KONNI evolves into stealthier RAT

blog.malwarebytes.com/threat-intelligence/2022/01/konni-evolves-into-stealthier-rat

Threat Intelligence Team January 26, 2022

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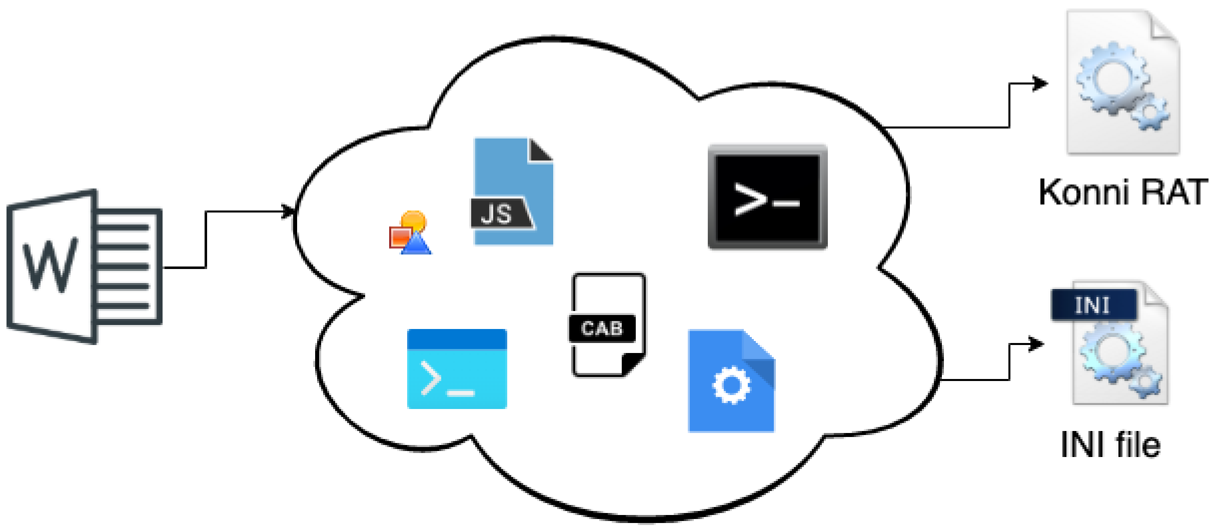
KONNI is a Remote Administration Tool that has being used for at least 8 years. The North Korean threat actor that is using this piece of malware has being identified under the Kimsuky umbrella. This group has been very busy, attacking political institutions located in Russia and South Korea. The last known attack where KONNI Rat was used was described here.

We found that KONNI Rat is being actively developed, and new samples are now including significant updates. In this blog post, we will cover some of the major changes and explain why the security community should keep a close eye on it.

Simplified Attack Chain

The attack usually starts leveraging a malicious Office document. When this document is opened by the victim, a multistage attack is started, involving various steps. But these steps are just the way that the attackers manage to accomplish tasks to elevate privileges, evade detection and deploy required files. As we described in a previous blog post, the attack chain could be summarized in the following diagram:



Simplified attack chain

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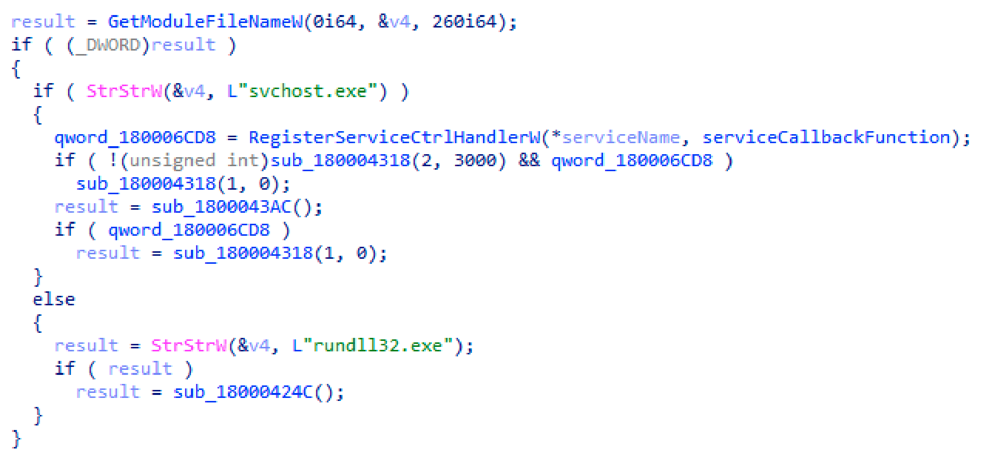
The final goal of the attack is installing what is called KONNI Rat, which is a .dll file supported by an .ini file. In a nutshell, the .dll file contains the functionality of the RAT, and the .ini file contains the address of the first C&C server. KONNI Rat's general behavior remains almost the same as previous versions, but there are changes we will cover below.

Rundll no longer supported

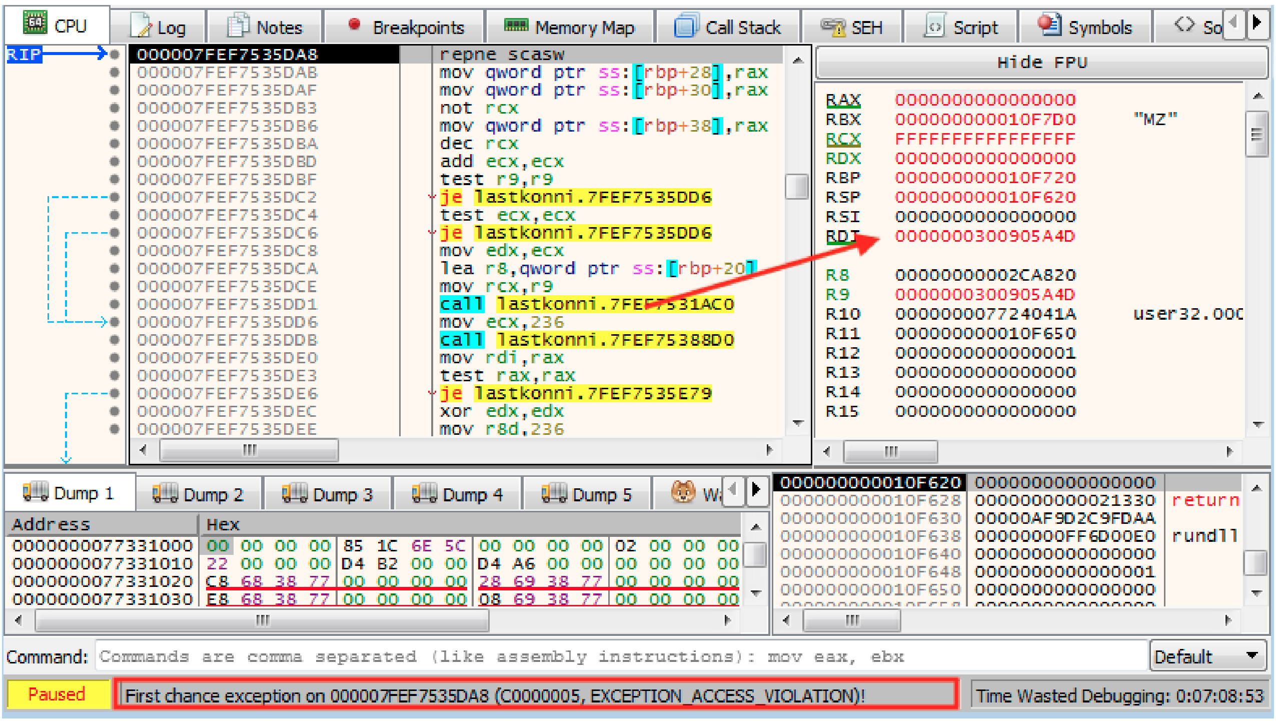
In previous KONNI Rat samples there were two branches. One handles if the malware was launched using a Windows service, and the other handles the execution through rundll. The next image shows these two old branches, with the strings svchost.exe and rundll32.exe visible:



```
result = GetModuleFileNameW(0i64, &v4, 260i64);
if ( (_DWORD)result )
{
  if ( StrStrW(&v4, L"svchost.exe") )
  {
    qword_180006CD8 = RegisterServiceCtrlHandlerW(*serviceName, serviceCallbackFunction);
    if ( !(unsigned int)sub_180004318(2, 3000) && qword_180006CD8 )
      sub_180004318(1, 0);
    result = sub_1800043AC();
    if ( qword_180006CD8 )
      result = sub_180004318(1, 0);
  }
  else
  {
    result = StrStrW(&v4, L"rundll32.exe");
    if ( result )
      result = sub_18000424C();
  }
}
```

Old main function showing svchost.exe and rundll32.exe strings

However, new samples will not show these strings. In fact, **rundll is no longer a valid way to execute the sample**. Instead, when an execution attempt occurs using rundll, an exception is thrown in the early stages.



```
000007FEF7535DA8   repne scasw
000007FEF7535DAB   mov qword ptr ss:[rbp+28],rax
000007FEF7535DAF   mov qword ptr ss:[rbp+30],rax
000007FEF7535DB3   not rcx
000007FEF7535DB6   mov qword ptr ss:[rbp+38],rax
000007FEF7535DBA   dec rcx
000007FEF7535DBD   add ecx,ecx
000007FEF7535DBF   test r9,r9
000007FEF7535DC2   je lastkonni.7FEF7535DD6
000007FEF7535DC4   test ecx,ecx
000007FEF7535DC6   je lastkonni.7FEF7535DD6
000007FEF7535DC8   mov edx,ecx
000007FEF7535DCA   lea r8,qword ptr ss:[rbp+20]
000007FEF7535DCE   mov rcx,r9
000007FEF7535DD1   call lastkonni.7FEF7531AC0
000007FEF7535DD6   mov ecx,236
000007FEF7535DDB   call lastkonni.7FEF75388D0
000007FEF7535DE0   mov rdi,rax
000007FEF7535DE3   test rax,rax
000007FEF7535DE6   je lastkonni.7FEF7535E79
000007FEF7535DEC   xor edx,edx
000007FEF7535DEE   mov r8d,236
```

```
RAX   0000000000000000
RBX   000000000010F7D0      "MZ"
RCX   FFFFFFFFFFFFFFFF
RDX   0000000000000000
RBP   000000000010F720
RSP   000000000010F620
RSI   0000000000000000
RDI   0000000300905A4D

R8    00000000002CA820
R9    0000000300905A4D
R10   000000007724041A      user32.00C
R11   000000000010F650
R12   0000000000000001
R13   0000000000000000
R14   0000000000000000
R15   0000000000000000
```

```
Address            Hex
0000000077331000   00 00 00 00  85 1C 6E 5C  00 00 00 00  02 00 00 00
0000000077331010   22 00 00 00  D4 B2 00 00  D4 A6 00 00  00 00 00 00
0000000077331020   C8 68 38 77  00 00 00 00  28 69 38 77  00 00 00 00
0000000077331030   E8 68 38 77  00 00 00 00  08 69 38 77  00 00 00 00
```

```
000000000010F620   0000000000000000
000000000010F628   0000000000021330   return
000000000010F630   00000AF9D2C9FDAA
000000000010F638   00000000FF6D00E0   rundll
000000000010F640   0000000000000000
000000000010F648   0000000000000001
000000000010F650   0000000000000000
```

```
Command: Commands are comma separated (like assembly instructions): mov eax, ebx        Default
Paused   First chance exception on 000007FEF7535DA8 (C0000005, EXCEPTION_ACCESS_VIOLATION)!   Time Wasted Debugging: 0:07:08:53
```

Exception produced by a rundll execution

In early stages of our analysis, we thought that they were using the classic process name check, or any other usual technique. The reality is far simpler and brilliant; the actual export just implements the SvcMain prototype so the program will break at some point when accessing one of the arguments.

In the previous image we see the state of the machine at the moment that this exception is thrown. RDI at that point should contain a pointer to the service name. The exception happens because the Service Main function meets one prototype and rundll32 will expect another different prototype:

VOID WINAPI **SvcMain**(DWORD dwArgc, LPTSTR *lpszArgv)

VOID WINAPI **runnableExport**(HWND hwnd, HINSTANCE hinst, LPSTR lpszCmdLine, int nCmdShow)

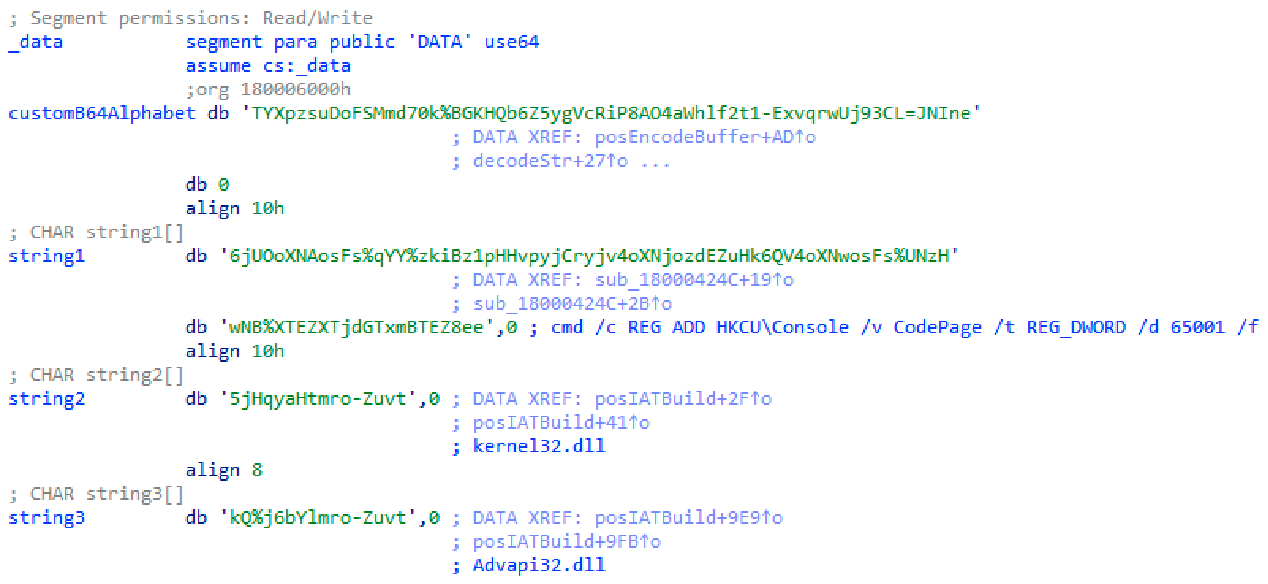
Basically, at some point of the execution, hinst will be treated as lspzArgv, causing the exception. But why did the attackers delete that functionality? There are multiple benefits.

First of all, we have not seen any recent attack that used rundll. In fact, the only way that the attackers launched KONNI Rat in recent campaigns involves registering a Windows service. So the rundll32 branch wasn't being used in real world attacks.

But there is another big reason in how sandboxes will fail in collecting the real behavior of the sample, as it just cannot execute that way.

Strings are now protected using AES

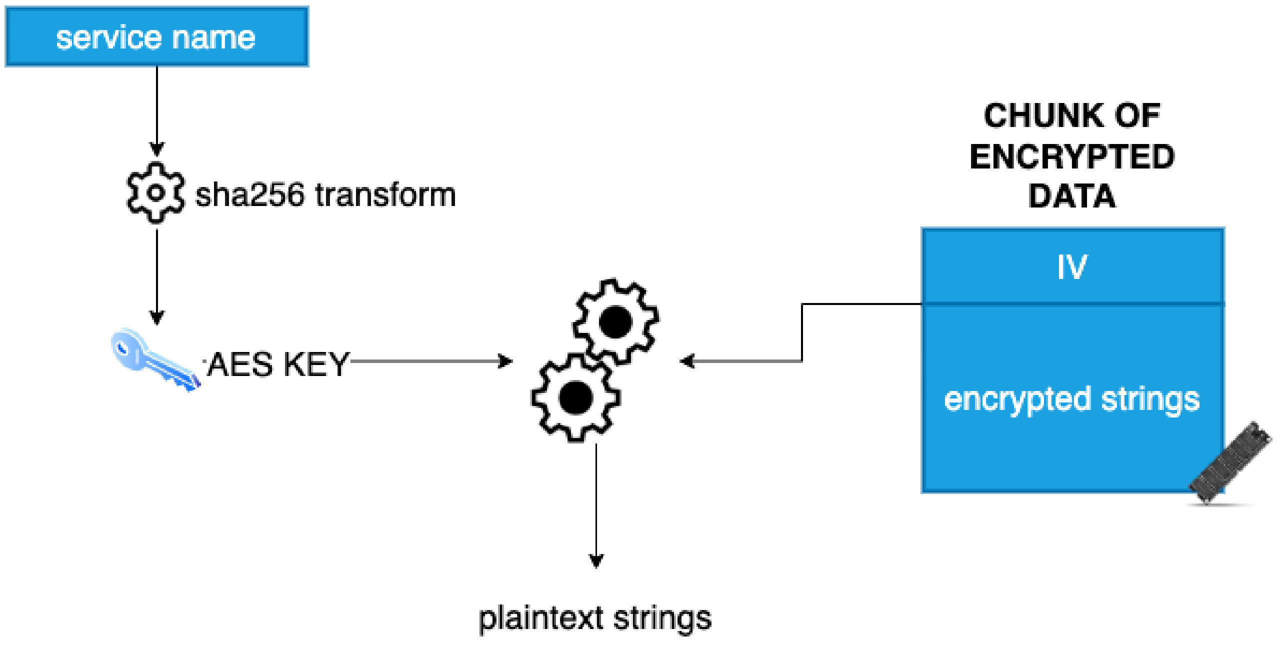
Multiple malware families protect their strings in order to defeat most basic string analysis. KONNI wasn't an exception, and also used this technique. Old samples were using base64 for obfuscation means. Also, they were using a custom alphabet. This custom alphabet was changed from time to time in order to make the decoding task more difficult:



```
; Segment permissions: Read/Write
_data           segment para public 'DATA' use64
                assume cs:_data
                ;org 180006000h
customB64Alphabet db 'TYXpzsuDoFSMmd70k%BGKHQb6Z5ygVcRiP8AO4aWhlf2t1-ExvqrwUj93CL=JNIne'
                                        ; DATA XREF: posEncodeBuffer+AD↑o
                                        ; decodeStr+27↑o ...
                db 0
                align 10h
; CHAR string1[]
string1         db '6jUOoXNAosFs%qYY%zkiBz1pHHvpyjCryjv4oXNjozdEZuHk6QV4oXNwosFs%UNzH'
                                        ; DATA XREF: sub_18000424C+19↑o
                                        ; sub_18000424C+2B↑o
                db 'wNB%XTEZXTjdGTxmBTEZ8ee',0 ; cmd /c REG ADD HKCU\Console /v CodePage /t REG_DWORD /d 65001 /f
                align 10h
; CHAR string2[]
string2         db '5jHqyaHtmro-Zuvt',0 ; DATA XREF: posIATBuild+2F↑o
                                        ; posIATBuild+41↑o
                                        ; kernel32.dll
                align 8
; CHAR string3[]
string3         db 'kQ%j6bYlmro-Zuvt',0 ; DATA XREF: posIATBuild+9E9↑o
                                        ; posIATBuild+9FB↑o
                                        ; Advapi32.dll
```

Old Konni samples included their custom base64 alphabet followed by the obfuscated strings

Now, the attackers made a major change in that regard by protecting the strings using AES encryption. The algorithm followed by new Konni RAT samples could be represented as follows:



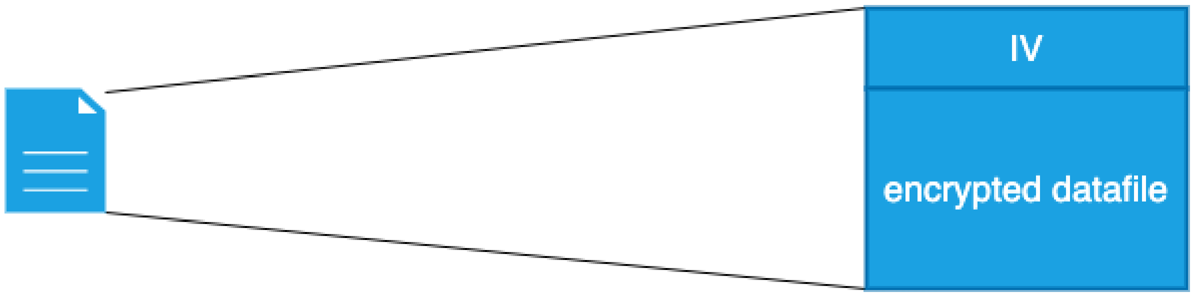
New KONNI samples now uses AES encryption for string protection

The reason behind that change is clear. As the key used for decryption is the service name, samples run by different service names will not work properly. Moreover, having only the sample **without knowing the service name becomes useless**, as these strings contain core information about the sample behavior.

Files are also protected using AES

KONNI Rat makes use of various support files when it is executed. One of these files is the .ini file, which contains the primary C&C server, but there are others like the .dat file that is supposed to be dropped eventually, and temporal files that are used to send some basic information about the computer.

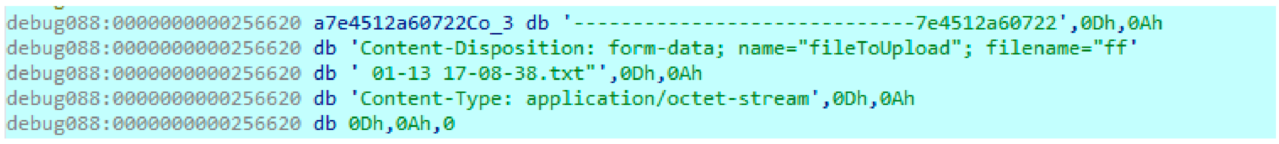
Our tests reveal that all of these files are dropped and protected using AES. Cleverly, they reused the algorithm used for string protection, making the file layout identical to the protected strings layout, as they appear in raw memory:



New KONNI samples now uses AES encryption also for file protection

As can be seen from the diagram, the file itself contains the IV and the encrypted data. The key used is extracted from its original filename. In some cases, the names match with the service name, so the keys used in the .ini and the .dat files are the result of applying a SHA256 to the service name as well.

Also, files sent to the C&C server are protected using AES. The IV is generated using a QueryPerformanceCounter API CALL. Filenames are generated concatenating 2 letters that represent the data with the current timestamp, followed by the extension. Furthermore, they will use this newly generated name as AES key, so they send this name through the request to the C&C server.



```
debug088:0000000000256620 a7e4512a60722Co_3 db '-----------------------------7e4512a60722',0Dh,0Ah
debug088:0000000000256620 db 'Content-Disposition: form-data; name="fileToUpload"; filename="ff'
debug088:0000000000256620 db ' 01-13 17-08-38.txt"',0Dh,0Ah
debug088:0000000000256620 db 'Content-Type: application/octet-stream',0Dh,0Ah
debug088:0000000000256620 db 0Dh,0Ah,0
```

Fragment of request about to be sent to the server

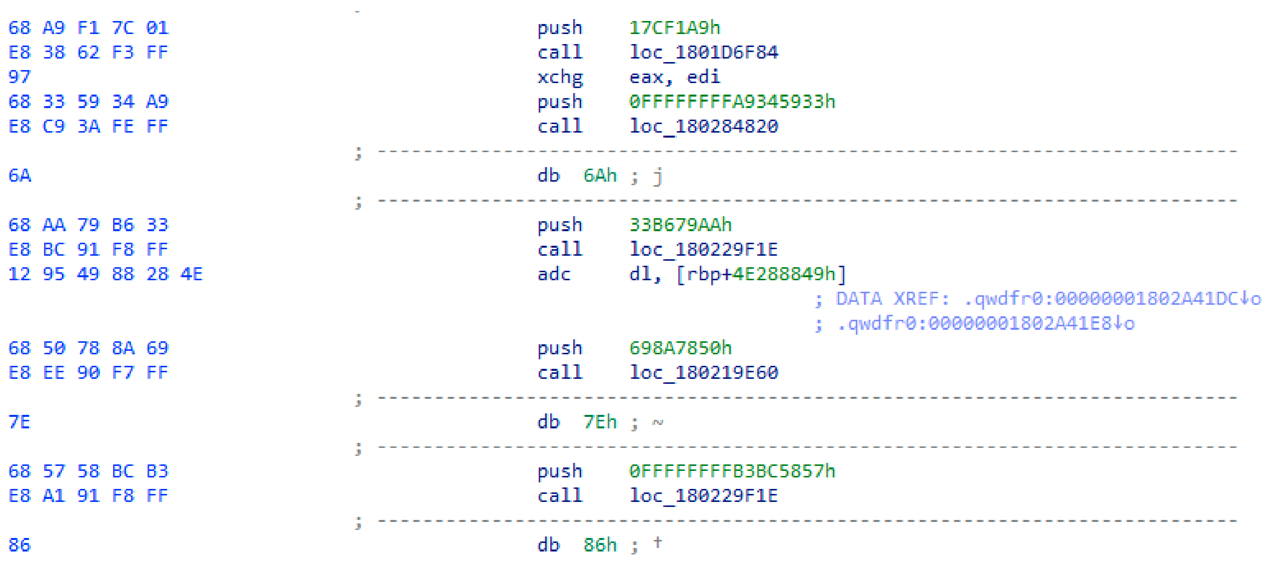
In that regard, as the filename is generated automatically using the timestamp, identical files will produce different request contents, as they were encrypted using that filename. **Network signatures could also fail** to detect the malicious activity, due to that.

Other obfuscation techniques

As we found some samples that were protected *just* by the means that we described before, we also have found others that were making use of an unidentified packer. We would like to share some of our notes regarding that packer, as others could find it useful in identification and attribution tasks.

Contiguous instruction obfuscation

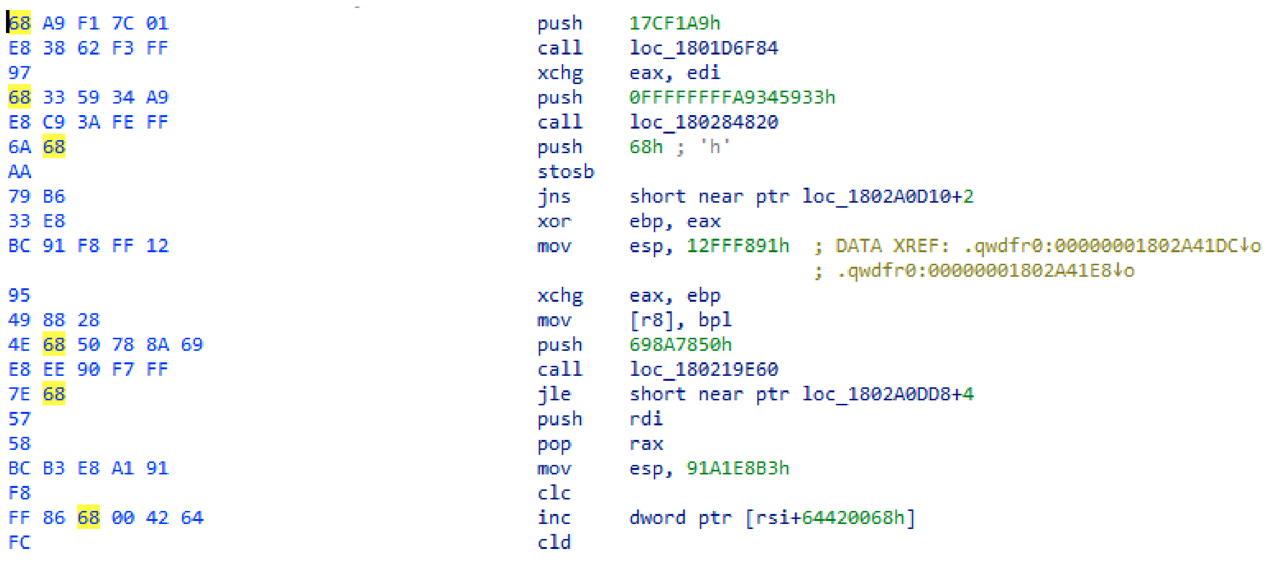
The flow of the obfuscated program will make use of series of push-call pairs of instructions, where the pushed values will indicate the actions that the program will take. An image can better explain that:



```
68 A9 F1 7C 01                    push    17CF1A9h
E8 38 62 F3 FF                    call    loc_1801D6F84
97                                xchg    eax, edi
68 33 59 34 A9                    push    0FFFFFFFFA9345933h
E8 C9 3A FE FF                    call    loc_180284820
                 ; ---------------------------------------------------------------------------
6A                                db  6Ah ; j
                 ; ---------------------------------------------------------------------------
68 AA 79 B6 33                    push    33B679AAh
E8 BC 91 F8 FF                    call    loc_180229F1E
12 95 49 88 28 4E                 adc     dl, [rbp+4E288849h]
                                                    ; DATA XREF: .qwdfr0:00000001802A41DC↓o
                                                    ; .qwdfr0:00000001802A41E8↓o
68 50 78 8A 69                    push    698A7850h
E8 EE 90 F7 FF                    call    loc_180219E60
                 ; ---------------------------------------------------------------------------
7E                                db  7Eh ; ~
                 ; ---------------------------------------------------------------------------
68 57 58 BC B3                    push    0FFFFFFFFB3BC5857h
E8 A1 91 F8 FF                    call    loc_180229F1E
                 ; ---------------------------------------------------------------------------
86                                db  86h ; †
```

Push – Call series

In particular, we find it interesting that the attackers have placed random bytes between these pairs. This silly trick causes wrong code interpretation for decompilers that will assume that bytes after the push instruction are part of the next instruction. The image below shows how IDA fails in analyzing the code:

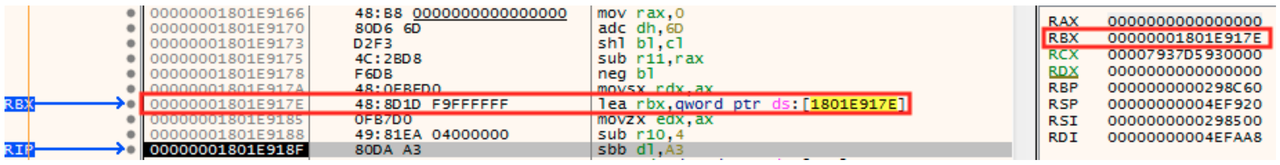


```
68 A9 F1 7C 01                    push    17CF1A9h
E8 38 62 F3 FF                    call    loc_1801D6F84
97                                xchg    eax, edi
68 33 59 34 A9                    push    0FFFFFFFFA9345933h
E8 C9 3A FE FF                    call    loc_180284820
6A 68                             push    68h ; 'h'
AA                                stosb
79 B6                             jns     short near ptr loc_1802A0D10+2
33 E8                             xor     ebp, eax
BC 91 F8 FF 12                    mov     esp, 12FFF891h  ; DATA XREF: .qwdfr0:00000001802A41DC↓o
                                                          ; .qwdfr0:00000001802A41E8↓o
95                                xchg    eax, ebp
49 88 28                          mov     [r8], bpl
4E 68 50 78 8A 69                 push    698A7850h
E8 EE 90 F7 FF                    call    loc_180219E60
7E 68                             jle     short near ptr loc_1802A0DD8+4
57                                push    rdi
58                                pop     rax
BC B3 E8 A1 91                    mov     esp, 91A1E8B3h
F8                                clc
FF 86 68 00 42 64                 inc     dword ptr [rsi+64420068h]
FC                                cld
```

Same code as before, showing how IDA won’t represent the real code

Obfuscated program flow

The used packer will obfuscate the original program flow. This is accomplished in various steps. The first required step is to find the Image Base value, placed in a fixed location and the RIP (Instruction Pointer) value.

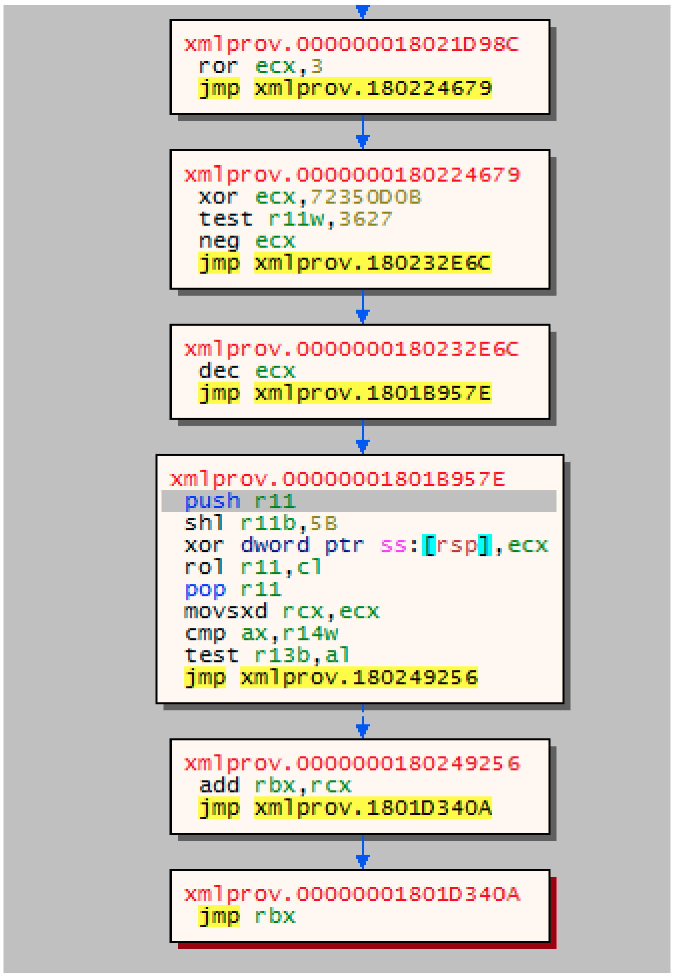


```
      00000001801E9166   48:B8 0000000000000000   mov rax,0
      00000001801E9170   80D6 6D                  adc dh,6D
      00000001801E9173   D2F3                     shl bl,cl
      00000001801E9175   4C:2BD8                  sub r11,rax
      00000001801E9178   F6DB                     neg bl
      00000001801E917A   48:0FBFD0                movsx rdx,ax
RBX → 00000001801E917E   48:8D1D F9FFFFFF         lea rbx,qword ptr ds:[1801E917E]
      00000001801E9185   0FB7D0                   movzx edx,ax
      00000001801E9188   49:81EA 04000000         sub r10,4
RIP → 00000001801E918F   80DA A3                  sbb dl,A3
```

```
RAX   0000000000000000
RBX   00000001801E917E
RCX   00007937D5930000
RDX   0000000000000000
RBP   0000000000298C60
RSP   00000000004EF920
RSI   0000000000298500
RDI   00000000004EFAA8
```

EBX will save the RIP value

Once the packer knows these two values, it will start jumping from one place to another, making analysis harder. For that, it will store in some register value of the next address to jump in registers. The value of these registers is calculated right after the jmp instruction, using structures like POP [reg] – JMP [reg] or ADD [reg1, reg2] – JMP [reg1]. Note that decompilers will fail in displaying the real flow, as the jumping address is determined by a somehow undefined register.



```
xmlprov.000000018021D98C
 ror ecx,3
 jmp xmlprov.180224679

xmlprov.0000000180224679
 xor ecx,72350D0B
 test r11w,3627
 neg ecx
 jmp xmlprov.180232E6C

xmlprov.0000000180232E6C
 dec ecx
 jmp xmlprov.1801B957E

xmlprov.00000001801B957E
 push r11
 shl r11b,5B
 xor dword ptr ss:[rsp],ecx
 rol r11,cl
 pop r11
 movsxd rcx,ecx
 cmp ax,r14w
 test r13b,al
 jmp xmlprov.180249256

xmlprov.0000000180249256
 add rbx,rcx
 jmp xmlprov.1801D340A

xmlprov.00000001801D340A
 jmp rbx
```

Obfuscated code showing a final jmp to RBX

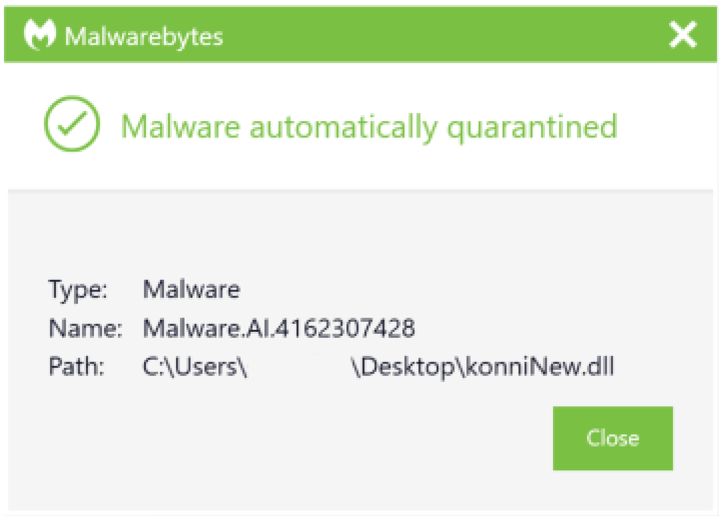
The combination of these simple techniques ends in the packer being now in control of the flow, but statically the decompiler cannot represent the path that the code will follow. Finally, the packer will execute a big amount of junk instructions and eventually will execute the real interesting code. For instance, the original code will take no more than 20 instructions between GetProcAddress calls in IAT building tasks. but the packed code executes more than 30,000 instructions.

According to our threat intel data, most recent attacks are not making use of that packer anymore.

Conclusion

As we have seen, KONNI Rat is far from being abandoned. The authors are constantly making code improvements. In our point of view, their efforts are aimed at breaking the typical flow recorded by sandboxes and making detection harder, especially via regular signatures as critical parts of the executable are now encrypted.

Malwarebytes users are protected against this attack.



Malware automatically quarantined

Type: Malware
Name: Malware.AI.4162307428
Path: C:\Users\ \Desktop\konniNew.dll

IOCs

A3CD08AFD7317D1619FBA83C109F268B4B60429B4EB7C97FC274F92FF4FE17A2
F702DFDDBC5B4F1D5A5A9DB0A2C013900D30515E69A09420A7C3F6EAAC901B12