Common WinDbg Commands (Thematically Grouped)

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1) Built-in help commands

Cmd	Variants / Params	Description
?	? ? /D	Display regular commands Display regular commands as DML
.help	.help .help /D .help /D a*	Display . commands Display . commands in DML format (top bar of links is given) Display . commands that start with a* (wildcard) as DML
.chain	.chain .chain /D	Lists all loaded debugger extensions Lists all loaded debugger extensions as DML (where extensions are linked to a .extmatch)
.extmatch	.extmatch /e ExtDLL FunctionFilter .extmatch /D /e ExtDLL FunctionFilter	Show all exported functions of an extension DLL. *FunctionFilter* = wildcard string Same in DML format (functions link to "!ExtName.help FuncName" commands) Example: **.extmatch /D /e uext *** (show all exported functions of uext.dll)
.hh	.hh .hh Text	Open WinDbg's help Text = text to look up in the help file index Example: **.hh dt**

2) General WinDbg's commands (show version, clear screen, etc.)

Cmd	Variants / Params	Description
version		Dump version info of debugger and loaded extension DLLs
vercommand		Dump command line that was used to start the debugger
vertarget		Version of target computer
CTRL+ALT+V		Toggle verbose mode ON/OFF In verbose mode some commands (such as register dumping) have more detailed output.
n	n [8 | 10 | 16]	Set number base
	.formats Expression	Show number formats = evaluates a numerical expression or symbol and displays it in multiple numerical formats (hex, decimal, octal, binary, time, ..)

		Example 1: .formats 5 Example 2: .formats poi(nLocal1) == .formats @@($!nLocal1)
.cls		Clear screen
.lastevent		Displays the most recent exception or event that occurred (why the debugger is waiting?)
.effmach	.effmach .effmach . .effmach # .effmach x86 | amd64 | ia64 | ebc	Dump effective machine (x86, amd64, ..): Use target computer's native processor mode Use processor mode of the code that is executing for the most recent event Use x86, amd64, ia64, or ebc processor mode This setting influences many debugger features: -> which processor's unwinder is used for stack tracing -> which processor's register set is active
.time		display time (system-up, process-up, kernel time, user time)

3) Debugging sessions (attach, detach, ..)

Cmd	Variants / Params	Description
.attach	PID	attach to a process
.detach		ends the debugging session, but leaves any user-mode target application running
q	q, qq	Quit = ends the debugging session and terminates the target application Remote debugging: q= no effect; qq= terminates the debug server
.restart		Restart target application

4) Expressions and commands

Cmd	Variants / Params	Description
;		Command separator (cm1; cm2; ..)
?	? Expression ?? Expression	Evaluate expression (use default evaluator) Evaluate c++ expression
.expr	.expr .expr /q .expr /s c++ .expr /s masm	Choose default expression evaluator Show current evaluator Show available evaluators Set **c++** as the default expression evaluator Set **masm** as the default expression evaluator
*	* [any text]	Comment Line Specifier Terminated by: end of line
$$	$$ [any text]	Comment Specifier Terminated by: end of line OR semicolon
.echo	.echo String .echo "String"	Echo Comment -> comment text + echo it Terminated by: end of line OR semicolon With the $$ token or the * token the debugger will ignore the inputted text without echoing it.

5) Debugger markup language (DML)

Starting with the 6.6.07 version of the debugger a new mechanism for enhancing output from the debugger and extensions was included: DML.
DML allows output to include directives and extra non-display information in the form of tags.
Debugger user interfaces parse out the extra information to provide new behaviors.

DML is primarily intended to address two issues:

- **Linking of related information**
- **Discoverability of debugger and extension functionality**

Cmd	Variants / Params	Description

.dml_start		Kick of to other DML commands
.prefer_dml	.prefer_dml [1 | 0]	Global setting: should DML-enhanced commands default to DML? Note that many commands like k, lm, .. output DML content thereafter.
.help /D		.help has a new DML mode where a top bar of links is given
.chain /D		.chain has a new DML mode where extensions are linked to a .extmatch
.extmatch /D		.extmatch has a new DML format where exported functions link to "!ExtName.help FuncName" commands
lmD		lm has a new DML mode where module names link to lmv commands
kM		k has a new DML mode where frame numbers link to a .frame/dv
.dml_flow	.dml_flow StartAddr TargetAddr	Allows for interactive exploration of code flow for a function. 1. Builds a code flow graph for the function starting at the given start address (similar to uf) 2. Shows the basic block given the target address plus links to referring blocks and blocks referred to by the current block Example: **.dml_flow CreateRemoteThread CreateRemoteThread+30**

6) Main extensions

Cmd	Variants / Params	Display supported commands for ..
!Ext.help		General extensions
!Exts.help		-||-
!Uext.help		User-Mode Extensions (non-OS specific)
!Ntsdexts.help		User-Mode Extensions (OS specific)
!logexts.help		Logger Extensions
!clr10\sos.help		Debugging managed code
!wow64exts.help		Wow64 debugger extensions
!Wdfkd.help		Kernel-Mode driver framework extensions
!Gdikdx.help		Graphics driver extensions
..		
!NAME.help	!NAME.help FUNCTION	Display detailed help about an exported function NAME = placeholder for extension DLL FUNCTION = placeholder for exported function Example: **!Ntsdexts.help handle** (show detailed help about !Ntsdexts.handle)

7) Symbols

Cmd	Variants / Params	Description
ld	ld ModuleName ld *	Load symbols for Module Load symbols for all modules
!sym	!sym !sym noisy !sym quiet	Get state of symbol loading Set **noisy** symbol loading (debugger displays info about its search for symbols) Set **quiet** symbol loading (=default)

x	x *[Options]* Module!Symbol x */t* .. x */v* .. x */a* .. x */n* .. x */z* ..	**Examine symbols**: displays symbols that match the specified pattern with data type verbose (symbol type and size) sort by address sort by name sort by size ("size" of a function symbol is the size of the function in memory)
ln	ln Addr	**List nearest symbols** = display the symbols at or near the given Addr. Useful to: • determine what a pointer is pointing to • when looking at a corrupted stack to determine which procedure made a call
.sympath	.sympath .sympath+	Display or set symbol search path Append directories to previous symbol path
.symopt	.symopt .symopt+ *Flags* .symopt- *Flags*	displays current symbol options add option remove option
.symfix	.symfix .symfix+ DownstreamStore	Set symbol store path to automatically point to http://msdl.microsoft.com/download/symbols + = append it to the existing path DownstreamStore = directory to be used as a downstream store. Default is WinDbgInstallationDir\Sym.
.reload	.reload .reload [/f | /v] .reload [/f | /v] Module	Reload symbol information for all modules** f = force immediate symbol load (overrides lazy loading); v = verbose mode Module = for Module only **Note: The .reload command does not actually cause symbol information to be read. It just lets the debugger know that the symbol files may have changed, or that a new module should be added to the module list. To force actual symbol loading to occur use the /f option, or the ld (Load Symbols) command.

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x *!	list all modules
x ntdll!*	list all symbols of ntdll
x /t /v MyDll!*	list all symbol in MyDll with data type, symbol type and size
x kernel32!*LoadLib*	list all symbols in kernel32 that contain the word LoadLib
.sympath+ C:\MoreSymbols	add symbols from C:\MoreSymbols (folder location)
.reload /f @"ntdll.dll"	Immediately reload symbols for ntdll.dll.
.reload /f @"C:\WINNT\System32\verifier.dll"	Reload symbols for verifier. Use the given path.

Also check the "!lmi" command.

8) Sources		
Cmd	Variants / Params	Description
.srcpath	.srcpath .srcpath+ DIR	Display or set source search path Append directory to the searched source path
.srcnoisy	*{1|0}*	Controls noisy source loading
.lines	[-e | -d | -t]	Toggle source line support: enable; disable; toggle
l (small letter L)	l+l, l-l l+o, l-o l+s, l-s l+t, l-t	show line numbers suppress all but [s] source and line number source mode vs. assembly mode

9) Exceptions, events, and crash analysis

Cmd	Variants / Params	Description
g	g gH gN	Go Go exception handled Go not handled
.lastevent		What happened? Shows most recent event or exception
!analyze	!analyze -v !analyze -hang !analyze -f	Display information about the current exception or bug check; verbose User mode: Analyzes the thread stack to determine whether any threads are blocking other threads. See an exception analysis even when the debugger does not detect an exception.
sx	sx sxe sxd sxn sxi sxr	Show all event filters with break status and handling break first-chance break second-chance notify; don't break ignore event reset filter settings to default values
.exr	.exr-1 .exr Addr	display most recent exception record display exception record at Addr
.ecxr		displays exception context record (registers) associated with the current exception
!cppexr	Addr	Display content and type of C++ exception

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exr -1	display most recent exception
.exr 7c901230	display exception at address 7c901230
!cppexr 7c901230	display c++ exception at address 7c901230

10) Loaded modules and image information

Cmd	Variants / Params	Description
lm	lm[v | l | k | u | f] *[m Pattern]* lmD	List modules; verbose | with loaded symbols | k-kernel or u-user only symbol info | image path; pattern that the module name must match DML mode of lm; lmv command links included in output
!dlls	!dlls !dlls -i !dlls -l !dlls -m !dlls -v !dlls -c ModuleAddr !dlls -?	all loaded modules with **load count** by initialization order by load order (default) by memory order with version info only module at ModuleAddr brief help
!imgreloc	*ImgBaseAddr*	information about relocated images
!lmi	*Module*	detailed info about a module (including exact symbol info)
!dh	!dh *ImgBaseAddr* !dh -f *ImgBaseAddr* !dh -s *ImgBaseAddr* !dh -h	Dump headers for ImgBaseAddr f = file headers only s = section headers only h = brief help The !lmi extension extracts the most important information from the image header and displays it in a concise summary format. It is often more useful than !dh.

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lm	display all loaded and unloaded modules
lmv m kernel32	display verbose (all possible) information for kernel32.dll
lmD	DML variant of lm

!dlls -v -c kernel32	display information for kernel32.dll, including **load-count**
!lmi kernel32	display detailed information about kernel32, including **symbol information**
!dh kernel32	display headers for kernel32

11) Process related information

Cmd	Variants / Params	Description
!dml_proc		(DML) displays current processes and allows drilling into processes for more information
| (pipe)		Print status of all processes being debugged
.tlist		lists all processes running on the system
!peb		display formatted view of the process's environment block (PEB)

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!peb	Dump formatted view of processes PEB (only some information)
r $peb	Dump address ob PEB. $peb == pseudo-register
dt ntdll!_PEB	Dump PEB struct
dt ntdll!_PEB @$peb -r	Recursively (-r) dump PEB of our process

12) Thread related information

Cmd	Variants / Params	Description
~	~ ~* *[Command]* ~. *[Command]* ~# *[Command]* ~Number *[Command]* ~~[TID] *[Command]* ~Ns	list threads all threads current thread thread that caused the current event or exception thread whose ordinal is Number thread whose thread ID is TID (the brackets are required) switch to thread N (new current thread) *[Command]: works for a few regular commands such as k, r*
~e	~* *e CommandString* ~. *e CommandString* ~# *e CommandString* ~Number *e CommandString*	Execute thread-specific commands (CommandString = one or more commands to be executed) for: all threads current thread thread which caused the current event thread with ordinal
~f	~Thread f	Freeze thread (see ~ for Thread syntax)
~u	~Thread u	Unfreeze thread (see ~ for Thread syntax)
~n	~Thread n	Suspend thread = increment thread's suspend count
~m	~Thread m	Resume thread = decrement thread's suspend count
!teb		display formatted view of the thread's environment block (TEB)
!tls	!tls -1 !tls SlotIdx !tls [-1 | SlotIdx] TebAddr	-1 = dump all slots for current thread SlotIdx = dump only specified slot TebAddr = specify thread; if omitted, the current thread is used
.ttime		display thread times (user + kernel mode)
!runaway	[Flags: 0 | 1 | 2]	display information about time consumed by each thread (0-user time, 1-kernel time, 2-time elapsed since thread creation). quick way to find out which threads are spinning out of control or consuming too much CPU time

!gle	!gle !gle -all	Dump last error for current thread Dump last error for all threads Point of interest: **SetLastError(dwErrCode)** checks the value of kernel32!g_dwLastErrorToBreakOn and possibly executes a DbgBreakPoint. **if** ((g_dwLastErrorToBreakOn != 0) && (**dwErrCode == g_dwLastErrorToBreakOn**)) **DbgBreakPoint();** The downside is that SetLastError is only called from within KERNEL32.DLL. Other calls to SetLastError are redirected to a function located in NTDLL.DLL, RtlSetLastWin32Error.
!error	!error ErrValue !error ErrValue 1	Decode and display information about an error value Treat ErrValue value as an NTSTATUS code

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~* k	call stack for all threads ~ !uniqstack
~2 f	Freeze Thread TID=2
~# f	Freeze the thread causing the current exception
~3 u	Unfreeze Thread TID=3
~2e r; k; kd	== ~2r; ~2k; ~2kd
~*e !gle	will repeat every the extension command !gle for every single thread being debugged
!tls -1	Dump all TLS slots for current thread
!runaway 7	1 (user time) + 2 (kernel time) + 4 (time elapsed since thread start)
!teb	Dump formatted view of our threads TEB (only some information)
dt ntdll!_TEB @$teb	Dump TEB of current thread

13) Breakpoints

Cmd	Variants / Params	Description
bl		List breakpoints
bc	bc * bc # [#] [#]	Clear all breakpoints Clear breakpoint #
be	be * be # [#] [#]	Enable all bps Enable bp #
bd	bd * bd # [#] [#]	Disable all bps Disable bp #
bp	bp [Addr] bp [Addr] ["CmdString"] [~Thrd] bp[#] [Options] [Addr] [Passes] ["CmdString"]	Set breakpoint at address CmdString = Cmd1; Cmd2; .. Executed every time the BP is hit. ~Thrd == thread that the bp applies too. # = Breakpoint ID Passes = Activate breakpoint after #Passes (it is ignored before)
bu	bu [Addr] See bp ..	Set unresolved breakpoint. bp is set when the module gets loaded
bm	bm **SymPattern** bm SymPattern ["CmdString"] [~Thrd] bm [Options] SymPattern [#Passes] ["CmdString"]	Set symbol breakpoint. SymPattern can contain wildcards CmdString = Cmd1; Cmd2; .. Executed every time the BP is hit. ~Thrd == thread that the bp applies too. Passes = Activate breakpoint after #Passes (it is ignored before) The syntax **bm SymPattern** is equivalent to using **x SymPattern** and then using bu on each of the results.

ba	ba [r|w|e] [Size] Addr [~Thrd] ba[#] [r|w|e] [Size] [Options] [Addr] [Passes] ["CmdString"]	Break on Access: [r=read/write, w=write, e=execute], Size=[1|2|4 bytes] [~Thrd] == thread that the bp applies too. # = Breakpoint ID Passes = Activate breakpoint after #Passes (it is ignored before)
br	br OldID NewID [OldID2 NewID2 ...]	renumbers one or more breakpoints

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With bp, the breakpoint location is always converted to an address. In contrast, a bu or a bm breakpoint is always associated with the symbolic value.

Simple Examples

bp `mod!source.c:12`	set breakpoint at specified source code
bm myprogram!mem*	SymbolPattern is equivalent to using x SymbolPattern
bu myModule!func	bp set as soon as myModule is loaded
ba w4 77a456a8	break on write access
bp @@(MyClass::MyMethod)	break on methods (useful if the same method is overloaded and thus present on several addresses)

Breakpoitns with options

Breakpoint that is triggered only once
bp mod!addr /1
Breakpoint that will start hitting after k-1 passes
bp mod!addr k

Breakpoints with commands: The command will be executed when the breakpoint is hit.

Produce a log every time the breakpoint is hit
ba w4 81a578a8 "k;g"
Create a dump every time BP is hit
bu myModule!func ".dump c:\dump.dmp; g"
DllMain called for MYDLL -> check reason
bu MYDLL!DllMain "j (dwo(@esp+8) == 1) '.echo MYDLL!DllMain -> DLL_PROCESS_ATTACH; kn' ; 'g' "
LoadLibraryExW(anyDLL) called -> display name of anyDLL
bu kernel32!LoadLibraryExW ".echo LoadLibraryExW for ->; du dwo(@esp+4); g"
LoadLibraryExW(MYDLL) called? -> Break only if LoadLibrary is called for MyDLL
bu kernel32!LoadLibraryExW ";as /mu ${/v:MyAlias} poi(@esp+4); .if ($spat(\"${MyAlias}\", \"*MYDLL*\") != 0) { kn; } .else { g }" • The first parameter to LoadLibrary (at address ESP + 4) is a string pointer to the DLL name in question. • The MASM $spat operator will compare this pointer to a predefined string-wildcard, this is *MYDLL* in our example. • Unfortunately $spat can accept aliases or constants, but no memory pointers. This is why we store our string in question to an alias (MyAlias) first. • Our kernel32!LoadLibraryExW breakpoint will hit only if the pattern compared by $spat matches. Otherwise the application will continue executing.
Skip execution of a function
bu sioctl!DriverEntry "r eip = poi(@esp); r esp = @esp + 0xC; .echo sioctl!DriverEntry skipped; g" • Right at a function's entry point the value found on the top of the stack contains the return address r eip = poi(@esp) -> Set EIP (instruction pointer) to the value found at offset 0x0 • DriverEntry has 2x4 byte parameters = 8 bytes + 4 bytes for the return address = 0xC r esp = @esp + 0xC -> Add 0xC to Esp (the stack pointer), effectively unwinding the stack pointer
bu MyApp!WinMain "r eip = poi(@esp); r esp = @esp + 0x14; .echo WinSpy!WinMain entered; g" • WinMain has 4x4 byte parameters = 0x10 bytes + 4 bytes for the return address = 0x14

Howto set a brekpoint in your code programatically?

- kernel32!DebugBreak
- ntdll!DbgBreakPoint
- __asm int 3 (x86 only)

14) Tracing and stepping (F10, F11)

Each step executes either a single assembly instruction or a single source line, depending on whether the debugger is in assembly mode or source mode.
Use the l+t and l-t commands or the buttons on the WinDbg toolbar to switch between these modes.

Cmd	Variants / Params	Description

g (F5)	g gu	Go (F5) Go up = execute until the current function is complete gu ~= g @$ra gu ~= bp /1 /c @$csp @$ra;g -> $csp = same as esp on x86 -> $ra = The return address currently on the stack
p (F10)	p pr p **Count** p [Count] **"Command"** p =StartAddress [Count] ["Command"] [~Thread] p [=StartAddress] [Count] ["Command"]	**Single step** - executes a single instruction or source line. Subroutines are treated as a single step. Toggle display of registers and flags Count = count of instructions or source lines to step through before stopping Command = debugger command to be executed after the step is performed StartAddress = Causes execution to begin at the specified address. Default is the current EIP. ~Thread = The specified thread is thawed and all others frozen
t (F11)	t ..	**Single trace** - executes a single instruction or source line. For subroutines each step is traced as well.
pt	pt ..	**Step to next return** - similar to the GU (go up), but staying in context of the current function If EIP is already on a **return** instruction, the entire return is executed. After this return is returned, execution will continue until another **return** is reached.
tt	tt ..	**Trace to next return** - similar to the GU (go up), but staying in context of the current function If EIP is already on a **return** instruction, the debugger traces into the return and continues executing until another **return** is reached.
pc	pc ..	**Step to next call** - executes the program until a call instruction is reached If EIP is already on a **call** instruction, the entire call will be executed. After this call is returned execution will continue until another **call** is reached.
tc	tc ..	**Trace to next call** - executes the program until a call instruction is reached If EIP is already on a **call** instruction, the debugger will trace into the call and continue executing until another **call** is reached.
pa	pa StopAddr par pa StopAddr **"Command"** pa **=StartAddress** StopAddr ["Command"]	**Step to address**; StopAddr = address at which execution will stop Called functions are treated as a single unit Toggle display of registers and flags Command = debugger command to be executed after the step is performed StartAddress = Causes execution to begin at the specified address. Default is the current EIP.
ta	ta StopAddr ..	**Trace to address**; StopAddr = address at which execution will stop Called functions are traced as well
wt	wt wt [Options] [= StartAddr] [EndAddr] wt -l Depth .. wt -m Module [-m Module2] .. wt -i Module [-i Module2] .. wt -oa .. wt -or .. wt -oR .. wt -nc .. wt -ns .. wt -nw ..	**Trace and watch data**. Go to the beginning of a function and do a **wt**. It will run through the entire function and display statistics. StartAddr = execution begin; EndAddr = address at which to end tracing (default = after RET of current function) l = maximum depth of traced calls m = restrict tracing to Module i = ignore code from Module oa = dump actual address of call sites or = dump return register values (EAX value) of sub-functions oR = dump return register values (EAX value) in the appropriate type nc = no info for individual calls ns = no summary info ns = no warnings
.step_filter	.step_filter .step_filter "FilerList" .step_filter /c	Dump current filter list = functions that are skipped when tracing (t, ta, tc) FilterList = Filter 1; Filter 2; ... symbols associated with functions to be stepped over (skipped) clear the filter list

		.step_filter is not very useful in assembly mode, as each function call is on a different line.

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g	go
g `:123`; ? poi(counter); g	executes the current program to source line 123; print the value of counter; resume execution
p	single step
pr	toggle displaying of registers
p 5 "kb"	5x steps, execute "kb" thereafter
pc	step to next CALL instruction
pa 7c801b0b	step until 7c801b0b is reached
wt	trace and watch sub-functions
wt -l 4 -oR	trace sub-functions to depth 4, display their return values

15) Call stack

Cmd	Variants / Params	Description
k	k [n] [f] [L] [#Frames] kb ... kp ... kP ... kv ...	dump stack; n = with frame #; f = distance between adjacent frames; L = omit source lines; number of stack frames to display first 3 params all params: param type + name + value all params formatted (new line) FPO info, calling convention
kd	kd [WordCnt]	display raw stack data + possible symbol info == dds esp
kM		DML variant with links to .frame #;dv
.kframes		Set stack length. The default is 20 (0x14).
.frame	.frame .frame # .frame /r [#]	show current frame specify frame # show register values The .frame command specifies which local context (scope) will be used to interpret local variables, or displays the current local context. When executing a near call, the processor pushes the value of the EIP register (which contains the offset of the instruction following the CALL instruction) onto the stack (for use later as a return-instruction pointer). This is the first step in building a frame. Each time a function call is made, another frame is created so that the called function can access arguments, create local variables, and provide a mechanism to return to calling function. The composition of the frame is dependant on the function calling convention.
!uniqstack	!uniqstack !uniqstack [b|v|p] [n] !uniqstack -?	show stacks for all threads [b = first 3 params, v = FPO + calling convention, p = all params: param type + name + value], [n = with frame #] brief help
!findstack	!findstack Symbol !findstack Symbol [0|1|2] !findstack -?	locate all stacks that contain Symbol or module [0 = show only TID, 1 = TID + frames, 2 = entire thread stack] brief help

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k	display call stack
kn	call stack with frame numbers
kb	display call stack with first 3 params
kb 5	display first 5 frames only

To get more than 3 Function Arguments from the stack
dd ChildEBP+8 (Parameters start at ChildEBP+8)

dd ChildEBP+8 (frame X) == dd ESP (frame X-1)

!uniqstack	get all stacks of our process (one for each thread)
!findstack kernel32 2	display all stacks that contain "kernel32"
.frame	show current frame
.frame 2	set frame 2 for the local context
.frame /r 0d	display registers in frame 0

16) Registers

Cmd	Variants / Params	Description
r	r r **Reg1, Reg2** r Reg=**Value** r Reg**:Type** r Reg:[Num]Type ~Thread r [Reg:[Num]Type]	Dump all registers Dump only specified registers (i.e.: **r eax, edx**) Value to assign to the register (i.e.: **r eax=5, edx=6**) Type = data format in which to display the register (i.e.: **r eax:uw**) ib = Signed byte ub = Unsigned byte iw = Signed word (2b) uw = Unsigned word (2b) id = Signed dword (4b) ud = Unsigned dword (4b) iq = Signed qword (8b) uq = Unsigned qword (8b) f = 32-bit floating-point d = 64-bit floating-point Num = number of elements to display (i.e.: **r eax:1uw**) Default is full register length, thus **r eax:uw** would display two values as EAX is a 32-bit register. Thread = thread from which the registers are to be read (i.e.: **~1 r eax**)
rM	rM Mask rM Mask Reg1, Reg2 rM Mask Reg=Value ..	Dump register types specified by Mask Dump only specified registers from current mask Value to assign to the register Flags for Mask 0x1 = basic integer registers 0x4 = floating-point registers == rF 0x8 = segment registers 0x10 = MMX registers 0x20 = Debug registers 0x40 = SSE XMM registers == rX
rF	rF rF Reg1, Reg2 rF Reg=Value ..	Dump all floating-point registers == rM 0x4 Dump only specified floating-point registers Value to assign to the register
rX	rX rX Reg1, Reg2 rX Reg=Value ..	Dump all SSE XMM registers == rM 0x40 Dump only specified SSE XMM registers Value to assign to the register
rm	rm rm ? rm Mask	Dump default register mask. This mask controls how registers are displayed by the "r". Dump a list of possible Mask bits Specify the mask to use when displaying the registers.

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rm ?	show possible bit mask
rm 1	enable integer registers only
r	dump all integer registers
r eax, edx	dump only eax and edx
r eax=5, edx=6	assign new values to eax and edx
r eax:1ub	dump only the first byte from eax

rm 0x20	enable debug register mask
r	dump debug registers
rF	dump all floating point register
rM 0x4	dump all floating point register
rm 0x4; r	dump all floating point registers

17) Information about variables

Cmd	Variants / Params	Description
dt	dt -h dt [mod!]**Name** dt [mod!]Name **Field** [Field] dt [mod!]Name [Field] **Addr** dt [mod!]Name***** dt [**-n|y**] [mod!]Name [**-n|y**] [Field] [Addr] dt [-n|y] [mod!]Name [-n|y] [Field] [Addr] **-abcehioprsv**	Brief help Dump variable info Dump only 'field-name(s)' (struct or unions) Addr of struct to be dumped list symbols (wildcard) -n Name = param is a name (use if name can be mistaken as an address) -y Name = partially match instead of default exact match **-a** = Shows array elements in new line with its index -b = Dump only contiguous block of struct -c = Compact output (all fields in one line) -i = Does not indent the subtypes -l ListField = Field which is pointer to the next element in list -o = Omit the offset value (fields of struct) -p = Dump from physical address **-r[l]** = Recursively dump subtypes/fields (up to l levels) -s [size] = For enumeration only, enumerate types only of given size. **-v** = Verbose output.
dv	dv dv **Pattern** dv [**/i /t /V**] [Pattern] dv [/i /t /V **/a /n /z**] [Pattern]	display local variables and parameters vars matching Pattern i = type (local, global, parameter), t = data type, V = memory address or register location a = sort by Addr, n = sort by name, z = sort by size

Collapse

dt ntdll!_PEB*	list all variables that contain the word _PEB
dt ntdll!_PEB* -v	list with verbose output (address and size included)
dt ntdll!_PEB* -v -s 9	list only symbols whose size is 9 bytes
dt ntdll!_PEB	dump _PEB info
dt ntdll!_PEB @$peb	dump _PEB for our process
dt ntdll!_PEB 7efde000	dump _PEB at Addr 7efde000 You can get our process's PEB address with "r @$peb" or with "!peb".
dt ntdll!_PEB Ldr SessionId	dump only PEB's Ldr and SessionId fields
dt ntdll!_PEB Ldr -y OS*	dump Ldr field + all fields that start with OS*
dt mod!var m_cs.	dump m_cs and expand its subfields
dt mod!var m_cs..	expand its subfields for 2 levels
dt ntdll!_PEB -r2	dump recursively (2 levels)
dv /t /i /V	dump local variables with type information (/t), addresses and EBP offsets (/V), classify them into categories (/i) Note: dv will also display the value of a THIS pointer for methods called with the "this calling-convention". BUG: You must first execute a few commands before dv displays the correct value. Right at a function's entry point the THIS pointer is present in ECX, so you can easily get it from there.

18) Memory

Cmd	Variants / Params	Description

d*	d[a| u| b| w| W| d| c| q| f| D] [/c #] [Addr] dy[b | d] ..	**Display memory** [#columns to display] a = ascii chars u = Unicode chars b = byte + ascii w = word (2b) W = word (2b) + ascii d = dword (4b) c = dword (4b) + ascii q = qword (8b) f = floating point (single precision - 4b) D = floating point (double precision - 8b) b = binary + byte d = binary + dword
e*	e[b | w | d | q | f | D] Addr Value e[a | u | za | zu] Addr "String"	**Edit memory** b = byte w = word (2b) d = dword (4b) q = qword (8b) f = floating point (single precision - 4b) D = floating point (double precision - 8b) a = ascii string za = ascii string (NULL-terminated) u = Unicode string zu = Unicode string (NULL-terminated)
ds, dS	ds *[/c #] [Addr]* dS *[/c #] [Addr]*	**Dump string struct** (struct! not null-delimited char sequence) s = STRING or ANSI_STRING S = UNICODE_STRING
d*s	dds [/c #] [Addr] dqs [/c #] [Addr]	**Display words and symbols** (memory at Addr is assumed to be a series of addresses in the symbol table) dds = dwords (4b) dqs = qwords (8b)
dd*, dq*, dp*	dd* dq* dp* d*a d*u d*p	**Display referenced memory** = display pointer at specified Addr, dereference it, and then display the memory at the resulting location in a variety of formats. the 2nd char determines the pointer size used: dd* -> 32-bit pointer used dq* -> 64-bit pointer used dp* -> standard size: 32-bit or 64-bit, depending on the CPU architecture the 3rd char determines how the dereferenced memory is displayed: d*a -> dereferenced mem as asci chars d*u -> dereferenced mem as Unicode chars d*p -> dereferenced mem as dword or qword, depending on the CPU architecture. If this value matches any known symbol, this symbol is displayed as well.

dl	dl[b] Addr MaxCount Size	**Display linked list** (LIST_ENTRY or SINGLE_LIST_ENTRY)
		b = dump in reverse order (follow BLinks instead of FLinks)
		Addr = start address of the list
		MaxCount = max # elements to dump
		Size = Size of each element
		
		Use !list to execute some command for each element in the list.

!address	!address -? !address Addr !address -summary !address -RegionUsageXXX	Display info about the memory used by the target process Brief help Dump info for region with Addr Dump summary info for process Dump specified regions (RegionUsageStack, RegionUsagePageHeap, ..)
!vprot	!vprot -? !vprot Addr	Brief Help Dump virtual memory protection info

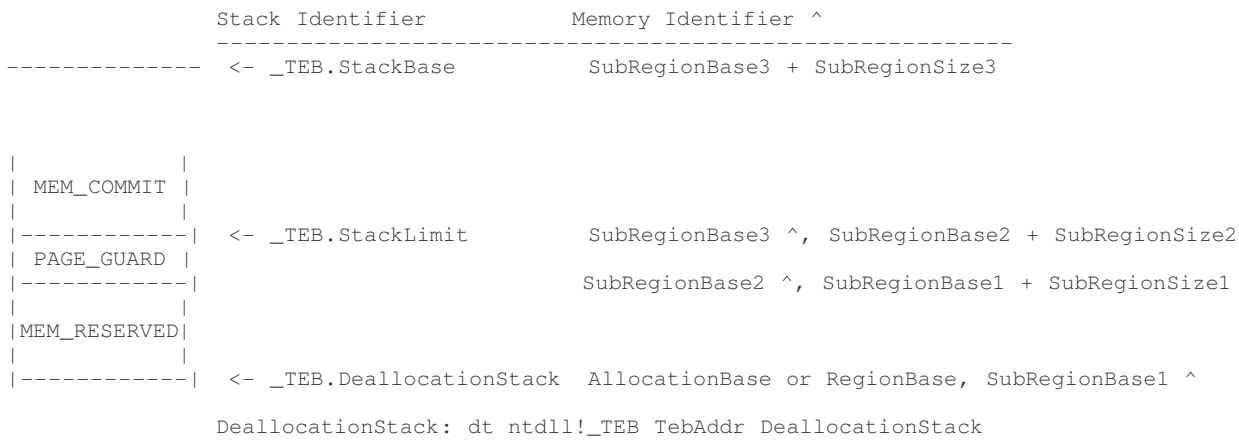
!mapped_file	!mapped_file -? !mapped_file Addr	Brief Help Dump name of the file containing given Addr

Collapse

dd 0046c6b0	display dwords at 0046c6b0
dd 0046c6b0 L1	display 1 dword at 0046c6b0
dd 0046c6b0 L3	display 3 dwords at 0046c6b0
du 0046c6b0	display Unicode chars at 0046c6b0
du 0046c6b0 L5	display 5 Unicode chars at 0046c6b0
dds esp == kd	display words and symbols on stack
!mapped_file 00400000	Dump name of file containing address 00400000
!address	show all memory regions of our process
!address -RegionUsageStack	show all stack regions of our process

!address esp	show info for committed sub-region for our thread's stack.
	Note: For stack overflows SubRegionSize (size of committed memory) will be large, i.e.:
	`AllocBase : SubRegionBase – SubRegionSize`
	`001e0000 : 002d6000 – 0000a000`

Determine stack usage for a thread



From MSDN CreateThread > dwStackSize > "Thread Stack Size":
"Each new thread receives its own stack space, consisting of both committed and reserved memory. By default, each thread uses 1 Mb of reserved memory, and one page of committed memory. The system will commit one page block from the reserved stack memory as needed."

19) Manipulating memory ranges

Cmd	Variants / Params	Description
c	c Range DestAddr	Compare memory
m	m Range DestAddr	Move memory
f	f Range Pattern	Fill memory. Pattern = a series of bytes (numeric or ASCII chars)

s	s *Range Pattern* s -[Flags]b *Range Pattern* s -[Flags]w *Range 'Pattern'* s -[Flags]d *Range 'Pattern'* s -[Flags]q *Range 'Pattern'* s -[Flags]a *Range "Pattern"* s -[Flags]u *Range "Pattern"* s -[Flags,l length]sa *Range* s -[Flags,l length]su *Range* s -[Flags]v *Range Object*	Search memory b = byte (default value) Pattern = a series of bytes (numeric or ASCII chars) w = word (2b) d = dword (4b) q = qword (8b) Pattern = enclosed in single quotation marks (for example, 'Tag7') a = ascii string (must not be null-terminated) u = Unicode string (must not be null-terminated) Pattern = enclosed in double quotation marks (for example, "This string") Search for any memory containing printable ascii strings Search for any memory containing printable Unicode strings Length = minimum length of such strings; the default is 3 chars Search for objects of the same type. Object = Addr of a pointer to the Object or of the Object itself Flags ------- w = search only writable memory 1 = output only addresses of search matches (useful if you are using the .foreach) Flags must be surrounded by a single set of brackets without spaces. Example: **s -[swl 10]Type Range Pattern**
.holdmem	.holdmem -a Range .holdmem -o .holdmem -c Range .holdmem -D .holdmem -d { Range | Address }	**Hold and compare memory.** The comparison is made byte-for-byte Memory range to safe Display all saved memory ranges Compares Range to all saved memory ranges Delete all saved memory ranges Delete specified memory ranges (any saved range containing Addr or overlapping with Range)

Collapse

c Addr (Addr+100) DestAddr	compare 100 bytes at Addr with DestAddr
c Addr L100 DestAddr	-||-
m Addr L20 DestAddr	move 20 bytes from Addr to DestAddr
f Addr L20 'A' 'B' 'C'	fill specified memory location with the pattern "ABC", repeated several times
f Addr L20 41 42 43	-||-
s 0012ff40 L20 'H' 'e' 'l' 'l' 'o'	search memory locations 0012FF40 through 0012FF5F for the pattern "Hello"
s 0012ff40 L20 48 65 6c 6c 6f	-||-
s -a 0012ff40 L20 "Hello"	-||-
s -[w]a 0012ff40 L20 "Hello"	search only writable memory

20) Memory: Heap

Cmd	Variants / Params	Description
!heap	!heap **-?** !heap !heap **-h** !heap -h [HeapAddr | Idx | 0] !heap -v [HeapAddr | Idx | 0] !heap **-s** [HeapAddr | 0] !heap -i [HeapAddr] !heap -x [-v] Address !heap -l	Brief help List heaps with index and HeapAddr List **heaps with index and range** (= startAddr(=HeapAddr), endAddr) Detailed heap info [Idx = heap Idx, 0 = all heaps] Validate heap [Idx = heap Idx, 0 = all heaps] **Summary info, i.e. reserved and committed memory** [Idx = heap Idx, 0 = all heaps] Detailed info for a block at given address Search heap block containing the address (v = search the whole process virtual space) Search for potentially leaked heap blocks

!heap -b, -B	!heap Heap -b [alloc | realloc | free] [Tag] !heap Heap -B [alloc | realloc | free]	Set conditional breakpoint in the heap manager [Heap = HeapAddr | Idx | 0] Remove a conditional breakpoint
!heap -flt	!heap -flt s Size !heap -flt r SizeMin SizeMax	Dump info for allocations matching the specified size Filter by range
!heap -stat	!heap **-stat** !heap **-stat -h** [HeapHandle | 0]	Dump heap **handle list** Dump usage statistic for every AllocSize [HeapHandle = given heap | 0 = all heaps]. The statistic includes AllocSize, #blocks, TotalMem for each AllocSize.
!heap -p	!heap -p -? !heap **-p** !heap -p -h HeapHandle !heap **-p -a UserAddr** !heap **-p -all**	Extended page heap help Summary for NtGlobalFlag, HeapHandle + NormalHeap list ** Detailed info about a page heap with Handle Details of heap allocation containing UserAddr. Prints backtraces when available. Details of all allocations in all heaps in the process. The output includes UserAddr and AllocSize for every HeapAlloc call.

It seems that the following applies for windows XP SP2:

a) Normal heap

1. CreateHeap -> creates a _HEAP
2. AllocHeap -> creates a _HEAP_ENTRY

b) Page heap enabled (gflags.exe /i +hpa)

1. CreateHeap -> creates a _DPH_HEAP_ROOT (+ _HEAP + 2x _HEAP_ENTRY)**
2. AllocHeap -> creates a _DPH_HEAP_BLOCK

** With page heap enabled there will still be a _HEAP with two constant _HEAP_ENTRY's for every CreateHeap call.

Term	Description	Heap type
HeapHandle	= value returned by **HeapCreate** or **GetProcessHeap** For normal heap: HeapHandle == HeapStartAddr	Normal & page
HeapAddr	= startAddr = NormalHeap	Normal & page
UserAddr, UserPtr	= value in the range [**HeapAlloc**...HeapAlloc+AllocSize] For normal heap this range is further within Heap[startAddr-endAddr]	Normal & page
UserSize	= AllocSize (value passed to HeapAlloc)	Normal & page
_HEAP	= HeapHandle = HeapStartAddr For every **HeapCreate** a _HEAP struct is created. You can use "!heap -p -all" to get these addresses.	Normal heap
_HEAP_ENTRY	For every **HeapAlloc** a _HEAP_ENTRY is created. You can use "!heap -p -all" to get these addresses.	Normal heap
_DPH_HEAP_ROOT	= usually HeapHandle + 0x1000 For every **HeapCreate** a _DPH_HEAP_ROOT is created. You can use "!heap -p -all" to get these addresses.	Page heap
_DPH_HEAP_BLOCK	For every **HeapAlloc** a _DPH_HEAP_BLOCK is created. You can use "!heap -p -all" to get these addresses.	Page heap

Collapse

dt ntdll!_HEAP	dump _HEAP struct
dt ntdll!_DPH_HEAP_ROOT	dump _DPH_HEAP_ROOT struct. Enable page heap. Then you can use "!heap -p -all" to get addresses of actual _DPH_HEAP_ROOT structs in your process.
dt ntdll! _DPH_HEAP_BLOCK	dump _DPH_HEAP_BLOCK struct. Enable page heap. Then you can use "!heap -p -all" to get addresses of actual _DPH_HEAP_BLOCK structs in your process.
!heap	list all heaps with index and HeapAddr
!heap -h	list all heaps with range information (startAddr, endAddr)
!heap -h 1	detailed heap info for heap with index 1
!heap -s 0	Summary for all heaps (reserved and committed memory, ..)
!heap -flt s 20	Dump heap allocations of size 20 bytes

!heap -stat	Dump HeapHandle list. HeapHandle = value returned by HeapCreate or GetProcessHeap
!heap -stat -h 00150000	Dump usage statistic for HeapHandle = 00150000
!heap 2 -b alloc mtag	Breakpoint on HeapAlloc calls with TAG=mtag in heap with index 2
!heap -p	Dump heap handle list
!heap -p -a 014c6fb0	Details of heap allocation containing address 014c6fb0 + call-stack if available
!heap -p -all	Dump details of all allocations in all heaps in the process

Who allocated memory - who called HeapAlloc?

1. Select "Create user mode stack trace database" for your image in GFlags (gflags.exe /i +ust)
2. From WinDbg's command line do a **!heap -p -a** , where is the address of your allocation ***.
3. While !heap -p -a will dump a call-stack, no source information will be included.
4. To get source information you must additionally enable page heap in step 1 (gflags.exe /i +ust +hpa)
5. Do a **dt ntdll!_DPH_HEAP_BLOCK StackTrace** , where is the DPH_HEAP_BLOCK address retrieved in step 3.
6. Do a **dds** ", where is the value retrieved in step 5.
   Note that dds will dump the stack with source information included.

Who created a heap - who called HeapCreate?

1. Select "Create user mode stack trace database" and "Enable page heap" for your image in GFlags (gflags.exe /i +ust +hpa)
2. a) From WinDbg's command line do a **!heap -p -h** , where is the value returned by **HeapCreate**. You can do a **!heap -stat** or **!heap -p** to get all heap handles of your process.
   b) Alternatively you can use **!heap -p -all** to get addresses of all _DPH_HEAP_ROOT's of your process directly.
3. Do a **dt ntdll!_DPH_HEAP_ROOT CreateStackTrace** , where is the address of a _DPH_HEAP_ROOT retrieved in step 2
4. Do a **dds** , where is the value retrieved in step 3.

Finding memory leaks

- From WinDbg's command line do a **!address –summary**.
  If **RegionUsageHeap** or **RegionUsagePageHeap** are growing, then you might have a memory leak on the heap. Proceed with the following steps.

1. Enable "Create user mode stack trace database" for your image in GFlags (gflags.exe /i +ust)
2. From WinDbg's command line do a **!heap -stat**, to get all active heap blocks and their handles.
3. Do a **!heap -stat -h 0**. This will list down handle specific allocation statistics for every AllocSize.
   For every AllocSize the following is listed: AllocSize, #blocks, and TotalMem. Take the AllocSize with maximum TotalMem.
4. Do a **!heap -flt s** . =AllocSize that we determined in the previous step. This command will list down all blocks with that particular size.
5. Do a **!heap -p -a** to get the stack trace from where you have allocated that much bytes. Use the that you got in step 4.
6. To get source information you must additionally enable page heap in step 1 (gflags.exe /i +ust +hpa)
7. Do a **dt ntdll!_DPH_HEAP_BLOCK StackTrace** , where is the DPH_HEAP_BLOCK address retrieved in step 5.
8. Do a **dds** ", where is the value retrieved in step 7.
   Note that dds will dump the stack with source information included.

***** What is a ?**

1. is usually the address returned by HeapAlloc:

```
int AllocSyze = 0x100000;         // == 1 MB
BYTE* pUserAddr = (BYTE*) HeapAlloc( GetProcessHeap(), HEAP_ZERO_MEMORY, AllocSyze);
```

2. Often any address in the range [UserAddr....UserAddr+AlloSize] is also a valid parameter:

```
!heap –p –a [UserAddr....UserAddr+AlloSize]
```

21) Application Verifier
Application Verifier profiles and tracks Microsoft Win32 APIs (heap, handles, locks, threads, DLL load/unload, and more), Exceptions, Kernel objects, Registry, File system. With the !avrf extension we get access to this tracking information!

Cmd	Variants / Params	Description
!avrf		Displays Application Verifier options. If an Application Verifier Stop has occurred, reveal the nature of the stop and what caused it.
!avrf	-?	Brief help
	-vs *N*	Dump last N entries from vspace log (MapViewOfFile, UnmapViewOfFile, ..).
	-vs *-a ADDR*	Searches ADDR in the vspace log.
	-hp *N*	HeapAlloc, HeapFree, new, and delete log
	-hp *-a ADDR*	Searches ADDR in the heap log.
	-cs *N*	DeleteCriticalSection API log (last #Entries). ~CCriticalSection calls this implicitly.
	-cs *-a ADDR*	Searches ADDR in the critical section delete log.
	-dlls *N*	
	-ex *N*	LoadLibrary/FreeLibrary log
	-cnt	exception log

	-threads -trm -trace *INDEX* -brk *[INDEX]*	global counters (WaitForSingleObject, HeapAllocation calls, ...) thread information + start parameters for child threads TerminateThread API log dump stack trace with INDEX. dump or set/reset break triggers.

22) Logging extension (logexts.dll)

You must enable the following options for you image in GFlags:
-> "Create user mode stack trace database"
-> "Stack Backtrace: (Megs)" -> 10
-> It seems that you sometimes also need to check and specify the "Debugger" field in GFlags

Cmd	Variants / Params	Description
!logexts.help		displays all Logexts.dll extension commands
!loge	!loge *[dir]*	Enable logging + possibly initialize it if not yet done. Output directory optional.
!logi		Initialize (=inject Logger into the target application) but don't enable logging.
!logd		Disable logging
!logo	!logo !logo [e|d] [d|t|v]	List output settings Enable/disable [d - Debugger, t - Text file, v - Verbose log] output. Use logviewer.exe to examine Verbose logs.
!logc	!logc !logc p # !logc [e|d] * !logc [e|d] # [#] [#]	List all categories List APIs in category # Enable/disable all categories Enable/disable category #
!logb	!logb p !logb f	Print buffer contents to debugger Flush buffer to log files
!logm	!logm !logm [i|x] [DLL] [DLL]	Display module inclusion/exclusion list Specify module inclusion/exclusion list

Collapse

Enable 19-ProcessesAndThreads and 22-StringManipulation logging:

!loge	Enable logging
!logc d *	Disable all categories
!logc p 19	Display APIs of category 19
logc e 19 22	Enable category 19 and 22
!logo d v	Disable verbose output
!logo d t	Disable text output
!logo e d	Enable debugger output

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