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Subject: [PATCH RFC] cgroups: implement device whitelist cgroup+lsn  
Posted by [serue](#) on Thu, 15 Nov 2007 23:23:25 GMT

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(This patch is based against the same CONFIG\_COMMONCAP patch as the capability bounding set patch I just sent out)

>From fcbd0bd0a8ee1e37a68f5381b47ec0746cb9b1cc Mon Sep 17 00:00:00 2001  
From: Serge E. Hallyn <serue@us.ibm.com>  
Date: Thu, 11 Oct 2007 15:27:48 -0400  
Subject: [PATCH 2/2] cgroups: implement device whitelist cgroup+lsn

Implement a cgroup using the LSM interface to enforce open and mknod on device files. Not a line of this code is expected to be used in a final version, this is just a proof of concept to explore whether we can or should use an LSM for this purpose until device namespaces are really needed. The alternative is to simply set up a static /dev for each container and remove CAP\_MKNOD from the container's bounding set. Several people feel that that approach is insufficient.

This patch implements a simple device access whitelist. A whitelist entry has 4 fields. 'type' is a (all), c (char), or b (block). 'all' means it applies to all types, all major numbers, and all minor numbers. Major and minor are obvious. Access is a composition of r (read), w (write), and m (mknod).

The root devcgroup starts with rwm to 'all'. A child devcg gets a copy of the parent. Admins can then add and remove devices to the whitelist. Once CAP\_HOST\_ADMIN is introduced it will be needed to add entries as well or remove entries from another cgroup, though just CAP\_SYS\_ADMIN will suffice to remove entries for your own group.

An entry is added by doing "echo <type> <maj> <min> <access>" > devcg.allow, for instance:

```
echo b 7 0 mrw > /cgroups/1/devcg.allow
```

An entry is removed by doing likewise into devcg.deny. Since this is a pure whitelist, not acls, you can only remove entries which exist in the whitelist. You must explicitly

```
echo a 0 0 mrw > /cgroups/1/devcg.deny
```

to remove the "allow all" entry which is automatically inherited from the root cgroup.

While composing this with the ns\_cgroup may seem logical, it may not be the right thing to do. Note that each newly created devcg gets

a copy of the parent whitelist. So if you had done

```
mount -t cgroup -o ns,devcg none /cgroups
```

then once a process in /cgroup/1 had done an unshare(CLONE\_NEWNS)  
it would be under /cgroup/1/node\_<pid>  
if an admin did

```
echo b 7 0 m > /cgroups/1/devcg.deny
```

then the entry would still be in the whitelist for /cgroups/1/node\_<pid>.  
Something to discuss if we get that far before nixing this whole idea.

The devcg module calls all the capability security hooks, so  
it does not need to (cannot) be stacked with capability.ko.  
The security hooks are defined in a separate file from the  
cgroup code so that the security/Makefile can force its hooks  
to be loaded after the selinux hooks. Otherwise selinux would  
refuse to load if CONFIG\_CGROUP\_DEV=y.

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

---

```
include/linux/cgroup_subsys.h | 6 +
init/Kconfig                  | 7 +
kernel/Makefile               | 1 +
kernel/dev_cgroup.c           | 410 +++++
security/Kconfig              | 4 +-
security/Makefile             | 1 +
6 files changed, 427 insertions(+), 2 deletions(-)
create mode 100644 kernel/dev_cgroup.c
```

```
diff --git a/include/linux/cgroup_subsys.h b/include/linux/cgroup_subsys.h
index d3ec2ed..9e2f5f7 100644
```

```
--- a/include/linux/cgroup_subsys.h
+++ b/include/linux/cgroup_subsys.h
@@ -36,3 +36,9 @@ SUBSYS(mem_cgroup)
#endif
```

```
/* */
+
+#ifdef CONFIG_CGROUP_DEV
+SUBSYS(devcg)
+#endif
+
+/* */
```

```
diff --git a/init/Kconfig b/init/Kconfig
index 96fba82..2907248 100644
--- a/init/Kconfig
```

```
+++ b/init/Kconfig
@@ -324,6 +324,13 @@ config CPUSETS
```

Say N if unsure.

```
+config CGROUP_DEV
+ bool "Device controller for cgroups"
+ depends on CGROUPS && SECURITY && EXPERIMENTAL
+ help
+   Provides a cgroup implementing whitelists for devices which
+   a process in the cgroup can mknod or open.
+
+config FAIR_GROUP_SCHED
+ bool "Fair group CPU scheduler"
+ default y
diff --git a/kernel/Makefile b/kernel/Makefile
index 876dbcd..1da0b66 100644
--- a/kernel/Makefile
+++ b/kernel/Makefile
@@ -41,6 +41,7 @@ obj-$(CONFIG_CGROUPS) += cgroup.o
 obj-$(CONFIG_CGROUP_DEBUG) += cgroup_debug.o
 obj-$(CONFIG_CPUSETS) += cpuset.o
 obj-$(CONFIG_CGROUP_NS) += ns_cgroup.o
+obj-$(CONFIG_CGROUP_DEV) += dev_cgroup.o
 obj-$(CONFIG_IKCONFIG) += configs.o
 obj-$(CONFIG_RESOURCE_COUNTERS) += res_counter.o
 obj-$(CONFIG_STOP_MACHINE) += stop_machine.o
diff --git a/kernel/dev_cgroup.c b/kernel/dev_cgroup.c
new file mode 100644
index 0000000..365877d
--- /dev/null
+++ b/kernel/dev_cgroup.c
@@ -0,0 +1,410 @@
+/*
+ * dev_cgroup.c - device cgroup subsystem
+ *
+ * Copyright 2007 IBM Corp
+ */
+
+#include <linux/devcg.h>
+
+/*
+ * Once 64-bit caps and CAP_HOST_ADMIN exist, we will be
+ * requiring (CAP_HOST_ADMIN|CAP_MKNOD) to create a device
+ * not in the whitelist, * (CAP_HOST_ADMIN|CAP_SYS_ADMIN)
+ * to edit the whitelist,
+ */
+static int devcg_can_attach(struct cgroup_subsys *ss,
```

```

+ struct cgroup *new_cgroup, struct task_struct *task)
+{
+ struct cgroup *orig;
+
+ if (current != task) {
+ if (!cgroup_is_descendant(new_cgroup))
+ return -EPERM;
+ }
+
+ if (atomic_read(&new_cgroup->count) != 0)
+ return -EPERM;
+
+ orig = task_cgroup(task, devcg_subsys_id);
+ if (orig && orig != new_cgroup->parent)
+ return -EPERM;
+
+ return 0;
+}
+
+/*
+ * called under cgroup_lock()
+ */
+int dev_whitelist_copy(struct list_head *dest, struct list_head *orig)
+{
+ struct dev_whitelist_item *wh, *tmp, *new;
+
+ list_for_each_entry(wh, orig, list) {
+ new = kmalloc(sizeof(*wh), GFP_KERNEL);
+ if (!new)
+ goto free_and_exit;
+ new->major = wh->major;
+ new->minor = wh->minor;
+ new->type = wh->type;
+ new->access = wh->access;
+ list_add_tail(&new->list, dest);
+ }
+
+ return 0;
+
+free_and_exit:
+ list_for_each_entry_safe(wh, tmp, dest, list) {
+ list_del(&wh->list);
+ kfree(wh);
+ }
+ return -ENOMEM;
+}
+
+/* Stupid prototype - don't bother combining existing entries */

```

```

+/*
+ * called under cgroup_lock()
+ * since the list is visible to other tasks, we need the spinlock also
+ */
+void dev_whitelist_add(struct dev_cgroup *dev_cgroup,
+ struct dev_whitelist_item *wh)
+{
+ spin_lock(&dev_cgroup->lock);
+ list_add_tail(&wh->list, &dev_cgroup->whitelist);
+ spin_unlock(&dev_cgroup->lock);
+}
+
+/*
+ * called under cgroup_lock()
+ * since the list is visible to other tasks, we need the spinlock also
+ */
+void dev_whitelist_rm(struct dev_cgroup *dev_cgroup,
+ struct dev_whitelist_item *wh)
+{
+ struct dev_whitelist_item *walk, *tmp;
+
+ spin_lock(&dev_cgroup->lock);
+ list_for_each_entry_safe(walk, tmp, &dev_cgroup->whitelist, list) {
+ if (walk->type & DEV_ALL) {
+ list_del(&walk->list);
+ kfree(walk);
+ continue;
+ }
+ if (walk->type != wh->type)
+ continue;
+ if (walk->major != wh->major || walk->minor != wh->minor)
+ continue;
+ walk->access &= ~wh->access;
+ if (!walk->access) {
+ list_del(&walk->list);
+ kfree(walk);
+ }
+ }
+ spin_unlock(&dev_cgroup->lock);
+}
+
+/*
+ * Rules: you can only create a cgroup if
+ * 1. you are capable(CAP_SYS_ADMIN)
+ * 2. the target cgroup is a descendant of your own cgroup
+ *
+ * Note: called from kernel/cgroup.c with cgroup_lock() held.
+ */

```

```

+static struct cgroup_subsys_state *devcg_create(struct cgroup_subsys *ss,
+ struct cgroup *cgroup)
+{
+ struct dev_cgroup *dev_cgroup, *parent_dev_cgroup;
+ struct cgroup *parent_cgroup;
+ int ret;
+
+ if (!capable(CAP_SYS_ADMIN))
+ return ERR_PTR(-EPERM);
+ if (!cgroup_is_descendant(cgroup))
+ return ERR_PTR(-EPERM);
+
+ dev_cgroup = kzalloc(sizeof(*dev_cgroup), GFP_KERNEL);
+ if (!dev_cgroup)
+ return ERR_PTR(-ENOMEM);
+ INIT_LIST_HEAD(&dev_cgroup->whitelist);
+ parent_cgroup = cgroup->parent;
+
+ if (parent_cgroup == NULL) {
+ struct dev_whitelist_item *wh;
+ wh = kmalloc(sizeof(*wh), GFP_KERNEL);
+ wh->minor = wh->major = 0;
+ wh->type = DEV_ALL;
+ wh->access = ACC_MKNOD | ACC_READ | ACC_WRITE;
+ list_add(&wh->list, &dev_cgroup->whitelist);
+ } else {
+ parent_dev_cgroup = cgroup_to_devcg(parent_cgroup);
+ ret = dev_whitelist_copy(&dev_cgroup->whitelist,
+ &parent_dev_cgroup->whitelist);
+ if (ret) {
+ kfree(dev_cgroup);
+ return ERR_PTR(ret);
+ }
+ }
+
+ spin_lock_init(&dev_cgroup->lock);
+ return &dev_cgroup->css;
+}
+
+static void devcg_destroy(struct cgroup_subsys *ss,
+ struct cgroup *cgroup)
+{
+ struct dev_cgroup *dev_cgroup;
+ struct dev_whitelist_item *wh, *tmp;
+
+ dev_cgroup = cgroup_to_devcg(cgroup);
+ list_for_each_entry_safe(wh, tmp, &dev_cgroup->whitelist, list) {
+ list_del(&wh->list);

```

```

+ kfree(wh);
+ }
+ kfree(dev_cgroup);
+}
+
+#define DEVCG_ALLOW 1
+#define DEVCG_DENY 2
+
+void set_access(char *acc, short access)
+{
+ int idx = 0;
+ memset(acc, 0, 4);
+ if (access & ACC_READ)
+ acc[idx++] = 'r';
+ if (access & ACC_WRITE)
+ acc[idx++] = 'w';
+ if (access & ACC_MKNOD)
+ acc[idx++] = 'm';
+}
+
+char type_to_char(short type)
+{
+ if (type == DEV_ALL)
+ return 'a';
+ if (type == DEV_CHAR)
+ return 'c';
+ if (type == DEV_BLOCK)
+ return 'b';
+ return 'X';
+}
+
+char *print_whitelist(struct dev_cgroup *devcgroup, int *len)
+{
+ char *buf, *s, acc[4];
+ struct dev_whitelist_item *wh;
+ int ret;
+ int count = 0;
+
+ buf = kmalloc(4096, GFP_KERNEL);
+ if (!buf)
+ return ERR_PTR(-ENOMEM);
+ s = buf;
+ *s = '\0';
+ *len = 0;
+
+ spin_lock(&devcgroup->lock);
+ list_for_each_entry(wh, &devcgroup->whitelist, list) {
+ set_access(acc, wh->access);

```

```

+ printk(KERN_NOTICE
+ "%s (count%d): whtype %hd maj %u min %u acc %hd\n",
+ __FUNCTION__, count, wh->type, wh->major, wh->minor,
+ wh->access);
+ ret = snprintf(s, 4095-(s-buf), "%c %u %u %s\n",
+ type_to_char(wh->type), wh->major, wh->minor, acc);
+ if (s+ret >= buf+4095) {
+ kfree(buf);
+ buf = ERR_PTR(-ENOMEM);
+ break;
+ }
+ s += ret;
+ *len += ret;
+ count++;
+ }
+ spin_unlock(&devcgroup->lock);
+
+ return buf;
+}
+
+static ssize_t devcg_access_read(struct cgroup *cgroup,
+ struct cftype *cft, struct file *file,
+ char __user *userbuf, size_t nbytes, loff_t *ppos)
+{
+ struct dev_cgroup *devcgrp = cgroup_to_devcg(cgroup);
+ int filetype = cft->private;
+ char *buffer;
+ int len, retval;
+
+ if (filetype != DEVCG_ALLOW)
+ return -EINVAL;
+ buffer = print_whitelist(devcgrp, &len);
+ if (IS_ERR(buffer))
+ return PTR_ERR(buffer);
+
+ retval = simple_read_from_buffer(userbuf, nbytes, ppos, buffer, len);
+ kfree(buffer);
+ return retval;
+}
+
+static inline short convert_access(char *acc)
+{
+ short access = 0;
+
+ while (*acc) {
+ switch (*acc) {
+ case 'r':
+ case 'R': access |= ACC_READ; break;

```



```

+ case 'w':
+ case 'W': access |= ACC_WRITE; break;
+ case 'm':
+ case 'M': access |= ACC_MKNOD; break;
+ case '\n': break;
+ default:
+ return -EINVAL;
+ }
+ acc++;
+ }
+
+ return access;
+}
+
+static inline short convert_type(char intype)
+{
+ short type = 0;
+ switch (intype) {
+ case 'a': type = DEV_ALL; break;
+ case 'c': type = DEV_CHAR; break;
+ case 'b': type = DEV_BLOCK; break;
+ default: type = -EACCES; break;
+ }
+ return type;
+}
+
+/*
+ * Current rules:
+ * CAP_SYS_ADMIN needed for all writes.
+ * when we have CAP_HOST_ADMIN, the rules will become:
+ * if (!writetoself)
+ *     require capable(CAP_HOST_ADMIN | CAP_SYS_ADMIN);
+ * if (is_allow)
+ *     require capable(CAP_HOST_ADMIN | CAP_SYS_ADMIN);
+ * require capable(CAP_SYS_ADMIN);
+ */
+static int have_write_permission(int is_allow, int writetoself)
+{
+ if (!capable(CAP_SYS_ADMIN))
+ return 0;
+ return 1;
+}
+
+static ssize_t devcg_access_write(struct cgroup *cgroup, struct cftype *cft,
+ struct file *file, const char __user *userbuf,
+ size_t nbytes, loff_t *ppos)
+{
+ struct cgroup *cur_cgroup;

```

```

+ struct dev_cgroup *devcgrp, *cur_devcgroup;
+ int filetype = cft->private;
+ char *buffer, acc[4];
+ int retval = 0;
+ int nitems;
+ char type;
+ struct dev_whitelist_item *wh;
+
+ devcgrp = cgroup_to_devcg(cgroup);
+ cur_cgroup = task_cgroup(current, devcg_subsys.subsys_id);
+ cur_devcgroup = cgroup_to_devcg(cur_cgroup);
+
+ if (!have_write_permission(filetype == DEVCG_ALLOW,
+   cur_devcgroup == devcgrp))
+   return -EPERM;
+
+ buffer = kmalloc(nbytes+1, GFP_KERNEL);
+ if (!buffer)
+   return -ENOMEM;
+
+ wh = kmalloc(sizeof(*wh), GFP_KERNEL);
+ if (!wh) {
+   kfree(buffer);
+   return -ENOMEM;
+ }
+
+ if (copy_from_user(buffer, userbuf, nbytes)) {
+   retval = -EFAULT;
+   goto out1;
+ }
+ buffer[nbytes] = 0; /* nul-terminate */
+
+ cgroup_lock();
+ if (cgroup_is_removed(cgroup)) {
+   retval = -ENODEV;
+   goto out2;
+ }
+
+ memset(wh, 0, sizeof(*wh));
+ memset(acc, 0, 4);
+ nitems = sscanf(buffer, "%c %u %u %3s", &type, &wh->major, &wh->minor,
+   acc);
+ retval = -EINVAL;
+ if (nitems != 4)
+   goto out2;
+ wh->type = convert_type(type);
+ if (wh->type < 0)
+   goto out2;

```

```

+ wh->access = convert_access(acc);
+ if (wh->access < 0)
+ goto out2;
+ retval = 0;
+ switch (filetype) {
+ case DEVCG_ALLOW:
+ printk(KERN_NOTICE
+ "%s: add whtype %hd maj %u min %u acc %hd\n",
+ __FUNCTION__, wh->type, wh->major, wh->minor,
+ wh->access);
+ dev_whitelist_add(devcgrp, wh);
+ break;
+ case DEVCG_DENY:
+ dev_whitelist_rm(devcgrp, wh);
+ break;
+ default:
+ retval = -EINVAL;
+ goto out2;
+ }
+
+ if (retval == 0)
+ retval = nbytes;
+
+out2:
+ cgroup_unlock();
+out1:
+ kfree(buffer);
+ return retval;
+}
+
+static struct cftype dev_cgroup_files[] = {
+ {
+ .name = "allow",
+ .read = devcg_access_read,
+ .write = devcg_access_write,
+ .private = DEVCG_ALLOW,
+ },
+ {
+ .name = "deny",
+ .write = devcg_access_write,
+ .private = DEVCG_DENY,
+ },
+ };
+
+static int devcg_populate(struct cgroup_subsys *ss,
+ struct cgroup *cont)
+{
+ return cgroup_add_files(cont, ss, dev_cgroup_files,

```

```

+   ARRAY_SIZE(dev_cgroup_files));
+}
+
+struct cgroup_subsys devcg_subsys = {
+ .name = "devcg",
+ .can_attach = devcg_can_attach,
+ .create = devcg_create,
+ .destroy = devcg_destroy,
+ .populate = devcg_populate,
+ .subsys_id = devcg_subsys_id,
+};
diff --git a/security/Kconfig b/security/Kconfig
index de7f9fe..0132e49 100644
--- a/security/Kconfig
+++ b/security/Kconfig
@@ -75,14 +75,14 @@ config SECURITY_NETWORK_XFRM

```

```

config SECURITY_CAPABILITIES
    bool "Default Linux Capabilities"
- depends on SECURITY
+ depends on SECURITY && !CGROUP_DEV
    help
        This enables the "default" Linux capabilities functionality.
        If you are unsure how to answer this question, answer Y.

```

```

config COMMONCAP
    bool
- default !SECURITY || SECURITY_CAPABILITIES || SECURITY_ROOTPLUG
+ default !SECURITY || SECURITY_CAPABILITIES || SECURITY_ROOTPLUG || CGROUP_DEV

```

```

config SECURITY_FILE_CAPABILITIES
    bool "File POSIX Capabilities (EXPERIMENTAL)"
diff --git a/security/Makefile b/security/Makefile
index 7cccc81..5a83753 100644
--- a/security/Makefile
+++ b/security/Makefile
@@ -13,3 +13,4 @@ obj-$(CONFIG_SECURITY) += security.o dummy.o inode.o
obj-$(CONFIG_SECURITY_SELINUX) += selinux/built-in.o
obj-$(CONFIG_SECURITY_CAPABILITIES) += capability.o
obj-$(CONFIG_SECURITY_ROOTPLUG) += root_plug.o
+obj-$(CONFIG_CGROUP_DEV) += dev_cgroup_lsm.o
--
1.5.1.1.GIT

```