D^3CTF 2019 ch1pfs wp

拿到一堆文件，先运行一下，要求输入key，进到/test/，里面有文件，但是cat出来一堆乱码。

把CH1P_fs.ko拖到IDA里面看看，可以发现是自己写的一个文件系统，insmod的时候要一个key，key生成f_key，f_key在文件读写的时候进行异或加密。

然后到处看了看（strings rootfs.img、网上找了一下相关的代码、找到个假的getkey），明确给的各个文件的用途：

- CH1P_fs.ko 文件系统的驱动
- image CH1P_fs加密后的文件系统，系统启动后挂载到/test/目录
- waifu.png 明文图片，image里面也有一张
- 其他qemu所需的文件

至此，

明确解题思路：

- 因为是使用顺序的异或加解密，可以通过waifu.png的明密文对找出f_key
- 使用f_key查看其他文件或反推出key

Step1 找出png的明密文对

我patch了rootfs.img中的CH1P_fs.ko，将读取文件时的异或加密nop掉，直接输出raw的文件，使得我们能够定位密文在image中的位置。

png: 0x23bda0-0x732da0

png很大，在image文件中并不是完全连续的，中间还有一些数据，借助hexedit在patch过的文件系统上对比，可以将png密文完全提取出来（但是没有必要

Step2 根据明密文对恢复f_key

拿到明密文对直接异或即能得到f_key

```
with open("ctf/waifu.png", "rb") as f:
    m_data = f.read()

with open("ctf/png_c", "rb") as f:
    c_data = f.read()


for r in range(3):
    f_key = []
```

```
    m = m_data[4096*r:4096*(r+1)]
    c = c_data[4096*r:4096*(r+1)]
    for i in range(4096):
        f_key.append(ord(m[i])^ord(c[i]))
    print f_key
```

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f_key = [255, 190, 241, 240, 224, 168, 167, 95, 148, 140, 12, 92, 26, 116, 75,
155, 245, 54, 107, 247, 70, 158, 181, 135, 131, 98, 103, 104, 79, 64, 87, 96,
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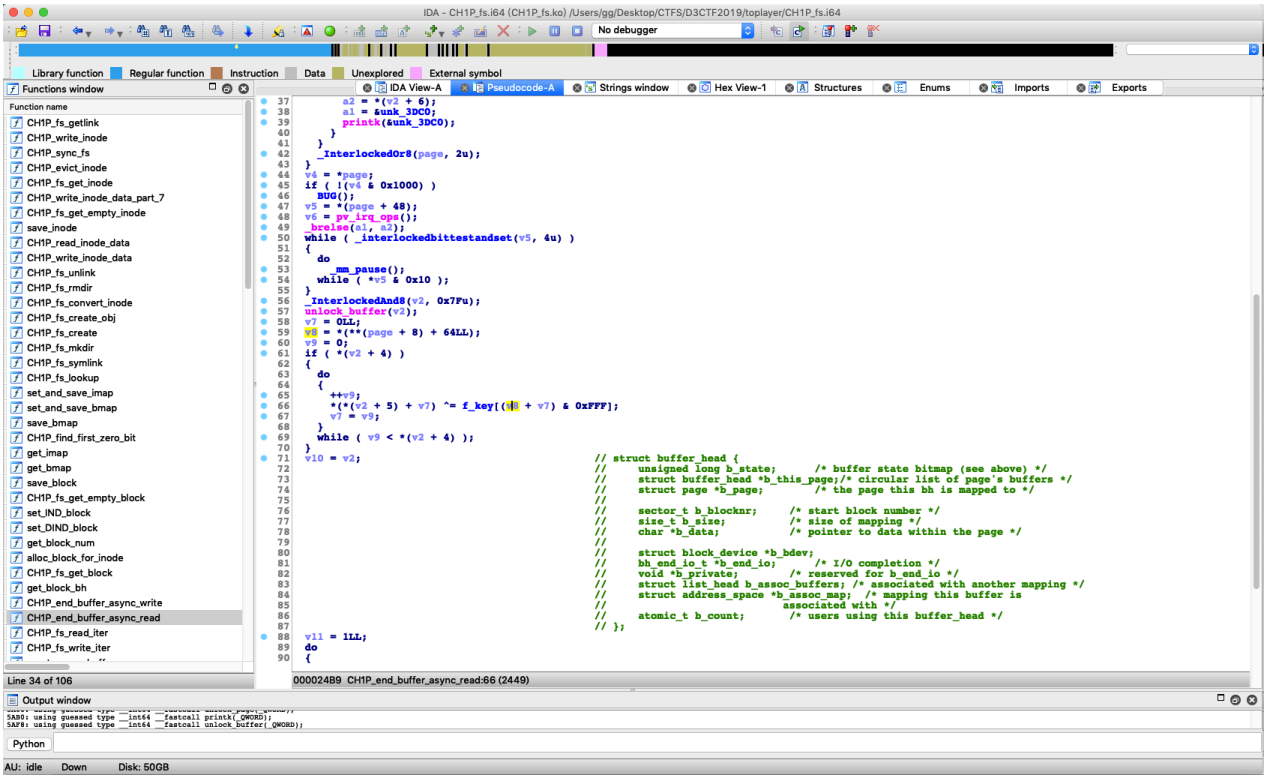
81, 156, 135, 139, 42, 103, 177, 184, 187, 254, 126, 161, 135, 12, 44, 252, 212, 91, 226, 148, 196, 110, 120, 29, 27, 70, 222, 6, 149, 1, 231, 11, 195, 213, 7, 236, 41, 80, 60, 167, 140, 76, 87, 250, 213, 46, 104, 80, 59, 74, 243, 186, 188, 115, 4, 154, 97, 27, 109, 118, 153, 73, 159, 137, 140, 41, 145, 228, 132, 139, 152, 9, 88, 31, 51, 200, 186, 142, 150, 128, 29, 169, 225, 56, 211, 96, 8, 241, 98, 126, 123, 19, 240, 72, 123, 177, 231, 34, 182, 242, 82, 130, 194, 101, 35, 203, 33, 234, 127, 28, 174, 62, 88, 8, 39, 92, 65, 144, 208, 123, 223, 23, 21, 132, 48, 104, 200, 105, 110, 228, 154, 150, 202, 93, 91, 28, 33, 222, 184, 232, 90, 232, 135, 79, 230, 184, 77, 34, 205, 198, 112, 136, 199, 79, 169, 166, 216, 101, 247, 150, 214, 160, 193, 101, 1, 242, 211, 170, 9, 126, 193, 170, 227, 25, 217, 201, 7, 165, 218, 24, 163, 229, 152, 193, 36, 118, 182, 12, 173, 225, 55, 200, 147, 4, 253, 66, 100, 242, 251, 20, 70, 246, 102, 107, 169, 193, 151, 80, 227, 19, 14, 237, 68, 102, 159, 201, 14, 33, 58, 155, 7, 207, 154, 255, 205, 253, 128, 15, 214, 5, 194, 56, 170, 157, 41, 33, 215, 152, 104, 190, 244, 100, 25, 7, 237, 54, 216, 176, 239, 219, 100, 140, 45, 180, 186, 94, 3, 75, 164, 183, 85, 186, 34, 213, 128, 251, 188, 44, 120, 210, 63, 115, 87, 126, 196, 8, 207, 35, 240, 218, 157, 19, 152, 25, 181, 253, 7, 75, 183, 218, 61, 102, 180, 26, 43, 161, 3, 198, 249, 110, 130, 173, 16, 250, 229, 51, 204, 95, 247, 71, 25, 42, 85, 64, 101, 1, 71, 141, 222, 25, 94, 244, 168, 157, 206, 215, 149, 226, 234, 165, 104, 75, 116, 7, 159, 96, 16, 85, 86, 20, 204, 64, 133, 108, 37, 197, 116, 190, 179, 27, 246, 177, 219, 91, 161, 147, 175, 60, 208, 254, 52, 148, 165, 106, 175, 30, 186, 26, 244, 148, 203, 167, 8, 38, 150, 88, 188, 97, 207, 155, 198, 88, 52, 210, 172, 219, 35, 37, 207, 210, 194, 247, 57, 76, 140, 18, 220, 90, 227, 58, 10, 65, 223, 221, 161, 125, 35, 67, 170, 98, 190, 16, 142, 164, 103, 113, 242, 96, 59, 101, 175, 120, 53, 158, 19, 127, 94, 215, 84, 202, 132, 109, 139, 225, 11, 52, 166, 121, 225, 159, 80, 74, 78, 13, 158, 159, 178, 149, 192, 14, 64, 153, 128, 218, 20, 208, 120, 55, 248, 110, 188, 26, 240, 231, 224, 201, 188, 221, 55, 127, 142, 19, 210, 174, 7, 126, 95, 90, 230, 157, 66, 194, 61, 219, 201, 215, 236, 79, 47, 89, 2, 168, 178, 133, 245, 56, 188, 4, 17, 94, 97, 124, 85, 227, 43, 248, 201, 190, 243, 195, 73, 105, 50, 90, 79, 226, 110, 230, 77, 88, 165, 60, 180, 254, 27, 180, 153, 211, 97, 69, 137, 75, 13, 17, 158, 74, 168, 53, 24, 194, 3, 208, 232, 101, 74, 202, 185, 122, 147, 78, 217, 109, 79, 169, 182, 116, 36, 182, 180, 69, 171, 101, 212, 168, 126, 96, 121, 109, 104, 142, 90, 115, 136, 155, 24, 115, 196, 83, 36, 136, 138, 149, 37, 6, 125, 206, 38, 151, 37, 185, 222, 90, 39, 253, 143, 12, 82, 10, 95, 1, 93, 53, 188, 48, 131, 129, 235, 156, 190, 68, 152, 204, 169, 253, 2, 12, 191, 238, 138, 236, 60, 254, 36, 99, 96, 44, 123, 33, 127, 78, 149, 128, 245, 54, 219, 162, 209, 215, 147, 43, 53, 102, 247, 66, 3, 243, 47, 237, 70, 131, 111, 2, 75, 90, 49, 130, 211, 163, 80, 201, 98, 172, 95, 195, 95, 63, 8, 43, 3, 206, 158, 62, 176, 245, 128, 173, 118, 7, 81, 217, 105, 104, 161, 179, 188, 137, 43, 115, 98, 81, 181, 35, 129, 199, 111, 192, 64, 247, 170, 87, 255, 228, 89, 3, 25, 106, 2, 13, 175, 157, 49, 56, 128, 238, 231, 211, 223, 63, 159, 11, 203, 46, 31, 123, 168, 146, 75, 204, 49, 77, 60, 89, 77, 123, 244, 240, 66, 71, 43, 219, 221, 28, 89, 210, 142, 220, 158, 123, 132, 252, 102, 142, 170, 136, 97, 138, 218, 9, 250, 230, 59, 133, 26, 150, 68, 150, 116, 80, 125, 243, 252, 136, 136, 20, 76, 128, 219, 154, 203, 217, 110, 5, 218, 150, 144, 93, 185, 242, 62, 154, 156, 220, 211, 215, 29, 142, 22, 232, 244, 9, 79, 213, 194, 241, 230, 171, 82, 25, 51, 137, 108, 239, 134, 10, 96, 241, 98, 162, 80, 68, 102, 194, 168, 167, 229, 183, 38, 85,

```
214, 123, 111, 101, 140, 24, 55, 121, 54, 184, 28, 16, 140, 0, 227, 254, 50,
221, 229, 110, 108, 57, 185, 241, 209, 83, 3, 12, 86, 158, 55, 98, 205, 86,
237, 230, 225, 114, 169, 130, 98, 157, 36, 96, 132, 117, 105, 82, 115, 243,
234, 107, 44, 53, 12, 238, 72, 178, 189, 32, 184, 21, 54, 184, 177, 80, 30,
48, 141, 88, 170, 150, 68, 233, 217, 204, 85, 147, 237, 119, 65, 126, 136,
131, 67, 179, 157, 127]
```

我只处理了前3*4096字节，发现key是一样的

Step3 解密其他数据

观察加解密的代码。如下图所示，还有个v8不知道，不过爆破4096次肯定能过出来




```
def find_m(flag_c):
    for _ in range(4096):

        flag_m = ""

        for i in range(len(flag_c)):
            flag_m += chr(int(flag_c[i], 16) ^ f_key[(i+_) % 4096])

        import string
        f = True
        for c in flag_m:
            if c not in string.printable:
                f = False
        if f:
```

```
            print flag_m
            return flag_m

hint_c = "97 8F C7 C3 00 F6 F9 78 03 6E 1B 29 FE 96 59 05 83 2F F0 C0 E2
89".split(" ")
# find_m(hint_c)
# good_but_tobecontinue

# find_m(flag_cc)
# not find

key_c = "95 C3 BF EB EF 6E E4 EA 7F 7D 10".split(" ")
find_m(key_c)
# d3_CH1pfs!
```

flag还拿不到，其他数据都能够解密了，有个key文件，解密得到key: `d3_CH1pfs!`，用key进入文件系统。

还有下一关：

```
/test # cat make_flag.sh
#!/bin/sh
gcc ../enc.c -o ./enc --static
./enc ../flag > flag
```

flag用enc加密过，但是并没有enc文件的影子，可能被删掉了，想到文件系统的删除并不是真·擦除，可能从image中恢复。

根据观察，image中只有两个大文件：png和busybox，统计了一下非零字节的个数，验证以上的想法

```
with open("ctf/image", "rb") as f:
    image_data = f.read()

print len(image_data)
count = 0
for c in image_data:
    if ord(c) != 0:
        count += 1
print hex(count)
```

对比发现文件系统里还有一个大文件，又因为enc是静态链接的，绝壁就是它了

如何提取：

- 修改record（不太熟悉linux文件系统，没有尝试

- 手动dump出raw的enc

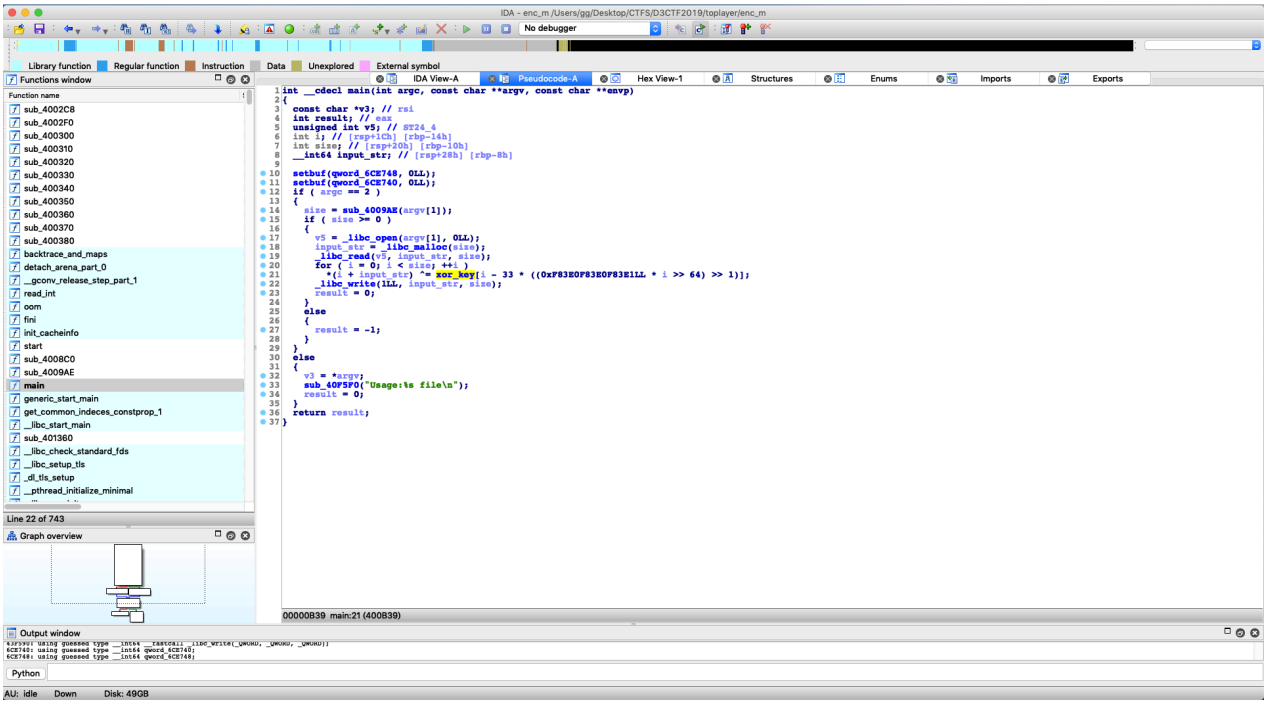
我用了下面这种比较笨的方法

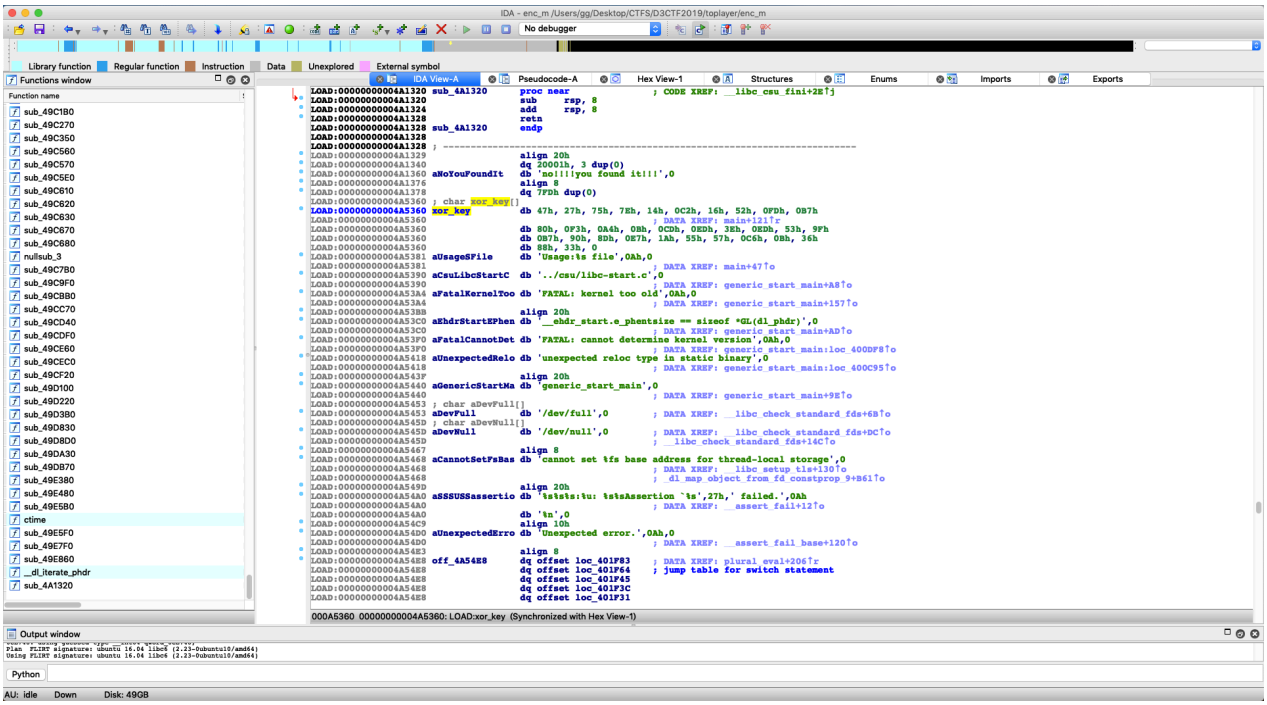
先拿f_key和ELF的开头四个字节定位到ELF的起始位置，手动从010editor中提取出来，中间夹杂着一些无用的数据。边用f_key恢复，拖到IDA里面查看，如果夹杂着没用的数据，汇编代码从那个位置开始很容易就能看出异常，微调即可。

```
def re_enc_binary():
    with open("ctf/enc_c", "rb") as f:
        enc_a_data = list(f.read())

    key_begin = 4

    res = []

    for i in range(len(enc_a_data)):
        # res.append(ord(enc_a_data[i]) ^ f_key[(key_begin+i) % 4096])
        enc_a_data[i] = chr(ord(enc_a_data[i]) ^ f_key[(key_begin+i) % 4096])

    # print res

    with open("ctf/enc_m", "wb") as f:
        f.write("".join(enc_a_data))
```

恢复出enc文件，拖到IDA中查看：

恢复符号表，可以发现逻辑十分简单：





又是异或而已，写出解密脚本：

```
xor_key = [
    0x47, 0x27, 0x75, 0x7E, 0x14, 0xC2, 0x16, 0x52, 0xFD, 0xB7,
    0x80, 0xF3, 0xA4, 0x0B, 0xCD, 0xED, 0x3E, 0xED, 0x53, 0x9F,
    0xB7, 0x90, 0x8D, 0xE7, 0x1A, 0x55, 0x57, 0xC6, 0x0B, 0x36,
    0x88, 0x33, 0
]


def find_flag():
    flag_c = "8B B3 49 9E FE B5 0E 27 D6 85 74 73 CD 14 52 C2 CE 33 8B 6A B3
84 BA 99 29 5D 54 9B 30 6D 19 25 20 50 C5 DE 61".split(
        " ")
    for _ in range(4096):

        flag_m = ""

        for i in range(len(flag_c)):
            flag_m += chr(int(flag_c[i], 16) ^ f_key[(i+_) % 4096] ^ xor_key[i
% 33])

        import string
        f = True
        for c in flag_m:
            if c not in string.printable:
                f = False
        if f:
            print flag_m
            return flag_m
# d3ctf{Do_you_think_vfs_1s_convenient}
```