

## Talos Vulnerability Report

TALOS-2021-1378

### Anker Eufy Homebase 2 home\_security CMD\_DEVICE\_GET\_SERVER\_LIST\_REQUEST out-of-bounds write vulnerability

NOVEMBER 29, 2021

#### CVE NUMBER

CVE-2021-21950,CVE-2021-21951

#### SUMMARY

An out-of-bounds write vulnerability exists in the CMD\_DEVICE\_GET\_SERVER\_LIST\_REQUEST functionality of the home\_security binary of Anker Eufy Homebase 2 2.1.6.9h. A specially-crafted network packet can lead to code execution.

#### CONFIRMED VULNERABLE VERSIONS

The versions below were either tested or verified to be vulnerable by Talos or confirmed to be vulnerable by the vendor.

Anker Eufy Homebase 2 2.1.6.9h

#### PRODUCT URLS

Eufy Homebase 2 - <https://us.eufylife.com/products/t88411d1>

#### CVSSV3 SCORE

10.0 - CVSS:3.0/AV:N/AC:L/PR:N/UI:N/S:C/C:H/I:H/A:H

#### CWE

CWE-119 - Improper Restriction of Operations within the Bounds of a Memory Buffer

#### DETAILS

The Eufy Homebase 2 is the video storage and networking gateway that enables the functionality of the Eufy Smarthome ecosystem. All Eufy devices connect back to this device, and this device connects out to the cloud, while also providing assorted services to enhance other Eufy Smarthome devices.

The Eufy Homebase 2's home\_security binary is a central cog in the device, spawning inordinate amount of pthreads immediately after executing, each with their own little task. For the purposes of this advisory, we care solely about the pthread in charge of a particular cloud connectivity occurring with IP address 18.224.66.194 on UDP port 8006. An example of such traffic is shown below:

```
// device -> cloud
0000  58 5a fe b9 0b 00 00 00 59 5e 42 61 01 00 00 00  XZ.....Y^Ba....
0010  00 00 01 00 54 38 30 31 30 4e 31 32 33 34 35 36  ....T8010N123456
0020  37 48 39 3a 00                789A.
```

This particular packet is the CMD\_DEVICE\_HEARTBEAT\_CHECK, and the server's response is seen below:

```
// cloud -> device response
0000  58 5a 32 b2 0b 00 00 00 59 5e 42 61 01 00 01 00  XZ2.....Y^Ba....
0010  00 00 01 00 54 38 30 31 30 4e 31 32 33 34 35 36  ....T8010N123456
0020  38 48 39 3a 00 7b 22 64 65 76 69 63 65 5f 69 70  789a.{"device_ip
0030  22 3a 22 37 31 2e 31 36 32 2e 32 33 37 2e 33 34  "71.162.237.34
0040  22 7d                "}
```

While there is some interesting information already visible, reversing the protocol and viewing with a decoder is much more informative:

```

[>_>] ---Pushpkt---
Magic      : 0x5a58
CRC        : 0x1234
Opcode     : 0x000b (CMD_DEVICE_HEARTBEAT_CHECK)
Bodylen    : 0x0000
Time (unix) : 1632154786
msg_ver    : 0x0001
is_resp    : 0x00
idk_lol    : 0x00
idk_lol2   : 0x0000
non_zero   : 0x0001
Hub SN     : T8010N123456789a\x00

[<_<] response pkt:
[>_>] ---Pushpkt---
Magic      : 0x5a58
CRC        : 0x5678
Opcode     : 0x000b (CMD_DEVICE_HEARTBEAT_CHECK)
Bodylen    : 0x001d
Time (unix) : 1632154746
msg_ver    : 0x0001
is_resp    : 0x01
idk_lol    : 0x00
idk_lol2   : 0x0000
non_zero   : 0x0001
Hub SN     : T8010N123456789a\x00
Msgbody    : {"device_ip": "71.162.237.34"}

```

While this specific command doesn't particularly do much, there does exist a decent amount of other opcodes to interact with:

```

opcode_dict = {
    0xb : "CMD_DEVICE_HEARTBEAT_CHECK",
    0xc : "CMD_DEVICE_GET_SERVER_LIST_REQUEST", // [1]
    0xd : "CMD_DEVICE_GET_RSA_KEY_REQUEST",    // [2]
    0x22 : "CMD_SERVER_GET_AES_KEY_INFO",
    0x3ea : "zx_app_unbind_hub_by_server",
    0x3eb : "zx_start_stream",
    0x3ec : "zx_stream_delete",
    0x3f1 : "zx_set_dev_storagetype_by_SN",
    0x40a : "APP_CMD_HUB_REBOOT",
    0x410 : "zx_unbind_dev_by_sn",
    0x464 : "APP_CMD_GET_EXCEPTION_LOG",
    0x46d : "CMD_GET_HUB_UPGRADE",
    0xbb8 : "turn_on_facial_recognition?",
    0xfa0 : "wifi_country_code_update",
    0xfa1 : "wifi_channel_update",
    0x1388 : "CMD_SET_DEFINE_COMMAND_VALUE",
    0x1770 : "CMD_SET_DEFINE_COMMAND_STRING"
}

```

While some of these opcode names look tantalizing, only the opcodes less than 0x10 require no authentication, so we're limited to CMD\_DEVICE\_GET\_SERVER\_LIST\_REQUEST [1] and CMD\_DEVICE\_GET\_RSA\_KEY\_REQUEST [2]. For the purposes of this advisory, we only need one of these: CMD\_DEVICE\_GET\_SERVER\_LIST\_REQUEST. Since the same vulnerable code pattern is found in two different functions, we'll discuss them separately.

#### CVE-2021-21950 - recv\_server\_device\_response\_msg\_process

In function `recv_server_device_response_msg_process`, the CMD\_DEVICE\_GET\_SERVER\_LIST\_REQUEST request is parsed as shown below:

```

005a1748 uint32_t recv_server_device_response_msg_process(struct dev_packet* devpkt, int32_t inp_msglen, struct sockaddr* dstaddr, int32_t sockfd)

005a179c     uint32_t opcode = zx.d((zx.d(devpkt->opcode:1.b) << 8).w | zx.w(devpkt->opcode.b))
005a17c8     struct dev_packet_full resp_buf
005a17c8     memset(&resp_buf, 0, 0x425)
005a17d8     uint32_t scratch = opcode
005a17e0     struct aes_key_st scratchbuf

005a17e0     if (scratch == 0xc)
005a1acc         m_heart_timeout_nums = 0
005a1ad8         m_udp_server_connect = 1

005a1ae8     int32_t resp_time = 0
005a1b0c     memcpy(&resp_buf, devpkt, inp_msglen)
005a1b30     struct cJSON* jsonobj = cJSON_Parse(&resp_buf.msg)

005a1b48     if (jsonobj != 0)
005a1b6c         uint32_t udp_server_num = zx.Json_GetInt(jsonobj, "nums", 0) // [3]
005a1ba4         resp_time = zx.Json_GetInt(jsonobj, "utc_time", 0) // [4]
// [...]
005a1c84         s_udp_server_total_nums = udp_server_num
005a1e9c         for (int32_t ctr = 0; ctr < udp_server_num; ctr = ctr + 1)
005a1cb8             memset(&scratchbuf, 0, 0x80)
005a1cf8             sprintf(&scratchbuf, 0x79ca14, 0x79ca1c, ctr + 1, var_798, var_794, var_790, var_78c, var_788) {"%s%d"}
005a1d20             char* str_value = zx.Json_GetString(obj: jsonobj, string: &scratchbuf, output_ptr: nullptr) // [5]
005a1d38             if (str_value != 0 && strlen(str_value) < 0x80)
005a1da0                 memset((ctr << 7) + 0x88287c, 0, 0x80)
005a1e00                 memcpy(0x88287c + (ctr << 7), str_value, strlen(str_value))
// [...]
005a1eb4         cJSON_Delete(cjson: jsonobj)
005a1ec0         int32_t var_768_4 = 0
005a1ed0         if (s_udp_server_total_nums > 0)
005a1ed8             update_udp_push_config_file()
005a1ee8         scratch = send_device_packet_by_command_id(opcode: 0xd)

```

Utilizing the cJSON library to pull out the `nums` field [3], the `utc_time` field [4], and also a list of domains from the json of the server's response [5], the CMD\_DEVICE\_GET\_SERVER\_LIST\_REQUEST opcode then stores this server list information inside of the `zx_udp_push_config.ini` file. When valid, the file might look like so:

```

/~ cat /mnt/zx_udp_push_config.ini
[NET]
domain_total=3
current_index=2
app_server_domain=security-app.eufylife.com
domain1=p2p-vir-6.eufylife.com
domain2=p2p-vir-7.eufylife.com
domain3=mediaserver-usa3.eufylife.com

```

We now have enough context to discuss the vulnerability, so let us go back to a particular subset of the above `recv_server_device_response_msg_process` code:

```

005a1b48     if (jsonobj != 0)
005a1b6c         uint32_t udp_server_num = zx_Json_GetInt(jsonobj, "nums", 0) // [6]
005a1ba4         resp_time = zx_Json_GetInt(jsonobj, "utc_time", 0)
// [...]
005a1c84         s_udp_server_total_nums = udp_server_num
005a1e9c         for (int32_t ctr = 0; ctr <= udp_server_num; ctr = ctr + 1) // [7]
005a1cb8             memset(&scratchbuf, 0, 0x80)
005a1cf8             sprintf(&scratchbuf, 0x79ca14, 0x79ca1c, ctr + 1, var_798, var_794, var_790, var_78c, var_788) {"%s%d"}
{"domain"}
005a1d20             char* str_value = zx_Json_GetString(obj: jsonobj, string: &scratchbuf, output_ptr: nullptr) // [8]
005a1d38             if (str_value != 0 && strlen(str_value) < 0x80) // [9]
005a1da0                 memset((ctr < 7) + 0x88287c, 0, 0x80) // [10]
005a1e00                 memcpy(0x88287c + (ctr < 7), str_value, strlen(str_value)) // [11]

```

When pulling the `nums` field, which serves as the total number of UDP server domains, we must note the total lack of validation on this field anywhere thereafter [6]. Thus, the amount of iterations for the loop at [7] is entirely attacker-controlled, along with the `int32_t ctr` variable at [7] as well. If the search for `domain1`, `domain2`, ... `domain%d` field from our packet JSON fails at [8], or if the string length of the value is greater than `0x80`, we skip the branch at [9] but stay within our loop at [7]. The `ctr` variable keeps incrementing. With all this in mind we can reason that the lines at [10] and [11] can be hit with whatever value inside of `ctr` that an attacker chooses. While there is a total packet length limit of `0x425` bytes found much earlier in the codebase, there's no requirement for our JSON to have `domain1` and `domain2` and so on and so forth. We would quickly run out of bytes before we could write outside of the `char s_udp_server_list[0x80][8]` at `0x88287c`. Thus, simply by inserting something like `"domain100000":aaaaaaaaaaaaaaaa...` and `"nums":100001` into a `CMD_DEVICE_GET_SERVER_LIST_REQUEST`, one can write `0x80` bytes to `0x88287c + (100000 << 7)`, something applicable to any address in memory, resulting in a write-what-where and subsequent code execution.

## Crash Information

```

Terminated with signal SIGSEGV, Segmentation fault.
#0 0x77226a84 in memset () from /lib/libc.so.0

[Current thread is 1 (LWP 5768)]

Backtrace stopped: frame did not save the PC
<(^.)>#info reg
zero      at      v0      v1      a0      a1      a2      a3
R0 00000000 1100ff00 0216207c 0216207c 02162084 00000000 00000000 021620fc
t0      t1      t2      t3      t4      t5      t6      t7
R8 00000000 00000000 00000200 00000100 00000807 00000800 00000400 00000008
s0      s1      s2      s3      s4      s5      s6      s7
R16 6148b52a 7fe43468 00000036 771de280 7c6c0000 00000000 00000007 0000e436
t8      t9      k0      k1      gp      sp      s8      ra
R24 00000001 77226a30 00000000 00000000 0083bdb0 7c6fe498 00000000 005a1da8
sr      lo      hi      bad      cause      pc
0100ff13 00000000 00000002 0216207c 0080000c 77226a84
fsr      fir
00000000 00000000
<(^.)>#x/4i $pc
=> 0x77226a84 <memset+84>:      sw      a1,-8(a0)
0x77226a88 <memset+88>:      bne      a0,a3,0x77226a80 <memset+80>
0x77226a8c <memset+92>:      sw      a1,-4(a0)
0x77226a90 <memset+96>:      andi      t0,a2,0x4
<(^.)>#bt
#0 0x77226a84 in memset () from /lib/libc.so.0
#1 0x005a1da8 in recv_server_device_response_msg_process (p_data=0x7c6ff8ec, data_len=175, server_sin=0x7c6ff8d8, socket_id=22) at src/zx_push_interface.c:633
#2 0x005a6584 in process_msg (p_data=0x7c6ff8ec, data_len=175, server_sin=0x7c6ff8d8, socket_id=22) at src/zx_push_interface.c:1507
#3 0x005a108c in zx_push_recv_packet (socket_id=22) at src/zx_push_interface.c:462
#4 0x005a05b4 in init_udp_server_domain () at src/zx_push_interface.c:340
#5 0x005a1128 in zx_push_receiver_msg_process (argv=0x0) at src/zx_push_interface.c:473
#6 0x771c3264 in pthread_start_thread () from /lib/libpthread.so.0
#7 0x772007f8 in __thread_start () from /lib/libc.so.0

<(^.)>#info reg a0
a0: 0x2162084

<(^.)>#info proc map
Mapped address spaces:
Start Addr  End Addr  Size  Offset objfile
0x4000000  0x7f8000  0x3f8000  0x0  /bin/home_security
0x8080000  0x837000  0x2f000  0x3f8000 /bin/home_security

```

## CVE-2021-21951 - read\_udp\_push\_config\_file

The previously-mentioned bug is also found in a second function, `read_udp_push_config_file`, in the same code pattern. After reading the `CMD_DEVICE_GET_SERVER_LIST_REQUEST` in `recv_server_device_response_msg_process`, these values are then written into the `/mnt/zx_udp_push_config.ini` file. On reboot, `read_udp_push_config_file` is hit and we read the `/mnt/zx_udp_push_config.ini` config file, all the same vulnerability principles being applicable.

```

0059f2f4         if (zx_file_readcfg(file: "/mnt/zx_udp_push_config.ini", char *section: 0x79c980, headername: "domain_total",
output: &var_110_0x80_size) != 0) {"[NET]"} // [1]
0059f348         $v0_1 = 0xffffffff
0059f324     else
0059f324         s_udp_server_total_nums = atoi(&var_110_0x80_size)
0059f334         if (s_udp_server_total_nums == 0)
0059f33c             $v0_1 = 0xffffffff
0059f378     else
0059f378         memset(&var_110_0x80_size, 0, 0x80)
0059f3bc         if (zx_file_readcfg(file: "/mnt/zx_udp_push_config.ini", char *section: 0x79c980, headername:
"current_index", output: &var_110_0x80_size) != 0) {"[NET]"}
0059f400         $v0_1 = 0xffffffff
0059f3ec     else
0059f3ec         s_current_udp_server_index = atoi(&var_110_0x80_size)

0059f6bc         while (true)
0059f6bc             if (ctr >= s_udp_server_total_nums) // [2]
0059f6bc                 if (s_udp_server_total_nums >= s_current_udp_server_index && s_x.d(*
((s_current_udp_server_index << 7) + 0x88287c)) != 0)
0059f6e8                     memset(0x8827f4, 0, 0x80)
0059f72c                     strncpy(0x8827f4, 0x88287c + (s_current_udp_server_index << 7), 0x7f) /
// [...]
0059f7a8                     $v0_1 = 0
0059f7a8                     break
0059f430                     memset(&var_110_0x80_size, 0, 0x80)
0059f460                     void var_90
0059f460                     memset(&var_90, 0, 0x80)
0059f4a0                     sprintf(&var_90, 0x79ca1c, ctr + 1, var_138, var_134, var_130, var_12c, var_128)
{"%s%d"} {"domain"}
0059f648         if (zx_file_readcfg(file: "/mnt/zx_udp_push_config.ini", char *section: 0x79c980, headername:
&var_90, output: &var_110_0x80_size) != 0) {"[NET]"}
0059f648         $v0_1 = 0xffffffff
0059f64c         break
0059f524         memset((ctr << 7) + 0x88287c, 0, 0x80)
0059f554         if (strlen(&var_110_0x80_size) < 0x80)
0059f5b4             strncpy((ctr << 7) + 0x88287c, &var_110_0x80_size, strlen(&var_110_0x80_size) - 1) // [3]
0059f5dc         var_138 = 0xb2
0059f5e4         var_134 = 0x28
0059f5f0         var_130 = 0x79ca24 {"s:%s"}
0059f5f8         var_12c = &var_90
0059f5fc         var_128 = (ctr << 7) + 0x88287c
0059f624         dzlog(0x79c99c, 0x17, 0x79dd8c, 0x19, 0xb2, 0x28, 0x79ca24, var_12c, var_128)
{"src/zx_push_interface.c"} {"s:%s"} {"read_udp_push_config_file"}
0059f63c         ctr = ctr + 1

```

At [1], we see the domain\_total field being pulled out of the config file. This value serves as an upper-bound loop condition for the loop at [2]. As our ctr variable increments until it reaches s\_udp\_server\_total\_nums, the domain%d fields are again searched for. If a match is found, then we again write to ((ctr << 7) + 0x88287c, an arbitrary value since we control the contents of the file. Thus, for example, with a domain100000=aaaaaaaaaaaaa... inside of the config file, an out-of-bounds write occurs, resulting in code execution.

#### TIMELINE

2021-09-30 - Vendor Disclosure  
2021-11-22 - Vendor Patched  
2021-11-29 - Public Release

#### CREDIT

Discovered by Lilith >\_ of Cisco Talos.

VULNERABILITY REPORTS

PREVIOUS REPORT

NEXT REPORT

TALOS-2021-1379

TALOS-2021-1384

