# Module 1

A journey from high level languages, through assembly, to the running process

https://github.com/hasherezade/malware_training_vol1

## Creating shellcodes

## Shellcode: advantages

- Self-sufficient: easy to inject into other applications
- Small: can fit into a tiny space i.e. caves between sections
- May be used as a loader: first code injected into an application, that follows to load other modules
- Sometimes (but less often) the full malicious functionality can be implemented as shellcode (i.e. Fobber malware)
- This type of code was popular in the past, virus era: where malware code was added to existing PE files (rather than injected into processes)

## Creating shellcode

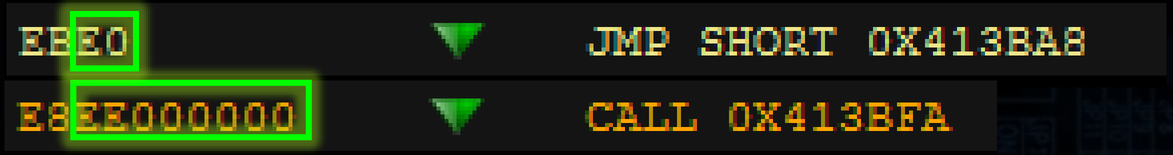
- In case of PE format we just write a code and don't have to worry how it is loaded: Windows Loader will do it
- It is different when we write shellcode
- We cannot rely on the conviniences provided by PE format and Windows Loader:
    - No sections
    - No Data Directories (imports, relocations)
    - Only code to provide everything we need…

## Creating shellcode

| Feature | PE file | shellcode |
|---|---|---|
| Loading | • via Windows Loader<br>• running new EXE triggers creation of a new process | • Custom, simplified<br>• must parasite on existing process (i.e. via code injection + thread injection) |
| Composition | Sections with specific access rights, carrying various elements (code, data, resources, etc) | All in one memory area (read,write,execute) |
| Relocation to the load base | Defined by relocation table, applied by Windows Loader | Cutom; position-independent code |
| Access to system API (Imports loading) | Defined by import table, applied by Windows Loader | Custom: retrieving imports via PEB lookup; no IAT, or simplified |

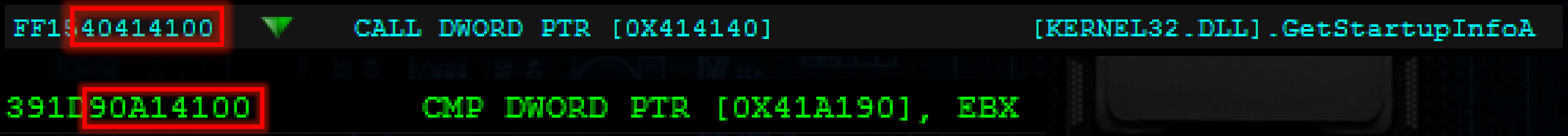
# Position-independent code

- In order to create a position-independent code, we must take care that all the addresses that we use are relative to the current intruction pointer address
- A short jump, long jump, call to a local funcion are relative -> we can use them!



```
EBE0           JMP SHORT 0X413BA8
E8EE000000     CALL 0X413BFA
```

- Any address that needs to be relocated (i.e. using of the data from different PE section) breaks the position independence:



```
FF1540414100   CALL DWORD PTR [0X414140]          [KERNEL32.DLL].GetStartupInfoA
391D90A14100   CMP DWORD PTR [0X41A190], EBX
```

## Retrieving the Imports

- In order to retrieve the imported functions, we will take advantage of the linklist pointed by PEB

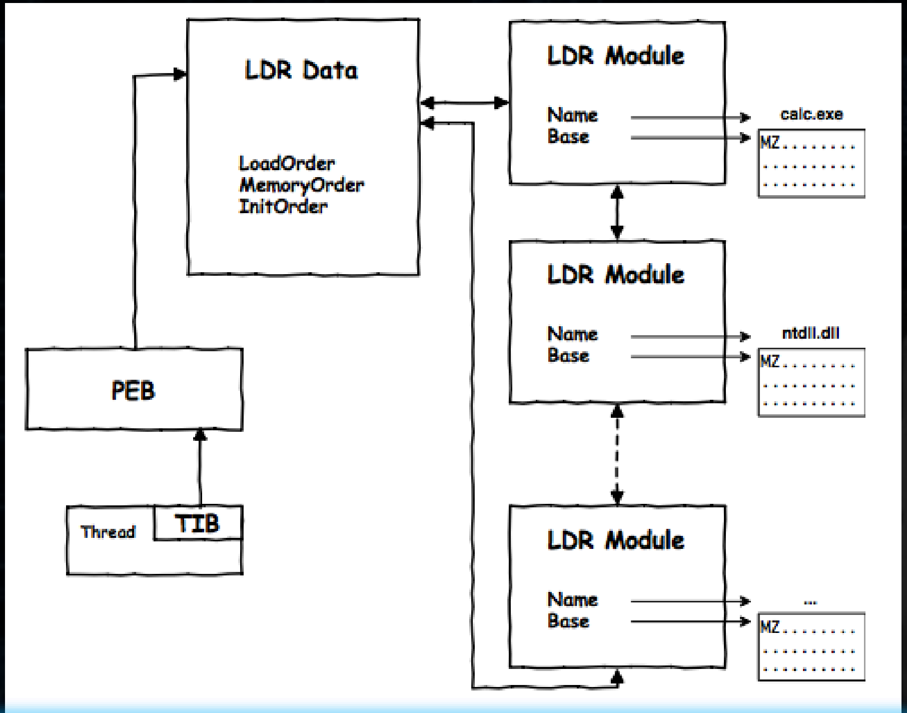


Image from:
[http://blog.malcom.pl/2017/shellcode-peb-i-adres-bazowy-modulu-kernel32-dll.html](http://blog.malcom.pl/2017/shellcode-peb-i-adres-bazowy-modulu-kernel32-dll.html)

# Retrieving the Imports

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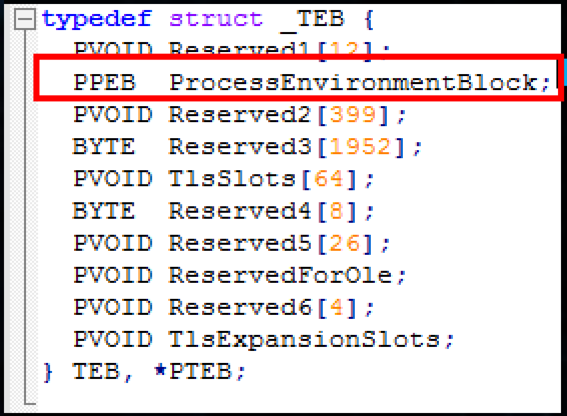
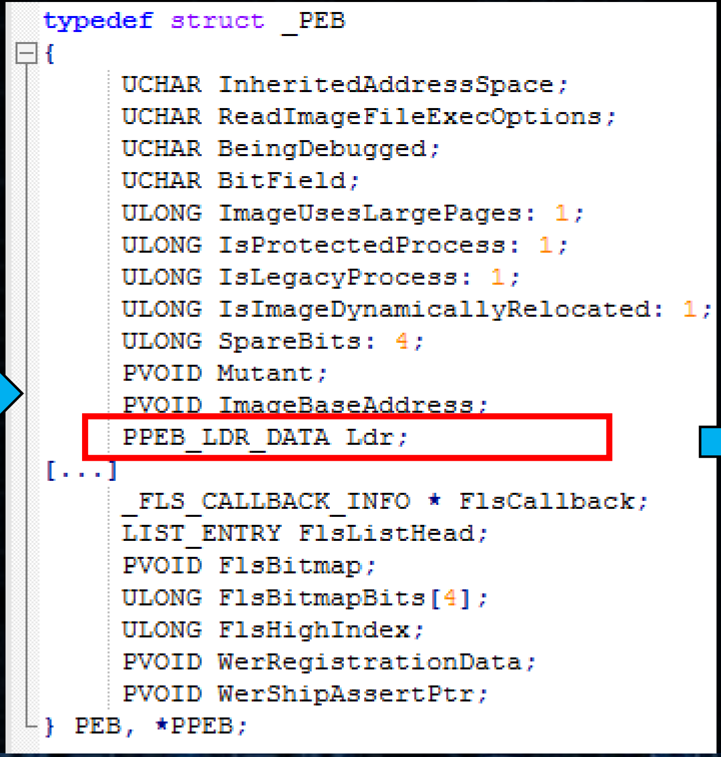
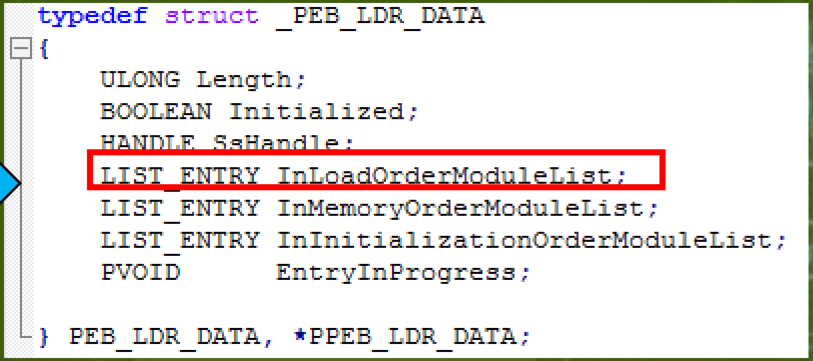


```
typedef struct _TEB {
    PVOID Reserved1[12];
    PPEB  ProcessEnvironmentBlock;
    PVOID Reserved2[399];
    BYTE  Reserved3[1952];
    PVOID TlsSlots[64];
    BYTE  Reserved4[8];
    PVOID Reserved5[26];
    PVOID ReservedForOle;
    PVOID Reserved6[4];
    PVOID TlsExpansionSlots;
} TEB, *PTEB;
```



```
typedef struct _PEB
{
        UCHAR InheritedAddressSpace;
        UCHAR ReadImageFileExecOptions;
        UCHAR BeingDebugged;
        UCHAR BitField;
        ULONG ImageUsesLargePages: 1;
        ULONG IsProtectedProcess: 1;
        ULONG IsLegacyProcess: 1;
        ULONG IsImageDynamicallyRelocated: 1;
        ULONG SpareBits: 4;
        PVOID Mutant;
        PVOID ImageBaseAddress;
        PPEB_LDR_DATA Ldr;
[...]
        _FLS_CALLBACK_INFO * FlsCallback;
        LIST_ENTRY FlsListHead;
        PVOID FlsBitmap;
        ULONG FlsBitmapBits[4];
        ULONG FlsHighIndex;
        PVOID WerRegistrationData;
        PVOID WerShipAssertPtr;
} PEB, *PPEB;
```

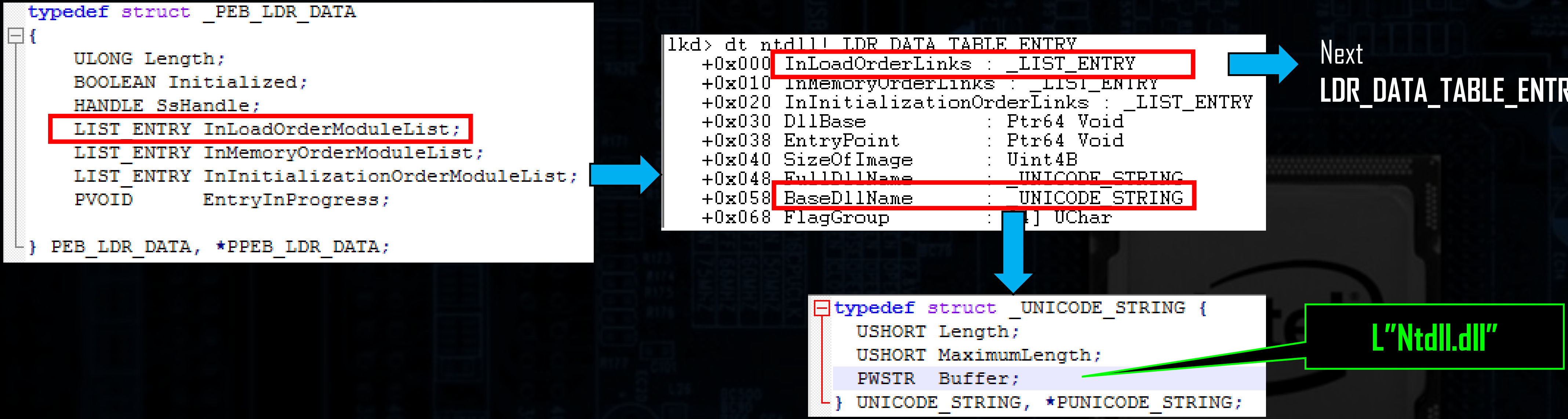


```
typedef struct _PEB_LDR_DATA
{
        ULONG Length;
        BOOLEAN Initialized;
        HANDLE SsHandle;
        LIST_ENTRY InLoadOrderModuleList;
        LIST_ENTRY InMemoryOrderModuleList;
        LIST_ENTRY InInitializationOrderModuleList;
        PVOID      EntryInProgress;

} PEB_LDR_DATA, *PPEB_LDR_DATA;
```

# Retrieving the Imports

- We will process each entry, searching for the DLL that we need…



```
typedef struct _PEB_LDR_DATA
{
    ULONG Length;
    BOOLEAN Initialized;
    HANDLE SsHandle;
    LIST_ENTRY InLoadOrderModuleList;
    LIST_ENTRY InMemoryOrderModuleList;
    LIST_ENTRY InInitializationOrderModuleList;
    PVOID      EntryInProgress;

} PEB_LDR_DATA, *PPEB_LDR_DATA;
```

```
lkd> dt ntdll!_LDR_DATA_TABLE_ENTRY
   +0x000 InLoadOrderLinks : _LIST_ENTRY
   +0x010 InMemoryOrderLinks : _LIST_ENTRY
   +0x020 InInitializationOrderLinks : _LIST_ENTRY
   +0x030 DllBase             : Ptr64 Void
   +0x038 EntryPoint          : Ptr64 Void
   +0x040 SizeOfImage         : Uint4B
   +0x048 FullDllName         : _UNICODE_STRING
   +0x058 BaseDllName         : _UNICODE_STRING
   +0x068 FlagGroup           : [4] UChar
```

```
typedef struct _UNICODE_STRING {
  USHORT Length;
  USHORT MaximumLength;
  PWSTR  Buffer;
} UNICODE_STRING, *PUNICODE_STRING;
```

# Retrieving the Imports

1. Get the PEB address
2. Via `PEB->Ldr->InMemoryOrderModuleList`, find:
   - `kernel32.dll` (which is always loaded)
   - or `ntdll.dll` (if we want to use low-leven equivalents of Import loading functions)
3. Walk through exports table to find addresses of:
   - `LoadLibraryA` (eventually: `ntdll.LdrLoadDll`)
   - `GetProcAddress` (eventually: `ntdll.LdrGetProcedureAddress`)
4. Use `LoadLibraryA` to load other needed DLLs
5. Use `GetProcAddress` to retrieve functions

## Creating shellcode: assembly

- We can use YASM for shellcodes written in pure assembly:

```
yasm -f bin demo.asm
```

- We will not use a linker, which means:
  - we need to fill imports by ourselves
  - we need to take care of relocations – or make the code position-independent

## Creating shellcode: C

- We can use a C compiler to generate assembly:

```
Cl /c /FA <file_name>.cpp
```

- ...that we will refactor to our shellcode, and compile by masm:

```
ml <file_name>.asm
```

- it will generate a PE: we will cut out the code section, that is our shellcode
- The key is the refactoring! We need to follow all the principles of building shellcodes...

## Creating shellcode: C

- Use the given template, and refactor the application in C into a valid shellcode, by following the steps…

```
Exercise time...
```