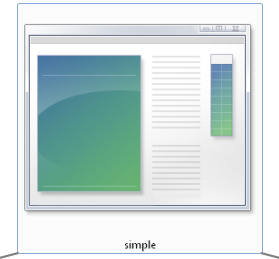
PE101 a Windows executable walkthrough

PORTABLE EXECUTABLE



SIMPLE.EXE

SHA-1: B7AF4CB51CE38E43E0306561EB2698FAB408CF9CB

DOWNLOAD @ PE101.CORKAMI.COM

HEADER

TECHNICAL DETAILS ABOUT THE EXECUTABLE

SECTIONS

CONTENTS OF THE EXECUTABLE

DOS HEADER

SHOWS IT'S A BINARY

PE HEADER

SHOWS IT'S A 'MODERN' BINARY

OPTIONAL HEADER

EXECUTABLE INFORMATION

DATA DIRECTORIES

POINTERS TO EXTRA STRUCTURES (EXPORTS, IMPORTS,...)

SECTIONS TABLE

DEFINES HOW THE FILE IS LOADED IN MEMORY

CODE

WHAT IS EXECUTED

IMPORTS

LINK BETWEEN THE EXECUTABLE AND (WINDOWS) LIBRARIES

DATA

INFORMATION USED BY THE CODE

DISSECTED PE

HEXADECIMAL DUMP	ASCII DUMP	FIELDS	VALUES	EXPLANATION
4D 5A 00 00-00 00 00 00-00 00 00 00-00 00 00 00	MZ..............	e_magic	'MZ'	CONSTANT SIGNATURE
Offset:0x30 00 00 00 00-00 00 00 00-00 00 00 00-40 00 00 00	............@...	e_lfanew	0x40	1 OFFSET OF THE PE HEADER
Offset:0x40 50 45 00 00-4C 01 03 00-00 00 00 00-00 00 00 00	PE..L...........	Signature	'PE', 0, 0	CONSTANT SIGNATURE
		Machine	0x14c [intel 386]	PROCESSOR: ARM/MIPS/INTEL/...
		NumberOfSections	3	2 NUMBER OF SECTIONS
00 00 00 00-E0 00 02 01...	....a...	SizeOfOptionalHeader	0xe0	2 RELATIVE OFFSET OF THE SECTION TABLE
		Characteristics	0x102 [32b EXE]	EXE/DLL/...
Offset:0x58 ...0B 01 00 00-00 00 00 00	....	Magic	0x10b [32b]	32 BITS/64 BITS
00 00 00 00-00 00 00 00-00 10 00 00-00 00 00 00	....	AddressOfEntryPoint	0x1000	5 WHERE EXECUTION STARTS
00 00 00 00-00 00 40 00-00 10 00 00-00 02 00 00	......@.........	ImageBase	0x400000	3 ADDRESS WHERE THE FILE SHOULD BE MAPPED IN MEMORY
00 00 00 00-00 00 00 00-04 00 00 00-00 00 00 00	....	SectionAlignment	0x1000	2 WHERE SECTIONS SHOULD START IN MEMORY
00 40 00 00-00 02 00 00-00 00 00 00-02 00 00 00	.@..............	FileAlignment	0x200	2 WHERE SECTIONS SHOULD START ON FILE
00 00 00 00-00 00 00 00-00 00 00 00-00 00 00 00	....	MajorSubsystemVersion	4 [NT 4 or later]	REQUIRED VERSION OF WINDOWS
00 00 00 00-10 00 00 00...	....	SizeOfImage	0x4000	TOTAL MEMORY SPACE REQUIRED
		SizeOfHeaders	0x200	3 TOTAL SIZE OF THE HEADERS
		Subsystem	2 [GUI]	DRIVER/GRAPHICAL/COMMAND LINE/...
		NumberOfRvaAndSizes	16	4 NUMBER OF DATA DIRECTORIES
...00 00 00 00-00 00 00 00	....			
00 20 00 00-00 00 00 00-00 00 00 00-00 00 00 00	....	ImportsVA	0x2000	4 RVA* OF THE IMPORTS
00 00 00 00-00 00 00 00-00 00 00 00-00 00 00 00	....			

Offset:0x138

2E 74 65 78-74 00 00 00	.text...
00 10 00 00-00 10 00 00-00 02 00 00-00 02 00 00	....
00 00 00 00-00 00 00 00-00 00 00 00-20 00 00 60	....
2E 72 64 61-74 61 00 00-00 10 00 00-00 20 00 00	.rdata..... ....
00 02 00 00-00 04 00 00-00 00 00 00-00 00 00 00	....
00 00 00 00-40 00 00 40-2E 64 61 74-61 00 00 00	....@..@.data...
00 10 00 00-00 30 00 00-00 02 00 00-00 06 00 00	.....0..........
00 00 00 00-00 00 00 00-00 00 00 00-40 00 00 C0	............@..+

SECTIONS TABLE

NAME	VIRTUALSIZE	VIRTUALADDRESS (RVA*)	SIZEOFRAWDATA (PHYSICAL SIZE)	POINTERTORAWDATA (PHYSICAL OFFSET)	CHARACTERISTICS
.text	0x1000	0x1000	0x200	0x200	CODE EXECUTE READ
.rdata	0x1000	0x2000	0x200	0x400	INITIALIZED READ
.data	0x1000	0x3000	0x200	0x600	DATA READ WRITE

FOR EACH SECTION, A SIZEOFRAWDATA SIZED BLOCK IS READ FROM THE FILE AT POINTERTORAWDATA OFFSET.
IT WILL BE LOADED IN MEMORY AT ADDRESS IMAGEBASE + VIRTUALADDRESS IN A VIRTUAL SIZE SIZED BLOCK, WITH SPECIFIC CHARACTERISTICS.

Offset:0x200/RVA:0x401000

6A 00 68 00-30 40 00 68-17 30 40 00-6A 00 FF 15	j.h.0@.h.0@.j. .
70 20 40 00-6A 00 FF 15-68 20 40 00	p.@.j. .h.@.

X86 ASSEMBLY

```
push 0
push 0x403000
push 0x403017
push 0
call [0x402070]
push 0
call [0x402068]
```

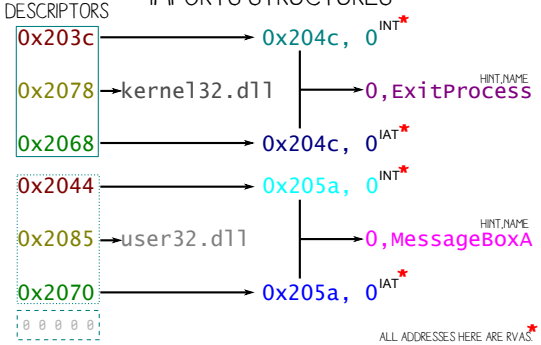
EQUIVALENT C CODE

```
MessageBox(0, "Hello World!","a simple PE executable", 0);
ExitProcess(0);
```

Offset:0x400/RVA:0x402000

3C 20 00 00-00 00 00 00-00 00 00 00-78 20 00 00	<...........x...
68 20 00 00-44 20 00 00-00 00 00 00-00 00 00 00	h...D...........
85 20 00 00-70 20 00 00-00 00 00 00-00 00 00 00	....p...........
00 00 00 00-00 00 00 00-00 00 00 00-4C 20 00 00	............L...
00 00 00 00-5A 20 00 00-00 00 00 00-00 00 45 78	....Z.........Ex
69 74 50 72-6F 63 65 73-73 00 00 00-4D 65 73 73	itProcess...Mess
61 67 65 42-6F 78 41 00-4C 20 00 00-00 00 00 00	ageBoxA.L.......
5A 20 00 00-00 00 00 00-6B 65 72 6E-65 6C 33 32	Z.......kernel32
2E 64 6C 6C-00 75 73 65-72 33 32 2E-64 6C 6C 00	.dll.user32.dll.

IMPORTS STRUCTURES



CONSEQUENCES

AFTER LOADING,
0X402068 WILL POINT TO KERNEL32.DLL`S EXITPROCESS
0X402070 WILL POINT TO USER32.DLL`S MESSAGEBOXA

Offset:0x600/RVA:0x403000

61 20 73 69-6D 70 6C 65-20 50 45 20-65 78 65 63	a.simple.PE.exec
75 74 61 62-6C 65 00 48-65 6C 6C 6F-20 77 6F 72	utable.Hello.wor
6C 64 21 00	ld!.

STRINGS

```
a simple PE executable\0
Hello world!\0
```

THIS IS THE WHOLE FILE, HOWEVER, MOST PE FILES CONTAIN MORE ELEMENTS.
EXPLANATIONS ARE SIMPLIFIED, FOR CONCISENESS.

LOADING PROCESS

1 HEADERS

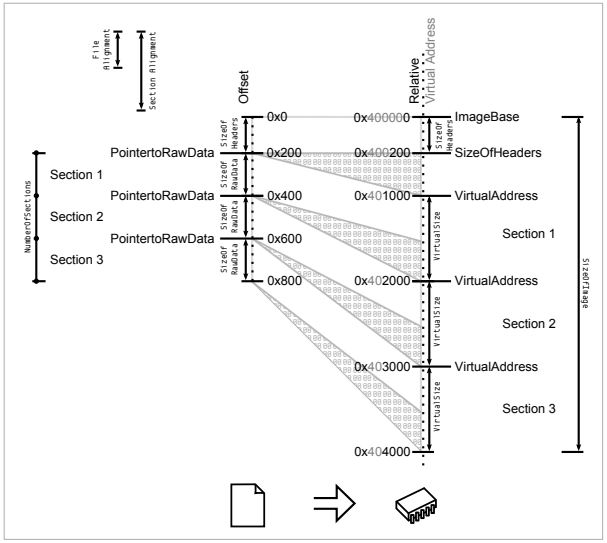
THE *DOS HEADER* IS PARSED
THE *PE HEADER* IS PARSED
(ITS OFFSET IS *DOS HEADER*'S E_LFANEW)
THE *OPTIONAL HEADER* IS PARSED
(IT FOLLOWS THE *PE HEADER*)

2 SECTIONS TABLE

SECTIONS TABLE IS PARSED
(IT IS LOCATED AT: OFFSET (*OPTIONALHEADER*) + *SIZEOFOPTIONALHEADER*)
IT CONTAINS *NUMBEROFSECTIONS* ELEMENTS
IT IS CHECKED FOR VALIDITY WITH ALIGNMENTS:
FILEALIGNMENTS AND *SECTIONALIGNMENTS*

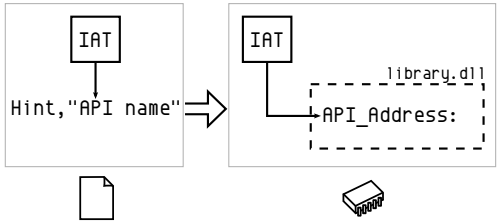
3 MAPPING

THE FILE IS MAPPED IN MEMORY ACCORDING TO:
THE *IMAGEBASE*
THE *SIZEOFHEADERS*
THE SECTIONS TABLE



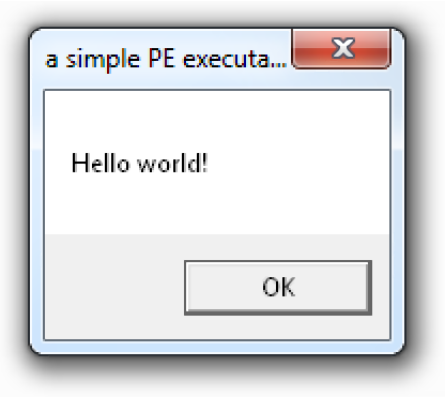
4 IMPORTS

DATADIRECTORIES ARE PARSED
THEY FOLLOW THE *OPTIONALHEADER*
THEIR NUMBER IS *NUMOFRVAANDSIZES*
IMPORTS ARE ALWAYS #2
IMPORTS ARE PARSED
EACH DESCRIPTOR SPECIFIES A *DLLNAME*
THIS DLL IS LOADED IN MEMORY
IAT AND *INT* ARE PARSED SIMULTANEOUSLY
FOR EACH API IN *INT*
ITS ADDRESS IS WRITTEN IN THE *IAT* ENTRY



5 EXECUTION

CODE IS CALLED AT THE *ENTRYPOINT*
THE CALLS OF THE CODE GO VIA THE IAT TO THE APIS



NOTES

MZ HEADER *AKA* DOS_HEADER
STARTS WITH 'MZ' (INITIALS OF *MARK ZBIKOWSKI* MS-DOS DEVELOPER)

PE HEADER *AKA* IMAGE_FILE_HEADERS / COFF FILE HEADER
STARTS WITH 'PE' (PORTABLE EXECUTABLE)

OPTIONAL HEADER *AKA* IMAGE_OPTIONAL_HEADER
OPTIONAL ONLY FOR NON-STANDARD PES BUT REQUIRED FOR EXECUTABLES

RVA RELATIVE VIRTUAL ADDRESS
ADDRESS RELATIVE TO IMAGEBASE (AT IMAGEBASE, RVA = 0)
ALMOST ALL ADDRESSES OF THE HEADERS ARE RVAS
IN CODE, ADDRESSES ARE *NOT* RELATIVE.

INT IMPORT NAME TABLE
NULL-TERMINATED LIST OF POINTERS TO HINT, NAME STRUCTURES

IAT IMPORT ADDRESS TABLE
NULL-TERMINATED LIST OF POINTERS
ON FILE IT IS A COPY OF THE INT
AFTER LOADING IT POINTS TO THE IMPORTED APIS

HINT
INDEX IN THE EXPORTS TABLE OF A DLL TO BE IMPORTED
NOT REQUIRED BUT PROVIDES A SPEED-UP BY REDUCING LOOK-UP

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