Advanced fuzzing workshop

Antonio Morales

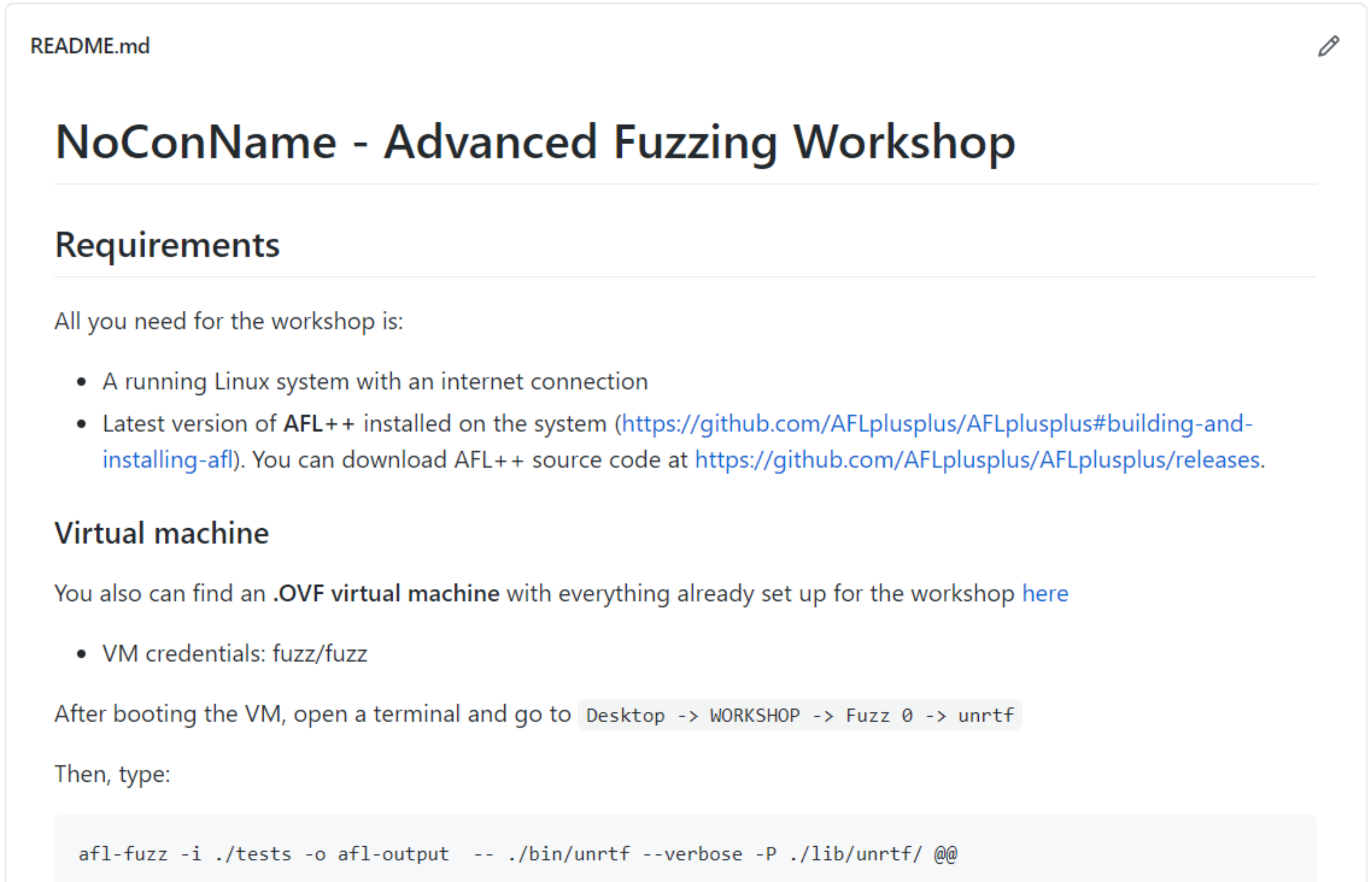
English & Spanish friendly

- Key concepts in both languages
- You can ask me anything (ENG/ES)

- Los conceptos importantes se explicarán en ambos idiomas.
- Me puedes preguntar en cualquiera de los 2 idiomas

Workshop repository

There you can find all you need for the workshop:
https://github.com/antonio-morales/NoConName_Advanced_Fuzzing_Workshop/



README.md

NoConName - Advanced Fuzzing Workshop

Requirements

All you need for the workshop is:

- A running Linux system with an internet connection
- Latest version of **AFL++** installed on the system (https://github.com/AFLplusplus/AFLplusplus#building-and-installing-afl). You can download AFL++ source code at https://github.com/AFLplusplus/AFLplusplus/releases.

Virtual machine

You also can find an **.OVF virtual machine** with everything already set up for the workshop here

- VM credentials: fuzz/fuzz

After booting the VM, open a terminal and go to `Desktop -> WORKSHOP -> Fuzz 0 -> unrtf`

Then, type:

```
afl-fuzz -i ./tests -o afl-output  -- ./bin/unrtf --verbose -P ./lib/unrtf/ @@
```

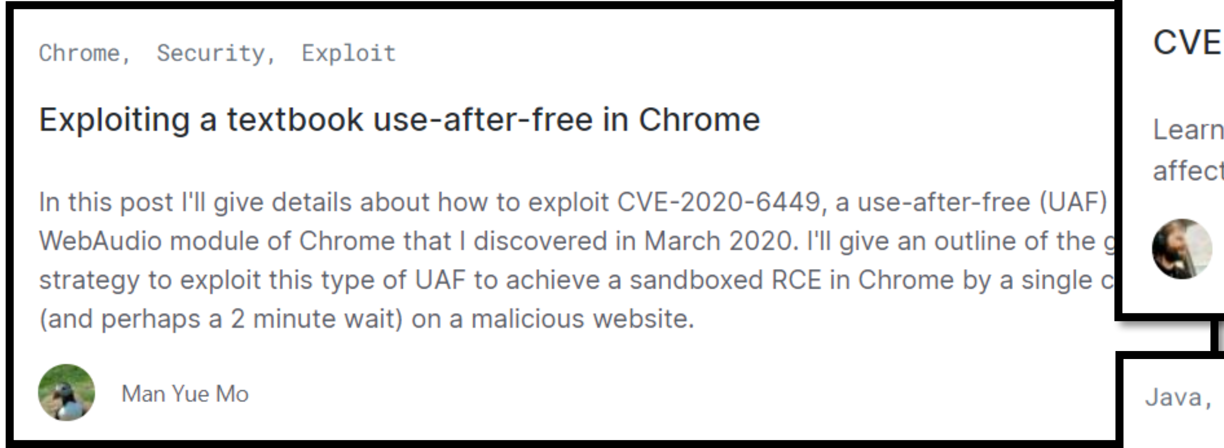
// WHO AM I

#define speaker	Antonio Morales
#define job	Security Researcher at GitHub
#define twitter	@nosoynadiemas

using namespace NoConName;

int main(int argc, char argv[]){*

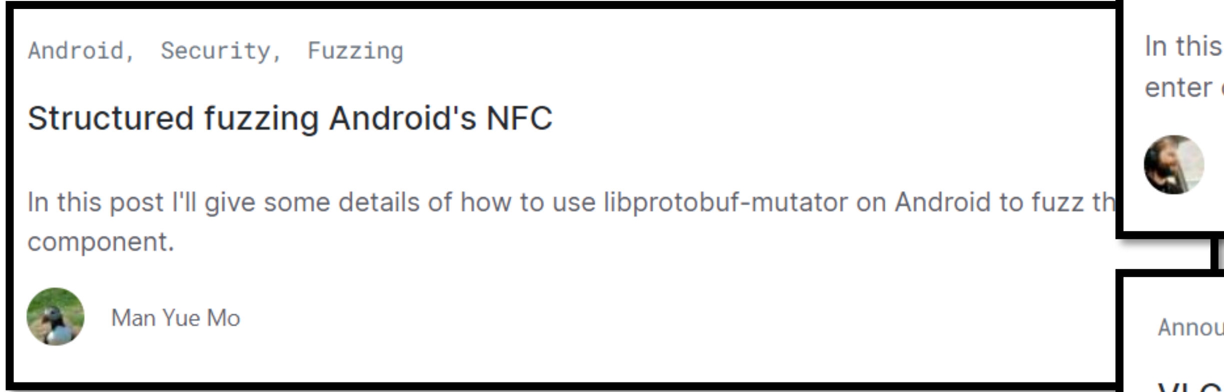
Security Lab


Chrome, Security, Exploit

Exploiting a textbook use-after-free in Chrome

In this post I'll give details about how to exploit CVE-2020-6449, a use-after-free (UAF)
WebAudio module of Chrome that I discovered in March 2020. I'll give an outline of the g
strategy to exploit this type of UAF to achieve a sandboxed RCE in Chrome by a single c
(and perhaps a 2 minute wait) on a malicious website.

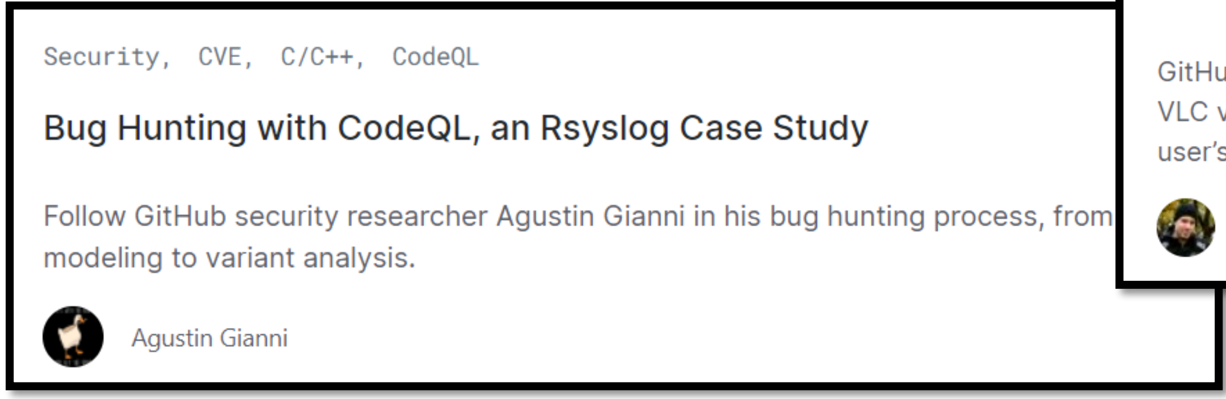
Man Yue Mo


Android, Security, Fuzzing

Structured fuzzing Android's NFC

In this post I'll give some details of how to use libprotobuf-mutator on Android to fuzz th
component.

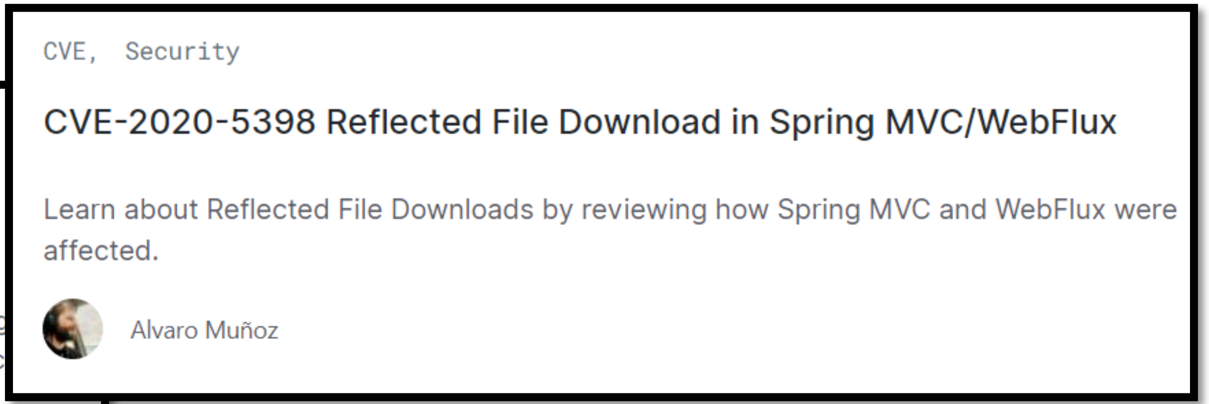
Man Yue Mo


Security, CVE, C/C++, CodeQL

Bug Hunting with CodeQL, an Rsyslog Case Study

Follow GitHub security researcher Agustin Gianni in his bug hunting process, from
modeling to variant analysis.

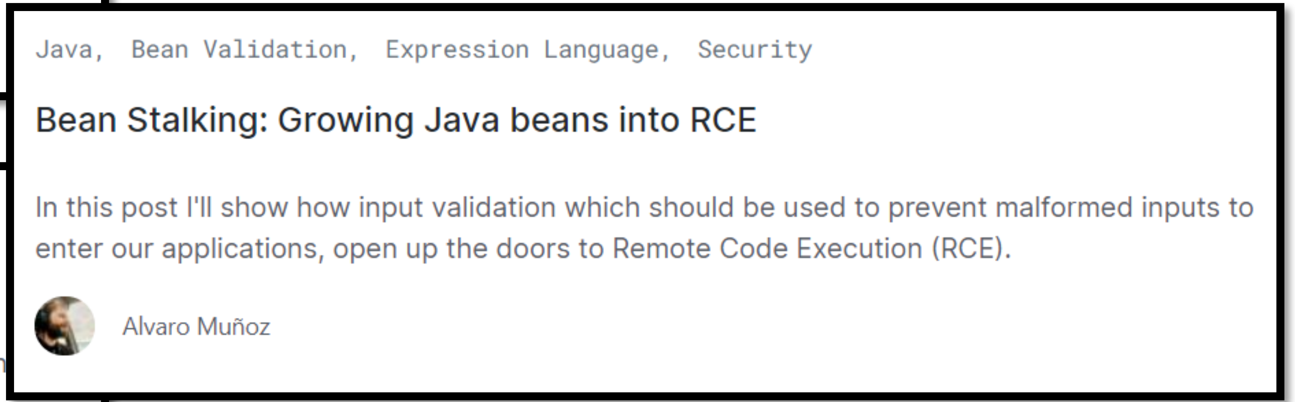
Agustin Gianni


CVE, Security

CVE-2020-5398 Reflected File Download in Spring MVC/WebFlux

Learn about Reflected File Downloads by reviewing how Spring MVC and WebFlux were affected.

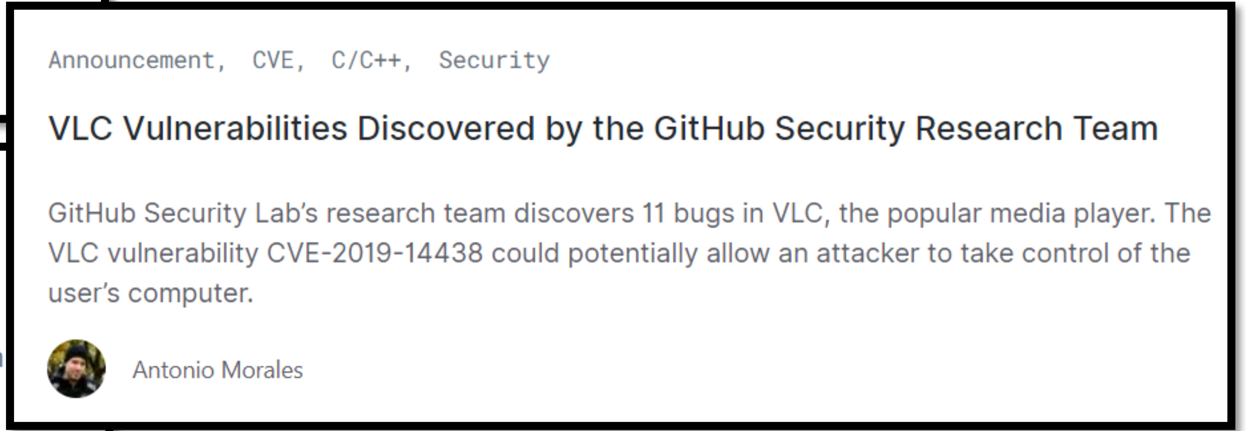
Alvaro Muñoz


Java, Bean Validation, Expression Language, Security

Bean Stalking: Growing Java beans into RCE

In this post I'll show how input validation which should be used to prevent malformed inputs to enter our applications, open up the doors to Remote Code Execution (RCE).

Alvaro Muñoz


Announcement, CVE, C/C++, Security

VLC Vulnerabilities Discovered by the GitHub Security Research Team

GitHub Security Lab's research team discovers 11 bugs in VLC, the popular media player. The VLC vulnerability CVE-2019-14438 could potentially allow an attacker to take control of the user's computer.

Antonio Morales

https://securitylab.github.com

What I do

- Mainly focused on C/C++ projects
- Fuzzing enthusiast
- Some of my work in the last year:

APACHE HTTP SERVER PROJECT

VLC media player

Notepad++

ProFtpd

PureFTPd
A secure FTP daemon

FreeRDP

Motivation

CVE-2019-20176	CVE-2019-14438	CVE-2019-14777	CVE-2020-4030	CVE-2020-9273
CVE-2020-9274	CVE-2019-14498	CVE-2019-14970	CVE-2020-11096	CVE-2019-14778
CVE-2020-9365	CVE-2019-14535	CVE-2020-13396	CVE-2020-11095	CVE-2020-11097
CVE-2020-6162	CVE-2019-14534	CVE-2020-13397	CVE-2020-4032	CVE-2019-14437
CVE-2020-6835	CVE-2019-14533	CVE-2020-13398	CVE-2020-4033	CVE-2019-14779
CVE-2020-9272	CVE-2019-14776	CVE-2020-11099	CVE-2020-4031	CVE-2020-11098

The aim of this workshop

Dumb Fuzzing

Smart Fuzzing

Workshop Format

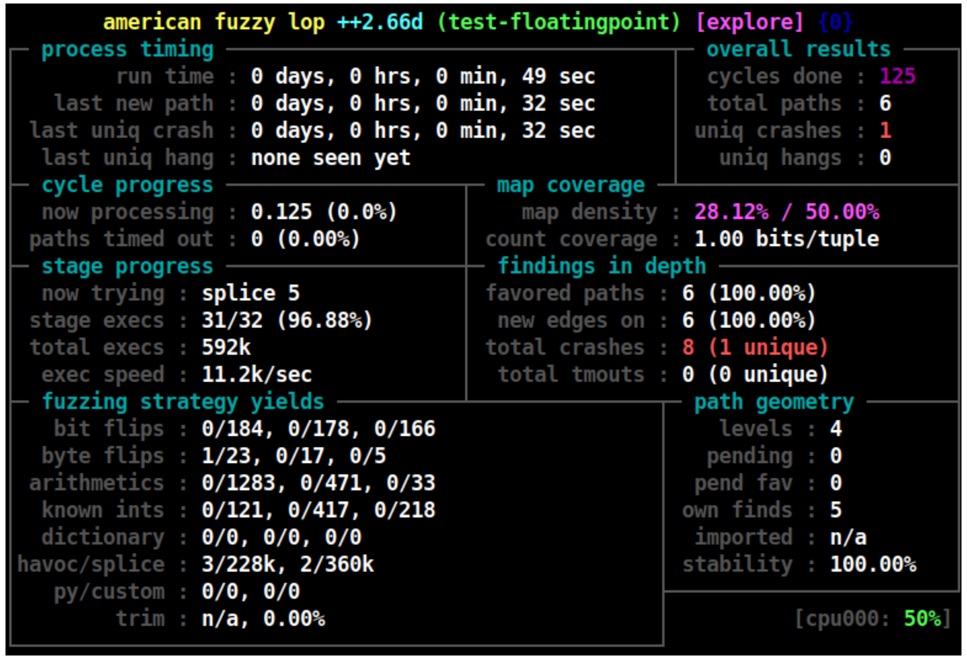
- It’s a hands-on CTF-style workshop (learning-by-doing method).
- You will learn while facing the challenges. I’m here to guide your learning.

- Es un taller totalmente práctico (basado en el aprendizaje autónomo)
- Aprenderás a través de intentar los retos. Mi labor será la de guiar tu aprendizaje.

Tools

All you need for the workshop is **AFL++ tool** running on a Linux system. Please, if you haven't download yet, do it now: https://github.com/AFLplusplus/AFLplusplus/releases

Installing AFL++ -> https://github.com/AFLplusplus/AFLplusplus#building-and-installing-afl



```
       american fuzzy lop ++2.66d (test-floatingpoint) [explore] {0}
┌─ process timing ────────────────────────────────────┬─ overall results ───┐
│        run time : 0 days, 0 hrs, 0 min, 49 sec     │  cycles done : 125  │
│   last new path : 0 days, 0 hrs, 0 min, 32 sec     │  total paths : 6    │
│ last uniq crash : 0 days, 0 hrs, 0 min, 32 sec     │ uniq crashes : 1    │
│  last uniq hang : none seen yet                    │   uniq hangs : 0    │
├─ cycle progress ───────────────────┬─ map coverage ─┴─────────────────────┤
│  now processing : 0.125 (0.0%)     │    map density : 28.12% / 50.00%     │
│ paths timed out : 0 (0.00%)        │ count coverage : 1.00 bits/tuple     │
├─ stage progress ───────────────────┼─ findings in depth ──────────────────┤
│  now trying : splice 5             │ favored paths : 6 (100.00%)          │
│ stage execs : 31/32 (96.88%)       │  new edges on : 6 (100.00%)          │
│ total execs : 592k                 │ total crashes : 8 (1 unique)         │
│  exec speed : 11.2k/sec            │  total tmouts : 0 (0 unique)         │
├─ fuzzing strategy yields ──────────┴───────────────┬─ path geometry ──────┤
│   bit flips : 0/184, 0/178, 0/166                  │    levels : 4        │
│  byte flips : 1/23, 0/17, 0/5                      │   pending : 0        │
│ arithmetics : 0/1283, 0/471, 0/33                  │  pend fav : 0        │
│  known ints : 0/121, 0/417, 0/218                  │ own finds : 5        │
│  dictionary : 0/0, 0/0, 0/0                        │  imported : n/a      │
│havoc/splice : 3/228k, 2/360k                       │ stability : 100.00%  │
│   py/custom : 0/0, 0/0                             ├──────────────────────┘
│        trim : n/a, 0.00%                           │          [cpu000: 50%]
└────────────────────────────────────────────────────┘
```

Para el workshop todo lo que necesitas es AFL++ . Si aún no lo has descargado, hazlo ahora: https://github.com/AFLplusplus/AFLplusplus/releases

Como instalar AFL++ -> https://github.com/AFLplusplus/AFLplusplus#building-and-installing-afl

RULES

Rule 1

- Challenges are intended to be solved by fuzzing.
- But you can use whatever method you want (good luck xD)

- Las pruebas están pensadas para ser resultas mediante fuzzing.
- Pero puedes utilizar el método que desees (buena suerte xD)

Rule 2

- There will be **3 different challenges**. The goal is to **find a reproducible bug** on each of them.

- We're looking for exploitable vulnerabilities. "Theoretical bugs" or code warnings are not welcome, sorry.

- In order to be the winner of a challenge, **you must provide a crash/PoC**.

- Habrá **3 pruebas distintas**. El objetivo es encontrar un bug en cada una de ellas.

- Se trata de encontrar vulnerabilidades explotables. Bugs teóricos o alertas de código no son bienvenidas. Además, para ser ganador del reto deberás de entregar un crash or PoC.

Rule 3

- Please, don’t disclose your solutions.
- Upload them to Google Drive / Dropbox / Onedrive or whatever cloud storage tool and **send me the link via private message.**

- Por favor, no reveles tus soluciones.
- En su lugar, subelas a Google Drive / Dropbox / Onedrive o cualquier servidor en la nube y **envíame por privado el enlace**

Rule 4

- I will give you some hints and tips before and during the challenge.
- I’ll release a **new hint every 10 minutes** (approx.)

- Daré varios consejos y pistas antes y durante cada reto
- Liberaré una **nueva pista cada 10 minutos** aproximadamente

Rule 5

- After each challenge, I will show my solution and I will explain it to you.
- There may be more than one correct solution.

- Daré varios consejos y pistas antes y durante cada reto
- Liberaré una **nueva pista cada 10 minutos** aproximadamente

Awards

- There will be **2 winners for each challenge** (6 total winners).
- The winners will be the fastest ones in solving the challenge (find the vulnerability).

- Cada reto tendrá 2 ganadores (6 ganadores total)
- Los ganadores serán los más rápidos en resolver el reto (encontrar la vulnerabilidad).

Rewards

Invertocat 2.0 Shirt
$25.00

Arctocat Shirt
$25.00

I [octocat] Code 2.0 Shirt
$25.00

GitHub Username Shirt
$25.00

Atom Shirt
$25.00

Atom 2.0 Shirt
$25.00

Octocat One-Piece
$18.00

Kids Octocat Raglan Tee
$18.00

GitHub Drip Tee
$25.00

Questocat Tee
$25.00

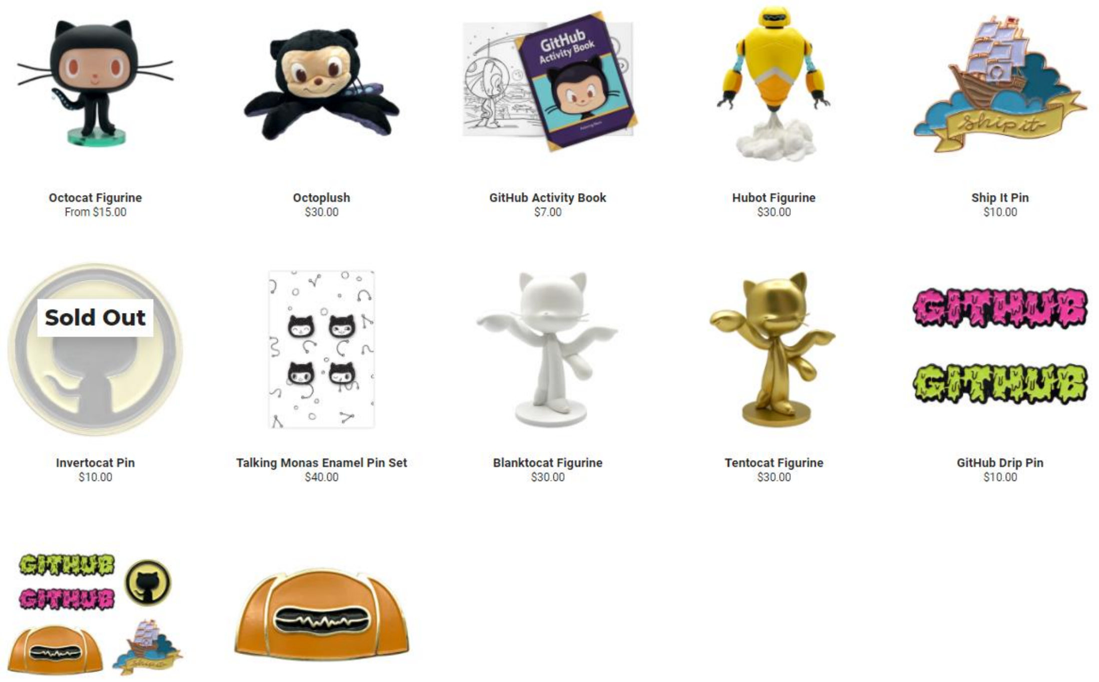
Invertocat 3.0 Shirt
$25.00

De Los Muertos Shirt
$25.00

Grim Repo Shirt
$25.00

Talking Monas - Kid's Raglan
$18.00

Talking Monas - Onesie
$18.00



Octocat Figurine
From $15.00

Octoplush
$30.00

GitHub Activity Book
$7.00

Hubot Figurine
$30.00

Ship It Pin
$10.00

Invertocat Pin
$10.00

Talking Monas Enamel Pin Set
$40.00

Blanktocat Figurine
$30.00

Tentocat Figurine
$30.00

GitHub Drip Pin
$10.00

https://github.myshopify.com/

QUESTIONS / PREGUNTAS

Workshop repository

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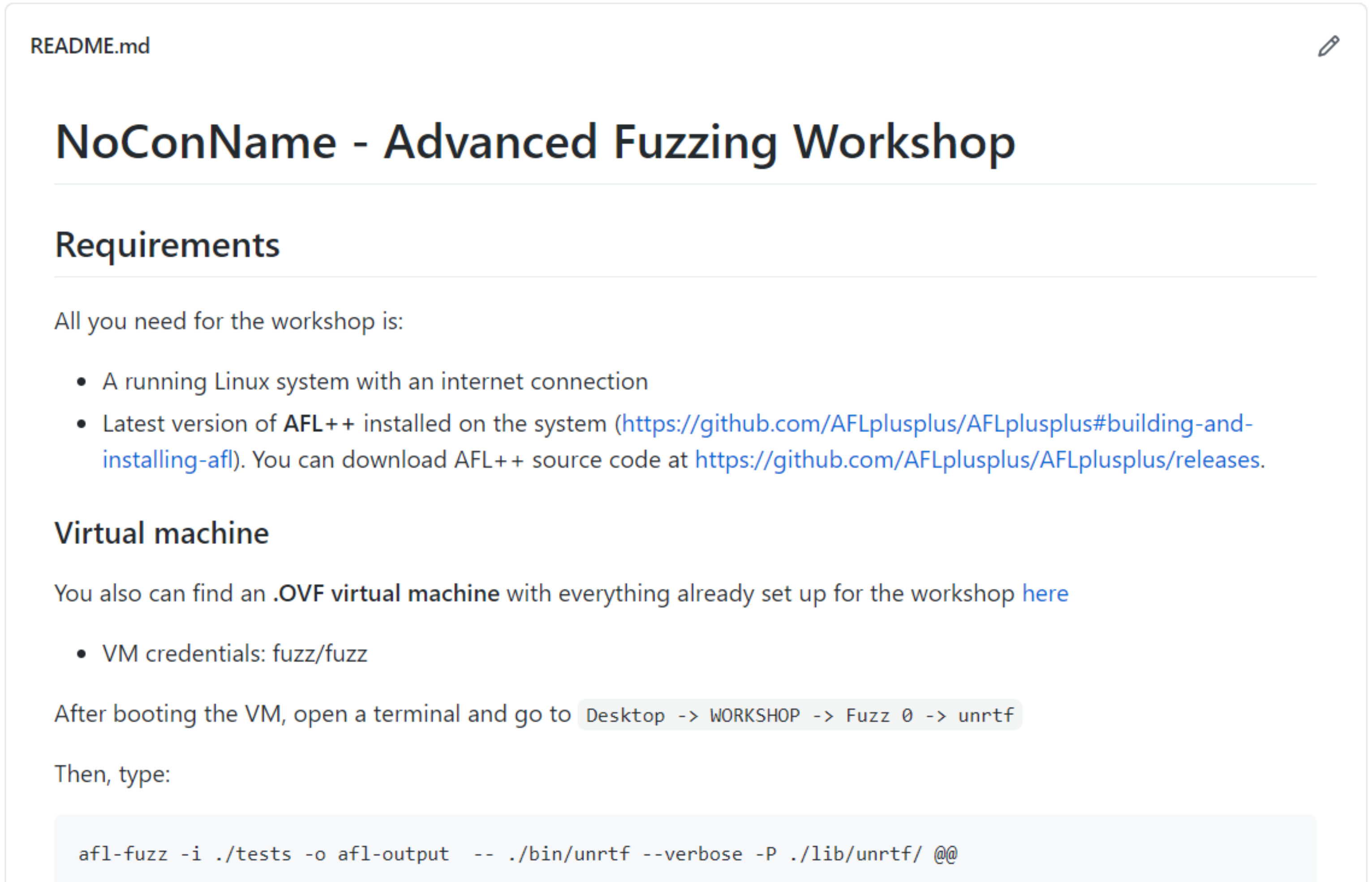

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- VM credentials: fuzz/fuzz

After booting the VM, open a terminal and go to `Desktop -> WORKSHOP -> Fuzz 0 -> unrtf`

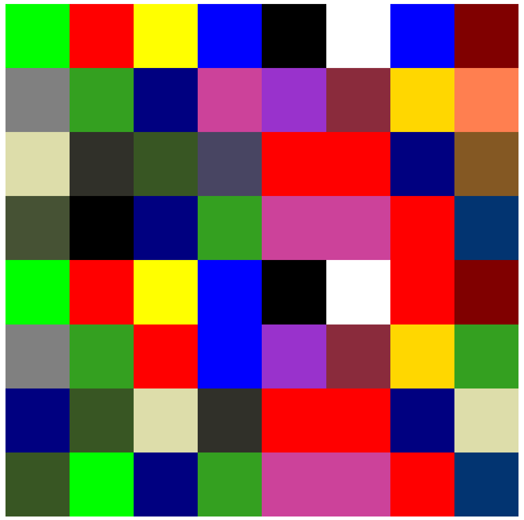
Then, type:

```
afl-fuzz -i ./tests -o afl-output  -- ./bin/unrtf --verbose -P ./lib/unrtf/ @@
```

Challenge 1 - ESIF (Extremely Stupid Image Format)

Get the code at: https://github.com/antonio-morales/NoConName_Advanced_Fuzzing_Workshop

PASSWORD: **ncn2k20aaa**



Convert ESIF format to PPM format

Build:

```
> gcc fuzz1.c -o fuzz1 -w -lcrypto -lssl
```

Run:

```
>  ./fuzz1 example.ESIF output.ppm
```

You can find "Example.ESIF" in the repository

Puedes encontrar "Example.ESIF" en el repositorio

Challenge 1 - ESIF (Extremely Stupid Image Format)

Ask me any doubt via PM

Reminder

40 minutes

LET'S GO!!!

Challenge 1 – TIP

- That’s all you need to start fuzzing with AFL:
- Esto es todo lo que necesitas para empezar a fuzzear con AFL:

[COMPILE] **afl-gcc** fuzz1.c -o fuzz1 -w -lcrypto –lssl

[FUZZING] **afl-fuzz** -i ./AFL/afl_in/ -o './AFL/afl_out' -- ./fuzz1 @@ output

- If you have any problem, first try with:

```
> sudo apt-get install libssl-dev
```

Challenge 1 – Tip

- I strongly advise you to link your binary with **ASan (AddressSanitizer)** and **UBSan (Undefined Behavior Sanitizer)**
- To do this, add **-fsanitize=address,undefined** to your compile line
- Don’t forget to add **-m none** to your AFL command line

- Te aconsejo encarecidamente que enlaces tu binario con **ASan (AddressSanitizer)** y **UBSan (Undefined Behavior Sanitizer)**
- Para ello, añade **-fsanitize=address,undefined** a tu linea de compilación
- No te olvides de añadir **–m none** a tu línea de comandos de AFL

Challenge 1 – Hint 1

- Code coverage can be really useful here.

```
> sudo apt install lcov
```

- You can enable it adding **--coverage** to your compile line

- I’ve just uploaded a Code Coverage folder to the repo2 new files to the repo: **lcov.sh** and **run_files**

- You can collect code coverage, as follows:

```
>  chmod +x run_files
>  chmod +x lcov.sh
> ./lcov.sh
```

Then, open **./html_coverage/index.html** to view generated LCOV code coverage report

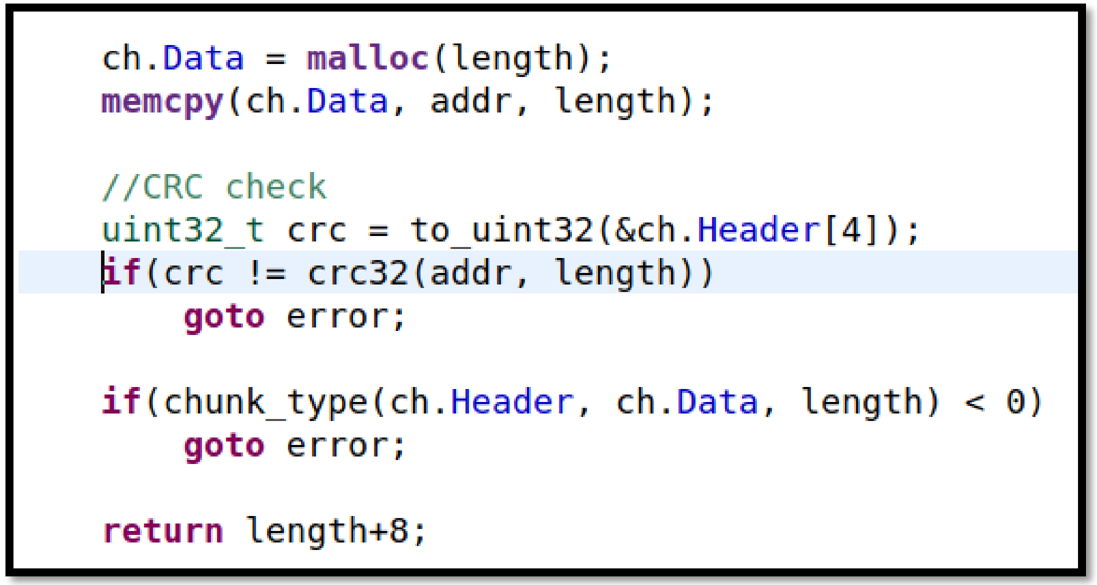
Challenge 1 – Hint 2

- Sometimes checksums can be a pain in the ass.
- Take a look at: https://securitylab.github.com/research/fuzzing-challenges-solutions-1

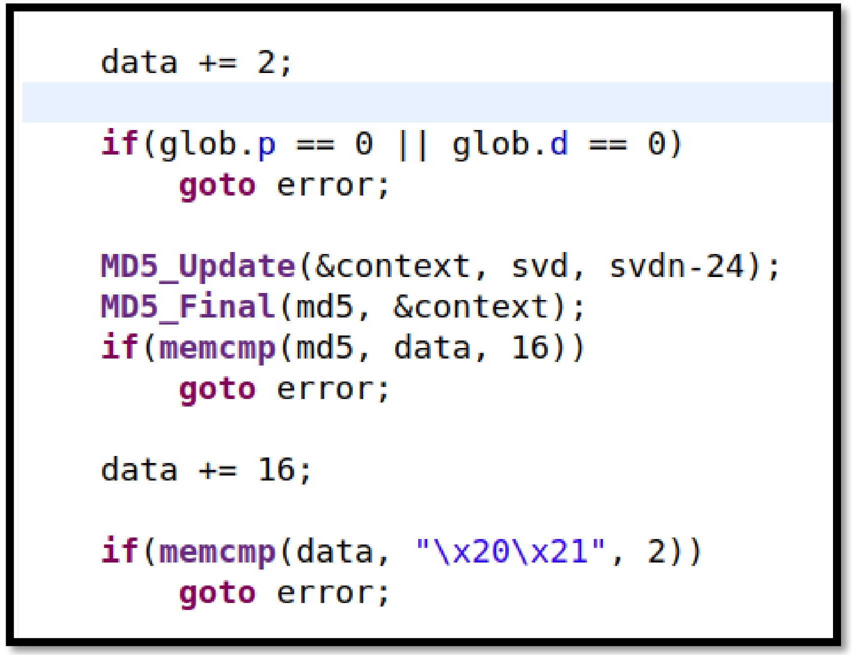
- En ocasiones los checksums pueden ser realmente molestos
- Echa un vistazo a: https://securitylab.github.com/research/fuzzing-challenges-solutions-1

Challenge 1 – Hint 3

Looks like there are some obstacles in the code...



```
ch.Data = malloc(length);
memcpy(ch.Data, addr, length);

//CRC check
uint32_t crc = to_uint32(&ch.Header[4]);
if(crc != crc32(addr, length))
    goto error;

if(chunk_type(ch.Header, ch.Data, length) < 0)
    goto error;

return length+8;
```

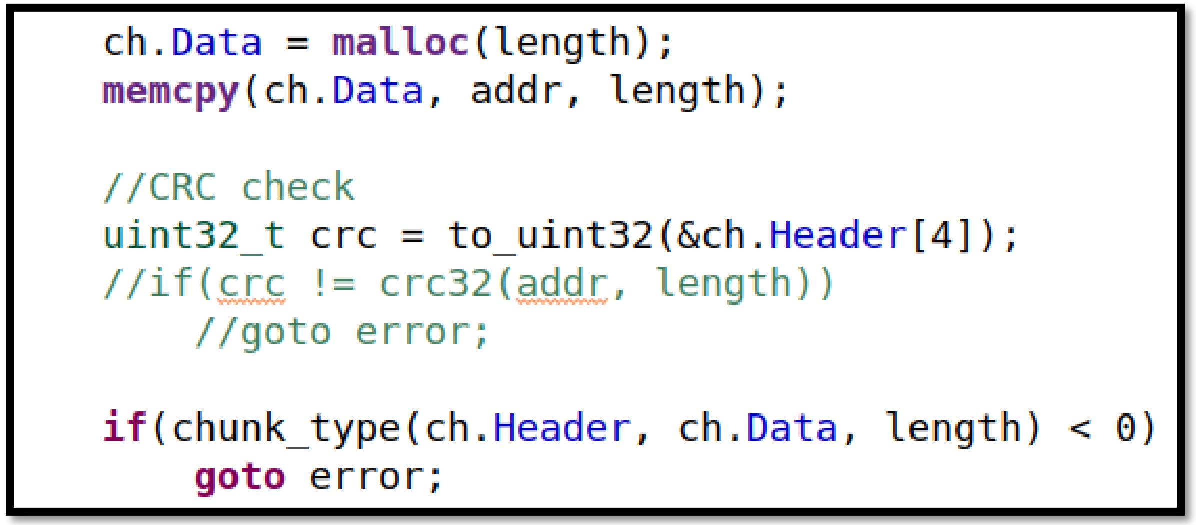


```
data += 2;

if(glob.p == 0 || glob.d == 0)
    goto error;

MD5_Update(&context, svd, svdn-24);
MD5_Final(md5, &context);
if(memcmp(md5, data, 16))
    goto error;

data += 16;

if(memcmp(data, "\x20\x21", 2))
    goto error;
```

Parece que hay algunos obstáculos en el código...

Challenge 1 – Hint 4

A little bit easier…



```
    ch.Data = malloc(length);
    memcpy(ch.Data, addr, length);

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    uint32_t crc = to_uint32(&ch.Header[4]);
    //if(crc != crc32(addr, length))
        //goto error;

    if(chunk_type(ch.Header, ch.Data, length) < 0)
        goto error;
```
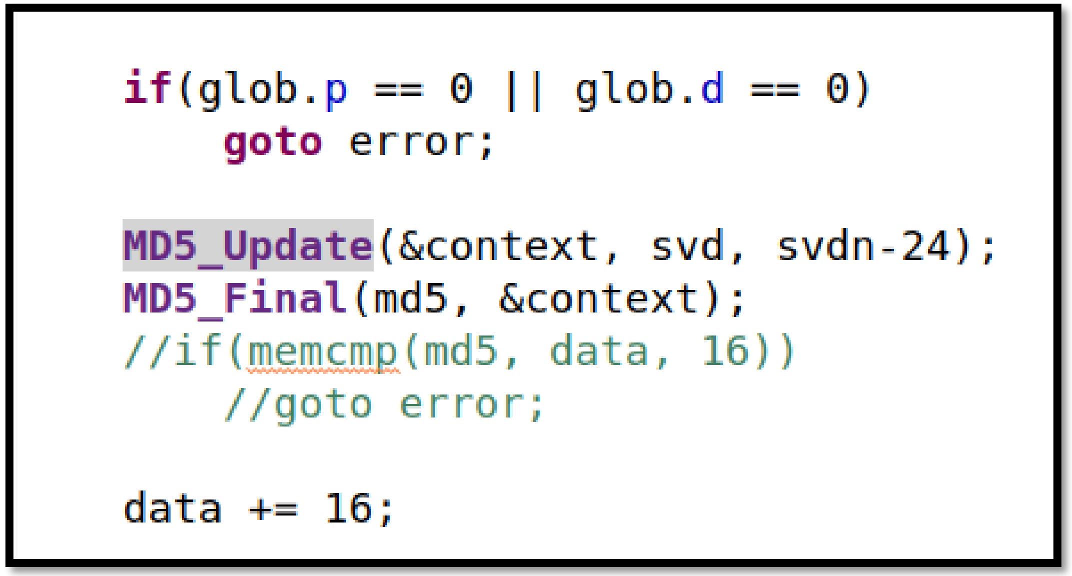



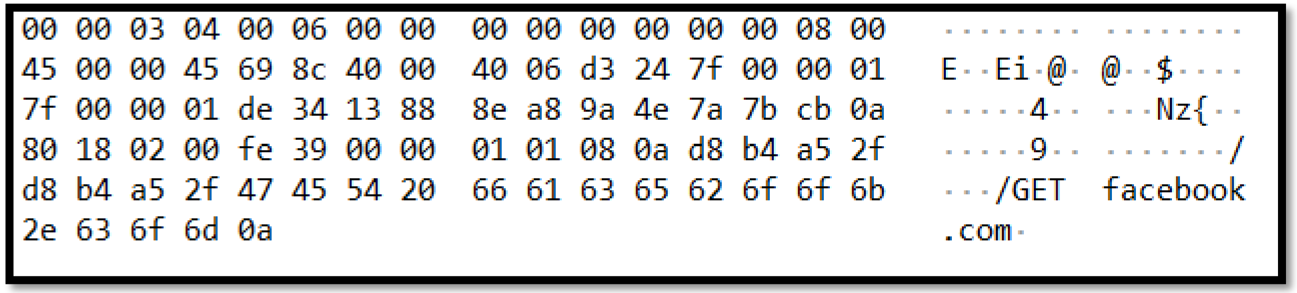
```
    if(glob.p == 0 || glob.d == 0)
        goto error;

    MD5_Update(&context, svd, svdn-24);
    MD5_Final(md5, &context);
    //if(memcmp(md5, data, 16))
        //goto error;

    data += 16;
```

Challenge 1 – My Solution

Challenge 2 – Crazy HTTP Server

Get the code at: https://github.com/antonio-morales/NoConName_Advanced_Fuzzing_Workshop

PASSWORD: **ncn2k20second**



```
00 00 03 04 00 06 00 00  00 00 00 00 00 00 08 00   ········ ········
45 00 00 45 69 8c 40 00  40 06 d3 24 7f 00 00 01   E··Ei·@· @··$····
7f 00 00 01 de 34 13 88  8e a8 9a 4e 7a 7b cb 0a   ·····4·· ···Nz{··
80 18 02 00 fe 39 00 00  01 01 08 0a d8 b4 a5 2f   ·····9·· ·······/
d8 b4 a5 2f 47 45 54 20  66 61 63 65 62 6f 6f 6b   ···/GET  facebook
2e 63 6f 6d 0a                                     .com·
```

An HTTP Server that is not what it seems!

Build:

```
> gcc fuzz2.c -o fuzz2 -w -lz
```

Run (as root):

```
> ./fuzz2
```

You can find some capture examples in the “Captures” folder

Puedes encontrar algunos ejemplos de paquetes capturados en el directorio “Captures”

Challenge 2 - Crazy HTTP Server

Ask me any doubt via PM

Reminder

50 minutes

LET'S GO!!!

Challenge 2 - Tip

- A **dictionary** can be useful… sometimes
- afl-fuzz -t 500 -m none -i ../AFL/afl_in/ -o ../AFL/afl_out -x ../AFL/mydict.txt -- ./fuzz2 @@

If you need more help, take a look at: https://securitylab.github.com/research/fuzzing-challenges-solutions-1 *("Providing a custom dictionary")*

- En ocasiones un **diccionario** puede ser util
- afl-fuzz -t 500 -m none -i ../AFL/afl_in/ -o ../AFL/afl_out -x ../AFL/mydict.txt -- ./fuzz2 @@

Si necesitas mas ayuda, echa un vistazo a: https://securitylab.github.com/research/fuzzing-challenges-solutions-1 *("Providing a custom dictionary")*

Challenge 2 – Hint 1

- The TCP/IP **port numbers below 1024** are special in that normal users are not allowed to run servers on them.
- Maybe you can change this port

- Los puertos TCP/IP por debajo de 1024 son privilegiados de forma que un usuario con privilegios normales no pueda ejecutar un servidor en ellos
- Quizás puedas cambiar el puerto

Challenge 2 – Hint 2

- Have you been able to extract the .PCAP content?
- If not, now you can download the raw content from GitHub repository

---

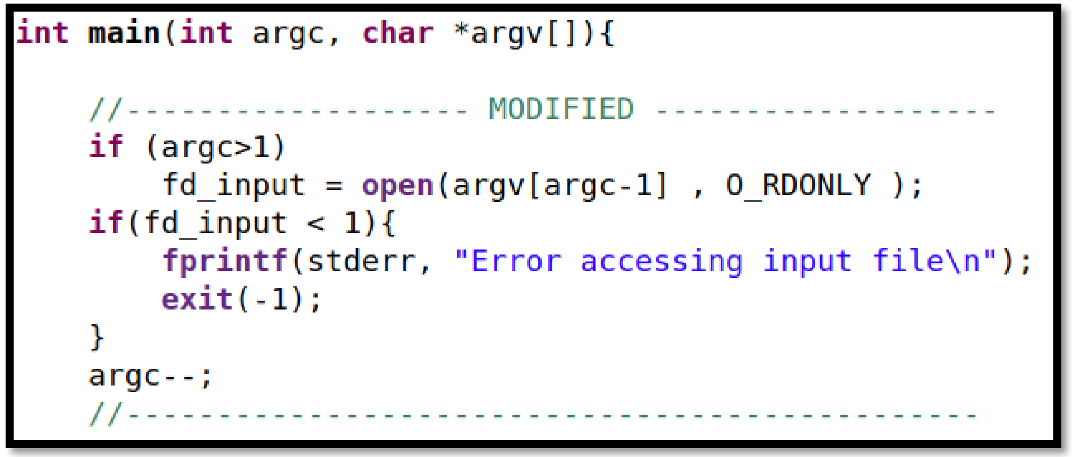
- Has podido extraer el contenido de los archivos .PCAP?
- Si no, puedes descargarte el contenido extraido del repositorio de GitHub

Challenge 2 – Hint 3

- AFL doesn’t support sockets natively. Maybe this link could help you: https://securitylab.github.com/research/fuzzing-sockets-FTP

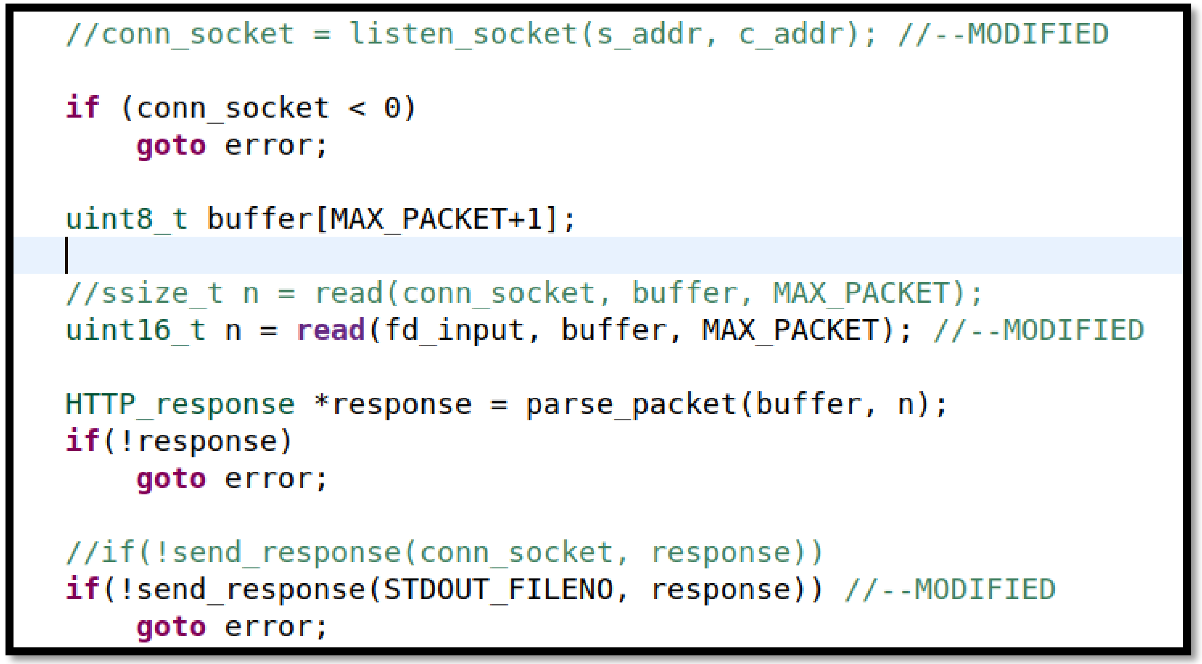
- AFL no soporta de forma nativa el fuzzeo de sockets. Pero quizás este link te pueda ser de ayuda: https://securitylab.github.com/research/fuzzing-sockets-FTP

Challenge 2 – Hint 4



```c
int main(int argc, char *argv[]){

    //------------------ MODIFIED ------------------
    if (argc>1)
        fd_input = open(argv[argc-1] , O_RDONLY );
    if(fd_input < 1){
        fprintf(stderr, "Error accessing input file\n");
        exit(-1);
    }
    argc--;
    //---------------------------------------------
```

Still not successful fuzzing sockets? Ok, look these code snippets



```c
//conn_socket = listen_socket(s_addr, c_addr); //--MODIFIED

if (conn_socket < 0)
    goto error;

uint8_t buffer[MAX_PACKET+1];

//ssize_t n = read(conn_socket, buffer, MAX_PACKET);
uint16_t n = read(fd_input, buffer, MAX_PACKET); //--MODIFIED

HTTP_response *response = parse_packet(buffer, n);
if(!response)
    goto error;

//if(!send_response(conn_socket, response))
if(!send_response(STDOUT_FILENO, response)) //--MODIFIED
    goto error;
```

Aún no has tenido éxito fuzzeando sockets? Ok, echa un vistazo a estos trozos de código

Challenge 2 – Hint 5

- Why is this code linked with **-lz**??

- Por qué esta enlazado el código con **-lz**??

Challenge 2 – My Solution

Challenge 3 - Check your grammar

- I will publish it soon at: https://github.com/antonio-morales/NoConName_Advanced_Fuzzing_Workshop/

- I will announce Challenge 3 winners next week ☺

- If you have any doubt on it, send me a pm via Twitter @nosoynadiemas

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- Lo publicaré en breve en: https://github.com/antonio-morales/NoConName_Advanced_Fuzzing_Workshop/

- Anunciaré los ganadores del Reto 3 la próxima semana ☺

- If you have any doubt on it, send me a pm via Twitter @nosoynadiemas

CONCLUSION

Conclusion

Don’t waste fuzzing iterations. Use your brain first

THE END

THANK YOU!
GRACIAS!

ASK ME ANYTHING

Antonio Morales Maldonado

Twitter: @nosoynadiemas
Email: antoniomoralesmaldonado@gmail.com