SIGPwny

SP2024 Week 06 • 2024-02-29

Password Cracking

Sagnik Chakraborty and Emma Hartman

Slide Styling Guidelines

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- Stick to SIGPwny theme colors in the color picker
- Review Branding Guidelines
  - https://sigpwny.com/branding

Announcements

- TracerFIRE
  - Forensics based competition held by Sandia
  - Sign ups coming soon!
- osu!gaming CTF 2024
  - Fun rhythm game themed CTF
  - March 1 11:00 AM - March 3 11:00 AM
- No Sunday meeting
  - Enjoy osu!gaming CTF!

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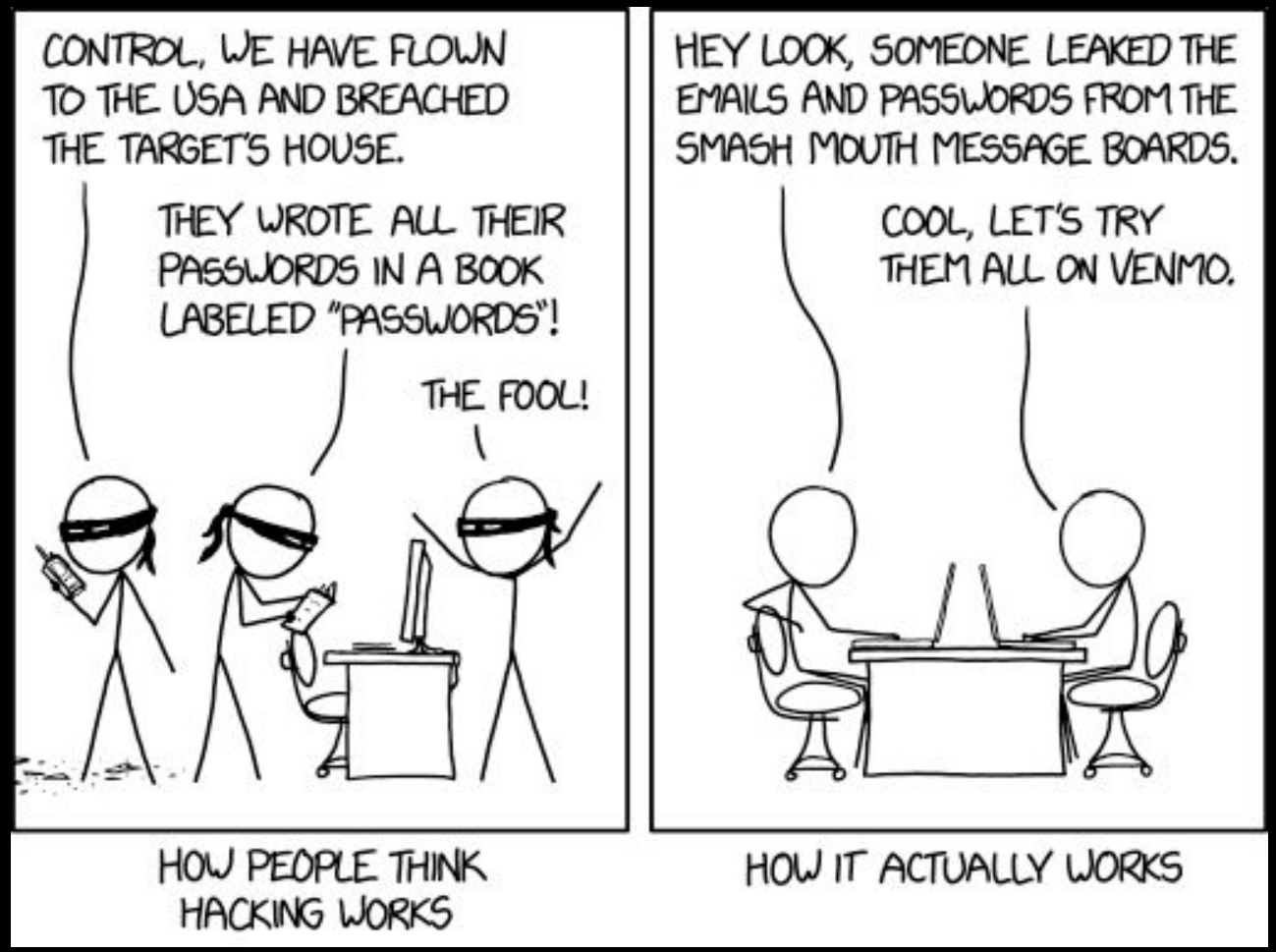


What is Hashing?

- A one way function (irreversible!) that takes something in plaintext and generates a garbled, fixed-length collection of bytes
- Every plaintext has its unique hash- we sometimes call it a fingerprint

```
Plaintext: "Hi"
MD5 hash: c1a5298f939e87e8f962a5edfc206918

Plaintext: "Hii" (example of the avalanche effect)
MD5 hash: 65c1aa5487711a23f7477200fd01e253

Plaintext: "Wow, this is a very long sentence!"
MD5 hash: 0df95e5a7e96079e67663243e29aeba3
```

Hashing Passwords

- Passwords should never be stored in plaintext: instead their hash representation is stored
- When you login with a password, the hash of the password is calculated and checked with the stored correct hash
- This way if an attacker obtains a hash, they can't obtain user passwords unless they brute force them
-

Server stores:	`5f4dcc3b5aa765d61d8327deb882cf99`
Client Guess 1: `hunter2`	`2ab96390c7dbe3439de74d0c9b0b1767`
Client Guess 2: `password`	`5f4dcc3b5aa765d61d8327deb882cf99`

Cracking Password Hashes

- As mentioned earlier, hashing is one way, so you can't easily get a password if you're given a hash
- The only way is to brute force or "crack" the hash with guesses of what the password could be
  - **Pure brute force**: using every possible combinations of letters, numbers, and symbols (takes a LONG time)
  - **Dictionary/wordlist attack**: limits the amount of guesses by guessing common, or likely valid passwords
  - **Rule-based dictionary attack**: like a dictionary attack but more versatile

Computing Hashes

- Generating a single hash takes less than a second but computing a lot of hashes in a brute force attack takes much longer
- Highly dependent on your compute power
- GPUs can crack passwords faster than CPUs
- People build custom password cracking rigs with lots of GPUs or just rent a high-compute cloud server on AWS/Google Cloud/Azure

Popular Wordlists

- rockyou.txt
  - This is the standard wordlist to use if you don't know anything about the password you're cracking
  - Contains ~32 million common passwords sourced from various password breaches
  - Short enough to go through in a reasonable amount of time, comprehensive enough for most cases
  - Most CTFs will use passwords from rockyou to simplify password cracking and make challenges not impossible
- SecLists
  - Repository of even more prebuilt wordlists

Creating a Custom Wordlist

- A wordlist attack has a higher chance of succeeding if you use words/phrases related to whoever created the password, instead of a generic wordlist like rockyou
  - e.g. pet names, song lyrics, keywords
- Tools: Mentalist, hashcat rules/hybrid attack

Different Hashing Functions

- MD5
- SHA256
- SHA512 (newer Linux systems)
- md5crypt (older Linux systems)
- NTLMv2 (newer Windows systems)
- LM (ancient Windows systems)
- RIPEMD (RIPE project from the EU)

Not All Hashes Are Created Equal

- A hashing function that takes more time to compute makes password cracking less effective
  - MD5 takes around 500ms to compute a hash
  - SHA512 takes around 1000ms to compute a hash (double of MD5)
  - Verifying a password takes double time (still insignificant), but cracking the password takes exponentially more time
- Bigger hashes sizes reduces the possibility of hash collisions
  - MD5 hashes contain 16 bytes
  - SHA512 hashes contain 64 bytes

Salting

- Adds a random string to the password before hashing
- This way an attacker can't just precompute all possible hashes beforehand and compare a hash to the database of all hashes
  - These precomputed databases are called rainbow tables

Salt = `59c^ad`

Password = `Password@123`

What's hashed: `59c^adPassword@123`

- The salt is stored with the hash

A Lesson in Hashes (ft. Microsoft)

LM hash function steps:

1. Convert all lowercase to uppercase
2. Pad password to 14 characters with NULL characters (or get rid of extra characters after first 14 characters)
3. Split the password to two 7 character chunks
4. Create two DES keys from each 7 character chunk
5. DES encrypt the string "KGS!@#$%" with these two chunks
6. Concatenate the two DES encrypted strings. This is the LM hash.

A Lesson in Hashes (ft. Microsoft)

Original password: `R3@1LyS3cur3P4sSw0rd!8953`

Effective password: `R3@LLYS3CLR3P4` (limited to 14 characters, uppercase only)

Split into two hashes:

`R3@LLYS -> 0081A58503BD7E1D`

`3CLR3P4 -> 5438E4541FAB2BDE`

Full LM hash: `0081A58503BD7E1D5438E4541FAB2BDE`

You can just precompute every 7 character password combination and compare the hash!

Tools

Hashcat

- Hashcat is an extremely fast (read: uses GPU) "password recovery" tool, which automates cracking passwords using the methods described earlier.
  - Three main command line switches you should know about:
    - -m NUM: Chooses the hash type, that is, which kind of hash you're trying to "reverse." For instance, `-m 0` is MD5.
    - -a NUM: Chooses the attack mode. Most of our challenges will use 0, straight mode.
    - -h: Help. Get a list of all hash types, attack modes, etc. supported by Hashcat.
  - See https://hashcat.net/wiki/doku.php?id=example_hashes to figure out what hash mode to use for the -m flag

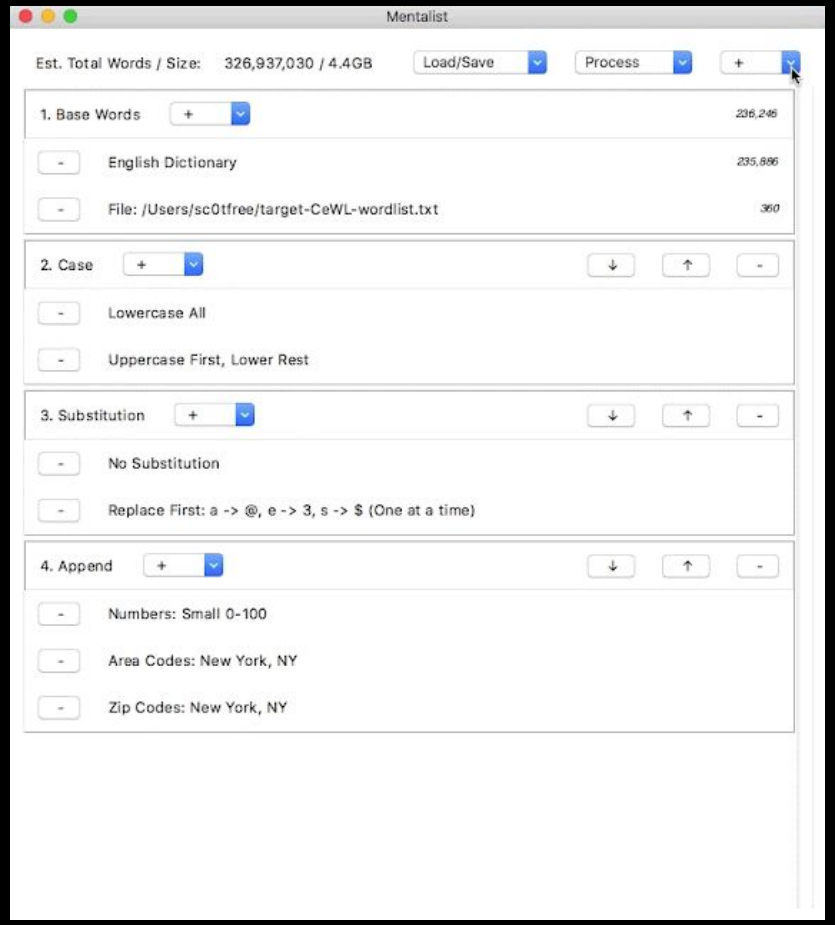
Hashcat Example

- Run Hashcat on example400.hash, using example.dict as a wordlist
  - `hashcat -a 0 -m 400 example400.hash example.dict`
- Same as above, but using Hashcat "rules":
  - `hashcat -a 0 -m 0 example0.hash example.dict -r rules/best64.rule`
- A Hashcat rule is a sort-of regular expression to try variants on your wordlist
- Hashcat has brute-force/hybrid attacks that are useful

John the Ripper

- Similar to hashcat, we recommend hashcat though
- Useful JtR exclusive tools (can download separately as a python script and feed into hashcat)
  - zip2john to create a password hash from an encrypted zip archive
  - pdf2john to create a password hash from an encrypted PDF file
- Use Hashcat's example hashes to identify the hash mode to use for the hash you are trying to crack

Mentalist



Easy to use GUI program to prepend or append numbers, characters, or even other wordlists to a wordlist!

PDFrip

- Multithreaded CLI tool designed to crack passcode-locked PDFs

Resources

- Hashcat: https://hashcat.net/hashcat/
- rockyou.txt: https://github.com/brannondorsey/naive-hashcat/releases/download/data/rockyou.txt
- Mentalist: https://github.com/sc0tfree/mentalist
- SecLists: https://github.com/danielmiessler/SecLists/tree/master/Passwords
- PDFrip: https://github.com/mufeedvh/pdfrip

Next Meetings

`2024-03-01` • **This Friday**

- osu!gaming CTF
- Light-hearted rhythm game themed CTF

`2024-03-07` • **Next Thursday**

- Esolangs with Henry and Pete
- Learn about nonstandard programming languages

`2024-03-10` • **Next Sunday**

- No meeting, have a good break!

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Meeting content can be found at sigpwny.com/meetings.

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