Lab 5: Diffie-Hellman, Public Key, Private Key and Hashing

Part 1 Demo: http://youtu.be/3n2TMpHqE18

1 Diffie-Hellman

No	Description	Result
1	Bob and Alice have agreed on the values: g=2,879, N= 9,929 Bob Select b=6, Alice selects a=9	Now calculate (using the Kali calculator): Bob's B value (g^x mod N): Alice's A value (g^y mod N):
2	Now they exchange the values. Next calculate the shared key:	Bob's value (A^b mod N): Alice's value (B^a mod N): Do they match? [Yes] [No]
3	If you are in the lab, select someone to share a value with. Next agree on two numbers (g and N). You should pick a random number, and so should they. Do not tell them what your random number is. Next calculate your public value, and get them to do the same. Next exchange values.	Numbers for g and N: Your private value: Your public value: The public value you received: Shared key: Do they match: [Yes] [No]

2 Symmetric Key

No	Description	Result
1	Log into vSoC 2, and select your Kali host on the DMZ or public network.	What is your IP address?

2	Use:
	
	`openssl list -cipher-commands`
	
	`openssl version`
		Outline five encryption methods that are supported:
		
		Outline the version of OpenSSL:

3	Using openssl and the command in the form: `openssl prime –hex 1111`	Check if the following are prime numbers: 42 [Yes][No] 1421 [Yes][No]
4	Now create a file named myfile.txt (either use Notepad or another editor). Next encrypt with aes-256-cbc `openssl enc -aes-256-cbc -in myfile.txt -out encrypted.bin` and enter your password.	Use following command to view the output file: `cat encrypted.bin` Is it easy to write out or transmit the output: [Yes][No]
5	Now repeat the previous command and add the –base64 option. `openssl enc -aes-256-cbc -in myfile.txt -out encrypted.bin –base64`	Use following command to view the output file: `cat encrypted.bin` Is it easy to write out or transmit the output: [Yes][No]

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>6</td><td>Now repeat the previous command and observe the encrypted output.

<code>openssl enc -aes-256-cbc -in myfile.txt -out encrypted.bin -base64</code></td><td>Has the output changed from the run in 4? [Yes][No]

Why has it changed?</td></tr>
<tr><td>7</td><td>Now let’s decrypt the encrypted file with the correct format:

<code>openssl enc -d -aes-256-cbc -in encrypted.bin -pass pass:napier -base64</code></td><td>Has the output been decrypted correctly?

What happens when you use the wrong password?</td></tr>
<tr><td>8</td><td>If you are working in the lab, now give your secret passphrase to your neighbour, and get them to encrypt a secret message for you.

To receive a file, you listen on a given port (such as Port 1234)

<code>nc -l -p 1234 > enc.bin</code>

And then send to a given IP address with:

<code>nc -w 3 [IP] 1234 < enc.bin</code></td><td>Did you manage to decrypt their message? [Yes][No]</td></tr>
<tr><td>9</td><td>With OpenSSL, we can define a fixed salt value that has been used in the cipher process. For example, in Linux:

<code>echo -n "Hello" | openssl enc -aes-128-cbc -pass pass:"london" -e -base64 -S 241fa86763b85341</code>
<code>Ulq+o+vs5mvAc3GUIKt8hA==</code>

<code>echo Ulq+o+vs5mvAc3GUIKt8hA== | openssl enc -aes-128-cbc -pass pass:"london" -d -base64 -S 241fa86763b85341</code></td><td>[qwerty]
[inkwell]
[london]
[paris]
[cake]</td></tr>
</table>

	`Hello` For a cipher text for **256-bit AES CBC** and a message of "Hello" with a salt value of "`241fa86763b85341`", try the following passwords, and determine the password used for a ciphertext of "`PxonB24+a9f3U/KmlB+/KA==`":	
10	Now, use the decryption method to prove that you can decrypt the ciphertext. `echo PxonB24+a9f3U/KmlB+/KA== | openssl enc -aes-256-cbc -pass pass:"`*`password`*`" -d  -base64 -S 241fa86763b85341`	

11	Investigate the following commands by running them several times:
	
	`echo -n "Hello" | openssl enc -aes-128-cbc -pass pass:"london" -e -base64 -S 241fa86763b85341`
	
	`echo -n "Hello" | openssl enc -aes-128-cbc -pass pass:"london" -e -base64 -salt`
		What do you observe?
		
		Why do you think causes this (ask your tutor if you want some detail)?

3 Public Key

No	Description	Result
1	With RSA, we have a public modulus (and which is N=p.q, and where p and q are prime numbers). To create this, we need to generate a key pair with: `openssl genrsa -out private.pem 1024` This file contains both the public and the private key.	What is the type of public key method used: How long is the default key: How long are the prime numbers that are used to generate the public key?

2	Use following command to view the output file: `cat private.pem`	What can be observed at the start and end of the file:
3	Next we view the RSA key pair: `openssl rsa -in private.pem -text -noout` You should now see the public exponent (e), the private exponent (d), the two prime numbers (p and q), and the public modulus (N).	Which number format is used to display the information on the attributes: Which are the elements of the key shown: Which are the elements of the public key? Which are the elements of the private key? What does the –noout option do?
4	Let's now secure the encrypted key with 3-DES: `openssl rsa -in private.pem -des3 -out key3des.pem` You should NEVER share your private key.	
5	Next, we will export the public key: `openssl rsa -in private.pem -out public.pem -outform PEM -pubout`	View the output public key. What does the header and footer of the file identify? Is the public key smaller in size than the private key? [<u>Yes</u>/No]

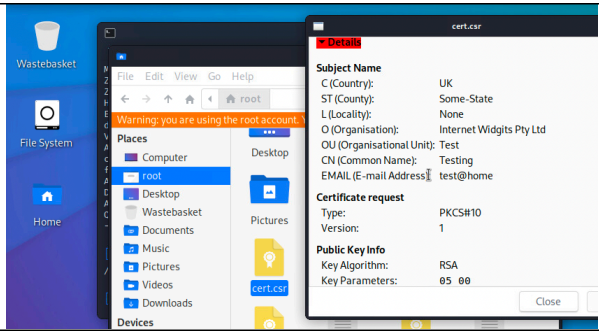
6	Now we will encrypt with our public key: `openssl rsautl -encrypt -inkey public.pem -pubin -in myfile.txt -out file.bin`	
7	And then decrypt with our private key: `openssl rsautl -decrypt -inkey private.pem -in file.bin -out decrypted.txt`	What are the contents of decrypted.txt:
8	If you are working in the lab, now give your public key to your neighbour, and get them to encrypt a secret message for you.	Did you manage to decrypt their message? [Yes][No]

4 Storing keys

We have stored our keys on a key ring file (PEM). Normally we would use a digital certificate to distribute our public key. In this part of the tutorial we will create a crt digital certificate file.

No	Description	Result
1	Next create the crt file with the following: `openssl req -new -key private.pem -out cert.csr`	View the CRT file by double clicking on it from the File Explorer. Using Google to search, what is PKCS#10, and which is it used for? What is the type of public key method used: What is the public key size (in bits): [512][1024][2048]

<table>
<tr><td></td><td>



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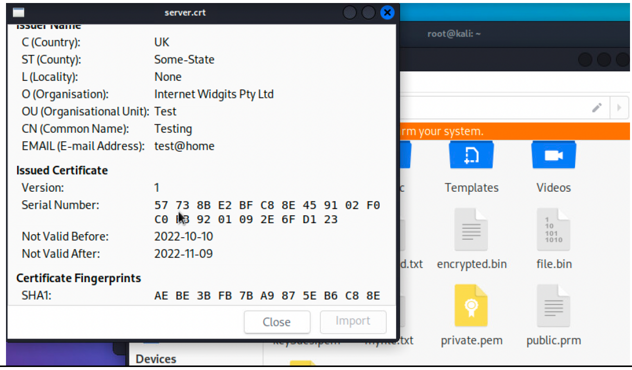
We can now take the code signing request, and create a certificate. For this we sign the certificate with a private key, in order to validate it:

```
openssl x509 -req -in cert.csr -signkey private.pem -out server.crt
```



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From the File System, click on the newly created certificate file (server.crt) and determine:

The size of the public key (in bits): [512][1024][2048]

The public key encryption method:

Which is the hashing method that has been signed to sign the certificate: [MD5][SHA-1][SHA-256]

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</table>

5 Hashing

http://youtu.be/Xvbk2nSzEPk

The current Hashcat version has problems with a lack of memory. To overcome this, install Hashcat 6.0.0. On Kali on your public network, first download Hashcat 6.0.0:

Download: `https://hashcat.net/files/hashcat-6.0.0.7z`

Next unzip it into your home folder. Then from your home folder, setup a link to Hashcat 6.0.0:

```
# ln -s hashcat hashcat-6.0.0/hashcat.bin
```

and then run Hashcat put "./" in from of the program name, such as:

```
# ./hashcat –version
v6.0.0
```

No	Description	Result

1	Using:
	
	`http://asecuritysite.com/encryption/md5`
	
	Match the hash signatures with their words ("Falkirk", "Edinburgh", "Glasgow" and "Stirling").
	
	`03CF54D8CE19777B12732B8C50B3B66F`
	`D586293D554981ED611AB7B01316D2D5`
	`48E935332AADEC763F2C82CDB4601A25`
	`EE19033300A54DF2FA41DB9881B4B723`
		`03CF5:` Is it [Falkirk][Edinburgh][Glasgow][Stirling]?
		
		`D5862:` Is it [Falkirk][Edinburgh][Glasgow][Stirling]?
		
		`48E93:` Is it [Falkirk][Edinburgh][Glasgow][Stirling]?
		
		`EE190:` Is it [Falkirk][Edinburgh][Glasgow][Stirling]?

2	Using: `http://asecuritysite.com/encryption/md5` Determine the number of hex characters in the following hash signatures.	MD5 hex chars: SHA-1 hex chars: SHA-256 hex chars:

		How does the number of hex characters relate to the length of the hash signature:

3	On Kali, for the following /etc/shadow file, determine the matching password:
	
	`bill:$apr1$waZS/8Tm$jDZmiZBct/c2hysERcZ3m1`
	`mike:$apr1$mKfrJquI$Kx0CL9krmqhCu0SHKqp5Q0`
	`fred:$apr1$Jbe/hCIb$/k3A4kjpJyC06BUUaPRKs0`
	`ian:$apr1$0GyPhsLi$jTTzW0HNS4Cl5ZEoyFLjB.`
	`jane: $1$rqOIRBBN$R2pOQH9egTTVN1Nlst2U7.`
		The passwords are password, napier, inkwell and Ankle123.
		[Hint: openssl passwd -apr1 -salt ZaZS/8TF napier]
		
		Bill's password:
		
		Mike's password:
		
		Fred's password:
		
		Ian's password:
		
		Jane's password:

4	On Kali, download the following:
	
	`http://asecuritysite.com/files02.zip`
	
	and the files should have the following MD5 signatures:
	
	`MD5(1.txt)= 5d41402abc4b2a76b9719d911017c592`
	`MD5(2.txt)= 69faab6268350295550de7d587bc323d`
	`MD5(3.txt)= fea0f1f6fede90bd0a925b4194deac11`
	`MD5(4.txt)= d89b56f81cd7b82856231e662429bcf2`
		Which file(s) have been modified:

5	From Kali, download the following ZIP file: `http://asecuritysite.com/letters.zip`	View the letters. Are they different? Now determine the MD5 signature for them. What can you observe from the result?

6 Hashing Cracking (MD5)

http://youtu.be/Xvbk2nSzEPk

No	Description	Result

1	On Kali, next create a words file (**words**) with the words of "napier", "password" "Ankle123" and "inkwell"
	
	Using hashcat crack the following MD5 signatures (hash1):
	`232DD5D7274E0D662F36C575A3BD634C`
	`5F4DCC3B5AA765D61D8327DEB882CF99`
	`6D5875265D1979BDAD1C8A8F383C5FF5`
	`04013F78ACCFEC9B673005FC6F20698D`
	
	Command used: `hashcat -m 0 hash1 words`
		`232DD...634C` Is it [napier][password][Ankle123][inkwell]?
		
		`5F4DC...CF99` Is it [napier][password][Ankle123][inkwell]?
		
		`6D587...5FF5` Is it [napier][password][Ankle123][inkwell]?
		
		`04013...698D` Is it [napier][password][Ankle123][inkwell]?

2	Using the method used in the first part of this tutorial, find crack the following for names of fruits (the fruits are all in lowercase):
	
	`FE01D67A002DFA0F3AC084298142ECCD`
	`1F3870BE274F6C49B3E31A0C6728957F`
	`72B302BF297A228A75730123EFEF7C41`
	`8893DC16B1B2534BAB7B03727145A2BB`
	`889560D93572D538078CE1578567B91A`
		`FE01D:`
		
		`1F387:`
		
		`72B30:`
		
		`8893D:`
		
		`88956:`

7 Hashing Cracking (LM Hash/Windows)

All of the passwords in this section are in lowercase. http://youtu.be/Xvbk2nSzEPk

No	Description	Result

1	On Kali, and using John the Ripper, and using a word list with the names of fruits, crack the following pwdump passwords:
	
	`fred:500:E79E56A8E5C6F8FEAAD3B435B51404EE:5EBE7DFA074DA8EE8AEF1FAA2BBDE876:::`
	`bert:501:10EAF413723CBB15AAD3B435B51404EE:CA8E025E9893E8CE3D2CBF847FC56814:::`
		Fred:
		Bert:

2	On Kali, and using John the Ripper, the following pwdump passwords (they are names of major Scottish cities/towns):
	
	`Admin:500:629E2BA1C0338CE0AAD3B435B51404EE:9408CB400B20ABA3DFEC054D2B6EE5A1:::`
	`fred:501:33E58ABB4D723E5EE72C57EF50F76A05:4DFC4E7AA65D71FD4E06D061871C05F2:::`
	`bert:502:BC2B6A869601E4D9AAD3B435B51404EE:2D8947D98F0B09A88DC9FCD6E546A711:::`
		Admin:
		Fred:
		Bert:

3	On Kali, and using John the Ripper, crack the following pwdump passwords (they are the names of animals):
	
	`fred:500:5A8BB08EFF0D416AAAD3B435B51404EE:85A2ED1CA59D0479B1E3406972AB1928:::`
	`bert:501:C6E4266FEBEBD6A8AAD3B435B51404EE:0B9957E8BED733E0350C703AC1CDA822:::`
	`admin:502:333CB006680FAF0A417EAF50CFAC29C3:D2EDBC29463C40E7629711942 1D2A707:::`.replace
		Fred:
		Bert:
		Admin:

8 Python tutorial

In Python, we can use the Hazmat (Hazardous Materials) library to implement symmetric key encryption.

Web link (Cipher code): http://asecuritysite.com/cipher01.zip

The code should be:

```
from cryptography.hazmat.primitives.ciphers import Cipher, algorithms, modes
from cryptography.hazmat.primitives import padding
from cryptography.hazmat.backends import default_backend

import hashlib
import sys
import binascii
```

```
val='hello'
password='hello123'

plaintext=val

def encrypt(plaintext,key, mode):
    method=algorithms.AES(key)
    cipher = Cipher(method,mode, default_backend())
    encryptor = cipher.encryptor()
    ct = encryptor.update(plaintext) + encryptor.finalize()
    return(ct)

def decrypt(ciphertext,key, mode):
    method=algorithms.AES(key)
    cipher = Cipher(method, mode, default_backend())
    decryptor = cipher.decryptor()
    pl = decryptor.update(ciphertext) + decryptor.finalize()
    return(pl)

def pad(data,size=128):
    padder = padding.PKCS7(size).padder()
    padded_data = padder.update(data)
    padded_data += padder.finalize()
    return(padded_data)

def unpad(data,size=128):
    padder = padding.PKCS7(size).unpadder()
    unpadded_data = padder.update(data)
    unpadded_data += padder.finalize()
    return(unpadded_data)

key = hashlib.sha256(password.encode()).digest()

print("Before padding: ",plaintext)

plaintext=pad(plaintext.encode())

print("After padding (CMS): ",binascii.hexlify(bytearray(plaintext)))

ciphertext = encrypt(plaintext,key,modes.ECB())
print("Cipher (ECB): ",binascii.hexlify(bytearray(ciphertext)))

plaintext = decrypt(ciphertext,key,modes.ECB())
```

```
plaintext = unpad(plaintext)
print("  decrypt: ",plaintext.decode())
```

How is the encryption key generate?

Which is the size of the key used? [<u>128-bit</u>][256-bit]

Which is the encryption mode used? [<u>ECB</u>][CBC][OFB]

Now update the code so that you can enter a string and the program will show the cipher text. The format will be something like:

```
python cipher01.py hello mykey
```

where "hello" is the plain text, and "mykey" is the key. A possible integration is:

```
import sys

if (len(sys.argv)>1):
        val=sys.argv[1]

if (len(sys.argv)>2):
        password=sys.argv[2]
```

Now determine the cipher text for the following (the first example has already been completed):

Message	Key	CMS Cipher
"hello"	"hello123"	0a7ec77951291795bac6690c9e7f4c0d
"inkwell"	"orange"	
"security"	"qwerty"	
"Africa"	"changeme"	

Finally, change the program so that it does 256-bit AES with CBC mode.