

Persistent BIOS Infection



“The early bird catches the worm”

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Agenda

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- A better choice
- What is the BIOS
- BIOS Structure
- How it works
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- Where to patch
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Introduction

- Practical approach to generic & reliable BIOS code injection
- True Persistency
- Rootkit(ish) behavior
- OS independant





A little bit of history:

Commonly used persistency methods:

- User mode backdoor
- Kernel mode backdoor

How can this be done more effectively?



BIOS Level backdoor:

- Takes control before any other software
- Stealth behavior
- Generally forgotten by almost all Antiviruses
- OS Independant (Runs outside the OS context)



What is the BIOS?

- BIOS stands for Basic Input Output System
- Boot firmware
- Hardware initialization (RAM, North Bridge, etc.)
- Size: 256 Kb and bigger
- Commonly stored on [EEPROM](#) or [flash memory](#)



BIOS Structure

- It is composed of various LZH compressed modules
- Each module has an 8 bit checksum
- There are some uncompressed modules:
 - Bootblock: In charge of the POST, and emergency boot
 - Decompression routine: decompresses the rest of the modules
- Various checksum checks.



+-----+-----+-----+-----+-----+-----+-----+-----+									
Class.Instance (Name)		Packed --->		Expanded		Compression		Offset	
+-----+-----+-----+-----+-----+-----+-----+-----+									
B.03	(BIOSCODE)	06DAF	(28079)	=>	093F0	(37872)	LZINT	(74%)	446DFh
B.02	(BIOSCODE)	05B87	(23431)	=>	087A4	(34724)	LZINT	(67%)	4B4A9h
B.01	(BIOSCODE)	05A36	(23094)	=>	080E0	(32992)	LZINT	(69%)	5104Bh
C.00	(UPDATE)	03010	(12304)	=>	03010	(12304)	NONE	(100%)	5CFDFh
X.01	(ROMEXEC)	01110	(04368)	=>	01110	(4368)	NONE	(100%)	6000Ah
T.00	(TEMPLATE)	02476	(09334)	=>	055E0	(21984)	LZINT	(42%)	63D78h
S.00	(STRINGS)	020AC	(08364)	=>	047EA	(18410)	LZINT	(45%)	66209h
E.00	(SETUP)	03AE6	(15078)	=>	09058	(36952)	LZINT	(40%)	682D0h
M.00	(MISER)	03095	(12437)	=>	046D0	(18128)	LZINT	(68%)	6BDD1h
L.01	(LOGO)	01A23	(06691)	=>	246B2	(149170)	LZINT	(4%)	6EE81h
L.00	(LOGO)	00500	(01280)	=>	03752	(14162)	LZINT	(9%)	708BFh
X.00	(ROMEXEC)	06A6C	(27244)	=>	06A6C	(27244)	NONE	(100%)	70DDAh
B.00	(BIOSCODE)	001DD	(00477)	=>	0D740	(55104)	LZINT	(0%)	77862h
.00	(TCPA_)	00004	(00004)	=>	00004	(004)	NONE	(100%)	77A5Ah
D.00	(DISPLAY)	00AF1	(02801)	=>	00FE0	(4064)	LZINT	(68%)	77A79h
G.00	(DECOMPCODE)	006D6	(01750)	=>	006D6	(1750)	NONE	(100%)	78585h
A.01	(ACPI)	0005B	(00091)	=>	00074	(116)	LZINT	(78%)	78C76h
A.00	(ACPI)	012FE	(04862)	=>	0437C	(17276)	LZINT	(28%)	78CECh
B.00	(BIOSCODE)	00BD0	(03024)	=>	00BD0	(3024)	NONE	(100%)	7D6AAh



How it works

- The first instruction executed by the CPU is a 16 byte opcode located at F000:FFF0
- The Bootblock POST (Power On Self Test) initialization routine is executed.
- Decompression routine is called and every module is executed.
- Initializes PCI ROMs.
- Loads bootloader from hard-disk and executes it.

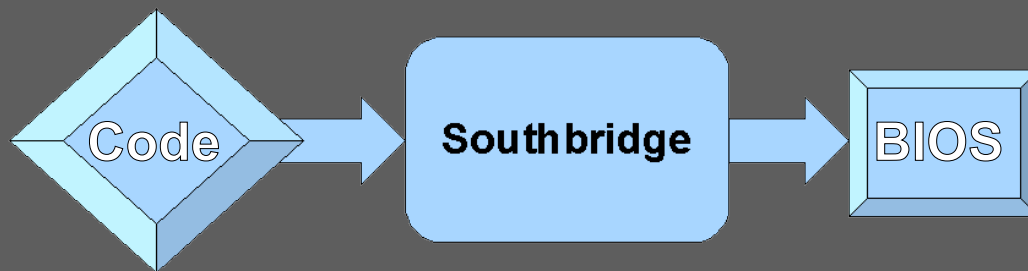


BIOS Memory Map

0x00100000	
0x000F0000	System BIOS
0x000E0000	BIOS temporary code
0x000D0000	ROMs (RAID, PCI, etc)
0x000C0000	VGA Video BIOS
0x000A0000	VGA Video RAM
0x0000400	DOS Programs
0x00000000	Interrupt vectors table

Update/flashing process

- BIOS is upgradeable.
- Vendors provide periodic updates to add new features and fix bugs. They also provide their own tools to flash from DOS, windows, and even from ActiveX!
- BIOS update procedure depends on South-Bridge and chip used.
- CoreBOOT project provides a generic BIOS flashing tool: flashrom, that supports most motherboard/chip combination.





A Simple way to patch BIOS

- BIOS contains several checksums
- Any modification leads to an unbootable system.
- We used two techniques:
 - 1) Use a BIOS building tool (Pinczakko's method)
 - 2) Patch and compensate the 8-bit checksum
- Three easy steps:
 - 1) Dump BIOS using flashrom
 - 2) Patch and compensate
 - 3) Re-flash



Where to patch

- Anywhere is valid:
 - f000:fff0: First instruction executed.
 - INT 0x19: Executed before booting
 - Insert a ROM module: Executing during POST
- The most practical place: Decompressor
 - It's uncompressed!
 - Located easily by pattern matching
 - Almost never change
 - Called multiple times during boot



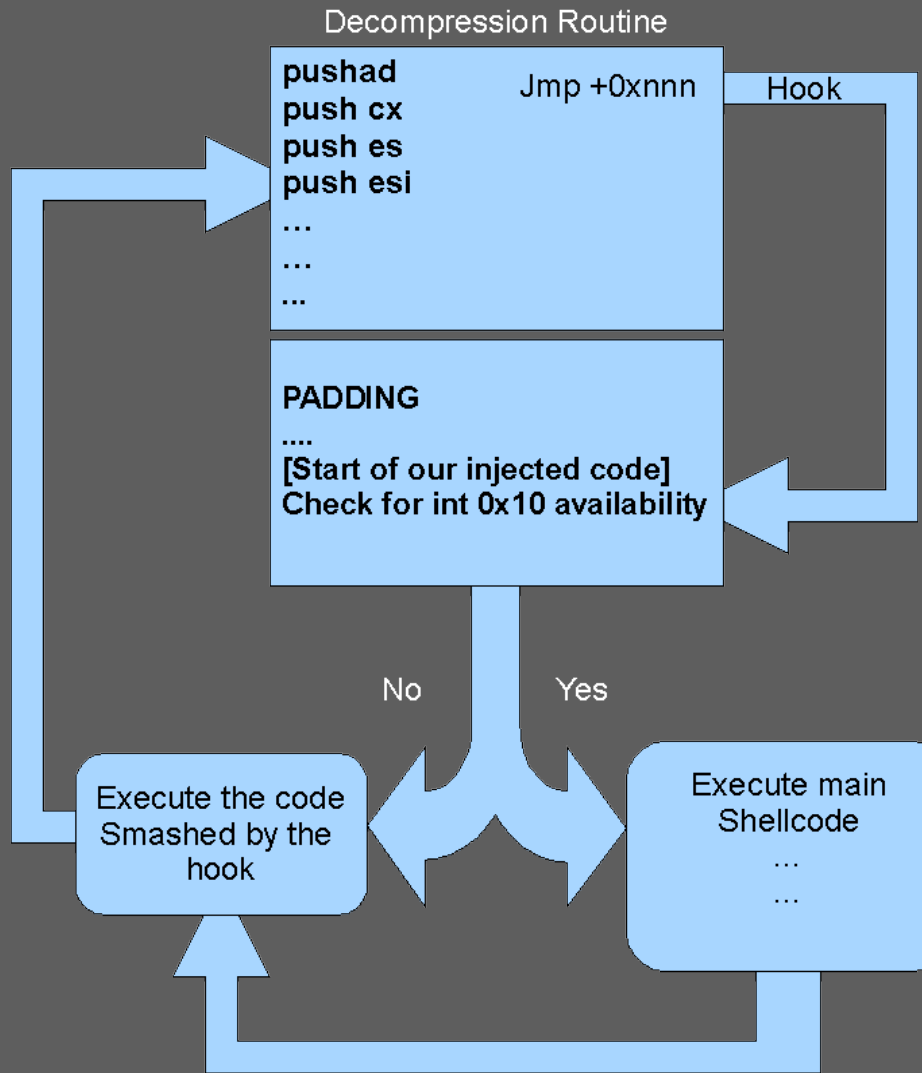
What can be done

- Depends. What resources are available from BIOS?
 - Standardized Hard Disk access (Int 13h)
 - Memory Manager (PMM)
 - network access (PXE, Julien Vanegue technique)
 - Modem and other hardware (Needs a driver)
- Our choice was to modify hard-disk content:
 - 1) Modify shadow file on unix
 - 2) Code injection on windows binaries



Shellcodes

- Shellcodes are all in 16 bit
- We use BIOS services for everything
- Easy to debug: BIOS execution environment can be emulated running the code as a COM file over DOS
- Pseudocode:
 - 1) Checks ready-signal
 - 2) Checks for services initialization
 - 3) Runs





Virtual machine demo

- Virtual machines also have a BIOS!
 - In VMWARE, It's embedded as a section of the main VM process, shared on all Vms.
 - Also can be specified on the VMX file for each VM.
 - Is a phoenix BIOS.
 - Very easy to develop because of the embedded GDB server.
 - Using Interrupt Vector Table as ready-signal
- Two attacks:
 - OpenBSD shadow file
 - Windows code injection
- This method will infect multiple virtual machines.



Real hardware demo

- We infected an Phoenix-Award BIOS
- Extensively used BIOS
- Using the VGA ROM signature as ready-signal.
- No debug allowed here, all was done by Reverse-Engineering and later, Int 10h (Not even printf!)
- Injector tool is a 100-line python script!



Future research

- Virtualized Rootkit
- PCI device placement (Modems, VGA, Ethernet and RAID controllers)
- The ultimate BIOS rootkit...

Thank you for your attention!