Persistent BIOS Infection

"The early bird catches the worm"

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CORE SECURITY TECHNOLOGIES

Agenda

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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

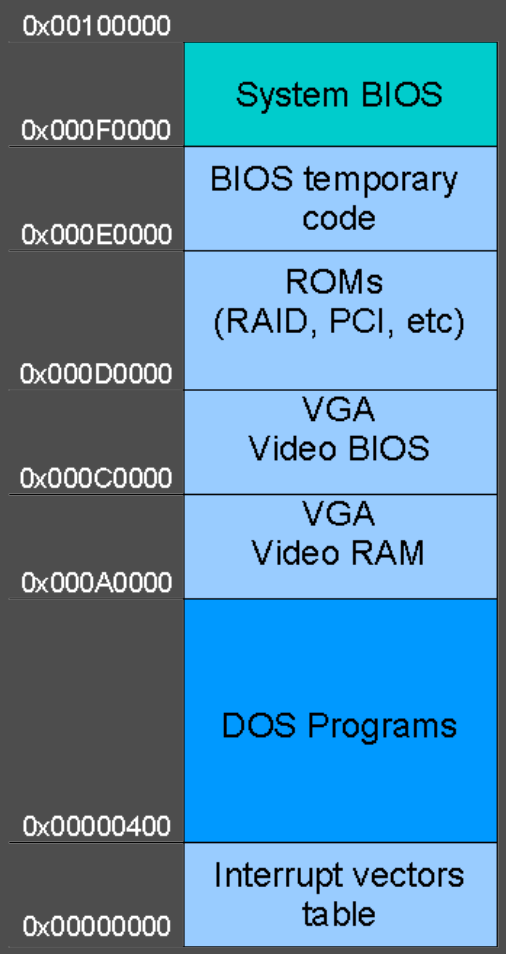
The Bootblock POST (Power On Self Test) initialization routine is executed.

Decompression routine is called and every module is executed.

Initializes PCI ROMs.

Loads bootloader from hard-disk and executes it.

BIOS Memory Map

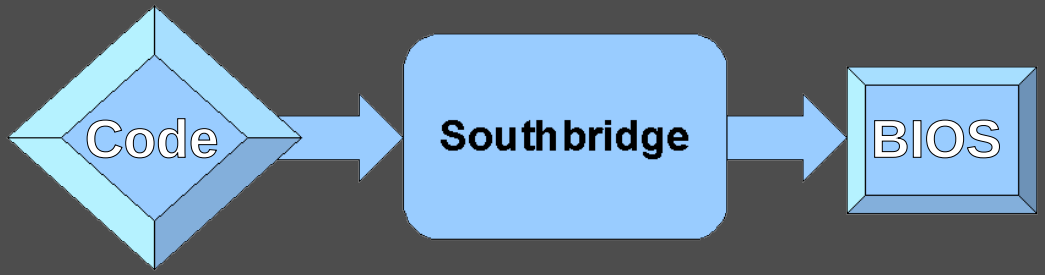


Update/flashing process

to add new features and fix bugs. They also provides it's own tools to flash from DOS, wind

on South-Bridge and chip used.

neric 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: Exected 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?
Standarized 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

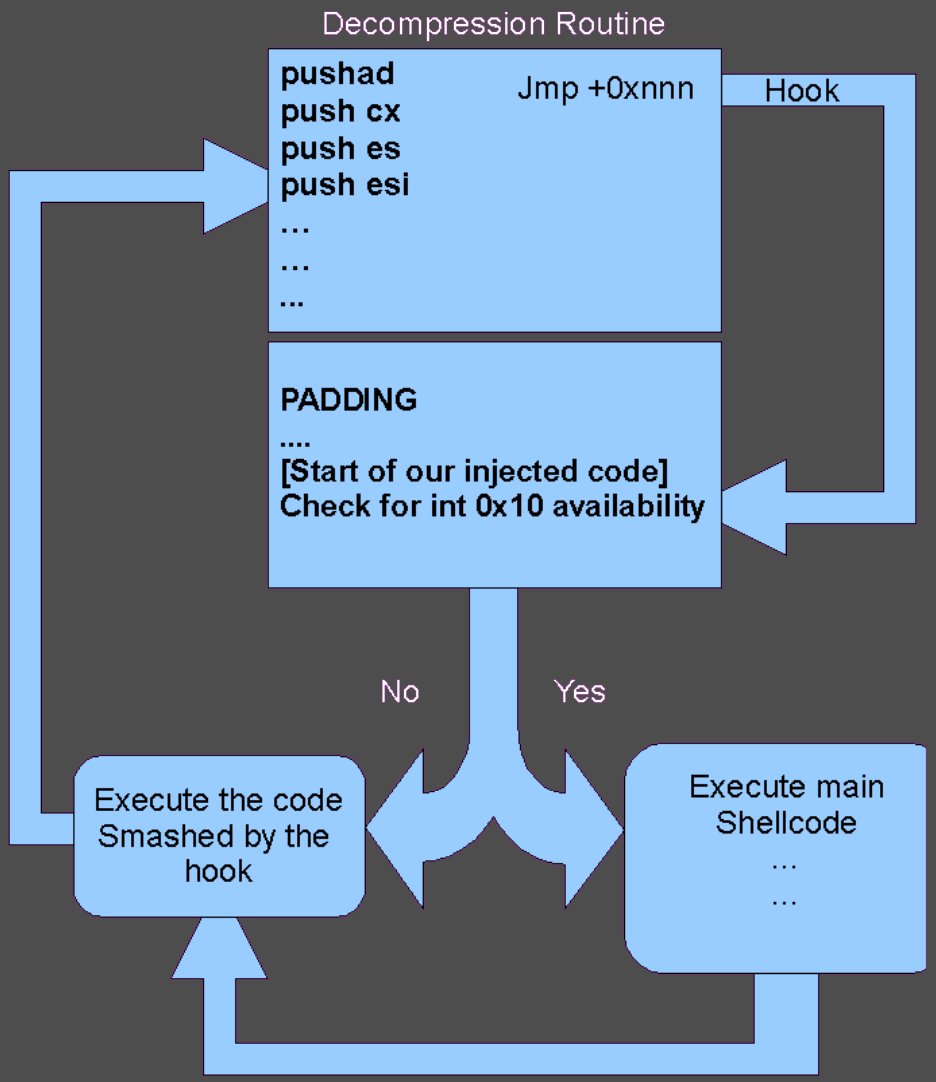
Shellcodes

des are all in 16 bit

BIOS services for everything

debug: BIOS execution enviroment can be emulated running the code as a COM file over D

code:
s ready-signal
hecks for services inicialization
uns


Decompression Routine
pushad
push cx
push es
push esi
…
…
...
Jmp +0xnnn
Hook
PADDING
....
[Start of our injected code]
Check for int 0x10 availability
No
Yes
Execute the code Smashed by the hook
Execute main Shellcode
…
…

How to protect yourself

he initial access with common methods (Antiviruses, Firewalls, etc.) to avoid the BIOS mod

e flash WP (Write Protection) on motherboard

lly signed BIOS firmwares

ading BIOS updates from untrusted sources

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 Vr
- 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.

eal hardware demo

Ve infected an Phoenix-Award BIOS

xtensively used BIOS

Jsing the VGA ROM signature as ready-signal.

lo debug allowed here, all was done by Reverse-Engineering and later, Int 10h (Not even pr

njector 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!