Using hashing to confirm a file download

The site dftt.sourceforge.net is the Digital Forensics Tool Testing image repository. This site contains 14 forensic images that can be used to test forensic analysis tools. These images are also useful in practicing and developing skills in using forensic tools and techniques before working on actual crime scene collected evidence. This is just one of many similar repositories of forensic image testing files.

Digital Forensics Tool Testing Images

Testing in the public view is an important part of increasing confidence in software and hardware tools. Developing extensive and exhaustive tests for digital investigation tools is a lengthy and complex process, which the Computer Forensic Tool Testing (CFTT) group at NIST has taken on.

To fill the gap between extensive tests from NIST and no public tests, I have been developing small test cases. The following are file system and disk images for testing digital (computer) forensic analysis and acquisition tools. They were submitted to the Computer Forensic Tool Testing (CFTT) e-mail list on Yahoo! Groups. The results can be found in the CFTT list archives and in the Test Report Tracker.

Test Images:

1. Extended Partition Test (July '03)
2. FAT Keyword Search Test (Aug '03)
3. NTFS Keyword Search Test #1 (Oct '03)
4. EXT3FS Keyword Search Test #1 (Nov '03)
5. FAT Daylight Savings Test (Jan '04)
6. FAT Undelete Test #1 (Feb '04)
7. NTFS Undelete (and leap year) Test #1 (Feb '04)
8. JPEG Search Test #1 (Jun '04)
9. FAT Volume Label Test #1 (Aug '04)
10. NTFS Autodetect Test #1 (Jan '05)
11. Basic Data Carving Test #1 (Mar '05) (by Nick Mikus)
12. Basic Data Carving Test #2 (Mar '05) (by Nick Mikus)
13. Windows Memory Analysis #1 (Jan '06) (by Jesse Kornblum)
14. ISO9660 Interpretation Test #1 (Aug '10)

Test Results:

- Submission and Posting Requirements
- Report Tracker

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Last Updated: August 11, 2010

EXT3FS Keyword Search #1 -Digital Forensics Tool Testing Image (#4)

http://dftt.sourceforge.net

Introduction

This test image is an EXT3FS file system with several ASCII strings. There are only 4 strings to search for, so this one is quite simple and short. It only tests the basic features of EXT3FS.

Download

This test image is a 'raw' partition image (i.e. 'dd') of an EXT3FS file system. The file system is 5MB and is compressed to 4MB. The MD5 of the image is `30e7f792cc853e34e17335b243605d3a`. This image is released under the GPL, so anyone can use it.

- zip

Search Terms

These should all be performed case sensitive and not as regular expressions. Results Form

Num	String	Sector - Offset	Fragment - Offset	File	Note
1	first	330 - 100	165 - 100	`/, /., /.., /lost+found/..`	File Name
	first	392 - 100	196 - 100	inode #8	Journal entry
	first	432 - 100	216 - 100	inode #8	Journal entry
	first	2416 - 181	1208 - 181	`/file1`	Allocated file
2	second	2419 - 509	1209 - 1021	`/file2`	Fragmented String
3	third	2420 - 80	1210 - 80	`/file3` (deleted)	Unallocated file
4	slacker	2417 - 179	1208 - 691	`/file1`	Slack space of `file1`

Author

Brian Carrier (carrier at cerias.purdue.edu) created the test cases and the test image. This test was released on November 24, 2003.

Disclaimers

Neither Purdue University or CERIAS sponsor this work.

These tests are not a complete test suite. These were the first ones that I thought of and no formal theory was put into their design.

Passing these tests provides no guarantees about a tool. Always use additional test cases (and email them to me so we can all benefit!).

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ls /media/cdrom0 (To view the contents of the DVD Drive)

cp /media/cdrom0/* /root/Downloads/ (To copy the forensic test image files to the /root/Download directory)

cd /root/Downloads (to change into the directory.)

ls -l

to view the contents and verify that the 4-kwsrch-ext3.zip file is present and is the size of 3954200 bytes.

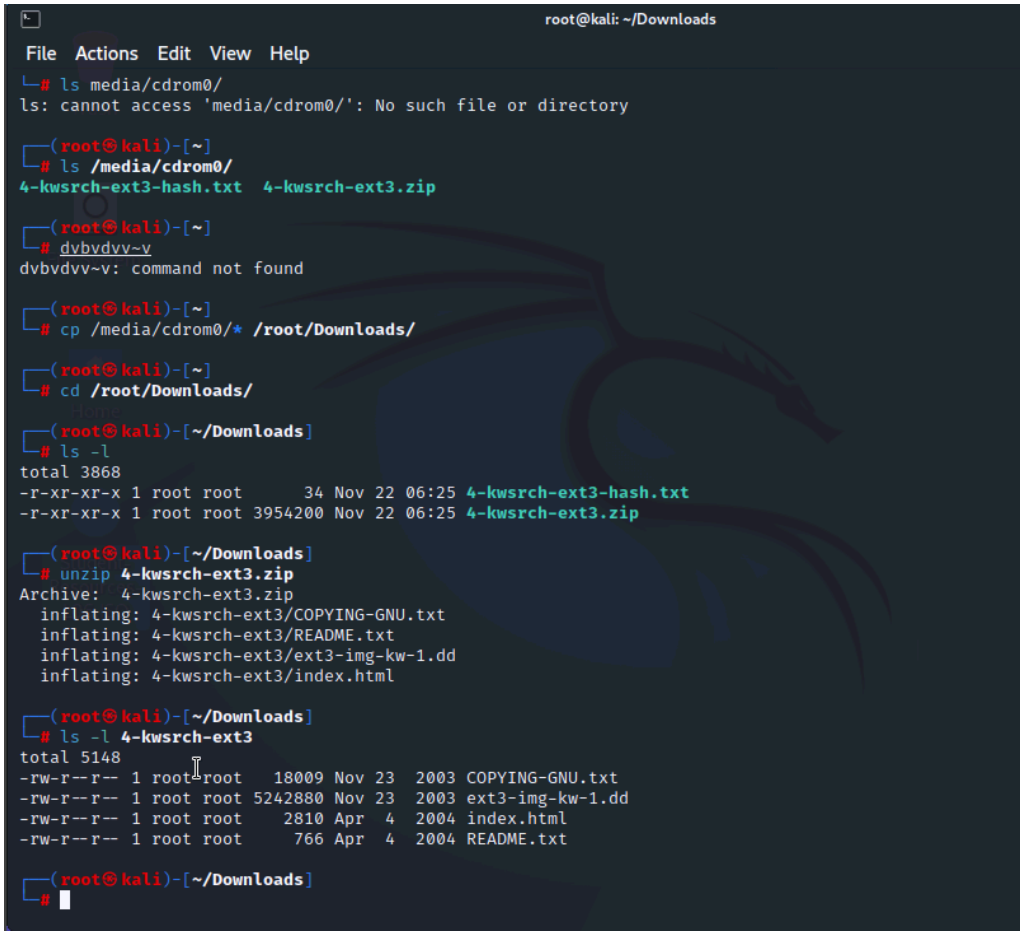
unzip 4-kwsrch-ext3.zip

to extract the contents of the zip archive into its default subdirectories.

ls -l 4-kwsrch-ext3

to view the contents of the new subdirectories.

There should be four files. One of them is ext3-img-kw-1.dd, which should be 5242880 bytes in size.



Most binary numbers are converted to hex when presented on the screen.

This is convenient as it uses 1/4 the number of characters to represent the same value.

This is because four digits in binary can be used to represent the decimal values of 0 when all the bits are zero through 15 when all the bits are ones.

These are the same ranges of values for a single hex character (i.e., 0-9 & A-F (10-15)).

With that information, you can count up the number of hex characters in a hash, then multiply by four (4) to determine the hash length.

Then, by knowing the hash length, you can make a reasonable guess as to the hashing algorithm used. Here is a brief chart of common hashing algorithms:

Algorithm	Bit length	Hex length
MD5	128	32
SHA-1	160	40
SHA-224	224	56
SHA-256	256	64
SHA-384	384	96
SHA-512	512	128

What is the bit length of an MD5 hash?
160
128
64
32
256
In the Terminal window, enter **ls -l** to view the contents of the extracted files.

cat 4-kwsrch-ext3-hash.txt.

This file contains the hash of the ext3-img-kw-1.dd drive image file.

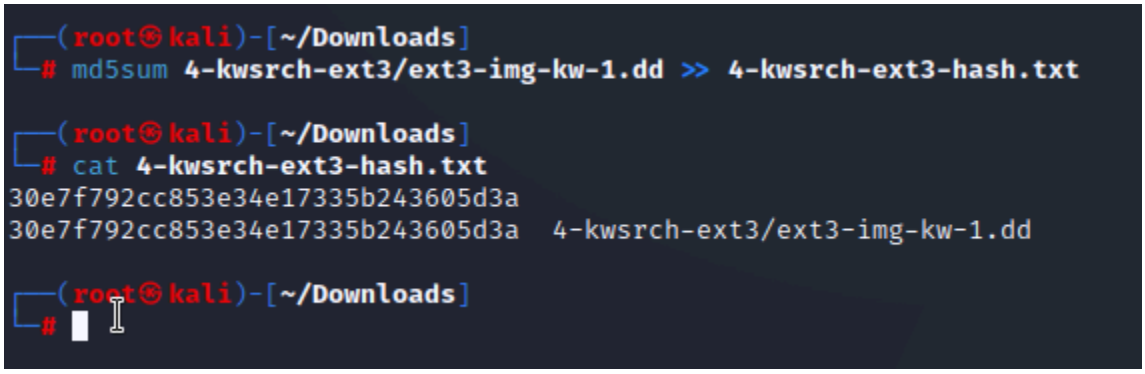
It was copied directly from dftt.sourceforge.net. This should be the same hash value you viewed on the website for the drive image file.

Enter the following:

md5sum 4-kwsrch-ext3/ext3-img-kw-1.dd >> 4-kwsrch-ext3-hash.txt

This command hashes the file and adds that hash to expected hash file.

cat 4-kwsrch-ext3-hash.txt



The first hash was copied directly from dftt.sourceforge.net for the ext3-img-kw-1.dd file.

The second hash was added by hashing the file obtained from the DVD/ISO resource.

Compare the two hashes to verify that they match.

Since the two hashes match exactly, you have verified the file's integrity. The file offered by the website is the file present on the Kali system.

The use of MD5 hash has been deprecated. This means it is no longer the preferred or recommended hashing algorithm to use to verify integrity. It is often better to use SHA-256, SHA-512, or even SHA-1. However, many sites and services still use MD5 in spite of this. So, you have to check the integrity of the files you download using whatever hashing algorithm the site uses. The process performed in this exercise would be the same. You need to switch to the hashing utility for the specific hashing algorithm needed, such as sha1sum, sha256sum, or sha512sum.

Older hashing algorithms are not necessarily broken or compromised, but they are more prone to **collisions**. A collision is when two different datasets produce the same hash value (when hashed by the same hashing algorithm). This is a known aspect of hashing due to the fact that hash algorithms accept nearly infinite inputs to produce a hash of a fixed length. *Generally, algorithms that produce a shorter hash value output are more prone to collisions than those with longer hash value outputs*.

You have now used hash matching to confirm the integrity of a download file.

This same process can be used to verify the integrity of any file from any source as long as you know the correct/expected hash and the hashing algorithm used to calculate that hash.

Use the MetaDefender to evaluate files

You have discovered a file that you are concerned about on a client workstation. The user claims not to know anything about the file. You think that it could be a hacker tool and possibly malicious, but you want to confirm that before initiating a system wipe and rebuild. You decide to perform an initial evaluation of the file via hash identification. In this exercise, you will perform suspicious file analysis through an online evaluation service.

Connect to the KALI virtual machine and sign in as root using Pa$$w0rd as the password.

Open a Terminal window and then maximize the Terminal window.

Enter cd /usr/share/windows-resources/binaries to change into the folder where the suspicious file is located.

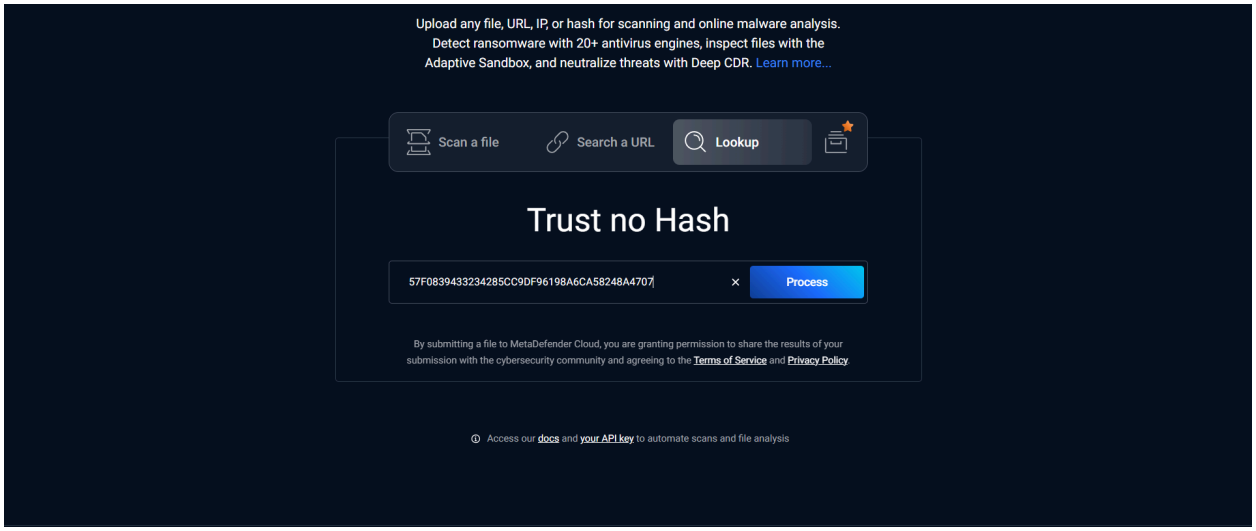
Enter ls -l to view a long listing of the contents of the directory.

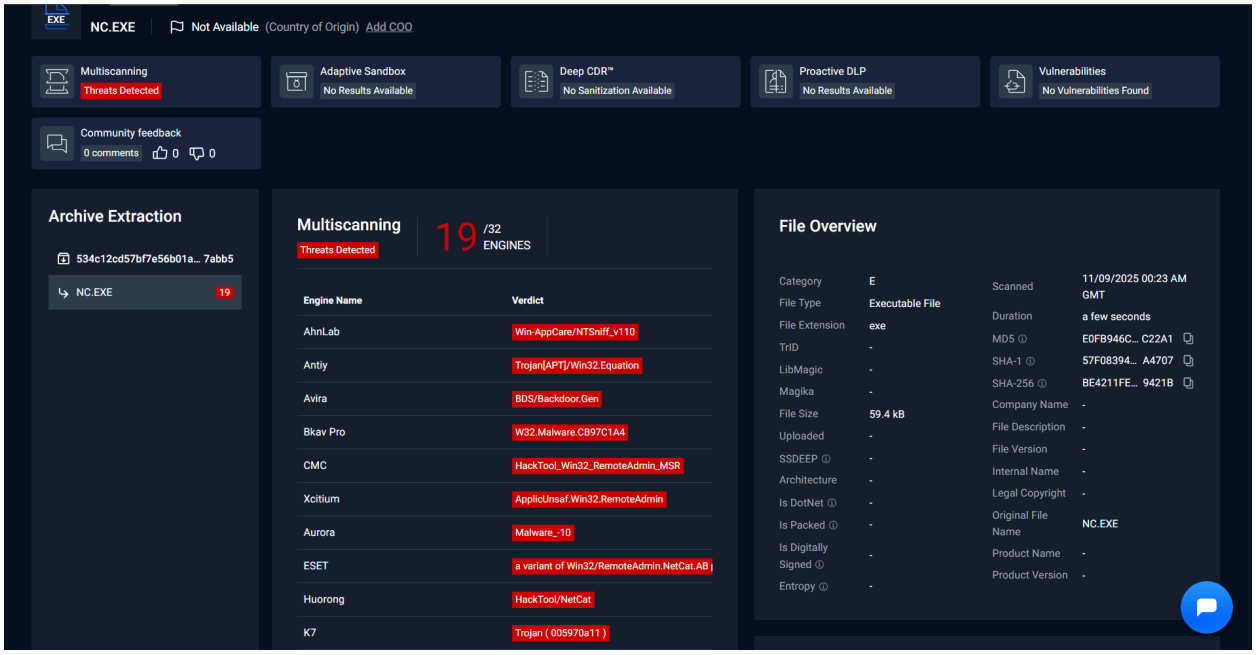
The file of concern is nc.exe.

Create a SHA1 hash value from the file by entering: sha1sum nc.exe.

sha1sum [filename]

Result should be: 57F0839433234285CC9DF96198A6CA58248A4707





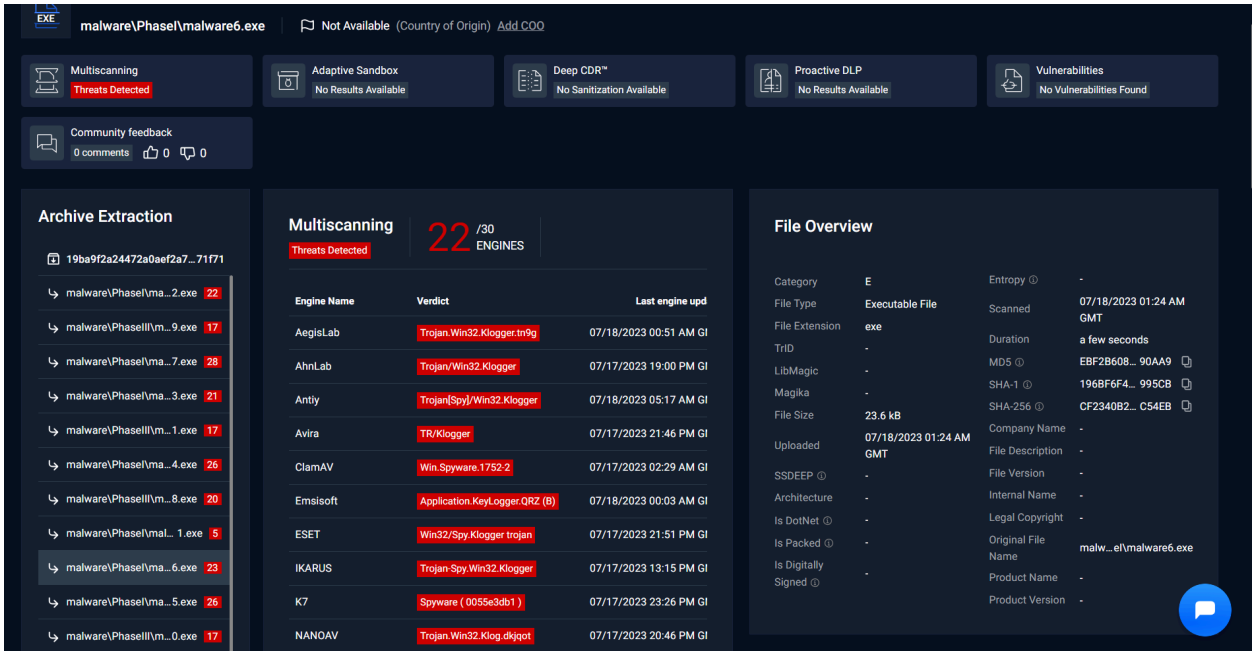
The results page should indicate that this hash is related to the nc.exe file.

Also notice that some, but not all, scanning engines detected something concerning about the file. Based on this information, you could make a decision on whether this suspicious file is malicious, a **potentially unwanted program (PUP)**, or benign.

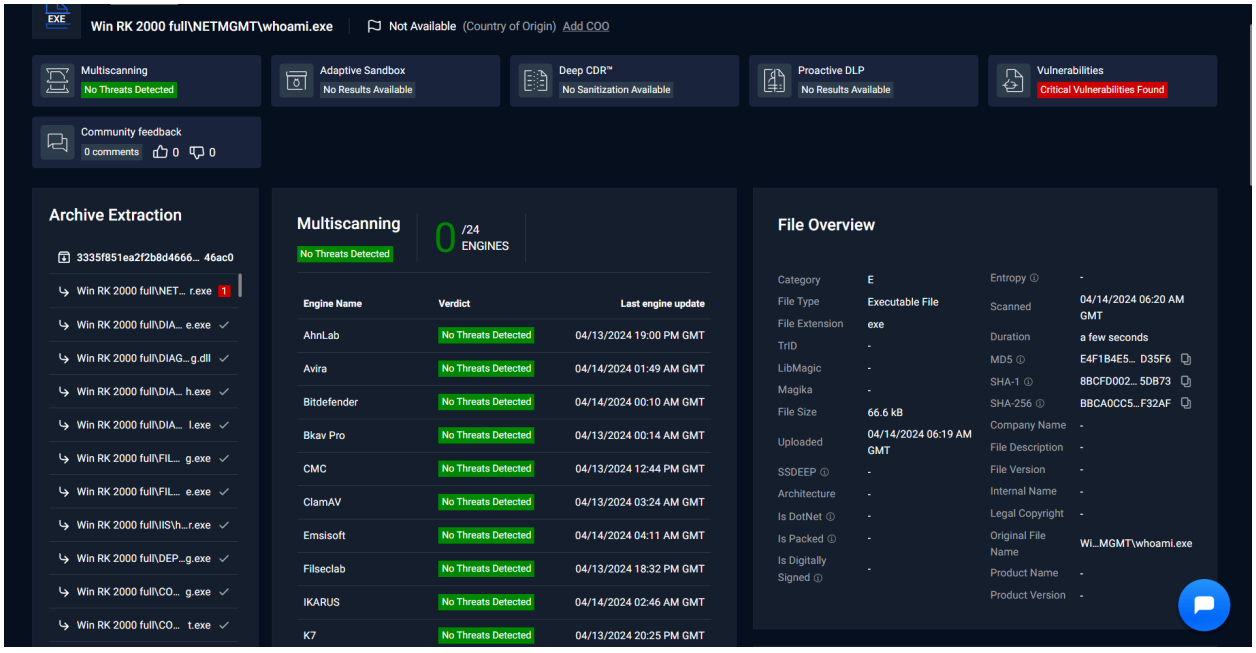
Just because an analysis engine lists a file as a threat does not actually mean it is malicious code. It is possible that the file is an administrative utility or even a hacker tool that could be used for malicious purposes, but is not inherently malicious. For example, a network sniffer is a useful tool, but not something you would want your typical user to have on their system. The same is true for keystroke loggers and password crackers. Not all analysis engines include PUPs in their detection databases.

Perform additional searches for other files. You can use file names or hashes from your own system, or you can return to the Kali VM and obtain file names and hashes from there.

For example, you could search for information on the klogger.exe file using the SHA1 hash of: 196BF6F43F85F97CC2851C840DA8E451256995CB.



Sha1 sum performed on whoami.exe (hash was 8bcfd002d484fda03a0e95c66d80e0c64f65db73)



Explore salting

Salting is *a means to improve the strength of hashing as a defense against brute force password cracking attacks*. The salting process is performed automatically by some OSes, such as Linux. In this exercise, you will view the existence of salts for existing user accounts. Next, you will create password hashes both with and without salting. Finally, you will crack the non-salted password quickly, and then you will see how salted password cracking takes significantly more time.

Connect to the KALI virtual machine and, if needed, sign in as root using Pa$$w0rd as the password.

A Terminal window should already be open.

Enter **cd ~**.

This command returns you to the root user's home directory (i.e., /root).

Enter grep **'\$' /etc/shadow**.

This command displays the entry lines for only those accounts which have a stored password hash.

Modern Linux systems salt password hashes by default. The most common default hashing scheme of Linux is **yescrypt**. **This is confirmed in the output by the "y " between the first two dollar signs**. **The "j9T " value between the second and third dollar signs are parameters used during the hashing process**. **The value between the third and fourth dollar signs is the salt used when producing the hash**. Then, the value after the fourth dollar sign (until the colon) is the salted password hash.

I. Since hashes produced by the yescrypt algorithm are extremely difficult to crack, generate your own password hashes to crack. Enter:

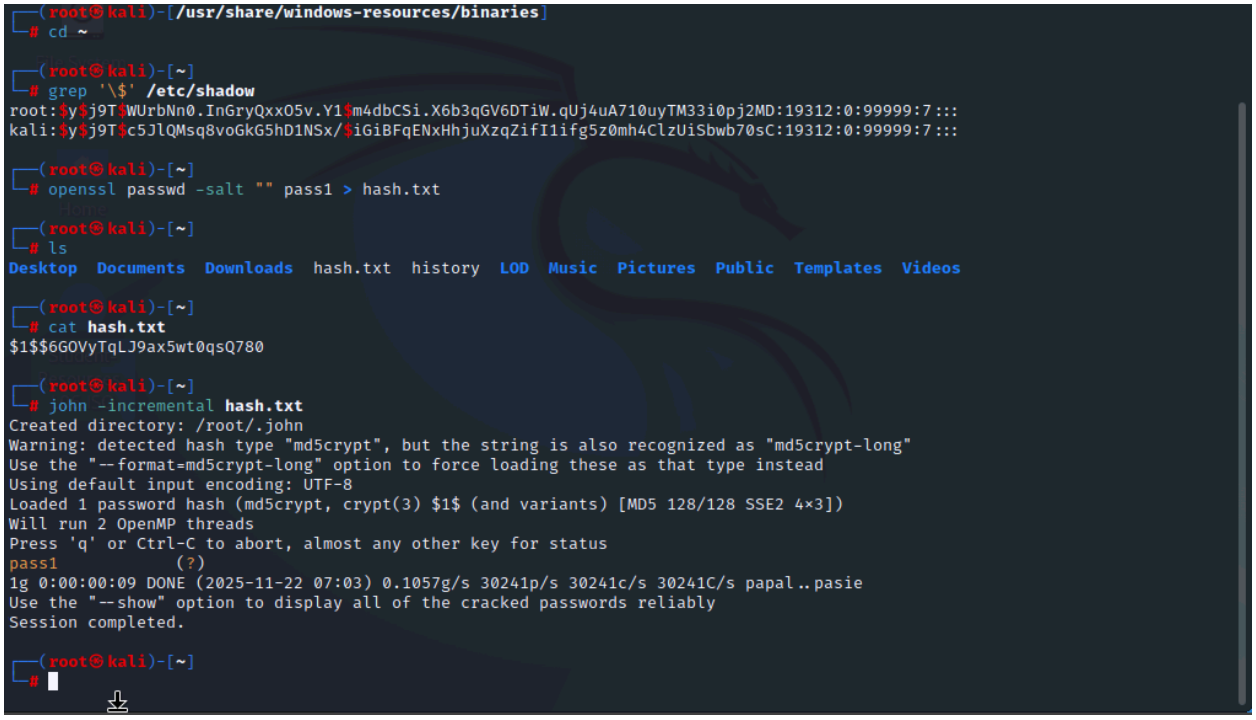
openssl passwd -salt "" pass1 > hash.txt

This command will generate an MD5 hash of the password pass1 *without using salting* and save it in the hash.txt file.

Enter **cat hash.txt** to view the contents of the file.

Notice that there is no value between the second and third dollar signs. This indicates the password hash is not salted.

The openssl tool generates MD5 hashes by default. This is encoded in the hash output by the 1 value between the first two dollar signs. There are other password hash options available by using parameters. For example **-5 uses SHA-256 and -6 uses SHA-512**. Each different hashing algorithm may alter the hash presentation. For example, MD5 hashes don't have parameters; thus, its output only contains the algorithm, salt, and hash.



Use **John the Ripper** to perform a brute force password crack against the unsalted password hash by entering:

john -incremental hash.txt

John should crack the unsalted password hash in less than 10 seconds.

II. Generate a salted password hash by entering:
openssl passwd -salt SALT pass1 > salted-hash.txt

A proper salt value is a random string. Some hashing algorithms support salts of up to 512 bytes. *Here, you are using a pre-selected salt of SALT to make it very obvious when viewing the hashing output.*

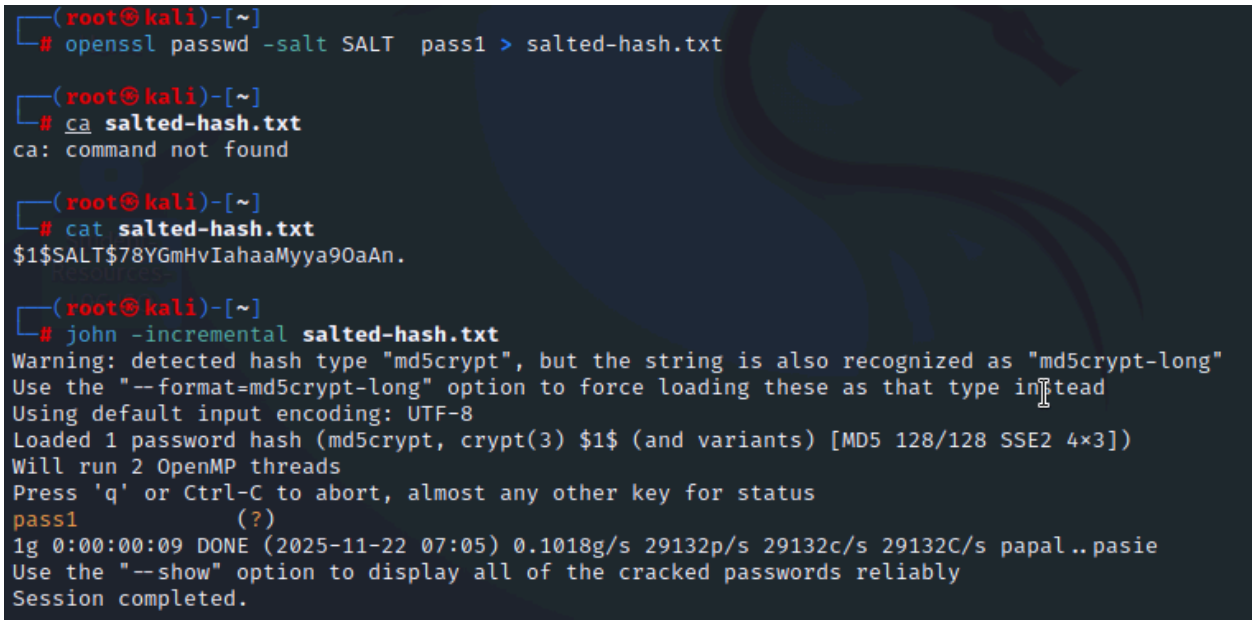
Enter **cat salted-hash.txt** to view the contents of the file.

Notice that the salt value of SALT is present between the 2nd & 3rd $

Use John the Ripper to perform a brute force password crack

john -incremental salted-hash.txt

John should crack the salted password hash in less than 10 seconds. *The full Linux hash statement is present in the salted-hash.txt file. Therefore, John is provided the salt value, which allows it to quickly crack the password.*

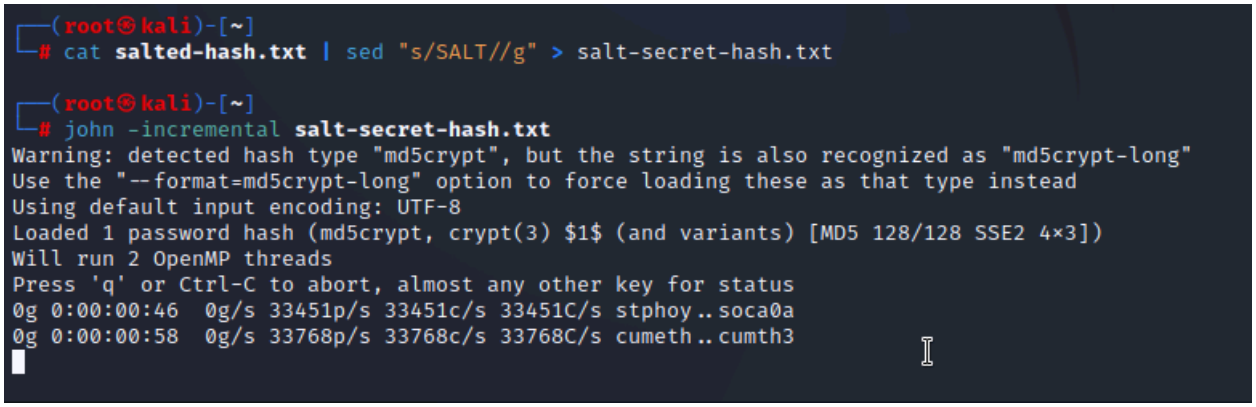


Remove the salt value from the file by entering:

cat salted-hash.txt | sed "s/SALT//g" > salt-secret-hash.txt

Use John the Ripper to perform a brute force password crack against the salted password hash when the salt value is not known by entering:

john -incremental salt-secret-hash.txt
*John will take up to 814,506,250 seconds (~25.8 years) to crack the salted password when it does **not** have knowledge of the salt value.*
This is because the hash is effectively produced from 9 characters instead of just the 5 of the original password.



The default character set used by John the Ripper is the standard US-ASCII table of 95 characters (i.e., uppercase, lowercase, numbers, and symbols present on a standard US keyboard).

Thus, with four salt characters (which could be any of the 95 character options) and the original five-character password (i.e., pass1), which took 10 seconds (or less) to crack, the salted hash of that password (with a 4 character salt) would take 10 seconds x 95 x 95 x 95 x 95 = 814,506,250 seconds.

Wait about 10 seconds, then press the spacebar on your keyboard to get a status report from John. Wait 10 more seconds, then press the spacebar again. You can repeat this several times.

Notice the far-right status element. This is the range of passwords being attempted at the instant you pressed the spacebar to present the status message.

The status output includes:

- Successful guesses (## g)
- Time elapsed, successful guesses/second (## g/s),
- Candidate passwords tested/second (## p/s),
- "Crypts"(password hash or cipher computations)/second (## c/s)
- Combinations of candidate password & target hash/second (## C/s)
- Current candidate passwords.

Type CTRL+C to terminate John.