R4ndom's Tutorial #16A: Dealing With Windows Messages

by R4ndom on Jul.30, 2012, under Beginner, Reverse Engineering, Tutorials

Well, after overcoming two viruses (one for me and one for my computer) I finally have the latest tutorial up. This tutorial will be part of a three part tutorial, all dealing with the same crackme (a pretty hard one) called Crackme12 by Detten. In the first part we will go over how Windows messaging works. The second part will be about self-modifying code. In this part we will also crack the app. In the third and final part we will introduce bruteforcing. And you guessed it, in the third part we will bruteforce this binary. Each part will continue where the previous left off.

This three part series will be challenging, but I guarantee you that if you take your time and experiment on your own, you will gain critical knowledge in reverse engineering. And remember, if you have any questions, feel free to ask in the forum. I will also give homework at the end of each tutorial that will help you prepare for the next one. This is where the real learning will come in .

As always, the files you need will be available in the download of this tutorial on the tutorials page. For the first part, the files include the crackme and a cheat sheet for Windows messaging.

So, without further ado, let's begin…

Introduction to Windows Messaging

In this tutorial we will talk about Windows messages and the procedures that handle them. In almost all programs, with the exception of apps written in Visual Basic *sigh* , .NET, or Java, tasks are accomplished through the use of a message driven callback procedure. What this means is that, unlike in the old DOS days of programming, in Windows you simply set up the window, providing the various settings, bitmaps, menu items etc you want displayed, and then you provide a loop that runs until the program ends. This loop's sole responsibility is to receive a 'message' from Windows and send it to our app's callback function. These messages can be anything, from moving a mouse, to clicking a button, to hitting the 'X' to close an app. When we make a Windows app, we provide this endless loop in our WinMain procedure, along with an address to call whenever a message comes in. This address is our callback. This loop then sends the messages it receives to our callback function with the address we provided, and in this callback we decide whether we want to do anything with this particular message, or simply let Windows handle it.

For example. we may display a simple message box with a warning in it and an OK button. All we care about is the message that says OK was clicked. We don't care if the user moved the window (a WM_MOVE message), or clicks in our window outside the OK button (a WM_MOUSEBUTTONDOWN message). But when the message come thru that the OK button was clicked, that's when we may want to do something. All of the messages we don't want to handle, Windows handles for us. The messages we do wish to handle, we simply override Windows and do something with it.

The main procedure that sets up the windows and contains the loop is called WinMain and the callback is generally called WndProc if it's a window, or DlgProc if it's a dialog box, though the names can be anything.

I have included in the download a guide to all Windows messages that you should have open during the tutorial. You can download all of the support files on the tutorials page. You can also download the windows messages cheat sheet on the tools page.

Loading the App

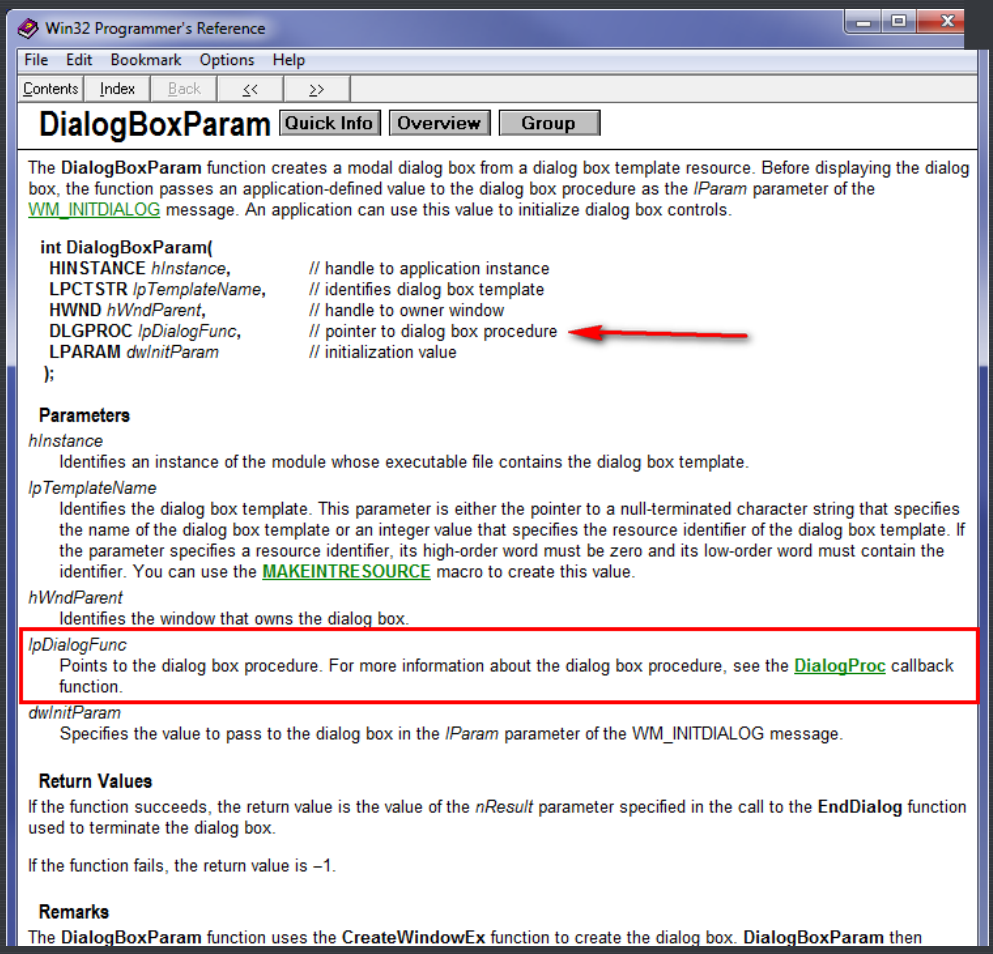
Go ahead and load Crackme12.exe into Olly and let's have a look around:

```
00401000  $  6A 00          PUSH 0                                   pModule = NULL
00401002  .  E8 C5040000    CALL <JMP.&KERNEL32.GetModuleHandleA>    GetModuleHandleA
00401007  .  A3 28304000    MOV DWORD PTR DS:[403028],EAX            kernel32.BaseThreadInitThu
0040100C  .  6A 00          PUSH 0                                   lParam = NULL
0040100E  .  68 2B104000    PUSH crackme1.0040102B                   DlgProc = crackme1.0040102
00401013  .  6A 00          PUSH 0                                   hOwner = NULL
00401015  .  68 20030000    PUSH 320                                 pTemplate = 320
0040101A  .  FF35 28304000  PUSH DWORD PTR DS:[403028]               hInst = NULL
00401020  .  E8 8F040000    CALL <JMP.&USER32.DialogBoxParamA>       DialogBoxParamA
00401025  .  50             PUSH EAX                                 ExitCode = 761F3388
00401026  .  E8 9B040000    CALL <JMP.&KERNEL32.ExitProcess>         ExitProcess
0040102B  $  55             PUSH EBP
0040102C  .  8BEC           MOV EBP,ESP
0040102E  .  817D 0C 10010000 CMP [ARG.2],110
00401035  .v 75 37          JNZ SHORT crackme1.0040106E
00401037  .  C705 48304000 000 MOV DWORD PTR DS:[403048],0
```

This is what a standard app, written in C or C++ looks like when using a dialog box as the main program window.

**** If the program used a regular window instead of a dialog box, it would look different. see below.****

Notice the arguments being pushed onto the stack and the call to DialogBoxParamA. This sets up a dialog box to be used as the program's main window (as opposed to a normal window, but don't get bogged down in the details- it really doesn't matter). Getting help on DialogBoxParamA we see:



For our purposes, the most important thing in this call is the address of DLGPROC. This is the address for the callback in our app that will handle all of the Windows messages. Looking back at the disassembly, we can clearly see this address:

```
00401000  $  6A 00          PUSH 0                                   pModule = NULL
00401002  .  E8 C5040000    CALL <JMP.&KERNEL32.GetModuleHandleA>    GetModuleHandleA
00401007  .  A3 28304000    MOV DWORD PTR DS:[403028],EAX            kernel32.BaseThreadInitThunk
0040100C  .  6A 00          PUSH 0                                   lParam = NULL
0040100E  .  68 2B104000    PUSH crackme1.0040102B                   DlgProc = crackme1.0040102B
00401013  .  6A 00          PUSH 0                                   hOwner = NULL
00401015  .  68 20030000    PUSH 320                                 pTemplate = 320
0040101A  .  FF35 28304000  PUSH DWORD PTR DS:[403028]               hInst = NULL
00401020  .  E8 8F040000    CALL <JMP.&USER32.DialogBoxParamA>       DialogBoxParamA
00401025  .  50             PUSH EAX                                 ExitCode = 761F3388
00401026  .  E8 9B040000    CALL <JMP.&KERNEL32.ExitProcess>         ExitProcess
0040102B  $  55             PUSH EBP
0040102C  .  8BEC           MOV EBP,ESP
```

In this case, it's 40102B. Let's head there and see what it looks like. This will be the…

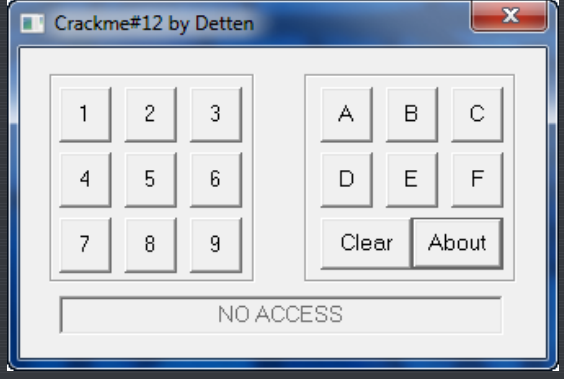
Main Dialog Callback Message Handler

Here we can we the beginning of it:

This is a fairly normal looking DlgProc. It is usually just a really big switch statement, though in assembly, it turns into a really big if/then statement. If you read through my last tutorial, this should look somewhat familiar, the only difference being that in this case, Olly could not figure out the case labels (ie. Case 113 (WM_TIMER)).

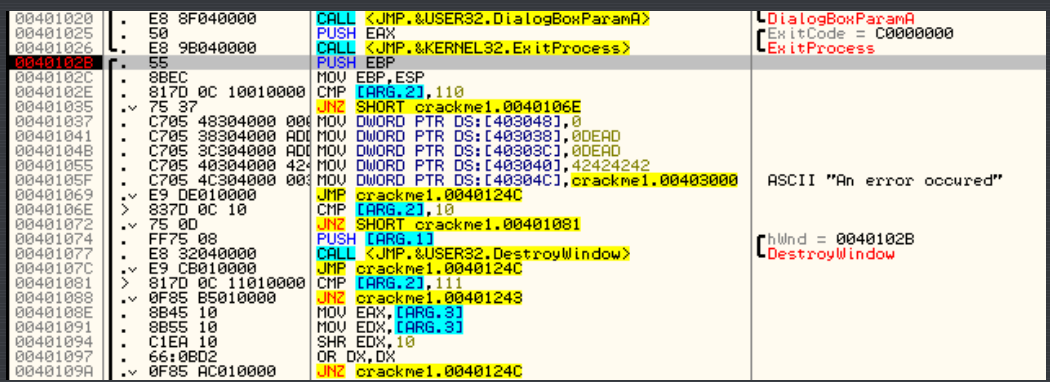
This procedure is here for one reason- to respond to the Windows messages that we wish to respond to. If you look closely, you will see a bunch of compare and jump statements. This is checking each section of code against the message ID that Windows has sent in. If the code matches one of these compare statements, that code is run. Otherwise, it will flow through all the compares, none will match, and it will be sent on to Windows for Windows to handle.

Let's view this process a little closer. Go ahead and run the app:



A very strange crackme, to say the least. Go ahead and play around with it. You will notice that you can continue to hit buttons and nothing happens, though it does have a 'clear' button. It seems that it wishes us to put in a specific code, and unless we do, the app will do nothing.

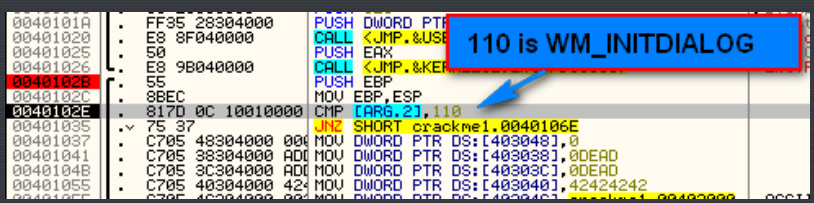
Let's now put a BP on the beginning of the DlgProc code at address 40102B and re-start the app so we can watch the messages come in:



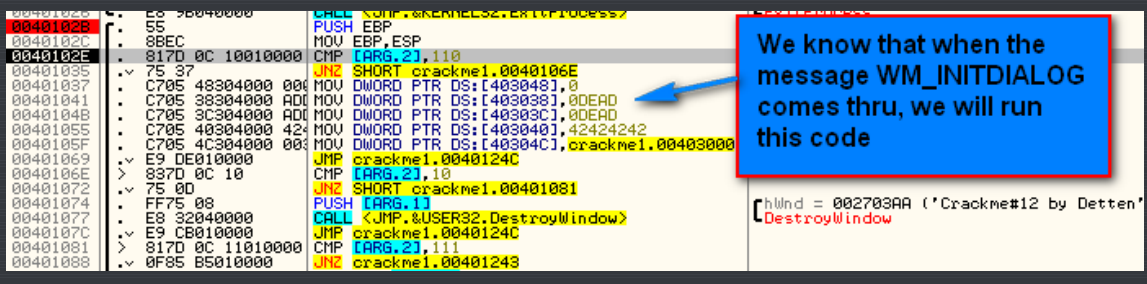
As soon as you start the app, we will immediately break at our BP. You will notice that a couple instructions in we start our first compare

40102E CMP [ARG.2], 110

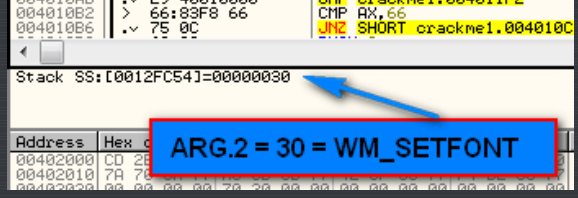
If you look up ID 110 in the list of Windows messages included in the download of this tutorial, you will see that 110 is the code for InitDialog:



This message gives our app a chance to initialize some things. If you step through and the message is INITDIALOG, we will fall through and perform the instructions beginning at 401037.

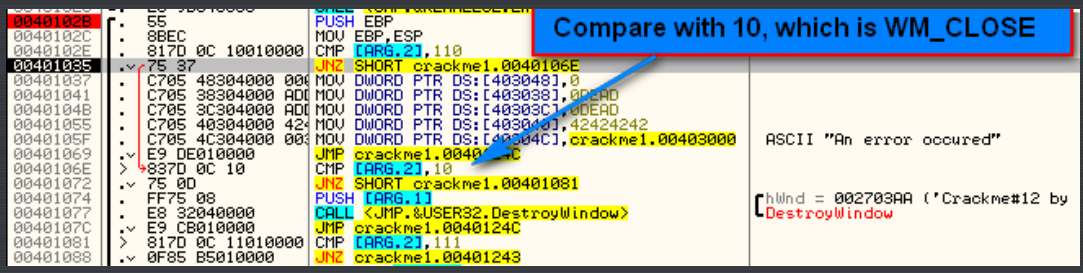


Looking down at the info area we can see that ARG.2 is not 110 but 30:

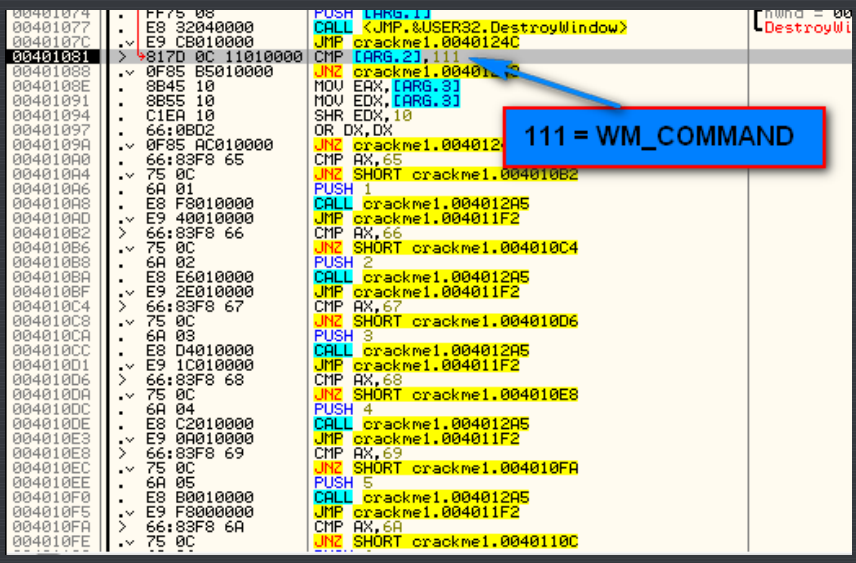


In our chart, 30 is the message for set font. So this is the first message Windows is sending through.

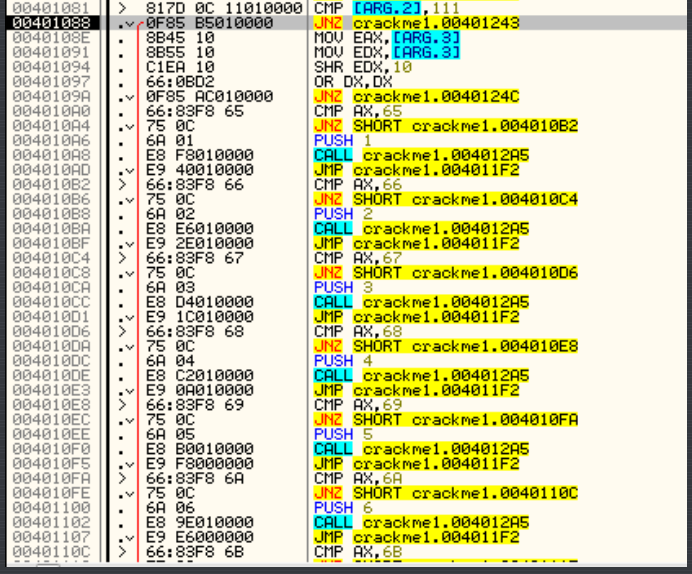
The next compare is with 10, which in our message cheat sheet is WM_CLOSE:



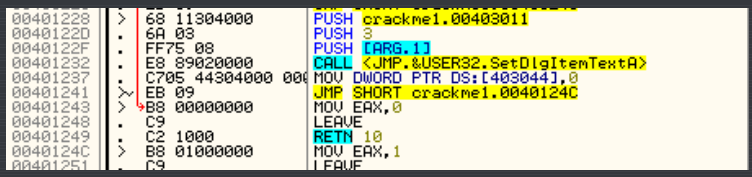
So when the close button is clicked, this code will be run. The next compare is 111 which is WM_COMMAND:



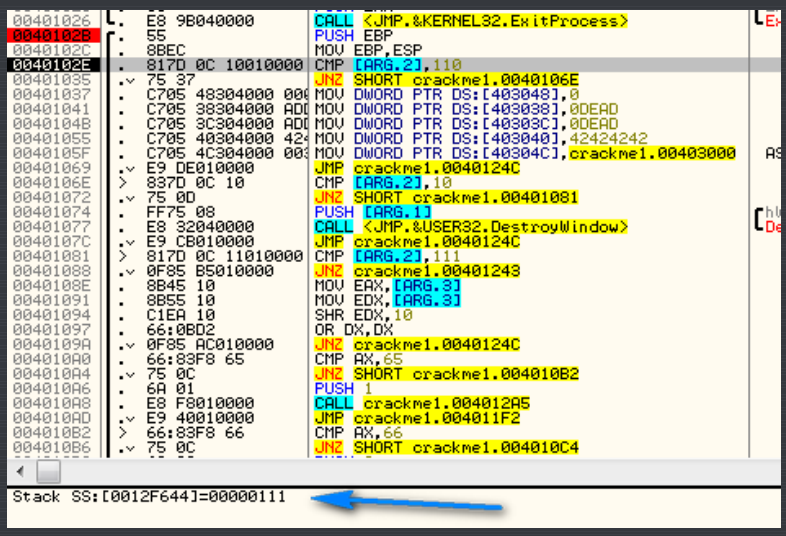
WM_COMMAND is a catchall for several Windows message types, usually connected to resources, for example a button click or selecting a menu, or clicking a toolbar icon. In addition to a WM_COMMAND message, a second integer is sent in the ARG.3 holder that helps clarify the command message. For example, if you clicked on a button, a WM_COMMAND message would come through and ARG.3 might have the button's ID in it. If you were drawing in a freehand draw program, ARG.3 may have the X and Y coordinates of where the mouse is currently:



Looking at this carefully, we can see that WM_COMMAND is the only other message (or really, collection of messages as each WM_COMMAND can be a different 'type') that this procedure handles. If you single step through you will notice that no code is run for our current message, WM_SETFONT, and we simply return at the end of our procedure. This tells Windows that we wish Windows to handle this message, not us:



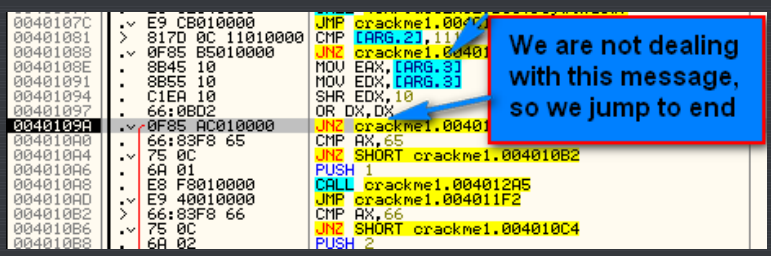
Hitting RUN again we will break on the next message:



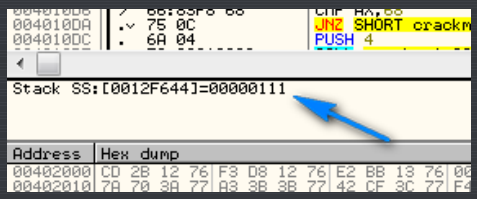
This time we see that it is a WM_COMMAND message. Stepping down to the compare that checks for this message at address 401081, we can then take a closer look at the WM_COMMAND handler:

```
00401074  .  FF75 08          PUSH [ARG.1]
00401077  .  E8 32040000      CALL <JMP.&USER32.DestroyWindow>
0040107C  .v E9 CB010000      JMP crackme1.0040124C
00401081  >  817D 0C 11010000 CMP [ARG.2],111
00401088  .v 0F85 B5010000    JNZ crackme1.00401243
0040108E  .  8B45 10          MOV EAX,[ARG.3]
00401091  .  8B55 10          MOV EDX,[ARG.3]
00401094  .  C1EA 10          SHR EDX,10
00401097  .  66:0BD2          OR DX,DX
0040109A  .v 0F85 AC010000    JNZ crackme1.0040124C
004010A0  .  66:83F8 65       CMP AX,65
004010A4  .v 75 0C            JNZ SHORT crackme1.004010B2
004010A6  .  6A 01            PUSH 1
004010A8  .  E8 F8010000      CALL crackme1.004012A5
004010AD  .v E9 40010000      JMP crackme1.004011F2
004010B2  >  66:83F8 66       CMP AX,66
004010B6  .v 75 0C            JNZ SHORT crackme1.004010C4
004010B8  .  6A 02            PUSH 2
004010BA  .  E8 E6010000      CALL crackme1.004012A5
004010BF  .v E9 2E010000      JMP crackme1.004011F2
004010C4  >  66:83F8 67       CMP AX,67
004010C8  .v 75 0C            JNZ SHORT crackme1.004010D6
004010CA  .  6A 03            PUSH 3
004010CC  .  E8 D4010000      CALL crackme1.004012A5
004010D1  .v E9 1C010000      JMP crackme1.004011F2
004010D6  >  66:83F8 68       CMP AX,68
004010DA  .v 75 0C            JNZ SHORT crackme1.004010E8
004010DC  .  6A 04            PUSH 4
004010DE  .  E8 C2010000      CALL crackme1.004012A5
004010E3  .v E9 0A010000      JMP crackme1.004011F2
004010E8  >  66:83F8 69       CMP AX,69
004010EC  .v 75 0C            JNZ SHORT crackme1.004010FA
004010EE  .  6A 05            PUSH 5
004010F0  .  E8 B0010000      CALL crackme1.004012A5
004010F5  .v E9 F8000000      JMP crackme1.004011F2
```

Notice it moves ARG.3 into EAX and EDX. It then performs a SHR (shift Right) on the EDX register in the amount of 10 (or 16 decimal). It then OR's this value, and if it's not a zero, we jump. Basically this is checking if the fifth bit of this argument is a zero or not (you are reading that assembly book, right?). This is because the upper bits of EDX tells us the ID of the resource that has been affected. In this case, it is a zero, so we will jump over the remaining code and return from our callback:



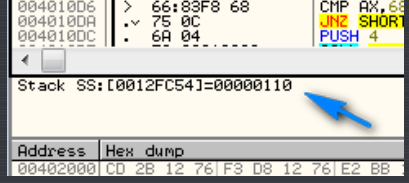
Here we can see we are dealing with a 111, or WM_COMMAND message:



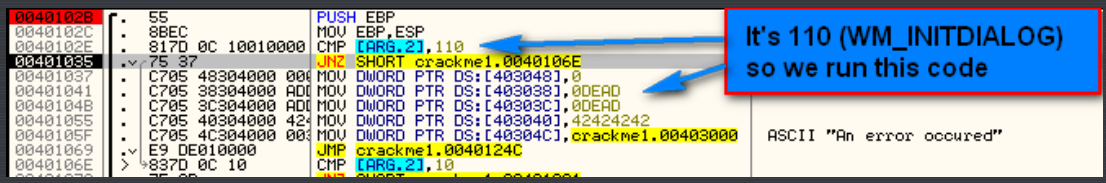
and here we can see the jump:

```
00401081  >  817D 0C 11010000 CMP [ARG.2],111
00401088  .v 0F85 B5010000    JNZ crackme1.00401243
0040108E  .  8B45 10          MOV EAX,[ARG.3]
00401091  .  8B55 10          MOV EDX,[ARG.3]
00401094  .  C1EA 10          SHR EDX,10
00401097  .  66:0BD2          OR DX,DX
0040109A  .v 0F85 AC010000    JNZ crackme1.0040124C
004010A0  .  66:83F8 65       CMP AX,65
004010A4  .v 75 0C            JNZ SHORT crackme1.004010B2
004010A6  .  6A 01            PUSH 1
004010A8  .  E8 F8010000      CALL crackme1.004012A5
004010AD  .v E9 40010000      JMP crackme1.004011F2
004010B2  >  66:83F8 66       CMP AX,66
004010B6  .v 75 0C            JNZ SHORT crackme1.004010C4
004010B8  .  6A 02            PUSH 2
004010BA  .  E8 E6010000      CALL crackme1.004012A5
004010BF  .v E9 2E010000      JMP crackme1.004011F2
004010C4  >  66:83F8 67       CMP AX,67
004010C8  .v 75 0C            JNZ SHORT crackme1.004010D6
004010CA  .  6A 03            PUSH 3
004010CC  .  E8 D4010000      CALL crackme1.004012A5
004010D1  .v E9 1C010000      JMP crackme1.004011F2
004010D6  >  66:83F8 68       CMP AX,68
004010DA  .v 75 0C            JNZ SHORT crackme1.004010E8
004010DC  .  6A 04            PUSH 4
004010DE  .  E8 C2010000      CALL crackme1.004012A5
004010E3  .v E9 0A010000      JMP crackme1.004011F2
004010E8  >  66:83F8 69       CMP AX,69
004010EC  .v 75 0C            JNZ SHORT crackme1.004010FA
004010EE  .  6A 05            PUSH 5
004010F0  .  E8 B0010000      CALL crackme1.004012A5
004010F5  .v E9 F8000000      JMP crackme1.004011F2
004010FA  >  66:83F8 6A       CMP AX,6A
004010FE  .v 75 0C            JNZ SHORT crackme1.0040110C
00401100  .  6A 06            PUSH 6
```

Running the app again, we again stop at our BP. This time we can see that we are dealing with a WM_INITDIALOG message:

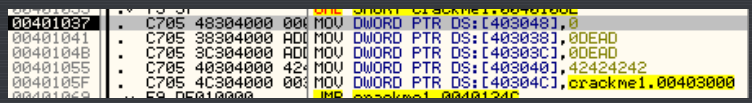


So we are going to run the couple of lines at the top that are part of the initialization of this dialog:

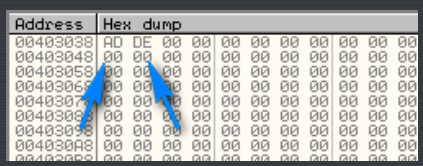


In this particular crackme, this code happens to be important. We see that several integers are stored into memory starting at 403038 (they are accessed out of order and 403038 is the lowest). Let's first bring that up in the dump window:

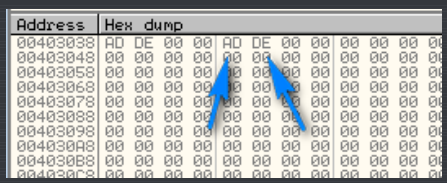
and see it is initialized to zeroes before we run these lines. Now step over the first MOV instruction and you won't see anything happen, but a zero is copied into address 403048. Stepping over the next instruction we can see the effects though:



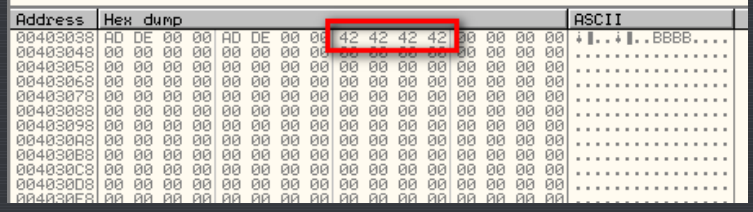
and here we can see that 0xDEAD was copied into memory (in little endian order):



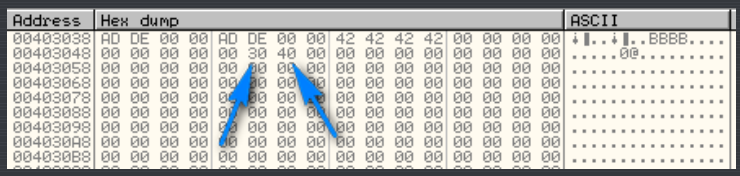
stepping over the next line does the same thing, but at address 40303C:



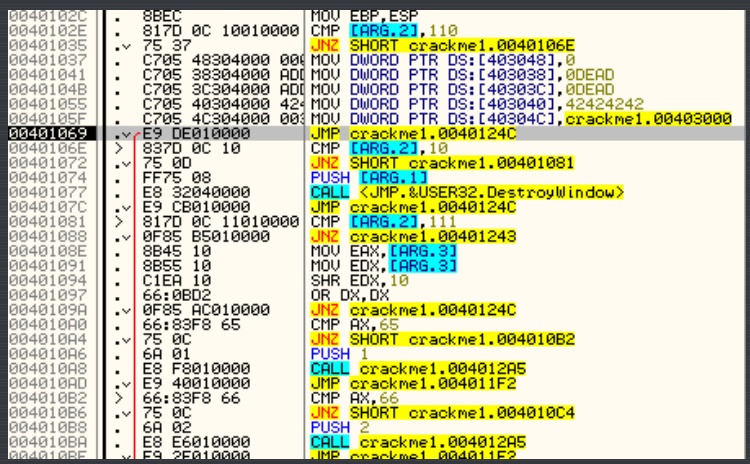
The fact that they are words written in hex is a dead giveaway that it is important to this crackme 🙂. Next, the value 42 is copied 4 times at address 403040. We can see the ASCII equivalent of "B" in the ASCII dump area:



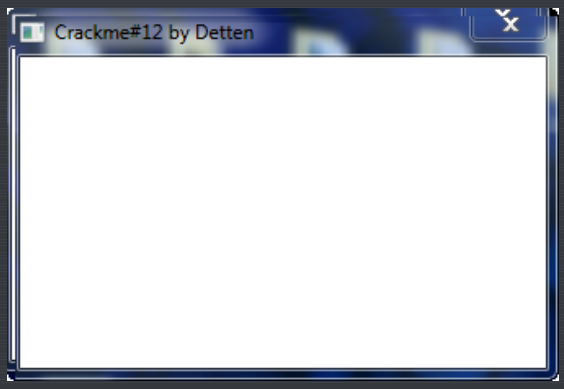
Lastly, the integer 403000 is copied into address 40304C, which Olly can tell is a pointer to code or data beginning at 403000 (remember little endian):



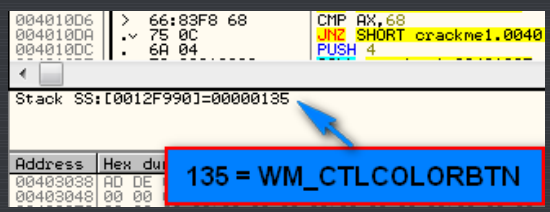
Finally, we jump to the end and return, waiting for the next message sent through:



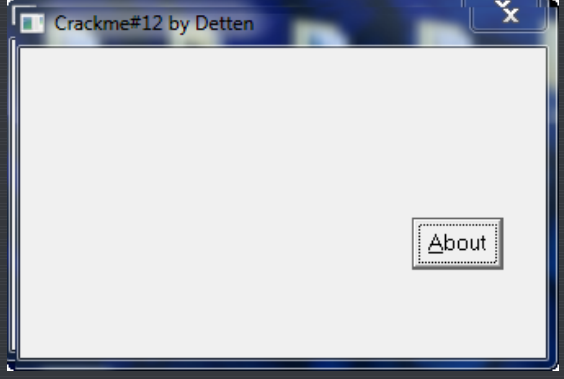
Clicking F9 a couple more times (10) you will see the main dialog window get created:



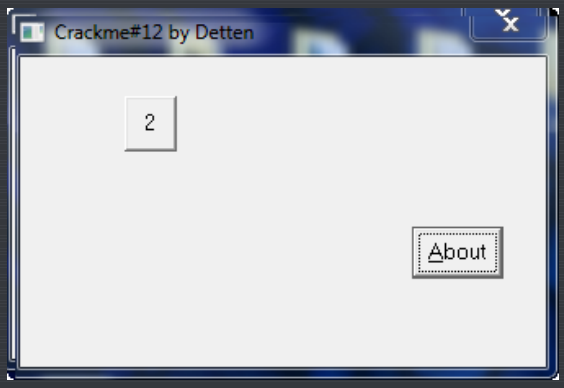
It gets very interesting at this point because as you hit F9, each time something new appears in the dialog box (after about 6 runs), as a message is received to draw that resource onto the screen. The next message is 135, or WM_CTLCOLORBUTTON:



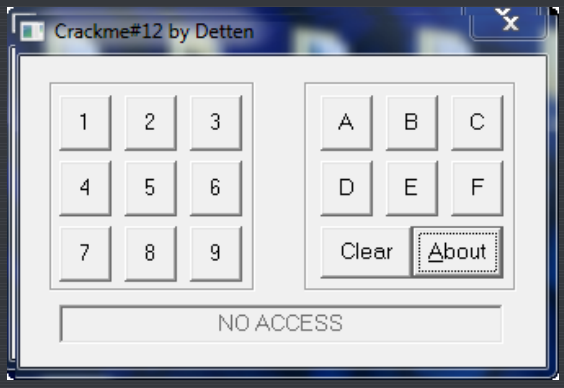
which draws a button on the window:



and next is the button with the '2′ in it:



At this point, clicking F9, you will actually see the dialog box get built, one button at a time. It's interesting to see all the messages come in and look them up in our chart. You will see that there are a lot of messages that come through. If you don't know one, just Google it and you can get a description of it. Toward the end, the label will be drawn at the bottom, and the "No access" text will be written to it. This will complete the window. I had to click F9 about 35 times before the window was complete:



So now you can see how a dialog box gets built. You set up the basics of the box, the title and the overall look, and you pass in a pointer (address) to a callback function that will handle all messages sent from Windows. Windows will then send a collection of messages, one at a time, to this callback, giving us the chance to run code at each message if we so desire. After the box has been completely built, Windows enters an inside loop that just sits there and waits for us to do something. As soon as we do, a message is sent to our callback with the appropriate ID of the action that has taken place. We can then decide to act on this message or ignore it and let Windows handle it.

One final thing you will notice is that, if the app is running in Olly, just moving the mouse over the window will cause Olly to pause at the beginning of the message handler with a new message. Windows is telling our handler that the mouse was moved over it. Basically, anything you do to that dialog box will send a message to our handler.

Homework

1. See if you can figure out what happens after clicking a button, especially to the memory contents

starting at address 403038. Do the different buttons do different things? Can you begin to understand the code that is modifying these memory locations?

2. Take a guess on how long the password is.

-till next time

R4ndom