ELF_PLEAD - Linux Malware Used by BlackTech - JPCERT/CC Eyes

By 朝長 秀誠 (Shusei Tomonaga)

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- BlackTech

In a past article, we introduced Linux malware ELF_TSCookie, which is used by an attack group BlackTech. This group also uses other kinds of malware that affects Linux OS. PLEAD module for Windows which we introduced before has its Linux version (ELF_PLEAD) as well. This article describe the details of ELF_PLEAD in comparison to PLEAD module.

Comparison between PLEAD Module and ELF_PLEAD

ELF_PLEAD and PLEAD module share many parts of the code, and most of the functions including communication are similar. Figure 1 shows the comparison of the main functions of PLEAD module and ELF_PLEAD.

Figure 1: Code comparison of PLEAD module and ELF_PLEAD
(Left: PLEAD module / Right: ELF_PLEAD)

It is clear from the flow of processing that the two types of malware are quite similar. The next sections will describe the features of ELF_PLEAD from the following perspectives:

- Configuration
- Communication protocol
- Commands

Configuration

ELF_PLEAD possesses its configuration with the size of 0x1AA. Figure 2 is an example of configuration. It contains information such as C&C servers and an encryption key. (Please see Appendix A for the details of configuration.)

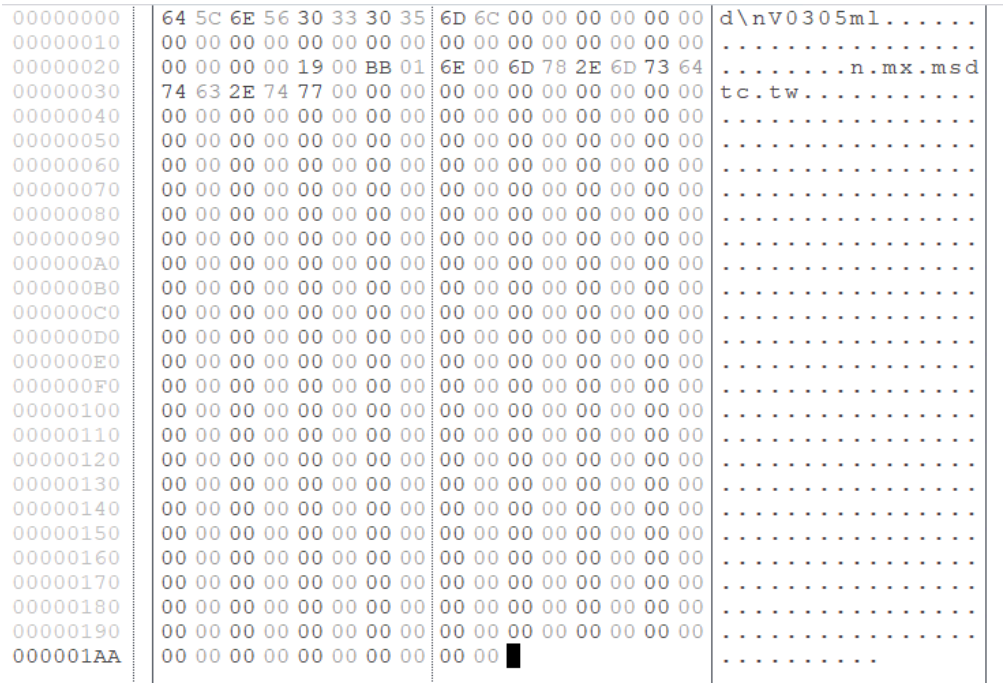


Figure 2: Configuration example

The configuration is RC4-encrypted, and the 32-byte string right before the encrypted configuration is the encryption key itself. Figure 3 is an example of encrypted configuration and its key.

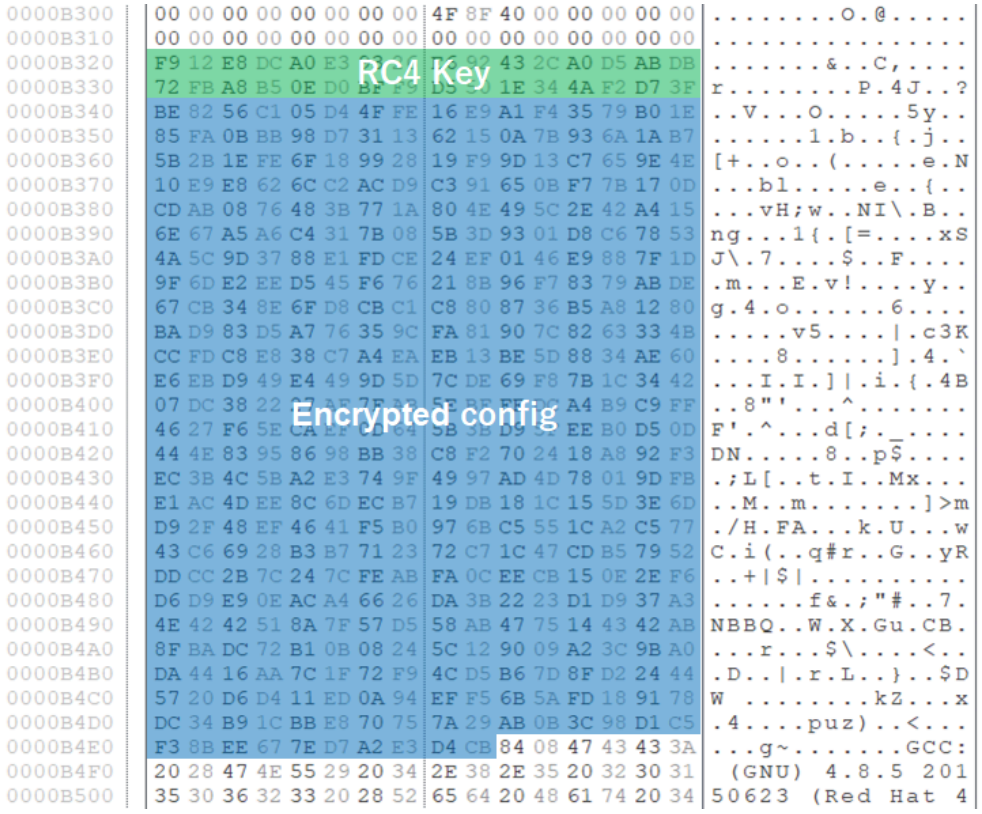


Figure 3: Encrypted configuration and encryption key

Communication protocol

While PLEAD module uses HTTP protocol to communicate with its C&C servers, ELF_PLEAD uses its custom protocol. Besides the difference, the data format and the method for exchanging the encryption key are almost the same. Figure 4 describes the flow of communication that ELF_PLEAD performs.

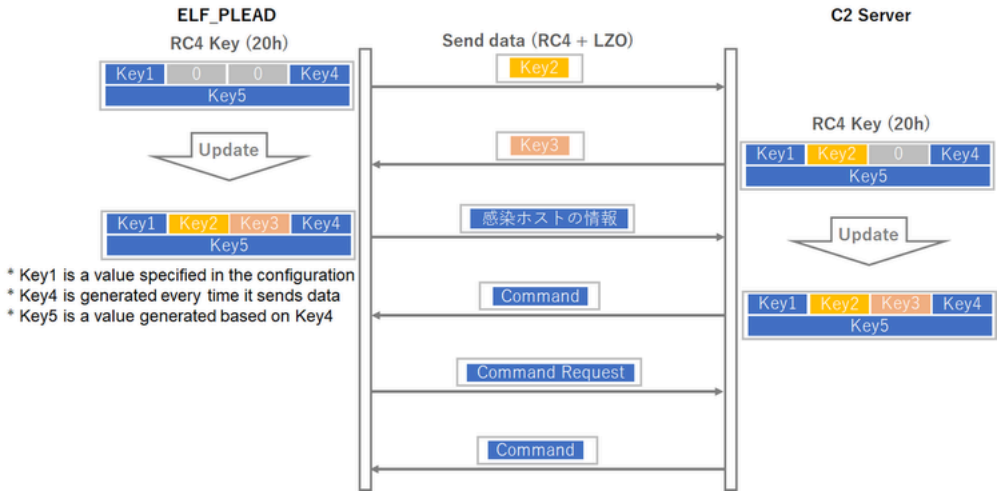


Figure 4: Communication flow of ELF_PLEAD

ELF_PLEAD exchanges a part of RC4 key at the time of first communication. After that, a RC4 key generated by the exchange will be used for the communication that follows. The data sent is RC4-encrypted and then LZO-compressed. (Please see Appendix B for the details of communication protocol.)

Commands

ELF_PLEAD is equipped with 5 command groups as follows. (Please see Appendix C for the details of command functions. The command number may vary in some samples.)

- CFileManager (group number 0): commands for operation on files
- CFileTransfer (group number 1): commands for sending/receiving files
- CRemoteShell (group number 2): commands for remote shell
- CPortForwardManager (group number 3): commands for proxy mode
- No name (group number 0xFF): commands for malware control

```
00008BA0 | A8 2D 40 00 00 00 00 00 | 60 2E 40 00 00 00 00 00 | .-@.....`.@.....
00008BB0 | 31 32 43 46 69 6C 65 4D | 61 6E 61 67 65 72 00 00 | 12CFileManager..
00008BC0 | 10 B5 60 00 00 00 00 00 | B0 8B 40 00 00 00 00 00 | ..`.......@.....
00008BD0 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | ................
00008BE0 | 00 00 00 00 00 00 00 00 | C0 8B 40 00 00 00 00 00 | ..........@.....
00008BF0 | C0 21 40 00 00 00 00 00 | D0 21 40 00 00 00 00 00 | .!@......!@.....
00008C00 | 61 62 00 00 00 00 00 00 | 28 3C 40 00 00 00 00 00 | ab......(<@.....
00008C10 | 68 3C 40 00 00 00 00 00 | 68 3C 40 00 00 00 00 00 | h<@.....h<@.....
00008C20 | 38 3C 40 00 00 00 00 00 | 68 3C 40 00 00 00 00 00 | 8<@.....h<@.....
00008C30 | 68 3C 40 00 00 00 00 00 | 48 3C 40 00 00 00 00 00 | h<@.....H<@.....
00008C40 | 58 3C 40 00 00 00 00 00 | 68 3C 40 00 00 00 00 00 | X<@.....h<@.....
00008C50 | 68 3C 40 00 00 00 00 00 | 68 3C 40 00 00 00 00 00 | h<@.....h<@.....
00008C60 | 18 3C 40 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | .<@.............
00008C70 | 31 33 43 46 69 6C 65 54 | 72 61 6E 73 66 65 72 00 | 13CFileTransfer.
00008C80 | 10 B5 60 00 00 00 00 00 | 70 8C 40 00 00 00 00 00 | ..`.....p.@.....
00008C90 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | ................
00008CA0 | 00 00 00 00 00 00 00 00 | 80 8C 40 00 00 00 00 00 | ..........@.....
00008CB0 | A0 2E 40 00 00 00 00 00 | B0 2E 40 00 00 00 00 00 | ..@.......@.....
00008CC0 | 64 65 71 75 65 3A 3A 5F | 4D 5F 72 61 6E 67 65 5F | deque::_M_range_
00008CD0 | 63 68 65 63 6B 00 31 32 | 43 50 6F 72 74 46 6F 72 | check.12CPortFor
00008CE0 | 77 61 72 64 00 00 00 00 | 00 00 00 00 00 00 00 00 | ward............
00008CF0 | 10 B5 60 00 00 00 00 00 | D6 8C 40 00 00 00 00 00 | ..`.......@.....
00008D00 | 31 39 43 50 6F 72 74 46 | 6F 72 77 61 72 64 4D 61 | 19CPortForwardMa
00008D10 | 6E 61 67 65 72 00 00 00 | 00 00 00 00 00 00 00 00 | nager...........
00008D20 | 10 B5 60 00 00 00 00 00 | 00 8D 40 00 00 00 00 00 | ..`.......@.....
00008D30 | 00 00 00 00 00 00 00 00 | 00 00 00 00 00 00 00 00 | ................
00008D40 | 00 00 00 00 00 00 00 00 | F0 8C 40 00 00 00 00 00 | ..........@.....
00008D50 | 00 4A 40 00 00 00 00 00 | 60 4B 40 00 00 00 00 00 | .J@.....`K@.....
00008D60 | 00 00 00 00 00 00 00 00 | 20 8D 40 00 00 00 00 00 | ........ .@.....
00008D70 | 70 4D 40 00 00 00 00 00 | B0 4D 40 00 00 00 00 00 | pM@......M@.....
```

Figure 5: Command group names

It is clear that the functions are almost the same as PLEAD module.

In closing

It has been confirmed that BlackTech uses different kinds of malware including TSCookie, PLEAD and KIVARS, which target Linux OS as well as Windows OS. If such malware is found in your Windows environment, it is recommended to check your Linux environment as well.

Shusei Tomonaga
(Translated by Yukako Uchida)

Appendix A: ELF_PLEAD Configuration

Table A: Configuration

Offset	Description	Remarks
0x000	RC4 Key	Used for encrypting communication
0x004	ID	
0x024	Port number 1	
0x026	Port number 2	
0x028	Port number 3	
0x02A	C&C server 1	
0x0AA	C&C server 2	
0x12A	C&C server 3	

- Configuration format may vary in some samples.

Appendix B: Contents of data exchanged

Table B-1: Format of sent data

Offset	Length	Contents
0x00	4	RC4 Key (Key4)
0x04	4	Hash value
0x08	4	RC4 key (Key1)
0x0C	2	Length of data sent
0x0E	2	Length of data at offset 0x10 before compression
0x10	-	Encrypted data (RC4 +LZO) (See Table A-2 for details.)

Table B-2: Format of encrypted data

Offset	Length	Contents
0x00	2	0xFF
0x02	4	RC4 key (Key2)
0x06	-	Random data (at least 128 bytes)

Table B-3: Format of received data

Offset	Length	Contents
0x00	4	RC4 key (Key4)

0x04	4	Hash value
0x08	4	RC4 key (Key1)
0x0C	2	Length of data sent
0x0E	2	Length of data at offset 0x10 before compression
0x10	-	Encrypted data (RC4 +LZO) (See Table A-4 for details.)

Table B-4: Format of encrypted data in the received data

Offset	Length	Contents
0x00	2	0x01FF
0x02	4	RC4 key (Key3)

Appendix C: ELF_PLEAD commands

Table C-1: Commands without group name (group number 0xFF)

Value	Contents
4	Send random data
5	Reconnect
6	Restart
7	End
8	End
9	Change socket
11	Change C2 server

Table C-2: Commands for CFileManager (group number 0)

Value	Contents
32	Send list of files
37	Send file size, mode, timestamp
39	Change file name
41	Delete file/directory
43	Upload file
45	Execute file

49	Create directory
51	Move file
53	Delete directory

Table C-3: Commands for CFileTransfer (group number 1)

Value	Contents
64	Send file/directory information
67	Create directory
70	Download file
71	Send file information
75	Upload file

Table C-4: Commands for CRemoteShell (group number 2)

Value	Contents
80	Launch remote shell

Table C-5: Commands for CPortForwardManager (group number 3)

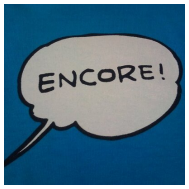
Value	Contents
96	Set up proxy
100	Connect proxy
102	Send proxy data
104	-
106	-
108	End proxy

Appendix D: C&C server

- mx.msdtc.tw

Appendix E: Malware hash value

- 5b5f8c4611510c11d413cb2bef70867e584f003210968f97e0c54e6d37ba8d8d
- ca0e83440b77eca4d2eda6efd9530b49ffb477f87f36637b5e43f2e428898766



朝長 秀誠 (Shusei Tomonaga)

Since December 2012, he has been engaged in malware analysis and forensics investigation, and is especially involved in analyzing incidents of targeted attacks. Prior to joining JPCERT/CC, he was engaged in security monitoring and analysis operations at a foreign-affiliated IT vendor. He presented at CODE BLUE, BsidesLV, BlackHat USA Arsenal, Botconf, PacSec and FIRST Conference. JSAC organizer.

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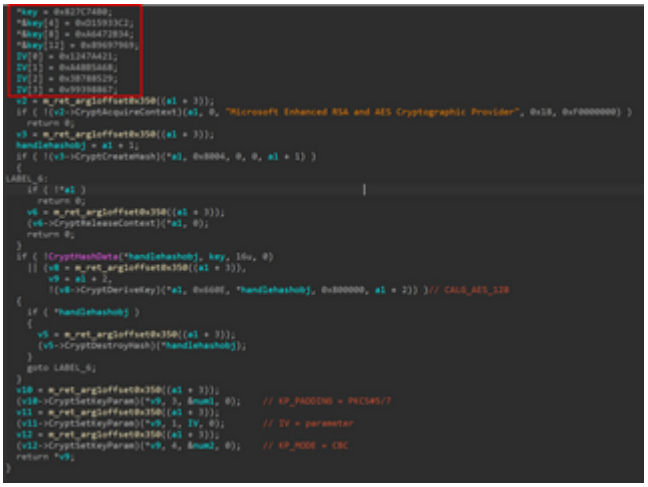
- 

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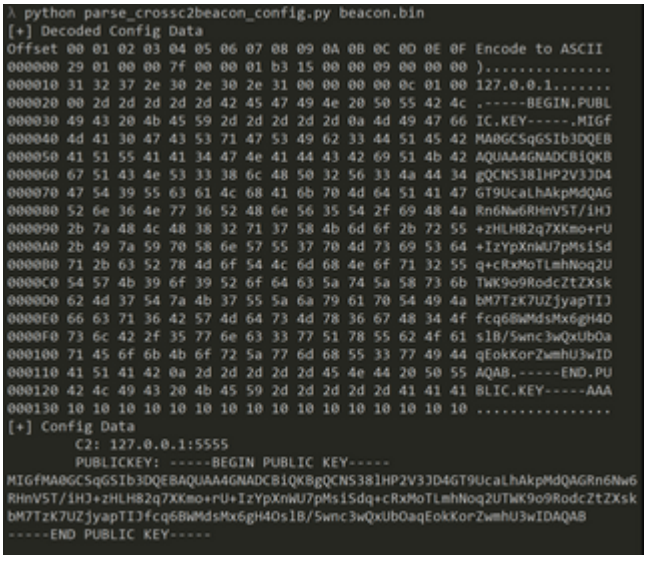
- 

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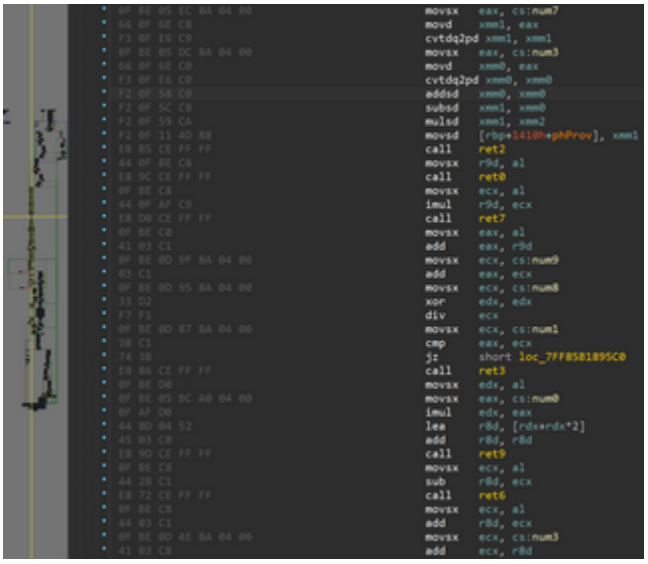
- 

  Malware Identified in Attacks Exploiting Ivanti Connect Secure Vulnerabilities

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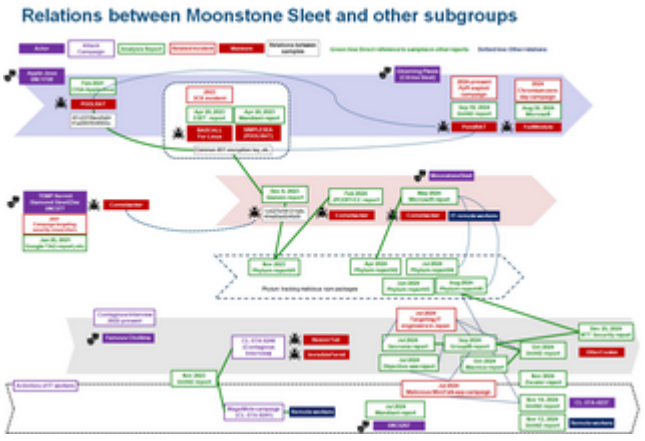
```
__int64 __fastcall mal_decode(__int64 encbuf, int bufsize)
{
  __int64 j_1; // rax
  int i; // [rsp+18h] [rbp-Ch]

  if ( encbuf )
  {
    for ( i = 0; ; ++i )
    {
      j_1 = (unsigned int)i;
      if ( i >= bufsize )
        break;
      *(_BYTE *)(encbuf + i) ^= Key1to7[i % 7];
    }
  }
  return j_1;
}
```

  DslogdRAT Malware Installed in Ivanti Connect Secure

- 

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