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ISP Assignment 2

1) Formspring:

The Formspring's list of password hashes involved Secure Hash Algorithm technique. The passwords encrypted in the SHA-256 format had a salt value ranging from 00 - 99. Salt is a randomly generated number added to the passwords before the passwords are converted into the hash value and because SHA-256 is irreversible, it is very difficult to crack the passwords, even if the salt value is known.
I used Hashcat tool for cracking the passwords using dictionary mode and brute force method. I got around 243 passwords recovered using dictionary mode and around 20k using brute force for around 2-3 hours.

Ashley Madison:
Ashley Madison list of password hashes was encrypted using a cryptographic function called bcrypt.

Bcrypt is more computationally intensive than some other functions like MD5. Also the Ashley Madison developers used a cost factor of 12 in their implementation, meaning that each possible password an attacker wants to test needs to be put through 4,096 rounds of hashing. This makes cracking passwords with a small size dictionary very slow. Better idea to improve chances of password cracking would be to use a large dictionary size.

2). After searching online a lot, I first tried using John The Ripper, password cracking tool. But I could not get enough good results using John The Ripper(JTR). I even installed Virtual Box on my system and then mounted Kali Linux on it to use the pre-installed resources it has for password cracking. But it turned out to be very slow and I could not get any results. Also tried to use Hydra. But I found Hashcat to one of the better password cracking tools. The reason for that is Hashcat uses wide variety of algorithms to crack passwords and more importantly is uses even the GPU which makes it comparatively faster than other password cracking tools.

The two techniques I used for cracking passwords are-
Dictionary mode
Brute Force

Dictionary mode attack is the simplest and fastest password cracking attack. The dictionary file has a lot of random words or previously cracked passwords which means we can hash them again using the same hashing technique which has been used for the passwords we are trying to recover. Now if the hashed values of the dictionary file and already hashed passwords

match, the tool displays out the plain text corresponding to that matched hash value. This attack is plausible only due to high performance capabilities of computers these days.

Brute force is one of the last options to crack passwords as it is really time consuming. Brute force requires a lot of computational power as it tries to guess all the possible combinations of all letters, numbers and special characters to crack a password. Advantage of using this technique is that if kept running for good amount of time, it can fetch many more results of cracked passwords than any other technique.

3)When I applied dictionary attack using Hashcat on Formspring's hashed passwords, I managed to crack around 4300 passwords. I used a common dictionary file which is rockyou.txt available on github. After getting these results, I added theis cracked password list to the dictionary file which I have. I again tried to crack more passwords and resulted in cracking more than 40K this time. I realized that using a previously password cracked list really increased the efficiency of cracking the remaining passwords.
Dictionary attack in Hashcat was done by using the following command-
./hashcat -m 1400 -a 0 formspring.txt rockyou.txt

```
Last login: Tue Feb 19 10:06:14 on ttys000
Restored session: Tue Feb 19 15:59:24 EST 2019
Manavs-MacBook-Pro:hashcat manavahlawat$ ./hashcat -m 1400 -a 0 formspring.txt rockyou.txt
hashcat (v5.1.0-42-g471a8ccc) starting...

OpenCL Platform #1: Apple
========================
* Device #1: Intel(R) Core(TM) i5-8259U CPU @ 2.30GHz, skipped.
* Device #2: Intel(R) Iris(TM) Plus Graphics 655, 384/1536 MB allocatable, 48MCU

Hashes: 419564 digests; 419564 unique digests, 1 unique salts
Bitmaps: 16 bits, 65536 entries, 0x0000ffff mask, 262144 bytes, 5/13 rotates
Rules: 1

Applicable optimizers:
* Zero-Byte
* Early-Skip
* Not-Salted
* Not-Iterated
* Single-Salt
* Raw-Hash

Minimum password length supported by kernel: 0
Maximum password length supported by kernel: 256

ATTENTION! Pure (unoptimized) OpenCL kernels selected.
This enables cracking passwords and salts > length 32 but for the price of drastically reduced performance.
If you want to switch to optimized OpenCL kernels, append -O to your commandline.

Watchdog: Hardware monitoring interface not found on your system.
Watchdog: Temperature abort trigger disabled.

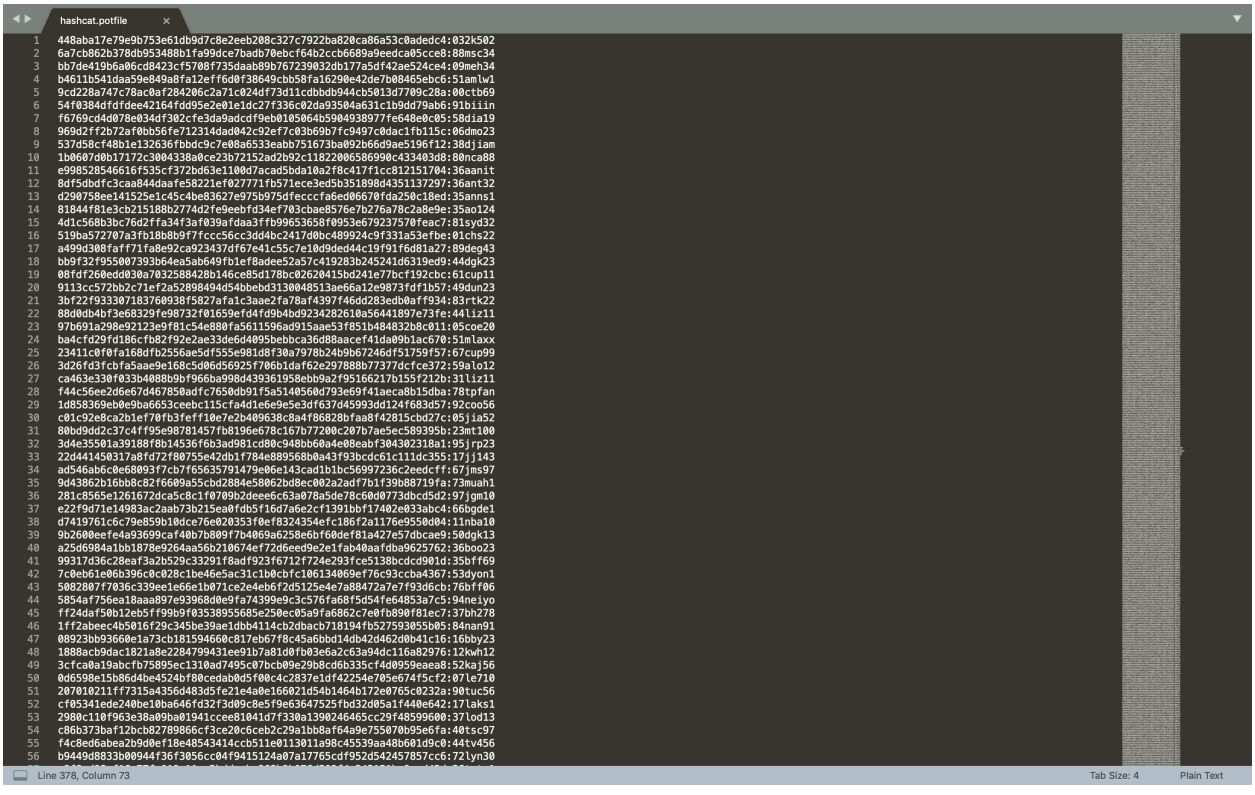
INFO: Removed 4206 hashes found in potfile.

Dictionary cache hit:
* Filename..: rockyou.txt
* Passwords.: 14344384
* Bytes.....: 139921497
* Keyspace..: 14344384

Approaching final keyspace - workload adjusted.


Session..........: hashcat
Status...........: Exhausted
Hash.Type........: SHA2-256
Hash.Target......: formspring.txt
Time.Started.....: Tue Feb 19 16:00:31 2019 (4 secs)
Time.Estimated...: Tue Feb 19 16:00:35 2019 (0 secs)
Guess.Base.......: File (rockyou.txt)
Guess.Queue......: 1/1 (100.00%)
Speed.#2.........:  3680.2 kH/s (10.96ms) @ Accel:64 Loops:1 Thr:64 Vec:1
Recovered........: 4206/419564 (1.00%) Digests, 0/1 (0.00%) Salts
Recovered/Time...: CUR:N/A,N/A,N/A AVG:0,0,0 (Min,Hour,Day)
Progress.........: 14344384/14344384 (100.00%)
Rejected.........: 0/14344384 (0.00%)
Restore.Point....: 14344384/14344384 (100.00%)
Restore.Sub.#2...: Salt:0 Amplifier:0-1 Iteration:0-1
Candidates.#2....: $HEX[30323133446f6d] -> $HEX[042a0337c2a156616d6f732103]

Started: Tue Feb 19 16:00:28 2019
Stopped: Tue Feb 19 16:00:37 2019
Manavs-MacBook-Pro:hashcat manavahlawat$
```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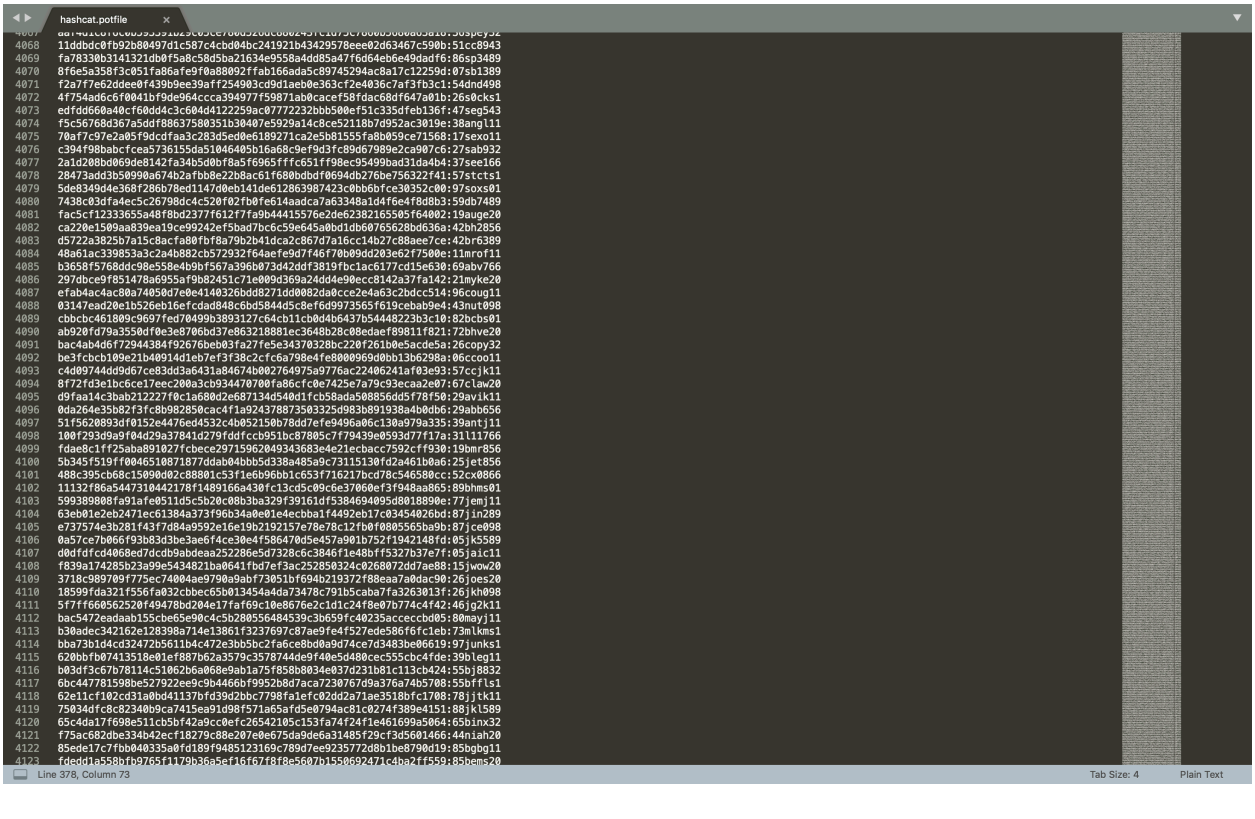
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Line 378, Column 73
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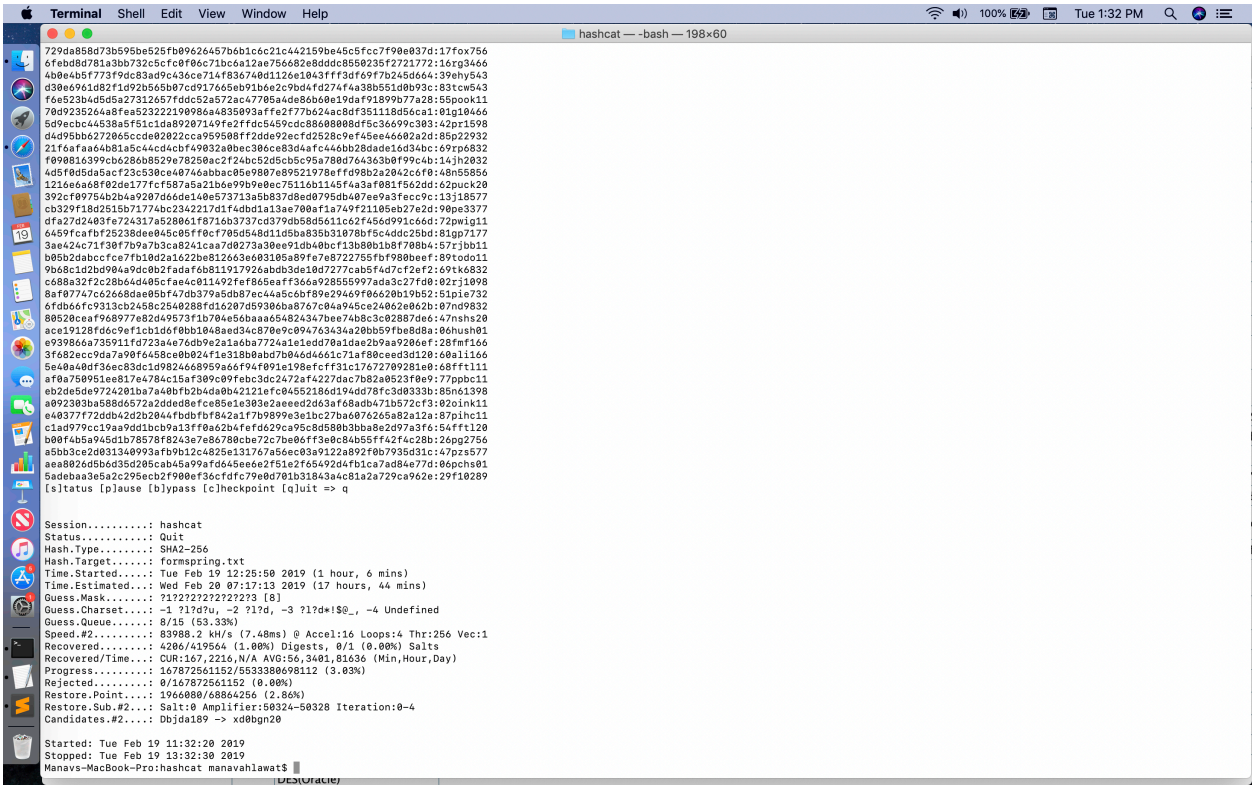
Then I tried to do brute force attack, and although it was really slow, but I managed to crack a lot more passwords than with the dictionary attack. The command used was-
./hashcat -m 1400 -a 3 formspring.txt

Cracking passwords for Ashley Madison turned out to be really difficult. I believe this was because they had a pretty good hashing technique which has bcrypt. After running the dictionary attack for around an hour, I managed to get only two passwords cracked. I had to stop the attack as the stats showed me that it would take more than an year to crack all the passwords.The command used was –

./hashcat -m 3200 -a 0 ashley.txt rockyou.txt –force

Using Brute force on Ashley Madison did not fetch me any results, as it was very slow and my system started to hang. I ran brute force attack for more than 3 hours but could not get any passwords cracked so I just aborted the operation.
The command used was-

./hashcat -m 3200 -a 3 ashley.txt –force

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c688a32f2c28b64d405cfae4c011492fef865eaff366a928555997ada3c27fd0:02rj1098
8af07747c62668dae05bf47db379a5db87ec44a5c6bf89e29469f06620b19b52:51pie732
6fdb66fc9313cb2458c2540288fd16207d59306ba8767c04a945ce24062e062b:07nd9832
80520ceaf968977e82d49573f1b704e56baaa654824347bee74b8c3c02887de6:47nshs20
ace19128fd6c9ef1cb1d6f0bb1048aed34c870e9c094763434a20bb59fbe8d8a:06hush01
e939866a735911fd23a4e76db9e2a1a6ba7724a1e1edd70a1dae2b9aa920bef:28fmf166
3f682ecc9da7a90f6458ce0b02a4fa318b0abd7b046d4661c71af80ceed3d120:60ali166
5e40a40df36ec83dc1d9824668959a66f94f091e198efcff31c17672709281e0:68fftl11
af0a750951ee817e4784c15af309c09febc3dc2472af4227dac7b82a0523f0e9:77ppbc11
eb2de5de9724201ba7a40bfb2b4da0b42121efc04552186d194dd78fc3d0333b:85n61398
a092303ba588d6572a2dded8efce85e1e303e2aeeed2d63af68adb471b572cf3:02oink11
e40377f72ddb42d2b2044fbdbfbf842a1f7b9899e3e1bc27ba6076265a82a12a:87pihc11
c1ad979cc19aa9dd1bcb9a13ff0a62b4fefd629ca95c8d580b3bba8e2d97a3f6:54fft120
b00f4b5a945d1b78578f8243e7e86780cbe72c7be06ff3e0c84b55ff42f4c28b:26pg2756
a5bb3ce2d031340993afb9b12c4825e131767a56ec03a9122a892f0b7935d31c:47pzs577
aea8026d5b6d35d205cab45a99afd645ee6e2f51e2f65492d4fb1ca7ad84e77d:06pchs01
5adebaa3e5a2c295ecb2f900ef36cfdfc79e0d701b31843a4c81a2a729ca962e:29f10289
[s]tatus [p]ause [b]ypass [c]heckpoint [q]uit => q


Session..........: hashcat
Status...........: Quit
Hash.Type........: SHA2-256
Hash.Target......: formspring.txt
Time.Started.....: Tue Feb 19 12:25:50 2019 (1 hour, 6 mins)
Time.Estimated...: Wed Feb 20 07:17:13 2019 (17 hours, 44 mins)
Guess.Mask.......: ?1?2?2?2?2?2?3 [8]
Guess.Charset....: -1 ?l?d?u, -2 ?l?d, -3 ?l?d*!$@_, -4 Undefined
Guess.Queue......: 8/15 (53.33%)
Speed.#2.........: 83988.2 kH/s (7.48ms) @ Accel:16 Loops:4 Thr:256 Vec:1
Recovered........: 4206/419564 (1.00%) Digests, 0/1 (0.00%) Salts
Recovered/Time...: CUR:167,2216,N/A AVG:56,3401,81636 (Min,Hour,Day)
Progress.........: 167872561152/5533380698112 (3.03%)
Rejected.........: 0/167872561152 (0.00%)
Restore.Point....: 1966080/68864256 (2.86%)
Restore.Sub.#2...: Salt:0 Amplifier:50324-50328 Iteration:0-4
Candidates.#2....: Dbjda189 -> xd0bgn20

Started: Tue Feb 19 11:32:20 2019
Stopped: Tue Feb 19 13:32:30 2019
Manavs-MacBook-Pro:hashcat manavahlawat$
```

```
Started: Tue Feb 19 16:02:03 2019
Stopped: Tue Feb 19 16:02:26 2019
Manavs-MacBook-Pro:hashcat manavahlawat$ ./hashcat -m 3200 -a 3 ashley.txt --force
hashcat (v5.1.0-42-g471a8ccc) starting...

OpenCL Platform #1: Apple
========================
* Device #1: Intel(R) Core(TM) i5-8259U CPU @ 2.30GHz, skipped.
* Device #2: Intel(R) Iris(TM) Plus Graphics 655, 384/1536 MB allocatable, 48MCU

Bitmap table overflowed at 18 bits.
This typically happens with too many hashes and reduces your performance.
You can increase the bitmap table size with --bitmap-max, but
this creates a trade-off between L2-cache and bitmap efficiency.
It is therefore not guaranteed to restore full performance.

Hashes: 2200290 digests; 2200290 unique digests, 2200290 unique salts
Bitmaps: 18 bits, 262144 entries, 0x0003ffff mask, 1048576 bytes, 5/13 rotates

Applicable optimizers:
* Zero-Byte
* Brute-Force

Minimum password length supported by kernel: 0
Maximum password length supported by kernel: 72

Watchdog: Hardware monitoring interface not found on your system.
Watchdog: Temperature abort trigger disabled.

INFO: Removed 2 hashes found in potfile.

The wordlist or mask that you are using is too small.
This means that hashcat cannot use the full parallel power of your device(s).
Unless you supply more work, your cracking speed will drop.
For tips on supplying more work, see: https://hashcat.net/faq/morework

Approaching final keyspace - workload adjusted.

[s]tatus [p]ause [b]ypass [c]heckpoint [q]uit => q


Session..........: hashcat
Status...........: Quit
Hash.Type........: bcrypt $2*$, Blowfish (Unix)
Hash.Target......: ashley.txt
Time.Started.....: Tue Feb 19 16:03:56 2019 (1 hour, 48 mins)
Time.Estimated...: Wed Dec  5 11:39:07 2085 (66 years, 289 days)
Guess.Mask.......: ?1 [1]
Guess.Charset....: -1 ?l?d?u, -2 ?l?d, -3 ?l?d*!$@_, -4 Undefined
Guess.Queue......: 1/15 (6.67%)
Speed.#2.........:        0 H/s (2.94ms) @ Accel:1 Loops:1 Thr:8 Vec:1
Recovered........: 2/2200290 (0.00%) Digests, 2/2200290 (0.00%) Salts
Recovered/Time...: CUR:0,0,N/A AVG:0,0,0 (Min,Hour,Day)
Progress.........: 421/136417980 (0.00%)
Rejected.........: 0/421 (0.00%)
Restore.Point....: 0/1 (0.00%)
Restore.Sub.#2...: Salt:6 Amplifier:49-50 Iteration:2604-2605
Candidates.#2....: H -> H

Started: Tue Feb 19 16:03:39 2019
Stopped: Tue Feb 19 17:52:32 2019
Manavs-MacBook-Pro:hashcat manavahlawat$
```

Estimated time was more than 66 years.

Also, there was a certain pattern in the cracked passwords. All of them were a combination of numbers and characters. Almost every password started and ended with numbers and had some characters in between.

There was a lot of difference in speeds of both the attacks. Dictionary attack was kind of fast. On the other side, brute force attack took like forever to fetch me results of cracked passwords.

4)Based on your experience, describe (briefly – you can use a bulleted list for this one) the steps you would follow to try to crack passwords in the future. Basically, if you are given a hash file (one with just a bunch of hex values) for company X, what would you do to try to recover as many passwords as possible.

->First, it is important to identify the hashing technique which has been used to hash the passwords because only then can we think of an approach to crack those hashed values.

->The second thing would be to write a piece of code for cracking those hash values or using a suitable password cracking tool(I used Hashcat above).

->Because dictionary attack seems to be the most efficient way of cracking hash values, third step would be to prepare a large relevant dictionary file which could help recover as many passwords as possible.
Next, it would help if one could recongnize the salts that have been used to hash the plain text. It would really make it simpler to crack the passwords now.
Next step would be to use the correct and most efficient attack modes using the password cracking tool (Hashcat in my case).
Once, you have a initial list of cracked passwords, the best method to improve the efficiency is to use the already cracked password list in the dictionary file and then use the attack mode again to get better results.
If the above steps do not get you success, one can always try the more time consuming brute force attack.

5) Finally, if you were in charge of creating a password scheme, describe at a high level what algorithms and storage methods you would use. This is an open-ended question, so provide as many details as needed to justify your response.

If I was in charge of creating a password scheme, I would either use a hashing technique from SHA family and then use salts with it to make it stronger and more difficult to crack. But the drawback for this technique would be that, if someone is familiar with the salt that has been used in the hash value, it becomes relatively easier to crack such hashed values.
So, from my experience after working on this assignment, I would go for bcrypt encryption technique to hash the plain text. Bcrypt seems to be the strongest hashing technique which was used by Ashley Madison's developers. As a result, I could not get enough passwords cracked in a limited amount of time.