File Infection Techniques: File Resident Viruses

CS 4440/7440 Malware Analysis & Defense
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Viruses: Online Resources

- Symantec Virus Encyclopedia: http://securityresponse.symantec.com/avcenter/vinfodb.html
- McAfee Virus Information Library: http://vil.nai.com/vil/default.aspx

File Infection Techniques

- Executable files (*.EXE, *.COM, *.BAT, etc.) are often the **target** of viruses
- Executing an infected file usually **triggers replication** of the virus into other files
- Executable file infection techniques can be categorized broadly by asking **where** the virus code is placed in the file

Location: Beginning of the File

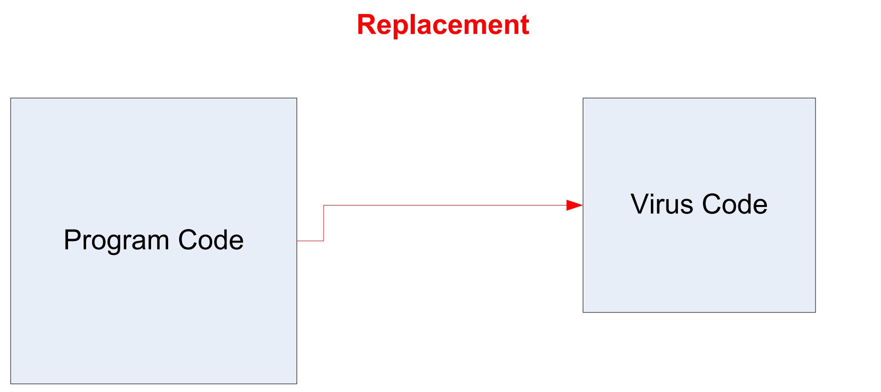
- Henceforth, *beginning* always refers to the start of the executable code, which might follow a header area in some file formats
- A virus can either preserve the original beginning of the file, or destroy it by overwriting
- Destructiveness always reduces the stealthiness of the virus

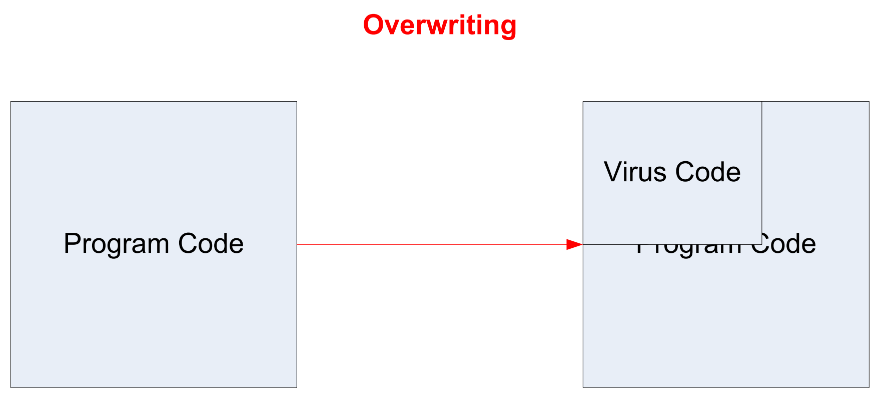
Beginning of the File with Destructive Overwrite

- Two primary methods:
  - Replace *.exe file with virus *.exe
  - Overwrite only the beginning of a *.exe that is larger than the virus *.exe
- Neither method is stealthy:
  - The *.exe has lost its functionality entirely, so the user notices that something is wrong
  - Anti-virus software finds a virus easily right at the beginning of the file
- The first method often changes the file size, making it even less stealthy than the second method

Beginning of the File with Destructive Overwrite

- Two primary methods:

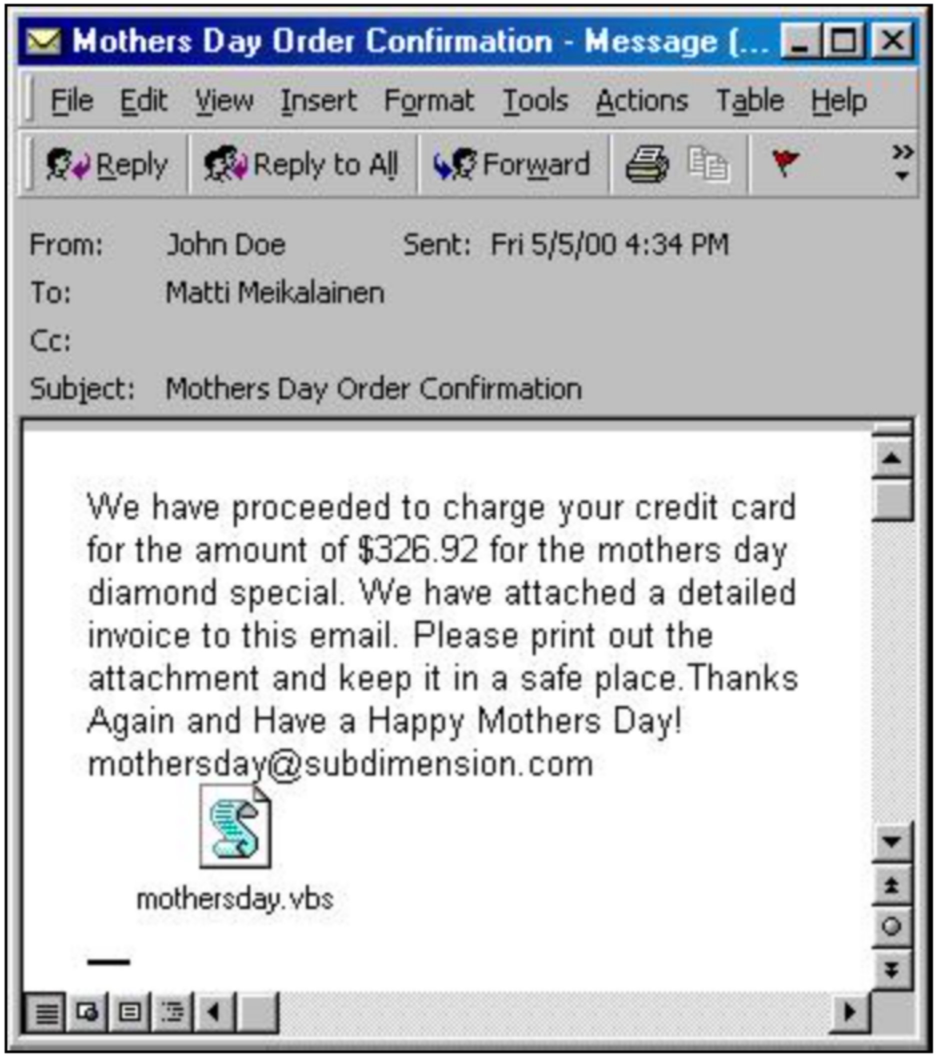




Beginning of the File with Destructive Overwrite cont' d.

- The file size change was only significant for stealthy viruses when first-generation anti-virus software depended on keeping track of file sizes
- Both kinds of overwriting viruses can only be repaired by restoring files from a backup
- E.g. the *LoveLetter* mass mailer worm, after replicating by email, overwrote **every** file on the system that had one of 32 file extensions: *.c, *.cpp, *.mp3, *.vbs, etc.
  - It had already replicated to other systems, so it no longer tried to remain stealthy; a common design for worms

Loveletter screenshot


Mothers Day Order Confirmation - Message (...
File Edit View Insert Format Tools Actions Table Help
Reply
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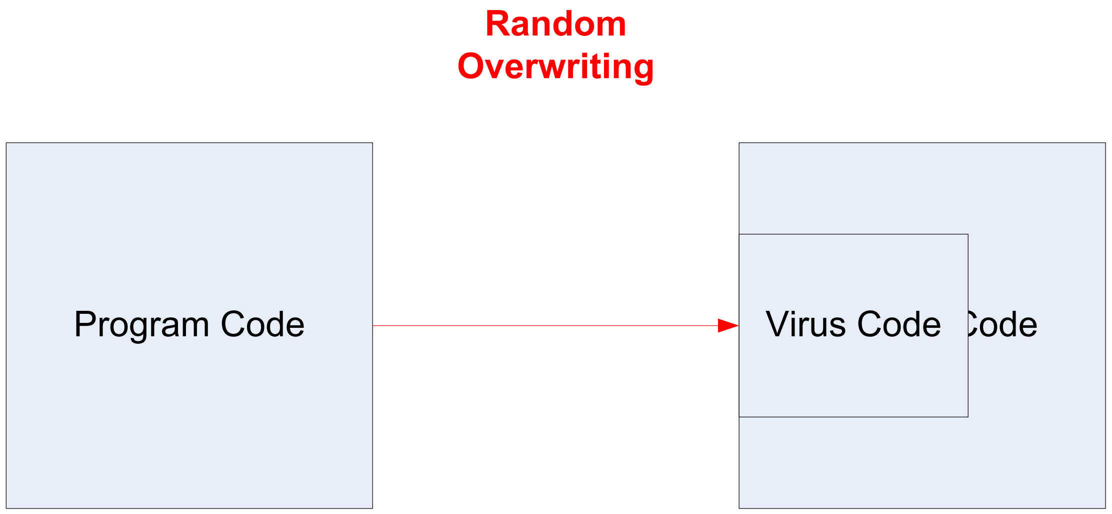
From: John Doe Sent: Fri 5/5/00 4:34 PM
To: Matti Meikalainen
Cc:
Subject: Mothers Day Order Confirmation

We have proceeded to charge your credit card for the amount of $326.92 for the mothers day diamond special. We have attached a detailed invoice to this email. Please print out the attachment and keep it in a safe place.Thanks Again and Have a Happy Mothers Day!
mothersday@subdimension.com

mothersday.vbs

Random File Location with Destr. Overwrite

- The Russian Omud virus, also called 8888, overwrote at a random location in the *.exe file.
  - Anti-virus software must now search the entire file to find it;
    - this defeated early anti-virus software
  - Control might transfer to the virus during execution of the *.exe, or it might not, or program might crash; stealth came at a price!

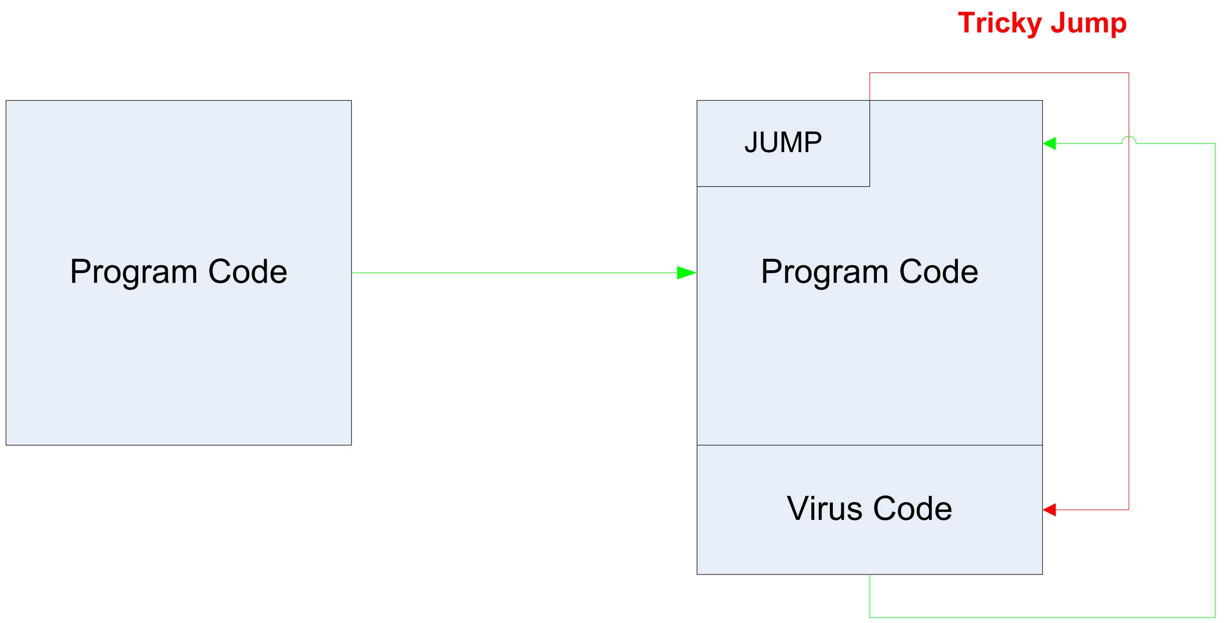


Appending Viruses

- A jump, or tricky jump, to the virus address is overwritten on the first few bytes of the executable
- Virus code is appended to the file
- Overwritten instructions are saved in the virus
  - When the virus is about to terminate, it executes the saved instructions and jumps back to the spot that followed them
  - Application program functionality is preserved (stealth)
- So common among DOS .COM files that it was called the *normal COM* virus technique;
  - *Vienna* and *Suicide* are famous examples of this kind of virus

Appending Viruses

- The jump, or tricky jump, is easily spotted by anti-virus software
- The file size has changed



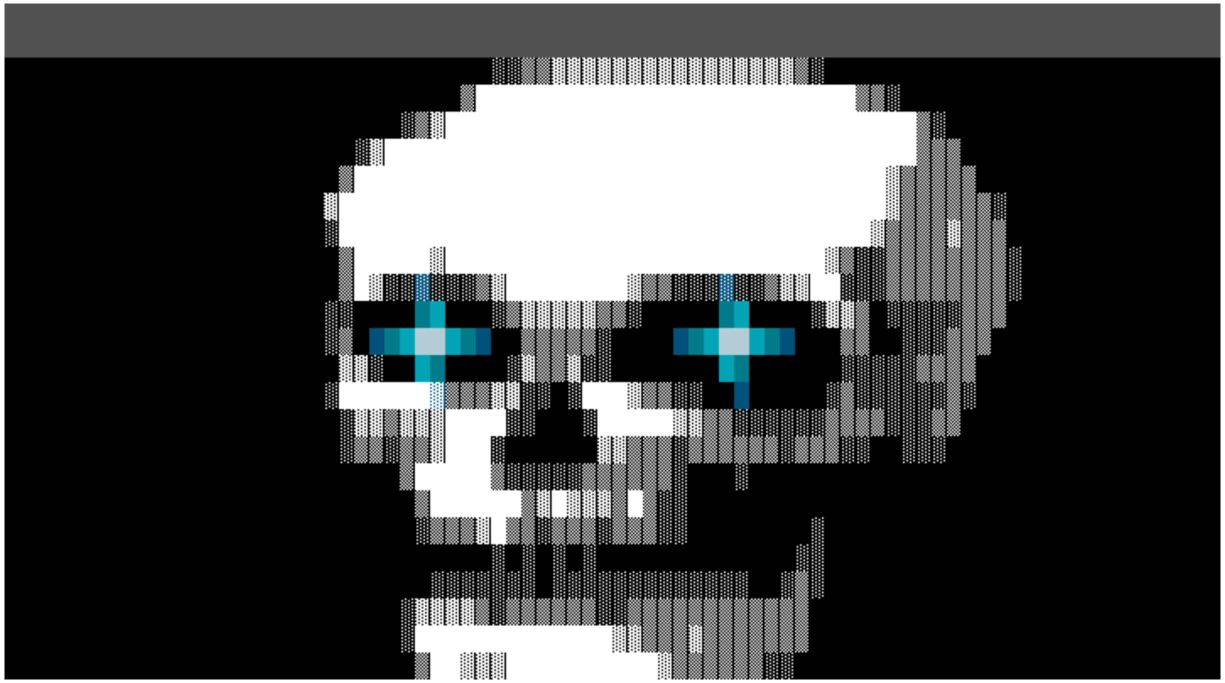
Appending Viruses

- The stealth depends on
  - executing the original application successfully when the virus code has finished, AND
  - not spending too long in the virus code
- In order to execute the application successfully, the virus often
  - copies the application code into a temporary file, then
    - calls system() or a similar function to execute the contents of that file
  - Must pass original command-line arguments!

Multiple Techniques

- Many viruses implement, in one virus, several of the techniques we have studied
- 1991 DOS normal COM example: Phantom
  - Appending COM file infector (normal COM)
  - Memory resident: installs itself into high DOS memory, reduces available memory by about 2KB, monitors system activity and infects COM files as they are executed
  - Hooks interrupts 20h and 21h in order to intercept COM file executions
  - Existed in multiple variants with different messages

Phantom Visual Payload



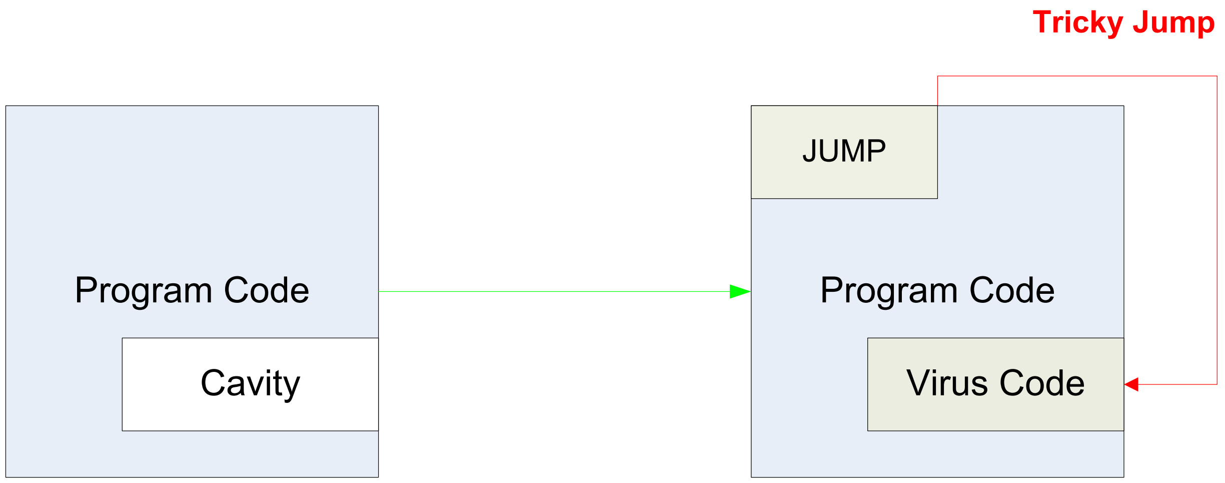
Amazing that the payload and the replication only took 2KB! Tight ASM programming.

Cavity Viruses

- Virus creators often search for space within a file that is filled with zeroes or ASCII blanks
- These spaces, or **cavities**, can be filled with virus code without changing the file size
- A single cavity might be big enough for the whole virus, or the virus might be distributed into multiple small cavities, loaded into memory by the virus loader code at the head of the virus, connected by jump instructions (a *fractionated cavity* virus)
- Still need to reach the start of the virus with a jump, or modify the PE entry point

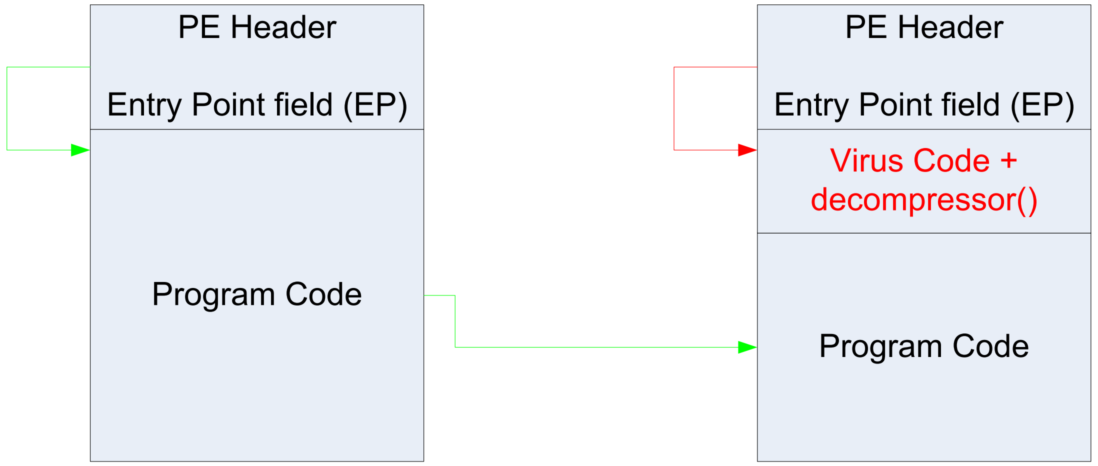
Cavity Viruses

- Jump, or modified PE entry point, detectable by anti-virus software
- Disinfection can be difficult (was the original cavity full of zeroes, or ASCII blanks?)



Compressing Viruses

- Application code is compressed
- Virus code plus decompressor code fits into the space that was saved
- Can keep the file size from changing
- Might not even change the entry point!



Compressing Viruses cont'd.

- How can a compressing virus be detected and disinfected?
- The virus code might even be compressed, so that only the decompressor code is recognizable as normal code
- However, a self-extracting archive would have a similar appearance and be quite legitimate
- File size and entry point could be unchanged
- Application behavior could be preserved

Detecting a Compressing Virus

- When a virus outbreak occurs, reports come in to major anti-virus software vendors from their customers
- More expensive system scans than are normal for a background anti-virus program might reveal that known applications now have unintelligible executables

1. Disassembly tools are used to examine the code, and
    1. **human intelligence** is needed to find the decompressor code
2. A copy of the virus code can be decompressed using the decompressor
3. The virus design is then figured out by walk-throughs

Detecting a Compressing Virus cont'd.

- Which other files on the system are targeted for infection can now be determined by examining the virus code
- A code pattern is devised that describes unique instruction sequences in the decompressor code
- The system is scanned to verify that this code pattern is not found in uninfected files
- The virus code pattern database is updated, and customers download the update
- More on pattern recognition shortly
- How can such a file be disinfected?

Disinfecting a Compressing Virus

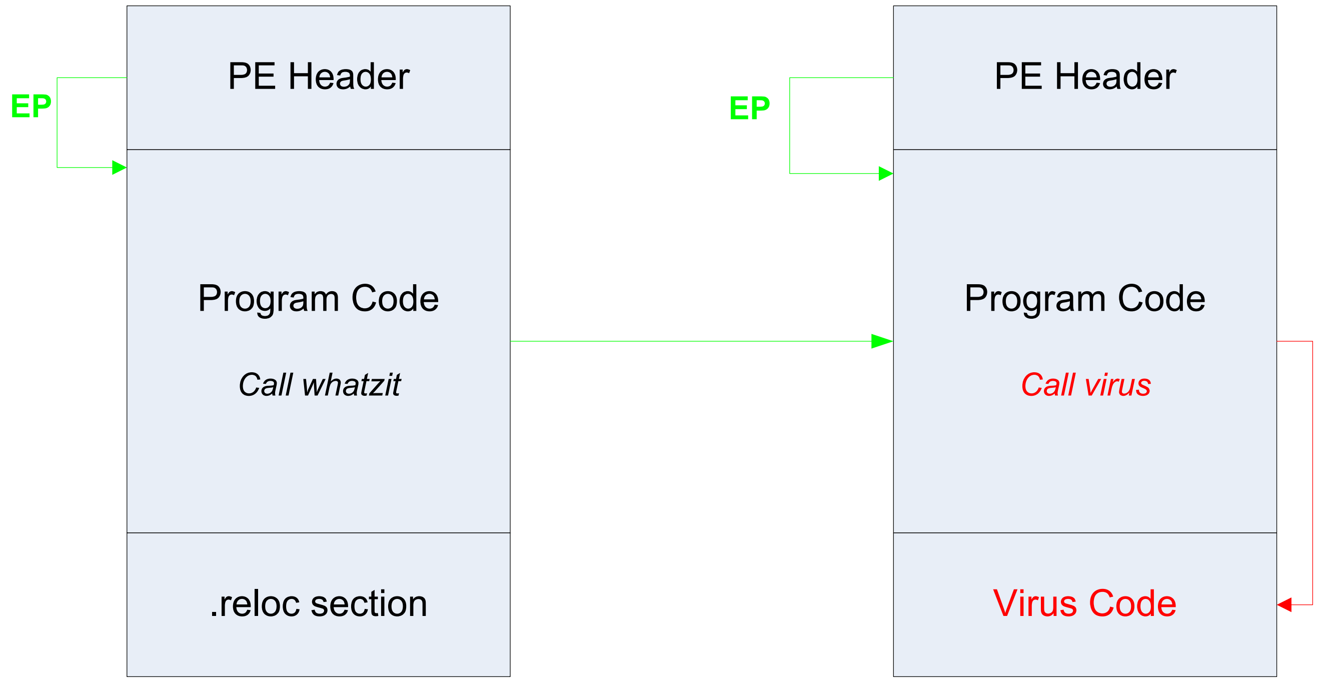
- With the virus and decompressor understood, the decompressor algorithm can be applied to the compressed application code
- The virus code and decompressor are removed
- The anti-virus software might maintain a database of cryptographic checksums for application executables
- If the disinfected application now matches its stored checksums, success is declared
- Otherwise, restore the file from backup

Entry-Point Obscuring (EPO) Viruses

- Anti-virus software closely examines PE file headers, entry points, and the initial code executed at the entry point
  - A stealthy virus must be designed to avoid changes to any of these locations
- An **EPO virus** obscures its own entry point by finding a call instruction in the targeted PE file and "hijacking" the call so that the virus code is called instead

EPO Viruses cont'd

- A function call within the application becomes a call to the virus code.



EPO Viruses cont’d

- The virus code saves the registers in order to preserve the parameters that were being passed. Also saves the original call target address.
- When the virus finishes executing,
  - it restores the registers and
  - does a jump back to the original call target
- Q: How does a virus find a call to hijack?

EPO Viruses cont'd

- How can a virus find a function call?
  - The binary opcodes can be scanned. However, constant data in the code section can happen to have the same value as a call opcode
- The most well-designed viruses examine the field that gives the target of the call.
  - What does the virus do with this field?
  - How does this help the virus?

If it points to an address that looks like a function prologue (e.g. `push ebp; mov esp,ebp`) then the virus proceeds to hijack the call

EPO Viruses cont' d

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  - If target points to an address that looks like a function prologue (e.g. `push ebp; mov esp,ebp`) then the virus proceeds to hijack the call

EPO Viruses cont’d

- The .reloc section gives information to be used if the program has to be relocated during execution,
  - i.e. reloaded at a different load point because the system had to defragment memory or some other reason
- Relocation during execution is unusual, so the .reloc section usually sits unused, e.g. in statically linked executables
  - Unfortunately, this provides a large cavity for viruses to use and still leave the file size unchanged
- How could such an infection be detected?

Detecting Call-Hijacking Viruses

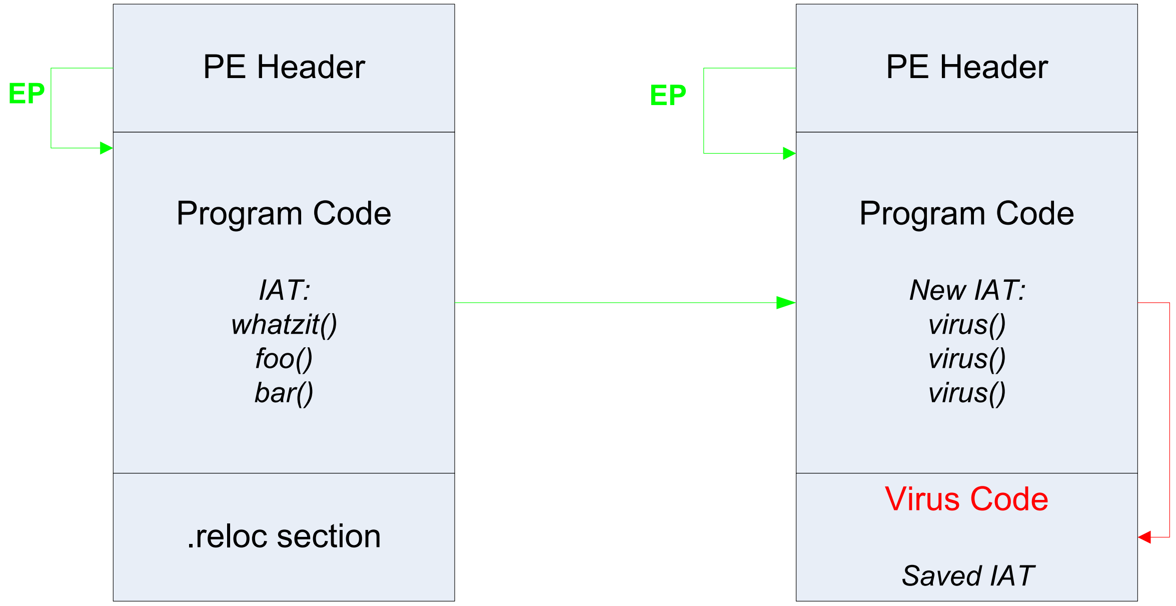
- The .reloc section is examined by modern anti-virus software to see if it looks like a legitimate .reloc section
- Code patterns such as saving state, tricky jumps, etc., can be detected in the .reloc section
- Some EPO viruses are accidentally destructive; hard to re-enter the application successfully in some cases

EPO Viruses: IAT Replacement

- The IAT (import address table) is the function pointer table that exports the API (application program interface) that the user application is presenting to outside callers
- Several IAT function pointers can be saved in the virus body, then replaced with pointers to the virus code
- After the virus code is memory-resident, it can restore the IAT in memory so that the API is preserved and stealth is maintained

EPO Viruses: IAT Replacement

- The *Tentacle* and *Tentacle-II* viruses were 16-bit Windows examples, infecting the NE (New Executable) files that were the ancestors of PE



Tentacle Screenshot