网络安全与管理——pgp的使用

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1 实验要求

① 以三到四人为一组，通过使用pgp软件完成密钥的生成，公钥的公布，利用pgp保护数据并传输，验证签名等工作。

② 这里我使用GnuPG

2 实验原理

2.1 PGP

PGP（英语：Pretty Good Privacy，直译：优良保密协议）是一套用于讯息加密、验证的应用程序。

PGP加密由一系列散列、数据压缩、对称密钥加密，以及公钥加密的算法组合而成。每个步骤均支持几种算法，用户可以选择一个使用。每个公钥均绑定一个用户名和/或者E-mail地址。该系统的最初版本通常称为可信网或X.509系统；X.509系统使用的是基于数字证书认证机构的分层方案，该方案后来被加入到PGP的实现中。当前的PGP加密版本通过一个自动密钥管理服务器来进行密钥的可靠存放。

2.2 GnuPG

GNU Privacy Guard（GnuPG 或 GPG）是一个密码学软件，用于加密、签名通信内容及管理非对称密码学的密钥。GnuPG 是自由软件，遵循 IETF 订定的 OpenPGP 技术标准设计，并与 PGP 保持兼容。

GnuPG 使用用户自行生成的非对称密钥对来加密信息，由此产生的公钥可以同其他用户以各种方式交换，如密钥服务器。他们必须小心交换密钥，以防止得到伪造的密钥。GnuPG 还可以向信息添加一个数字签名，这样，收件人可以验证信息完整性和发件人。

GnuPG 支持的各种加密算法：

- 对称加密：CAST5、Camellia、Triple DES、AES、Blowfish、Twofish、ChaCha20、IDEA（从 1.4.13 和 2.0.20 开始被添加）
- 非对称加密：ElGamal、RSA、DSA、ECDSA、EdDSA
- 密码散列函数：RIPEMD-160、MD5、SHA-1、SHA-2、Tiger
- 数字签名：DSA、RSA、ECDSA、EdDSA

3 实验步骤

3.1 安装GnuPG

```
root@VM-4-4-centos ~# yum install gnupg
Loaded plugins: fastestmirror, langpacks
Repository epel is listed more than once in the configuration
Determining fastest mirrors
epel
extras
ius
mysql-connectors-community
mysql-tools-community
mysql57-community
os
shells_fish_release_2
updates
(1/8): extras/7/x86_64/primary_db
(2/8): mysql-connectors-community/x86_64/primary_db
(3/8): epel/7/x86_64/primary_db
(4/8): mysql-tools-community/x86_64/primary_db
(5/8): ius/x86_64/primary
(6/8): mysql57-community/x86_64/primary_db
(7/8): epel/7/x86_64/updateinfo
(8/8): updates/7/x86_64/primary_db
ius
Package gnupg2-2.0.22-5.el7_5.x86_64 already installed and latest version
Nothing to do
```

3.2 生成密钥

3.2.1 创建密钥

```
root@VM-4-4-centos ~# gpg --gen-key
gpg (GnuPG) 2.0.22; Copyright (C) 2013 Free Software Foundation, Inc.
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
```

3.2.2 选择密钥类型

```
Please select what kind of key you want:
   (1) RSA and RSA (default)
   (2) DSA and Elgamal
   (3) DSA (sign only)
   (4) RSA (sign only)
Your selection? 1
```

3.2.3 选择密钥有效时长

这里我选择无限期

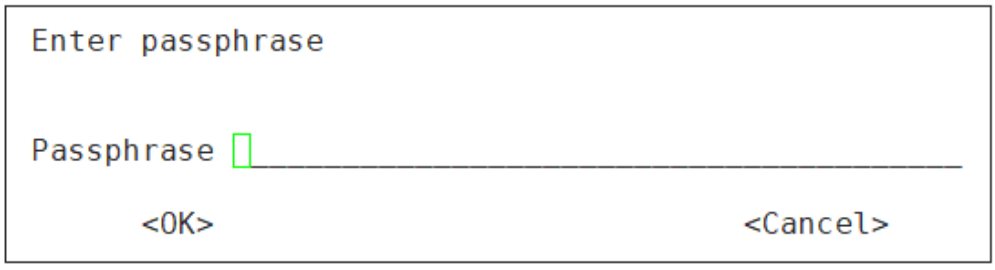
```
Please specify how long the key should be valid.
         0 = key does not expire
      <n>  = key expires in n days
      <n>w = key expires in n weeks
      <n>m = key expires in n months
      <n>y = key expires in n years
Key is valid for? (0) 0
Key does not expire at all
Is this correct? (y/N) y
```

3.2.4 填写个人信息

```
GnuPG needs to construct a user ID to identify your key.

Real name: Yi Junquan
Email address: 2696974822@qq.com
Comment: software
You selected this USER-ID:
    "Yi Junquan (software) <2696974822@qq.com>"

Change (N)ame, (C)omment, (E)mail or (O)kay/(Q)uit? O


```

3.2.5 设置密码

```
You need a Passphrase to protect your secret key.
```



3.2.6 生成密钥

```
We need to generate a lot of random bytes. It is a good idea to perform
some other action (type on the keyboard, move the mouse, utilize the
disks) during the prime generation; this gives the random number
generator a better chance to gain enough entropy.
jsiasohfaosaojdoajdojajjajjjahhahsoasduoduaoudjldajldasjkdaskdiouoeiajksajWe
need to generate a lot of random bytes. It is a good idea to perform
some other action (type on the keyboard, move the mouse, utilize the
disks) during the prime generation; this gives the random number
```

```
generator a better chance to gain enough entropy.
gpg: /root/.gnupg/trustdb.gpg: trustdb created
gpg: key 20424507 marked as ultimately trusted
public and secret key created and signed.

gpg: checking the trustdb
gpg: 3 marginal(s) needed, 1 complete(s) needed, PGP trust model
gpg: depth: 0  valid:   1  signed:   0  trust: 0-, 0q, 0n, 0m, 0f, 1u
pub   2048R/20424507 2022-06-07
      Key fingerprint = FC27 85F2 925C 096B 10A2  0CA9 F843 5EE8 2042 4507
uid                  Yi Junquan (software) <2696974822@qq.com>
sub   2048R/AA8CDF2E 2022-06-07

```

上面的字符串"20424507"，这是"用户ID"的Hash字符串，可以用来替代"用户ID"。

3.3 管理密钥

3.3.1 列出密钥

list-keys参数列出系统中已有的密钥

```
root@VM-4-4-centos ~#   gpg --list-keys
/root/.gnupg/pubring.gpg
------------------------
pub   2048R/20424507 2022-06-07
uid                  Yi Junquan (software) <2696974822@qq.com>
sub   2048R/AA8CDF2E 2022-06-07
```

第一行显示公钥文件名（pubring.gpg），第二行显示公钥特征（2048位，Hash字符串和生成时间），第三行显示"用户ID"，第四行显示私钥特征。

3.3.2 输出密钥

公钥文件（.gnupg/pubring.gpg）以二进制形式储存，armor参数可以将其转换为ASCII码显示。

```
gpg --armor --output public-key.txt --export 20424507
```

"用户ID"指定哪个用户的公钥，output参数指定输出文件名（public-key.txt）。

类似地，export-secret-keys参数可以转换私钥。

3.3.3 上传公钥

公钥服务器是网络上专门储存用户公钥的服务器。send-keys参数可以将公钥上传到服务器。

```
root@VM-4-4-centos ~# gpg  --keyserver hkp://keyserver.ubuntu.com:80 --send-keys 20424507
gpg: sending key 20424507 to hkp server keyserver.ubuntu.com
```

在服务器上搜索公钥是否上传成功：

```
root@VM-4-4-centos ~# gpg --keyserver hkp://keyserver.ubuntu.com:80 --search-keys 2696974822@qq.com
gpg: searching for "2696974822@qq.com" from hkp server keyserver.ubuntu.com
(1) Yi Junquan (software) <2696974822@qq.com>
      2048 bit RSA key 20424507, created: 2022-06-07
Keys 1-1 of 1 for "2696974822@qq.com".  Enter number(s), N)ext, or Q)uit > q
```

可见上传公钥成功

3.3.4 获取他人公钥

这里我获取的是徐礼祯同学的公钥（我与他以及杨兆瑞同学合作完成该实验）。

```
root@VM-4-4-centos ~# gpg --keyserver hkp://keyserver.ubuntu.com:80 --search-keys Corona09@163.com
gpg: searching for "Corona09@163.com" from hkp server keyserver.ubuntu.com
(1) Corona X <Corona09@163.com>
      2048 bit RSA key C282680C, created: 2022-06-07
Keys 1-1 of 1 for "Corona09@163.com".  Enter number(s), N)ext, or Q)uit > 1
gpg: requesting key C282680C from hkp server keyserver.ubuntu.com
gpg: key C282680C: public key "Corona X <Corona09@163.com>" imported
gpg: Total number processed: 1
gpg:               imported: 1  (RSA: 1)

```

3.4 加密和解密

3.4.1 加密

encrypt参数用于加密。`gpg --recipient [用户ID] --output demo.en.txt --encrypt demo.txt`

recipient参数指定接收者的公钥，output参数指定加密后的文件名，encrypt参数指定源文件。运行上面的命令后，demo.en.txt就是已加密的文件，可以把它发给对方。

```
root@VM-4-4-centos /tmp# gpg --recipient C282680C --output yjqencrypt.txt --encrypt yjqtest.txt
gpg: 160789BF: There is no assurance this key belongs to the named user

pub  2048R/160789BF 2022-06-07 Corona X <Corona09@163.com>
 Primary key fingerprint: DC1B 2EBA D490 E664 F333  C433 77A6 5B9B C282 680C
      Subkey fingerprint: 6F25 A88F 9602 D8EE BE3E  5425 59E7 8A88 1607 89BF

It is NOT certain that the key belongs to the person named
in the user ID.  If you *really* know what you are doing,
you may answer the next question with yes.

Use this key anyway? (y/N) y

```

源文件和加密后的文件内容如下：

```
root@VM-4-4-centos /tmp# cat yjqtest.txt
美哉吾校，真理之花，青年之模楷，邦国之荣华，
校旗飘扬，与日俱长，为世界之光，为世界之光。
美哉吾校，鼓舞群伦，启发我睿智，激励我热忱，
英俊济跄，经营四方，为世界之光，为世界之光。
美哉吾校，性灵泉源，科学之奥府，艺术之林园，
实业扩张，进步无疆，为世界之光，为世界之光。
美哉吾校，灿烂文明，实学培国本，民族得中兴，
宇土茫茫，山高水长，为世界之光，为世界之光。
root@VM-4-4-centos /tmp# cat yjqencrypt.txt

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   ¶°
¹´`¢
    $«□0G8S?|5« Ⓐ₀Vv•⏎
```
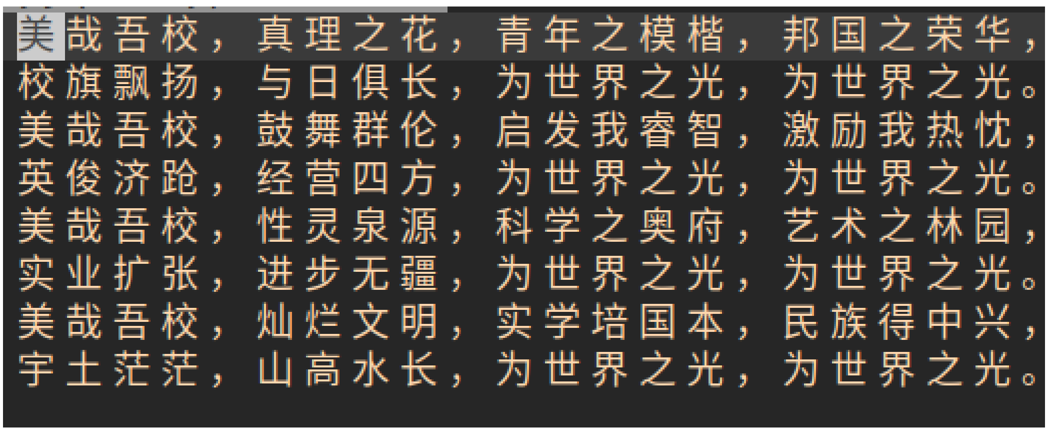

3.4.2 解密

由徐礼祯同学解密后得到


美哉吾校，真理之花，青年之模楷，邦国之荣华，
校旗飘扬，与日俱长，为世界之光，为世界之光。
美哉吾校，鼓舞群伦，启发我睿智，激励我热忱，
英俊济跄，经营四方，为世界之光，为世界之光。
美哉吾校，性灵泉源，科学之奥府，艺术之林园，
实业扩张，进步无疆，为世界之光，为世界之光。
美哉吾校，灿烂文明，实学培国本，民族得中兴，
宇土茫茫，山高水长，为世界之光，为世界之光。

同时我使用`gpg --decrypt mod.en.txt`解密徐礼祯同学发来的文件。

```
root@VM-4-4-centos /tmp# gpg --decrypt mod.en.txt
```

```
2
3  You need a passphrase to unlock the secret key for
4  user: "Yi Junquan (software) <2696974822@qq.com>"
5  2048-bit RSA key, ID AA8CDF2E, created 2022-06-07 (main key ID 20424507)
6
7  gpg: encrypted with 2048-bit RSA key, ID AA8CDF2E, created 2022-06-07
8        "Yi Junquan (software) <2696974822@qq.com>"
9  泉佬我榜，西交希望；软院代表，世界之光.
10 __   __  _  ___     _____ ___  _
11 \ \ / / | |/ _ \  |_   _/ _ \| |
12  \ V /  | | | | |   | || | | | |
13   | | |_| | |_| |   | || |_| | |___
14   |_|\___/ \__\_\   |_| \__\_\_____|
```

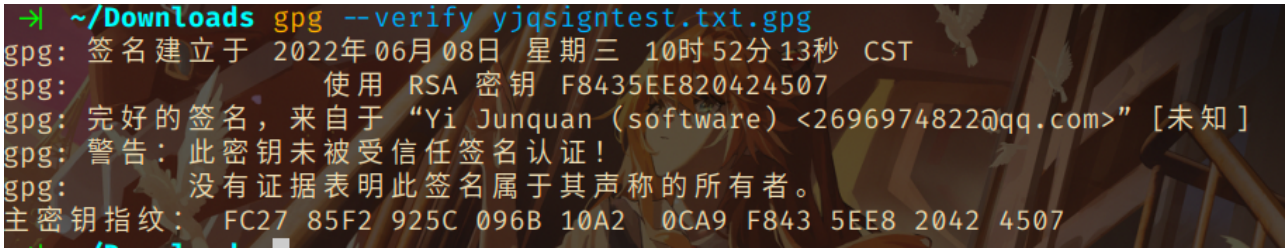
3.5 签名

3.5.1 签名

```
1  root@VM-4-4-centos /tmp# vim yjqsigntest.txt
2  root@VM-4-4-centos /tmp# gpg --sign yjqsigntest.txt
3
4  You need a passphrase to unlock the secret key for
5  user: "Yi Junquan (software) <2696974822@qq.com>"
6  2048-bit RSA key, ID 20424507, created 2022-06-07
7
```

3.5.2 验证签名

由徐礼祯同学验证签名得到：



3.5.3 签名+加密

`gpg --local-user [发信者ID] --recipient [接收者ID] --armor --sign --encrypt demo.txt`

local-user参数指定用发信者的私钥签名，recipient参数指定用接收者的公钥加密，armor参数表示采用ASCII码形式显示，sign参数表示需要签名，encrypt参数表示指定源文件。

```
1  root@VM-4-4-centos /tmp#  gpg --local-user 20424507  --recipient  C282680C --armor --sign --encrypt yjqsignencrypt.txt
2
3  You need a passphrase to unlock the secret key for
4  user: "Yi Junquan (software) <2696974822@qq.com>"
```

```
2048-bit RSA key, ID 20424507, created 2022-06-07

gpg: 160789BF: There is no assurance this key belongs to the named user

pub  2048R/160789BF 2022-06-07 Corona X <Corona09@163.com>
 Primary key fingerprint: DC1B 2EBA D490 E664 F333  C433 77A6 5B9B C282 680C
      Subkey fingerprint: 6F25 A88F 9602 D8EE BE3E  5425 59E7 8A88 1607 89BF

It is NOT certain that the key belongs to the person named
in the user ID.  If you *really* know what you are doing,
you may answer the next question with yes.

Use this key anyway? (y/N) y
```

4 实验结果

成功完成密钥的生成，公钥的公布，利用pgp保护数据并传输，验证签名等工作。