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Subject: [PATCH 08/17] Pid-NS(V3) Define/use pid->upid\_list list.  
Posted by [Sukadev Bhattiprolu](#) on Sat, 16 Jun 2007 23:01:27 GMT  
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Subject: [PATCH 08/17] Pid-NS(V3) Define/use pid->upid\_list list.

From: Sukadev Bhattiprolu <sukadev@us.ibm.com>

With multiple pid namespaces, a process would be known by several pid\_t values, one in each pid namespace. To represent this, we introduce a 'struct upid' which associates a single pid\_t value with a single pid namespace.

We then replace the pid->nr field in 'struct pid' with a list of struct upid entries (referred to as 'pid->upid\_list'). This list represents the multiple pid\_t values of the process, one in each namespace. The current patch adds just one element to this list, corresponding to 'init\_pid\_ns'. Subsequent patches implement multiple pid namespaces and add more elements to the list.

The 'struct upid' also replaces 'struct pid' in the pid\_hash table to enable us to find processes given a pid\_t from any namespace (i.e we find 'struct upid' for a given pid\_t and from the 'struct upid', we find the 'struct pid' of the process)

We finally reimplement find\_pid() and pid\_to\_nr() to use pid->upid\_list and remove unused fields from 'struct pid'.

Changelog:

2.6.21-mm2-pidns3:

- 'struct upid' used to be called 'struct pid\_nr' and a list of these were hanging off of 'struct pid'. So, we renamed 'struct pid\_nr' and now hold them in a statically sized array in 'struct pid' since the number of 'struct upid's for a process is known at process-creation time.

2.6.21-rc3-mm2:

- [Eric Biederman] Combine all logical changes into one patch
- [Eric Biederman] Implement \_\_pid\_nr(pid\_ns, pid) for use in procs. (now called pid\_to\_nr\_in\_ns()).
- [Serge Hallyn]: Remove (!pid\_nr) check in free\_pid\_nr()

Signed-off-by: Cedric Le Goater <clg@fr.ibm.com>

Signed-off-by: Sukadev Bhattiprolu <sukadev@us.ibm.com>

---

fs/proc/array.c | 30 ++++++--

```

fs/proc/base.c          | 9 ++
include/linux/init_task.h | 14 +++-
include/linux/pid.h      | 62 ++++++++-----
include/linux/pid_namespace.h | 15 ++++
kernel/fork.c           | 2
kernel/pid.c            | 145 ++++++-----
7 files changed, 220 insertions(+), 57 deletions(-)

```

Index: lx26-22-rc4-mm2/include/linux/pid.h

```

=====
--- lx26-22-rc4-mm2.orig/include/linux/pid.h 2007-06-15 18:44:50.000000000 -0700
+++ lx26-22-rc4-mm2/include/linux/pid.h 2007-06-15 19:47:58.000000000 -0700
@@ -16,6 +16,25 @@ enum pid_type
    PIDTYPE_MAX
};

+struct pid_namespace;
+
+/*
+ * A struct upid holds a process identifier (or pid->nr) for a given
+ * pid namespace.
+ *
+ * A list of 'struct upid' entries is stored in the struct pid. This list
+ * is used to get the process identifier associated with the pid
+ * namespace it is being seen from.
+ */
+struct upid
+{
+ /* Try to keep pid_chain in the same cacheline as nr for find_pid */
+ struct hlist_node pid_chain; /* link hash collisions on pid_hash */
+ int nr; /* user space pid number */
+ struct pid_namespace *pid_ns; /* pid namespace in which nr is valid */
+ struct pid *pid; /* back to task's unique kernel pid */
+};
+
+/*
+ * What is struct pid?
+ */
@@ -48,12 +67,11 @@ enum pid_type
struct pid
{
    atomic_t count;
- /* Try to keep pid_chain in the same cacheline as nr for find_pid */
- int nr;
- struct hlist_node pid_chain;
    /* lists of tasks that use this pid */
    struct hlist_head tasks[PIDTYPE_MAX];
    struct rcu_head rcu;

```

```

+ int num_upids;
+ struct upid upid_list[1];
};

extern struct pid init_struct_pid;
@@ -100,16 +118,10 @@ extern struct pid *FASTCALL(find_pid(int
extern struct pid *find_get_pid(int nr);
extern struct pid *find_ge_pid(int nr);

-extern struct pid *alloc_pid(enum copy_process_type);
+extern struct pid *dup_struct_pid(enum copy_process_type);
extern void FASTCALL(free_pid(struct pid *pid));

-static inline pid_t pid_to_nr(struct pid *pid)
-{
- pid_t nr = 0;
- if (pid)
- nr = pid->nr;
- return nr;
-}
+extern pid_t pid_to_nr(struct pid *pid);

#define do_each_pid_task(pid, type, task) \
do { \
@@ -122,4 +134,32 @@ static inline pid_t pid_to_nr(struct pid
} \
} while (0)

+/*
+ * Return the pid_t by which the process @pid is known in the pid
+ * namespace @ns.
+ *
+ * Return 0 if:
+ * - @pid is NULL (eg: procfs calls this for task_pgrp(init_task)
+ *   which is NULL).
+ *
+ * - process does not have pid_t in the namespace @ns (eg: parent
+ *   process of a child reaper does not exist in the child namespace.
+ *   A getppid() call by the child reaper results in 0).
+ */
+static inline pid_t pid_to_nr_in_ns(struct pid *pid, struct pid_namespace *ns)
+{
+ int i;
+ struct upid *upid;
+
+ if (!pid)
+ return 0;
+

```

```

+ for (i = 0; i < pid->num_upids; i++) {
+ upid = &pid->upid_list[i];
+ if (upid->pid_ns == ns)
+ return upid->nr;
+ }
+ return 0;
+}
+

```

```

#endif /* _LINUX_PID_H */

```

Index: lx26-22-rc4-mm2/include/linux/init\_task.h

```

=====
--- lx26-22-rc4-mm2.orig/include/linux/init_task.h 2007-06-15 18:44:07.000000000 -0700
+++ lx26-22-rc4-mm2/include/linux/init_task.h 2007-06-15 19:47:58.000000000 -0700
@@ -89,19 +89,27 @@ extern struct nsproxy init_nsproxy;

```

```

extern struct group_info init_groups;

```

```

-#define INIT_STRUCT_PID { \
- .count = ATOMIC_INIT(1), \
- .nr = 0, \
+#define INIT_STRUCT_UPID { \
+ .nr = 0, \
+ /* Don't put this struct pid in pid_hash */ \
+ .pid_chain = { .next = NULL, .pprev = NULL }, \
+ .pid_ns = &init_pid_ns, \
+ .pid = &init_struct_pid, \
+}
+
+#define INIT_STRUCT_PID { \
+ .count = ATOMIC_INIT(1), \
+ .tasks = { \
+ { .first = &init_task.pids[PIDTYPE_PID].node }, \
+ { .first = &init_task.pids[PIDTYPE_PGID].node }, \
+ { .first = &init_task.pids[PIDTYPE_SID].node }, \
+ }, \
+ .rcu = RCU_HEAD_INIT, \
+ .num_upids = 1, \
+ .upid_list = { INIT_STRUCT_UPID }, \
+}

+
#define INIT_PID_LINK(type) \
{ \
. node = { \

```

Index: lx26-22-rc4-mm2/kernel/pid.c

```

=====
--- lx26-22-rc4-mm2.orig/kernel/pid.c 2007-06-15 18:44:50.000000000 -0700
+++ lx26-22-rc4-mm2/kernel/pid.c 2007-06-15 19:48:11.000000000 -0700

```

```

@@ -30,6 +30,7 @@
#include <linux/init_task.h>

#define pid_hashfn(nr) hash_long((unsigned long)nr, pidhash_shift)
+
static struct hlist_head *pid_hash;
static int pidhash_shift;
static struct kmem_cache *pid_cachep;
@@ -179,10 +180,67 @@ static int next_pidmap(struct pid_namesp
    return -1;
}

+static void clear_upid(struct upid *upid)
+{
+ /* We can be called with write_lock_irq(&tasklist_lock) held */
+ unsigned long flags;
+
+ free_pidmap(upid->pid_ns, upid->nr);
+
+ spin_lock_irqsave(&pidmap_lock, flags);
+ hlist_del_rcu(&upid->pid_chain);
+ spin_unlock_irqrestore(&pidmap_lock, flags);
+
+ put_pid_ns(upid->pid_ns);
+}
+
+static int init_upid(struct upid *upid, struct pid *pid,
+ struct pid_namespace *pid_ns)
+{
+ int nr;
+
+ nr = alloc_pidmap(pid_ns);
+ if (nr < 0)
+ return nr;
+
+ upid->pid_ns = get_pid_ns(pid_ns);
+ upid->nr = nr;
+
+ /*
+  * The pid and upid are created and destroyed at the same time,
+  * as a single unit. We don't need to refcount the pid use
+  * here.
+  */
+ upid->pid = pid;
+
+ INIT_HLIST_NODE(&upid->pid_chain);
+ spin_lock_irq(&pidmap_lock);
+ hlist_add_head_rcu(&upid->pid_chain, &pid_hash[pid_hashfn(nr)]);

```

```

+ spin_unlock_irq(&pidmap_lock);
+
+ return 0;
+}
+
+/*
+ * Return the pid_t by which the process @pid is known in the active
+ * pid namespace of the caller.
+ *
+ * TODO: pid_to_nr() cannot be easily inlined due to dependencies between
+ *      'task_struct', 'nsproxy' and 'pid_namespace'. As a part of
+ *      implementing multiple pid namespaces, we remove 'pid_namespace'
+ *      from 'nsproxy' and inline this function.
+ */
+pid_t pid_to_nr(struct pid *pid)
+{
+ return pid_to_nr_in_ns(pid, task_active_pid_ns(current));
+}
+EXPORT_SYMBOL_GPL(pid_to_nr);
+
+fastcall void put_pid(struct pid *pid)
+{
+ if (!pid)
+ return;
+
+ if ((atomic_read(&pid->count) == 1) ||
+     atomic_dec_and_test(&pid->count))
+ kmem_cache_free(pid_cache, pid);
@@ -197,66 +255,91 @@ static void delayed_put_pid(struct rcu_h

fastcall void free_pid(struct pid *pid)
{
- /* We can be called with write_lock_irq(&tasklist_lock) held */
- unsigned long flags;
+ int i;
+ struct upid *upid;

+ /* check this here to keep copy_process() cleaner */
+ if (unlikely(pid == &init_struct_pid))
+ return;

- spin_lock_irqsave(&pidmap_lock, flags);
- hlist_del_rcu(&pid->pid_chain);
- spin_unlock_irqrestore(&pidmap_lock, flags);
+ /* clear any upids that we actually initialized */
+ for (i = 0; i < pid->num_upids; i++) {
+ upid = &pid->upid_list[i];
+ if (!upid->pid_ns)

```

```

+ break;
+ clear_upid(upid);
+ }

- free_pidmap(&init_pid_ns, pid->nr);
  call_rcu(&pid->rcu, delayed_put_pid);
}

-struct pid *alloc_pid(enum copy_process_type copy_src)
+static struct pid *alloc_struct_pid(int num_upids)
{
    struct pid *pid;
    enum pid_type type;
- int nr = -1;
-
- /* check this here to keep copy_process() cleaner */
- if (unlikely(copy_src == COPY_IDLE_PROCESS))
- return &init_struct_pid;

- pid = kmem_cache_alloc(pid_cachep, GFP_KERNEL);
+ /* for now we only support one pid namespace */
+ BUG_ON(num_upids != 1);
+ pid = kmem_cache_zalloc(pid_cachep, GFP_KERNEL);
    if (!pid)
- goto out;
-
- nr = alloc_pidmap(task_active_pid_ns(current));
- if (nr < 0)
- goto out_free;
+ return NULL;

    atomic_set(&pid->count, 1);
- pid->nr = nr;
+ pid->num_upids = num_upids;
+
    for (type = 0; type < PIDTYPE_MAX; ++type)
        INIT_HLIST_HEAD(&pid->tasks[type]);

- spin_lock_irq(&pidmap_lock);
- hlist_add_head_rcu(&pid->pid_chain, &pid_hash[pid_hashfn(pid->nr)]);
- spin_unlock_irq(&pidmap_lock);
+ return pid;
+}
+
+struct pid *dup_struct_pid(enum copy_process_type copy_src)
+{
+ int rc;
+ int i;

```

```

+ int num_upids;
+ struct pid *pid;
+ struct upid *upid;
+ struct upid *parent_upid;
+ struct pid *parent_pid = task_pid(current);
+
+ /* check this here to keep copy_process() cleaner */
+ if (unlikely(copy_src == COPY_IDLE_PROCESS))
+ return &init_struct_pid;
+
+ num_upids = parent_pid->num_upids;
+
+ pid = alloc_struct_pid(num_upids);
+ if (!pid)
+ return NULL;
+
+ for (i = 0; i < num_upids; i++) {
+ upid = &pid->upid_list[i];
+ parent_upid = &parent_pid->upid_list[i];
+ rc = init_upid(upid, pid, parent_upid->pid_ns);
+ if (rc)
+ goto out_free_pid;
+ }

-out:
    return pid;

-out_free:
- kmem_cache_free(pid_cachep, pid);
- pid = NULL;
- goto out;
+out_free_pid:
+ free_pid(pid);
+ return NULL;
}

struct pid * fastcall find_pid(int nr)
{
    struct hlist_node *elem;
- struct pid *pid;
+ struct upid *upid;
+ struct pid_namespace *ns = task_active_pid_ns(current);
+
+ /* TODO: Include pid namespace in the hash function */

- hlist_for_each_entry_rcu(pid, elem,
+ hlist_for_each_entry_rcu(upid, elem,
    &pid_hash[pid_hashfn(nr)], pid_chain) {

```



```

- if (pid->nr == nr)
- return pid;
+ if ((upid->pid_ns == ns) && (upid->nr == nr))
+ return upid->pid;
}
return NULL;
}

```

Index: lx26-22-rc4-mm2/fs/proc/array.c

```
=====
--- lx26-22-rc4-mm2.orig/fs/proc/array.c 2007-06-15 18:44:44.000000000 -0700
```

```
+++ lx26-22-rc4-mm2/fs/proc/array.c 2007-06-15 18:44:50.000000000 -0700
```

```
@@ -75,6 +75,7 @@
```

```
#include <linux/cpuset.h>
```

```
#include <linux/rcupdate.h>
```

```
#include <linux/delayacct.h>
```

```
+#include <linux/pid_namespace.h>
```

```
#include <asm/uaccess.h>
```

```
#include <asm/pgtable.h>
```

```
@@ -161,8 +162,18 @@ static inline char * task_state(struct t
```

```
struct group_info *group_info;
```

```
int g;
```

```
struct fdtable *fdt = NULL;
```

```
+ pid_t ppid = 0;
```

```
+ pid_t tracer_pid = 0;
```

```
+ /* TODO get pid_ns from proc mnt rather than current */
```

```
+ struct pid_namespace *ns = task_active_pid_ns(current);
```

```
rcu_read_lock();
```

```
+
```

```
+ if (pid_alive(p)) {
```

```
+ ppid = pid_to_nr_in_ns(task_parent_tgid(p), ns);
```

```
+ tracer_pid = pid_to_nr_in_ns(task_tracer_pid(p), ns);
```

```
+ }
```

```
+
```

```
buffer += sprintf(buffer,
```

```
"State:\t%s\n"
```

```
"Tgid:\t%d\n"
```

```
@@ -172,9 +183,10 @@ static inline char * task_state(struct t
```

```
"Uid:\t%d\t%d\t%d\t%d\n"
```

```
"Gid:\t%d\t%d\t%d\t%d\n",
```

```
get_task_state(p),
```

```
- p->tgid, p->pid,
```

```
- pid_alive(p) ? rcu_dereference(p->real_parent)->tgid : 0,
```

```
- pid_alive(p) && p->ptrace ? rcu_dereference(p->parent)->pid : 0,
```

```
+ pid_to_nr_in_ns(task_tgid(p), ns),
```

```
+ pid_to_nr_in_ns(task_pid(p), ns),
```

```
+ ppid,
```

```

+ tracer_pid,
  p->uid, p->euid, p->suid, p->fsuid,
  p->gid, p->egid, p->sgid, p->fsgid);

@@ -362,6 +374,8 @@ static int do_task_stat(struct task_stru
  unsigned long rsslim = 0;
  char tcomm[sizeof(task->comm)];
  unsigned long flags;
+ /* TODO get pid_ns from proc mnt rather than current */
+ struct pid_namespace *ns = task_active_pid_ns(current);

  state = *get_task_state(task);
  vsize = eip = esp = 0;
@@ -384,7 +398,7 @@ static int do_task_stat(struct task_stru
  struct signal_struct *sig = task->signal;

  if (sig->tty) {
-   tty_pgrp = pid_to_nr(sig->tty->pgrp);
+   tty_pgrp = pid_to_nr_in_ns(sig->tty->pgrp, ns);
    tty_nr = new_encode_dev(tty_devnum(sig->tty));
  }

@@ -414,9 +428,9 @@ static int do_task_stat(struct task_stru
  stime += cputime_to_clock_t(sig->stime);
}

- sid = signal_session(sig);
- pgid = process_group(task);
- ppid = rcu_dereference(task->real_parent)->tgid;
+ sid = pid_to_nr_in_ns(task_session(task), ns);
+ pgid = pid_to_nr_in_ns(task_pgrp(task), ns);
+ ppid = pid_to_nr_in_ns(task_parent_tgid(task), ns);

  unlock_task_sighand(task, &flags);
}
@@ -447,7 +461,7 @@ static int do_task_stat(struct task_stru
  res = sprintf(buffer, "%d (%s) %c %d %d %d %d %d %u %lu \
%lu %lu %lu %lu %ld %ld %ld %ld %d 0 %llu %lu %ld %lu %lu %lu %lu \
%lu %lu %lu %lu %lu %lu %lu %d %d %u %u %llu\n",
- task->pid,
+ pid_to_nr_in_ns(task_pid(task), ns),
  tcomm,
  state,
  ppid,

```

Index: lx26-22-rc4-mm2/fs/proc/base.c

```

=====
--- lx26-22-rc4-mm2.orig/fs/proc/base.c 2007-06-15 18:44:07.000000000 -0700
+++ lx26-22-rc4-mm2/fs/proc/base.c 2007-06-15 19:26:40.000000000 -0700

```

```

@@ -73,6 +73,7 @@
#include <linux/audit.h>
#include <linux/poll.h>
#include <linux/nsproxy.h>
+#include <linux/pid_namespace.h>
#include <linux/oom.h>
#include <linux/elf.h>
#include "internal.h"
@@ -2295,13 +2296,15 @@ static struct task_struct *next_tgid(uns
{
    struct task_struct *task;
    struct pid *pid;
+ /* TODO get pid_ns from proc mnt rather than current */
+ struct pid_namespace *ns = task_active_pid_ns(current);

    rcu_read_lock();
retry:
    task = NULL;
    pid = find_ge_pid(tgid);
    if (pid) {
- tgid = pid->nr + 1;
+ tgid = pid_to_nr_in_ns(pid, ns) + 1;
    task = pid_task(pid, PIDTYPE_PID);
    /* What we to know is if the pid we have find is the
     * pid of a thread_group_leader. Testing for task
@@ -2341,6 +2344,8 @@ int proc_pid_readdir(struct file * filp,
    struct task_struct *reaper = get_proc_task(filp->f_path.dentry->d_inode);
    struct task_struct *task;
    int tgid;
+ /* TODO get pid_ns from proc mnt rather than current */
+ struct pid_namespace *ns = task_active_pid_ns(current);

    if (!reaper)
        goto out_no_task;
@@ -2355,7 +2360,7 @@ int proc_pid_readdir(struct file * filp,
    for (task = next_tgid(tgid);
         task;
         put_task_struct(task), task = next_tgid(tgid + 1)) {
- tgid = task->pid;
+ tgid = pid_to_nr_in_ns(task_pid(task), ns);
    filp->f_pos = tgid + TGID_OFFSET;
    if (proc_pid_fill_cache(filp, dirent, filldir, task, tgid) < 0) {
        put_task_struct(task);
Index: lx26-22-rc4-mm2/include/linux/pid_namespace.h
=====
--- lx26-22-rc4-mm2.orig/include/linux/pid_namespace.h 2007-06-15 18:44:44.000000000 -0700
+++ lx26-22-rc4-mm2/include/linux/pid_namespace.h 2007-06-15 19:47:58.000000000 -0700
@@ -15,6 +15,18 @@ struct pidmap {

```

```

#define PIDMAP_ENTRIES      ((PID_MAX_LIMIT + 8*PAGE_SIZE - 1)/PAGE_SIZE/8)

+/*
+ * Some properties/terminology for pid namespaces:
+ *
+ * Processes currently exist only in (or belong only to) the init_pid_ns.
+ * When we introduce the ability to clone the pid namespace, a process
+ * would exist in several namespaces. Of the many namespaces that the
+ * process can exist, one namespace is special and we refer to it as the
+ * 'active pid namespace' of the process.
+ *
+ * For now, we have only one pid namespace - init_pid_ns which is the
+ * 'active pid namespace' for all processes in the system.
+ */
struct pid_namespace {
    struct kref kref;
    struct pidmap pidmap[PIDMAP_ENTRIES];
@@ -24,9 +36,10 @@ struct pid_namespace {

extern struct pid_namespace init_pid_ns;

-static inline void get_pid_ns(struct pid_namespace *ns)
+static inline struct pid_namespace *get_pid_ns(struct pid_namespace *ns)
{
    kref_get(&ns->kref);
+ return ns;
}

extern struct pid_namespace *copy_pid_ns(int flags, struct pid_namespace *ns);
Index: lx26-22-rc4-mm2/kernel/fork.c
=====
--- lx26-22-rc4-mm2.orig/kernel/fork.c 2007-06-15 18:44:50.000000000 -0700
+++ lx26-22-rc4-mm2/kernel/fork.c 2007-06-15 19:47:58.000000000 -0700
@@ -1027,7 +1027,7 @@ static struct task_struct *copy_process(
    if (p->binfmt && !try_module_get(p->binfmt->module))
        goto bad_fork_cleanup_put_domain;

- pid = alloc_pid(copy_src);
+ pid = dup_struct_pid(copy_src);
    if (!pid)
        goto bad_fork_put_binfmt_module;

--

```

---

Containers mailing list  
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