本文将重点介绍内核如何枚举SSDT表和SSSDT表，这两个表是操作系统内核中非常重要的一部分，它们记录了系统API函数和系统服务函数的地址和相关信息。因此，枚举这些表是实现许多驱动保护和系统监控的关键步骤。

在本文中，我们将逐步介绍如何使用内核驱动程序来枚举SSDT表和SSSDT表。我们将详细介绍如何获取内核的地址空间、如何定位这些表、如何遍历这些表、以及如何获取这些表中函数的地址和相关信息。我们还将介绍如何使用这些信息来实现一些常见的驱动保护和系统监控功能，例如API钩子、系统调用监控和根套接字过滤等。

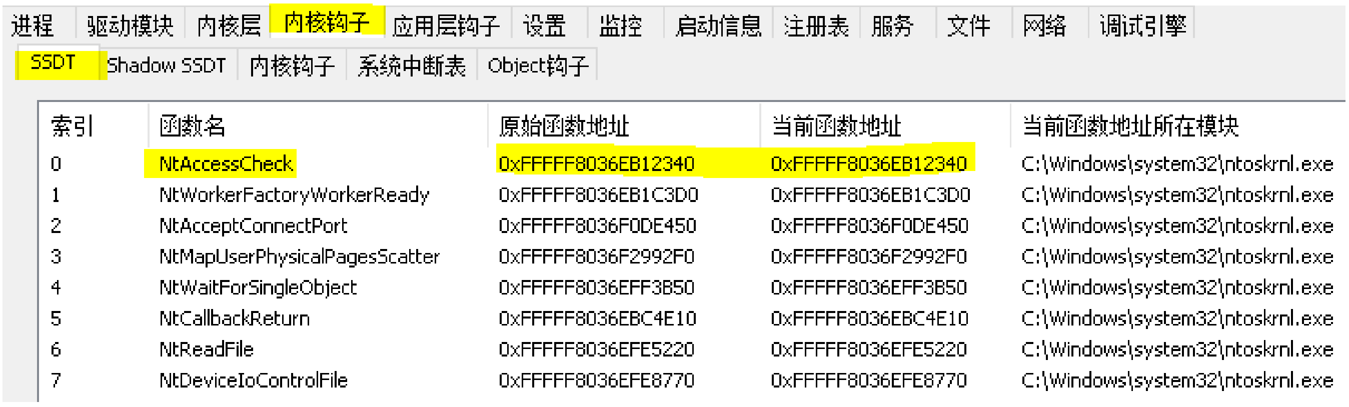
在SSDT枚举篇的第一部分，我们将介绍如何枚举SSDT表。我们将详细介绍如何在内核中定位SSDT表、如何遍历SSDT表中的每个系统API函数、以及如何获取这些函数的地址和相关信息。我们还将提供实例演示，帮助读者更好地理解这些技术的实现方法和步骤。

在SSDT枚举篇的第二部分，我们将介绍如何枚举SSSDT表。我们将详细介绍如何在内核中定位SSSDT表、如何遍历SSSDT表中的每个系统服务函数、以及如何获取这些函数的地址和相关信息。我们还将提供实例演示，帮助读者更好地理解这些技术的实现方法和步骤。

通过本文，读者将了解如何在内核驱动程序中实现对SSDT表和SSSDT表的枚举，以及如何利用这些表来实现驱动保护和系统监控。我们将提供详细的示例代码和实例演示，帮助读者更好地理解这些技术的实现方法和步骤。

微软的`Windows 10`系统已经覆盖了大多数个人PC终端，以前的方法也该进行迭代更新了，或许在网上你能够找到类似的文章，但我可以百分百肯定都不能用，今天`LyShark`将带大家一起分析`Win10 x64`最新系统`SSDT`表的枚举实现。

看一款闭源ARK工具的枚举效果:



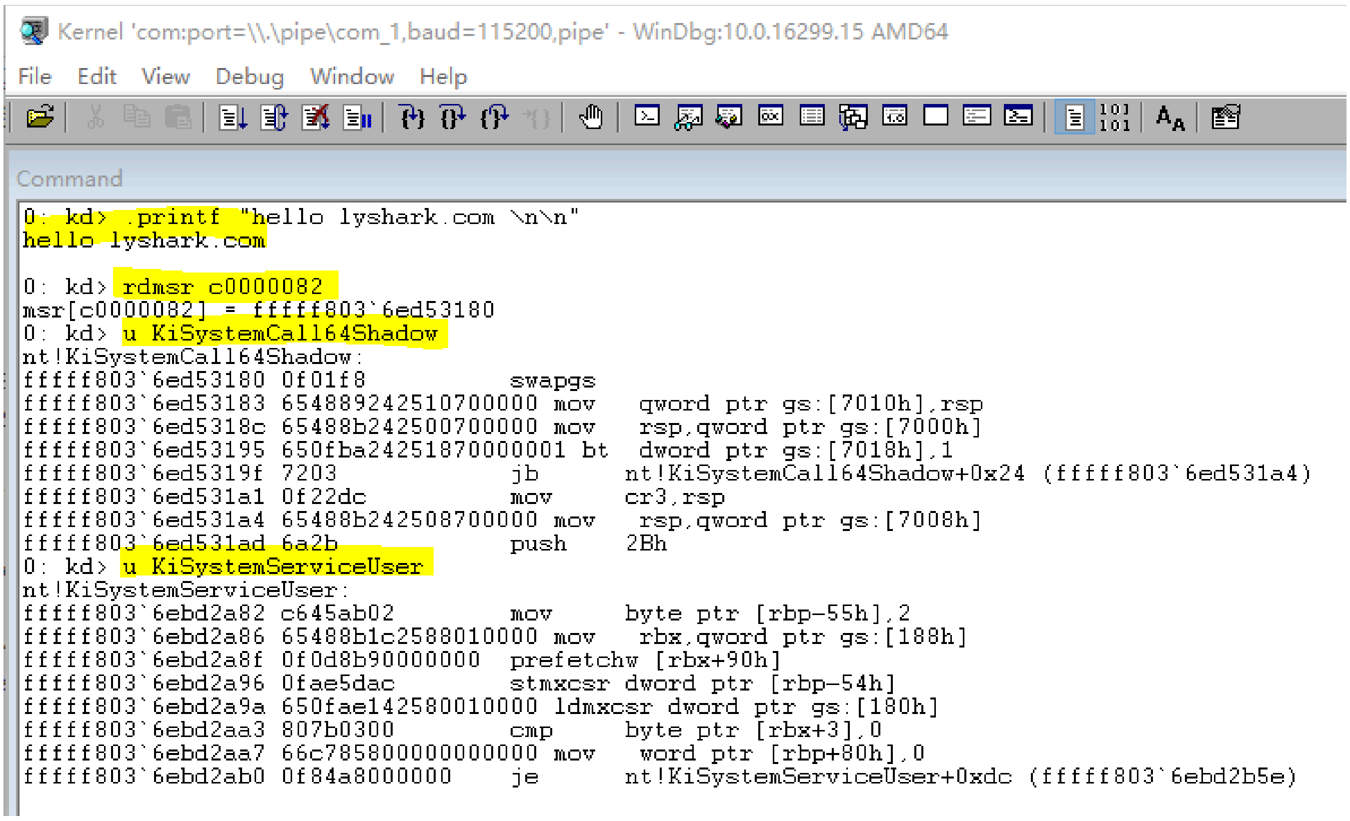
索引	函数名	原始函数地址	当前函数地址	当前函数地址所在模块
0	NtAccessCheck	0xFFFFF8036EB12340	0xFFFFF8036EB12340	C:\Windows\system32\ntoskrnl.exe
1	NtWorkerFactoryWorkerReady	0xFFFFF8036EB1C3D0	0xFFFFF8036EB1C3D0	C:\Windows\system32\ntoskrnl.exe
2	NtAcceptConnectPort	0xFFFFF8036F0DE450	0xFFFFF8036F0DE450	C:\Windows\system32\ntoskrnl.exe
3	NtMapUserPhysicalPagesScatter	0xFFFFF8036F2992F0	0xFFFFF8036F2992F0	C:\Windows\system32\ntoskrnl.exe
4	NtWaitForSingleObject	0xFFFFF8036EFF3B50	0xFFFFF8036EFF3B50	C:\Windows\system32\ntoskrnl.exe
5	NtCallbackReturn	0xFFFFF8036EBC4E10	0xFFFFF8036EBC4E10	C:\Windows\system32\ntoskrnl.exe
6	NtReadFile	0xFFFFF8036EFE5220	0xFFFFF8036EFE5220	C:\Windows\system32\ntoskrnl.exe
7	NtDeviceIoControlFile	0xFFFFF8036EFE8770	0xFFFFF8036EFE8770	C:\Windows\system32\ntoskrnl.exe

直接步入正题，首先`SSDT`表中文为系统服务描述符表，SSDT表的`作用`是把`应用`层与`内核`层`联系起来`起到`桥梁`的作用，枚举`SSDT表`也是`反内核`工具最基本的功能，通常在`64位`系统中要想找到`SSDT`表，需要先找到`KeServiceDescriptorTable`这个函数，由于该函数没有被导出，所以只能动态的查找它的地址，庆幸的是我们可以通过查找`msr(c0000082)`这个特殊的寄存器来替代查找`KeServiceDescriptorTable`这一步，在新版系统中查找SSDT可以归纳为如下这几个步骤。

- rdmsr c0000082 -> KiSystemCall64Shadow -> KiSystemServiceUser -> SSDT

首先第一步通过`rdmsr C0000082` MSR寄存器得到`KiSystemCall64Shadow`的函数地址，计算`KiSystemCall64Shadow`与`KiSystemServiceUser`偏移量，如下图所示。

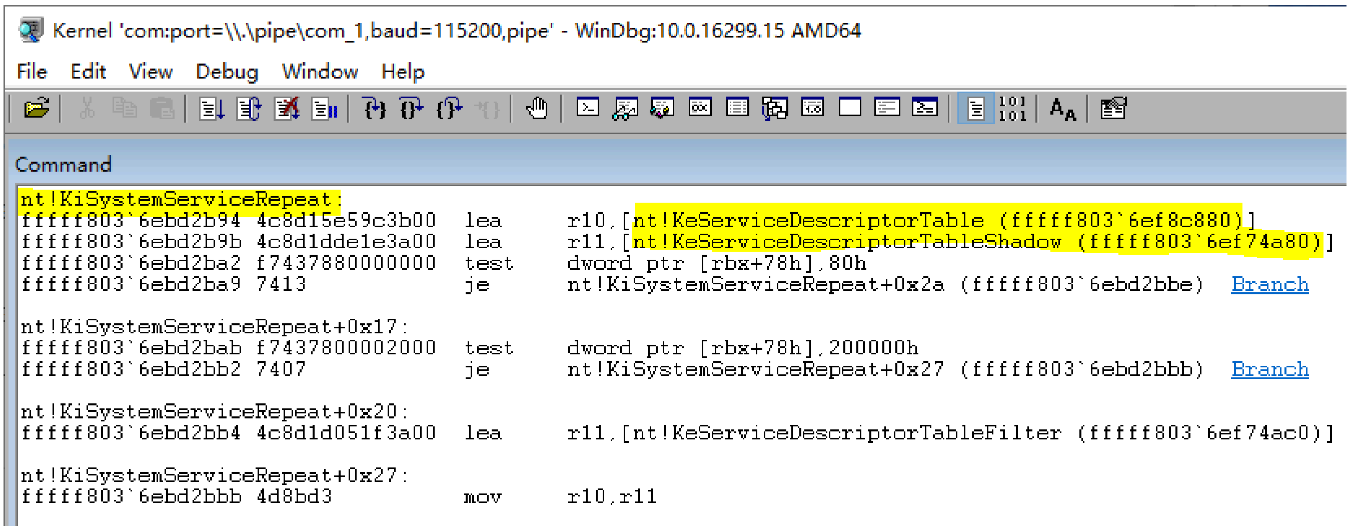
- 得到相对偏移`6ed53180(KiSystemCall64Shadow) - 6ebd2a82(KiSystemServiceUser) = 1806FE`
- 也就是说`6ed53180(rdmsr) - 1806FE = KiSystemServiceUser`


Kernel 'com:port=\\.\pipe\com_1,baud=115200,pipe' - WinDbg:10.0.16299.15 AMD64
File Edit View Debug Window Help
Command

```
0: kd> .printf "hello lyshark.com \n\n"
hello lyshark.com

0: kd> rdmsr c0000082
msr[c0000082] = fffff803`6ed53180
0: kd> u KiSystemCall64Shadow
nt!KiSystemCall64Shadow:
fffff803`6ed53180 0f01f8          swapgs
fffff803`6ed53183 654889242510700000 mov   qword ptr gs:[7010h],rsp
fffff803`6ed5318c 65488b242500700000 mov   rsp,qword ptr gs:[7000h]
fffff803`6ed53195 650fba24251870000001 bt  dword ptr gs:[7018h],1
fffff803`6ed5319f 7203            jb      nt!KiSystemCall64Shadow+0x24 (fffff803`6ed531a4)
fffff803`6ed531a1 0f22dc          mov     cr3,rsp
fffff803`6ed531a4 65488b242508700000 mov   rsp,qword ptr gs:[7008h]
fffff803`6ed531ad 6a2b            push    2Bh
0: kd> u KiSystemServiceUser
nt!KiSystemServiceUser:
fffff803`6ebd2a82 c645ab02        mov     byte ptr [rbp-55h],2
fffff803`6ebd2a86 65488b1c2588010000 mov   rbx,qword ptr gs:[188h]
fffff803`6ebd2a8f 0f0d8b90000000  prefetchw [rbx+90h]
fffff803`6ebd2a96 0fae5dac        stmxcsr dword ptr [rbp-54h]
fffff803`6ebd2a9a 650fae142580010000 ldmxcsr dword ptr gs:[180h]
fffff803`6ebd2aa3 807b0300        cmp     byte ptr [rbx+3],0
fffff803`6ebd2aa7 66c785800000000000 mov   word ptr [rbp+80h],0
fffff803`6ebd2ab0 0f84a8000000    je      nt!KiSystemServiceUser+0xdc (fffff803`6ebd2b5e)
```

如上当我们找到了`KiSystemServiceUser`的地址以后，在`KiSystemServiceUser`向下搜索可找到`KiSystemServiceRepeat`里面就是我们要找的`SSDT`表基址。

其中`fffff8036ef8c880`则是`SSDT表`的基地址，紧随其后的`fffff8036ef74a80`则是`SSSDT表`的基地址。


Kernel 'com:port=\\.\pipe\com_1,baud=115200,pipe' - WinDbg:10.0.16299.15 AMD64
File Edit View Debug Window Help
Command

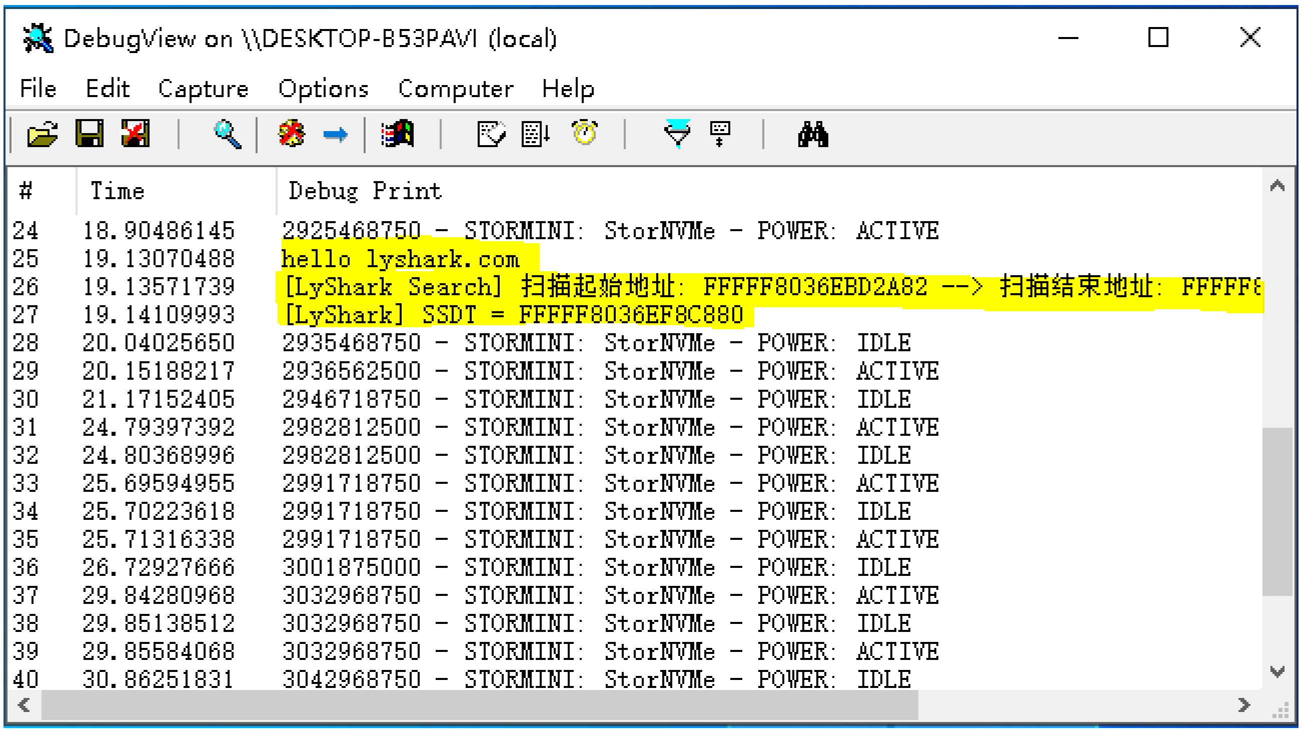
```
nt!KiSystemServiceRepeat:
fffff803`6ebd2b94 4c8d15e59c3b00  lea     r10,[nt!KeServiceDescriptorTable (fffff803`6ef8c880)]
fffff803`6ebd2b9b 4c8d1dde1e3a00  lea     r11,[nt!KeServiceDescriptorTableShadow (fffff803`6ef74a80)]
fffff803`6ebd2ba2 f7437880000000  test    dword ptr [rbx+78h],80h
fffff803`6ebd2ba9 7413            je      nt!KiSystemServiceRepeat+0x2a (fffff803`6ebd2bbe)  Branch

nt!KiSystemServiceRepeat+0x17:
fffff803`6ebd2bab f7437800002000  test    dword ptr [rbx+78h],200000h
fffff803`6ebd2bb2 7407            je      nt!KiSystemServiceRepeat+0x27 (fffff803`6ebd2bbb)  Branch

nt!KiSystemServiceRepeat+0x20:
fffff803`6ebd2bb4 4c8d1d051f3a00  lea     r11,[nt!KeServiceDescriptorTableFilter (fffff803`6ef74ac0)]

nt!KiSystemServiceRepeat+0x27:
fffff803`6ebd2bbb 4d8bd3          mov     r10,r11
```

那么如果将这个过程通过代码的方式来实现，我们还需要使用`《内核枚举IoTimer定时器》`中所使用的特征码定位技术，如下我们查找这段特征。

```c
#include <ntifs.h>
#pragma intrinsic(__readmsr)

ULONGLONG ssdt_address = 0;

// 获取 KeServiceDescriptorTable 首地址
ULONGLONG GetLySharkCOMKeServiceDescriptorTable()
{
    // 设置起始位置
    PUCHAR StartSearchAddress = (PUCHAR)__readmsr(0xC0000082) - 0x1806FE;

    // 设置结束位置
    PUCHAR EndSearchAddress = StartSearchAddress + 0x100000;
    DbgPrint("[LyShark Search] 扫描起始地址: %p --> 扫描结束地址: %p \n", StartSearchAddress,
EndSearchAddress);

    PUCHAR ByteCode = NULL;

    UCHAR OpCodeA = 0, OpCodeB = 0, OpCodeC = 0;
    ULONGLONG addr = 0;
    ULONG templong = 0;

    for (ByteCode = StartSearchAddress; ByteCode < EndSearchAddress; ByteCode++)
    {
        // 使用MmIsAddressValid()函数检查地址是否有页面错误
        if (MmIsAddressValid(ByteCode) && MmIsAddressValid(ByteCode + 1) &&
MmIsAddressValid(ByteCode + 2))
        {
            OpCodeA = *ByteCode;
            OpCodeB = *(ByteCode + 1);
            OpCodeC = *(ByteCode + 2);

            // 对比特征值 寻找 nt!KeServiceDescriptorTable 函数地址
            /*
            nt!KiSystemServiceRepeat:
            fffff803`6ebd2b94 4c8d15e59c3b00  lea     r10,[nt!KeServiceDescriptorTable
(fffff803`6ef8c880)]
            fffff803`6ebd2b9b 4c8d1dde1e3a00  lea     r11,[nt!KeServiceDescriptorTableShadow
(fffff803`6ef74a80)]
            fffff803`6ebd2ba2 f7437880000000  test    dword ptr [rbx+78h],80h
            fffff803`6ebd2ba9 7413            je      nt!KiSystemServiceRepeat+0x2a
(fffff803`6ebd2bbe)  Branch
            */
            if (OpCodeA == 0x4c && OpCodeB == 0x8d && OpCodeC == 0x15)
            {
                // 获取高位地址fffff802
                memcpy(&templong, ByteCode + 3, 4);

                // 与低位64da4880地址相加得到完整地址
                addr = (ULONGLONG)templong + (ULONGLONG)ByteCode + 7;
                return addr;
            }
        }
    }
    return  0;
}

VOID UnDriver(PDRIVER_OBJECT driver)
{
    DbgPrint(("驱动程序卸载成功! \n"));
}
```

```
NTSTATUS DriverEntry(PDRIVER_OBJECT DriverObject, PUNICODE_STRING RegistryPath)
{
    DbgPrint("hello lyshark.com");

    ssdt_address = GetLySharkCOMKeServiceDescriptorTable();
    DbgPrint("[LyShark] SSDT = %p \n", ssdt_address);

    DriverObject->DriverUnload = UnDriver;
    return STATUS_SUCCESS;
}
```

如上代码中所提及的步骤我想不需要再做解释了，这段代码运行后即可输出SSDT表的基址。


DebugView on \\DESKTOP-B53PAVI (local)
File Edit Capture Options Computer Help

```
#   Time         Debug Print
24  18.90486145  2925468750 - STORMINI: StorNVMe - POWER: ACTIVE
25  19.13070488  hello lyshark.com
26  19.13571739  [LyShark Search] 扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8
27  19.14109993  [LyShark] SSDT = FFFFF8036EF8C880
28  20.04025650  2935468750 - STORMINI: StorNVMe - POWER: IDLE
29  20.15188217  2936562500 - STORMINI: StorNVMe - POWER: ACTIVE
30  21.17152405  2946718750 - STORMINI: StorNVMe - POWER: IDLE
31  24.79397392  2982812500 - STORMINI: StorNVMe - POWER: ACTIVE
32  24.80368996  2982812500 - STORMINI: StorNVMe - POWER: IDLE
33  25.69594955  2991718750 - STORMINI: StorNVMe - POWER: ACTIVE
34  25.70223618  2991718750 - STORMINI: StorNVMe - POWER: IDLE
35  25.71316338  2991718750 - STORMINI: StorNVMe - POWER: ACTIVE
36  26.72927666  3001875000 - STORMINI: StorNVMe - POWER: IDLE
37  29.84280968  3032968750 - STORMINI: StorNVMe - POWER: ACTIVE
38  29.85138512  3032968750 - STORMINI: StorNVMe - POWER: IDLE
39  29.85584068  3032968750 - STORMINI: StorNVMe - POWER: ACTIVE
40  30.86251831  3042968750 - STORMINI: StorNVMe - POWER: IDLE
```

如上通过调用`GetLySharkCOMKeServiceDescriptorTable()`得到`SSDT`地址以后我们就需要对该地址进行解密操作。

得到`ServiceTableBase`的地址后，就能得到每个服务函数的地址。但这个表存放的并不是`SSDT`函数的完整地址，而是其相对于`ServiceTableBase[Index]>>4`的数据，每个数据占四个字节，所以计算指定`Index`函数完整地址的公式是；

- 在x86平台上: FuncAddress = KeServiceDescriptorTable + 4 * Index
- 在x64平台上：FuncAddress = [KeServiceDescriptorTable+4*Index]>>4 + KeServiceDescriptorTable

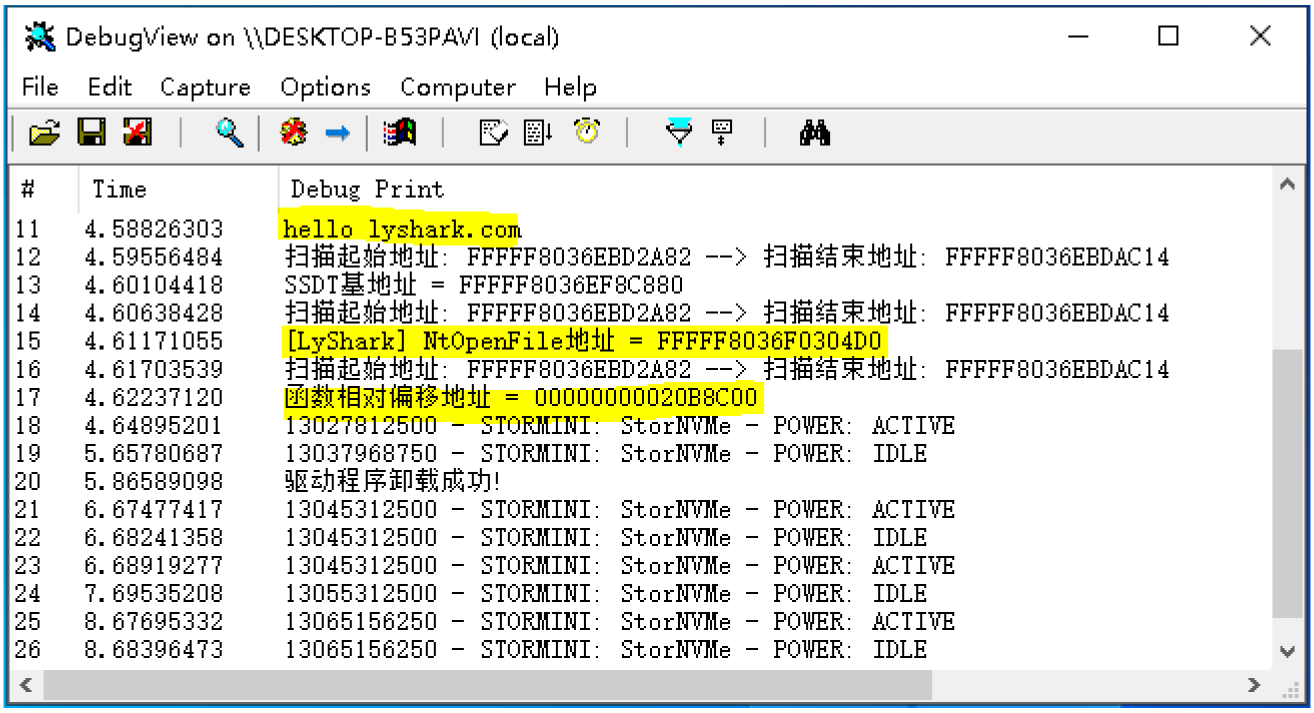
如下汇编代码就是一段解密代码，代码中`rcx`寄存器传入SSDT的下标，而`rdx`寄存器则是传入SSDT表基址。

```
48:8BC1                    | mov rax,rcx                           |  rcx=index
4C:8D12                    | lea r10,qword ptr ds:[rdx]            |  rdx=ssdt
8BF8                       | mov edi,eax                           |
C1EF 07                    | shr edi,7                             |
83E7 20                    | and edi,20                            |
4E:8B1417                  | mov r10,qword ptr ds:[rdi+r10]        |
4D:631C82                  | movsxd r11,dword ptr ds:[r10+rax*4]   |
49:8BC3                    | mov rax,r11                           |
49:C1FB 04                 | sar r11,4                             |
4D:03D3                    | add r10,r11                           |
49:8BC2                    | mov rax,r10                           |
C3                         | ret                                   |
```

有了解密公式以后代码的编写就变得很容易，如下是读取SSDT的完整代码。

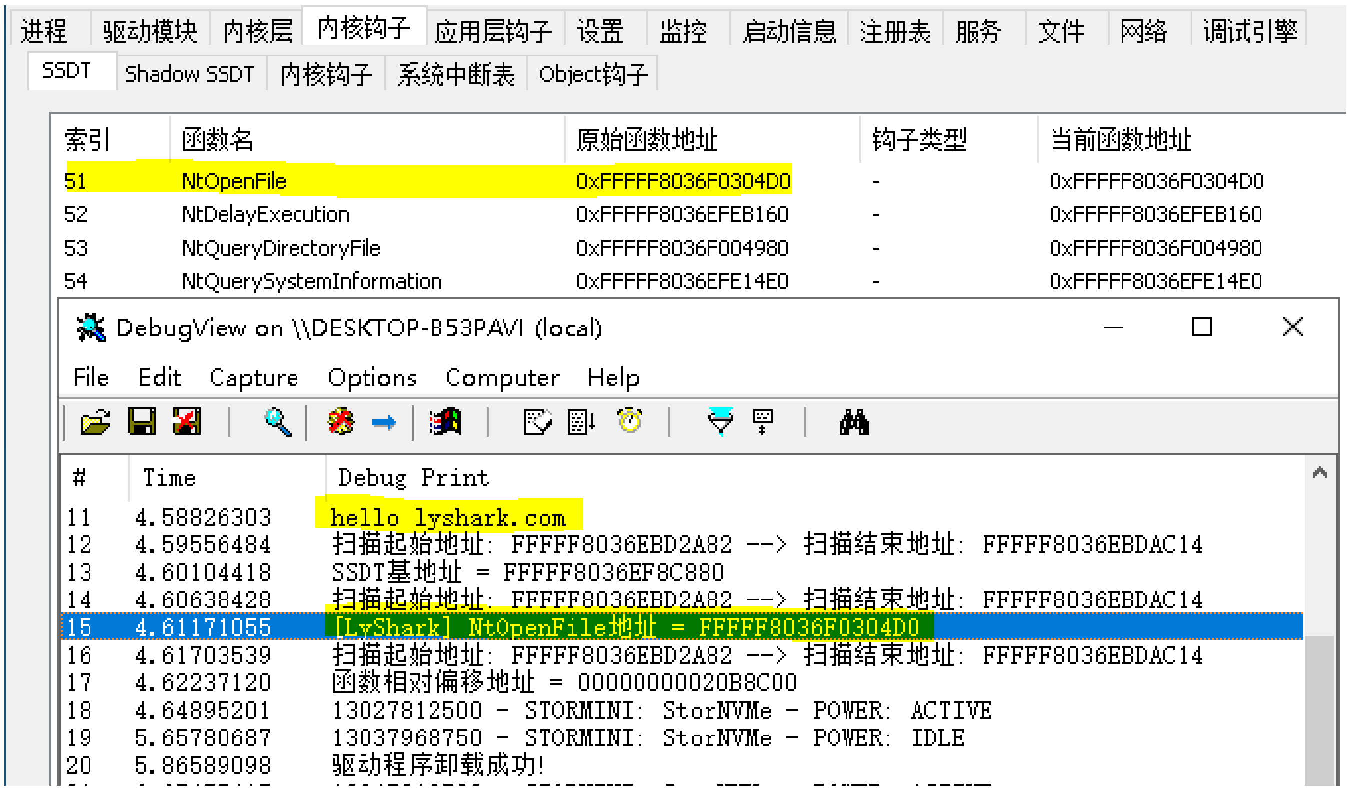
```
#include <ntifs.h>
#pragma intrinsic(__readmsr)

typedef struct _SYSTEM_SERVICE_TABLE
{
    PVOID     ServiceTableBase;
    PVOID     ServiceCounterTableBase;
    ULONGLONG   NumberOfServices;
    PVOID     ParamTableBase;
} SYSTEM_SERVICE_TABLE, *PSYSTEM_SERVICE_TABLE;

ULONGLONG ssdt_base_aadress;
PSYSTEM_SERVICE_TABLE KeServiceDescriptorTable;

typedef UINT64(__fastcall *SCFN)(UINT64, UINT64);
SCFN scfn;

// 解密算法
VOID DecodeSSDT()
{
    UCHAR strShellCode[36] =
"\x48\x8B\xC1\x4C\x8D\x12\x8B\xF8\xC1\xEF\x07\x83\xE7\x20\x4E\x8B\x14\x17\x4D\x63\x1C\x82\x49\x8B\xC3\x49\xC1\xFB\x04\x4D\x03\xD3\x49\x8B\xC2\xC3";
    /*
    48:8BC1                    | mov rax,rcx                           |  rcx=index
    4C:8D12                    | lea r10,qword ptr ds:[rdx]            |  rdx=ssdt
    8BF8                       | mov edi,eax                           |
    C1EF 07                    | shr edi,7                             |
    83E7 20                    | and edi,20                            |
    4E:8B1417                  | mov r10,qword ptr ds:[rdi+r10]        |
    4D:631C82                  | movsxd r11,dword ptr ds:[r10+rax*4]   |
    49:8BC3                    | mov rax,r11                           |
    49:C1FB 04                 | sar r11,4                             |
    4D:03D3                    | add r10,r11                           |
    49:8BC2                    | mov rax,r10                           |
    C3                         | ret                                   |
    */
    scfn = ExAllocatePool(NonPagedPool, 36);
    memcpy(scfn, strShellCode, 36);
}

// 获取 KeServiceDescriptorTable 首地址
ULONGLONG GetKeServiceDescriptorTable()
{
    // 设置起始位置
    PUCHAR StartSearchAddress = (PUCHAR)__readmsr(0xC0000082) - 0x1806FE;

    // 设置结束位置
    PUCHAR EndSearchAddress = StartSearchAddress + 0x8192;
    DbgPrint("扫描起始地址: %p --> 扫描结束地址: %p \n", StartSearchAddress, EndSearchAddress);

    PUCHAR ByteCode = NULL;

    UCHAR OpCodeA = 0, OpCodeB = 0, OpCodeC = 0;
    ULONGLONG addr = 0;
    ULONG templong = 0;

    for (ByteCode = StartSearchAddress; ByteCode < EndSearchAddress; ByteCode++)
    {
        // 使用MmIsAddressValid()函数检查地址是否有页面错误
        if (MmIsAddressValid(ByteCode) && MmIsAddressValid(ByteCode + 1) &&
MmIsAddressValid(ByteCode + 2))
        {
            OpCodeA = *ByteCode;
            OpCodeB = *(ByteCode + 1);
            OpCodeC = *(ByteCode + 2);

            // 对比特征值 寻找 nt!KeServiceDescriptorTable 函数地址
            // LyShark.com
            // 4c 8d 15 e5 9e 3b 00  lea r10,[nt!KeServiceDescriptorTable
(fffff802`64da4880)]
            // 4c 8d 1d de 20 3a 00  lea r11,[nt!KeServiceDescriptorTableShadow
(fffff802`64d8ca80)]
            if (OpCodeA == 0x4c && OpCodeB == 0x8d && OpCodeC == 0x15)
            {
                // 获取高位地址fffff802
                memcpy(&templong, ByteCode + 3, 4);

                // 与低位64da4880地址相加得到完整地址
                addr = (ULONGLONG)templong + (ULONGLONG)ByteCode + 7;
                return addr;
            }
        }
    }
    return  0;
}

// 得到函数相对偏移地址
ULONG GetOffsetAddress(ULONGLONG FuncAddr)
{
    ULONG dwtmp = 0;
    PULONG ServiceTableBase = NULL;
    if (KeServiceDescriptorTable == NULL)
    {
        KeServiceDescriptorTable = (PSYSTEM_SERVICE_TABLE)GetKeServiceDescriptorTable();
    }
    ServiceTableBase = (PULONG)KeServiceDescriptorTable->ServiceTableBase;
    dwtmp = (ULONG)(FuncAddr - (ULONGLONG)ServiceTableBase);
    return dwtmp << 4;
}

// 根据序号得到函数地址
ULONGLONG GetSSDTFunctionAddress(ULONGLONG NtApiIndex)
{
    ULONGLONG ret = 0;
    if (ssdt_base_aadress == 0)
    {
        // 得到ssdt基地址
        ssdt_base_aadress = GetKeServiceDescriptorTable();
    }
    if (scfn == NULL)
    {
        DecodeSSDT();
    }
    ret = scfn(NtApiIndex, ssdt_base_aadress);
    return ret;
}

VOID UnDriver(PDRIVER_OBJECT driver)
{
    DbgPrint(("驱动程序卸载成功! \n"));
}

NTSTATUS DriverEntry(PDRIVER_OBJECT DriverObject, PUNICODE_STRING RegistryPath)
{
    DbgPrint("hello lyshark.com \n");

    ULONGLONG ssdt_address = GetKeServiceDescriptorTable();
    DbgPrint("SSDT基地址 = %p \n", ssdt_address);

    // 根据序号得到函数地址
    ULONGLONG address = GetSSDTFunctionAddress(51);
    DbgPrint("[LyShark] NtOpenFile地址 = %p \n", address);

    // 得到相对SSDT的偏移量
    DbgPrint("函数相对偏移地址 = %p \n", GetOffsetAddress(address));

    DriverObject->DriverUnload = UnDriver;
    return STATUS_SUCCESS;
}
```

运行后即可得到`SSDT`下标为`51`的函数也就是得到`NtOpenFile`的绝对地址和相对地址。


DebugView on \\DESKTOP-B53PAVI (local)
File Edit Capture Options Computer Help

```
#   Time         Debug Print
11  4.58826303   hello lyshark.com
12  4.59556484   扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8036EBDAC14
13  4.60104418   SSDT基地址 = FFFFF8036EF8C880
14  4.60638428   扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8036EBDAC14
15  4.61171055   [LyShark] NtOpenFile地址 = FFFFF8036F0304D0
16  4.61703539   扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8036EBDAC14
17  4.62237120   函数相对偏移地址 = 0000000020B8C00
18  4.64895201   13027812500 - STORMINI: StorNVMe - POWER: ACTIVE
19  5.65780687   13037968750 - STORMINI: StorNVMe - POWER: IDLE
20  5.86589098   驱动程序卸载成功!
21  6.67477417   13045312500 - STORMINI: StorNVMe - POWER: ACTIVE
22  6.68241358   13045312500 - STORMINI: StorNVMe - POWER: IDLE
23  6.68919277   13045312500 - STORMINI: StorNVMe - POWER: ACTIVE
24  7.69535208   13055312500 - STORMINI: StorNVMe - POWER: IDLE
25  8.67695332   13065156250 - STORMINI: StorNVMe - POWER: ACTIVE
26  8.68396473   13065156250 - STORMINI: StorNVMe - POWER: IDLE
```

你也可以打开ARK工具，对比一下是否一致，如下图所示，`LyShark` 的代码是没有任何问题的。


进程 驱动模块 内核层 内核钩子 应用层钩子 设置 监控 启动信息 注册表 服务 文件 网络 调试引擎
SSDT Shadow SSDT 内核钩子 系统中断表 Object钩子

索引	函数名	原始函数地址	钩子类型	当前函数地址
51	NtOpenFile	0xFFFFF8036F0304D0	-	0xFFFFF8036F0304D0
52	NtDelayExecution	0xFFFFF8036EFEB160	-	0xFFFFF8036EFEB160
53	NtQueryDirectoryFile	0xFFFFF8036F004980	-	0xFFFFF8036F004980
54	NtQuerySystemInformation	0xFFFFF8036EFE14E0	-	0xFFFFF8036EFE14E0

DebugView on \\DESKTOP-B53PAVI (local)
File Edit Capture Options Computer Help

```
#   Time         Debug Print
11  4.58826303   hello lyshark.com
12  4.59556484   扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8036EBDAC14
13  4.60104418   SSDT基地址 = FFFFF8036EF8C880
14  4.60638428   扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8036EBDAC14
15  4.61171055   [LyShark] NtOpenFile地址 = FFFFF8036F0304D0
16  4.61703539   扫描起始地址: FFFFF8036EBD2A82 --> 扫描结束地址: FFFFF8036EBDAC14
17  4.62237120   函数相对偏移地址 = 0000000020B8C00
18  4.64895201   13027812500 - STORMINI: StorNVMe - POWER: ACTIVE
19  5.65780687   13037968750 - STORMINI: StorNVMe - POWER: IDLE
20  5.86589098   驱动程序卸载成功!
```

根据上述方法的内容进行扩展，枚举完整SSDT表我们可以这样来实现，通过循环一个列表依次输出所有的SSDT字符串并得到其地址，代码如下所示；

```
#include <ntifs.h>

#pragma intrinsic(__readmsr)

typedef struct _SYSTEM_SERVICE_TABLE
{
    PVOID       ServiceTableBase;
    PVOID     ServiceCounterTableBase;
    ULONGLONG   NumberOfServices;
    PVOID     ParamTableBase;
} SYSTEM_SERVICE_TABLE, *PSYSTEM_SERVICE_TABLE;

ULONGLONG ssdt_base_aadress;
PSYSTEM_SERVICE_TABLE KeServiceDescriptorTable;

typedef UINT64(__fastcall *SCFN)(UINT64, UINT64);
SCFN scfn;

// 解密算法
VOID DecodeSSDT()
{
    UCHAR strShellCode[36] =
"\x48\x8B\xC1\x4C\x8D\x12\x8B\xF8\xC1\xEF\x07\x83\xE7\x20\x4E\x8B\x14\x17\x4D\x63\x1C\x82\x4
9\x8B\xC3\x49\xC1\xFB\x04\x4D\x03\xD3\x49\x8B\xC2\xC3";
    /*
    48:8BC1                  | mov rax,rcx                        |  rcx=index
    4C:8D12                  | lea r10,qword ptr ds:[rdx]         |  rdx=ssdt
    8BF8                     | mov edi,eax                        |
    C1EF 07                  | shr edi,7                          |
    83E7 20                  | and edi,20                         |
    4E:8B1417                | mov r10,qword ptr ds:[rdi+r10]     |
    4D:631C82                | movsxd r11,dword ptr ds:[r10+rax*4] |
    49:8BC3                  | mov rax,r11                        |
    49:C1FB 04               | sar r11,4                          |
    4D:03D3                  | add r10,r11                        |
    49:8BC2                  | mov rax,r10                        |
    C3                       | ret                                |
    */
    scfn = ExAllocatePool(NonPagedPool, 36);
    memcpy(scfn, strShellCode, 36);
}

// 获取 KeServiceDescriptorTable 首地址
ULONGLONG GetKeServiceDescriptorTable()
{
    // 设置起始位置
    PUCHAR StartSearchAddress = (PUCHAR)__readmsr(0xC0000082) - 0x1806FE;

    // 设置结束位置
    PUCHAR EndSearchAddress = StartSearchAddress + 0x8192;
    // DbgPrint("扫描起始地址: %p --> 扫描结束地址: %p \n", StartSearchAddress,
EndSearchAddress);

    PUCHAR ByteCode = NULL;

    UCHAR OpCodeA = 0, OpCodeB = 0, OpCodeC = 0;
    ULONGLONG addr = 0;
    ULONG templong = 0;

    for (ByteCode = StartSearchAddress; ByteCode < EndSearchAddress; ByteCode++)
    {
        // 使用MmIsAddressValid()函数检查地址是否有页面错误
        if (MmIsAddressValid(ByteCode) && MmIsAddressValid(ByteCode + 1) &&
MmIsAddressValid(ByteCode + 2))
        {
            OpCodeA = *ByteCode;
            OpCodeB = *(ByteCode + 1);
            OpCodeC = *(ByteCode + 2);

            // 对比特征值 寻找 nt!KeServiceDescriptorTable 函数地址
            // LyShark.com
            // 4c 8d 15 e5 9e 3b 00  lea r10,[nt!KeServiceDescriptorTable
(fffff802`64da4880)]
            // 4c 8d 1d de 20 3a 00  lea r11,[nt!KeServiceDescriptorTableShadow
(fffff802`64d8ca80)]
            if (OpCodeA == 0x4c && OpCodeB == 0x8d && OpCodeC == 0x15)
            {
                // 获取高位地址fffff802
                memcpy(&templong, ByteCode + 3, 4);

                // 与低位64da4880地址相加得到完整地址
                addr = (ULONGLONG)templong + (ULONGLONG)ByteCode + 7;
                return addr;
            }
        }
    }
    return  0;
}

// 得到函数相对偏移地址
ULONG GetOffsetAddress(ULONGLONG FuncAddr)
{
    ULONG dwtmp = 0;
    PULONG ServiceTableBase = NULL;
    if (KeServiceDescriptorTable == NULL)
    {
        KeServiceDescriptorTable = (PSYSTEM_SERVICE_TABLE)GetKeServiceDescriptorTable();
    }
    ServiceTableBase = (PULONG)KeServiceDescriptorTable->ServiceTableBase;
    dwtmp = (ULONG)(FuncAddr - (ULONGLONG)ServiceTableBase);
    return dwtmp << 4;
}

// 根据序号得到函数地址
ULONGLONG GetSSDTFunctionAddress(ULONGLONG NtApiIndex)
{
    ULONGLONG ret = 0;
    if (ssdt_base_aadress == 0)
    {
        // 得到ssdt基地址
        ssdt_base_aadress = GetKeServiceDescriptorTable();
    }
    if (scfn == NULL)
    {
        DecodeSSDT();
    }
    ret = scfn(NtApiIndex, ssdt_base_aadress);
    return ret;
}

// 查询函数系统地址
ULONG_PTR QueryFunctionSystemAddress(PWCHAR name)
{
    UNICODE_STRING na;
    ULONG_PTR address;
    RtlInitUnicodeString(&na, name);
    address = (ULONG_PTR)MmGetSystemRoutineAddress(&na);
    return address;
}

VOID UnDriver(PDRIVER_OBJECT driver)
{
    DbgPrint(("驱动程序卸载成功! \n"));
}

NTSTATUS DriverEntry(PDRIVER_OBJECT DriverObject, PUNICODE_STRING RegistryPath)
{
    DbgPrint("hello lyshark.com \n");
    char *SSDT[464] = { "NtAccessCheck", "NtWorkerFactoryWorkerReady",
"NtAcceptConnectPort", "NtMapUserPhysicalPagesScatter", "NtWaitForSingleObject",
"NtCallbackReturn", "NtReadFile", "NtDeviceIoControlFile", "NtWriteFile",
"NtRemoveIoCompletion", "NtReleaseSemaphore", "NtReplyWaitReceivePort", "NtReplyPort",
"NtSetInformationThread", "NtSetEvent", "NtClose", "NtQueryObject",
"NtQueryInformationFile", "NtOpenKey", "NtEnumerateValueKey", "NtFindAtom",
"NtQueryDefaultLocale", "NtQueryKey", "NtQueryValueKey", "NtAllocateVirtualMemory",
"NtQueryInformationProcess", "NtWaitForMultipleObjects32", "NtWriteFileGather",
"NtSetInformationProcess", "NtCreateKey", "NtFreeVirtualMemory",
"NtImpersonateClientOfPort", "NtReleaseMutant", "NtQueryInformationToken",
"NtRequestWaitReplyPort", "NtQueryVirtualMemory", "NtOpenThreadToken",
"NtQueryInformationThread", "NtOpenProcess", "NtSetInformationFile", "NtMapViewOfSection",
"NtAccessCheckAndAuditAlarm", "NtUnmapViewOfSection", "NtReplyWaitReceivePortEx",
"NtTerminateProcess", "NtSetEventBoostPriority", "NtReadFileScatter", "NtOpenThreadTokenEx",
"NtOpenProcessTokenEx", "NtQueryPerformanceCounter", "NtEnumerateKey", "NtOpenFile",
"NtDelayExecution", "NtQueryDirectoryFile", "NtQuerySystemInformation", "NtOpenSection",
"NtQueryTimer", "NtFsControlFile", "NtWriteVirtualMemory", "NtCloseObjectAuditAlarm",
"NtDuplicateObject", "NtQueryAttributesFile", "NtClearEvent", "NtReadVirtualMemory",
"NtOpenEvent", "NtAdjustPrivilegesToken", "NtDuplicateToken", "NtContinue",
"NtQueryDefaultUILanguage", "NtQueueApcThread", "NtYieldExecution", "NtAddAtom",
"NtCreateEvent", "NtQueryVolumeInformationFile", "NtCreateSection", "NtFlushBuffersFile",
"NtApphelpCacheControl", "NtCreateProcessEx", "NtCreateThread", "NtIsProcessInJob",
"NtProtectVirtualMemory", "NtQuerySection", "NtResumeThread", "NtTerminateThread",
"NtReadRequestData", "NtCreateFile", "NtQueryEvent", "NtWriteRequestData",
"NtOpenDirectoryObject", "NtAccessCheckByTypeAndAuditAlarm", "NtQuerySystemTime",
"NtWaitForMultipleObjects", "NtSetInformationObject", "NtCancelIoFile", "NtTraceEvent",
"NtPowerInformation", "NtSetValueKey", "NtCancelTimer", "NtSetTimer", "NtAccessCheckByType",
"NtAccessCheckByTypeResultList", "NtAccessCheckByTypeResultListAndAuditAlarm",
"NtAccessCheckByTypeResultListAndAuditAlarmByHandle", "NtAcquireProcessActivityReference",
"NtAddAtomEx", "NtAddBootEntry", "NtAddDriverEntry", "NtAdjustGroupsToken",
"NtAdjustTokenClaimsAndDeviceGroups", "NtAlertResumeThread", "NtAlertThread",
"NtAlertThreadByThreadId", "NtAllocateLocallyUniqueId", "NtAllocateReserveObject",
"NtAllocateUserPhysicalPages", "NtAllocateUuids", "NtAllocateVirtualMemoryEx",
"NtAlpcAcceptConnectPort", "NtAlpcCancelMessage", "NtAlpcConnectPort",
"NtAlpcConnectPortEx", "NtAlpcCreatePort", "NtAlpcCreatePortSection",
"NtAlpcCreateResourceReserve", "NtAlpcCreateSectionView", "NtAlpcCreateSecurityContext",
"NtAlpcDeletePortSection", "NtAlpcDeleteResourceReserve", "NtAlpcDeleteSectionView",
"NtAlpcDeleteSecurityContext", "NtAlpcDisconnectPort",
"NtAlpcImpersonateClientContainerOfPort", "NtAlpcImpersonateClientOfPort",
"NtAlpcOpenSenderProcess", "NtAlpcOpenSenderThread", "NtAlpcQueryInformation",
"NtAlpcQueryInformationMessage", "NtAlpcRevokeSecurityContext", "NtAlpcSendWaitReceivePort",
"NtAlpcSetInformation", "NtAreMappedFilesTheSame", "NtAssignProcessToJobObject",
"NtAssociateWaitCompletionPacket", "NtCallEnclave", "NtCancelIoFileEx",
"NtCancelSynchronousIoFile", "NtCancelTimer2", "NtCancelWaitCompletionPacket",
"NtCommitComplete", "NtCommitEnlistment", "NtCommitRegistryTransaction",
"NtCommitTransaction", "NtCompactKeys", "NtCompareObjects", "NtCompareSigningLevels",
"NtCompareTokens", "ArbPreprocessEntry", "NtCompressKey", "NtConnectPort",
"NtConvertBetweenAuxiliaryCounterAndPerformanceCounter", "ArbAddReserved",
"NtCreateDebugObject", "NtCreateDirectoryObject", "NtCreateDirectoryObjectEx",
"NtCreateEnclave", "NtCreateEnlistment", "NtCreateEventPair", "NtCreateIRTimer",
"NtCreateIoCompletion", "NtCreateJobObject", "ArbAddReserved", "NtCreateKeyTransacted",
"NtCreateKeyedEvent", "NtCreateLowBoxToken", "NtCreateMailslotFile", "NtCreateMutant",
"NtCreateNamedPipeFile", "NtCreatePagingFile", "NtCreatePartition", "NtCreatePort",
"NtCreatePrivateNamespace", "NtCreateProcess", "NtCreateProfile", "NtCreateProfileEx",
"NtCreateRegistryTransaction", "NtCreateResourceManager", "NtCreateSectionEx",
"NtCreateSemaphore", "NtCreateSymbolicLinkObject", "NtCreateThreadEx", "NtCreateTimer",
"NtCreateTimer2", "NtCreateToken", "NtCreateTokenEx", "NtCreateTransaction",
"NtCreateTransactionManager", "NtCreateUserProcess", "NtCreateWaitCompletionPacket",
"NtCreateWaitablePort", "NtCreateWnfStateName", "NtCreateWorkerFactory",
"NtDebugActiveProcess", "NtDebugContinue", "NtDeleteAtom", "NtDeleteBootEntry",
"NtDeleteDriverEntry", "NtDeleteFile", "NtDeleteKey", "NtDeleteObjectAuditAlarm",
"NtDeletePrivateNamespace", "NtDeleteValueKey", "NtDeleteWnfStateData",
"NtDeleteWnfStateName", "NtDisableLastKnownGood", "NtDisplayString", "NtDrawText",
"NtEnableLastKnownGood", "NtEnumerateBootEntries", "NtEnumerateDriverEntries",
"NtEnumerateSystemEnvironmentValuesEx", "NtEnumerateTransactionObject", "NtExtendSection",
"NtFilterBootOption", "NtFilterToken", "NtFilterTokenEx", "NtFlushBuffersFileEx",
"NtFlushInstallUILanguage", "ArbPreprocessEntry", "NtFlushKey",
"NtFlushProcessWriteBuffers", "NtFlushVirtualMemory", "NtFlushWriteBuffer",
"NtFreeUserPhysicalPages", "NtFreezeRegistry", "NtFreezeTransactions",
"NtGetCachedSigningLevel", "NtGetCompleteWnfStateSubscription", "NtGetContextThread",
"NtGetCurrentProcessorNumber", "NtGetCurrentProcessorNumberEx", "NtGetDevicePowerState",
"NtGetMUIRegistryInfo", "NtGetNextProcess", "NtGetNextThread", "NtGetNlsSectionPtr",
"NtGetNotificationResourceManager", "NtGetWriteWatch", "NtImpersonateAnonymousToken",
"NtImpersonateThread", "NtInitializeEnclave", "NtInitializeNlsFiles",
"NtInitializeRegistry", "NtInitiatePowerAction", "NtIsSystemResumeAutomatic",
"NtIsUILanguageComitted", "NtListenPort", "NtLoadDriver", "NtLoadEnclaveData", "NtLoadKey",
"NtLoadKey2", "NtLoadKeyEx", "NtLockFile", "NtLockProductActivationKeys",
"NtLockRegistryKey", "NtLockVirtualMemory", "NtMakePermanentObject",
"NtMakeTemporaryObject", "NtManageHotPatch", "NtManagePartition", "NtMapCMFModule",
"NtMapUserPhysicalPages", "NtMapViewOfSectionEx", "NtModifyBootEntry",
"NtModifyDriverEntry", "NtNotifyChangeDirectoryFile", "NtNotifyChangeDirectoryFileEx",
"NtNotifyChangeKey", "NtNotifyChangeMultipleKeys", "NtNotifyChangeSession",
"NtOpenEnlistment", "NtOpenEventPair", "NtOpenIoCompletion", "NtOpenJobObject",
"NtOpenKeyEx", "NtOpenKeyTransacted", "NtOpenKeyTransactedEx", "NtOpenKeyedEvent",
"NtOpenMutant", "NtOpenObjectAuditAlarm", "NtOpenPartition", "NtOpenPrivateNamespace",
"NtOpenProcessToken", "NtOpenRegistryTransaction", "NtOpenResourceManager",
"NtOpenSemaphore", "NtOpenSession", "NtOpenSymbolicLinkObject", "NtOpenThread",
"NtOpenTimer", "NtOpenTransaction", "NtOpenTransactionManager", "NtPlugPlayControl",
"NtPrePrepareComplete", "NtPrePrepareEnlistment", "NtPrepareComplete",
"NtPrepareEnlistment", "NtPrivilegeCheck", "NtPrivilegeObjectAuditAlarm",
"NtPrivilegedServiceAuditAlarm", "NtPropagationComplete", "NtPropagationFailed",
"NtPulseEvent", "NtQueryAuxiliaryCounterFrequency", "NtQueryBootEntryOrder",
"NtQueryBootOptions", "NtQueryDebugFilterState", "NtQueryDirectoryFileEx",
"NtQueryDirectoryObject", "NtQueryDriverEntryOrder", "NtQueryEaFile",
"NtQueryFullAttributesFile", "NtQueryInformationAtom", "NtQueryInformationByName",
"NtQueryInformationEnlistment", "NtQueryInformationJobObject", "NtQueryInformationPort",
"NtQueryInformationResourceManager", "NtQueryInformationTransaction",
"NtQueryInformationTransactionManager", "NtQueryInformationWorkerFactory",
"NtQueryInstallUILanguage", "NtQueryIntervalProfile", "NtQueryIoCompletion",
"NtQueryLicenseValue", "NtQueryMultipleValueKey", "NtQueryMutant", "NtQueryOpenSubKeys",
"NtQueryOpenSubKeysEx", "CmpCleanUpHigherLayerKcbCachesPreCallback",
"NtQueryQuotaInformationFile", "NtQuerySecurityAttributesToken", "NtQuerySecurityObject",
"NtQuerySecurityPolicy", "NtQuerySemaphore", "NtQuerySymbolicLinkObject",
"NtQuerySystemEnvironmentValue", "NtQuerySystemEnvironmentValueEx",
"NtQuerySystemInformationEx", "NtQueryTimerResolution", "NtQueryWnfStateData",
"NtQueryWnfStateNameInformation", "NtQueueApcThreadEx", "NtRaiseException",
"NtRaiseHardError", "NtReadOnlyEnlistment", "NtRecoverEnlistment",
"NtRecoverResourceManager", "NtRecoverTransactionManager",
"NtRegisterProtocolAddressInformation", "NtRegisterThreadTerminatePort",
"NtReleaseKeyedEvent", "NtReleaseWorkerFactoryWorker", "NtRemoveIoCompletionEx",
"NtRemoveProcessDebug", "NtRenameKey", "NtRenameTransactionManager", "NtReplaceKey",
"NtReplacePartitionUnit", "NtReplyWaitReplyPort", "NtRequestPort", "NtResetEvent",
"NtResetWriteWatch", "NtRestoreKey", "NtResumeProcess", "NtRevertContainerImpersonation",
"NtRollbackComplete", "NtRollbackEnlistment", "NtRollbackRegistryTransaction",
"NtRollbackTransaction", "NtRollforwardTransactionManager", "NtSaveKey", "NtSaveKeyEx",
"NtSaveMergedKeys", "NtSecureConnectPort", "NtSerializeBoot", "NtSetBootEntryOrder",
"NtSetBootOptions", "NtSetCachedSigningLevel", "NtSetCachedSigningLevel2",
"NtSetContextThread", "NtSetDebugFilterState", "NtSetDefaultHardErrorPort",
"NtSetDefaultLocale", "NtSetDefaultUILanguage", "NtSetDriverEntryOrder", "NtSetEaFile",
"NtSetHighEventPair", "NtSetHighWaitLowEventPair", "NtSetIRTimer",
"NtSetInformationDebugObject", "NtSetInformationEnlistment", "NtSetInformationJobObject",
"NtSetInformationKey", "NtSetInformationResourceManager", "NtSetInformationSymbolicLink",
"NtSetInformationToken", "NtSetInformationTransaction",
"NtSetInformationTransactionManager", "NtSetInformationVirtualMemory",
"NtSetInformationWorkerFactory", "NtSetIntervalProfile", "NtSetIoCompletion",
"NtSetIoCompletionEx", "BvgaSetVirtualFrameBuffer", "NtSetLowEventPair",
"NtSetLowWaitHighEventPair", "NtSetQuotaInformationFile", "NtSetSecurityObject",
"NtSetSystemEnvironmentValue", "NtSetSystemEnvironmentValueEx", "NtSetSystemInformation",
"NtSetSystemPowerState", "NtSetSystemTime", "NtSetThreadExecutionState", "NtSetTimer2",
"NtSetTimerEx", "NtSetTimerResolution", "NtSetUuidSeed", "NtSetVolumeInformationFile",
"NtSetWnfProcessNotificationEvent", "NtShutdownSystem", "NtShutdownWorkerFactory",
"NtSignalAndWaitForSingleObject", "NtSinglePhaseReject", "NtStartProfile", "NtStopProfile",
"NtSubscribeWnfStateChange", "NtSuspendProcess", "NtSuspendThread", "NtSystemDebugControl",
"NtTerminateEnclave", "NtTerminateJobObject", "NtTestAlert", "NtThawRegistry",
"NtThawTransactions", "NtTraceControl", "NtTranslateFilePath", "NtUmsThreadYield",
"NtUnloadDriver", "NtUnloadKey", "NtUnloadKey2", "NtUnloadKeyEx", "NtUnlockFile",
"NtUnlockVirtualMemory", "NtUnmapViewOfSectionEx", "NtUnsubscribeWnfStateChange",
"NtUpdateWnfStateData", "NtVdmControl", "NtWaitForAlertByThreadId", "NtWaitForDebugEvent",
"NtWaitForKeyedEvent", "NtWaitForWorkViaWorkerFactory", "NtWaitHighEventPair",
"NtWaitLowEventPair" };

    for (size_t lyshark = 0; lyshark < 464; lyshark++)
    {
        // 获取起源地址
        ANSI_STRING ansi = { 0 };
        UNICODE_STRING uncode = { 0 };

        ULONGLONG ssdt_address = GetKeServiceDescriptorTable();
        // DbgPrint("SSDT基地址 = %p \n", ssdt_address);

        // 根据序号得到函数地址
        ULONGLONG address = GetSSDTFunctionAddress(lyshark);
        ULONG offset = GetOffsetAddress(address);

        RtlInitAnsiString(&ansi, SSDT[lyshark]);
        RtlAnsiStringToUnicodeString(&uncode, &ansi, TRUE);
        PULONGLONG source_address = MmGetSystemRoutineAddress(&uncode);
        DbgPrint("[LyShark] 序号 => [%d] | 当前地址 => %p | 起源地址 => %p | 相对地址 => %p |
SSDT => %s \n", lyshark, address, source_address, offset, SSDT[lyshark]);
```

```
    }

    DriverObject->DriverUnload = UnDriver;
    return STATUS_SUCCESS;
}
```

我们运行这段程序，即可得到整个系统中所有的SSDT表地址信息；

在WinDBG中可看到完整的输出内容，当然有些函数没有被导出，起源地址是拿不到的。