NEOHAPSIS

Neohapsis Labs Present

A Donkeys With Hats Production

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NEOHAPSIS

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NEOHAPSIS

MALWARE
IN WILD DETECTION
FIGHT !!

HOW MALWARE IS DETECTED

- The obvious
  - Files that shouldn’t exist
  - Processes that shouldn’t be running
  - Changes to user accounts
- The stupid (crappy code)
  - Oopses
  - Panics
  - BSODs
  - Don’t touch the kernel unless you know what you are doing…
  - Know what you’re patching
- Network sniffing or remote port scanning
- AV and rootkit detection methods

ROOTKIT DETECTION METHODS

- Signature based (typical AV)
- Behavioral analysis
    - Ask for the same information in multiple ways and check for different responses
    - Heuristics based detection
        - spawn shell, redirect IO to socket, connect socket outbound
        - CreateRemoteThread(), WriteProcessMemory()
    - Typically high false positive rate
- Integrity monitoring
    - Critical file integrity monitors (tripwire, etc)
    - Code integrity checks (syscall table, IDT, any other static (per kernel) values)

CODE INTEGRITY CHECKS

System.map

c017f470 T sys_getdents
c017f630 T sys_getdents64

VS

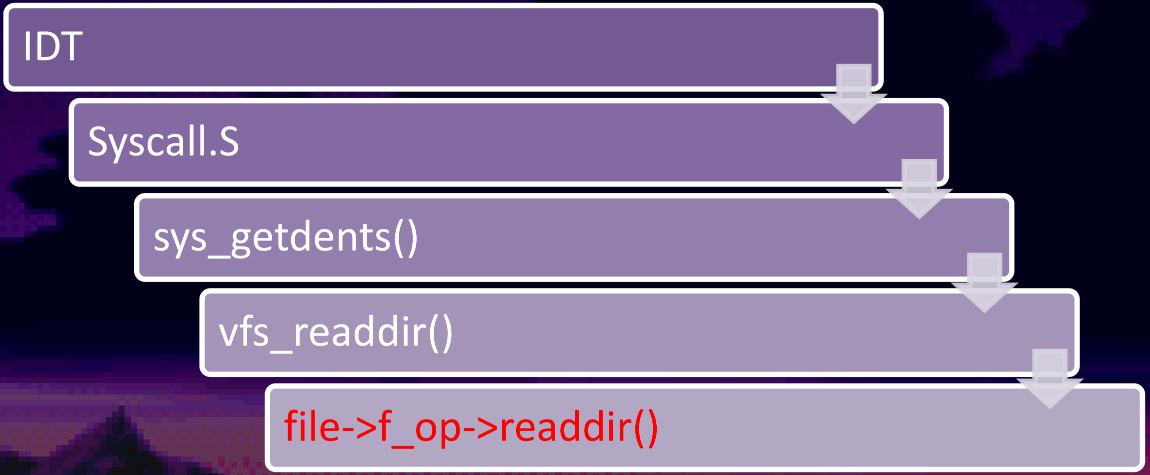
sys_call_table[]

sys_getdents == f98245c0
sys_getdents64 == f982abcc

• Similarly we can check interrupt descriptor table (IDT) entries against know interrupt handlers.

• Any other static function pointers can be checked in this way (although checking all of them could be painful).

SYSCALL CASE STUDY



```
struct file_operations {
        struct module *owner;
        loff_t (*llseek) (struct file *, loff_t, int);
        ssize_t (*read) (struct file *, char __user *, size_t, loff_t *);
        ssize_t (*aio_read) (struct kiocb *, char __user *, size_t, loff_t);
        ssize_t (*write) (struct file *, const char __user *, size_t, loff_t *);
        ssize_t (*aio_write) (struct kiocb *, const char __user *, size_t, loff_t);
        int (*readdir) (struct file *, void *, filldir_t);
        …
};
```

NEW TARGET?

- If we modify ext3_file_operations->readdir to an evil hook, we gain control of sys_getdents() for files residing on an ext3 filesystem
- This pointer is dynamic and will likely point to a variable address in a module providing the filesystem driver
- This becomes non-trivial to check (tons of dynamic functions pointers with variable locations)

```
static int (*old_readdir)(struct file *, void *, filldir_t);
static int evil_readdir(struct file * filp, void * dirent, filldir_t filldir) {
  r = old_readdir(filp, dirent, filldir);
  // Modify returned dirent buffer
  return r;
}

int module_init(void) {
  ...
  fs_dirops = (struct file_operations *)ADDRESS_OF_ORIG_FS_READDIR;
  old_readdir = fs_dirops->readdir;
  fs_dirops->readdir = evil_readdir;
  ...
}
```

TAKING IT FURTHER

- Aside from file hiding we can implement similar hooks of dynamic file operations to accomplish other things
    - Process hiding
    - Hiding network connections or listening sockets
    - Filtering reads for evade tripwire etc
- The file and directory operations for various proc entries are a goldmine

For Example:

- proc_root_operations
- tcp4_seq_afinfo

REMOTE NETWORK MONITORING

- Attacker needs a way to regain access to a system once owned and trigger certain actions to be taken by the rootkit
- Persistent connections are trivially detectable if the victim can watch network traffic from a host we don't own
- Listening is also bad idea as a port scan may hose us
- A combination of these methods makes it very difficult for us to control the owned system with some assurance that the traffic won't be detected

A SOLUTION?

- Making the assumption that the owned machine serves some purpose, connectivity must already exist (HTTPD, SMTPD, SSHD)
- Why not use legitimate connections to pre-existing services to create our tunnel?
    - Difficult to implement on a case-by-case basis
    - Requires modifications to daemon code or some other nasty hack

OUR OLD ENEMY, THE LOG FILE?

- One thing services have in common are log files (and they contain client supplied data)
- We can implement a generic pattern based hook below the write() system call which implements command and control functionality
- Additionally within write() we can block this write from completing, keeping our actions out of the logs
- As before, we target dynamic function pointers to avoid detection through code integrity checking

MALWARE

IN WILD DETECTION

IMPLEMENTING OUR HOOK

```
write(
  [/var/log/messages file descriptor],
  "Apr 23 14:41:53 owned sshd[18346]: Accepted keyboard-interactive/pam for H4X0R from 66.147.239.94 port 31337 ssh2\n",
  [Length]
)

write(
  [/var/log/httpd/access_log file descriptor],
  "66.147.239.94 – H4X0R - [23/Apr/2010:14:41:53 -0600] \"GET / HTTP/1.1\" 200 3825",
  [Length]
)
```

```
write(
  [/var/log/messages file descriptor],
  "Apr 23 14:41:53 owned sshd[18346]: Accepted keyboard-interactive/pam for BEGINMAGIC[Cmd]ENDMAGIC from 66.147.239.94 port 
31337 ssh2\n",
  [Length]
)

write(
  [/var/log/httpd/access_log file descriptor],
  "66.147.239.94 – BEGINMAGIC[Cmd]ENDMAGIC - [23/Apr/2010:14:41:53 -0600] \"GET / HTTP/1.1\" 200 3825",
  [Length]
)
```

MALWARE

IN WILD DETECTION

IMPLEMENTING OUR HOOK

```
if (strcmp(filp->f_path.dentry->d_name.name, LOGFILE_NAME) == 0) {
  buffer = (char *)kmalloc(len, GFP_KERNEL);
  if (!buffer) goto out;
  copy_from_user(buffer, buf, len);
  if ((p = strstr(buffer, BEGINMAGIC)) == NULL) goto freeout;
  // parse command from the buffer
  return SUCCESS!;
}
freeout:
kfree(buffer);
out:
return o_filewrite(filp, buf, len, ppos);
```

MALWARE
IN WILD DETECTION
FINISH HIM !!

MALWARE
EXECUTABLE ANALYSIS
FIGHT !!

EXECUTABLE ANALYSIS PROCESS

- Identify malicious executables
- Send off to appsec experts (aka Neohapsis) for analysis
- Unpack if necessary, as a base-case
    - Load executable up to OEP
    - Dump memory at that point (right before execution)
- Start trying to figure out what exactly it is doing
    - Static and Runtime Analysis
        - IDA, Olly/ImmunityDBG, Wireshark, etc
    - Identify remote connections and hosts
    - Identify control channels and mechanisms
    - Analyze impact that this may have on the compromised server

TYPICAL EXECUTABLE FILE ANALYSIS COUNTERMEASURES

- Anti-debugging
  - Runtime tricks to prevent executable from being debugged
  - Once known, easy to defeat
  - Boring…

- Packers
  - Compression-based, simple obfuscation
  - Boring…

- Cryptors
  - Encryption-based packers
  - Interest starts here
  - What is the main hurdle here? Key Storage!
    - Malware we have seen stores the key someplace in the executable
    - Once process is known, key is easily retrievable

THE DRM PROBLEM

Question:	Answer:
• How can we execute code on a system we do not trust without manual interaction?	• We can't, otherwise you wouldn't have been able to play Assassins Creed 2 for free

- Best DRM systems are those whose content's benefit comes from being online, requires authentication to an uncontrolled 3rd party
- Use this same idea within a cryptor, in our implementation a kernel module cryptor
- Userspace process that uses init_module to load decrypted kernel module

THE DECRYPTION PROCESS

1. 3rd party server stores the following information
   - Client IP or ID
   - Current private key
   - Current file location
2. Userspace cryptor loads, makes a request to server
   - Gets private key, file location, and new public key
3. Decrypt and load module
4. Shred current encrypted data
5. Re-encrypts kernel module and wipe memory of plaintext
6. Store to a new location and send new location to server

ENCRYPTED FILE LOCATION

- Encrypted file location not stored on server
- Forensic analysis could target files that have a very high entropy to identify encrypted data
- What else has a high entropy? Compressed files!
- GZIP files have extra headers, can put our encrypted kernel module in here (http://www.faqs.org/rfcs/rfc1952.htm)

ID1	**ID2**	**CM**	**FLG**	**MTIME**	**XFL**	**OS**

- If FLG bit 2 == 1 (FEXTRA), we have extra optional fields to store data

SI1	**SI2**	**LEN**	**LEN Bytes of Data…**

- What are some fun GZIP'ed files that no one cares about?
  - Manpages!
  - Malware can be evil and informative all at the same time!

WHAT DOES THIS MEAN FOR EXECUTABLE ANALYSIS PROCESS?

- The decryption key is not stored on the file system
- Decryption key cannot be pulled from network logs
- To get this key you have to interact with an attacker controlled server
- This server can implement strict heuristic checks to see if the decryption key should be nuked
    - Source IP address
    - Current running processes on the machine
    - Time since boot
    - … infinite list
    - Any combination of these values
- Static analysis process has just one chance to get this information or forever loses the ability to decrypt the code
    - wireshark; ./evil.exe … == FAIL
    - strings evil.exe; wget http://... == FAIL
    - … == FAIL
- Requires a strong coordination between the owned company, the people who did disk acquisition, and the people doing the file analysis

MALWARE
EXECUTABLE ANALYSIS
FINISH HIM !!

MALWARE
FORENSIC TOOLS
FIGHT !!

ONE FINAL FRONT

- The few, the proud, the court approved forensic tools
- Either EnCase or FTK is used in almost every case involving digital forensics
- When less vetted (less popular) software is used, there is a high risk that the defense will question the methods used
    - Incentive to use popular tools
    - Self perpetuating process (the more they are used the more they will be used in the future)

SECURE ++

- So how do these “highly vetted” tools hold up?
- Lets talk 0-day

MALWARE FORENSIC TOOLS

BUT WHY PICK ON ONE?

- Specialized tools need the same specialized code, so why not buy it from a (unspecified) third-party?
- Cross-application vulnerabilities are awesome
- Opps… we owned forensics

SO WHAT DOES THIS MEAN?

- Once we control the forensic tool, we control the examiner’s experience arbitrarily
- We can implement a rootkit that targets the specific tool used
  - File hiding
  - Incorrect search results
  - Planted evidence
- We don’t even have to worry about payload size or delivery as we have unlimited storage in the drive image
- Typically, forensic examiners’ systems should not have network connectivity so our payload should be a self contained package

MALWARE
FORENSIC TOOLS
FINISH HIM !!

DEMO TIME

MALWARE
FORENSIC TOOLS

MALWARE
FORENSIC TOOLS
FLAWLESS 0-DAY
FATALITY

QUESTIONS?

NEOHAPSIS