pledge(2): mitigating security bugs

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pkgsrcCon 2017, London
About Me

- sys admin and developer @SNB
- OpenBSD developer
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Mitigations

- stack protector
- ASLR
- W^X
- priv-sep and priv-drop
dangerous system calls

Disable system calls a process should not call
- SE Linux
- seccomp
- Capsicum
- systrace
- pledge(2)
pledge(2)

- introduced in OpenBSD 5.8 as tame(2), than renamed to pledge(2)
- around 500 programs with pledge(2) support in base
- around 50 ports patched to have pledge(2) support (unzip, mutt, memcached, chromium, ...)
A new way of approaching the problem

- study the program
- figure out all syscalls the program needs
- promise only the operations that are really needed
- ktrace(1) and gdb(1) if something goes wrong
▶ program is annotated with pledge(2) calls/promises
▶ kernel enforces annotations and kills the program that does not respect promises
pledge(2) promises

```c
#include <unistd.h>

int pledge(const char *promises, const char *paths[]);
```

- `"": `exit(2)`
- `stdio`: `malloc + rw stdio`
- `rpath, wpath, cpath, tmppath`: `open files`
- `fattr`: explicit changes to "fd" (chmod & friends)
- `unix, inet`: `open sockets`
- `dns`: `dns requests`
- `route`: `routing operations`
- `sendfd`: sends file descriptors via `sendmsg(2)`
- `recvfd`: receive file descriptors via `recvmsg(2)`
- `getpw`: `passwd/group file access`
- `ioctl`: small subset of `ioctl(2)` is permitted
- `tty`: subset of `ioctl` for `tty` operations
- `proc`: `fork(2), vfork(2), kill(2)` and other processes related operations
- `exec`: `execve(2)` is allowed to create another process which will be unpledged
- `settime`: allows to set the system time
- `pf`: allows a subset of `ioctl(2)` operations on `pf(4)` device
pledge(2) logging

- dmesg(8) on OpenBSD $\leq 6.1$
- lastcomm(1) and daily(8) on OpenBSD $\geq 6.2$ (with accounting enabled)
pledge(2) logging

rm - giovanni ttyp1 0.00 secs Sat Jun 17 15:56 (0:00:00.00)
ls - giovanni ttyp1 0.00 secs Sat Jun 17 15:56 (0:00:00.00)
rm - giovanni ttyp1 0.00 secs Sat Jun 17 15:56 (0:00:00.00)
hello -DXP giovanni ttyp1 0.00 secs Sat Jun 17 15:56 (0:00:00.16)
c - giovanni ttyp1 0.00 secs Sat Jun 17 15:56 (0:00:00.64)
pledge(2) logging

From root@bigio.paclan.it Sat Jun 17 16:08:46 2017
Delivered-To: root@bigio.paclan.it
From: Charlie Root <root@bigio.paclan.it>
To: root@bigio.paclan.it
Subject: bigio.paclan.it daily output

giovanni@bigio.paclan.it:/usr/src/sys/arch/amd64/compile/GENERIC

4:08PM up 35 mins, 3 users, load averages: 0.26, 0.13, 0.10
Purging accounting records:
hello -DXP giovanni tttyp1 0.00 secs Sat Jun 17 15:56 (0:00:00.16)
```c
#include <stdio.h>
#include <unistd.h>

int main(int argc, char **argv) {
    FILE *fd;
    if(pledge("stdio", NULL) != -1) {
        printf("Hello pkgsrcCon !\n");
        if((fd = fopen("/etc/passwd", "r")) ) {
            printf("Passwd file opened\n");
            fclose(fd);
        } else {
            return 1;
        }
        return 0;
    }
}
```
use OpenBSD::Pledge;
my $file = "/usr/share/dict/words";
pledge(qw( rpath )) || die "Unable to pledge: $!";
open my $fh, '<', $file or die "Unable to open $file: $!\n";
while ( readline($fh) ) {
    print if /pledge/i;
}
close $fh;
system("ls");
let’s hack

Index: worms.c
===================================================================
RCS file: /var/cvs/src/games/worms/worms.c,v
retrieving revision 1.22
retrieving revision 1.23
diff -u -p -r1.22 -r1.23
--- worms.c 18 Feb 2015 23:16:08 -0000 1.22
+++ worms.c 21 Nov 2015 05:29:42 -0000 1.23
@@ -1,4 +1,4 @@
-/* $OpenBSD: worms.c,v 1.22 2015/02/18 23:16:08 tedu Exp $ */
+/* $OpenBSD: worms.c,v 1.23 2015/11/21 05:29:42 deraadt Exp $ */
/
 * Copyright (c) 1980, 1993
@@ -182,6 +182,9 @@ main(int argc, char *argv[])
   struct termios term;
   speed_t speed;
   time_t delay = 0;
+  + if (pledge("stdio rpath tty", NULL) == -1)
+    + err(1, "pledge");
   /* set default delay based on terminal baud rate */
   if (tcgetattr(STDOUT_FILENO, &term) == 0 &&

```
let’s hack, ports(7)

$OpenBSD: patch-memcached,c,v 1.11 2016/09/02 14:20:31 giovanni Exp$

+++ memcached.c Thu Jun 30 00:02:09 2016
@@ -23,6 +23,7 @@
 #include <sys/uio.h>
 #include <ctype.h>
 #include <stdarg.h>
+-#include <unistd.h>
 /* some POSIX systems need the following definition
 * to get mlockall flags out of sys/mman.h. */
@@ -6100,6 +6101,32 @@ int main (int argc, char **argv) {
 if (pid_file != NULL) {
     save_pid(pid_file);
     }
+- if (settings.socketpath != NULL) {
+-     if (pid_file != NULL) {
+-         if (pledge("stdio cpath unix", NULL) == -1) {
+-             fprintf(stderr, "%s: pledge: %s\n", argv[0], strerror(errno));
+-             exit(1);
+-         } else {
+-             if (pledge("stdio unix", NULL) == -1) {
+-                 fprintf(stderr, "%s: pledge: %s\n", argv[0], strerror(errno));
+-                 exit(1);
+-             } else {
+-                 if (pledge("stdio cpath inet", NULL) == -1) {
+-                     fprintf(stderr, "%s: pledge: %s\n", argv[0], strerror(errno));
+-                     exit(1);
+-                 } else {
+-                     if (pledge("stdio inet", NULL) == -1) {
+-                         fprintf(stderr, "%s: pledge: %s\n", argv[0], strerror(errno));
+-                         exit(1);
+-                     } else {
+-                         fprintf(stderr, "%s: pledge: %s\n", argv[0], strerror(errno));
+-                         exit(1);
+-                     } } } } } 
+
 /* Drop privileges no longer needed */
what to do if something goes wrong?
what to do if something goes wrong?

$ gdb hello hello.core
GNU gdb 6.3
Copyright 2004 Free Software Foundation, Inc.
GDB is free software, covered by the GNU General Public License, and you are
welcome to change it and/or distribute copies of it under certain conditions.
Type "show copying" to see the conditions.
There is absolutely no warranty for GDB. Type "show warranty" for details.
This GDB was configured as "amd64-unknown-openbsd6.1"
Core was generated by 'hello'.
Program terminated with signal 6, Aborted.
Loaded symbols for /home/data/server/dati/Documenti/convegni/pkgsrcCon 2017/src/hello
Reading symbols from /usr/lib/libc.so.89.5...done.
Loaded symbols for /usr/lib/libc.so.89.5
Reading symbols from /usr/libexec/ld.so...done.
Loaded symbols for /usr/libexec/ld.so
#0 0x000009f584a507aa in _thread_sys_open () at {standard input}:5
  {standard input}: No such file or directory.
in {standard input}
(gdb) bt
#0 0x000009f584a507aa in _thread_sys_open () at {standard input}:5
#1 0x000009f584a3f559 in *_libc_open_cancel (path=Variable "path" is not available.
  ) at /usr/src/lib/libc/sys/w_open.c:36
#2 0x000009f584a9a982 in *_libc_fopen (file=0x9f2b8b00b20 "/etc/passwd", mode=Variable "mode" is not available.
  ) at /usr/src/lib/libc/stdio/fopen.c:54
#3 0x000009f2b8a005dc in main (argc=1, argv=0x7f7fffffc3c58) at hello.c:8
Current language: auto; currently asm
(gdb)
The future?