EXPLORING THE CHINESE DDOS THREAT LANDSCAPE

Nacho Sanmillan
Intezer, Israel

nacho@intezer.com

ABSTRACT

Chinese threat actors have been shown to be predominant in the DDoS ecosystem, there being a high volume of known cross-platform DDoS botnets with alleged Chinese origin operating in *Linux* as well as *Windows* systems and exercising long-term activities over the years.

In this paper we will begin with a brief overview of the current most predominant Chinese threat groups, ChinaZ and Nitol, along with some other subgroups.

We will cover their motivations, some of their malware characteristics, and how long they have been operational along with an overview of each group's background.

Furthermore, we will cover a range of code and artifact similarities between the groups and our give own interpretation of such connections. We will also discuss how Chinese threat groups may seem to be sharing code, showing different cases of code similarities between different families and a case study involving a specific Gh0st RAT variant found in the wild that has been seen in several Chinese threat actor campaigns, including some involving an APT.

Finally, we will summarize our findings and suggest future points of investigation.

INTRODUCTION

In recent years, there has been a significant rise in DDoS attacks, a large proportion of which have been considered to have Chinese origins. Furthermore, China has emerged as having one of the highest rates of DDoS attacks [1]. An example of these attacks is one that targeted *GitHub* in February 2018 [2] that was linked to a campaign against the anti-censorship project GreatFire [3], forcing the website to go offline for approximately 10 minutes. Another example is the attack against Telegram on 12 June 2019 that was linked with Hong Kong protests [4] against changes in extradition bills.

This series of events shows that a high volume of DDoS operations originate in China. In addition, there is a highly populated and growing community of DDoS threat actors with alleged Chinese origin that have recorded long-term activities.

The Chinese DDoS threat landscape has been found to be complicated in terms of classification, leading to misinterpretations – for example, classifying groups to later find out that specific groups are composed of several subgroups and the other way around, leading the community to use different names to reference, in essence, the same group.

The hierarchy of these groups is not clearly known, nor is it known whether they are part of the same collective. We will be breaking apart some of the most well-known Chinese DDoS groups, revealing bonds that might correlate some of these groups and that might potentially uncover some further leads on how this community operates.

2. NOTORIOUS CHINESE DDOS THREAT ACTORS

Among the vast number of Chinese DDoS groups, we highlight two groups which will be the main protagonists of this paper: ChinaZ and Nitol.

2.1 ChinaZ

ChinaZ is an alleged Chinese threat group first reported by *MalwareMustDie* in November 2014 [5]. This threat group was discovered operating several multi-platform DDoS botnets targeting *Linux* and *Windows* systems.

It is important to mention that this group has deployed what may be some of the current most predominant DDoS botnets targeting *Linux* systems, having developed Linux.Elknot along with its predecessor Linux.BillGates.

This group is known to have been in operation since late 2013 and has the ability to deploy several different DDoS attack methodologies.

In 2014, *Avast* researchers Peter Kálnai and Jaromír Horejší presented an extensive piece of research on ChinaZ's cross-platform DDoS tools [6].

Furthermore, in 2016, researchers Ya Liu and Hui Wang from *Qihoo 360* presented their findings regarding BillGates [7], in which they explained the several DDoS attacks that the group had conducted, in particular two attacks deployed against 12 root name servers in 2015 [8].

2.1.1 ChinaZ deployed DDoS botnets

Apart from the Elknot/BillGates DDoS botnets, ChinaZ is known to have developed many others. Figure 1 shows a timeline of some of the malware believed to be linked to ChinaZ.

Figure 1: ChinaZ malware timeline.

We can see that this group started developing DDoS botnets as early as the end of 2013 with the development of Elknot/DNSAmp. 2014 to 2015 was the period in which the greatest volume of malware was developed by this group, implementing seven new DDoS bot strains: BillGates, AESDDoS, IptableX, XorDDoS, MrBlack, DDoSClient and ChinaZ.DDoS. From 2016 to 2018 this group seems not to have been very active, the number of new malware strains dropping considerably. In 2019 a new DDoS bot malware with connections to Elknot was discovered, known as ChaChaBot.

The common victims of this group have been small to medium-sized local businesses, online gaming sites, e-commerce shops and forums.

Monetization has been achieved by deploying DDoS attacks as a service and demanding a ransom to stop the specified attacks.

An interesting fact about the progression of this threat actor group, based on claims made by *MalwareMustDie*, is that at some point ChinaZ recruited students to develop some of its malware. This was the case with DDoSClient.

Furthermore, some of these families have been seen being served together in HTTP file servers (also commonly known as HFS), which is the general way these Chinese malware families have been seen hosted. Figures 2–4 show some different ChinaZ malware families being hosted together.

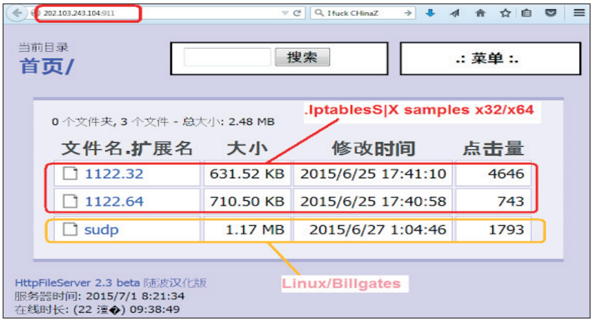


Figure 2: BillGates and Iptables (source: MalwareMustDie).

Figure 3: MrBlack and ChinaZ (source: MalwareMustDie).

Figure 4: DDoSClient and BillGates (source: Intezer).

In addition, all these different families share a common code base. We can easily spot this by plotting a graph based on code-reuse connections with an already classified corpus of 34 x86 binaries belonging to the different ChinaZ families against our ELF corpus database composed of hundreds of thousands of classified ELF binaries in which 80% are x86 files. This code reuse analysis is based on genetic analysis – meaning that the code comparison is based on small, already classified fragments of code, excluding common code fragments such as code seen in libraries and other irrelevant pieces of code. The results are shown in Figure 5.

We can differentiate two different clusters, mainly dividing all families discovered from 2014 to 2016 in one cluster and ChaChaBot, which was discovered during 2018, in the other. Each node in the graph represents a different file and edges represent code connections based on genetic analysis. The colour of each node represents the weight of genes for that specific file, and each colour represents the weight of each connection in terms of genes, where darker colours represent a higher weight and lighter colours represent a lower weight of connections.

Furthermore, these two clusters show that the presented Chinese DDoS malware families do share a substantial amount of code.

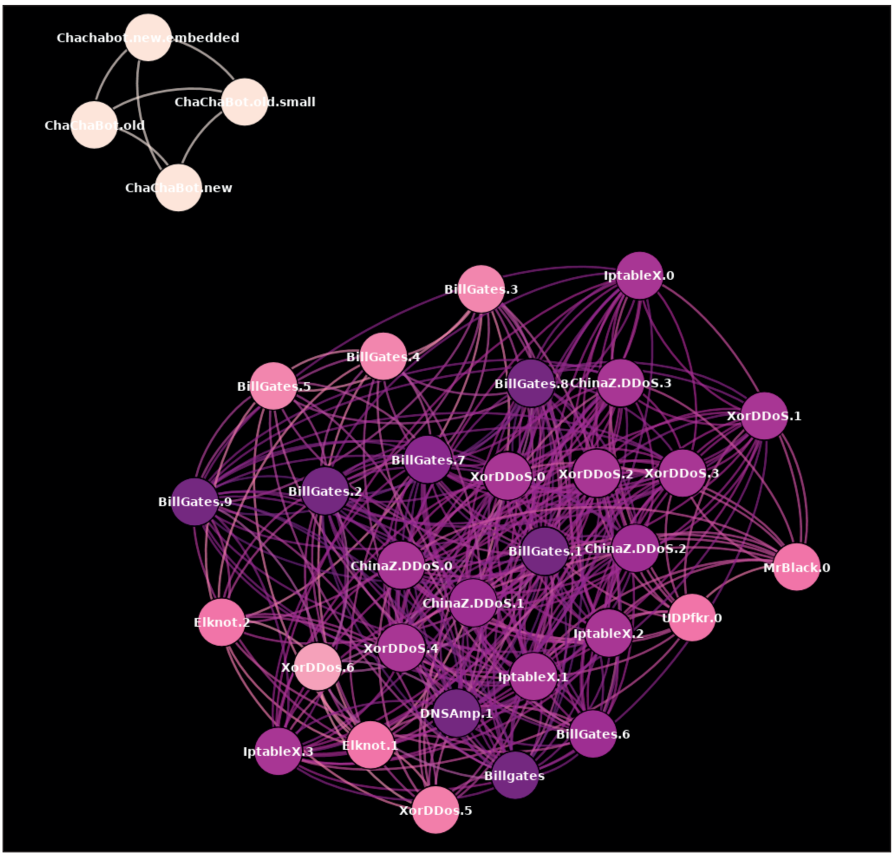
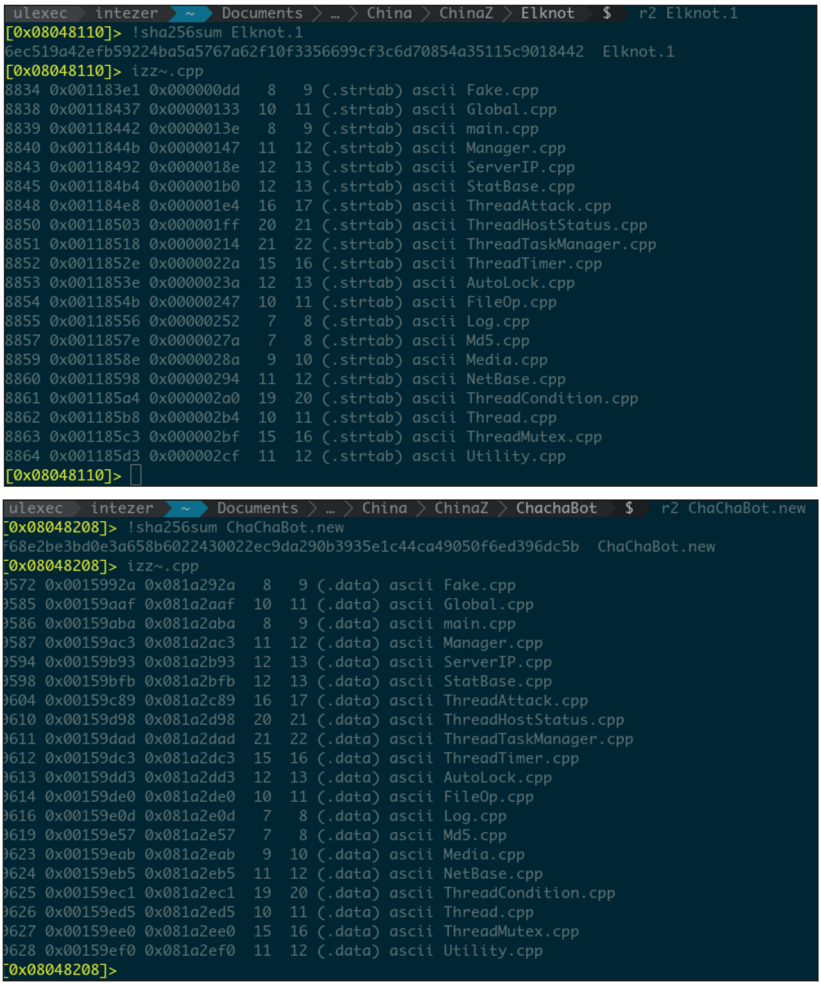


Figure 5: ChinaZ code reuse.

ChaChaBot allegedly ported code from Elknot, although this common shared code base seems to be significantly different from the original Elknot code, which may imply that it was highly modified. This theory does make sense, especially considering that there is a four-year gap between Elknot and the ChaChaBot family, so it is perfectly feasible that ChaChaBot has integrated some modified Elknot code.

By analysing some of the ChaChaBot binaries, we observed that some of the functions that had been reused from Elknot had the same names as previously seen in Elknot samples, including source code file names (Figure 6).



```
ulexec  intezer  ~  Documents  …  China  ChinaZ  Elknot  $  r2 Elknot.1
[0x08048110]> !sha256sum Elknot.1
6ec519a42efb59224ba5a5767a62f10f3356699cf3c6d70854a35115c9018442  Elknot.1
[0x08048110]> izz~.cpp
8834 0x001183e1 0x000000dd   8   9 (.strtab) ascii Fake.cpp
8838 0x00118437 0x00000133  10  11 (.strtab) ascii Global.cpp
8839 0x00118442 0x0000013e   8   9 (.strtab) ascii main.cpp
8840 0x0011844b 0x00000147  11  12 (.strtab) ascii Manager.cpp
8843 0x00118492 0x0000018e  12  13 (.strtab) ascii ServerIP.cpp
8845 0x001184b4 0x000001b0  12  13 (.strtab) ascii StatBase.cpp
8848 0x001184e8 0x000001e4  16  17 (.strtab) ascii ThreadAttack.cpp
8850 0x00118503 0x000001ff  20  21 (.strtab) ascii ThreadHostStatus.cpp
8851 0x00118518 0x00000214  21  22 (.strtab) ascii ThreadTaskManager.cpp
8852 0x0011852e 0x0000022a  15  16 (.strtab) ascii ThreadTimer.cpp
8853 0x0011853e 0x0000023a  12  13 (.strtab) ascii AutoLock.cpp
8854 0x0011854b 0x00000247  10  11 (.strtab) ascii FileOp.cpp
8855 0x00118556 0x00000252   7   8 (.strtab) ascii Log.cpp
8857 0x0011857e 0x0000027a   7   8 (.strtab) ascii Md5.cpp
8859 0x0011858e 0x0000028a   9  10 (.strtab) ascii Media.cpp
8860 0x00118598 0x00000294  11  12 (.strtab) ascii NetBase.cpp
8861 0x001185a4 0x000002a0  19  20 (.strtab) ascii ThreadCondition.cpp
8862 0x001185b8 0x000002b4  10  11 (.strtab) ascii Thread.cpp
8863 0x001185c3 0x000002bf  15  16 (.strtab) ascii ThreadMutex.cpp
8864 0x001185d3 0x000002cf  11  12 (.strtab) ascii Utility.cpp
[0x08048110]>

ulexec  intezer  ~  Documents  …  China  ChinaZ  ChachaBot  $  r2 ChaChaBot.new
0x08048208]> !sha256sum ChaChaBot.new
f68e2be3bd0e3a658b6022430022ec9da290b3935e1c44ca49050f6ed396dc5b  ChaChaBot.new
0x08048208]> izz~.cpp
572 0x0015992a 0x081a292a   8   9 (.data) ascii Fake.cpp
585 0x00159aaf 0x081a2aaf  10  11 (.data) ascii Global.cpp
586 0x00159aba 0x081a2aba   8   9 (.data) ascii main.cpp
587 0x00159ac3 0x081a2ac3  11  12 (.data) ascii Manager.cpp
594 0x00159b93 0x081a2b93  12  13 (.data) ascii ServerIP.cpp
598 0x00159bfb 0x081a2bfb  12  13 (.data) ascii StatBase.cpp
604 0x00159c89 0x081a2c89  16  17 (.data) ascii ThreadAttack.cpp
610 0x00159d98 0x081a2d98  20  21 (.data) ascii ThreadHostStatus.cpp
611 0x00159dad 0x081a2dad  21  22 (.data) ascii ThreadTaskManager.cpp
612 0x00159dc3 0x081a2dc3  15  16 (.data) ascii ThreadTimer.cpp
613 0x00159dd3 0x081a2dd3  12  13 (.data) ascii AutoLock.cpp
614 0x00159de0 0x081a2de0  10  11 (.data) ascii FileOp.cpp
616 0x00159e0d 0x081a2e0d   7   8 (.data) ascii Log.cpp
619 0x00159e57 0x081a2e57   7   8 (.data) ascii Md5.cpp
623 0x00159eab 0x081a2eab   9  10 (.data) ascii Media.cpp
624 0x00159eb5 0x081a2eb5  11  12 (.data) ascii NetBase.cpp
625 0x00159ec1 0x081a2ec1  19  20 (.data) ascii ThreadCondition.cpp
626 0x00159ed5 0x081a2ed5  10  11 (.data) ascii Thread.cpp
627 0x00159ee0 0x081a2ee0  15  16 (.data) ascii ThreadMutex.cpp
628 0x00159ef0 0x081a2ef0  11  12 (.data) ascii Utility.cpp
0x08048208]>
```

Figure 6: Some of the functions reused from Elknot in ChaChaBot samples had the same names as previously seen in Elknot samples.

We decided to apply a string-reuse analysis on the same test group. The results are shown in Figure 7.

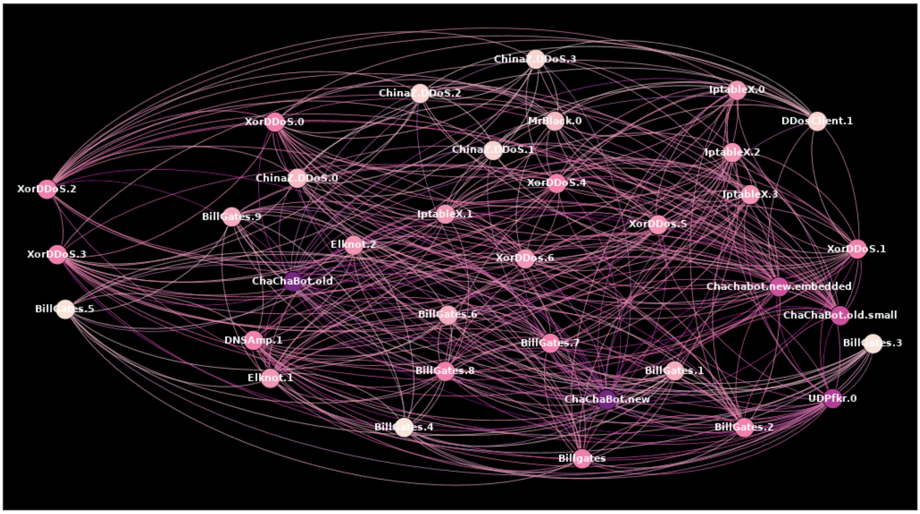


Figure 7: ChinaZ string reuse.

The graph shown in Figure 7 is a string reuse graph with the same test group. Colour schemes for nodes and edges follow the same convention as previously discussed.

The graph shows that all of the different samples, including ChaChaBot samples, reuse a substantial number of strings, reinforcing the theory that ChaChaBot adapted some Elknot code, despite there being no direct code-reuse connection.

In addition, we have millions of classified strings. In contrast with code reuse, the match is cross-platform and architecture-agnostic, meaning that we can find strings shared between tools from different operating systems and different architectures.

It has been speculated that this group has been sharing code through Chinese forums, which could have also been a source of monetization and could explain how families with modified code bases, such as ChaChaBot, have emerged.

2.2 Nitol

Nitol is a DDoS botnet that targeted mainly *Windows* systems that was first discovered around August 2011 [9]. Infections from this botnet were most prevalent in China.

Microsoft researchers in China initially discovered Nitol while investigating the sale of computers loaded with counterfeit copies of the *Windows* operating system.

It was discovered that most of the Nitol infected endpoints were brand new from the factory, implying that the malware was potentially installed somewhere during the assembly and manufacturing process, and all infected endpoints also had a counterfeit version of the *Windows* operating system.

On 10 September 2012 [10] *Microsoft* took legal action against the Nitol botnet, obtaining a court order to sinkhole one of Nitol's predominant domains for C&C communication, hosted under 3322.org [11].

2.2.1 Nitol artifacts and modus operandi

Nitol's main outstanding characteristic was that it was developed mainly to spread via removable media and mapped network shares.

The main Nitol binary comes in the form of a DLL named lpk.dll. The genuine lpk DLL is part of the Microsoft Language Pack and, by default, this DLL is loaded by every process, much like kernel32.dll.

Nitol copies itself in multiple directories and attempts to exploit the module loading process used by *Windows*. This technique is commonly known as search order hijacking – the malware loads itself into a given process virtual address space, taking precedence over the genuine target library desired to hijack, in this case lpk.dll located at System32. This technique is illustrated in Figure 8.

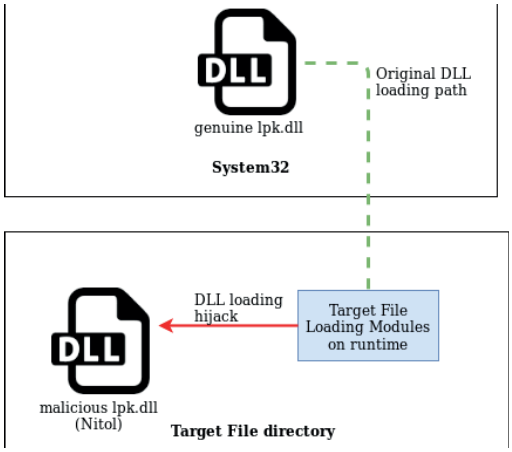


Figure 8: Nitol DLL hijacking.

The main lpk.dll Nitol library will drop several other samples with different functionalities.

The most common implant seen dropped by Nitol is a piece of malware known as ServStart.

Figure 9 is a *FireEye* description [12] of this malware.

SERVSTART (aka Nitol) is a Trojan that installs either as a binary executable or a dynamic link library and registers itself as a service. That service enables a remote user to connect to a remote server, download and run or install other malicious files, stop or restart the system, and perform distributed denial of service activities. The malware is capable of communication via TCP or UDP connections and it installs itself with a mutex to ensure a single copy of the software is installed. It is also capable of updating or uninstalling itself from a system.

Figure 9: FireEye's description of ServStart.

We at *Intezer* also came across ServStart being dropped by Nitol [13].

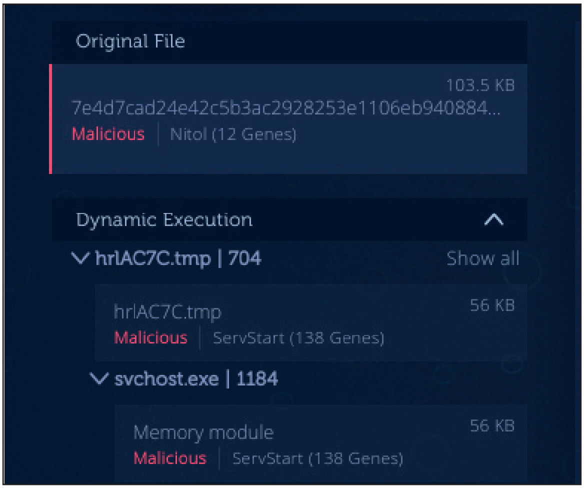


Figure 10: ServStart being dropped by Nitol [13].

Nowadays, lpk.dll infection is not commonly seen, although ServStart is a very common piece of malware seen in the wild.

3. CHINAZ AND NITOL CORRELATIONS

In this section we will go through an investigation we conducted at *Intezer* while tracking some ChinaZ servers, in which we found connections between ChinaZ and Nitol.

3.1 ChinaZ attacks discovered via honeypots

We at *Intezer* have several deployed honeypots and we monitor different malware behaviour through them. We came across an interesting intrusion conducted via SSH/Telnet credential brute-forcing.

Figure 11 is the log of the intrusion session in one of our honeypots.

The downloader bash script seems to be fairly simple in logic, changing directories from /root to /tmp once it detected that the dropped implant could not be executed, after several attempts at changing its file permissions.

Once we accessed where the script was trying to download its corresponding files, we found the files being hosted in a Chinese HTTP File Server (HFS) panel. Figure 12 is a screenshot of this panel.

3.2 Analysis of ChinaZ artifacts

As previously mentioned, ChinaZ is known to use Chinese HFS instances, and unlike other major DDoS botnets such as Mirai, ChinaZ operates mostly on *Windows* servers.

In this particular HFS server we saw various files. The two *Linux* prefixed files are both regular BillGates builds. We confirmed this based on our code reuse engine, shown in Figure 13.

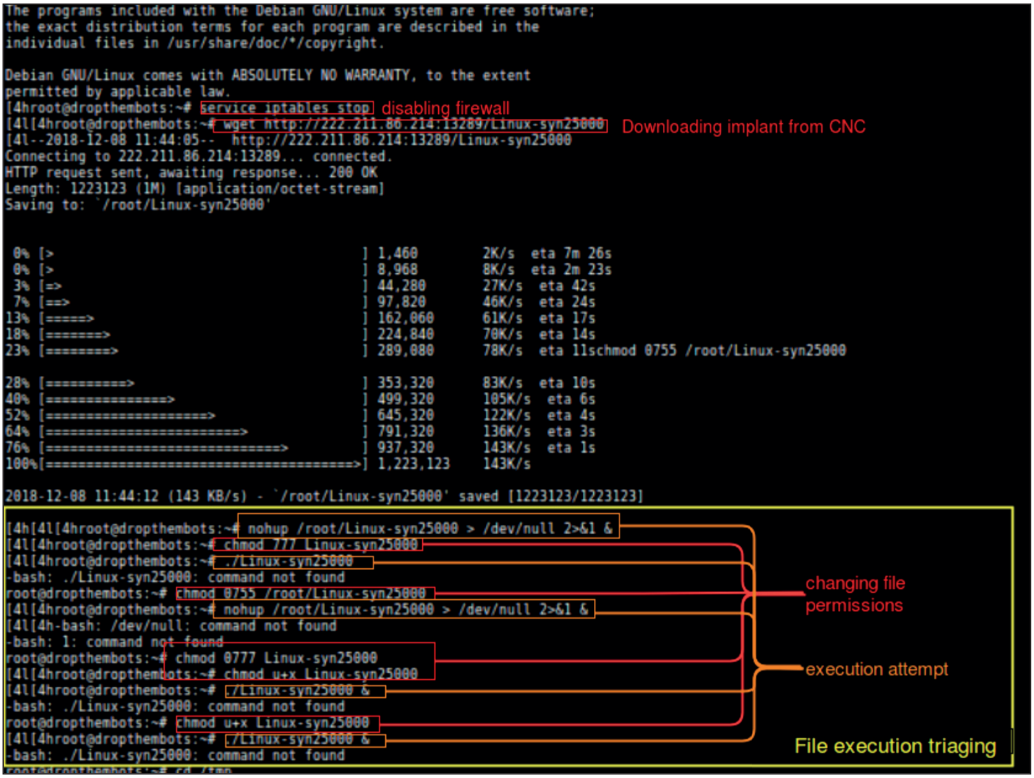


Figure 11: Log of the intrusion session in one of our honeypots.

Figure 12: ChinaZ panel.

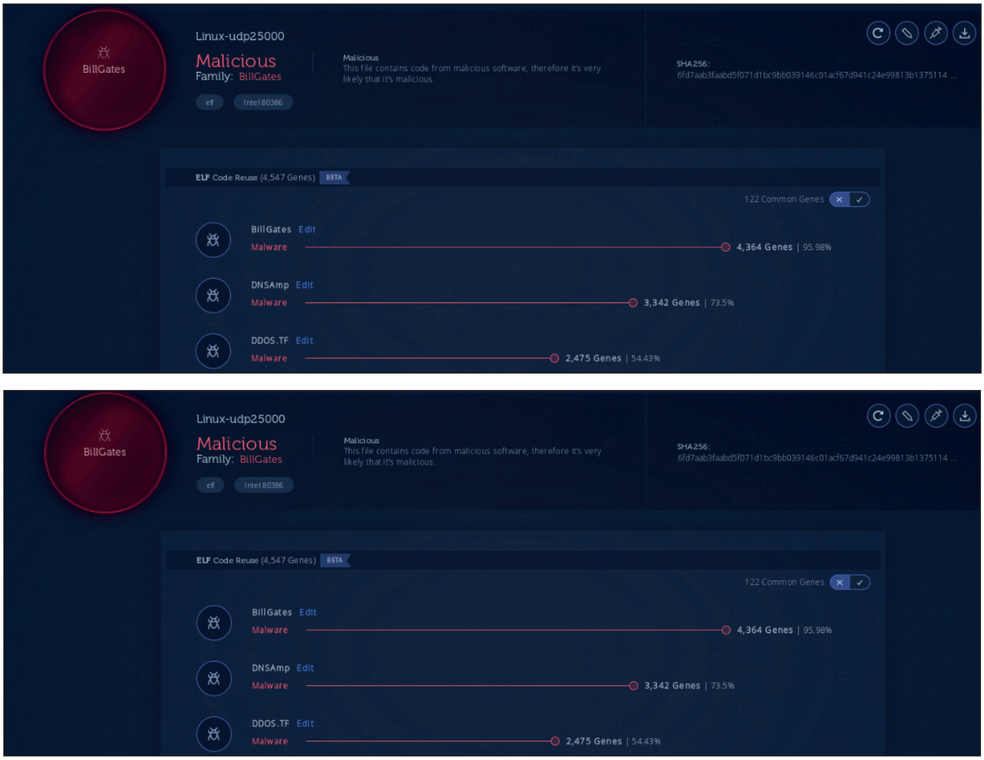


Figure 13: BillGates analysis [14, 15].

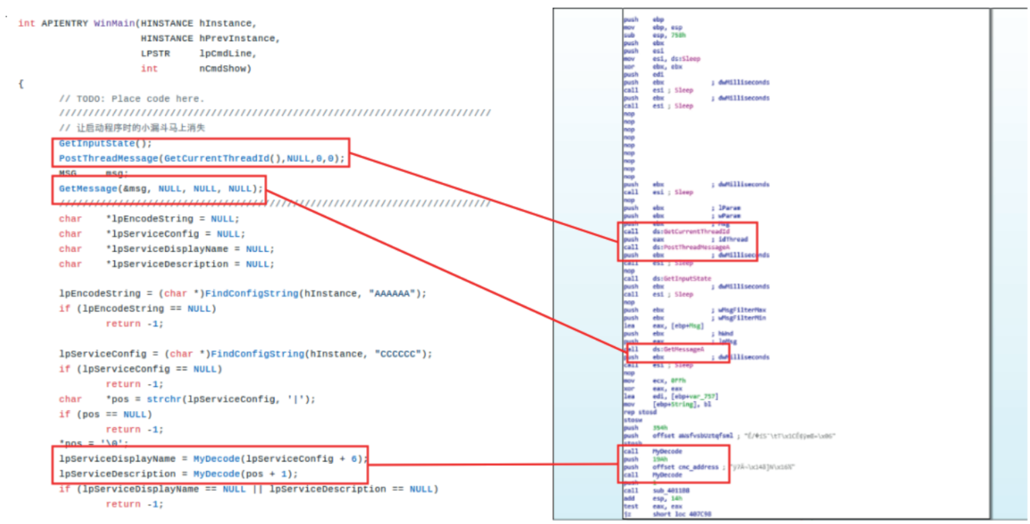


Figure 14: ChinaZ vs. Gh0st RAT source comparison.

Furthermore, we noticed a hosted *Windows* binary that we later confirmed to be a Gh0st RAT instance. Figure 14 shows a comparison with the open-source version hosted on *GitHub* [16].

We also wanted to confirm that both the BillGates and the Gh0st RAT instances were operated by the same actor, therefore we checked their C&Cs, which were found to be the same, although they communicated through different channels using different ports, as shown in Figure 15.

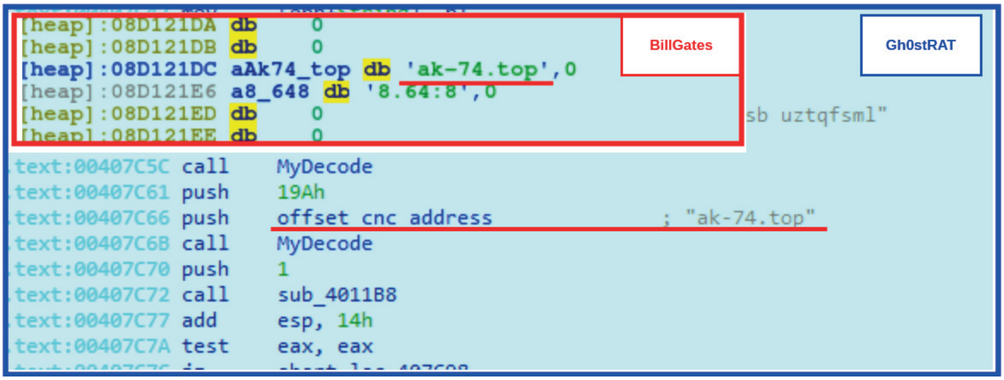


Figure 15: BillGates and Gh0st RAT instances were operated by the same actor, although they communicated through different channels using different ports.

Furthermore, we found a compressed archive labelled 'Black Wolf Linux Blasting V4.0' (in Chinese) among the different binaries hosted in the HFS server. Inside this RAR file we encountered the files shown in Figure 16.

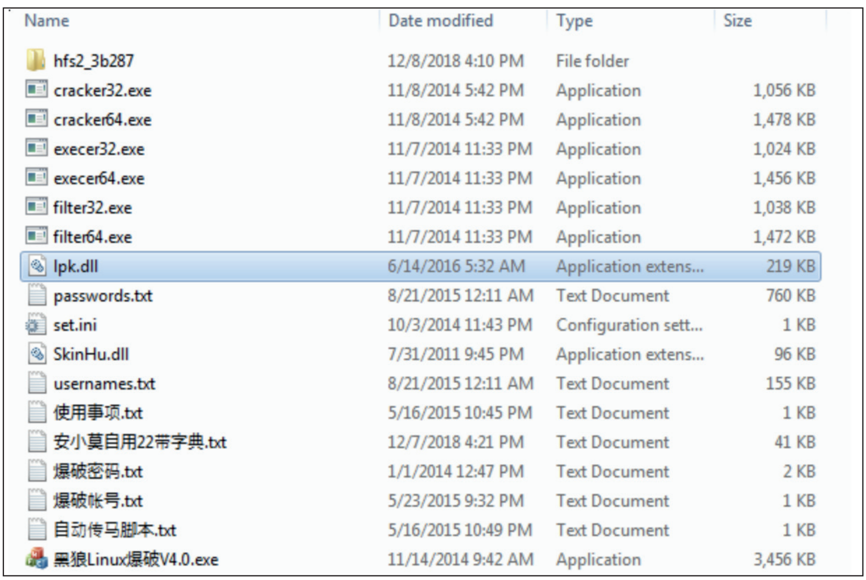


Figure 16: Contents of RAR file.

Most interestingly, the contents of the compressed archive appeared to be a Chinese DDoS tool.

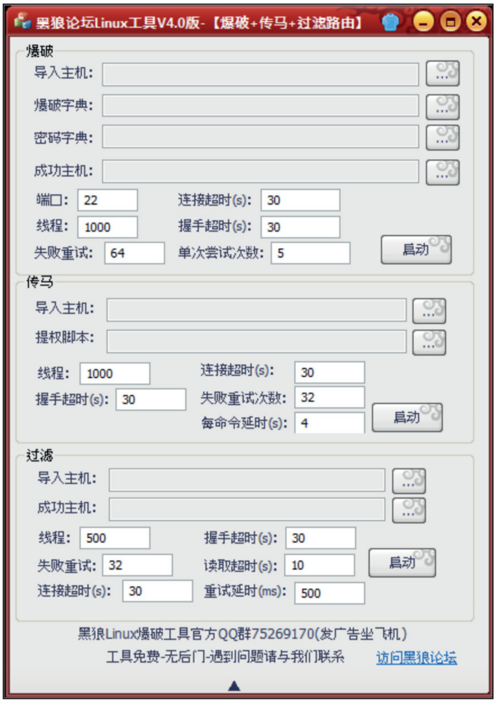


Figure 17: DDoS tool.

This tool enables users to edit which files will be used on deployment, and other related configurations such as the timeout. We observed this specific DDoS tool advertised in a range of Chinese forums, such as the one shown in Figure 18.

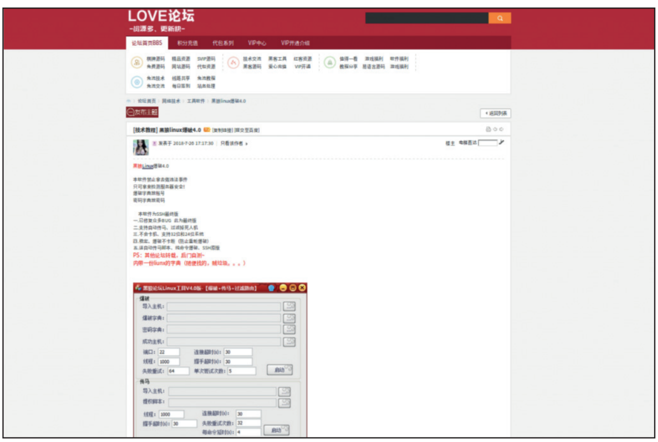


Figure 18: Chinese forum advertising the DDoS tool.

If we analyse one of the scripts inside the zip file and compare it with our initial honeypot hit log, we can assume that the attack was deployed using this tool.

```
自动传马脚本.txt
service iptables stop
wget Ð¡Âí1ÏÂÔØµØÖ·
chmod 0755 /root/Ð¡Âí1Ãû³Æ
nohup /root/Ð¡Âí1Ãû³Æ > /dev/null 2>&1 &
chmod 777 Ð¡Âí1Ãû³Æ
./Ð¡Âí1Ãû³Æ
chmod 0755 /root/Ð¡Âí1Ãû³Æ
nohup /root/Ð¡Âí1Ãû³Æ &gt; /dev/null 2&gt;&amp;1 &amp;
chmod 0777 Ð¡Âí1Ãû³Æ
chmod u+x Ð¡Âí1Ãû³Æ
./Ð¡Âí1Ãû³Æ &
chmod u+x Ð¡Âí1Ãû³Æ
./Ð¡Âí1Ãû³Æ &
cd /tmp
service iptables stop
wget Ð¡Âí2ÏÂÔØµØÖ·
chmod 0755 /root/Ð¡Âí2Ãû³Æ
nohup /root/Ð¡Âí2Ãû³Æ > /dev/null 2>&1 &
chmod 777 Ð¡Âí2Ãû³Æ
./164
chmod 0755 /root/Ð¡Âí2Ãû³Æ
nohup /root/Ð¡Âí2Ãû³Æ &gt; /dev/null 2&gt;&amp;1 &amp;
chmod 0777 Ð¡Âí2Ãû³Æ
chmod u+x Ð¡Âí2Ãû³Æ
./Ð¡Âí2Ãû³Æ &
chmod u+x dos6cc4
./Ð¡Âí2Ãû³Æ &
cd /tmp
echo "cd  /root/">>/etc/rc.local
echo "./Ð¡Âí1Ãû³Æ&">>/etc/rc.local
echo "./Ð¡Âí2Ãû³Æ&">>/etc/rc.local
echo "/etc/init.d/iptables stop">>/etc/rc.local
```

Figure 19: ChinaZ DDoS tool script.

We were not sure whether this Chinese DDoS tool was distributed by ChinaZ, or if the group purchased the tool in order to use it in its campaigns.

Moreover, after analysing these files, we decided to look up the specific C&C domain name seen in the BillGates and Gh0st RAT instances found in the initial HFS server, to see if this domain had multiple resolutions and find more potential servers linked to this actor. Figure 20 shows the *RiskIQ* reverse look-up of C&Cs.

RESOLUTIONS

Show : 25 ◂ 1-7 of 7 ▸ Sort : Last Seen Descending ▾ Download Copy

Resolve	Location	Network	ASN	First	Last	Source	Tags
58.218.66.97	CN	58.218.66.0/24	23650	2018-12-16	2018-12-16	pingly	
223.111.147.77	CN	223.108.0.0/14	56046	2018-12-16	2018-12-16	pingly	
222.211.86.214	CN	222.211.86.0/24	38283	2018-12-09	2018-12-10	pingly	
101.254.179.134	CN	101.254.176.0/22	23724	2018-09-22	2018-09-24	riskiq	
222.222.12.156	CN	222.222.0.0/15	4134	2018-09-19	2018-09-20	riskiq	
192.168.0.1	N/A	Unknown		2018-09-19	2018-09-20	riskiq	
192.168.0.0	N/A	Unknown		2018-09-19	2018-09-20	riskiq	

Figure 20: RiskIQ C&C reverse lookup.

All of the IPs shown in Figure 20 denote a server that would resolve to 'ak-74.top', the C&C domain seen in the first HFS server. Based on these resolutions we were able to find other panels such as the one shown in Figure 21.

Figure 21: Second ChinaZ panel.

We instantly recognized the same pattern in terms of the naming convention as well as the types of files being hosted in this HFS server. In contrast with the previous HFS server, this server is only hosting *Windows* binaries and a compressed archive.

Figure 22 shows a list of the files contained in the *7z* compressed file.

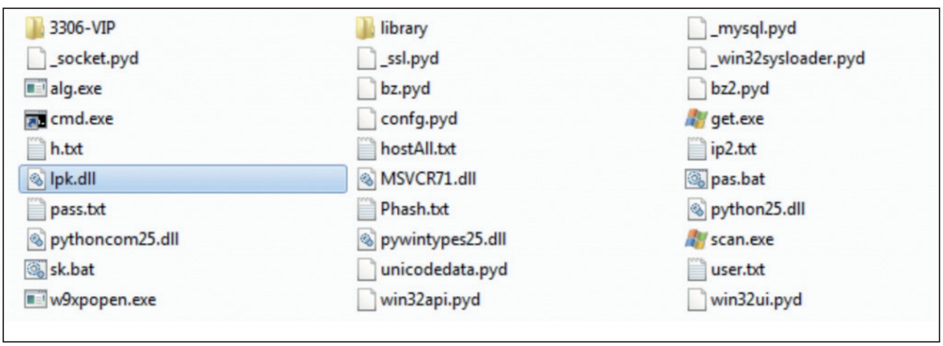
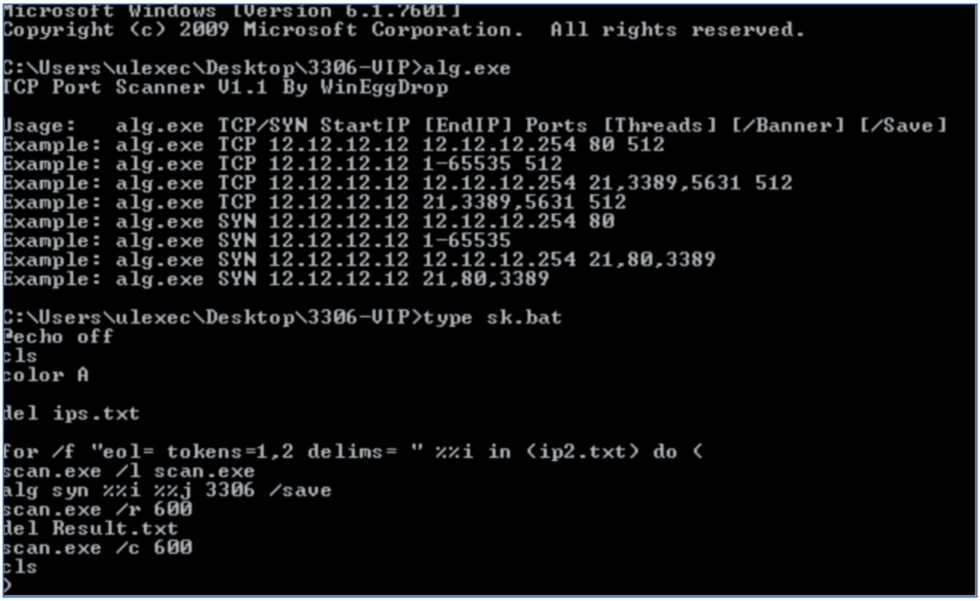


Figure 22: Files contained in the compressed file.

These files appear to be composing a port scanner tool written in Python that could also be used to deploy DDoS attacks.



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\ulexec\Desktop\3306-VIP>alg.exe
TCP Port Scanner V1.1 By WinEggDrop

Usage:   alg.exe TCP/SYN StartIP [EndIP] Ports [Threads] [/Banner] [/Save]
Example: alg.exe TCP 12.12.12.12 12.12.12.254 80 512
Example: alg.exe TCP 12.12.12.12 1-65535 512
Example: alg.exe TCP 12.12.12.12 12.12.12.254 21,3389,5631 512
Example: alg.exe TCP 12.12.12.12 21,3389,5631 512
Example: alg.exe SYN 12.12.12.12 12.12.12.254 80
Example: alg.exe SYN 12.12.12.12 1-65535
Example: alg.exe SYN 12.12.12.12 12.12.12.254 21,80,3389
Example: alg.exe SYN 12.12.12.12 21,80,3389

C:\Users\ulexec\Desktop\3306-VIP>type sk.bat
@echo off
cls
color A

del ips.txt

for /f "eol= tokens=1,2 delims= " %%i in (ip2.txt) do (
scan.exe /l scan.exe
alg syn %%i %%j 3306 /save
scan.exe /r 600
del Result.txt
scan.exe /c 600
cls
)
```

Figure 23: DDoS tool.

In the screenshot shown in Figure 23 we can observe an executable responsible for the main TCP/SYN flood, and the script used to deploy DDoS attacks.

The remaining binaries were another Gh0st RAT and a *Windows* instance of Linux.DDosClient, also known to have been developed by ChinaZ actors.

3.3 ChinaZ hosting infected DDoS tools with Nitol artifacts

Inside the hosted compressed files were varying components. However, among all of the files, the most notable was a DLL labelled 'lpk.dll', which appeared in every hosted compressed archive that we found in this investigation. This DLL has been known to have been hijacked in the past by Nitol [17], as mentioned at the beginning of the paper, and as shown in Figure 24.

We confirmed, based on code reuse, that this was indeed Nitol, as shown in Figure 25.

After analysing these findings, we came to the conclusion that the actors behind this botnet may be operating on infected physical *Windows* systems, and consequently deploying malware infected with previous malware belonging to older campaigns, therefore indirectly linking Nitol and ChinaZ.

A fact supporting this theory was that, after analysis, this specific DLL failed to connect to its correspondent C&C, but at some point in the infection chain a Parite file infector was also dropped from both the Nitol DLL implants as well as from the hosted *Windows* Gh0st RATs (Figure 26).

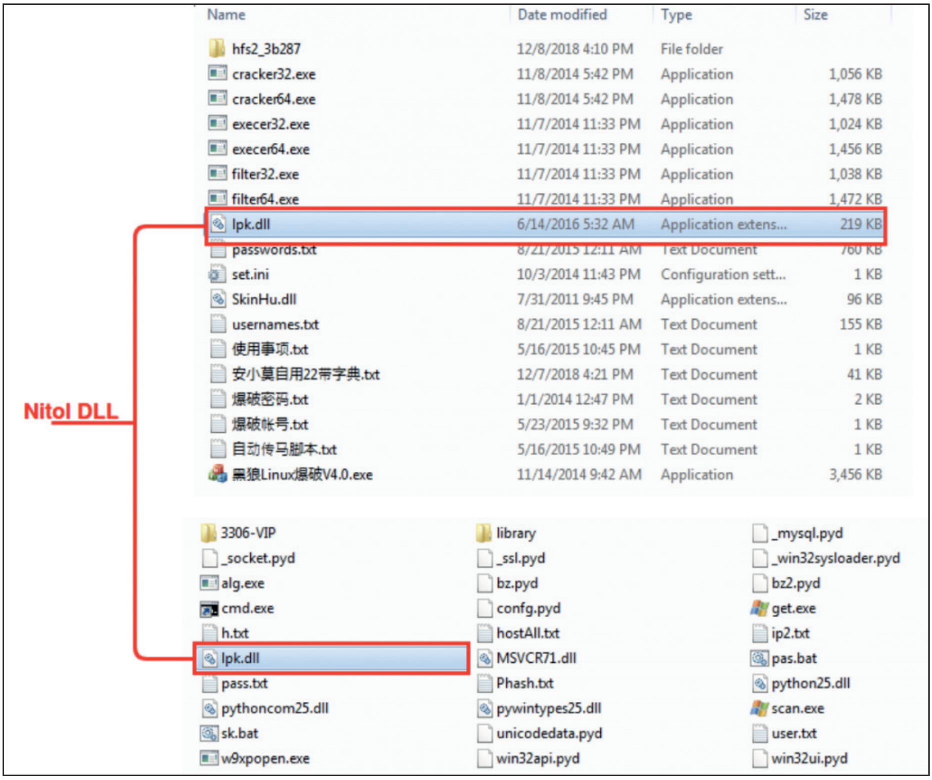


Figure 24: Lpk.dll.

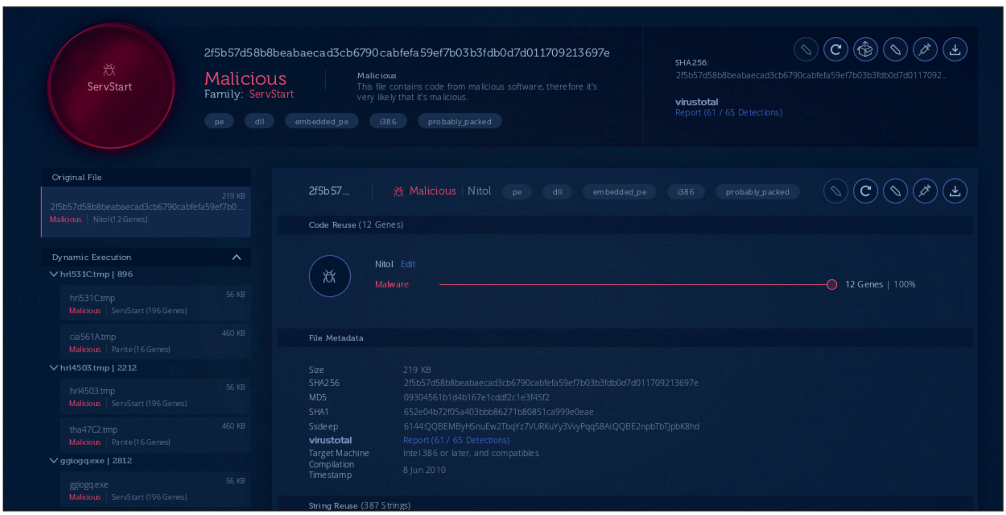


Figure 25: Confirmation that the file was Nitol.

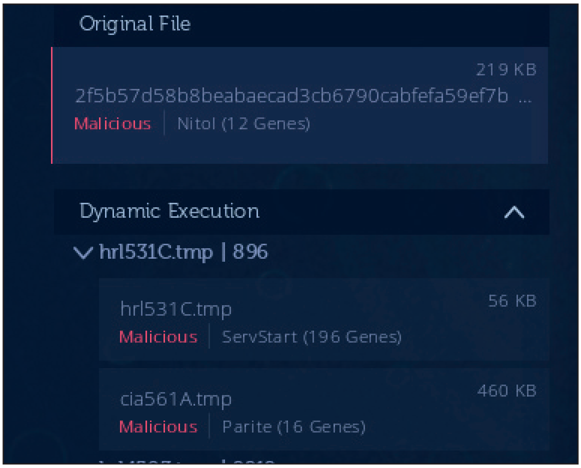


Figure 26: At some point in the infection chain a Parite file infector was dropped.

It is known that in 2010 there was a strong infection wave of Chinese servers that, today, are still operative and deploying infected malware. This may be why we can find Parite drops from files hosted in these servers.

Figure 27: Tweet by @benkow_ [19].

It should be noted how little effort is made by the actors to maintain a clean development environment for their newer malware campaigns, if the theory explained above is indeed true.

3.4 Hidden link between ServStart and MrBlack

Based on the previous findings regarding Nitol and ChinaZ, we decided to continue with this investigation in order to figure out whether we could find more artifacts that would link Nitol and ChinaZ.

In this section we will discuss several discovered links between MrBlack from ChinaZ and ServStart from Nitol.

MrBlack [20] is an IoT botnet also known to have *Windows* variants [21]. As documented by *MalwareMustDie*, MrBlack is the simplified version of AES.DDoS [22], an ELF DDoS tool of

Chinese origin that was in circulation before ChinaZ was ever established.

Throughout our investigation we came across the HFS panel shown in Figure 28.

Figure 28: HFS panel showing DDoSClient and MrBlack.

Figure 29 is a code reuse analysis of the hosted *Windows* binary classifying the file as a Win32/MrBlack instance.

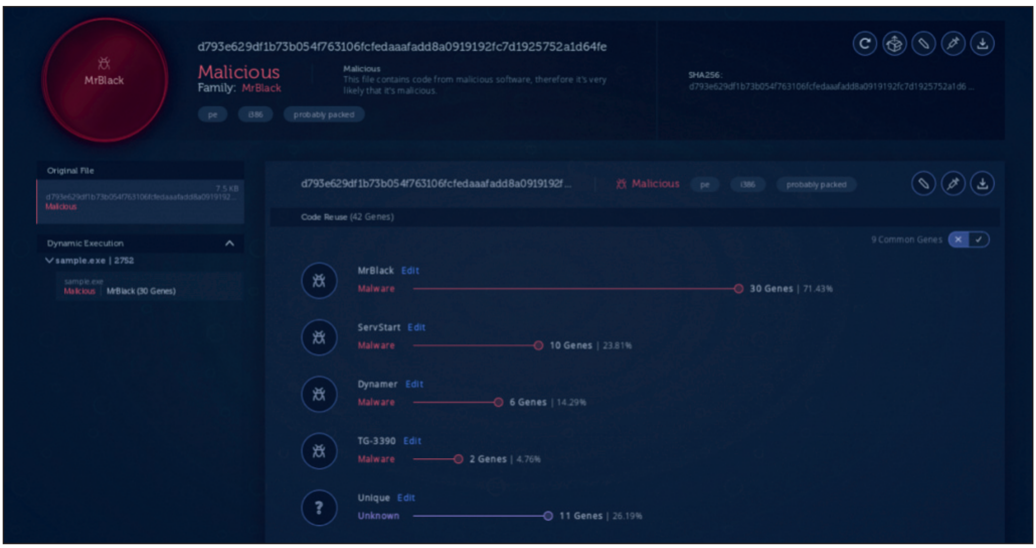


Figure 29: Code reuse analysis [23].

If we look closely we can see that the hosted instance of Win32.MrBlack shares 10 genes with ServStart [25], a trojan associated with the Nitol family, as previously mentioned.

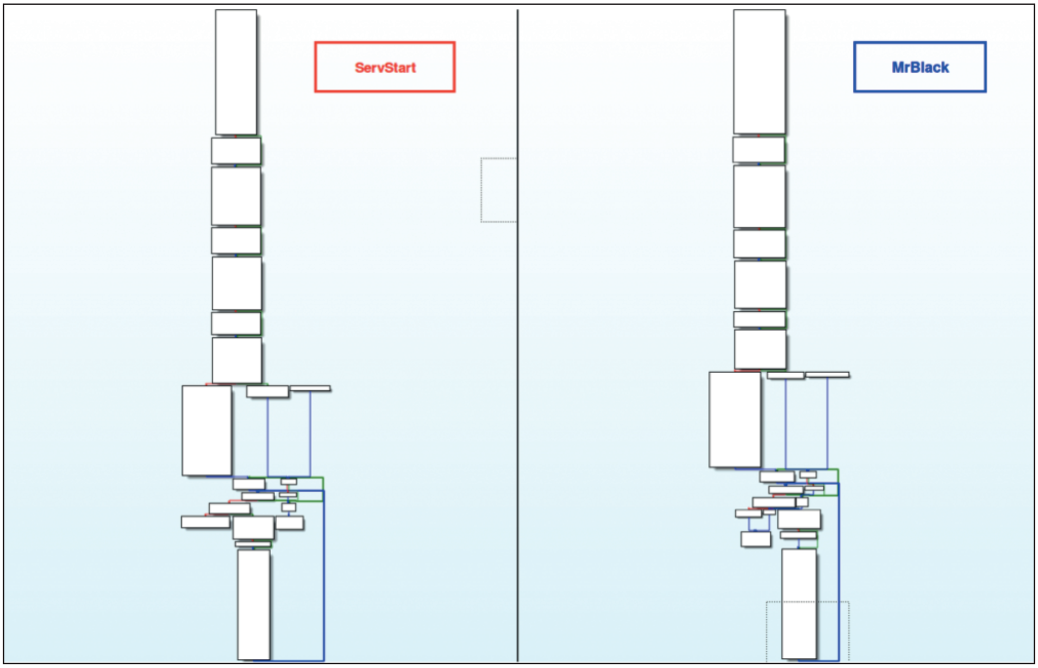


Figure 30: ServStart vs. MrBlack: the same SYN flood function.

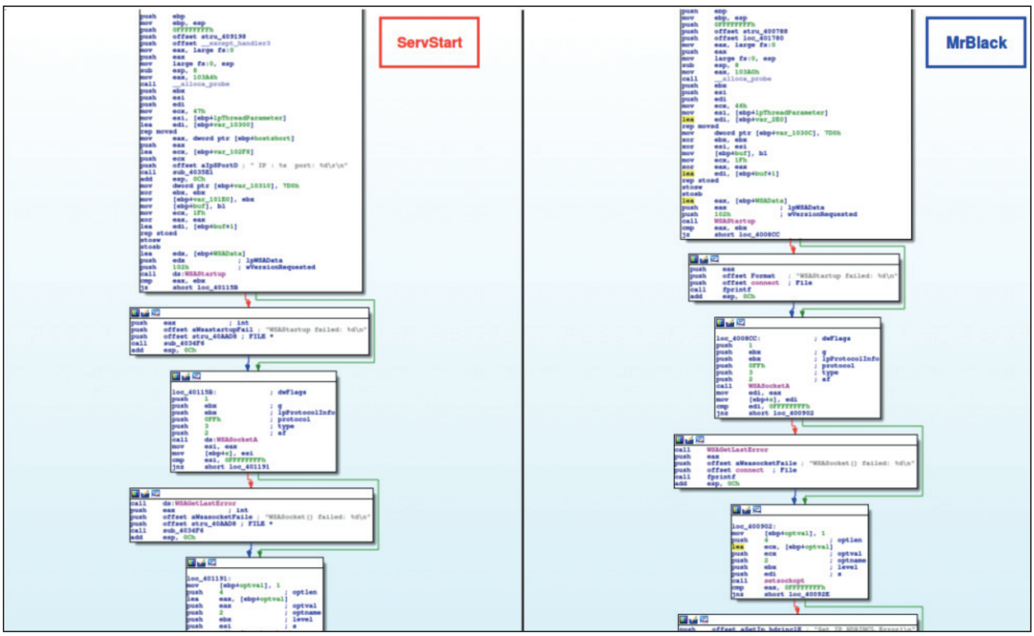


Figure 31: ServStart vs. MrBlack: slight variations throughout the code.

After analysis of these 10 genes we observed that this instance of MrBlack has exactly the same SYN flood function as the ServStart instance (Figure 30).

We can observe that there are slight variations present throughout the code (Figure 31), but most of the function is identical, specifically the main flood loop (Figure 32).

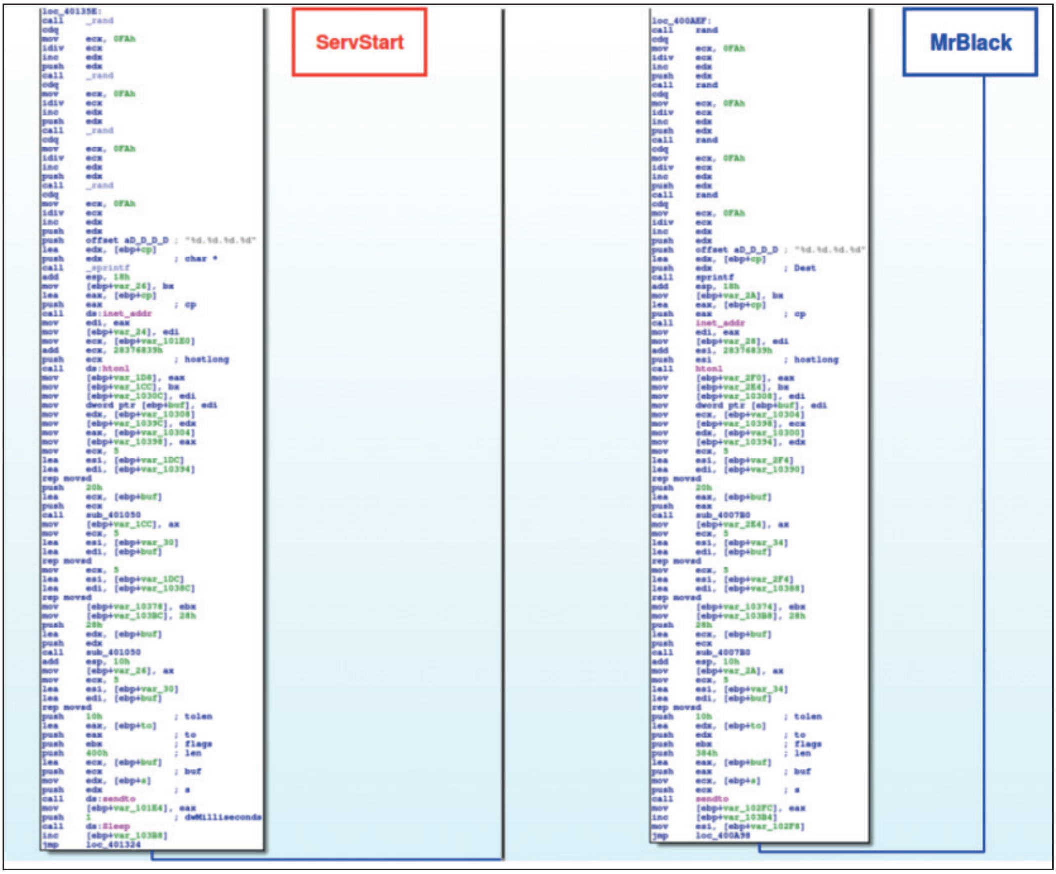


Figure 32: ServStart vs. MrBlack: most of the function is identical.

Reinforcing this connection between MrBlack and ServStart, we discovered additional panels such as the one shown in Figure 33.

In this panel we found two instances of Linux.MrBlack along with seven instances of a variant of ServStart. We have identified the MrBlack instances based on code reuse (Figure 34).

Regarding the ServStart variants, we can see that they share a substantial amount of code with respect to previous ServStart variants (Figure 35).

It is important to note that these newer ServStart variants have a recent compilation timestamp, and were only submitted to *VirusTotal* one week before the day we discovered them.

Figure 33: MrBlack panel.

Figure 34: MrBlack identified based on code reuse [25].

Figure 35: ServStart variants share a substantial amount of code with previous variants [26].

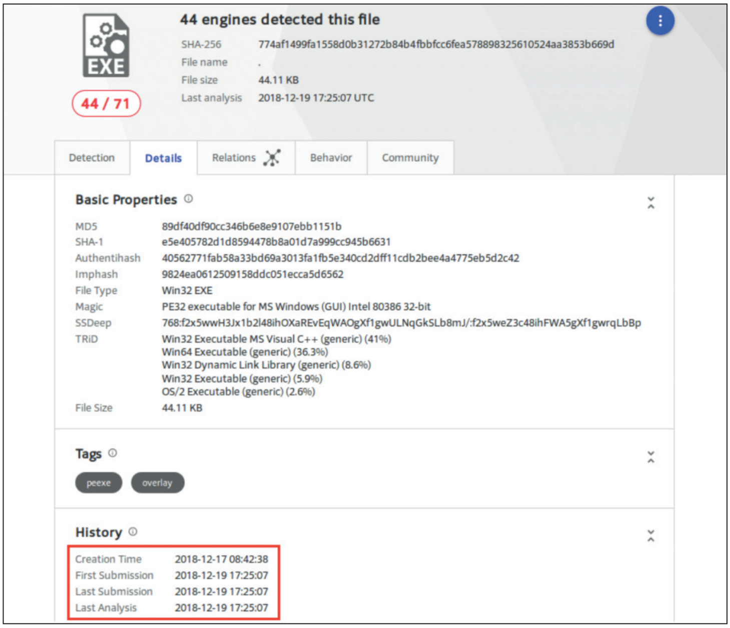


Figure 36: The newer variants were submitted to VirusTotal a week before we discovered them.

We found several nearly identical functions that had been reused from previous variants of ServStart. Figure 37 is an example of one of these common functions.

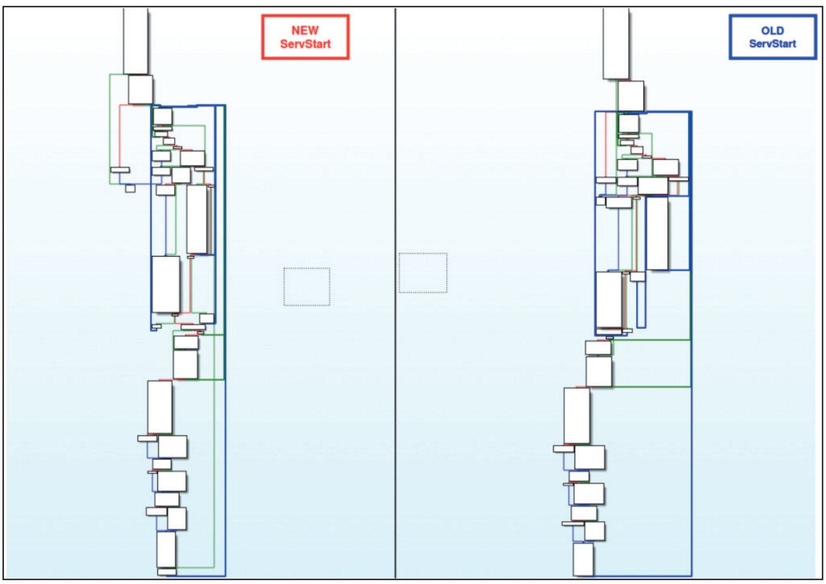


Figure 37: Common functions between the new and old ServStarts.

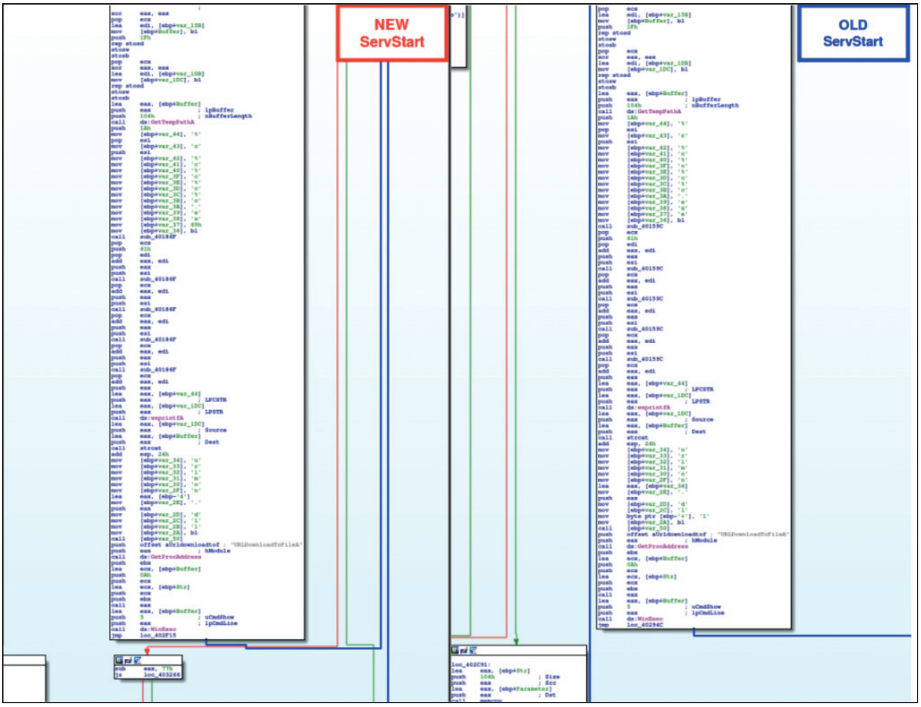


Figure 38: Code fragments.

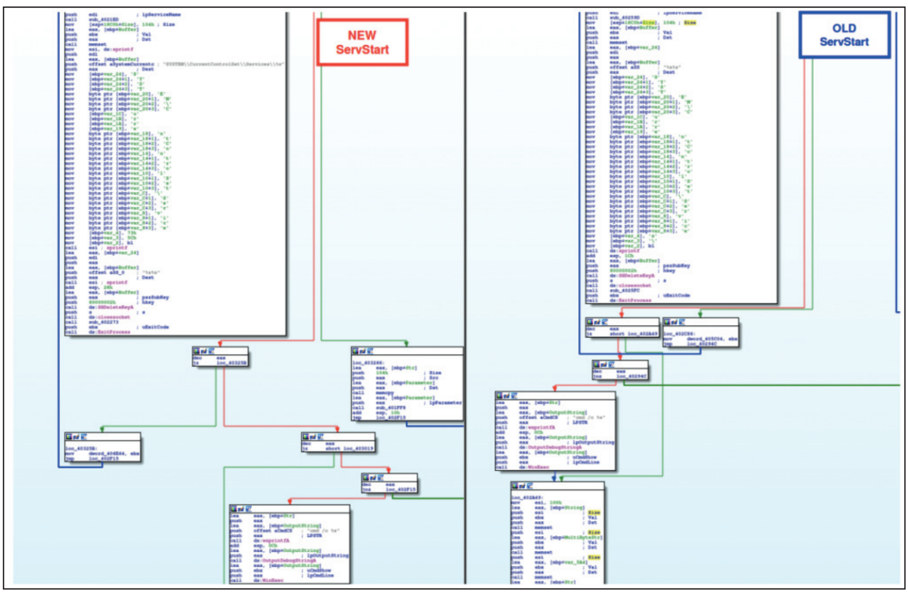


Figure 39: Common code with noticeable differences between the newer and older ServStart versions.

Within the common code we found exact code fragments like the one shown in Figure 38.

Furthermore, we also found common code with noticeable differences between the newer and older ServStart versions. An example of this is shown in Figure 39.

4. CHINESE GH0ST RAT VARIANT CASE STUDY

The Gh0st RAT clients we discovered among several HFS servers all appear to be modified instances of Gh0st RAT that share notable characteristics. In this section we will be covering how this Chinese Gh0st RAT variant has been used across a series of known Chinese actors.

These Gh0st RAT variants were initially encountered hosted in ChinaZ HFS servers with the names ‘BX.exe’ or ‘shadow.exe’.

If we take a closer look we observe that there are similarities with the Gh0st RAT instance deployed in Operation PZCHAO by Iron Tiger APT, an APT group with alleged Chinese origin. The RC4 key used to decrypt the C&C is the same as the one used in the PZCHAO campaign, ‘Mother360’.

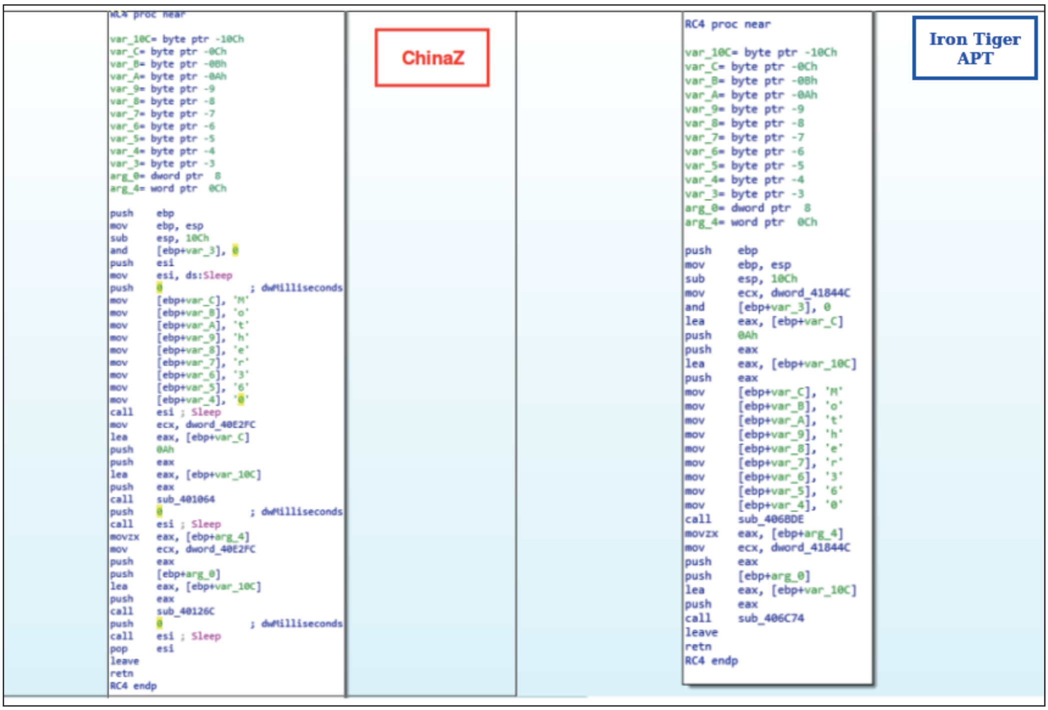


Figure 40: ChinaZ vs. Iron Tiger.

Based on a *Bitdefender* blog post about operation PZCHAO, this cryptographic key was not only used to decode the malware’s C&C addresses but was also the key used to decrypt traffic between the client and the C&C server.

Although these two Gh0st RATs may share common code, it is important to understand how to interpret these similarities. As previously mentioned, ChinaZ has been known to employ DDoS botnets in its campaigns. Usually, APT groups do not rely on DDoS attacks. These similarities may not necessarily correlate ChinaZ with Iron Tiger APT, but they may be evidence of the existence of a common Gh0st RAT variant shared within the Chinese community, by having the possibility to have 'Mother360' as one of the default hard-coded keys. The reason for this interpretation is based on the fact that APT groups are rarely involved with DDoS operations since the mere thought of correlating these two models does not seem practical, and the probability unlikely.

In addition, we found the use of the same cryptographic key in Gh0st RAT variants used by other Chinese actors.

A report written by *Qihoo 360* [28] in 2015 describes a piece of malware very similar to Nitol.

This malware was composed of several artifacts. The artifacts were a Gh0st RAT and a Zip file with a malicious DLL, as shown in Figure 41.

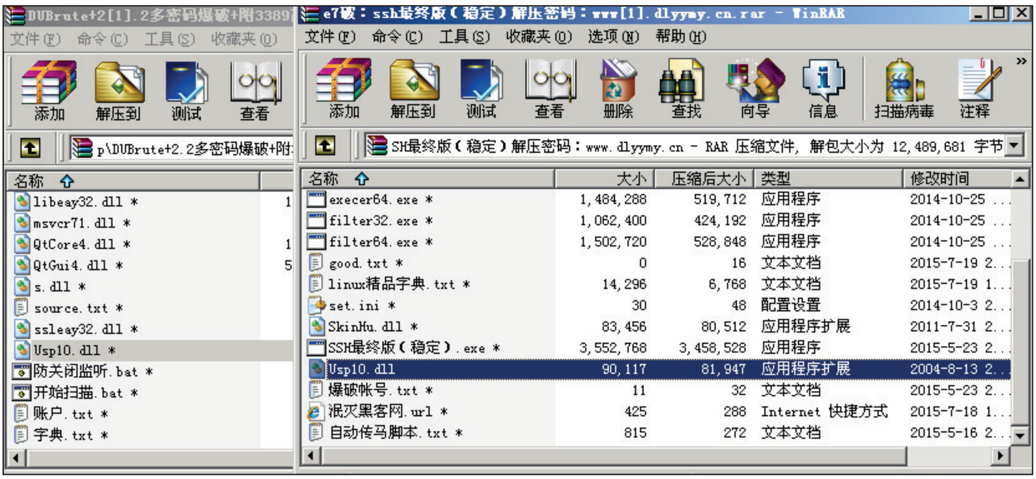


Figure 41: Malicious DLL, Usp10.dll.

Unlike Nitol's lpk.dll, this malicious DLL is called Usp10.dll, but once we dive into the DLL we can see that it also has ways to operate as lpk.dll, as shown in Figure 42.

Furthermore, the Gh0st RAT instance does decode a subdomain known to be exploited by Nitol in the past within 3322.org domain name, as shown in Figure 43.

Another interesting feature of this Gh0st RAT is that it has a characteristic stack string at WinMain, as shown in Figure 44.

Based on this stack string we were able to find different Gh0st RAT instances deployed by the same actor. A majority of these instances use the same cryptographic key as seen in the Gh0st RAT variants used by ChinaZ and Iron Tiger APT: 'Mother360' (Figure 45).

In addition, this malware resembling Nitol was found to use SMTP as a communication channel, and some of the emails intercepted by *Qihoo 360* show identical logs of attacks to those spotted in our honeypot leveraged by ChinaZ, which may imply that these groups are using the same intrusion artifacts in their campaigns (Figure 46).

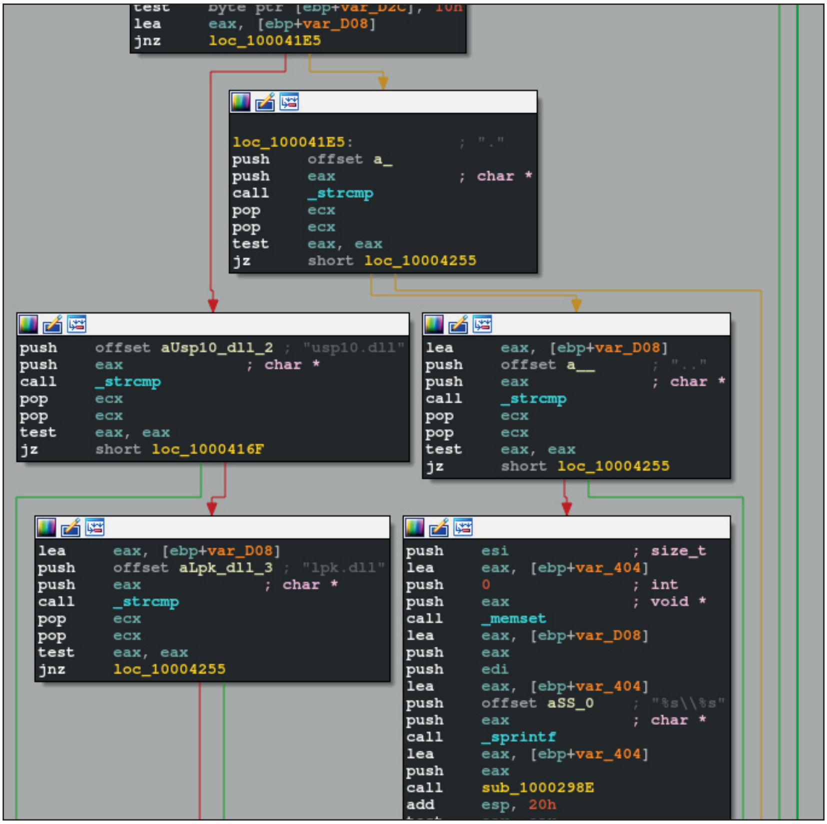


Figure 42: Usp10.dll has ways to operate as lpk.dll.

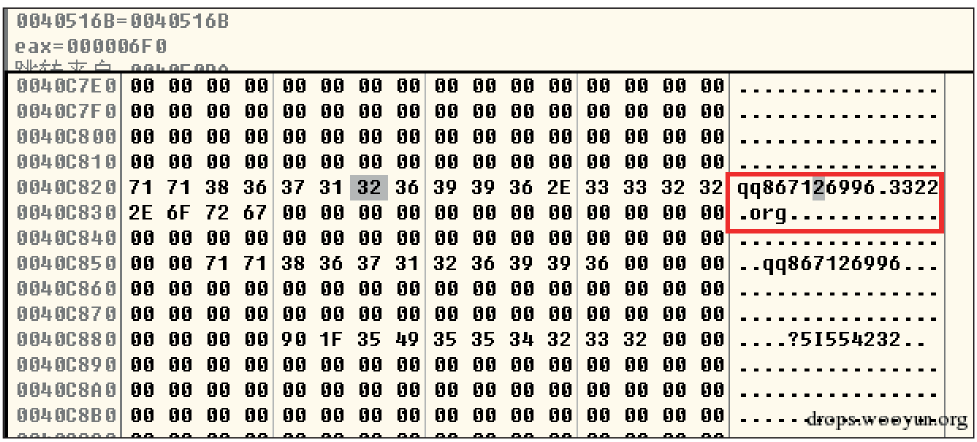


Figure 43: The Gh0st RAT decodes a subdomain known to have been exploited by Nitol.

```
.text:004062C7                 push    ebp
.text:004062C8                 mov     ebp, esp
.text:004062CA                 push    0FFFFFFFFh
.text:004062CC                 push    offset _WinMain@16_0_SEH
.text:004062D1                 mov     eax, large fs:0
.text:004062D7                 push    eax
.text:004062D8                 mov     large fs:0, esp
.text:004062DF                 push    ecx
.text:004062E0                 sub     esp, 14Ch
.text:004062E6                 push    ebx
.text:004062E7                 push    esi
.text:004062E8                 push    edi
.text:004062E9                 mov     [ebp+var_10], esp
.text:004062EC                 mov     [ebp+var_24], 'K'
.text:004062F0                 mov     [ebp+var_23], 'i'
.text:004062F4                 mov     [ebp+var_22], 'l'
.text:004062F8                 mov     [ebp+var_21], 'l'
.text:004062FC                 mov     [ebp+var_20], 'q'
.text:00406300                 mov     [ebp+var_1F], 'i'
.text:00406304                 mov     [ebp+var_1E], 'p'
.text:00406308                 mov     [ebp+var_1D], 'i'
.text:0040630C                 mov     [ebp+var_1C], 'l'
.text:00406310                 mov     [ebp+var_1B], 'a'
.text:00406314                 mov     [ebp+var_1A], 'n'
.text:00406318                 mov     [ebp+var_19], 'g'
.text:0040631C                 mov     [ebp+var_18], 0
.text:00406320                 push    0Dh
.text:00406322                 lea     eax, [ebp+var_24]
.text:00406325                 push    eax
.text:00406326                 lea     ecx, [ebp+var_12C]
```

Figure 44: Nitol has a characteristic stack string at WinMain.

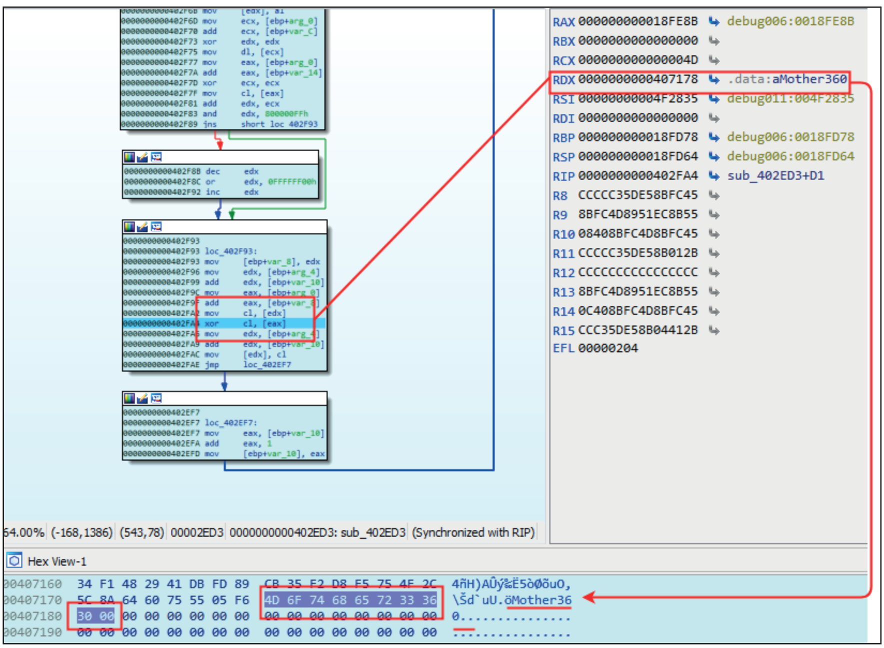


Figure 45: 'Mother360'.

Figure 46: Some of the emails show identical logs of attacks to those spotted in our honeypot leveraged by ChinaZ.

These findings reinforce the hypothesis that the cryptographic key ‘Mother360’ is not exclusive for any given group but rather a common key in a given Gh0st RAT strain that is shared within the Chinese cybercrime community.

We decided to find Gh0st RAT variants that were using this cryptographic key and plot them on a graph in order to have a better idea of how many potential variants of this Gh0st RAT are using this same cryptographic key. Figure 47 shows the results of plotting 573 Gh0st RAT samples that utilize the same cryptographic key against our code-reuse engine.

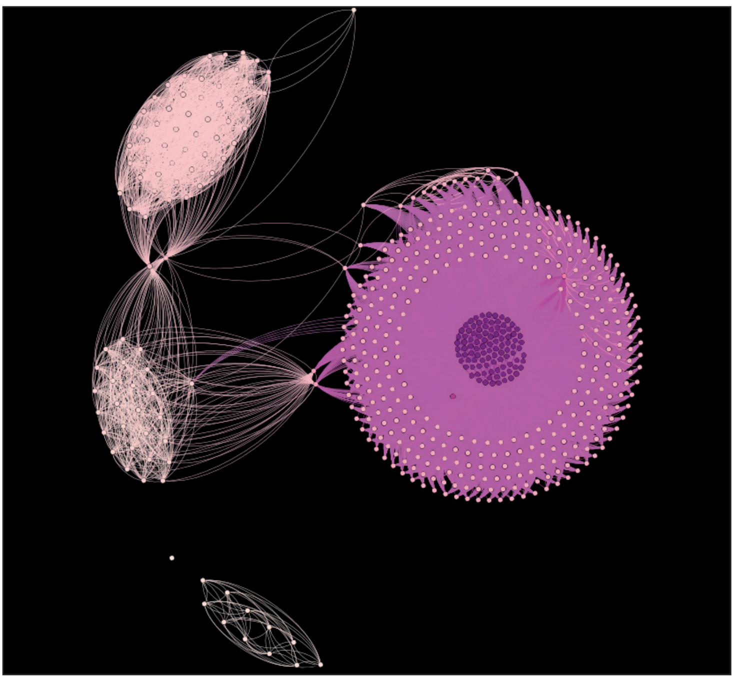


Figure 47: The results of plotting 573 Gh0st RAT samples that utilize the ‘Mother360’ cryptographic key against our code-reuse engine.

5. CONCLUSION

In this paper we have covered several artifacts. A summary of the findings regarding Nitol and ChinaZ are the following:

These two groups have been shown to share the same goals in their campaigns with an emphasis on the deployment of DDoS botnets. In addition, both groups have alleged Chinese origins.

A range of ChinaZ's *Windows* servers have been infected by Nitol artifacts. These two families share relevant code with one another, such as DDoS flood implementations, and new ServStart variants have been spotted being hosted alongside MrBlack *Linux* instances.

Regarding the several Gh0st RAT variants found using the cryptographic key 'Mother360' we confirmed that this key is not exclusive to any specific group, although all of the Gh0st variants found using this cryptographic key have been seen used by some Chinese threat actor.

These findings suggest that a common practice of Chinese threat actors is to collaborate in communities. We based this conclusion on the high ratio of code similarities in malware belonging to different groups, the integration of similar pieces of malware with specific characteristics such as the Gh0st RAT case study (and potentially ServStart), and the use of similar modus operandi to deploy and host their malware.

An overview of the findings is shown in Figure 48.

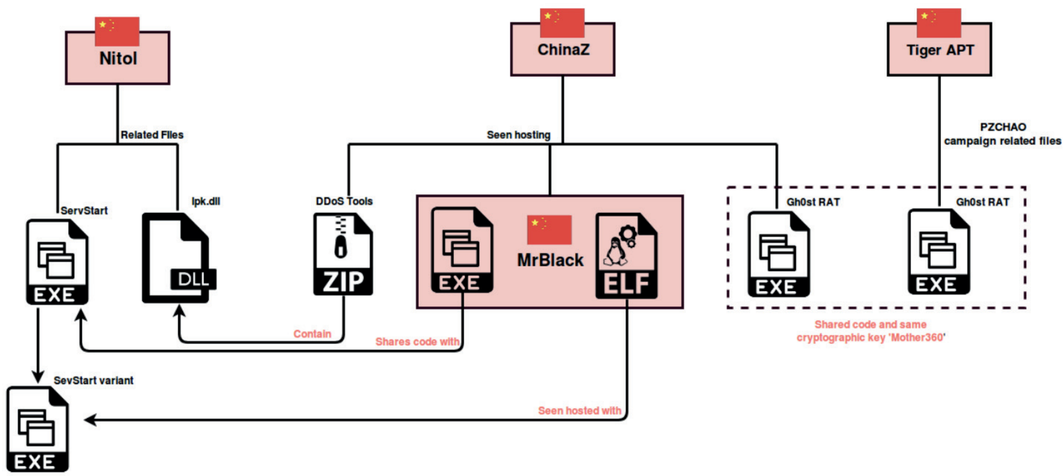


Figure 48: Overview of our findings.

REFERENCES

[1] Kupreev, O.; Badovskaya, E.; Gutnikov, A. DDoS Attacks in Q3 2018. Securelist. October 2018. https://securelist.com/ddos-report-in-q3-2018/88617/.

[2] Russel, J. The world's largest DDoS attack took GitHub offline for less than ten minutes. TechCrunch. https://techcrunch.com/2018/03/02/the-worlds-largest-ddos-attack-took-github-offline-for-less-than-tens-minutes/.

[3] Fisher, D. DDoS Attack on GitHub Linked to Earlier One Against GreatFire.org. Threatpost. March 2015. https://threatpost.com/ddos-attack-on-github-linked-to-earlier-one-against-greatfire-org/111919/.

[4] Griffiths, J.; Regan, H.; Ben Westcott, B.; George, S.; Hollingsworth, J. CNNHong Kong protests over China extradition bill. CNN. June 2019. https://edition.cnn.com/asia/live-news/hong-kong-protests-june-12-intl-hnk/index.html.

[5] MMD-0030-2015 - New ELF malware on Shellshock: the ChinaZ. Malware Must Die! January 2015. http://blog.malwaremustdie.org/2015/01/mmd-0030-2015-new-elf-malware-on.html.

[6] Kálnai, P.; Horejší, J. Chinese Chicken: Multiplatform DDoS botnets. Botconf. https://www.botconf.eu/wp-content/uploads/2014/12/2014-2.10-Chinese-Chicken-Multiplatform-DDoS-Botnets.pdf.

[7] Liu, Y.; Wang, H. The Elknot DDoS Botnets We Watched. Virus Bulletin. https://www.virusbulletin.com/uploads/pdf/conference_slides/2016/Liu_Wang-vb-2016-TheElknotDDoSBotnetsWeWatched.pdf.

[8] Events of 2015-11-30. https://root-servers.org/news/events-of-20151130.txt.

[9] https://web.archive.org/web/20130113130129/http:/blogs.technet.com/cfs-filesystemfile.ashx/__key/communityserver-blogs-components-weblogfiles/00-00-00-80-54/3755.Microsoft-Study-into-b70.pdf.

[10] Leydon, J. Microsoft seizes Chinese dot-org to kill Nitol bot army. The Register. September 2012. https://www.theregister.co.uk/2012/09/13/botnet_takedown/.

[11] Leydon, J. Chinese Nitol botnet host back up after Microsoft settles lawsuit. The Register. October 2012. https://www.theregister.co.uk/2012/10/04/nitol_botnet_settlement/.

[12] Cyber threats to the aerospace and defense industries. FireEye. https://www.fireeye.com/content/dam/fireeye-www/current-threats/pdfs/ib-aerospace.pdf.

[13] ServStart. Intezer Analyze. https://analyze.intezer.com/#/analyses/76e7c95a-f5ea-4c86-bd7d-0b1a982962c6.

[14] BillGates. Intezer Analyze. https://analyze.intezer.com/#/files/2c7fa76ff852ba960e2eed6a135f4e614366005819d78a87401d875faeff2d40.

[15] BillGates. Intezer Analyze. https://analyze.intezer.com/#/files/6fd7aab3faabd5f071d1bc9bb039146c01acf67d941c24e99813b1375114e908.

[16] gh0st. https://github.com/sincoder/gh0st.

[17] Analysis of Nitol. Hard Work Never Fails. July 2017. http://www.edison-newworld.com/2017/07/analysis-of-nitol.html.

[18] ServStart. Intezer Analyze. https://analyze.intezer.com/#/files/2f5b57d58b8beabaecad3cb6790cabfefa59ef7b03b3fdb0d7d011709213697e.

[19] @benkow_. https://twitter.com/benkow_/status/961713159630393346?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E961713159630393346&ref_url=https%3A%2F%2Fwww.intezer.com%2Fblog-chinaz-relations%2F.

[20] Zeifman, I.; Atias, R.; Gayer, O. Lax Security Opens the Door for Mass-Scale Abuse of SOHO Routers. Imperva. May 2015. https://www.incapsula.com/blog/ddos-botnet-soho-router.html.

[21] MMD-0048-2016 - DDOS.TF = (new) ELF & Win32 DDoS service with ASP + PHP/MySQL MOF webshells. Malware Must Die! January 2016. http://blog.malwaremustdie.org/2016/01/mmd-0048-2016-ddostf-new-elf-windows.html.

[22] MMD-0026-2014 - Linux/AES.DDoS: Router Malware Warning | Reversing an ARM arch ELF. Malware Must Die! September 2014. http://blog.malwaremustdie.org/2014/09/reversing-arm-architecture-elf-elknot.html.

[23] ChinaZ.DDoS. Intezer Analyze. https://analyze.intezer.com/#/files/7495be154047e2c3c3b9735d61c6f1256eea776eb536e42f2ea76d5c11fc7f84.

[24] Win32/Nitol. Microsoft Security Intelligence. https://www.microsoft.com/en-us/wdsi/threats/malware-encyclopedia-description?Name=Win32%2FNitol.

[25] MrBlack. Intezer Analyze. https://analyze.intezer.com/#/files/f025b6d531e7dcba68a309636f622fbe8ee212d457c9cc00e7bf339dca65fec2.

[26] ServStart. Intezer Analyze. https://analyze.intezer.com/#/files/774af1499fa1558d0b31272b84b4fbbfcc6fea578898325610524aa3853b669d.

[27] Operation PZCHAO Inside a highly specialized espionage infrastructure. Bitdefender. https://download.bitdefender.com/resources/files/News/CaseStudies/study/185/Bitdefender-Business-2017-WhitePaper-PZCHAO-crea2452-en-EN-GenericUse.pdf.

[28] Qihoo 360 report (translation). https://translate.google.com/translate?hl=en&sl=zh-CN&u=https://wooyun.js.org/drops/%25E7%25BD%2591%25E7%25BB%259C%25E5%25B0%258F%25E9%25BB%2591%25E6%258F%25AD%25E7%25A7%2598%25E7%25B3%25BB%25E5%2588%2597%25E4%25B9%258B%25E9%25BB%2591%25E8%2589%25B2SEO%25E5%2588%259D%25E6%258E%25A2.html&prev=search.

IOCS

ChinaZ Gh0st RAT variant with 'Mother360' key:

A9c54bdba780bcdc34f15b62f0ac1da8bcf4d65b4587d0d95bd2a9b5be5dfee6
908d817f81f9276f5afad1a33a7e2de7566fd5c967ad95782a4d904ca0e5efdd
9e24ba7304ae7c4f153fa8e97d2e6779d0e4377cee270b83d20d91afef7fe6f4

Iron Tiger APT gh0st RAT:

D4262bbfe779d18b83b950bb993d3d46154bf1da5a4868ff6fa3e54c167eed71

BillGates:

92c191c41bcc701de5d633a0edb8cab6085ea13ede079651a2cc4a4ae54b29bb
6fd7aab3faabd5f071d1bc9bb039146c01acf67d941c24e99813b1375114e908

Infected ChinaZ DDoS tools with Nitol:
B883b32264bcafd0c5ede5ff7399388feb51dbdf183f7ad52024c08cd221d574
23c69edc4695f6c2184484682757f024f0e20573dba599030fde1cdaeae9915c

ChinaZ.DDoSClient:

80952e211eb98773909f0f3e7ce783ce2f410327058a4760efad2ff0dbebcb88
D97ffba4169df8b206f6fc588ba594e84539b321fae9247723d6b42940116fa5
A8d0928098cc43e7b9e8ba3b03507d342489dea832816dfc083c356b346f8a3d
7495be154047e2c3c3b9735d61c6f1256eea776eb536e42f2ea76d5c11fc7f84

Win32/MrBlack:

D793e629df1b73b054f763106fcfedaaafadd8a0919192fc7d1925752a1d64fe

Linux/MrBlack:

F025b6d531e7dcba68a309636f622fbe8ee212d457c9cc00e7bf339dca65fec2
Fb69075f4383f3537af46d2098b3bcdcb7c1bdd6896c580cd9ead6f56fb5219c

ServStart:

4f4f24f0333ed6e8883971129f216fab608b6e4d0c97c58a2b3b6a1106c77bf7
7db53e95a1339d4d023d61087907a5b07bf6720a2dd88b12882a2c5c201a92ea
7e6a2448e06a1d97ff317a5dc4ed969cef077a3568fd214cbe61854b7ff1a6d1

New ServStart:

774af1499fa1558d0b31272b84b4fbbfcc6fea578898325610524aa3853b669d
E3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
D104daec5e990de0233efdde8747a1d829c90b7b9a2169a7bcf5744fa1d95e6e