Classifying tasks into control groups

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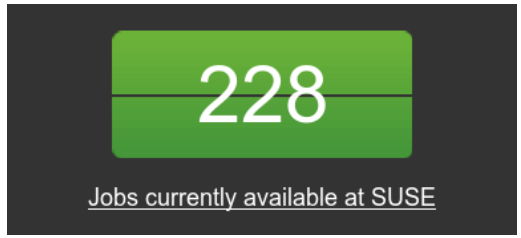

- https://jobs.suse.com/

Agenda

- Kernel APIs
- libcg
- systemd
- Problems
- Conclusion

Kernel APIs

Control groups

- Multiple hierarchies

```
host:~ # grep cgroup /proc/mounts
cgroup /sys/fs/cgroup/systemd cgroup rw,nosuid,nodev,noexec,
    relatime,xattr,name=systemd 0 0
cgroup /sys/fs/cgroup/memory cgroup rw,nosuid,nodev,noexec,
    relatime,memory 0 0
cgroup /sys/fs/cgroup/pids cgroup rw,nosuid,nodev,noexec,relatime,
    pids 0 0
...
```

- Multiple membership

```
host:~ # cat /proc/self/cgroup
12:pids:/user.slice/user-0.slice/session-2.scope
...
6:memory:/
...
1:name=systemd:/user.slice/user-0.slice/session-2.scope
```

Control groups – continuation

- Cgroup sysfs API

```
host:~ # ls -g /sys/fs/cgroup/systemd/
drwxr-xr-x  2 root 0 Sep 12 19:48 init.scope
drwxr-xr-x 68 root 0 Sep 12 19:48 system.slice
drwxr-xr-x  4 root 0 Sep 12 19:48 user.slice
-rw-r--r--  1 root 0 Sep 12 19:48 cgroup.procs
-rw-r--r--  1 root 0 Sep 12 19:48 notify_on_release
-rw-r--r--  1 root 0 Sep 12 19:48 release_agent
-rw-r--r--  1 root 0 Sep 12 19:48 tasks
...
```

- Cgroup v2

```
host:~ # ls -g /sys/fs/cgroup/unified/
drwxr-xr-x  2 root 0 Sep 12 10:24 init.scope
drwxr-xr-x 68 root 0 Sep 12 19:31 system.slice
drwxr-xr-x  4 root 0 Sep 12 19:08 user.slice
-r--r--r--  1 root 0 Sep 12 19:48 cgroup.controllers
-rw-r--r--  1 root 0 Sep 12 19:48 cgroup.procs
-rw-r--r--  1 root 0 Sep 12 19:48 cgroup.subtree_control
```

Cgroup v2

- Tejun Heo, Johannes Weiner: Resource Control @FB
- `https://goo.gl/7JCgja`

Process events API

- Netlink socket address group `CN_IDX_PROC`

```
/* /usr/include/linux/cn_proc.h */
struct proc_event {
        enum what {
                PROC_EVENT_NONE = 0x00000000,
                PROC_EVENT_FORK = 0x00000001,
                PROC_EVENT_EXEC = 0x00000002,
                PROC_EVENT_UID  = 0x00000004,
                PROC_EVENT_GID  = 0x00000040,
                PROC_EVENT_SID  = 0x00000080,
                PROC_EVENT_PTRACE = 0x00000100,
                PROC_EVENT_COMM = 0x00000200,
                PROC_EVENT_COREDUMP = 0x40000000,
                PROC_EVENT_EXIT = 0x80000000
        } what;
        /* ... */
}
```

libcg

libcg – configparser

- Constructs hierarchies per description

```
# /etc/cgconfig.conf

group daemons/www {
        cpu {
                cpu.shares = 1000;
        }
}

group daemons/ftp {
        cpu {
                cpu.shares = 500;
        }
}

mount {
        cpu = /mnt/cgroups/cpu;
        cpuacct = /mnt/cgroups/cpuacct;
}
```

libcg – cgrulesengd

- Uses `CN_IDX_PROC` API
- Puts processes into groups according to rules

```
# /etc/cgrules.conf

@students    cpu,cpuacct   /students/%u
student:cp   *             /usergroup/students/cp
```

libcg – helpers

- Start a process in the cgroup

```
cgexec -g cpu,memory:test1 ls -l
```

- Apply rules in batch mode

```
cgclassify $PID ...
```

Question

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- What is the difference between `cgroup.procs` and `tasks` control files? (cgroup v1)

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```

- Answer: Processes vs threads granularity.

systemd

systemd and cgroups

- systemd mounts cgroup filesystems
- systemd places processes in specific cgroups
  - .service
  - .scope
- tracking running processes
- realizing resource limits

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"512 PIDs should be enough for everyone."

systemd cgroups hierarchy

- systemd{,-logind,-machined}

```
host:~ # systemd-cgls
-.slice
|-system.slice
| |-dbus.service
| | `-712 /usr/bin/dbus-daemon --system --address=syste...
| |-sshd.service
| | `-1660 /usr/sbin/sshd -D
| `-...
|-user.slice
| |-user-0.slice
| | `-...
| `-user-471.slice
|   `-...
|-machine.slice
| `-machine-qemu\x218machine\x2dname.scope
|   `-7499 /usr/bin/qemu-system-x86_64 -name guest=mach...
`-init.scope
  `-1 /usr/lib/systemd/systemd --switched-root --system...
```

systemd user.slice

- Managed by pam_systemd
- Subpartitioning with `Delegate=yes`

```
host:~ # systemd-cgls /user.slice
user.slice:
`-user-0.slice
  |-session-5.scope
  | |-8645 sshd: root@pts/1
  | `-8647 -bash
  |-session-8.scope
  | |- 1961 login -- root
  | `-13151 -bash
  `-user@0.service
    |-dbus.service
    | `-7330 /usr/bin/dbus-daemon --session --address=s...
    `-init.scope
      |-6648 /usr/lib/systemd/systemd --user
      `-6649 (sd-pam)
```

Problems

Race condition of `CN_IDX_PROC`

- Process 1 (`cgrulesengd`)
  - receive `PROC_EVENT_FORK`/`PROC_EVENT_EXEC`
  - read process metadata (UID, GID)
  - classify process via sysfs API
- Process 2 (to be classified)
  - `fork`, `exec`
  - do the work

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- Process 2 (to be classified)
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- No ordering between classification and process 2 execution
- Solution
  - classify first, execute second
  - example

```
systemd-run --slice=dest.slice --scope $COMMAND $ARGS
```

Conflict between systemd and libcg

- *"cpu quota of cgconfig doesn't work after hostnamectl execution"*

```
ExecStart=/usr/bin/cgexec -g cpu:group1 /usr/bin/daemon
```

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ExecStart=/usr/bin/cgexec -g cpu:group1 /usr/bin/daemon
```

```
int unit_realize_cgroup(Unit *u) {
        unit_queue_siblings(u);
        return unit_realize_cgroup_now(u, manager_state(u->manager
            ));
}

void unit_queue_siblings(Unit *u) {
        SET_FOREACH(m, u->siblings) {
                if (unit_has_mask_realized(m, unit_get_target_mask
                    (m)))
                        continue;
                unit_add_to_cgroup_queue(m);
        }
}
```

- processes of seemingly unrelated services may be reclassified

Conflict between systemd and libcg – solution

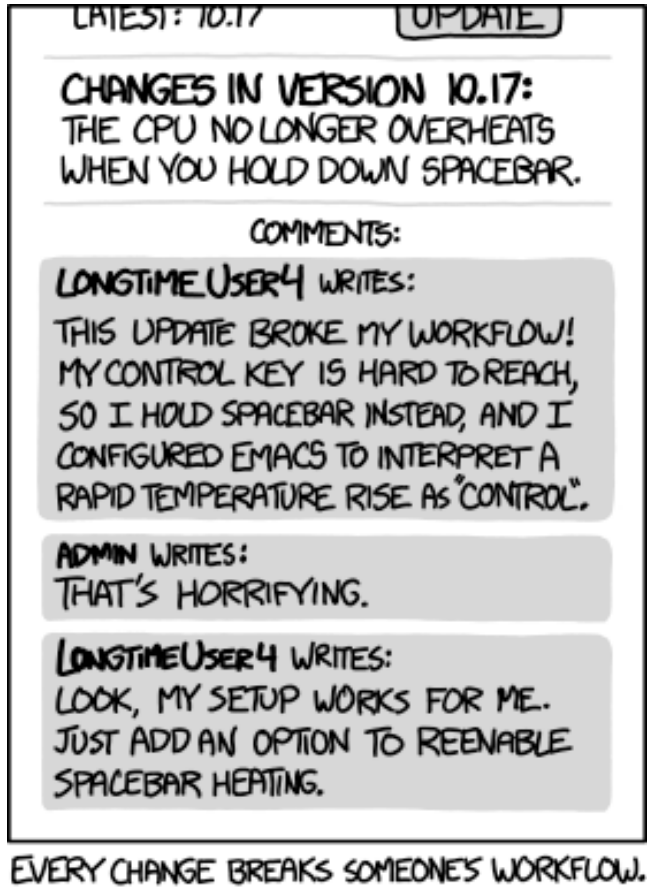
- libcg is fading out
- systemd takes over cgroup management

Conflict between systemd and libcg – solution

- libcg is fading out
- systemd takes over cgroup management
  - but...

libcg and systemd feature parity

- classifying based on running executable
  - racy anyway
- classifying into templated cgroups
  - configured a slice tree
  - user slices attached *arbitrarily*
- more unspecified use cases



EVERY CHANGE BREAKS SOMEONE'S WORKFLOW.

sudo in init scripts

```
# /etc/pam.d/sudo
...
session include common-session
...
```

```
# /etc/pam.d/common-session
...
session optional pam_systemd.so
...
```

- daemon processes are extracted from service cgroup

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- daemon processes are extracted from service cgroup
- port init script into systemd service
- use `setpriv`
- modify PAM configuration

Conclusion

- cgroups are meant to be generic
- libcg uses interesting but nonfunctional API
- systemd usurps cgroups (but allows delegation)
- systemd does not solve everything
- libcg can be dropped (in favor of cgroup v2)

Q & (A)

The end