DEF CON 26

XORI

FINDING XORI

Malware Analysis Triage with Automated Disassembly

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QUICK OVERVIEW

THE CURRENT STATE OF DISASSEMBLERS

Brief overview of pros and cons with current popular open source PE disassemblers.

FUNCTIONALITY & FEATURES

Overview how we pulled together the different aspects of disassemblers and emulator

USAGE & DEMO

How the output is used for automation. Applying the tool on various malware samples and shellcode.

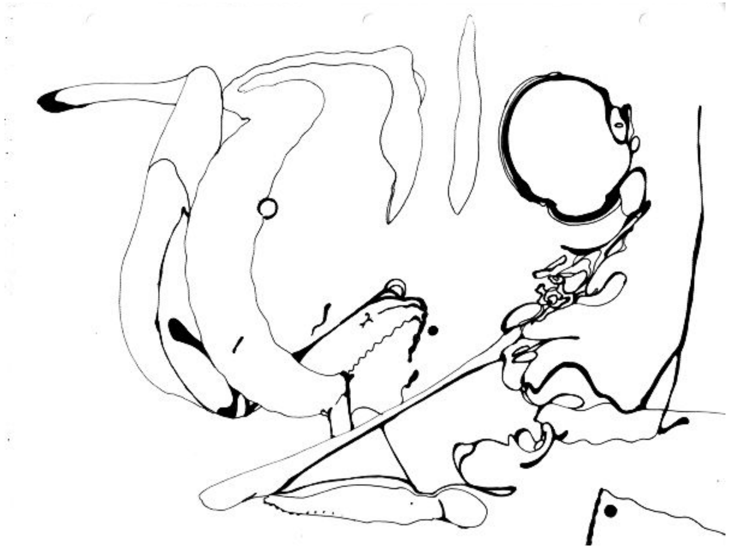
THE PROBLEM

There are millions of malware samples to look at and a few reverse engineers.

We need to change the way we are going about this if we are going to keep up.

How to leverage large scale disassembly in an automated way with many samples?

- Improve the scalability in malware analysis
- Integration and automation



PRESENT DAY COMMON DISASSEMBLERS

	CAPSTONE	RADARE2	IDA PRO	HOPPER	BINARY NINJA
SIZE	small	small	large	medium	large
STABILITY	✔	✖	✔	✔	✔
PRICE	-	-	$$$	$	$$
CROSS PLATFORM	✔	~	✔	✖	✔
USABILITY	~	~	✔	~	~
ACCURACY	~	~	✔	~	~
INTEGRATION	✔	~	✖	✖	✖

REQUIREMENTS

- Fast development
- Stability and resilience
- Cross platform
- Output can be easily integrated
- Ease of use
- Core feature set
- Output accuracy

EVALUATING DISASSEMBLERS

The first step - Diving into the code:

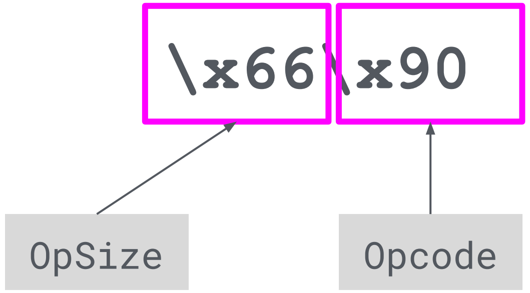
- Verifying the accuracy of various disassemblers
- Understand each of their strengths and limitations

We adopted different aspects of disassemblers and emulator modules.

- Much of Capstone is also based on the LLVM & GDB repositories
- QEMU is the emulation is straightforward, easy to understand
- Converted some of the logic into Rust, while also fixing a few bugs along the way.

Evaluating Example

X86 32bit:



XCHG AX, AX [Objdump]✓

XCHG AX, AX [IDA Pro]✓

NOP [Capstone]✖

NOP [Distorm]✖

DEVELOPED IN RUST

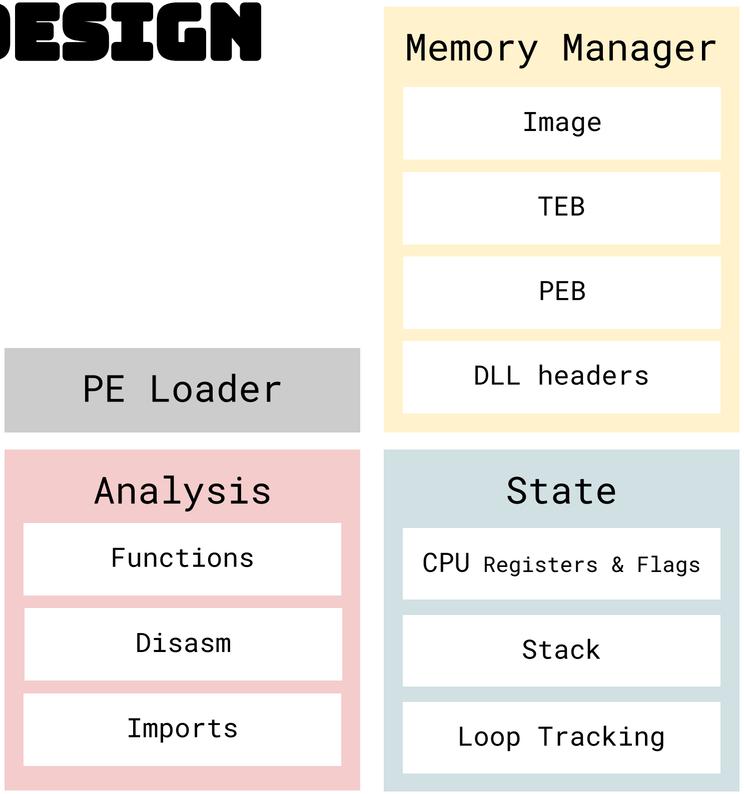
Why Rust?

- Same capabilities in C\C++
- Stack protection
- Proper memory handling (guaranteed memory safety)
- Provides stability and speed (minimal runtime)
- Faster development
- Helpful compiler

CURRENT FEATURES

- Open source
- Supports i386 and x86-64 architecture only at the moment
- Displays strings based on referenced memory locations
- Manages memory
- Outputs Json
- 2 modes: with or without emulation
  - Light Emulation - meant to enumerate all paths (Registers, Stack, Some Instructions)
  - Full Emulation - only follows the code's path (Slow performance)
- Simulated TEB & PEB structures
- Evaluates functions based on DLL exports

DESIGN



PE LOADER

Handles the loading of the PE image into memory and sets up the TEB/PEB as well as initializing the offsets to loaded DLLs and import table.

MEMORY MANAGER

This structure contains all of the mmap memory for the Image, TEB/PEB, and DLL headers. Accessors for Read & Write to avoid errors in inaccessible memory.

ANALYSIS

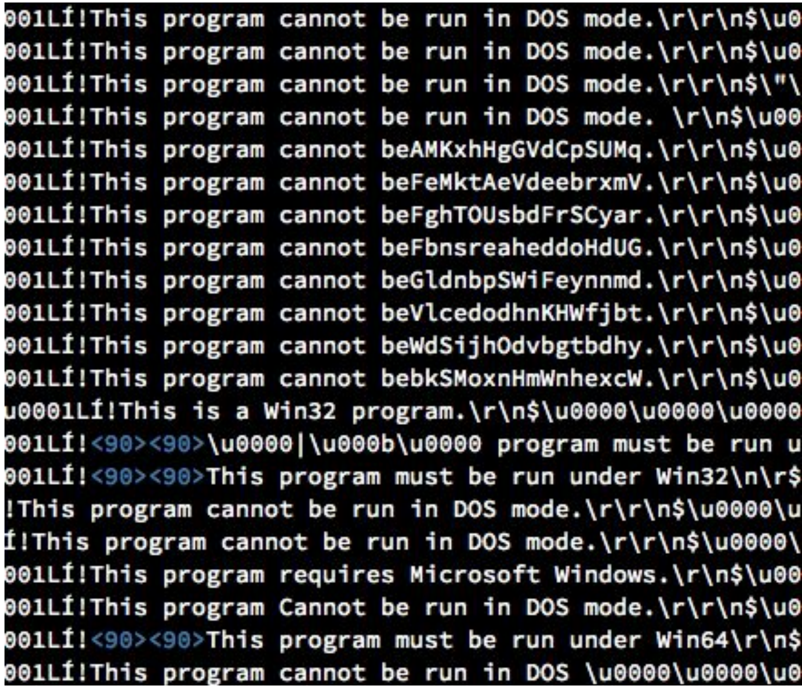
The core container for the disassembly, functions, and imports.

STATE

This structure contains the CPU state of the registers & flags, a new copy of the stack, and short circuiting for looping during emulation.

ROLL YOUR OWN PE PARSER

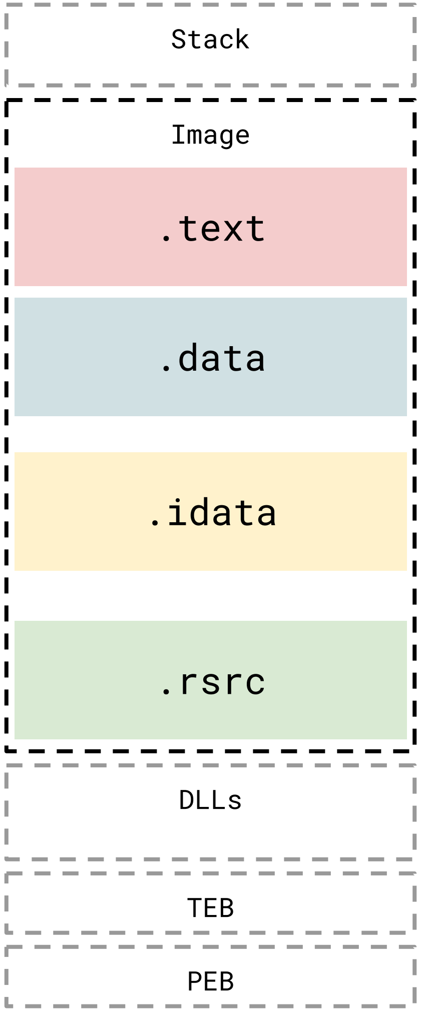
- Although a few Rust PE parsers exist: goblin, pe-rs we decided to create our own.
- Chose to write it using the **nom** parser combinator framework
- Ideally less error prone due to safe macro constructions
- Many lessons learned
- From a historical perspective a PE parser start reading a 16 bit DOS file
- Then optionally switches to a PE32 or a PE32+
- This is like a history of DOS and Microsoft Windows in a single parser.



```
001Lí!This program cannot be run in DOS mode.\r\r\n$\u0
001Lí!This program cannot be run in DOS mode.\r\r\n$\u0
001Lí!This program cannot be run in DOS mode.\r\r\n$\"\
001Lí!This program cannot be run in DOS mode. \r\n$\u00
001Lí!This program cannot beAMKxhHgGVdCpSUMq.\r\r\n$\u0
001Lí!This program cannot beFeMktAeVdeebrxmV.\r\r\n$\u0
001Lí!This program cannot beFghTOUsbdFrSCyar.\r\r\n$\u0
001Lí!This program cannot beFbnsreaheddoHdUG.\r\r\n$\u0
001Lí!This program cannot beGldnbpSWiFeynnmd.\r\r\n$\u0
001Lí!This program cannot beVlcedodhnKHWfjbt.\r\r\n$\u0
001Lí!This program cannot beWdSijhOdvbgtbdhy.\r\r\n$\u0
001Lí!This program cannot bebkSMoxnHmWnhexcW.\r\r\n$\u0
u0001Lí!This is a Win32 program.\r\n$\u0000\u0000\u0000
001Lí!<90><90>\u0000|\u000b\u0000 program must be run u
001Lí!<90><90>This program must be run under Win32\n\r$
!This program cannot be run in DOS mode.\r\r\n$\u0000\u
í!This program cannot be run in DOS mode.\r\r\n$\u0000\
001Lí!This program requires Microsoft Windows.\r\n$\u00
001Lí!This program Cannot be run in DOS mode.\r\r\n$\u0
001Lí!<90><90>This program must be run under Win64\r\n$
001Lí!This program cannot be run in DOS \u0000\u0000\u0
```

ANALYSIS ENRICHMENT

- The header is used to build the memory sections of the PE Image
- Similar to the PE loader in windows, it will load the image similar to how it would be loaded in the addressable memory. Where the imports are given memory address, rewritten in the image.



Symbols

- We needed a way to load DLL exports and header information without doing it natively.
- Built a parser that would generate json files for consumption called pesymbols.
- Instead of relying on the Import Table of the PE, it generates virtual addresses of the DLL and API in the Image's Import Table. This way you can track the actual address of the function being pushed into various registers.
- The virtual address start is configurable as well as the json location.

Configurable in xori.json

```
"dll_address32": 1691680768, 0x64D50000
"dll_address64": 8789194768384, 0x7FE64D50000
"function_symbol32":
"./src/analysis/symbols/generated_user_syswow64.json",
"function_symbol64":
"./src/analysis/symbols/generated_user_system32.json",
...
```

Example

generated_user_syswow64.json

```
     "name": "kernel32.dll",
     "exports": [
       {
         "address": 696814,
         "name": "AcquireSRWLockExclusive",
         "ordinal": 1,
         "forwarder": true,
         "forwarder_name": "NTDLL.RtlAcquireSRWLockExclusive"
       },
       {
         "address": 696847,
         "name": "AcquireSRWLockShared",
         "ordinal": 2,
         "forwarder": true,
         "forwarder_name": "NTDLL.RtlAcquireSRWLockShared"
       },
       ...
```

DEALING WITH DYNAMIC API CALLS

TEB/PEB

The TEB and PEB structures are simulated based on the the imports and known dlls in a windows 7 environment.

MEMORY MANAGEMENT

Segregated memory for the local memory storage such as the stack.

THE STACK

If references to functions are pushed into a register or stack will be able to be tracked.

DEALING WITH DYNAMIC API CALLS

Header Imports
"ExitProcess"
"GetLastError"
"GetLocalTime"
"GetModuleHandleA"

Dynamic Imports
"LoadLibraryA"
"VirtualProtect"
"ShellExecuteA"

```
                                 00   mov [0x401000], eax
                                 00   push 0x401041 ; LoadLibraryA
                              40 00   push [0x401000]
                                 00   call 0x4012cb
                                      cmp eax, 0x0
                              00 00   je 0x4013da
                                 00   mov [0x401004], eax ; wI
                                 00   push 0x40104e ; VirtualProtect
0x401115     FF 35 00 10 40 00        push [0x401000]
0x40111b     E8 AB 01 00 00           call 0x4012cb
0x401120     83 F8 00                 cmp eax, 0x0
0x401123     0F 84 B1 02 00 00        je 0x4013da
0x401129     A3 08 10 40 00           mov [0x401008], eax
0x40112e     6A 00                    push 0x0
                                      push 0x0
                                 00   push 0x40101c ; shell32.dll
                              40 00   call [0x401004] ; kernel32.dll!LoadLibraryA
                                 00   mov [0x40100c], eax
                                 00   push 0x401033 ; ShellExecuteA
                              40 00   push [0x40100c]
                                 00   call 0x4012cb
0x401152     A3 10 10 40 00           mov [0x401010], eax
```

Loads LoadLibrary from the PEB

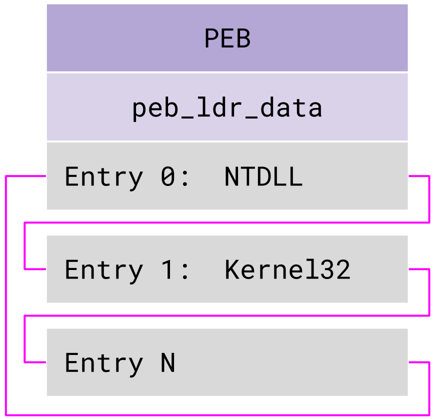
Stores the address into ptr [0x401004]

Calls the new ptr

TEB & PEB

In Rust, you can serialize structs into vectors of bytes. This way you can allow the assembly emulation to access them natively while also managing the access.

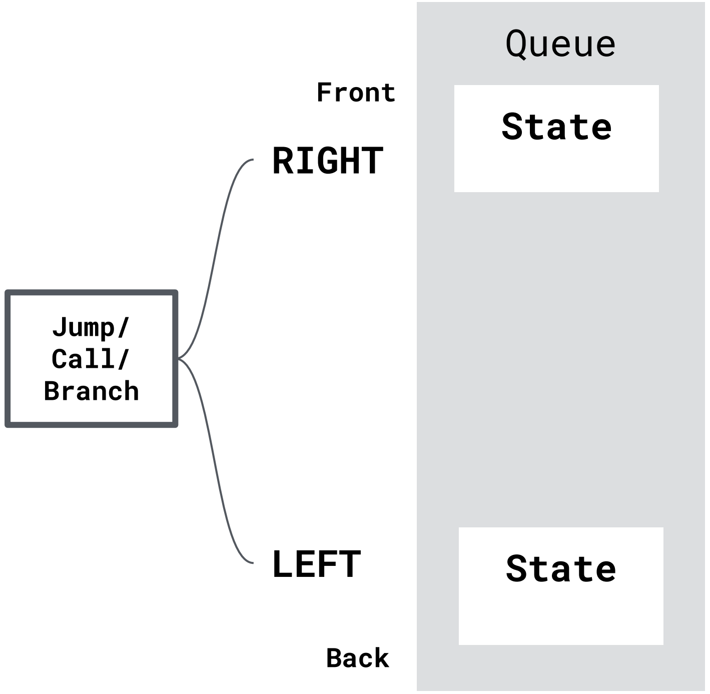
```
let teb_binary: Vec<u8> =
serialize(&teb_struct).unwrap();
```



```
#[derive(Serialize, Deserialize)]
struct ThreadInformationBlock32
{
    // reference: https://en.wikipedia.org/wiki/Win32_Thread_Information_Block
    seh_frame:                  u32,   //0x00
    stack_base:                 u32,   //0x04
    stack_limit:                u32,   //0x08
    subsystem_tib:              u32,   //0x0C
    fiber_data:                 u32,   //0x10
    arbitrary_data:             u32,   //0x14
    self_addr:                  u32,   //0x18
    //End                       of NT subsystem independent part
    environment_ptr:            u32,   //0x1C
    process_id:                 u32,   //0x20
    thread_id:                  u32,   //0x24
    active_rpc_handle:          u32,   //0x28
    tls_addr:                   u32,   //0x2C
    peb_addr:                   u32,   //0x30
    last_error:                 u32,   //0x34
    critical_section_count:     u32,   //0x38
    csr_client_thread:          u32,   //0x3C
    win32_thread_info:          u32,   //0x40
    win32_client_info:          [u32; 31],    //0x44
    ...
```

HANDLING BRANCHES & CALLS

- Branches and calls have 2 directions
    - Left & Right
- In light emulation mode, both the left and right directions are followed
- Each direction is placed onto a queue with it's own copy of the state.
- Any assembly not traversed will not be analyzed.
- All function calls are tracked for local and import table mapping.



HANDLING LOOPING

- Infinite loops are hard to avoid
- Built a way to configure the maximum amount of loops a one can take
  - Forward
  - Backward
  - Standard Loop
- The state contains the looping information
- Once the maximum is reached, it will disable the loop

CONFIGURABLE IN XORI.JSON

```
"loop_default_case": 4000,
...
```

AUTOMATION FOR BULK ANALYSIS

- 4904 samples processed at 7.7 samples per second on dual 8-core E5-2650 Xeon w/ 2 threads per core
- Creates JSON output of important PE features from binary files allowing bulk data analysis: clustering, outlier detection and visualization.
- You can then easily throw Xori output into a database, document store or do a little data science at the command line

```
$ jq '.import_table|map(.import_address_list)|map(.[].func_name)' *header.json |sort|uniq -c|sort -n
   1662   "ExitProcess",
   1697   "Sleep",
   1725   "CloseHandle",
   1863   "GetProcAddress",
   1902   "GetLastError",
```

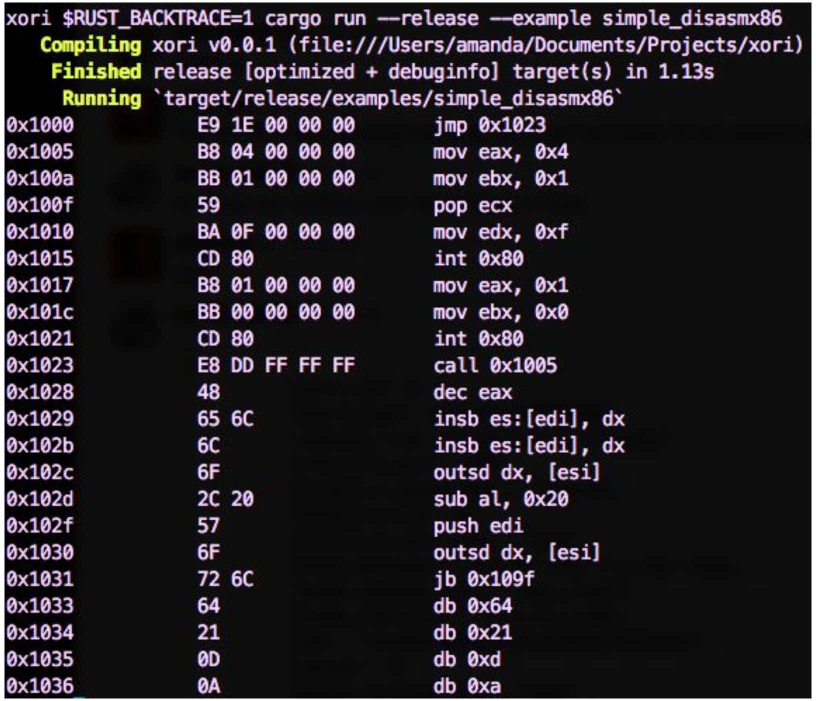
EXAMPLES

Simplest way to run xori

```
Cd ./xori

Cargo build --release

./target/release/xori -f wanacry.exe
```

BASIC DISASSEMBLER

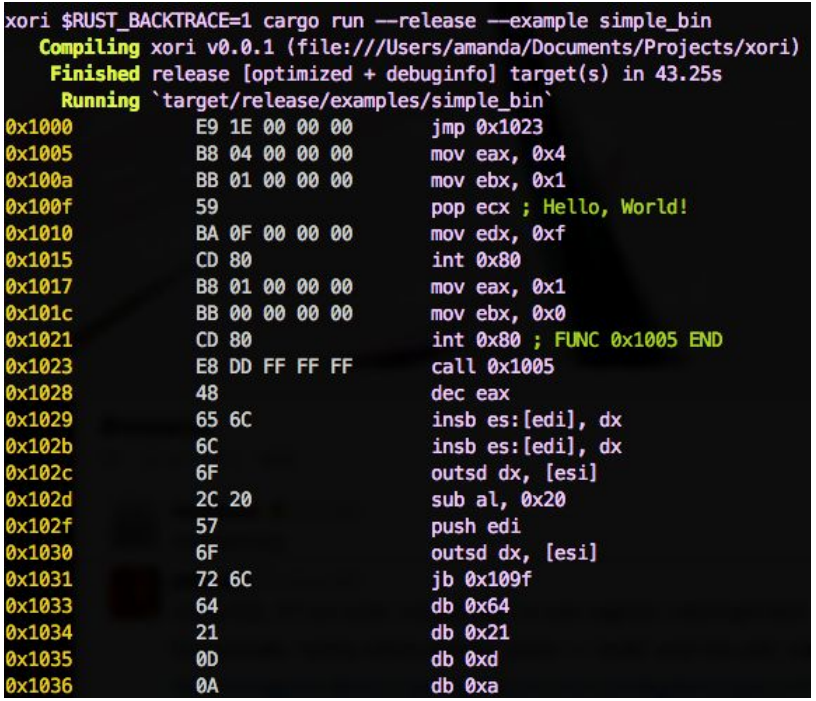
```rust
extern crate xori;
use std::fmt::Write;
use xori::disasm::*;
use xori::arch::x86::archx86::X86Detail;

fn main()
{
    let xi = Xori { arch: Arch::ArchX86, mode: Mode::Mode32 };
    let start_address = 0x1000;
    let binary32 = b"\xe9\x1e\x00\x00\x00\xb8\x04\
    \x00\x00\x00\xbb\x01\x00\x00\x00\x59\xba\x0f\
    \x00\x00\x00\xcd\x80\xb8\x01\x00\x00\x00\xbb\
    \x00\x00\x00\x00\xcd\x80\xe8\xdd\xff\xff\xff\
    \x48\x65\x6c\x6c\x6f\x2c\x20\x57\x6f\x72\x6c\
    \x64\x21\x0d\x0a";

    let mut vec: Vec<Instruction<X86Detail>> = Vec::new();
    xi.disasm(binary32, binary32.len(),
        start_address, start_address, 0, &mut vec);
    if vec.len() > 0
    {
        //Display values
        for instr in vec.iter_mut()
        {
            let addr: String = format!("0x{:x}", instr.address);
            println!("{:16} {:20} {} {}", addr,
                hex_array(&instr.bytes, instr.size),
                instr.mnemonic, instr.op_str);
        }
    }
}
```



```
xori $RUST_BACKTRACE=1 cargo run --release --example simple_disasmx86
   Compiling xori v0.0.1 (file:///Users/amanda/Documents/Projects/xori)
    Finished release [optimized + debuginfo] target(s) in 1.13s
     Running `target/release/examples/simple_disasmx86`
0x1000           E9 1E 00 00 00       jmp 0x1023
0x1005           B8 04 00 00 00       mov eax, 0x4
0x100a           BB 01 00 00 00       mov ebx, 0x1
0x100f           59                   pop ecx
0x1010           BA 0F 00 00 00       mov edx, 0xf
0x1015           CD 80                int 0x80
0x1017           B8 01 00 00 00       mov eax, 0x1
0x101c           BB 00 00 00 00       mov ebx, 0x0
0x1021           CD 80                int 0x80
0x1023           E8 DD FF FF FF       call 0x1005
0x1028           48                   dec eax
0x1029           65 6C                insb es:[edi], dx
0x102b           6C                   insb es:[edi], dx
0x102c           6F                   outsd dx, [esi]
0x102d           2C 20                sub al, 0x20
0x102f           57                   push edi
0x1030           6F                   outsd dx, [esi]
0x1031           72 6C                jb 0x109f
0x1033           64                   db 0x64
0x1034           21                   db 0x21
0x1035           0D                   db 0xd
0x1036           0A                   db 0xa
```

Binary File Disassembler

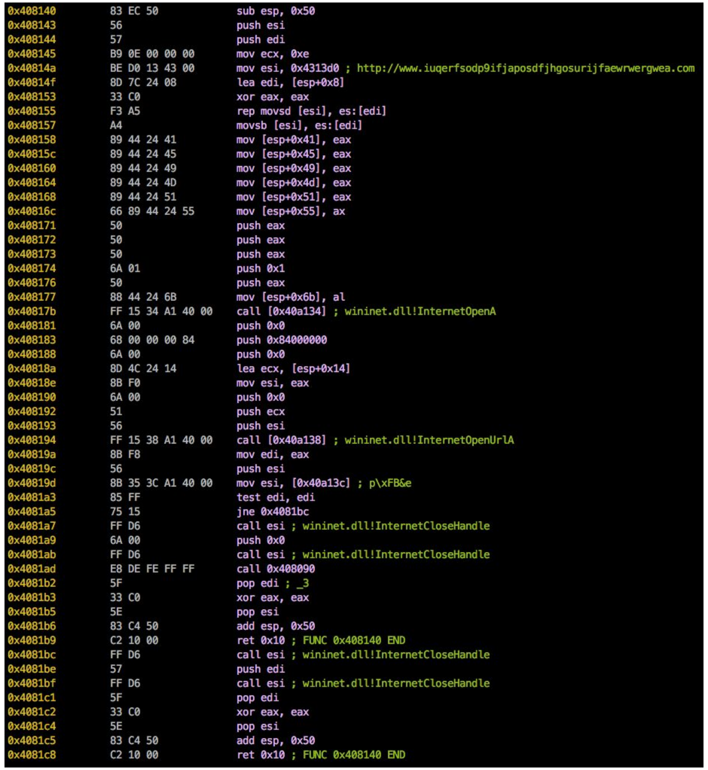
```rust
extern crate xori;
extern crate serde_json;
use serde_json::Value;
use std::path::Path;
use xori::analysis::analyze::analyze;
use xori::disasm::*;

fn main()
{
    let mut binary32 = b"\xe9\x1e\x00\x00\x00\xb8\x04\
    \x00\x00\x00\xbb\x01\x00\x00\x00\x59\xba\x0f\
    \x00\x00\x00\xcd\x80\xb8\x01\x00\x00\x00\xbb\
    \x00\x00\x00\x00\xcd\x80\xe8\xdd\xff\xff\xff\
    \x48\x65\x6c\x6c\x6f\x2c\x20\x57\x6f\x72\x6c\
    \x64\x21\x0d\x0a".to_vec();

    let mut config_map: Option<Value> = None;
    if Path::new("xori.json").exists()
    {
        config_map = read_config(&Path::new("xori.json"));
    }
    match analyze(&Arch::ArchX86, &mut binary32, &config_map)
    {
        Some(analysis)=>{
            if !analysis.disasm.is_empty(){
                println!("{}", analysis.disasm);
            }
        },
        None=>{},
    }
}
```



```
xori $RUST_BACKTRACE=1 cargo run --release --example simple_bin
   Compiling xori v0.0.1 (file:///Users/amanda/Documents/Projects/xori)
    Finished release [optimized + debuginfo] target(s) in 43.25s
     Running `target/release/examples/simple_bin`
0x1000          E9 1E 00 00 00          jmp 0x1023
0x1005          B8 04 00 00 00          mov eax, 0x4
0x100a          BB 01 00 00 00          mov ebx, 0x1
0x100f          59                      pop ecx ; Hello, World!
0x1010          BA 0F 00 00 00          mov edx, 0xf
0x1015          CD 80                   int 0x80
0x1017          B8 01 00 00 00          mov eax, 0x1
0x101c          BB 00 00 00 00          mov ebx, 0x0
0x1021          CD 80                   int 0x80 ; FUNC 0x1005 END
0x1023          E8 DD FF FF FF          call 0x1005
0x1028          48                      dec eax
0x1029          65 6C                   insb es:[edi], dx
0x102b          6C                      insb es:[edi], dx
0x102c          6F                      outsd dx, [esi]
0x102d          2C 20                   sub al, 0x20
0x102f          57                      push edi
0x1030          6F                      outsd dx, [esi]
0x1031          72 6C                   jb 0x109f
0x1033          64                      db 0x64
0x1034          21                      db 0x21
0x1035          0D                      db 0xd
0x1036          0A                      db 0xa
```

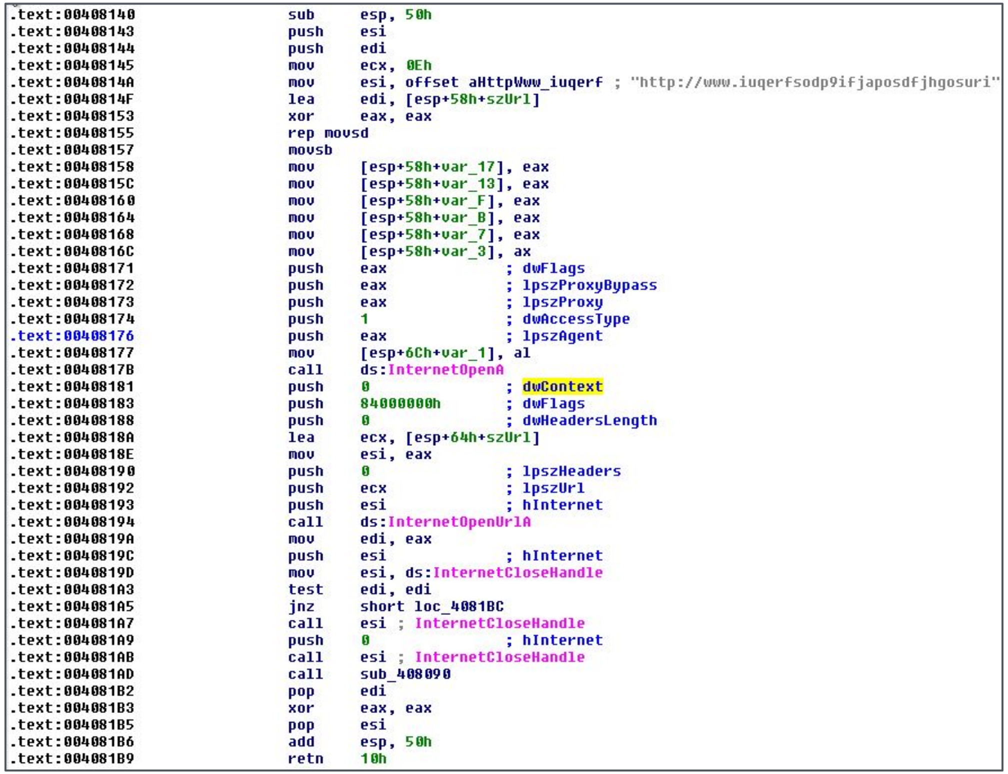
WANACRY RANSOMWARE

XORI



```
0x408140    83 EC 50           sub esp, 0x50
0x408143    56                 push esi
0x408144    57                 push edi
0x408145    B9 0E 00 00 00     mov ecx, 0xe
0x40814a    BE D0 13 43 00     mov esi, 0x4313d0 ; http://www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com
0x40814f    8D 7C 24 08        lea edi, [esp+0x8]
0x408153    33 C0              xor eax, eax
0x408155    F3 A5              rep movsd [esi], es:[edi]
0x408157    A4                 movsb [esi], es:[edi]
0x408158    89 44 24 41        mov [esp+0x41], eax
0x40815c    89 44 24 45        mov [esp+0x45], eax
0x408160    89 44 24 49        mov [esp+0x49], eax
0x408164    89 44 24 4D        mov [esp+0x4d], eax
0x408168    89 44 24 51        mov [esp+0x51], eax
0x40816c    66 89 44 24 55     mov [esp+0x55], ax
0x408171    50                 push eax
0x408172    50                 push eax
0x408173    50                 push eax
0x408174    6A 01              push 0x1
0x408176    50                 push eax
0x408177    88 44 24 6B        mov [esp+0x6b], al
0x40817b    FF 15 34 A1 40 00  call [0x40a134] ; wininet.dll!InternetOpenA
0x408181    6A 00              push 0x0
0x408183    68 00 00 00 84     push 0x84000000
0x408188    6A 00              push 0x0
0x40818a    8D 4C 24 14        lea ecx, [esp+0x14]
0x40818e    8B F0              mov esi, eax
0x408190    6A 00              push 0x0
0x408192    51                 push ecx
0x408193    56                 push esi
0x408194    FF 15 38 A1 40 00  call [0x40a138] ; wininet.dll!InternetOpenUrlA
0x40819a    8B F8              mov edi, eax
0x40819c    56                 push esi
0x40819d    8B 35 3C A1 40 00  mov esi, [0x40a13c] ; p\xFB&e
0x4081a3    85 FF              test edi, edi
0x4081a5    75 15              jne 0x4081bc
0x4081a7    FF D6              call esi ; wininet.dll!InternetCloseHandle
0x4081a9    6A 00              push 0x0
0x4081ab    FF D6              call esi ; wininet.dll!InternetCloseHandle
0x4081ad    E8 DE FE FF FF     call 0x408090
0x4081b2    5F                 pop edi ; _3
0x4081b3    33 C0              xor eax, eax
0x4081b5    5E                 pop esi
0x4081b6    83 C4 50           add esp, 0x50
0x4081b9    C2 10 00           ret 0x10 ; FUNC 0x408140 END
0x4081bc    FF D6              call esi ; wininet.dll!InternetCloseHandle
0x4081be    57                 push edi
0x4081bf    FF D6              call esi ; wininet.dll!InternetCloseHandle
0x4081c1    5F                 pop edi
0x4081c2    33 C0              xor eax, eax
0x4081c4    5E                 pop esi
0x4081c5    83 C4 50           add esp, 0x50
0x4081c8    C2 10 00           ret 0x10 ; FUNC 0x408140 END
```

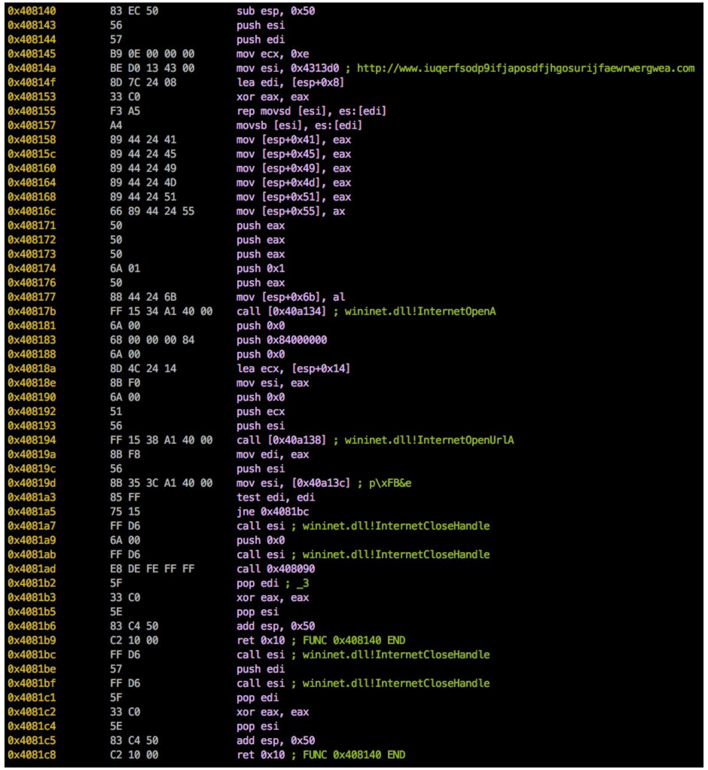
IDA PRO



```
.text:00408140                 sub     esp, 50h
.text:00408143                 push    esi
.text:00408144                 push    edi
.text:00408145                 mov     ecx, 0Eh
.text:0040814A                 mov     esi, offset aHttpWww_iuqerf ; "http://www.iuqerfsodp9ifjaposdfjhgosuri"
.text:0040814F                 lea     edi, [esp+58h+szUrl]
.text:00408153                 xor     eax, eax
.text:00408155                 rep movsd
.text:00408157                 movsb
.text:00408158                 mov     [esp+58h+var_17], eax
.text:0040815C                 mov     [esp+58h+var_13], eax
.text:00408160                 mov     [esp+58h+var_F], eax
.text:00408164                 mov     [esp+58h+var_B], eax
.text:00408168                 mov     [esp+58h+var_7], eax
.text:0040816C                 mov     [esp+58h+var_3], ax
.text:00408171                 push    eax             ; dwFlags
.text:00408172                 push    eax             ; lpszProxyBypass
.text:00408173                 push    eax             ; lpszProxy
.text:00408174                 push    1               ; dwAccessType
.text:00408176                 push    eax             ; lpszAgent
.text:00408177                 mov     [esp+6Ch+var_1], al
.text:0040817B                 call    ds:InternetOpenA
.text:00408181                 push    0               ; dwContext
.text:00408183                 push    84000000h       ; dwFlags
.text:00408188                 push    0               ; dwHeadersLength
.text:0040818A                 lea     ecx, [esp+64h+szUrl]
.text:0040818E                 mov     esi, eax
.text:00408190                 push    0               ; lpszHeaders
.text:00408192                 push    ecx             ; lpszUrl
.text:00408193                 push    esi             ; hInternet
.text:00408194                 call    ds:InternetOpenUrlA
.text:0040819A                 mov     edi, eax
.text:0040819C                 push    esi             ; hInternet
.text:0040819D                 mov     esi, ds:InternetCloseHandle
.text:004081A3                 test    edi, edi
.text:004081A5                 jnz     short loc_4081BC
.text:004081A7                 call    esi ; InternetCloseHandle
.text:004081A9                 push    0               ; hInternet
.text:004081AB                 call    esi ; InternetCloseHandle
.text:004081AD                 call    sub_408090
.text:004081B2                 pop     edi
.text:004081B3                 xor     eax, eax
.text:004081B5                 pop     esi
.text:004081B6                 add     esp, 50h
.text:004081B9                 retn    10h
```

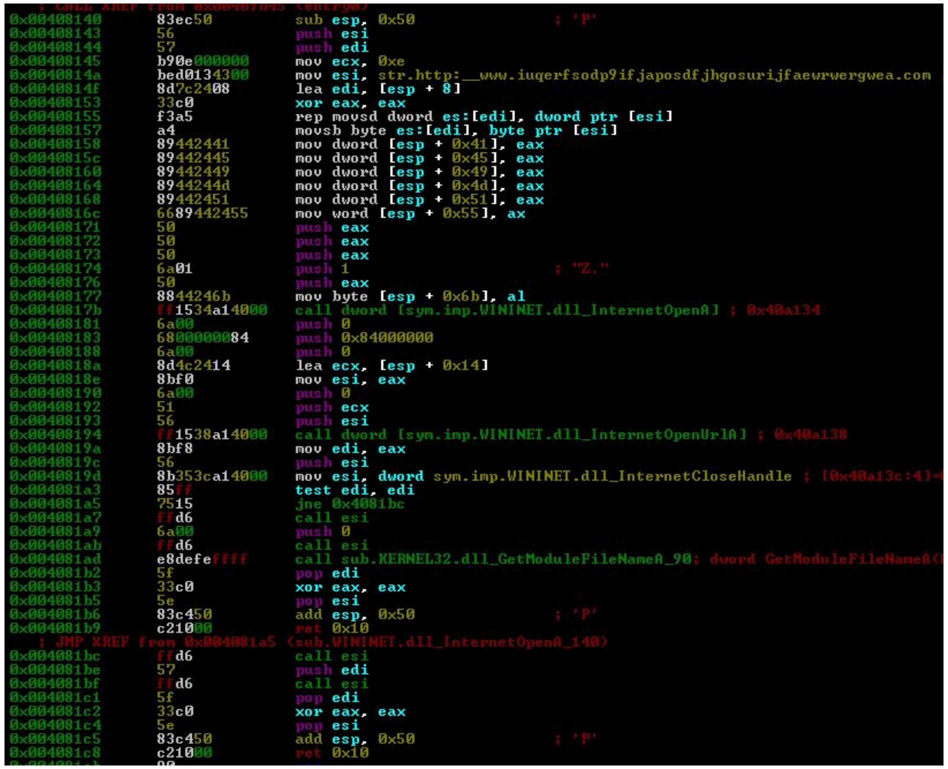
WANACRY RANSOMWARE

XORI



```
0x408140        83 EC 50             sub esp, 0x50
0x408143        56                   push esi
0x408144        57                   push edi
0x408145        B9 0E 00 00 00       mov ecx, 0xe
0x40814a        BE D0 13 43 00       mov esi, 0x4313d0 ; http://www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com
0x40814f        8D 7C 24 08          lea edi, [esp+0x8]
0x408153        33 C0                xor eax, eax
0x408155        F3 A5                rep movsd [esi], es:[edi]
0x408157        A4                   movsb [esi], es:[edi]
0x408158        89 44 24 41          mov [esp+0x41], eax
0x40815c        89 44 24 45          mov [esp+0x45], eax
0x408160        89 44 24 49          mov [esp+0x49], eax
0x408164        89 44 24 4D          mov [esp+0x4d], eax
0x408168        89 44 24 51          mov [esp+0x51], eax
0x40816c        66 89 44 24 55       mov [esp+0x55], ax
0x408171        50                   push eax
0x408172        50                   push eax
0x408173        50                   push eax
0x408174        6A 01                push 0x1
0x408176        50                   push eax
0x408177        88 44 24 6B          mov [esp+0x6b], al
0x40817b        FF 15 34 A1 40 00    call [0x40a134] ; wininet.dll!InternetOpenA
0x408181        6A 00                push 0x0
0x408183        68 00 00 00 84       push 0x84000000
0x408188        6A 00                push 0x0
0x40818a        8D 4C 24 14          lea ecx, [esp+0x14]
0x40818e        8B F0                mov esi, eax
0x408190        6A 00                push 0x0
0x408192        51                   push ecx
0x408193        56                   push esi
0x408194        FF 15 38 A1 40 00    call [0x40a138] ; wininet.dll!InternetOpenUrlA
0x40819a        8B F8                mov edi, eax
0x40819c        56                   push esi
0x40819d        8B 35 3C A1 40 00    mov esi, [0x40a13c] ; p\xFB&e
0x4081a3        85 FF                test edi, edi
0x4081a5        75 15                jne 0x4081bc
0x4081a7        FF D6                call esi ; wininet.dll!InternetCloseHandle
0x4081a9        6A 00                push 0x0
0x4081ab        FF D6                call esi ; wininet.dll!InternetCloseHandle
0x4081ad        E8 DE FE FF FF       call 0x408090
0x4081b2        5F                   pop edi ; _3
0x4081b3        33 C0                xor eax, eax
0x4081b5        5E                   pop esi
0x4081b6        83 C4 50             add esp, 0x50
0x4081b9        C2 10 00             ret 0x10 ; FUNC 0x408140 END
0x4081bc        FF D6                call esi ; wininet.dll!InternetCloseHandle
0x4081be        57                   push edi
0x4081bf        FF D6                call esi ; wininet.dll!InternetCloseHandle
0x4081c1        5F                   pop edi
0x4081c2        33 C0                xor eax, eax
0x4081c4        5E                   pop esi
0x4081c5        83 C4 50             add esp, 0x50
0x4081c8        C2 10 00             ret 0x10 ; FUNC 0x408140 END
```

RADARE2



```
  ; CALL XREF from 0x00407b45 (entry0)
0x00408140      83ec50           sub esp, 0x50                    ; 'P'
0x00408143      56               push esi
0x00408144      57               push edi
0x00408145      b90e000000       mov ecx, 0xe
0x0040814a      bed0134300       mov esi, str.http:__www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com
0x0040814f      8d7c2408         lea edi, [esp + 8]
0x00408153      33c0             xor eax, eax
0x00408155      f3a5             rep movsd dword es:[edi], dword ptr [esi]
0x00408157      a4               movsb byte es:[edi], byte ptr [esi]
0x00408158      89442441         mov dword [esp + 0x41], eax
0x0040815c      89442445         mov dword [esp + 0x45], eax
0x00408160      89442449         mov dword [esp + 0x49], eax
0x00408164      8944244d         mov dword [esp + 0x4d], eax
0x00408168      89442451         mov dword [esp + 0x51], eax
0x0040816c      6689442455       mov word [esp + 0x55], ax
0x00408171      50               push eax
0x00408172      50               push eax
0x00408173      50               push eax
0x00408174      6a01             push 1                           ; "Z."
0x00408176      50               push eax
0x00408177      8844246b         mov byte [esp + 0x6b], al
0x0040817b      ff1534a14000     call dword [sym.imp.WININET.dll_InternetOpenA] ; 0x40a134
0x00408181      6a00             push 0
0x00408183      6800000084       push 0x84000000
0x00408188      6a00             push 0
0x0040818a      8d4c2414         lea ecx, [esp + 0x14]
0x0040818e      8bf0             mov esi, eax
0x00408190      6a00             push 0
0x00408192      51               push ecx
0x00408193      56               push esi
0x00408194      ff1538a14000     call dword [sym.imp.WININET.dll_InternetOpenUrlA] ; 0x40a138
0x0040819a      8bf8             mov edi, eax
0x0040819c      56               push esi
0x0040819d      8b353ca14000     mov esi, dword sym.imp.WININET.dll_InternetCloseHandle ; [0x40a13c:4]=
0x004081a3      85ff             test edi, edi
0x004081a5      7515             jne 0x4081bc
0x004081a7      ffd6             call esi
0x004081a9      6a00             push 0
0x004081ab      ffd6             call esi
0x004081ad      e8defeffff       call sub.KERNEL32.dll_GetModuleFileNameA_90; dword GetModuleFileNameA(
0x004081b2      5f               pop edi
0x004081b3      33c0             xor eax, eax
0x004081b5      5e               pop esi
0x004081b6      83c450           add esp, 0x50                    ; 'P'
0x004081b9      c21000           ret 0x10
  ; JMP XREF from 0x004081a5 (sub.WININET.dll_InternetOpenA_140)
0x004081bc      ffd6             call esi
0x004081be      57               push edi
0x004081bf      ffd6             call esi
0x004081c1      5f               pop edi
0x004081c2      33c0             xor eax, eax
0x004081c4      5e               pop esi
0x004081c5      83c450           add esp, 0x50                    ; 'P'
0x004081c8      c21000           ret 0x10
```

DEMO

XORI

github.com/endgameinc/xori

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