Cryptography is hard: Breaking the DoNex ransomware

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whoami

- Malware reverse engineer
- CTI analyst

- Specializes in ransomware
- Finding & exploiting weaknesses to build decryptors

crysearch.nl

in/gijs-rijnders/

vx-underground

Your chances of being a victim of ransomware increases over 250% if your organization owns a computer.

Do not use computers.

[Reposted, apparently people didn't get the joke]

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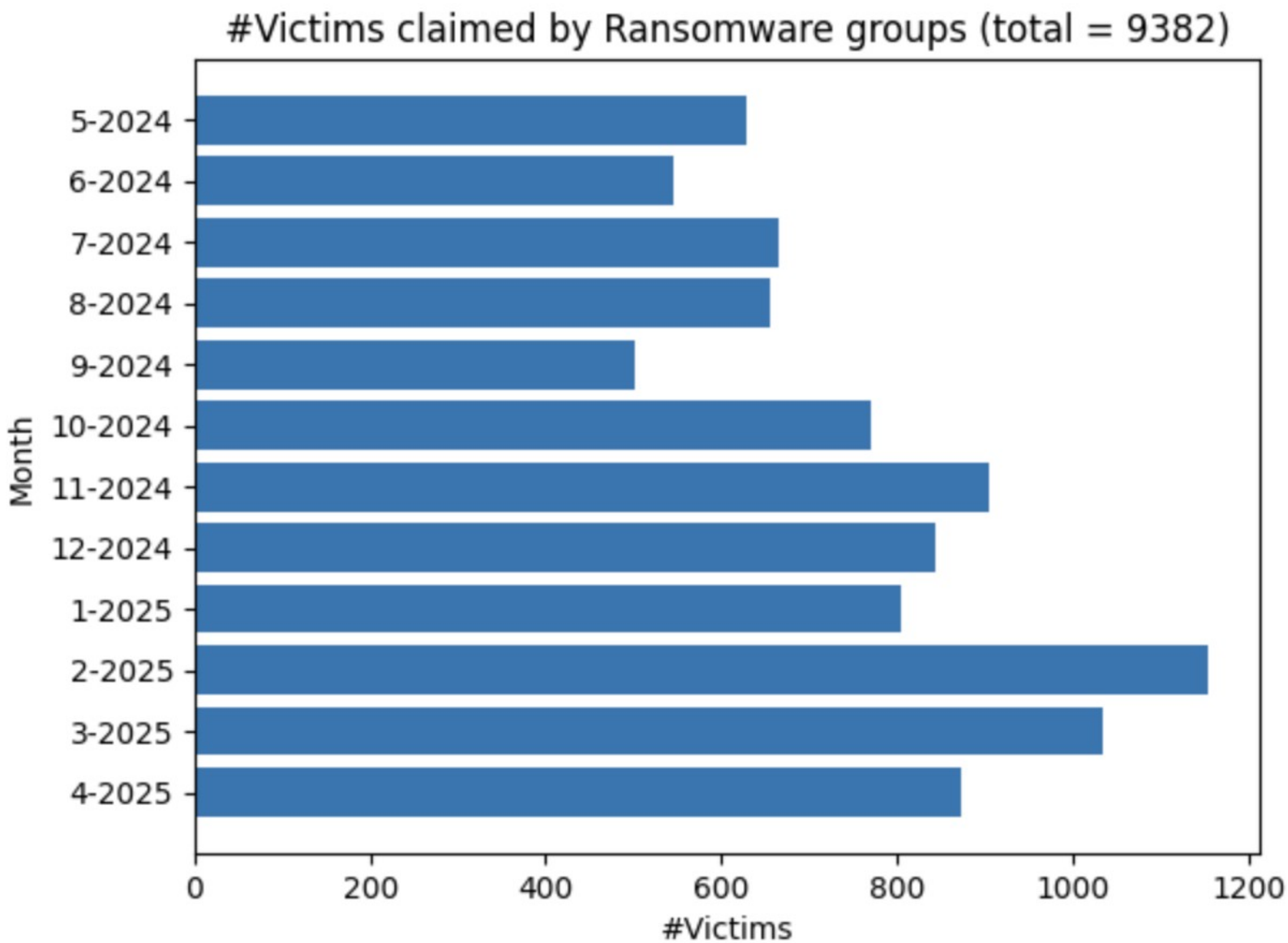
3.4K 22:06


#Victims claimed by Ransomware groups (total = 9382)
Month
5-2024
6-2024
7-2024
8-2024
9-2024
10-2024
11-2024
12-2024
1-2025
2-2025
3-2025
4-2025
0
200
400
600
800
1000
1200
#Victims

Donex ransomeware leakage

Home About Archives

mirel

Nous sommes votre partenaire en matière de recrutement et de sélection. Nous nous déplaçons sans en gagement en entreprise afin de { ... }

2024.02.27

CHOCOTOPIA

Chocotopia is a center of entertainment in the heart of Prague. You can visit here Museum of Chocola and experience Chocolate { ... }

2024.02.27

elsapspa

Da oltre 50 anni, Elsap è un'impresa dedita alla rappresentanza e alla distribuzione di componenti ele onici ed elettromeccanici { ... }

2024.02.24

Donex ransomeware leakage

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CHOCOTOPIA

2024-02-27 |

Chocotopia is a center of entertainment in the heart of Prague.

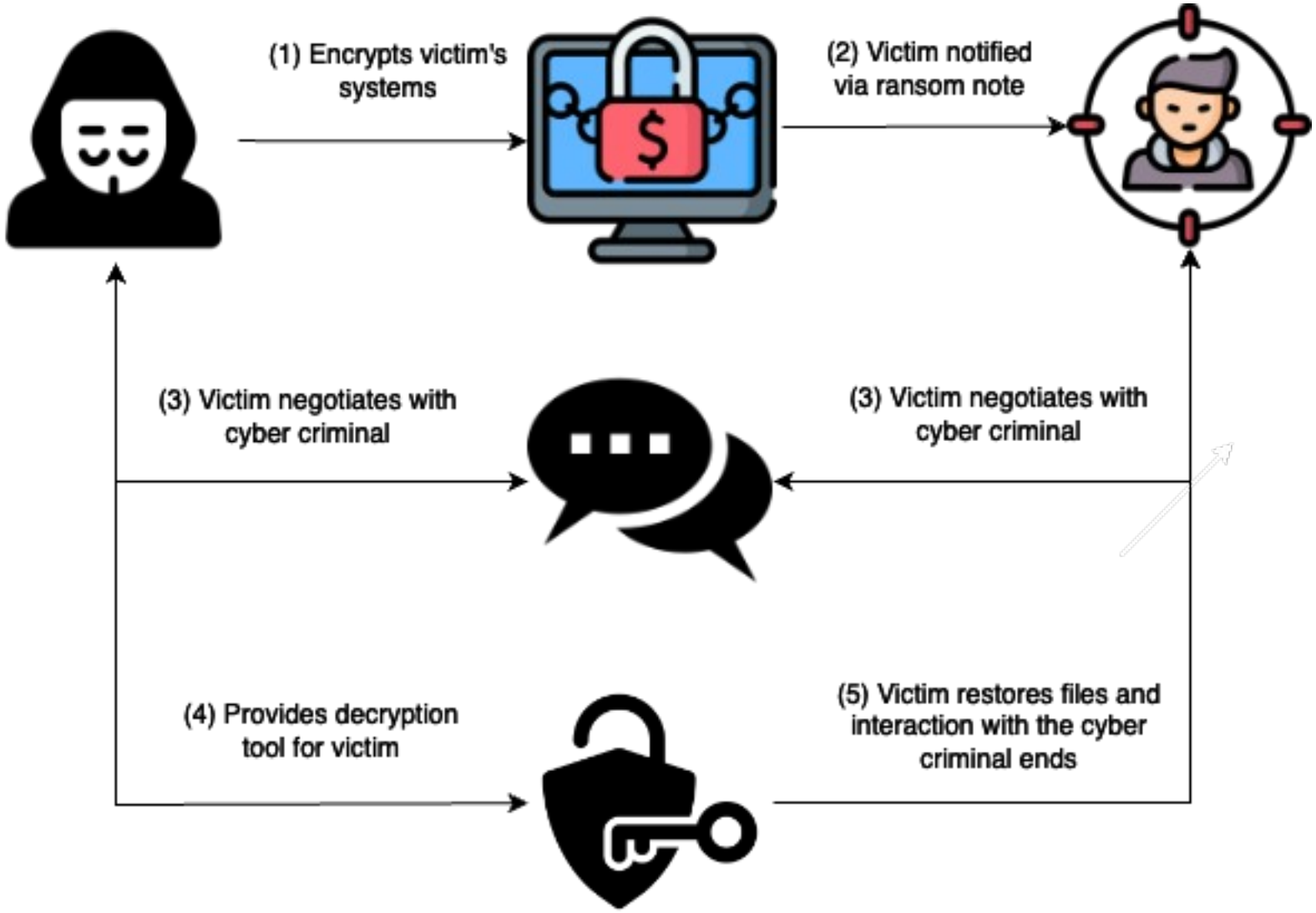
You can visit here Museum of Chocolate and experience Chocolate workshops, Wax museum of legends by Grévin, Candy shop, and our Snack @ dessert bar.

Currently, our new Chocotopia Experience center is open and looking forward for visitors, who are looking for unique adventure.

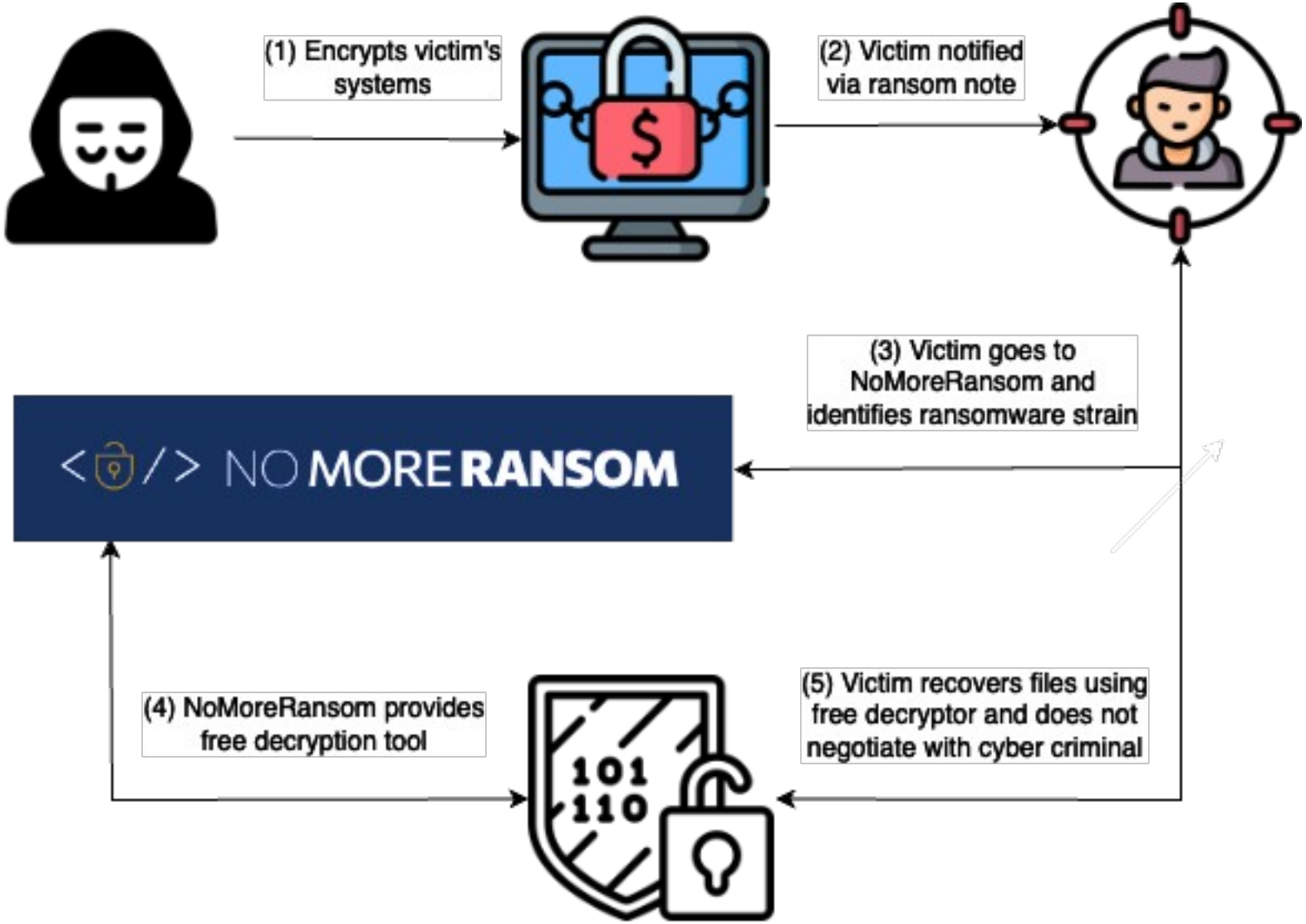
Website: www.chocotopia.cz

Total leaked:33GB

How the cyber criminal plans it

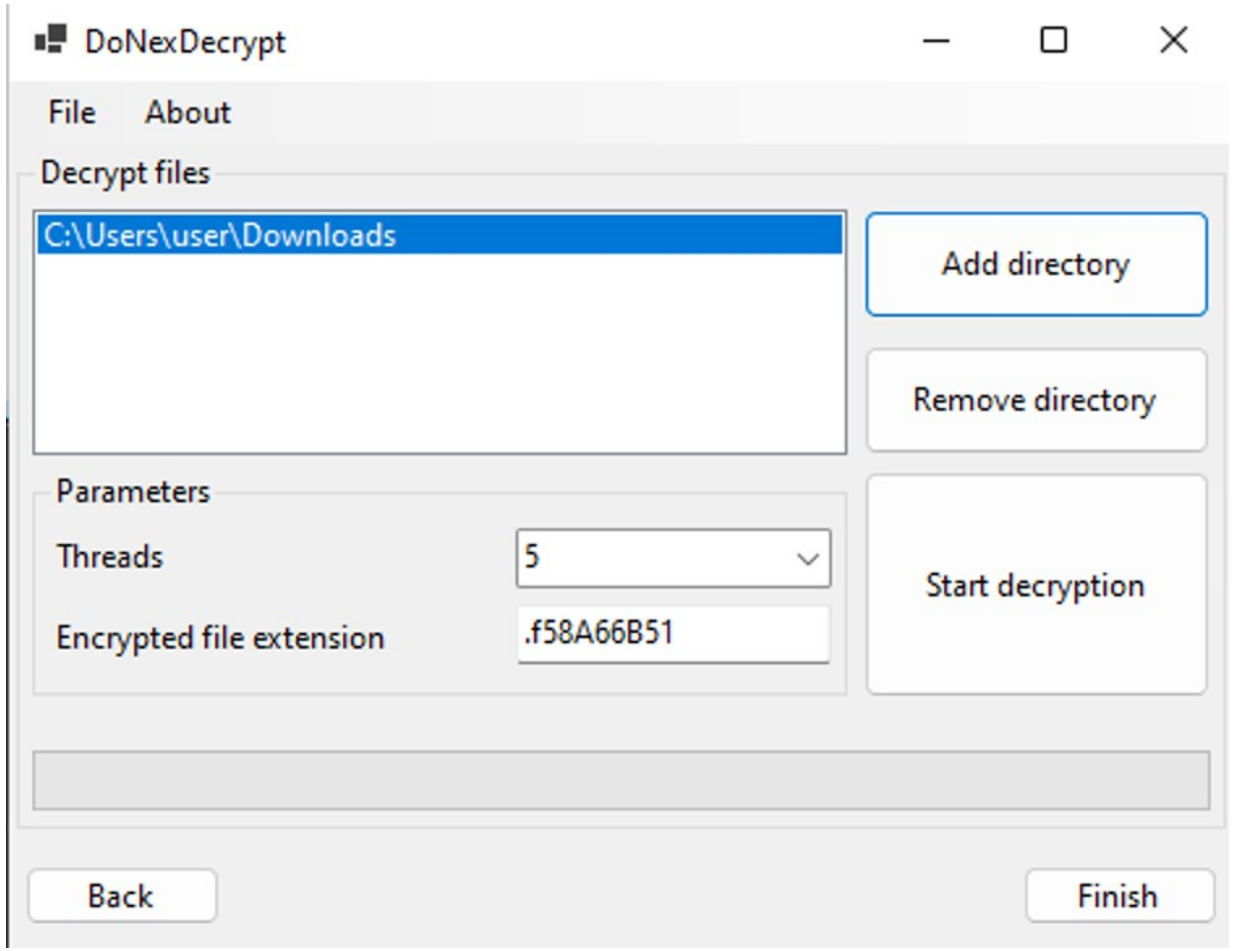


How we plan it



Building a decryptor

- Implements inverse logic of ransomware
- Based on
  - Cryptographic weakness
  - Leaked decryption keys



Distributing decryptors

Upload encrypted files here (size cannot be larger than 1 MB)

Choose first file from PC

Choose second file from PC

Type below any email, website URL, onion or/and bitcoin address you see in the RANSOM DEMAND. Note: Be especially accurate with the spelling.

Or upload the file (.txt or .html) with the ransom note left by criminals

Go! Find out

TO TOP

The general advice is not to pay the ransom. By sending your money to cybercriminals you'll only confirm that ransomware works, and there's no guarantee you'll get the decryption key you need in return.

EUROPOL POLITIE

Powered by:

powered by aws Barracuda

And now... DoNeX

```
if ( CreateMutexA(0, 1, "CheckMutex") && GetLastError() == ERROR_ALREADY_EXISTS )
{
  _loaddll(0);
  JUMPOUT(0x403338);
}
for ( i = 0; i < 0x21C0; i += 64 )
{
  *(__m128i *)&xml_config[i] = _mm_xor_si128((__m128i)xor_key_vector, *(__m128i *)&xml_config[i]);
  *(__m128i *)&xml_config[i + 16] = _mm_xor_si128((__m128i)xor_key_vector, *(__m128i *)&xml_config[i + 16]);
  *(__m128i *)&xml_config[i + 32] = _mm_xor_si128(*(__m128i *)&xml_config[i + 32], (__m128i)xor_key_vector);
  *(__m128i *)&xml_config[i + 48] = _mm_xor_si128((__m128i)xor_key_vector, *(__m128i *)&xml_config[i + 48]);
}
for ( ; i < 0x21E7; ++i )
  xml_config[i] ^= 0xA9u;
config_ptr = maybe_parse_xml(0, (char)xml_config, (int)returns_2);
```

Execute script

Snippet list

Name

Decrypt config

Line 1 of 1

Please enter script body

```
key = 0xA9
ea = 0x435000
size = 0x21E7
patch = True

decrypted = bytearray()
for i in range(size):
    dec = get_wide_byte(ea + i) ^ key
    decrypted.append(dec)
    if patch:
        patch_byte(ea + i, dec)
print(decrypted)
```

Line:1 Column:1

The configuration

- Ransom note
- Whitelisted files / directories
- Victim-specific options

```
<?xml version="1.0" encoding="UTF-8"?>
<root>
        <white_extens>386;adv;ani;bat;bin;cab;cmd;com;cpl;cur;
        <white_files>bootmgr;autorun.inf;boot.ini;bootfont.bin
        <white_folders>$recycle.bin;config.msi;$windows.~bt;$w
        <kill_keep>sql;oracle;mysq;chrome;veeam;firefox;excel;
        <services>vss;sql;svc$;memtas;mepocs;msexchange;sophos
        <black_db>ldf;mdf</black_db>
        <encryption_thread>30</encryption_thread>
        <walk_thread>15</walk_thread>
        <local_disks>true</local_disks>
        <network_shares>true</network_shares>
        <kill_processes>true</kill_processes>
        <kill_services>true</kill_services>
        <shutdown_system>true</shutdown_system>
        <delete_eventlogs>true</delete_eventlogs>
        <cmd>wmic shadowcopy delete /nointeractive</cmd>
        <cmd>vssadmin Delete Shadows /All /Quiet</cmd>
        <content>            !!! DoNex ransomware warning !!!

&gt;&gt;&gt;&gt; Your data are stolen and encrypted
```

The Cryptography: key generation

```
random_encryption_key = generates_secure_random_key((HCRYPTPROV)&savedregs, 16);
pointer_to_footer = rsa_encrypts_buffer(random_encryption_key, 16u);
```

```
params[1] = hCryptProv;
params[2] = retaddr;
if ( CryptAcquireContextA(params, 0, 0, 1u, 0)
  || GetLastError() != -2146893802
  || (result = (char *)CryptAcquireContextA(params, 0, 0, 1u, 8u)) != 0 )
{
  pbBuffer = (PBYTE)malloc(random_len);
  memset(pbBuffer, 0, random_len);
  if ( CryptGenRandom(params[0], random_len, pbBuffer) )
  {
    v4 = 0;
    if ( random_len > 0 )
    {
      if ( (unsigned int)random_len >= 8 && unk_439E74 >= 2 )
      {
        v5 = _mm_cvtsi32_si128(6u);
        v6 = _mm_cvtsi32_si128(0x1Fu);
        do
        {
          v7 = _mm_cvtepu8_epi32(_mm_cvtsi32_si128(*(_DWORD *)&pbBuffer[v4]));
          v8 = _mm_sra_epi32(
                 _mm_add_epi32(
                   (__m128i)_mm_shuffle_ps(
                              (__m128)_mm_mul_epi32(_mm_unpacklo_epi32(v7, v7), (__m128i)xmmword_4293F0),
                              (__m128)_mm_mul_epi32(_mm_unpackhi_epi32(v7, v7), (__m128i)xmmword_4293F0),
                              221),
```

Following the trail

xrefs to random_encryption_key

Direction	Typ	Address	Text	
Up	r	encrypts_file_mode_1+203	push	random_encryption_key
Up	r	clears_event_logs_and_s...	mov	eax, random_encryption_key
Up	w	clears_event_logs_and_s...	mov	random_encryption_key, 0
	w	extract_config_and_prep...	mov	random_encryption_key, eax
D...	r	encrypts_local_file+37C	push	random_encryption_key

Line 1 of 5

Help Search

```
    FileW = CreateFileW(lpNewFileName, 0xC0000000, 0, 0, OPEN_EXISTING, 0x80u, 0);// Open file with GENERIC_READ | GENERIC_WRITE.
    if ( FileW != (HANDLE)-1 )
    {
      Size = 0;
      v16 = (unsigned __int64)(file_size.QuadPart / (unsigned int)number_of_blocks) >> 32;
      v21 = v16;
      v22 = file_size.QuadPart / (unsigned int)number_of_blocks;
      i = 0;
      do
      {
        lpNewFileName = (LPCWSTR)((__PAIR64__(v16, v22)) >> 32);
        v18 = i * v22;
        SetFilePointer(FileW, i * v22, (PLONG)&lpNewFileName, 0);
        ReadFile(FileW, lpBuffer, read_block_size, &NumberOfBytesRead, 0);
        salsa20_encrypt((int)random_encryption_key, 1, &v20, 0, (int)lpBuffer, read_block_size);// State reinitialized every time
        SetFilePointer(FileW, v18, (PLONG)&lpNewFileName, 0);
        v20 = lpBuffer;
        WriteFile(FileW, lpBuffer, read_block_size, &NumberOfBytesRead, 0);
        v16 = v21;
        i = Size + 1;
        Size = i;
      }
      while ( i < number_of_blocks );
      SetFilePointerEx(FileW, file_size, 0, 0);
      WriteFile(FileW, pointer_to_footer, 0x200u, &NumberOfBytesRead, 0);// Writes footer, size = 512 bytes
      CloseHandle(FileW);
      write_ransom_note(lpFileName);
      if ( v19 )
        j___free_base(v19);
    }
  }
}
```

The encryption function

```
        __int64 *nonce_ptr,
        unsigned int a4,
        PBYTE buffer,
        int buffer_length)
{
  void *key_schedule_proc; // edx
  PBYTE v7; // eax
  unsigned int v8; // ebx
  int v9; // edi
  BYTE *v10; // eax
  int v11; // esi
  BYTE *v12; // ecx
  char keystream[64]; // [esp+0h] [ebp-50h] BYREF
  __int64 nonce_int64; // [esp+40h] [ebp-10h] BYREF
  __int64 v16; // [esp+48h] [ebp-8h]
  void *use_128_bita; // [esp+5Ch] [ebp+Ch]
  PBYTE buffera; // [esp+68h] [ebp+18h]

  key_schedule_proc = salsa20_schedule_32;
  if ( use_128_bit )
    key_schedule_proc = 0;
  v16 = 0LL;
  if ( use_128_bit == 1 )
    key_schedule_proc = salsa20_schedule_16;
  use_128_bita = key_schedule_proc;
  if ( !key_schedule_proc )
    return 1;
  if ( !encryption_key )
    return 1;
  if ( !nonce_ptr )
    return 1;
  v7 = buffer;
  if ( !buffer )
    return 1;
  v8 = a4;
  nonce_int64 = *nonce_ptr;
  if ( (a4 & 0x3F) != 0 )
  {
    LOBYTE(v16) = a4 >> 6;
    BYTE1(v16) = a4 >> 14;
    BYTE2(v16) = a4 >> 22;
    BYTE3(v16) = a4 >> 30;
    ((void (__cdecl *)(PBYTE, __int64 *, char *))key_schedule_proc)(encryption_key, &nonce_int64,
    v7 = buffer;
```

```
unsigned int __cdecl salsa20_schedule_32(int a1, int a2, int a3)
{
  int v3; // esi
  int v4; // edi
  unsigned int v5; // kr00_4
  int v6; // ecx
  int v8; // edx
  int v9; // edi
  char v10; // al
  int v11; // esi
  int v12; // edx
  int v13; // ecx
  int v14; // eax
  int v15; // edx
  int v16; // edx
  unsigned int v17; // ecx
  unsigned int result; // eax
  int v19[16]; // [esp+Ch] [ebp-90h]
  int v20[16]; // [esp+4Ch] [ebp-50h] BYREF
  int state[4]; // [esp+8Ch] [ebp-10h] BYREF

  qmemcpy(state, "expand 32-byte k", sizeof(state));
  v3 = a3 + 1;
```

```
unsigned int __cdecl salsa20_schedule_16(char *a1, int a2, int a3)
{
  int v3; // esi
  int v4; // edi
  unsigned int v5; // kr00_4
  _BYTE *v6; // edx
  char *v7; // ecx
  int v8; // esi
  char v9; // al
  int v10; // esi
  int v11; // edi
  int v12; // edx
  int v13; // ecx
  int v14; // eax
  int v15; // edx
  int v16; // edx
  unsigned int v17; // ecx
  unsigned int result; // eax
  int v19[16]; // [esp+Ch] [ebp-90h]
  int v20[16]; // [esp+4Ch] [ebp-50h] BYREF
  int v21[4]; // [esp+8Ch] [ebp-10h] BYREF

  qmemcpy(v21, "expand 16-byte k", sizeof(v21));
```

Salsa20 or ChaCha20?

```
#include <stdint.h>
#define ROTL(a,b) (((a) << (b)) | ((a) >> (32 - (b))))
#define QR(a, b, c, d)(      \
    b ^= ROTL(a + d, 7),     \
    c ^= ROTL(b + a, 9),     \
    d ^= ROTL(c + b,13),     \
    a ^= ROTL(d + c,18))
#define ROUNDS 20
```

The constant is the same as Salsa20 ("expand 32-byte k"). ChaCha replaces the Salsa20 quarter-round `QR(a, b, c, d)` with:

```
a += b; d ^= a; d <<<= 16;
c += d; b ^= c; b <<<= 12;
a += b; d ^= a; d <<<= 8;
c += d; b ^= c; b <<<= 7;
```

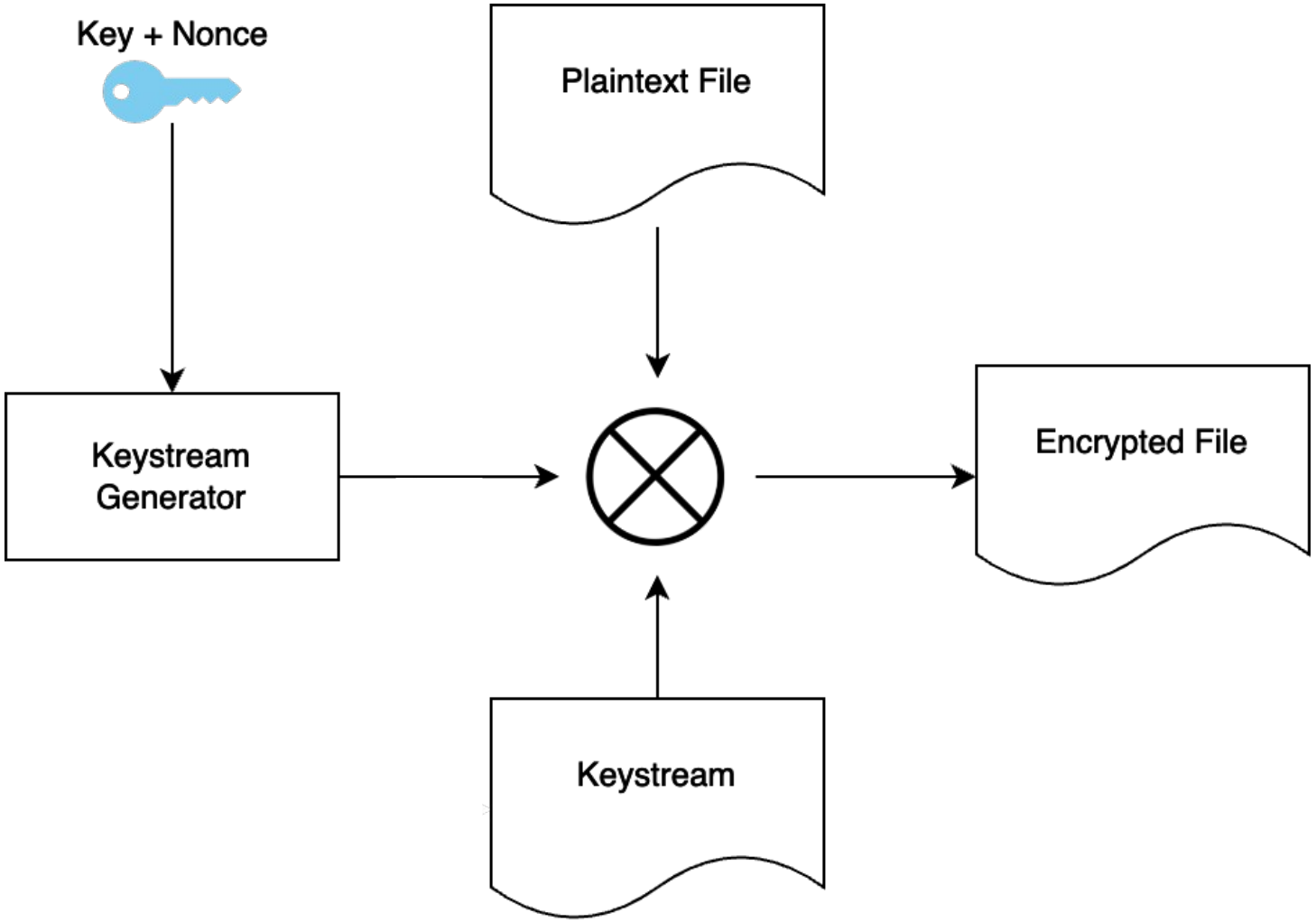
```
int __cdecl salsa20_key_expansion(_DWORD *a1)
{
  int result; // eax

  a1[4] ^= __ROL4__(*a1 + a1[12], 7);
  a1[8] ^= __ROL4__(a1[4] + *a1, 9);
  a1[12] ^= __ROL4__(a1[8] + a1[4], 13);
  *a1 ^= __ROR4__(a1[12] + a1[8], 14);
  a1[9] ^= __ROL4__(a1[5] + a1[1], 7);
  a1[13] ^= __ROL4__(a1[9] + a1[5], 9);
  a1[1] ^= __ROL4__(a1[13] + a1[9], 13);
  a1[5] ^= __ROR4__(a1[1] + a1[13], 14);
  a1[14] ^= __ROL4__(a1[10] + a1[6], 7);
  a1[2] ^= __ROL4__(a1[14] + a1[10], 9);
  a1[6] ^= __ROL4__(a1[2] + a1[14], 13);
  a1[10] ^= __ROR4__(a1[6] + a1[2], 14);
  a1[3] ^= __ROL4__(a1[15] + a1[11], 7);
  a1[7] ^= __ROL4__(a1[3] + a1[15], 9);
  a1[11] ^= __ROL4__(a1[7] + a1[3], 13);
  result = __ROR4__(a1[11] + a1[7], 14);
  a1[15] ^= result;
  return result;
}
```

Key in global variable, nonce is zero...

```
xxd -l 128 check2.xlsx f58A66B51
00000000: ed97 e2de 5249 c056 2236 5bb4 1791 37e9  ....RI.V"6[...7.
00000010: 8d43 7726 2542 d2af d7a2 b50f 2797 d94c  .Cw&%B......'..L
00000020: 3100 06bb b3a0 c832 fa4b 53ae 83c7 71a5  1......2.KS...q.
00000030: 0339 a23f 078c 1570 bb9f 6669 db15 d25d  .9.?...p..fi...]
00000040: 2f65 d38c b8f2 7259 5de5 d23a 9d15 2b2b  /e....rY]..:..++
00000050: 35c8 578f 8fba 20e9 7f30 7d72 7b6c 7e97  5.W... ..0}r{l~.
00000060: ec93 af84 b557 9e46 1d05 19f6 7832 940a  .....W.F....x2..
00000070: 3674 70c0 4567 821f e8e8 ae17 a1d3 08d2  6tp.Eg..........
```

```
xxd -l 128 check.xlsx f58A66B51
00000000: ed97 e2de 5249 c056 2236 5bb4 1791 37e9  ....RI.V"6[...7.
00000010: 8d43 7726 2542 d2af d7a2 b50f 2797 d94c  .Cw&%B......'..L
00000020: 3100 06bb b3a0 c832 fa4b 53ae 83c7 71a5  1......2.KS...q.
00000030: 0339 a23f 078c 1570 bb9f 6669 db15 d25d  .9.?...p..fi...]
00000040: 2f65 d38c b8f2 7259 5de5 d23a 9d15 2b2b  /e....rY]..:..++
00000050: 35c8 578f 8fba 20e9 7f30 7d72 7b6c 7e97  5.W... ..0}r{l~.
00000060: ec93 af84 b557 9e46 1d05 19f6 7832 940a  .....W.F....x2..
00000070: 3674 70c0 4567 821f e8e8 ae17 a1d3 08d2  6tp.Eg..........
```

Stream ciphers & re-using key material



The XOR operation

A	B	A xor B
0	0	0
1	0	1
0	1	1
1	1	0

$$A \otimes B = C$$

$$A \otimes 0 = A$$

$$A \otimes A = 0$$

$$B \otimes C = A$$

Recovering the keystream

A = plaintext

C = ciphertext

K = keystream

$$A \otimes K = C$$

$$C \otimes A = K$$

In practice, it's not that easy

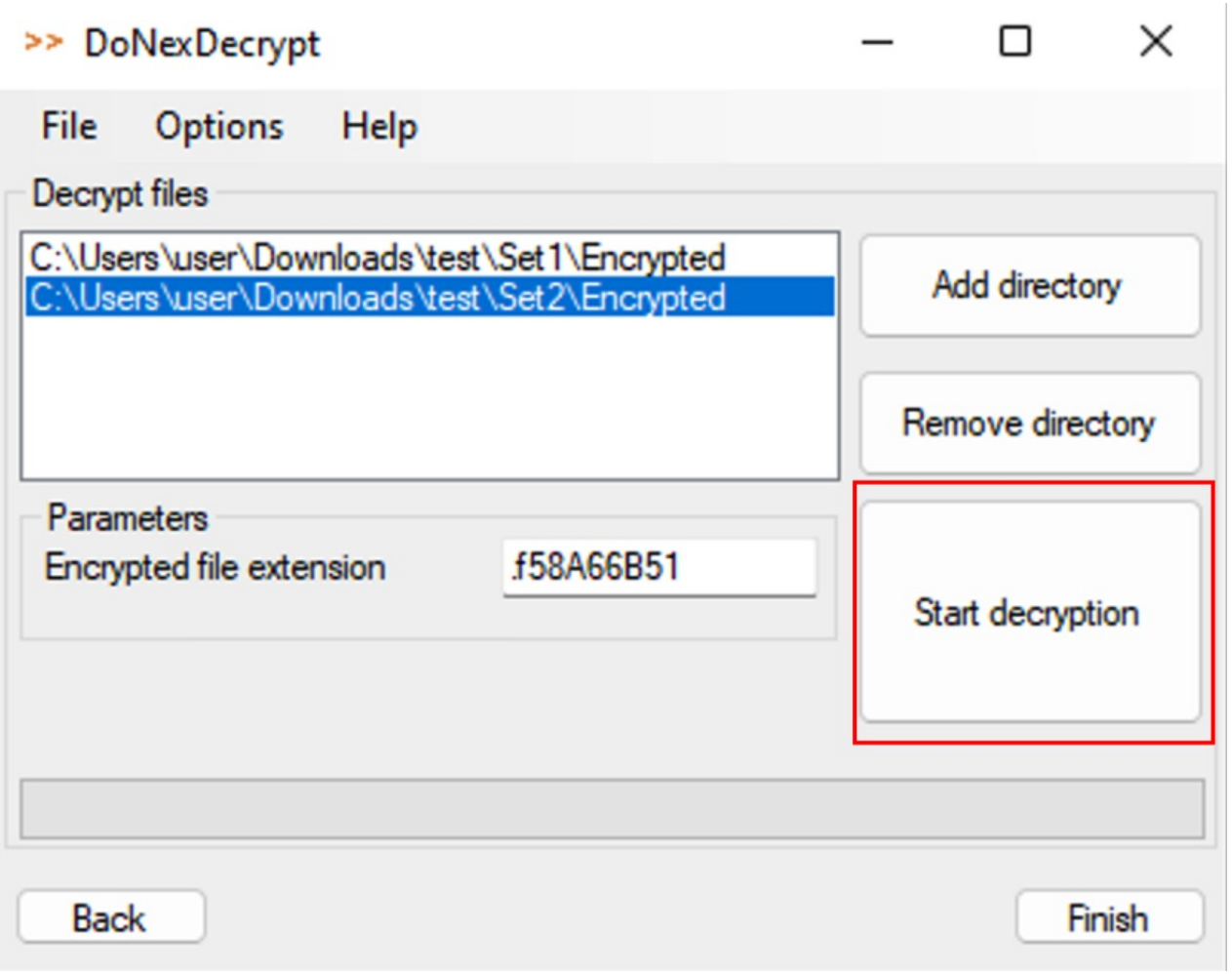
File Size	Encrypted
< 1MiB	Entire file
<10MiB	First 1MiB
<100MiB	5 blocks of 1MiB
>100MiB	100 blocks of 1MiB

```
  if ( !lpFileName )
    return;
  salsa20_nonce = 0LL;
  number_of_blocks = 1;
  if ( file_size.HighPart > 0 )
    goto LABEL_10;
  if ( file_size.QuadPart > 0x100000 )
  {
    if ( file_size.HighPart < 0 || file_size.LowPart <= 0xA00000 )
      goto LABEL_11;
    if ( file_size.LowPart <= 0x6400000 )
    {
      number_of_blocks = 5;
LABEL_11:
      read_block_size = 0x100000;
      goto LABEL_12;
    }
LABEL_10:
    number_of_blocks = 100;
    goto LABEL_11;
  }
  read_block_size = file_size.LowPart;
  if ( file_size.LowPart )
  {
LABEL_12:
    lpBuffer = malloc(read_block_size);
    memset(lpBuffer, 0, read_block_size);
```

In practice, it’s not that easy

```
    FileW = CreateFileW(lpNewFileName, 0xC0000000, 0, 0, OPEN_EXISTING, 0x80u, 0);// Open file with GENERIC_READ | GENERIC_WRITE.
    if ( FileW != (HANDLE)-1 )
    {
      Size = 0;
      v16 = (unsigned __int64)(file_size.QuadPart / (unsigned int)number_of_blocks) >> 32;
      v21 = v16;
      v22 = file_size.QuadPart / (unsigned int)number_of_blocks;
      i = 0;
      do
      {
        lpNewFileName = (LPCWSTR)((i * __PAIR64__(v16, v22)) >> 32);
        v18 = i * v22;
        SetFilePointer(FileW, i * v22, (PLONG)&lpNewFileName, 0);
        ReadFile(FileW, lpBuffer, read_block_size, &NumberOfBytesRead, 0);
        salsa20_encrypt((int)random_encryption_key, 1, &v20, 0, (int)lpBuffer, read_block_size);// State reinitialized every time
        SetFilePointer(FileW, v18, (PLONG)&lpNewFileName, 0);
        v19 = lpBuffer;
        WriteFile(FileW, lpBuffer, read_block_size, &NumberOfBytesRead, 0);
        v16 = v21;
        i = Size + 1;
        Size = i;
      }
      while ( i < number_of_blocks );
      SetFilePointerEx(FileW, file_size, 0, 0);
      WriteFile(FileW, pointer_to_footer, 0x200u, &NumberOfBytesRead, 0);// Writes footer, size = 512 bytes
      CloseHandle(FileW);
      writes_ransom_note(lpFileName);
      if ( v19 )
        j___free_base(v19);
    }
  }
}
```

Putting it all together



Meme from Dynexo GmbH