Metasm Feelings

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Plan

Metasm: prends-moi

- opensource (LGPL)
- full ruby
- http://metasm.cr0.org/
- extensible
- scriptable
- full interactive documentation over IRC[1]
- yadda yadda

[1] irc://freenode/metasm

Main features

- Cross-arch assembler
- Disassembler
  - Intelligent
  - Emulation
  - Instruction semantics
- Debugger
  - Linux
  - Win32
  - GDBServer
- C Parser
- C Compiler
- Decompiler
- xtrem GUI

Target architectures

OS

- Windows
- Linux

Arch

- X86
- X64
- ARM
- MIPS
- PowerPC
- Sh4

Previous works

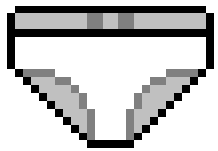
- Mainly static analysis of software protections:
  - Deobfuscation
  - Devirtualisation
- SSTIC (fr) - challenges (T2 2007, poeut, ...)
- HITB 2009 - realworld software protection
- Check the papers (with translation) on http://metasm.cr0.org/

Sample uses

```
require 'metasm'
include Metasm

np = OS.current.find_process('notepad')
# read the virtual memory of a running process
p np.memory[0x40000, 0x200]

# inject a shellcode
sc = Shellcode.assemble(Ia32.new, ''jmp esp'').encode_string
np.memory[0x40000, sc.length] = sc
```



Sample uses

```
require 'open-uri'

puts ''retrieving source code...''
html = open('http://recon.cx/2010/cfp.html').read
source = html[ /unsigned.*\}/m ]
abort ''no source found :('' if not source

elf = Metasm::ELF.compile_c(Metasm::Ia32.new, source)
elf.encode_string ; elf.decode
dasm = elf.disassembler

# selfmodify plugin, handles trivial decoding loops
dasm.load_plugin 'selfmodify'

w = Metasm::Gui::DasmWindow.new('recon-cfp', dasm, 'buf')

Metasm::Gui.main
```

Plan

Trace engine

Scriptable debugger

- High level API: $\Rightarrow$ `bpx()`, `stepover()`, etc.
- Disassembler: code graph

Building tools

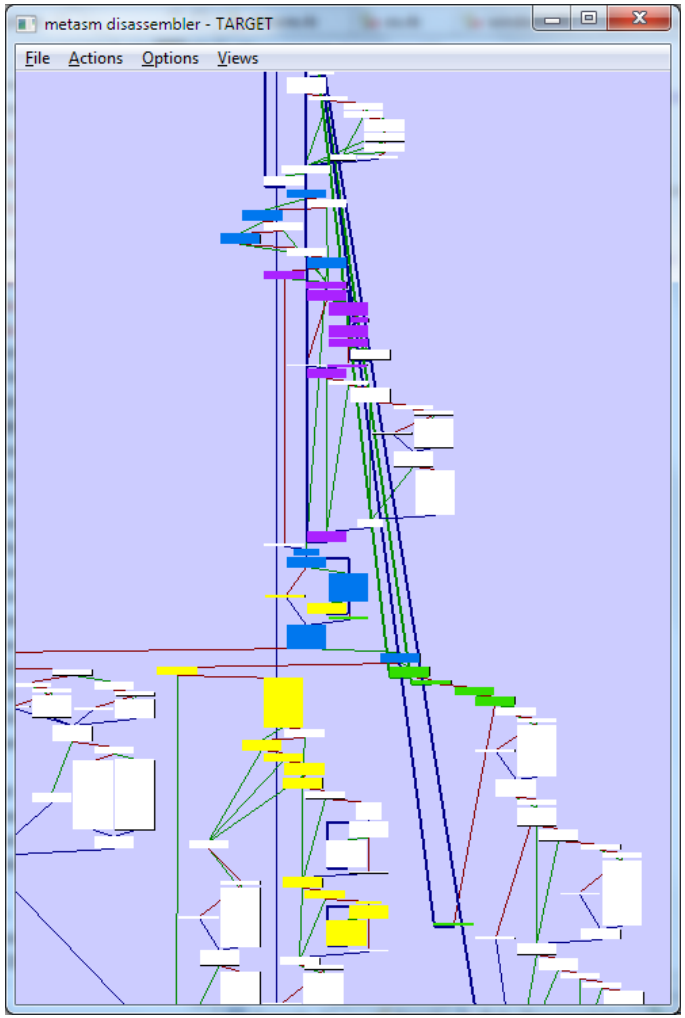
- Block-by-block trace algorithm implemented using the API
  $\Rightarrow$ can be used on any supported target
- Database support for free with rubygems[a]
  $\Rightarrow$ Trivial to store execution traces

[a] Currently using DataMapper

Trace visualization

Scriptable GUI as well

- Execution path coloring
- Possible to add controls: trace selection, etc.
- Advanced data manipulation
  - Trace “replay”
  - Trace diffing



Demo

Trace creation
Trace diffing
Trace replay

Plan

MSR debug registers

- Hardware registers from processors (`Intel/AMD`)
- Branch tracing MSR: `IA32_DEBUGCTL` (0x1D9)
- Can trigger an `INT1` whenever a branch is taken with TF set
- Implementation for WinXP in 2006 by Pedram Amini (`NtSystemDebugControl`)
  `Branch Tracing with Intel MSR Registers` [2]
- Same concepts can be applied on Windows 7 through the KD module[3]:
  - Issue `IOCTLs` to \\.**kldbgdrv** device
  - Need to boot with /**DEBUG** option

[2] `http://www.openrce.org/blog/view/535/Branch_Tracing_with_Intel_MSR_Registers`
[3] `http://www.ivanlef0u.tuxfamily.org/?p=382`

DynLdr

We'd like to call `Kernel32!DeviceIOControl()` from our ruby script

DynLdr

DynLdr is a Metasm component to generate ruby bindings from C headers

- Handles arbitrary C function prototypes (incl. __stdcall)
- Handles most numeric macros/enums
- Wrapper for C structures

MSR: C definitions

```
class MSR < Metasm::DynLdr
  new_api_c <<EOS

typedef struct _KLDBG {
    SYSDBG_COMMAND DbgCommandClass;
    PVOID DbgCommand;
    DWORD DbgCommandLen;
} KLDBG, * PKLDBG;

typedef enum _SYSDBG_COMMAND {
    SysDbgReadVirtual = 8,
    SysDbgWriteVirtual = 9,
    SysDbgReadMsr = 16,
    SysDbgWriteMsr = 17,
}

HANDLE WINAPI OpenServiceA(
    HANDLE hSCManager,
    LPCSTR lpServiceName,
    DWORD dwDesiredAccess
);
EOS
end
```

MSR: from Ruby to kernel device

```
def readmsr(addr)
    msr = alloc_c_struct('SYSDBG_MSR', 'msraddress' => addr)

    kldbg = alloc_c_struct('KLDBG')
    kldbg['dbgcommandclass'] = SYSDBGREADMSR
    kldbg['dbgcommand'] = msr
    kldbg['dbgcommandlen'] = msr.length

    lpBytesReturned = 0.chr*8

    deviceiocontrol(@hdevice, IOCTL, kldbg, kldbg.length, \
        msr, msr.length, lpBytesReturned, NULL)

    return msr['data']
end
```

Glue the bricks together

- Tweak debugger's interpretation of `INT1`
- Handle trap flag logic
- Add support for `MSR`:
  - Load `kldbgdrv` driver
  - Read/Write the `IA32_DEBUGCTL` MSR
- Integrate within `Bintrace` module

- Keep in mind that MSR are core-specific on SMP systems

$\Rightarrow$ OMGWTFBBQ

Port to Linux

- MSR interaction trivial, via mainline `msr LKM` creates char device: `/dev/cpu/*/msr`
- $\sim$30 lines of Ruby code

Demo

Branch tracing of `hostname.exe`

Plan

Broadcom NIC firmware

- Runs on the card
- Independant MIPS processor
- Dedicated ram&flash
- Controlled from host through MMIO

- Already examined by Perez&Duflot (CSW10)
  (custom-designed lowlevel interface)
- Guillaume Delugré, from our lab, has done similar works
  - a custom `LKM` exposes a char device
  - read/write to card memory space via a cli interface
  - set breakpoints, read regs, etc. through MMIO

NICDBG

- Metasm comes with a MIPS disassembler

  $\Rightarrow$ **Get a disassembler/debugger GUI for free**

- Include Bintrace modules in the debugger

  $\Rightarrow$ **Record live trace of execution**

Demo

NIC debugging
Trace card initialisation routines

Conclusion

Metasm is good for you

- Covers lots of everyday reversing tasks
- Avoid reinventing the wheel
- Plan, do, check, act
- The tracing module will be published soon[4]

[4] `http://esec.fr.sogeti.com/blog/`

KTHXBYE

Questions ?

http://metasm.cr0.org/

http://esec.fr.sogeti.com/blog/