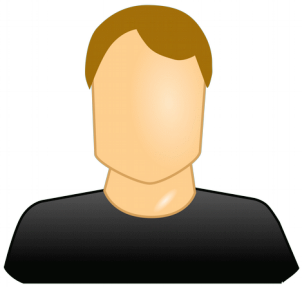


Public Key Cryptography

Digital signature
(for authentication & integrity)



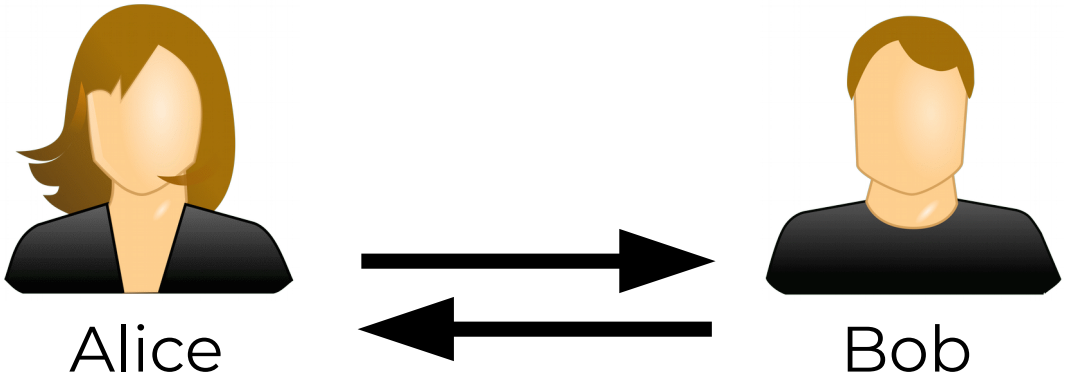
Alice



Bob

Public Key Cryptography

PKC is based on **one-way functions**



DH-RSA:

- discrete logarithm problem

  e.g. $453^{x} \pmod{21997} = 5787$ x = **?**

- prime factorization

  e.g. prime factors of 7774733 = **?**

Public Key Cryptography

Birth of **Public Key Cryptography**:

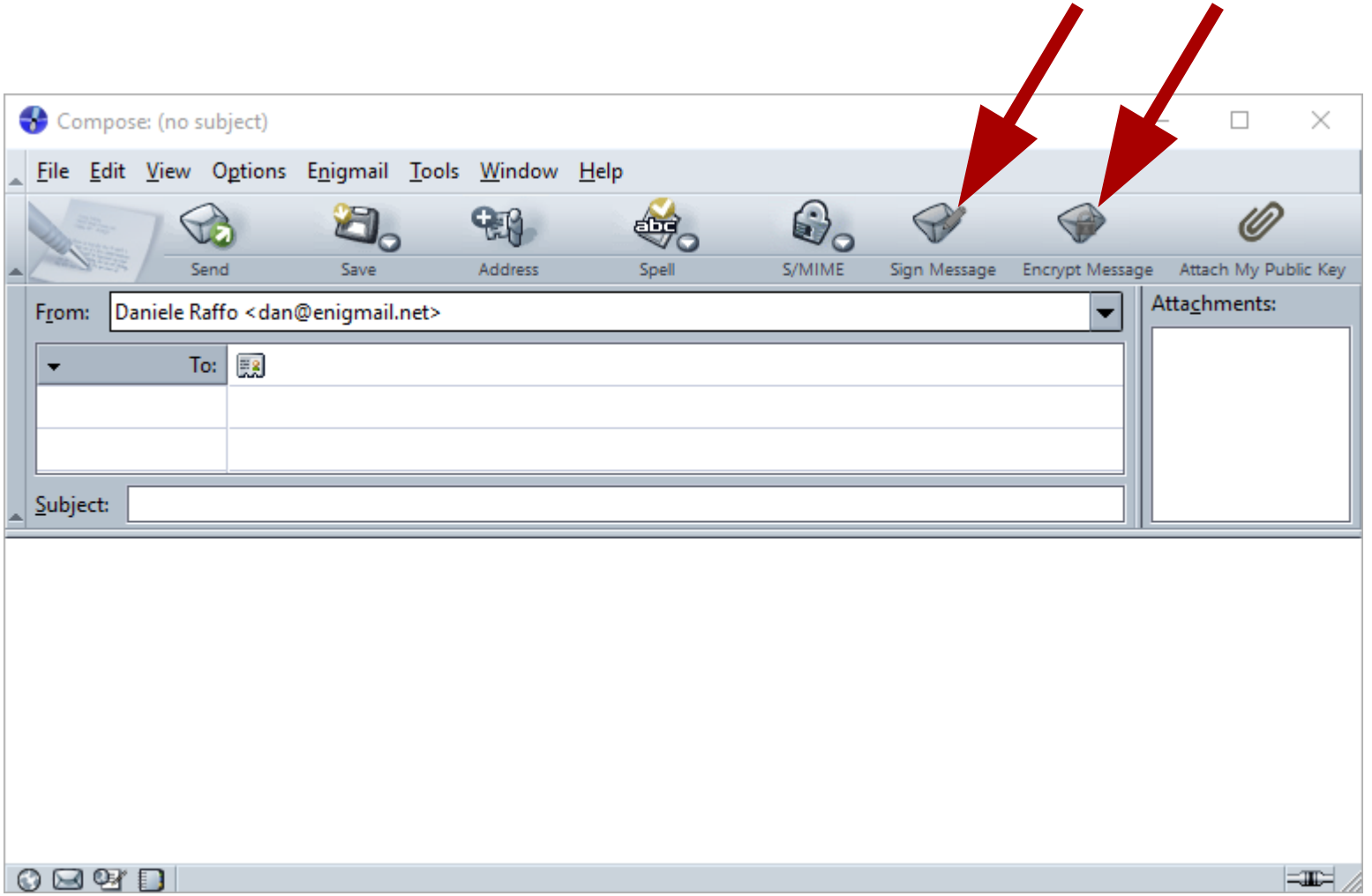
- 1976: Diffie-Hellman-Merkle key exchange
- 1977: Rivest-Shamir-Adleman, RSA cipher

➔ 1973: Ellis & Cocks (UK GCHQ) invent PKC, but discovery was classified until 1997!

Public Key Cryptography

- 1991: **PGP** (Pretty Good Privacy)
- 1998: OpenPGP standard
- 1999: **GnuPG** / **GPG** (GNU Privacy Guard)
- 2001: **Enigmail**, a plugin for Thunderbird
- 2014: ProtonMail

Enigmail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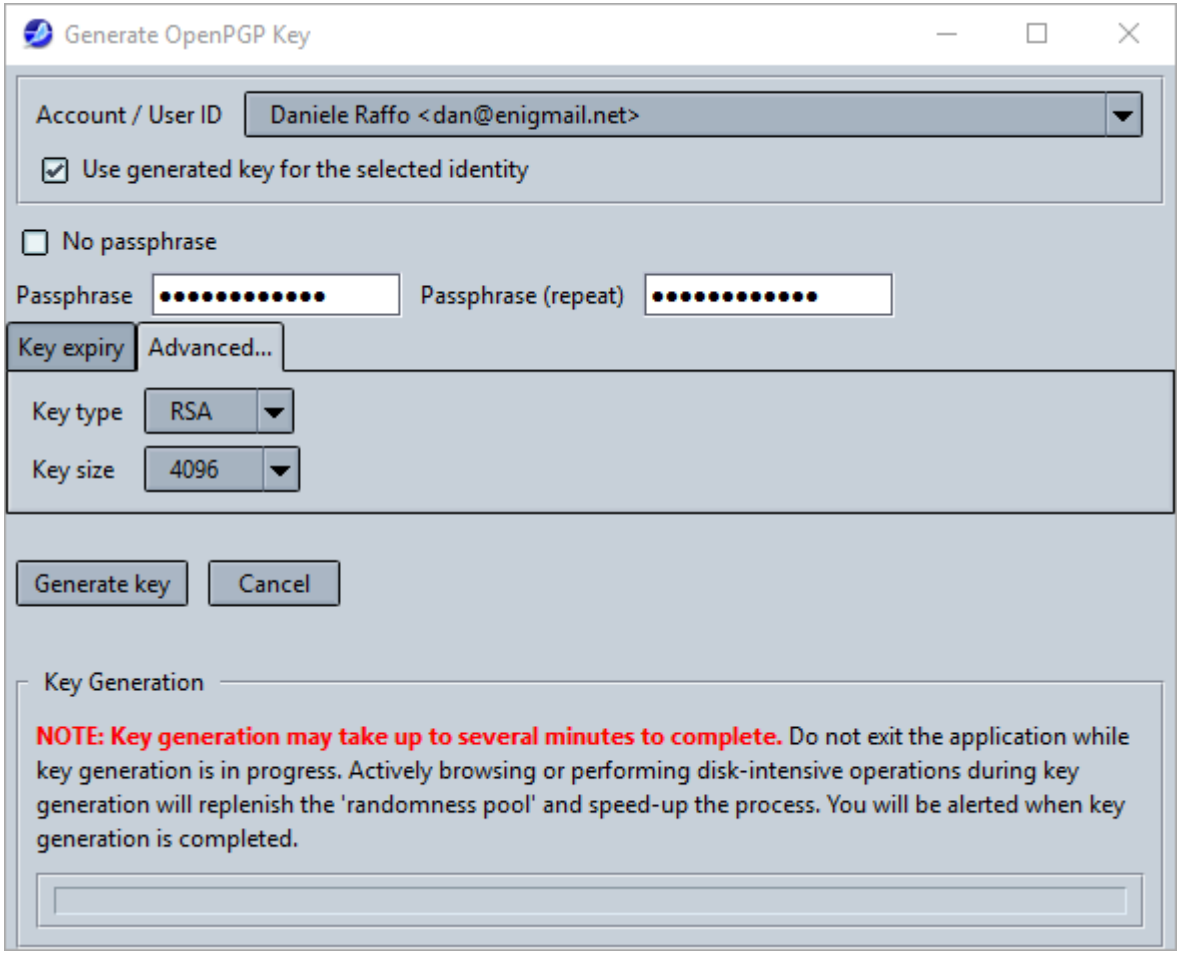
File Edit View Options Enigmail Tools Window Help
Send
Save
Address
Spell
S/MIME
Sign Message
Encrypt Message
Attach My Public Key
From: Daniele Raffo <dan@enigmail.net>
To:
Subject:
Attachments:

Enigmail

First operation: create a key pair



Enigmail

Public key file

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-----END PGP PUBLIC KEY BLOCK-----
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Enigmail

Private key file

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(...)
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-----END PGP PRIVATE KEY BLOCK-----
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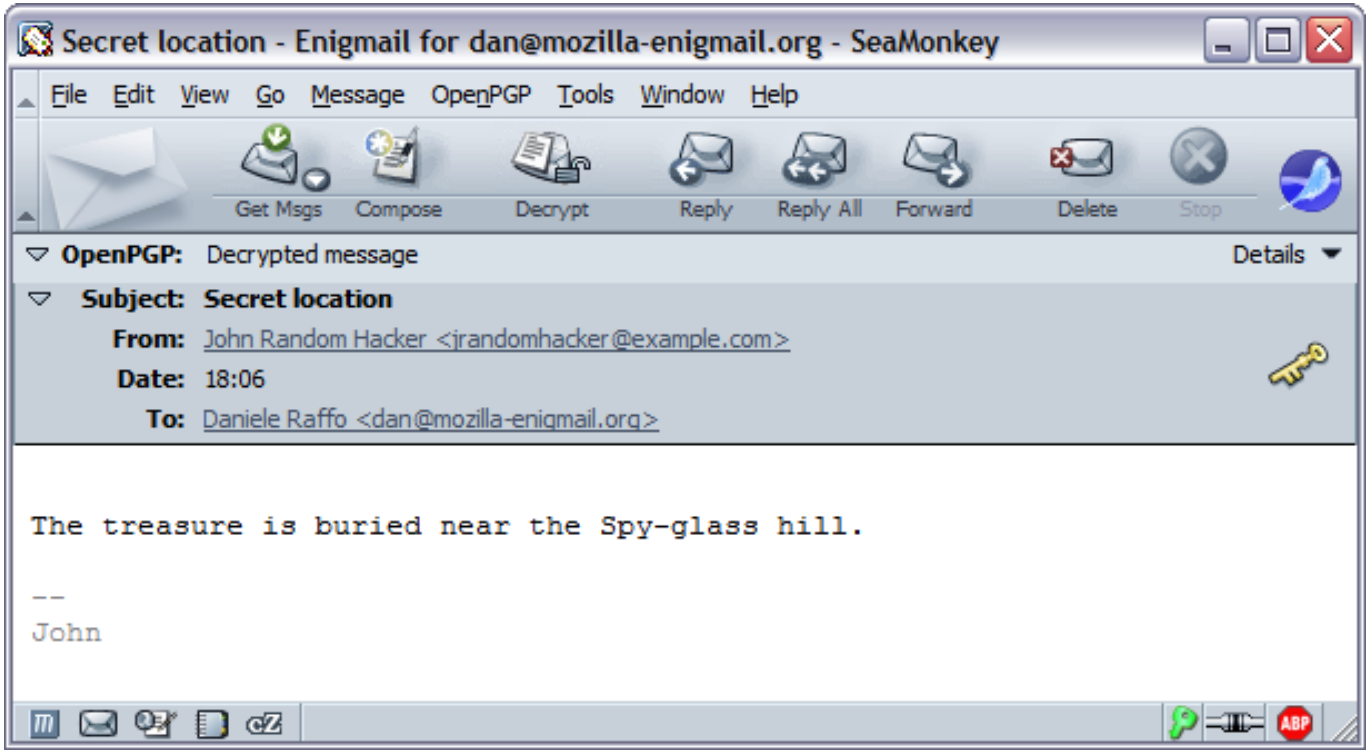
Do not distribute your private key!

Enigmail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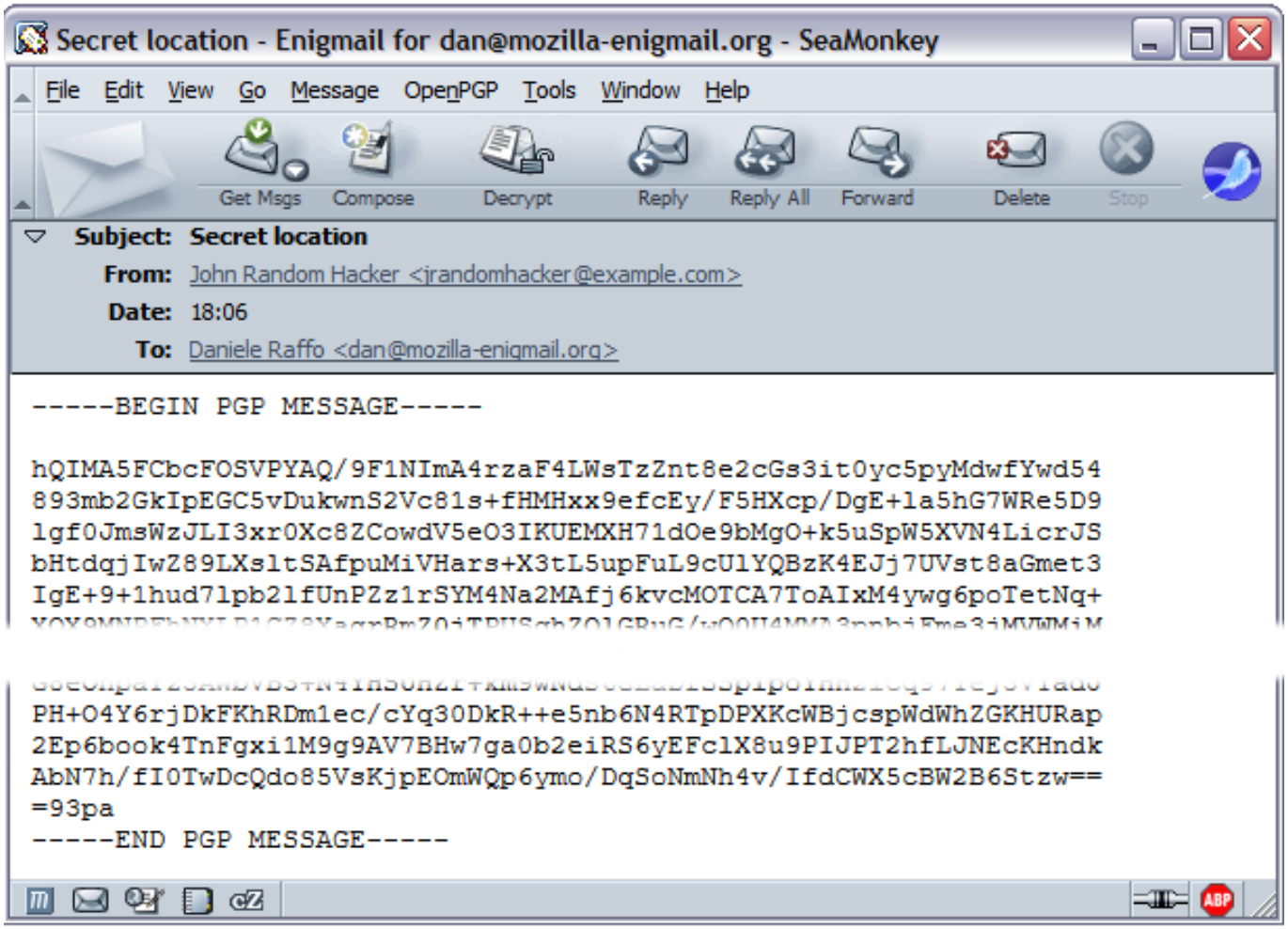
Get Msgs
Compose
Decrypt
Reply
Reply All
Forward
Delete
Stop
OpenPGP: Decrypted message
Details
Subject: Secret location
From: John Random Hacker <jrandomhacker@example.com>
Date: 18:06
To: Daniele Raffo <dan@mozilla-enigmail.org>
The treasure is buried near the Spy-glass hill.
--
John

Enigmail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From: John Random Hacker <jrandomhacker@example.com>
Date: 18:06
To: Daniele Raffo <dan@mozilla-enigmail.org>
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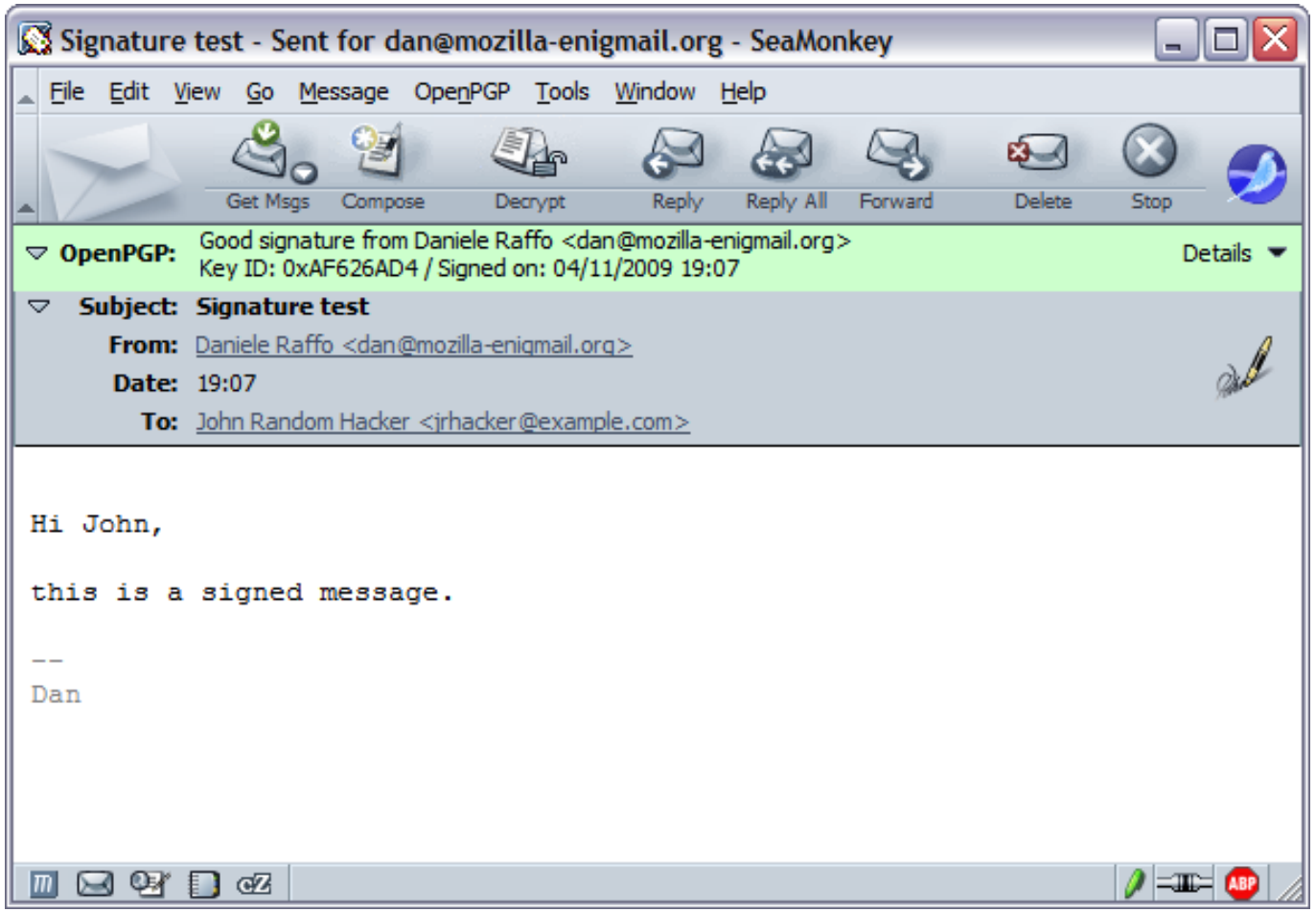
Enigmail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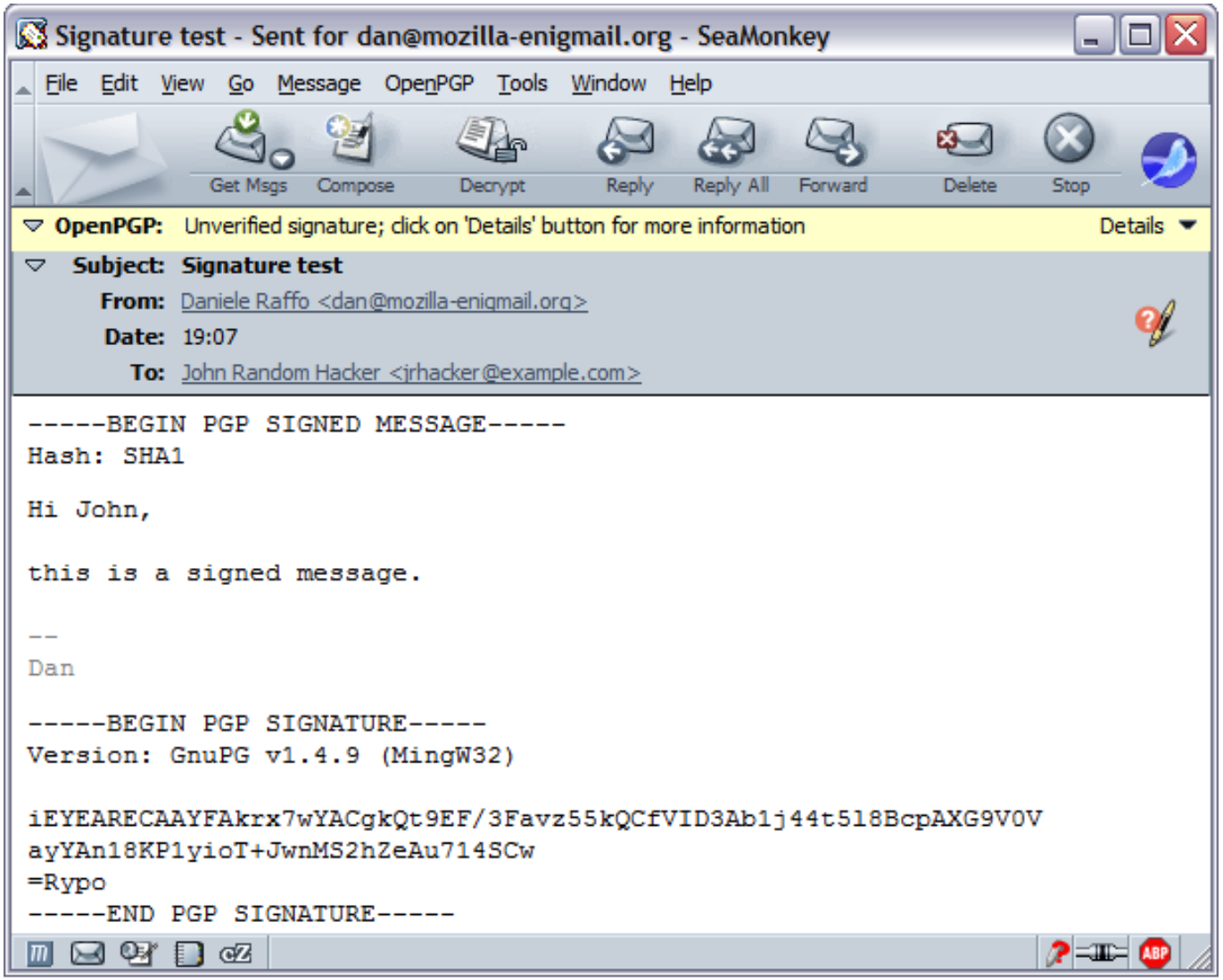
Get Msgs Compose Decrypt Reply Reply All Forward Delete Stop
OpenPGP: Good signature from Daniele Raffo <dan@mozilla-enigmail.org>
Key ID: 0xAF626AD4 / Signed on: 04/11/2009 19:07
Details
Subject: Signature test
From: Daniele Raffo <dan@mozilla-enigmail.org>
Date: 19:07
To: John Random Hacker <jrhacker@example.com>
Hi John,
this is a signed message.
--
Dan

Enigmail


Signature test - Sent for dan@mozilla-enigmail.org - SeaMonkey
File Edit View Go Message OpenPGP Tools Window Help
Get Msgs Compose Decrypt Reply Reply All Forward Delete Stop
OpenPGP: Unverified signature; click on 'Details' button for more information
Details
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From: Daniele Raffo <dan@mozilla-enigmail.org>
Date: 19:07
To: John Random Hacker <jrhacker@example.com>
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Hash: SHA1
Hi John,
this is a signed message.
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Dan
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Version: GnuPG v1.4.9 (MingW32)
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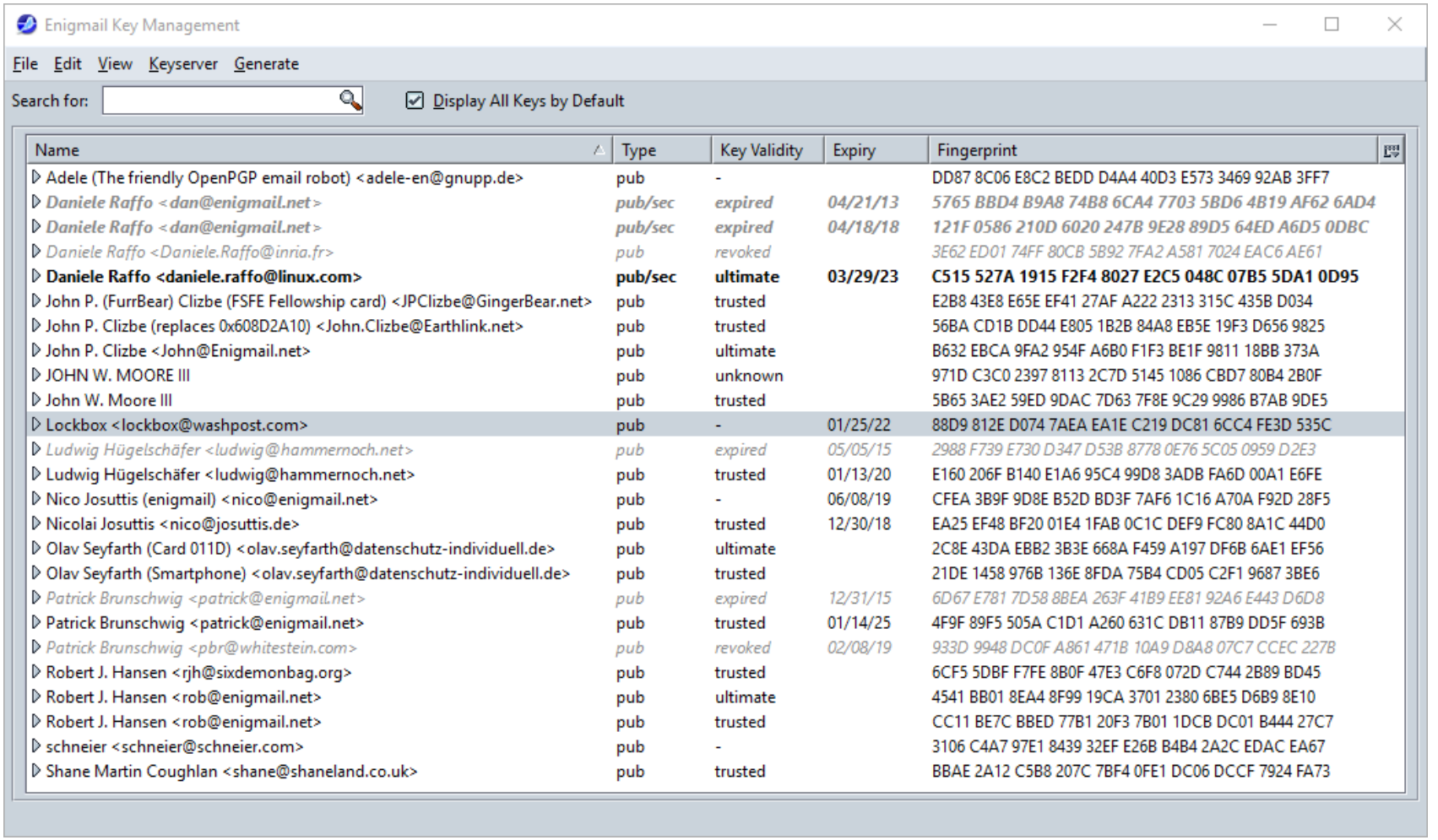
-----END PGP SIGNATURE-----

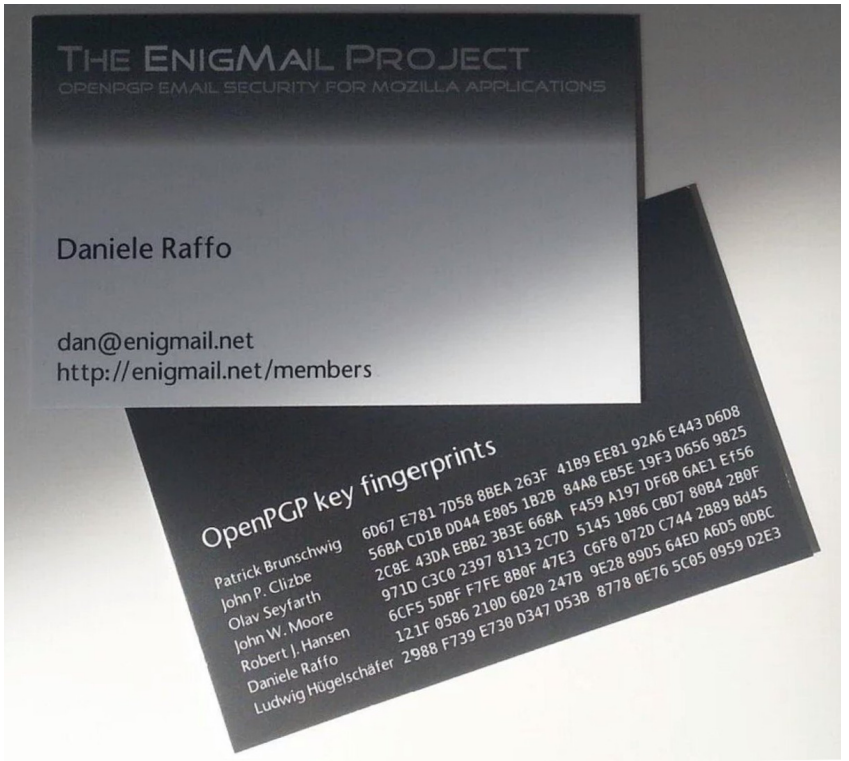
Enigmail

Your **keyring** contains all your collected keys



Public Key Cryptography

Check a public key's **fingerprint** to ensure that it belongs to the correct person



Public Key Cryptography

How to obtain someone's PGP public key:

- by hand, via e-mail, from website, etc.
- from a keyserver
- via Web of Trust / key signing parties
- from Web Key Directory

Public Key Cryptography

Other uses of PKC:

- SSL/TLS (HTTPS)
- secure IM: WhatsApp, Signal, etc.
- digitally signed software
- SSH
- S/MIME email security

Public Key Cryptography

Different techniques for key authentication

S/MIME, HTTPS, signed software:
➔ public key is embedded in a certificate issued by a trusted CA

SSH, secure IM:
➔ trust on first use (optional fingerprint check)

Public Key Cryptography

Thanks for your attention!