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Subject: Re: checkpointing and restoring processes  
Posted by [Cedric Le Goater](#) on Wed, 06 Jun 2007 12:48:07 GMT  
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Mark Pflueger wrote:

> hi everyone!

>

> i'm not subscribed to the list, so if you care to flame because of my noob

> question, just do it to the list, otherwise please cc me.

you should subscribe to [containers@lists.osdl.org](mailto:containers@lists.osdl.org) and send your ideas on that list. There's a BOF on that topic at OLS if you can attend.

cheers,

C.

> i'm trying to write a checkpoint/restore module for processes and so have

> a basic version going already - problem is, when i restore the process,

> one of three things happens at random. first is, the process restored

> segfaults. second is, i get a kernel null pointer dereference and third

> is, i get a virtual address lookup error and a kernel crash. the trace

> back and the address always change.

>

> the user space process is as simple as i could make it: (error checking  
> and debugging messages are left out)

>

>

> void take\_chkpt(void) {

> pid\_t pid;

> char call\_pid[10];

> char call\_num[10];

>

> chkptpid = getpid();

> snprintf(call\_pid, 9, "%d", chkptpid);

> snprintf(call\_num, 9, "%d", checkpointnum);

>

> switch(pid = fork()) {

> case -1:

> fprintf(stderr, "Fork failed.\n");

> return;

> break;

> case 0: /\* child process \*/

> if(!execl("child\_take", call\_pid, call\_num, (char \*)0))

> perror("execl: ");

> break;

> default: /\* parent process \*/

> waitpid(pid, NULL, 0);

```

>         break;
>     }
>
>     return;
> }
>
>
> void restore_chkpts(void) {
>     pid_t pid;
>     char call_pid[10];
>     char call_num[10];
>
>     ENTERFUN();
>
>     if(restore_retry) // do nothing on second call to restore
>         return;
>
>     chkptpid = getpid();
>     snprintf(call_pid, 9, "%d", chkptpid);
>     snprintf(call_num, 9, "%d", checkpointnum);
>
>     switch(pid = fork()) {
>     case -1:
>         fprintf(stderr, "MP: Fork failed.\n");
>         return;
>         break;
>     case 0: /* child process */
>         if(!execl("child_restore", call_pid, call_num, (char *)0))
>             perror("execl: ");
>         break;
>     default: /* parent process */
>         INF(("Parent Process"));
>         restore_retry=1;
>         INF(("Wait for Child..."));
>         waitpid(pid, NULL, 0);
>         break;
>     }
>
>     LEAVEFUN();
>
>     return;
> }
>
> int main(int argc, char* argv[]) {
>     take_chkpt();
>     printf("Hello cruel world!\n");
>     restore_chkpts();
>     return 0;

```

```

> }
>
> where child_take and child_restore do the following:
>
>
> void child_take_chkpt(int chkptpid, int checkpointnum) {
>     struct chkpt_ioctl chkptio;
>     int dev_fd; // ioctl device file
>     char chkptname[30];
>
>     if ((dev_fd = open(CHKPT_DEVICE, O_RDWR)) < 0) {
>         perror("MP: Open device file");
>         exit(EXIT_FAILURE);
>     }
>     chkptio.pid = chkptpid;
>     snprintf(chkptname, 29, "/tmp/chkpt_%d_%d", chkptio.pid, checkpointnum);
>     chkptio.file = creat(chkptname, 00755);
>     sleep(1); // to go sure the parent process is in waitpid -- ugly,
> but works
>     kill(chkptio.pid, SIGSTOP);
>     sleep(1);
>     ioctl(dev_fd, CHKPT_IOCTL_SAVE, (unsigned long)&chkptio);
>     close(dev_fd);
>     close(chkptio.file);
>     kill(chkptio.pid, SIGCONT);
>     exit(0);
> }
>
> void child_restore_chkpts(int chkptpid, int checkpointnum) {
>     struct chkpt_ioctl chkptio;
>     int dev_fd; // ioctl device file
>     char chkptname[30];
>
>     snprintf(chkptname, 29, "/tmp/chkpt_%d_%d", chkptpid, checkpointnum-1);
>     chkptio.file = open(chkptname, O_RDONLY);
>     chkptio.pid = chkptpid;
>     dev_fd = open(CHKPT_DEVICE, O_RDWR);
>     sleep(1);
>     kill(chkptpid, SIGSTOP);
>     sleep(1);
>     ioctl(dev_fd, CHKPT_IOCTL_RESTORE, (unsigned long)&chkptio);
>     close(chkptio.file);
>     close(dev_fd);
>     kill(chkptpid, SIGCONT);
>     exit(0);
> }
>
> the header for the files is this:

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>
>
> enum {
>     CHKPT_IOCTL_SAVE,
>     CHKPT_IOCTL_RESTORE
> };
>
> struct chkpt_ioctl {
>     pid_t pid; // for fork tests
>     int file;
> };
>
> struct chkpt {
>     pid_t pid; // for fork tests
>     struct pt_regs regs;
>     unsigned int datasize;
>     unsigned int brksize;
>     unsigned int stacksize;
> };
>
>
> and finally the kernel module:
>
> int chkpt_ioctl_handler(struct inode *i, struct file *f,
>     unsigned int cmd, unsigned long arg) {
>     struct chkpt_ioctl pmio, *u_pmio;
>     int ret = -1;
>
>     u_pmio = (struct chkpt_ioctl *)arg;
>
>     switch(cmd) {
>     case CHKPT_IOCTL_SAVE:
>         if (copy_from_user(&pmio, u_pmio, sizeof(struct
> chkpt_ioctl))) {
>             printk("...failed to copy from user\n");
>             ret = -1;
>             break;
>         }
>         if(chkpt_save(&pmio) < 0) {
>             printk("...failed to save chkpt\n");
>             ret = -1;
>             break;
>         }
>         ret = 0;
>         break;
>     case CHKPT_IOCTL_RESTORE:
>         INFO(("CHKPT_IOCTL_RESTORE"));
>         if (copy_from_user(&pmio, u_pmio, sizeof(struct

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```

> chkpt_ioctl))) {
>         printk("...failed to copy from user\n");
>         ret = -1;
>         break;
>     }
>     if (chkpt_restore(&pmio) < 0) {
>         printk("...failed to restore chkpt\n");
>         ret = -1;
>         break;
>     }
>     ret = 0;
>     break;
> default:
>     printk("...illegal ioctl cmd\n");
>     ret = -1;
>     break;
> }
> return ret;
> }
>
> static int chkpt_save(struct chkpt_ioctl *chkptio) {
>     struct task_struct *tsk;
>     struct chkpt chkpt;
>     unsigned int datasz, brksz, stacksz;
>     struct file *f;
>
>     if (!(tsk = find_task_by_pid(chkptio->pid))) {
>         printk("...task %d not found\n", chkptio->pid);
>         return -1;
>     }
>
>     f = current->files->fd[chkptio->file];
>
>     datasz = tsk->mm->end_data - tsk->mm->start_data; // data
>     brksz = tsk->mm->brk - tsk->mm->start_brk; // brk
>     stacksz = tsk->thread.esp0 - tsk->thread.esp; // stack
>
>     /* saving most important information belonging to tsk */
>     /* NO FILES, SOCKETS, PIPES, SHARED MEMORY AND SEMAPHORES */
>     chkpt.pid = chkptio->pid;
>     /* REGISTERS */
>     memcpy(&chkpt.regs, REGS, sizeof(struct pt_regs));
>     if (in_syscall(tsk))
>         intr_syscall(&chkpt.regs);
>     chkpt.datasize = datasz;
>     chkpt.brksize = brksz;
>     chkpt.stacksize = stacksz;
>     pack_write(f, (void *)&chkpt, sizeof(struct chkpt), 0);

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> /* TASK */
> pack_write(f, (void*)tsk, THREAD_SIZE, 0);
> /* MEMORY */
> pack_write(f, (void *)tsk->mm->start_data, datasz, 0);
> pack_write(f, (void *)tsk->mm->start_brk, brksz, 0);
> pack_write(f, (void *)tsk->thread.esp, stacksz, 0);
>
> pack_write(f, NULL, 0, 1); /* last packet */
>
> return 0;
> }
>
> static int pack_write (struct file *f, char *buf, int len,
>     int last_pkt) {
>     static char *pack = NULL;
>     static long pos = 0;
>     int ret, to_copy, wrtn = 0;
>
>     if (pack==NULL)
>     {
> pack=(char*)kmallocl(PACKET_SIZE, GFP_KERNEL);
> if (!pack)
> {
>     printk("pack_write: no mem!\n");
>     return -1;
> }
> }
>
> while (len>0)
> {
> to_copy = (len>(PACKET_SIZE-pos))?(PACKET_SIZE-pos):(len);
>
>     memcpy(&(pack[pos]), buf+wrtn, to_copy);
>
>     pos += to_copy;
>     len -= to_copy;
>     wrtn +=to_copy;
>
> if ( (pos==PACKET_SIZE) || (last_pkt) )
> {
>     mm_segment_t fs = get_fs();
>
>     set_fs(KERNEL_DS);
>     ret = f->f_op->write(f, pack, pos, &(f->f_pos));
>     set_fs(fs);
>     if (ret!=pos)
> return ret;
>
>

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> pos = 0;
> if (last_pkt)
> {
> kfree(pack);
> pack = NULL;
> }
> }
> }
>
> if ( (last_pkt) && (pack!=NULL) )
> {
> if (pos!=0)
> {
> mm_segment_t fs = get_fs();
>
> set_fs(KERNEL_DS);
> wrtn = f->f_op->write(f, pack, pos, &f->f_pos);
> set_fs(fs);
> }
> kfree(pack);
> pack = NULL;
> pos = 0;
> }
>
> return wrtn;
> }
>
> static int in_syscall(struct task_struct *tsk) {
> unsigned char ins, opc;
> long ret;
> unsigned long flags;
> struct pt_regs *regs;
>
> spin_lock_irqsave(&runqueue_lock, flags);
>
> regs = (((struct pt_regs *) (THREAD_SIZE + (unsigned long)tsk)) -
> 1);
>
> get_user(ins, (unsigned char *) (regs->eip) - 2);
> get_user(opc, (unsigned char *) (regs->eip) - 1);
>
> if ((ins == 0xCD) && (opc == 0x80)) {
> ret = regs->orig_eax;
> } else {
> ret = 0;
> }
>
> if (ret && ((regs->orig_eax < 0) || (regs->orig_eax >

```

```

> NR_syscalls))) {
>     INFO(("syscall number out of bounds %ld\n",
> regs->orig_eax));
>     ret = 0;
> }
>
> spin_unlock_irqrestore(&runqueue_lock, flags);
>
> return ret;
> }
>
> static int intr_syscall(struct pt_regs *regs) {
>
>     /* handle in_syscall depending on syscall number */
>     switch(regs->orig_eax) {
>     case 4: /* write */
>         /* report interruption */
>         regs->eax = -EINTR;
>         break;
>     default:
>         /* restart */
>         regs->eax = regs->orig_eax;
>         regs->eip -= 2;
>         break;
>     }
>
>     return regs->orig_eax;
> }
>
> static int chkpt_restore(struct chkpt_ioctl *chkptio) {
>     struct task_struct *tsk, *saved_tsk;
>     struct chkpt chkpt;
>     struct file *f;
>
>     if ((tsk = find_task_by_pid(chkptio->pid)) == NULL) {
>         printk("...failed task not found %u\n", chkptio->pid);
>         return -1;
>     }
>
>
>     if ((saved_tsk = kmalloc(sizeof(struct task_struct), GFP_KERNEL))
> == NULL) {
>         printk("kmalloc failed\n");
>         return -1;
>     }
>
>     f = current->files->fd[chkptio->file];
>     do_read(f, &f->f_pos, (void *)&chkpt, sizeof(struct chkpt));

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> do_read(f, &f->f_pos, (void *)saved_tsk, THREAD_SIZE);
>
> /* TASK */
> if (pm_overwrite(tsk, saved_tsk) == NULL) {
>     printk("...failed task overwrite\n");
>     return -1;
> }
> /* REGISTERS */
> memcpy(REGS, &chkpt.regs, sizeof(struct pt_regs));
> /* MEMORY */
> do_read(f, &f->f_pos, (void *)tsk->mm->start_data,
> chkpt.datasize);
> do_read(f, &f->f_pos, (void *)chkpt.regs.esp, chkpt.stacksize);
> do_read(f, &f->f_pos, (void *)tsk->mm->start_brk, chkpt.brksize);
> kfree(saved_tsk);
>
> return 0;
> }
>
>
> static int inline do_read(struct file *file, loff_t *offset,
> char * addr, unsigned long count) {
> mm_segment_t old_fs;
> int ret;
>
> if (!file->f_op->read)
> return -ENOSYS;
> old_fs = get_fs();
> set_fs(get_ds());
> ret = file->f_op->read(file, addr, count, offset);
> set_fs(old_fs);
> return ret;
> }
>
> /* overwrite tsk with the one in pmio, making a backup first,
> then restoring all values dependant on the current local
> OS state (except register values) */
> static struct task_struct *pm_overwrite(struct task_struct *tsk,
> struct task_struct *saved_tsk) {
> struct task_struct *backup;
>
> if ((backup = kmalloc(sizeof(*backup), GFP_KERNEL)) == NULL) {
>     printk("kmalloc failed\n");
>     return NULL;
> }
>
> memcpy(backup, tsk, sizeof(struct task_struct));
>

```

```

> write_lock_irq(&tasklist_lock);
>
> memcpy(tsk, saved_tsk, THREAD_SIZE);
>
> tsk->next_task = backup->next_task;
> tsk->prev_task = backup->prev_task;
>
> tsk->exec_domain = backup->exec_domain;
> tsk->binfmt      = backup->binfmt;
>
> tsk->pid         = backup->pid;
> tsk->pgrp        = backup->pgrp;
> tsk->tty_old_pgrp = backup->tty_old_pgrp;
> tsk->session     = backup->session;
> tsk->tgid        = backup->tgid;
> tsk->leader      = backup->leader;
>
> tsk->p_opptr      = backup->p_opptr;
> tsk->p_pptr       = backup->p_pptr;
> tsk->p_cptra      = backup->p_cptra;
> tsk->p_ysptr      = backup->p_ysptr;
> tsk->p_osptr      = backup->p_osptr;
>
> tsk->thread_group = backup->thread_group;
>
> tsk->pidhash_next = backup->pidhash_next;
> tsk->pidhash_pprev = backup->pidhash_pprev;
>
> tsk->real_timer   = backup->real_timer;
>
> tsk->uid          = backup->uid;
> tsk->euid         = backup->euid;
> tsk->suid         = backup->suid;
> tsk->fsuid        = backup->fsuid;
> tsk->gid          = backup->gid;
> tsk->egid         = backup->egid;
> tsk->sgid         = backup->sgid;
> tsk->fsgid        = backup->fsgid;
>
> tsk->ngroups      = backup->ngroups;
> memcpy(tsk->groups, backup->groups, sizeof(tsk->groups));
>
> tsk->cap_effective = backup->cap_effective;
> tsk->cap_inheritable = backup->cap_inheritable;
> tsk->cap_permitted  = backup->cap_permitted;
> tsk->keep_capabilities = backup->keep_capabilities;
>
> tsk->user = backup->user;

```

```

>
>     tsk->tty = backup->tty;
>
>     tsk->semundo    = backup->semundo;
>     tsk->semsleeping = backup->semsleeping;
>
>     tsk->fs = backup->fs;
>
>     tsk->files = backup->files;
>
>     tsk->sigmask_lock = backup->sigmask_lock;
>     tsk->sig          = backup->sig;
>     tsk->pending      = backup->pending;
>
>     tsk->sas_ss_sp    = backup->sas_ss_sp;
>     tsk->sas_ss_size  = backup->sas_ss_size;
>     tsk->notifier     = backup->notifier;
>     tsk->notifier_data = backup->notifier_data;
>     tsk->notifier_mask = backup->notifier_mask;
>
>     tsk->parent_exec_id = backup->parent_exec_id;
>     tsk->self_exec_id   = backup->self_exec_id;
>
>     tsk->alloc_lock = backup->alloc_lock;
>
>     tsk->mm          = backup->mm;
>     tsk->active_mm = backup->active_mm;
>
>     write_unlock_irq(&tasklist_lock);
>     kfree(backup);
>     return tsk;
> }
>
> /* standard module stuff */
>
> int __init chkpt_init(void)
> {
>     if (register_chrdev(CHKPT_DEV_MAJOR, "chkpt", &file_ops)) {
>         printk("...failed register_chrdev\n");
>         return -1;
>     }
>     return 0;
> }
>
> void __exit chkpt_exit(void)
> {
>     unregister_chrdev(CHKPT_DEV_MAJOR, "chkpt");
>     return;

```

> }  
>  
> EXPORT\_SYMBOL(chkpt\_init);  
> EXPORT\_SYMBOL(chkpt\_exit);  
> EXPORT\_SYMBOL(chkpt\_ioctl\_handler);  
>  
> if anyone has any ideas, please let me know. thanx in advance.  
>  
> greetings  
>  
> marks  
> -  
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