function hooking for osx and linux

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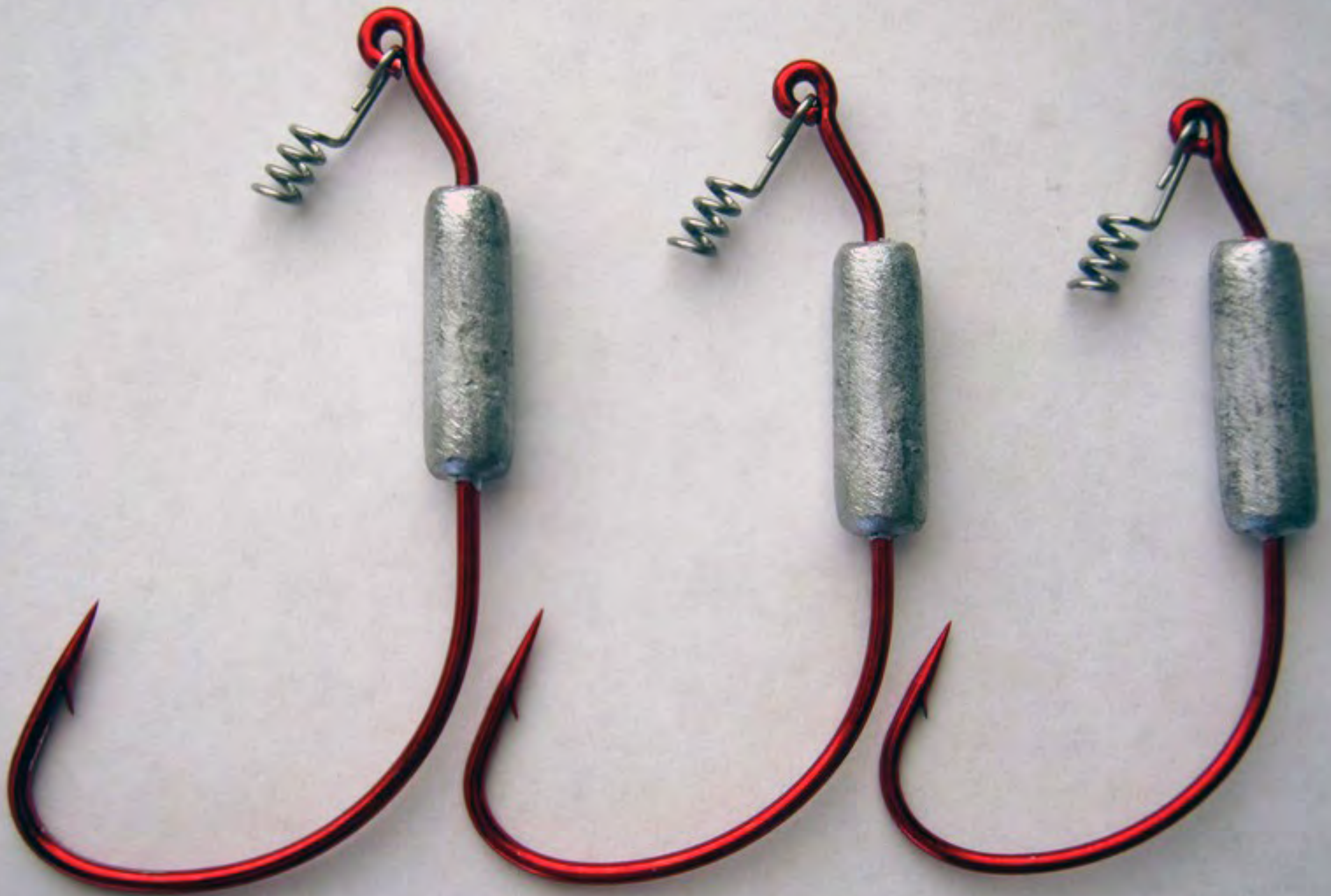
slides are on
timetobleed.com

(free jmpesp)

i'm not a security researcher.

call me a script kiddie:
@joedamato

laughinglarry.com



slayerinc.com

assembly is in att syntax

dbgrady.files.wordpress.com

WTF is an ABI ?

WTF is an Application
Binary
Interface ?

alignment
thomasgroup.com

calling convention

object file and
library formats
tandemfs.org

hierarchy of specs

HIERARCHY OF BEARDS.

System V ABI (271 pages)

System V ABI AMD64 Architecture Processor Supplement (128 pages)

System V ABI Intel386 Architecture Processor Supplement (377 pages)

MIPS, ARM, PPC, and IA-64 too!

mac osx x86-64 calling convention

based on

System V ABI AMD64 Architecture
Processor Supplement

BUFFALO TRACE
DISTILLERY

Beer Still
Capacity
60,000 gallons

gregs-wines.com

alignment
thomasgroup.com

end of argument area must be aligned on a 16byte boundary.

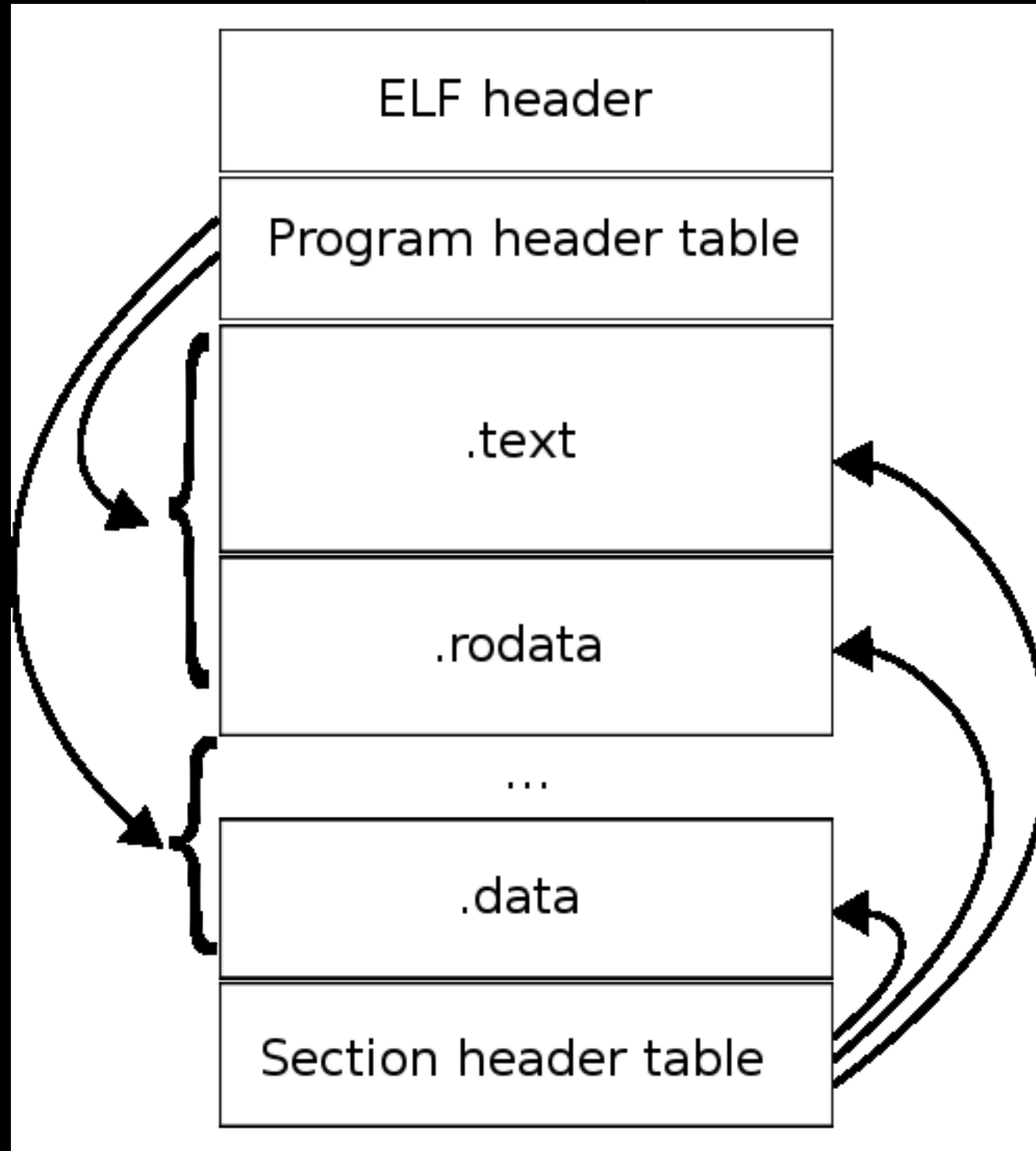
```
and $0xfffffffffffffff0, %rsp
```

calling convention

- function arguments from left to right live in: `%rdi`, `%rsi`, `%rdx`, `%rcx`, `%r8`, `%r9`
- that's for INTEGER class items.
- Other stuff gets passed on the stack (like on i386).
- registers are either caller or callee saved

object file and
library formats
tandemfs.org

ELF Objects



en.wikipedia.org

ELF Objects

- ELF objects have headers
  - elf header (describes the elf object)
  - program headers (describes segments)
  - section headers (describes sections)
- libelf is useful for wandering the elf object extracting information.
- the executable and each .so has its own set of data

ELF Object sections

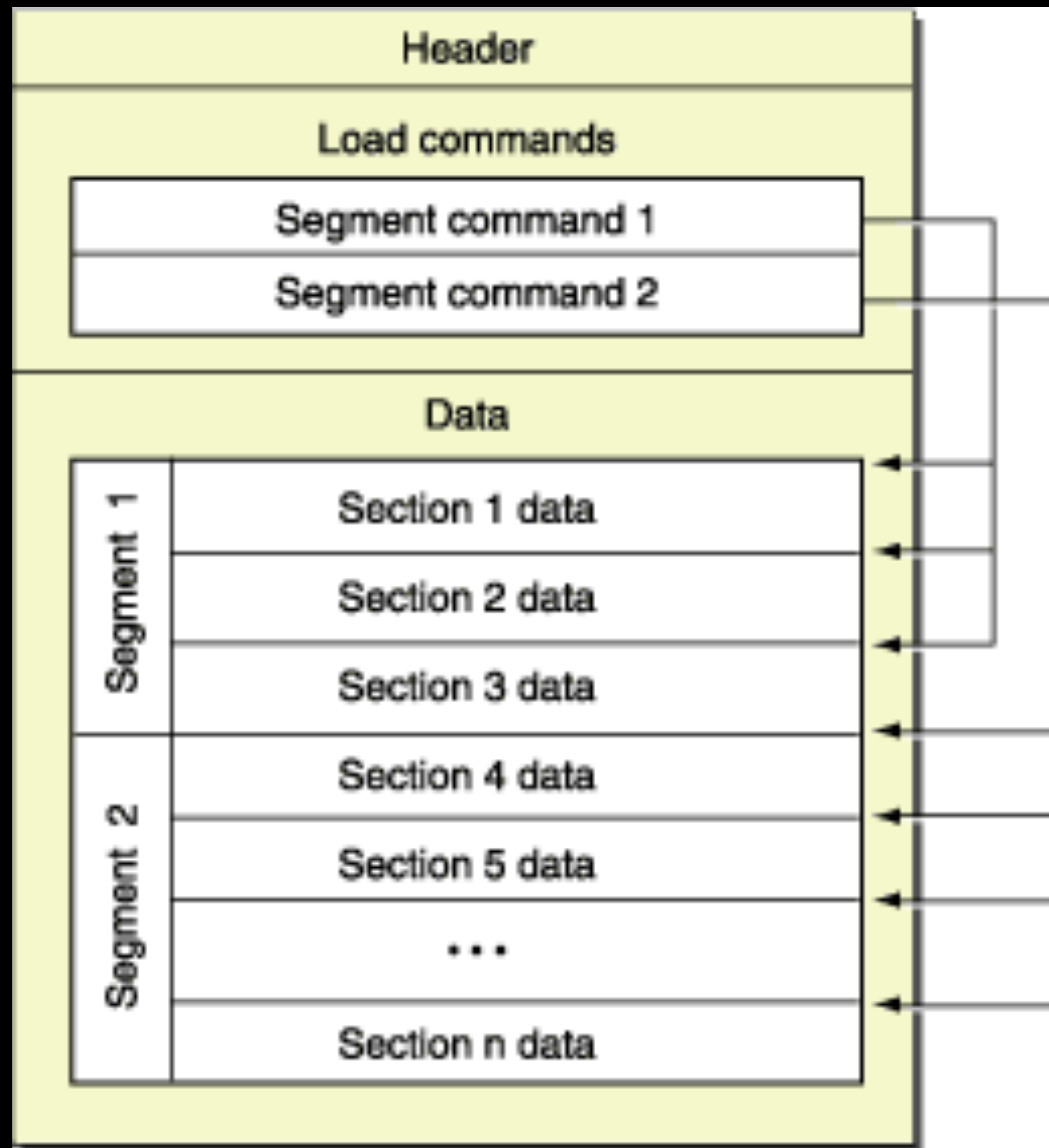
- .text - code lives here
- .plt - stub code that helps to “resolve” absolute function addresses.
- .got.plt - absolute function addresses; used by .plt entries.
- .debug_info - debugging information
- .gnu_debuglink - checksum and filename for debug info

ELF Object sections

- .dynsym - maps *exported* symbol names to offsets
- .dynstr - stores *exported* symbol name strings
- .symtab - maps symbol names to offsets
- .strtab - symbol name strings
- more sections for other stuff.

Gillette
MACH3
8

Mach-O Objects



developer.apple.com

Mach-O Objects

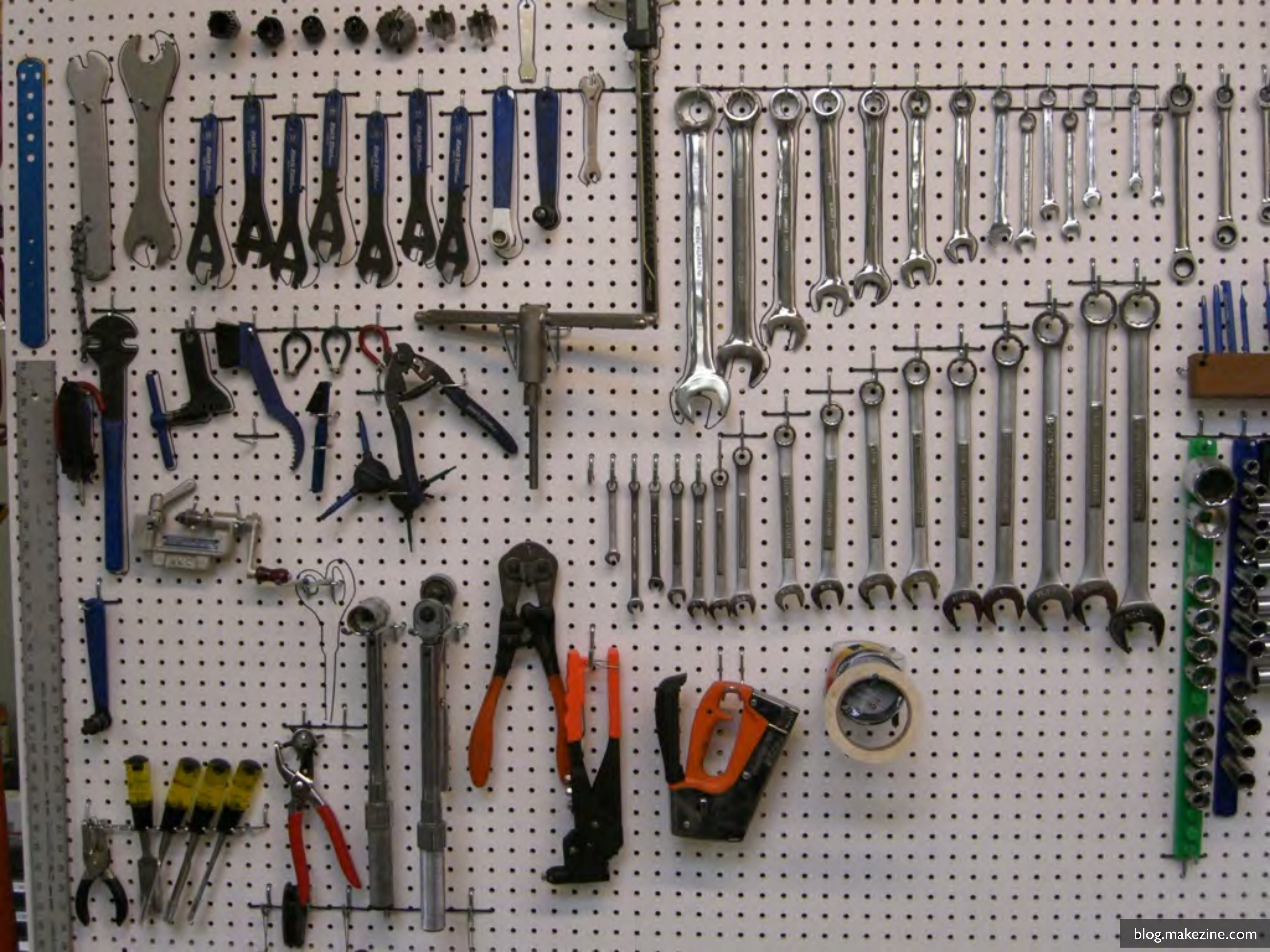
- Mach-O objects have load commands
  - header (describes the mach-o object)
  - load commands (describe layout and linkage info)
  - segment commands (describes sections)
- dyld(3) describes some apis for touching mach-o objects
- the executable and each dylib/bundle has its own set of data

Mach-O sections

- __text - code lives here
- __symbol_stub1 - list of jmpq instructions for runtime dynamic linking
- __stub_helper - stub code that helps to "resolve" absolute function addresses.
- __la_symbol_ptr - absolute function addresses; used by symbol stub

Mach-O sections

- symtabs do not live in a segment, they have their own load commands.
- LC_SYMTAB - holds offsets for symbol table and string table.
- LC_DYSYMTAB - a list of 32bit offsets into LC_SYMTAB for dynamic symbols.


blog.makezine.com

nm

% nm /usr/bin/ruby

```
000000000048ac90 t Balloc
0000000000491270 T Init_Array
0000000000497520 T Init_Bignum
000000000041dc80 T Init_Binding
000000000049d9b0 T Init_Comparable
000000000049de30 T Init_Dir
00000000004a1080 T Init_Enumerable
00000000004a3720 T Init_Enumerator
00000000004a4f30 T Init_Exception
000000000042c2d0 T Init_File
0000000000434b90 T Init_GC
```

symbol "value"

symbol names

objdump

% objdump -D /usr/bin/ruby

```
0000000000434860 <rb_newobj>:
  434860:   48 83 ec 08             sub    $0x8,%rsp
  434864:   8b 05 82 12 2c 00       mov    0x2c1282(%rip),%eax       # 6f5aec <during_gc>
  43486a:   85 c0                   test   %eax,%eax
  43486c:   75 6b                   jne    4348d9 <rb_newobj+0x79>
  43486e:   48 83 3d 3a 85 2a 00    cmpq   $0x0,0x2a853a(%rip)       # 6dcdb0 <malloc_limit>
  434875:   00
  434876:   74 58                   je     4348d0 <rb_newobj+0x70>
  434878:   48 83 3d 20 12 2c 00    cmpq   $0x0,0x2c1220(%rip)       # 6f5aa0 <freelist>
  43487f:   00
  434880:   74 4e                   je     4348d0 <rb_newobj+0x70>
  434882:   48 8b 05 17 12 2c 00    mov    0x2c1217(%rip),%rax       # 6f5aa0 <freelist>
  434889:   48 8b 50 08             mov    0x8(%rax),%rdx
  43488d:   48 89 15 0c 12 2c 00    mov    %rdx,0x2c120c(%rip)       # 6f5aa0 <freelist>
  434894:   48 c7 00 00 00 00 00    movq   $0x0,(%rax)
  43489b:   48 c7 40 08 00 00 00    movq   $0x0,0x8(%rax)
  4348a2:   00
```

offsets | opcodes | instructions | helpful metadata

readelf

% readelf -a /usr/bin/ruby

```
[ 6] .dynstr           STRTAB           000000000040a270  0000a270
     0000000000003815  0000000000000000   A       0     0     1
[ 7] .gnu.version      VERSYM           000000000040da86  0000da86
     000000000000086e  0000000000000002   A       5     0     2
[ 8] .gnu.version_r    VERNEED          000000000040e2f8  0000e2f8
     00000000000000c0  0000000000000000   A       6     5     8
[ 9] .rela.dyn         RELA             000000000040e3b8  0000e3b8
     0000000000000078  0000000000000018   A       5     0     8
[10] .rela.plt         RELA             000000000040e430  0000e430
     0000000000001248  0000000000000018   A       5    12     8
[11] .init             PROGBITS         000000000040f678  0000f678
     0000000000000018  0000000000000000  AX       0     0     4
[12] .plt              PROGBITS         000000000040f690  0000f690
     0000000000000c40  0000000000000010  AX       0     0     4
[13] .text             PROGBITS         00000000004102d0  000102d0
     0000000000096988  0000000000000000  AX       0     0     16
```

This is a *tiny* subset of the data available

otool

% otool -l /usr/bin/ruby

```
Load command 0
      cmd LC_SEGMENT_64
  cmdsize 72
  segname __PAGEZERO
   vmaddr 0x0000000000000000
   vmsize 0x0000000100000000
  fileoff 0
 filesize 0
  maxprot 0x00000000
 initprot 0x00000000
   nsects 0
    flags 0x0
Load command 1
      cmd LC_SEGMENT_64
  cmdsize 632
  segname __TEXT
   vmaddr 0x0000000100000000
   vmsize 0x00000000000d6000
  fileoff 0
 filesize 876544
  maxprot 0x00000007
 initprot 0x00000005
   nsects 7
    flags 0x0
```

This is a *tiny* subset of the data available

nerve.com

strip

- You can strip out whatever sections you want....
- but your binary may not run.
- you need to leave the dynamic symbol/ string tables intact or dynamic linking will not work.

bassfishin.com

Calling functions

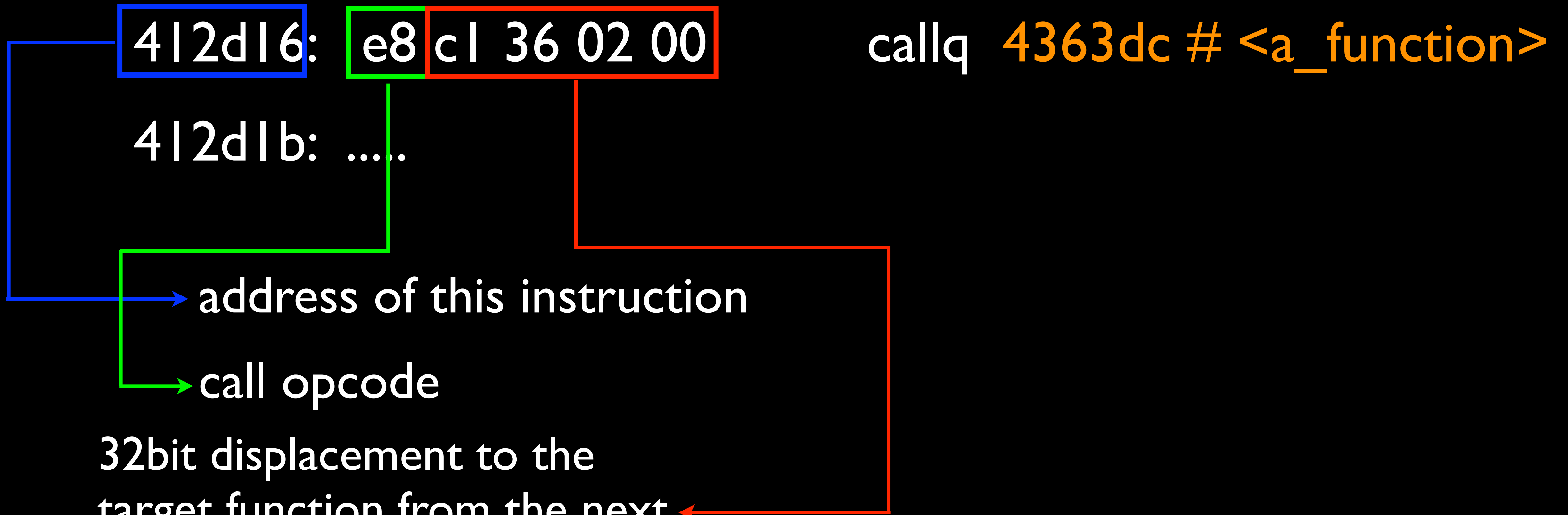
```
callq *%rbx

callq 0xdeadbeef
```

other ways, too...

anatomy of a call

(objdump output)



32bit displacement to the target function from the next instruction.

anatomy of a call

(objdump output)

412d16: e8 c1 36 02 00 callq 4363dc # <a_function>

412d1b: .....

(x86 is little endian)

412d1b + 000236c1 = 4363dc

Hook a_function

Overwrite the displacement so that all calls to a_function actually call a different function instead.

It may look like this:

```
int other_function()
{
        /* do something good/bad */

        /* be sure to call a_function! */
        return a_function();
}
```

codez are easy

```
/* CHILL, it's fucking psuedo code */

while (are_moar_bytes()) {
  curr_ins = next_ins;
  next_ins = get_next_ins();
  if (curr_ins->type == INSN_CALL) {
    if ((hook_me - next_ins) == curr_ins->displacement) {
      /* found a call hook_me!*/
      rewrite(curr_ins->displacement, (replacement_fn - next_ins));
      return 0;
    }
  }
}
```

... right?.....

lemur.com

32bit displacement

- overwriting an existing call with another call
- stack will be aligned
- args are good to go
- can’t redirect to code that is outside of:
  - [rip + 32bit displacement]
- you can scan the address space looking for an available page with mmap, though...

Doesn’t work for all

calling a function that is exported by a dynamic library **works differently.**

How runtime dynamic linking works (elf)

```
callq  0x7ffff7afd6e0 <rb_newobj@plt>

0x7ffff7afd6e0 <rb_newobj@plt>:     jmpq   *0x2c43b2(%rip)        # 0x7ffff7dc1a98
0x7ffff7afd6e6 <rb_newobj@plt+6>:   pushq  $0x4e
0x7ffff7afd6eb <rb_newobj@plt+11>:  jmpq   0x7ffff7afd1f0
```

.got.plt entry

0x7ffff7afd6e6

How runtime dynamic linking works (elf)

```
callq  0x7ffff7afd6e0 <rb_newobj@plt>

0x7ffff7afd6e0 <rb_newobj@plt>:     jmpq   *0x2c43b2(%rip)        # 0x7ffff7dc1a98
0x7ffff7afd6e6 <rb_newobj@plt+6>:   pushq  $0x4e
0x7ffff7afd6eb <rb_newobj@plt+11>:  jmpq   0x7ffff7afd1f0
```

.got.plt entry

0x7ffff7afd6e6

Initially, the .got.plt entry contains the address of the instruction after the jmp.

How runtime dynamic linking works (elf)

```
callq  0x7ffff7afd6e0 <rb_newobj@plt>

0x7ffff7afd6e0 <rb_newobj@plt>:     jmpq   *0x2c43b2(%rip)        # 0x7ffff7dc1a98
0x7ffff7afd6e6 <rb_newobj@plt+6>:   pushq  $0x4e
0x7ffff7afd6eb <rb_newobj@plt+11>:  jmpq   0x7ffff7afd1f0
```

.got.plt entry

0x7ffff7afd6e6

An ID is stored and the rtld is invoked.

How runtime dynamic linking works (elf)

```
callq  0x7ffff7afd6e0 <rb_newobj@plt>

0x7ffff7afd6e0 <rb_newobj@plt>:     jmpq   *0x2c43b2(%rip)        # 0x7ffff7dc1a98
0x7ffff7afd6e6 <rb_newobj@plt+6>:   pushq  $0x4e
0x7ffff7afd6eb <rb_newobj@plt+11>:  jmpq   0x7ffff7afd1f0
```

.got.plt entry

rtld writes the address of rb_newobj to the .got.plt entry.

0x7ffff7b34ac0

How runtime dynamic linking works (elf)

```
callq  0x7ffff7afd6e0 <rb_newobj@plt>
```

```
0x7ffff7afd6e0 <rb_newobj@plt>:     jmpq   *0x2c43b2(%rip)        # 0x7ffff7dc1a98
0x7ffff7afd6e6 <rb_newobj@plt+6>:   pushq  $0x4e
0x7ffff7afd6eb <rb_newobj@plt+11>:  jmpq   0x7ffff7afd1f0
```

.got.plt entry

rtld writes the address of rb_newobj to the .got.plt entry.

0x7ffff7b34ac0

calls to the PLT entry jump immediately to rb_newobj now that .got.plt is filled in.

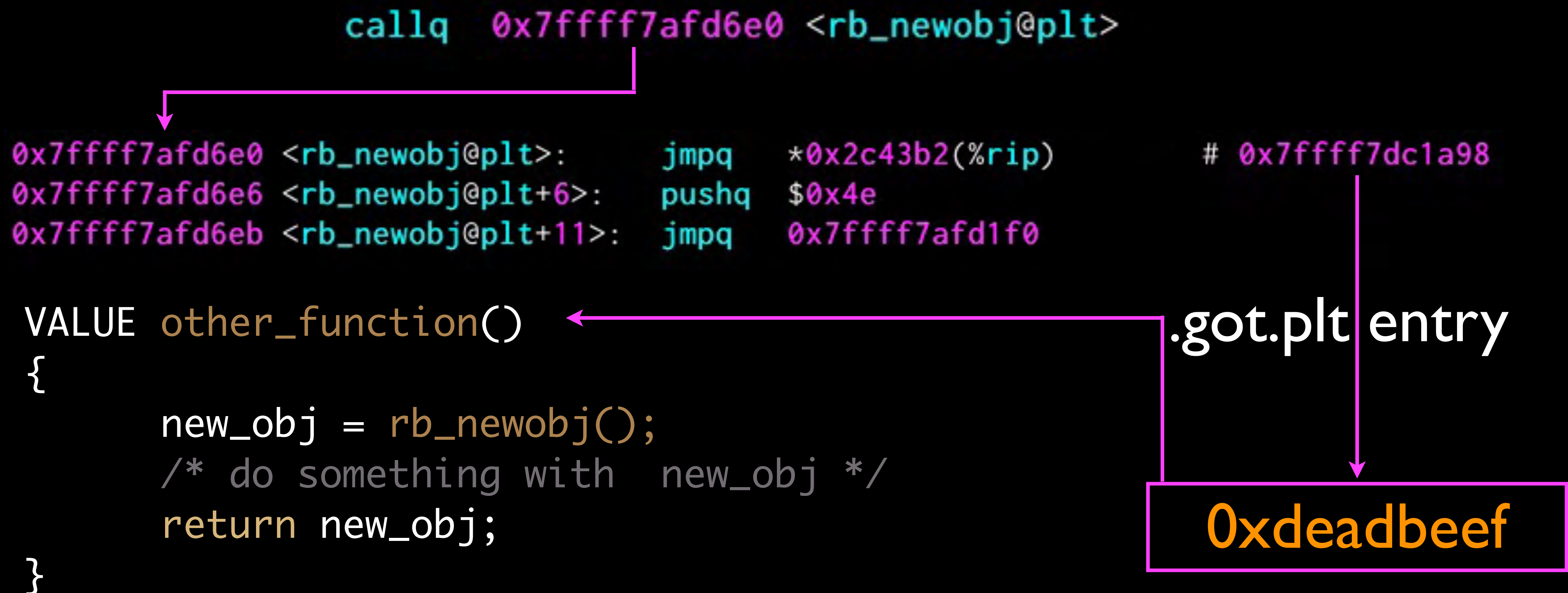
```
0x00007ffff7b34ac0 <rb_newobj+0>: sub    $0x8,%rsp
0x00007ffff7b34ac4 <rb_newobj+4>: mov    0x2a840a(%rip),%eax        # 0x7ffff7ddced4 <during_gc>
0x00007ffff7b34aca <rb_newobj+10>:  test   %eax,%eax
```

rs.tacklewarehouse.com

Hook the GOT

Redirect execution by overwriting all the .got.plt entries for rb_newobj in each DSO with a handler function instead.

Hook the GOT



WAIT... other_function() calls rb_newobj() isn't that an infinite loop?

NO, it isn't. other_function() lives in it's own DSO, so its calls to rb_newobj() use the .plt/.got.plt in its own DSO.

As long as we leave other_function()'s DSO unmodified, we'll avoid an infinite loop.

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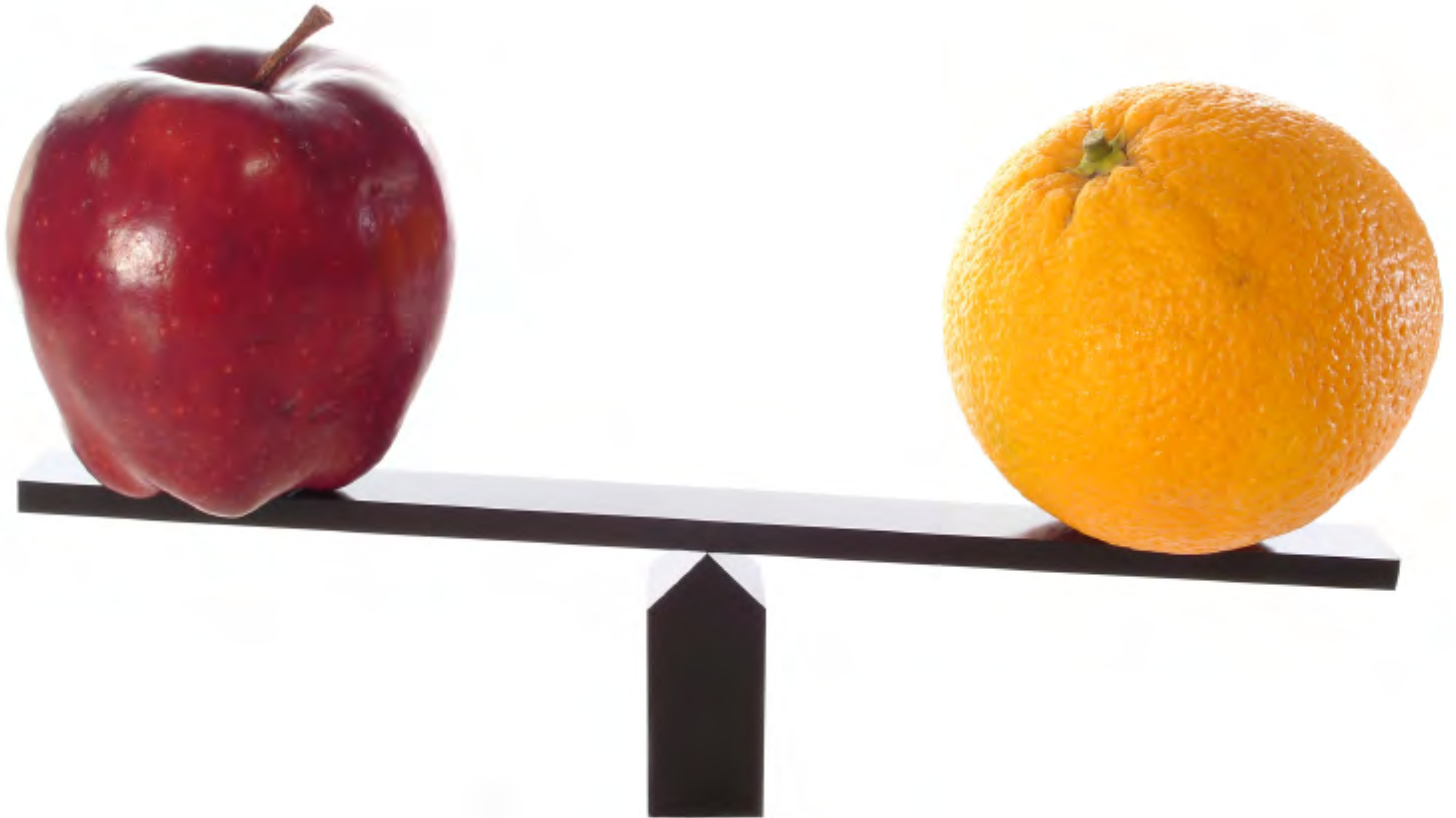
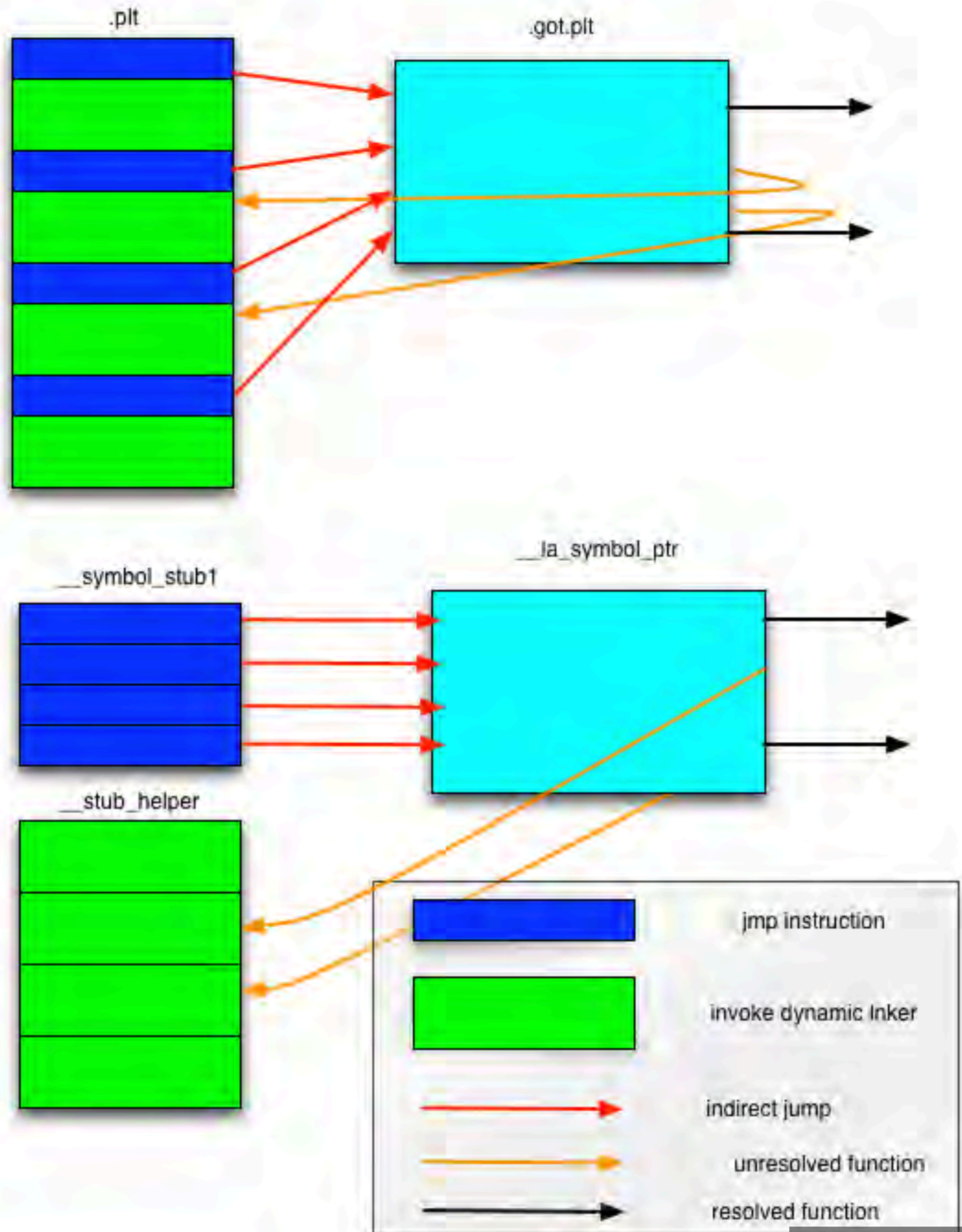


tlaneve.files.wordpress.com

elf

mach-o



what else is left?

inline functions.

add_freelist

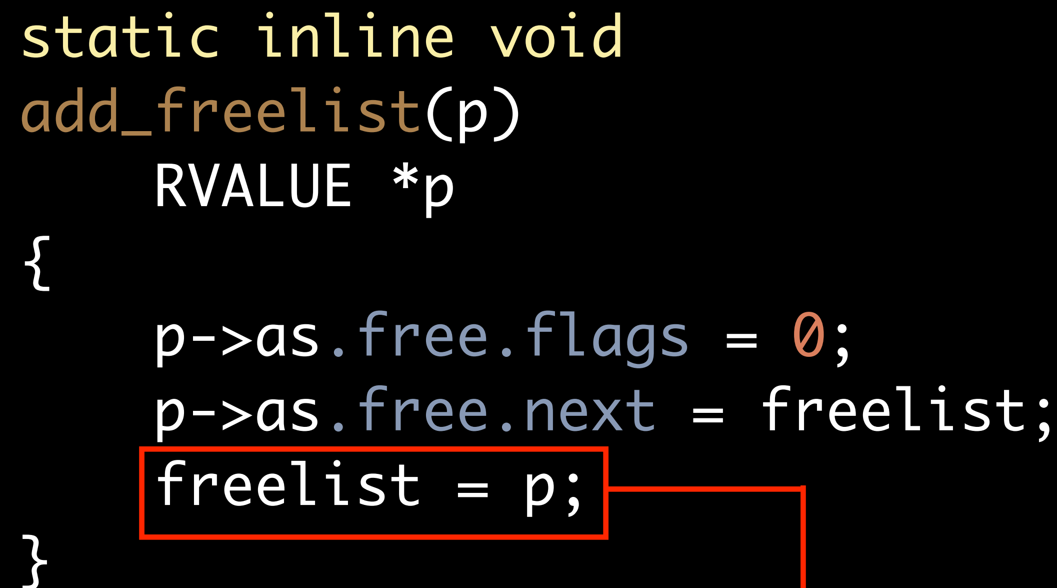
- Can’t hook because add_freelist is *inlined*:

```
static inline void
add_freelist(p)
    RVALUE *p
{
    p->as.free.flags = 0;
    p->as.free.next = freelist;
    freelist = p;
}
```

- The compiler has the option of inserting the instructions of this function directly into the callers.
- If this happens, you won’t see any calls.

So... what now?

- Look carefully at the code:



- Notice that freelist gets updated.
- freelist has file level scope.
- hmmmm......

A (stupid) crazy idea

- freelist has file level scope and lives at some static address.
- add_freelist updates freelist, so...
- Why not *search the binary for mov instructions that have freelist as the target!*
- Overwrite that mov instruction with a call to our code!
- But... we have a problem.
- The system isn't ready for a call instruction.

alignment
thomasgroup.com

calling convention
arianlim.wordpress.com

Isn't ready? What?

- The 64bit ABI says that the stack must be aligned to a 16byte boundary after any/all arguments have been arranged.
- Since the overwrite is just some random mov, no way to guarantee that the stack is aligned.
- If we just plop in a call instruction, we won't be able to arrange for arguments to get put in the right registers.
- So now what?

jmp

- Can use a jmp instruction.
- Transfer execution to an assembly stub **generated at runtime.**
  - recreate the overwritten instruction
  - set the system up to call a function
- do something good/bad
- jmp back when done to resume execution

picasaweb.google.com/lh/photo/-R3BPlqOq8MfQGFTduIqCA

checklist

- save and restore caller/callee saved registers.
- align the stack.
- recreate what was overwritten.
- arrange for any arguments your replacement function needs to end up in registers.
- invoke your code.
- resume execution as if nothing happened.

this instruction updates the freelist and comes from add_freelist:

```
48 89 1d 1a 1a 2c 00     mov     %rbx,0x2c1a1a(%rip)        # 0x6f5aa0 <freelist>
```

Can’t overwrite it with a call instruction because the state of the system is not ready for a function call.

```
e9 e3 8d bc 3f           jmpq    0x40000800
90                       nop
90                       nop
```

address of assembly stub

The jmp instruction and its offset are 5 bytes wide. Can’t grow or shrink the binary, so insert 2 one byte NOPs.

this instruction updates the freelist and comes from add_freelist:

```
48 89 1d 1a 1a 2c 00     mov     %rbx,0x2c1a1a(%rip)        # 0x6f5aa0 <freelist>
```

Can’t overwrite it with a call instruction because the state of the system is not ready for a function call.

```
e9 e3 8d bc 3f          jmpq    0x40000800
90                      nop     → must jump back here
90                      nop
```

The jmp instruction and its offset are 5 bytes wide. Can’t grow or shrink the binary, so insert 2 one byte NOPs.

shortened assembly stub

```
mov     %rbx,-0x3f8eaa6f(%rip)         # recreate overwritten instruction
push    %rax                            # save %rax incase the handler destroys it
push    %rdi                            # save %rdi, we need it to pass arg 1
mov     -0x3f8eaa77(%rip),%rdi         # mov top of freelist to rdi (arg 1 to handler)
push    %rbx                            # save rbx
push    %rbp                            # save rbp
mov     %rsp,%rbp                       # set base pointer to current stack pointer
and     $0xfffffffffffffff0,%rsp        # align stack to conform with 64bit ABI
mov     $0x7ffff6a479b4,%rbx            # mov the handler address into %rbx
callq   *%rbx                           # call handler via %rbx
leaveq                                  # mov rbp, rsp; pop rbp
pop     %rbx                            # restore rbx
pop     %rdi                            # restore rdi
pop     %rax                            # restore rax
jmpq    0x437a1f <gc_sweep+1096>        # continue execution
```

shortened assembly stub

```
mov     %rbx,-0x3f8eaa6f(%rip)          # recreate overwritten instruction
push    %rax                            # save %rax incase the handler destroys it
push    %rdi                            # save %rdi, we need it to pass arg 1
mov     -0x3f8eaa77(%rip),%rdi          # mov top of freelist to rdi (arg 1 to handler)
push    %rbx                            # save rbx
push    %rbp                            # save rbp
mov     %rsp,%rbp                       # set base pointer to current stack pointer
and     $0xfffffffffffffff0,%rsp        # align stack to conform with 64bit ABI
mov     $0x7ffff6a479b4,%rbx            # mov the handler address into %rbx
callq   *%rbx                           # call handler via %rbx
leaveq                                  # mov rbp, rsp; pop rbp
pop     %rbx                            # restore rbx
pop     %rdi                            # restore rdi
pop     %rax                            # restore rax
jmpq    0x437a1f <gc_sweep+1096>        # continue execution
```

```
void handler(VALUE freed_object)
{
        mark_object_freed(freed_object);
        return;
}
```

and it actually works.

gem install memprof

http://github.com/ice799/memprof

listverse.files.wordpress.com

Sample Output

```ruby
require 'memprof'
Memprof.start
require "stringio"
StringIO new
Memprof.stats
```

```
108 /custom/ree/lib/ruby/1.8/x86_64-linux/stringio.so:0:__node__
 14 test2.rb:3:String
  2 /custom/ree/lib/ruby/1.8/x86_64-linux/stringio.so:0:Class
  1 test2.rb:4:StringIO
  1 test2.rb:4:String
  1 test2.rb:3:Array
  1 /custom/ree/lib/ruby/1.8/x86_64-linux/stringio.so:0:Enumerable
```

memprof.com

a web-based heap visualizer and leak analyzer

new rails3-beta application *by tmm1* about a month ago

ruby-1.8.7-p249/bin/ruby

- ruby 1.8.7 (2010-01-10 patchlevel 249) [i686-darwin10.2.0]
- executing ./script/rails
- compiled with -g -O2 -fno-common -pipe -fno-common $(cflags)
- memory usage is 97156 bytes
- working directory is test/code/newapp
- 6 IO objects and 10 file descriptors
- 20 shared libraries

404869 objects

- 78 global variables
- 213 constants inside Object
- objects grouped by age
- objects grouped by type
- objects with most outbound references

2428 classes and 695 modules

- namespace hierarchy
- class hierarchy
- instances per class
- duplicate classes by name

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a web-based heap visualizer and leak analyzer

152105	site_ruby/1.8/rubygems/spec_fetcher.rb
95743	site_ruby/1.8/rubygems/version.rb
48321	bundler-0.9.10/lib/bundler/source.rb
46873	object
46849	Bundler::RemoteSpecification
46849	line 59
8	Bundler::Index
6	Process::Status
3	Gem::Builder
2	Bundler::Specification
2	Gem::Installer
2	Gem::Version
1	Range
1214	node

- #<Gem::Version:0x3554a70>
  - #<Bundler::RemoteSpecification:0x6af24e8>
    - #<Array:0x63688d0 length=3>
      - #<Hash:0x620f420 length=10656>
        - #<Bundler::Index:0x620f4c0>
          - #<Bundler::Installer:0x175e110>
    - #<Array:0x6af3a50 length=3>
      - #<Hash:0x1740ae8 length=10656>
        - #<Bundler::Index:0x1740b88>
          - #<Scope variables=_, ~, o>
          - #<Bundler::Source::Rubygems:0x17723e0>

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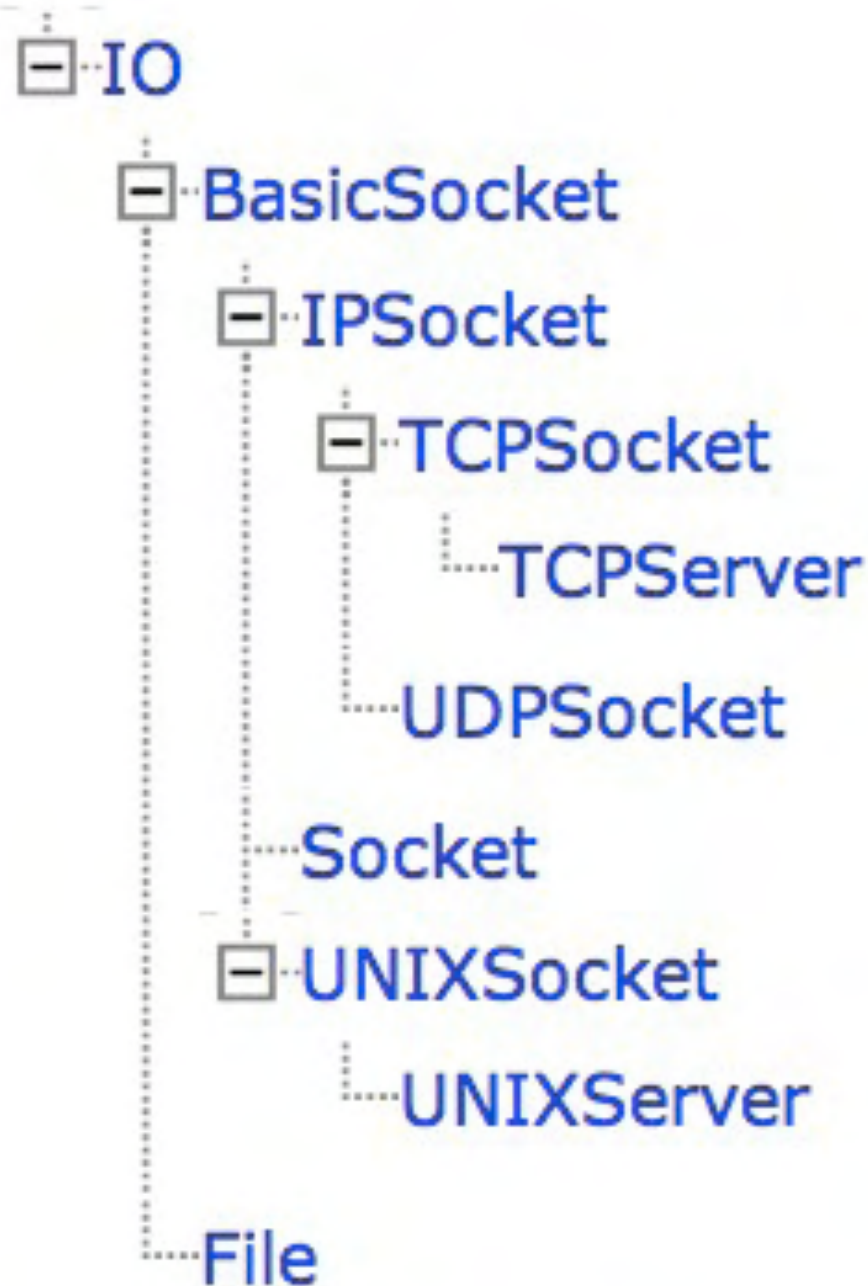
a web-based heap visualizer and leak analyzer



memprof.com

a web-based heap visualizer and leak analyzer

address	#<Array:0x6279948 length=4096>
file	gems/googlecharts-1.3.6/lib/gchart.rb
line	15
type	array
class	Array
length	4096
0	"AA"
1	"AB"
2	"AC"
3	"AD"
4	"AE"
5	"AF"
6	"AG"
7	"AH"
8	"AI"
9	"AJ"
10	"AK"
11	"AL"

```
def self.simple_chars
  @simple_chars ||= ('A'..'Z').to_a + ('a'..'z').to_a + ('0'..'9').to_a
end

def self.chars
  @chars ||= simple_chars + ['-', '.']
end

def self.ext_pairs
  @ext_pairs ||= chars.map { |char_1| chars.map { |char_2| char_1 + char_2 } }.flatten
end
```

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a web-based heap visualizer and leak analyzer

address	node:WHILE
type	node
node_type	WHILE
file	lib/ruby/1.8/singleton.rb
line	147
n1	node:CALL
n2	node:BLOCK
n3	0

```
while false.equal?(@__instance__) do
  Thread.critical = false
  sleep(nil)
  Thread.critical = true
end
```

address	node:OP_ASGN2
type	node
node_type	OP_ASGN2
file	ruby/1.8/date/format.rb
line	551
n1	node:LVAR
n2	node:IF
n3	node:OP_ASGN2

```
e._cent ||= (val >= 69) ? (19) : (20)
```

{"_id":"0x35da08"}

1 object detail references

address	node:DEFN
type	node
node_type	DEFN
file	lib/ruby/1.8/delegate.rb
line	267
n1	true
n2	:method_missing
n3	node:SCOPE

```
def method_missing(m, *args, &block)
  super(m, *args, &block) unless @_dc_obj.respond_to?(m)
  @_dc_obj.__send__(m, *args, &block)
end
```

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a web-based heap visualizer and leak analyzer

```
{"type":"file"}
```

4 objects list group

0x1a6ae8 #<TCPSocket:0x1a6ae8>

IO:0x1b5b88>

IO:0x1b5bb0>

IO:0x1b5bd8>

```
{"_id":"0x1a6ae8"}
```

1 object detail references

address	#<TCPSocket:0x1a6ae8>
file	-e
line	1
time	1269746382129610
type	file
class	TCPSocket
fileno	(IPv4:3u) 192.168.1.138:54337 -> 74.125.19.105:http (ESTABLISHED)
mode	readable writable readwrite sync

- (REG:txt) i686-darwin10.2.0/digest/sha1.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/digest.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/strscan.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/fcntl.bundle
- (REG:txt) i686-darwin10.2.0/racc/cparse.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/zlib.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/socket.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/openssl.bundle
- (REG:txt) 1.8/i686-darwin10.2.0/nkf.bundle
- (REG:txt) eventmachine-0.12.10/lib/rubyeventmachine.bundle

community.devexpress.com

```
config.middleware.use(Memprof::Tracer)
```

```
{
  "time": 4.3442,

  "rails":
    "controller": "test",
    "action": "index"
  },

  "request": {
    "REQUEST_PATH": "/test,
    "REQUEST_METHOD": "GET"
  },
```

← total time for request

← rails controller/action

← request env info

```
config.middleware.use(Memprof::Tracer)
```

```
"mysql": {
  "queries": 3,
  "time": 0.00109302
},

"gc": {
  "calls": 8,
  "time": 2.04925
},
```

← 3 mysql queries

← 8 calls to GC

← 2 secs spent in GC

```
config.middleware.use(Memprof::Tracer)
  "objects": {
    "created": 3911103,       ← 3 million objs created
    "types": {
      "none": 1168831,        ← 1 million method calls
      "object": 1127,         ← object instances
      "float": 627,
      "string": 1334637,      ← lots of strings
      "array": 609313,        ← lots of arrays
      "hash": 3676,
      "match": 70211          ← regexp matches
    }
  }
}
```

smiley-faces.org

SOCIAL ENGINEERING

Verify requests for sensitive information and

mindfulsecurity.com

evil lives

http://github.com/ice799/memprof/tree/dnw

- makes ruby faster!11!!1
- hooks read syscall
- looks for magic cookie (JOE)
- turns off GC
- Ruby is fast.

it makes ruby faster!!1!

look a bullshit benchmark!

it makes ruby faster!!1!

#NORMAL RUBY!!!!11!!

[joe@mawu:/Users/joe/code/defcon/memprof/ext]% ab -c 10 -n 200 http://blah:4567/hi/JOE

Benchmarking blah (be patient)
Completed 100 requests
Completed 200 requests
Finished 200 requests

Concurrency Level: 10
Time taken for tests: 7.462 seconds
Complete requests: 200
Failed requests: 0
Write errors: 0
Requests per second: 26.80 [#/sec] (mean)
Time per request: 373.108 [ms] (mean)
Time per request: 37.311 [ms] (mean, across all concurrent requests)

it makes ruby faster!!1!

```
# fast0r RUBY!!!11!111
[joe@mawu:/Users/joe/code/defcon]% ab -c 10 -n 200 http://blah:4567/hi/JOE

Benchmarking blah (be patient)
Completed 100 requests
Completed 200 requests
Finished 200 requests

Concurrency Level:      10
Time taken for tests:   6.594 seconds
Complete requests:      200
Failed requests:        0
Write errors:           0
Requests per second:    30.33 [#/sec] (mean)
Time per request:       329.708 [ms] (mean)
Time per request:       32.971 [ms] (mean, across all concurrent requests)
```

you can do anything

- this example is stupid, but you can do anything.
- hook read/write and phone home with data.
- fork a backdoor when a specific cookie is seen
- whatever

break.com

zanyvideos.com

injectso

- written by Shaun Clowes
- injects libraries into *running* processes using ptrace(2).
- super clever hack!

FUCKING MAGNETS

HOW DO THEY WORK

hockeydrunk.com

injecting live processes

- ptrace(2)
  - allows you to view and modify the register set and address space of another process
  - permissions on memory are ignored

fucking injectso, how does it work?

- attach to target process using ptrace
- save a copy of a small piece of the program stack.
- save a copy of the register set
- create a fake stack frame with a saved return address of 0

fucking injectso, how does it work?

- set register set to point at dlopen
  - rip = &dlopen
  - rdi = dso name
  - rsi = mode
- let er rip, waitpid and it’ll segfault on return to 0.
- restore stack, register set, resume as normal.

ptrace

- remote allocating memory is a pain in the ass.
- generating segfaults in running processes might be bad (core dumps, etc).
- binary patching is hard, doing it with ptrace is harder.

evil dso

- getting the user to use your library might be hard.
- already running processes will need to be killed first.
- need to poison each time app is started.
- binary patching is hard.

realmofraven.com

combine ‘em

- use injectso hack to load an evil dso
- evil dso will take it from there

64bit injectso port

- ported by Stealth
- http://c-skills.blogspot.com/2007/05/injectso.html
- i did some trivial cleanup and put the codez on github
- http://github.com/ice799/injectso64
- tested it on 64bit ubuntu VM, works.

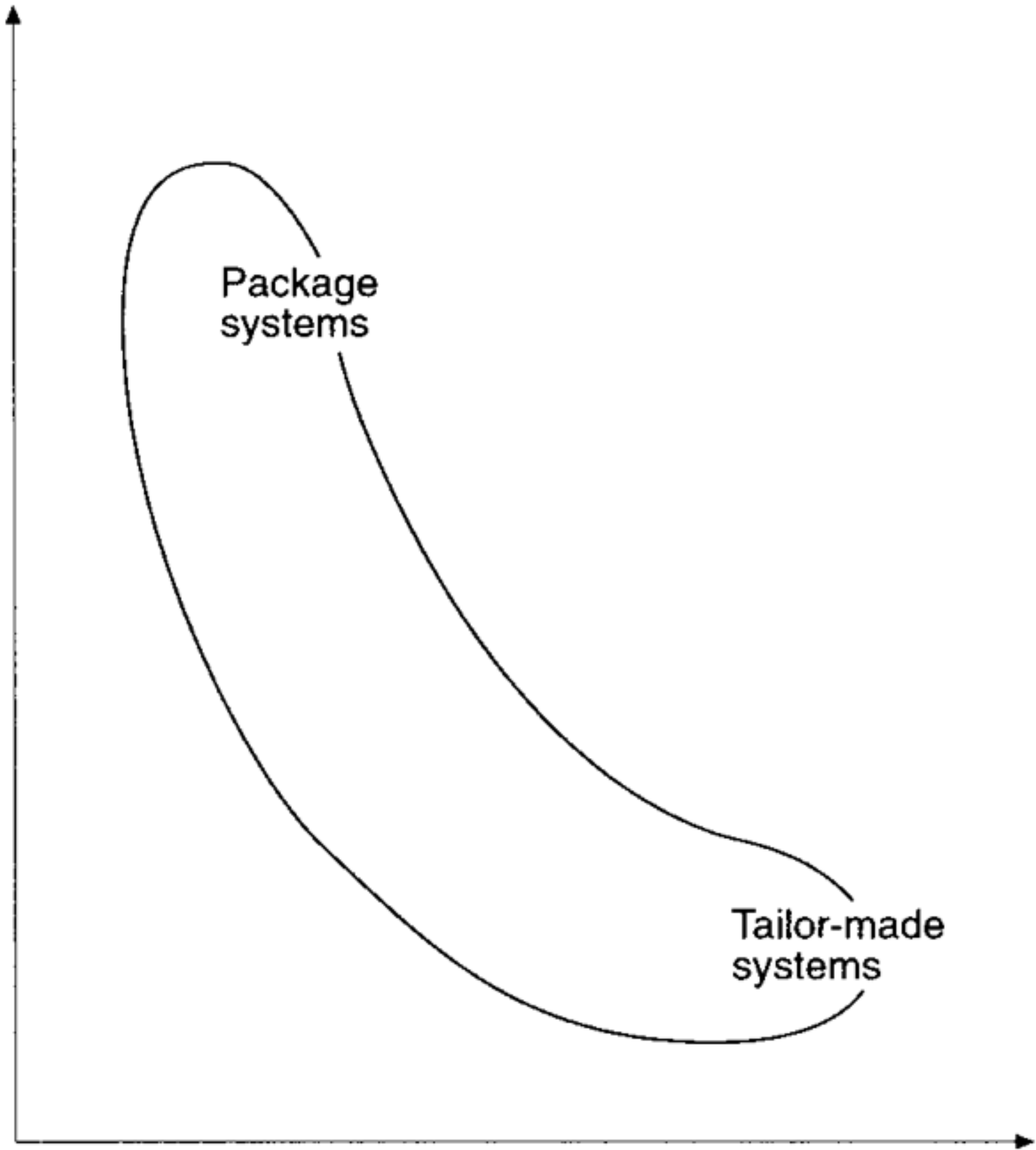
injectso

+

evil-binary-patching-dso

customdynamics.com

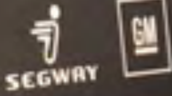
buycostumes.com



emeraldinsight.com

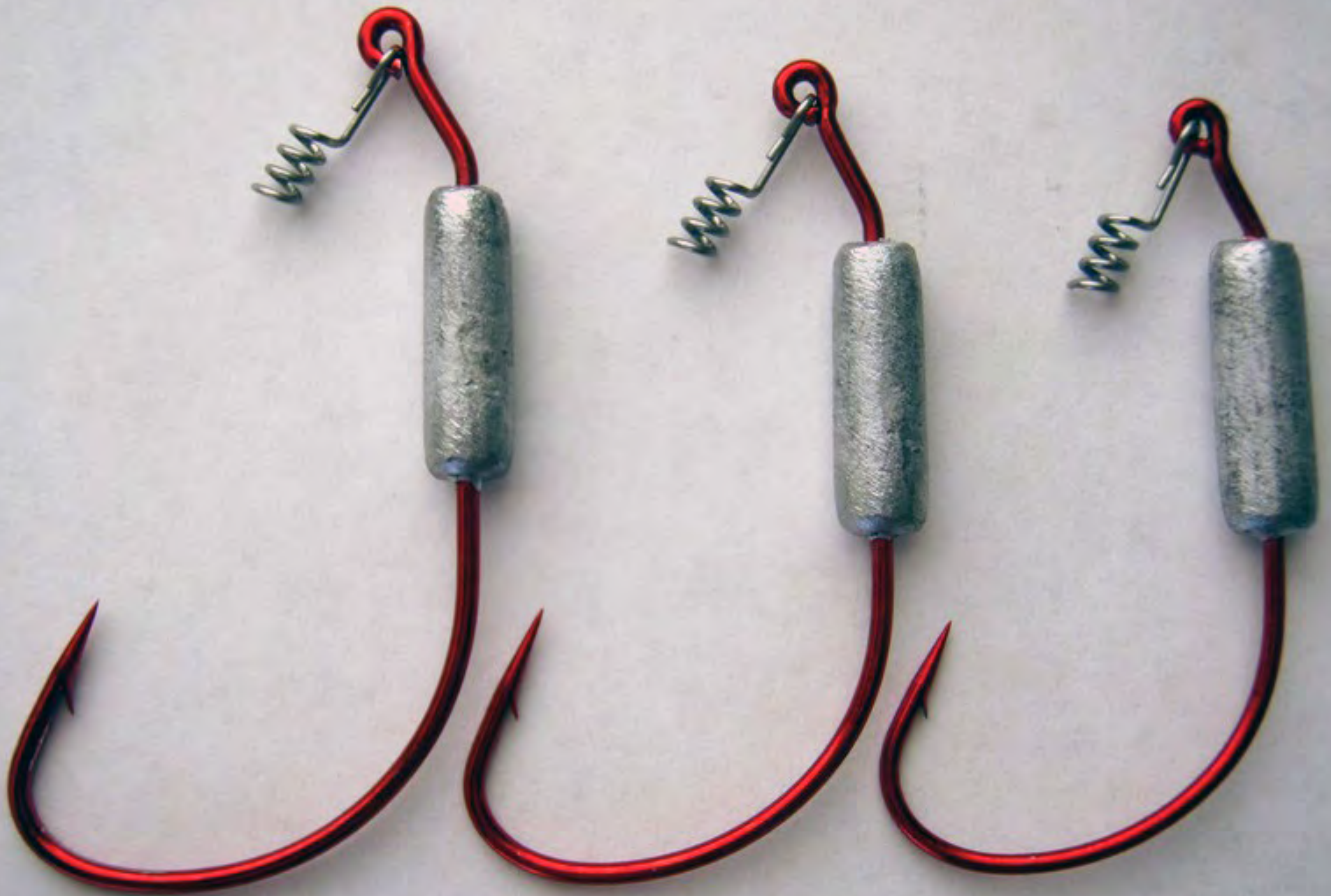
how to defend against it

- NX bit - call mprotect
- strip debug information - mostly prebuilt binaries
- statically link everything - extremely large binaries
- put all .text code in ROM - maybe?
- don't load DSOs at runtime - no plugins, though
- disable ptrace - no gdb/strace.
- check /proc/<pid>/maps - word.



slashgear.com

my future research: exploring alternative binary formats.



slayerinc.com

globalhealthandfitness.com

alignment
thomasgroup.com

calling convention
arianlim.wordpress.com

object file and
library formats
tandemfs.org

questions?

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http://timetobleed.com/string-together-global-offset-tables-to-build-a-ruby-memory-profiler/
http://timetobleed.com/hot-patching-inlined-functions-with-x86_64-asm-metaprogramming/
http://timetobleed.com/rewrite-your-ruby-vm-at-runtime-to-hot-patch-useful-features/
http://timetobleed.com/dynamic-linking-elf-vs-mach-o/
http://timetobleed.com/dynamic-symbol-table-duel-elf-vs-mach-o-round-2/

Worth1000.com
tallteacher.files.wordpress.com

“Interesting Behavior of OS X”

- Steven Edwards (winehacker@gmail.com)
- november 29 2007
- http://www.winehq.org/pipermail/wine-devel/2007-November/060846.html

leopard has a pe loader?

handle = dlopen("./procexp.exe", RTLD_NOW | RTLD_FIRST);

```
steven-edwardss-imac:temp sedwards$ ./a.out
dlopen(./procexp.exe, 258): Library not loaded: WS2_32.dll
 Referenced from: /Users/sedwards/Library/Application
Support/CrossOver/Bottles/winetest/drive_c/windows/temp/
procexp.exe
 Reason: image not found
```

cfs2.tistory.com