Return-into-libc without Function Calls (on the x86)

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Table of Contents

- Introduction
- Problem
- Design
- Implementation
- Conclusion

Introduction

- Software-development with C/C++
- Memory Corruption
  - Stack overflow
  - Buffer overflow

Introduction

- Software-development with C/C++
- Memory Corruption
  - Stack overflow
  - Buffer overflow
- Code Injection Attacks
- Code Reuse Attacks

Introduction - Code Injection

- Function-level
- External code injecting

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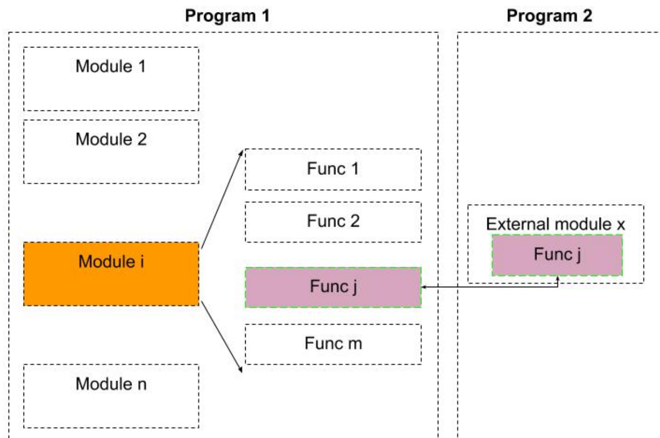
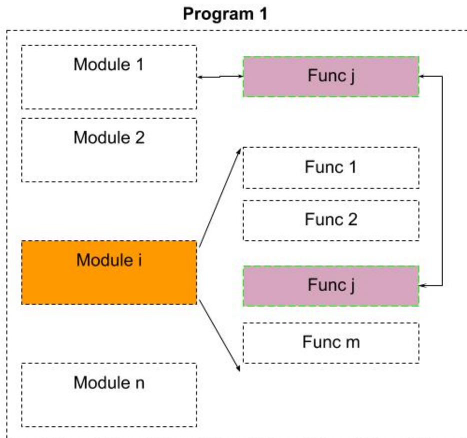


Introduction - Code Reuse

- Function-level
- Internal code reuse

Introduction - Code Reuse

- Function-level
- Internal code reuse



Problem

- Removing certain functions from libc
- Changing the assembler's code generation choices
- Defense against code reuse attacks

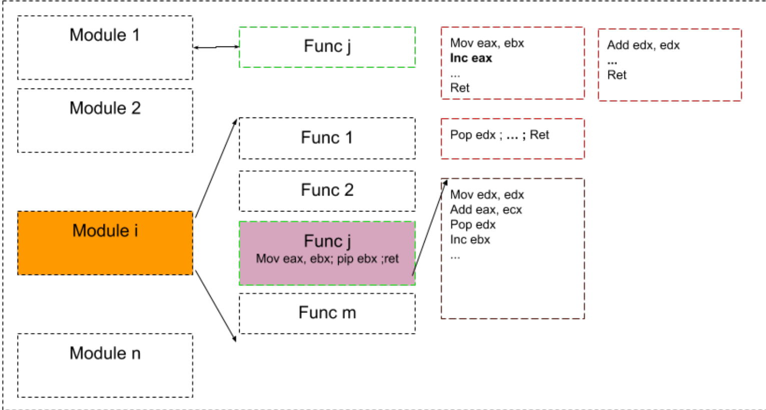
Design

- Return-oriented programming - ROP
- Instruction-level - gadgets
- Discovering useful instructions sequences in Libc

Design

- Return-oriented programming - ROP
- Instruction-level - gadgets
- Discovering useful instructions sequences in Libc
  - Useful code sequence
  - Ending with a ret instruction
  - Boring instructions

Design - ROP



Design - GALILEO Algorithm

Algorithm GALILEO:

    create a node, *root*, representing the `ret` instruction;
    place *root* in the trie;
    for *pos* **from** 1 **to** *textseg_len* **do**:
        if the byte at *pos* is `c3`, i.e., a `ret` instruction, **then**:
            call BUILDFROM(*pos*, *root*).

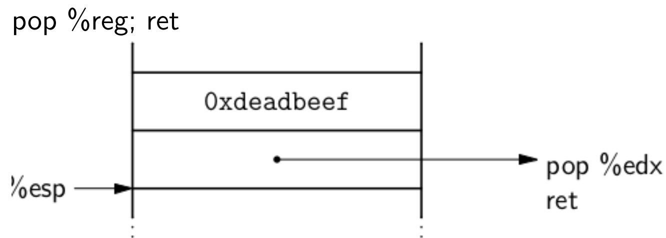
Procedure BUILDFROM(index *pos*, instruction *parent_insn*):

    for *step* **from** 1 **to** *max_insn_len* **do**:
        if bytes $\left[(pos - step) \ldots (pos - 1)\right]$ decode as a valid instruction *i*
            ensure *insn* is in the trie as a child of *parent_insn*;
            if *insn* isn't boring **then**:
                call BUILDFROM(*pos* − *step*, *insn*).

Figure 1: The GALILEO Algorithm.

Gadget - Load/Store

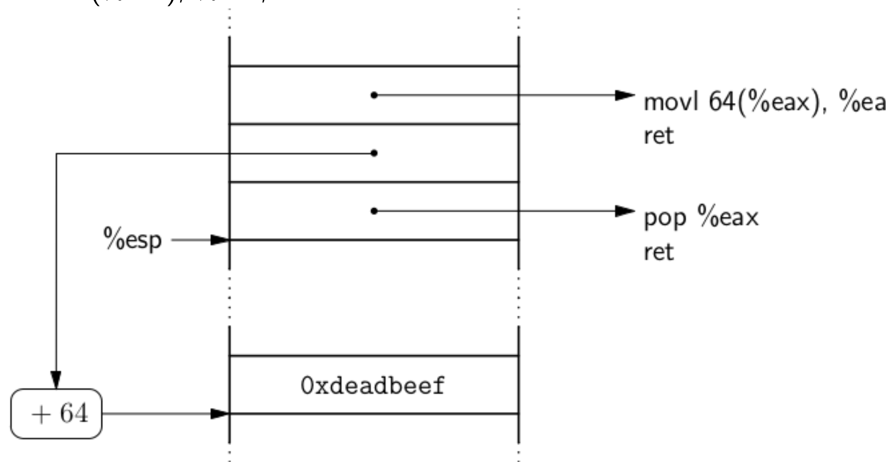
Loading a Constant



Gadget - Load/Store

Loading from Memory

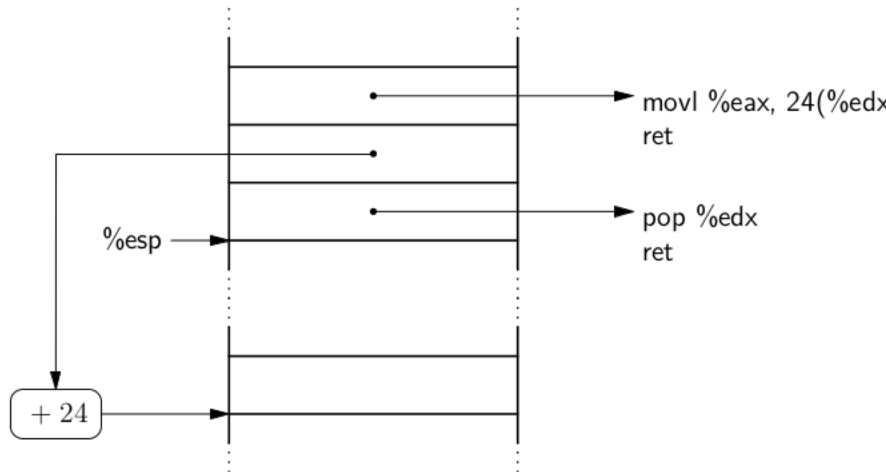
movl 64(%eax), %eax; ret



Gadget - Load/Store

Storing to Memory

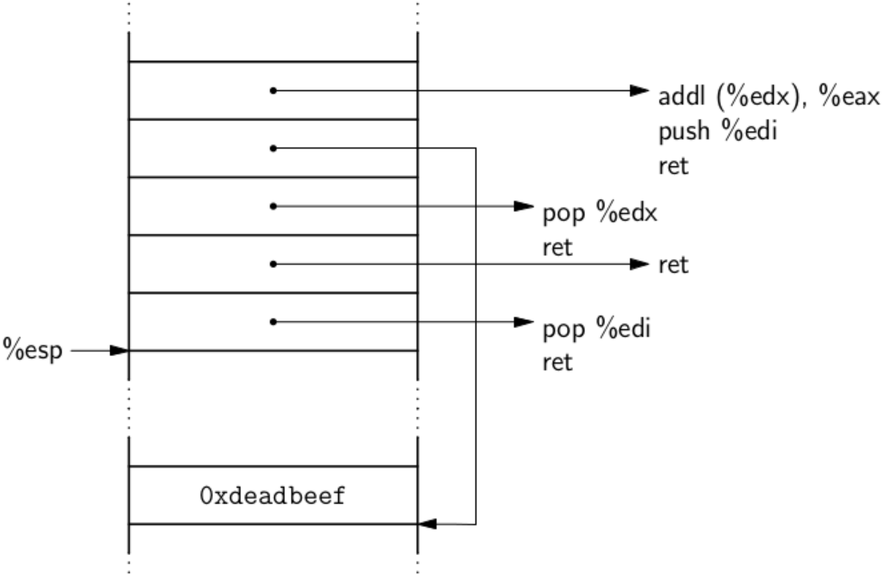
movl %eax,24(%edx); ret



Gadget - Arithmetic and Logic

Add

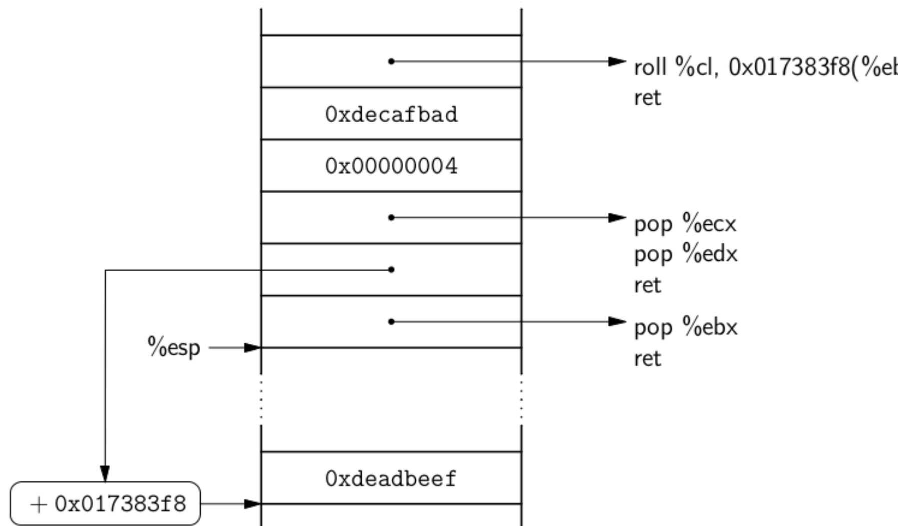
addl (%edx),%eax; push %edi; ret



Gadget - Arithmetic and Logic

Shifts and Rotates

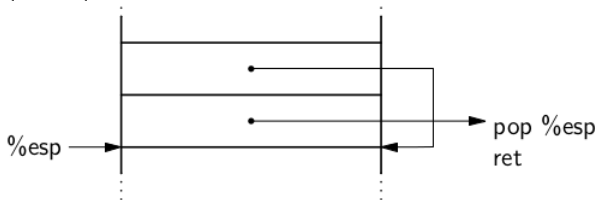
roll %cl, 0x17383f8(%ebx);ret



Gadget - Control Flow

Unconditional Jumps

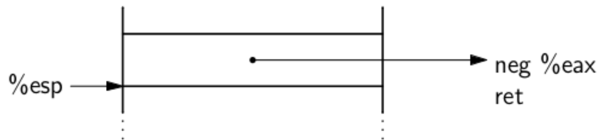
changing the value of %esp to point to a new gadget
pop %esp; ret



Gadget - Control Flow

Conditional Jumps

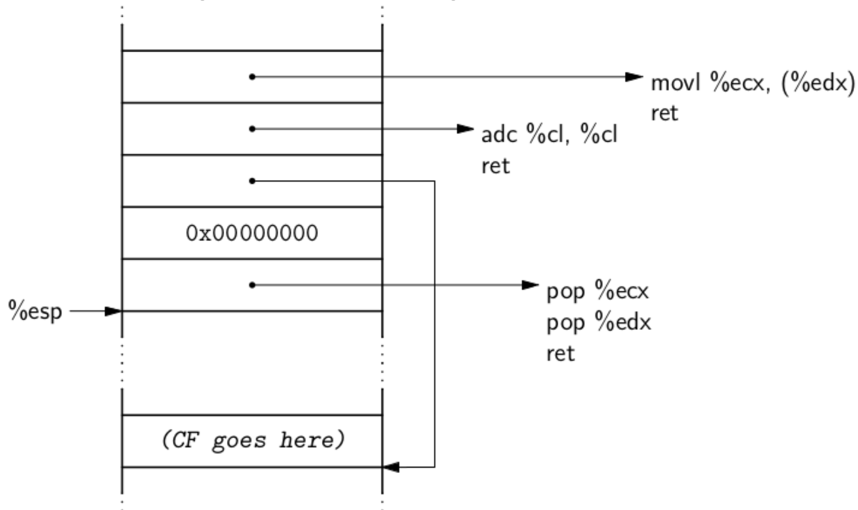
Phase One: Clear CF if %eax is zero, set CF if %eax is nonzero.



Gadget - Control Flow

Conditional Jumps

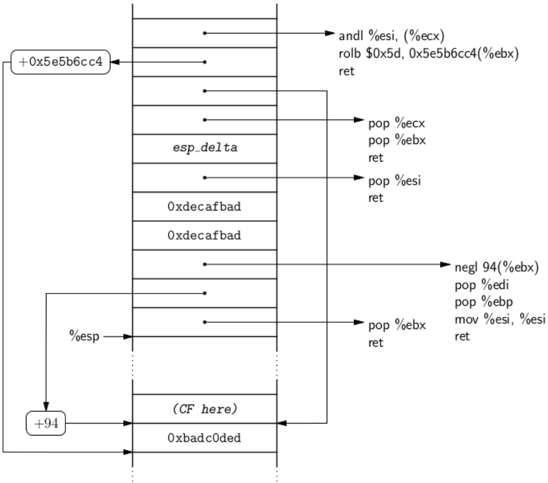
Phase Two: Store either 1 or 0 in the data
word labeled "CF goes here," depending on whether CF is set or not.



Gadget - Control Flow

Conditional Jumps

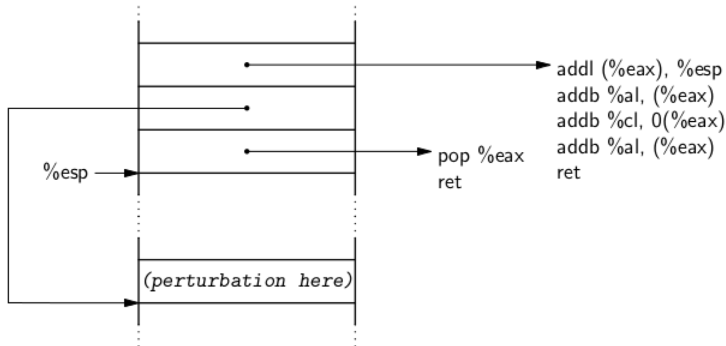
Phase Three: part one: Convert the word (labeled "CF here") containing either 1 or 0 to contain either esp delta or 0. The data word labeled 0xbadc0ded is used for scratch.



Gadget - Control Flow

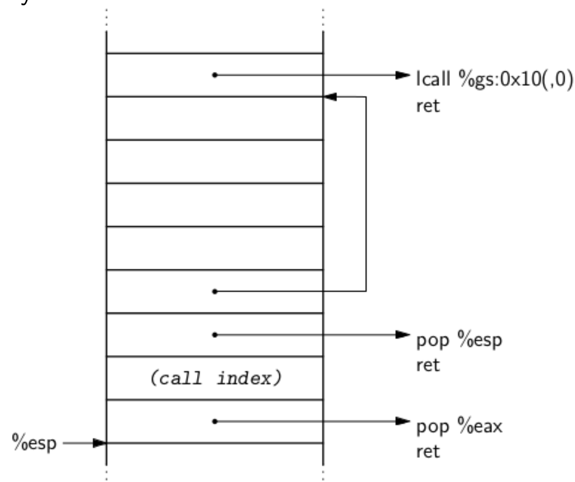
Conditional Jumps

Phase Three: two: Apply the perturbation in the word labeled "perturbation here" to the stack pointer. The perturbation is relative to the end of the gadget.



Gadget - System Calls

System call's number



Implementation

Buffer overflow

- Buffer overflow vulnerability
- No randomization
- No stack-protector

Implementation

Steps

- @.data (@ of .data for to place some strings)
- int $0x80 (for execute our payload)
- mov %eax,(%ecx) — pop %ebp — ret (for mov eax into buffer)
- inc %eax — ret (for increment eax to up to 11)
- pop %edx — pop %ecx — pop %ebx — ret (for pop address)
- pop %eax — pop %ebx — pop %esi — pop %edi — ret (here just pop %eax will be useful)
- xor %eax,%eax — ret (for put %eax to zero)

Questions?