Malware report
CCN-CERT ID-15/20

Snake Locker

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AVISO LEGAL

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1. ABOUT CCN-CERT, NATIONAL GOVERNMENTAL CERT

The CCN-CERT is the Computer Emergency Response Team of the National Cryptologic Centre, CCN, within the National Intelligence Centre, CNI. This service was created in 2006 as a **Spanish National Governmental CERT** and its functions are included in Law 11/2002 regulating the CNI, RD 421/2004 regulating the CCN and RD 3/2010, dated 8th January, regulating the National Security Scheme (ENS), modified by RD 951/2015 of 23rd October.

Its mission therefore is to contribute to the improvement of Spanish cybersecurity, being the national alert and response centre that cooperates and helps to respond quickly and efficiently to cyberattacks and to actively confront cyber threats, including the coordination at the national public level of the different Incident Response Teams or existing Security Operations Centres.

Its ultimate aim is to make cyberspace more secure and reliable, preserving classified information (as stated in Article 4.F of Law 11/2002) and sensitive information, defending Spanish Technological Heritage, training expert personnel, applying security policies and procedures and using and developing the most appropriate technologies for this purpose.

In accordance with these regulations and Law 40/2015 on the LegalRegulation for the Public Sector, the CCN-CERT is responsible for the management of cyber incidents affecting any public body or company. In the case of critical operators in the public sector, the management of cyber incidents will be carried out by the CCN-CERT in coordination with the CNPIC.

2. EXECUTIVE SUMMARY

This paper exposes the analysis of the malware identified by the MD5 **47EBE9F8F5F73F07D456EC12BB49C75D**, which belongs to the malware family known as **SNAKE/EKANS LOCKER**. **SNAKE/EKANS** is a locker which main objective is to cipher user´s files and documents and request a ransom for the recovery tool. During the analysis, several evidencies were found that links this sample with the ransomware that recently hit Fresenius, Europe's largest private hospital operator.

3. SNAKE LOCKER

3.1 FILE DETAILS

The malware is an **unsigned 32-bit executable** with the following **MD5** hash:

FILE NAME	MD5
Unknown	47EBE9F8F5F73F07D456EC12BB49C75D

The compilation date is set to Thursday 1st January 1970, 00:00:00 (UTC), however this information cannot be trusted as it can be easily modified. In that particular case the date is NULL and that is the reason why it is set to 1970.

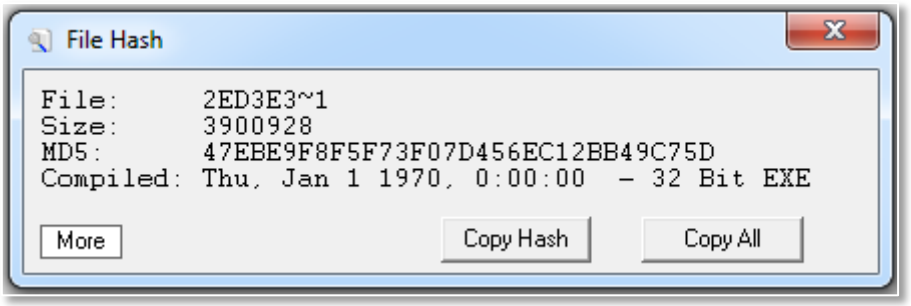


Figure 1. Internal creation date/time of sample.

The sample doesn't have file properties.

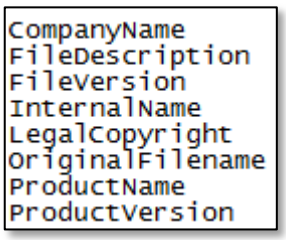


Figure 2. Fake file properties of the sample.

3.2 TECHNICAL ANALYSIS

This ransomware is written in Golang **(Go 1.10)** and contains a much higher level of obfuscation than is commonly seen with these types of infections. Although Golan is not a language typically used to develop malware, it is now commonly used with RaaS (Ransomware as a Service).

```
File: 2ed3e37608e65be8b6e8c59f8c93240bd0efe9a60c08c21f4889c00eb6082d74.exe
MD5:  47ebe9f8f5f73f07d456ec12bb49c75d
Size: 3900928

Ascii Strings:
------------------------------------------------------------------------------
0000004D  !This program cannot be run in DOS mode.
00000178  .text
0000019F  `.data
000001C8  .idata
000001F0  .symtab
00000401  Go build ID: "SPlES9E155q_V-b330Fx/tblnamFk-AFuyVtAqkB6/L8WLP6oE3GX
FUGixfAITrn2V"
```

Figure 3. Malware is programmed in GoLang.

The malware starts requesting a DNS resolution of "**ADS.FRESENIUS.COM**". **Fresenius** is the Europe's largest private hospital operator. It has been recently hit by a ransomware cyber-attack on its technology systems. Base on this information, we can confirm that this sample is the one used to compromise **Fresenius**.

```
.text:00545760    jbe     loc_5458A4
.text:00545766    sub     esp, 4Ch
.text:00545769    lea     eax, aAdsFresenIusCo ; "ADS.FRESENIUS.COM"
.text:0054576F    mov     [esp+4Ch+var_4C], eax
.text:00545772    mov     [esp+4Ch+var_48], 11h
.text:0054577A    call    net_LookupIP
.text:0054577F    mov     eax, [esp+4Ch+var_40]
```

Figure 4. DNS resolution of **ADS.FRESENIUS.COM**.

Once the malware resolves "**ADS.FRESENIUS.COM**" to the associated IP address, it is compared with the IP "**10.2.10.41**", which is clearly a private address. No references to any public IP have been found linked with "**ADS.FRESENIUS.COM**", therefore that address is a **FRESENIUS's** internal server. It is most likely the attacker infiltrates their network before SNAKE malware was launched. The attacker decided to use the DNS resolution of "**ADS.FRESENIUS.COM**" as a "**killswitch**", limiting the attack to **FRESENIUS**'s computers because they are able to resolve "**ADS.FRESENIUS.COM**" to the IP address "**10.2.10.41**". If the DNS resolution fails or doesn't match "**10.2.10.41**", the malware will finish its execution. But before exiting, it decrypts the following message in memory: "**There can be only one**", however it just remains in memory and it is not used for anything else. The decryption algorithm for this message is the following:

- Increase each byte by **0x2A**
- Cipher the result using XOR and the following key:

31 0C A3 60 37 5A A7 C1 38 06 10 31 6D 6C 70 0F B0 CB C0 1D 4D 2D

The same algorithm is used to decrypt all strings and configurations settings used during the execution of malware; however, each encrypted data uses a different XOR key. Annex IV contains an IdaPython script which will decrypt and save to disk all the strings.

```
runtime_stringtoslicebyte(&v26, data_enc, 0x1C);
v33 = v8;
runtime_stringtoslicebyte(&v18, xor_key_, 0x1C);
v32 = v8;
fillmem___(0, &v11);
v1 = v32;
v2 = v33;
for ( i = 0; (int)i < v9; ++i )
{
  if ( i >= v0 || i >= 0x1C )
    runtime_panicindex(
      v5,
      v6,
      v7,
      v8,
      v9,
      v10,
      v9,
      v11,
      v12,
      v13,
      v14,
      v15,
      v16,
      v17,
      v18,
      v19,
      v20,
      v21,
      v22,
      v23,
      v24,
      v25,
      v26,
      v27,
      v28,
      v29,
      v30,
      v31);
  *((_BYTE *)&v11 + i) = *(_BYTE *)(v1 + i) ^ (*(_BYTE *)(v2 + i) + 0x2A);
}
runtime_slicebytetostring(0, &v11, 28, 28);
```

Figure 5. Decryption algorithm.

The next functionality is achieved via a Windows Management Interface (WMI) call. The malware executes the WMI command "**select DomainRole FROM Win32_ComputerSystem**" to identify if the computer is joined to a domain and its role. The malware will only execute its malicious payload if the role is one of the following: **Domain Server, Domain Controller** or **Backup/Secondary Domain**

Controller, which mean that a standard workstation or a workstation not joined to the domain will not be infected.

The malware checks for the existence of the Mutex **"Global\EKANS"**. If present, the ransomware will stop with the following message decrypted in memory **"already encrypted!"**. Otherwise, the Mutex is created and the infection moves forward. This feature can be used to block the ransomware execution, because if the mutex already exists in the system, the computer will not be infected.

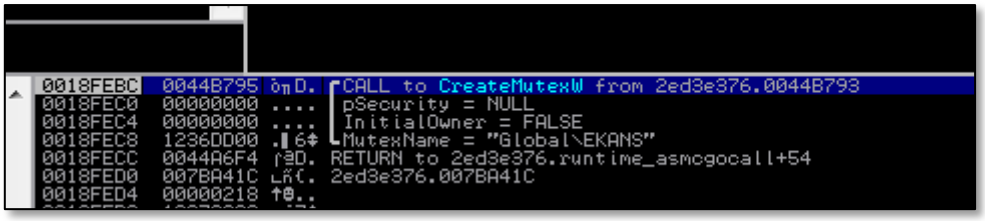


Figure 6. Mutex creation.

The malware contains the following RSA public key, which will be used to encrypt each of the AES keys used to encrypt the files:

RSA PUBLIC KEY
-----BEGIN RSA PUBLIC KEY-----
MIIBCgKCAQEAuMBx+hZWQFjyOGwHtb13JhGJS6FohQRzg4ouAuFPC59VydRSfcWp
0YCwSMR4NbJw38/527eGeG3vPeSg1aqz4fFEISm3GR9i2bLWxl7r7gQx2iuwQbZJ
jzSm7ymwc7P9rOERdgTHFltz+x1JIa/pUEUdjpSgJMrcEYeix4TDVUjKMPFZbvAo
wU/wTRJmb6/Cv0ibyEfyDNUazP+jdqojgI9egCmRTX56LmH41Q1Y3pQQFLFx0pge
MOizcr4c0HAqUJw9lu2/a4ATQ/DS/nk3J2DF+1RPhDXWrYJY3iIK6NldZTa2ZWx4
ZDfceIe2t/4GcgpBdSTU9Q+fBmbcyY3qvQIDAQAB
-----END RSA PUBLIC KEY-----

The malware contains a hard-coded list within the encoded strings of the malware. If any of these services is running in the targeted system, the ransomware will stop the service. A full list is provided in Appendix II of this report.

```
text:0055ADF6                   mov     eax, 0
text:0055ADFB                   lea     edi, [esp+13ACh+var_9F8]
text:0055AE02                   call    fillmem_____
text:0055AE07                   call    main_decrypt_Acronis_VSS_Prov ; Acronis VSS Provider
text:0055AE0C                   mov     eax, [esp+13ACh+var_13A8]
text:0055AE10                   mov     [esp+13ACh+var_115C], eax
text:0055AE17                   mov     ecx, [esp+13ACh+var_13AC]
text:0055AE1A                   mov     [esp+13ACh+var_C98], ecx
text:0055AE21                   call    main_decrypt_Enterprise_Clien ; Enterprise Client Service
text:0055AE26                   mov     eax, [esp+13ACh+var_13A8]
text:0055AE2A                   mov     [esp+13ACh+var_1160], eax
text:0055AE31                   mov     ecx, [esp+13ACh+var_13AC]
text:0055AE34                   mov     [esp+13ACh+var_C9C], ecx
text:0055AE3B                   call    main_decrypt_Sophos_Agent ; Sophos Agent
text:0055AE40                   mov     eax, [esp+13ACh+var_13A8]
text:0055AE44                   mov     [esp+13ACh+var_1164], eax
text:0055AE4B                   mov     ecx, [esp+13ACh+var_13AC]
text:0055AE4E                   mov     [esp+13ACh+var_CA0], ecx
text:0055AE55                   call    main_decrypt_Sophos_AutoUpdat ; Sophos AutoUpdate Service
text:0055AE5A                   mov     eax, [esp+13ACh+var_13A8]
text:0055AE5E                   mov     [esp+13ACh+var_1168], eax
text:0055AE65                   mov     ecx, [esp+13ACh+var_13AC]
text:0055AE68                   mov     [esp+13ACh+var_CA4], ecx
text:0055AE6F                   call    main_decrypt_Sophos_Clean_Ser ; Sophos Clean Service
text:0055AE74                   mov     eax, [esp+13ACh+var_13A8]
```

Figure 7. Hard-coded list of services.

The ransomware also contains another hard-coded list of processes name. The malware force stops ("kills") by name the processes from this list. The malware will kill the processes using the function **TerminateProcess()**. A full list is provided in Appendix III of this report.

```
text:00547D59                   mov     [esp+4658h+var_2320], eax
text:00547D60                   mov     [esp+4658h+var_231C], eax
text:00547D67                   call    main_decrypt_ccflic0_exe ; ccflic0.exe
text:00547D6C                   mov     eax, [esp+4658h+var_4654]
text:00547D70                   mov     [esp+4658h+var_34C0], eax
text:00547D77                   mov     ecx, [esp+4658h+var_4658]
text:00547D7A                   mov     [esp+4658h+var_232C], ecx
text:00547D81                   call    main_decrypt_ccflic4_exe ; ccflic4.exe
text:00547D86                   mov     eax, [esp+4658h+var_4654]
text:00547D8A                   mov     [esp+4658h+var_34C4], eax
text:00547D91                   mov     ecx, [esp+4658h+var_4658]
text:00547D94                   mov     [esp+4658h+var_2330], ecx
text:00547D9B                   call    main_decrypt_healthservice_ex ; healthservice.exe
text:00547DA0                   mov     eax, [esp+4658h+var_4654]
text:00547DA4                   mov     [esp+4658h+var_34C8], eax
text:00547DAB                   mov     ecx, [esp+4658h+var_4658]
text:00547DAE                   mov     [esp+4658h+var_2334], ecx
text:00547DB5                   call    main_decrypt_ilicensesvc_exe ; ilicensesvc.exe
text:00547DBA                   mov     eax, [esp+4658h+var_4654]
text:00547DBE                   mov     [esp+4658h+var_34CC], eax
text:00547DC5                   mov     ecx, [esp+4658h+var_4658]
text:00547DC8                   mov     [esp+4658h+var_2338], ecx
text:00547DCF                   call    main_decrypt_nimbus_exe ; nimbus.exe
text:00547DD4                   mov     eax, [esp+4658h+var_4654]
text:00547DD8                   mov     [esp+4658h+var_34D0], eax
text:00547DDF                   mov     ecx, [esp+4658h+var_4658]
text:00547DE2                   mov     [esp+4658h+var_233C], ecx
text:00547DE9                   call    main_decrypt_prlicensemgr_exe ; prlicensemgr.exe
```

Figure 8. Hard-coded list of processes names.

While some of the referenced processes appear to relate to security or management software (virtual machines, remote management, network administration…), the majority of the listed processes concern databases, data backup solutions or ICS-related processes.

Moving forward, the malware executes, via a Windows Management Interface (WMI) call, the following command: **"SELECT * FROM Win32_ShadowCopy"**, which provides information related to Shadow Copy Backups on the victim. Using this information, the malware will remove all Volume Shadow Copy backups found on the system.

```
main_decrypt_SELECT___FROM_Wi(v28, v51);  // Select * from Win32_ShadowCopy
v105 = v29;
v106 = v52;
v107 = 0;
v108 = 0;
runtime_convT2Estring(&string_autogen_F80FJP, &v105, v74);
v107 = v75;
v108 = v81;
call_2_GetUserDefaultLCID(v96, v102, v91, (int)&v107, 1, 1);
v6 = *(_WORD *)v85 == 9 ? *(_DWORD *)(v85 + 8) : 0;
v97 = v6;
if ( !runtime_deferproc(8, (int)&off_627864, v6) )
{
  main_decrypt_Count_0(v20, v53);
  ljajcmidoepkeidljcnm_kabnhilbikcapomfdenj_kabnhilbikcapomfdenj_lpklbejknnjcjajdojai_Oincdhkfoefndcdokhch(
    v97,
    v30,
    v54,
    0,
    0,
    0);
  v7 = *(_DWORD *)(v85 + 8);
  v90 = *(_DWORD *)(v85 + 8);
  v8 = 0;
  while ( v8 < v7 )
  {
    v88 = v8;
    main_decrypt_ItemIndex(v20, v55);
```

Figure 9. Removal of Volume Shadow Copy backups.

During the encryption procedure, the malware will exclude files located in Windows system folders (except Temp folder) and also the following files, regardless of their location on disk.

EXCLUDED FILES	
Ntldr	NTDETECT.COM
boot.ini	Bootfont.bin
Bootsect.bak	Desktop.ini
Ctfmon.exe	Iconcache.db
Ntuser.dat	Ntuser.dat.log
Ntuser.ini	Thumbs.db

The malware also skips, from encryption process, the following list of files and file extensions, but only if they are found in any the following folders (including a regular expression):

EXCLUDED SYSEM FILES	
Desktop.ini	Iconcache.db
Ntuser.dat	Ntuser.ini
Ntuser.dat.log1	Ntuser.dat.log2
Usrclass.dat	Usrclass.dat.log1
Usrclass.dat.log2	Bootmgr
Bootnxt	

EXCLUDED FILE EXTENSIONS					
.dll	.exe	.sys	.mui	.tmp	.lnk
.config	.settingcontent-ms	.tlb	.olb	.blf	.ico
.regtrans-ms	.devicemetadata-ms	.manifest	.bat	.cmd	.ps1

EXCLUDED FOLDERS
:\$Recycle.Bin
:\ProgramData
:\Users\All Users
:\Program Files
:\Local Settings
:\Boot
:\System Volume Information
:\Recovery\
\AppData\
\Temp\
.+\\Microsoft\\(User Account Pictures|Windows\\(Explorer|Caches)|Device Stage\\Device|Windows)\\ (This is a regular expression)

Although the malware contains an extensive list of file extensions, typically used to select the files to encrypt, this list is never used and the malware just encrypts any file (except those excluded using the criteria explained in this section).

FILES EXTENSIONS		
.docx	.sql	.bkp
.accdb	.py	.db
.accde	.ppam	.db-journal
.accdr	.pps	.csproj
.accdt	.ppsm	.sln
.asp	.ppsx	.md
.aspx	.ppt	.pl
.back	.pptm	.js
.backup	.pptx	.html
.backupdb	.hpp	.htm
.bak	.java	.dbf
.mdb	.jsp	.rdo
.mdc	.php	.arc
.mdf	.doc	.vhd
.war	.docm	.vmdk
.xls	.pst	.vdi
.xlsx	.psd	.vhdx
.xlsm	.dot	.edb
.xlr	.dotm	.c
.zip	.cpp	.h
.rar	.cs	
.sqlitedb	.csv	

When encrypting a file, the malware uses **AES CTR mode**, with a random key (0x20 bytes) and a random **IV** (0x10 bytes).

```
v35 = v12;
v34 = v10;
runtime_makeslice64(&uint8, 16, 0, 16, 0, v19, v23);
v33 = v27;
IV_size_ = IV_size;
IV_ = IV;
crypto_rand_Read(IV, IV_size);
main_dasfasd(AES_key_size, IV);
runtime_makeslice(&uint8);
v30 = AES_key_size;
IV__ = IV;
AES_key_ = AES_key;
crypto_rand_Read(AES_key, AES_key_size);
main_dasfasd(AES_key_size, IV);
if ( v34 > 0x9C4000 && v35 == 0 || v35 > 0 )
{
  main_encrypt_file(v39, AES_key, AES_key_size, IV, IV, IV_size, v27, v27);
  v49 = v27;
  v4 = 2;
}
```

Figure 10. Random AES key and IV.

The AES key is ciphered with **RSA-OAEP** and uses **ripemd160** as its hashing algorithm. The RSA public key (included in this report) is embedded within the encoded strings of the malware.

```
runtime_newobject(&sha1_digest);
*ripemd160_hash_func = 0x67452301;
ripemd160_hash_func[1] = 0xEFCDAB89;
ripemd160_hash_func[2] = 0x98BADCFE;
ripemd160_hash_func[3] = 0x10325476;
ripemd160_hash_func[4] = 0xC3D2E1F0;
ripemd160_hash_func[21] = 0;
ripemd160_hash_func[22] = 0;
ripemd160_hash_func[23] = 0;
crypto_rsa_EncryptOAEP(
  (int)&off_6BACC0,
  (int)ripemd160_hash_func,
  dword_7B9640,
  dword_7B9644,
  a1,
  aes_key,
  a3,
  a4,
  0,
  0,
  0);
```

Figure 11. AES key encrypted with RSA-OAEP.

The AES encrypted key, along with the original file name and the IV is encoded using **GOB** (encoded algorithm from Golang) and included at the end of the file.

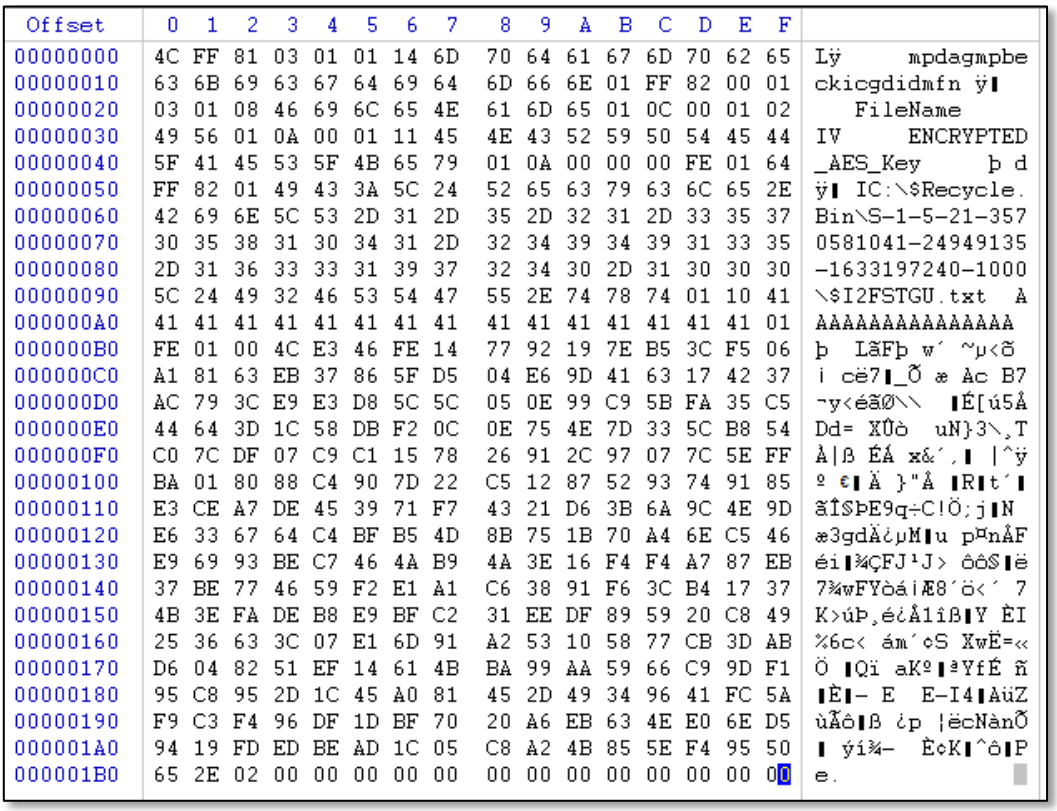
```
runtime_newobject(&bytes_Buffer);
v28 = v15;
((void (__cdecl *)(interfaceType **))encoding_gob_NewEncoder)(&off_6BA260);
v27 = v17;
((void (*)(void))loc_44B376)();
runtime_convT2E(&main_mpdagmpbeckicgdidmfn, &v34);
encoding_gob__ptr_Encoder_Encode(v17, v17, v18);
result = v18;
if ( !v18 )
{
  os___File__Seek(a10, 0, 0);
  if ( v21 )
  {
    main_decrypt__v__1(v13, v16);
    sub_545470();
    result = v22;
  }
```

Figure 12. GOB encoding process.

GOB STRUCT

// Decoded gob 1
 	
//Types
// type ID: 65
type mpdagmpbeckicgdidmfn struct {
FileName string
IV []byte
ENCRYPTED_AES_Key []byte
 	
}

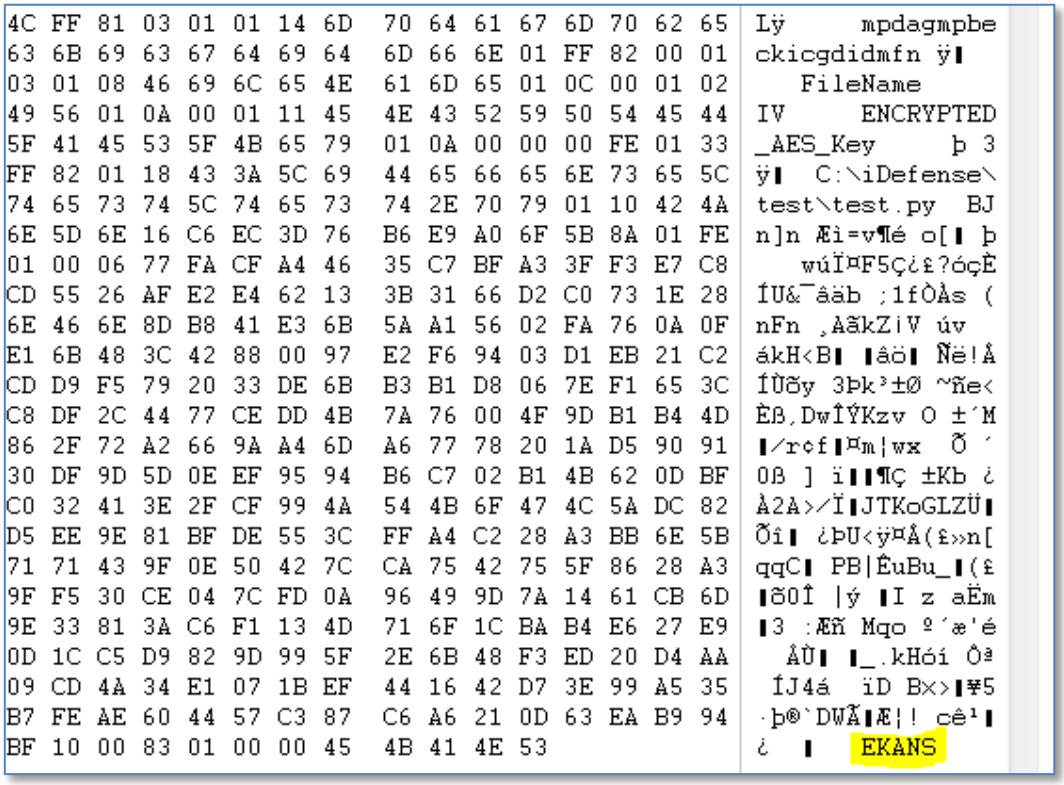
The **GOB Struct** used for encoding these data is the following:



Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00000000	4C	FF	81	03	01	01	14	6D	70	64	61	67	6D	70	62	65	Lÿ mpdagmpbe
00000010	63	6B	69	63	67	64	69	64	6D	66	6E	01	FF	82	00	01	ckicgdidmfn ÿ‚
00000020	03	01	08	46	69	6C	65	4E	61	6D	65	01	0C	00	01	02	FileName
00000030	49	56	01	0A	00	01	11	45	4E	43	52	59	50	54	45	44	IV ENCRYPTED
00000040	5F	41	45	53	5F	4B	65	79	01	0A	00	00	00	FE	01	64	_AES_Key þ d
00000050	FF	82	01	49	43	3A	5C	24	52	65	63	79	63	6C	65	2E	ÿ‚ IC:\$Recycle.
00000060	42	69	6E	5C	53	2D	31	2D	35	2D	32	31	2D	33	35	37	Bin\S-1-5-21-357
00000070	30	35	38	31	30	34	31	2D	32	34	39	34	39	31	33	35	0581041-24949135
00000080	2D	31	36	33	33	31	39	37	32	34	30	2D	31	30	30	30	-1633197240-1000
00000090	5C	24	49	32	46	53	54	47	55	2E	74	78	74	01	10	41	\$I2FSTGU.txt A
000000A0	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	01	AAAAAAAAAAAAAAA
000000B0	FE	01	00	4C	E3	46	FE	14	77	92	19	7E	B5	3C	F5	06	þ LãFþ w' ~µ<õ
000000C0	A1	81	63	EB	37	86	5F	D5	04	E6	9D	41	63	17	42	37	¡ cë7†_Õ æ Ac B7
000000D0	AC	79	3C	E9	E3	D8	5C	5C	05	0E	99	C9	5B	FA	35	C5	¬y<éãØ\\ ‡É[ú5Å
000000E0	44	64	3D	1C	58	DB	F2	0C	0E	75	4E	7D	33	5C	B8	54	Dd= XÛò uN}3\¸T
000000F0	C0	7C	DF	07	C9	C1	15	78	26	91	2C	97	07	7C	5E	FF	À|ß ÉÁ x&',— |^ÿ
00000100	BA	01	80	88	C4	90	7D	22	C5	12	87	52	93	74	91	85	º €ˆÄ }"Å ‡R“t'…
00000110	E3	CE	A7	DE	45	39	71	F7	43	21	D6	3B	6A	9C	4E	9D	ãÎ§ÞE9q÷C!Ö;jœN
00000120	E6	33	67	64	C4	BF	B5	4D	8B	75	1B	70	A4	6E	C5	46	æ3gdÄ¿µM‹u p¤nÅF
00000130	E9	69	93	BE	C7	46	4A	B9	4A	3E	16	F4	F4	A7	87	EB	éi“¾ÇFJ¹J> ôô§‡ë
00000140	37	BE	77	46	59	F2	E1	A1	C6	38	91	F6	3C	B4	17	37	7¾wFYòá¡Æ8'ö<´ 7
00000150	4B	3E	FA	DE	B8	E9	BF	C2	31	EE	DF	89	59	20	C8	49	K>úÞ¸é¿Â1îß‰Y ÈI
00000160	25	36	63	3C	07	E1	6D	91	A2	53	10	58	77	CB	3D	AB	%6c< ám'¢S XwË=«
00000170	D6	04	82	51	EF	14	61	4B	BA	99	AA	59	66	C9	9D	F1	Ö ‚Qï aKº™ªYfÉ ñ
00000180	95	C8	95	2D	1C	45	A0	81	45	2D	49	34	96	41	FC	5A	•È•- E E-I4–AüZ
00000190	F9	C3	F4	96	DF	1D	BF	70	20	A6	EB	63	4E	E0	6E	D5	ùÃô–ß ¿p ¦ëcNànÕ
000001A0	94	19	FD	ED	BE	AD	1C	05	C8	A2	4B	85	5E	F4	95	50	” ýí¾- È¢K…^ô•P
000001B0	65	2E	02	00	00	00	00	00	00	00	00	00	00	00	00	00	e.

Figure 13. Example of a GOB encoded data chunk.

In each file that is encrypted, SNAKE Ransomware will append the "**EKANS**" file marker shown below. EKANS is SNAKE in reverse.



4C	FF	81	03	01	01	14	6D	70	64	61	67	6D	70	62	65	Lÿ mpdagmpbe
63	6B	69	63	67	64	69	64	6D	66	6E	01	FF	82	00	01	ckicgdidmfn ÿ‚
03	01	08	46	69	6C	65	4E	61	6D	65	01	0C	00	01	02	FileName
49	56	01	0A	00	01	11	45	4E	43	52	59	50	54	45	44	IV ENCRYPTED
5F	41	45	53	5F	4B	65	79	01	0A	00	00	00	FE	01	33	_AES_Key þ 3
FF	82	01	18	43	3A	5C	69	44	65	66	65	6E	73	65	5C	ÿ‚ C:\iDefense\
74	65	73	74	5C	74	65	73	74	2E	70	79	01	10	42	4A	test\test.py BJ
6E	5D	6E	16	C6	EC	3D	76	B6	E9	A0	6F	5B	8A	01	FE	n]n Æì=v¶é o[Š þ
01	00	06	77	FA	CF	A4	46	35	C7	BF	A3	3F	F3	E7	C8	wúÏ¤F5Ç¿£?óçÈ
CD	55	26	AF	E2	E4	62	13	3B	31	66	D2	C0	73	1E	28	ÍU&¯âäb ;1fÒÀs (
6E	46	6E	8D	B8	41	E3	6B	5A	A1	56	02	FA	76	0A	0F	nFn ¸AãkZ¡V úv
E1	6B	48	3C	42	88	00	97	E2	F6	94	03	D1	EB	21	C2	ákH<B^ ˆâö” ÑË!Â
CD	D9	F5	79	20	33	DE	6B	B3	B1	D8	06	7E	F1	65	3C	ÍÙõy 3Þk³±Ø ~ñe<
C8	DF	2C	44	77	CE	DD	4B	7A	76	00	4F	9D	B1	B4	4D	ÈB¸DwÎÝKzv O ±´M
86	2F	72	A2	66	9A	A4	6D	A6	77	78	20	1A	D5	90	91	†/r¢fšm¦wx Õ '
30	DF	9D	5D	0E	EF	95	94	B6	C7	02	B1	4B	62	0D	BF	0ß] ï••¶Ç ±Kb ¿
C0	32	41	3E	2F	CF	99	4A	54	4B	6F	47	4C	5A	DC	82	À2A>/Ï™JTKoGLZÜ‚
D5	EE	9E	81	BF	DE	55	3C	FF	A4	C2	28	A3	BB	6E	5B	Õî ¿ÞU<ÿ¤Â(£»n[
71	71	43	9F	0E	50	42	7C	CA	75	42	75	5F	86	28	A3	qqC PB|ÊuBu_†(£
9F	F5	30	CE	04	7C	FD	0A	96	49	9D	7A	14	61	CB	6D	õ0Î |ý –I z aËm
9E	33	81	3A	C6	F1	13	4D	71	6F	1C	BA	B4	E6	27	E9	3 :Æñ Mqo º´æ'é
0D	1C	C5	D9	82	9D	99	5F	2E	6B	48	F3	ED	20	D4	AA	ÅÙ‚ _.kHói Ôª
09	CD	4A	34	E1	07	1B	EF	44	16	42	D7	3E	99	A5	35	ÍJ4á ïD B×>™¥5
B7	FE	AE	60	44	57	C3	87	C6	A6	21	0D	63	EA	B9	94	·þ®`DWÃ‡Æ¦! cê¹”
BF	10	00	83	01	00	00	45	4B	41	4E	53					¿ ƒ EKANS

Figure 14. File Marker.

At the end of the encryption process, each encrypted file will be renamed. The malware will append a random 5 character string to the files extension. For example, a file named test.doc will be encrypted and renamed like test.dociOwKp.

However the malware doesn't do the encryption and renaming at the same time. The ransomware first scan the whole system to select the files to encrypt, base on the exclusions criteria already explained. Then, using this pre-builted list of files, launch the encryption process. Only when all the files are encrypted, the malware renames them. This makes the encryption process particularly slow but very efecttive from the attacker point of view, because the victim will not be alerted of what is going on until all the files are encrypted and renamed. Otherwise, if the user notice that something is encrypting and renaming her files, she could stop the encryption process before it is complete.

When done encrypting the computer, the ransomware will create a ransom note in the following folders:

- **C:\Users\Public\Desktop\Decrypt-Your-Files.txt**
- **C:\Decrypt-Your-Files.txt**

```
main_decrypt_ransom_note();
v36 = v12;
v39 = v3;
v44 = a1;
v45 = a2;
v46 = 0;
v47 = 0;
runtime_convT2Estring(&string_autogen_F80FJP, &v44, v21);
v46 = v22;
v47 = v26;
fmt_Sprintf(v39, v36, &v46, 1, 1);
runtime_stringtoslicebyte(0, v30, v31);
main_decrypt_public(v4, v13);
os_Getenv(v5, v14, v23, v27);
v35 = v28;
v38 = v24;
main_decrypt_systemdrive(v6, v15);
os_Getenv(v7, v16, v24, v28);
v37 = v25;
v34 = v29;
main_decrypt_pub___v_root___v(v8, v17);
v42 = v38;
v43 = v35;
v40 = v25;
v41 = v29;
v48 = &string_autogen_F80FJP;
v49 = &v42;
v50 = &string_autogen_F80FJP;
v51 = &v40;
sub_545470();
if ( v35 > 0 )
{
  main_decrypt__Desktop_(v9, v18);
```

Figure 15. Creation of ransom note.

A copy of the ransom note is provided in Appendix I of this report. The ransom note contains a variable (email address) that is resolved during the infection. This ransom note contains instructions to contact a listed email address for payment

EMAIL ADDRESS IN RANSOM NOTE
---------- | How to contact us to get your files back? ---------- The only way to restore your files is by purchasing a decryption tool loaded with a private key we created specifically for your network. Once run on an effected computer, the tool will decrypt all encrypted files - and you can resume day-to-day operations, preferably with better cyber security in mind. If you are interested in purchasing the decryption tool contact us at **%s**
---------- | How to contact us to get your files back? ---------- The only way to restore your files is by purchasing a decryption tool loaded with a private key we created specifically for your network. Once run on an effected computer, the tool will decrypt all encrypted files - and you can resume day-to-day operations, preferably with better cyber security in mind. If you are interested in purchasing the decryption tool contact us at **alfredmir@protonmail.com**

instructions. This email address is **alfredmir@protonmail.com**.

4. PERSISTANCE

This malware doesn't use any persistence mechanism to remains active in the system during reboots.

5. YARA

The following YARA rule can be used to detect computers infected with this ransomware.

SNAKE

```
import "pe"

rule snake_locker {
  meta:
    description = "Ransomware snake Locker"
    date = "2020-05-25"
    hash1 = "47EBE9F8F5F73F07D456EC12BB49C75D"

  strings:
    $s1 = {  6D 70 64 61 67 6D 70 62 65 63 6B 69 63 67 64 69 64 6D 66 6E }
    $s2 = {  8D 05 ?? ?? ?? 00 89 44 24 04 c7 44 24 08 ?? ?? ?? 00 e8 ?? ?? e? ff 8b 44 24 0c [25-25] 89
54 24 04 c7 44 24 08 ?? ?? ?? 00 e8 }

  condition:
    uint16(0) == 0x5a4d and
    filesize < 5MB and
    ($s1 or $s2 or
    pe.imphash() == "96c44fa1eee2c4e9b9e77d7bf42d59e6" )
}
```

6. IOCS

The following IOC's can be used to detect computers infected with this malware.

	IOCs
MD5	47EBE9F8F5F73F07D456EC12BB49C75D
File names	C:\Users\Public\Desktop\Decrypt-Your-Files.txt C:\Decrypt-Your-Files.txt
Email	alfredmir@protonmail.com
DNS	ADS.FRESENIUS.COM
Mutex	Global\EKANS This Mutex can be used to block the execution of the malware in a clean computer. If the Mutex already exists when the malware is executed, the malware will not execute its malicious payload.

7. APPENDIX I

Snake Ransom note.

RANSOM NOTE
---------- | What happened to your files? ---------- We breached your corporate network and encrypted the data on your computers. The encrypted data includes documents, databases, photos and more - all were encrypted using a military grade encryption algorithms (AES-256 and RSA-2048). You cannot access those files right now. But dont worry! You can still get those files back and be up and running again in no time. ---------- | How to contact us to get your files back? ---------- The only way to restore your files is by purchasing a decryption tool loaded with a private key we created specifically for your network. Once run on an effected computer, the tool will decrypt all encrypted files - and you can resume day-to-day operations, preferably with better cyber security in mind. If you are interested in purchasing the decryption tool contact us at %s ---------- | How can you be certain we have the decryption tool? ---------- In your mail to us attach up to 3 non critical files (up to 3MB, no databases or spreadsheets). We will send them back to you decrypted. ---------- | What happens if you dont contact us within 48 hours or refuse payment? ---------- We publish sensitve databases and documents we collected from your network. ----------

8. APPENDIX II

Hard-coded list of services to stop.

LISTA DE SERVICIOS	
Acronis VSS Provider	NtLmSspNtmsSvc
AcrSch2Svc	ntrtscanPOP3Svc
AdobeARMservice	odservTlntSvr
AlerterERSvc	oracleservice
Antivirus	OracleService
ArcserveUDPPS	PDVFSService
ArcserveUDPPS	ProLiantMonitor
ARSMbedbgDCAgent	ReportServer
ASLogWatch	ReportServer$TPSRESvc
avast! AntivirusaswBccmfewc	ReportServer$TPSSQLBrowserAVP
avbackupNetSvc	RSCDsvcLRSDRVX
BackupExecAgentAccelerator	RumorServer
BackupExecAgentBrowser	sacsvr
BackupExecDeviceMediaService	SamSs
bcrservice	SAVServiceSAVAdminService
CAARCAppSvc	SDD_Service
CAARCUpdateSvc	SDRSVCShMonitor
CASAD2DwebSvc	SentinelAgent
CASARPSWebSVC	SepMasterServiceSmcinstSMTPSvc
CASDatastoreSvc	SmcService
ccEvtMgrccSetMgrCSAdmin	SNACSntpService
CSAuth	Sophos AgentSophos MCS AgentAcronisAgent
CSDbSyncCSLog	Sophos AutoUpdate Service
CSMon	Sophos Clean Service
CSRadiusCSTacacsSymantecVGAuthService	Sophos Device Control Service
Cylance	Sophos File Scanner Service
DB2INST2myAgtSvcIBMDataServerMgrIBMDSServer41	Sophos Health Service
DB2LICD_DB2COPY1DB2DAS00DB2-0	Sophos MCS Client
Enterprise Client Service	Sophos Message Router
EPUpdateService	Sophos Safestore Service
EraserSvc11710	Sophos System Protection ServiceSophos Web
EsgShKernel	Control Service
ESHASRV	sophosspsSstpSvcSQLAgent$ECWDB2
EventlogNetDDE	SophosVeeam
FA_Scheduler	SplunkForwarder
gupdatemHealthService	SQL Backups
IDriverTMSMQMMS	SQLAgent$CXDB
IISAdminIMAP4Svcmacmnsvcmasvc	SQLAgent$ITRIS
ImapiService	SQLAgent$NET2
KAVFSmfefire	SQLAgent$PROD
klnagentMSSQL$SOPHOS	SQLAgent$PROD
MBAMService	SQLAgent$SOPHOS
MBEndpointAgent	SQLAgent$SOPHOS
McAfeeFramework	SQLAgent$TPS
McShieldmfemms	SQLAgent$TPSAMA
McTaskManager	SQLBrowser
mfevtpMSOLAP$TPSmozyprobackup	SQLsafe Backup Service
MsDtsServer	SQLsafe Filter Service
MsDtsServer100	SQLSERVERAGENT
MsDtsServer110	SQLTELEMETRY
MsDtsServer130	SQLWriter

LISTA DE SERVICIOS	
MSExchangeES	SSISTELEMETRY130epredlineTmPfw
MSExchangeIS	svcGenericHost
MSExchangeMGMT	swi_filterTmCCSFswi_service
MSExchangeMTA	swi_update
MSExchangeSA	swi_update_64
MSExchangeSRS	Symantec System Recovery
msftesql$PROD	sysdown
msftesql$PROD	System
MSOLAP$SQL_2008	Telemetryserver
MSOLAP$TPSAMA	tmlistenTrueKey
MSSQL$BKUPEXEC	tpautoconnsvc
MSSQL$ECWDB2	TPVCGateway
MSSQL$EPOSERVER	TrueKeySchedulerUI0DetectW3Svc
MSSQL$ITRIS	VeeamBackupSvc
MSSQL$NET2	VeeamBrokerSvc
MSSQL$PROD	VeeamCatalogSvc
MSSQL$SHAREPOINTMSSQL$SQL_2008	VeeamCloudSvc
MSSQL$SQLEXPRESSkavfsslpKAVFSGT	VeeamDeploySvc
MSSQL$SYSTEM_BGCMSSQL$TPSMySQL57MSSQL$TPSA	VeeamMountSvc
MA	VeeamNFSSvc
MSSQLFDLauncher	VeeamRESTSvc
MSSQLMySQLmssql	VMTools
MSSQLSERVER	VMware
msvsmon90	wbengineWRSVC
MySQL80nxlogSAP	WdNisSvcBITSepagWinDefend
Net2ClientSvc	WebClientWinVNC4CissesrvCpqRcmc3gupdate
NetMsmqActivatorEhttpSrvekrn	Zoolz 2 Service

9. APPENDIX III

Hard-coded list of processes to kill.

LISTA DE PROCESOS				
a2guard.exe	cwbunnav.exe	mcshld9x.exe	ravxp.exe	rdrcef.exe
a2service.exe	cylancesvc.exe	mcsvhost.exe	rcsvcmon.exe	realmon.exe
a2start.exe	cylanceui.exe	mcsysmon.exe	mcshell.exe	redirsvc.exe
aawservice.exe	dao_log.exe	mctray.exe	mcshield.exe	regmech.exe
acaas.exe	dbeng50.exe	mctskshd.exe	mcshld9x.exe	remupd.exe
acaegmgr.exe	dbserv.exe	mcui32.exe	mcsvhost.exe	repmgr64.exe
acaif.exe	dbsnmp.exe	mcuimgr.exe	mcsysmon.exe	reportersvc.exe
acais.exe	dbsrv9.exe	mcupdate.exe	mctray.exe	reportsvc.exe
acctmgr.exe	defwatch.exe	mcupdmgr.exe	mctskshd.exe	retinaengine.exe
aclient.exe	defwatchrnav.exe	mcvsftsn.exe	mcui32.exe	rfwmain.exe
aclntusr.exe	deloeminfs.exe	mcvsrte.exe	mcuimgr.exe	rfwproxy.exe
ad-aware2007.exe	deteqt.agent.exe	mcvsshld.exe	mcupdate.exe	rfwsrv.exe
adminserver.exe	diskmon.exe	mcwce.exe	mcupdmgr.exe	rfwstub.exe
aexnsagent.exe	djsnetcn.exe	mcwcecfg.exe	mcvsftsn.exe	rnreport.exe
aexnsrcvsvc.exe	dlservice.exe	mfeann.exe	mcvsrte.exe	routernt.exe
aexsvc.exe	dltray.exe	mfecanary.exe	mcvsshld.exe	rpcserv.exe
aexswdusr.exe	dolphincharge.exe	mfeesp.exe	mcwce.exe	rscdsvc.exe
aflogvw.exe	doscan.exe	mfefire.exe	mcwcecfg.exe	rsnetsvr.exe
afwserv.exe	dpmra.exe	mfefw.exe	mfeann.exe	rssensor.exe
agntsvc.exe	drwagntd.exe	mfehcs.exe	mfecanary.exe	ravstub.exe
ahnrpt.exe	drwagnui.exe	mfemactl.exe	mfeesp.exe	ravtask.exe

LISTA DE PROCESOS				
ahnsd.exe	drweb.exe	mfemms.exe	mfefire.exe	ravtray.exe
ahnsdsv.exe	drweb32.exe	mfetp.exe	mfefw.exe	ravupdate.exe
alert.exe	drweb32w.exe	mfevtps.exe	mfehcs.exe	ravxp.exe
alertsvc.exe	drweb386.exe	mfewc.exe	mfemactl.exe	rcsvcmon.exe
almon.exe	drwebcgp.exe	mfewch.exe	mfemms.exe	rstray.exe
alogserv.exe	drwebcom.exe	mgavrtcl.exe	mfetp.exe	rtvscan.exe
alsvc.exe	drwebdc.exe	mghtml.exe	mfevtps.exe	rulaunch.exe
alunotify.exe	drwebmng.exe	mgntsvc.exe	mfewc.exe	safeservice.exe
alupdate.exe	drwebscd.exe	monsvcnt.exe	mfewch.exe	sahookmain.exe
amsvc.exe	drwebupw.exe	monsysnt.exe	mgavrtcl.exe	saservice.exe
amswmagtcaf.exe	drwebwcl.exe	mpcmdrun.exe	mghtml.exe	sav32cli.exe
anvir.exe	drwebwin.exe	mpf.exe	mgntsvc.exe	savfmsectrl.exe
aphost.exe	drwinst.exe	mpfagent.exe	monsvcnt.exe	savfmselog.exe
appsvc32.exe	drwupgrade.exe	mpfconsole.exe	monsysnt.exe	savfmsesjm.exe
aps.exe	dsmcad.exe	mpfservice.exe	mpcmdrun.exe	savfmsesp.exe
apvxdwin.exe	dsmcsvc.exe	mpfsrv.exe	mpf.exe	savfmsesrv.exe
ashavast.exe	dwarkdaemon.exe	mpftray.exe	mpfagent.exe	savfmsetask.exe
ashbug.exe	dwengine.exe	mps.exe	mpfconsole.exe	savfmseui.exe
ashchest.exe	dwhwizrd.exe	mpsevh.exe	mpfservice.exe	savmain.exe
ashcmd.exe	dwnetfilter.exe	mpsvc.exe	mpfsrv.exe	savroam.exe
ashdisp.exe	dwrcst.exe	mrf.exe	mpftray.exe	savscan.exe
ashenhcd.exe	dwwin.exe	msaccess.exe	mps.exe	savservice.exe
ashlogv.exe	edisk.exe	msascui.exe	mpsevh.exe	savui.exe
ashmaisv.exe	eeyeevnt.exe	mscifapp.exe	mpsvc.exe	sbamsvc.exe
ashpopwz.exe	egui.exe	msdtssrvr.exe	mrf.exe	scan32.exe
ashquick.exe	ehttpsrv.exe	msftesql.exe	msaccess.exe	scanfrm.exe
ashserv.exe	ekrn.exe	mskagent.exe	msascui.exe	scanmsg.exe
ashsimp2.exe	elogsvc.exe	mskdetct.exe	mscifapp.exe	scansbserv.exe
ashsimpl.exe	emlproui.exe	msksrver.exe	msdtssrvr.exe	scanwscs.exe
ashskpcc.exe	emlproxy.exe	msksrvr.exe	msftesql.exe	scfagent_64.exe
ashskpck.exe	encsvc.exe	msmdsrv.exe	mskagent.exe	scfmanager.exe
ashupd.exe	engineserver.exe	msmpeng.exe	mskdetct.exe	scfservice.exe
ashwebsv.exe	entitymain.exe	mspmspsv.exe	msksrver.exe	scftray.exe
asupport.exe	epmd.exe	mspub.exe	msksrvr.exe	schdsrvc.exe
aswdisp.exe	era.exe	msscli.exe	msmdsrv.exe	schupd.exe
aswregsvr.exe	erlsrv.exe	msseces.exe	msmpeng.exe	sdrservice.exe
aswserv.exe	esecservice.exe	msssrv.exe	mspmspsv.exe	sdtrayapp.exe
aswupdsv.exe	esmagent.exe	myagttry.exe	mspub.exe	seccenter.exe
aswwebsv.exe	etagent.exe	mydesktopqos.exe	msscli.exe	seestat.exe
atrshost.exe	etconsole3.exe	mysqld.exe	msseces.exe	semsvc.exe
atwsctsk.exe	etcorrel.exe	mysqld-nt.exe	msssrv.exe	sesclu.exe
aupdrun.exe	etreporter.exe	mysqld-opt.exe	myagttry.exe	setloadorder.exe
aus.exe	etrssfeeds.exe	n.exe	mydesktopqos.exe	setupguimngr.exe
auth8021x.exe	etscheduler.exe	nailgpip.exe	mysqld.exe	sevinst.exe
autoup.exe	euqmonitor.exe	naprdmgr.exe	mysqld-nt.exe	sgbhp.exe
avadmin.exe	eventparser.exe	navapsvc.exe	mysqld-opt.exe	shstat.exe
avagent.exe	evtarmgr.exe	navapw32.exe	n.exe	sidebar.exe
avastsvc.exe	evtmgr.exe	navectrl.exe	nailgpip.exe	siteadv.exe
avastui.exe	ewidoctrl.exe	navelog.exe	naprdmgr.exe	slee81.exe
avcenter.exe	ewidoguard.exe	navesp.exe	navapsvc.exe	smc.exe
avconfig.exe	excel.exe	navshcom.exe	navapw32.exe	smcgui.exe
avconsol.exe	execstat.exe	navw32.exe	navectrl.exe	smex_activeupda.exe
avengine.exe	explicit.exe	navwnt.exe	navelog.exe	smex_master.exe
avesvc.exe	fameh32.exe	ncdaemon.exe	navesp.exe	smex_remoteconf.exe
avfwsvc.exe	fcappdb.exe	nd2svc.exe	navshcom.exe	smex_systemwatc.exe
avgam.exe	fcdblog.exe	ndetect.exe	navw32.exe	sms.exe

LISTA DE PROCESOS				
avgamsvr.exe	fch32.exe	ndrvs.exe	navwnt.exe	smsectrl.exe
avgas.exe	fchelper64.exe	ndrvx.exe	ncdaemon.exe	smselog.exe
avgcc.exe	fcsms.exe	neotrace.exe	nd2svc.exe	smsesjm.exe
avgcc32.exe	fcssas.exe	nerosvc.exe	ndetect.exe	smsesp.exe
avgcefrend.exe	fih32.exe	netcfg.exe	ndrvs.exe	smsesrv.exe
avgchsvx.exe	firefox.exe	networkagent.exe	ndrvx.exe	smsetask.exe
avgcmgr.exe	firesvc.exe	ngctw32.exe	neotrace.exe	smseui.exe
avgcsrva.exe	firetray.exe	ngserver.exe	nerosvc.exe	smsx.exe
avgcsrvx.exe	firewallgui.exe	nimbus.exe	netcfg.exe	snac.exe
avgctrl.exe	fmon.exe	nimcluster.exe	networkagent.exe	sndmon.exe
avgdiag.exe	forcefield.exe	nip.exe	ngctw32.exe	sndsrvc.exe
avgemc.exe	fortiesnac.exe	nipsvc.exe	ngserver.exe	snhwsrv.exe
avgemca.exe	fortifw.exe	nisoptui.exe	nimbus.exe	snicheckadm.exe
avgemcx.exe	fortiproxy.exe	nisserv.exe	nimcluster.exe	snichecksrv.exe
avgfws.exe	fortitray.exe	nissrv.exe	nip.exe	snicon.exe
avgfws8.exe	fortiwf.exe	nisum.exe	nipsvc.exe	snsrv.exe
avgfws9.exe	fpavserver.exe	njeeves.exe	nisoptui.exe	spbbcsvc.exe
avgfwsrv.exe	fprottray.exe	nlclient.exe	nisserv.exe	spideragent.exe
avgidsagent.exe	frameworkservice.exe	nlsvc.exe	nissrv.exe	spiderml.exe
avgidsui.exe	frzstate2k.exe	nmagent.exe	nisum.exe	spidernt.exe
avginet.exe	fsaa.exe	nmain.exe	njeeves.exe	spiderui.exe
avgmfapx.exe	fsaua.exe	nod32.exe	nlclient.exe	spntsvc.exe
avgmsvr.exe	fsav32.exe	nod32krn.exe	nlsvc.exe	spooler.exe
avgnsa.exe	fsavgui.exe	nod32kui.exe	nmagent.exe	spyemergency.exe
avgnsx.exe	fscuif.exe	nod32view.exe	nmain.exe	sqlagent.exe
avgnt.exe	fsdfwd.exe	npfmntor.exe	nod32.exe	sqlbrowser.exe
avgregcl.exe	fsgk32.exe	npfmsg.exe	nod32krn.exe	sqlservr.exe
avgrsa.exe	fsgk32st.exe	npfmsg2.exe	nod32kui.exe	sqlwriter.exe
avgrssvc.exe	fsguidll.exe	npfsvice.exe	nod32view.exe	srvload.exe
avgrsx.exe	fsguiexe.exe	npmdagent.exe	npfmntor.exe	srvmon.exe
avgscanx.exe	fshdll32.exe	nprotect.exe	npfmsg.exe	sschk.exe
avgserv.exe	fshoster32.exe	npscheck.exe	npfmsg2.exe	ssm.exe
avgserv9.exe	fshoster64.exe	npssvc.exe	npfsvice.exe	ssp.exe
avgsvc.exe	fsm32.exe	nrmenctb.exe	npmdagent.exe	ssscheduler.exe
avgsystx.exe	fsma32.exe	nscsrvce.exe	nprotect.exe	starta.exe
avgtray.exe	fsmb32.exe	nsctop.exe	npscheck.exe	steam.exe
avguard.exe	fsorsp.exe	nsmdemf.exe	npssvc.exe	stinger.exe
avgui.exe	fspex.exe	nsmdmon.exe	nrmenctb.exe	stopa.exe
avgupd.exe	fsqh.exe	nsmdreal.exe	nscsrvce.exe	stopp.exe
avgupdln.exe	fwcfg.exe	nsmdsch.exe	nsctop.exe	stwatchdog.exe
avgupsvc.exe	fwinst.exe	nsmdtr.exe	nsmdemf.exe	svcgenerichost.exe
avgvv.exe	fws.exe	ntcaagent.exe	nsmdmon.exe	svcharge.exe
avgw.exe	gcascleaner.exe	ntcadaemon.exe	nsmdreal.exe	svcntaux.exe
avgwb.dat	gcasdtserv.exe	ntcaservice.exe	nsmdsch.exe	svdealer.exe
avgwdsvc.exe	gcasnotice.exe	ntevl.exe	nsmdtr.exe	svframe.exe
avgwizfw.exe	gcasserv.exe	ntrtscan.exe	ntcaagent.exe	svtray.exe
avkproxy.exe	GDDServer.exe	ntservices.exe	ntcadaemon.exe	swc_service.exe
avkservice.exe	gdfwsvc.exe	nvcoas.exe	ntcaservice.exe	swdsvc.exe
avktray.exe	gdscan.exe	nvcsched.exe	ntevl.exe	sweepsrv.sys
avkwctl.exe	ghost_2.exe	nymse.exe	ntrtscan.exe	swi_service.exe
avltmain.exe	ghosttray.exe	oasclnt.exe	ntservices.exe	swnetsup.exe
avmailc.exe	googleupdate.exe	ocautoupds.exe	nvcoas.exe	swnxt.exe
avmcdlg.exe	guard.exe	ocomm.exe	nvcsched.exe	swserver.exe
avnotify.exe	guardgui.exe	ocssd.exe	nymse.exe	symlcsvc.exe
avp.exe	gziface.exe	oespamtest.exe	oasclnt.exe	symproxysvc.exe
avpcc.exe	gzserv.exe	ofcdog.exe	ocautoupds.exe	symsport.exe

LISTA DE PROCESOS				
avpdtagt.exe	hasplmv.exe	ofcpfwsvc.exe	ocomm.exe	symtray.exe
avpexec.exe	hdb.exe	okclient.exe	ocssd.exe	symwsc.exe
avpm.exe	hpqwmiex.exe	olfsnt40.exe	oespamtest.exe	synctime.exe
avpncc.exe	hwapi.exe	omniagent.exe	ofcdog.exe	sysdoc32.exe
avps.exe	icepack.exe	omtsreco.exe	ofcpfwsvc.exe	system.exe
avpui.exe	idsinst.exe	onenote.exe	okclient.exe	taskhostw.exe
avpupd.exe	iface.exe	onlinent.exe	olfsnt40.exe	tbirdconfig.exe
avscan.exe	igateway.exe	onlnsvc.exe	omniagent.exe	tbmon.exe
avscc.exe	ilicensesvc.exe	op_viewer.exe	omtsreco.exe	tclproc.exe
avserver.exe	inet_gethost.exe	opscan.exe	onenote.exe	tdimon.exe
avshadow.exe	infopath.exe	oracle.exe	onlinent.exe	tfgui.exe
avsynmgr.exe	inicio.exe	outlook.exe	onlnsvc.exe	tfservice.exe
avtask.exe	inonmsrv.exe	outpost.exe	op_viewer.exe	tftray.exe
avwebgrd.exe	inorpc.exe	paamsrv.exe	opscan.exe	tfun.exe
basfipm.exe	inort.exe	padfsvr.exe	oracle.exe	thebat.exe
bavtray.exe	inotask.exe	pagent.exe	outlook.exe	thebat64.exe
bcreporter.exe	inoweb.exe	pagentwd.exe	outpost.exe	thunderbird.exe
bcrservice.exe	isafe.exe	pasystemtray.exe	paamsrv.exe	tiaspn~1.exe
bdagent.exe	isafinst.exe	patch.exe	padfsvr.exe	tmas.exe
bdc.exe	isntsmtp.exe	patrolagent.exe	pagent.exe	tmlisten.exe
bdlite.exe	isntsysmonitor.exe	patrolperf.exe	pagentwd.exe	tmntsrv.exe
bdmcon.exe	ispwdsvc.exe	pavbckpt.exe	pasystemtray.exe	tmpfw.exe
bdredline.exe	isqlplussvc.exe	pavfires.exe	patch.exe	tmproxy.exe
bdss.exe	isscsf.exe	pavfnsvr.exe	patrolagent.exe	tnbutil.exe
bdsubmit.exe	issdaemon.exe	pavjobs.exe	patrolperf.exe	tnslsnr.exe
bhipssvc.exe	issvc.exe	pavkre.exe	pavbckpt.exe	tpsrv.exe
bka.exe	isuac.exe	pavmail.exe	pavfires.exe	traflnsp.exe
blackd.exe	iswmgr.exe	pavprot.exe	pavfnsvr.exe	trjscan.exe
blackice.exe	itmrt_trace.exe	pavprsrv.exe	pavjobs.exe	trupd.exe
blupro.exe	itmrtsvc.exe	pavreport.exe	pavkre.exe	tsansrf.exe
bmrt.exe	ixaptsvc.exe	pavsched.exe	pavmail.exe	tsatisy.exe
bullguard.exe	ixavsvc.exe	pavsrv50.exe	pavprot.exe	tscutynt.exe
bwgo0000fspc.exe	ixfwsvc.exe	pavsrv51.exe	pavprsrv.exe	tsmpnt.exe
ca.exe	kabackreport.exe	pavsrv52.exe	pavreport.exe	ucservice.exe
caav.exe	kaccore.exe	pavupg.exe	pavsched.exe	udaterui.exe
caavcmdscan.exe	kanmcmain.exe	pccclient.exe	pavsrv50.exe	uiseagnt.exe
caavguiscan.exe	kansgui.exe	pccguide.exe	pavsrv51.exe	uiwatchdog.exe
cafw.exe	kansvr.exe	pcclient.exe	pavsrv52.exe	umxagent.exe
caissdt.exe	kastray.exe	pccnt.exe	pavupg.exe	umxcfg.exe
calogdump.exe	kav.exe	pccntmon.exe	pccclient.exe	umxfwhlp.exe
capfaem.exe	kav32.exe	pccntupd.exe	pccguide.exe	umxpol.exe
capfasem.exe	kavfs.exe	pccpfw.exe	pcclient.exe	unsecapp.exe
capfsem.exe	kavfsgt.exe	pcctlcom.exe	pccnt.exe	unvet32.exe
capmuamagt.exe	kavfsrcn.exe	pcscan.exe	pccntmon.exe	up2date.exe
casc.exe	kavfsscs.exe	pcscm.exe	pccntupd.exe	update_task.exe
caunst.exe	kavfswp.exe	pcscnsrv.exe	pccpfw.exe	updaterui.exe
cavrep.exe	kavisarv.exe	pcsws.exe	pcctlcom.exe	updtnv28.exe
cavrid.exe	kavmm.exe	pctsauxs.exe	pcscan.exe	upfile.exe
cavscan.exe	kavshell.exe	pctsgui.exe	pcscm.exe	uplive.exe
cavtray.exe	kavss.exe	pctssvc.exe	pcscnsrv.exe	uploadrecord.exe
ccap.exe	kavstart.exe	pctstray.exe	pcsws.exe	upschd.exe
ccapp.exe	kavsvc.exe	pep.exe	pctsauxs.exe	url_response.exe
ccemflsv.exe	kavtray.exe	persfw.exe	pctsgui.exe	urllstck.exe
ccenter.exe	kb891711.exe	pmgreader.exe	pctssvc.exe	usbguard.exe
ccevtmgr.exe	keysvc.exe	pmon.exe	pctstray.exe	useractivity.exe
ccflic0.exe	kis.exe	pnmsrv.exe	pep.exe	useranalysis.exe

LISTA DE PROCESOS				
ccflic4.exe	kislive.exe	pntiomon.exe	persfw.exe	usergate.exe
cclaw.exe	kissvc.exe	pop3pack.exe	pmgreader.exe	usrprmpt.exe
ccnfagent.exe	klnacserver.exe	pop3trap.exe	pmon.exe	v2iconsole.exe
ccprovsp.exe	klnagent.exe	poproxy.exe	pnmsrv.exe	v3clnsrv.exe
ccproxy.exe	klserver.exe	powerpnt.exe	pntiomon.exe	v3exec.exe
ccpxysvc.exe	klswd.exe	ppclean.exe	pop3pack.exe	v3imscn.exe
ccsetmgr.exe	klwtblfs.exe	ppctlpriv.exe	pop3trap.exe	v3lite.exe
ccsmagtd.exe	kmailmon.exe	ppppwallrun.exe	poproxy.exe	v3main.exe
ccsvchst.exe	knownsvr.exe	pqibrowser.exe	powerpnt.exe	v3medic.exe
cctray.exe	knupdatemain.exe	pqv2isvc.exe	ppclean.exe	v3sp.exe
ccupdate.exe	kpf4gui.exe	pralarmmgr.exe	ppctlpriv.exe	v3svc.exe
cdm.exe	kpf4ss.exe	prconfigmgr.exe	ppppwallrun.exe	vetmsg.exe
cfftplugin.exe	kpfw32.exe	preventmgr.exe	pqibrowser.exe	vettray.exe
cfnotsrvd.exe	kpfwsvc.exe	prevsrv.exe	pqv2isvc.exe	visio.exe
cfp.exe	krbcc32s.exe	prftpengine.exe	pralarmmgr.exe	vmacthlp.exe
cfpconfg.exe	kswebshield.exe	prgateway.exe	prconfigmgr.exe	vmtoolsd.exe
cfpconfig.exe	kvdetech.exe	printdevice.exe	preventmgr.exe	vmwaretray.exe
cfplogvw.exe	kvmonxp.kxp	prlicensemgr.exe	prevsrv.exe	vpatch.exe
cfpsbmit.exe	kvmonxp_2.kxp	procexp.exe	prftpengine.exe	vpc32.exe
cfpupdat.exe	kvolself.exe	proficysts.exe	prgateway.exe	vpdn_lu.exe
cfsmsmd.exe	kvsrvxp.exe	proutil.exe	printdevice.exe	vprosvc.exe
checkup.exe	kvsrvxp_1.exe	prproficymgr.exe	prlicensemgr.exe	vprot.exe
chrome.exe	kvxp.kxpfssm32.exe	prrds.exe	procexp.exe	vptray.exe
cis.exe	kwatch.exe	prreader.exe	proficysts.exe	vrv.exe
cistray.exe	kwsprod.exe	prrouter.exe	proutil.exe	vrvmail.exe
cka.exe	kxeserv.exe	prstubber.exe	prproficymgr.exe	vrvmon.exe
clamscan.exe	leventmgr.exe	prsummarymgr.exe	prrds.exe	vrvnet.exe
clamtray.exe	livesrv.exe	prunsrv.exe	prreader.exe	vshwin32.exe
clamwin.exe	lmon.exe	prwriter.exe	prrouter.exe	vsmain.exe
client.exe	log_qtine.exe	psanhost.exe	prstubber.exe	vsmon.exe
client64.exe	loggetor.exe	psctris.exe	prsummarymgr.exe	vsserv.exe
clps.exe	luall.exe	psctrls.exe	prunsrv.exe	vsstat.exe
clpsla.exe	lucoms.exe	psh_svc.exe	prwriter.exe	vstskmgr.exe
clpsls.exe	lucoms~1.exe	pshost.exe	psanhost.exe	webproxy.exe
clshield.exe	lucomserver.exe	psimreal.exe	psctris.exe	webscanx.exe
cmdagent.exe	lwdmserver.exe	psimsvc.exe	psctrls.exe	webtrapnt.exe
cmdinstall.exe	macmnsvc.exe	pskmssvc.exe	psh_svc.exe	wfxctl32.exe
cmgrdian.exe	macompatsvc.exe	psuamain.exe	pshost.exe	wfxmod32.exe
cntaosmgr.exe	mantispm.exe	psuaservice.exe	psimreal.exe	wfxsnt40.exe
collwrap.exe	masalert.exe	pthosttr.exe	psimsvc.exe	win32sysinfo.exe
comhost.exe	massrv.exe	pview.exe	pskmssvc.exe	winlog.exe
console.exe	masvc.exe	pviewer.exe	psuamain.exe	winroute.exe
cpd.exe	mbamservice.exe	pwdfilthelp.exe	psuaservice.exe	winvnc4.exe
cpdclnt.exe	mbamtray.exe	pxemtftp.exe	pthosttr.exe	winword.exe
cpf.exe	mcagent.exe	pxeservice.exe	pview.exe	wordpad.exe
cpntsrv.exe	mcapexe.exe	qclean.exe	pviewer.exe	wrctrl.exe
cramtray.exe	mcappins.exe	qdcsfs.exe	pwdfilthelp.exe	wrsa.exe
crashrep.exe	mcconsol.exe	qhsafetray.exe	pxemtftp.exe	wrspysetup.exe
crdm.exe	mcdash.exe	qhwatchdog.exe	pxeservice.exe	wscntfy.exe
crssvc.exe	mcdetect.exe	qoeloader.exe	qclean.exe	wssfcmai.exe
csacontrol.exe	mcepoc.exe	qserver.exe	qdcsfs.exe	xagt.exe
csadmin.exe	mcepocfg.exe	rapapp.exe	qhsafetray.exe	xcommsvr.exe
csauth.exe	mcinfo.exe	rapuisvc.exe	qhwatchdog.exe	xfilter.exe
csdbsync.exe	mcmnhdlr.exe	ras.exe	qoeloader.exe	xfssvccon.exe
csinject.exe	mcmscsvc.exe	rasupd.exe	qserver.exe	zanda.exe
csinsm32.exe	mcnasvc.exe	rav.exe	rapapp.exe	zapro.exe

LISTA DE PROCESOS				
csinsmnt.exe	mcods.exe	ravalert.exe	rapuisvc.exe	zavaux.exe
cslog.exe	mcpalmcfg.exe	ravmon.exe	ras.exe	zavcore.exe
csmon.exe	mcpromgr.exe	ravmond.exe	rasupd.exe	zillya.exe
csradius.exe	mcproxy.exe	ravservice.exe	rav.exe	zlclient.exe
csrss_tc.exe	mcregwiz.exe	ravstub.exe	ravalert.exe	zlh.exe
cssauth.exe	mcsacore.exe	ravtask.exe	ravmon.exe	zonealarm.exe
cstacacs.exe	mcshell.exe	ravtray.exe	ravmond.exe	zoolz.exe
ctdataload.exe	mcshield.exe	ravupdate.exe	ravservice.exe	

10. APPENDIX IV

IdaPython Script to decrypt all hard-coded strings encrypted in the malware body. Result is written to a file on disk.

IDAPYTHON SCRIPT

```
import re

def decrypt(ea, data, key, size):
 print(hex(data))
 print(hex(key))
 print(hex(ea))

 result=""
 for i in range(0,size):
  aux = ( ( (get_wide_byte(data+i) + 0x2A) & 0xFF ) ^ get_wide_byte(key+(i%size) ) )
  result = result + chr(aux)


 f.write(hex(ea) + " - " + get_func_name(ea) + "\n")
 f.write("------------------------------------------------------------\n")
 f.write(result + "\n")
 f.write("------------------------------------------------------------\n\n")

 refs=XrefsTo(ea, 0)
 for ea_refs in refs:
  #print(ea_refs.frm)
  if len(result) >= 0x100:
    comment=result[0:0x100]
  else:
    comment=result[0:len(result)]

  if len(result) >= 0x10:
    functionName=result[0:0x10]
  else:
    functionName=result[0:len(result)]

  set_cmt(ea_refs.frm, comment, 0)

 set_name(ea, "main_decrypt_" + functionName , SN_NOCHECK | SN_FORCE)

 #print(result)

f=open("c:\\\\temp\\\\strings.txt","w")
```

IDAPYTHON SCRIPT

```
#ea=get_screen_ea()
#functionName = get_func_name(ea)
for segea in Segments():
 for funcea in Functions(segea, get_segm_end(segea)):
   for (startea, endea) in Chunks(funcea):
      i=0
      flags=0
      for head in Heads(startea, endea):
         if ( (i==0x07 or i==0x08) and print_insn_mnem(head) == "lea" and print_operand(head,0) ==
"eax"):
            data_addr=get_operand_value(head,1)
            #print(hex(data_addr))
            flags=flags+1
         if ( (i==0x11 or i==0x12) and print_insn_mnem(head) == "lea" and print_operand(head,0) ==
"edx"):
            key_addr=get_operand_value(head,1)
            #print(hex(key_addr))
            flags=flags+1
         if (flags==0x02 and print_insn_mnem(head) == "cmp" and print_operand(head,0) == "ebp" and
get_operand_type(head,1) == 5):
            size=get_operand_value(head,1)
            #print(get_operand_type(head,1))
            print_operand(head,1)
            flags=flags+1
         if flags == 3:
            decrypt(startea, data_addr, key_addr, size)
            break
         i=i+1

f.close()
```