The Container Security in Healthcare Data Exchange System

Bachelor's degree graduation project

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Outline

1. Outcome
   - Expected Outcome
   - Current Outcome
2. Interfaces
   - Linux feature
   - Exploit
3. Related work
   - Study
   - Simple container
4. Current progress
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Outcome

Medical cloud

- Container
- Privacy, Security
- Load balanceability, Portability, Manageability

Current outcome

- An easy container with Linux namespace.

```
→ container git:(main) ✗ gcc *.[ch] -o c
→ container git:(main) ✗ sudo ./c "bash"
Success on creating container
Start container: bash with clone id: 193761
In container PID: 1
bash-5.0# ./test.sh
This is the self test script in contaiiner!
Support bash cat echo ls rm hostname, 5 commands.
./test.sh
-----------FILE: test.sh ------------
     1  #!/bin/bash
     2
     3  echo "This is the self test script in contaiiner!"
     4  echo "Support bash cat echo ls rm hostname, 5 commands."
     5
     6  echo $0
     7
     8  echo "-----------FILE: test.sh ------------"
     9  cat -n test.sh
    10  echo "-------------------------------------"
    11
    12  echo $(hostname) >天竺鼠車車
    13  cat 天竺鼠車車
    14  rm 天竺鼠車車
    15  ls
-------------------------------------
container
bin  dev  etc  home  lib  lib64  mnt  opt  proc  root  run  sbin  sys  test.sh  tmp  usr  var
bash-5.0# exit
```

List of attack surface

- cgroups with race condition
- namespace
  - wrong privileges
  - Cannot cross namespace? Really?
- init.
  - stack overflow(thread)?
  - fork and CoW?
  - defunct processing
- lib/syscall/kernel exploit

Interfaces

namespace

- Start from 2.4.19(2003)
- Completed in Linux kernel 3.8(2013)
- System calls
  - clone, unshare, setns
- Nested, scope

```
➜  container git:(main) ✗ sudo unshare --fork --pid --mount-proc bash
[sudo] password for scc:
root@scc-lab:/media/d/git/nsysu/cs/try/lc/container# ps -a
    PID TTY          TIME CMD
      1 pts/1    00:00:00 bash
      8 pts/1    00:00:00 ps
root@scc-lab:/media/d/git/nsysu/cs/try/lc/container# exit
exit
➜  container git:(main) ✗
```

namespace

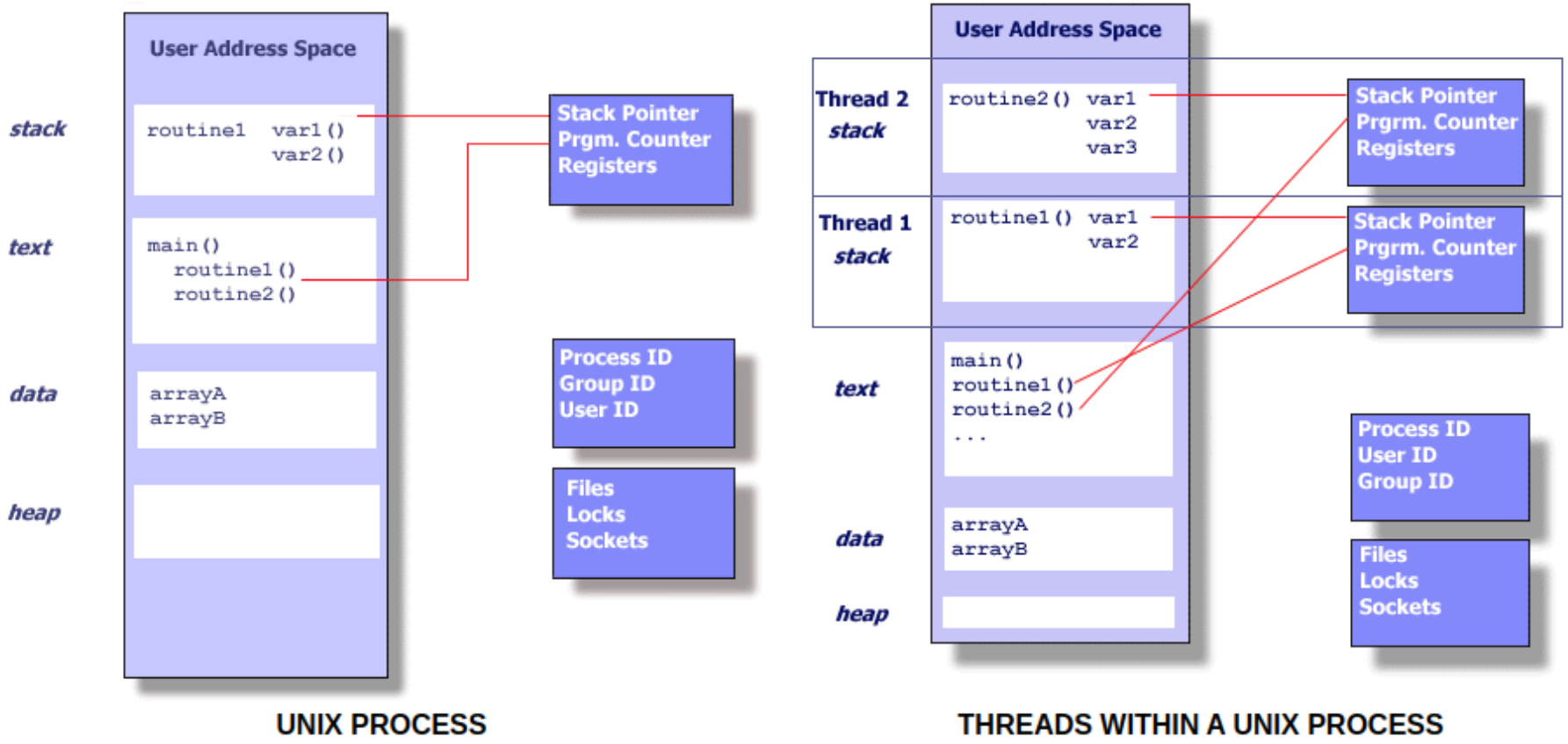
- 6 mechanisms
  - Mount, UTS, IPC, PID, NET, USER
- ps: mount -t proc proc /proc
- $PID = 1$, the "init"[1]
  - SIGTERM, SIGKILL
  - The defunct
- Starting in Linux 3.8, unprivileged processes can create user namespaces, . . . unprivileged applications now have access to functionality that was formerly limited to root. . . . Thus, it may happen that user namespaces have some as-yet unknown security issues.[2]

cgroups

- Access controller
  - Resource limiting: CPU, Mem, IO...
  - Prioritization: CPU, IO...
  - Accounting: evaluate
  - Control: freeze, check, and resume
- The OOM killer 4.19
  - Guarantee the integrity of the workload.

Stack overflow

- Default: 8MB
- The init of container, confused here.



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Related work

The 3 Big issue

- Concepts
- Container security
- High-performance server

Concepts

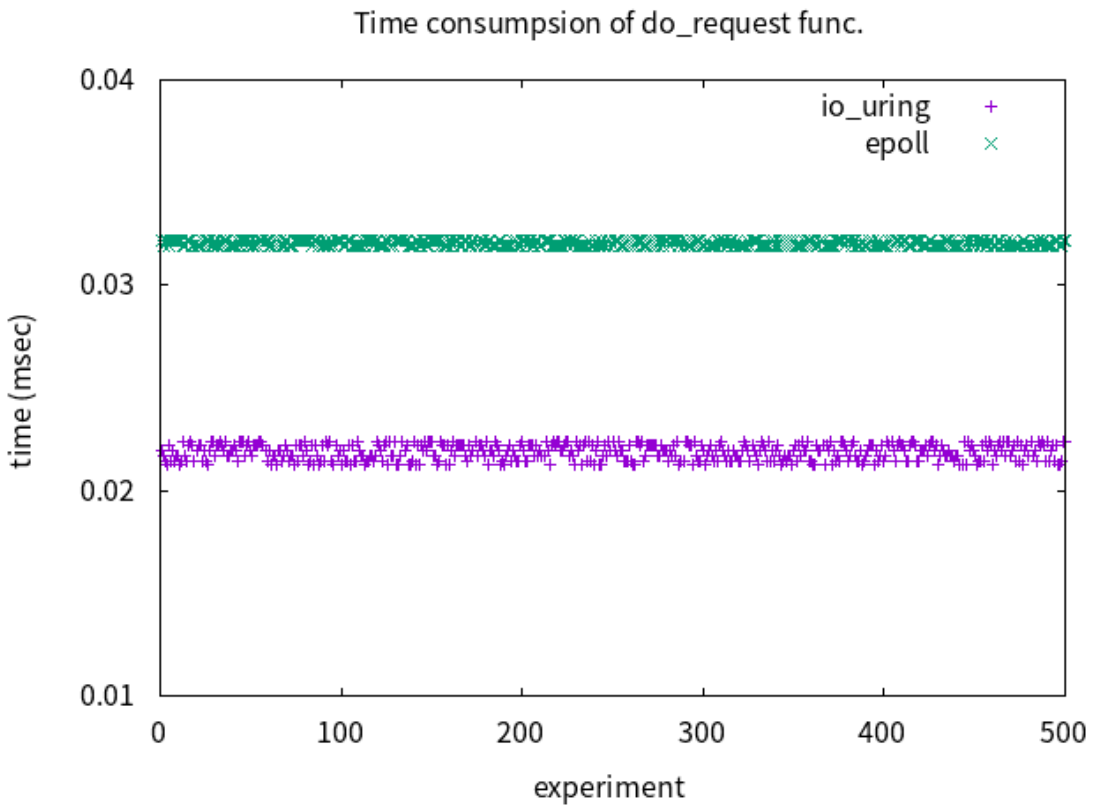
- Virtual machines and containers
- The FHIR system
- Linux kernel features
  - namespaces, cgroups, capabilities, seccomp
  - mmap, copy on write, race condition
  - aio, epoll, io_uring

Container security

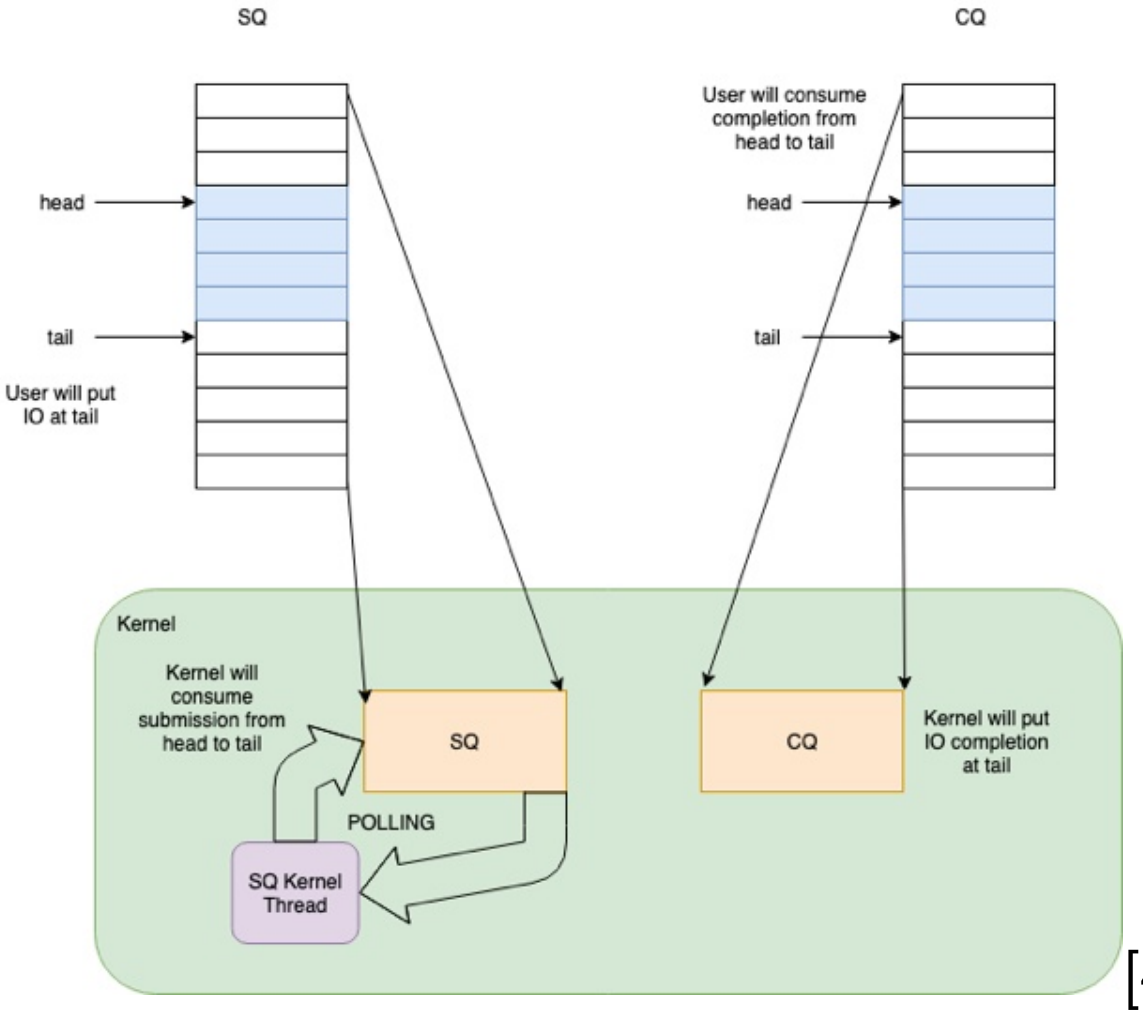
- Study of the Dirty Copy On Write
- Container Security: Issues, Challenges, and the Road Ahead
- Linux kernel exploit

High-performance server

- PINE: Optimizing Performance Isolation in Container Environments
- The epoll vs. io_uring performance comparison



The io_uring



[4]

My container

Code review

My container

```
int cont_start(char *argv[], int do_wait);
int cont_stop();
```

My container

```
int cont_start(char *argv[], int do_wait)
{
    c_stkptr = (char *) malloc(STK_SIZE);
    c_pid = (long) loader(argv);
    if (c_pid)
        printf("%s on creating container\n", strerror(errno));
    printf("Start container: %s with clone id: %d\n", argv[0], c_pid);
    if (do_wait)
        waitpid(c_pid, NULL, 0);
}
```

```
static inline pid_t loader(char *argv[])
{
    return clone(run, c_stkptr + STK_SIZE,
                 CLONE_NEWNS | CLONE_NEWUTS | CLONE_NEWPID | SIGCHLD, argv);
}
```

My container

```
static void isol()
{
    unshare(CLONE_FILES | CLONE_FS | CLONE_SYSVSEM |
   CLONE_NEWCGROUP);
    sethostname("container", 10);
    if (chroot(STRINGIZE_VALUE_OF(ROOTFS)))
        perror("chroot error");
    printf("In container PID: %ld\n", (long) getpid());
}
```

```
static int run(void *argv)
{
    char **arg = (char **) argv;
    isol();
    chdir("/");
    int ret = execvp(arg[0], arg);
    if (ret)
        printf("%s in container\n", strerror(errno));
    return ret;
}
```

Current progress

Application of MOST

- Papers: 1.0
- FIXME: 0.9
- Pages: 1.6
- My Exp.: Maybe. . .

Demo

Live demo.

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Reference

References I

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