Debugging Windows Applications with IDA Bochs Plugin

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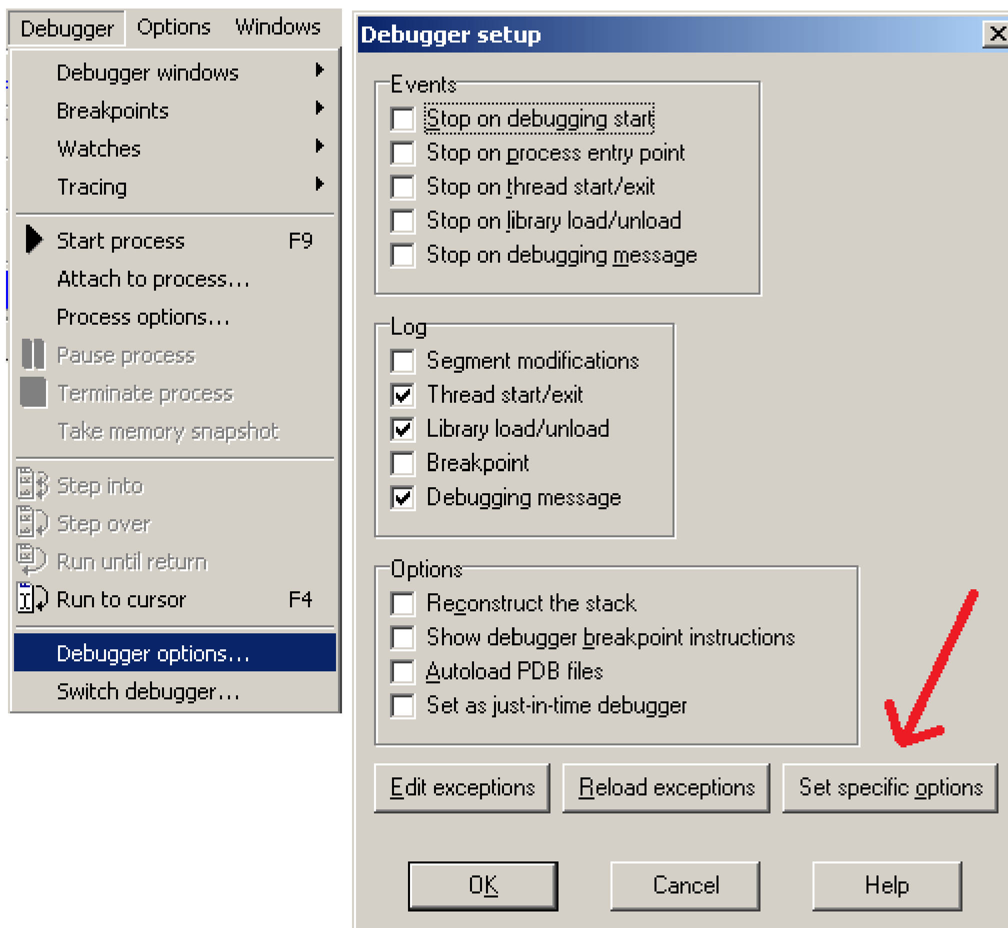
Quick overview:

The IDA Bochs debugger plugin allows malware researchers to debug malicious code in a safe/emulated environment. This is implemented using the open source x86 emulator Bochs,.

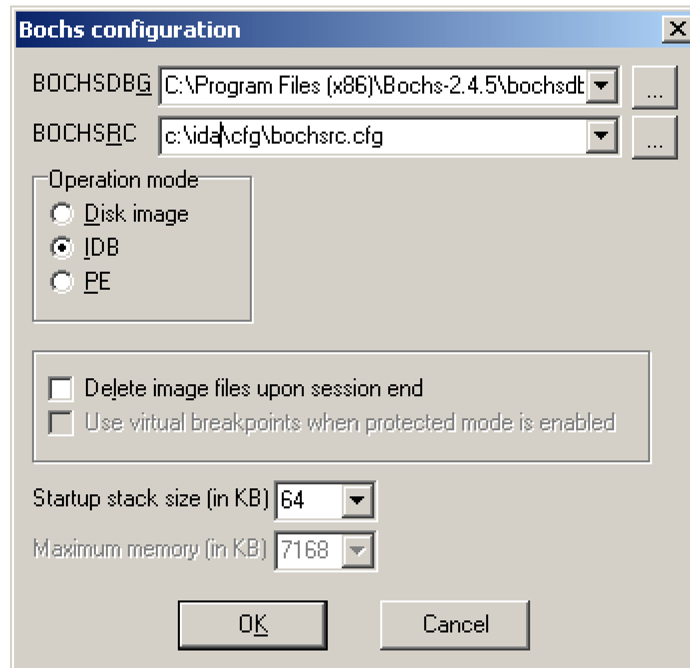
To get started, you need to install supported Bochs version (v2.3.7 or above) from http://bochs.sourceforge.net/

After installing it, make sure you « Switch Debugger » and select the Bochs debugger.

IDA can automatically detect where Bochs is installed, but if it fails it is possible to reconfigure it in the Debugger Setup / Specific Debugger options:



In this screen, « Debugger specific options », we configure the Bochs plugin:



BOCHSDBG
This parameter specifies the path to the bochsdbg.exe executable. IDA tries to guess it by looking at the BXSHARE environment variable or by checking the system registry for Bochs registry keys

BOCHSRC

This is the path to the Bochs configuration file template. It contains special variables prefixed with "$". These variables should not be modified or changed by the user, they are automatically filled by the plugin. Other entries in this template can be modified as needed.

Operation mode

The user can choose between the following three operation modes:

- Disk image: Debug a complete operating system (use IDA Pro as an interface to the Bochs debugger)
- IDB: Debug the contents of the database (or just a selection)
- PE: Debug an MS Windows PE files

Delete image files upon session end

If enabled, IDA will automatically delete the Bochs disk images used during the debugging session (this option only applies to IDB and PE operation modes).
In the IDB operation mode, the Bochs plugin tries to find a previously created image, verifies that it corresponds to the database and uses it as is. Unchecking this option in this case (IDB operation mode) can speed up launching the debugger.

Debugging a Bochs disk image:

With the disk image loader it is possible to debug any Bochs disk image.

First prepare a virtual machine:

- myvm.bochsrc: This file contains the Bochs configuration, such as the disk image file name, cdrom config, network card, bios file, etc...
- myvm_diskimage.bin: This is the actual disk image file containing the operating system

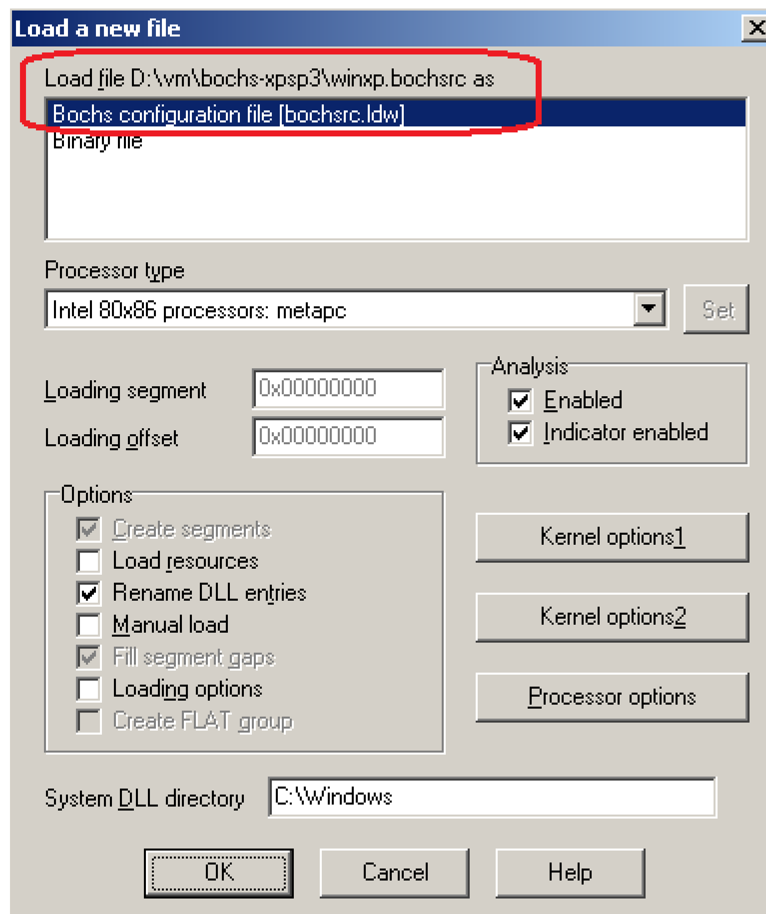
Then test if the VM works properly with Bochs:

« bochs.exe -f myvm.bochsrc »

If everything is okay then Bochs should start emulating the operating system in question.

Now let us debug the image with IDA Pro:

- Run IDA Pro and load the bochsrc file (for example: myvm.bochsrc)
- IDA Pro should recognize the file:

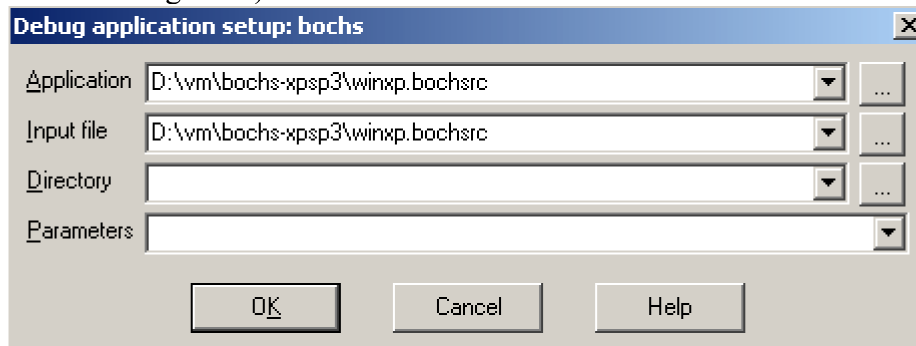


- The first disk sector will be loaded into IDA Pro

- Now simply add breakpoints and/or just press F9 to start debugging

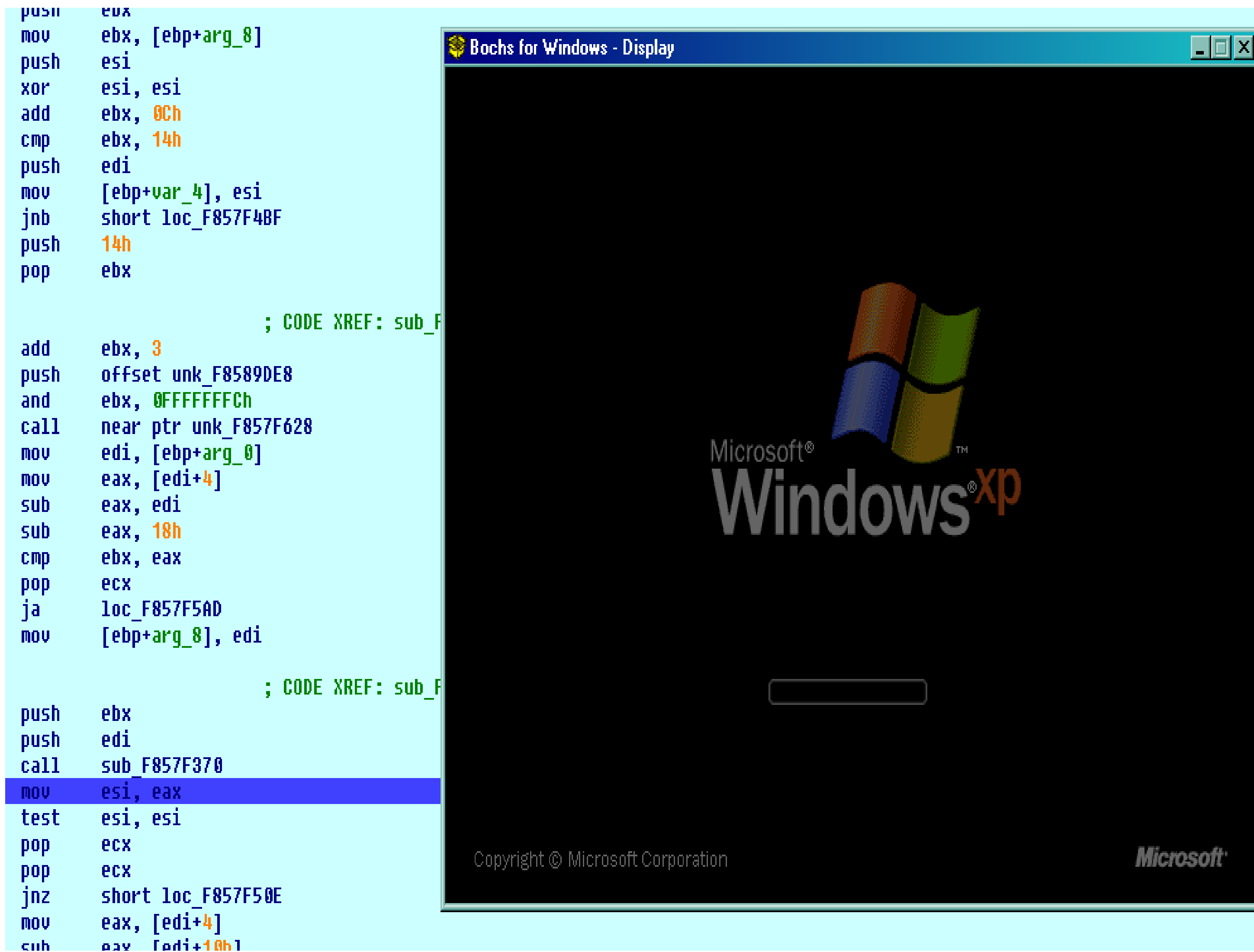
In case IDA Pro did not recognize the bochsrc file, then manually setup Bochs like this:

- Run IDA Pro with a dummy database: “idag -t”
- Save the database in the same directory as the Bochs diskimage and bochsrc file
- Select the “Bochs local debugger” from the debuggers menu
- Go to “Debugger / Specific options” and make sure the “Disk image” operation mode is selected
- Go to “Debugger / Process options” and enter the bochsrc file name in the “Application” field. (the other fields are ignored)



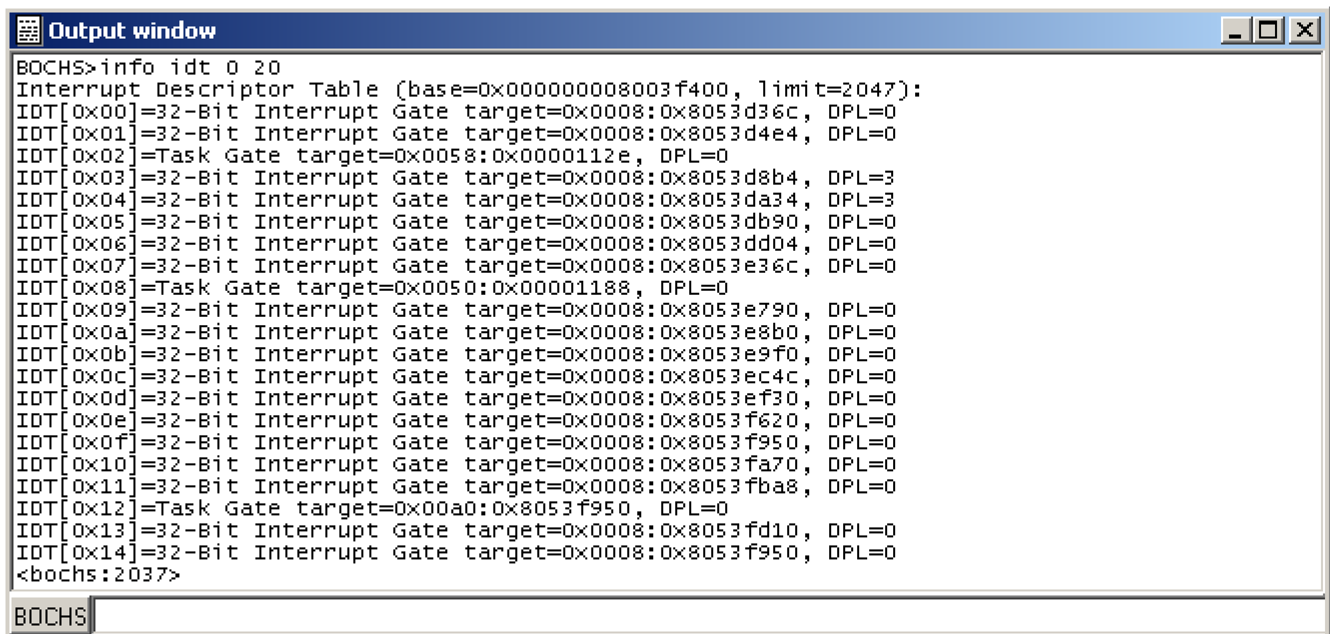
That's it. Now we can simply press F9 and start the debugger.

In this screenshot, IDA Bochs in Disk image mode is used to debug MS Windows XP.



It is possible to send commands using the command line interpreter in IDA Pro. First press « . » (dot) and then type the desired command.

For example, we can send Bochs debugger the « **info idt** » command:



Debugging code snippets:

The IDB operation mode is used to debug code snippets by simply selecting the code from the database.
In this mode, the input file format is not important. It is possible to debug code snippet from an object file, DLL file, memory dump or any other database that contains x86/32bits code.

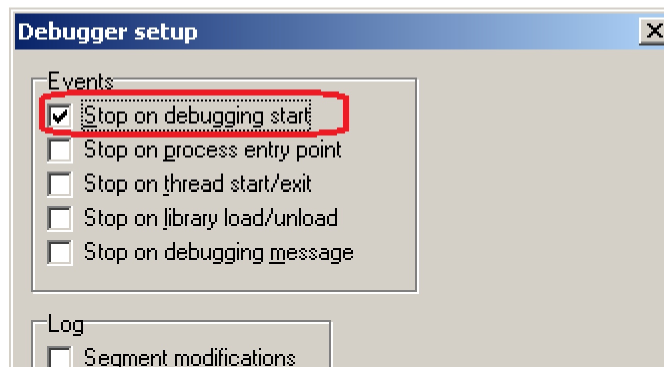
Using this mode is in fact too simple, we just have to tell it what code to debug:

- Current cursor position: Position the cursor in the database and press F9 to start debugging
- Selection: Select start and End ranges and press F9
- ENTRY and EXIT labels: Create these two labels and press F9. IDA will start executing at « ENTRY » and stop when it reaches « EXIT »

In the following screenshot, after selecting the code, we press F9 to start debugging.

```
.text:00401001                 mov     ebp, esp
.text:00401003                 add     esp, 0FFFFFFBCh
.text:00401006                 pusha
.text:00401007                 ror     edi, 15h
.text:0040100A                 mov     dx, 9616h
.text:0040100E                 lea     edi, ds:4F79E667h
.text:00401014                 lea     ebx, ds:2FD465DEh
.text:0040101A                 mov     si, 17DBh
.text:0040101E                 not     ecx
.text:00401020                 mov     ebx, 0D75C2031h
.text:00401025                 push    offset loc_40105A
.text:0040102A                 mov     edx, ebx
.text:0040102C                 rol     edx, 0Fh
.text:0040102F                 mov     ebx, esi
```

It is advisable to turn on the “Stop on debugging start” option when using the IDB mode. This enables the debugger to suspend automatically when the debugger starts.



Debugging win32 programs:

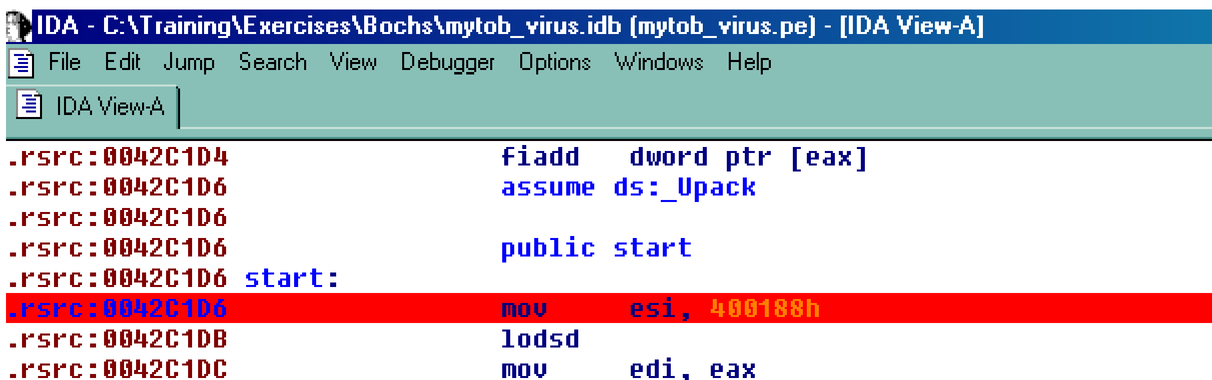
It is possible to use the Bochs debugger plugin / PE mode to debug MS win32 programs, which can be PE programs, DLLs and even system driver files.

The PE mode has many features, which are detailed in the help file and on the blog page http://hexblog.com/2008/11/bochs_plugin_goes_alpha.html

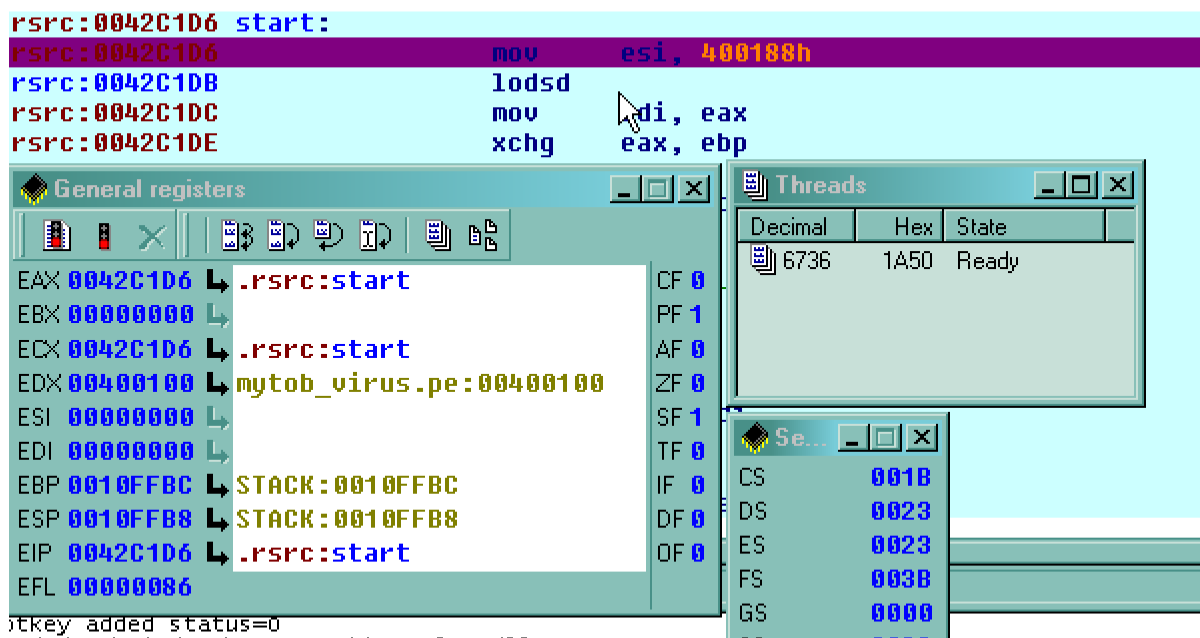
This mode is best used to debug packed malware.

For example, we will load the “Mytob” virus into IDA Pro and then the Bochs debugger / PE mode to unpack this malware.

First we put a breakpoint at the start of the program:

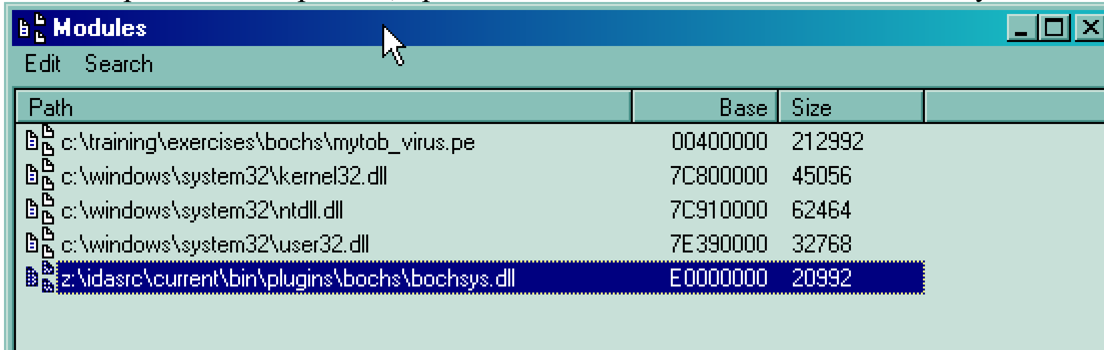


Now we press F9 to start the process and break at the beginning:

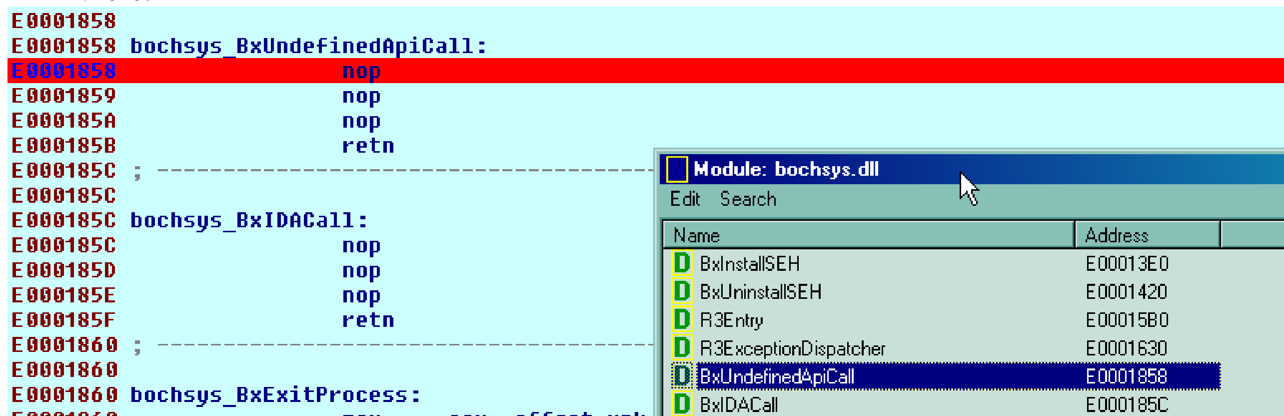


Let us use a feature in the Bochs PE mode that will allow us to break in the proximity of the original entrypoint. With this method, we do not have to trace all the way through the unpacking code.

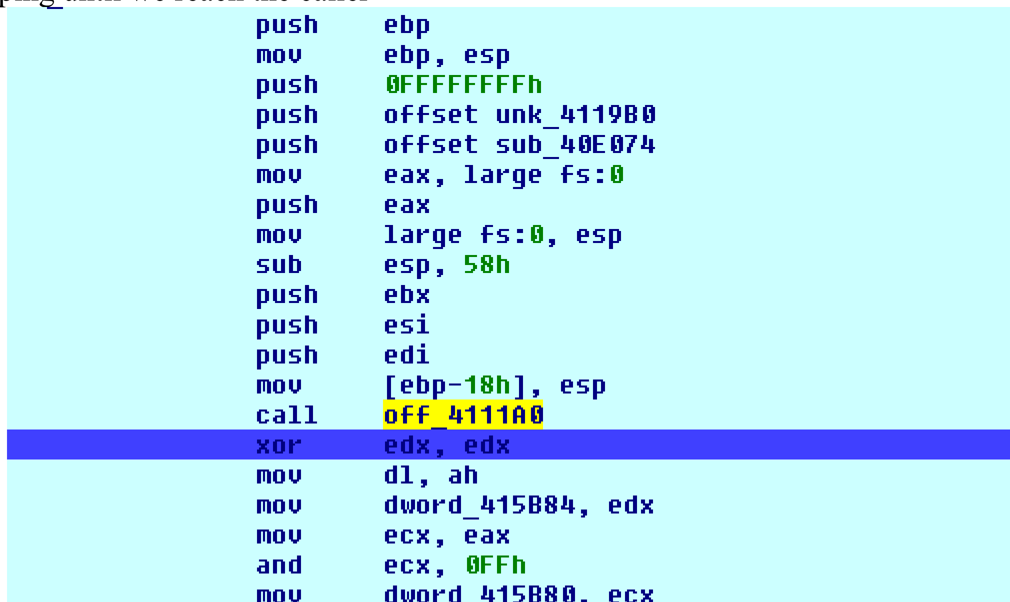
- While the process is suspended, open the modules window and select “bochsys.dll”



- Now double clicking on it will show all its exports. We are interested in “BxUndefinedApiCall”. So we simply select it and double click on it and put a breakpoint there.



- Now we press F9 again to let the malware run.
- The first time this breakpoint is reached, we could step a bit and inspect the caller. We have a high probability that the call came from the unpacked code. Anyway, we let us verify that by stepping until we reach the caller



As we see, that tracing up to the caller led us to this code which looks familiar and is actually the startup code for many VC++ programs.

Let us go to that offset and see what we got:

```
00411184 off_411184      dd offset kernel32_CompareStringW
00411184                                          ; DATA XREF: sub_410323+3E↑r
00411184                                          ; sub_410323+261↑r
00411188 off_411188      dd offset kernel32_DeleteFileA ; DATA XREF: sub_402840+FD↑r
00411188                                          ; sub_402840+132↑r ...
0041118C off_41118C      dd offset kernel32_SetThreadPriority
0041118C                                          ; DATA XREF: .Upack:00403F4F↑r
00411190 off_411190      dd offset unk_7C804247   ; DATA XREF: sub_4098E7+F0↑r
00411190                                          ; sub_40C1DD+28↑r
00411194 off_411194      dd offset kernel32_TerminateProcess
00411194                                          ; DATA XREF: sub_409FA2+17↑r
00411198 off_411198      dd offset kernel32_GetStartupInfoA
00411198                                          ; DATA XREF: .Upack:0040A18A↑r
00411198                                          ; sub_40DDD0+59↑r
0041119C off_41119C      dd offset kernel32_GetCommandLineA
0041119C                                          ; DATA XREF: .Upack:0040A15F↑r
004111A0 off_4111A0      dd offset kernel32_GetVersion ; DATA XREF: .Upack:0040A111↑r
```

It looks like we located the import functions RVAs. Let us use the “renimp.idc” script to give relevant names to these offsets:

```
00411188 ; BOOL __stdcall DeleteFileA(LPCSTR lpFileName)
00411188 DeleteFileA     dd offset kernel32_DeleteFileA ; DATA XREF: sub_402840+FD↑r
00411188                                          ; sub_4028
0041118C ; BOOL __stdcall SetThreadPriority(HANDLE hThread,
0041118C SetThreadPriority dd offset kernel32_SetThreadPriority
0041118C                                          ; DATA XREF: .Upack:00403F4F↑r
00411190 off_411190      dd offset unk_7C804247   ; DATA XREF: sub_4098E7+F0↑r
00411190                                          ; sub_40C1DD+28↑r
00411194 ; BOOL __stdcall TerminateProcess(HANDLE hProcess, UINT uExitCode)
00411194 TerminateProcess dd offset kernel32_TerminateProcess
00411194                                          ; DATA XREF: sub_409FA2+17↑r
00411198 ; void __stdcall GetStartupInfoA(LPSTARTUPINFOA lpStartupInfo)
00411198 GetStartupInfoA dd offset kernel32_GetStartupInfoA
00411198                                          ; DATA XREF: .Upack:0040A18A↑r
00411198                                          ; sub_40DDD0+59↑r
0041119C ; LPSTR __stdcall GetCommandLineA()
0041119C GetCommandLineA dd offset kernel32_GetCommandLineA
0041119C                                          ; DATA XREF: .Upack:0040A15F↑r
004111A0 ; DWORD __stdcall GetVersion()
004111A0 GetVersion      dd offset kernel32_GetVersion ; DATA XREF: .Upack:0040A111↑r
```

And finally let us go back to the OEP and see how it looks like now:

```
040A0EB start           proc near               ; CODE
040A0EB
040A0EB var_68          = dword ptr -68h
040A0EB var_64          = dword ptr -64h
040A0EB var_60          = dword ptr -60h
040A0EB var_5C          = byte ptr -5Ch
040A0EB var_30          = dword ptr -30h
040A0EB var_2C          = word ptr -2Ch
040A0EB var_18          = dword ptr -18h
040A0EB var_14          = dword ptr -14h
040A0EB var_4           = dword ptr -4
040A0EB
040A0EB                 push    ebp
040A0EC                 mov     ebp, esp
040A0EE                 push    0FFFFFFFFh
040A0F0                 push    offset unk_4119B0
040A0F5                 push    offset sub_40E074
040A0FA                 mov     eax, large fs:0
040A100                 push    eax
040A101                 mov     large fs:0, esp
040A108                 sub     esp, 58h
040A10B                 push    ebx
040A10C                 push    esi
040A10D                 push    edi
040A10E                 mov     [ebp+var_18], esp
040A111                 call    GetVersion
040A117                 xor     edx, edx
040A119                 mov     dl, ah
040A11B                 mov     dword_415B84, edx
```

That is it!

We got it unpacked, now we can delete unused segments, take a memory snapshot and get ready for static analysis or even decompilation with the Hex-Rays decompiler.

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