Part II – Introduction to Windows Internals

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Who am I #1

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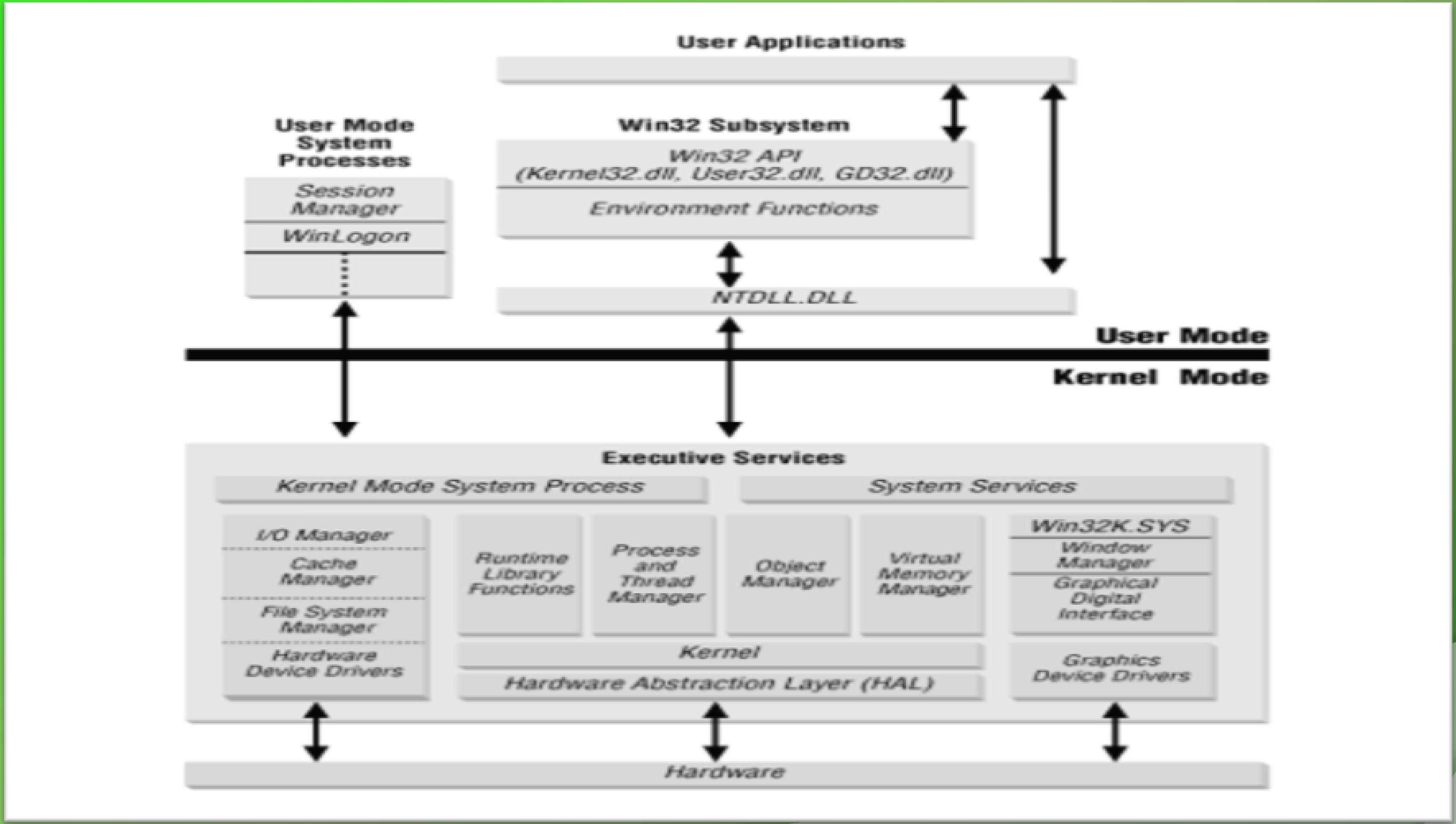
Windows Architecture



Memory Management

- **Virtual Memory**
  - An invisible layer between a software and physical memory
  - Every process first get loaded into its virtual memory address space
  - Small units called "pages" are used to do mapping between physical memory and virtual memory.
- **Paging**
  - Memory management scheme that stores and retrieves data from secondary storage for use in main memory
  - Uses same size blocks called pages
  - Page table is used to translate virtual addresses in physical memory addresses

Memory Management Cont.

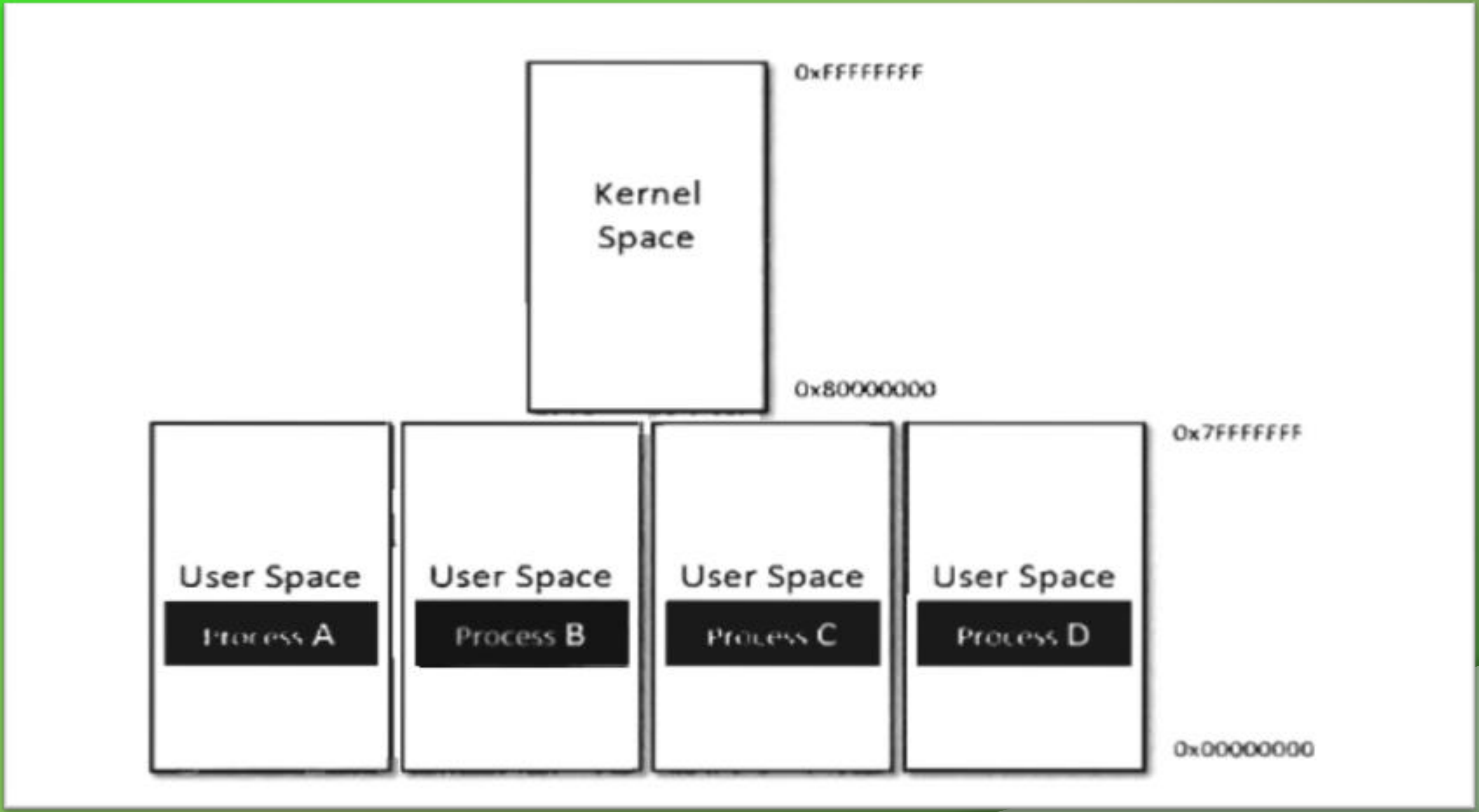
- **User Address Space**

- Allocated for user mode applications.
- All processes execute in their own virtual space.
- Use operating system dlls to interact with kernel

- **Kernel Address Space**

- Strictly reserved for kernel, device drivers and operating system executive.
- No user mode application can directly interact with the kernel.

Kernel & User Address Space

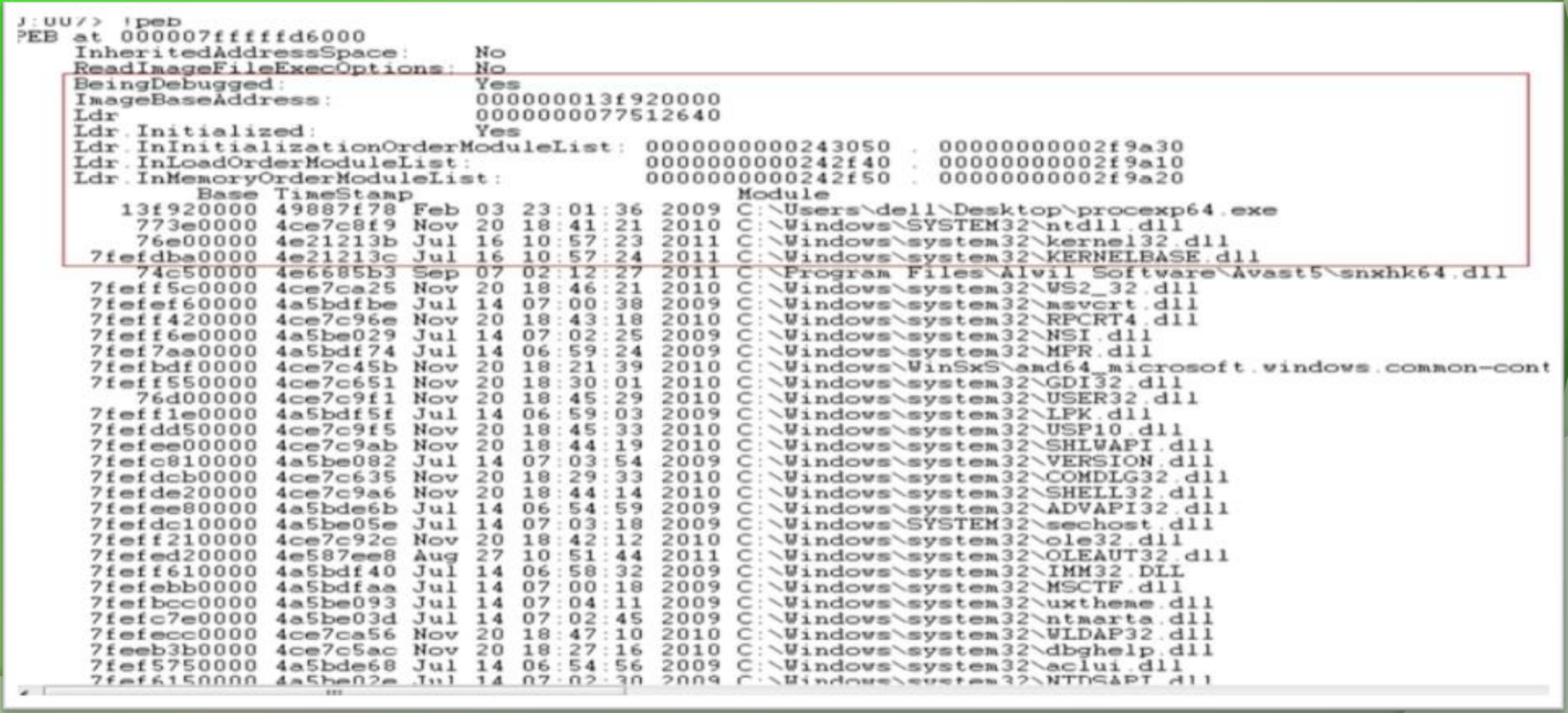


Process and Thread

- **Process**
  - Executing instance of an application.
  - Isolated address space
  - PEB data structure store information about process
  - PEB is an user space data structure
- **Threads**
  - Multiple threads share the same address space in the process.
  - Each process has **at least a single** executing thread.
  - TEB data structure store information about thread

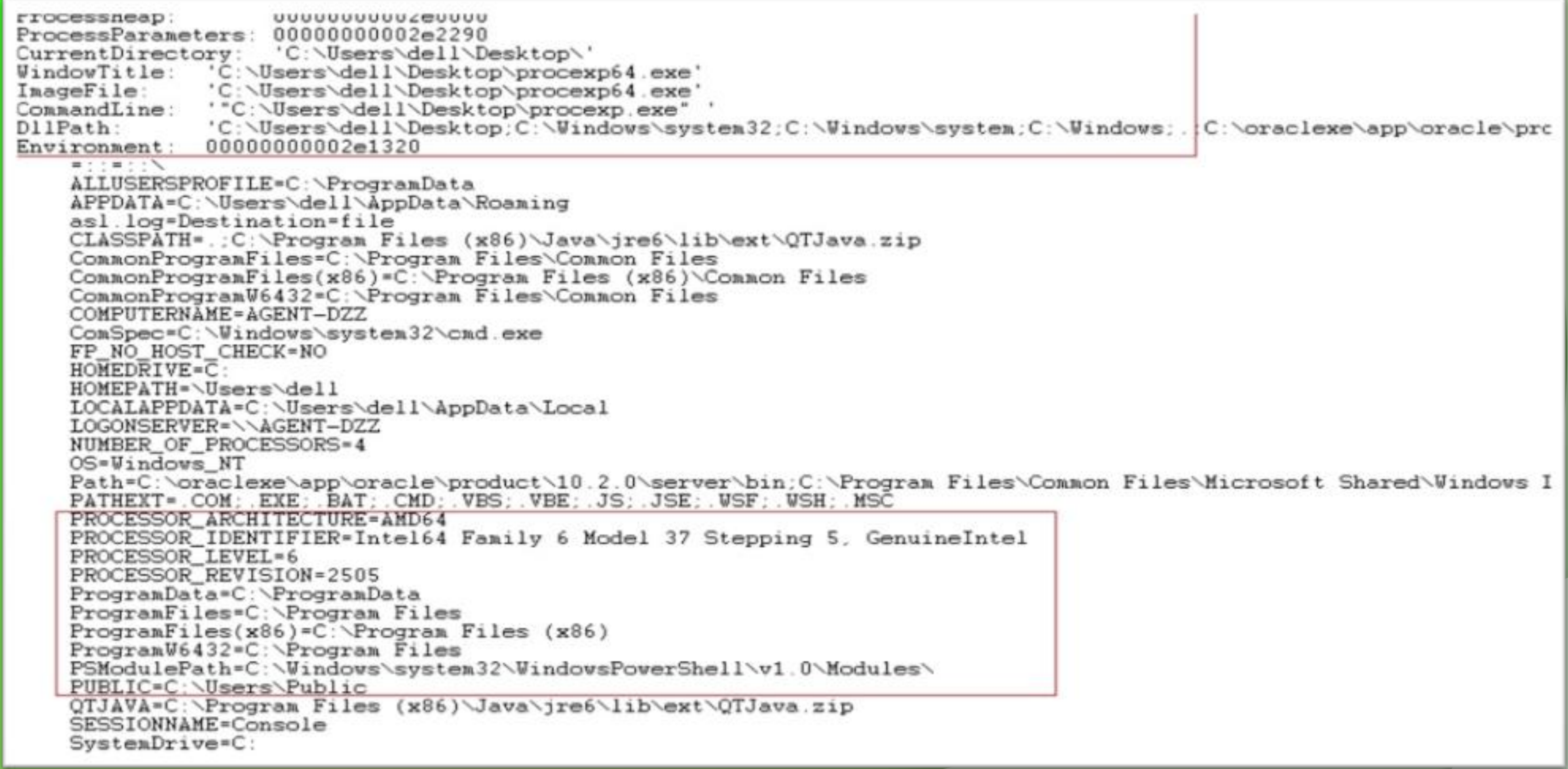
PEB (Process Environment Block)

An opaque data structure that store information about process in user space



```
0:000> !peb
PEB at 000007fffffd6000
    InheritedAddressSpace:    No
    ReadImageFileExecOptions: No
    BeingDebugged:            Yes
    ImageBaseAddress:         000000013f920000
    Ldr                       0000000077512640
    Ldr.Initialized:          Yes
    Ldr.InInitializationOrderModuleList: 0000000000243050 . 00000000002f9a30
    Ldr.InLoadOrderModuleList:           0000000000242f40 . 00000000002f9a10
    Ldr.InMemoryOrderModuleList:         0000000000242f50 . 00000000002f9a20
            Base TimeStamp                     Module
       13f920000 49887f78 Feb 03 23:01:36 2009 C:\Users\dell\Desktop\procexp64.exe
        773e0000 4ce7c8f9 Nov 20 18:41:21 2010 C:\Windows\SYSTEM32\ntdll.dll
        76e00000 4e21213b Jul 16 10:57:23 2011 C:\Windows\system32\kernel32.dll
     7fefdba0000 4e21213c Jul 16 10:57:24 2011 C:\Windows\system32\KERNELBASE.dll
        74c50000 4e6685b3 Sep 07 02:12:27 2011 C:\Program Files\Alwil Software\Avast5\snxhk64.dll
     7feff5c0000 4ce7ca25 Nov 20 18:46:21 2010 C:\Windows\system32\WS2_32.dll
     7fefef60000 4a5bdfbe Jul 14 07:00:38 2009 C:\Windows\system32\msvcrt.dll
     7feff420000 4ce7c96e Nov 20 18:43:18 2010 C:\Windows\system32\RPCRT4.dll
     7feff6e0000 4a5be029 Jul 14 07:02:25 2009 C:\Windows\system32\NSI.dll
     7fef7aa0000 4a5bdf74 Jul 14 06:59:24 2009 C:\Windows\system32\MPR.dll
     7fefbdf0000 4ce7c45b Nov 20 18:21:39 2010 C:\Windows\WinSxS\amd64_microsoft.windows.common-cont
     7feff550000 4ce7c651 Nov 20 18:30:01 2010 C:\Windows\system32\GDI32.dll
        76d00000 4ce7c9f1 Nov 20 18:45:29 2010 C:\Windows\system32\USER32.dll
     7feff1e0000 4a5bdf5f Jul 14 06:59:03 2009 C:\Windows\system32\LPK.dll
     7fefdd50000 4ce7c9f5 Nov 20 18:45:33 2010 C:\Windows\system32\USP10.dll
     7fefee00000 4ce7c9ab Nov 20 18:44:19 2010 C:\Windows\system32\SHLWAPI.dll
     7fefc810000 4a5be082 Jul 14 07:03:54 2009 C:\Windows\system32\VERSION.dll
     7fefdcb0000 4ce7c635 Nov 20 18:29:33 2010 C:\Windows\system32\COMDLG32.dll
     7fefde20000 4ce7c9a6 Nov 20 18:44:14 2010 C:\Windows\system32\SHELL32.dll
     7fefee80000 4a5bde6b Jul 14 06:54:59 2009 C:\Windows\system32\ADVAPI32.dll
     7fefdc10000 4a5be05e Jul 14 07:03:18 2009 C:\Windows\SYSTEM32\sechost.dll
     7feff210000 4ce7c92c Nov 20 18:42:12 2010 C:\Windows\system32\ole32.dll
     7fefed20000 4e587ee8 Aug 27 10:51:44 2011 C:\Windows\system32\OLEAUT32.dll
     7feff610000 4a5bdf40 Jul 14 06:58:32 2009 C:\Windows\system32\IMM32.DLL
     7fefebb0000 4a5bdfaa Jul 14 07:00:18 2009 C:\Windows\system32\MSCTF.dll
     7fefbcc0000 4a5be093 Jul 14 07:04:11 2009 C:\Windows\system32\uxtheme.dll
     7fefc7e0000 4a5be03d Jul 14 07:02:45 2009 C:\Windows\system32\ntmarta.dll
     7fefecc0000 4ce7ca56 Nov 20 18:47:10 2010 C:\Windows\system32\WLDAP32.dll
     7feeb3b0000 4ce7c5ac Nov 20 18:27:16 2010 C:\Windows\system32\dbghelp.dll
     7fef5750000 4a5bde68 Jul 14 06:54:56 2009 C:\Windows\system32\aclui.dll
     7fef6150000 4a5be02e Jul 14 07:02:30 2009 C:\Windows\system32\NTDSAPI.dll
```

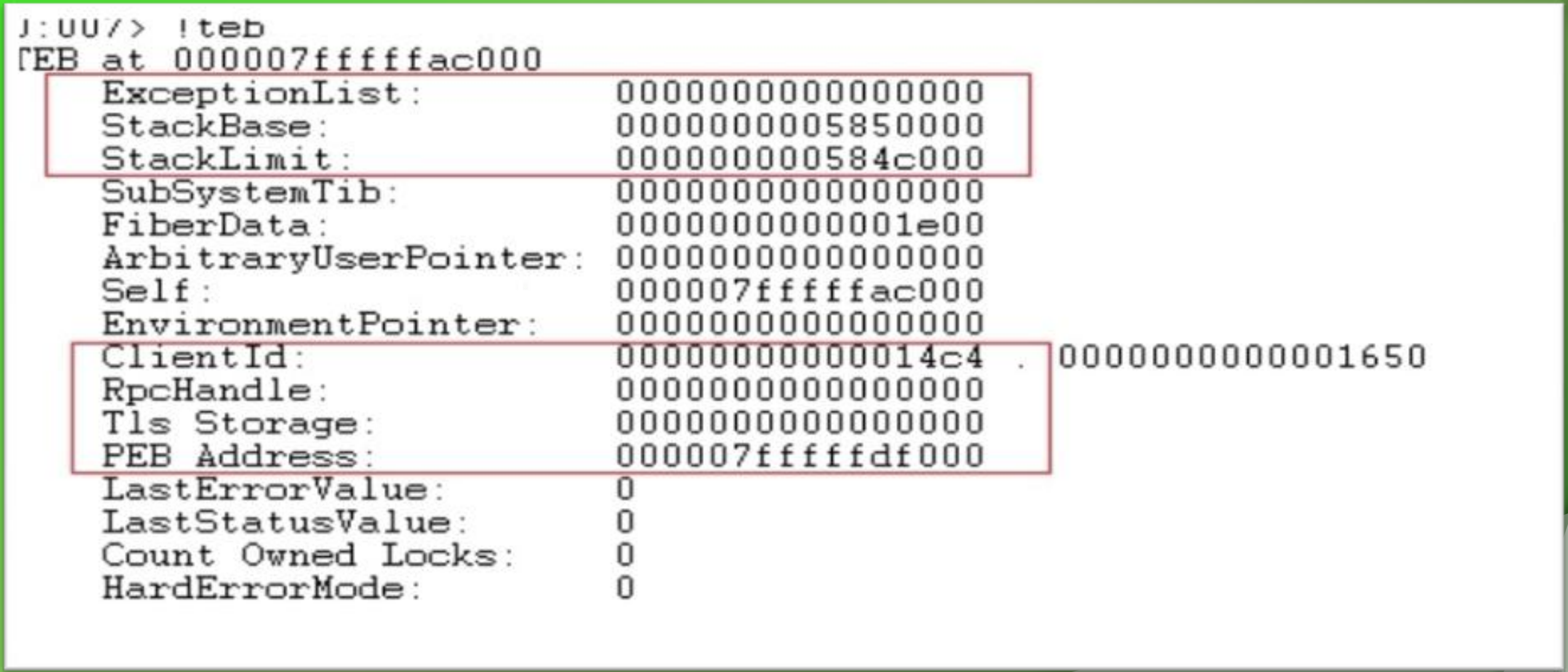
PEB Cont.



```
ProcessHeap:        00000000002e0000
ProcessParameters:  00000000002e2290
CurrentDirectory:   'C:\Users\dell\Desktop\'
WindowTitle:   'C:\Users\dell\Desktop\procexp64.exe'
ImageFile:     'C:\Users\dell\Desktop\procexp64.exe'
CommandLine:   '"C:\Users\dell\Desktop\procexp.exe" '
DllPath:       'C:\Users\dell\Desktop;C:\Windows\system32;C:\Windows\system;C:\Windows;.;C:\oraclexe\app\oracle\prc
Environment:   00000000002e1320
    =::=::\
    ALLUSERSPROFILE=C:\ProgramData
    APPDATA=C:\Users\dell\AppData\Roaming
    asl.log=Destination=file
    CLASSPATH=.;C:\Program Files (x86)\Java\jre6\lib\ext\QTJava.zip
    CommonProgramFiles=C:\Program Files\Common Files
    CommonProgramFiles(x86)=C:\Program Files (x86)\Common Files
    CommonProgramW6432=C:\Program Files\Common Files
    COMPUTERNAME=AGENT-DZZ
    ComSpec=C:\Windows\system32\cmd.exe
    FP_NO_HOST_CHECK=NO
    HOMEDRIVE=C:
    HOMEPATH=\Users\dell
    LOCALAPPDATA=C:\Users\dell\AppData\Local
    LOGONSERVER=\\AGENT-DZZ
    NUMBER_OF_PROCESSORS=4
    OS=Windows_NT
    Path=C:\oraclexe\app\oracle\product\10.2.0\server\bin;C:\Program Files\Common Files\Microsoft Shared\Windows I
    PATHEXT=.COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSH;.MSC
    PROCESSOR_ARCHITECTURE=AMD64
    PROCESSOR_IDENTIFIER=Intel64 Family 6 Model 37 Stepping 5, GenuineIntel
    PROCESSOR_LEVEL=6
    PROCESSOR_REVISION=2505
    ProgramData=C:\ProgramData
    ProgramFiles=C:\Program Files
    ProgramFiles(x86)=C:\Program Files (x86)
    ProgramW6432=C:\Program Files
    PSModulePath=C:\Windows\system32\WindowsPowerShell\v1.0\Modules\
    PUBLIC=C:\Users\Public
    QTJAVA=C:\Program Files (x86)\Java\jre6\lib\ext\QTJava.zip
    SESSIONNAME=Console
    SystemDrive=C:
```

TEB (Thread Environment Block)

TEB is a data structure that store information about thread

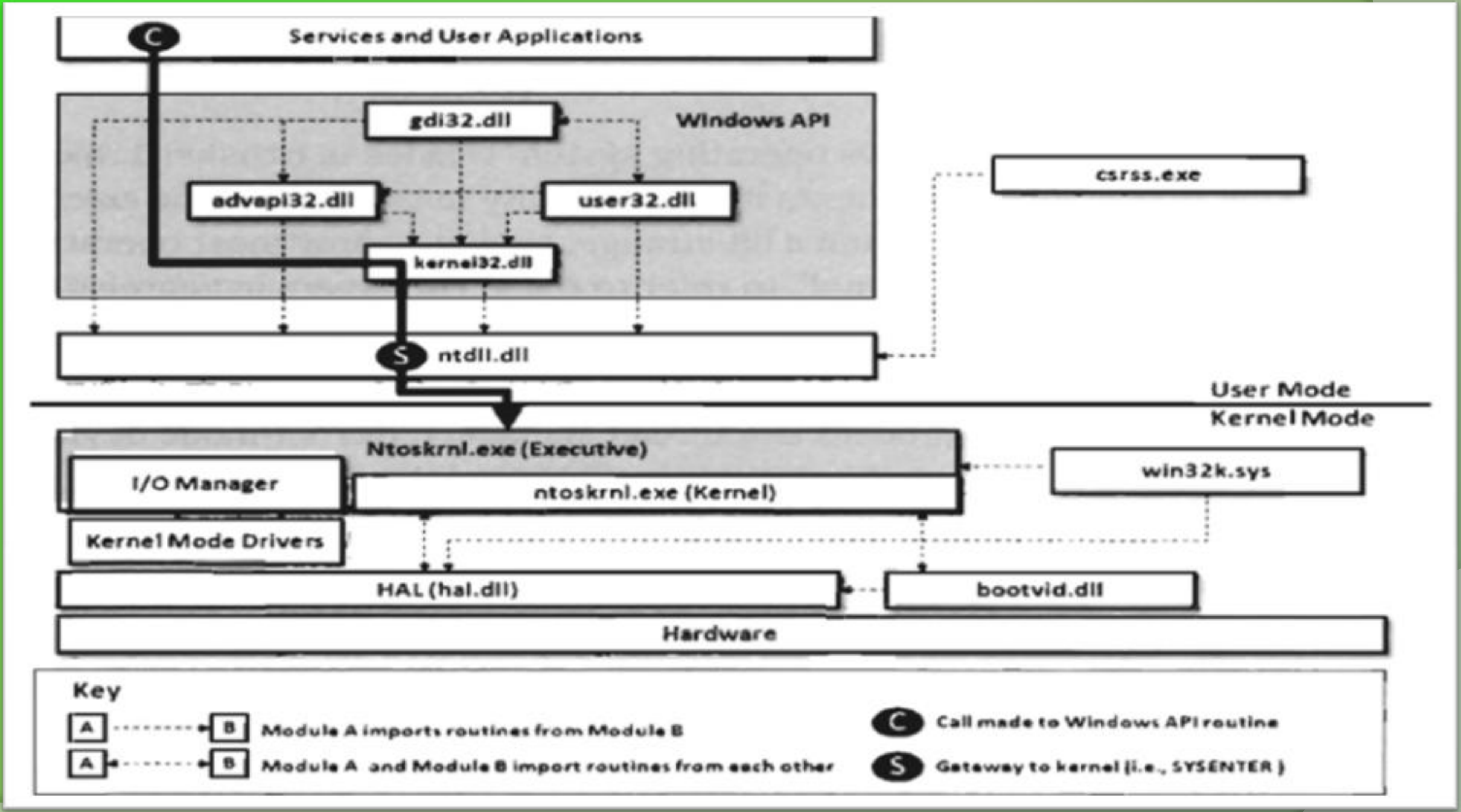


```
0:007> !teb
TEB at 000007fffffac000
    ExceptionList:        0000000000000000
    StackBase:            0000000005850000
    StackLimit:           000000000584c000
    SubSystemTib:         0000000000000000
    FiberData:            0000000000001e00
    ArbitraryUserPointer: 0000000000000000
    Self:                 000007fffffac000
    EnvironmentPointer:   0000000000000000
    ClientId:             00000000000014c4 . 0000000000001650
    RpcHandle:            0000000000000000
    Tls Storage:          0000000000000000
    PEB Address:          000007fffffdf000
    LastErrorValue:       0
    LastStatusValue:      0
    Count Owned Locks:    0
    HardErrorMode:        0
```

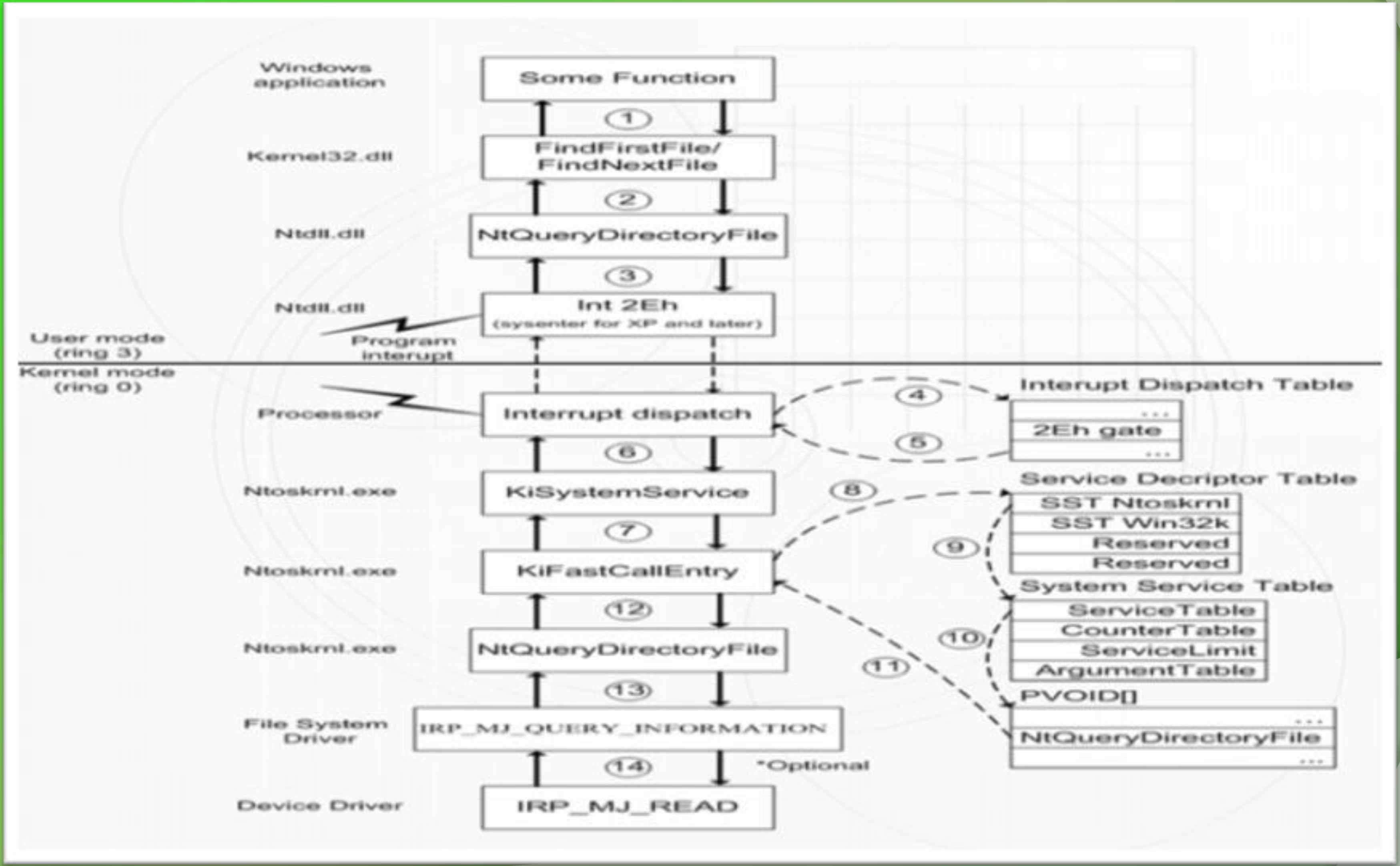
Application Programming Interface

- **API**
  - Includes functions, classes, data structures and variables
  - Interface between various software components to communicate with each other.
  - Windows APIs are used to interact with kernel or other modules.
- **MSDN**
  - Provides documentation for various API functions.
- **System Dlls**
  - ntdll.dll, kernel32.dll, user32.dll, advapi32.dll, hal.dll etc

System Service Dispatching



System Service Dispatching Cont.



Important API

- **File and Directories**

- CreateFile, GetSystemDirectory, ReadFile, WriteFile etc

- **Network**

- socket, send, recv, URLDownloadToFile etc

- **Registry**

- RegOpenKey, RegSetValue, RegQueryValue etc

Important API Cont.

- **Processes, Threads, Synchronization using mutex, semaphore.**

- CreateProcess, ReadProcessMemory, WriteProcessMemory,CreateRemoteThread, CreateMutex etc

- **Memory**

- VirtualAlloc, VirtualProtect ,HeapAlloc, LocalAlloc etc

Reference

- Complete Reference Guide for Reversing & Malware Analysis Training

Thank You !

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