
Subject: [PATCH 2/3] capabilities: introduce per-process capability bounding set (v3)

Posted by [serue](#) on Mon, 01 Oct 2007 14:41:48 GMT

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From: Serge Hallyn <serue@us.ibm.com>

Date: Fri, 28 Sep 2007 10:33:56 -0500

Subject: [PATCH 2/3] capabilities: introduce per-process capability bounding set (v3)

The capability bounding set is a set beyond which capabilities cannot grow. Currently cap_bset is per-system. It can be manipulated through sysctl, but only init can add capabilities. Root can remove capabilities. By default it includes all caps except CAP_SETPCAP.

This patch makes the bounding set per-process. It is inherited at fork from parent. Noone can add elements, CAP_SYS_ADMIN is required to remove them. Perhaps a new capability should be introduced to control the ability to remove capabilities, in order to help prevent running a privileged app with enough privs to be dangerous but not enough to be successful.

One example use of this is to start a safer container. For instance, until device namespaces or per-container device whitelists are introduced, it is best to take CAP_MKNOD away from a container.

The following hacky test program will get and set the bounding set. For instance

```
./bset get
(lists capabilities in bset)
./bset strset cap_sys_admin
(starts shell with new bset)
(use capset, setuid binary, or binary with
file capabilities to try to increase caps)
```

```
=====
bset.c:
=====
```

```
#include <sys/prctl.h>
#include <linux/capability.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>
```

```

#include <string.h>

#ifndef PR_GET_CAPBSET
#define PR_GET_CAPBSET 23
#endif

#ifndef PR_SET_CAPBSET
#define PR_SET_CAPBSET 24
#endif

unsigned long newval;
int cmd_getbcap;

char *captable[] = {
    "cap_dac_override",
    "cap_dac_read_search",
    "cap_fowner",
    "cap_fsetid",
    "cap_kill",
    "cap_setgid",
    "cap_setuid",
    "cap_setpcap",
    "cap_linux_immutable",
    "cap_net_bind_service",
    "cap_net_broadcast",
    "cap_net_admin",
    "cap_net_raw",
    "cap_ipc_lock",
    "cap_ipc_owner",
    "cap_sys_module",
    "cap_sys_rawio",
    "cap_sys_chroot",
    "cap_sys_ptrace",
    "cap_sys_pacct",
    "cap_sys_admin",
    "cap_sys_boot",
    "cap_sys_nice",
    "cap_sys_resource",
    "cap_sys_time",
    "cap_sys_tty_config",
    "cap_mknod",
    "cap_lease",
    "cap_audit_write",
    "cap_audit_control",
    "cap_setfcap"};

char *inttocap(unsigned long v)
{

```

```

char *str = NULL;
int i;

str = malloc(1);
str[0] = '\0';
for (i=0; i<31; i++) {
    if (v & (1 << (i+1))) {
        char *tmp = captable[i];
        str = realloc(str, strlen(str)+2+strlen(tmp));
        sprintf(str+strlen(str), "%s", tmp);
    }
}
return str;
}

int getbcap(void)
{
    unsigned long bcap;
    int ret;
    unsigned int ver;

    ret = prctl(PR_GET_CAPBSET, &ver, &bcap);
    if (ret == -1)
        perror("prctl");
    if (ver != _LINUX_CAPABILITY_VERSION)
        printf("wrong capability version: %lu not %lu\n",
            ver, _LINUX_CAPABILITY_VERSION);
    printf("prctl get_bcap returned %lu (ret %d)\n", bcap, ret);
    printf("that is %s\n", inttocap(bcap));
    return ret;
}

int setbcap(unsigned long val)
{
    int ret;

    ret = prctl(PR_SET_CAPBSET, _LINUX_CAPABILITY_VERSION, val);
    return ret;
}

int usage(char *me)
{
    printf("Usage: %s get\n", me);
    printf("    %s set <newval>\n", me);
    printf("    %s strset capability_string\n", me);
    printf("    capability_string is for instance:\n");
    printf("    cap_sys_admin,cap_mknod,cap_dac_override\n");
    return 1;
}

```

```

}

unsigned long captoint(char *cap)
{
if (strcmp(cap, "cap_dac_override") == 0)
    return 1;
else if (strcmp(cap, "cap_dac_read_search") == 0)
    return 2;
else if (strcmp(cap, "cap_fowner") == 0)
    return 3;
else if (strcmp(cap, "cap_fsetid") == 0)
    return 4;
else if (strcmp(cap, "cap_kill") == 0)
    return 5;
else if (strcmp(cap, "cap_setgid") == 0)
    return 6;
else if (strcmp(cap, "cap_setuid") == 0)
    return 7;
else if (strcmp(cap, "cap_setpcap") == 0)
    return 8;
else if (strcmp(cap, "cap_linux_immutable") == 0)
    return 9;
else if (strcmp(cap, "cap_net_bind_service") == 0)
    return 10;
else if (strcmp(cap, "cap_net_broadcast") == 0)
    return 11;
else if (strcmp(cap, "cap_net_admin") == 0)
    return 12;
else if (strcmp(cap, "cap_net_raw") == 0)
    return 13;
else if (strcmp(cap, "cap_ipc_lock") == 0)
    return 14;
else if (strcmp(cap, "cap_ipc_owner") == 0)
    return 15;
else if (strcmp(cap, "cap_sys_module") == 0)
    return 16;
else if (strcmp(cap, "cap_sys_rawio") == 0)
    return 17;
else if (strcmp(cap, "cap_sys_chroot") == 0)
    return 18;
else if (strcmp(cap, "cap_sys_ptrace") == 0)
    return 19;
else if (strcmp(cap, "cap_sys_pacct") == 0)
    return 20;
else if (strcmp(cap, "cap_sys_admin") == 0)
    return 21;
else if (strcmp(cap, "cap_sys_boot") == 0)
    return 22;

```

```

else if (strcmp(cap, "cap_sys_nice") == 0)
    return 23;
else if (strcmp(cap, "cap_sys_resource") == 0)
    return 24;
else if (strcmp(cap, "cap_sys_time") == 0)
    return 25;
else if (strcmp(cap, "cap_sys_tty_config") == 0)
    return 26;
else if (strcmp(cap, "cap_mknod") == 0)
    return 27;
else if (strcmp(cap, "cap_lease") == 0)
    return 28;
else if (strcmp(cap, "cap_audit_write") == 0)
    return 29;
else if (strcmp(cap, "cap_audit_control") == 0)
    return 30;
else if (strcmp(cap, "cap_setfcap") == 0)
    return 31;
}

```

```

unsigned long parse_cap_string(char *capstring)
{
    unsigned long tmp, newval = 0;
    char *token = strtok(capstring, ",");

    while (token) {
        tmp = captoint(token);
        if (tmp < 0)
            return -1;
        newval |= 1<<tmp;
        token = strtok(NULL, ",");
    }
    return newval;
}

```

```

int read_args(int argc, char *argv[])
{
    if (strcmp(argv[1], "get") == 0) {
        cmd_getbcap = 1;
        return 0;
    }
    if (strcmp(argv[1], "strset") == 0) {
        newval = parse_cap_string(argv[2]);
        if (newval < 0)
            return newval;
        return 0;
    }
    if (strcmp(argv[1], "set") != 0)

```

```

    return 1;
if (argc != 3)
    return 1;
newval = strtoul(argv[2], NULL, 10);
return 0;
}

int main(int argc, char *argv[])
{
    int ret;

    if (argc<2)
        return usage(argv[0]);

    if ((ret=read_args(argc, argv)))
        return ret;

    if (cmd_getbcap)
        return getbcap();

    ret = setbcap(newval);
    if (ret != 0)
        return ret;
    return execl("/bin/bash", "/bin/bash", NULL);
}
=====

```

Changelog:

Return -EINVAL if no capabilities.

As suggested by Andrew Morgan, send the capability version along with the bset for prctl(PR_SET_CAPBSET) and PR_GET_CAPBSET)

Signed-off-by: Serge Hallyn <serue@us.ibm.com>

```

include/linux/capability.h | 23 ++++++
include/linux/init_task.h | 1 +
include/linux/prctl.h      | 4 ++++
include/linux/sched.h      | 2 +-
include/linux/security.h   | 5 -----
include/linux/sysctl.h     | 3 ---
kernel/fork.c              | 1 +
kernel/sys.c               | 18 ++++++
kernel/sysctl.c            | 35 -----
kernel/sysctl_check.c      | 7 -----
security/commoncap.c       | 21 ++++++
11 files changed, 63 insertions(+), 57 deletions(-)

```

```

diff --git a/include/linux/capability.h b/include/linux/capability.h
index 7a8d7ad..7ff1e04 100644
--- a/include/linux/capability.h
+++ b/include/linux/capability.h
@@ -197,7 +197,6 @@ typedef __u32 kernel_cap_t;
#define CAP_IPC_OWNER      15

/* Insert and remove kernel modules - modify kernel without limit */
-/* Modify cap_bset */
#define CAP_SYS_MODULE      16

/* Allow ioperm/iopl access */
@@ -332,6 +331,17 @@ typedef __u32 kernel_cap_t;
#define CAP_INIT_EFF_SET   to_cap_t(~0 & ~CAP_TO_MASK(CAP_SETPCAP))
#define CAP_INIT_INH_SET   to_cap_t(0)

+#ifdef CONFIG_SECURITY_FILE_CAPABILITIES
+/*
+ * Because of the reduced scope of CAP_SETPCAP when filesystem
+ * capabilities are in effect, it is safe to allow this capability to
+ * be available in the default configuration.
+ */
+# define CAP_INIT_BSET CAP_FULL_SET
+#else
+# define CAP_INIT_BSET CAP_INIT_EFF_SET
+#endif
+
+
#define CAP_TO_MASK(x) (1 << (x))
#define cap_raise(c, flag) (cap_t(c) |= CAP_TO_MASK(flag))
#define cap_lower(c, flag) (cap_t(c) &= ~CAP_TO_MASK(flag))
@@ -377,6 +387,17 @@ static inline kernel_cap_t cap_invert(kernel_cap_t c)
int capable(int cap);
int __capable(struct task_struct *t, int cap);

+#ifdef CONFIG_COMMONCAP
+extern int cap_prctl_setbset(unsigned long new_bset);
+extern int cap_prctl_getbset(unsigned long *bset);
+#else
+#include <linux/errno.h>
+static inline int cap_prctl_setbset(unsigned long new_bset)
+{ return -EINVAL; }
+static inline int cap_prctl_getbset(unsigned long *bset)
+{ return -EINVAL; }
+#endif
+
+
#endif /* __KERNEL__ */

```

```

#endif /* !_LINUX_CAPABILITY_H */
diff --git a/include/linux/init_task.h b/include/linux/init_task.h
index cae35b6..5c84d14 100644
--- a/include/linux/init_task.h
+++ b/include/linux/init_task.h
@@ -147,6 +147,7 @@ extern struct group_info init_groups;
 .cap_effective = CAP_INIT_EFF_SET, \
 .cap_inheritable = CAP_INIT_INH_SET, \
 .cap_permitted = CAP_FULL_SET, \
+ .cap_bset = CAP_INIT_BSET, \
 .keep_capabilities = 0, \
 .user = INIT_USER, \
 .comm = "swapper", \
diff --git a/include/linux/prctl.h b/include/linux/prctl.h
index e2eff90..a7de023 100644
--- a/include/linux/prctl.h
+++ b/include/linux/prctl.h
@@ -63,4 +63,8 @@
#define PR_GET_SECCOMP 21
#define PR_SET_SECCOMP 22

+/* Get/set the capability bounding set */
+#define PR_GET_CAPBSET 23
+#define PR_SET_CAPBSET 24
+
#endif /* _LINUX_PRCTL_H */
diff --git a/include/linux/sched.h b/include/linux/sched.h
index 4f21af1..7c21341 100644
--- a/include/linux/sched.h
+++ b/include/linux/sched.h
@@ -973,7 +973,7 @@ struct task_struct {
 uid_t uid,euid,suid,fsuid;
 gid_t gid,egid,sgid,fsgid;
 struct group_info *group_info;
- kernel_cap_t cap_effective, cap_inheritable, cap_permitted;
+ kernel_cap_t cap_effective, cap_inheritable, cap_permitted, cap_bset;
 unsigned keep_capabilities:1;
 struct user_struct *user;
#ifdef CONFIG_KEYS
diff --git a/include/linux/security.h b/include/linux/security.h
index ff3f857..e2d2f06 100644
--- a/include/linux/security.h
+++ b/include/linux/security.h
@@ -34,11 +34,6 @@
#include <linux/xfrm.h>
#include <net/flow.h>

-/*

```

```

- * Bounding set
- */
-extern kernel_cap_t cap_bset;
-
extern unsigned securebits;

struct ctl_table;
diff --git a/include/linux/sysctl.h b/include/linux/sysctl.h
index e99171f..3771782 100644
--- a/include/linux/sysctl.h
+++ b/include/linux/sysctl.h
@@ -103,7 +103,6 @@ enum
    KERN_NODENAME=7,
    KERN_DOMAINNAME=8,

- KERN_CAP_BSET=14, /* int: capability bounding set */
    KERN_PANIC=15, /* int: panic timeout */
    KERN_REALROOTDEV=16, /* real root device to mount after initrd */

@@ -968,8 +967,6 @@ extern int proc_dostring(struct ctl_table *, int, struct file *,
    void __user *, size_t *, loff_t *);
extern int proc_dointvec(struct ctl_table *, int, struct file *,
    void __user *, size_t *, loff_t *);
-extern int proc_dointvec_bset(struct ctl_table *, int, struct file *,
-    void __user *, size_t *, loff_t *);
extern int proc_dointvec_minmax(struct ctl_table *, int, struct file *,
    void __user *, size_t *, loff_t *);
extern int proc_dointvec_jiffies(struct ctl_table *, int, struct file *,
diff --git a/kernel/fork.c b/kernel/fork.c
index f85731a..df13a01 100644
--- a/kernel/fork.c
+++ b/kernel/fork.c
@@ -1082,6 +1082,7 @@ static struct task_struct *copy_process(unsigned long clone_flags,
#ifdef CONFIG_SECURITY
    p->security = NULL;
#endif
+ p->cap_bset = current->cap_bset;
    p->io_context = NULL;
    p->audit_context = NULL;
    cgroup_fork(p);
diff --git a/kernel/sys.c b/kernel/sys.c
index 796299c..cff511f 100644
--- a/kernel/sys.c
+++ b/kernel/sys.c
@@ -1739,7 +1739,23 @@ asmlinkage long sys_prctl(int option, unsigned long arg2, unsigned
long arg3,
    case PR_SET_SECCOMP:
        error = prctl_set_seccomp(arg2);

```

```

    break;
-
+ case PR_GET_CAPBSET: {
+   unsigned long bset;
+   error = cap_prctl_getbset(&bset);
+   if (error)
+     return error;
+   error = put_user(_LINUX_CAPABILITY_VERSION,
+     (__u32 __user *)arg2);
+   if (error)
+     break;
+   error = put_user(bset, (unsigned long __user *)arg3);
+   return error;
+ }
+ case PR_SET_CAPBSET:
+   if (arg2 != _LINUX_CAPABILITY_VERSION)
+     return -EINVAL;
+   error = cap_prctl_setbset(arg3);
+   break;
  default:
    error = -EINVAL;
    break;
diff --git a/kernel/sysctl.c b/kernel/sysctl.c
index b11d22b..7bff6a2 100644
--- a/kernel/sysctl.c
+++ b/kernel/sysctl.c
@@ -363,15 +363,6 @@ static struct ctl_table kern_table[] = {
    .proc_handler = &proc_dointvec_taint,
  },
#endif
-#ifdef CONFIG_SECURITY_CAPABILITIES
- {
-   .procname = "cap-bound",
-   .data = &cap_bset,
-   .maxlen = sizeof(kernel_cap_t),
-   .mode = 0600,
-   .proc_handler = &proc_dointvec_bset,
- },
-#endif /* def CONFIG_SECURITY_CAPABILITIES */
#ifdef CONFIG_BLK_DEV_INITRD
{
    .ctl_name = KERN_REALROOTDEV,
@@ -1882,26 +1873,6 @@ static int do_proc_dointvec_bset_conv(int *negp, unsigned long
*lvalp,
    return 0;
}

-#ifdef CONFIG_SECURITY_CAPABILITIES

```

```

-/*
- * init may raise the set.
- */
-
-int proc_dointvec_bset(struct ctl_table *table, int write, struct file *filp,
- void __user *buffer, size_t *lenp, loff_t *ppos)
-{
- int op;
-
- if (write && !capable(CAP_SYS_MODULE)) {
- return -EPERM;
- }
-
- op = is_global_init(current) ? OP_SET : OP_AND;
- return do_proc_dointvec(table, write, filp, buffer, lenp, ppos,
- do_proc_dointvec_bset_conv, &op);
-}
-#endif /* def CONFIG_SECURITY_CAPABILITIES */
-
-/*
- * Taint values can only be increased
- */
@@ -2315,12 +2286,6 @@ int proc_dointvec(struct ctl_table *table, int write, struct file *filp,
return -ENOSYS;
}

-int proc_dointvec_bset(struct ctl_table *table, int write, struct file *filp,
- void __user *buffer, size_t *lenp, loff_t *ppos)
-{
- return -ENOSYS;
-}
-
-int proc_dointvec_minmax(struct ctl_table *table, int write, struct file *filp,
- void __user *buffer, size_t *lenp, loff_t *ppos)
{
diff --git a/kernel/sysctl_check.c b/kernel/sysctl_check.c
index 3c9ef5a..41c7f16 100644
--- a/kernel/sysctl_check.c
+++ b/kernel/sysctl_check.c
@@ -38,10 +38,6 @@ static struct trans_ctl_table trans_kern_table[] = {
{ KERN_NODENAME, "hostname" },
{ KERN_DOMAINNAME, "domainname" },

-#ifdef CONFIG_SECURITY_CAPABILITIES
- { KERN_CAP_BSET, "cap-bound" },
-#endif /* def CONFIG_SECURITY_CAPABILITIES */
-
{ KERN_PANIC, "panic" },

```

```

{ KERN_REALROOTDEV, "real-root-dev" },

@@ -1535,9 +1531,6 @@ int sysctl_check_table(struct ctl_table *table)
    (table->strategy == sysctl_ms_jiffies) ||
    (table->proc_handler == proc_dostring) ||
    (table->proc_handler == proc_dointvec) ||
-#ifdef CONFIG_SECURITY_CAPABILITIES
-    (table->proc_handler == proc_dointvec_bset) ||
-#endif /* def CONFIG_SECURITY_CAPABILITIES */
    (table->proc_handler == proc_dointvec_minmax) ||
    (table->proc_handler == proc_dointvec_jiffies) ||
    (table->proc_handler == proc_dointvec_userhz_jiffies) ||
diff --git a/security/commoncap.c b/security/commoncap.c
index 43f9027..324ff2a 100644
--- a/security/commoncap.c
+++ b/security/commoncap.c
@@ -36,9 +36,6 @@
# define CAP_INIT_BSET CAP_INIT_EFF_SET
#endif /* def CONFIG_SECURITY_FILE_CAPABILITIES */

-kernel_cap_t cap_bset = CAP_INIT_BSET; /* systemwide capability bound */
-EXPORT_SYMBOL(cap_bset);
-
/* Global security state */

unsigned securebits = SECUREBITS_DEFAULT; /* systemwide security settings */
@@ -307,7 +304,8 @@ void cap_bprm_apply_creds (struct linux_binprm *bprm, int unsafe)
/* Derived from fs/exec.c:compute_creds. */
kernel_cap_t new_permitted, working;

- new_permitted = cap_intersect (bprm->cap_permitted, cap_bset);
+ new_permitted = cap_intersect (bprm->cap_permitted,
+    current->cap_bset);
    working = cap_intersect (bprm->cap_inheritable,
        current->cap_inheritable);
    new_permitted = cap_combine (new_permitted, working);
@@ -580,3 +578,18 @@ int cap_vm_enough_memory(struct mm_struct *mm, long pages)
    return __vm_enough_memory(mm, pages, cap_sys_admin);
}

+int cap_prctl_setbset(unsigned long new_bset)
+{
+    if (!capable(CAP_SYS_ADMIN))
+        return -EPERM;
+    if (!cap_issubset(new_bset, current->cap_bset))
+        return -EPERM;
+    current->cap_bset = new_bset;
+    return 0;

```

```
+}  
+  
+int cap_prctl_getbset(unsigned long *bset)  
+{  
+ *bset = current->cap_bset;  
+ return 0;  
+}  
--  
1.5.1.6
```

Containers mailing list
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<https://lists.linux-foundation.org/mailman/listinfo/containers>
