UNIX & Security

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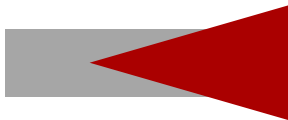
Dual-Mode Operation

- Sharing system resources requires the operating system to ensure that a program cannot arbitrarily interfere with other programs

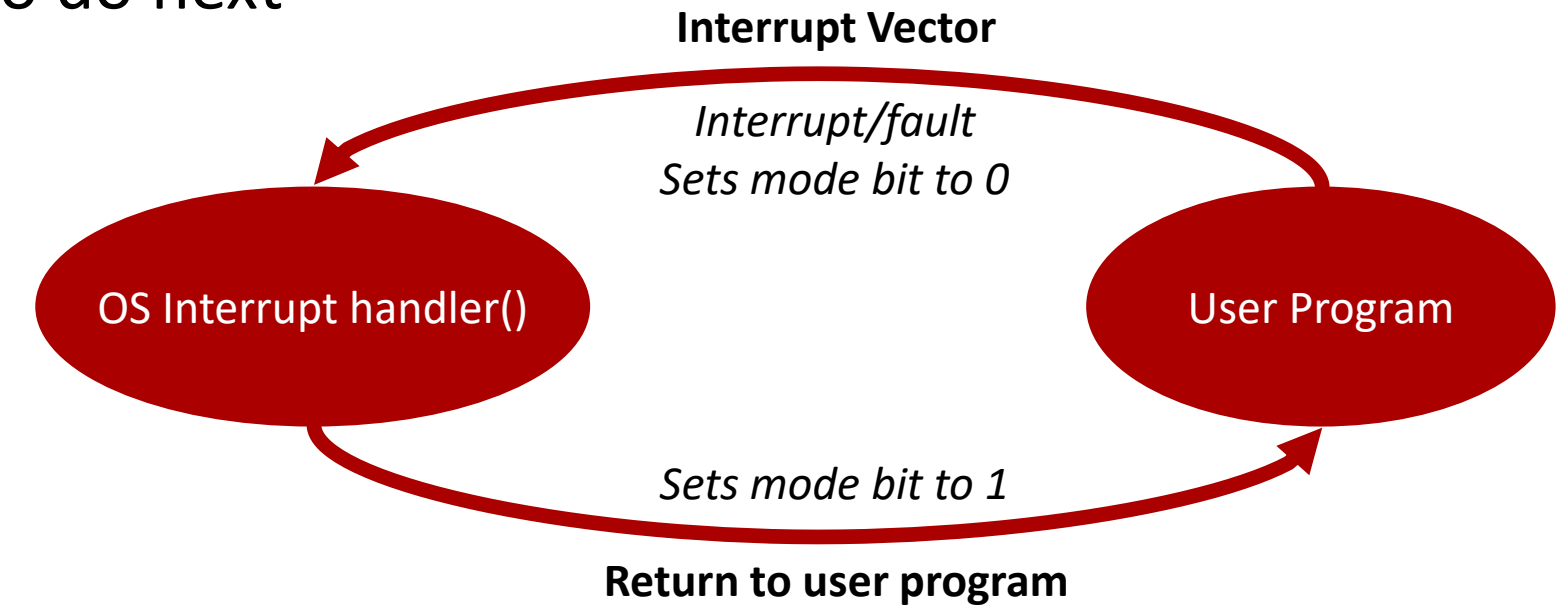
- The hardware itself provides support to differentiate between at least two modes of operations:
  - User mode: execution done on behalf of a user
  - Monitor mode (also supervisor mode or system mode): execution done on behalf of the operating system

- Privileged instructions can be issued only in monitor mode



Dual-Mode Operation

- The *mode bit* is added to computer hardware to indicate the current mode: monitor (0) or user (1)
- When an interrupt or fault occurs, the hardware switches to monitor mode by following the address, stored in the *interrupt vector,* to the *interrupt handler* function in the OS; this handler will let the OS decide what to do next



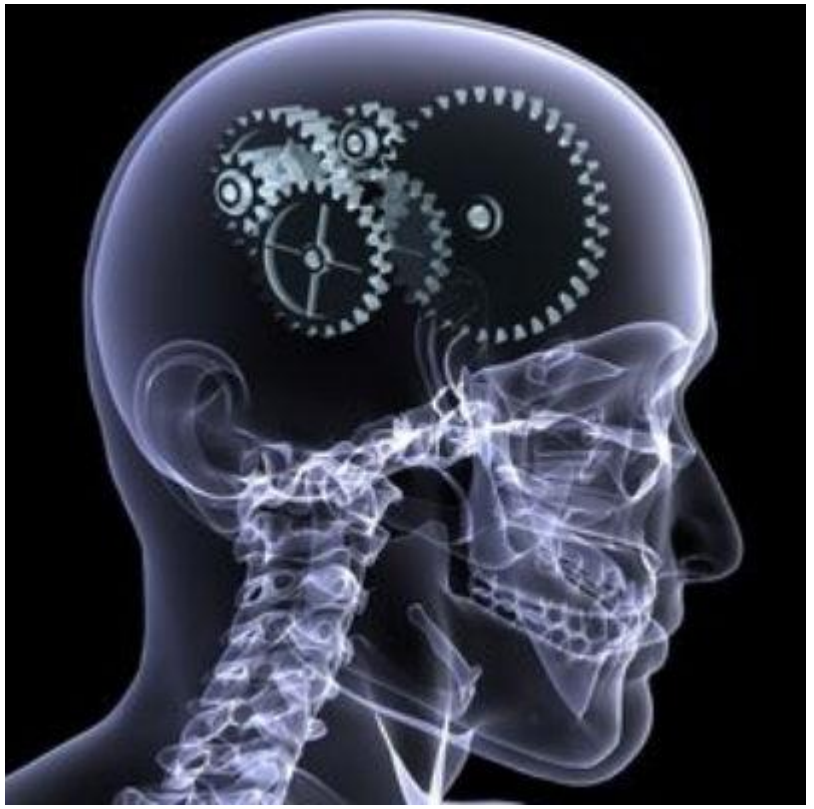
I/O Protection

- All I/O instructions (`read()`, `write()`, `send()`, `recv()`, `fgets()`, `putc()`, etc.) are privileged instructions

- Because: the OS must ensure that a user program could never gain control of the computer in monitor mode by storing a new address in the interrupt vector

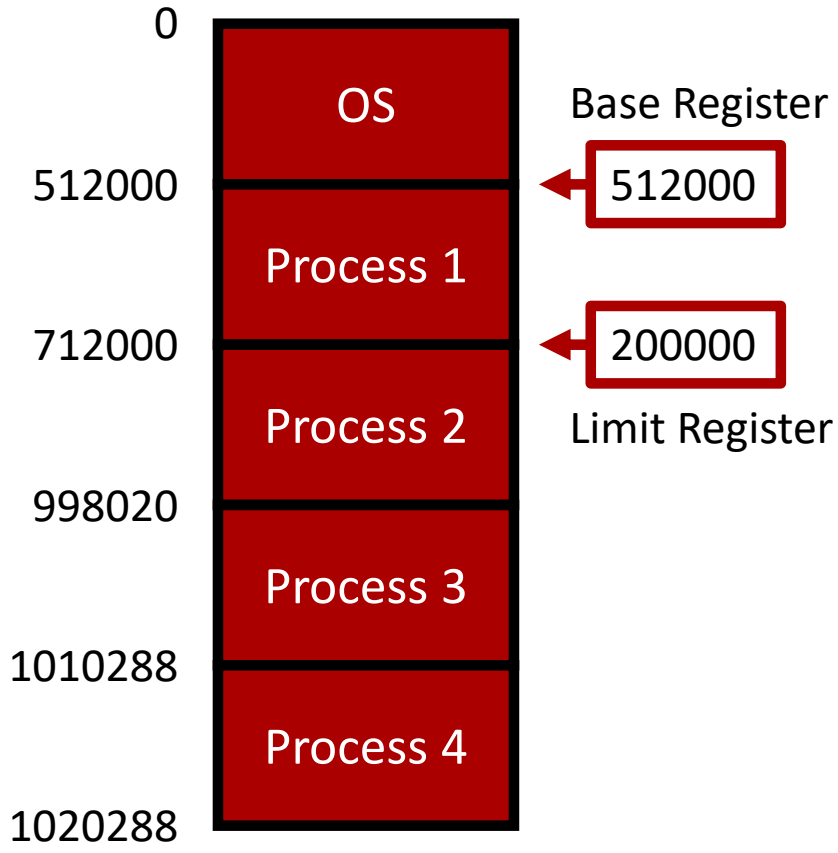
Memory Protection

- Must provide memory protection at least for the interrupt vector and the interrupt handler function
- In order to have memory protection, add two registers that determine the range of legal addresses a program may access:
  - **Base register** – holds the smallest legal physical memory address.
  - **Limit register** – contains the size of the range
- Memory outside the defined range is protected



Memory Protection

- The base and limit registers define a logical address space, which is virtualized for the process to start at address 0
- When executing in monitor mode, the operating system has unrestricted access to both monitor and user's memory
- Obviously, the load instructions for the base and limit registers are privileged instructions



CPU Protection

- If the CPU is executing program instructions one after the next, how does the OS retain control?
- A timer interrupts the control flow after a specified period to ensure that the operating system has a chance to determine what to do
  - Timer is decremented every clock tick
  - When timer reaches the value 0, the interrupt vector is followed to the interrupt handler
- Timer commonly used to implement time sharing
- Also used to compute the current time
- “Load-timer” is a privileged instruction

General-System Architecture

- Given the I/O instructions are privileged, how does the user program perform I/O?

- With a *system call*: the method used by a process to request action by the operating system
  - Control passes through the interrupt vector to a service routine in the OS, and the mode bit is set to monitor mode
  - The monitor verifies that the parameters are correct and legal, executes the request, and returns control to the program instruction immediately following the system call

User Account Rights Protect Files

- User files are protected from other users by defining access based on user accounts

- If you are logged in as an account with access (e.g., you're the owner, or a group owner), you can manipulate the file:
  - chmod
  - vim
  - touch
  - rm
  - etc.

Acting as a Different User - Pretexting

- If you want to temporarily act as a different user (but stay logged on as yourself), you can use the `su` command:
  - `su yoog`

Obviously, you'll need to know `yoog`'s login credentials

- You can also execute just one action with the `sudo` command:
  - `sudo -u yoog rm -rf ~/yoogFiles/*`

- These commands change your effective user and/or group IDs, all of which can be displayed with the `id` command

The root User Account

- Most UNIX systems have a super-user account, typically called root, which has permissions to do anything
  - `su root`
  - `sudo -u root pkill -u brewsteb`
- As root, you can change file ownership, change limits on how many processes users can run at once, add and delete user accounts, and many other things
- It is generally considered bad form to stay logged-in to root itself - it's preferred that you make use of `sudo` to make changes

SUID, SGID

- Each executable has two security bits associated with it: SUID, and SGID
  - If SUID is set, the executable runs with effective user ID of the *owner* of the file
  - If SGID is set, the executable runs with effective user ID of the *group owner* of the file

- This is different from before – we're now talking about specific executibles that have bits that enable them to run as different users
  - As opposed to *being* a different user, and then running programs, as `su` and `sudo` allow

Changing SUID Example

```
$ which ping
/bin/ping
$ ls -pla /bin/ping
-rwsr-xr-x. 1 root root 38264 May 10  2016 /bin/ping
$ chmod u-s /bin/ping
chmod: changing permissions of `/bin/ping': Operation not permitted
$ ls -pla junk.test
-rw-rw----. 1 brewsteb upg57541 332 Nov 17 09:47 junk.test
$ chmod u+s junk.test
$ ls -pla junk.test
-rwSrw----. 1 brewsteb upg57541 332 Nov 17 09:47 junk.test
$ chmod u+x junk.test
$ ls -pla junk.test
-rwsrw----. 1 brewsteb upg57541 332 Nov 17 09:47 junk.test
```

Can’t change the permissions of a file I don’t own

Capital ‘**S**’ means that the SUID bit is set, but user execute is not

Changes to lower case ‘**s**’ now that SUID is set

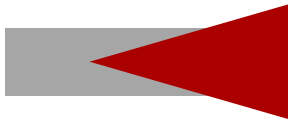
chmod Revisited

- It turns out that there are twelve mode bits:
  - 4000 - Setuid on execution
  - 2000 - setgid on execution
  - 1000 - set sticky bit
  - 0400 - read by owner
  - 0200 - write by owner
  - 0100 - execute by owner
  - 0040 - read by group
  - 0020 - wr
  - 0010 - execute by group
  - 0004 - read by others
  - 0002 - write by others
  - 0001 - execute by others

Why SUID Matters

- What if you replace the contents of the real `ping`, which has SUID set and is owned by root, with your own code?

- It would have the same permissions (owned by root), but could do anything you want to the system



Why SUID Matters

- What happens when you set the SUID bit on your own executables?
- They would still be owned by you, and thus would run as you
  - Since you're not root this isn't very interesting

- Can you give your custom executable to root?
- No – this is specifically why you have to *be* logged in as root to change file ownership!
  - `chown` doesn't work unless you're root
  - `chgrp` don't work unless you are a member of that group

Strongest Forms of Security

- The strongest forms of security involve network and physical isolation, but these seriously limit utility
- If you do grant physical access to your computer - even disabling local login access - you still have to worry about:
  - Bootable devices (live CDs, flash drives, etc.) can boot a different OS that can access the hard drive of your computer
  - Hard drive could be stolen and read
  - Reading link-level NIC lights, keyboard EM
- With local logins, passwords = pain

Actual Password Security… is a Pain in the Neck

- Don't let users write them down
- Age the passwords
- Enforce stronger (but more annoying) passwords
  - 1337: @nt3@t3|2
  - random: Z1#3s8u*h
  - long: Ho\/\/doYouTypeMeF@st
- Restrict use of previous passwords
- Password dictionary check

Password Security

- Longer is better than more complicated
  - Lower case letters = 26 possibilities per character
  - Upper case letters = 26 possibilities per character
  - Numbers = 10 possibilities per character
  - Special Characters = 30 possibilities per character
  - Any given character could be 1 of 92 choices
  - There are then 92^8 8-character passwords:
    - $92 \times 92 \times 92 \times 92 \times 92 \times 92 \times 92 \times 92 = 92^8$
  - $92^8 = 5.1 \times 10^{15} = 5{,}132{,}188{,}731{,}375{,}616$

Password Security

- Longer is better than more complicated
  - $92^8 = 5.1 \times 10^{15} =$ 5,132,188,731,375,616
  - Using just lower case letters:
    - $26^8 = 2.0 \times 10^{11} =$ 208,827,064,576
  - A 12 character, lower-case password:
    - $26^{12} = 9.5 \times 10^{16} =$ 95,428,956,661,682,176

Password Security

- Which is easier to remember:
  - TR0m&on3
  - ihavetwoarms
- Which are you more likely to write down?
- FYI, 4 common words are important in the example above
  - See xkcd's excellent correct horse battery staple comic:
    https://xkcd.com/936/

Most common passwords recovered from hacked data dumps

1	123456
2	password
3	12345
4	12345678
5	qwerty
6	123456789
7	1234
8	baseball
9	dragon
10	football

splashdata

Login Failures

- What happens if you don't lock a user account if too many failures happen?
  - A account can be brute forced by guessing possibilities
- Passwords are generated with the sausage model (one-way):
  - username: UserBob
  - password: 123456 *-> hashes to ->* a3R7nito5fo%r
- Store the pair UserBob / a3R7nito5fo%r
- This encrypted pair is public knowledge, but the encryption method is one-way

Password Encryption

- If anyone knew how to reverse the password method, then:
  - a3R7nito5fo%r *-> comes from ->* 123456
- Fortunately it is very hard to crack the one-way encryption
- Problem: why is storing the password file publicly dangerous, and why is having a large encrypted password file stolen a problem?
  - A dictionary can be built of encryptions by turning the crank sequentially:
    - 123454 = JoF9#$94(4k9!
    - 123455 = fj49#mc903#0Q
    - **123456 = a3R7nito5fo%r**
    - 123457 = h9^wehf9*3xd9

Monitoring and Logs

- With all of the insecure protocols still in use (telnet, FTP), keep a tight eye on everything with log files:
  - Network
  - Account login/logout
  - Program usage
  - File access
  - Security checks
  - etc.

Getting Root Access when you're not supposed to have it…

- Try the front door first:

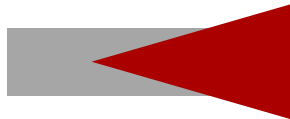
ACCOUNT: *PASSWORD*

- **root: root**
- sys: sys / system / bin
- bin: sys / bin
- **mountfsys: mountfsys**
- adm: adm
- uucp: uucp
- nuucp: anon
- anon: anon
- user: user
- games: games
- **install: install**
- demo: demo
- **umountfsys: umountfsys**
- **sync: sync**
- admin: admin
- guest: guest
- daemon: daemon

Getting Root Access when you're not supposed to have it…

- Assuming social engineering didn't work, you'll have to use fancy stuff:
  - Port scans + port/program insecurities
  - Buffer overflows (with system access)
  - Boot hacking (with physical access)

- Why are we talking about this stuff?
  - So you can protect yourself against it



Breaking Into Windows

- Boot off of the installation media (Windows Server 2008 DVD, here)

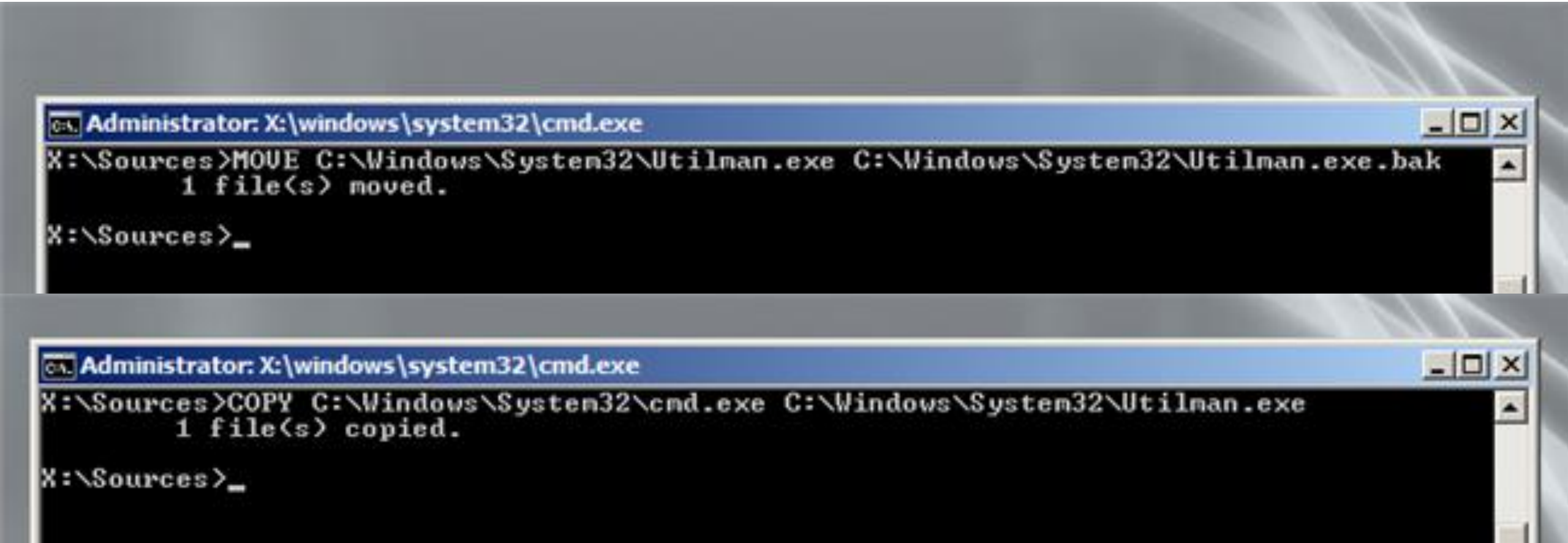
http://www.howtogeek.com/106333/how-to-reset-your-forgotten-domain-admin-password-on-server-2008-r2/

Breaking Into Windows

- Click here…

Breaking Into Windows

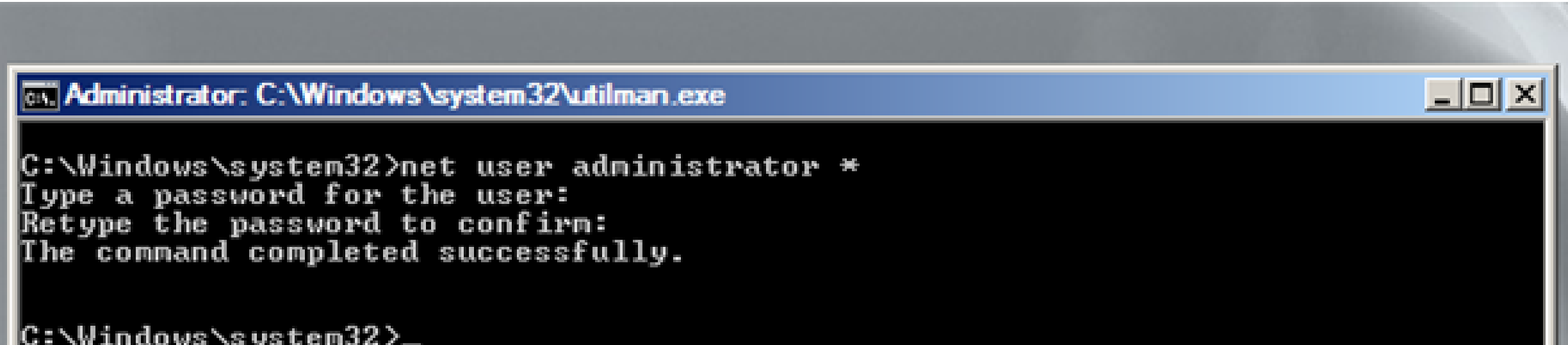
- Enter these two commands…



Breaking Into Windows

- Reboot without CD, booting normally into Windows on the hard drive, then click here:

- Instead of accessibility, you get a privileged prompt! Change the password like this…

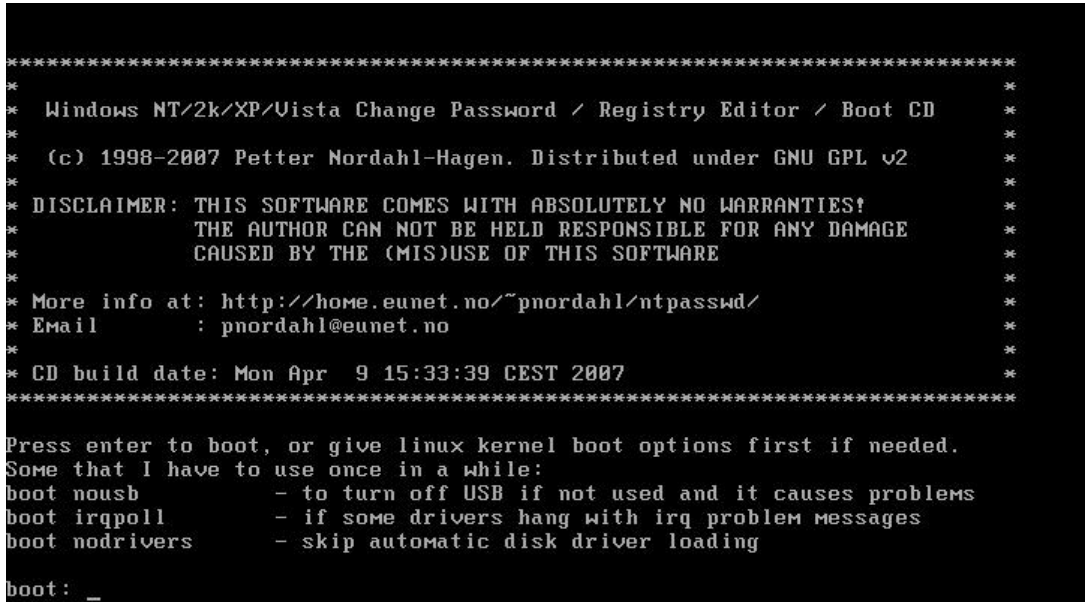


Breaking Into Windows

- Log in using the new password!
- Remember to put the files back where you got them from
- Works in Windows 7, 8, 8.1, 10, and Server 2012, too!
- Why not create a few new local user accounts of your own, while you're in there?
- Q: Why can't we create domain accounts?

Password Annihilator - with Physical Access

- Reset, change, or blank out any Windows password by booting from a flash drive or CD:
  - http://pogostick.net/~pnh/ntpasswd/



http://www.techrepublic.com/blog/windows-and-office/reset-lost-windows-passwords-with-offline-registry-editor/

Apple and You?

- In August of 2012, Wired Magazine editor Mat Honan had his Apple account penetrated
- The perpetrators used Mat's Apple account to remotely erase all data on his iPhone, iPad, and MacBook
- This was accomplished by using what multiple companies knew about Mat to put together a complete profile

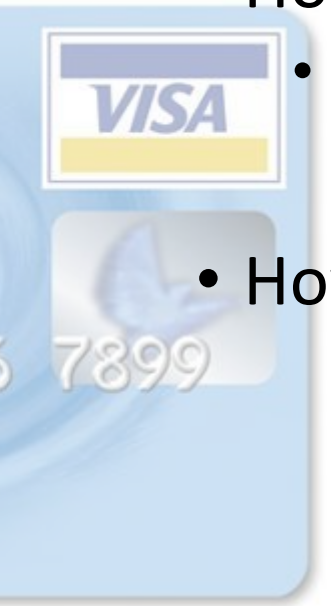
-Ariel Zambelich, Wired

Who ARE you?

- The perps proved they were Mat, which let them reset Mat's Apple password, and then reset his equipment

- How can you prove you're Mat?
  - Apple says that Mat is the last four digits of his credit card

- How do we get these last four digits?



How to become Mat

1. Call Amazon, tell them you are the Account Holder
   - You'll need Name, Email address, Billing address
2. Add a credit card over the phone
3. Hang Up
4. Call Back, tell them you've lost access to your account
   - You'll need Name, Email address, Billing address, and a credit card number
   - They let you add a new email address: use yours
5. From the web, reset the password, using your new email
6. View the last four digits of the credit cards in the account

Security Isn’t Easy

- That’s literally all this slide says