

Relatório INE5429

Segurança em Computação

E-mail Seguro

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1 PGP

Foi gerado um certificado pgp de 2048 bits com o comando `gpg --gen-key`:

```
gpg: next trustdb check due at 2018-07-25
pub   2048R/3E9FDAF3 2018-05-26 [expires: 2018-07-25]
       Key fingerprint = 606A E8C2 FEBB 54F8 2895  B4FE A1D4 FD19 3E9F DAF3
uid           Bruno Marques (Secure e-mail work) <brunomn95@gmail.com>
sub   2048R/CEDF0AA2 2018-05-26 [expires: 2018-07-25]
```

Após isto utilizou-se o cliente de e-mail Thunderbird com o add-on Enigmail. Foi adicionado o certificado pgp gerado ao cliente de e-mail para realizar a assinatura e ciframento das mensagens que serão enviadas.

1.1 Criação do e-mail seguro

Para criar o e-mail seguro utilizou-se da interface gráfica do thunderbird com o add-on enigmail, o qual através do botões presentes é ativado o ciframento e a assinatura da mensagem. As figuras 1 e 2 mostram isto.

Figura 1 – Autenticação e encriptação desativada

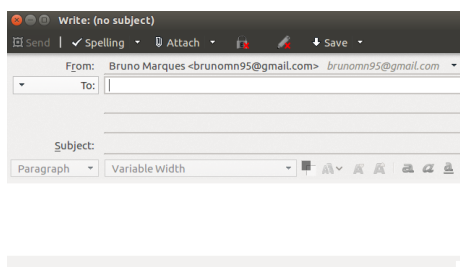
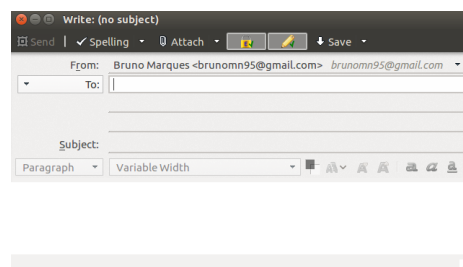


Figura 2 – Autenticação e encriptação ativada



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1.2 Formatos DER e PEM

São formatos de arquivos para armazenar certificados e chaves. O formato `.pem` (Privacy-Enhanced Mail), é delimitado pelas seguintes linhas:

```
-----BEGIN CERTIFICATE-----  
-----END CERTIFICATE-----
```

Ele suporta diversos certificados digitais, incluindo uma cadeia de certificados. Se sua organização utilizar cadeia de certificados, utilize este formato para criar certificados ca. (IBM, 2018)

Já o formato `.der` contém dados binários. Ele só pode ser utilizado para um único certificado, ao contrário de um arquivo `.pem`, que pode conter vários certificados. (IBM, 2018)

1.3 E-mail original enviado e e-mail seguro

Figura 3 – E-mail original

Olá, este é um e-mail seguro.

Figura 4 – E-mail formato PEM

```
-----BEGIN PGP MESSAGE-----  
Version: GnuPG v2
```

```
hQEMA0qXobb03wqiAQf+NT55Sv0Cci/PY073F+QVs/n/TuS9moS2xQxm04t4kXDx  
r3r/n36AFwoT3F+3WlnKinSCRUGZzUgJB55CEdMBpttP07dWdlzHxegoRUul+sa8  
DIUpq9yE0UG0zZACj2Ql1uzeCKz8TMAL8KX23QiLyk2yWwx+Bhw1/r6LpFBj051A  
spmmMaMsLeeab5Lacg+hAKhwUvf9MQmSL90r9jJr4BEIvwPuBkp2rda7S/+uahvq  
eRX15x4VQKweACu/Vagk9emibD0ef6lsKBFupwDV8RC91XK3IHQ37/kPs2F15WLM  
+9yXZJ8SOPf5Vskr4xwFOHuTMxVb94aGQT82Wlp0WtLpAQk3NrsfTZXWNqCkLQEk  
jHGAQYcT6TSKOB0VDdXS7JDki0FdjUlQkZ0xa4fb0BttNh2v25bqhimXYwLc2X  
t8RzQ4U0gDGDBmCnEQiyeX4HCDy+v9P0kDZTyZp5FH7MVfb3qHLk3IKfYuwJeCZo  
Z0o9yJjwcs9MLP7XkurgAaskfW/U8pWF3z0iWF6xPdYcKYf1CglMmd5zyLyG1S8x  
4WHIT8jZjIMpZrJmbx1WypCqDqBY9L5thnvCe1rXxx46wE7FZpBoRAa6GvVSYxa5  
c6mLXLz9+jUCBFTa8TcP8nJZL7Lc0cIzTGH5FaKl0q8KQKR74ajjpC4JLA2Dqeyu  
9yr11sYwXRlF7TYUGyhs+/yuyqN8Kbbd2RvkeF90gQCAJG4+gXtAJ5AQdqHY7MzP  
d5Sq2YmZ+dMt1kh5uoj0RsmPyzPnKnsAaW0qMzi7VnlFOEkOnJJLywyJ0hA7Bup/  
lvysjDNNXxwF5n8eaqwhdW6U+MwXqIdsBUdvQrf1YQsFq+1VxxoIlh761NDtFv/Z  
L4FEr5WZChcLIGRyusfdSaqBFiunJ9uH2ZssgSvVd/9rKH106cMFmCuy06w7Xei7  
c07bCY1P40nyay+5R2QkE/8rotJsmdxT2st9lCPpaICJh0XnolhhTALKFVWYr9MP  
S67SaJf8JqjLroUtmizyLOHAHvT8v1Q9QuS0z1BSowt1pdstsH+8dMy0IzeEE1X9  
qjhZ3gxg0VajhKCcz/iykQw1IggYqzenBA2HIFCT1lw6QZPhBGE1WGbLSQr9vnug  
gyIY3kqJUB6rJgMM5zNIedY/gSGyHGqf8JJACcp6NtEFDkEaCbWWZ6GPSrfv+5BX  
fUMigEJa4qHH5P0x7gMdwKYPaXk1TlGn8BdJ/GXEgn8okEw9QbmDA9mAthipCFEv  
x5NWP/II55pn+jRQrNtQUP00/LTn33V1NXTfgwpYJWzR4my5bD00n8eZVoeN0/Ik  
Mg==  
=MsFf  
-----END PGP MESSAGE-----
```

1.4 E-mail recebido

Figura 5 – E-mail recebido

```
-----BEGIN PGP MESSAGE-----
Version: GnuPG v2

hQEMA0qXobb03wqiAQf7BX1YIJS1FdvxtszFqyf4ZHyhJvIV+1C9smtkP/ac23uV
1NM1kW/0vYKaunY051XX2pM/YV8BBm1drtBL90xzFEox0J4UpC76p2FHw/FYjtcu
CYxQyc5enm2eKF59FfICedzcBsdel3rhVt0u4BXa0HbGwZ/g11FHANB512tQ/ifh
JG2ui1apS1ZQL4r8f9Zif4czB6S6jXfkIwW+i1KwXCWKtLCUMCOFAiM7WrJCywg3
A1K+SJes3yKilUBuJ7GwbBFHQUh1530Pnio153HSJC5DZik8bZPKfd0UfLeouev
8AQ9Qp4guy1Jhj7/MEsD031k/cctRbSz46E9Gu8VwtLpAdoQF0aS+h3CprYGutHC
9+jJ+i5aKTtAN2I6Mj7+F9k5hEAt5J0cbdv6D8Ua0mWMENDPM8ZNFLp8Pr4ybRGm
RXrp/ZHOu1I+hmjW/QOKNmGMR49rH7rBqFyv3P90kjxrYCKFrKY1jnGSLCKNaE2Z
a/qf04KU94qbvY7pcY0dvxKX0pS7MdJjaUrZa1SBvoJPdEaFNrPAwadd9H5DzCon
TNp6Mcm0xh089ExxRzEgqj/rV0vP+Pj0oVSUST200AVNu9Y4hbgM61pbtWb4KU67
dhieZHBvZdpde8gYKqJsu2jo2+LiNM0zKffpRd9JcU4Cv0Rk0YiHZ/p1Aw9Vf8Sm
nGATyJw4jWk8f4g71UIvXNExX8fwhp8L641UnTpBbI/kCfAPw775huIGe0onkqbK
8y01JvmYn6gA1lvbxcUe6h/bMTC8pRzqzpxXGmX9PDiRN1lhd7+3MxICWfA173kx
R1GU74nPJQlgmUx9uFHkgy+v8MZfzp1+zAJR5GgH1iwB1M4lME8/k7Fa0iSRJK9c
PDvVqVF1C7YMdezLxZnwVeZPwP9ZwDOWldFijTmFwAhsExr6LV0tySp5pgjnPVZM
dKoRXbdPkiEczet+onbamI1fVS/qiCWb1zvNlzh02eLy8IdzYw1GEcoaDYgLtV6/
MuS5ZolED0ETOAEFDmjq2YbAHGccM5kz6xGibnz1M10yh016+tXNQajHAcceyLbkB
DMfLFSRZhyw/9A00kYsXcMs6Mq6TtiDlcCfPG88+L9946H70+EQQUFEsnYUmSTPU
Sx1UFRicBZoMo2KBR0g8g6hvpfxusJ2J4C87LGs1v3PtCgZ38xwqvYqX4xnIBbtF
nfb3PvHwvX6UXnvI+gHx32V4iL8nT/1A31gctYf173SXa08JZn56BC1K7N2BtSKH
wmCV5SG0nwh0t+11JqcsXhNWgb9Ah4pQHY3//oag3NdjS/WUK0bE6jbbvBy3i5A=
=MGaQ
-----END PGP MESSAGE-----
```

Figura 6 – E-mail decifrado

```
Custódio já corrigiu as provas?
```

2 X.509

2.1 S/MIME

S/MIME (Secure/Multipurpose Internet Mail Extensions) é um padrão para encriptação e assinatura de dados MIME, com o uso de chave pública. Esse padrão foi originalmente desenvolvido pela RSA Security. Este padrão preve os seguintes serviços: autenticação, integridade de mensagem, não repúdio, privacidade e segurança de dados. (WIKIPEDIA, 2018)

2.2 Gerando certificado X.509

O certificado foi gerado utilizando o ICPEdu Certificado Digital - Pessoa P1 - Sistema Automatizado de Emissão de Certificado (<https://p1.icpedu.rnp.br/default/certification/installcertificate/>), que gerou o certificado no formato .p12. Para convertê-lo para formato PEM foi utilizado o seguinte comando:

```
openssl pkcs12 -in SAEC-P1-Bruno-Marques.p12 -out bruno.pem -clcerts -nokeys
```

Figura 7 – Certificado X.509 formato PEM

-----BEGIN CERTIFICATE-----
MIIGTCCBEWgAwIBAgIECnwbVDANBgkqhkiG9w0BAQOAFADCBiDEWMBQGA1UEAxMN
QUMgUGVzc29hc3YBMTELMakGA1UECBMU0mXcZaJBgNVBAYTAkJSMR0wGwYJKoZI
hvcNAQkBFBg5jY2RAaWNLmVkdS5icjEMMAoGA1UEChMhDUBk5QM8wDQYDVQQLEwZJ
Q1BFZHUxJfJAUBgNVBAcTDUzsb3JpYW5vcG9saXNwHhcNMTgwNTI2MTc1NTU2WhcN
MTkwNTI2MTc1NTU2WjB7MTAwLgYDVQQDEydCcncvubyBNYXJxdWVzIGRvIE5hc2Np
bWVudG86MDkxMzI5OTA5MDEENjA0BgNVBAcTLVVGUOMGLSBVbml2ZXJzaWRhZGUG
RmVkdXJhbkZkZSBTYW50YSBQZXRhcmluYTEPMAOGA1UEChMGSUNQRWR1MIIBIjA
BgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAgJUw0QC9EiFNa+1XXH3vcwW4l3dM
TkzVdCnw/xWqk+0lehNkGfx88/0v8K9SYbNV+8KTxNK6GLYc4ernY/0ixWklvbxG
i0SHETqKOUNXWWP+0vFQVCBV2BfwMxGKpjTgyVIOpUn871zGK5gNhWmOFY2SQL8S
TlI/6bS7bslC3gig0vIS5FV3MQp9UCnPdBIuk4r60bbrzU0mcM8tfEoM11xA3T8n
SMAgI2PuvaEVu06L44HHdnVdFsOsJyGTA7dJYZtLmSPjywOrDEhszgLqENVCpn6z
NztQI6hm37UX0aP4sEbAgmv4Wg0WfU0x8hg2HiU1EmSXBuAUpRuoJzxCl1wIDAQAB
o4IB2TCCAdUwgaQGA1UdEQSBnDCBmYEVYnJ1bm8ubW5AZ3JhZC51ZnNjLmJyoDgG
BWBMAQMB0C8ELTA5MjIxOtk1MDkxMzI5OTA5MDEwMDAwMDAwMDAwMDAwMDAwMDAw
MDAwMDAwMKAktBgVgTAEGBAAkBCiWMDAwMDAwMDAwMDAwMDAwMDAwMDAwMDAwMDAw
MDAwMDAwBGBCBWMAQEDDA4EDDDAwMDAwMDAwMDAwMDAABgNVHRMEAjaAAMBOGA1Ud
DgQWBBSK8aR0YXmVZqv4RydDKY9xbs2h1DCBgwYDVROjBHwweoAUFIRzfqIQ0IwJ
3XWrHX9BSC1+Y2ihX6RdMFxsCzAJBgNVBAYTAkJSMQ8wDQYDVQQKEwZJQ1BFRFUX
DDAKBgNVBAoTA1JOUDEOMAwGA1UECXMFR09QUMxHTAbBgNVBAMTFFEDIFJhaXog
ZGEgSUNQRURVIFYyggENMEOGA1UdIARGMEQwQgYKKwYBBAH8fAEBBDAOMDIGCCSG
AQUFBwIBFIzodHRwczoVl3AxLmljcgVkdS5ybnAuYnIvZHBjLWFWjLXAXLnbkZjA0
BgNVHQ8BAf8EBAMCBwAwHQYDVROlBBYwFAYIKwYBBQUHAWIGCCSGAQUFBwMEMA0
CSqGSib3DQEBDQUAA4ICAQBsdr9+5Ww2ztpt8zavoKZXov0q1bTXzomJAu0fhIiv
1lrCv2qc80rtnlndu+Su04C5Ra0S0T0w9e4kXk7U3KB/mNI9Gd6w9fAZnYAKW6F
oinW0039cN80rtldlhfExqQzi68gQb68XAY0yalcWp+1uta0JenC0112ylNBPjY
uY8SO5V3k3c0CAdAypmVfch+yS0J0e9qFt40Zk1QbS0nJXSihFMftVZMZHBIjYhR
E7TzVJyQioGUIV8sJdWiSWZVr4bJIFEaua90EcrNAHWIspGDM0q2EVcPjF52qtRZ
8EXVJj1ydB0xziflz9zo9znA61UgJs7iwh7cS1MDFrF15DtCzJ7m2mj3zMLMKEu
jcnqoYlvnfItEmtj20gbw7PEp23QxZ+um2fJsqs8y8KSEwG8RTVUSMIbEzLNveV2
KgnStuuw10A9Nke0oWlCAWn9H02evqNK9MFoF+Gh3Arnx2JfpQ/ZIAukOX9JmAw7
P05gWzHiCAe855eAyAs4PzqKh2EwM00Jfeifmb0NBHwpFhnEYBqcINSU45pIAE8D
Kd1RISRgrA+HiDAmHOBZ9qA41nK20KD6C8tAKFAaJPs7AKU2jdnmo6oC645kfUNE
v8uSQHVd58T6EDBohyaSLOhJBCFmW5NRLTEZ35Yfc9Fq5mYpjXLZvlnUTyLo6K+
1Q==
-----END CERTIFICATE-----

2.3 Ferramenta para trabalhar com o X.509

A ferramenta escolhida foi o Thunderbird.

2.4 E-mail original enviado e e-mail seguro

O certificado gerado foi importado para o Thunderbird para então gerar o email seguro. A autoridade certificadora também teve que ser importada no Thunderbird.

E-mail formato original

Olá, este é um e-mail seguro com X.509.

E-mail sigiloso

From: Bruno Marques <bruno.mn@grad.ufsc.br>
Subject: X.509 6
Message-ID: <e8c2a9d6-9693-57f8-7279-6a170e4ba9f5@grad.ufsc.br>
Date: Sat, 26 May 2018 18:19:08 -0300
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:52.0) Gecko/20100101
Thunderbird/52.8.0
MIME-Version: 1.0
Content-Type: application/pkcs7-mime; name="smime.p7m"; smime-type=enveloped-data
Content-Transfer-Encoding: base64
Content-Disposition: attachment; filename="smime.p7m"
Content-Description: S/MIME Encrypted Message

MIAGCSqGSIb3DQEHA6CAMIACAQAxgGuMIIBqgIBADCBkTCBiDEWMBQGA1UEAxMNQUMgUGVz
c29hcyBQMTELMakGA1UECBMCUOMxGzAJBgNVBAYTAkJSRMR0wGwYJKoZIhvcNAQkBFg5jY2RA
aWNwLmVkdS5icjEMMAoGA1UEChMDUk5QMq8wDQYDVQQLEwZJQ1BFZHUxZjAUBGNVBAcTDUZs
b3JpYW5vcG9saXMCBHDcG1QwDQYJKoZIhvcNAQEBBQAEggEAXXZM3E/g1wMz804qbJVoPwMf
adQ1RLag+8dMh4DGQHN5NtqnyXLpslCcT1JmU7fZP2/DWwkyEGhE4pqP9e2W/0uxPOLsifqv
DtqUcE/hNyVOKmVEGJu5CYVhcTxWxdbukxdMm3AnsJgUb5u11BsrNIQsJllpUqnnBM4o3+LN
4/IYcZsr1Vfn8MRUyYC5oNWBVYvfvf8IDGwE7X0EVL1A9b5tisFiaemKrzD6lWByJNxDAX8c
tMOCp3Ab0CP1pB4drroN7hk+L0qstJ3B02SBXlnvxnwEqvD0o00hBxW7lWAL2Yjdz/v+ccD
7yAch3uQa/OnbtFrdTjRoVog6FmgsDCABgkqhkiG9w0BBwEwFAYIKoZIhvcNAwcECHJwq/WT
QLqxoIAEghnYpYiu5/SATgSrpFX5QYQHRhiv15hoNvvqIpKeCS7g4lztEgIemwQ+Nqr+jtKw
9wDnN7Yg96EQ+1QYfIvkwnujzP1gqIVYxRNW5G1a147BTGiIAioCzL2UVyyAetD0GzQoyWv2
+vZdDcdfl1DN2NTZ7vLQUH9TDWgKu048x1LYkOYNec80U4qavjXYFf0i4wx2w4Zhreq+Bgd
3YYB7qCx+OKYGELESA0m4bS1IICYDXs0Ax4UnEVKBpVkiBwo4Jyom77gtdDvZXj5DwbT8Lw0
kPmVw+K1lY4fzausyDCA6gqQIIPbH7m0XhN6W8DpGyLOYJSXHMmr07C1tDSdJykDP1jdsTl
QIdrgPOBLbIkxJqqp0aDmGLYy6AsTWwExRFDCKfNJJpET2y6+OK8b2Tln56QWKxSIyGIAuK
YUOb0jwn+6x09QW4cS3A/YKKdl56zta00aJGpWa2sYI7pvPLZR6BfZbIynG+fU1TPRvdFy+0
MB3x9e1JZ32KScJvsyjn1QZHZs0mDkZUJfmKKoizeLdBL0jPJB9Lzahpe/gVG9w4mmJ47gm
vXMxG5z9iz28mdPDuy2aWqMgj05aB7cdzRpXXVx32LKj0eJFux1PMP+NDM+mXDVoha+FZlVe
eociwh3aGsJ19DaB6Hk0r9iojc7xpLA8oExUsMPuYPRrR5wzJSqH7woEikQ4LrYnfevhW4vk
ft04CbVH/wIgaEEed9ytCTLv6CzpT4v/SjF61Pt+aFac9Kh+HT+mdJu+ujwxsYPM03G90toe
uVoylk0/LZobauAiZ4SRDnohAOK6wAN/tfGhlL6ZqDpgnpLlRhW00rzN541sDC3uWiN0tEwG
QSMF0cCV3pMRAGDCNVNiUFvLjJ3jfCRYrm+xn1KUftW2JxU6srGFOjhQjBitbyBwV40rgLR+
3fLki80Ma81WmQcJIRPuYQ3cEBnt+3YssG5eqVYCBf8Aw8Afky1J4r6tLSVP5aez1bHFjHA8
wlu1x7Azbk2TWD2j0HpyFKSqs999XkVE430Lp60xaFHDkjdgIb1HvGDgXWfXa/073EwwoPTA
NqMj/61Y+8HxGcJewYlksJjP+q1G0EsDWXMuM9a2V/rkHU7H5+N9RkNU9HmY+VVU7dgqESeo
rwnuAfyY4yms3zwnGsfIH+KQFW6pQ94SXbaLF0wSG8eASk6o6Pw6sge+/S0mNgpzSLI9PXb6
xNI/p9beE3t7Btov9jd3Xpw0qrMLRrXYAC10P4efD8LF14lwtakmGkxM6pbo+HvbXGsJdE0f
1sv3cJF/00oMK01xIRKXUjZW4DSfld3XvV7uSiXcqYTKZanFiUXMPbNiIrifjfo+oiLaIsY
30A4A1NjJ8KkE10q1h0il8Bkt6JH6xcxrfEDoWfYd+Z9RCf1jQvs9hqQePi54bs7MVAM1nVG
NgPFvfg+1+PhXLmoSZJZ3wvDL1vYSIQ4Lk6+RJonokUHSgi0XL7V9fvuvyVEwk7uHfH5r+A
DnxjvDfFTXclvd/xaFUpoxC0dqmfM1KT4iZsLe00/XIcTg3p7NRCEa1cEZLb7H6360JppRyl
I3hB59kKapGwnhF/DnnLOPUDmaXwuavn8K16g37BTpg/WGNcSDtRF5pmEXzU/zFpDt755d2C
1aPGz3RJkwf1HeyAVAestMbwMW4YvqQ3PNAMVpHGTfy7NG5xrUx37AqMcFapFGc3e0Qe/7ef
bFdc0uK2zwE5cjIelAonmZCFHFvSMiuaDt6T/pGEit5xhe8DBMKUAKLoLNs3dTL+NfhyVIG
C+vQHD7KC3pCngIi5vADUWh0yiLnNXFHYPsTo4UKd9Tc7Adc1brnNeS4VSIQ8iBXhvn1Loa
IkKfTkQKc50ql+r+06vtW1DF0uJnuP1SxpYSaZL9wNFC4mp59pv3vqcj8VKwUvAVHbrG6b
8JQ8V31YdSrvzrWyyWuK7WjGyW+cZKbFHCpcAjoQCpJ2hdMzyBMB5bQU9ryS4170F67W+s0
My+eB1mkv4SNDye5mpaoKQRXW1YNd1mB+4L3/1r+/ygl5zc2NllrWz2s7JaIyTQqj5jb+aaa
ZEQ8rMP6dtk8LS7gBAjKyBJQsx/wFUM99u61hpiAImRkbbi2wMPxspboLdFK94EZ/kGADm+T
E/TTNSJB+sfQvLEBpoTXUYivZHSVfcoSNB5tDSBT7KBqPRFm3T1EPvyXhr8WAbGcrU0ZrOZ3
78hKTFi5WzrYbhAgEX3BXpt12NbiaFnA3akmg3qToYGWp2YU4ajQ+e7uie5ozQ7eVTQZWgUV
ugoU7zViEquDs0DmCq6lLuPGRduISgE9Qe9mvzLh3jM20wd3m/mY0cLYV9Tvt4NuaKBV+T/
6BA2RA7Vu3h3YIj+Ze8b1hlXi4eAbiicEU01BT8L730V+f3S78JRQ/mY4tRry19bME4fG5bp
15dTQqUUEtPqKm5+JGqSiHNNb9QL/Sm4PQn6t+ouIp6/kUn6PyGTs4UEPffBILXHSfWg1kS
OHHknX+0/h0ZqzmrHnjS80FvsvQwy9slhF+s0UgroHmAZJpT7EAozbQ4ppBjTnN1rgjn9P7y
vl5uBjJllogAJwrGB4QxKp1SgOGZW1m/Imx6W4Yh9bKW3sBcfuGJu6ELgzz2daNxJBB79Rg

2dWFLNfGtBvhVnvkQs10tOg87JbJhM/DP5NEBgjSTo5zKRgk+75PJBVHbZiqdasGTfQGEvCq
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2.5 E-mail recebido com X.509

E-mail recebido:

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A prova não foi corrigida ainda... x.x
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