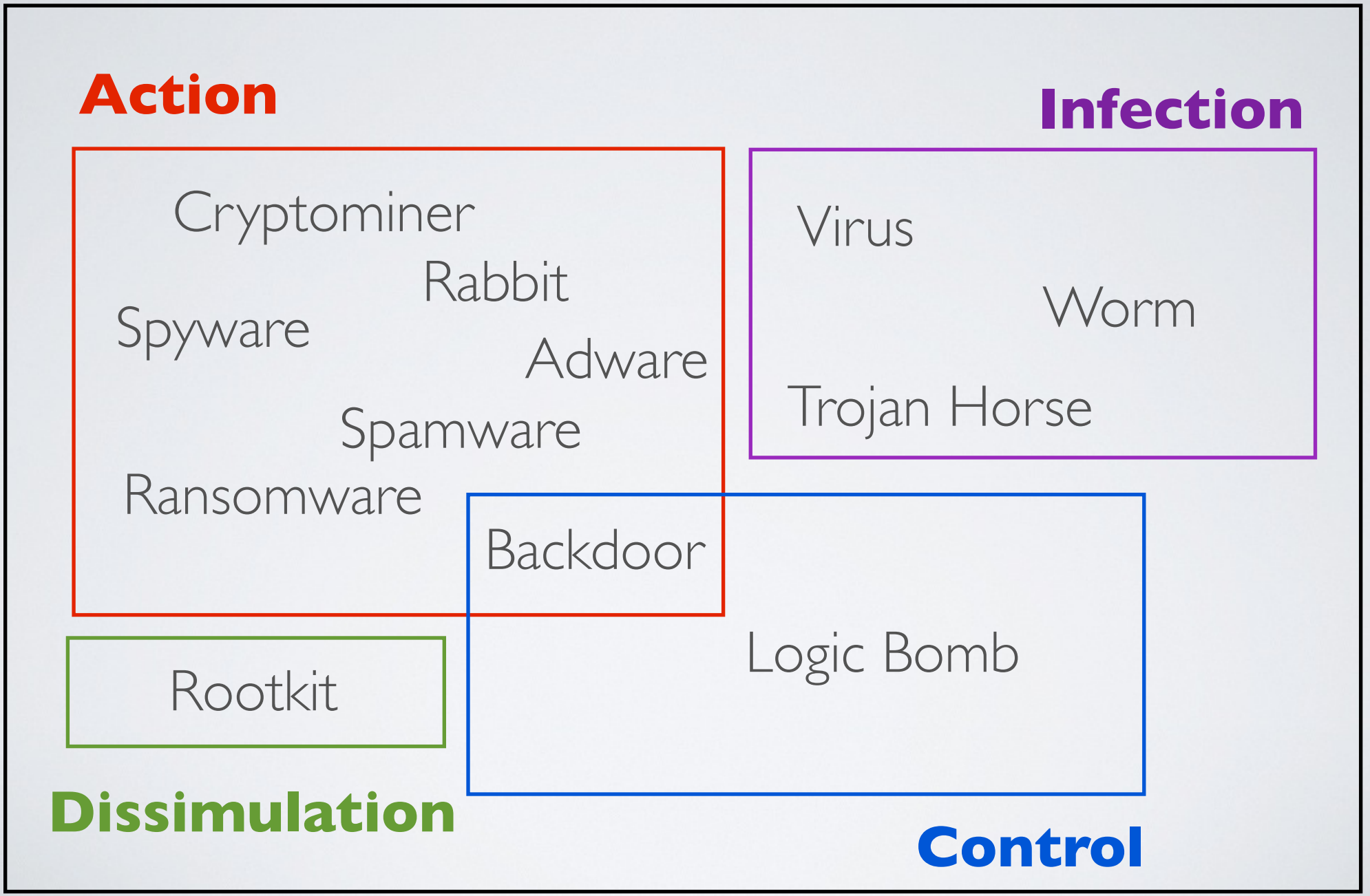
Malicious Code

Thierry Sans

Malware


Action
Infection
Cryptominer
Rabbit
Spyware
Adware
Spamware
Ransomware
Virus
Worm
Trojan Horse
Backdoor
Logic Bomb
Rootkit
Dissimulation
Control

Action

- performs unsolicited operations on the system

- **Rabbit** exhausts the hardware resources of a system until failure
- **Backdoor** allows an attacker to take control of the system bypassing authorization mechanisms
- **Spyware** collects information
- **Spamware** uses the system to send spam
- **Ransomware** restricts access to system's data and resources and demands for a ransom
- **Adware** renders unsolicited advertisement

Dissimulation

- avoid detection by anti-malware programs

Rootkit hides the existence of malicious activities

Infection

- penetrate a system and spread to others

Replication

- copy itself to spread

- **Virus** contaminates existing executable programs
- **Worm** exploits a service's vulnerability

Subterfuge

- based on user's credulity

- **Trojan Horse** tricks the user to execute the malicious code

Control

- activate the malicious code

- **Backdoor** communicates with command & control servers allowing an attacker to control the virus
- **Logic Bomb** activates the malicious code when certain conditions are met on the system

The history of malicious code

Chronology

- 70's - The era of the first self-replicating programs
- 80's - The era of maturity and first pandemics
- 90's - The era of self-modifying virus and macro viruses
- 00's - The era of Trojan horses and internet worms
- 10's - The era of cyber-warfare viruses

70's - The era of the first self-replicating programs

The era of the first self-replicating programs (70's)

ANIMAL (a popular game)

- Replication through the filesystem
- No effect

Simple Joke

Creeper (and **Reaper**) on Tenex OS (Arpanet)

- Replication through a modem and copied itself to the remote system
- Displays the message
  `I'M THE CREEPER : CATCH ME IF YOU CAN`

Disruptive

The **Rabbit** program

- Replication through the filesystem
- Reduces system performance till crashing

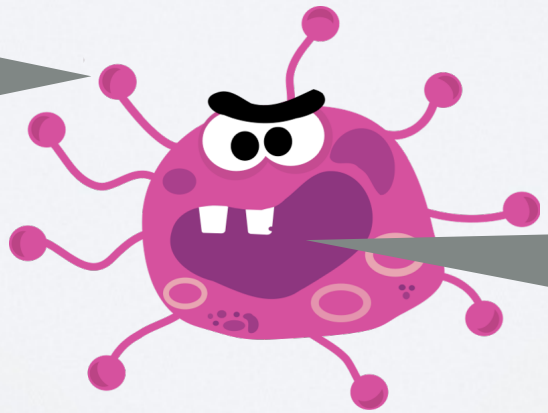
Destructive

Anatomy of a Virus

A **virus** can be

- a malicious code embedded in an existing program and replicates itself by infecting other programs through the filesystem or the network
- a program that exists by itself and replicates through the filesystem or network

Infection vector
how the virus penetrate the system



The payload
what the virus does

Resident vs. Non-resident

Non-resident virus

- The virus becomes inactive as soon as the infected program terminates

Resident virus

- The virus remains in memory even after the infected programs terminates

80's - The era of maturity and first pandemics

Apparition of boot sector viruses

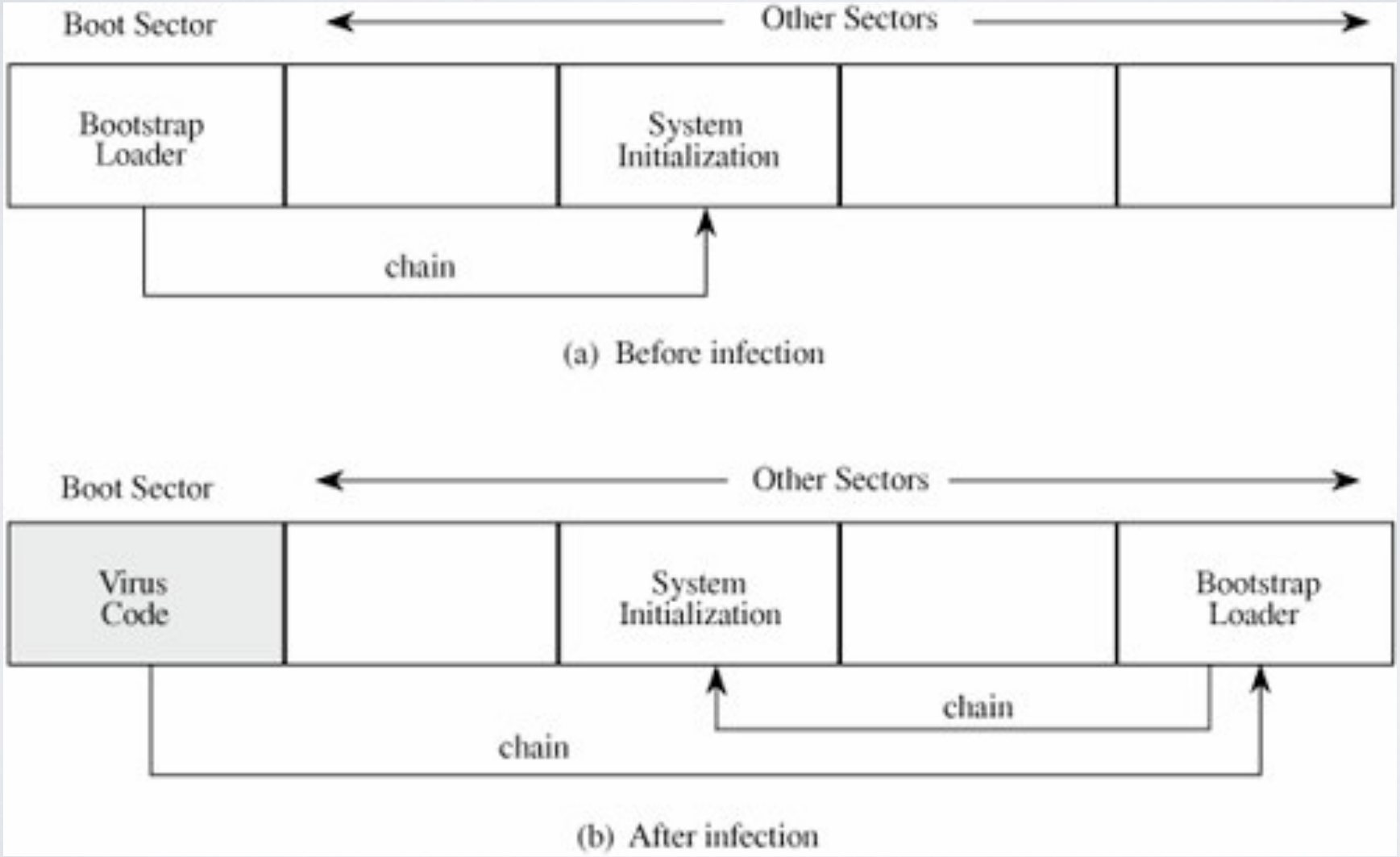
Elk Cloner (Apple II) in 1982

- An infected computer would display a short poem on every 50th boot

Brain (IBM/PC) in 1984

- The disk label is changed to "Brain" and an advertisement text is written in boot sectors

Anatomy of a "boot sector" virus



1987 - the beginning of pandemics

Jerusalem (MS-DOS)

- Destroys all executable files on infected machines upon every occurrence of Friday the 13th

SCA (Amiga)

- Displays a text every 15th boot
- 40% of the Amiga owners were infected

Christmas Tree EXEC (IBM/PC)

- Displays a snow flow animation
- Paralyzed several international computer networks in December 1987

The first anti-virus softwares (end of 80's)

Virus scanner (detection)

- Signature based -
  Using a signature database of existing viruses
- Behavior based
  Looking for suspicious code patterns that can be used by viruses

Virus removal tools (sanitation)

- Cleaning the memory and the filesystem

Avoiding detection

Cascade (1987)

- The virus encrypts itself with a cryptographic key and changes this key when replicating itself

✓ Each instance of the virus does not look the same

➡ This is the emergence of polymorphic viruses

90's - The era of self-modifying virus and macros viruses

The era of self-modifying virus (90's)

The **Chameleon** family (1990)

Ply (1996)

- DOS 16-bit based complicated polymorphic virus with built-in permutation engine

Anatomy of a "polymorphic" virus

A **polymorphic virus** mutates when replicating (but keeps the original algorithm intact)

- By using cryptography
- By injecting garbage code
- By doing permutations within certain instructions or block of instructions
- By using code obfuscation technique

How to detect it?

➡ By detecting code patterns used for the self-modification

Metamorphic Virus

A **metamorphic virus** can reprogram itself

- by using different instructions
- and by using different strategies to implement a functionality

Zmist (2000)

- First metamorphic virus

Simile (2001)

- First a multi-OS metamorphic virus

Macro Viruses

A **macro virus** is written in scripting languages used by some office applications (can be cross-platform)

- Written in VBS, embedded in a MS-office document, activated when the document is open (autoload function)

Concept (1995)

Melissa (1999)

- March 26 1999, Melissa shut down e-mail systems that got clogged with infected e-mails

00's - The era of Trojan horses and internet worms

Anatomy of a Trojan horse

A **Trojan horse** is a program that disguise itself as a legitimate program or file

➡ In most cases, Trojan horses replicate themselves through emails

The big stars among trojan horses

VBS/Loveletter ILOVEYOU (2000)

- Caused 5.5 to 10 billion dollars in damage

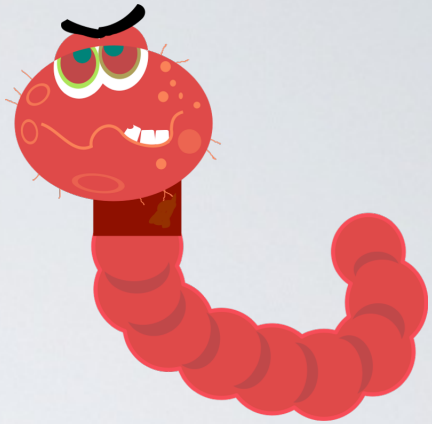
Sobig (2002)

- Sobig.F set a record in sheer volume of e-mails

MyDoom (2002)

- Broke the record set by Sobig.F

Anatomy of a worm



A **worm** exploits a security flaw (often of a network service) to infect the machine and replicates itself through the network

- ➡ Very fast infection (does not need the user to be activated)
- ➡ Has a payload as well (more or less harmful)

Factors

- The wide adoption of internet
- The global network is a good medium for virus pandemics
- The multiplication of internet applications and services
- Fast publication of program vulnerabilities
- Slow release of corrective patches
- Slower adoption of these patches (not automatic)

Code-Red (2001)

- Exploits a security flaw (buffer overflow) of Microsoft IIS web server (MS01-033) patched one month earlier
- In few days, 359 000 machines infected

Nimda (2001)

- Exploits another security flaw of MS-IIS
- The Internet's most widespread worm so far (the most part of the infection was done in 22min)

Klez (2001)

- Exploits a security flaw of Microsoft Internet Explorer layout engine used by Outlook and IE
- Infection through email attachment however the user does not have to open this attachment to get infected

SQL-Slammer (also called **Sapphire**) (2002)

- Exploits a security flaw in MS-SQL servers for which a patch had been released six months earlier (MS02-039)
- Infected 75,000 machines in 10 minutes causing caused a massive denial of service and dramatically slowed down global Internet traffic

Sasser (2002)

- Exploiting a buffer overflow of Microsoft LSASS on Windows 2000 and XP systems
- Many companies had to shut down their services

Blaster (also known as **Lovesan**) (2003)

- Exploits a security flaw in DCOM-RPC services on Windows 2000 and XP
- Was supposed to do SYN flood on August 15, 2003 against port 80 of windowsupdate.com

Welchia (also known as **Nachia**) (2003)

- Exploits the same security flaw than Blaster
- Corrects the security flaw by patching the system

Conficker (2008)

- Exploits a security flaw in NetBIOS
- Disables auto-update
- Embeds a dictionary password cracker and a backdoor to turn the machine into a "bot"
- Believed to be originated from Ukraine and/or Russia

The first web-worm

Santy (2004)

- Exploited a vulnerability in phpBB and used Google in order to find new targets
- It infected around 40 000 sites before Google filtered the search query used by the worm, preventing it from spreading

The emergence of XSS worms

An **XSS worm** exploits a cross site scripting (XSS) within a website (see lecture on *web security*)

Samy (2005)

- Targeting MySpace (social network)

JTV.worm (2008)

- Targeting Justin.tv (video casting)

Twitter.worm (2010)

- Targeting Twitter (micro-blogging)

10's - The era of cyber-warfare malware & Ransomware & IoT malware

The first cyber-warfare virus

W32.Dozor (July 2009)

- A virus that created a botnet dedicated to perform a DDoS attack South Korea and US government website on July 4th
- Believed to be originated from China and/or North Korea

Stuxnet (Sept 2010)

- A very sophisticated virus that targets SCADA systems (supervisory control and data acquisition)
- Believed that it took down 4000 nuclear centrifuges in Iran
- Believed to be originated from the USA and Israel

Flame also called **Skywiper** (May 2012)

- An *espionage* virus that embeds sophisticated spywares
- Believed to be originated from the USA (*Olympic Games* defense program)

Another trend - Ransomware

Reveton (2012)

- Displays a message from the law enforcement agency saying that you have pirated software and child pornography on your machine
- Ask you to pay a fine using a prepaid cash service

CryptoLocker (2013)

- Encrypt specific files on your machine with a 2048 RSA key
- Ask you to pay a ransom with Bitcoins

"Ransomware attacks grew by 500% in 2013 and turned vicious"

source : *Symantec Internet Security Threat Report 2014*

... and it turned vicious

WannaCry and **Petya** (2017)

- Use a vulnerability found in the NSA hacking toolkit leak
- Researcher have found a "kill switch"
- Paralyzed hospitals in UK and trains in Germany

Late 10's - the mergence of IoT malware and Cryptominers

Mirai (2016)

- Infects IoT devices
- Most powerful DDoS attacks to date

Coinhive (2018)

- Javascript embedded in website (either legitimately or not) and popular malware as well

The stupid trend of hoax viruses

A **hoax virus**

1. gives you the method to detect and remove the virus (often a real and important system file)
2. asks you to transfer this email to your contacts

What are the effects?

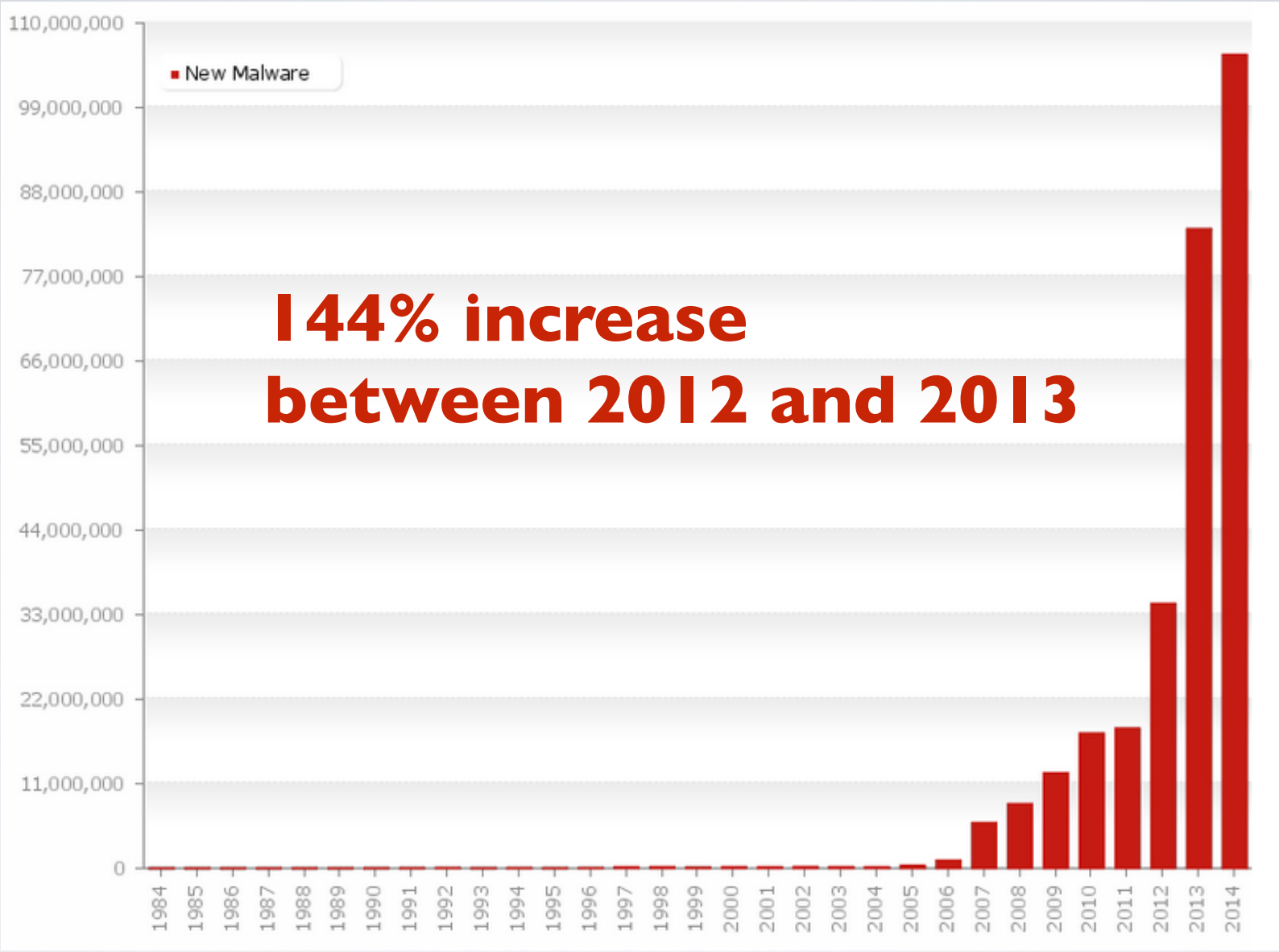
- Hoax virus are harmless (almost) and do nothing by themselves (but users do)

How to remove it?

- Delete the email :)

Modern Malicious Code

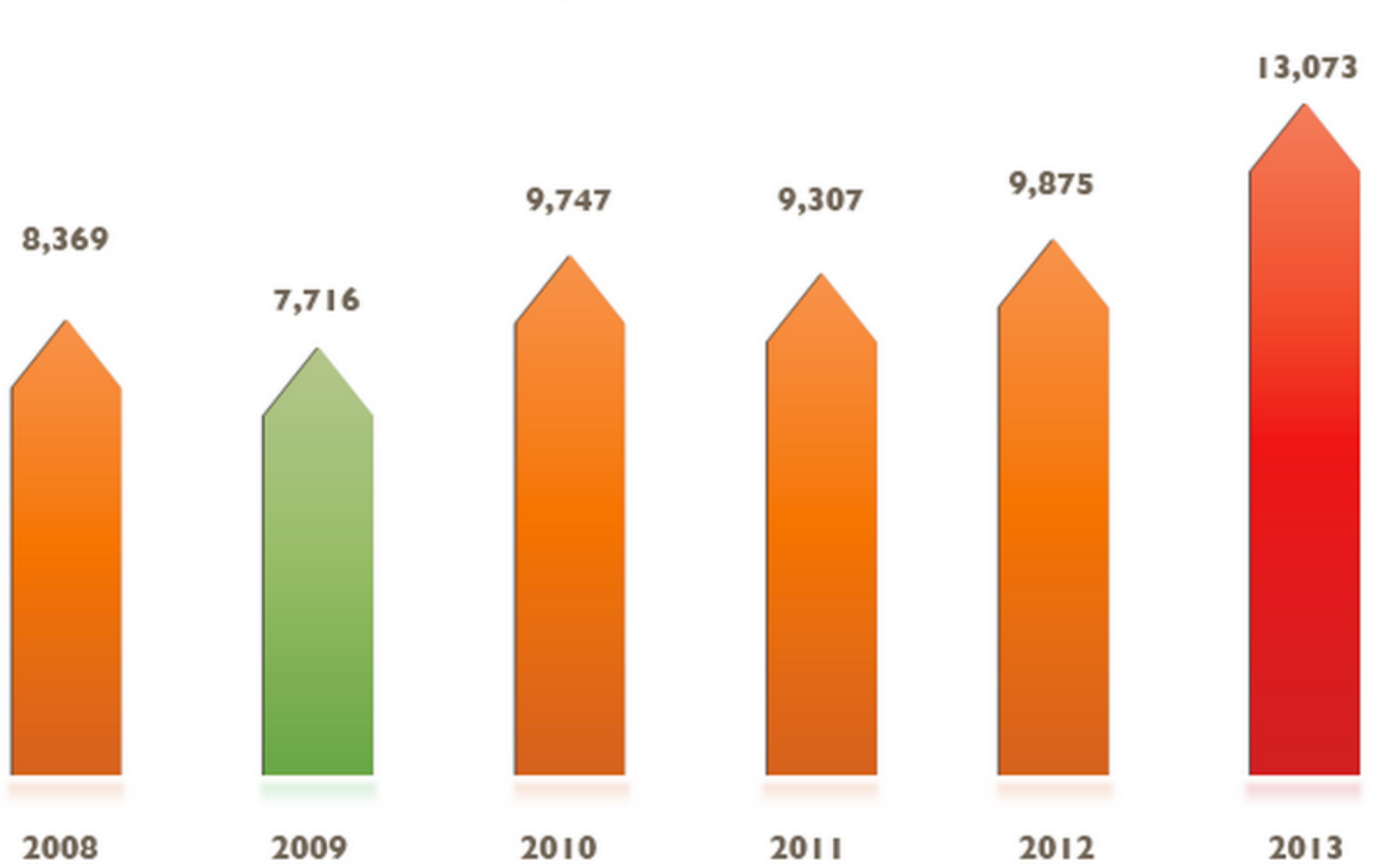
Thierry Sans



The Explosion of Unknown Malware

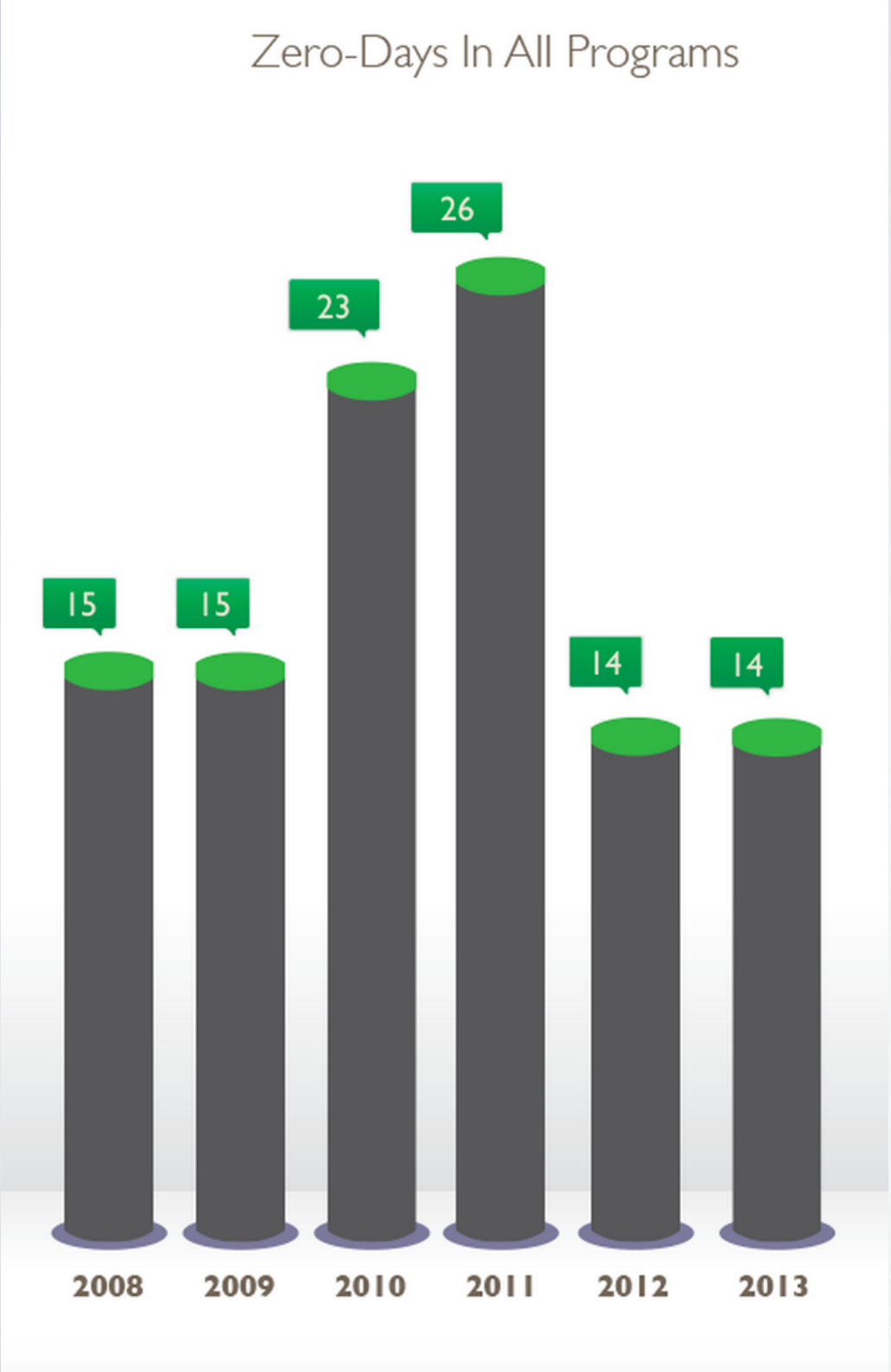
AV-TEST Institute

av-test.org



Vulnerability Review 2013

Secunia



Vulnerability Review 2013

Secunia

Why?

“Malicious Software and its Underground Economy”

joint work with *Omar Abou Selo* (undergrad at CMU) in 2014

Original research problem

➡ how easy is it to hire a hacker or get cutting-edge hacking tools on the internet (hacker’s forums)?

Conclusion

➡ creating a new malware is as simple as assembling pieces available online

How to create a new malware? 3 step process

1. Create the malware's payload
2. Make the malware undetectable
3. Spread the malware

How to create a new malware? 3 step process

1. **Create the malware's payload a.k.a building a RAT**
2. Make the malware undetectable
3. Spread the malware

What a malware do

- take control of the victim's device turning it into a **zombie/bot**
- act as a **spam relay** or **DDoS relay**
- steal **personal information**
  including passwords, credit card numbers, banking credentials
- **click bot :** generating web traffic
- … and so on

Remote Administration Tool (RAT)

Basically a **remote administration tool** with

- stealth features
- and specific functionalities such as :
    - camera controller
    - hardware destroyer
    - password / credit card loggers
    - … and so on

DIY RAT - program a RAT yourself

Pro

- ➡ Free
- ➡ Personalized

Cons

- ➡ Time consuming
- ➡ Requires good expertise of the targeted system

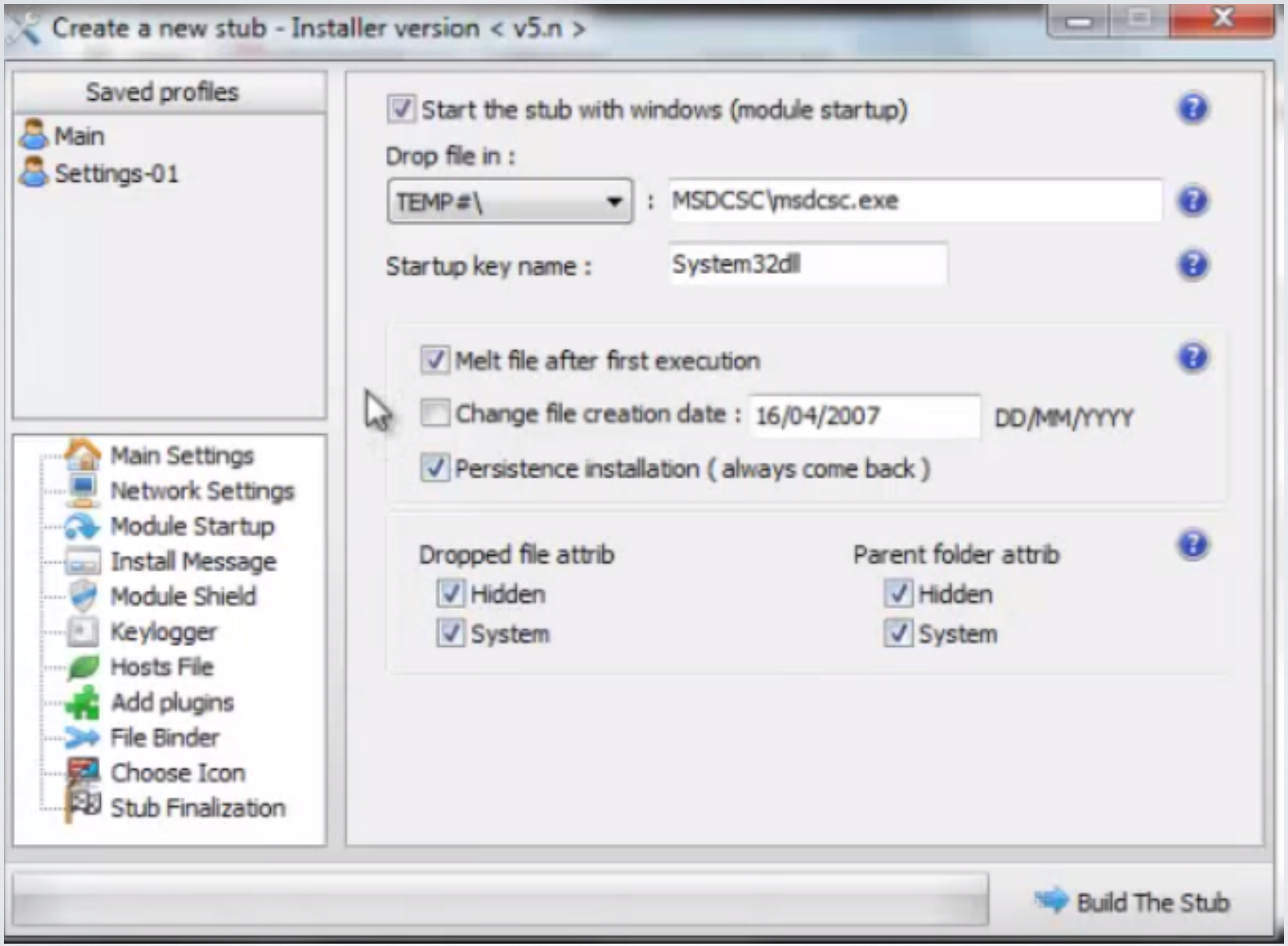
Buy a RAT as a COTS*

Some RAT Builders

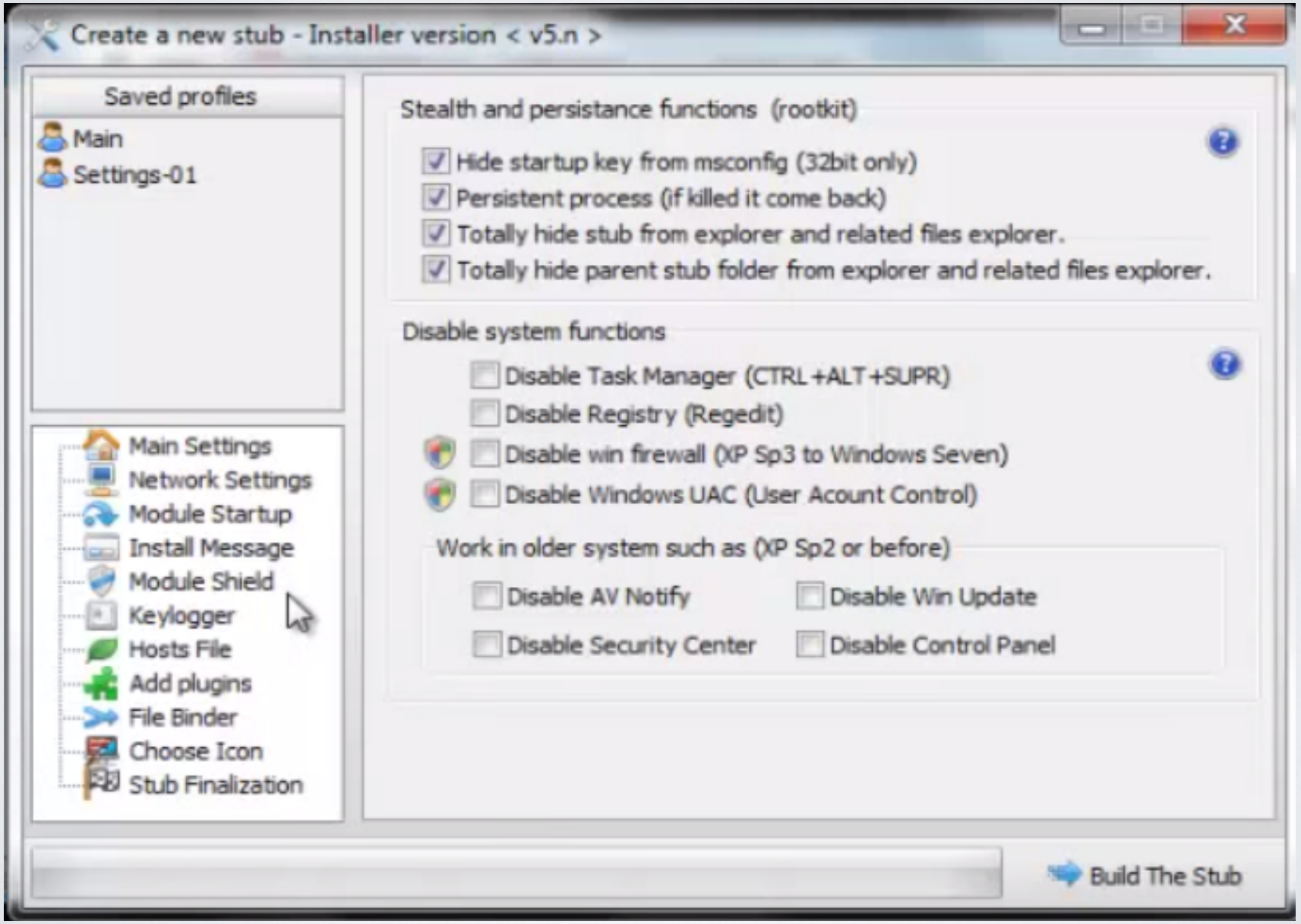
- **Zeus** (2007) initially $700, now open source
- **DarkComet** (2008), open source
- **BlackShades** (2010) can now be purchased from an official company $49 - $56

* Commercial Off-The-Shelf

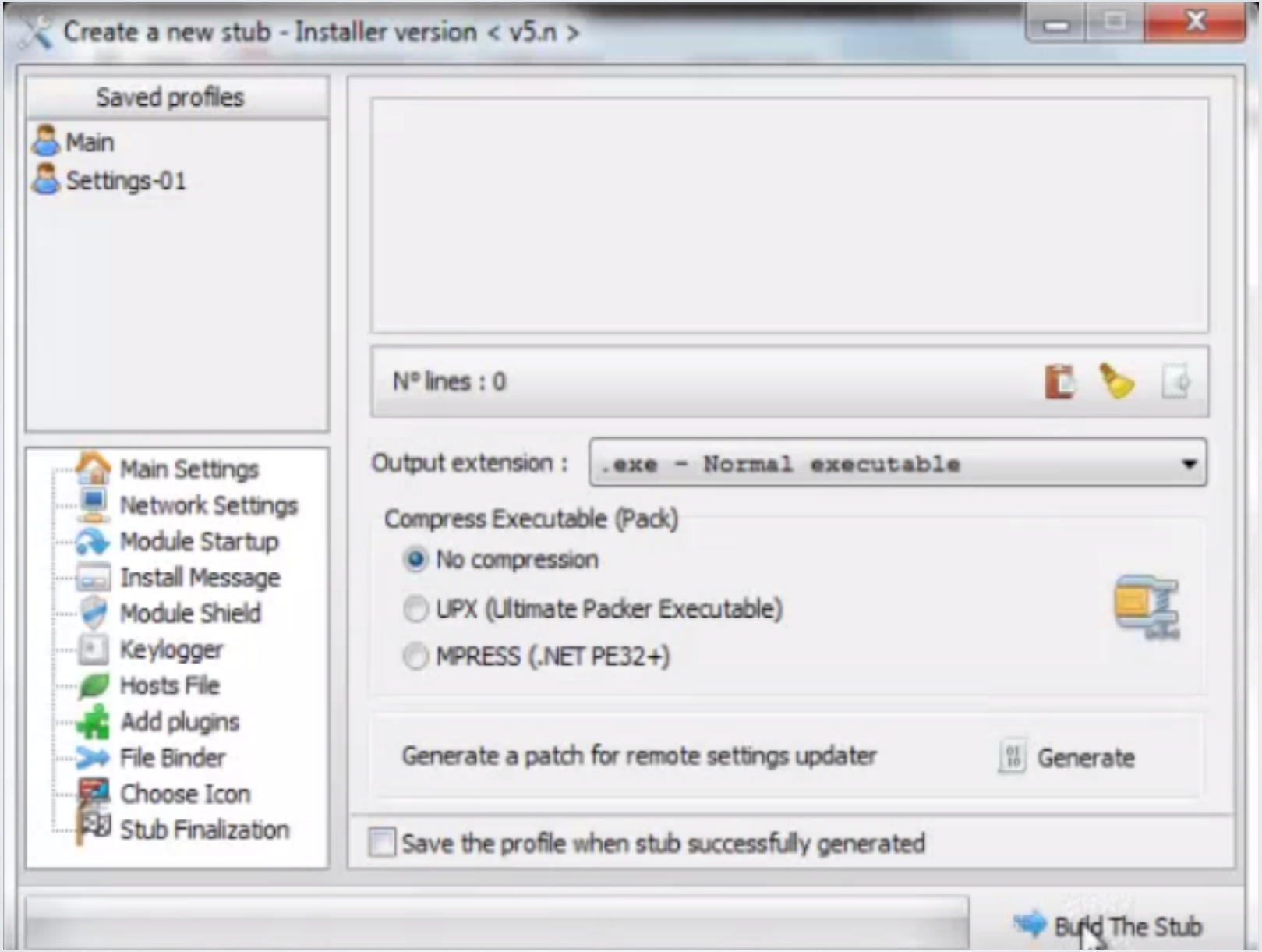
Startup and file options



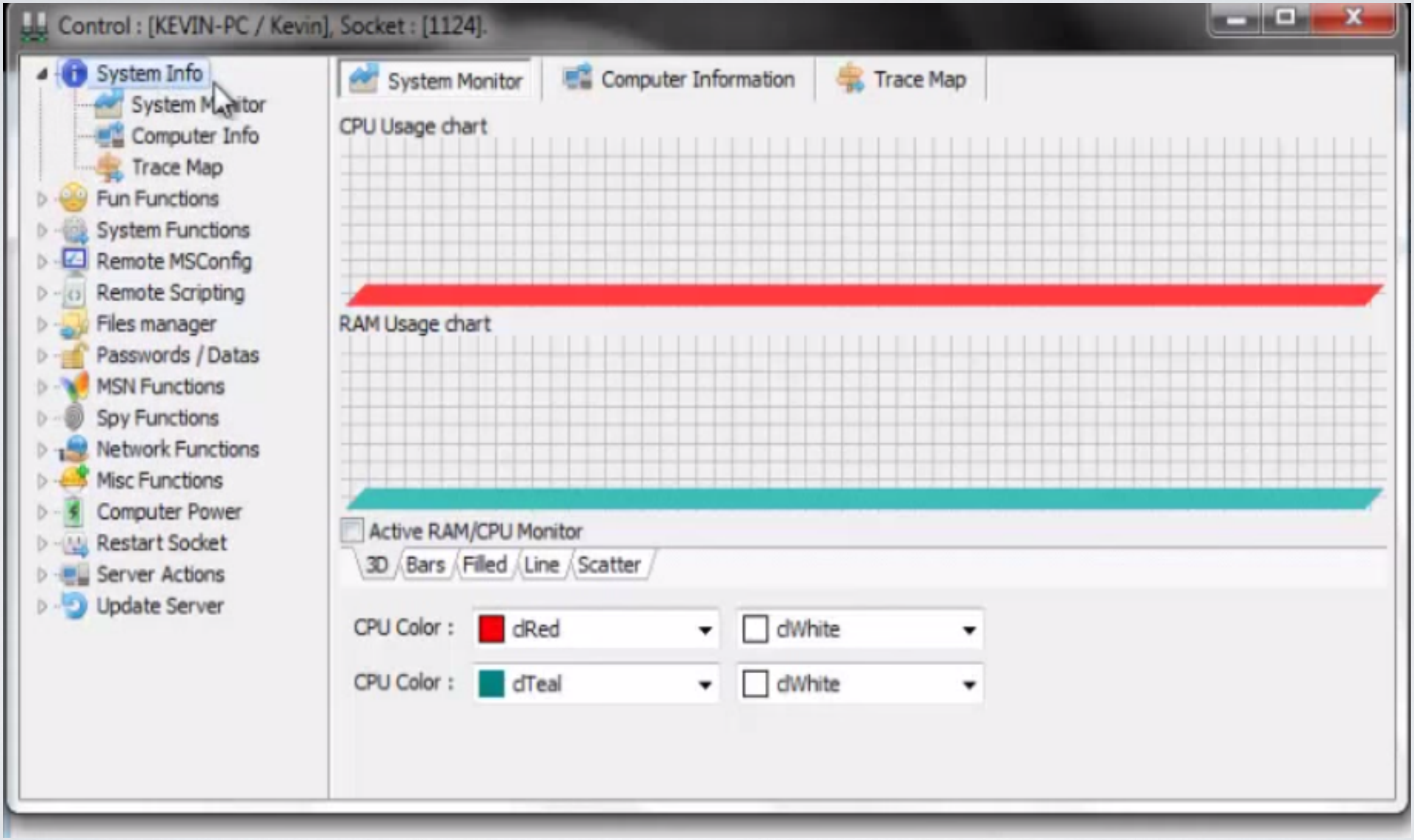
Stealth and persistence options



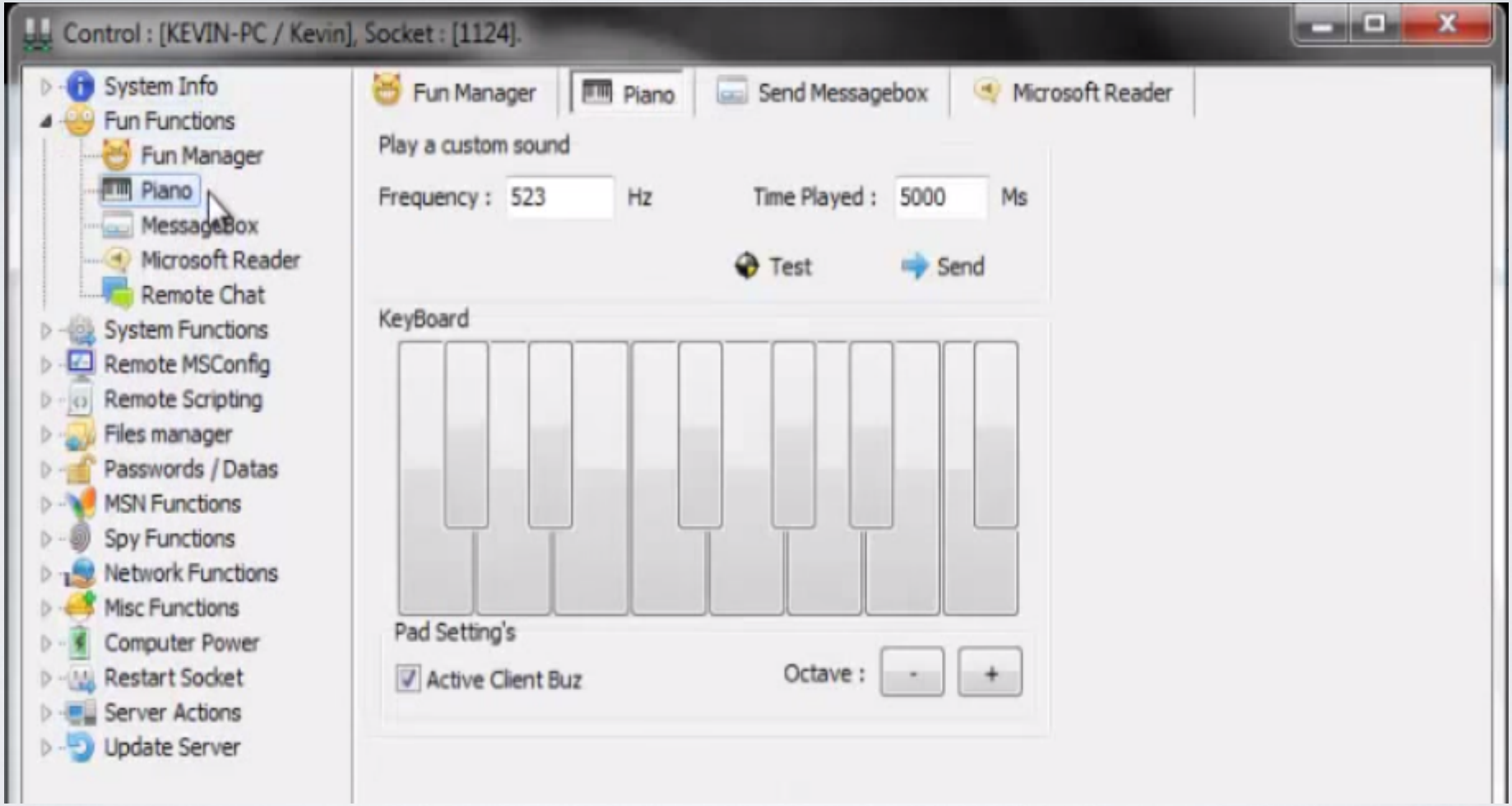
Finally building the RAT



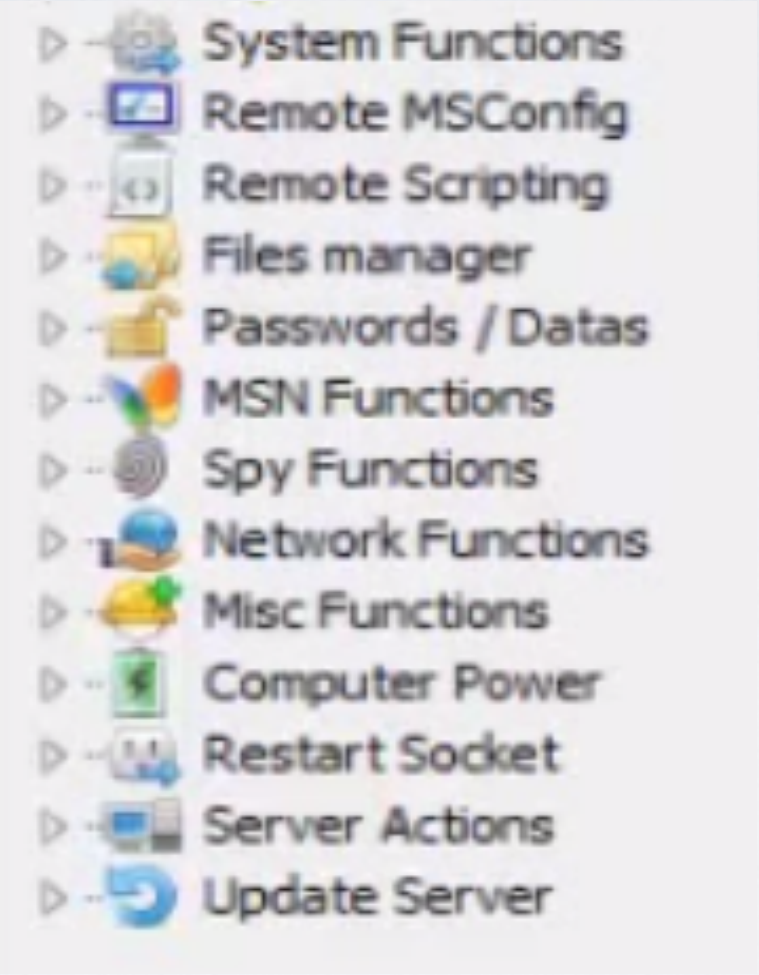
Monitor System info



Troll


Control : [KEVIN-PC / Kevin], Socket : [1124].
System Info
Fun Functions
Fun Manager
Piano
MessageBox
Microsoft Reader
Remote Chat
System Functions
Remote MSConfig
Remote Scripting
Files manager
Passwords / Datas
MSN Functions
Spy Functions
Network Functions
Misc Functions
Computer Power
Restart Socket
Server Actions
Update Server
Fun Manager
Piano
Send Messagebox
Microsoft Reader
Play a custom sound
Frequency : 523 Hz
Time Played : 5000 Ms
Test
Send
KeyBoard
Pad Setting's
Active Client Buz
Octave :
-
+

Other functionalities



Are we done yet?

virustotal

SHA256: 858fb1fc03614802aee5be779b454b16384a1c051f925dbb360e8fcfa12fc6a3

File name: DarkCometRAT531.zip

Detection ratio: 42 / 50

Analysis date: 2014-04-27 11:58:13 UTC (5 hours, 26 minutes ago)

Analysis | Relationships | Additional information | Comments 1 | Votes

Antivirus	Result	Update
AVG	Generic23.AVVP.dropper	20140427
Ad-Aware	Trojan.Generic.KDV.388330	20140427
Agnitum	HackTool.Binder!uc8D13KnW4U	20140427
AntiVir	SPR/Binder.bs.1	20140426
Antiy-AVL	HackTool/Win32.Binder	20140427
Avast	Win32:Malware-gen	20140427

How to create a new malware? 3 step process

1. Create the malware's payload

2. **Make the malware undetectable a.k.a packing a malware**

3. Spread the malware

How antiviruses detect malware? 2 techniques

1. **Static Analysis**

➡ Scan program comparing it to a collection of signatures

How to bypass it ? encryption and code obfuscation

2. **Dynamic Analysis**

➡ Run program in a sandbox and infer from its behavior

How to bypass it? detect the sandbox environment and employ trigger based behaviors

DIY packing - make the code undetectable yourself

Pro

- ➡ Free
- ➡ Personalized

Cons

- ➡ Time consuming
- ➡ Requires good expertise of cryptography, code obfuscation and execution environment

Buy a Crypter as a COTS

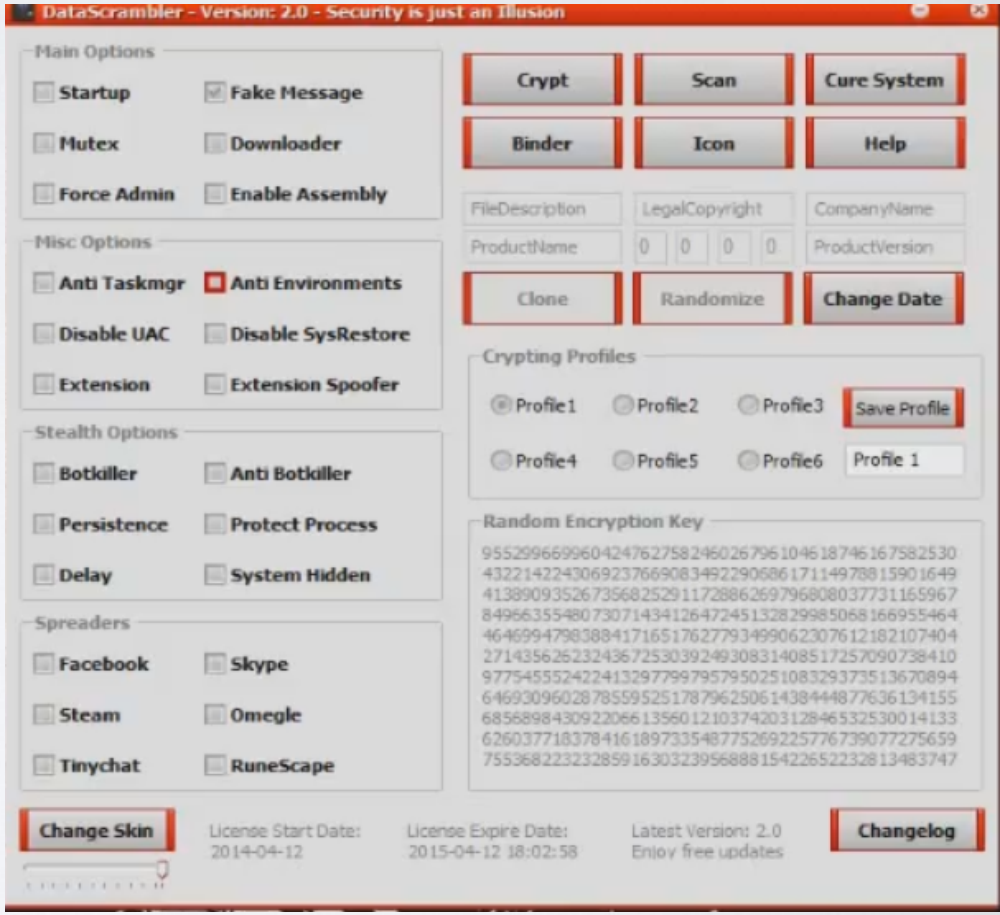
Some available Crypters

- **Byte Crypter** $35 for 3 months, $60 for lifetime
- **Datascrambler** $20 for 3 months, $40 for a year
- **BlackShades Crypter** from an official company $60 for 3 months, $100 for a year

A look at Datascrambler

Functionalities include:

- Start malware on startup
- Block sandbox from monitoring
- Kill other bots on victims pc
- Protect from botkiller
- Delay for dynamic analysis
- Persistence
- Binder



How to create a new malware? 3 step process

1. Create the malware's payload
2. Make the malware undetectable
3. **Spread the malware**

Spread the malware using social engineering

➡ Trick people to download and install the malware

- tutorial about hacking that makes you install the malware
- video/chat player to access exclusive content or talk to exclusive people
- pirated software on P2P networks

Pro

➡ Free

Cons

➡ Difficult to get cautious people infected

➡ Limited impact

Spread the malware using through a webpage

- Exploit a browser/plugin vulnerability to automatically download and install the malware on the victim's device

Pro

- Everyone with a vulnerable browser can be infected
- Can be used for massive infections and targeted ones

Cons

- Requires good expertise of the target browser, its vulnerabilities and how to exploit them

Buy an Exploit Bundle/Kit and associated services

1. **Exploit bundle** : $25/day, $400/month, up to $3,000
   - ➡ program to embed into a webpage

2. **Bulletproof host** : $15–250 per month
   - ➡ hosting service to bypass any kind of IP filtering anti-spam, anti-virus, anti-malware, law enforcement, search engine anti-malware service and so on

3. **Traffic** : $4–10 per 1,000 unique hits
   - ➡ attract people to visit the infected webpage

Examples of Exploits Kits

http://contagiodump.blogspot.com/2010/06/overview-of-exploit-packs-update.html

- **Blackhole** (2010, latest version in 2013)
  19 CVEs mainly targeting Java and Adobe products
  http://community.websense.com/blogs/securitylabs/pages/black-hole-exploit-kit.aspx

- **Redkit** (2013)
  4 CVEs mainly targeting Java
  http://nakedsecurity.sophos.com/2013/05/03/lifting-the-lid-on-the-redkit-exploit-kit-part-1/

Buy installs of your malware

➡ Use a spreading service also called Pay-Per-Install (PPI)
$12 – $550 per 1000 infections

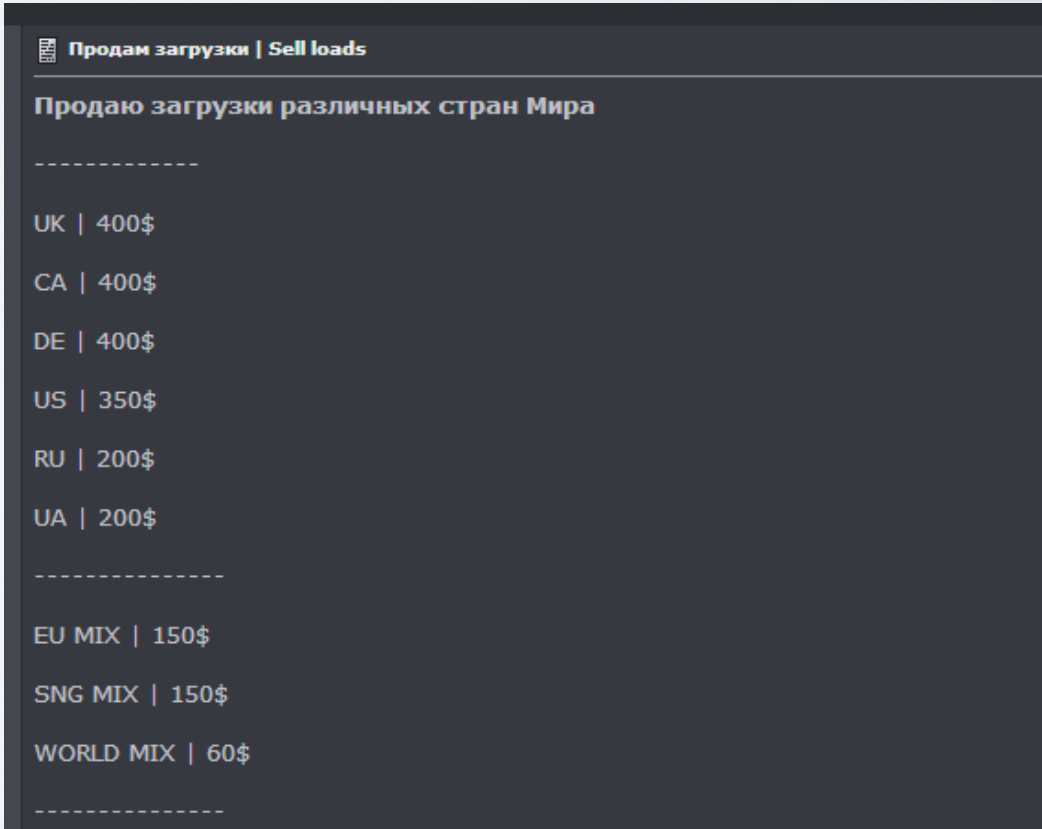
Pro

➡ Easy

➡ Can be selective about the geolocation of the hosts

Cons

➡ Pricy



Conclusion

Creating a malware, making it undetectable and spreading it would normally be difficult and require a good deal of expertise

However, the cyber underground market makes this process accessible to the mass given a small amount of money

Consequences

Antivirus “is dead” says Brian Dye, Symantec's senior vice president for information security. **"We don't think of antivirus as a moneymaker in any way."**

Symantec Develops New Attack on Cyberhacking
The Wall Street Journal

Other findings

The cyber underground market offers many services

- Buy *Youtube* views, *Facebook* likes, *Twitter* followers
- Hacker for hire
- Botnet rental
- DDoS services
- Spamming services
- "Update" your college grades

Excellent Reference

“Russian Underground 101”

Max Goncharov, Trend Micro Incorporated, 2012

http://www.trendmicro.com/cloud-content/us/pdfs/security-intelligence/white-papers/wp-russian-underground-101.pdf