CS 241 Honors
Minilectures 2 - Revenge of the Sys

University of Illinois Urbana–Champaign

March 7, 2018

Logistics

- Next week is Peer Mentoring - Try to have something to share with your peers!

CS 241 Honors
Linking and Loading

Kevin Hong

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March 7, 2018

Linking and Loading

Motivation

```c
#include <pthread.h> //Dynamic Linked Library

void* hello_thread(void *payload){ //Pthread
    write(1, "Hello world!", 12); //Sys Call
    return NULL;
}

int main(){ //Process Start
    pthread_create(NULL, hello_thread,
        NULL, NULL);
    pthread_exit() //Some kind of scheduling
}
```

What are we even talking about?

There are two types of libraries, those compiled with your programs and those that are linked dynamically at runtime. There are many benefits to use programs that get compiled with your program, but some drawbacks.

Cost-Benefit Analysis: Compile-Time Libraries

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Drawbacks

- Updating is often tedious
- Your executable is bigger
- Your library cannot be reused by other applications

Solution: Dynamic Libraries

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- Updating your executable's library is a piece of cake
- Reduce the size of your executable
- That library can be used by other applications.

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- Any problem in computer science and be solved with another layer of abstraction.
- Have the functions in your code point to pointer where the functions are going to be.
- Have your code jump to the pointer and the pointer jump to the actual function

Where is the table stored

"In Unix-like systems that use ELF for executable images and dynamic libraries, such as Solaris, 64-bit versions of HP-UX, Linux, FreeBSD, NetBSD, OpenBSD, and DragonFly BSD, the path of the dynamic linker that should be used is embedded at link time into the .interp section of the executable's PT_INTERP segment. In those systems, dynamically loaded shared libraries can be identified by the filename suffix .so (shared object)." - Wikipedia

So what does that mean?

- Exec generates lookup-table (PT_INTERP segment)
- Calls to a library will cause a jump to the lookup table
- Lookup table entry will redirect the program to the library function
- After execution, returns back to your program

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- When a process is done, reduce the reference count and return the page back to the system if need be.

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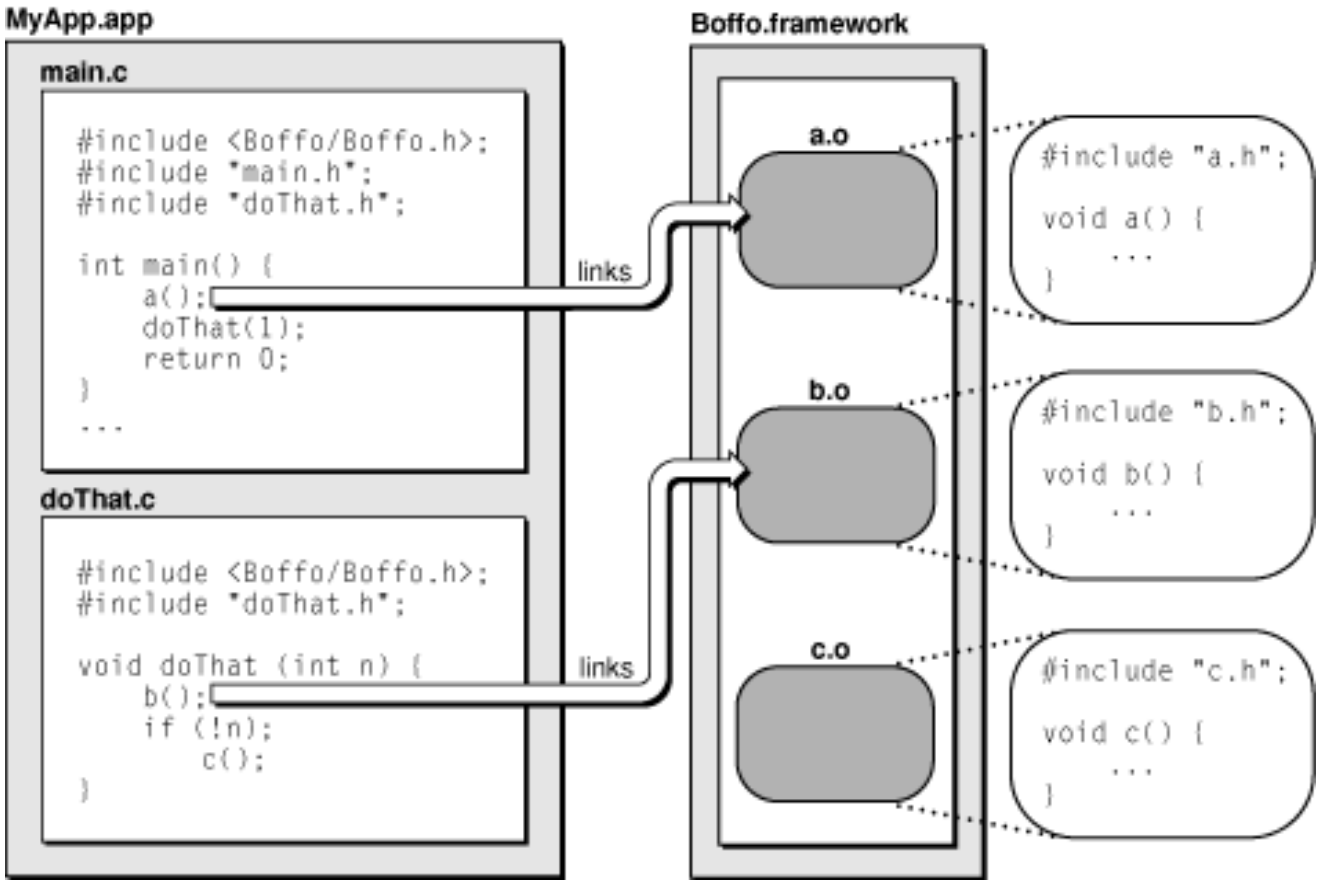

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- Some viruses redirect library calls (hint: LD_PRELOAD) thus, executing commands that the user is not aware of.

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- Example: libc had a buffer overflow bug (any application that uses libc was affected).
- But the pros outweigh the cons so DLLs are here to stay.

Drawbacks: Hacking with Bugs

- Demo time!

Edit history

- Bhuvan Venkatesh
- Aneesh Durg

CS 241 Honors
Life without GLIBC

Aneesh Durg

University of Illinois Urbana–Champaign

March 7, 2018

glibc is just another library?

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- ...and no
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  - glibc is a shared library
  - but glibc does some pretty special things

Need proof?

- Let's compile sample.c and check linking output
- Let's also check gdb using:
  - set backtrace past-main on
  - set backtrace past-entry on

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- Well maintained
- Well optimized
- Provides clean, easy-to-use interface (we'll see more about this later)
- Unless you know what you're doing, DO NOT get rid of glibc!

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- Use-case specific optimization (ignore the general case - think about your malloc)

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- What's wrong with a library being bloated?
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  - limited resource environments
  - Remember - just loading an executable requires memory
- So how bad are we actually talking? (in terms of bytes)

Tools of the trade

Here's some tools we'll use today:

- `wc` - Allows us to check size
- `objdump` - Allows us to dump a compiled program
- `gcc` - We're going to need some special flags
- `x86 asm` - Not afraid to get your hands dirty with assembly right?

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- Step 5 - Okay, but can we do EVEN better?

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  - Write a shared library that wraps glibc
  - Compile glibc with only the features that you want - hooray for open source!

Sources

- http://weeb.ddns.net/0/programming/c_without_standard_library_linux.txt

Distributed Denial-of-Service (DDoS) Attacks

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Previous known record was the attack on Dyn in October 2016.

- Peak traffic of around 1 Tbps.
- Used a botnet of IoT devices infected by Mirai.
- Took down siginifcant portions of the internet
  Amazon.com, GitHub, PayPal, Reddit, Slack

Background

- User Datagram Protocol (UDP)
- DoS and DDoS
- Amplification
- memcached
- Border Gateway Protocol (BGP)

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- Transport Layer (Layer 4) protocol on top of IP.
- Not TCP (Transmission Control Protocol).
- Connectionless.
- Send and forget.
- Like sending a letter in the mail.
  - No guarantee of delivery, order, or correctness.
  - Used for many real-time applications, where we only care about the freshest information.

DoS and DDoS

Denial of Service (DoS): attacks in which the target is sent massive amounts of network traffic in an attempt to make the target inaccessible to legitimate users or otherwise malfunction.

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- Easy to defend against: just block the source of traffic.
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Distributed Denial of Service DDoS): DoS attacks in which traffic is sent to the target from a large number of sources.

- Hard to carry out (usually): need control over many hosts.
- Hard to defend against: can't simply block a few hosts.
- Can be massive in scale; viable against large targets.

Amplification

Amplification: when a server responds to an n byte request with a response of size (much) larger than n.

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- Common amplifiers are NTP, DNS, SNMP.
  - NTP: *monlist*, 550x amplification
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  (note: these are all UDP services. Why?)
- UDP has no way of verifying source IP.
- Send requests to amplifiers with the target's IP as source; amplifier responds to target with large request.

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Open-source "distributed memory object caching system".

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- Over 50,000x amplification. 200 B request $\rightarrow$ 100 MB response

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- ASs route traffic to/from each other.

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  - There are estimated to be around 100,000 such servers.
- Hit GitHub with 1.3Tbps of traffic at its peak.
- GitHub survived! This was an example of excellent mitigation.
- There was apparently a *larger* attack the next day.

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- All traffic to GitHub went through Prolexic's scrubbing centers.
  - Datacenters capable of massive capacity filter out all DDoS traffic.
  - Filtered out UDP traffic on port 11211 (memcached default).
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- GitHub traffic went through Prolexic for about 6 hours.

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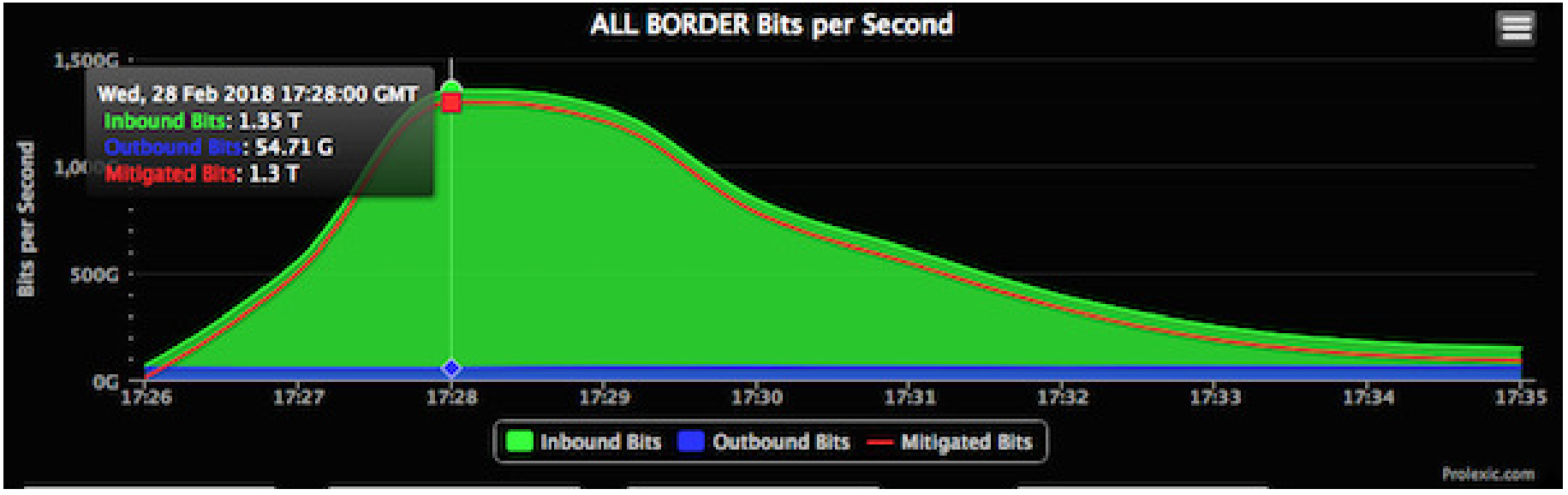

Lessons

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Learn more:

- GitHub Incident Report
- Akamai Incident Report
- Poke around with BGP: `bgp.he.net`
- Other attacks: `krebsonsecurity.com/tag/ddos/`