

OS Security

Malware

Radboud University, Nijmegen, The Netherlands



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A short recap

- ▶ Processes access memory through virtual addresses
- ▶ Mapping between virtual and physical addresses is (typically) done in hardware, but managed through the OS
- ▶ OS separates memory space of different processors
- ▶ Memory attack: Write shellcode to buffer, overflow buffer, overwrite return address with pointer to shell code
 - ▶ Countermeasure: NX (or $W \oplus X$)
- ▶ Advanced attack: return to libc, generalization: ROP
 - ▶ Countermeasure: Address Space Layout Randomization

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 - ▶ Compartmentalization and virtualization (Dec 19 & Jan 09)

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- ▶ Different ways to categorize malware:
 - ▶ By their malicious behavior (what they do)
 - ▶ By their spreading routine
 - ▶ By privilege of the malicious code

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- ▶ The earliest viruses are from the 70s spreading in the ARPANET
- ▶ Originally most viruses spread over floppy disks
- ▶ Today obviously mainly spread over the Internet

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- ▶ The central ingredient is recursion!

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- ▶ Famous example of the first type of worm: Loveletter (aka ILOVEYOU)
 - ▶ Worm that started spreading in May 2000
 - ▶ Spread by e-mail with subject line “I love you”
 - ▶ Read address book of infected host and sent to the address book (from the user’s mail address)
 - ▶ Malicious Attachment had filename LOVE-LETTER-FOR-YOU.TXT.vbs (Windows by default did not show the vbs)
 - ▶ Deleted all files ending on .jpg, .jpeg, .vbs, .vbe, .js, .jse, .css, .wsh, .sct and .hta and replaced them by a copy of itself (with additional ending .vbs)
 - ▶ Caused an estimated damage of US\$10,000,000,000

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- ▶ Example of the second type: Sasser
 - ▶ Spread through a buffer overflow in the “Local Security Authority Subsystem Service” (LSASS) in Windows XP and 2000
 - ▶ Communication through TCP on ports 445 and 139
 - ▶ Services running by default on Windows (and reachable from outside)

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 - ▶ Trojan was nicknamed *R2D2* because the string “C3PO-r2d2-POE” was found in its code

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 - ▶ (i) Timing Channels (e.g. CPU load)
 - ▶ (ii) Storage Channels (e.g. existence of files)

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 - ▶ Flame tried to blend in with legitimate Microsoft applications by cloaking itself with an older cryptography algorithm that Microsoft used to digitally sign programs
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- ▶ Can detect and remove a kernel rootkit only when booting another clean OS

Bootkits

- ▶ Malware can compromise the boot process of a computer
- ▶ Rootkits that modify the bootloader are called *bootkits*
- ▶ Bootkits are typically installed in the MBR of the hard drive
- ▶ Bootkits can make sure to re-infect a computer at each reboot

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<http://leaksource.files.wordpress.com/2013/12/nsa-ant-iratemonk.jpg>
- ▶ Impressive piece of work on firmware malware: DAGGER
 - ▶ Infects computer through Intel's Advanced Management Technology (AMT)
 - ▶ Includes keylogger, sends all keystrokes over the network
 - ▶ Operating system cannot see any of this
 - ▶ For a great talk, see
<http://www.youtube.com/watch?v=Ck8bIjAUJgE>

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- ▶ Finally, some malware just destroys data (digital vandalism)

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 - ▶ Typical requirement: no false positives!
- ▶ Mainly two techniques to detect malware:
 - ▶ *Signature-based detection*: Look for known patterns in files
 - ▶ *Behavior-based detection*: Analyse behavior and make decision

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- ▶ Signatures can be as simple as a cryptographic hash or sequence of system calls
- ▶ Typically look for certain code sequences (less susceptible to minor changes)
- ▶ Generally powerful technique against known malware
- ▶ Used by all major anti-malware software

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- ▶ More advanced: self-mutating code (metamorphism)
- ▶ Virus that prints mutated copies of itself

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- ▶ Obviously, the GPU can also be used for malware detection (signature matching)
- ▶ Seamans and Alexander described GPU extension to ClamAV in 2007
- ▶ Speedup of signature detection on Nvidia GTX 7800 compared to 3-GHz Pentium 4:
 - ▶ 27× for 0% match rate
 - ▶ 17× for 1% match rate
 - ▶ 11× for 50% match rate

Behavior-based malware detection

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- ▶ Typically not good at detecting really new malware
- ▶ Certainly not *reliable* at detecting new malware

Antivirus software (AV) can't hurt, or can it?

- ▶ Common security recommendation for end users: “Use a malware scanner (AV) and keep it up to date”
- ▶ “Wisdom” behind this recommendation: AV certainly makes security better (even if it doesn't detect everything)

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 - POODLE - Padding Oracle On Downgraded Legacy Encryption
 - MiTM attack exploiting web browser vulnerability when web browsers and servers will downgrade to SSL 3.0 if there are problems negotiating a TLS session

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- ▶ This exists, for details see <http://research.swtch.com/zip>
- ▶ Not restricted to zip, also works with gzip