
Subject: [RFC][PATCH 3/5] Container Freezer: Implement freezer cgroup subsystem

Posted by [Matt Helsley](#) on Thu, 24 Apr 2008 06:47:59 GMT

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This patch implements a new freezer subsystem for Paul Menage's control groups framework. It provides a way to stop and resume execution of all tasks in a cgroup by writing in the cgroup filesystem.

This is the basic mechanism which should do the right thing for user space tasks in a simple scenario. This will require more work to get the freezing right (cf. `try_to_freeze_tasks()`) for ptraced tasks.

It's important to note that freezing can be incomplete. In that case we return EBUSY. This means that some tasks in the cgroup are busy doing something that prevents us from completely freezing the cgroup at this time. After EBUSY, the cgroup will remain partially frozen -- reflected by freezer.state reporting "FREEZING" when read. The state will remain "FREEZING" until one of these things happens:

- 1) Userspace cancels the freezing operation by writing "RUNNING" to the freezer.state file
- 2) Userspace retries the freezing operation by writing "FROZEN" to the freezer.state file (writing "FREEZING" is not legal and returns EIO)
- 3) The tasks that blocked the cgroup from entering the "FROZEN" state disappear from the cgroup's set of tasks.

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TODO:

Check that we handle ptrace'd and vfork-ing tasks correctly.

Changelog:

v2:

Moved the "kill" file into a separate cgroup subsystem (signal) and it's own patch.

Changed the name of the file from freezer.freeze to freezer.state.

Switched from taking 1 and 0 as input to the strings "FROZEN" and "RUNNING", respectively. This helps keep the interface human-usable if/when we need to more states.

Checked that stopped or interrupted is "frozen enough"

Since `try_to_freeze()` is called upon wakeup of these tasks this should be fine. This idea comes from recent changes to

the freezer.

Checked that if (task == current) whilst freezing cgroup we're ok

Fixed bug where -EBUSY would always be returned when freezing

Added code to handle userspace retries for any remaining -EBUSY

```
include/linux/cgroup_freezer.h | 65 ++++++++
include/linux/cgroup_subsys.h | 6
init/Kconfig                  | 7 +
kernel/Makefile               | 1
kernel/cgroup_freezer.c       | 276 +++++
kernel/freezer.c              | 1
6 files changed, 356 insertions(+)
```

Index: linux-2.6.25-mm1/include/linux/cgroup_freezer.h

```
=====
--- /dev/null
+++ linux-2.6.25-mm1/include/linux/cgroup_freezer.h
@@ -0,0 +1,65 @@
+#ifndef _LINUX_CGROUP_FREEZER_H
+#define _LINUX_CGROUP_FREEZER_H
+/*
+ * cgroup_freezer.h - control group freezer subsystem interface
+ *
+ * Copyright IBM Corporation, 2007
+ *
+ * Author : Cedric Le Goater <clg@fr.ibm.com>
+ *
+ * This program is free software; you can redistribute it and/or modify it
+ * under the terms of version 2.1 of the GNU Lesser General Public License
+ * as published by the Free Software Foundation.
+ *
+ * This program is distributed in the hope that it would be useful, but
+ * WITHOUT ANY WARRANTY; without even the implied warranty of
+ * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
+ */
+
+#include <linux/cgroup.h>
+
+#ifdef CONFIG_CGROUP_FREEZER
+enum freezer_state {
+ STATE_RUNNING = 0,
+ STATE_FREEZING,
+ STATE_FROZEN,
+};
+
+struct freezer {
+ struct cgroup_subsys_state css;
```

```
+ enum freezer_state state;
+ spinlock_t lock;
+};
+
+static inline struct freezer *cgroup_freezer(
+ struct cgroup *cgroup)
+{
+ return container_of(
+ cgroup_subsys_state(cgroup, freezer_subsys_id),
+ struct freezer, css);
+}
+
+static inline int cgroup_frozen(struct task_struct *task)
+{
+ struct cgroup *cgroup = task_cgroup(task, freezer_subsys_id);
+ struct freezer *freezer = cgroup_freezer(cgroup);
+ enum freezer_state state;
+
+ spin_lock(&freezer->lock);
+ state = freezer->state;
+ spin_unlock(&freezer->lock);
+
+ return (state == STATE_FROZEN);
+}
+
+#else /* !CONFIG_CGROUP_FREEZER */
+
+static inline int cgroup_frozen(struct task_struct *task)
+{
+ return 0;
+}
+
+#endif /* !CONFIG_CGROUP_FREEZER */
+
+#endif /* _LINUX_CGROUP_FREEZER_H */
Index: linux-2.6.25-mm1/include/linux/cgroup_subsys.h
=====
--- linux-2.6.25-mm1.orig/include/linux/cgroup_subsys.h
+++ linux-2.6.25-mm1/include/linux/cgroup_subsys.h
@@ -46,5 +46,11 @@ SUBSYS(mem_cgroup)
#ifdef CONFIG_CGROUP_DEVICE
SUBSYS(devices)
#endif

/* */
+
+#ifndef CONFIG_CGROUP_FREEZER
+SUBSYS(freezer)
```

```
+#endif
```

```
+
```

```
+/* */
```

```
Index: linux-2.6.25-mm1/init/Kconfig
```

```
=====
```

```
--- linux-2.6.25-mm1.orig/init/Kconfig
```

```
+++ linux-2.6.25-mm1/init/Kconfig
```

```
@@ -321,10 +321,17 @@ config GROUP_SCHED
```

```
    default y
```

```
    help
```

```
        This feature lets CPU scheduler recognize task groups and control CPU
        bandwidth allocation to such task groups.
```

```
+config CGROUP_FREEZER
```

```
+    bool "control group freezer subsystem"
```

```
+    depends on CGROUPS
```

```
+    help
```

```
+        Provides a way to freeze and unfreeze all tasks in a
```

```
+    cgroup
```

```
+
```

```
config FAIR_GROUP_SCHED
```

```
    bool "Group scheduling for SCHED_OTHER"
```

```
    depends on GROUP_SCHED
```

```
    default y
```

```
Index: linux-2.6.25-mm1/kernel/Makefile
```

```
=====
```

```
--- linux-2.6.25-mm1.orig/kernel/Makefile
```

```
+++ linux-2.6.25-mm1/kernel/Makefile
```

```
@@ -46,10 +46,11 @@ obj-$(CONFIG_BSD_PROCESS_ACCT) += acct.o
```

```
obj-$(CONFIG_KEXEC) += kexec.o
```

```
obj-$(CONFIG_BACKTRACE_SELF_TEST) += backtracetest.o
```

```
obj-$(CONFIG_COMPAT) += compat.o
```

```
obj-$(CONFIG_CGROUPS) += cgroup.o
```

```
obj-$(CONFIG_CGROUP_DEBUG) += cgroup_debug.o
```

```
+obj-$(CONFIG_CGROUP_FREEZER) += cgroup_freezer.o
```

```
obj-$(CONFIG_CPUSETS) += cpuset.o
```

```
obj-$(CONFIG_CGROUP_NS) += ns_cgroup.o
```

```
obj-$(CONFIG_UTS_NS) += utsname.o
```

```
obj-$(CONFIG_USER_NS) += user_namespace.o
```

```
obj-$(CONFIG_PID_NS) += pid_namespace.o
```

```
Index: linux-2.6.25-mm1/kernel/cgroup_freezer.c
```

```
=====
```

```
--- /dev/null
```

```
+++ linux-2.6.25-mm1/kernel/cgroup_freezer.c
```

```
@@ -0,0 +1,276 @@
```

```
+/*
```

```
+ * cgroup_freezer.c - control group freezer subsystem
```

```

+ *
+ * Copyright IBM Corporation, 2007
+ *
+ * Author : Cedric Le Goater <clg@fr.ibm.com>
+ *
+ * This program is free software; you can redistribute it and/or modify it
+ * under the terms of version 2.1 of the GNU Lesser General Public License
+ * as published by the Free Software Foundation.
+ *
+ * This program is distributed in the hope that it would be useful, but
+ * WITHOUT ANY WARRANTY; without even the implied warranty of
+ * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
+ */
+
+#include <linux/module.h>
+#include <linux/cgroup.h>
+#include <linux/fs.h>
+#include <linux/uaccess.h>
+#include <linux/freezer.h>
+#include <linux/cgroup_freezer.h>
+
+static const char *freezer_state_strs[] = {
+ "RUNNING\n",
+ "FREEZING\n",
+ "FROZEN\n"
+};
+
+
+struct cgroup_subsys freezer_subsys;
+
+
+static struct cgroup_subsys_state *freezer_create(
+ struct cgroup_subsys *ss, struct cgroup *cgroup)
+{
+ struct freezer *freezer;
+
+ if (!capable(CAP_SYS_ADMIN))
+ return ERR_PTR(-EPERM);
+
+ freezer = kzalloc(sizeof(struct freezer), GFP_KERNEL);
+ if (!freezer)
+ return ERR_PTR(-ENOMEM);
+
+ spin_lock_init(&freezer->lock);
+ freezer->state = STATE_RUNNING;
+ return &freezer->css;
+}
+

```

```

+static void freezer_destroy(struct cgroup_subsys *ss,
+    struct cgroup *cgroup)
+{
+    kfree(cgroup_freezer(cgroup));
+}
+
+
+static int freezer_can_attach(struct cgroup_subsys *ss,
+    struct cgroup *new_cgroup,
+    struct task_struct *task)
+{
+    struct freezer *freezer = cgroup_freezer(new_cgroup);
+    int retval = 0;
+
+    if (freezer->state == STATE_FROZEN)
+        retval = -EBUSY;
+
+    return retval;
+}
+
+static void freezer_fork(struct cgroup_subsys *ss, struct task_struct *task)
+{
+    struct cgroup *cgroup = task_cgroup(task, freezer_subsys_id);
+    struct freezer *freezer = cgroup_freezer(cgroup);
+
+    spin_lock_irq(&freezer->lock);
+    if (freezer->state == STATE_FREEZING)
+        freeze_task(task, 1);
+    spin_unlock_irq(&freezer->lock);
+}
+
+static int freezer_check_if_frozen(struct cgroup *cgroup)
+{
+    struct cgroup_iter it;
+    struct task_struct *task;
+    unsigned int nfrozen = 0, ntotal = 0;
+
+    cgroup_iter_start(cgroup, &it);
+
+    while ((task = cgroup_iter_next(cgroup, &it))) {
+        ntotal++;
+        if (frozen(task))
+            nfrozen++;
+    }
+    cgroup_iter_end(cgroup, &it);
+
+    return (nfrozen == ntotal);
+}

```

```

+
+static ssize_t freezer_read(struct cgroup *cgroup,
+    struct cftype *cft,
+    struct file *file, char __user *buf,
+    size_t nbytes, loff_t *ppos)
+{
+ struct freezer *freezer = cgroup_freezer(cgroup);
+ enum freezer_state state;
+
+ spin_lock_irq(&freezer->lock);
+ if (freezer->state == STATE_FREEZING)
+ if (freezer_check_if_frozen(cgroup))
+ freezer->state = STATE_FROZEN;
+
+ state = freezer->state;
+ spin_unlock_irq(&freezer->lock);
+
+ return simple_read_from_buffer(buf, nbytes, ppos,
+    freezer_state_strs[state],
+    strlen(freezer_state_strs[state]) + 1);
+}
+
+static int freezer_freeze_tasks(struct cgroup *cgroup)
+{
+ struct cgroup_iter it;
+ struct task_struct *task;
+ unsigned int num_cant_freeze_now = 0;
+
+ cgroup_iter_start(cgroup, &it);
+ while ((task = cgroup_iter_next(cgroup, &it)) {
+ if (!freeze_task(task, 1))
+ continue;
+ if (task_is_stopped_or_traced(task) && freezing(task))
+ /*
+  * So long as the freeze flag is set these tasks
+  * will immediately go into the fridge upon waking.
+  */
+ continue;
+ if (!freezing(task) && !freezer_should_skip(task))
+ num_cant_freeze_now++;
+ }
+ cgroup_iter_end(cgroup, &it);
+
+ return num_cant_freeze_now ? -EBUSY : 0;
+}
+
+static int freezer_unfreeze_tasks(struct cgroup *cgroup)
+{

```

```

+ struct cgroup_iter it;
+ struct task_struct *task;
+
+ cgroup_iter_start(cgroup, &it);
+ while ((task = cgroup_iter_next(cgroup, &it)))
+   thaw_process(task);
+
+ cgroup_iter_end(cgroup, &it);
+ return 0;
+}
+
+static int freezer_freeze(struct cgroup *cgroup, enum freezer_state goal_state)
+{
+ struct freezer *freezer = cgroup_freezer(cgroup);
+ int retval = 0;
+
+ spin_lock_irq(&freezer->lock);
+retry:
+ if (goal_state == freezer->state)
+   goto unlock;
+
+ switch (freezer->state) {
+ case STATE_RUNNING:
+   if (goal_state == STATE_FROZEN) {
+     freezer->state = STATE_FREEZING;
+     retval = freezer_freeze_tasks(cgroup);
+   }
+   break;
+ case STATE_FREEZING:
+   if (freezer_check_if_frozen(cgroup)) {
+     freezer->state = STATE_FROZEN;
+     goto retry;
+   }
+
+   if (goal_state == STATE_FROZEN) {
+     /* Userspace is retrying after
+      * "echo FROZEN > freezer.state" returned -EBUSY */
+     retval = freezer_freeze_tasks(cgroup);
+     break;
+   }
+   /* goal_state == STATE_RUNNING, so unfreeze */
+ case STATE_FROZEN:
+   if (goal_state == STATE_RUNNING) {
+     freezer->state = STATE_RUNNING;
+     retval = freezer_unfreeze_tasks(cgroup);
+   }
+   break;
+ default:

```

```

+ break;
+ }
+unlock:
+ spin_unlock_irq(&freezer->lock);
+
+ return retval;
+}
+
+static ssize_t freezer_write(struct cgroup *cgroup,
+    struct cftype *cft,
+    struct file *file,
+    const char __user *userbuf,
+    size_t nbytes, loff_t *unused_ppos)
+{
+ char *buffer;
+ int retval = 0;
+ enum freezer_state goal_state;
+
+ if (nbytes >= PATH_MAX)
+ return -E2BIG;
+
+ /* +1 for nul-terminator */
+ buffer = kmalloc(nbytes + 1, GFP_KERNEL);
+ if (buffer == NULL)
+ return -ENOMEM;
+
+ if (copy_from_user(buffer, userbuf, nbytes)) {
+ retval = -EFAULT;
+ goto free_buffer;
+ }
+ buffer[nbytes] = 0; /* nul-terminate */
+ strstrip(buffer);
+ if (strcmp(buffer, "RUNNING") == 0)
+ goal_state = STATE_RUNNING;
+ else if (strcmp(buffer, "FROZEN") == 0)
+ goal_state = STATE_FROZEN;
+ else {
+ retval = -EIO;
+ goto free_buffer;
+ }
+
+ cgroup_lock();
+
+ if (cgroup_is_removed(cgroup)) {
+ retval = -ENODEV;
+ goto unlock;
+ }
+
+

```

```

+ retval = freezer_freeze(cgroup, goal_state);
+ if (retval == 0)
+   retval = nbytes;
+unlock:
+ cgroup_unlock();
+free_buffer:
+ kfree(buffer);
+ return retval;
+}
+
+static struct cftype files[] = {
+ {
+   .name = "state",
+   .read = freezer_read,
+   .write = freezer_write,
+ },
+};
+
+static int freezer_populate(struct cgroup_subsys *ss, struct cgroup *cgroup)
+{
+ return cgroup_add_files(cgroup, ss, files, ARRAY_SIZE(files));
+}
+
+struct cgroup_subsys freezer_subsys = {
+ .name = "freezer",
+ .create = freezer_create,
+ .destroy = freezer_destroy,
+ .populate = freezer_populate,
+ .subsys_id = freezer_subsys_id,
+ .can_attach = freezer_can_attach,
+ .attach = NULL,
+ .fork = freezer_fork,
+ .exit = NULL,
+};

```

Index: linux-2.6.25-mm1/kernel/freezer.c

--- linux-2.6.25-mm1.orig/kernel/freezer.c

+++ linux-2.6.25-mm1/kernel/freezer.c

```

@@ -120,5 +120,6 @@ int freeze_task(struct task_struct *p, i
 }
 }
 task_unlock(p);
 return ret;
 }
+EXPORT_SYMBOL(freeze_task);

```

--

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