OllyDbg 2.0 Help

(preliminary, strongly incomplete version)

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Introduction

This guide is not a detailed description of the OllyDbg 2.0. Rather, it highlights some interesting and non-obvious features of the new debugger.

Differences between versions 1.10 and 2.00

The second version of the 32-bit debugger OllyDbg is redesigned practically from scratch. As a result, it is faster, more powerful and much more reliable than its predecessor. Well, at least in the future, because many useful features from the version 1.10 are not yet available in 2.00.

However, version 2.00 already contains many new features that were not available before. Among them:

- New debugging engine, redesigned from scratch, that overcomes many bugs and limitations of the previous version;
- Full support for SSE instructions, including SSE3 and SSE4. SSE registers are accessed directly, without code injection;
- Execution of commands in the context of debugger, allowing run trace speed - with conditions and protocolling! - of up to 1,000,000 commands per second;
- Unlimited number of memory breakpoints;
- Conditional memory and hardware breakpoints;
- Reliable, analysis-independent hit trace;
- Analyser that recognizes the number (and sometimes the meaning) of the arguments of unknown functions;
- Detaching from debugged process;
- Debugging of child processes;
- Built-in help for integer and FPU commands;
- Option to pause on TLS callback;
- Option to pass unprocessed exceptions to the unhandled exception filter.

OllyDbg 2.0 overview

OllyDbg 2.0 is a 32-bit assembler-level analyzing Degugger with intuitive interface. It is especially useful if source code is not available or when you experience problems with your compiler.

Requirements. Developed and tested mainly under Windows 2000 and Windows XP, but should work under any Windows version: 95, 98, ME, NT, 2000, XP, 2003 Server, Vista, Windows 7 and so on. For a comfortable debugging you will need at least 500-MHz processor. OllyDbg is memory hungry. If you debug large application with all features enabled, it may allocate 200-300 megabytes for backup and analysis data.

Supported instruction sets. OllyDbg 2.0 supports all existing 80x86-compatible CPUs: MMX, 3DNow!, including Athlon extentions, and SSE instructions up to SSSE3 and SSE4.

Configurability. More than 120 options (oh, no! This time it's definitely too much!) control OllyDbg's behaviour and appearance.

Data formats. Dump windows display data in all common formats: hexadecimal, ASCII, UNICODE, 16- and 32-bit signed/unsigned/hexadecimal integers, 32/64/80-bit floats, addresses, disassembly (MASM, IDEAL, HLA or AT&T). It also decodes and comments many Windows-specific structures, including PE headers, PEB, Thread data blocks and so on.

Help. OllyDbg 2.0 includes built-in help on all 80x86 integer and floating-point commands. If you possess Windows API help (*win32.hlp*, not included due to copyright reasons), you can attach it and get instant help on system API calls.

Startup. You can specify executable file in command line, select it from menu, drag-and-drop file to OllyDbg, restart last debugged program or attach to already running application. OllyDbg supports just-in-time debugging and debugging of child processes. You can detach from the debugged process, and it will continue execution. Installation is not necessary!

Code highlighting. Disassembler can highlight different types of commands (jumps, conditional jumps, pushes and pops, calls, returns, privileged and invalid) and different operands (general, FPU/SSE or segment/system registers, memory operands on stack or in other memory, constants). You can create custom highlighting schemes.

Threads. OllyDbg can debug multithread applications. You can switch from one thread to another, suspend, resume and kill threads or change their priorities. Threads window displays errors for each thread (as returned by call to GetLastError).

Analysis. Analyzer is one of the most significant parts of OllyDbg. It recognizes procedures, loops, switches, tables, constants and strings embedded in code, tricky constructs, calls to API functions, number of function's arguments, import sections and so on. It attempts to determine not only the number of stack arguments in the unknown functions, but even their meaning. Analysis makes binary code much more readable, facilitates debugging and reduces probability of misinterpretations and crashes. It is not compiler-oriented and works equally good with any PE program.

Full UNICODE support. All operations available for ASCII strings are also available for UNICODE, and vice versa. OllyDbg is able to recognize UTF-8 strings.

Names. OllyDbg knows symbolic names of many (currently 7700) constants, like window messages, error codes or bit fields, and decodes them in calls to known functions.

Known functions. OllyDbg recognizes by name more than 2200 frequently used Windows API functions and decodes their arguments. You can add your own descriptions. You may set logging breakpoint on a known or guessed function and protocol arguments to the log.

Calls. OllyDbg can backtrace nested calls on the stack even when debugging information is unavailable and procedures use non-standard prologs and epilogs.

Stack. In the Stack window, OllyDbg uses heuristics to recognize return addresses and stack frames. Notice however that they can be remnants from the previous calls. If program is paused on the known function, stack window decodes arguments of known and guessed functions. Stack also traces and displays the chain of SE handlers.

Search. Plenty of possibilities! Search for command (exact or imprecise) or sequence of commands, for constant, binary or text string (not necessarily contiguous), for all commands that reference address, constant or address range, for all jumps to selected location, for all referenced text strings, for all intermodular calls, for masked binary sequence in the whole allocated memory and so on. If multiple locations are found, you can quickly navigate between them.

Breakpoints. OllyDbg supports all common kinds of breakpoints: INT3, memory and hardware. You may specify number of passes and set conditions for pause. Breakpoints may conditionally protocol data to the log. Number of INT3 and memory breakpoints is unlimited: in the extreme case of hit trace, OllyDbg sometimes sets more than 100000 INT3 breakpoints. On a fast CPU, OllyDbg can process up to 20-30 thousand breakpoints per second.

Watches. Watch is an expression evaluated each time the program pauses. You can use registers, constants, address expressions, boolean and algebraical operations of any complexity.

Execution. You can execute program step-by-step, either entering subroutines or executing them at once. You can run program till next return, to the specified location, or backtrace it from the deeply nested system API call back to the user code. When application runs, you keep full control over it. For example, you can view memory, set breakpoints and even modify code "on-the-fly". At any time, you can pause or restart the debugged program.

Hit trace. Hit trace shows which commands or procedures were executed so far, allowing you to test all branches of your code. Hit trace starts from the actual location and sets INT3 breakpoints on all branches that were not traced so far. The breakpoints are removed when command is reached (hit).

Run trace. Run trace executes program in the step-by-step mode and protocols execution to the large circular buffer. Run trace is fast: when fast command emulation is enabled, OllyDbg traces up to 1 million commands per second! Run trace protocols registers (except for SSE), flags, contents of accessed memory, thread errors and - for the case that your code is self-modifying - the original commands. You may specify the condition to stop run trace, like address range, expression or command. You can save run trace to the file and compare two independent runs. Run trace allows to backtrack and analyse history of execution in details, millions and millions of commands.

Profiling. Profiler calculates how many times some instruction is listed in the run trace buffer. With profiler, you know which part of the code takes most of execution time.

Patching. Built-in assembler automatically selects the shortest possible code. Binary editor shows data simultaneously in ASCII, UNICODE and hexadecimal form. Old good copy-and-paste is also available. Automatical backup allows to undo changes. You can copy modifications directly to executable file, OllyDbg will even adjust fixups.

UDD. OllyDbg saves all program- and module-related information to the individual file and restores it when module is reloaded. This information includes labels, comments, breakpoints, watches, analysis data, conditions and so on.

Customization. You can specify custom fonts, colour and highlighting schemes.

And much more! This list is far from complete, there are many features that make OllyDbg 2.0 the friendly debugger.

(No) registration

OllyDbg 2.00 is Copyright (C) 2000-2009 Oleh Yuschuk. It is a closed-source freeware. For you as a user this means that you can use OllyDbg for free, whether for private purposes or commercially, according to the license agreement. Registration is not necessary. I have introduced it for the first version just to see how popular my program is. The results were above any expectations. I was overwhelmed with the registration forms, and this had noticeable negative influence on my productivity. Therefore: there is **no registration** for the OllyDbg 2.00.

However, if you are professor or teacher and use OllyDbg for **educational purposes**, I would be very glad if you contact me (Ollydbg@t-online.de), especially if you have ideas how to make my product more student-friendly or better suited for the educational process.

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Fair use. Many software manufacturers explicitly disallow you any attempts of disassembling, decompilation, reverse engineering or modification of their programs. This restriction also covers all third-party dynamic-link libraries your application may use, including system libraries. If you have any doubts, contact the owner of copyright. The so called „fair use" clause can be misleading. You may want to discuss whether it applies in your case with competent lawyer. Please don't use OllyDbg for illegal purposes!

Your privacy and security. The following statements apply to versions 1.00 - 2.00 at the moment when I upload corresponding archives (containing OllyDbg.exe and support files) to Internet ("original OllyDbg"). They do not apply to any third-party plugins.

I <u>guarantee</u> that original OllyDbg:

- never tries to spy processes other than being debugged, or act as a network client or server, or send any data to any other computer by any means (except for remote files specified by user), or act as a Trojan Horse of any kind;

- neither reads nor modifies the system Registry unless explicitly requested, and these requested modifications are limited to the following 6 keys (OllyDbg 2.0: currently only the last two):

HKEY_CLASSES_ROOT\exefile\shell\Open with OllyDbg
HKEY_CLASSES_ROOT\exefile\shell\Open with OllyDbg\command
HKEY_CLASSES_ROOT\dllfile\shell\Open with OllyDbg
HKEY_CLASSES_ROOT\dllfile\shell\Open with OllyDbg\command

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\AeDebug\Debugger
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\AeDebug\Auto

- does not create, rewrite or modify any files in system directories;

- does not modify, unless explicitly requested, any executable file or DLL on any computer, including OllyDbg itself;

- logs your debugging activities only on your explicit request (except for the File History kept in *ollydbg.ini* and *.udd files with debug information). Even more, I guarantee that without your allowance OllyDbg will create or modify files only in the directory where it resides and in the working directories specified in the Options dialog;

- (last but by no means least) contains no apparent or hidden „nag" screens forcing you to register this shareware, nor any features that limit the functionality of OllyDbg after any period of time.

Beware of viruses. Although I've checked the original archive with several virus scanners, please do not assume that your distribution of OllyDbg is free from viruses or Trojan horses camouflaged as OllyDbg or support routine. I accept no responsibility for damages of any kind caused to your computer(s) by any virus or Trojan horse attached to any of the files included into archive, or to archive as a whole, or for damages resulting from the modifications applied to OllyDbg by third persons.

Installation

OllyDbg requires no installation. Simply create new folder and unpack *Odbg200.zip* to this folder. If necessary, drag-and-drop *ollydbg.exe* to the desktop to create shortcut.

If you are a hardcore user and run OllyDbg on Windows NT 4.0, you will need *psapi.dll*. This library is not included.

Some very, very old versions of Windows 95 do not include API functions *VirtualQueryEx* and *VirtualProtectEx*. These functions are very important for debugging. If OllyDbg reports that functions are absent, normal debugging is hardly possible. Please upgrade your OS.

Support

The available support is limited to the Internet page http://www.ollydbg.de. From here you will be able also to download bugfixes and new versions. If you have problems, send email to Ollydbg@t-online.de. Usually I answer within a week. **Unless you explicitly disallow this, I reserve the right to place excerpts from your emails on my Internet site**.

Full source code is available but will cost you some money. This is a „clean-room" implementation that contains no third-party code. You can order either the whole source code or its parts like Disassembler, Assembler or Analyzer. To get more information, send me a mail. By the way, I plan to release Disassembler 2.0 under GPL v3.

Description of .udd file format is available on request. It is free.

Assembler and disassembler

General information

OllyDbg 2.0 supports all 80x86 commands, FPU, MMX, 3DNow!, SSE, SSE2, SSE3, SSSE3 and SSE4 extensions. Please note following peculiarities and deviations from Intel's standard:

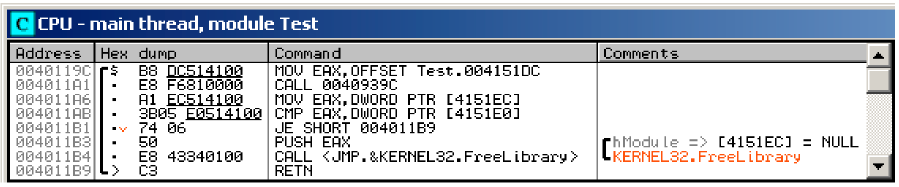
- REP RET (AMD branch prediction bugfix) is supported;
- Multibyte NOPs (like NOP [EAX]) are supported. However, Assembler always attempts to select the shortest possible form, therefore it's hard to set the required NOP length;
- FWAIT is always decoded separately from the following FPU command;
- No-operand forms of binary FPU commands are not supported, use two-operand forms (FADDP ST(1),ST instead of FADDP);
- LFENCE: only form with E8 is accepted (0F AE E8);
- MFENCE: only form with F0 is accepted (0F AE F0);
- SFENCE: only form with F8 is accepted (0F AE F8);
- PINSRW: register is decoded as 16-bit (only low 16 bits are used anyway);
- PEXTRW: memory operand is not allowed, according to Intel;
- SMSW: register is decoded as 16-bit (only low 16 bits are used anyway);
- INSERTPS: source XMM register is commented only as a low float, whereas command may use any float;
- Some FPU, MMX and SSE commands accept either register only or memory only in ModRM byte. If counterpart is not defined, Disassembler reports it as an unknown command. Integer commands, like LES, report in this case invalid operands.
- SSE4 commands that use register XMM0 as a third operand are available both in 2- and in 3-operand formats, but Disassembler will show only the full 3-operand form;
- Assembler accepts CBW, CWD, CDQ, CWDE with explicit AL/AX/EAX as operand. Disassembler, however, uses only implicit no-operand form.

Disassembling options

OllyDbg supports four different decoding modes: MASM, Ideal, HLA and AT&T.

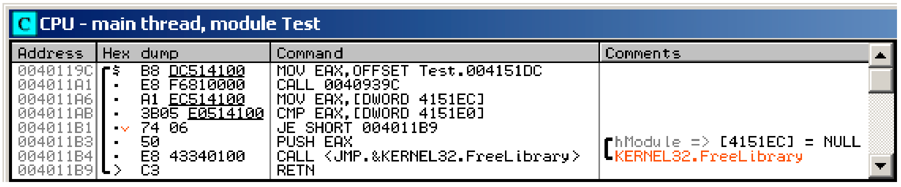
It's not necessary to represent MASM - this is the de facto standard of the programming. Ideal mode, introduced by Borland, is very similar to MASM but differently decodes memory addresses. High Level Assembly language, created by Randall Hyde, uses yet another, functional syntax where first operand is a source and arguments are operands are taken into the brackets. AT&T is popular among the Linux programmers.

Example of MASM syntax:



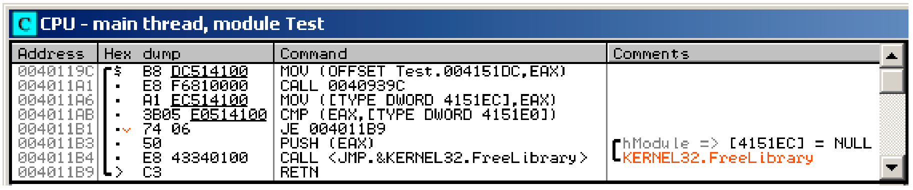
```
Address   Hex dump           Command                               Comments
0040119C ┌$  B8 DC514100     MOV EAX,OFFSET Test.004151DC
004011A1 │.  E8 F6810000     CALL 0040939C
004011A6 │.  A1 EC514100     MOV EAX,DWORD PTR [4151EC]
004011AB │.  3B05 E0514100   CMP EAX,DWORD PTR [4151E0]
004011B1 │.v 74 06           JE SHORT 004011B9
004011B3 │.  50              PUSH EAX                              ┌hModule => [4151EC] = NULL
004011B4 │.  E8 43340100     CALL <JMP.&KERNEL32.FreeLibrary>      └KERNEL32.FreeLibrary
004011B9 └>  C3              RETN
```

Example of Ideal syntax:



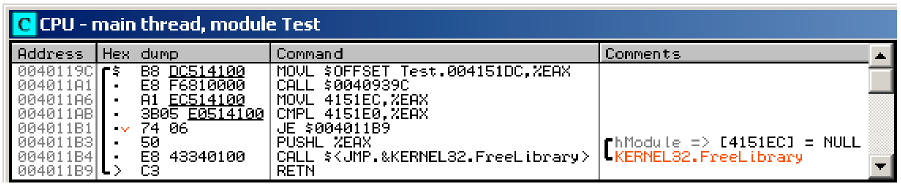
```
CPU - main thread, module Test
Address   Hex dump           Command                            Comments
0040119C ┌$  B8 DC514100     MOV EAX,OFFSET Test.004151DC
004011A1 │.  E8 F6810000     CALL 0040939C
004011A6 │.  A1 EC514100     MOV EAX,[DWORD 4151EC]
004011AB │.  3B05 E0514100   CMP EAX,[DWORD 4151E0]
004011B1 │.v 74 06           JE SHORT 004011B9
004011B3 │.  50              PUSH EAX                           ┌hModule => [4151EC] = NULL
004011B4 │.  E8 43340100     CALL <JMP.&KERNEL32.FreeLibrary>   └KERNEL32.FreeLibrary
004011B9 └>  C3              RETN
```

Example of HLA syntax:



```
CPU - main thread, module Test
Address   Hex dump           Command                            Comments
0040119C ┌$  B8 DC514100     MOV (OFFSET Test.004151DC,EAX)
004011A1 │.  E8 F6810000     CALL 0040939C
004011A6 │.  A1 EC514100     MOV ([TYPE DWORD 4151EC],EAX)
004011AB │.  3B05 E0514100   CMP (EAX,[TYPE DWORD 4151E0])
004011B1 │.v 74 06           JE 004011B9
004011B3 │.  50              PUSH (EAX)                         ┌hModule => [4151EC] = NULL
004011B4 │.  E8 43340100     CALL <JMP.&KERNEL32.FreeLibrary>   └KERNEL32.FreeLibrary
004011B9 └>  C3              RETN
```

Example of AT&T syntax:



```
CPU - main thread, module Test
Address   Hex dump           Command                            Comments
0040119C ┌$  B8 DC514100     MOVL $OFFSET Test.004151DC,%EAX
004011A1 │.  E8 F6810000     CALL $0040939C
004011A6 │.  A1 EC514100     MOVL 4151EC,%EAX
004011AB │.  3B05 E0514100   CMPL 4151E0,%EAX
004011B1 │.v 74 06           JE $004011B9
004011B3 │.  50              PUSHL %EAX                         ┌hModule => [4151EC] = NULL
004011B4 │.  E8 43340100     CALL $<JMP.&KERNEL32.FreeLibrary>  └KERNEL32.FreeLibrary
004011B9 └>  C3              RETN
```

Assembler will recognize any syntax, except for AT&T: currently it is only for disassembly.

HLA is a public domain software, you can download it together with documentation and sources from http://webster.cs.ucr.edu.

Other code display options are more or less self-explaining.

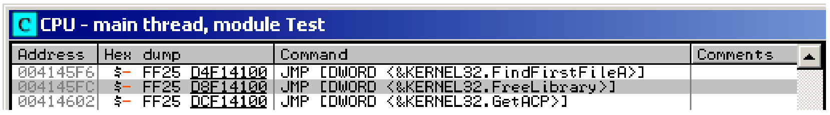
Internally generated names

Names created by Analyser are usually taken into the triangular brackets, like <ModuleEntryPoint> or <STRUCT IMAGE_DATA_DIRECTORY>.

On the previous examples, you may see the call to API function FreeLibrary():

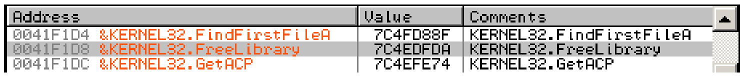
```
CALL <JMP.&KERNEL32.FreeLibrary>
```

What does it mean? Prefix JMP means that this call does not lead directly to FreeLibrary(), but to the jump to this function:



```
CPU - main thread, module Test
Address   Hex dump           Command                                  Comments
004145F6  $- FF25 D4F14100   JMP [DWORD <&KERNEL32.FindFirstFileA>]
004145FC  $- FF25 D8F14100   JMP [DWORD <&KERNEL32.FreeLibrary>]
00414602  $- FF25 DCF14100   JMP [DWORD <&KERNEL32.GetACP>]
```

Jump itself is indirect, it uses contents of the doubleword where loader has placed the address of the import:



```
Address                            Value      Comments
0041F1D4 &KERNEL32.FindFirstFileA  7C4FD88F   KERNEL32.FindFirstFileA
0041F1D8 &KERNEL32.FreeLibrary     7C4EDFDA   KERNEL32.FreeLibrary
0041F1DC &KERNEL32.GetACP          7C4EFE74   KERNEL32.GetACP
```

Now it is clear. If memory location contains imported address of some API function, analyser uses C notation to form the name of this location: &module.function, in our case &KERNEL32.FreeLibrary.

Indirect jump to imported address is JMP [<&KERNEL32.FreeLibrary>], and call to indirect jump is CALL [<JMP.&KERNEL32.FreeLibrary>]. You can't use internal names in expressions and commands.

Caveats

All constants in the OllyDbg are hexadecimal by default. If you want to specify decimal constant, follow it with the point:

MOV EAX,1000.	translates to	MOV EAX,3E8

Hexadecimal constant may begin with a letter (A-F). But symbolic labels have higher priority. Assume that you have defined label ABCD at address 0x00401017. In this case,

MOV EAX,ABC	translates to	MOV EAX,0ABC
MOV EAX,ABCD	translates to	MOV EAX,401017

To avoid ambiguity, precede hexadecimal constants with 0 or 0x.

There are only few exceptions to this rule. Indices of arguments and local variables are decimal. For example, ARG.10 is the address of the tenth call argument with offset $10_{10}·4=40_{10}$=0x28. To memorize this rule, note that ARG and index are separated with a decimal point.

Ordinals are also in decimal. COMCTL32.#332 means export with ordinal 332_{10}.

Analyser

OllyDbg is an analysing debugger. For each module (executable file or DLL) it attempts to separate code from data, recognize procedures, locate embedded strings and switch tables, determine loops and switches, find function calls and decode their arguments, and even predict value of registers during the execution.

This task is not simple. Some of the existing compilers are highly optimizing and use different tricks to accelerate the code. It’s impossible to take them all into account. Therefore the analyser is not limited to some particular compiler and tries to use generic rules that work equally good with any code.

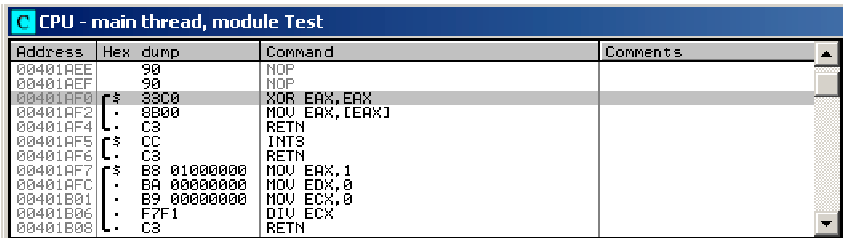
How is it possible at all? OllyDbg makes 12 passes through the program, each time gathering information that will be used on the next steps. For example, on the first pass it disassembles every possible address within the code sections and checks whether this can be the first byte of the command. Valid command can not start on fixup, it can’t be jump to the non-existing memory etc. Additionally it counts all found calls to every destination. Of course, many of these calls are artefacts, but it's unlikely that two wrong calls will point to the same command, and almost impossible that there are three of them. So if there are three or more calls to the same address, the analyser is sure that this address is entry point of some frequently used subroutine. On the second pass OllyDbg uses found entries as starting points for the code walk and determines other entries, and so on. In this way I locate commands that are 99.9% sure. Some bytes, however, are not in this chain. I probe them with 20 highly efficient heuristical methods. They are not as reliable, and analyser can make errors. But their number decreases with each release.

Procedures

Procedure, from the Analyzer's point of view, is a contiguous piece of code where, starting from the entry point, one can reach, at least theoretically, all other commands (except for NOPs or similar spaceholders that fill alignment gaps). Strict procedure has exactly one entry point and at least one return. If you select fuzzy mode, any more or less consistent piece of code will be considered separate procedure.

Modern compilers perform global code optimizations that may split procedure in several parts. In such case fuzzy mode is especially useful. The probability of misinterpretation, however, is rather high.

Procedures are marked by long fat parenthesis in the dump column. Dollar sign **$** to the right marks call destinations, sign "greater than" **>** - jump destinations, point • – other analysed commands. Three procedures on the picture below implement writing to the memory at address 0 (NULL pointer), INT3 and division by zero in the test application:



```
Address   Hex dump        Command          Comments
00401AEE      90          NOP
00401AEF      90          NOP
00401AF0 ┌$   33C0        XOR EAX,EAX
00401AF2 │.   8B00        MOV EAX,[EAX]
00401AF4 └.   C3          RETN
00401AF5 ┌$   CC          INT3
00401AF6 └.   C3          RETN
00401AF7 ┌$   B8 01000000 MOV EAX,1
00401AFC │.   BA 00000000 MOV EDX,0
00401B01 │.   B9 00000000 MOV ECX,0
00401B06 │.   F7F1        DIV ECX
00401B08 └.   C3          RETN
```

Stack variables

Usually call to the function with several stack arguments looks like this (assuming all doubleword arguments):

```
...
PUSH argument3
```

```
      PUSH argument2
      PUSH argument1
      CALL F
      ...
```

Called function creates new stack frame (not always!) and allocates N doublewords of local memory on the stack:

```
   F: PUSH EBP
      MOV EBP,ESP
      SUB ESP,N*4
      ...
```

After these two sequences are executed, stack will have the following layout:

```
              +-------------------+
              |  (unused memory)  |
      ESP->   |  local N          |   [LOCAL.N]
              |  ...              |   ...
              |  local 2          |   [LOCAL.2]
              |  local 1          |   [LOCAL.1]
      EBP->   |  Old EBP          |   [LOCAL.0]
              |  Return address   |   [RETADDR]
              |  argument1        |   [ARG.1]
              |  argument2        |   [ARG.2]
              |  argument3        |   [ARG.3]
              |  ...              |
              +-------------------+
```

ARG.1 marks the address of the first function argument on the stack, [ARG.1] - its contents, ARG.2 - address of the second argument and so on. LOCAL.0 is the address of the doubleword immediately preceding return address. If called function creates standard stack frame, then [LOCAL.0] contains preserved old ESP value and local data begins with LOCAL.1, otherwise local data begins with LOCAL.0. Note that ARGs and LOCALs have decimal indices - an exception justified by the point in the notation.

Some subroutines tamper with the return address on the stack. If OllyDbg detects access to this location, it marks it as [RETADDR].

When subroutine uses standard stack frame, register EBP serves as a frame pointer. LOCAL.1 is then simply a EBP-4, LOCAL.2 is EBP-8, ARG.1 is EBP+8 etc. Modern optimizing compilers prefer to use EBP as a general-purpose register and address arguments and locals over ESP. Of course, they must keep trace of all ESP modifications. Have a look at the following code:

```
   F: MOV EAX,[ESP+8]      ; ESP=RETADDR
      PUSH ESI             ; ESP=RETADDR
      MOV ESI,[ESP+8]      ; ESP=RETADDR-4
```

When procedure is called (address F:), ESP points to the return address on the stack. Two doublewords below is the second argument, ARG.2. Command PUSH decrements ESP by 4. Therefore the last line accesses now ARG.1. The code is equivalent to:

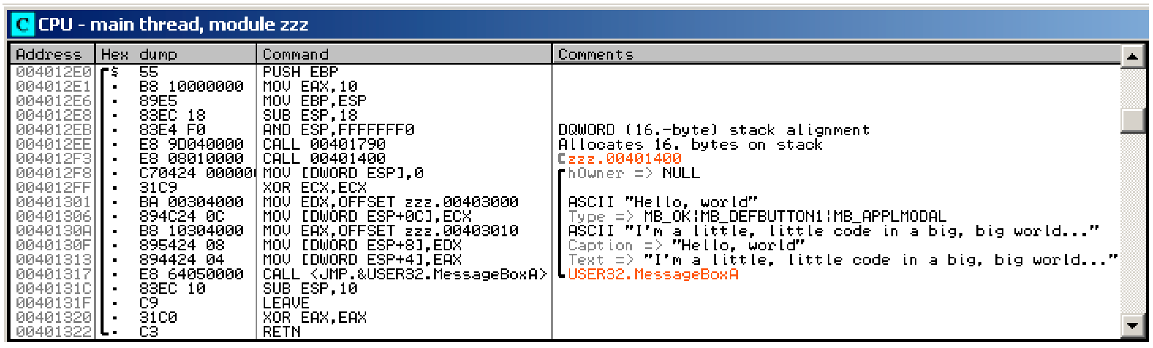
```
   F: MOV EAX,[ARG.2]
      PUSH ESI
      MOV ESI,[ARG.1]
```

Of course, analyser makes this for you. Keeping trace of ESP, however, takes plenty of memory. If memory is low, you may turn off the ESP trace for system DLLs. As a negative effect, stack walk will get unreliable.

Some compilers do not push each argument separately. Instead, they allocate memory on the stack (SUB ESP,nnn) and then write arguments using ESP as index. First doubleword argument is [ESP], second - [ESP+4] and so on.

This sample program was translated with MinGW (gcc).

```
int main() {
  MessageBox(NULL,"I'm a little, little code in a big, big world...",
    "Hello, world",MB_OK);
  return 0;
}
```



```
CPU - main thread, module zzz
Address  Hex dump          Command                          Comments
004012E0 ┌$  55            PUSH EBP
004012E1 │.  B8 10000000   MOV EAX,10
004012E6 │.  89E5          MOV EBP,ESP
004012E8 │.  83EC 18       SUB ESP,18
004012EB │.  83E4 F0       AND ESP,FFFFFFF0                 DQWORD (16.-byte) stack alignment
004012EE │.  E8 9D040000   CALL 00401790                    Allocates 16. bytes on stack
004012F3 │.  E8 08010000   CALL 00401400                    Czzz.00401400
004012F8 │.  C70424 000000 MOV [DWORD ESP],0                ┌hOwner => NULL
004012FF │.  31C9          XOR ECX,ECX                      │
00401301 │.  BA 00304000   MOV EDX,OFFSET zzz.00403000      │ASCII "Hello, world"
00401306 │.  894C24 0C     MOV [DWORD ESP+0C],ECX           │Type => MB_OK|MB_DEFBUTTON1|MB_APPLMODAL
0040130A │.  B8 10304000   MOV EAX,OFFSET zzz.00403010      │ASCII "I'm a little, little code in a big, big world..."
0040130F │.  895424 08     MOV [DWORD ESP+8],EDX            │Caption => "Hello, world"
00401313 │.  894424 04     MOV [DWORD ESP+4],EAX            │Text => "I'm a little, little code in a big, big world..."
00401317 │.  E8 64050000   CALL <JMP.&USER32.MessageBoxA>   └USER32.MessageBoxA
0040131C │.  83EC 10       SUB ESP,10
0040131F │.  C9            LEAVE
00401320 │.  31C0          XOR EAX,EAX
00401322 └.  C3            RETN
```

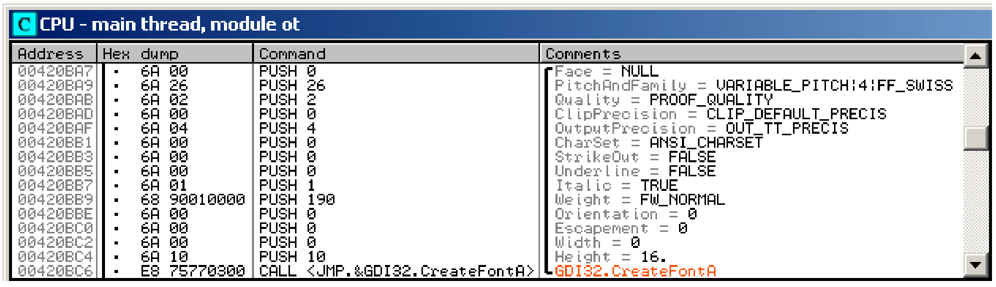
Note that the order of arguments for *MessageBox()* is *(hOwner*, *Text*, *Caption*, *Type)*. MinGW has changed this order. Still, OllyDbg 2 was able to recognize the arguments.

Known functions

OllyDbg contains descriptions of more than 2200 standard API functions from the following libraries:

- KERNEL32.DLL
- GDI32.DLL
- USER32.DLL
- NTDLL.DLL
- VERSION.DLL
- ADVAPI32.DLL
- SHLWAPI.DLL
- COMDLG32.DLL
- MSVCRT.DLL

It also knows more than 7700 symbolic constants, grouped into 480 types, and can decode them in the code:



```
CPU - main thread, module ot
Address  Hex dump        Command                        Comments
00420BA7 │ .  6A 00        PUSH 0                         ┌Face = NULL
00420BA9 │ .  6A 26        PUSH 26                        │PitchAndFamily = VARIABLE_PITCH|4|FF_SWISS
00420BAB │ .  6A 02        PUSH 2                         │Quality = PROOF_QUALITY
00420BAD │ .  6A 00        PUSH 0                         │ClipPrecision = CLIP_DEFAULT_PRECIS
00420BAF │ .  6A 04        PUSH 4                         │OutputPrecision = OUT_TT_PRECIS
00420BB1 │ .  6A 00        PUSH 0                         │CharSet = ANSI_CHARSET
00420BB3 │ .  6A 00        PUSH 0                         │StrikeOut = FALSE
00420BB5 │ .  6A 00        PUSH 0                         │Underline = FALSE
00420BB7 │ .  6A 01        PUSH 1                         │Italic = TRUE
00420BB9 │ .  68 90010000  PUSH 190                       │Weight = FW_NORMAL
00420BBE │ .  6A 00        PUSH 0                         │Orientation = 0
00420BC0 │ .  6A 00        PUSH 0                         │Escapement = 0
00420BC2 │ .  6A 00        PUSH 0                         │Width = 0
00420BC4 │ .  6A 10        PUSH 10                        │Height = 16.
00420BC6 │ .  E8 75770300  CALL <JMP.&GDI32.CreateFontA>  └GDI32.CreateFontA
```

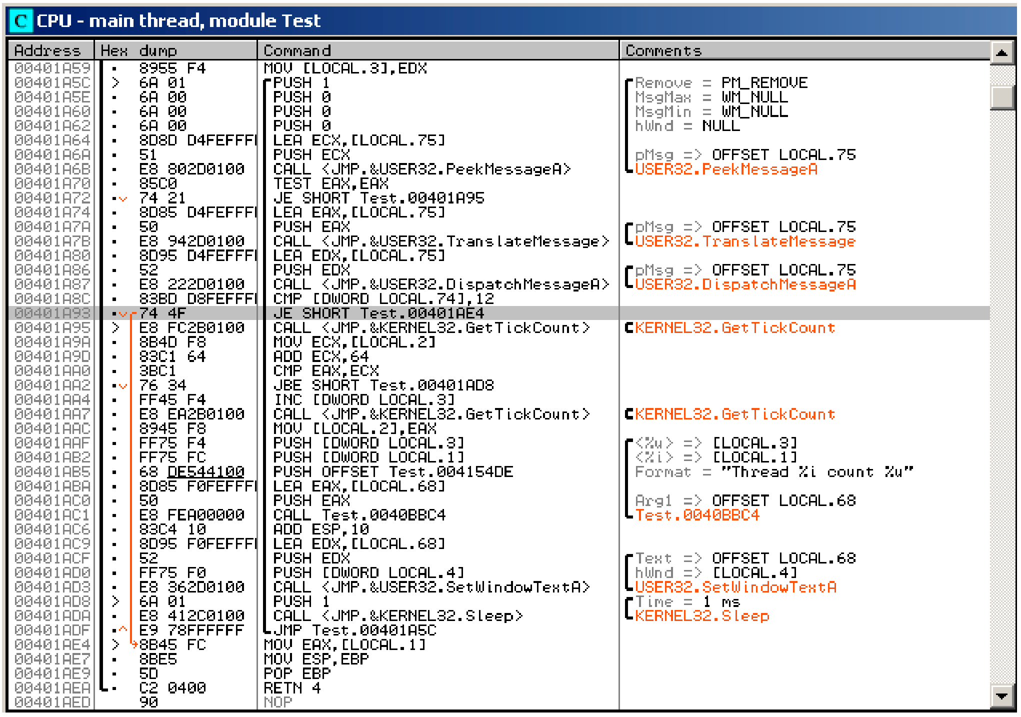
You can use known constants in assembler commands and arithmetic expressions. For example, CMP EAX,WM_PAINT is a valid command that compiles to 83F8 0F.

Loops

Loop is a closed continuous sequence of commands where last command is a jump to the first. Loop must have single entry point and unlimited number of exits. Loops correspond to the high-level operators *do*, *while* and *for.* OllyDbg recognizes nested loops of any complexity. Loops are marked by parenthesis in the disassembly. If entry is not the first command in the loop, OllyDbg marks it with a small triangle.

Below is the main loop of the threads created by the test application, together with the C code. Selected command is loop exit. Long red arrow shows its destination:

```
...
while (1) {
  if (PeekMessage(&msg,NULL,0,0,PM_REMOVE)) {
    TranslateMessage(&msg);
    DispatchMessage(&msg);
    if (msg.message==WM_QUIT) break;
  };
  if (GetTickCount()>t+100) {
    u++; t=GetTickCount();
    sprintf(s,"Thread %i count %u",threadindex,u);
    SetWindowText(hw,s);
  };
  Sleep(1);
};
return threadindex;
```



CPU - main thread, module Test

```
Address   Hex dump        Command                                   Comments
00401A59   .  8955 F4      MOV [LOCAL.3],EDX
00401A5C   >  6A 01        PUSH 1                                   Remove = PM_REMOVE
00401A5E   .  6A 00        PUSH 0                                   MsgMax = WM_NULL
00401A60   .  6A 00        PUSH 0                                   MsgMin = WM_NULL
00401A62   .  6A 00        PUSH 0                                   hWnd = NULL
00401A64   .  8D8D D4FEFFF LEA ECX,[LOCAL.75]
00401A6A   .  51           PUSH ECX                                 pMsg => OFFSET LOCAL.75
00401A6B   .  E8 802D0100  CALL <JMP.&USER32.PeekMessageA>          USER32.PeekMessageA
00401A70   .  85C0         TEST EAX,EAX
00401A72   .v 74 21        JE SHORT Test.00401A95
00401A74   .  8D85 D4FEFFF LEA EAX,[LOCAL.75]
00401A7A   .  50           PUSH EAX                                 pMsg => OFFSET LOCAL.75
00401A7B   .  E8 942D0100  CALL <JMP.&USER32.TranslateMessage>      USER32.TranslateMessage
00401A80   .  8D95 D4FEFFF LEA EDX,[LOCAL.75]
00401A86   .  52           PUSH EDX                                 pMsg => OFFSET LOCAL.75
00401A87   .  E8 222D0100  CALL <JMP.&USER32.DispatchMessageA>      USER32.DispatchMessageA
00401A8C   .  83BD D8FEFFF CMP [DWORD LOCAL.74],12
00401A93   .v 74 4F        JE SHORT Test.00401AE4
00401A95   >  E8 FC2B0100  CALL <JMP.&KERNEL32.GetTickCount>        KERNEL32.GetTickCount
00401A9A   .  8B4D F8      MOV ECX,[LOCAL.2]
00401A9D   .  83C1 64      ADD ECX,64
00401AA0   .  3BC1         CMP EAX,ECX
00401AA2   .v 76 34        JBE SHORT Test.00401AD8
00401AA4   .  FF45 F4      INC [DWORD LOCAL.3]
00401AA7   .  E8 EA2B0100  CALL <JMP.&KERNEL32.GetTickCount>        KERNEL32.GetTickCount
00401AAC   .  8945 F8      MOV [LOCAL.2],EAX
00401AAF   .  FF75 F4      PUSH [DWORD LOCAL.3]                     <%u> => [LOCAL.3]
00401AB2   .  FF75 FC      PUSH [DWORD LOCAL.1]                     <%i> => [LOCAL.1]
00401AB5   .  68 DE544100  PUSH OFFSET Test.004154DE                Format = "Thread %i count %u"
00401ABA   .  8D85 F0FEFFF LEA EAX,[LOCAL.68]
00401AC0   .  50           PUSH EAX                                 Arg1 => OFFSET LOCAL.68
00401AC1   .  E8 FEA00000  CALL Test.0040BBC4                       Test.0040BBC4
00401AC6   .  83C4 10      ADD ESP,10
00401AC9   .  8D95 F0FEFFF LEA EDX,[LOCAL.68]
00401ACF   .  52           PUSH EDX                                 Text => OFFSET LOCAL.68
00401AD0   .  FF75 F0      PUSH [DWORD LOCAL.4]                     hWnd => [LOCAL.4]
00401AD3   .  E8 362D0100  CALL <JMP.&USER32.SetWindowTextA>        USER32.SetWindowTextA
00401AD8   >  6A 01        PUSH 1                                   Time = 1 ms
00401ADA   .  E8 412C0100  CALL <JMP.&KERNEL32.Sleep>               KERNEL32.Sleep
00401ADF   .^ E9 78FFFFFF  JMP Test.00401A5C
00401AE4   >  8B45 FC      MOV EAX,[LOCAL.1]
00401AE7   .  8BE5         MOV ESP,EBP
00401AE9   .  5D           POP EBP
00401AEA   .  C2 0400      RETN 4
00401AED      90           NOP
```

Note that sprintf() called at address 00401AC1 is a library function used by compiler and is not known as such. But there are other calls somewhere in the code, so analyser was able to decide that its second parameter is a format string, and has decoded the remaining parameters correspondingly.

Switches and cascaded IFs

To implement a switch, many compilers load switch variable into some register and then subtract parts of it, like in the following sequence:

```
MOV EDX,<switch variable>
SUB EDX,100
JB DEFAULTCASE
JE CASE100         ; Case 100
```

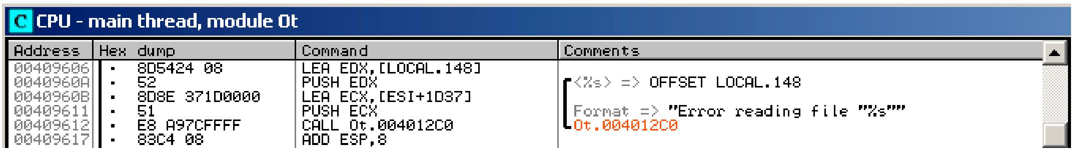
```
DEC EDX
JNE DEFAULTCASE
...                 ; Case 101
```

This sequence may also include one- and two-stage switch tables, direct comparisons, optimizations and other stuff. If you are deep enough in the tree of comparisons and jumps, it's very hard to say which case is it. OllyDbg does it for you. It marks all cases, including default, and even attempts to suggest the meaning of cases, like 'A', WM_PAINT or EXCEPTION_ACCESS_VIOLATION. If sequence of commands doesn't modify register (i.e. consists only of comparisons), then this is probably not a switch, but a cascaded if operator:

```
if (i==100) {...}
else if (i==101) {...}
else if (i==102) {...}
```

Prediction of registers

Look at this code snippet:



```
CPU - main thread, module Ot
Address   Hex dump          Command                  Comments
00409606  .  8D5424 08      LEA EDX,[LOCAL.148]
0040960A  .  52             PUSH EDX                 ┌<%s> => OFFSET LOCAL.148
0040960B  .  8D8E 371D0000  LEA ECX,[ESI+1D37]       │
00409611  .  51             PUSH ECX                 │Format => "Error reading file "%s""
00409612  .  E8 A97CFFFF    CALL Ot.004012C0         └Ot.004012C0
00409617  .  83C4 08        ADD ESP,8
```

Analyser recognized that procedure at address 004012C0 is similar to *printf*: its first argument is a format string. (In fact, this function displays error messages). Such procedures may have variable number of arguments and use C-style conventions for the parameters, namely that arguments are remove from the stack by the calling program. Command ADD ESP,8 after the call does exactly this: it removes 8 bytes of data, or two doublewords frof the stack. The first doubleword is the pointer to format string. Therefore this call must have one additional parameter. Format string indicates the same: it expects one pointer to the string.

String address is the second argument in the call. By stating <%s> => OFFSET LOCAL.148 Ollydbg tells you the following: register EDX at the moment of PUSH EDX will contain address of the local variable 148 (148.-th doubleword preceding return address). Indeed, previous command (LEA EAX,[LOCAL.148]) loads this address to EDX.

Symbol **=>** in comments means "predicted to be equal to". For example, PUSH ECX will push address of the displayed format string... Wait! Operator at 0040960B just adds 0x1D37 to ESI. But where ESI is defined?

If you look through the procedure, you will be able to restore the structure of the code:

```
...
MOV ESI,OFFSET Ot.0045E7EC ; Here ESI is defined
...
PUSH ESI
...                        ; Inlined strcpy()
POP ESI
...
CALL Ot.xxx
...
CALL OT.yyy
...
LEA EDX,[LOCAL.148]        ; Our code
PUSH EDX
LEA ECX,[ESI+1D37]
PUSH ECX
CALL Ot.004012C0
ADD ESP,8
...
```

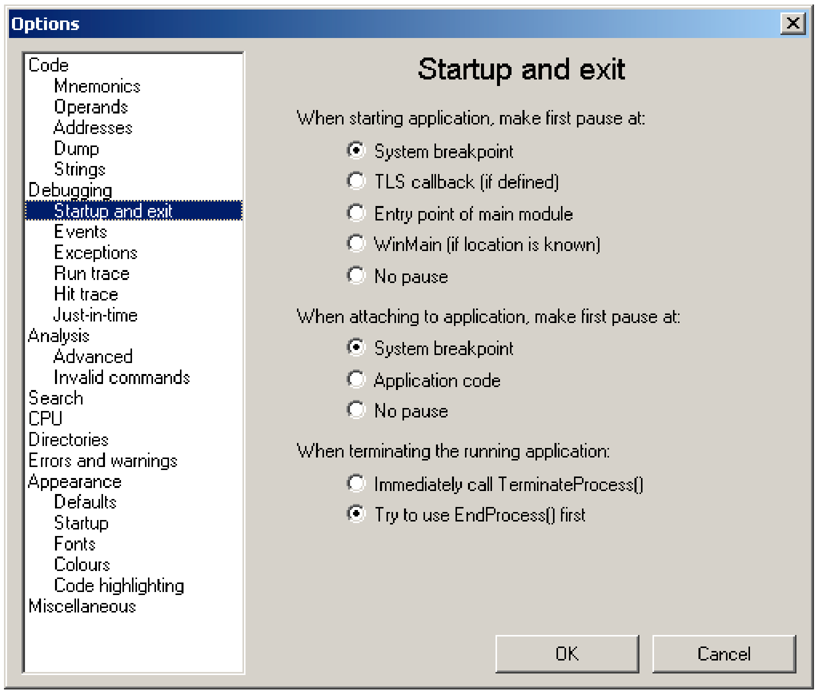
At the beginning, program loads ESI with the address of static data block. This operation is not very meaningfull here but would make more sense in the multithreaded applications that use thread local storage. Pair PUSH ESI/POP ESI preserves value of ESI from modification by inlined *strcpy()*: it uses MOVS. But then you see two calls to unknown functions xxx and yyy. Why analyser is sure that they leave ESI unchanged? Well, either analyser determined this directly from the code of xxx and yyy, or you told it by selecting corresponding analysis option. All API function and many separately compiled procedures use *stdcall* convention: functions should preserve registers EBX, EBP, ESI and EDI.

Debugging

Attaching to running processes

You can attach OllyDbg to the running process, provided that you have sufficient privileges. From the main menu, select **File | Attach...** and choose process from the list of running processes.
If main thread is suspended (for example, application was created as CREATE_SUSPENDED), OllyDbg will automatically resume it. For different reasons, this is not possible under Windows 2000. Attempt to attach to the suspended application will result in crash.
While attaching, Windows creates new thread in the contents of the Debuggee. This thread executes DbgBreakPoint(), thus giving Debugger the chance to make all necessary preparations. The thread is marked as temporary by the OllyDbg. Under Windows 2000, OllyDbg is unable to recognize this thread as temporary and reports it as an ordinary thread.

Attaching to running process is controlled by the following options:



Startup and exit

When starting application, make first pause at:
[✓ System breakpoint]
TLS callback (if defined)
Entry point of main module
WinMain (if location is known)
No pause

When attaching to application, make first pause at:
[✓ System breakpoint]
Application code
No pause

When terminating the running application:
Immediately call TerminateProcess()
[✓ Try to use EndProcess() first]

When attaching to application, make first pause at: System breakpoint - asks OllyDbg to pause application on the system breakpoint in the temporary thread;
When attaching to application, make first pause at: Application code - asks to pause application in the main thread at the location that was executing at the moment of attaching. Usually this is *ntdll.dll*;
When attaching to application, make first pause at: No pause - application should continue execution.

Detaching from the debugging process

Under Windows XP and higher OS versions, you can detach from the running process. From the main menu, select **File | Detach**. OllyDbg automatically removes all breakpoints, but does not resume threads that were suspended by you. Don't forget to do it manually!

Debugging of child processes

OllyDbg is a single-process debugger. To debug child processes, it launches new instances of itself, so that each child gets its own copy of the OllyDbg. This is possible only under Windows XP or higher Windows versions, and only if parent process was started by OllyDbg.

Due to the limitations of the Windows, debugging of grandchildren is not supported. That is, if you debug process A and it spawns process B, B will be passed to the OllyDbg. If now B spawns process C, debugger will get no notification and C will run free. Of course, you can attach to the C later.

Debugging of child processes is controlled by the option **Debugging events | Debug child processes**.

Breakpoints

OllyDbg supports the following types of breakpoints:

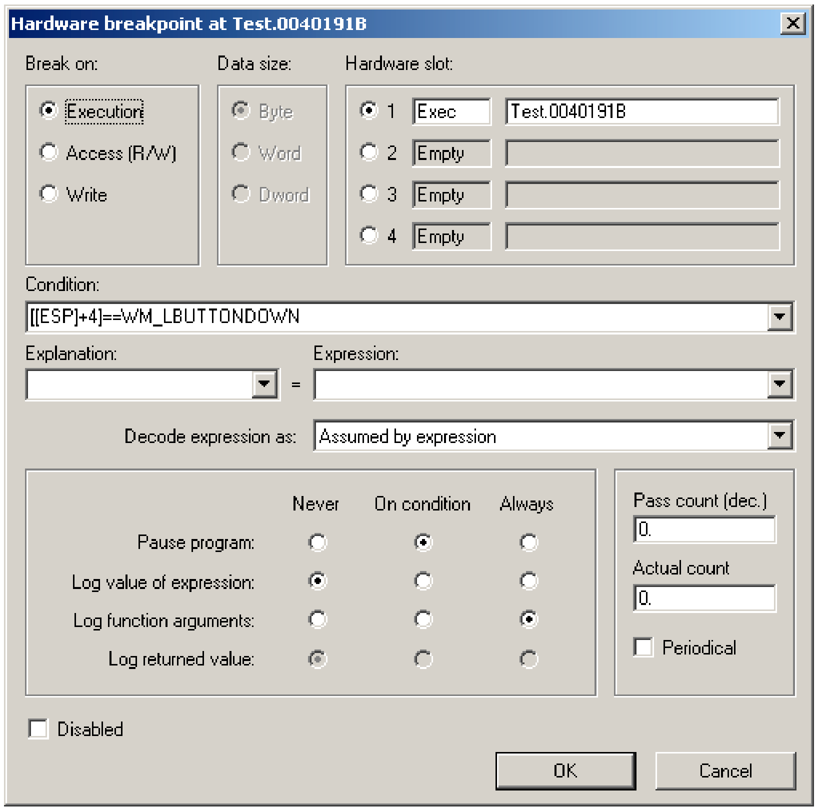
- INT3 breakpoints on code execution;
- Memory breakpoints on memory access, write to memory or code execution;
- Hardware breakpoints on memory access, write to memory or code execution.

Additionally, you can set breakpoint on access to memory block (not available for DOS-based Windows versions). They will be discussed elsewhere.

Number of INT3 and memory breakpoints is unlimited. Note that Windows protects memory only in chunks of 4096 bytes. Therefore, if memory breakpoint is set within the memory block with frequently accessed variables, OllyDbg will get many false breakpoints, which may significantly slow down the speed of execution. In some cases, run trace with allowed emulation of the commands may be faster! For details, see chapter "Run trace and profiling". Caveat: avoid setting memory breakpoints on the stack. If address from the protected memory block is passed to the system, system call will fail, terminating the application or influencing its operation. This is possible with memory breakpoints on data, too, but with significantly lower probability.

Number of hardware breakpoints is limited to 4 by the CPU.

Simple breakpoint pauses execution each time the command is executed or memory is accessed. You may also set conditional logging breakpoints with many additional options. The picture below represents hardware breakpoint on the call to PeekMessageA() at address 0x0040191B in the main loop of the test application and corresponding protocol. Each time the breakpoint is hit, the parameters of the call are saved to the log. We want to pause application when received message is WM_LBUTTONDOWN. First parameter in the call is the pointer to the structure MSGA. It is pushed last and therefore has address [DWORD ESP], or simply [ESP]. Message identifier is the second element of the structure, doubleword at address [ESP]+4. Its contents, [[ESP]+4] is compared with the constant WM_LBUTTONDDOWN. If they are equal, execution will be paused:



Hardware breakpoint at Test.0040191B

Break on: [✓ Execution] Access (R/W) Write

Data size: [✓ Byte] Word Dword

Hardware slot:

[✓ 1]	Exec	Test.0040191B
2	Empty	
3	Empty	
4	Empty	

Condition: [[ESP]+4]==WM_LBUTTONDOWN

Explanation: = Expression:

Decode expression as: Assumed by expression

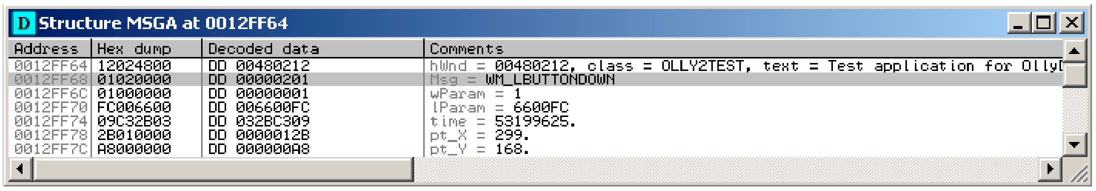
	Never	On condition	Always
Pause program:		✓	
Log value of expression:	✓		
Log function arguments:			✓
Log returned value:	✓		

Pass count (dec.) 0.

Actual count 0.

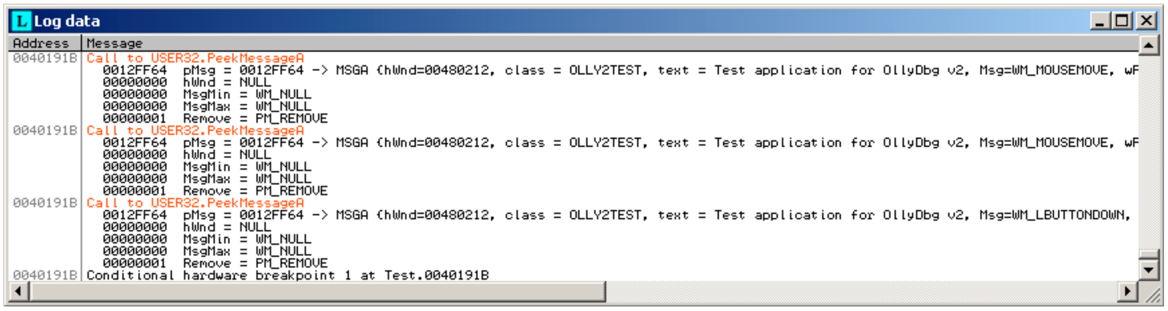
☐ Periodical

☐ Disabled



Structure MSGA at 0012FF64

```
Address  Hex dump Decoded data Comments
0012FF64 12024800 DD 00480212  hWnd = 00480212, class = OLLY2TEST, text = Test application for OllyD
0012FF68 01020000 DD 00000201  Msg = WM_LBUTTONDOWN
0012FF6C 01000000 DD 00000001  wParam = 1
0012FF70 FC006600 DD 006600FC  lParam = 6600FC
0012FF74 09C32B03 DD 032BC309  time = 53199625.
0012FF78 2B010000 DD 0000012B  pt_X = 299.
0012FF7C A8000000 DD 000000A8  pt_Y = 168.
```



Log data

```
Address  Message
0040191B Call to USER32.PeekMessageA
           0012FF64  pMsg = 0012FF64 -> MSGA {hWnd=00480212, class = OLLY2TEST, text = Test application for OllyDbg v2, Msg=WM_MOUSEMOVE, wF
           00000000  hWnd = NULL
           00000000  MsgMin = WM_NULL
           00000000  MsgMax = WM_NULL
           00000001  Remove = PM_REMOVE
0040191B Call to USER32.PeekMessageA
           0012FF64  pMsg = 0012FF64 -> MSGA {hWnd=00480212, class = OLLY2TEST, text = Test application for OllyDbg v2, Msg=WM_MOUSEMOVE, wF
           00000000  hWnd = NULL
           00000000  MsgMin = WM_NULL
           00000000  MsgMax = WM_NULL
           00000001  Remove = PM_REMOVE
0040191B Call to USER32.PeekMessageA
           0012FF64  pMsg = 0012FF64 -> MSGA {hWnd=00480212, class = OLLY2TEST, text = Test application for OllyDbg v2, Msg=WM_LBUTTONDOWN,
           00000000  hWnd = NULL
           00000000  MsgMin = WM_NULL
           00000000  MsgMax = WM_NULL
           00000001  Remove = PM_REMOVE
0040191B Conditional hardware breakpoint 1 at Test.0040191B
```

Run trace and profiling

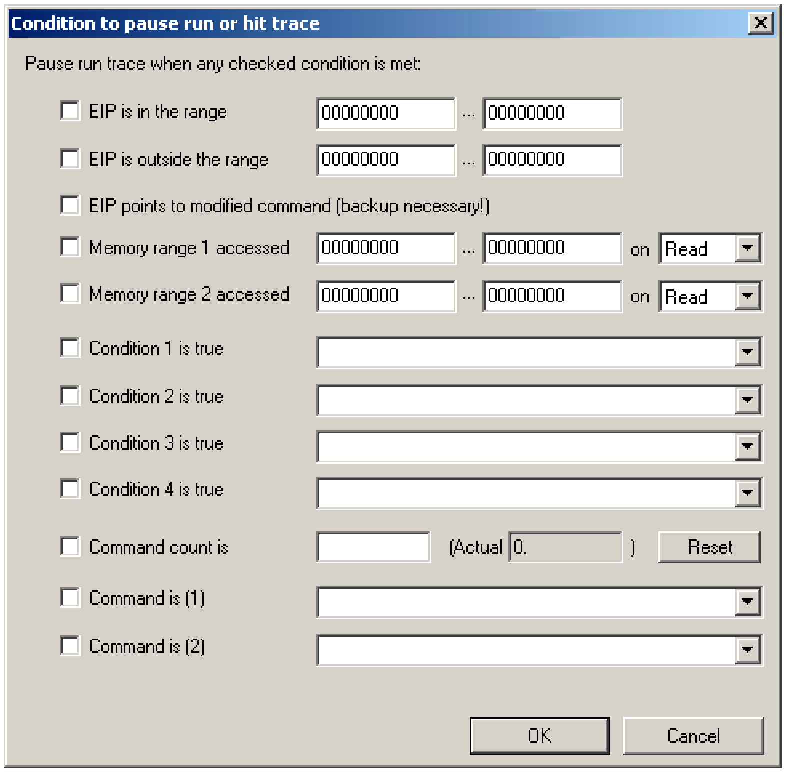
Run trace is the way to execute and protocol the debugged application command by command. In this way, one can locate the most frequently executed pieces of code, detect jumps to nowhere or just backtrace program execution that precedes some event.

In its simplest form, run trace sets breakpoint on the next command and continues execution. This method, however, is very slow. Windows need up to hundred microseconds to pause application and pass debugging event to debugger. This limits run trace to 10-30 thousand commands per second.

To accelerate run trace, OllyDbg can emulate commands internally, without passing control to the debuggee. The emulation is currently limited to the 55 frequently used integer commands, like MOV, ADD, CALL or conditional jumps. If command is not known or cannot be emulated (like SYSENTER), OllyDbg passes it to the application. Still, execution speed reaches 300-600 thousand, in simple loops up to one million commands per second. In many cases, this is sufficient for the "almost real-time" behaviour of Windows applications.

Each traced command is protocolled to the large circular buffer. The protocol includes address, contents of the integer registers and flags. If you need, you may save command code, FPU registes and contents of the accessed memory. Note however that each additional option reduces the number of the commands in the buffer. For example, if buffer is 256 MB large and all extras are turned off, it keeps up to 16.7 million commands, and with extras on - only 7 to 10 million.

Probably the most interesting feature of the run trace is its ability to pause execution when some event occurs (command Trace|Set condition... from the main menu):


Condition to pause run or hit trace

Pause run trace when any checked condition is met:

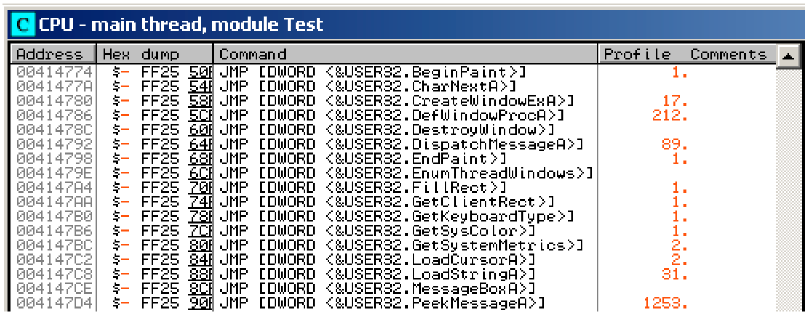
☐ EIP is in the range	00000000	...	00000000		
☐ EIP is outside the range	00000000	...	00000000		
☐ EIP points to modified command (backup necessary!)					
☐ Memory range 1 accessed	00000000	...	00000000	on	Read
☐ Memory range 2 accessed	00000000	...	00000000	on	Read
☐ Condition 1 is true					
☐ Condition 2 is true					
☐ Condition 3 is true					
☐ Condition 4 is true					
☐ Command count is		(Actual	0.	)	Reset
☐ Command is (1)					
☐ Command is (2)					

Option "EIP points to modified command" can be used to find entry point of the program packed by self-extractor. (By the way, hit trace in this case is much faster). When you start run or hit trace and option is active, Ollydbg compares actual command code with the backup copy abd pauses when they differ. Of course, backup copy must exist. The simplest way to assure it is to activate Options|Debugging options|Auto backup user code.

Pause on access to memory range can be implemented with memory breakpoints. Note however that 80x86 CPU protects memory only in 4096-byte chunks. If memory breakpoint is set on the small part of the actively used memory block, execution will cause large number of false debugging events. To recover, OllyDbg must remove memory protection, execute single command that caused exception and restore memory breakpoint again. This requires plenty of time. If command emulation is actvated, run trace may be significantly - up to 20 times - faster than memory breakpoint.

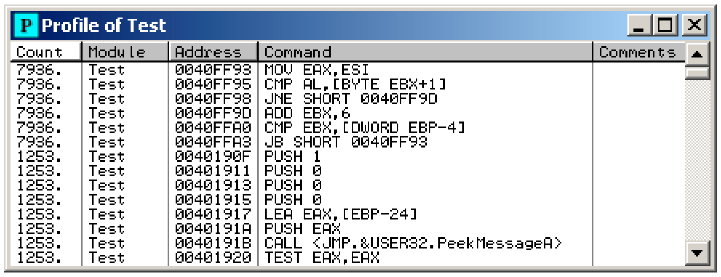
Condition is any valid expression, for example EAX==0 or ([BYTE 450002] & 0x80)!=0. Registers are taken from the actual thread. The evaluation of conditional expressions is very quick and has only minor influence on the run trace speed.

If you need to know how frequently each traced command was executed, choose **Comments | Show profile** in the Disassembler, or **Profile selected module** or **Global profile** in the Run trace. In the first case, Comments column will show how many times this command is present in the trace data:


CPU - main thread, module Test

```
Address   Hex dump       Command                                    Profile   Comments
00414774  $- FF25 50     JMP [DWORD <&USER32.BeginPaint>]                1.
0041477A  $- FF25 54     JMP [DWORD <&USER32.CharNextA>]
00414780  $- FF25 58     JMP [DWORD <&USER32.CreateWindowExA>]          17.
00414786  $- FF25 5C     JMP [DWORD <&USER32.DefWindowProcA>]          212.
0041478C  $- FF25 60     JMP [DWORD <&USER32.DestroyWindow>]
00414792  $- FF25 64     JMP [DWORD <&USER32.DispatchMessageA>]         89.
00414798  $- FF25 68     JMP [DWORD <&USER32.EndPaint>]                  1.
0041479E  $- FF25 6C     JMP [DWORD <&USER32.EnumThreadWindows>]
004147A4  $- FF25 70     JMP [DWORD <&USER32.FillRect>]                  1.
004147AA  $- FF25 74     JMP [DWORD <&USER32.GetClientRect>]             1.
004147B0  $- FF25 78     JMP [DWORD <&USER32.GetKeyboardType>]           1.
004147B6  $- FF25 7C     JMP [DWORD <&USER32.GetSysColor>]               1.
004147BC  $- FF25 80     JMP [DWORD <&USER32.GetSystemMetrics>]          2.
004147C2  $- FF25 84     JMP [DWORD <&USER32.LoadCursorA>]               2.
004147C8  $- FF25 88     JMP [DWORD <&USER32.LoadStringA>]              31.
004147CE  $- FF25 8C     JMP [DWORD <&USER32.MessageBoxA>]
004147D4  $- FF25 90     JMP [DWORD <&USER32.PeekMessageA>]           1253.
```

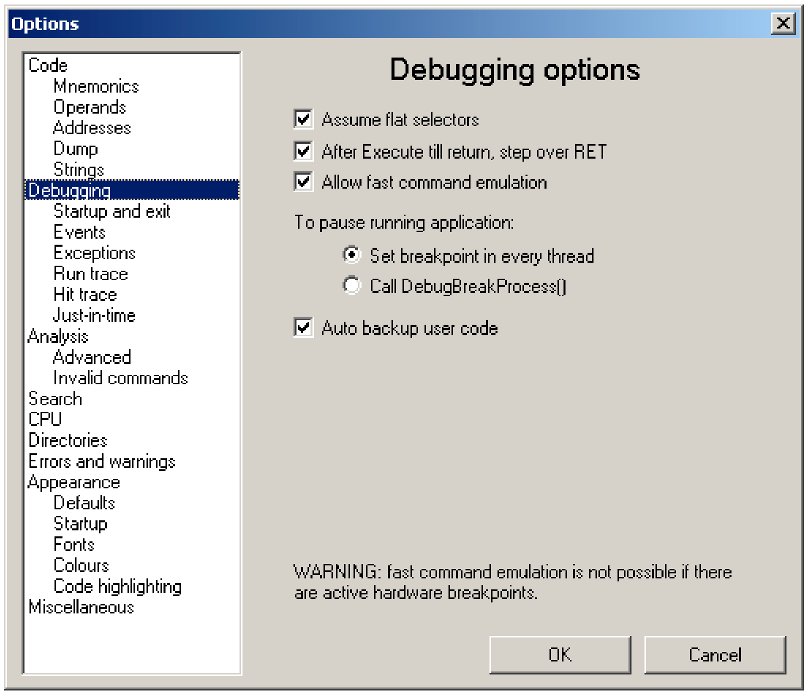
In the two remaining cases Profile window will list traced commands, sorted by their frequency:


Profile of Test

```
Count  Module  Address   Command                              Comments
7936.  Test    0040FF93  MOV EAX,ESI
7936.  Test    0040FF95  CMP AL,[BYTE EBX+1]
7936.  Test    0040FF98  JNE SHORT 0040FF9D
7936.  Test    0040FF9D  ADD EBX,6
7936.  Test    0040FFA0  CMP EBX,[DWORD EBP-4]
7936.  Test    0040FFA3  JB SHORT 0040FF93
1253.  Test    0040190F  PUSH 1
1253.  Test    00401911  PUSH 0
1253.  Test    00401913  PUSH 0
1253.  Test    00401915  PUSH 0
1253.  Test    00401917  LEA EAX,[EBP-24]
1253.  Test    0040191A  PUSH EAX
1253.  Test    0040191B  CALL <JMP.&USER32.PeekMessageA>
1253.  Test    00401920  TEST EAX,EAX
```

As you can see, snippet at address 0040FF93 in module *Test* was executed most frequently.

Run trace is controlled by the following set of options:



Debugging options

- [✓] Assume flat selectors
- [✓] After Execute till return, step over RET
- [✓] Allow fast command emulation

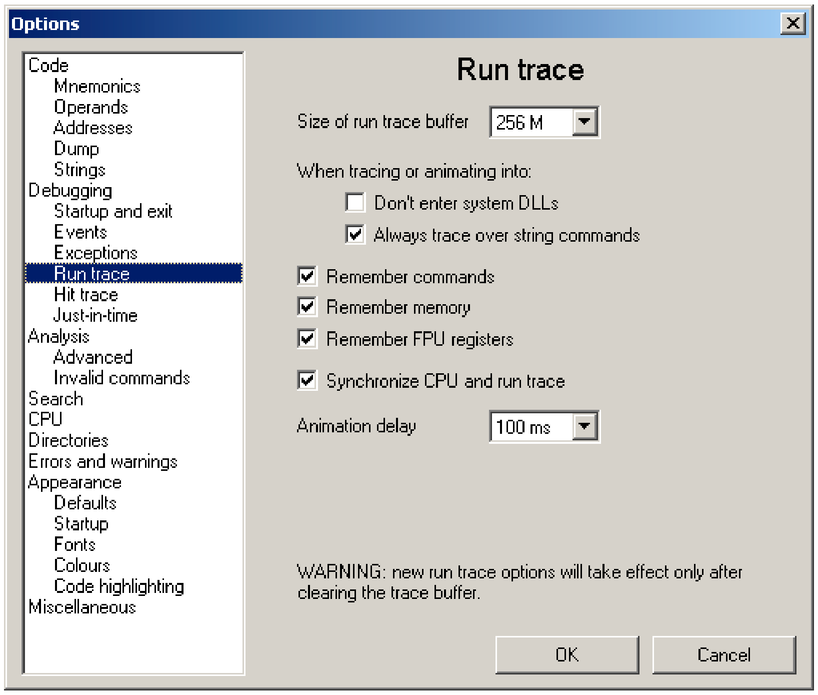
To pause running application:

- ● Set breakpoint in every thread
- ○ Call DebugBreakProcess()

- [✓] Auto backup user code

WARNING: fast command emulation is not possible if there are active hardware breakpoints.

Allow fast command emulation - allows OllyDbg to emulate some frequently used CPU commands internally, thus accelerating the debugging. Emulation is currently not compatible with the hardware breakpoints. If some hardware breakpoint is active, emulation is disabled;



Run trace

Size of run trace buffer: 256 M

When tracing or animating into:

- [ ] Don't enter system DLLs
- [✓] Always trace over string commands

- [✓] Remember commands
- [✓] Remember memory
- [✓] Remember FPU registers

- [✓] Synchronize CPU and run trace

Animation delay: 100 ms

WARNING: new run trace options will take effect only after clearing the trace buffer.

Size of run trace buffer - allocates memory for the circular buffer with run trace data. As a rule of thumb, one megabyte keeps 30000 - 60000 commands;

Don't enter system DLLs - requests OllyDbg to execute calls to Windows API functions at once, in the trace-over mode. Note that if API functions call user-space callbacks, they will not be traced, too;

Always trace over string commands - requests OllyDbg to trace over string commands, like REP MOVSB. If this option is deactivated, each MOVSB iteration will be protocolled separately;

Remember commands - saves copy of the traced command to the trace buffer. Only necessary if debugged application uses self-modified code;

Remember memory - saves actual contents of the addressed memory operands to the trace buffer;

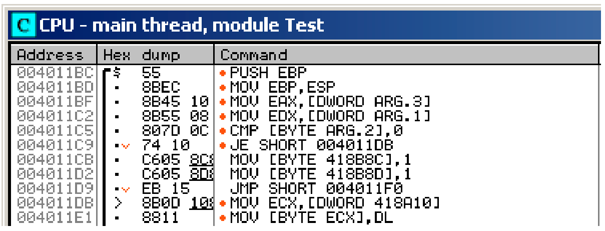
Remember FPU registers - saves floating-point registers to the trace buffer;

Synchronize CPU and run trace - moves CPU selection and updates CPU registers each time you change selection in the Run trace protocol.

Hit trace

The sense of debugging is to find and remove all bugs from the debugged application. To approach this ideal, you need to execute every subroutine and every branch, otherwise latent errors are preprogrammed. But how do you know whether particular piece of code was executed? Hit trace will give you the answer.

It starts from the actual location. OllyDbg sets INT3 breakpoints on all branches that were not traced so far. After trace breakpoint is reached, it removes it and marks command as hit. This allows to check at a glance whether some branch of code was executed. Here is an example: code at 004011CB was never executed.



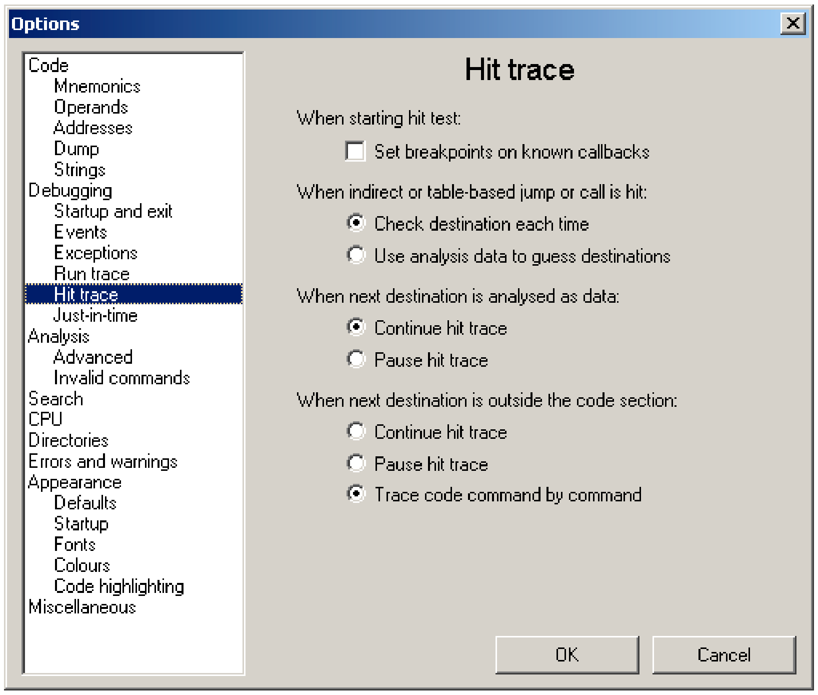
CPU - main thread, module Test

```
Address   Hex dump     Command
004011BC ┏$  55        PUSH EBP
004011BD ┃.  8BEC      MOV EBP,ESP
004011BF ┃.  8B45 10   MOV EAX,[DWORD ARG.3]
004011C2 ┃.  8B55 08   MOV EDX,[DWORD ARG.1]
004011C5 ┃.  807D 0C   CMP [BYTE ARG.2],0
004011C9 ┃.v 74 10     JE SHORT 004011DB
004011CB ┃.  C605 8C   MOV [BYTE 418B8C],1
004011D2 ┃.  C605 8D   MOV [BYTE 418B8D],1
004011D9 ┃.v EB 15     JMP SHORT 004011F0
004011DB ┃>  8B0D 10   MOV ECX,[DWORD 418A10]
004011E1 ┃.  8811      MOV [BYTE ECX],DL
```

Hit tracing is astoundingly fast, after short startup period application runs with almost full speed. Problems may occur with indirect branches and calls, like CALL [0x405000] or JMP [0x123456+EAX*4]. In this case you have two options: either to check the destination each time, or use analysis results to guess the set of possible destinations. The first way is more reliable, the second is significantly faster. If you are in doubt, use the first option.

Some malware and antivirus programs place the pieces of the code in the kernel memory (usually 0x80000000 and above). OllyDbg is unable to set INT3 breakpoints and continues in the step-by-step execution mode until the user memory is reached.

Hit trace is controlled by the following set of options:



Hit trace

When starting hit test:

[ ] Set breakpoints on known callbacks

When indirect or table-based jump or call is hit:

[✓ Check destination each time] Use analysis data to guess destinations

When next destination is analysed as data:

[✓ Continue hit trace] Pause hit trace

When next destination is outside the code section:

Continue hit trace Pause hit trace [✓ Trace code command by command]

Set breakpoints on known callbacks - if active, OllyDbg sets trace breakpoint on all known callback functions when hit trace starts, so that calls from Windows API functions, like SendMessage(), can be traced;

When indirect or table-based jump or call is hit: Check destination each time / Use analysis data to guess destinations - controls tracing of indirect jumps and calls. The first option assures reliable hit trace, the second makes it faster;

When next destination is analysed as data: Continue hit trace / Pause hit trace - this situation may happen either when Analyser erroneously recognized valid code as data, or if debugged program is self-modified or creates code on-the-fly. In the second case, be careful: INT3 breakpoint may have disastrous effects on the execution!

When next destination is outside the code section: Continue hit trace / Pause hit trace / Trace code

command by command - if debugged program creates code on-the fly or loads it dynamically from the disc, setting INT3 breakpoints on it may lead to crash. Step-by-step tracing is the safest, but also the slowest option.

Search

Imprecise search patterns

When searching for command or sequence of commands, you can specify imprecise Assembler patterns that match many different instructions. For example, MOV EAX,ANY will match MOV EAX,ECX; MOV EAX,12345; MOV EAX,[FS:0] and many other commands.

Imprecise patterns use following keywords:

Keyword	Matches
R8	Any 8-bit register (AL,BL, CL, DL, AH, BH, CH, DH)
R16	Any 16-bit register (AX, BX, CX, DX, SP, BP, SI, DI)
R32	Any 32-bit register (EAX, EBX, ECX, EDX, ESP, EBP, ESI, EDI)
SEG	Any segment register (ES, CS, SS, DS, FS, GS)
FPUREG	Any FPU register (ST0..ST7)
MMXREG	Any MMX register (MM0..MM7)
SSEREG	Any SSE register (XMM0..XMM7)
CRREG	Any control register (CR0..CR7)
DRREG	Any debug register (DR0..DR7)
CONST	Any constant
ANY	Any register, constant or memory operand

You can freely combine these keywords in memory addresses, like in the following examples:

Memory address	Matches
[CONST]	Any fixed memory location, like [400000]
[R32]	Memory locations with address residing in register, like [ESI]
[R32+1000]	Sum of any 32-bit register and constant 1000, like [EBP+1000]
[R32+CONST]	Sum of any 32-bit register and any offset, like [EAX-4] or [EBP+8]
[ANY]	Any memory operand, like [ESI] or [FS:EAX*8+ESI+1234]

If you are searching for the sequence of commands, it's important to emphasize the interaction of the commands in a sequence. Suppose that you are looking for all comparisons of two memory operands. 80x86 has no such instruction (except CMPS, but it's slow and requires lengthy preparations). Therefore compiler will generate the following code:

```
MOV EAX,[location 1]
CMP EAX,[location 2]
```

However, it is possible that compiler will choose ECX instead of EAX, or any other register. To take into account all such cases, OllyDbg has special depending registers:

Register	Meaning
RA, RB	All instances of 32-bit register **RA** in the command or sequence must reference the same register; the same for **RB**; but **RA** and **RB** must be different
R8A, R8B	Same as above, but **R8A** and **R8B** are 8-bit registers
R16A, R16B	Same as above, but **R16A** and **R16B** are 16-bit registers
R32A, R32B	Same as **RA, RB**

For example, search for XOR RA,RA will find all commands that use XOR to zero 32-bit register, whereas XOR RA,RB will exclude such cases. Correct sequence for the mentioned example is

```
MOV RA,[CONST]
CMP RA,[CONST]
```

There are also several imprecise commands:

Command	Matches
JCC	Any conditional jump (JB, JNE, JAE...)
SETCC	Any conditional set byte command (SETB, SETNE...)
CMOVCC	Any conditional move command (CMOVB, CMOVNE...)
FCMOVCC	Any conditional floating-point move (FCMOVB, FCMOVE...)

Examples:

Pattern	Found commands
MOV R32,ANY	MOV EBX,EAX MOV EAX,ECX MOV EAX,[DWORD 4591DB] MOV EDX,[DWORD EBP+8] MOV EDX,[DWORD EAX*4+EDX] MOV EAX,004011BC
ADD R8,CONST	ADD AL,30 ADD CL,0E0 ADD DL,7
XOR ANY,ANY	XOR EAX,EAX XOR AX,SI XOR AL,01 XOR ESI,00000088 XOR [DWORD EBX+4],00000002 XOR ECX,[DWORD EBP-12C]
MOV EAX,[ESI+CONST]	MOV EAX,[DWORD ESI+0A0] MOV EAX,[DWORD ESI+18] MOV EAX,[DWORD ESI-30]

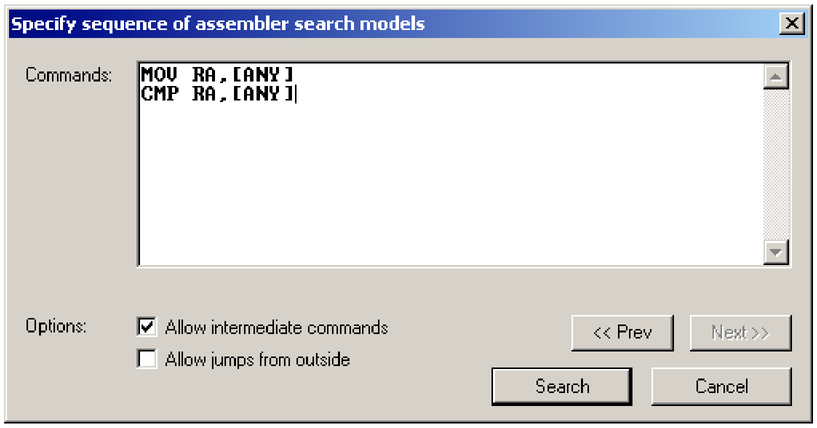
Note that in the last line, [DWORD ESI-30] is equivalent to [DWORD ESI+0FFFFFFD0].

Sequences of commands

OllyDbg can search for a sequence of commands. Suppose that you want to find all comparisons of two memory locations, as mentioned above. You specify your search pattern as

```
MOV RA,[CONST]
CMP RA,[CONST]
```

However, there is a problem. Optimizing compiler may place several other commands between MOV and CMP that do not use regisetr RA. What to do? For OllyDbg, this is not a problem. Just check **Allow intermediate commands** in the search dialog:



```
MOV RA,[ANY]
CMP RA,[ANY]
```

[✓] Allow intermediate commands
[ ] Allow jumps from outside

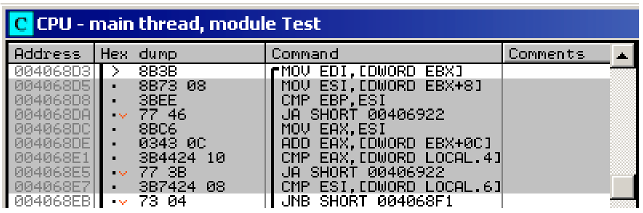
If intermediate commands have no influence on the specified commands (this also includes modification of flags), they will be allowed. For example,

```
MOV EAX,[123456]
XOR EDI,EAX
CMP EAX,[12345A]
```

is allowed (XOR EDI,EAX leaves contents of EAX unchanged), whereas

```
MOV EAX,[123456]
XOR EAX,EDI
CMP EAX,[12345A]
```

does not match the sequence because EAX will no longer contain [123456]. Another case is shown below:



```
Address   Hex dump         Command                        Comments
004068D3  >  8B3B          MOV EDI,[DWORD EBX]
004068D5  .  8B73 08       MOV ESI,[DWORD EBX+8]
004068D8  .  3BEE          CMP EBP,ESI
004068DA  .v 77 46         JA SHORT 00406922
004068DC  .  8BC6          MOV EAX,ESI
004068DE  .  0343 0C       ADD EAX,[DWORD EBX+0C]
004068E1  .  3B4424 10     CMP EAX,[DWORD LOCAL.4]
004068E5  .v 77 3B         JA SHORT 00406922
004068E7  .  3B7424 08     CMP ESI,[DWORD LOCAL.6]
004068EB  .v 73 04         JNB SHORT 004068F1
```

If there is a jump to CMP or intermediate command, EAX may contain different value, so usually such sequences are invalid. But if you want to take such cases into account, check **Allow jumps from outside**.

Apologies

"We apologize for inconveniences"
Douglas Adams

I'm not a native English speaker. Please forgive me all the grammatical errors. I would be very pleased if you let me know about especially unhappy phrases and suggest replacement.

I apologize for my semantical errors in the C code. They usually result in a window reporting that processor exceptionally dislikes command or data at some address. Of course, I can only blame my otherwise excellent compiler because it did literally what I wrote, not what I meant. Please forgive him and send me this address together with the version of OllyDbg and brief explanation.

I apologize also for inconveniences. If you miss some very useful function, please send me a mail, but don't expect too much.