LABS

Debugging Workshop Labs

TABLE OF CONTENTS

Module 2 Labs: Debugger Installation and Setup

Lab Objectives

Lab 2 – Debugger Installation and Setup

Exercise 1 – Installing Debugging Tools for Windows

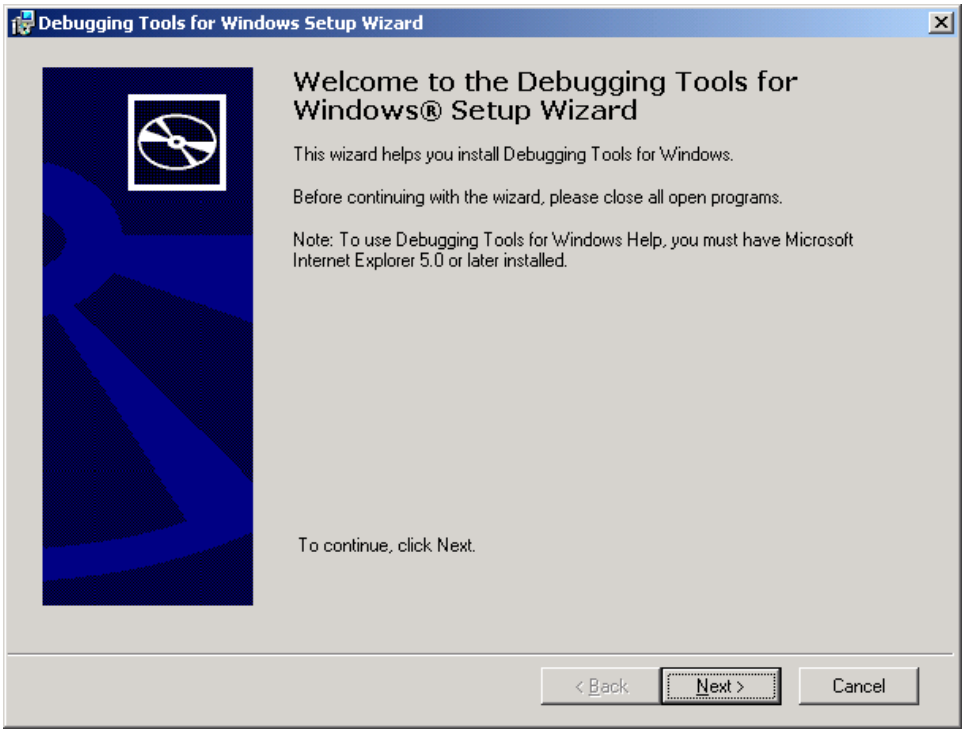
Estimated Time to Complete this Lab: 10 minutes

Exercise 2: Installing Debugging Tools for Windows

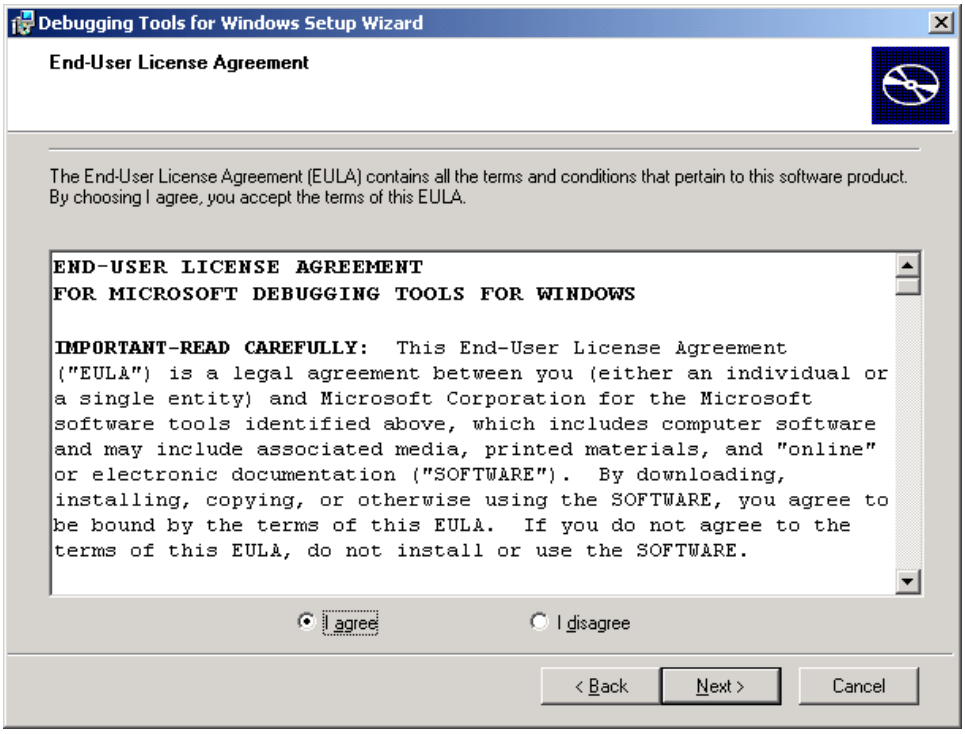
In this exercise you will install the *Debugging Tools for Windows* package with its default configuration.

Note: Some of the dialogs may be slightly different from those printed here.

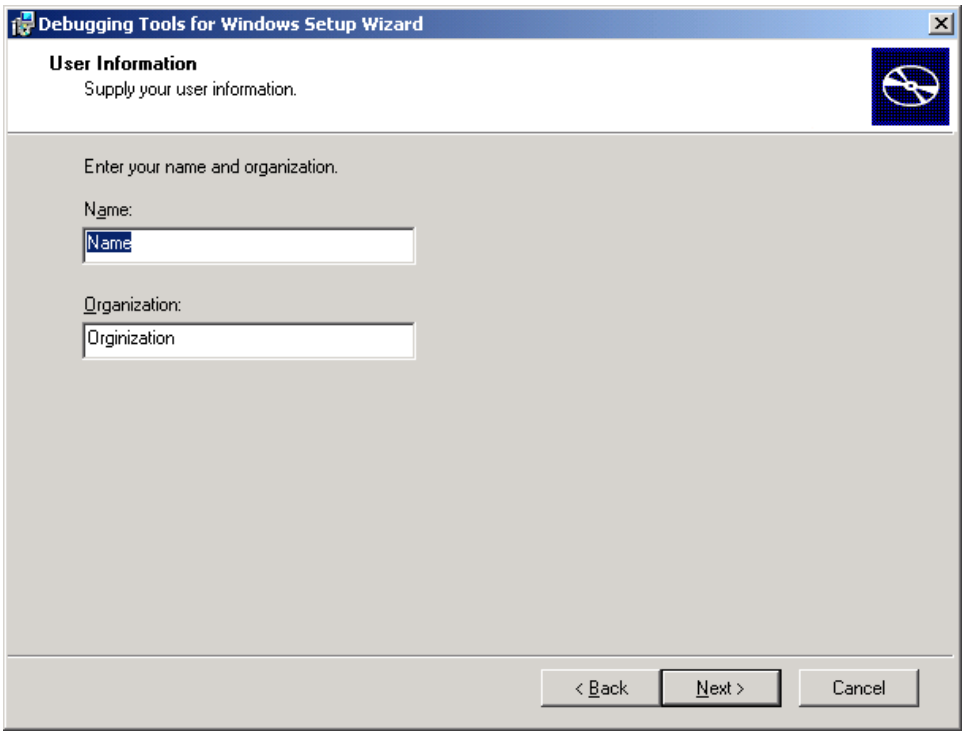
1. From the *d:\\Labs\Debuggers* folder execute *dbg_x86_6.0.17.0.exe*.
   Note: Your instructor may provide this file in a different location or name.



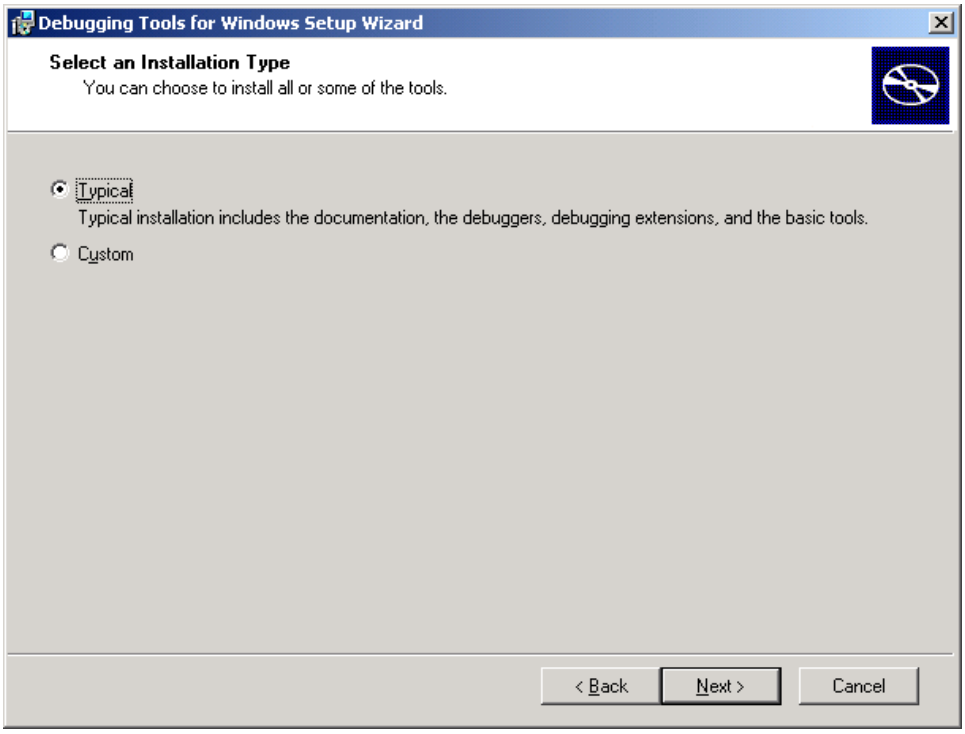
2. Select "*Next*" to continue.



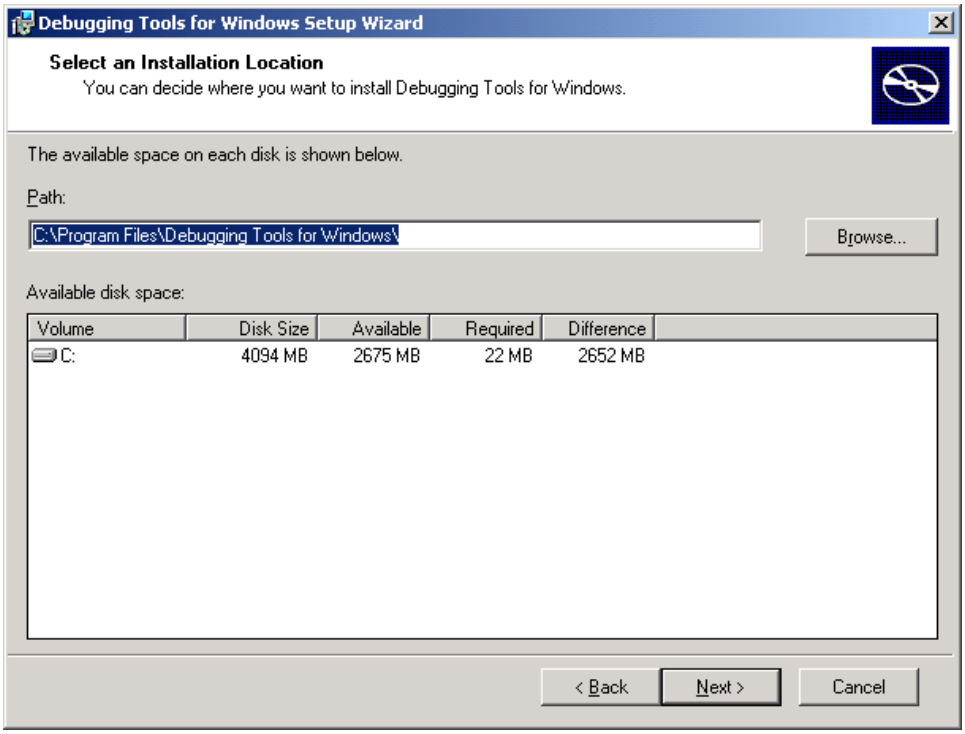
3. Select the "*I Agree*" radio button to accept the EULA. Then select "*Next*" to continue the installation.



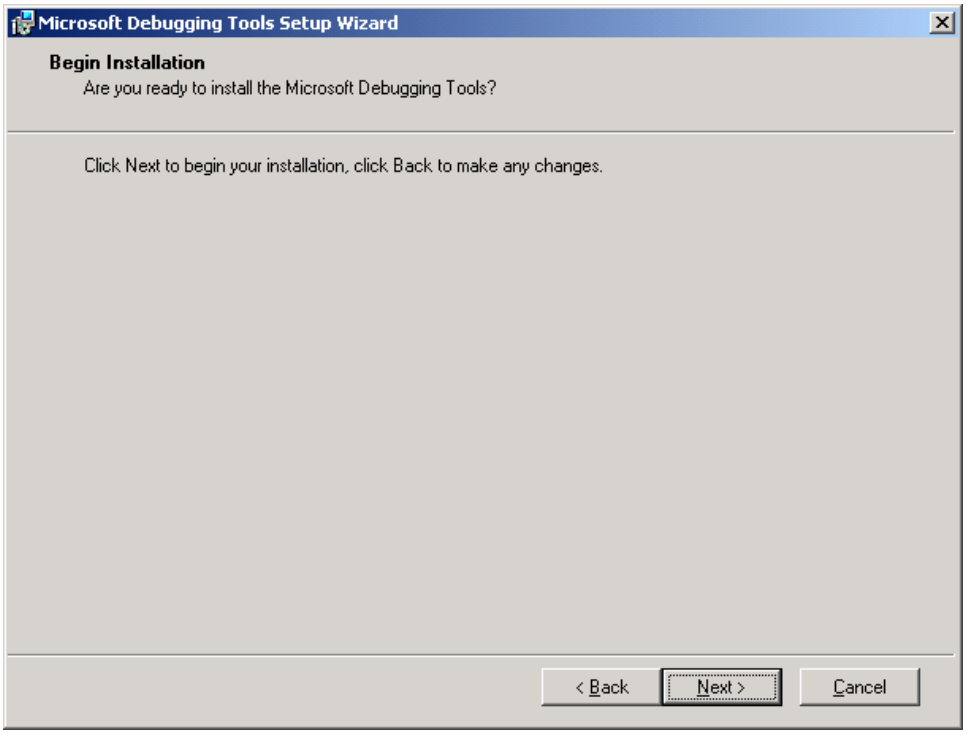
4. Enter a name and an organization and then select "*Next.*"



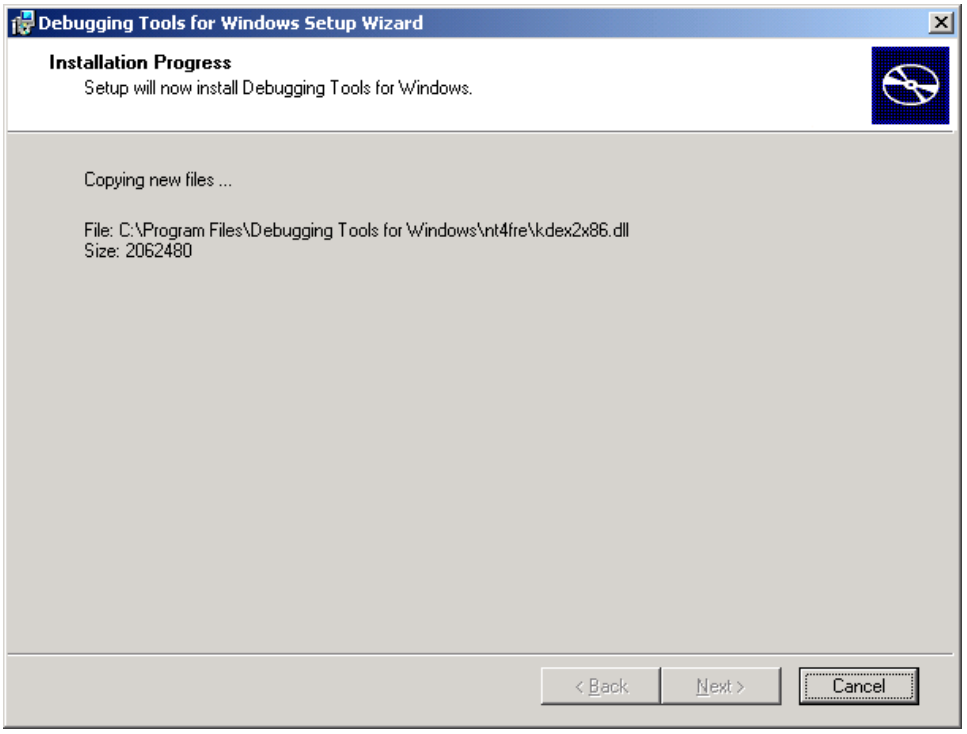
5. Select "*Next*" to accept the "*Typical*" installation type.



6. Accept the default installation location by selecting "*Next.*"



7. Select "*Next*."



8. When the installation is complete a dialog box should appear informing you that he installation was successful:

9. Select "*Finish"* to complete the installation of the Debugging Tools for Windows.

Module 3 Labs: Introduction to Debugger Operation

Lab Objectives

Lab 3 – Introduction to Debugger Operation

Exercise 1 – Opening a Kernel-Mode Dump File

Exercise 2 – Collecting Information from Dump Files

Exercise 3 – Open memory1.dmp

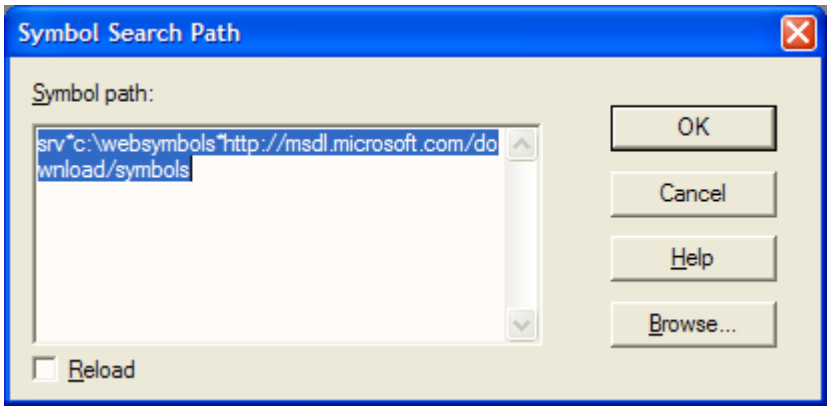
Estimated Time to Complete this Lab: 45 minutes

Exercise 1: Opening a Kernel-Mode Dump File

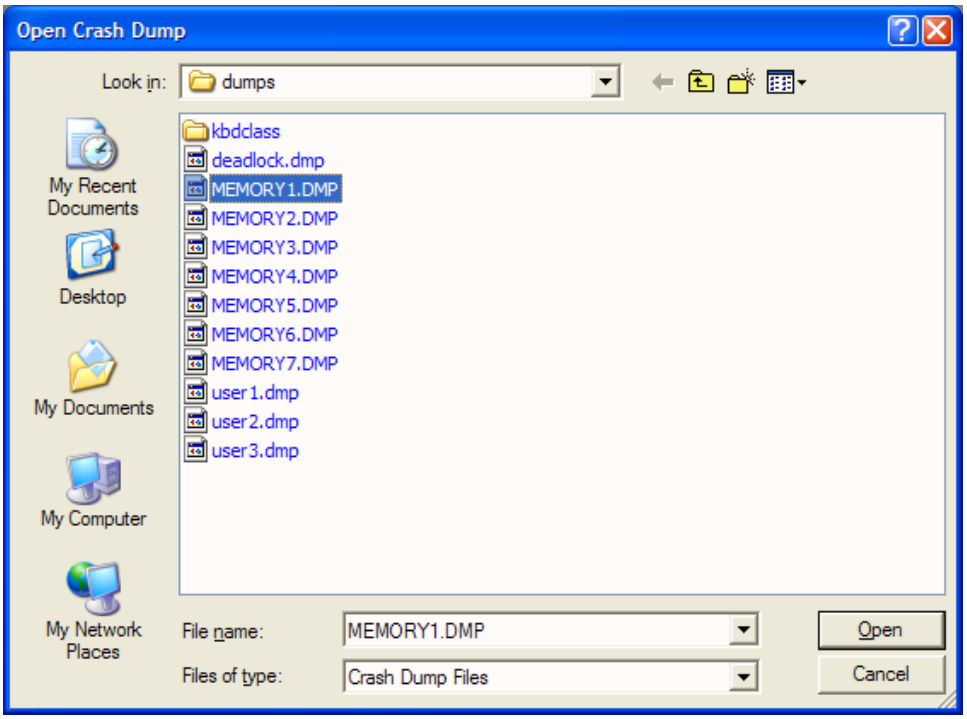
In this exercise, you will use WinDbg to load a kernel mode memory dump file for analysis. The file is located in the c:\dumps directory. (Your instructor may provide an alternate file path.)

1. Select **Start | Program | Microsoft Debugging Tools | WinDbg**.
2. Select File | Symbol File Path. The "Symbol Search Path" dialog should appear.
3. As shown below, set the symbol path to **srv*c:\websymbols*http://msdl.microsoft.com/download/symbols**

   Note: Your instructor may provide an alternate symbol search path.

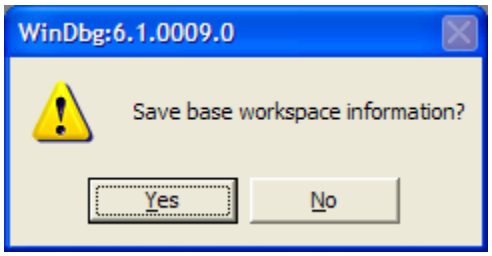


4. Select **File | Open Crash Dump.**

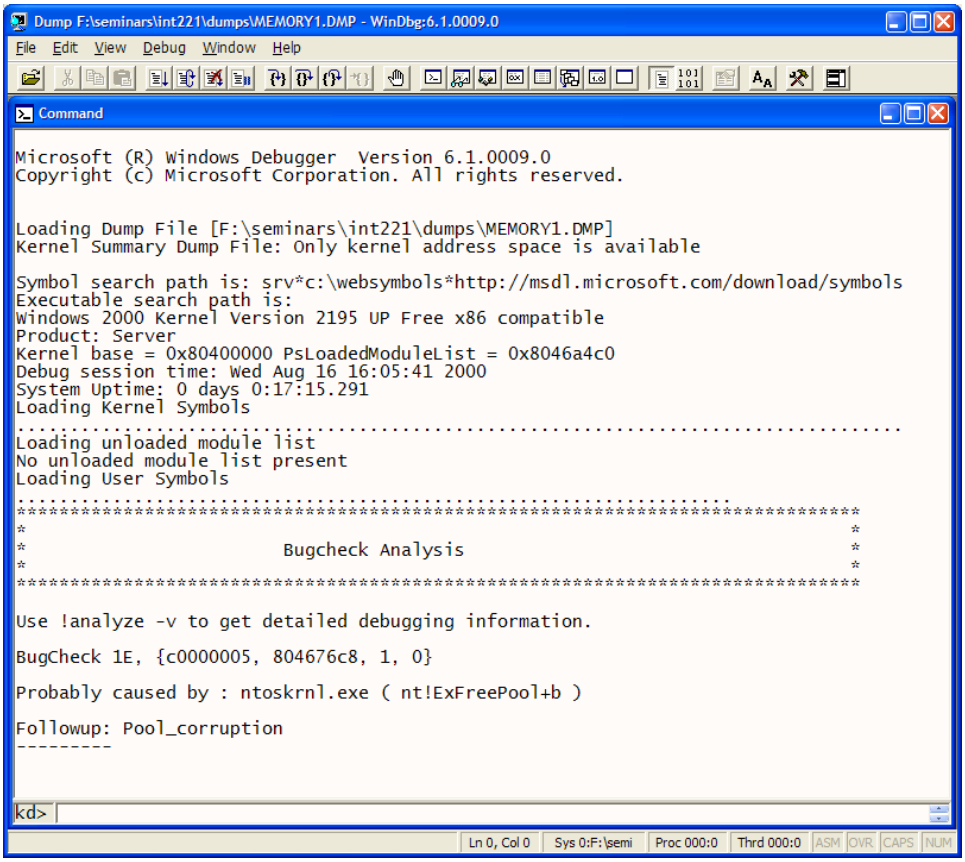


5. Select MEMORY1.DMP and then select Open.

6. A “save workspace information?” dialog box may appear. Click “No.” (We will say more about workspaces later.)



7. The debugger should open the dump file, display the bugcheck code and parameters, and report other information about the dump.



8. Check the debugger output carefully for any signs of symbol problems. In this case there are none, so we can proceed with analysis. If any messages such as

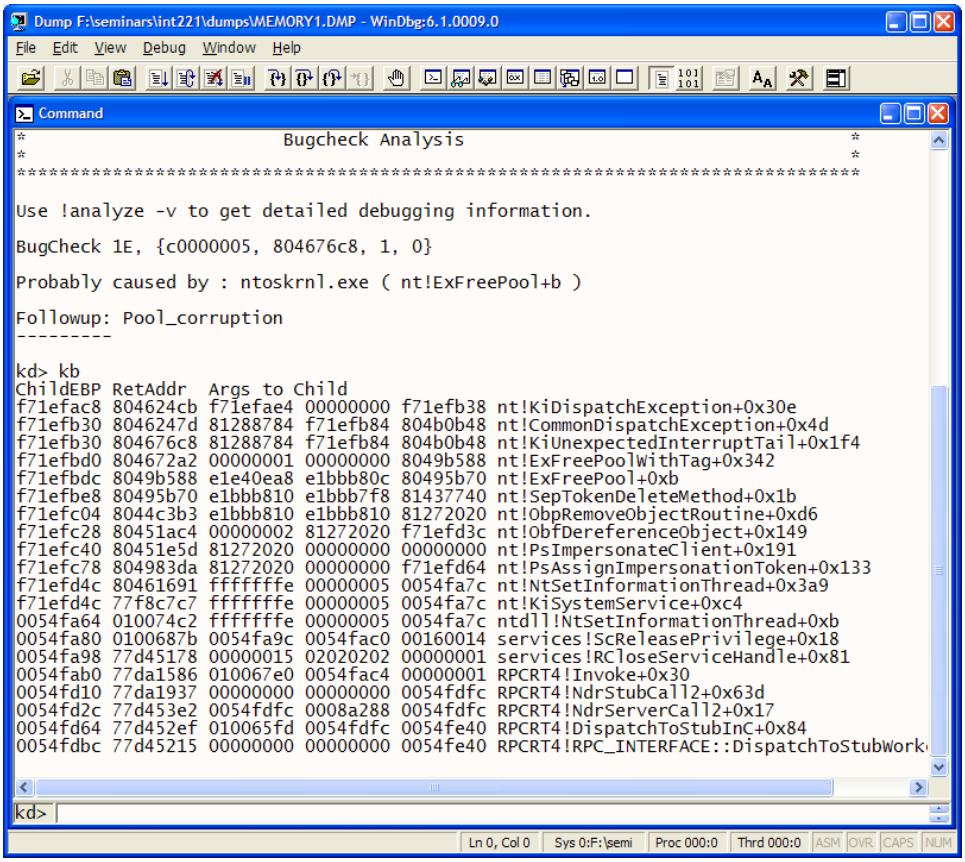
   ```
   *** ERROR: Symbol file could not be found.  Defaulted to
   export symbols for ntoskrnl.exe -
   ```

   or

   ```
   ***** Kernel symbols are WRONG. Please fix symbols to do
   analysis.
   ```

   appear, you must correct the problem before proceeding. Refer to the workbook for information and examples of the **!sym noisy** and **.reload** commands.

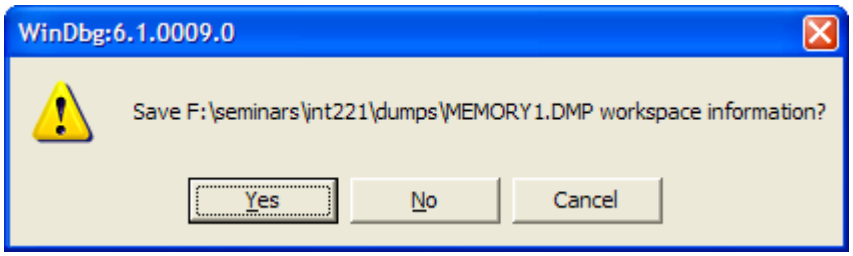
9. Next let's take a look at the stack trace. Type "**kb** <enter>".



   The output should be identical (or at least similar) to that shown here. The stack backtrace shows the sequence of procedure calls leading up to the crash. The most recent calls are at the top of the stack trace. For example, The most recent routine called here was KiDispatchException; KiDispatchException was called by CommonDispatchException, which was called by KiUnexpectedInterruptTail, etc.

10. To end the debugging session, use either Shift-F5 or Debug | Stop Debugging. Alternately, you can close the WinDbg process completely, with Alt-F4, File | Exit.

11. A “Save workspace information?” dialog box will appear. Click the “No” button.



Exercise 2: Collecting Information from Dump Files

In this exercise, you will use WinDbg to load a series of kernel mode memory dump files and gather information from them. The files are located in the c:\dumps directory.

1. Select **Start | Program | Microsoft Debugging Tools | WinDbg**.
   Alternately, if WinDbg is already running from the previous exercise, you can use Shift-F5, or the Debug | Stop Debugging command, to close that debugging session while leaving WinDbg running.
2. Open the Symbol File Path dialog. Set the symbol file path to that used in the previous exercise.
3. Open the Open Crash Dump dialog. Open **memory2.dmp** from the same path used in the previous exercise.
4. Inspect the debugger output for symbol file problems. If any exist, resolve them before proceeding.
5. Inspect the stack trace for the names of the routines currently executing.
6. Repeat the above sequence for **memory3.dmp** through **memory7.dmp** , and for **deadlock.dmp** .

Exercise 3: Open memory1.dmp

We will be using the debugger to inspect **memory1.dmp** while reviewing the information in the next module. Therefore, start the debugger once again, open **memory1.dmp** , and have it available for discussion during the next lecture period.

Module 4 Labs: Key Concepts and Data Structures

Lab Objectives

Lab 4 – Key Concepts and Data Structures

Exercise 1 – Viewing Processor-Specific Support Files

Exercise 2 – Viewing Installed Device Drivers

Exercise 3 – Viewing the Process Tree using TList

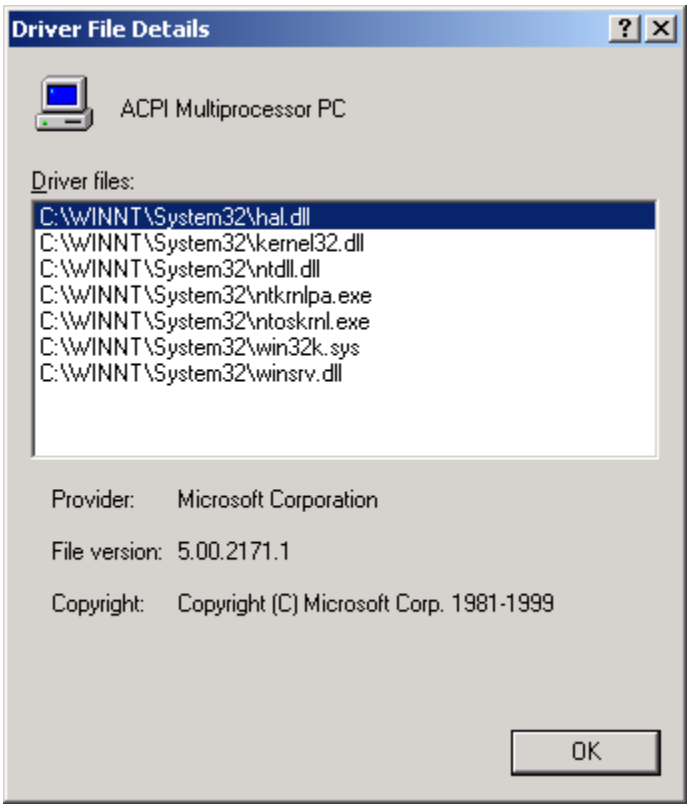
Exercise 4 – Looking at Pool Allocations by Tag

Estimated Time to Complete this Lab: 30 Minutes

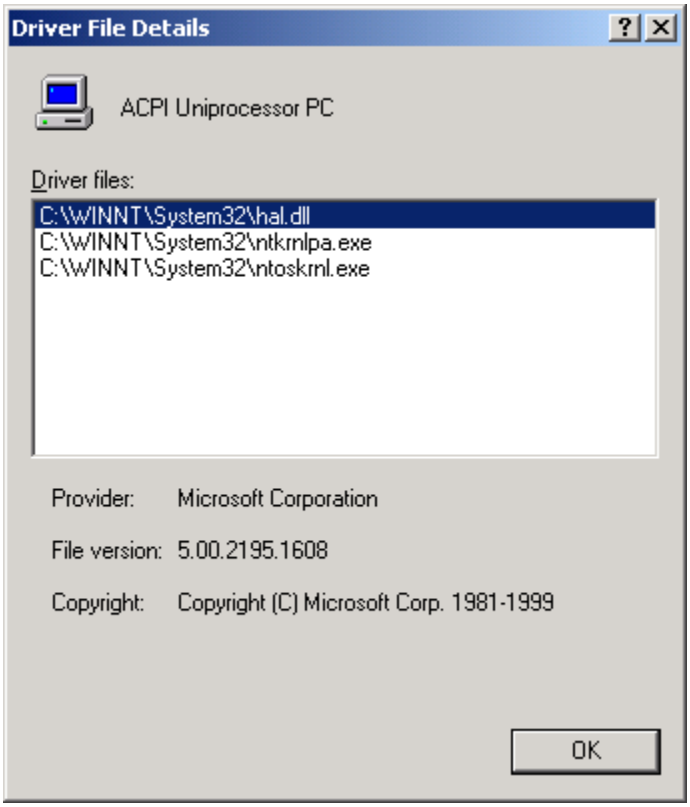
Exercise 1: Viewing Processor-Specific Support Files

1. Open the System properties (either by selecting System from Control Panel or by right-clicking on the My Computer icon on your desktop and selecting Properties).
2. Click on the Hardware tab.
3. Click Device Manager.
4. Expand the Computer object.
5. Double-click on the child node underneath Computer.
6. Click on the Driver tab.
7. Click Driver Details.

You should see this dialog box for a multiprocessor system:



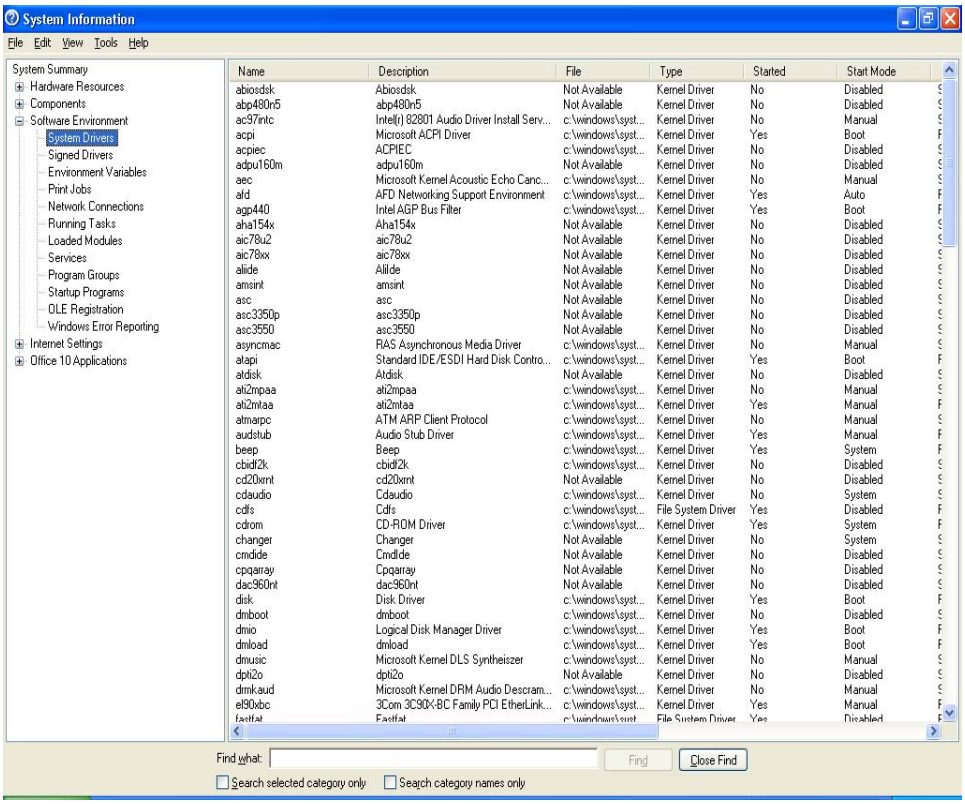
You should see this dialog box for a uniprocessor system:



Exercise 2: Viewing Installed Device Drivers

You can list the installed drivers by running MSInfo32.exe. (From the Start menu, select Run, then type MSInfo32.exe.) From within MSInfo32.exe, expand Software Environment, then select System Drivers.

Here's a sample output of the list of installed drivers:



This window displays the list of device drivers defined in the registry, their type, and their state (Running or Stopped). Device drivers and Win32 service processes are both defined in the same place: HKLM\SYSTEM\CurrentControlSet\Services. However, they are distinguished by a type code—type 1 is a kernel-mode device driver, and type 2 is a file system driver.

Alternatively, you list the currently loaded device drivers with the Drivers utility (*Drivers.exe* in the Windows Resource Kit) or the PStat utility (*PStat.exe* in the Platform SDK). These tools have been included in the *labs\tools* folder on your CD for class.

Here is a partial output from the Drivers utility:

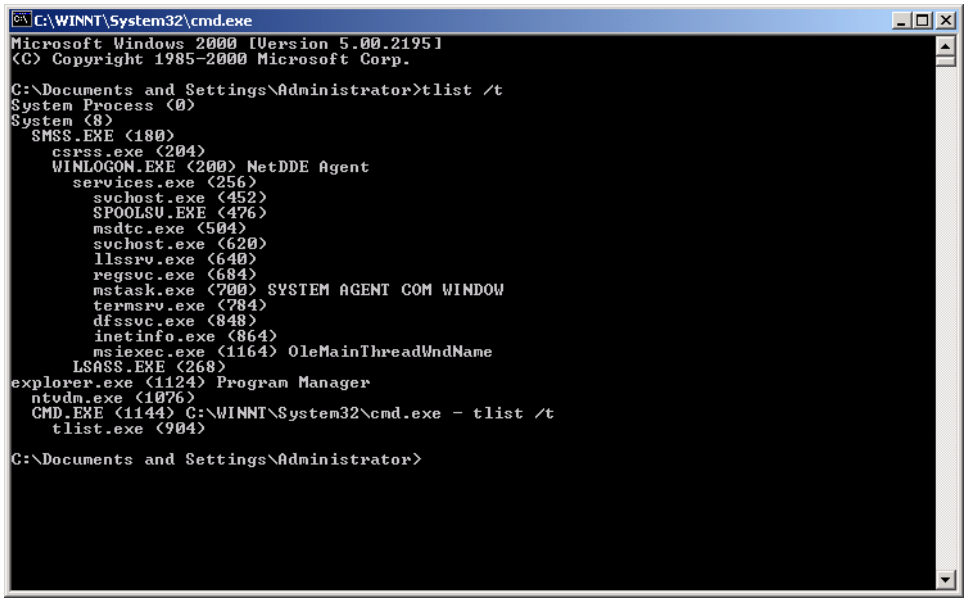
```
C:\>drivers
  ModuleName   Code   Data  Bss   Paged    Init          LinkDate
-------------------------------------------------------------------
ntoskrnl.exe 429184  96896    0  775360  138880  Tue Dec 07 18:41:11 1999
     hal.dll  25856   6016    0   16160   10240  Tue Nov 02 20:14:22 1999
 BOOTVID.DLL   5664   2464    0       0     320  Wed Nov 03 20:24:33 1999
    ACPI.sys  92096   8960    0   43488    4448  Wed Nov 10 20:06:04 1999
  WMILIB.SYS    512      0    0    1152     192  Sat Sep 25 14:36:47 1999
     pci.sys  12704   1536    0   31264    4608  Wed Oct 27 19:11:08 1999
  isapnp.sys  14368    832    0   22944    2048  Sat Oct 02 16:00:35 1999
compbatt.sys   2496      0    0    2880    1216  Fri Oct 22 18:32:49 1999
   BATTC.SYS    800      0    0    2976     704  Sun Oct 10 19:45:37 1999
intelide.sys   1760     32    0       0     128  Thu Oct 28 19:20:03 1999
```

```
 PCIIDEX.SYS   4544    480   0   10944    1632  Wed Oct 27 19:02:19 1999
  pcmcia.sys  32800   8864   0   23680    6240  Fri Oct 29 19:20:08 1999
  ftdisk.sys   4640     32   0   95072    3392  Mon Nov 22 14:36:23 1999

-------------------------------------------------------------------------
      Total 4363360  580320  0 3251424  432992
```

Exercise 3: Viewing the Process Tree Using TList

Viewing the Process Tree

One unique attribute about a process that most tools don't display is the parent or creator process ID. You can retrieve this value with the Performance tool (or programmatically) by querying the Creating Process ID. The Windows Support Tools command **tlist /t** uses the information in the attribute to display a *process tree* that shows the relationship of a process to its parent. Here's an example of output from **tlist /t:**

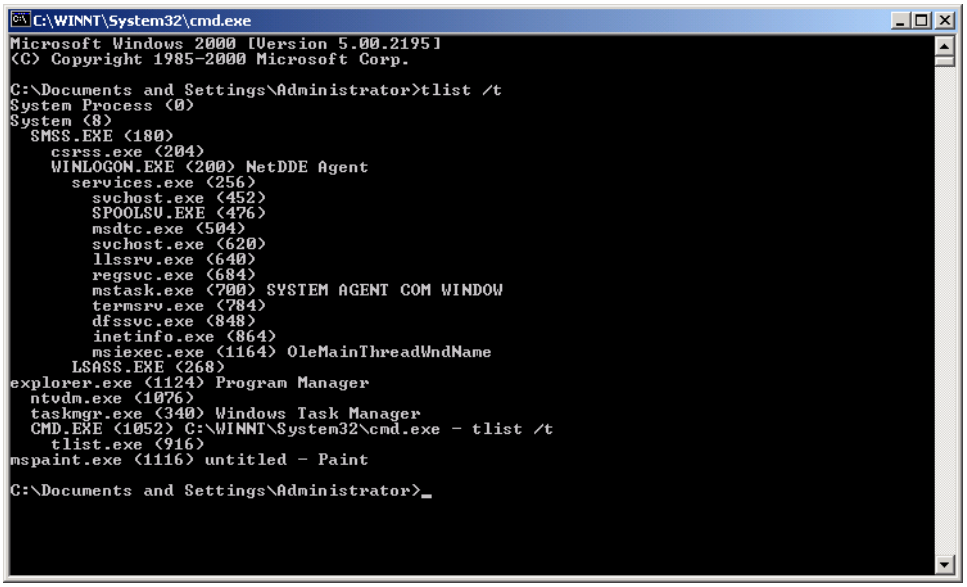


TList indents each process to show its parent/child relationship. Processes whose parents aren't alive are left-justified, because even if a grandparent process exists, there's no way to find that relationship. Windows maintains only the creator process ID, not a link back to the creator of the creator, and so forth.

To demonstrate the fact that Windows doesn't keep track of more than just the parent process ID, follow these steps:

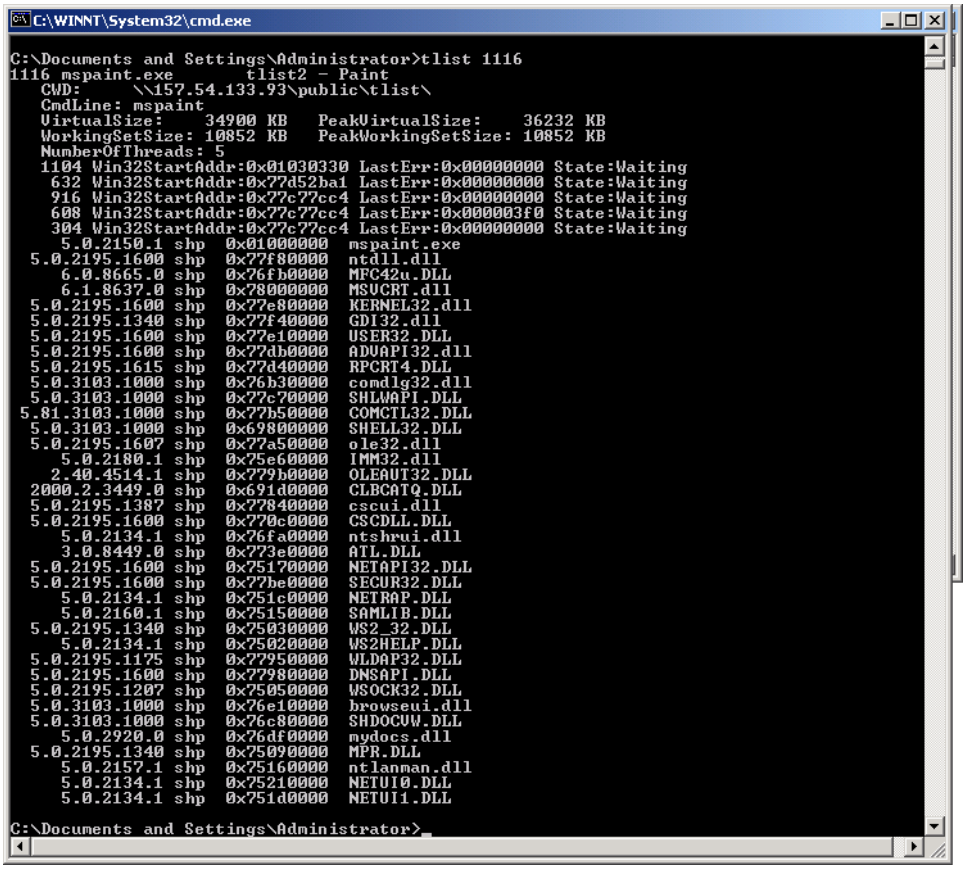
1. Open a Command Prompt window.
2. Type *start cmd* (which runs a second Command Prompt).
3. Bring up Task Manager.
4. Switch to the second Command Prompt.
5. Type *mspaint* (which runs Microsoft Paint).
6. Click the intermediate (second) Command Prompt window.
7. Type *exit*. (Notice that Paint remains.)
8. Switch to Task Manager.
9. Click the Applications tab.
10. Right-click on the Command Prompt task, and select Go To Process.
11. Click on the Cmd.exe process highlighted in gray.
12. Right-click on this process, and select End Process Tree.
13. Click Yes in the Task Manager Warning message box.

The first Command Prompt window will disappear, but you should still see the Paintbrush window because it was the grandchild of the Command Prompt process you terminated; and because the intermediate process (the parent of Paintbrush) was terminated, there was no link between the parent and the grandchild.



Notice that tlist.exe will also give you thread and loaded module information for a process when you enter **tlist** <*pid*>.

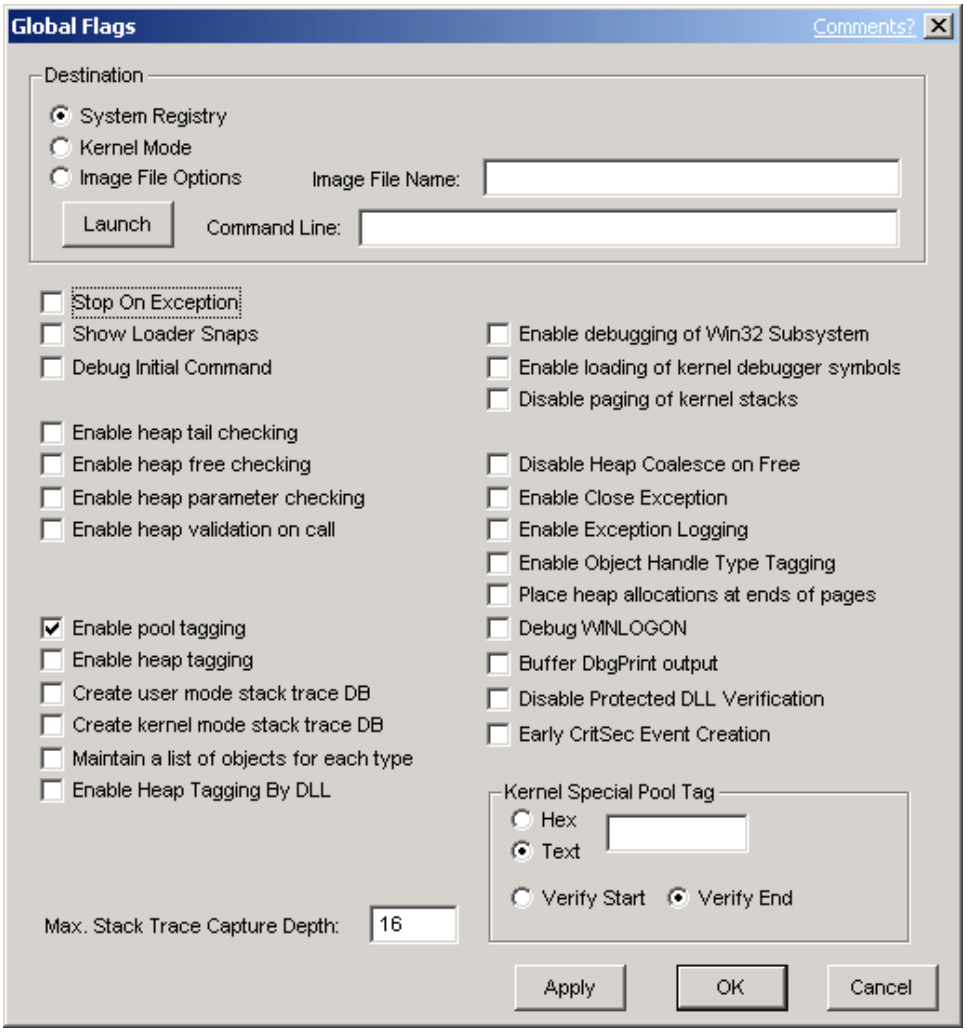
1. Type "*tlist <pid>"* from the command window. Using the Process Id for mspaint.exe.



Exercise 4: Looking at Pool Allocations by Tag

When kernel memory is allocated from either the paged or non-paged pool, a tag is used to help us track who is making those allocations. Pool can be allocated using the *ExAllocatePool* without specifying a tag, but this is rare. In this exercise we will enable pool tagging and take a look at memory being allocated and de-allocated in real time.

1. Select **Start | Run** .
2. Enter gflags <enter>
3. Select "Enable Pool Tagging."
4. Select "Apply", then select "OK" to continue.



5. This change requires a reboot. To see the error message poolmon.exe returns without pool tagging enabled, run poolmon.exe from a command prompt:

```
    C:\Documents and Settings\toddwe>poolmon
    Query pooltags failed (returned: c0000002)
Did you remember to enable pool tagging with gflags.exe and reboot?
```

6. Restart the system.
7. Run poolmon.exe from a command prompt. You should see something like this:

```
Memory:  261676K Avail:  136472K  PageFlts:  1720   InRam Krnl: 1612K P:23112K
 Commit: 120952K Limit: 632852K Peak: 125452K            Pool N: 8560K P:23268K
 Tag  Type     Allocs            Frees            Diff   Bytes      Per Alloc

    ( Paged        34 (   0)        34 (   0)        0       0 (     0)       0
 1MEM Nonp          1 (   0)         0 (   0)        1    3232 (     0)    3232
 2MEM Nonp          1 (   0)         0 (   0)        1    3936 (     0)    3936
 3MEM Nonp          3 (   0)         0 (   0)        3     288 (     0)      96
 8042 Paged         8 (   0)         8 (   0)        0       0 (     0)       0
 8042 Nonp          5 (   0)         0 (   0)        5    4064 (     0)     812
 AGP  Paged         5 (   0)         3 (   0)        2     384 (     0)     192
 AcdM Nonp          1 (   0)         0 (   0)        1   12288 (     0)   12288
 AcdN Nonp          1 (   0)         0 (   0)        1    4096 (     0)    4096
 AcpA Nonp         25 (   0)        22 (   0)        3     256 (     0)      85
               AcpA Paged         1 (   0)         0 (   0)        1     544 (     0)
              544
```

8. Now, change the way you view the information using the keys shown below:

   P - Sorts tag list by Paged, Non-Paged, or mixed – cycles between these three.

   B - Sorts tags by max byte usage.

   M - Sorts tags by max byte allocation.

   T - Sort tags alphabetically by tag name.

   E - Display totals across bottom – cycles between paged and non-paged totals.

   A - Sorts tags by allocation size.

   F - Sorts tags by "frees".

   S - Sorts tags by the differences of allocs and frees.

   Q - Quit.

Module 5 Labs: Crash Dump Analysis I

Lab Objectives

Lab 5 – Crash Dump Analysis I

Exercise 1 – Analyzing a Kernel-Mode Dump File (Part 1)

Estimated Time to Complete this Lab: 75 minutes

Exercise 1: Analyzing a Kernel-Mode Dump File (Part 1)

In this exercise, you will use WinDbg to load the sample kernel mode memory dump files again, this time performing a first level of analysis of each. Following are detailed instructions for the first dump file:

1. Load *memory1.dmp* by repeating steps 1,through 8 from Lab Module 3, Exercise 1.
2. The first thing we need to look at when looking at a memory dump file is the crash dump analysis performed by Windbg itself. Type "**!analyze -v** <enter>" to see the interpretation made by the debugger:

```
kd> !analyze -v
*******************************************************************************
*                                                                             *
*                        Bugcheck Analysis                                    *
*                                                                             *
*******************************************************************************

KMODE_EXCEPTION_NOT_HANDLED (1e)
This is a very common bugcheck.  Usually the exception address pinpoints
the driver/function that caused the problem.  Always note this address
as well as the link date of the driver/image that contains this address.
Arguments:
Arg1: c0000005, The exception code that was not handled
Arg2: 804676c8, The address that the exception occurred at
Arg3: 00000001, Parameter 0 of the exception
Arg4: 00000000, Parameter 1 of the exception

Debugging Details:
------------------


EXCEPTION_CODE: (NTSTATUS) 0xc0000005 - The instruction at "0x%08lx" referenced memory at
"0x%08lx". The memory could not be "%s".

FAULTING_IP:
nt!ExFreePoolWithTag+342
804676c8 890a              mov     [edx],ecx

EXCEPTION_PARAMETER1:  00000001

EXCEPTION_PARAMETER2:  00000000

WRITE_ADDRESS:  00000000

DEFAULT_BUCKET_ID:  DRIVER_FAULT

BUGCHECK_STR:  0x1E

TRAP_FRAME:  f71efb38 -- (.trap ffffffff71efb38)
ErrCode = 00000002
eax=e1e40fc0 ebx=00000000 ecx=00000000 edx=00000000 esi=e1e40ea0 edi=81438428
eip=804676c8 esp=f71efbac ebp=f71efbd0 iopl=0         nv up ei pl zr na po nc
cs=0008  ss=0010  ds=0023  es=0023  fs=0030  gs=0000             efl=00010246
nt!ExFreePoolWithTag+342:
804676c8 890a              mov     [edx],ecx         ds:0023:00000000=????????
Resetting default context

LAST_CONTROL_TRANSFER:  from 804672a2 to 804676c8

STACK_TEXT:
f71efbd0 804672a2 00000001 00000000 8049b588 nt!ExFreePoolWithTag+0x342
f71efbdc 8049b588 e1e40ea8 e1bbb80c 80495b70 nt!ExFreePool+0xb
f71efbe8 80495b70 e1bbb810 e1bbb7f8 81437740 nt!SepTokenDeleteMethod+0x1b
f71efc04 8044c3b3 e1bbb810 e1bbb810 81272020 nt!ObpRemoveObjectRoutine+0xd6
f71efc28 80451ac4 00000002 81272020 f71efd3c nt!ObfDereferenceObject+0x149
f71efc40 80451e5d 81272020 00000000 00000000 nt!PsImpersonateClient+0x191
f71efc78 804983da 81272020 00000000 f71efd64 nt!PsAssignImpersonationToken+0x133
```

```
f71efd4c 80461691 fffffffe 00000005 0054fa7c nt!NtSetInformationThread+0x3a9
f71efd4c 77f8c7c7 fffffffe 00000005 0054fa7c nt!KiSystemService+0xc4
0054fa64 010074c2 fffffffe 00000005 0054fa7c ntdll!NtSetInformationThread+0xb
0054fa80 0100687b 0054fa9c 0054fac0 00160014 services!ScReleasePrivilege+0x18
0054fa98 77d45178 00000015 02020202 00000001 services!RCloseServiceHandle+0x81
0054fab0 77da1586 010067e0 0054fac4 00000001 RPCRT4!Invoke+0x30
0054fd10 77da1937 00000000 00000000 0054fdfc RPCRT4!NdrStubCall2+0x63d
0054fd2c 77d453e2 0054fdfc 0008a288 0054fdfc RPCRT4!NdrServerCall2+0x17
0054fd64 77d452ef 010065fd 0054fdfc 0054fe40 RPCRT4!DispatchToStubInC+0x84
0054fdbc 77d45215 00000000 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStubWorker+0x100
0054fddc 77d4fa80 0054fdfc 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStub+0x5e
0054fe44 77d4f9d7 00000000 000fc328 001112f0 RPCRT4!OSF_SCALL::DispatchHelper+0xa4
0054fe58 77d4f779 00000000 00000000 00000001 RPCRT4!OSF_SCALL::DispatchRPCCall+0x115
0054fe90 77d4f4d8 000fc310 00000003 00000000 RPCRT4!OSF_SCALL::ProcessReceivedPDU+0x43
0054feb0 77d4f0bc 000fc310 0000002c 00015f90 RPCRT4!OSF_SCALL::BeginRpcCall+0xd0
0054ff10 77d4f033 00000000 000fc310 0000002c RPCRT4!OSF_SCONNECTION::ProcessReceiveComplete+0x235
0054ff20 77d5bb62 00088860 0000000c 00000000 RPCRT4!ProcessConnectionServerReceivedEvent+0x1b
0054ff74 77d5ba15 77d4b7bf 00088860 00070178 RPCRT4!LOADABLE_TRANSPORT::ProcessIOEvents+0x9d
0054ff78 77d4b7bf 00088860 00070178 00070640 RPCRT4!ProcessIOEventsWrapper+0x9
0054ffa8 77d4b771 0008b120 0054ffec 77e92ca8 RPCRT4!BaseCachedThreadRoutine+0x4f
0054ffb4 77e92ca8 0008d2c0 00070178 00070640 RPCRT4!ThreadStartRoutine+0x18
0054ffec 00000000 77d4b759 0008d2c0 00000000 KERNEL32!BaseThreadStart+0x52


FOLLOWUP_IP:
nt!ExFreePool+b
804672a2 c20400          ret     0x4

FOLLOWUP_NAME:  Pool_corruption

SYMBOL_NAME:  nt!ExFreePool+b

MODULE_NAME:  nt

IMAGE_NAME:  ntoskrnl.exe

DEBUG_FLR_IMAGE_TIMESTAMP:  384d9b17

STACK_COMMAND:  .trap ffffffff71efb38 ; kb

BUCKET_ID:  0x1E_W_nt!ExFreePool+b

Followup: Pool_corruption
---------
```

3. This bug check is "Stop 0x1E" (Unhandled Exception). This tells us the system encountered and exception and none of the exceptions handlers handled it. So it gets passed on up to the debugger if one is available; if not, as in this case, it crashes the system with a Stop 0x1E.
4. The **!analyze –v** output includes a stack trace. Inspect this for evidence of the faulty routines. In the case of an unhandled exception, the routine at the top of the stack *as displayed by –**analyze** –**v*** is the routine that encountered the exception. This is not, however, the routine that was ultimately at fault.
5. Note that the stack trace included within the **!analyze –v** output is slightly different from that displayed by **kb** or **kv**. Use one of these commands to display the stack, and notice the differences.

```
kd> kb
ChildEBP RetAddr  Args to Child
f71efac8 804624cb f71efae4 00000000 f71efb38 nt!KiDispatchException+0x30e
f71efb30 8046247d 81288784 f71efb84 804b0b48 nt!CommonDispatchException+0x4d
f71efb30 804676c8 81288784 f71efb84 804b0b48 nt!KiUnexpectedInterruptTail+0x1f4
f71efbd0 804672a2 00000001 00000000 8049b588 nt!ExFreePoolWithTag+0x342
f71efbdc 8049b588 e1e40ea8 e1bbb80c 80495b70 nt!ExFreePool+0xb
f71efbe8 80495b70 e1bbb810 e1bbb7f8 81437740 nt!SepTokenDeleteMethod+0x1b
f71efc04 8044c3b3 e1bbb810 e1bbb810 81272020 nt!ObpRemoveObjectRoutine+0xd6
f71efc28 80451ac4 00000002 81272020 f71efd3c nt!ObfDereferenceObject+0x149
```

```
f71efc40 80451e5d 81272020 00000000 00000000 nt!PsImpersonateClient+0x191
f71efc78 804983da 81272020 00000000 f71efd64 nt!PsAssignImpersonationToken+0x133
f71efd4c 80461691 fffffffe 00000005 0054fa7c nt!NtSetInformationThread+0x3a9
f71efd4c 77f8c7c7 fffffffe 00000005 0054fa7c nt!KiSystemService+0xc4
0054fa64 010074c2 fffffffe 00000005 0054fa7c ntdll!NtSetInformationThread+0xb
0054fa80 0100687b 0054fa9c 0054fac0 00160014 services!ScReleasePrivilege+0x18
0054fa98 77d45178 00000015 02020202 00000001 services!RCloseServiceHandle+0x81
0054fab0 77da1586 010067e0 0054fac4 00000001 RPCRT4!Invoke+0x30
0054fd10 77da1937 00000000 00000000 0054fdfc RPCRT4!NdrStubCall2+0x63d
0054fd2c 77d453e2 0054fdfc 0008a288 0054fdfc RPCRT4!NdrServerCall2+0x17
0054fd64 77d452ef 010065fd 0054fdfc 0054fe40 RPCRT4!DispatchToStubInC+0x84
0054fdbc 77d45215 00000000 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStubWorker+0x100
```

6. Use the **!process 0 0** command to display a brief list of processes and their executable image names.

```
kd> !process 0 0
**** NT ACTIVE PROCESS DUMP ****
PROCESS 814370a0  SessionId: 0  Cid: 0008    Peb: 00000000  ParentCid: 0000
    DirBase: 00030000  ObjectTable: 81437b88  TableSize: 148.
    Image: System

PROCESS 812b9520  SessionId: 0  Cid: 0098    Peb: 7ffdf000  ParentCid: 0008
    DirBase: 025c9000  ObjectTable: 812c3ca8  TableSize:  33.
    Image: smss.exe

PROCESS 812a17a0  SessionId: 0  Cid: 00b4    Peb: 7ffdf000  ParentCid: 0098
    DirBase: 0325e000  ObjectTable: 812b6228  TableSize: 347.
    Image: csrss.exe

PROCESS 81296320  SessionId: 0  Cid: 00c8    Peb: 7ffdf000  ParentCid: 0098
    DirBase: 035c3000  ObjectTable: 812a5928  TableSize: 352.
    Image: winlogon.exe

PROCESS 81286aa0  SessionId: 0  Cid: 00e4    Peb: 7ffdf000  ParentCid: 00c8
    DirBase: 038c2000  ObjectTable: 81288768  TableSize: 719.
    Image: services.exe

PROCESS 812839a0  SessionId: 0  Cid: 00f8    Peb: 7ffdf000  ParentCid: 00c8
    DirBase: 0393d000  ObjectTable: 81283908  TableSize: 338.
    Image: lsass.exe

PROCESS 8123fd60  SessionId: 0  Cid: 01ac    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 046c5000  ObjectTable: 812682c8  TableSize: 216.
    Image: svchost.exe

PROCESS 81258a40  SessionId: 0  Cid: 01d0    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 04833000  ObjectTable: 8123e468  TableSize: 132.
    Image: SPOOLSV.EXE

PROCESS 8120e340  SessionId: 0  Cid: 0210    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 06369000  ObjectTable: 8122b228  TableSize: 151.
    Image: msdtc.exe

PROCESS 811df300  SessionId: 0  Cid: 0284    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 06734000  ObjectTable: 812109e8  TableSize: 185.
    Image: svchost.exe

PROCESS 811fca80  SessionId: 0  Cid: 0294    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 069c0000  ObjectTable: 812078e8  TableSize: 120.
    Image: llssrv.exe

PROCESS 811c16e0  SessionId: 0  Cid: 02c4    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 069ec000  ObjectTable: 811fc228  TableSize:  30.
    Image: regsvc.exe

PROCESS 811c97a0  SessionId: 0  Cid: 02e0    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 06c1c000  ObjectTable: 811bfb08  TableSize:  93.
    Image: mstask.exe

PROCESS 811db020  SessionId: 0  Cid: 0310    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 067e3000  ObjectTable: 8128ece8  TableSize: 526.
    Image: inetinfo.exe
```

```
PROCESS 811774a0  SessionId: 0  Cid: 0354    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 03bfa000  ObjectTable: 811eca68  TableSize:  41.
    Image: dfssvc.exe

PROCESS 810ce020  SessionId: 0  Cid: 0418    Peb: 7ffdf000  ParentCid: 0458
    DirBase: 05d13000  ObjectTable: 810cf9a8  TableSize: 253.
    Image: explorer.exe

PROCESS 810b83a0  SessionId: 0  Cid: 0258    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 00a84000  ObjectTable: 811eba28  TableSize:  85.
    Image: msiexec.exe

PROCESS 810abae0  SessionId: 0  Cid: 04bc    Peb: 7ffdf000  ParentCid: 0498
    DirBase: 02f1e000  ObjectTable: 8127c388  TableSize: 356.
    Image: IEXPLORE.EXE

PROCESS 810d16c0  SessionId: 0  Cid: 0470    Peb: 7ffdf000  ParentCid: 01ac
    DirBase: 04336000  ObjectTable: 81179488  TableSize:  81.
    Image: mdm.exe

PROCESS 810a3520  SessionId: 0  Cid: 0518    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 06030000  ObjectTable: 811f6448  TableSize: 120.
    Image: clisvcl.exe

PROCESS 810a21c0  SessionId: 0  Cid: 0508    Peb: 7ffdf000  ParentCid: 04c8
    DirBase: 07fcc000  ObjectTable: 81189ba8  TableSize:  75.
    Image: launch32.exe

PROCESS 81122620  SessionId: 0  Cid: 0544    Peb: 7ffdf000  ParentCid: 0518
    DirBase: 06726000  ObjectTable: 8110a368  TableSize: 112.
    Image: SMSAPM32.exe

PROCESS 81099340  SessionId: 0  Cid: 01dc    Peb: 7ffdf000  ParentCid: 00e4
    DirBase: 00a76000  ObjectTable: 810c4868  TableSize:  47.
    Image: hinv32.exe

PROCESS 81098020  SessionId: 0  Cid: 0404    Peb: 7ffdf000  ParentCid: 0544
    DirBase: 00d13000  ObjectTable: 810fe828  TableSize:  43.
    Image: SWDist32.exe
```

7. Use the **!thread** command to display the currently running thread.

```
kd> !thread
THREAD 81272020  Cid e4.15c  Teb: 7ffda000  Win32Thread: e1b7e888 RUNNING
IRP List:
    810bcae8: (0006,00b8) Flags: 00000970  Mdl: 00000000
    810ab008: (0006,00b8) Flags: 00000800  Mdl: 00000000
    8121a3a8: (0006,00b8) Flags: 00000970  Mdl: 00000000
    810d8e68: (0006,00b8) Flags: 00000800  Mdl: 00000000
    81219228: (0006,00b8) Flags: 00000970  Mdl: 00000000
    810fea28: (0006,00b8) Flags: 00000970  Mdl: 00000000
    810c44c8: (0006,00b8) Flags: 00000970  Mdl: 00000000
    81254808: (0006,00b8) Flags: 00000970  Mdl: 00000000
    81165448: (0006,00b8) Flags: 00000970  Mdl: 00000000
    8126c008: (0006,00b8) Flags: 00000970  Mdl: 00000000
    811f12a8: (0006,00b8) Flags: 00000970  Mdl: 00000000
    8121d748: (0006,00b8) Flags: 00000970  Mdl: 00000000
    8125ea48: (0006,00b8) Flags: 00000970  Mdl: 00000000
    8117b308: (0006,00b8) Flags: 00000970  Mdl: 00000000
    811b4468: (0006,00b8) Flags: 00000970  Mdl: 00000000
    812ae848: (0006,00b8) Flags: 00000970  Mdl: 00000000
Not impersonating
Owning Process 81286aa0
WaitTime (seconds)      103380
Context Switch Count    5193                  LargeStack
UserTime                  0:00:00.0260
KernelTime                0:00:00.0630
Start Address KERNEL32!BaseThreadStartThunk (0x77e92c50)
Win32 Start Address RPCRT4!ThreadStartRoutine (0x77d4b759)
Stack Init f71f0000 Current f71ef2bc Base f71f0000 Limit f71ed000 Call 0
Priority 10 BasePriority 9 PriorityDecrement 0 DecrementCount 0

ChildEBP RetAddr  Args to Child
```

```
f71efac8 804624cb f71efae4 00000000 f71efb38 nt!KiDispatchException+0x30e
f71efb30 8046247d 81288784 f71efb84 804b0b48 nt!CommonDispatchException+0x4d
f71efb30 804676c8 81288784 f71efb84 804b0b48 nt!KiUnexpectedInterruptTail+0x1f4
f71efbd0 804672a2 00000001 00000000 8049b588 nt!ExFreePoolWithTag+0x342
f71efbdc 8049b588 e1e40ea8 e1bbb80c 80495b70 nt!ExFreePool+0xb
f71efbe8 80495b70 e1bbb810 e1bbb7f8 81437740 nt!SepTokenDeleteMethod+0x1b
f71efc04 8044c3b3 e1bbb810 e1bbb810 81272020 nt!ObpRemoveObjectRoutine+0xd6
f71efc28 80451ac4 00000002 81272020 f71efd3c nt!ObfDereferenceObject+0x149
f71efc40 80451e5d 81272020 00000000 00000000 nt!PsImpersonateClient+0x191
f71efc78 804983da 81272020 00000000 f71efd64 nt!PsAssignImpersonationToken+0x133
f71efd4c 80461691 fffffffe 00000005 0054fa7c nt!NtSetInformationThread+0x3a9
f71efd4c 77f8c7c7 fffffffe 00000005 0054fa7c nt!KiSystemService+0xc4
0054fa64 010074c2 fffffffe 00000005 0054fa7c ntdll!NtSetInformationThread+0xb
0054fa80 0100687b 0054fa9c 0054fac0 00160014 services!ScReleasePrivilege+0x18
0054fa98 77d45178 00000015 02020202 00000001 services!RCloseServiceHandle+0x81
0054fab0 77da1586 010067e0 0054fac4 00000001 RPCRT4!Invoke+0x30
0054fd10 77da1937 00000000 00000000 0054fdfc RPCRT4!NdrStubCall2+0x63d
0054fd2c 77d453e2 0054fdfc 0008a288 0054fdfc RPCRT4!NdrServerCall2+0x17
0054fd64 77d452ef 010065fd 0054fdfc 0054fe40 RPCRT4!DispatchToStubInC+0x84
0054fdbc 77d45215 00000000 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStubWorker+0x100
0054fddc 77d4fa80 0054fdfc 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStub+0x5e
0054fe44 77d4f9d7 00000000 000fc328 001112f0 RPCRT4!OSF_SCALL::DispatchHelper+0xa4
0054fe58 77d4f779 00000000 00000000 00000001 RPCRT4!OSF_SCALL::DispatchRPCCall+0x115
0054fe90 77d4f4d8 000fc310 00000003 00000000 RPCRT4!OSF_SCALL::ProcessReceivedPDU+0x43
0054feb0 77d4f0bc 000fc310 0000002c 00015f90 RPCRT4!OSF_SCALL::BeginRpcCall+0xd0
0054ff10 77d4f033 00000000 000fc310 0000002c RPCRT4!OSF_SCONNECTION::ProcessReceiveComplete+0x235
0054ff20 77d5bb62 00088860 0000000c 00000000 RPCRT4!ProcessConnectionServerReceivedEvent+0x1b
0054ff74 77d5ba15 77d4b7bf 00088860 00070178 RPCRT4!LOADABLE_TRANSPORT::ProcessIOEvents+0x9d
0054ff78 77d4b7bf 00088860 00070178 00070640 RPCRT4!ProcessIOEventsWrapper+0x9
0054ffa8 77d4b771 0008b120 0054ffec 77e92ca8 RPCRT4!BaseCachedThreadRoutine+0x4f
0054ffb4 77e92ca8 0008d2c0 00070178 00070640 RPCRT4!ThreadStartRoutine+0x18
0054ffec 00000000 77d4b759 0008d2c0 00000000 KERNEL32!BaseThreadStart+0x52
```

8. Use the **!process** command to display complete details for the process that owns that thread. Inspecting the output from !thread, we find that the owning process address is 81286aa0, so **!process 81286aa0** can be used,

9. Use the **!drivers** command to display the list of drivers that were loaded in the system.

```
kd> !drivers
System Driver and Image Summary
Base       Code Size      Data Size      Image Name        Creation Time
80400000 142dc0 (1292 k) 4d680 (310 k) ntoskrnl.exe  Tue Dec 07 15:41:11 1999
80062000  13c40 (  80 k)  34e0 ( 14 k)      hal.dll  Sat Oct 30 15:48:14 1999
f7410000   1760 (   6 k)  1000 (  4 k)  BOOTVID.DLL  Wed Nov 03 17:24:33 1999
f7000000   bdc0 (  48 k)  22a0 (  9 k)      pci.sys  Wed Oct 27 16:11:08 1999
f7010000   99c0 (  39 k)  18e0 (  7 k)   isapnp.sys  Sat Oct 02 13:00:35 1999
f75c8000    760 (   2 k)   520 (  2 k) intelide.sys  Thu Oct 28 16:20:03 1999
f7280000   42e0 (  17 k)   e80 (  4 k)  PCIIDEX.SYS  Wed Oct 27 16:02:19 1999
f7288000   64a0 (  26 k)   a20 (  3 k) MountMgr.sys  Fri Oct 22 15:48:06 1999
fcd4e000  192c0 ( 101 k)  2b00 ( 11 k)   ftdisk.sys  Mon Nov 22 11:36:23 1999
f7500000   12e0 (   5 k)   640 (  2 k) Diskperf.sys  Thu Sep 30 17:30:40 1999
f75c9000    740 (   2 k)   560 (  2 k)   WMILIB.SYS  Sat Sep 25 11:36:47 1999
f7502000    d80 (   4 k)   b40 (  3 k)   dmload.sys  Tue Nov 30 11:47:49 1999
fcd2c000  1a380 ( 105 k)  6be0 ( 27 k)     dmio.sys  Tue Nov 30 11:47:49 1999
f7414000   21a0 (   9 k)   720 (  2 k)  PartMgr.sys  Thu Oct 14 17:59:16 1999
fcd17000  11b80 (  71 k)  2c00 ( 11 k)    atapi.sys  Sat Dec 04 12:19:32 1999
f7290000   58e0 (  23 k)   e60 (  4 k)     disk.sys  Fri Oct 22 15:27:46 1999
f7020000   6d20 (  28 k)  1240 (  5 k) CLASSPNP.SYS  Wed Oct 06 16:55:45 1999
fcd05000   e100 (  57 k)  3be0 ( 15 k)      Dfs.sys  Tue Nov 30 16:23:01 1999
fccf4000   c820 (  51 k)  4000 ( 16 k)   KSecDD.sys  Fri Oct 22 16:38:14 1999
fcc71000  7ae60 ( 492 k)  7840 ( 31 k)     Ntfs.sys  Mon Nov 29 23:37:55 1999
fcc48000  23320 ( 141 k)  5680 ( 22 k)     NDIS.sys  Mon Nov 29 23:37:30 1999
fcc32000  117e0 (  70 k)  3680 ( 14 k)      Mup.sys  Fri Nov 05 14:31:58 1999
f7298000   43e0 (  17 k)   8e0 (  3 k)   agp440.sys  Tue Sep 28 16:37:32 1999
f75cb000    2e0 (   1 k)   4a0 (  2 k)  audstub.sys  Sat Sep 25 11:35:33 1999
f7050000   b680 (  46 k)   c20 (  4 k)  rasl2tp.sys  Mon Nov 29 23:09:07 1999
f7484000   1700 (   6 k)   840 (  3 k) ndistapi.sys  Tue Oct 12 16:54:43 1999
f6fc9000  13400 (  77 k)  2ac0 ( 11 k)  ndiswan.sys  Mon Nov 29 23:09:01 1999
```

```
f7490000   2d20 (  12 k)   f20 (  4 k)      TDI.SYS  Mon Nov 29 23:19:49 1999
f7060000   a620 (  42 k)  1100 (  5 k)  raspptp.sys  Mon Nov 29 23:09:13 1999
f7358000   3740 (  14 k)   9c0 (  3 k)  ptilink.sys  Wed Oct 13 16:29:00 1999
f7368000   33e0 (  13 k)   a40 (  3 k)   raspti.sys  Fri Oct 08 13:45:10 1999
f7070000   c5e0 (  50 k)  20e0 (  9 k) parallel.sys  Fri Oct 22 15:00:54 1999
f7080000   a000 (  40 k)  20c0 (  9 k) VIDEOPRT.SYS  Sat Nov 06 13:55:20 1999
f6f8f000   c900 (  51 k)  4540 ( 18 k) atiragem.sys  Fri Nov 05 15:43:11 1999
f73a8000   5d00 (  24 k)   980 (  3 k)    cdrom.sys  Wed Oct 27 16:46:36 1999
f73c8000   3da0 (  16 k)   ec0 (  4 k)     USBD.SYS  Sat Oct 09 13:41:58 1999
f73b8000   70a0 (  29 k)   900 (  3 k)     uhcd.sys  Tue Oct 05 13:45:47 1999
f7090000   d000 (  52 k)  1c00 (  7 k) el90xbc5.sys  Tue Oct 19 10:09:18 1999
f6f4e000  17b40 (  95 k)  3cc0 ( 16 k)       KS.SYS  Tue Nov 30 00:51:38 1999
f6f6a000  1c740 ( 114 k)  7a40 ( 31 k)  portcls.sys  Fri Nov 05 23:53:25 1999
f70a0000   6720 (  26 k)  3420 ( 14 k) es1371mp.sys  Fri Nov 05 14:33:27 1999
f75cc000    580 (   2 k)   540 (  2 k)   swenum.sys  Sat Sep 25 11:36:31 1999
f6f39000    dc0 (   4 k) 137c0 ( 78 k)   update.sys  Mon Oct 25 12:28:24 1999
f70b0000   8460 (  34 k)  2940 ( 11 k) i8042prt.sys  Wed Dec 01 23:34:06 1999
f72f8000   44a0 (  18 k)  1720 (  6 k) kbdclass.sys  Tue Oct 26 16:12:37 1999
f7308000   48c0 (  19 k)  1540 (  6 k)  parport.sys  Sat Sep 25 11:36:43 1999
f70c0000   c200 (  49 k)  2dc0 ( 12 k)   serial.sys  Mon Oct 25 12:27:55 1999
f74ac000   2a60 (  11 k)   720 (  2 k)  serenum.sys  Tue Oct 19 15:36:55 1999
f7328000      0 (   0 k)     0 (  0 k)      fdc.sys  unavailable
f7338000   3ac0 (  15 k)  1660 (  6 k) mouclass.sys  Fri Oct 01 16:33:11 1999
f70d0000   8420 (  34 k)  1600 (  6 k)  NDProxy.SYS  Thu Sep 30 16:25:35 1999
f7350000   4860 (  19 k)  1e80 (  8 k)      EFS.SYS  Sat Oct 09 13:59:21 1999
f70e0000   8940 (  35 k)   f20 (  4 k)   usbhub.sys  Fri Nov 12 15:29:21 1999
f74c4000   1b00 (   7 k)   680 (  2 k) gameenum.sys  Sat Sep 25 11:35:57 1999
f7380000   3a60 (  15 k)   d40 (  4 k) flpydisk.sys  Mon Sep 27 20:47:21 1999
f750c000   12a0 (   5 k)   640 (  2 k)   Fs_Rec.SYS  Sat Sep 25 11:39:38 1999
f75d0000    2a0 (   1 k)   480 (  2 k)     Null.SYS  Sat Sep 25 11:34:58 1999
f75d1000    720 (   2 k)   540 (  2 k)     Beep.SYS  Wed Oct 20 15:18:59 1999
f74d4000   2800 (  10 k)   aa0 (  3 k)      vga.sys  Sat Sep 25 11:37:40 1999
f75d2000    4a0 (   2 k)   800 (  2 k)    mnmdd.SYS  Sat Sep 25 11:37:40 1999
f73a0000   4140 (  17 k)   e20 (  4 k)     Msfs.SYS  Tue Oct 26 16:21:32 1999
f7100000   7940 (  31 k)  1380 (  5 k)     Npfs.SYS  Sat Oct 09 16:58:07 1999
f7514000   1380 (   5 k)   7e0 (  2 k)   rasacd.sys  Sat Sep 25 11:41:23 1999
f6eae000  43500 ( 270 k)  7020 ( 29 k)    tcpip.sys  Mon Nov 29 23:38:42 1999
f7110000   7400 (  29 k)  1000 (  4 k)    msgpc.sys  Mon Nov 29 23:37:21 1999
f72b8000   63e0 (  25 k)  12a0 (  5 k)   wanarp.sys  Sat Oct 30 15:36:06 1999
f6e89000  21980 ( 135 k)  2840 ( 11 k)    netbt.sys  Mon Nov 29 23:37:39 1999
f7120000   6f20 (  28 k)   fa0 (  4 k)  netbios.sys  Tue Oct 12 12:34:19 1999
f6e67000  1de80 ( 120 k)  3220 ( 13 k)    rdbss.sys  Tue Nov 30 00:52:29 1999
f6dcf000  52ca0 ( 332 k)  a180 ( 41 k)   mrxsmb.sys  Tue Nov 30 00:52:10 1999
f75d3000    740 (   2 k)   560 (  2 k) dump_WMILIB.SYS  Sat Sep 25 11:36:47 1999
f6dba000  11b80 (  71 k)  2c00 ( 11 k) dump_atapi.sys  Sat Dec 04 12:19:32 1999
a0000000 177d60 (1504 k) 2d5a0 (182 k)   win32k.sys  Tue Nov 30 00:51:03 1999
f6d6f000  1f360 ( 125 k)  2c00 ( 11 k) atiraged.dll  Tue Nov 30 01:31:17 1999
f643d000  170c0 (  93 k)  25a0 ( 10 k)      afd.sys  Mon Nov 29 23:12:04 1999
f6362000   fc40 (  64 k)  2120 (  9 k)   wdmaud.sys  Wed Oct 27 11:40:45 1999
f652f000   9520 (  38 k)  1f40 (  8 k) sysaudio.sys  Mon Oct 25 12:28:14 1999
f7574000    d40 (   4 k)   860 (  3 k)   ParVdm.SYS  Mon Sep 27 20:28:16 1999
f60aa000  35520 ( 214 k)  59e0 ( 23 k)      srv.sys  Mon Nov 29 23:38:21 1999
f7250000   d820 (  55 k)  1280 (  5 k)     Cdfs.SYS  Mon Oct 25 12:23:52 1999
f604c000  21360 ( 133 k)  2a00 ( 11 k)  Fastfat.SYS  Mon Oct 25 12:20:50 1999
f6096000   2160 (   9 k)   ac0 (  3 k)     spud.sys  Fri Nov 19 15:36:27 1999
f5f36000  11f20 (  72 k)  2ac0 ( 11 k)    ipsec.sys  Mon Nov 29 23:08:54 1999
f5eea000  16f60 (  92 k)  ccc0 ( 52 k)   kmixer.sys  Tue Nov 09 22:52:30 1999

No unloaded module list present
Loading User Symbols
01000000  14a00 (  83 k)   e00 (  4 k) services.exe  Mon Oct 25 12:20:14 1999
77f80000  4a400 ( 297 k) 2b000 (172 k)    ntdll.dll  Wed Oct 27 13:06:08 1999
77d40000  67a00 ( 415 k)  4c00 ( 19 k)   RPCRT4.DLL  Thu Dec 02 15:29:06 1999
77e80000  5d200 ( 373 k) 55800 (342 k) KERNEL32.DLL  Tue Nov 30 23:37:24 1999
77db0000  4f400 ( 317 k)  7e00 ( 32 k) ADVAPI32.DLL  Tue Nov 30 23:37:24 1999
75170000  46600 ( 282 k)  5200 ( 21 k) NETAPI32.DLL  Sat Dec 04 18:28:08 1999
78000000  32000 ( 200 k) 13000 ( 76 k)   MSVCRT.DLL  Wed Sep 29 18:51:35 1999
77be0000   a600 (  42 k)  1000 (  4 k)  SECUR32.DLL  Tue Nov 30 23:37:25 1999
751c0000   1e00 (   8 k)   800 (  2 k)   NETRAP.DLL  Tue Nov 30 01:31:07 1999
75150000   8600 (  34 k)  2e00 ( 12 k)   SAMLIB.DLL  Tue Nov 30 01:31:08 1999
75030000   f600 (  62 k)  1c00 (  7 k)   WS2_32.DLL  Tue Nov 30 01:31:09 1999
75020000   3600 (  14 k)   c00 (  3 k)  WS2HELP.DLL  Tue Nov 30 01:31:09 1999
77950000  1ce00 ( 116 k)  9c00 ( 39 k)  WLDAP32.DLL  Tue Nov 30 23:37:27 1999
77980000  1d800 ( 118 k)  2c00 ( 11 k)   DNSAPI.DLL  Tue Nov 30 23:37:27 1999
```

```
75050000   2200 (   9 k)  2e00 ( 12 k)  WSOCK32.DLL  Tue Nov 30 01:31:09 1999
77e10000  57200 ( 349 k)  b400 ( 45 k)   USER32.DLL  Tue Nov 30 23:37:24 1999
77f40000  36600 ( 218 k)  2800 ( 10 k)    GDI32.DLL  Fri Nov 12 00:44:52 1999
767a0000  12800 (  74 k)  2e00 ( 12 k) UMPNPMGR.DLL  Tue Nov 30 23:37:35 1999
77c10000  4de00 ( 312 k)  c200 ( 49 k)  USERENV.DLL  Tue Nov 30 23:37:25 1999
76810000  2e600 ( 186 k)  9c00 ( 39 k)   SCESRV.DLL  Tue Nov 30 23:37:35 1999
77bf0000   cc00 (  51 k)  1000 (  4 k)  NTDSAPI.DLL  Tue Nov 30 23:37:25 1999
76890000   9600 (  38 k)  1400 (  5 k) eventlog.dll  Tue Nov 30 23:37:35 1999
77360000  13400 (  77 k)  2c00 ( 11 k) dhcpcsvc.dll  Tue Nov 30 23:37:29 1999
77520000    e00 (   4 k)   800 (  2 k)     ICMP.DLL  Tue Nov 30 23:37:29 1999
77340000   d800 (  54 k)  3400 ( 13 k) IPHLPAPI.DLL  Tue Nov 30 23:37:29 1999
77320000  12400 (  73 k)  1400 (  5 k)   MPRAPI.DLL  Tue Nov 30 23:37:29 1999
77a50000  e0200 ( 897 k) 11600 ( 70 k)    OLE32.DLL  Tue Nov 30 23:37:25 1999
779b0000  85000 ( 532 k)  f000 ( 60 k) OLEAUT32.DLL  Tue Nov 30 23:37:26 1999
773b0000  21600 ( 134 k)  9e00 ( 40 k) ACTIVEDS.DLL  Tue Nov 30 23:37:29 1999
77380000  1de00 ( 120 k)  1c00 (  7 k)  ADSLDPC.DLL  Tue Nov 30 23:37:29 1999
77830000   9a00 (  39 k)  1000 (  4 k)  RTUTILS.DLL  Tue Nov 30 23:37:27 1999
77890000  60a00 ( 387 k) 29a00 (167 k) SETUPAPI.DLL  Tue Nov 30 23:37:27 1999
774e0000  2b800 ( 174 k)  3a00 ( 15 k) RASAPI32.DLL  Tue Nov 30 23:37:29 1999
774c0000   c600 (  50 k)  1200 (  5 k)   RASMAN.DLL  Tue Nov 30 23:37:29 1999
77530000  1ca00 ( 115 k)  2400 (  9 k)   TAPI32.DLL  Tue Nov 30 23:37:28 1999
77b50000  64400 ( 401 k) 22800 (138 k) COMCTL32.DLL  Tue Nov 30 23:37:25 1999
77c70000  42600 ( 266 k)  4600 ( 18 k)  SHLWAPI.DLL  Tue Nov 30 23:37:25 1999
77cc0000  6d600 ( 438 k)  f000 ( 60 k)  CLBCATQ.DLL  Tue Nov 30 23:37:24 1999
768a0000  13200 (  77 k)  2c00 ( 11 k) dnsrslvr.dll  Tue Nov 30 23:37:35 1999
76880000   1800 (   6 k)   800 (  2 k)   lmhsvc.dll  Tue Nov 30 23:37:35 1999
74fd0000   c400 (  49 k)  1000 (  4 k)    msafd.dll  Tue Nov 30 01:31:09 1999
75010000   3000 (  12 k)   e00 (  4 k) wshtcpip.dll  Tue Nov 30 01:31:09 1999
65780000   7a00 (  31 k)  1000 (  4 k)   WINSTA.DLL  Thu Dec 02 15:30:10 1999
76770000  15800 (  86 k)  2200 (  9 k)   wkssvc.dll  Tue Nov 30 23:37:36 1999
76670000   7c00 (  31 k)  2e00 ( 12 k) CRYPTDLL.DLL  Tue Nov 30 23:37:36 1999
77840000   7600 (  30 k)  1400 (  5 k)    rnr20.dll  Tue Nov 30 23:37:27 1999
74b40000   3200 (  13 k)  1400 (  5 k)   alrsvc.dll  Tue Nov 30 01:31:14 1999
768c0000   1c00 (   7 k)   e00 (  4 k) dmserver.dll  Tue Nov 30 23:37:35 1999
770b0000      0 (   0 k)  3c00 ( 15 k) CFGMGR32.DLL  Tue Nov 30 23:37:31 1999
767e0000   ea00 (  59 k)  5000 ( 20 k)   Srvsvc.dll  Tue Nov 30 23:37:35 1999
77800000  16c00 (  91 k)  4600 ( 18 k) WINSPOOL.DRV  Tue Nov 30 23:37:27 1999
76870000   6c00 (  27 k)  1800 (  6 k)   msgsvc.dll  Tue Nov 30 23:37:35 1999
768d0000   d400 (  53 k)  1e00 (  8 k) cryptsvc.dll  Tue Nov 30 23:37:35 1999
76850000  12400 (  73 k)  9600 ( 38 k)   psbase.dll  Tue Nov 30 23:37:35 1999
74ff0000   b600 (  46 k)  4600 ( 18 k)  mswsock.dll  Tue Nov 30 01:31:09 1999
76800000   2a00 (  11 k)  1a00 (  7 k) seclogon.dll  Tue Nov 30 23:37:35 1999
777e0000   3c00 (  15 k)   c00 (  3 k)   winrnr.dll  Tue Nov 30 23:37:27 1999
777f0000    e00 (   4 k)   800 (  2 k) rasadhlp.dll  Tue Nov 30 23:37:27 1999
767c0000  14200 (  81 k)  1c00 (  7 k)   trkwks.dll  Tue Nov 30 23:37:35 1999
76790000   8800 (  34 k)  3600 ( 14 k)  w32time.dll  Tue Nov 30 23:37:36 1999
768f0000   a800 (  42 k)  1400 (  5 k)  browser.dll  Tue Nov 30 23:37:34 1999
7ca00000  1c000 ( 112 k)  4000 ( 16 k)  rsabase.dll  Tue Oct 12 16:30:37 1999
77440000  69600 ( 422 k)  ac00 ( 43 k)  CRYPT32.dll  Tue Nov 30 23:37:29 1999
77430000   c200 (  49 k)   600 (  2 k)   MSASN1.DLL  Tue Nov 30 23:37:29 1999
76750000   7800 (  30 k)  9e00 ( 40 k)  wmicore.dll  Tue Nov 30 23:37:36 1999
70170000  b0800 ( 706 k) 68600 (418 k)    ESENT.dll  Tue Nov 30 01:32:20 1999
775a0000 11a800 (1130 k) 123800 (1166 k)  shell32.dll  Tue Nov 30 23:37:27 1999
```

10. Load the additional *memory*N.*dmp* files and perform a similar level of analysis on each. .

Module 6 Labs: Kernel Debugging I

Lab Objectives

Lab 6 – Kernel Debugging I

Exercise 1 – Setting Up a Kernel Debugging Session

Exercise 2 – Debugging a "System Hang" Caused by a High-Priority Thread

Exercise 3 – Debugging a "System Hang" Caused by a Driver Looping at High IRQL

Estimated Time to Complete this Lab: minutes

Exercise 1: Setting up a Kernel Debugging Session

In this exercise you will set up and verify a two-machine, "live" kernel debugging environment.

This lab assumes that you have completed the labs in Modules 2 and 3.

Part 1: Setting up the target computer in debug mode

This lab demonstrates how to configure the target computer to startup in "debug mode." (With Windows 2000 and later versions, you can also select F8 during startup and select debug mode.)

1. Select **Start | Run** and type "cmd" into the test box and select OK or press <enter>.
2. If necessary, change to the c: drive, by typing "**c:**<enter>".
3. Change into the root directory of c: drive, by typing "**cd**<enter>".
4. Type "**attrib boot.ini –r –s –h** <enter>".
5. Type "**notepad boot.ini** <enter>" .

   The *boot.ini* file will look similar to this:

```
[boot loader]
timeout=30
default=multi(0)disk(0)rdisk(0)partition(1)\WINNT
[operating systems]
multi(0)disk(0)rdisk(0)partition(1)\WINNT="Microsoft Windows 2000 Professional" /fastdetect
```

   Note This sample is from an x86 computer running Windows 2000 Professional.

   Note The lines in *boot.ini* can be quite long. Depending on your settings in Notepad, Notepad may or may not display them "wrapped" to fit the width of the window. In later steps you will save a modified version of this file. Do not save the file with any new line breaks!

6. If there is more than one line following [operating systems] in *boot.ini*, each specifies a disk partition and directory from which a Windows operating sytem may be started. Identify one of these which you want to be able to boot in debug mode.
7. Make a copy of the line specifying the operating system you want to be able to boot in debug mode. The sample file shown above would now look like this:

```
[boot loader]
timeout=30
default=multi(0)disk(0)rdisk(0)partition(1)\WINNT
[operating systems]
multi(0)disk(0)rdisk(0)partition(1)\WINNT="Microsoft Windows 2000 Professional" /fastdetect
multi(0)disk(0)rdisk(0)partition(1)\WINNT="Microsoft Windows 2000 Professional" /fastdetect
```

8. Append **/debugport=com1** to the end of the new line you just added to the file.

   Here is the result of the change to the sample *boot.ini* file after it has been modified by steps one through eight:

```
[boot loader]
timeout=30
default=multi(0)disk(0)rdisk(0)partition(1)\WINNT
[operating systems]
multi(0)disk(0)rdisk(0)partition(1)\WINNT="Microsoft Windows 2000 Professional" /fastdetect
multi(0)disk(0)rdisk(0)partition(1)\WINNT="Microsoft Windows 2000 Professional" /fastdetect
/debugport=Com1
```

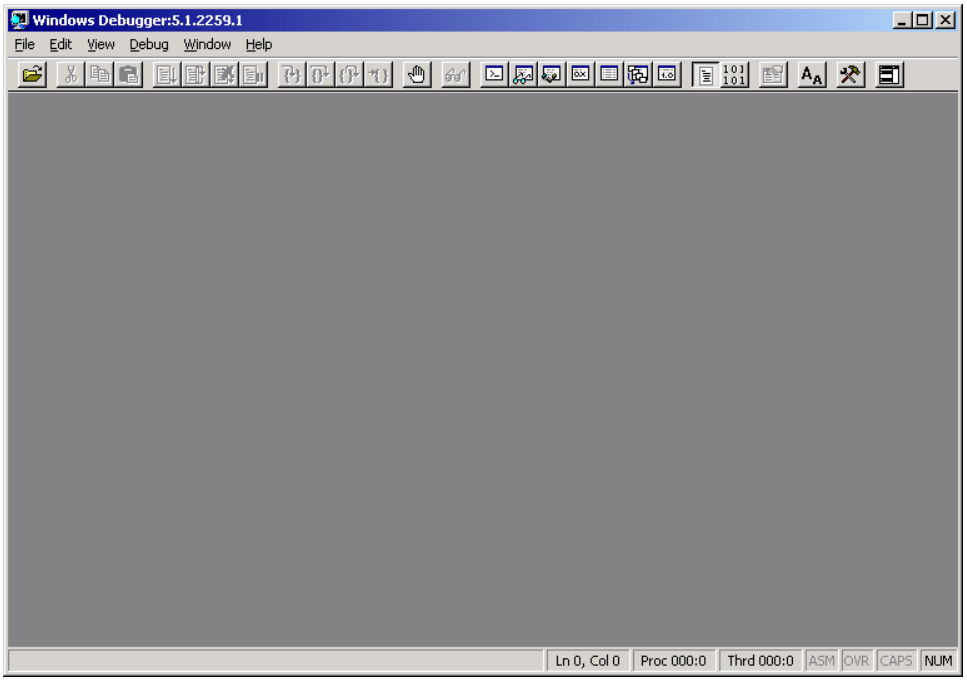
Note: In the actual file, **there must be no line break** between "/fastdetect" and "/debugport=Com1". The line break in the preceding is an artifact of the printing requirements for this document.

9. Save the *boot.ini* file and quit notepad.

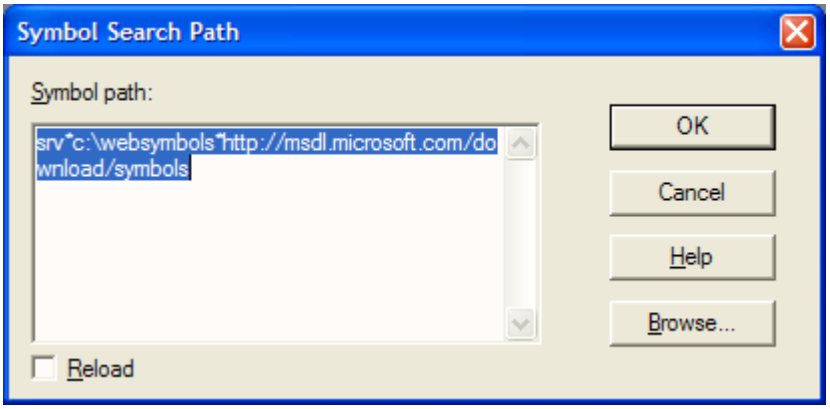
10. Shut down and restart Windows on the target computer. You'll notice that a boot option screen appears, offering you at least two choices, one that includes the notation "debugger enabled" and one that does not. Select the one that says "debugger enabled".

Part 2: Starting a Debug Session With WinDbg on the Host System

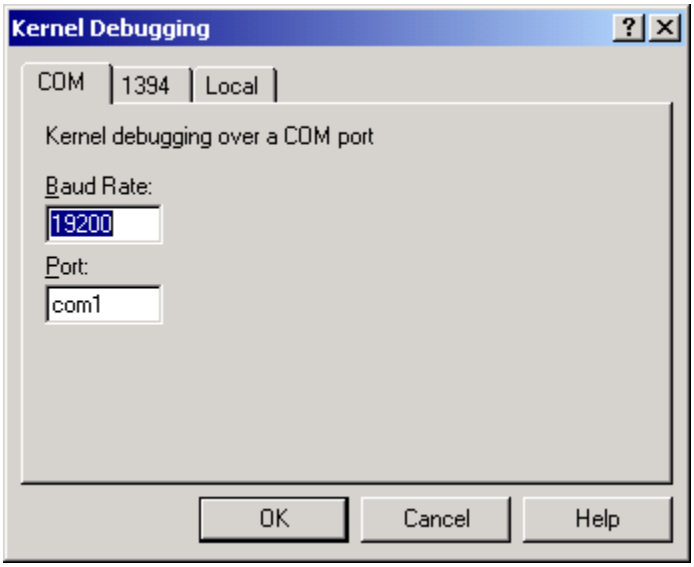
11. Select **Start | Programs | Microsoft Debugging Tools** | **WinDbg**.



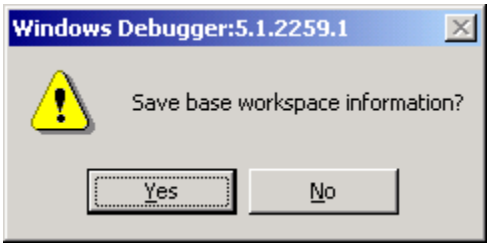
12. Select **File** | **Symbols File Path…** or press **Ctrl+S.**
13. Enter "**srv*c:\websymbols*http://msdl.microsoft.com/download/symbols**" and then select OK. (Your instructor may supply a different symbol path.)



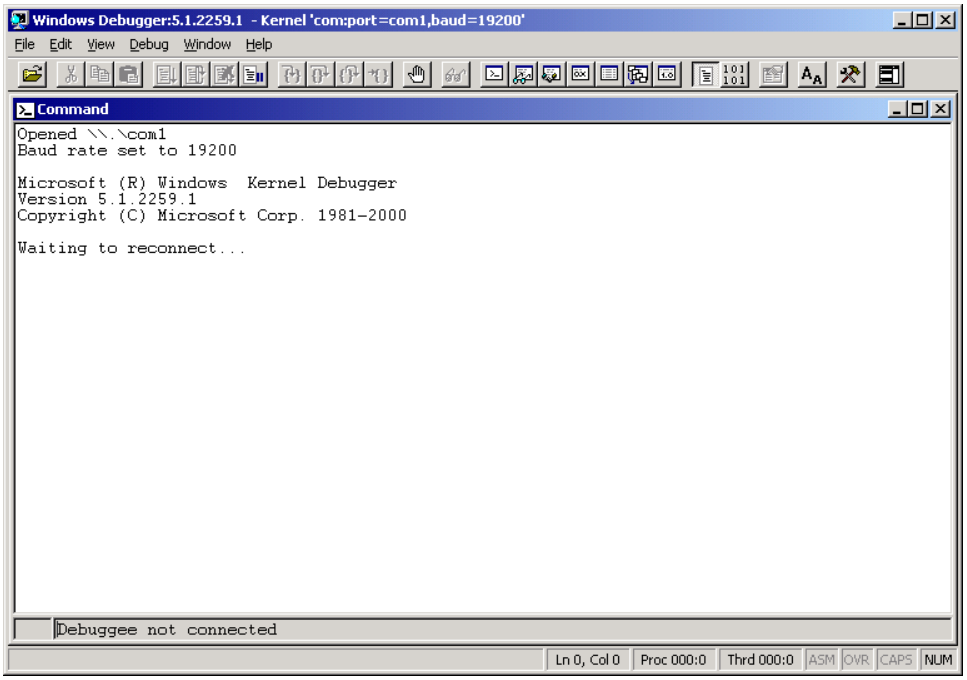
14. Select **File** | **Kernel Debug…** or press **Ctrl+K**
15. Enter *19200* for Baud Rate and *COM1* for Port



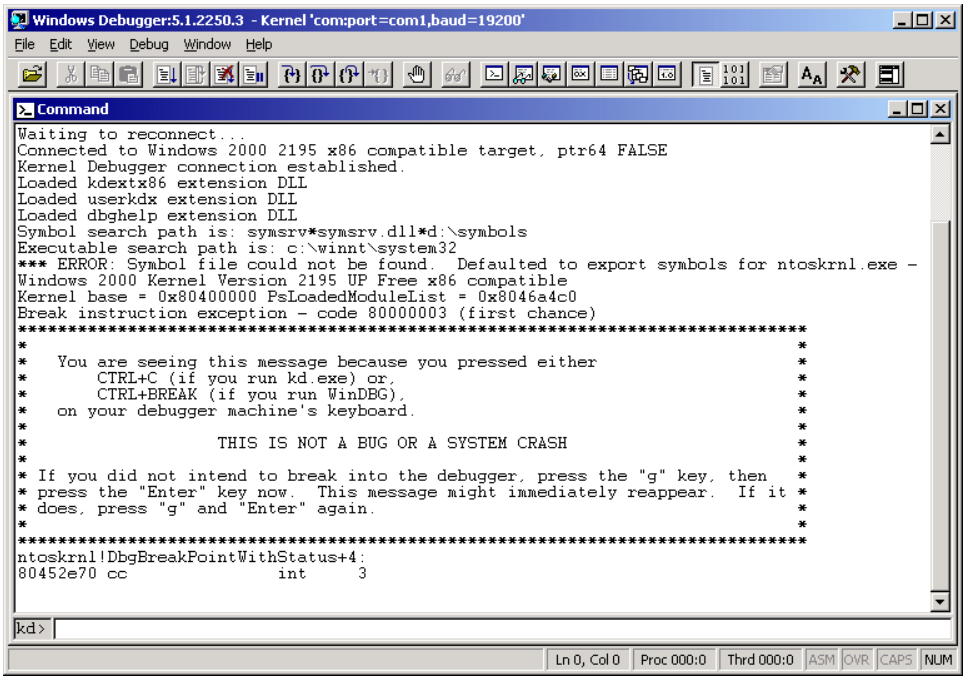
16. Select OK
17. You will be prompted to save base workspace information. If you are certain the symbol path is correct, select Yes; otherwise, select No.



The Windows Debugger will look something like this:

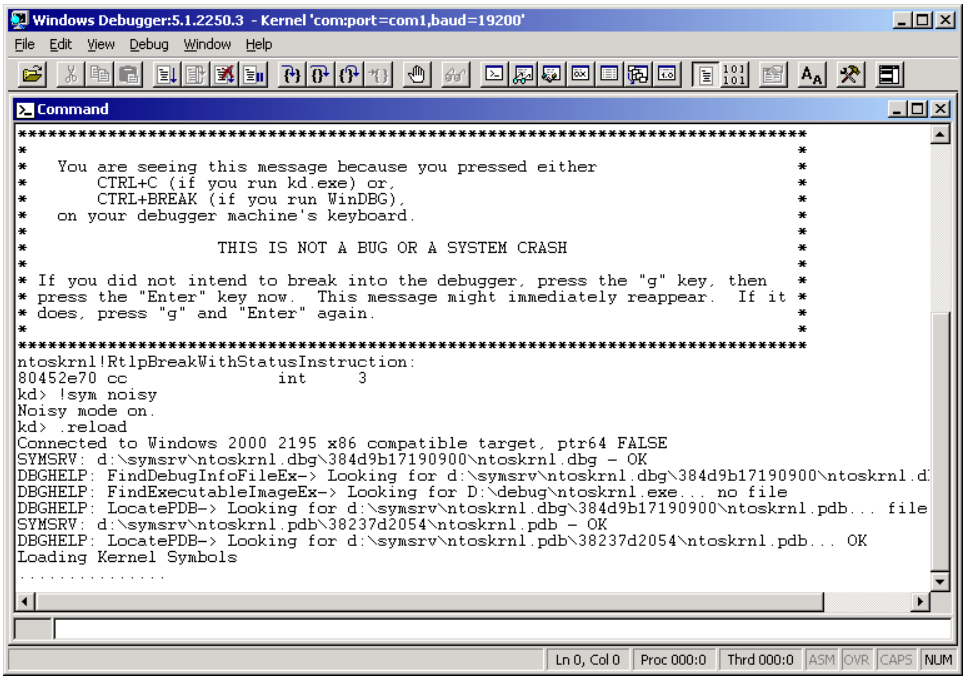


18. Select **Debug** | **Break** or press **Ctrl**+Break



The debugger's output should look similar to the above.

19. Observe that the target system is now "frozen," completely unresponsive to any sort of input.
20. Type **!sym noisy** and press <enter>. This will allow you to see the symbols when they are loaded.
21. Type **.reload** and press enter.



22. Use the **kb** (stack backtrace) command to display the current stack. Inspect the sequence of procedure calls.
23. Use the **!thread** extension to display information about the current thread. Use the **!process** extension to display information about the process that owns that thread.
24. What was happening on the target system when you broke into it?
25. Use the debugger's **s (step)** command to execute a few instructions. Notice the stack changing. What is happening on the target system?
26. Use the debugger's **g** (continue from breakpoint) command, or select **Debug | Go,** to allow the target to continue executing, then select **Debug** | **Break** or press **Ctrl+Break** to break into the target again. Use the **kb** and **!thread** commands to examine the current thread. Has anything changed?
27. Use some of the other debugger commands to examine the state of the target system.
28. When finished, use the debugger's **g** (continue from breakpoint) command, or select **Debug | Go,** to allow the target to continue executing, then select **File | Exit**, or use Alt-F4, to exit WinDbg.

Exercise 2: Debugging a "System Hang" Caused by a High-Priority Thread

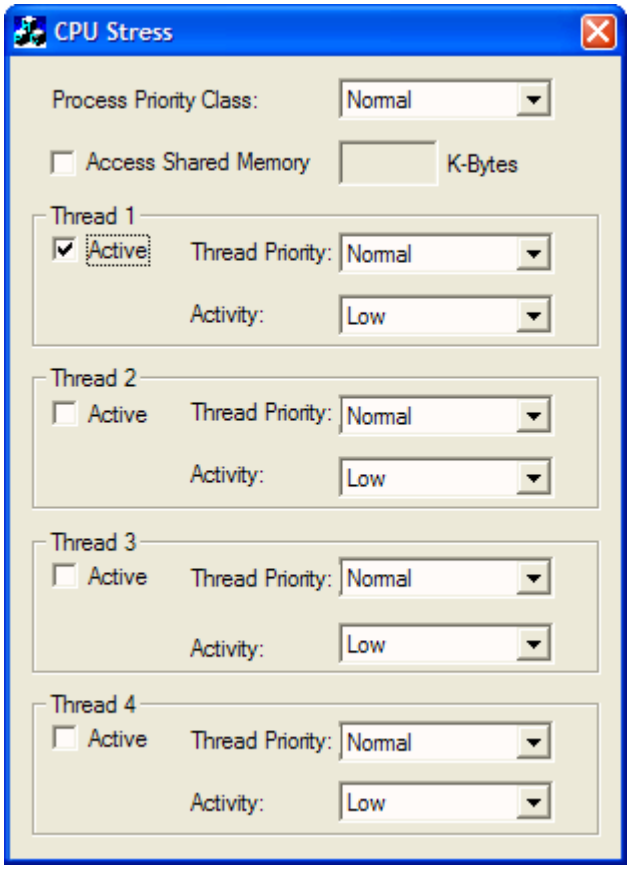
In this lab you will use a WinDbg kernel debugging session to determine the cause of a system hang.

This lab assumes that you have completed Exercise 1 in this module.

Part 1: Creating the Problem Scenario

1. Ensure that your target system was booted with debugger enabled. If not, reboot it and select the "debugger enabled" option from the boot menu.

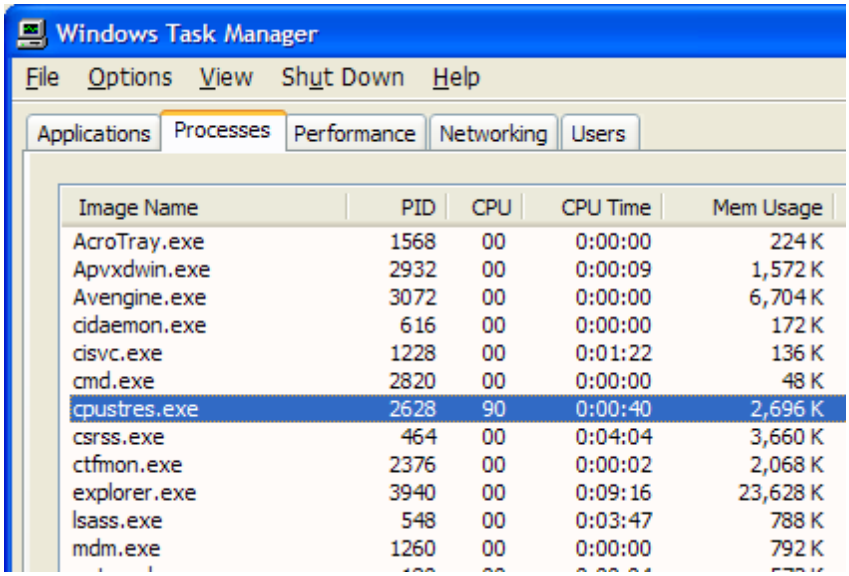
2. On the target system, start the Resource Kit utility *cpustres.exe.* Select **Start | Run,** type "cpustres" into the text box and select OK or press <enter>. The following dialog box should appear:



3. If the target system is a multiprocessor system, check as many of the "Thread 1 – active", "Thread 2 – active", etc., boxes, as there are CPUs.

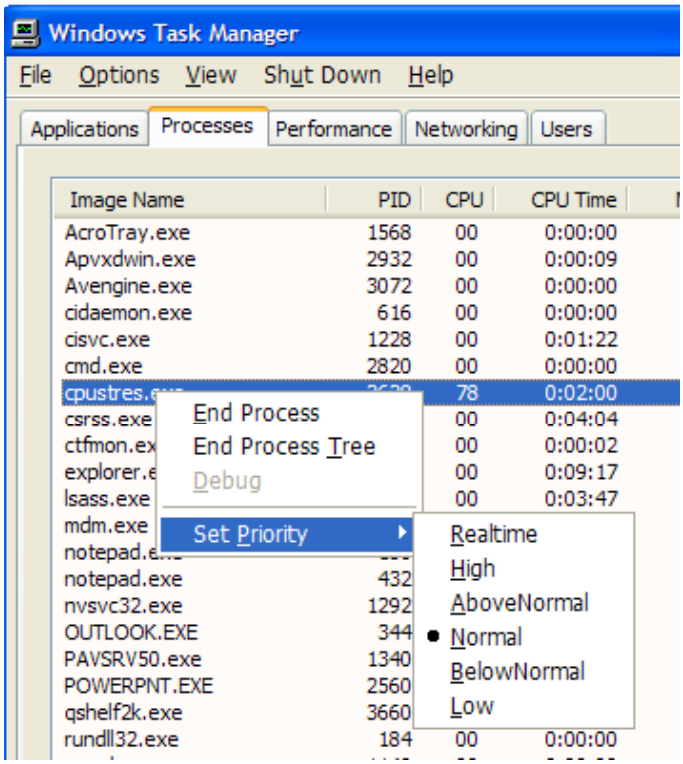
4. Set the "Activity" level of Thread 1 to "Maximum."

5. On the target system, start Task Manager by right-clicking in an empty area of the Task Bar, and selecting Task Manager (or use Ctrl-Alt-Delete). Within Task Manager, select the Processes tab. Locate the process running CpuStres.Exe. Note that its CPU usage is close to 100%.



6. In the dialog box of *CpuStres*, try setting the thread's "activity level" to various values, and observe the effect on the CPU time used by the process. You could try enabling additional threads as well.

7. In Task Manager's Processes tab, Right-click on the CpuStres.Exe process and select "Set Priority."



8. In the selection box, click on "Realtime." This changes the priority class of the process, setting it above that of many critical threads in the operating system.

9. Note that the target system is now completely unresponsive to keyboard input.

Part 2: Analyzing the Problem with WinDbg

10. On the host system, begin a debugging session using WinDbg, as described in Exercise 1, steps 8 through 15 in this module.

11. Use the debugger commands you lave learned to examine the state of the target system.

    a. Can you identify the "problem" thread? Do you see things in the debugger's display of the thread that are consistent with the problems you observe on the target system?

    b. Can you identify the process to which the "problem" thread belongs? What program is the process running?

    c. What other threads are trying to execute on the target system? What routines are they executing?

    d. Is there anything you can do with the debugger to allow the target system to resume normal operation?

    e. Assuming for the moment that the problem was not apparent – are there any debugger commands that might allow you to collect more information for further analysis, without continuing to tie up the system with a kernel debugging session?

    f. What could you have done if the target system had not been booted with "debugger enabled"?

Exercise 3: Debugging a "System Hang" at High IRQL

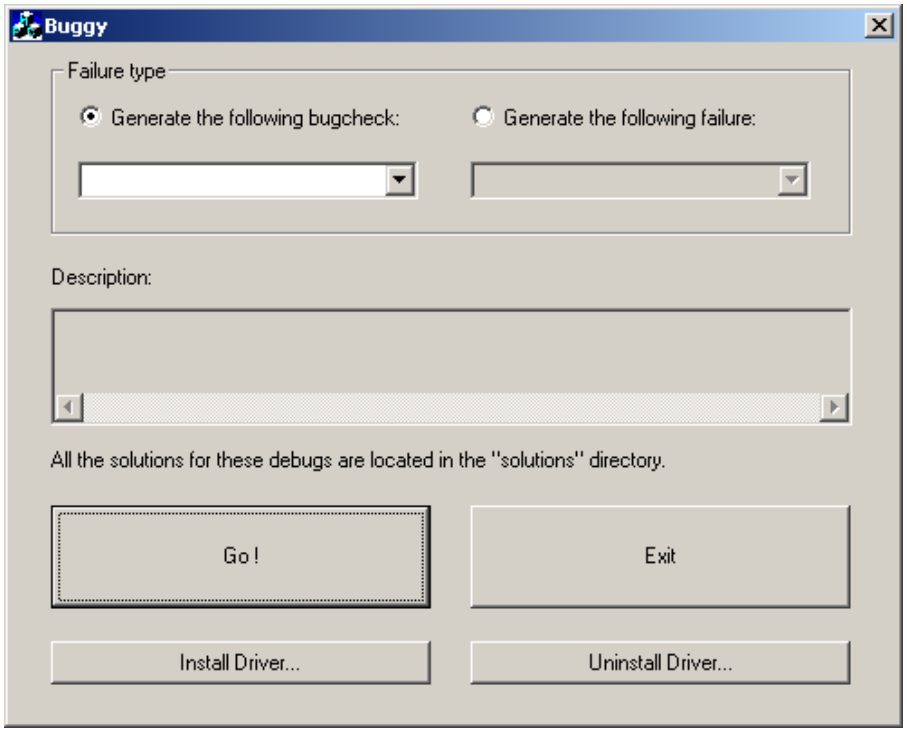
In this lab you will use a WinDbg kernel debugging session to determine the cause of a system hang, this one created by a driver spending excessive time at high IRQL (Interrupt Request Level). This will appear similar to the previous case, but the problem scenario is quite different.

This lab assumes that you have completed Exercise 1 in this module.

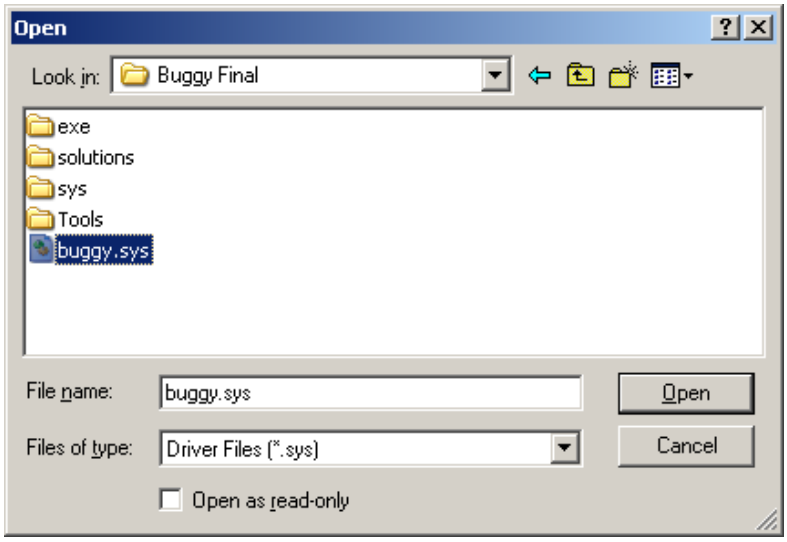
Part 1: Installing the Buggy application

In this section, you will install the *Buggy* application and driver. The *buggy.sys* driver contains examples of many common types of driver problems. The *buggy.exe* application allows you to load the *buggy.sys* driver and cause it to execute the code to exhibit these problems. In later labs, we'll interactively debug the code in *buggy.sys* in a live kernel debugging session using WinDbg; here, we'll just use WinDbg to identify the failing component.

1. Locate **Buggy.exe** on the CD in **labs\Buggy** and launch this application.



2. Click on the "**Install Driver…**" button.



3. Select **buggy.sys** and click **Open**.

Part 2: Creating the Problem Scenario

Once the driver is installed, the *Buggy* application offers the ability to generate various bugchecks and failures. Once the bugcheck or failure has been selected, clicking on the **"Go !"** button will immediately generate the problem. So, take note that your system will become unusable once this button has been pressed!

4. Using the "Failure type" radio buttons, select "**Generate the following failure:**"
5. Using the right-hand drop-down menu, select "Loop at high IRQL"
6. Click on the "**Go!**" button.
7. Observe that the target system is now completely unresponsive to mouse movement, keyboard input, etc.

Part 3: Analyzing the Problem with WinDbg

8. On the host system, begin a debugging session using WinDbg, as described in Exercise 1, steps 8 through 15 in this module.

9. Use the debugger commands you lave learned to examine the state of the target system.

    a. Can you identify the "problem" thread? Do you see things in the debugger's display of the thread that are consistent with the problems you observe on the target system? How is it different from the "CpuStres" case?

    b. Can you identify the process to which the "problem" thread belongs? What program is the process running?

    c. What other threads are trying to execute on the target system? What routines are they executing? How is this different from the "CpuStres" case?

    d. Is there anything you can do with the debugger to allow the target system to resume normal operation?

Module 7 Labs: Understanding Disassembled Code

Lab Objectives

Lab 7 – Understanding Disassembled Code

Exercise 1 – Mapping Assembly to C / C++

Exercise 2 – Reading Assembly Language (Part 1)

Exercise 3 – Reading Assembly Language (Part 2)

Estimated Time to Complete this Lab: 30 Minutes

Exercise 1: Mapping Assembly to C / C++

Match the C/C++ code to the corresponding Assembly code.

Given the three lettered boxes (A-C) on the left that contain C/C++ code, and the three numbered boxes (1-3) to the right that contain Assembly code, fill in the following blanks to correctly match a C/C++ box to the Assembly code box that contains the corresponding code.

A → _____

B → _____

C → _____

A

```
void main(void)
{
        int x = 0;
        int y = 1;
        int z = 3;
        x = y + z;
}
```

1

```
00401034   mov       ecx,dword ptr [ebp-4]
00401037   cmp       ecx,dword ptr [ebp-0Ch]
0040103A   jne       0040103E
0040103C   jmp       00401042
0040103E   xor       eax,eax
00401040   jmp       00401044
00401042   jmp       0040103E
00401044   mov       esp,ebp
00401046   pop       ebp
00401047   ret
```

B

```
if (x == z)
      goto End;
End:
        return 0;
```

2

```
0040AE4E   mov         edx,1
0040AE53   test        edx,edx
0040AE55   je          0040AE6C
0040AE57   mov         eax,dword ptr [ebp-4]
0040AE5A   shl         eax,1
0040AE5C   mov         dword ptr [ebp-4],eax
0040AE5F   cmp         dword ptr [ebp-4],4E20h
0040AE66   jl          0040AE6A
0040AE68   jmp         0040AE6C
0040AE6A   jmp         0040AE4E
0040AE6C   xor         eax,eax
0040AE6E   jmp         0040AE72
0040AE70   jmp         0040AE6C
0040AE72   mov         esp,ebp
0040AE74   pop         ebp
0040AE75   ret
```

C

```
while (true)
{
    x*=2;
    if (x >= 20000)
    break;
}
return 0;
```

3

```
00401010   push        ebp
00401011   mov         ebp,esp
00401013   sub         esp,0Ch
00401016   mov         dword ptr [ebp-4],0
0040101D   mov         dword ptr [ebp-8],1
00401024   mov         dword ptr [ebp-0Ch],3
0040102B   mov         eax,dword ptr [ebp-8]
0040102E   add         eax,dword ptr [ebp-0Ch]
00401031   mov         dword ptr [ebp-4],eax
00401034   mov         esp,ebp
00401036   pop         ebp
00401037   ret
```

Exercise 2: Reading Assembly Language (Part 1)

Determine what the Assembly code is doing and then answer the questions below.

Note:

The CDQ instruction is a way to convert a DWORD to a QUAD word and preserve the sign. The result of this conversion is stored in EDX:EAX. In the example below, CDQ is acting on EAX (which has a value of 0xA), and when widened EDX will contain 0x0 and EAX will contain 0xA. (So, you should basically ignore the CDQ for this example).

```
0040AE20   push        ebp
0040AE21   mov         ebp,esp
0040AE23   sub         esp,10h
0040AE26   mov         dword ptr [ebp-4],0Ah
0040AE2D   mov         dword ptr [ebp-0Ch],3
0040AE34   mov         eax,dword ptr [ebp-4]
0040AE37   cdq         (Ignore me… see above for why)
0040AE38   idiv        eax,dword ptr [ebp-0Ch]
0040AE3B   mov         dword ptr [ebp-8],eax
0040AE3E   mov         eax,dword ptr [ebp-0Ch]
0040AE41   imul        eax,dword ptr [ebp-8]
0040AE45   mov         ecx,dword ptr [ebp-4]
0040AE48   sub         ecx,eax
0040AE4A   mov         dword ptr [ebp-10h],ecx
0040AE4D   mov         esp,ebp
0040AE4F   pop         ebp
0040AE50   ret
```

What is the Value stored in ebp-4? _____

What is the Value stored in ebp-8? _____

What is the Value stored in ebp-10? _____

What is the Value stored in ebp-0xc _____

What is this program doing?

Exercise 3: Reading Assembly Language (Part 2)

Determine what the Assembly code is doing and then answer the questions below.

Note:

JGE is Jump if Greater or Equal.

```
0040AE20   push        ebp
0040AE21   mov         ebp,esp
0040AE23   sub         esp,8
0040AE26   mov         dword ptr [ebp-4],5
0040AE2D   mov         dword ptr [ebp-8],1
0040AE34   jmp         0040AE3F
0040AE36   mov         eax,dword ptr [ebp-8]
0040AE39   add         eax,1
0040AE3C   mov         dword ptr [ebp-8],eax
0040AE3F   cmp         dword ptr [ebp-8],6
0040AE43   jge         0040AE51
0040AE45   mov         ecx,dword ptr [ebp-4]
0040AE48   imul        ecx,dword ptr [ebp-8]
0040AE4C   mov         dword ptr [ebp-4],ecx
0040AE4F   jmp         0040AE36
0040AE51   mov         esp,ebp
0040AE53   pop         ebp
0040AE54   ret
```

1. What is the Value stored in ebp-4? _____
2. What is the Value stored in ebp-8? _____
3. What is this program doing?

Module 8 Labs: Call Stacks

Lab Objectives

Lab 8 – Call Stacks

Exercise 1 – Reading a Call Stack

Exercise 2 – Identifying Calling Conventions

Estimated Time to Complete this Lab: 30 Minutes

Exercise 1: Reading a Call Stack

Given the following call stack, determine the return address, the locals, and the two variables passed to devidem!Devidem()..

```
ChildEBP
0012ff64 devidem!Devidem+0x18
0012ff80 devidem!main+0x28
0012ffc0 devidem!mainCRTStartup+0xb4
0012fff0 KERNEL32!BaseProcessStart+0x3d

0:000> dd esp-10
0012ff50  00402f44 002f0000 40000069 00000800
0012ff60  00000002 0012ff80 00401028 00000006
0012ff70  00000003 00000000 00000003 00000006
0012ff80  0012ffc0 00401144 00000001 002f0d70
0012ff90  002f0db8 00000000 00000000 7ffdf000
0012ffa0  80100000 be4a7d00 0012ff94 00000000
0012ffb0  0012ffe0 00402764 00407118 00000000
0012ffc0  0012fff0 77e87903 00000000 00000000
```

_____ Return address pushed on stack during call to devidem!Devidem()

_____ Return address pushed on stack during call to devidem!main()

_____ Value of the first argument passed to devidem!Devidem()

_____ Value of the second argument passed to devidem!Devidem()

_____ Value of the local variable for devidem!Devidem()

Exercise 2: Identifying Calling Conventions

Determine what calling conventions are being used below.

____ CDECL

____ FASTCALL

____ STDCALL

A

```
0040103e push    ebp
0040103f mov     ebp,esp
00401041 sub     esp,0xc
00401044 mov     [ebp-0xc],edx
00401047 mov     [ebp-0x8],ecx
0040104a mov     dword ptr [ebp-0x4],0x0
00401051 mov     eax,[ebp-0x8]
00401054 add     eax,[ebp-0xc]
00401057 mov     [ebp-0x4],eax
0040105a mov     eax,[ebp-0x4]
0040105d mov     esp,ebp
0040105f pop     ebp
00401060 ret
```

B

```
00401040 push    ebp
00401041 mov     ebp,esp
00401043 push    ecx
00401044 mov     dword ptr [ebp-0x4],0x0
0040104b mov     eax,[ebp+0x8]
0040104e add     eax,[ebp+0xc]
00401051 mov     [ebp-0x4],eax
00401054 mov     eax,[ebp-0x4]
00401057 mov     esp,ebp
00401059 pop     ebp
0040105a ret     0x8
```

C

```
00401043 push    ebp
00401044 mov     ebp,esp
00401046 push    ecx
00401047 mov     dword ptr [ebp-0x4],0x0
0040104e mov     eax,[ebp+0x8]
00401051 add     eax,[ebp+0xc]
00401054 mov     [ebp-0x4],eax
00401057 mov     eax,[ebp-0x4]
0040105a mov     esp,ebp
0040105c pop     ebp
0040105d ret
```

Module 9 Labs: Crash Dump Analysis II

Lab Objectives

Lab 9 – Crash Dump Analysis II

Exercise 1 – Using WinDbg to Analyze a Kernel-Mode Dump File (Part 3)

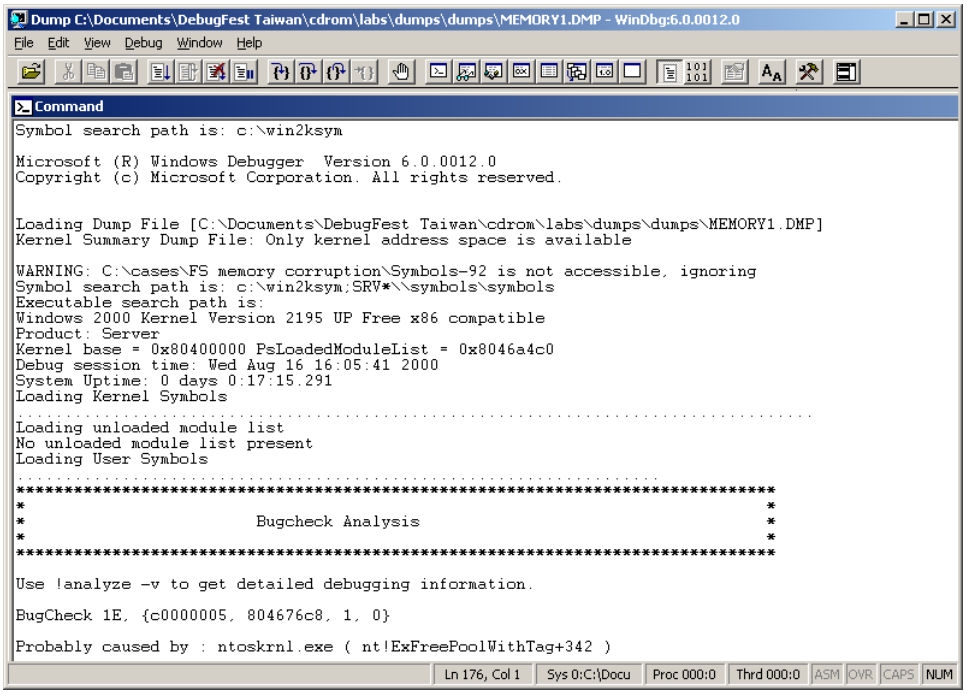
Estimated Time to Complete this Lab: 90 minutes

Exercise 1: Using WinDbg to Analyze the Kernel-Mode Dump (Part 3)

In this exercise, you will use WinDbg to load a couple of sample memory.dmp files for analysis. The files are located in the c:\dumps directory.

Continuing the analysis of the *memory.dmp* file

1. Load *memory.dmp* by repeating steps 1, 2, and 3 from Lab 3.



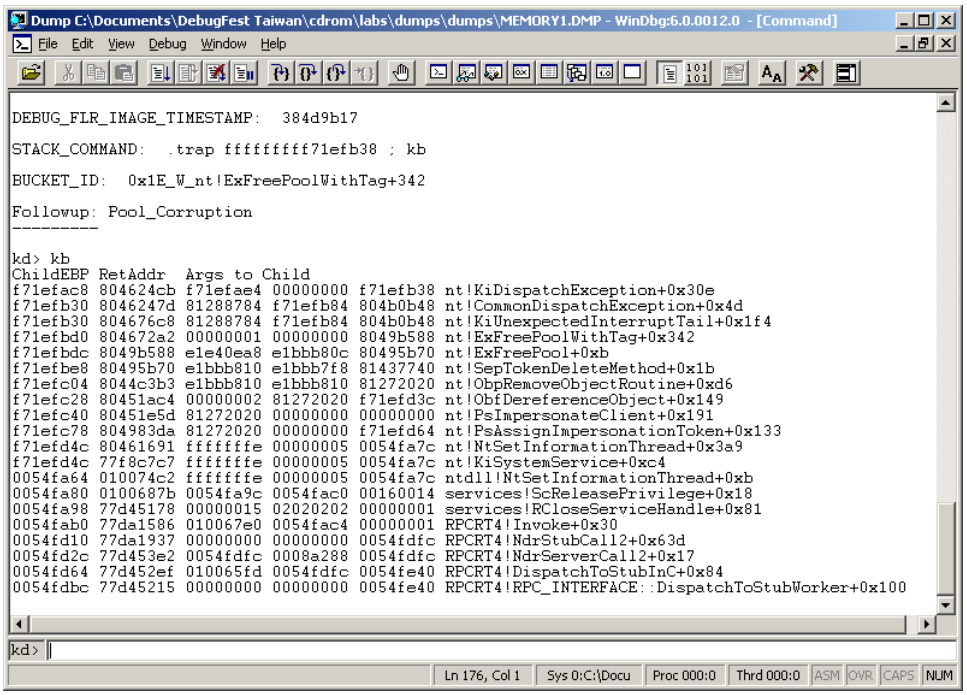
2. The first thing we need to look at when looking at a memory dump file is the crash dump analysis performed by Windbg itself. Type "**!analyze -v** <enter>" to see the interpretation made by the debugger:

```
kd> !analyze -v
*******************************************************************************
*                                                                             *
*                        Bugcheck Analysis                                    *
*                                                                             *
*******************************************************************************

KMODE_EXCEPTION_NOT_HANDLED (1e)
This is a very common bugcheck.  Usually the exception address pinpoints
the driver/function that caused the problem.  Always note this address
as well as the link date of the driver/image that contains this address.
Some common problems are exception code 0x80000003.  This means a hard
coded breakpoint or assertion was hit, but this system was booted
/NODEBUG.  This is not supposed to happen as developers should never have
hardcoded breakpoints in retail code, but ...
If this happens, make sure a debugger gets connected, and the
system is booted /DEBUG.  This will let us see why this breakpoint is
happening.
An exception code of 0x80000002 (STATUS_DATATYPE_MISALIGNMENT) indicates
that an unaligned data reference was encountered.  The trap frame will
supply additional information.
Arguments:
Arg1: c0000005, The exception code that was not handled
Arg2: 804676c8, The address that the exception occurred at
Arg3: 00000001, Parameter 0 of the exception
Arg4: 00000000, Parameter 1 of the exception
```

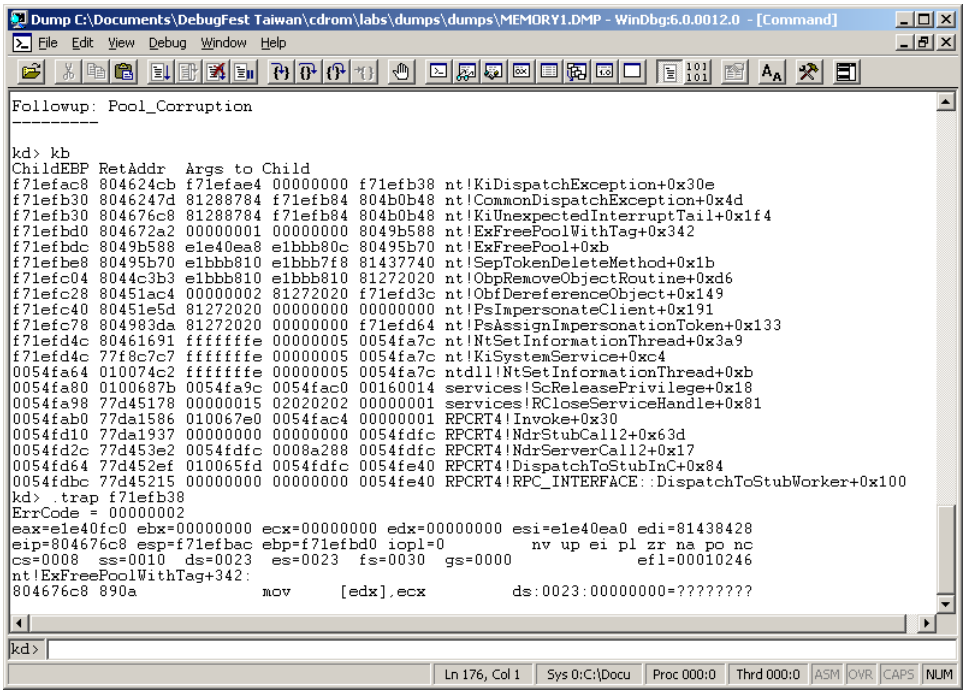
```
Debugging Details:
------------------


EXCEPTION_CODE:  c0000005

FAULTING_IP:
nt!ExFreePoolWithTag+342
804676c8 890a            mov     [edx],ecx

EXCEPTION_PARAMETER1:  00000001

EXCEPTION_PARAMETER2:  00000000

WRITE_ADDRESS:  00000000

DEFAULT_BUCKET_ID:  DRIVER_FAULT

BUGCHECK_STR:  0x1E_W

TRAP_FRAME:  f71efb38 -- (.trap fffffffff71efb38)
ErrCode = 00000002
eax=e1e40fc0 ebx=00000000 ecx=00000000 edx=00000000 esi=e1e40ea0 edi=81438428
eip=804676c8 esp=f71efbac ebp=f71efbd0 iopl=0         nv up ei pl zr na po nc
cs=0008  ss=0010  ds=0023  es=0023  fs=0030  gs=0000             efl=00010246
nt!ExFreePoolWithTag+342:
804676c8 890a            mov     [edx],ecx         ds:0023:00000000=????????
Resetting default context

LAST_CONTROL_TRANSFER:  from 804672a2 to 804676c8

STACK_TEXT:
f71efbd0 804672a2 00000001 00000000 8049b588 nt!ExFreePoolWithTag+0x342
f71efbdc 8049b588 e1e40ea8 e1bbb80c 80495b70 nt!ExFreePool+0xb
f71efbe8 80495b70 e1bbb810 e1bbb7f8 81437740 nt!SepTokenDeleteMethod+0x1b
f71efc04 8044c3b3 e1bbb810 e1bbb810 81272020 nt!ObpRemoveObjectRoutine+0xd6
f71efc28 80451ac4 00000002 81272020 f71efd3c nt!ObfDereferenceObject+0x149
f71efc40 80451e5d 81272020 00000000 00000000 nt!PsImpersonateClient+0x191
f71efc78 804983da 81272020 00000000 f71efd64 nt!PsAssignImpersonationToken+0x133
f71efd4c 80461691 fffffffe 00000005 0054fa7c nt!NtSetInformationThread+0x3a9
f71efd4c 77f8c7c7 fffffffe 00000005 0054fa7c nt!KiSystemService+0xc4
0054fa64 010074c2 fffffffe 00000005 0054fa7c ntdll!NtSetInformationThread+0xb
0054fa80 0100687b 0054fa9c 0054fac0 00160014 services!ScReleasePrivilege+0x18
0054fa98 77d45178 00000015 02020202 00000001 services!RCloseServiceHandle+0x81
0054fab0 77da1586 010067e0 0054fac4 00000001 RPCRT4!Invoke+0x30
0054fd10 77da1937 00000000 00000000 0054fdfc RPCRT4!NdrStubCall2+0x63d
0054fd2c 77d453e2 0054fdfc 0008a288 0054fdfc RPCRT4!NdrServerCall2+0x17
0054fd64 77d452ef 010065fd 0054fdfc 0054fe40 RPCRT4!DispatchToStubInC+0x84
0054fdbc 77d45215 00000000 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStubWorker+0x100
0054fddc 77d4fa80 0054fdfc 00000000 0054fe40 RPCRT4!RPC_INTERFACE::DispatchToStub+0x5e
0054fe44 77d4f9d7 00000000 000fc328 001112f0 RPCRT4!OSF_SCALL::DispatchHelper+0xa4
0054fe58 77d4f779 00000000 00000000 00000001 RPCRT4!OSF_SCALL::DispatchRPCCall+0x115
0054fe90 77d4f4d8 000fc310 00000003 00000000 RPCRT4!OSF_SCALL::ProcessReceivedPDU+0x43
0054feb0 77d4f0bc 000fc310 0000002c 00015f90 RPCRT4!OSF_SCALL::BeginRpcCall+0xd0
0054ff10 77d4f033 00000000 000fc310 0000002c
PCRT4!OSF_SCONNECTION::ProcessReceiveComplete+0x235
0054ff20 77d5bb62 00088860 0000000c 00000000 RPCRT4!ProcessConnectionServerReceivedEvent+0x1b
0054ff74 77d5ba15 77d4b7bf 00088860 00070178 RPCRT4!LOADABLE_TRANSPORT::ProcessIOEvents+0x9d
0054ff78 77d4b7bf 00088860 00070178 00070640 RPCRT4!ProcessIOEventsWrapper+0x9
0054ffa8 77d4b771 0008b120 0054ffec 77e92ca8 RPCRT4!BaseCachedThreadRoutine+0x4f
0054ffb4 77e92ca8 0008d2c0 00070178 00070640 RPCRT4!ThreadStartRoutine+0x18
0054ffec 00000000 77d4b759 0008d2c0 00000000 KERNEL32!BaseThreadStart+0x52


FOLLOWUP_IP:
nt!ExFreePoolWithTag+342
804676c8 890a            mov     [edx],ecx

FOLLOWUP_NAME:  Pool_Corruption

SYMBOL_NAME:  nt!ExFreePoolWithTag+342

MODULE_NAME:  nt
```

```
IMAGE_NAME:  ntoskrnl.exe

DEBUG_FLR_IMAGE_TIMESTAMP:  384d9b17

STACK_COMMAND:  .trap ffffffff71efb38 ; kb

BUCKET_ID:  0x1E_W_nt!ExFreePoolWithTag+342

Followup: Pool_Corruption
---------
```

3. This bug check is "Stop 0x1E" (Unhandled Exception). This tells us the system encountered and exception and none of the exceptions handlers handled it. So it gets passed on up to the debugger if one is available if not like in this case it crashes the system with a Stop 0x1E.
4. Next let's take a look at the stack trace. Type "**kb** <enter>".

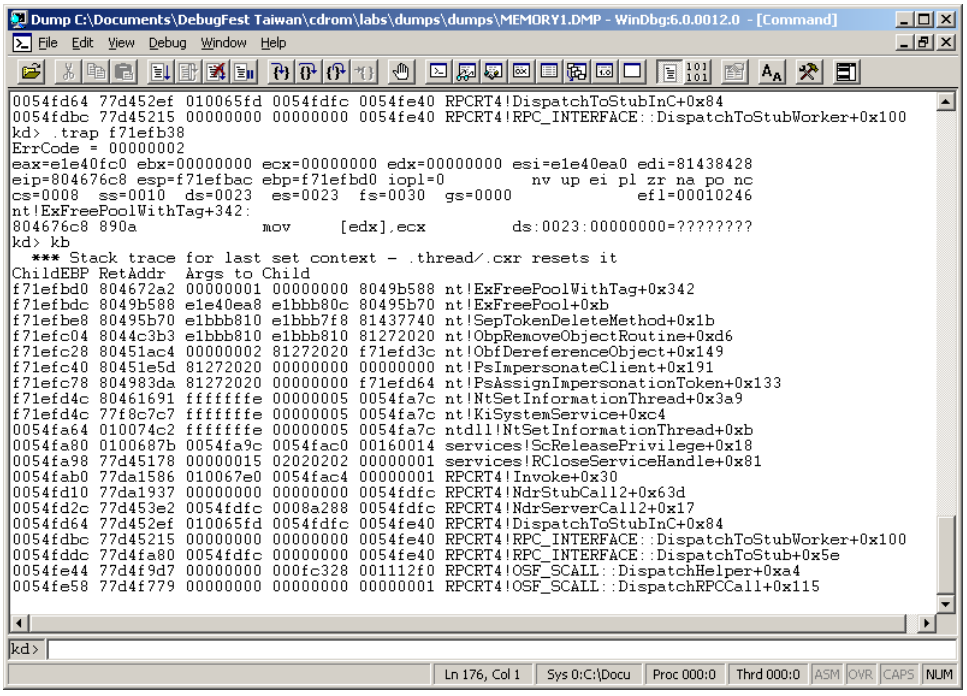


5. Next we need to find the trap frame. The trap frame will actually show us the state of the CPU when the exception occurred. The current system context is the exception handling code. To do this we type "**.trap <***address***>** <enter>", where **<***address***>** is the address of the trap frame. From the debugger documentation's description of bugcheck 0x1E, we know that the third parameter of KiDispatchException is the trap frame. The third parameter passed to KiDispatchException in the above stack trace is 0xF71EFB38, so that is the address we will supply to the **.trap** command:



6. The screen shot above shows us the result of supplying the trap frame address to the debugger. The values represent the registers and the last instruction processed at the point the exception occurred. We can see that we are trying to move the contents of ecx to the memory location referenced in edx. We can also see that value of edx is 0x00000000 or NULL, which is invalid. This caused the exception. So we need to determine how edx became zero!

7. Type "**kb** <enter>" to take a look at the stack trace. Notice that the same **kb** command now displays the stack trace in the context of the trap frame, because we have issued the **.trap** <*address*> command. (If you want to return back to the previous context, just issue a **.thread** command.)



8. Note that WinDbg's **!analyze –v** command actually performed much of this analysis. The command finds the trap frame address, issued the **.trap** command, and displayed the registers, faulting instruction, and stack with that **.trap** command in effect. It also told us how to recall that context at any time:

```
STACK_COMMAND:  .trap ffffffff71efb38 ; kb
```

9. We can see in this case we are trying to free some memory, as we are in a routine called ExFreePoolWithTag. We might infer from the arguments to this routine that the address we are trying to free is 0x00000001, which would be invalid.
10. We can also see that this routine was in turn called from ExFreePool, and the first argument (the address of pool to be freed) was valid in that routine. So it appears that we either lost the correct value during a context switch or someone else wrote over some of our memory.
11. Examine this crash dump in more detail, and try to answer the following questions:
    a. Is the preceding analysis correct?
    b. What debugger commands have we seen that are associated with the memory pools?
    c. What do those commands tell you about the address passed as the first argument to ExFreePool?
    d. What is the code in ExFreePoolWithTag doing that caused it to try to reference address 0?
12. Load up the additional *memory.dmp* files and see if you can isolate the point of failure.

    Hint: Start out by using **!analyze -v** . Refer to the debugger help file for information on each particular stop message and parameters. Use the DDK (Driver Developer's Kit) documentation to aid in the understanding of many of the system routines you find on the stack.

Module 10 Labs: Kernel Debugging II

Lab Objectives

Lab 10 – Kernel Debugging II

Exercise 1 – Using Some Basic Debugger Commands in Kernel Mode
Exercise 2 – Live Debugging Using "Buggy.sys"
Exercise 3 – Finding a Resource Deadlock
Exercise 4 – Using PoolMon to find a Kernel-Mode Memory Leak
Exercise 5 – Remote Debugging with WinDbg

Estimated Time to Complete this Lab: 90 minutes

Exercise 1: Using Some Basic Debugger Commands in Kernel Mode

In this exercise we will experiment with some of the more advanced debugger commands we've learned in a live kernel debugging scenario.

1. Ensure that your target system was booted with debugging enabled.

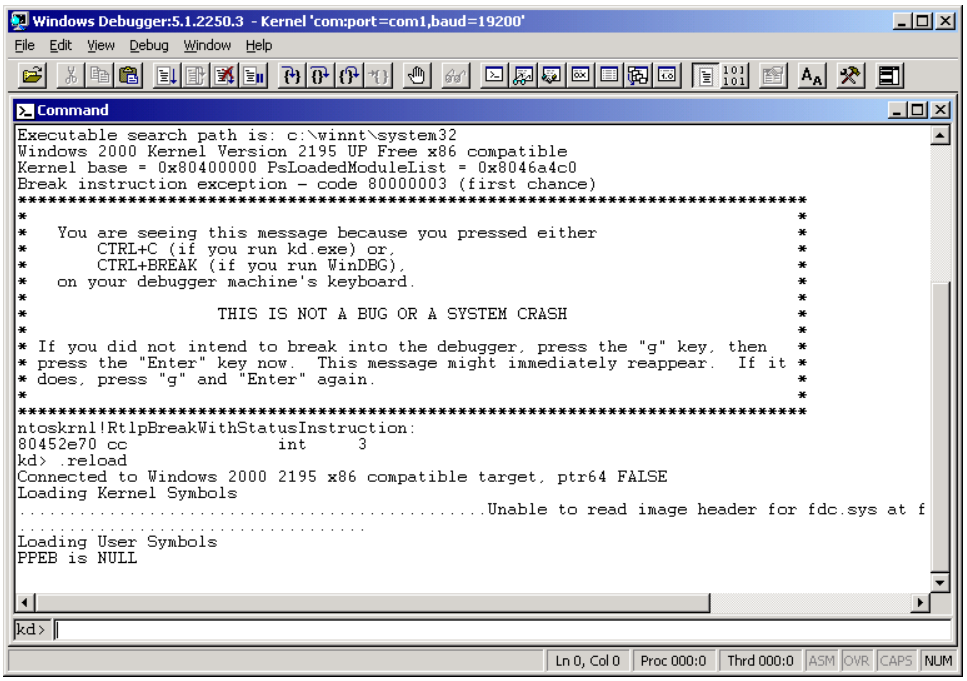
2. Select **Start | Programs | Microsoft Debugging Tools** | **WinDbg**.

3. Select **File | Kernel Debugging**.

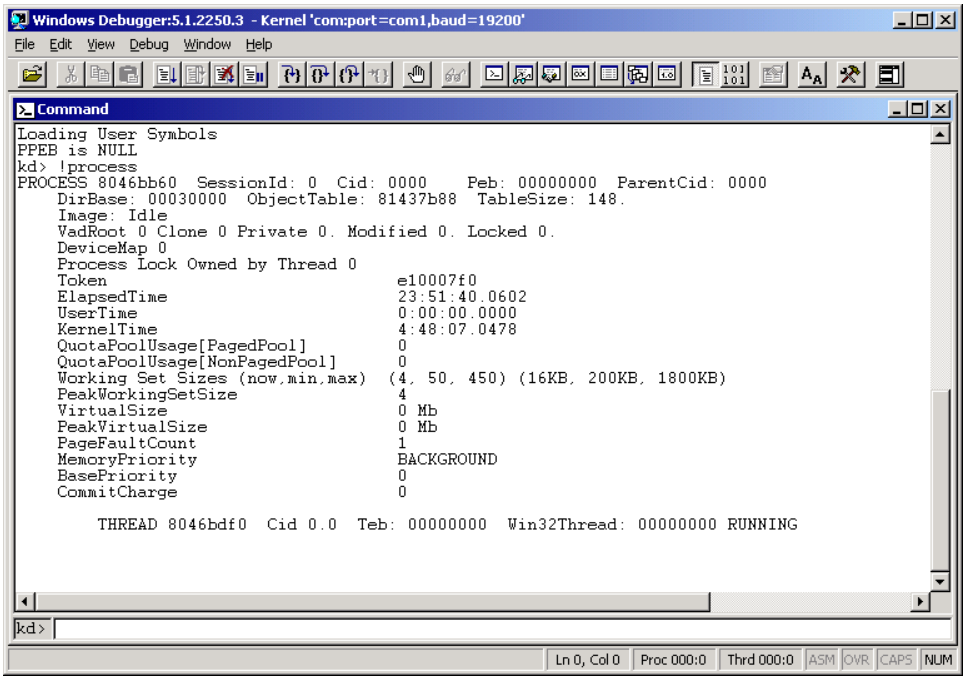
4. Enter *19200* for the baud rate and *COM1* for the port.

5. Press CTRL+Break to break into the target.

6. Type "**.reload** <enter>" to reload the symbols.



7. Now let's take a look around. Type *"**!process**"* to view the active process at the time we broke in:

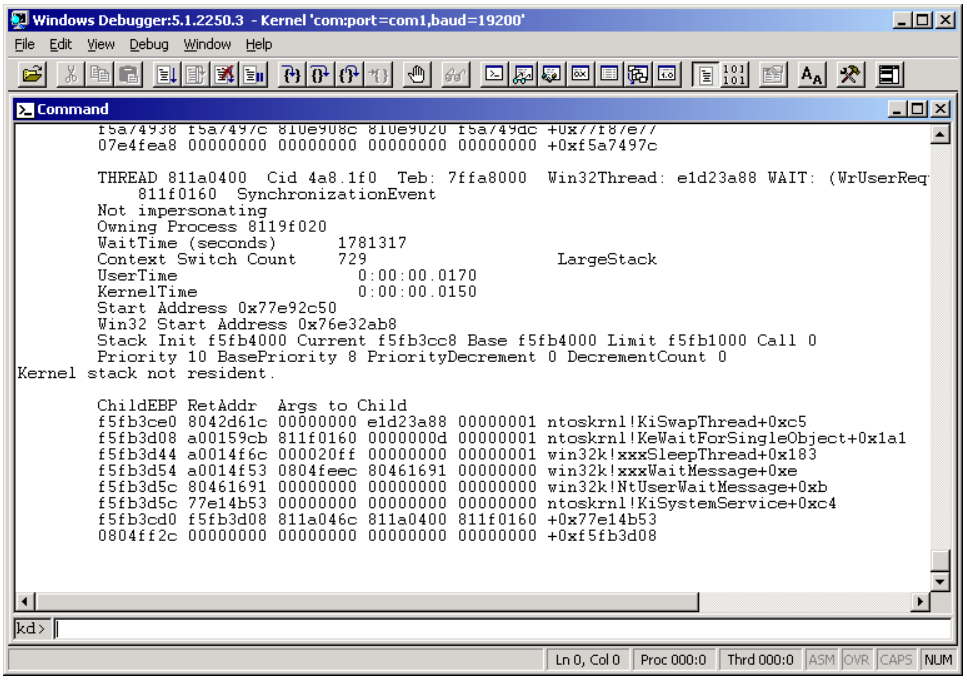


Note: The Idle Process is running on the computer used in these screenshots. Your experience may be different.

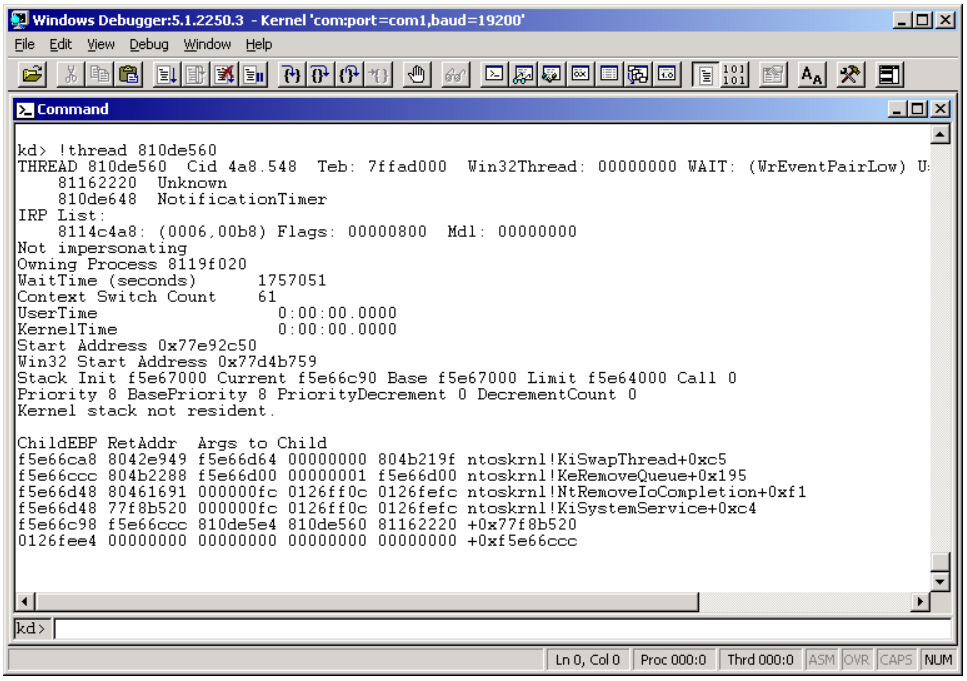
8. Now type "**!process 0 0**". This will give you a list of all of the processes on the system.

9. Find the Client ID ("CID") for the explorer process on your target computer.

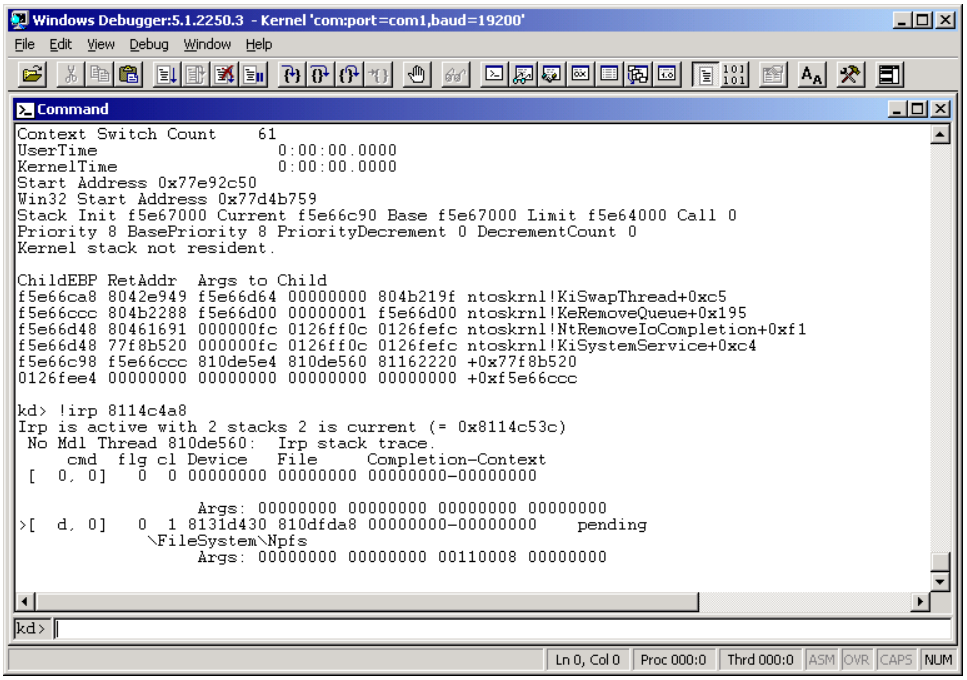
10. Now type "**!process <***CID***> 7** <enter>". This will dump out the EPROCESS structure for the explorer process along with all of the linked ETHREAD structures.



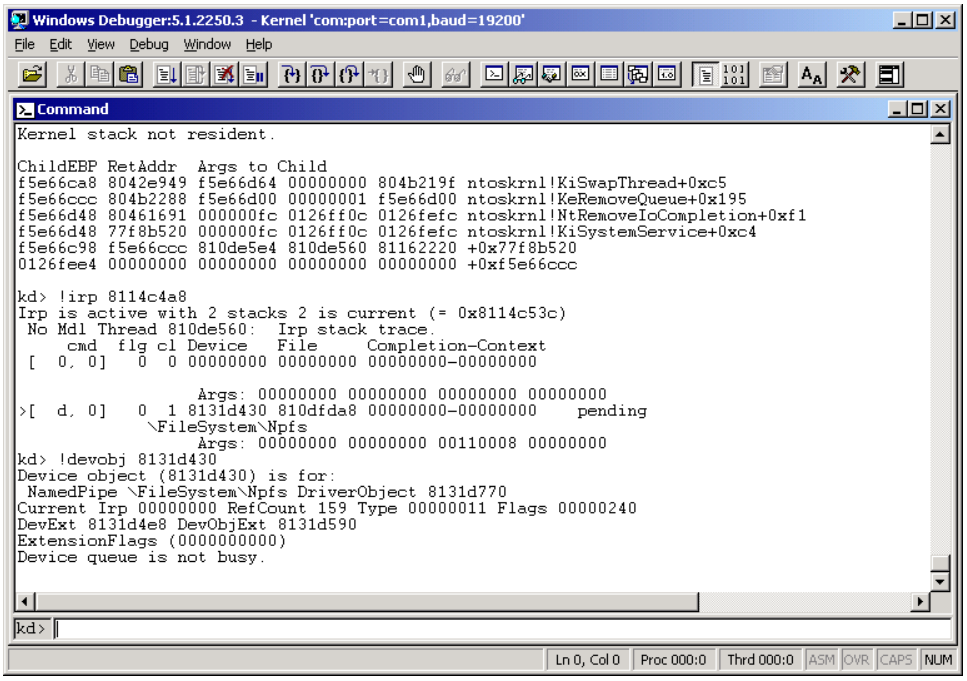
11. Find a thread with an IRP List. Dump out that thread by typing "**!thread <***address***>** <enter>".



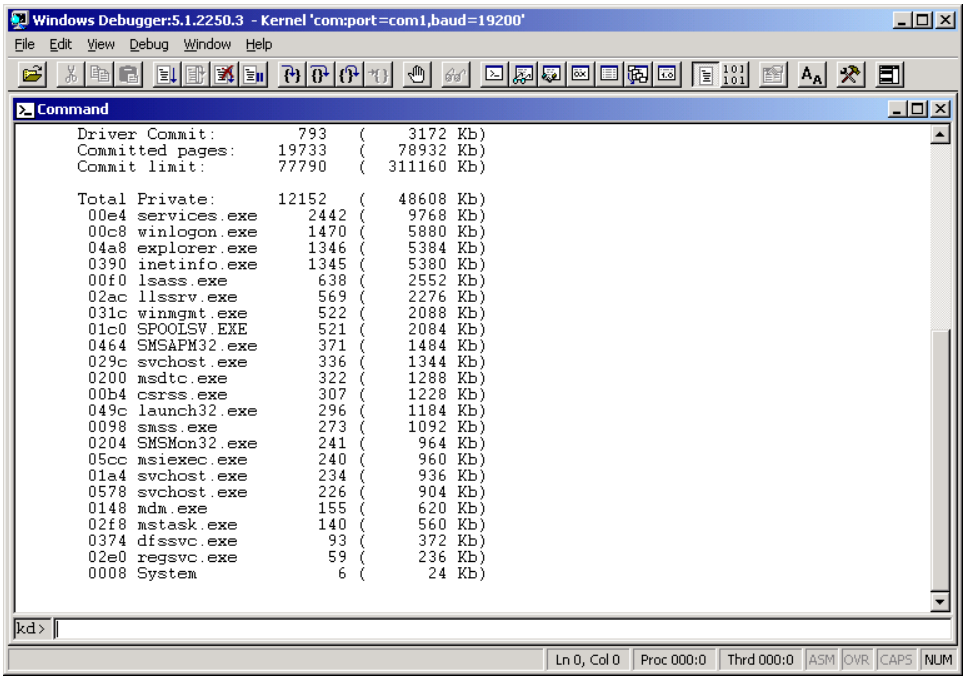
12. Next let's take a look at the IRP (I/O Request Packet). Type "**!irp <***address***>** <enter>."



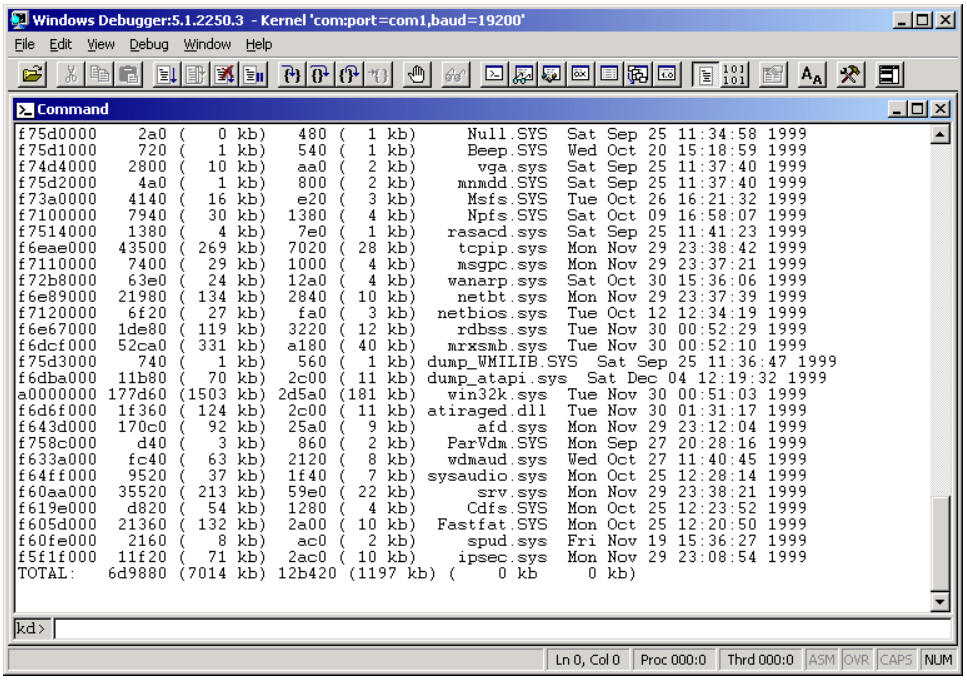
13. Next, we will look at the device objects associated with this IRP. Type "**!devobj <***address***>** <enter>" to look at the device object.



14. Type "**!vm** <enter>" to take a look at the virtual memory usage.



15. Type "**!drivers** <enter>" to get a list of loaded drivers.

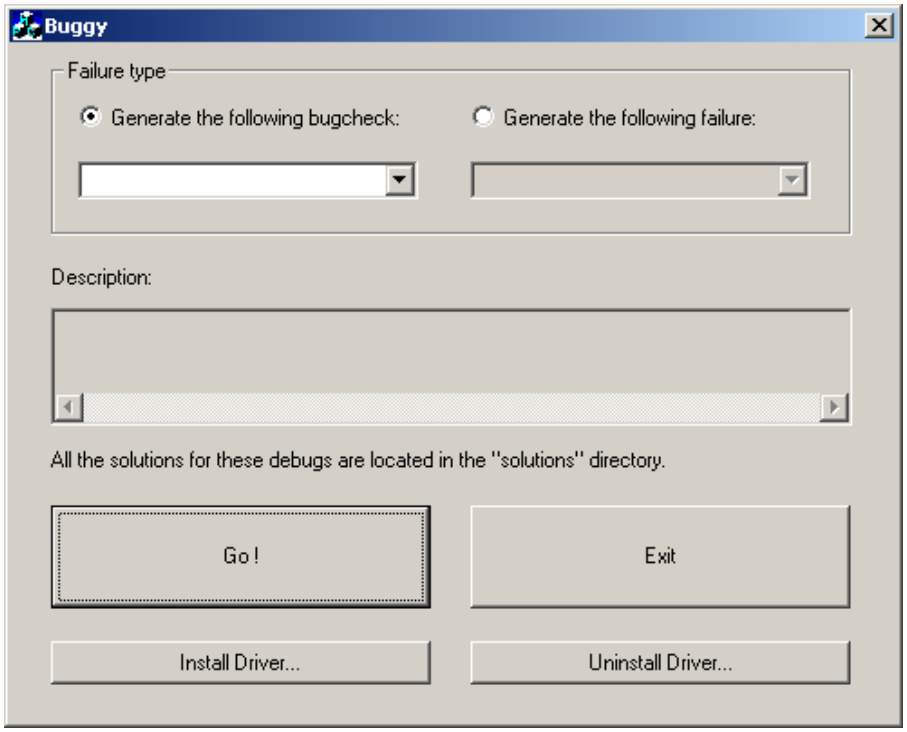

Windows Debugger:5.1.2250.3 - Kernel 'com:port=com1,baud=19200'
File Edit View Debug Window Help
Command
f75d0000 2a0 (0 kb) 480 (1 kb) Null.SYS Sat Sep 25 11:34:58 1999
f75d1000 720 (1 kb) 540 (1 kb) Beep.SYS Wed Oct 20 15:18:59 1999
f74d4000 2800 (10 kb) aa0 (2 kb) vga.sys Sat Sep 25 11:37:40 1999
f75d2000 4a0 (1 kb) 800 (2 kb) mnmdd.SYS Sat Sep 25 11:37:40 1999
f73a0000 4140 (16 kb) e20 (3 kb) Msfs.SYS Tue Oct 26 16:21:32 1999
f7100000 7940 (30 kb) 1380 (4 kb) Npfs.SYS Sat Oct 09 16:58:07 1999
f7514000 1380 (4 kb) 7e0 (1 kb) rasacd.sys Sat Sep 25 11:41:23 1999
f6eae000 43500 (269 kb) 7020 (28 kb) tcpip.sys Mon Nov 29 23:38:42 1999
f7110000 7400 (29 kb) 1000 (4 kb) msgpc.sys Mon Nov 29 23:37:21 1999
f72b8000 63e0 (24 kb) 12a0 (4 kb) wanarp.sys Sat Oct 30 15:36:06 1999
f6e89000 21980 (134 kb) 2840 (10 kb) netbt.sys Mon Nov 29 23:37:39 1999
f7120000 6f20 (27 kb) fa0 (3 kb) netbios.sys Tue Oct 12 12:34:19 1999
f6e67000 1de80 (119 kb) 3220 (12 kb) rdbss.sys Tue Nov 30 00:52:29 1999
f6dcf000 52ca0 (331 kb) a180 (40 kb) mrxsmb.sys Tue Nov 30 00:52:10 1999
f75d3000 740 (1 kb) 560 (1 kb) dump_WMILIB.SYS Sat Sep 25 11:36:47 1999
f6dba000 11b80 (70 kb) 2c00 (11 kb) dump_atapi.sys Sat Dec 04 12:19:32 1999
a0000000 177d60 (1503 kb) 2d5a0 (181 kb) win32k.sys Tue Nov 30 00:51:03 1999
f6d6f000 1f360 (124 kb) 2c00 (11 kb) atiraged.dll Tue Nov 30 01:31:17 1999
f643d000 170c0 (92 kb) 25a0 (9 kb) afd.sys Mon Nov 29 23:12:04 1999
f758c000 d40 (3 kb) 860 (2 kb) ParVdm.SYS Mon Sep 27 20:28:16 1999
f633a000 fc40 (63 kb) 2120 (8 kb) wdmaud.sys Wed Oct 27 11:40:45 1999
f64ff000 9520 (37 kb) 1f40 (7 kb) sysaudio.sys Mon Oct 25 12:28:14 1999
f60aa000 35520 (213 kb) 59e0 (22 kb) srv.sys Mon Nov 29 23:38:21 1999
f619e000 d820 (54 kb) 1280 (4 kb) Cdfs.SYS Mon Oct 25 12:23:52 1999
f605d000 21360 (132 kb) 2a00 (10 kb) Fastfat.SYS Mon Oct 25 12:20:50 1999
f60fe000 2160 (8 kb) ac0 (2 kb) spud.sys Fri Nov 19 15:36:27 1999
f5f1f000 11f20 (71 kb) 2ac0 (10 kb) ipsec.sys Mon Nov 29 23:08:54 1999
TOTAL: 6d9880 (7014 kb) 12b420 (1197 kb) (0 kb 0 kb)
kd>
Ln 0, Col 0
Proc 000:0
Thrd 000:0
ASM
OVR
CAPS
NUM

Exercise 2: Live Debugging using “Buggy.Sys”

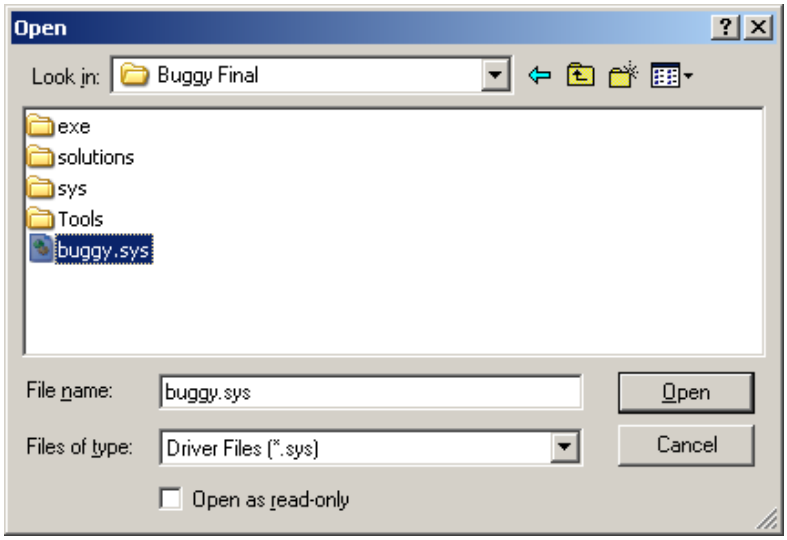
Part 1: Installing the Buggy application

In this section, you will install the buggy application and driver.
This way, you will be able to generate various bugchecks and failures and debug them lively using WinDbg.

1. Locate **Buggy.exe** on the CD in **labs\Buggy** and launch this application.



2. Click on the “**Install Driver…**” button.



3. Select **buggy.sys** and click **Open**.

Part 2: Using the Buggy application

The application offers the possibility to generate various bugchecks and failures.

You can select the Failure type using the radio buttons. The choices are:

- **"Generate the following bugcheck:"**
  Selecting this option allows you to choose a stop screen you want to generate. You can generate blue screens associated with the following codes: 0x0A, 0x4E, 0x7E, 0x35, 0x50, 0xD1.
- **"Generate the following failure:"**
  Selecting this option allows you to generate the following problems: Deadlocks, Pool corruptions, Pool leaks, CPU used at 100%.

Once the bugcheck or failure has been select, pressing the **"Go !"** button will generate the problem. So, take note that your system will become unusable once this button has been pressed!

Part 3: Choosing which problem you want to debug

The problems that are generated by Buggy are very different and require more or less skills to debug. The solution for all the cases are on the CD in the **labs\buggy\solutions** directory. Please try to debug the problems using the knowledge you have gained during this training and have a look at the solution later.

Here is a table summarizing the problems generated by the application and the driver. A difficulty level is associated with each of them:

Bugcheck code	Description	Difficulty
0x0A	IRQL_NOT_LESS_OR_EQUAL	★
0x4E	PFN_LIST_CORRUPT	★★
0x7E	SYSTEM_THREAD_EXCEPTION_NOT_HANDLED	★★★
0x35	NO_MORE_IRP_STACK_LOCATIONS	★
0x50	PAGE_FAULT_IN_NONPAGED_AREA	★★
0xD1	DRIVER_IRQL_NOT_LESS_OR_EQUAL	★

Failure type	Description	Difficulty
Paged Pool Corruption	Memory corruption in the paged pool.	★
Non Paged Pool Corruption	Memory corruption in the non paged pool.	★
Paged Pool Leak	Memory leak coming from paged pool	★★
Non Paged Pool Leak	Memory leak coming from non paged pool.	★★
Deadlock	Deadlock with dispatcher synchronization objects	★★★★

Deadlock 2	Deadlock involving other synchronization objects	★★★
100% CPU	CPU fully used by a thread	★★

★	Easy
★★	Medium
★★★	Difficult
★★★★	Very difficult

Please first choose a problem with a difficulty level associated with your confidence and experience level.

You might begin with an easy problem first.

Step 4 – Debugging the problem

Once you have chosen the problem you want to troubleshoot, setup the kernel debugger as you have learned in the previous labs.

You will need the symbols file for buggy.sys and you might use the sources of this driver as well.

The symbol file Buggy.pdb is located in **Labs\Buggy** on your CD.

The sources of the driver are located in **Labs\Buggy\sys** and the sources of the application are located in **Labs\Buggy\exe**.

Once the debugger is attached and setup, you can go ahead and generate the problem of your choice on the target computer. You can try debugging the problem in two different ways:

1. Have the debugger connected to the target system, and stimulate the problem. Instead of producing a blue screen and a crash dump, the system will break into the debugger. You will be able to use the debugger to examine the **Buggy** driver's code at the point of failure.
2. Examine the source code for **buggy.sys** and determine which driver routines are involved in the bugcheck or failure scenario you are exercising. Before using the **buggy** application to stimulate the problem, break into the target system with the debugger and set a breakpoint on one of those routines. When you stimulate the problem, the system should encounter the breakpoint and the debugger should get control. You can then use the debugger's **s (step), t (trace),** and other commands to examine the behavior of the code in detail.

Don't forget to use the WinDbg help file for this exercise – it contains valuable information!

Have some extra time?

If you have some extra time at the end of this lab period, try enabling Driver Verifier for the driver *buggy.sys*, and see if you can get Driver Verifier to catch either the "memory corruption in paged pool" or "memory corruption in nonpaged pool" problem with this driver!

Exercise 3: Finding a Resource Deadlock

In this exercise, you will use WinDbg to load a sample dump file named deadlock.dmp. The file is located in the c:\dumps directory. In this lab, use the debugger commands we have covered so far and try to located the resource deadlock.

Note: This file is build 2195sp1.

Loading the *deadlock.dmp* file with WinDbg

1. Select **Start | Program | Microsoft Debugging Tools | WinDbg**.
2. Select **File | Open Crash Dumps.**
3. Select **deadlock.dmp.**

Hint: Start with !locks. Determine which threads own which reesources. Then determine what they are waiting on...

Exercise 4: Using PoolMon to find a Kernel-Mode Memory Leak

In this exercise, you will use a utility called *memleak.exe*. You can find this tool in the Labs share in the directory memtools.

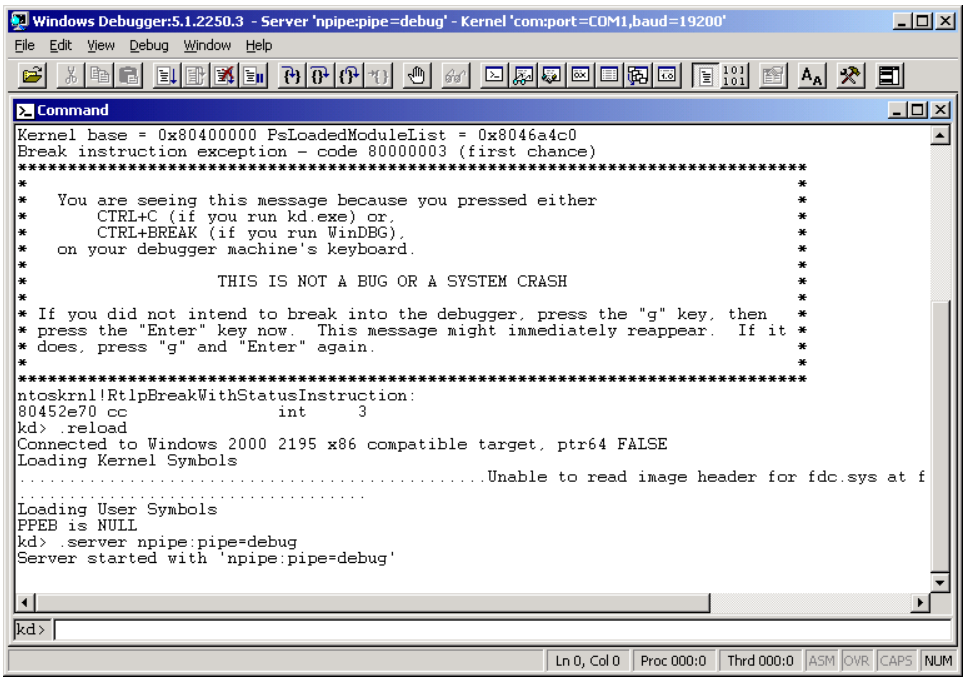
Like the previous lab, in this lab we will not be giving step by step instructions.

1. Expand the memleak tool to your local system by typing "**memleak_x86 -c**".
2. After expanding all of the files, run the executable image *memleak_x86.exe* to install the kernel mode portion of this utility. A reboot will be necessary.
3. Using *memleak.exe*, create a non-paged pool leak of size 1000 bytes. Read the *memleak.txt* file for the correct syntax (**memleak 1 1000**).
4. Start perfmon, and log non-paged pool bytes every 15 seconds.
5. Now continue to make more allocations and see if you can see them in perfmon.
6. Now run poolmon and see if you can determine what tag the driver is using.

Exercise 5: Remote Debugging with WinDbg

Starting a Remote Debugging Session With WinDbg

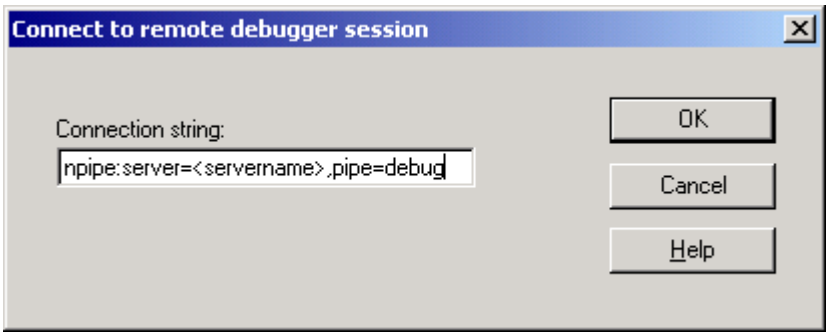
1. Click the **Start** | **Programs** | **Microsoft Debugging Tools** | **WinDbg**.
2. Select **File** | **Kernel Debug…** or press **Ctrl+K**
3. Enter *19200* for Baud Rate and *COM1* for Port.
4. Select OK, then select YES to save base workspace information.
5. Select **Debug** | **Break** or press Ctrl+Break
6. Type **.reload** and press <enter>.
7. Type **.server npipe:pipe=debug** and press <enter>.



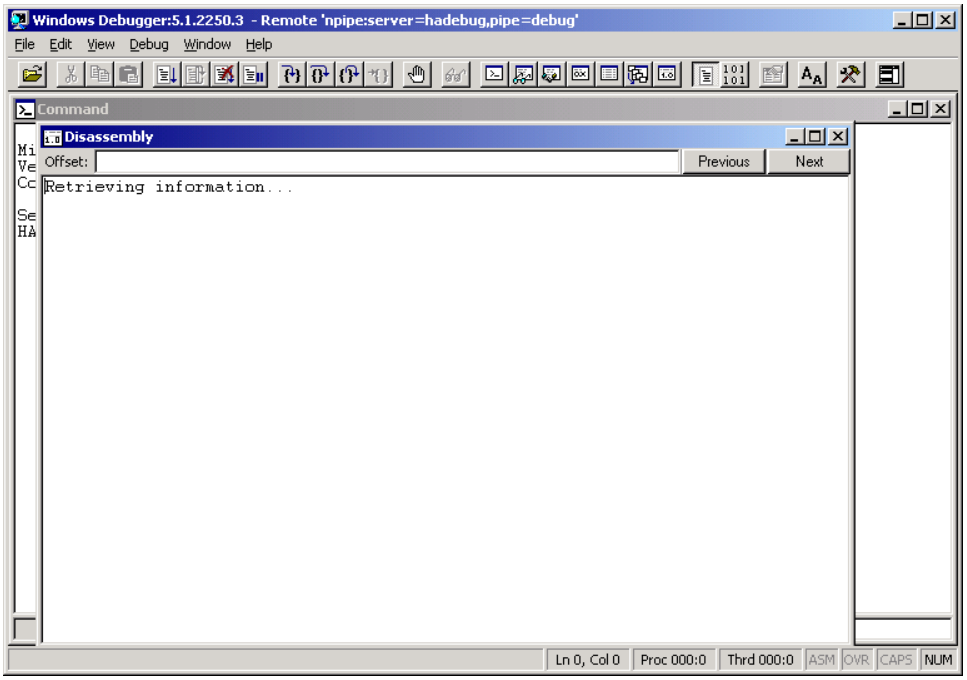
Connecting to a Remote Debugging Session With WinDbg

For this exercise, work with the group next to you and have them connect to your remote debug session while you connect to theirs from you host computers.

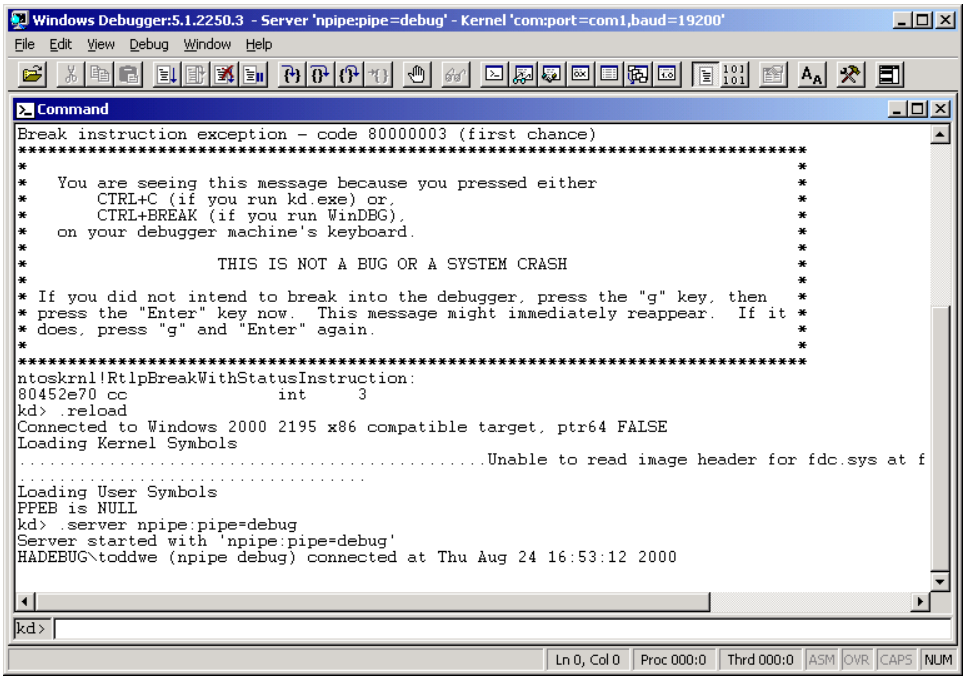
1. Click the **Start** | **Programs** | **Microsoft Debugging Tools** | **WinDbg**.
2. Select **File** | **Connect to Remote Sessions…** or press **Ctrl+R**.
3. Type "**npipe:server=**<*servername*>**, pipe=debug**" and select OK.



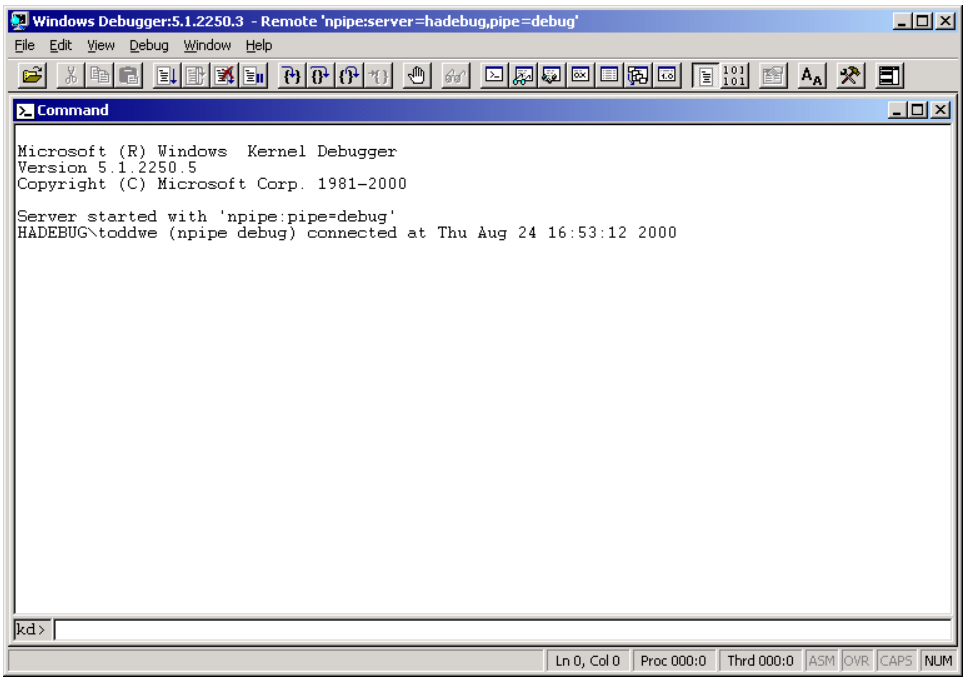
You should see something like this:



Once you are connected your WinDbg in Server mode will look like this:



Your WinDbg session running in Remote mode will look like this:



Module 11 Labs: User-Mode Debugging

Lab Objectives

Lab 11 – User-Mode Debugging

Exercise 1 – Attaching to Running Process

Exercise 2 – Using Some Basic Debugger Commands in User Mode

Exercise 3 – Analyzing a User-Mode Dump File

Exercise 4 – Using UMDH to Find a Memory Leak in an Application

Estimated Time to Complete this Lab: 60 minutes

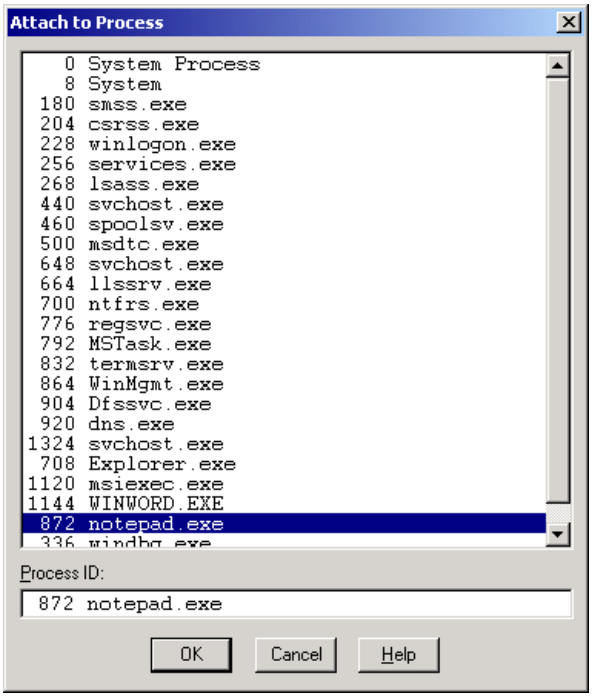
Exercise 1: Attaching to Running Process

Attach to a Running Process Using WinDbg

1. Select **Start | Run** and type “notepad” into the test box and select OK or press <enter>.

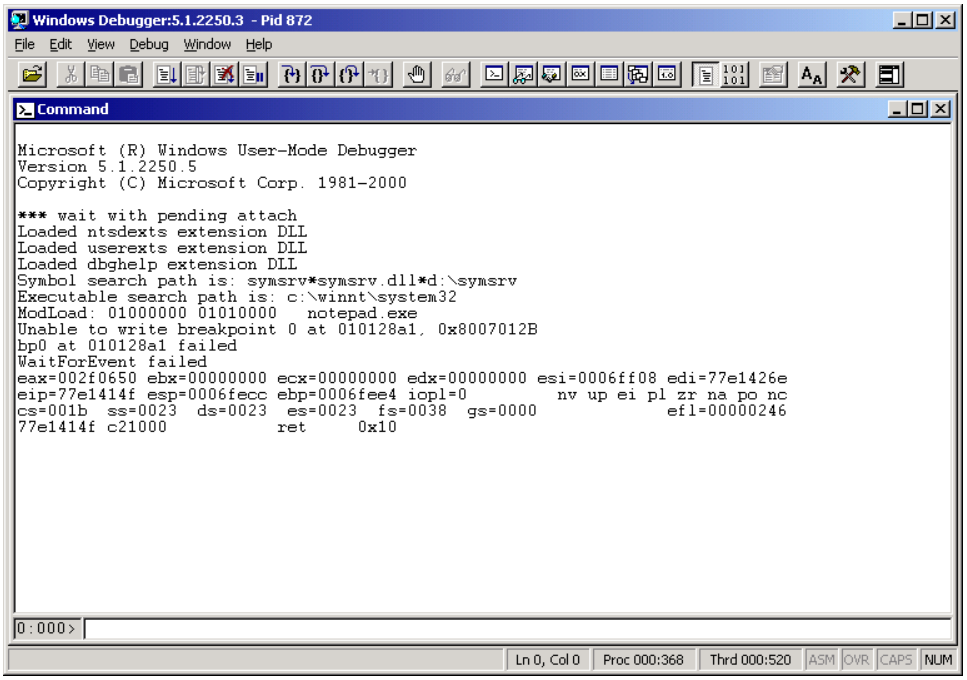
2. Select **Start | Programs | Microsoft Debugging Tools | WinDbg**.

3. Select **File | Attach to a process…**



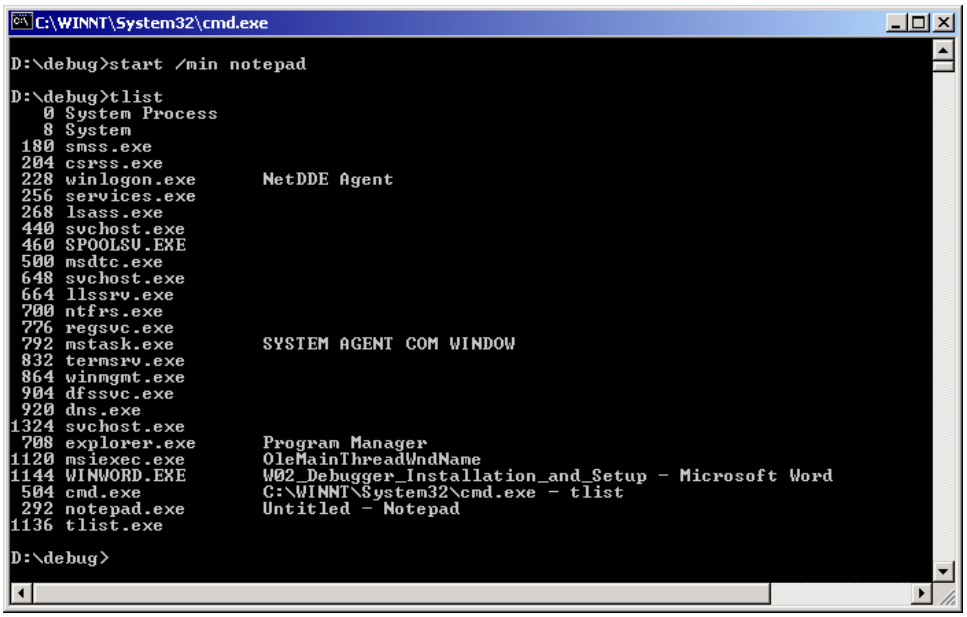
4. Scroll down and select notepad.exe from the list.

5. Select OK.

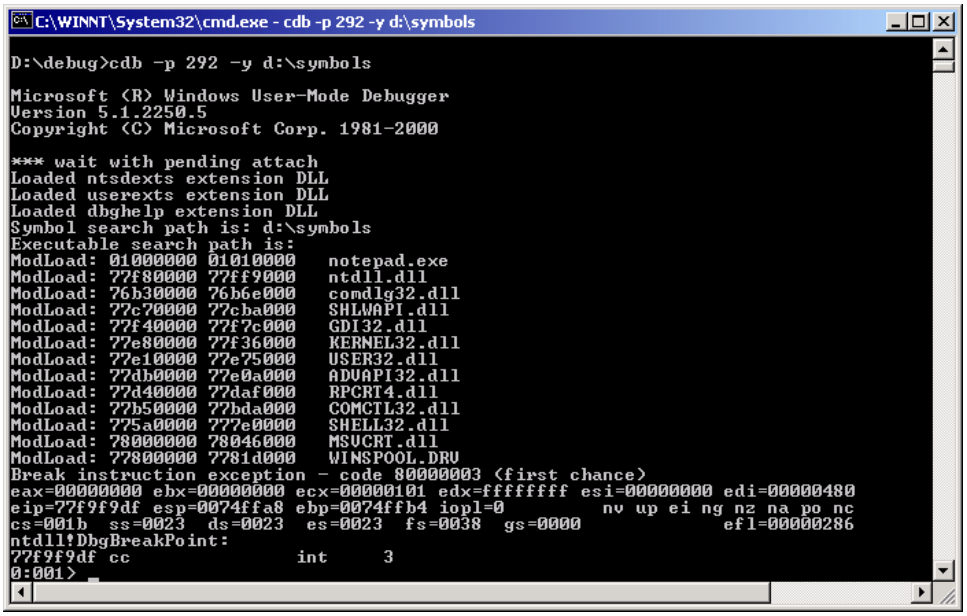


Attach to a Running Process Using CDB

1. Select **Start | Run** and type “cmd” into the test box and select OK or press <enter>.
2. Change into the “C:\Program Files\Debugging Tools for Windows” directory.
3. Type “**start /min notepad** <enter>”
4. Type “**tlist** <enter>”.



Type :“**cdb –p** <*PID*> **–y srv*c:\symbols\2195*http://msdl.microsoft.com/download/symbols**. <enter>”.



5. Type "**q** <Enter>" to quit.

Exercise 2: Using Some Basic Debugger Commands in User Mode

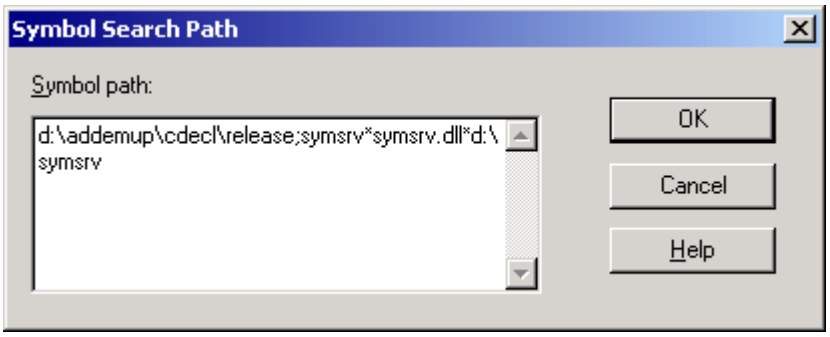
This lab assumes that you have completed the previous labs.

Note: Illustrations may differ from actual instructions.

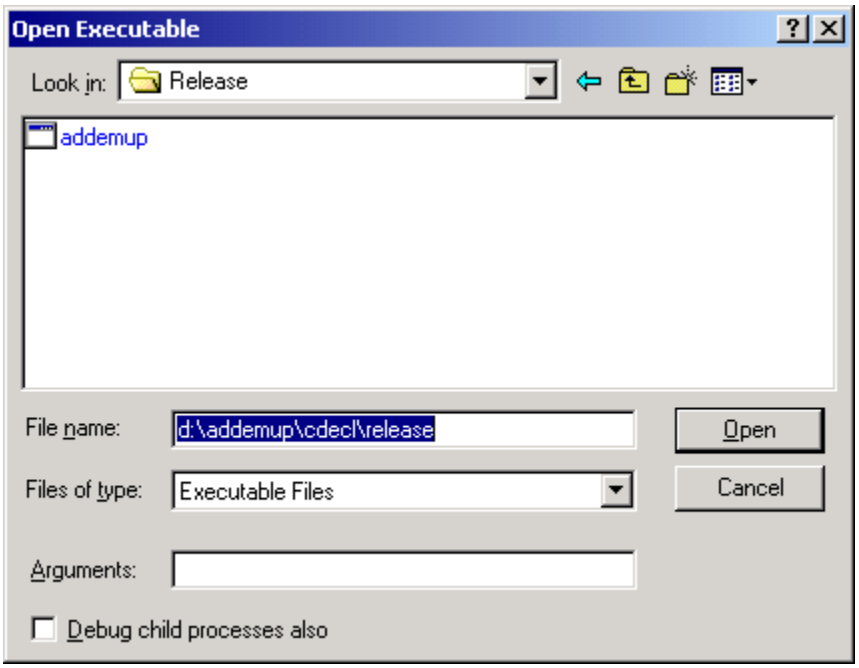
Debugging a Process Using WinDbg

1. Map a drive to the *Labs* share on your instructor's computer.
2. Copy the Addemup folder down to your local C: drive.

   Note: The Addemup folder is located on your class CD in the *\labs\files\addemup* directory.
3. Select **Start | Programs | Microsoft Debugging Tools | WinDbg**.
4. Select **File | Symbol File Path…**
5. Add "**C:\Addemup\cdecl\release;**" to the start of the symbol path and select OK.



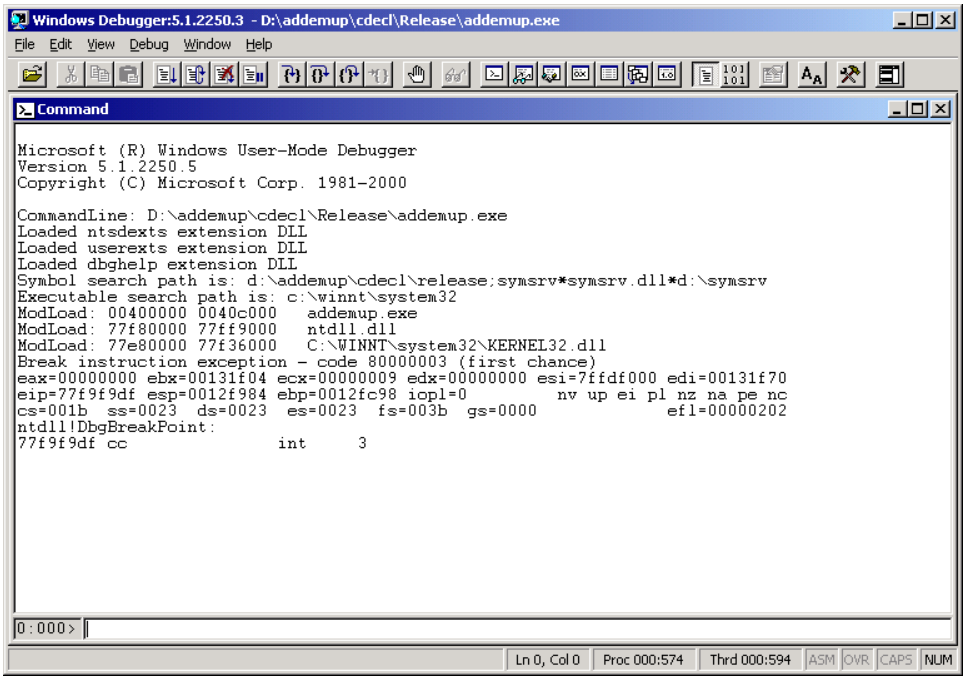
6. Select **File | Open Executable**.
7. Type *"c:\Addemup\cdecl\release <enter>."*



8. Select the application “Addemup” and then select Open.

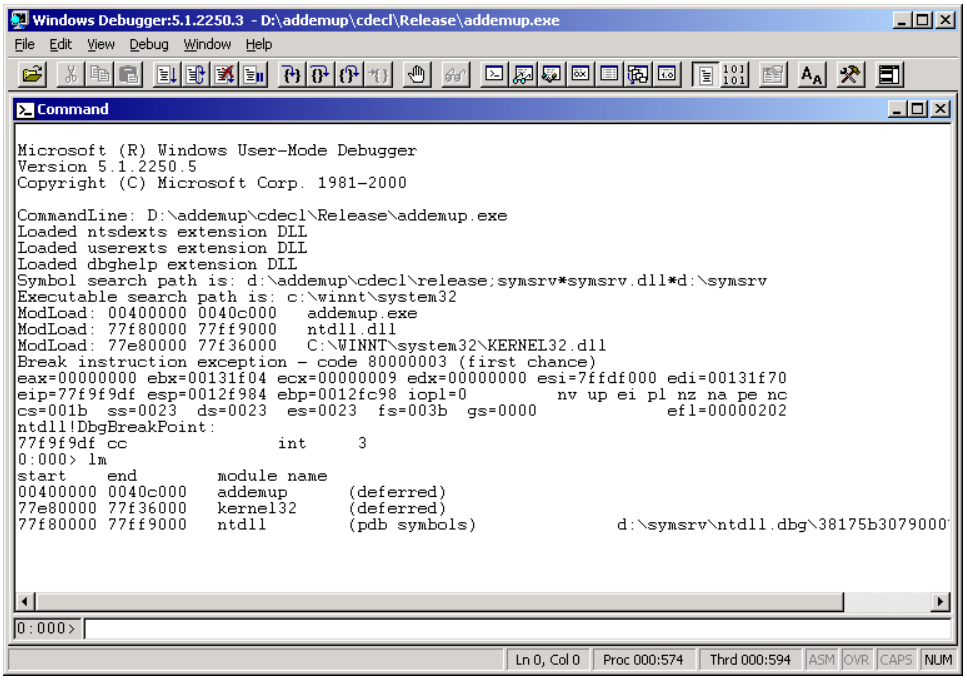
9. You will see the “Save base workspace” dialog box again. Select Yes to continue:

Now you should see some thing like this:

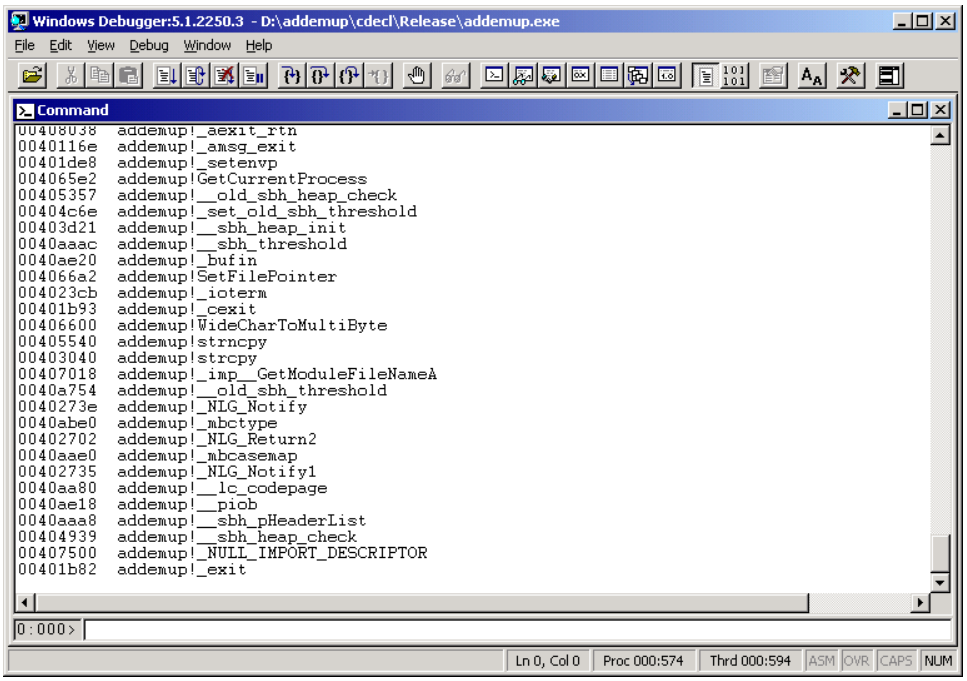


Note: After opening Addemup.exe, occasionally the default window of WinDbg switches to the Disassembly screen. If this occurs, click on the Window menu and select Command from the drop-down list.

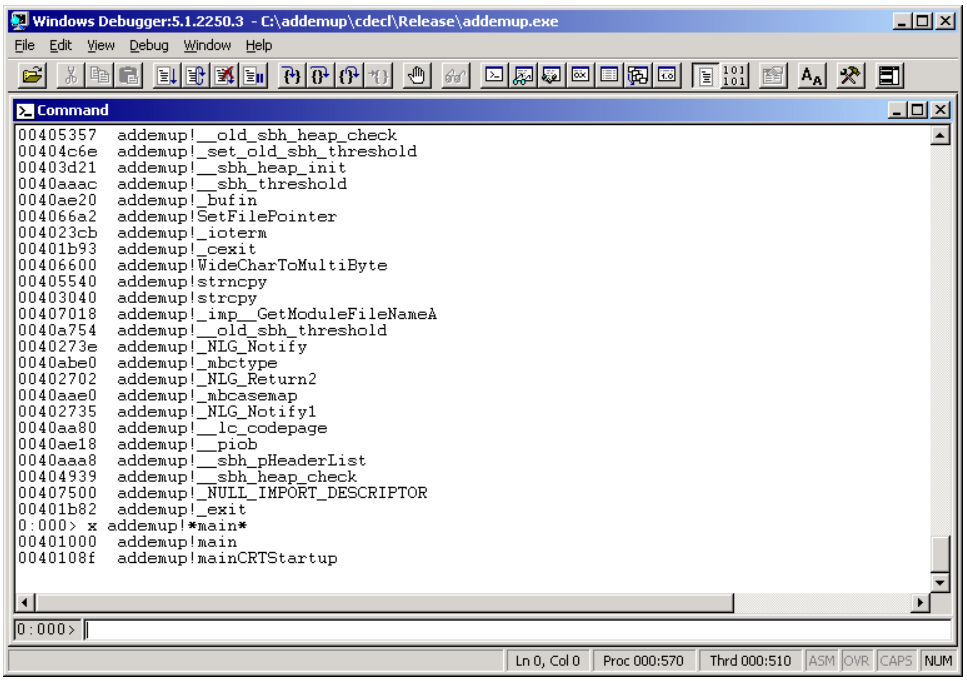
10. Enter “**LM** <enter>” into the command window to get a list of loaded modules.



11. Type "**x addemup!*** <enter>" to get a look at the functions within the addemup module.



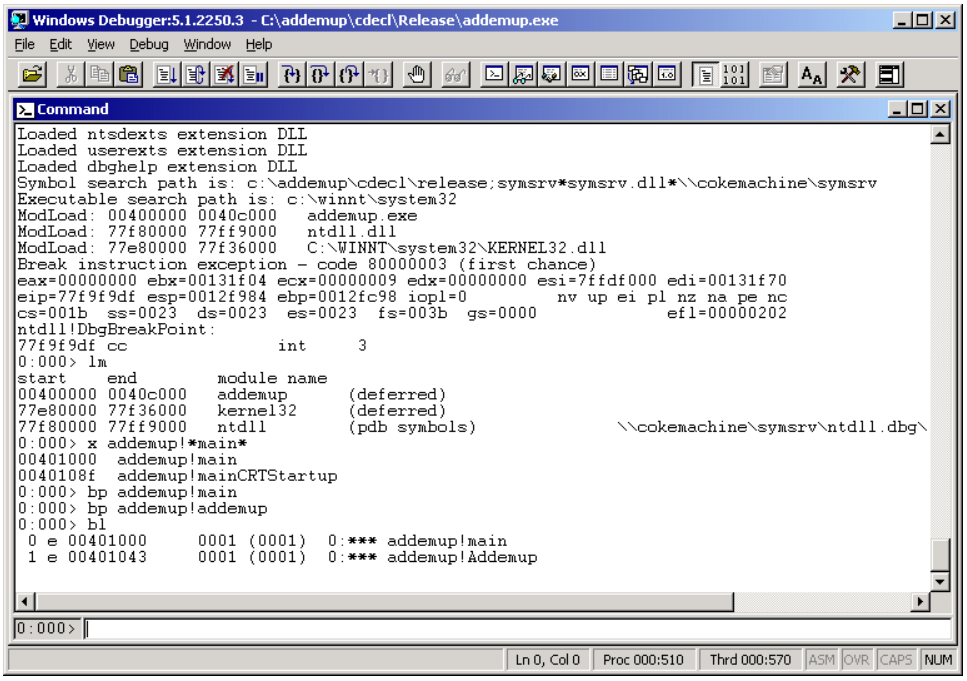
12. As you can see that can be a lot of information. This time let's search for the main() function within addemup. Type "**x addemup!*main*** <enter>."



13. Type "**BU addemup!main** <enter>" or "**BU 401000** <enter>". This sets a break point on the main() function.

14. Type "**BU addemup!addemup** <enter>." This sets a break point on the addemup() function within the process addemup.

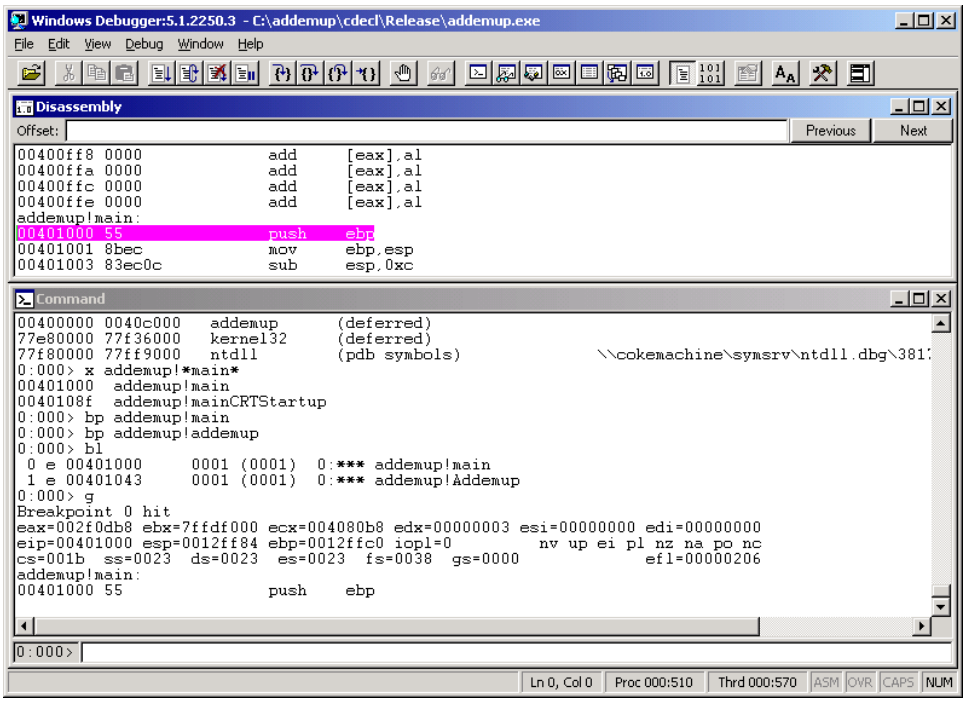
15. Type "**BL** <enter>" to see a list of breakpoints.



16. Type "**g** <enter>" to cause the process to run ("go").

17. When the first breakpoint is hit, the debugger will stop and display the disassembly window at that spot in the code.

18. Select **Windows | Arrange All Windows**.

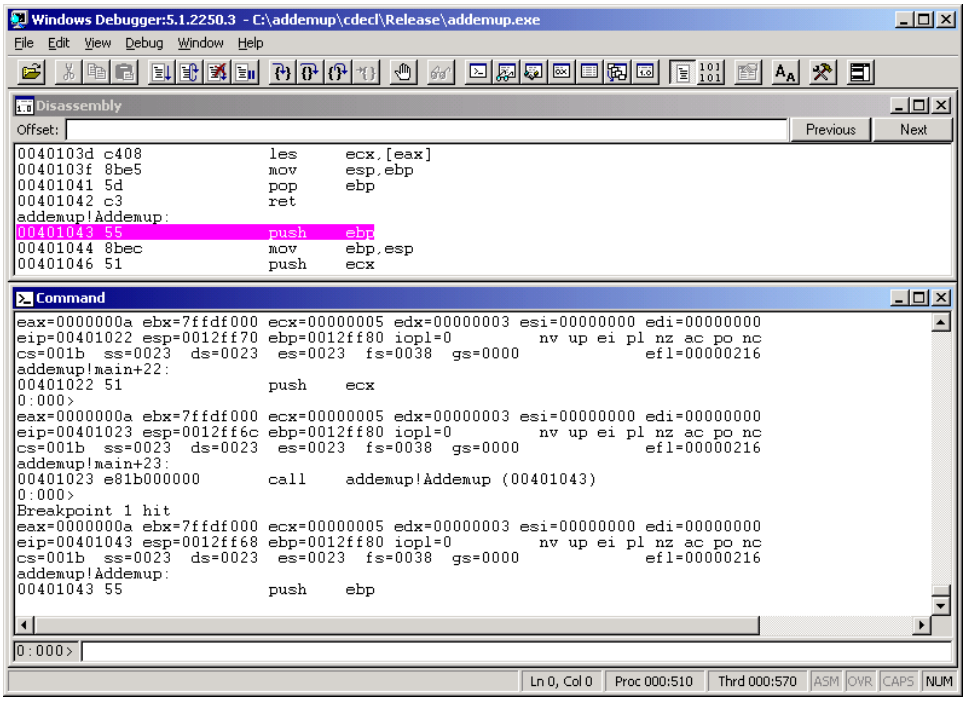


19. Type "**t** <enter>" to trace through the code one instruction at a time.

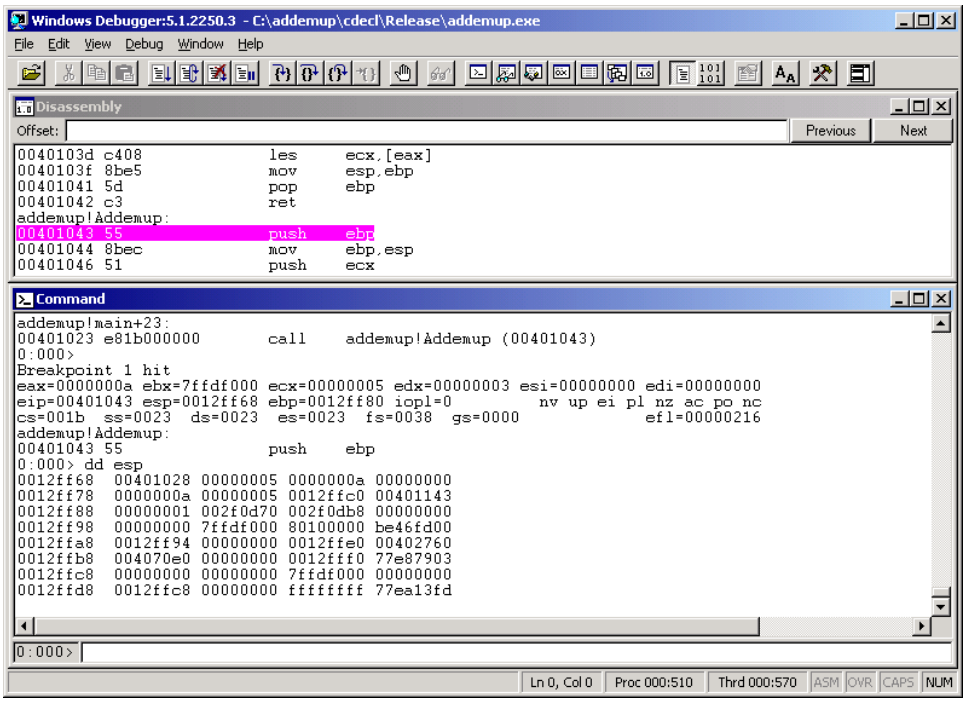
20. Hit the <enter> key several times and watch the debugger step through the assembly code in the top window. Hitting the <enter> key alone will repeat the last instruction.

21. Stop as soon as the following instruction is executed: “call addemup!addemup” .

The Debugger should look similar to this:

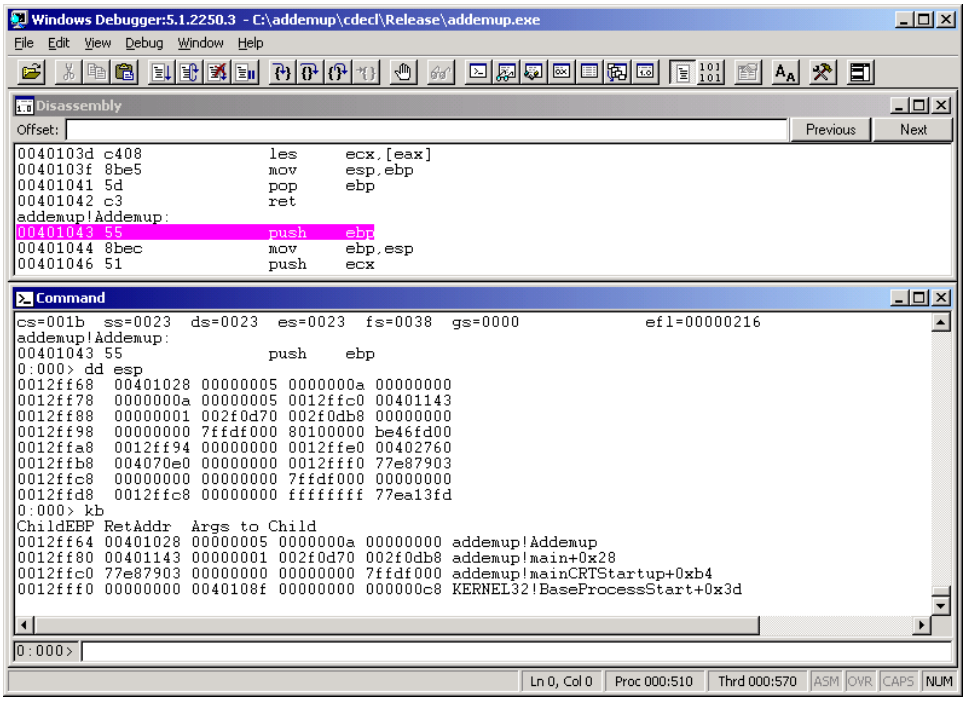


22. Type “**dd esp** <enter> to look at the current stack.

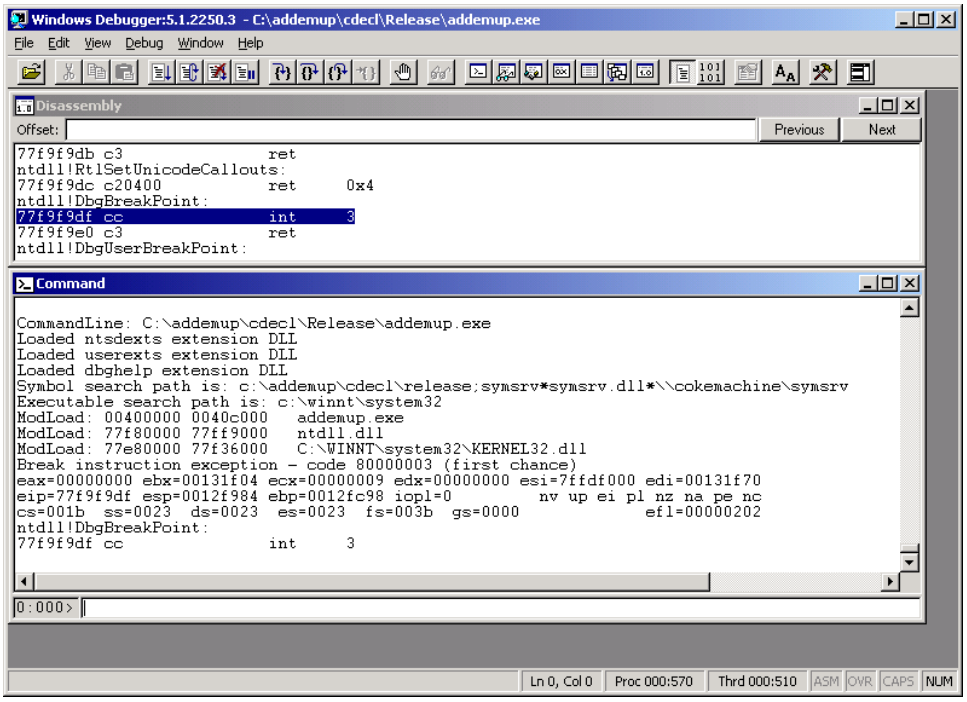


Notice the return address at the top of the stack. You can also see the two parameters being passed on the stack.

23. Type “**kb** <enter>” to look at the current stack trace.



24. Select **Debug | Restart.** Select **Yes** to save workspace information when the dialog box pops up. This will restart the process back to when all the modules are loaded.

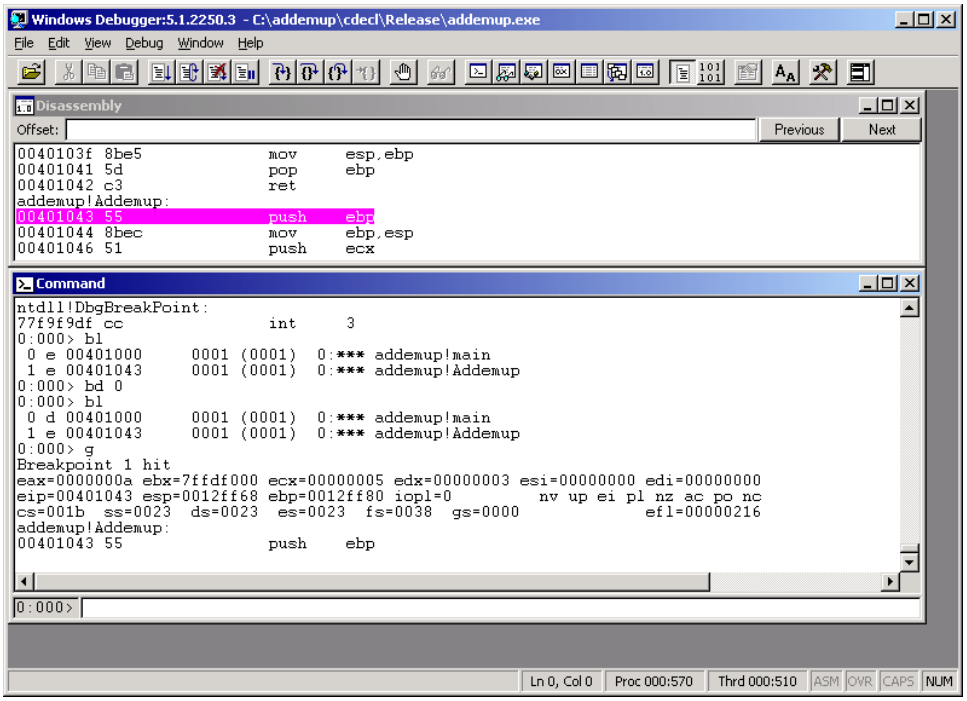


25. Type "**bl** <enter>" again to look at the current break points.

26. Type "**bd** 0 <enter>" to disable break point 0 at addemup!main().

27. Type "**bl** <enter>" again to see that the break point is disabled.

28. Type "**g** <enter>" to cause the process to run ("Go").



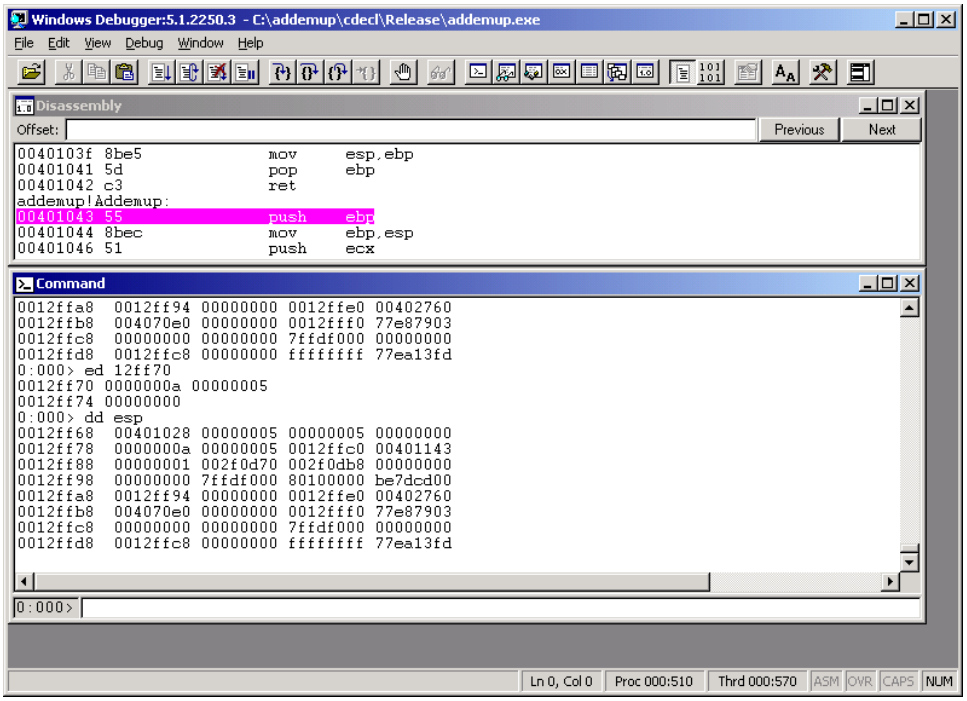
29. Type "**kb** <enter>" to look at the current stack trace.

30. Now let's have some fun. Type "**dd esp** <enter>" to dump the stack again.

31. Now let's change the second parameter to 0x00000005. Type "**ed 12ff70** <enter>".

32. Type "**00000005** <enter> <enter>". That's seven 0's, one 5, and two enters!

33. Type "**dd esp** <enter>" again to see the changes…



34. Now let's step through a line at a time and see what our change did. Type "**t** <enter>".

35. We execute "push ebp". You can type "**dd esp** <enter>" to check – this is where we save the ebp for the previous function "ChildEBP"

36. Type "**t** <enter>" again. Note that in the assembly window the red highlighting stays on the first instruction of the function. That indicates the break point. Another confusing point is that after each **T** (trace) command, the debugger window shows the current registers and the next instruction, not the instruction that was just executed. The assembly window also highlights the next instruction to be executed in blue. So the last instruction we executed set our current stack pointer by copying the current stack pointer (register esp) into our base pointer register ebp. You can see this by comparing the current register settings for ebp and the previous one.

37. Type "**t** <enter>". Now we push ecx to make room for our one local. Notice the stack pointer is decremented by 4 bytes.

38. Type "**t** <enter>". Notice the instruction *"mov dword ptr [ebp-4], 0x0"*. If you remember from our discussion from the previous section. [ebp-4] is our first local variable. This line of code is zeroing out that location in memory. This is equivalent to our line of c code "int c = 0".

39. Type "**t** <enter>". The next instruction *"mov eax, [ebp+8]"* is loading our first parameter into eax. Remember ebp+4 =return address, ebp+8 =first parameter, and ebp+c is our second parameter. The [ ] mean to move the contents stored at the address referenced by ebp+8 apposed to moving the value of ebp+8 into eax…

40. Type "**t** <enter>". The next instruction *"add eax, [ebp+c]"* is the same as eax=eax+[ebp+c]. So we add what is stored in the register eax to the value stored at the location referenced by [ebp+c] and put the resulting sum back into eax.

41. Type "**t** <enter>". The next instruction *"mov [ebp-4], eax"* is moving the result from the previous addition into the location referenced by [ebp-4] or into the location of our local variable 'c'.

42. Type "**t** <enter>". The next thing we do is copy that value right back into eax . This satisfies the c code instruction *"return (c)"*. If we had turned on compiler optimizations, you would see this overlap…

43. Notice at this point how our return value is 0x000000a. Let's have even more fun and change it again.

44. Type "**t** <enter>" to move the value of Local 'c' back into eax so that we can return it to the calling function.

45. Type "**r eax=00000010** <enter>". You can type *"**R** <enter>"* to verify the value was changed.

46. Type "**t** <enter>". The next instruction *" mov esp, ebp"* copies the saved stack pointer back to it's previous value.

47. Type "**t** <enter>". The next instruction *" pop ebp"* restores our base pointer to its previous value.

48. Type "**t** <enter>". We return back to the calling function to the next instruction following the call to addemup!addemup().

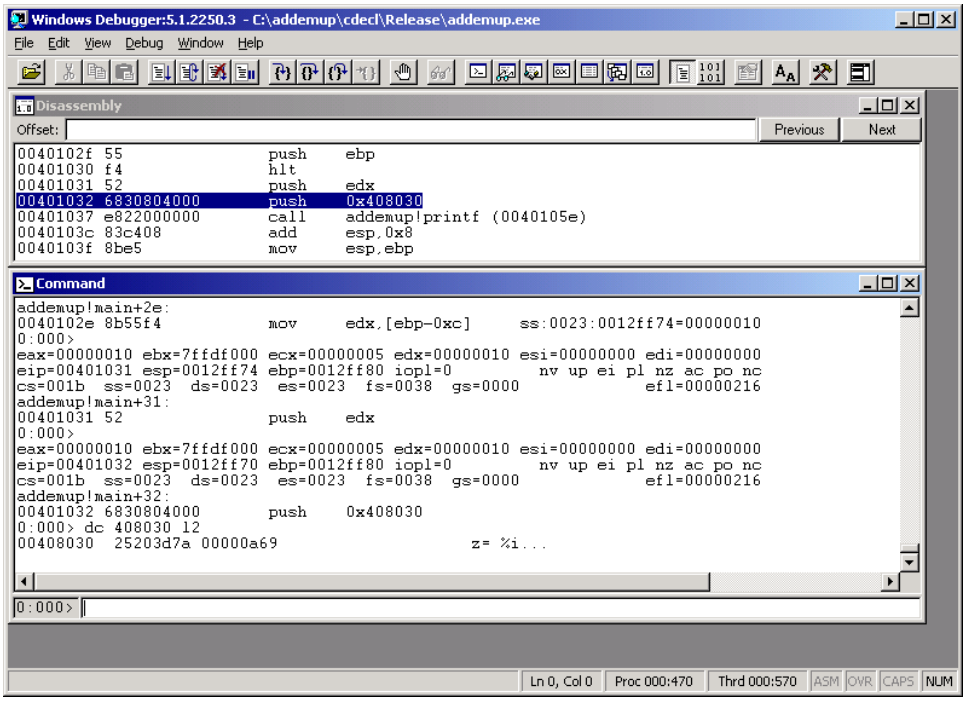
49. Type "**t** <enter>" next, since this was a CDECL function the calling function needs to add 8 bytes to the stack pointer to adjust for the two arguments we passed during the previous call to addemup!addemup().

50. Type "**t** <enter>". The next instruction *"mov [ebp-0xc], eax"* loads the return value into the location referenced by [ebp-0xc] which is our third local variable or 'z'.

51. Type "**t** <enter>". The next instruction moves that value into edx.

52. Type "**t** <enter>". The next instruction pushes edx onto the stack. This is the second parameter being passed to printf().

53. Type "**t** <enter>". The next instruction *"push 408030"* is pushing a pointer or the memory location of the "z= %I\n" string being passed to printf(). Type ***"dc 408030 L2**<enter>"* to dump that memory location and view its contents. The "L2" tells the debugger to only dump 2 dwords.



54. Type "**t** <enter>". The next instruction is the actual call to printf().

55. Type "**t** <enter>". Then Press **<Shift-F11>** to step out of printf(). Stepping through it line by line may take some time…. ☺

56. Take a look at the command window that was opened up when we started addemup. You should see the string "z= 16"

57. Type "**t** <enter>". The next instruction in addemup!main, *"add esp, 0xc",* fixes up the stack again for the parameters that we passed to printf(). What calling convention does printf() use?

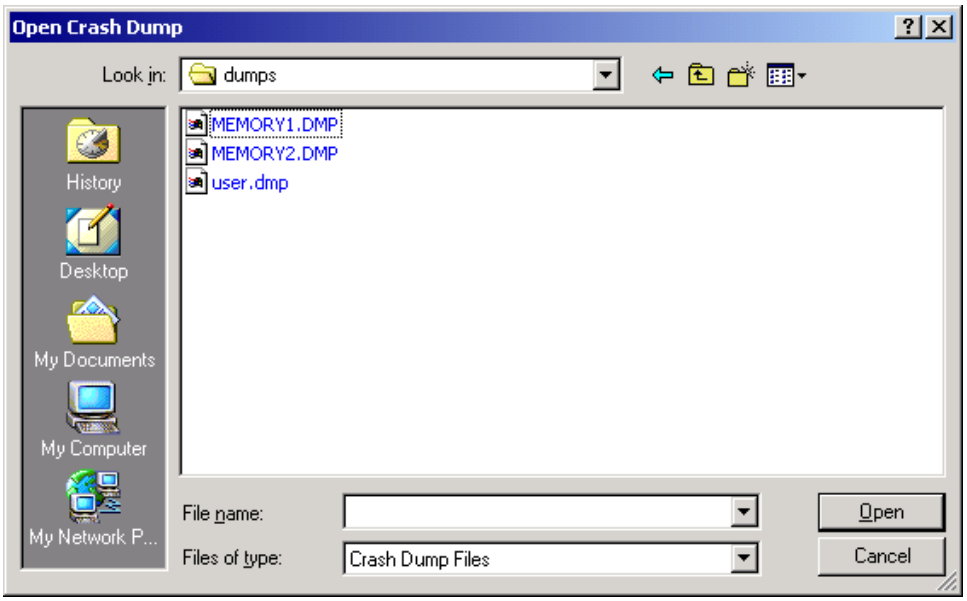
58. The next couple of instructions just continue to clean up before we exit, but since we are 58 lines into the exercise we will just Type "**q** <enter> to quit…..

Exercise 3: Analyzing a User-Mode Dump File

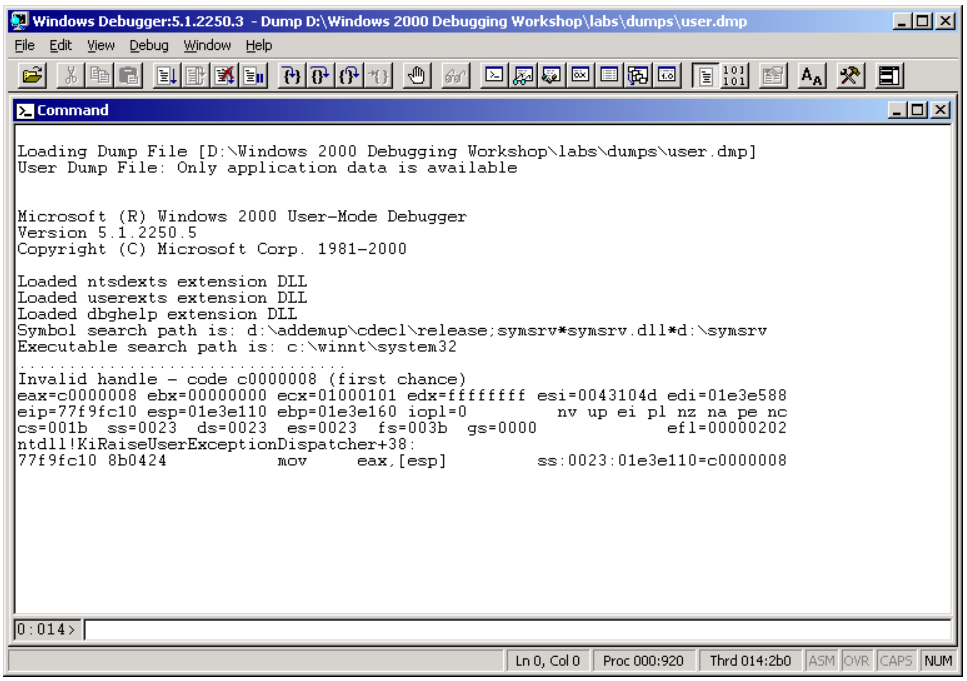
In this exercise, you will use WinDbg to load a couple of sample user.dmp files for analysis. The files are located in the c:\dumps directory.

Loading a user.dmp file using WinDbg

1. Select **Start | Program | Microsoft Debugging Tools | WinDbg**.
2. Select **File | Open Crash Dump.**



3. Select *user1.dmp* and then select Open.



4. We can see that the process failed with status 0xc000008 STATUS_INVALID_HANDLE.

5. Type "**kb** <enter>" to get a look at the stack trace. This shows you what was going on at the point when we failed.
6. From the stack trace you can see that *inojobsv.exe* attempted to close an invalid handle. Most likely the handle had been previously freed!
7. Load up the additional *user.dmp* files and see if you can isolate the point of failure.

Exercise 4 – Using UMDH to Find a Memory Leak in an Application

In this exercise, you will use a utility called *leakyapp.exe* to generate a user mode leak. You can find this tool in the Labs share in the directory *memtools*. Like the previous lab, in this lab we will not be giving step by step instructions.

1. Expand the *umdhtools.exe* tool to your local system.
2. Start *leakyapp.exe*.
3. Use *tlist.exe* to get the PID for *leakyapp.exe*.
4. Use the *umdh.exe* utility to locate the leak.

Refer to the the workbook (Module 11, page 352) for instructions on how to use *umdh.exe*.

Hint: You need to set some global flags and reboot...