anti-virus and anti-anti-virus

logistics: TRICKY

HW assignment out

“infecting” an executable

anti-virus techniques

last time: signature-based detection
  - regular expression-like matching
  - snippets of virus(-like) code

heuristic detection
  - look for “suspicious” things

behavior-based detection
  - look for virus activity

not explicitly mentioned: producing signatures
  - manual? analysis

not explicitly mentioned: “disinfection”
  - manual? analysis

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regular expression cheatsheet

`a` — matches `a`

`a*` — matches *(empty string)*, `a`, `aa`, `aaa`, …

`a\` — matches the string `a*`

`foo|bar` — matches `foo`, `bar`

`[ab]` — matches `a`, `b`

`[^ab]` — matches any byte except `a` and `b`

`(foo|bar)*` —
(empty string), `foo`, `bar`, `foobar`, `barfoo`, …

`(.|\n)*` — matches anything whatsoever

recall: why regular expressions?

(essentially) one-pass, lookup table

not the most flexible, but fast

flex — regular expressions + code for exceptions

recall: faster than regular expressions?

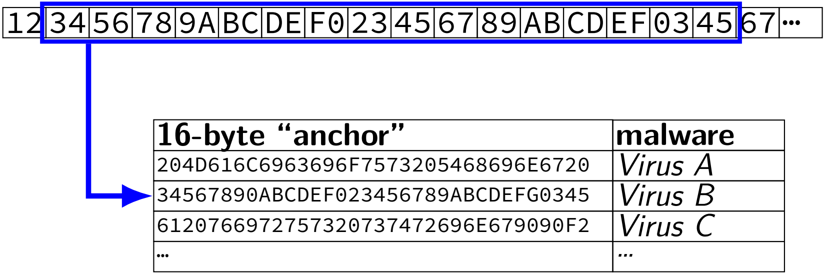
optimization 1: look for fixed-length strings

- sliding window + hashtable
- test with full pattern

optimization 2: head/tail scanning

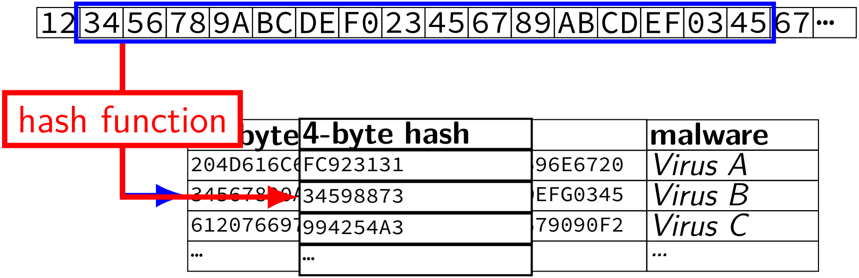
- avoid reading whole files

scanning for fixed strings

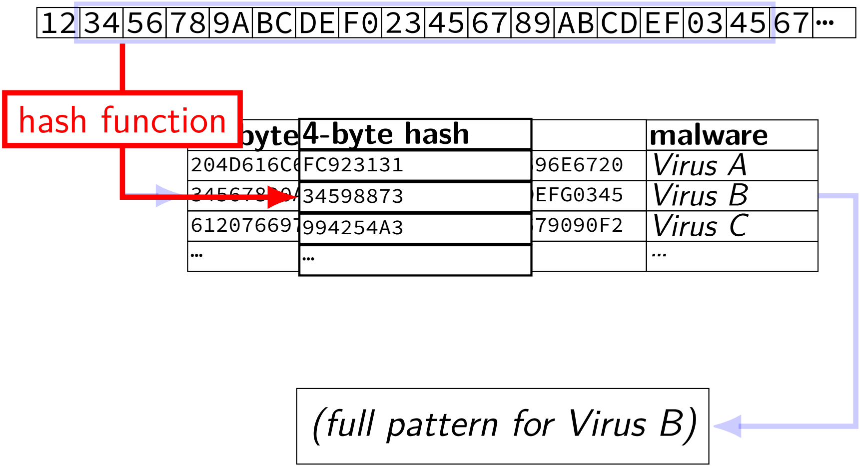


16-byte “anchor”	**malware**
`204D616C6963696F7573205468696E6720`	*Virus A*
`34567890ABCDEF023456789ABCDEFG0345`	*Virus B*
`6120766972757320737472696E679090F2`	*Virus C*
...	...

scanning for fixed strings



scanning for fixed strings



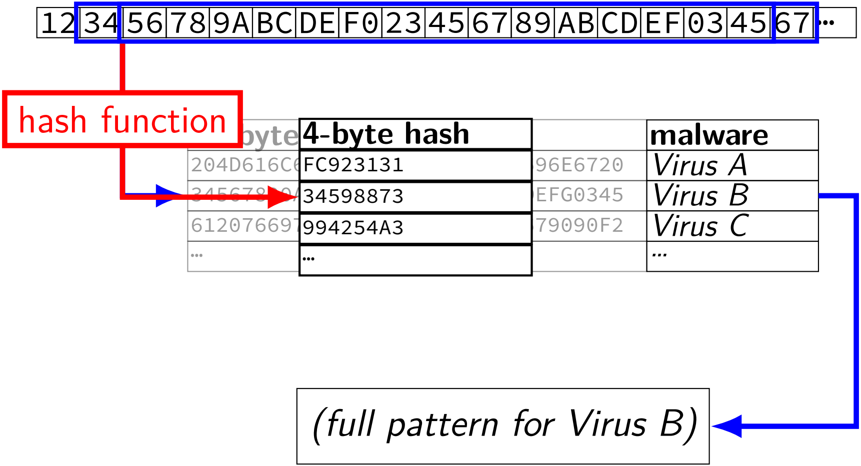
12 34 56 78 9A BC DE F0 23 45 67 89 AB CD EF 03 45 67 …

hash function

byte	4-byte hash		malware
204D616C6	FC923131	96E6720	*Virus A*
345678[illegible]	34598873	EFG0345	*Virus B*
612076697	994254A3	79090F2	*Virus C*
…	…		…

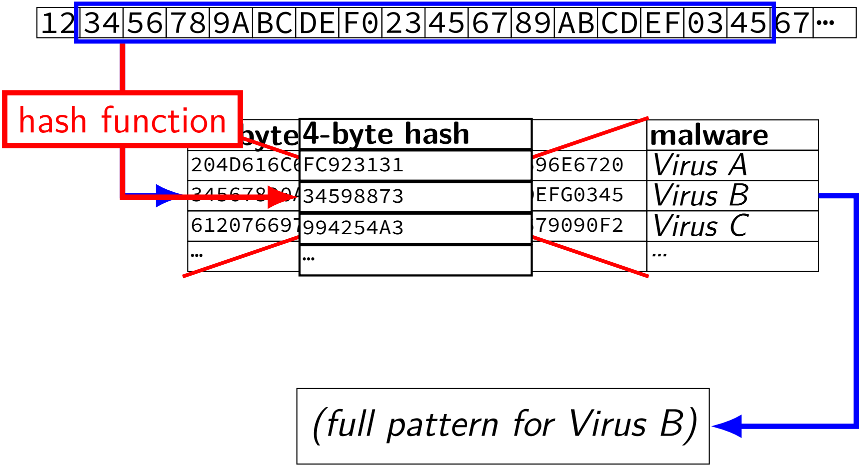
(full pattern for Virus B)

scanning for fixed strings



4-byte hash	malware
FC923131	*Virus A*
34598873	*Virus B*
994254A3	*Virus C*
…	…

scanning for fixed strings



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…	…		…

(full pattern for Virus B)

virus patterns

specific — large snippet of code from virus
  - false positives essentially impossible

general — strategy (e.g. push + ret)
  - false positives possible
  - real applications might do this?
  - might appear in application data?

detecting new malware

goal: detect unseen malware

some signatures might do this — look for strategies

also look for anomalies

- hope that real compilers/linkers/etc. don't do …

anti-virus techniques

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not explicitly mentioned: “disinfection”
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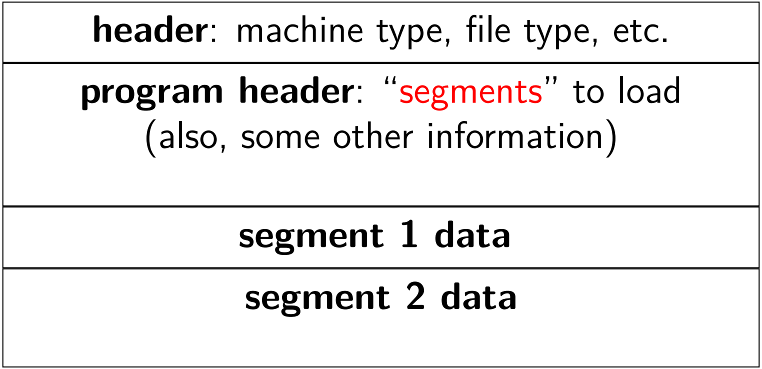
viruses and executable formats



header: machine type, file type, etc.

program header: "segments" to load
(also, some other information)

segment 1 data

segment 2 data

viruses and executable formats

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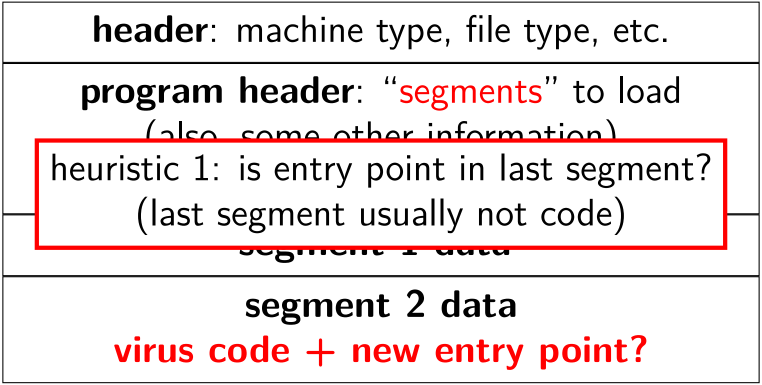
program header: "segments" to load
(also, some other information)
length edited by virus

segment 1 data

segment 2 data
virus code + new entry point?

viruses and executable formats



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program header: "segments" to load
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segment 1 data

segment 2 data
virus code + new entry point?

heuristic 1: is entry point in last segment?
(last segment usually not code)

viruses and executable formats

header: machine type, file type, etc.

program header: "segments" to load
(also, some other information)
new segment added by virus

segment 1 data

segment 2 data

segment 3 data — virus segment

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heuristic 1: is entry point in last segment?
(last segment usually not code)

segment 1 data

segment 2 data

segment 3 data — virus segment

viruses and executable formats

header: machine type, file type, etc.

program header: "segments" to load

heuristic 2: did virus mess up header?
(e.g. do sizes used by linker but not loader disagree)
section names disagree with usage?

segment 2 data

segment 3 data — virus segment

defeating entry point checking

insert jump in normal code section and...

- set as entry point; or
- assume it's reached 'soon'

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"dynamic" heuristic: run code in VM for a while, see if switches sections

heuristics: library calls

dynamic linking — functions called by name

how do viruses add to dynamic linking tables?

- often don't! — instead dynamically look-up functions
- if do — could mess that up/lots of code

heuristic: look for API function name strings
(outside linking info)

evading library call checking

modify dynamic linking tables

reimplement library call manually

    Linux: usually easy
    Windows: system calls not well documented, change

hide names

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hide names

hiding library call names

common approach: store hash of name

runtime: read library, scan list of functions for name

bonus: makes analysis harder

anti-virus techniques

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behavior-based detection

things malware does that other programs don't?

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modify system files

modifying existing executables

open network connections to lots of random places

…

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…

monitor all programs for weird behavior

problem: false positives (e.g. installers)

heuristic detection

virus “shortcuts”
    - generally: not producing executable via normal linker
    - generally: trying to make analysis harder
    - `push` then `ret` instead of `jmp`
    - entry point in “wrong” segment
    - switching segments
    - library calls without normal dynamic linker mechanisms

infection behavior
    - modifying executables/system files
    - weird network connections

example heuristics: DREBIN (1)

from 2014 research paper on Android malware: Arp et al, “DREBIN: Effective and Explainable Detection of Android Malware in Your Pocket”

features from applications (without running):

- hardware requirements
- requested permissions
- whether it runs in background, with pushed notifications, etc.
- what API calls it uses
- network addresses

detect dynamic code generation explicitly

statistics (i.e. machine learning) to determine score

example heuristics: DREBIN (2)

advantage: Android uses Dalvik bytecode (Java-like)

- high-level "machine code"
- much easier/more useful to analyze

accuracy?

- tested on 131k apps, 94% of malware, 1% false positives
- versus best commercial: 96%, $< 0.3\%$ false positives
  - (probably has explicit patterns for many known malware samples)

...but

- statistics: training set needs to be typical of malware
- cat-and-mouse: what would attackers do in response?

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anti-anti-virus

defeating signatures:

avoid things compilers/linkers never do

make analysis harder
- takes longer to produce signatures
- takes longer to produce “repair” program

make changing viruses
- make any one signature less effective

some terms

armored viruses

viruses designed to make analysis harder

metamorphic/polymorphic/oligomorphic viruses

viruses that change their code each time
different terms — different types of changes (later)

encrypted(?) data

```
char obviousString[] =
    "Please␣open␣this␣100%"
    "␣safe␣attachment";
char lessObviousString[] =
    "oSZ^LZ\037POZQ\037KWVL\037\016\017"
    "\017\032\037L^YZ\037^KK^\\WRZQK";
for (int i = 0; i < sizeof(lessObviousString) - 1
    lessObviousString[i] =
        lessObviousString[i] ^ '?';
}
```

recall: hiding API calls

```
/* functions, functionsNames retrieved
   from library before */
/* 0xd7c9e758 = hash("GetFileAttributesA") */
unsigned hashOfString = 0xd7c9e758;
for (int i = 0; i < num_functions; ++i) {
    unsigned functionHash = 0;
    for (int j = 0; j < strlen(functionNames[i]);
        functionHash = (functionHash * 7 +
                        functionNames[i][j]);
    }
    if (functionHash == hashOfString) {
        return functions[i];
    }
}
```

encrypted data and signatures

doesn't really stop signatures

- "encrypted" string + decryption code is more unique

but makes analyzing virus a little harder

- how much harder?
- exercise: how would you decrypt strings?

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can we do better?

encrypted(?) viruses

```
char encrypted[] = "\x12\x45...";
char key[] = "...";
virusEntryPoint() {
    decrypt(encrypted, key);
    goto encrypted;
}
decrypt(char *buffer, char *key) {...}
```

choose a new key each time!

not good encryption — key is there

sometimes mixed with compression

encrypted viruses: no signature?

`decrypt` is a pretty good signature

still need to a way to disguise that code

how about analysis? how does one analyze this?

not just anti-antivirus

“encrypted” body

just running objdump not enough…

instead — run debugger, set breakpoint after “decryption”

dump decrypted memory afterwords

unneeded steps

understanding the “encryption” algorithm
  - more complex encryption algorithm won’t help

extracting the key and encrypted data
  - making key less obvious won’t help

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needed to know when encryption finished

needed debugger to work

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countermeasures?
- encrypt in strange order? multiple passes?
- anti-debugging (later)

example: Cascade decrypter

```
    lea encrypted_code, %si
decrypt:
    mov $0x682, %sp // length of body
    xor %si, (%si)
    xor %sp, (%si)
    inc %si
    dec %sp
    jnz decrypt
encrypted_code:
    ...
```

Szor Listing 7.1

example: Cascade decrypter

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Szor Listing 7.1

decrypter

more variations:

  nested decrypters, different orders, etc.

still problem: decrypter code is signature

...but harder to distinguish different malware

often tries to frustrate debugging in other ways

  e.g. use stack pointer (not for the stack)
  (more on this later)

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“disinfection” — want to precisely identify malware

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often tries to frustrate debugging in other ways

- e.g.
- (mo

easiest way to defeat decrypter manually:
run in debugger until code is decrypted

legitimate “packers”

some commercial software is packaged in this way

…including antidebugging stuff

why? intended to be copy/reverse engineering protection

playing mouse

signature-based techniques:

- scan for pattern of constant part of virus
- scan for strings, approx. 16-bytes long
- shortcut: scan top and bottom

virus-writer hat: how can you defeat these?

- encrypting code? — encrypter is pattern

playing mouse

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- scan for pattern of constant part of virus
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change some trivial part of virus — e.g. add nops somewhere

adding nops

instead of copying, copy but insert nops

a little tricky — only between instructions

could have hard-coded places to insert

- likely easy to turn into signature
- or tricky to write

or can parse instructions

- x86 encoding isn't *that bad*
- malware can use limited subset

producing changing malware

not just nop:

switch between synonym instructions

swap registers

random instructions that manipulate ‘unused’ register

…

oligomorphic viruses

use packing technique but

make slight changes to decrypters

example: W95/Memorial

```
  mov $0x405000, %ebp
  mov $0x550, %ecx
  lea 0x2e(%ebp), %esi
  add 0x29(%ebp), %ecx
  mov 0x2d(%ebp), %al

decrypt:
  nop
  nop
  xor %al, (%esi)
  inc %esi
  nop
  inc %al
  dec %ecx
  jnz decrypt
  ...
```

```
  mov $0x550, %ecx
  mov $0x13bc000, %ebp
  lea 0x2e(%ebp), %esi
  add 0x29(%ebp), %ecx
  mov 0x2d(%ebp), %al

decrypt:
  nop
  nop
  xor %al, (%esi)
  inc %esi
  nop
  inc %al
  loop decrypt
  ...
  ...
```

Szor, Listsings 7.3 and 7.4

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```

change instruction order; location of decryption key/etc.

Szor, Listsings 7.3 and 7.4

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variable choices of loop instructions

Szor, Listsings 7.3 and 7.4

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  ...
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Szor: “96 different decryptor patterns”

Szor, Listsings 7.3 and 7.4

more advanced changes?

Szor calls W95/Memorial oligomoprhic

- “encrypted” code
- plus small changes to decrypter

What about doing more changes to decrypter?

- many, many variations

Szor calls doing this polymorphic

polymorphic example: 1260

example: 1260 (virus)

```
    inc %si
    mov $0x0e9b, %ax
    clc
    mov $0x12a, %di
    nop
    mov $0x571, %cx
decrypt:
    xor %cx, (%di)
    sub %dx, %bx
    sub %cx, %bx
    sub %ax, %bx
    nop
    xor %cx, %dx
    xor %ax, (%di)
    ...
```

```
    mov $0x0a43, %ax
    nop
    mov $0x15a, %di
    sub %dx, %bx
    sub %cx, %bx
    mov $0x571, %cx
    clc
decrypt:
    xor %cx, (%di)
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adapted from Szor, Listing 7.5

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do-nothing instructions

adapted from Szor, Listing 7.5

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    ...
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different decryption “key”

adapted from Szor, Listing 7.5

lots of variation

essentially limitless variations of decrypter

- huge number of `nop`-like sequences
- plus reordering non-`nop` instructions

can't just make scanner that skips obvious `nop`s

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could try to analyze more deeply for nops

- could identify when instruction's result is unused

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- huge number of `nop`-like sequences
- plus reordering non-`nop` instructions

can't just make scanner that skips obvious `nop`s

could try to analyze more deeply for nops

- could identify when instruction's result is unused

but attacker can be more sophisticated:

```
inc %ax; dec %ax
xor %ax, %bx; xor %bx, %ax; xor %ax, %bx
…
```

interlude: anti-packer strategies

finding packers

easiest way to decrypt self-decrypting code — run it!

solution: virtual machine in antivirus software

makes antivirtualization/emulation more important

finding packers with VM

run program in VM for a while
- how long?

then scan memory for known patterns

or detect jumping to written memory

stopping packers

it's unusual to jump to code you wrote

modern OSs: memory is executable or writable — not both

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modern OSs: memory is executable or writable — not both

diversion: DEP/`W^X`

memory executable or writeable — but not both

exists for exploits (later in course), not packers

requires hardware support to be fast (early 2000s+)

various names for this feature:

- Data Execution Prevention (DEP) (Windows)
- `W^X` ("write XOR execute")
- NX/XD/XN bit (underlying hardware support)
  - (No Execute/eXecute Disable/eXecute Never)

special system call to switch modes

unusual, but...

binary translation

- convert machine code to new machine code at runtime

Java virtual machine, JavaScript implementations

- “just-in-time” compilers

dynamic linkers

- load new code from a file — same as writing code?

those packed commercial programs

programs need to explicitly ask for write+exec

finding packers

easiest way to decrypt self-decrypting code — run it!

solution: virtual machine in antivirus software

makes antivirtualization/emulation more important

antivirtualization techniques

query virtual devices

time operations that are slower in VM/emulation

use operations not supported by VM

antivirtualization techniques

query virtual devices

time operations that are slower in VM/emulation

use operations not supported by VM

virtual devices

VirtualBox device drivers?

VMware-brand ethernet device?

…

antivirtualization techniques

query virtual devices

  solution: mirror devices of some real machine

time operations that are slower in VM/emulation

use operations not supported by VM

antivirtualization techniques

query virtual devices

time operations that are slower in VM/emulation

use operations not supported by VM

slower operations

not-“native” VM:

  everything is really slow

otherwise — trigger “callbacks” to VM implementation:

  system calls?

  allocating and accessing memory?

…and hope it’s reliably slow enough

antivirtualization techniques

query virtual devices

time operations that are slower in VM/emulation

- solution: virtual clock

use operations not supported by VM

antivirtualization techniques

query virtual devices

time operations that are slower in VM/emulation

use operations not supported by VM

operations not supported

missing instructions kinds?
- FPU instructions
- MMX/SSE instructions
- undocumented (!) CPU instructions

not handling OS features?
- setting up special handlers for segfault
- multithreading
- system calls that make callbacks
- ...

antivirus not running system VM to do decryption
needs to emulate lots of the OS itself

attacking emulation patience

looking for unpacked virus in VM

...or other malicious activity

when are you done looking?

attacking emulation patience

looking for unpacked virus in VM

...or other malicious activity

when are you done looking?

malware solution: take too long

- not hard if emulator uses “slow” implementation

attacking emulation patience

looking for unpacked virus in VM

...or other malicious activity

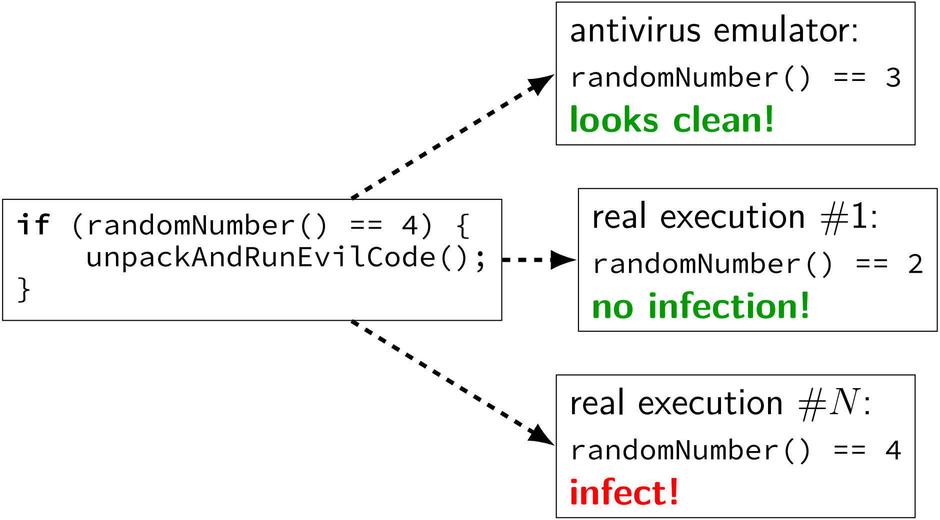
when are you done looking?

malware solution: take too long

- not hard if emulator uses “slow” implementation

malware solution: don’t infect consistently

probability



```
if (randomNumber() == 4) {
    unpackAndRunEvilCode();
}
```

antivirus emulator:

`randomNumber() == 3`

looks clean!

real execution $\#1$:

`randomNumber() == 2`

no infection!

real execution $\#N$:

`randomNumber() == 4`

infect!

on goats

analysis (and maybe detection) uses *goat files*

"sacrificial goat" to get changed by malware

heuristics can avoid simple goat files, e.g.:

- don't infect small programs
- don't infect huge programs
- don't infect programs with huge amounts of `nops`
- …

goats as detection

tripwire for malware

touching do-nothing `.exe` — very likely bad

goats as analysis

more important for analysis of changing malware

want examples of multiple versions

want it to be obvious where malware code added

- e.g. big cavities to fill in original
- e.g. obvious patterns in original code/data

changing bodies

“decrypting” a virus body gives body for “signature”

- “just” need to run decrypter

how about avoiding static signatures entirely

called metamorphic

- versus polymorphic — only change “decrypter”

example: changing bodies

```
pop %edx
mov $0x4h, %edi
mov %ebp, %esi
mov $0xC, %eax
add $0x88, %edx
mov (%edx), %ebx
mov %ebx, 0x1118(%esi,%eax,4)
```

```
pop %eax
mov $0x4h, %ebx
mov %ebp, %esi
mov $0xC, %edi
add $0x88, %eax
mov (%eax), %esi
mov %esi, 0x1118(%esi,
```

code above: after decryption

every instruction changes

still has good signatures

- with alternatives for each possible register selection

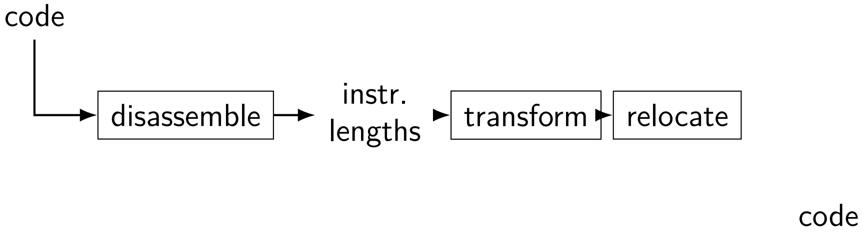
but harder to write/slower to match

case study: Evol

via Lakhatia et al, "Are metamorphic viruses really invincible?", Virus Bulletin, Jan 2005.

"mutation engine"

run as part of propagating the virus



code

disassemble

instr. lengths

transform

relocate

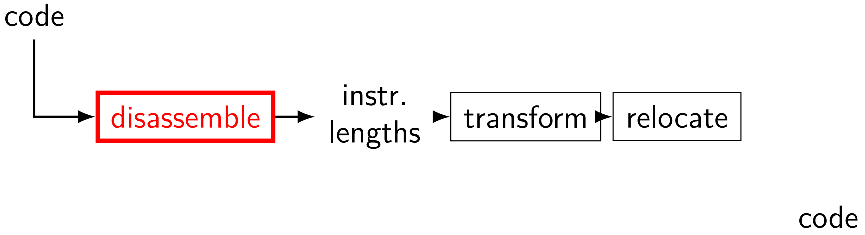
code

case study: Evol

via Lakhatia et al, “Are metamorphic viruses really invincible?”, Virus Bulletin, Jan 2005.

“mutation engine”

  run as part of propagating the virus



code

disassemble

instr. lengths

transform

relocate

code

Evol instruction lengths

sounds really complicated?

virus only handles instructions it has:

- about 61 opcodes, 32 of them identified by first four bits
  - e.g. opcode `0x7`*x* – conditional jump

no prefixes, no floating point

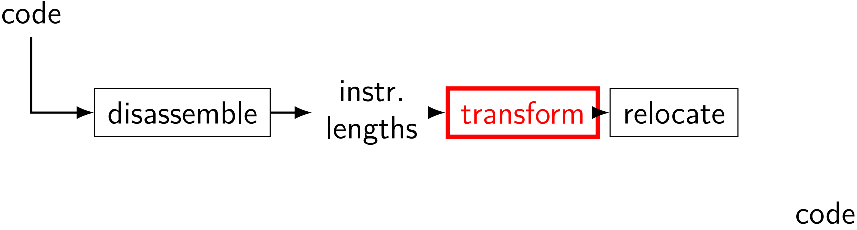
only `%reg` or `$constant` or `offset(%reg)`

case study: Evol

via Lakhatia et al, “Are metamorphic viruses really invincible?”, Virus Bulletin, Jan 2005.

“mutation engine”

run as part of propagating the virus



Evol transformations

some stuff left alone

static or random one of N transformations

example:

```
mov %eax, 8(%ebp)
```

```
push %ecx
mov %ebp, %ecx
add $0x12, %ecx
mov %eax, −0xa(%ecx)
pop %ecx
```

uses more stack space — save temporary
code gets bigger each time

Lakhotia et al., "Are metamorphic viruses really invincible?", Virus Bulletin, Jan 2005

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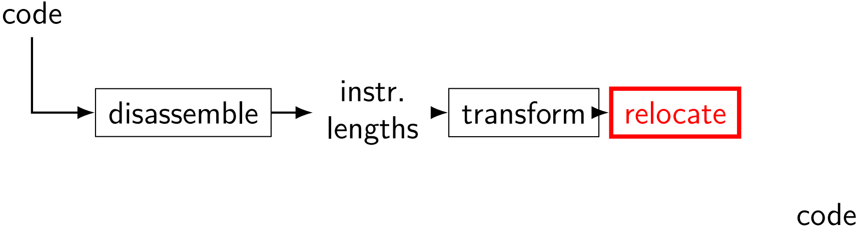

mutation with relocation

table mapping old to new locations
  list of number of bytes generated by each transformation

list of locations references in original
  record relative offset in jump
  record absolute offset in original

relocation example

```
    mov ...
    mov ...
decrypt:
    xor %rax, (%rbx)
    inc %rbx
    dec %rcx
    jne decrypt
```

orig. len	new len	instr
5	10	mov1
2	3	mov2
2	7	xor1
1	1	inc1
1	5	dec1
3	3	jne1

address loc	orig. target	new target
$10+3+7+1+5+1$ (jne1+1)	xor1 $(5+2)$	xor1 $(10+3)$

mutation engines

tools for writing polymorphic viruses

best: no constant bytes, no “no-op” instructions

tedious work to build state-machine-based detector
- ((almost) a regular expression to match it)
- apparently done manually
- automatable?

pattern: used until reliably detected

fancier mutation

can do mutation on generic machine code

“just” need full disassembler

identify both instruction lengths and addresses

hope machine code not written to rely on machien code sizes, etc.

hope to identify tables of function pointers, etc.

fancier mutation

also an infection technique
- no “cavity” needed — create one

obviously tricky to implement
- need to fix all executable headers
- what if you misparse assembly?
- what if you miss a function pointer?

example: Simile virus

antiantivirus

already covered:

- break disassemblers — with packers
- break VMs/emulators

break debuggers

- make analysis harder

break antivirus software itself

- “retrovirus”

antiantivirus

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diversion: debuggers

we'll care about two pieces of functionality:

breakpoints

- debugger gets control when certain code is reached

single-step

- debugger gets control after a single instruction runs

diversion: debuggers

we'll care about two pieces of functionality:

breakpoints

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single-step

debugger gets control after a single instruction runs

implementing breakpoints

idea: change

```
movq %rax, %rdx
addq %rbx, %rdx // BREAKPOINT HERE
subq 0(%rsp), %r8
...
```

into

```
movq %rax, %rdx
jmp debugger_code
subq 0(%rsp), %r8
...
```

implementing breakpoints

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movq %rax, %rdx
addq %rbx, %rdx // BREAKPOINT HERE
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...
```

into

```
movq %rax, %rdx
jmp debugger_code
subq 0(%rsp), %r8
...
```

problem: `jmp` might be bigger than `addq`?

int 3

x86 breakpoint instruction: **`int 3`**

- Why 3? fourth entry in table of handlers

one byte instruction encoding: CC

debugger modifies code to insert breakpoint

- has copy of original somewhere

invokes handler setup by OS

- debugger can ask OS to be run by handler
- or changes pointer to handler directly on old OSes

int 3 handler

kind of exception handler

- recall: exception handler = way for CPU to run OS code

x86 CPU saves registers, PC for debugger

x86 CPU has easy to way to resume debugged code from handler

detecting int 3 directly (1)

checksum running code

```
mycode:
    ...
    movq $0, %rbx
    movq $mycode, %rax
loop:
    addq (%rax), %rbx
    addq $8, %rax
    cmpq $endcode, %rax
    jl loop
    cmpq %rbx, $EXPECTED_VALUE
    jne debugger_found
    ...
endcode:
```

detecting int 3 directly (2)

query the “handler” for int 3

- old OSs only; today: cannot set directly

modern OSs: ask if there’s a debugger attached

…or try to attach as debugger yourself

- doesn’t work — debugger present, probably
- does work — broke any debugger?

```
 // Windows API function!
if (IsDebuggerPresent()) {
```

modern debuggers

`int 3` is the oldest x86 debugging mechanism

modern x86: 4 “breakpoint” registers (DR0–DR3)

- contain address of program instructions
- need more than 4? sorry

processor triggers exception when address reached

- 4 extra registers + comparators in CPU?

flag to invoke debugger if debugging registers used

- enables nested debugging

diversion: debuggers

we'll care about two pieces of functionality:

breakpoints

- debugger gets control when certain code is reached

single-step

- debugger gets control after a single instruction runs

implementing single-stepping (1)

set a breakpoint on the following instruction?

```
movq %rax, %rdx
addq %rbx, %rdx // ←— STOPPED HERE
subq 0(%rsp), %r8 // ←— SINGLE STEP TO HERE
subq 8(%rsp), %r8
...
```

transformed to

```
movq %rax, %rdx
addq %rbx, %rdx // ←— STOPPED HERE
int 3 // ←— SINGLE STEP TO HERE
subq 8(%rsp), %
...
```

then `jmp` to `addq`

implementing single-stepping (1)

set a breakpoint on the following instruction?

```
movq %rax, %rdx
addq %rbx, %rdx // ←− STOPPED HERE
subq 0(%rsp), %r8 // ←− SINGLE STEP TO HERE
subq 8(%rsp), %r8
...
```

transformed to

```
movq %rax, %rdx
addq %rbx, %rdx // ←− STOPPED HERE
int 3 // ←− SINGLE STEP TO HERE
subq 8(%rsp), %
...
```

then `jmp` to `addq`

implementing single-stepping (2)

typically hardware support for single stepping

x86:`int 1` handler (second entry in table)

x86: TF flag: execute handler after every instruction

...except during handler (whew!)

Defeating single-stepping

try to install your own `int 1` handler
    (if OS allows)

try to clear TF?
    (if debugger doesn't reset it)

unstealthy debuggers

is a debugger installed?

- unlikely on Windows, maybe ignore those machines

is a debugger process running (don't check if it's tracing you)

…

confusing debuggers

“broken” executable formats

- e.g., recall ELF: segments and sections
- corrupt sections — program still works
- overlapping segments/sections — program still works

use the stack pointer not for the stack

- stack trace?

antiantivirus

already covered:

- break disassemblers — with packers
- break VMs/emulators

break debuggers

- make analysis harder

break antivirus software itself

- “retrovirus”

attacking antivirus (1)

how does antivirus software scan new things?

- register handlers with OS/applications — new files, etc.

how about registering your own?

hooking

hooking — getting a ‘hook’ to run on (OS) operations

e.g. creating new files

ideal mechanism: OS support

less ideal mechanism: change library loading

e.g. replace ‘open’, ‘fopen’, etc. in libraries

less ideal mechanism: replace OS exception (system call) handlers

very OS version dependent

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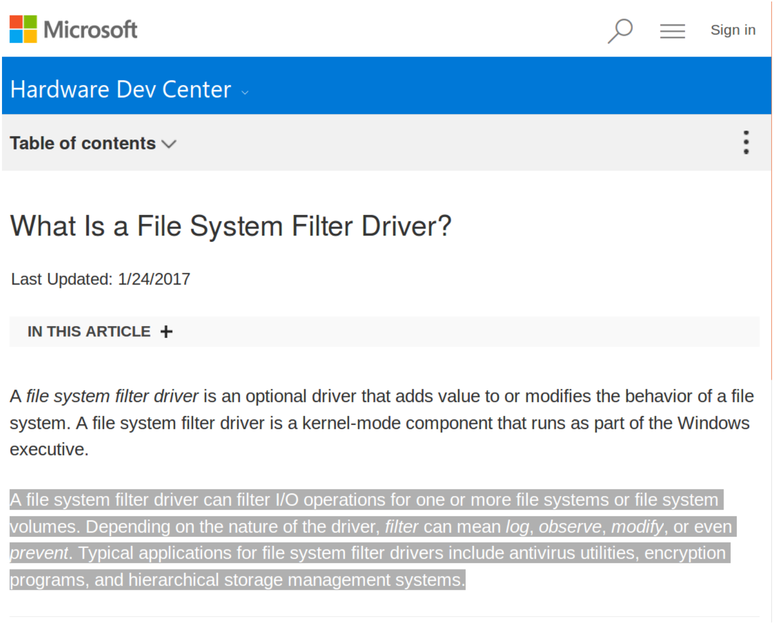

What Is a File System Filter Driver?

Last Updated: 1/24/2017

A *file system filter driver* is an optional driver that adds value to or modifies the behavior of a file system. A file system filter driver is a kernel-mode component that runs as part of the Windows executive.

A file system filter driver can filter I/O operations for one or more file systems or file system volumes. Depending on the nature of the driver, *filter* can mean *log*, *observe*, *modify*, or even *prevent*. Typical applications for file system filter drivers include antivirus utilities, encryption programs, and hierarchical storage management systems.

hooking

hooking — getting a ‘hook’ to run on (OS) operations

- e.g. creating new files

ideal mechanism: OS support

less ideal mechanism: change library loading

- e.g. replace ‘open’, ‘fopen’, etc. in libraries

less ideal mechanism: replace OS exception (system call) handlers

- very OS version dependent

changing library loading

e.g. install new library — or edit loader, but …

not everything uses library functions

what if your wrapper doesn't work exactly the same?

hooking

hooking — getting a ‘hook’ to run on (OS) operations

- e.g. creating new files

ideal mechanism: OS support

less ideal mechanism: change library loading

- e.g. replace ‘open’, ‘fopen’, etc. in libraries

less ideal mechanism: replace OS exception (system call) handlers

- very OS version dependent

attacking antivirus (2)

just directly modify it

- example: IDEA.6155 modifies database of scanned files

preserve checksums

- example: HybrisF preserved CRC32 checksums of infected files
- some AV software won't scan again

armored viruses

"encrypted" viruses

- not strong encryption — key is there!

self-changing viruses:

encrypted ⟷ oligiomorphic ⟷ polymorphic ⟷ metamorphi

breaking debuggers, antivirus

residence

our model of malware — runs when triggered

reality: sometimes keep on running

- evade active detection
- spread to new programs/files as created/run

real signatures: ClamAV

ClamAV: open source email scanning software

signature types:

- hash of file
- hash of contents of segment of executable
  - built-in executable, archive file parser
- fixed string
- basic regular expressions
  - wildcards, character classes, alternatives
- more complete regular expressions
  - including features that need more than state machines
- meta-signatures: match if other signatures match
- icon image fuzzy-matching