Threat Spotlight: Ratsnif - New Network Vermin from OceanLotus

threatvector.cylance.com/en_us/home/threat-spotlight-ratsnif-new-network-vermin-from-oceanlotus.html

Overview

The OceanLotus Group (aka APT32, CobaltKitty | previous reports: The SpyRATs of OceanLotus; OceanLotus APT Group Leveraging Steganography) is using a suite of remote access trojans dubbed "Ratsnif" to leverage new network attack capabilities. Blackberry Cylance threat researchers have analyzed the Ratsnif trojans, which offer a veritable swiss-army knife of network attack techniques. The trojans, under active development since 2016, combine capabilities like packet sniffing, gateway/device ARP poisoning, DNS poisoning, HTTP injection, and MAC spoofing.

We delved into four distinct Ratsnif samples, three of them developed in 2016, the fourth created during the latter half of 2018.

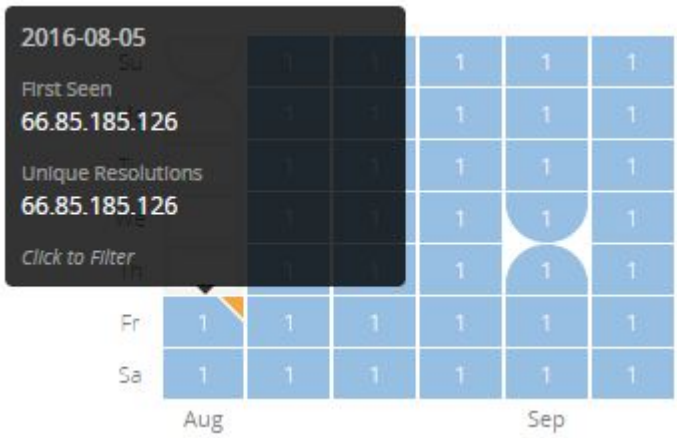
Sample 1

MD5	516ad28f8fa161f086be7ca122351edf
SHA256	b4e3b2a1f1e343d14af8d812d4a29440940b99aaf145b5699dfe277b5bf-b8405
Filename	javaw.exe, Client.exe
Path	X:\Project\BotFrame\Debug\Client.exe
Size	1.32 MB (1,387,520 bytes)
File Type	PE32 executable for MS Windows (console) Intel 80386 32-bit
Alias	OceanLotus APT32 Ratsnif
Compile Time	2016-08-05 07:57:13

Overview

The earliest example of Ratsnif uncovered thus far was compiled on the same day that its C2 domain was first activated:

It appears to be a debug build, and closely resembles a later variant from September 2016 that will be the main focus of analysis for the three 2016 variants described in this article.



Sample 2

MD5	b2f8c9ce955d4155d466fbbb7836e08b
SHA256	b214c7a127cb669a523791806353da5c5c04832f123a0a6d-f118642eee1632a3
File-name	javaw.exe, Client.exe
Path	X:\Project\BotFrame\Debug\Client.exe
Size	1.32 MB (1,387,520 bytes)
File type	PE32 executable for MS Windows (console) Intel 80386 32-bit
Alias	OceanLotus APT32 Ratsnif
Compile Time	2016-08-06 04:30:06

Overview

Compiled less than 24 hours after the previous sample, this build contains only one minor difference in functionality, whereby a call to *pcap_dump_flush()* has been removed prior to recompilation:

```
int __cdecl sub_4AC2C0(int a1, int a2)
{
  int result; // eax
  int v3; // [esp+D0h] [ebp-8h]

  v3 = *(_DWORD *)(a1 + 24);
  pcap_dump(*(u_char **)(v3 + 4), (const struct pcap_pkthdr *)a2, *(const u_char **)(a2 + 16));
  pcap_dump_flush(*(pcap_dumper_t **)(v3 + 4));
  result = pcap_dump_ftell(*(pcap_dumper_t **)(v3 + 4));
  if ( result >= 10485760 )
  {
    pcap_dump_close(*(pcap_dumper_t **)(v3 + 4));
    sub_48412B(fname);
    result = (int)pcap_dump_open(*(pcap_t **)(v3 + 8), fname);
    *(_DWORD *)(v3 + 4) = result;
  }
  return result;
}
```

Figure 1. Call to pcap_dump_flush in b4e3b2a1f1e343d14af8d812d4a29440940b99aaf145b5699dfe277b5bfb8405

```
int __cdecl sub_4AC2C0(int a1, int a2)
{
  int result; // eax
  int v3; // [esp+D0h] [ebp-8h]

  v3 = *(_DWORD *)(a1 + 24);
  pcap_dump(*(u_char **)(v3 + 4), (const struct pcap_pkthdr *)a2, *(const u_char **)(a2 + 16));
  result = pcap_dump_ftell(*(pcap_dumper_t **)(v3 + 4));
  if ( result >= 10485760 )
  {
    pcap_dump_close(*(pcap_dumper_t **)(v3 + 4));
    sub_48412B(fname);
    result = (int)pcap_dump_open(*(pcap_t **)(v3 + 8), fname);
    *(_DWORD *)(v3 + 4) = result;
  }
  return result;
}
```

Figure 2. Missing call to pcap_dump_flush in b214c7a127cb669a523791806353da5c5c04832f123a0a6df118642eee1632a3

In addition, the CodeView debugging information has changed, reflecting the new "age" of the sample after recompilation:

```
.rdata:005B59DC ; Debug information (IMAGE_DEBUG_TYPE_CODEVIEW)
.rdata:005B59DC asc_5B59DC      db 'RSDS'               ; DATA XREF: .rdata:005950B4â†‘o
.rdata:005B59DC                                         ; CV signature
.rdata:005B59E0                 dd 0BD2FD537h           ; Data1 ; GUID
.rdata:005B59E0                 dw 65BAh                ; Data2
.rdata:005B59E0                 dw 40E0h                ; Data3
.rdata:005B59E0                 db 9Bh, 0A5h, 17h, 57h, 3Dh, 8Bh, 0A0h, 0ABh; Data4
.rdata:005B59F0                 dd 14h                  ; Age
.rdata:005B59F4                 db 'X:\Project\BotFrame\Debug\Client.pdb',0 ; PdbFileName
```

Figure 3. Age of 0x14 in b4e3b2a1f1e343d14af8d812d4a29440940b99aaf145b5699dfe277b5bfb8405

```
.rdata:005B59DC ; Debug information (IMAGE_DEBUG_TYPE_CODEVIEW)
.rdata:005B59DC asc_5B59DC      db 'RSDS'               ; DATA XREF: .rdata:005950B4â†‘o
.rdata:005B59DC                                         ; CV signature
.rdata:005B59E0                 dd 0BD2FD537h           ; Data1 ; GUID
.rdata:005B59E0                 dw 65BAh                ; Data2
.rdata:005B59E0                 dw 40E0h                ; Data3
.rdata:005B59E0                 db 9Bh, 0A5h, 17h, 57h, 3Dh, 8Bh, 0A0h, 0ABh; Data4
.rdata:005B59F0                 dd 15h                  ; Age
.rdata:005B59F4                 db 'X:\Project\BotFrame\Debug\Client.pdb',0 ; PdbFileName
.rdata:005B5A19                 align 4
.rdata:005B5A1C ; Debug information (IMAGE_DEBUG_TYPE_VC_FEATURE)
```

Figure 4. Age of 0x15 in b214c7a127cb669a523791806353da5c5c04832f123a0a6df118642eee1632a3

Both samples were submitted to VirusTotal within a minute of being compiled and contain the same path as the PDB information. It seems likely this sample was automatically submitted to an online scanning service by the developer:

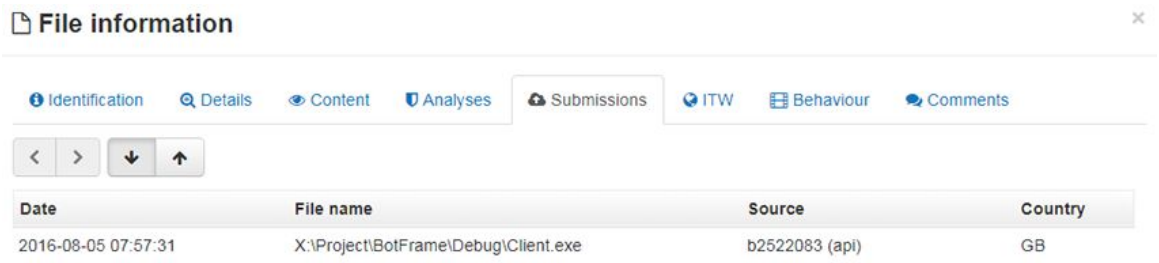


Figure 5. VirusTotal submission showing date/time and path

Sample 3

MD5	7f0ac1b4e169edc62856731953dad126
SHA256	b20327c03703ebad191c0ba025a3f26494f-f12c5908749e33e71589ae1e1f6b3
Filename	javaw.exe, adobe.exe
Path	N/A
Size	432 KB (442,880 bytes)
File Type	PE32 executable (DLL) (GUI) Intel 80386, for MS Windows
Alias	OceanLotus APT32 Ratsnif

Compile Time	2016-09-13 09:26:42

Overview

Remarkably similar in functionality to the previous samples from August 2016, this sample is a release build and was likely one of the earlier Ratsnifs to be deployed by OceanLotus in-the-wild.

Threat Features

- C2 over HTTP
- Packet sniffing
- ARP poisoning
- DNS spoofing
- HTTP redirection
- Remote shell

Analysis

Upon execution, Ratsnif creates a run once mutex named "onceinstance", initialises Winsock version 2.2, and harvests system information such as the username, computer name, workstation configuration (via NetWkstaGetInfo API), Windows system directory and network adapter information. This information will then be sent to the attacker's C2 server via an HTTP post to the */cl_client_online.php* API endpoint. Next, a logging thread is created, which is used to route log messages to the C2 via HTTP POST requests to */cl_client_logs.php.* The malware then proceeds to load wpcap.dll, before importing the following functions:

- pcap_sendqueue_transmit
- pcap_findalldevs
- pcap_freealldevs
- pcap_open_live
- pcap_sendqueue_alloc
- pcap_next_ex
- pcap_sendqueue_queue
- pcap_sendpacket
- pcap_close
- pcap_sendqueue_destroy
- pcap_dump_open
- pcap_dump_ftell
- pcap_dump_flush
- pcap_dump_close
- pcap_dump

With WinPcap successfully loaded, a further HTTP POST request is made to */cl_client_cmd.php,* which is used to obtain a command code from the attacker. This code will check for commands every 10 seconds. C2 commands are decrypted using AES with a hard-coded static key via Windows APIs, before being dispatched by a simple command processor.

C2

All observed Ratsnif samples have been hardcoded with one or more C2 domains, regardless of whether they are used. This sample contains 2 hard-coded domains, although only one appears to have ever been active:

- search[.]webstie[.]net
- dns[.]domain-resolve[.]org (inactive)

The C2 server itself is expected to expose a fairly intuitively named web API, supporting the following endpoints:

URL	**Description**
/cl_client_online.php	POST containing harvested system information
/cl_client_cmd.php	GET C2 command
/cl_client_cmd_res .php	POST result of C2 command
/cl_client_logs.php	POST log message

The malware contains support for the following commands issued via the *cl_client_cmd.php* HTTP response:

Command	Parameters	Description
dump	N/A	Sets an internal "dump" flag to 1, causing intercepted packets to be written to file (ntdata.tmp) when the "devIp" command is issued. If the dump file exceeds 10MB it will be deleted and recreated.
devIp	IP	Loads WinPcap, performs ARP poisoning against the specified IP and optionally sniffs/dumps packets to ntdata.tmp
gatewayIp	IP	If no gateway IP is already poisoned, use SendArp() to poison the ARP table
tarDns	Domain;IP	Accepts a domain name to hijack and an IP address to redirect to. During packet retransmission, traffic on port 53 UDP with a matching domain will be altered.
scan	IP	Performs an ARP and SMB port scan. The following SMB packet header is used: .rdata:00458D28 smb_packet db 0 .rdata:00458D29 db 0 .rdata:00458D2A db 0 .rdata:00458D2B db 87h ; â€¡ .rdata:00458D2C db 0FFh ; Ã¿ .rdata:00458D2D aSmbs db 'SMBs',0 .rdata:00458D32 db 0 .rdata:00458D33 db 0 <snip> .rdata:00458D98 db 0 .rdata:00458D99 aGuest db 'guest',0 .rdata:00458D9F db 0 .rdata:00458DA0 aNmap db 'Nmap',0 .rdata:00458DA5 aNativeLanman db 'Native Lanman',0 The packet header appears to be based on an nmap script: https://svn.nmap.org/nmap/nselib/smb.lua?
vicIp	IP	After poisoning a device or gateway, this command will create several threads to perform additional ARP poisoning, packet sniffing, and packet retransmission.
exIp	List of IP;Port	List of IP addresses and ports to exclude from monitoring
logtm		Not implemented
runtm	Integer	Converts and stores the supplied argument from ASCII string to an integer using *atoi()*
httprd	Hostname	Redirects HTTP request using one of 2 methods, either updating the hostname in the request directly or using an HTTP 301 response code.
httpExt	List of extensions	Specifies a list of file extensions to perform HTTP redirection on
shell	Command-line	CreateProcessA with stdout redirected
stop		Stops poisoning
exit	Exit code	Stops poisoning and terminates with exit code

Sample 4

MD5	88eae0d31a6c38cfb615dd75918b47b1
SHA256	7fd526e1a190c10c060bac21de17d2c90e-b2985633c9ab74020a2b78acd8a4c8
File-name	N/A
Path	N/A

Size	745 KB (762,880 bytes)
File Type	PE32 executable (DLL) (GUI) Intel 80386, for MS Windows
Alias	OceanLotus APT32 Ratsnif
Compile Time	Wed, 08 Aug 2018 02:52:52 UTC

Overview

Surfacing during the latter half of 2018 and wrapped in a bespoke OceanLotus shellcode loader, this sample was first reported in a blog from Macnica Networks. Compared to the 2016 variants this sample introduces a configuration file and does not rely on C2 for operation. It also adds new features in the form of HTTP injection, protocol parsing, and SSL hijacking.

Threat Features

- Deployed by OceanLotus loader
- Use of separately supplied configuration file, tailored to the victim's network environment (as opposed to backdoor commands in the previous versions)
- Use of separately supplied SSL certificates to perform SSL hijacking
- Use of WolfSSL library (version 3.11) for decryption of SSL traffic (https://github.com/wolfSSL/wolfssl)
- Use of http_parser.c for parsing HTTP traffic (https://elixir.bootlin.com/zephyr/v1.13.0/source/subsys/net/lib/http/http_parser.c)
- Packet sniffing focused on extracting login credentials and other sensitive data via protocol parsing
- ARP poisoning
- DNS spoofing
- HTTP redirection
- HTTP injection

Analysis

For this particular sample, the actual sniffer executable is Base64 encoded within a loader DLL and wrapped in two layers of shellcode. The loader DLL decodes the payload, copies it to memory and executes the 1st stage shellcode, which will decompress the binary and execute the 2nd stage shellcode in a separate thread. The 2nd stage shellcode will inject the sniffer executable into memory and hook several API functions responsible for returning the process command line (GetCommandLineA,

GetCommandLineW, _acmdln, _wcmdln), so they return a hardcoded string instead. The string contains the parameter that specifies a path to the config file, as well as the executable's original path:

```
C:\Users\Administrator\Desktop\api\temp\royal\HkYh9CvH7.exe -p
C:\ProgramData\setting.cfg
```

Figure 6. Embedded command-line

It is not immediately obvious why the attackers used this convoluted method to pass the config path to the malware.

The configuration file is a simple text file, Base64 encoded, where the first line is ignored, and each subsequent line specifies a parameter. For example:

```
[unused_line]
-ip [ATTACKER IP ADDRESS]
-ga [DEFAULT GATEWAY]
-subnet [SUBNET MASK]
-sniff -ssl_ip [IP ADDRESS]
-html_inject [BROWSER PROCESS NAME]
-dlog_ip [IP ADDRESS]
-mac [ATTACKER MAC ADDRESS] "true"|"false"
-name [DOMAIN NAME] [REDIRECTION IP]
-all
-dnsttl [INT VALUE]
-log [LOGFILE PATH]
-pass [CREDENTIALS DUMP PATH]
-dwn_ip [IP ADDRESS]
```

Figure 7. Configuration file options

However, there is a bug in parsing the value of the *dwn_ip* parameter, which will result in a memory read violation if the value is present in the configuration:

```
    v46 = *(char **)current_string;
  print_debug_msg("Invalid parameter: %s\n", v46);
  goto inc_counter_next;
}
if ( v5 < v3 )
{
  std::basic_string<char,std::char_traits<char>,std::allocator<char>>::operator=(
    (std::basic_string<char,std::char_traits<char>,std::allocator<char> > *)dwn_ip_param,
    *(const char **)(v2 + 4 * v5++));
  print_debug_msg(
    "download ip: %s\n",
    *(_DWORD *)dwn_ip_param,
    *(_DWORD *)&dwn_ip_param[4],
    *(_DWORD *)&dwn_ip_param[8],
    *(_DWORD *)&dwn_ip_param[12],
    *(_DWORD *)&dwn_ip_param[16],
    *(_DWORD *)&dwn_ip_param[20]);
```

Figure 8: Bug in the code: the value of "dwn_ip" is passed as a string, while print_debug_msg expects a pointer to a string

Once executed, the sniffer will read the configuration from the specified file, decode it using Base64 and parse it to an in-memory structure. If the "-sniff" parameter is specified in the configuration, the malware will add a firewall exception and disable Large Send Offload (LSO) for each network adapter in the registry:

```
netsh advfirewall firewall add rule name=\"Core Networking - Router Solicitation\" dir=in action=allow program={self_path} enable=yes
```

Figure 9. Command-line used to add Windows firewall rule

```
wmic path win32_networkadapter where index=%d call disable
```

Figure 10. Command-line used to disable network adapters prior to disabling LSOs

After importing the same APIs from wpcap.dll as the 2016 variants (with the addition of pcap_geterr), the malware creates threads responsible for ARP poisoning and DNS spoofing.

In order to be able to decrypt the SSL traffic, the malware performs SSL hijacking, using an open source library called WolfSSL and separately supplied certificate and private key files. For that purpose, it creates an internal WolfSSL server, listening on the first available port in the range 65000 – 65535:

```
.text:02356C49                  mov     word ptr [ebp+snifall_struct], 303h
.text:02356C52                  mov     ax, word ptr [ebp+snifall_struct]
.text:02356C59                  mov     [ecx], ax       ; version 0x303
.text:02356C5C                  mov     word ptr [ecx+2], 100h ; side = 1, downgrade = 0
.text:02356C62
.text:02356C62 loc_2356C62:
.text:02356C62                  call    wolfSSL_CTX_new_ex
.text:02356C67                  sub     esp, 0Ch
.text:02356C6A                  mov     [esi+sniffall.wolfssl_ctx_srv], eax
.text:02356C6D
.text:02356C6D wolfSSL_CTX_use_PrivateKey_file:
.text:02356C6D                  mov     edx, offset aCertApacheCrt ; "./cert/apache.crt"
.text:02356C72                  push    0               ; 0 = CERT_TYPE
.text:02356C74                  push    ecx             ; format: 03, 03, 01, 00
.text:02356C75                  mov     ecx, eax        ; wolfssl_ctx
.text:02356C77                  call    wolfssl_ProcessFile
.text:02356C7C                  add     esp, 8
.text:02356C7F
.text:02356C7F wolfSSL_CTX_use_certificate_file:
.text:02356C7F                  mov     edx, offset aCertApacheKey ; "./cert/apache.key"
.text:02356C84                  push    1               ; 1 = PRIVATEKEY_TYPE
.text:02356C86                  push    ecx
.text:02356C87                  mov     ecx, [esi+sniffall.wolfssl_ctx_srv]
.text:02356C8A                  call    wolfssl_ProcessFile
```

Figure 11: Use of WolfSSL

Unlike the 2016 variants of Ratsnif that stored all packets to a PCAP file, the 2018 variant employs multiple sniffer classes for harvesting sensitive information from packets. This will minimize the amount of data the attacker has to collect, exfiltrate and process, and also reveals what information the attacker is interested in.

The malware can sniff traffic for the following protocols/ports:

Inter-face	Ports	Headers
CSniff Ftp	21, 990	ABOR ACCT ADAT ALLO APPE AUTH CCC CDUP CONF CWD DELE ENC EPRT EPSV FEAT HELP HOST LANG LIST LPRT LPSV MDTM MIC MKD MLSD MLST MODE NLST OPTS PASS PASV PBSZ PORT PROT PWD QUIT REIN REST RETR RMD RNFR RNTO SITE SIZE SMNT STAT STOR STOU STRU SYST TYPE USER XCUP XMKD XPWD XRCP XRMD XRSQ XSEM XSEN 230
CSnif-fImap	143, 993	CAPABILITY LOGOUT STARTTLS AUTHENTICATE LOGIN SELECT EXAMINE CREATE RENAME LSUB STATUS APPEND CHECK CLOSE EXPUNGE FETCH STORE UID
CSnif-fLdap	389, 636, 10389, 10636	Various
CSniff Nntp	119	AUTHINFO USER AUTHINFO PASS ANONYMOUS 281
CSniff Pop	110, 995	RCEV RCVD RSET +OK USER PASS RETR QUIT
CSniff Smb	445	Various
CSniff Smtp	25, 465	HELO MAIL RCPT SEND SOML SAML VRFY EXPN TURN FROM
CSniff Tds	1433	SELECT name, password_hash FROM master.sys.sql_logins where is_disabled = 0; -- priv
CSniff Telnet	23	Login Failed login: password:
Sniff-Http2	80, 443	Various

Each sniffer class interface contains two methods for extracting sensitive information from the incoming and outgoing packets, respectively. These typically rely on searching for cleartext header strings to facilitate credential theft:

```
if ( memchr___strnicmp(pckt_data, pckt_length, (size_t)"login:", 6u, this, 0) )
{
    _this->commandId = 1;
}
else if ( memchr___strnicmp(pckt_data, pckt_length, (size_t)"password:", 9u, v5, 0) )
{
    _this->commandId = 2;
}
```

Figure 12. Searching for login and password commands in the Telnet protocol

In addition, the HTTP sniffer interface is also able to perform injection to insert arbitrary attacker supplied content into HTML.

C2

Although this sample contains a Base64 encoded C2 URL hardcoded in the .rdata section (the same address as in the 2016 versions), the malware never seems to use it; instead, it logs the captured information into text files for further exfiltration by another module.

Example

To recreate conditions in which the sample would operate, a default gateway was configured on 192.168.8.135 and was running iNetSim to act as the DNS and HTTP servers. The attacker machine was located at 192.168.8.134 and the victim at 192.168.8.138. Ratsnif was configured to operate as follows:

```
TEST CONFIG
-ip "192.168.8.134"
-ga "192.168.8.135"
-subnet "255.255.255.0"
-sniff
-ssl_ip "192.168.8.254"
-html_inject "iexplore.exe"
-dlog_ip "192.168.8.254"
-mac "00:0C:29:59:62:46" "true"
-name "www.google.com" "192.168.8.135"
-dnsttl "100"
-log "C:\ratsnif.log"
-pass "C:\ratsnif.pcap"
-dwn_ip
```

Figure 13. Configuration used for testing

Figure 14 shows the malware sending ARP packets asking for the MAC addresses of all the machines on the subnet specified in the config file, whilst ignoring itself (192.168.8.134) and the default gateway (192.168.8.135):

No.	Time	Source	Destination	Protocol	Length	Info
238	14.319283	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.128? Tell 192.168.8.134
239	14.319565	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.129? Tell 192.168.8.134
240	14.319634	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.130? Tell 192.168.8.134
241	14.319706	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.131? Tell 192.168.8.134
242	14.319725	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.132? Tell 192.168.8.134
243	14.319814	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.133? Tell 192.168.8.134
244	14.319819	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.136? Tell 192.168.8.134
245	14.319926	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.137? Tell 192.168.8.134
246	14.319931	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.138? Tell 192.168.8.134
247	14.320043	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.139? Tell 192.168.8.134
248	14.320048	Vmware_ff:1d:99	Vmware_59:62:46	ARP	60	192.168.8.138 is at 00:0c:29:ff:1d:99
249	14.320049	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.140? Tell 192.168.8.134
250	14.320153	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.141? Tell 192.168.8.134
251	14.320157	Vmware_59:62:46	Broadcast	ARP	60	Who has 192.168.8.142? Tell 192.168.8.134

Figure 14. ARP Broadcasts

Figure 15 shows the malware sending ARP packets asking for the MAC addresses of all the machines on the subnet specified in the config file, whilst ignoring itself (192.168.8.134) and the default gateway (192.168.8.135): ARP Broadcasts

Once it has MAC addresses for all machines on the subnet, Ratsnif will then send unsolicited ARP packets to those addresses, updating the MAC address of the default gateway for each victim:

No.	Time	Source	Destination	Protocol	Length	Info
829	155.847747	Vmware_59:62:46	Vmware_c0:00:01	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
830	155.847864	Vmware_59:62:46	Vmware_f2:b9:74	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
832	158.859296	Vmware_59:62:46	Vmware_ff:1d:99	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
833	158.859324	Vmware_59:62:46	Vmware_c0:00:01	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
834	158.859325	Vmware_59:62:46	Vmware_f2:b9:74	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
835	161.871165	Vmware_59:62:46	Vmware_ff:1d:99	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
836	161.871181	Vmware_59:62:46	Vmware_c0:00:01	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
837	161.871257	Vmware_59:62:46	Vmware_f2:b9:74	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
839	164.880463	Vmware_59:62:46	Vmware_ff:1d:99	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
840	164.880472	Vmware_59:62:46	Vmware_c0:00:01	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
841	164.880574	Vmware_59:62:46	Vmware_f2:b9:74	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
842	167.892011	Vmware_59:62:46	Vmware_ff:1d:99	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
843	167.892185	Vmware_59:62:46	Vmware_c0:00:01	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46
844	167.892467	Vmware_59:62:46	Vmware_f2:b9:74	ARP	60	192.168.8.135 is at 00:0c:29:59:62:46

Figure 15. ARP Poisoning

Figure 16 shows the effect on the victim machine, with the attacker IP address and the default gateway IP address (192.168.8.135) both now sharing the same physical address:

```
Interface: 192.168.8.138 --- 0xb
  Internet Address      Physical Address      Type
  192.168.8.1           00-50-56-c0-00-01     dynamic
  192.168.8.134         00-0c-29-59-62-46     dynamic
  192.168.8.135         00-0c-29-59-62-46     dynamic
  192.168.8.139         00-0c-29-99-a8-f2     dynamic
  192.168.8.254         00-50-56-f2-b9-74     dynamic
  192.168.8.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static
```

Figure 16. arp -a results showing poisoned ARP Table on the victim machine

Once the ARP table is poisoned, all traffic destined for the default gateway will be routed through Ratsnif and can be stored and manipulated prior to retransmission.

Finally, Figure 17 shows a poisoned DNS response for , whereby the DNS query was intercepted by Ratsnif, modified to point to an attacker controlled IP address and the fake response sent to the original requestor:

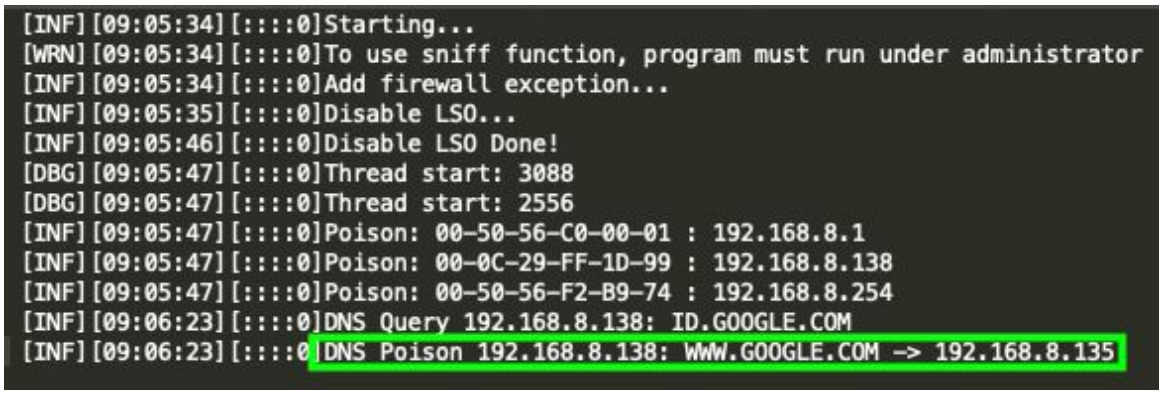


Figure 17. Ratsnif log file output showing ARP poisoning and DNS spoofing in action

C2

search.webstie.net

Whois

Attribute	Value
Server	whois.web4africa.net
Registrar	WEB4AFRICA INC
Email	contact@privacyprotect.org
Name	Domain Admin, C/O ID#10760
Organization	Privacy Protection Service INC d/b/a PrivacyProtect.org
Street	PO Box 16
City	Nobby Beach

State	Queensland
Postal	QLD 4218
Country	AUSTRALIA
Phone	4536946676
NameServers	ns21.cloudns.net ns22.cloudns.net ns23.cloudns.net ns24.cloudns.net

History

Obtained via Shodan, this history shows when the C2 server exposed various ports, including HTTP, SMB and RDP, for the purpose of controlling Ratsnif and other OceanLotus malware:

```
66.85.185.126
Hostnames:              host66.treinarweb.com.br;ess.amosbusiness.info
City:                   Tempe
Country:                United States
Organization:           Secured Servers LLC
Updated:                2019-05-27T21:17:16.616721
Number of open ports:   6

Ports:
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-05-27)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-05-18)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-05-06)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-04-29)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-04-20)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-04-05)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-03-28)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-03-24)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-03-05)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-03-05)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-02-10)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-01-06)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-01-06)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2019-01-06)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2018-12-29)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2018-12-27)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2018-11-29)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2018-11-19)
     22/tcp OpenSSH (7.2p2 Ubuntu-4ubuntu2.1)           (2018-11-17)
     22/tcp              (2018-11-01)
     22/tcp              (2018-10-26)
     22/tcp              (2018-10-24)
     22/tcp              (2018-10-09)
     22/tcp OpenSSH (6.6.1)             (2018-03-03)
     25/tcp Microsoft ESMTP (8.5.9600.16384)            (2018-03-25)
     25/tcp Microsoft ESMTP (8.5.9600.16384)            (2018-03-24)
     80/tcp Microsoft IIS httpd (8.5)           (2018-04-13)
     80/tcp Microsoft IIS httpd (8.5)           (2018-04-08)
     80/tcp Microsoft IIS httpd (8.5)           (2018-03-30)
     80/tcp              (2017-04-18)
     80/tcp              (2017-04-17)
     80/tcp              (2017-04-15)
     80/tcp              (2017-04-09)
    137/udp              (2017-10-02)
    137/udp              (2017-09-01)
    137/udp              (2017-08-14)
    137/udp              (2017-08-12)
    137/udp              (2017-07-24)
    137/udp              (2017-07-16)
    137/udp              (2017-07-16)
    137/udp              (2017-07-06)
    137/udp              (2017-07-05)
    137/udp              (2017-06-09)
    137/udp              (2017-05-26)
    137/udp              (2017-04-16)
    445/tcp              (2018-06-15)
    445/tcp              (2018-06-07)
    445/tcp              (2018-03-22)
    445/tcp              (2017-11-03)
    445/tcp              (2017-11-01)
    445/tcp              (2017-09-24)
    445/tcp              (2017-09-24)
    445/tcp              (2017-08-18)
    445/tcp              (2017-08-17)
    445/tcp              (2017-08-11)
    445/tcp              (2017-08-10)
    445/tcp              (2017-07-25)
    445/tcp              (2017-07-24)
    445/tcp              (2017-06-18)
    445/tcp              (2017-06-13)
    445/tcp              (2017-05-20)
    445/tcp              (2017-05-17)
    445/tcp              (2017-05-09)
    445/tcp              (2017-04-28)
   3389/tcp              (2018-09-27)
        |-- SSL Versions: -SSLv2, -SSLv3, TLSv1, TLSv1.1, TLSv1.2
        |-- Diffie-Hellman Parameters:
                Bits:           1024
                Generator:
                Fingerprint:    RFC2409/Oakley Group 2
   3389/tcp              (2018-07-01)
        |-- SSL Versions: -SSLv2, -SSLv3, TLSv1, TLSv1.1, TLSv1.2
        |-- Diffie-Hellman Parameters:
                Bits:           1024
                Generator:
                Fingerprint:    RFC2409/Oakley Group 2
   3389/tcp              (2018-06-11)
        |-- SSL Versions: -SSLv2, -SSLv3, TLSv1, TLSv1.1, TLSv1.2
        |-- Diffie-Hellman Parameters:
                Bits:           1024
                Generator:
```

Figure 18. Shodan history for search.webstie.net

Conclusions

Ratsnif is an intriguing discovery considering the length of time it has remained undetected, likely due to limited deployment. It offers a rare glimpse of over two years of feature development, allowing us to observe how threat actors tailor tooling to their nefarious purposes. While all samples borrow heavily from open-source code/snippets, overall development quality is deemed to be poor. Simply put, Ratsnif does not meet the usual high standards observed in OceanLotus malware.

Appendix

Indicators of Compromise (IOCs)

Indicator	Type	Description
b4e3b2a1f1e343d14af8d812d4a29440940b99a af145b5699dfe277b5bfb8405	SHA256	Ratsnif
b214c7a127cb669a523791806353- da5c5c04832f123a0a6df118642eee1632a3	SHA256	Ratsnif
b20327c03703ebad191c0ba025a3f26494f- f12c5908749e33e71589ae1e1f6b3	SHA256	Ratsnif
7fd526e1a190c10c060bac21de17d2c90e- b2985633c9ab74020a2b78acd8a4c8	SHA256	Ratsnif
onceinstance	Mutex	Mutex name
search[.]webstie[.]net	Domain	C2
66.85.185.126	IP	search[.]webstie[.]net
dns[.]domain-resolve[.]org	Domain	C2
X:\Project\BotFrame\Debug\Client.pdb	PDB	PDB Path
ntdata.tmp	File	Packet capture output

Core Networking - Router Solicitation	Windows Firewall Rule	7fd5…

MITRE

Tactic	ID	Name	Notes
Discovery	T1040	Network Sniffing	Sniffs packets and saves to file
	T1046	Network Service Scanning	ARP/SMB
	T1082	System Information Discovery	User/computer name, system directory and workstation information
Command and Control	T1043	Commonly Used Port	HTTP/HTTPS
	T1065	Uncommonly Used Port	65000 - 65536
	T1001	Data Obfuscation	RSA/AES C2 encryption
Impact	T1493	Transmitted Data Manipulation	Performs packet interception, modification and retransmission

About The Author

The Cylance Threat Research Team *The Cylance Threat Research team examines malware and suspected malware to better identify its abilities, function and attack vectors. Threat Research is on the frontline of information security and often deeply examines malicious software, which puts us in a unique position to discuss never-seen-before threats.*

Author's Bio