Project 1

Fast correction

Project #1

- waitpid vs wait
- WEXITSTATUS
- Memory leaks !
- fflush after the >, before the fork
  - Why? Because the children and the parent can run in any order

  → When piping a list of commands to your shell, some flushed in bad order

The leftovers

- cd alone goes back to $HOME
- Space arguments under quotes ("")

Project #1

- Check your indentation, choose a style
  - Just after a little googling for tools :
    - cppcheck
      - Check for common errors
    - indent
      - Auto indent
    - uncrustify
      - C, C++, C#, D, Java and Pawn source code beautifie
    - vera++

- Fork + exec to test if program exists is way much costly than stat (or other syscall to check for file existence)

Programming in the Linux Kernel

Kernel sources organization

- arch/x86 has every hardware-specific code for the 32-bit Intel processors
  - other arch/xxx directory can be ignored
- include the include files needed to build the kernel code
- init the initialization code
- mm the memory management code
- drivers Code needed to communicate with external devices
- fs file system code
- kernel contains the main kernel code
- net networking code.
  - Not the drivers, which are in driver… IP stack, TCP, ...

More on http://www.tldp.org/LDP/tlk/sources/sources.html

Find something

- launch **cscope -R** in your kernel directory,
- use "**Find this C symbol**" to locate any *use* of a function/structure field/macro/variable ...
- use "**Find this global definition**" to locate where the body of the function/structure declaration/... sits.
- enjoy the other features, too :)

or…

- Use an IDE like Eclipse with the C/C++ plugin

In fact, it's complimentary. I use the twos

Macros

Kernel programmers love macros. Macros are replaced by some piece of code by the preprocessor, and does not suffer from “stack overhead” of functions.

```
if (unlikely(PageDirty(page))) {
        ...
```

Kernel C Code

unlikely (and the contrary, *likely*) is a simple macro, which optimise code for the “else” branch of a condition (no jump).

You may encounter some functions that doesn’t exist anywhere… Like *PageDirty*

```
PAGEFLAG(Dirty, dirty)  → Will make PageDirty Available
```

Kernel C Code

They are defined by another macro, but never explicitly defined :

Define

For the same reasons, they love define. The .config file is a big “definer”.

You’ll encounter some things like this :

```
#ifdef CONFIG_SMP
        struct plist_node pushable_tasks;
#endif
```

Kernel C Code

It means that if CONFIG_SMP is enabled in the config file, the code is taken into account, if not it’s like if it never existed

```
host % cat .config | grep CONFIG_SMP
CONFIG_SMP=y
```

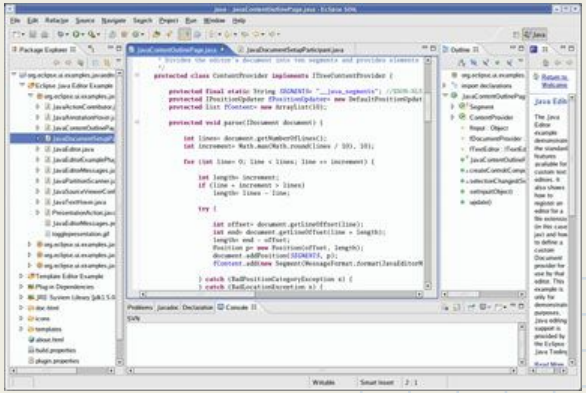
Terminal

How to know if it’s activated ?

IDE

As said, any file editor like gedit (or vim/nano/emacs if you like to suffer) will work. Helping you with cscope in another window is a good idea.

But you may benefit from an IDE. I personally (and it's probably not the best) use **Eclipse**. You can "CTRL-CLICK" a function/macro/variable like *PageDirty* to jump to its definition.



It's **really** up to you.

Working with friends

- Don’t even try Dropbox…
- SVN is probably the easiest.
- **GIT** is more powerful.

You can use montefiore’s GitLab server on http://gitlab.montefiore.ulg.ac.be to have a free GIT repository ! Just create an account, a group, invite your collaborator to the group, and create a project inside your group namespace.

You can directly fork my git repo at http://gitlab.montefiore.ulg.ac.be/info0940/kernel-4.4.50 which contains the kernel-4.4.50 sources, along with a tag “4.4.50” to make the creation of patchs easier.

Adding changes to git

Of course the patch will work if you committed your branch before...

After each minor changes in the files :

- Use *git add FILE* to add the flies that you changed
- Use *git add --patch FILE* to add only some parts of the changes done in the file
- Use *git commit* when all changes are “added”

OR

- Use *git commit --interactive*

- Try to type a good commit message, explicitly telling what you changed
- (use *git push* to send the changes to your colleagues, which will receive them with *git pull*)

VCS Warning

DO
NOT

Include compiled, binary files into your VCS, especially gitlab.montefiore.ulg.ac.be !

Patch with GIT

If you use GIT for development, making a patch is easier.

Add all the clean linux sources files to your repo before doing anything else with *git add -A .* Create a tag “4.4.50” before any modifications (This is already done if you forked my GIT project).

- To see the differences with the clean sources, use *git diff 4.4.50*
- *git format-patch 4.4.50* will create one patch per commit, and can even directly send them by e-mail.
- To have a patch compliant to “patch -p1” and make only one patch file :

```
host % git diff 4.4.50 HEAD > g42-s01-source.patch
```
Terminal

In other terms, while format-patch is good practice, avoid it for this course as I cannot automatically find if your patch is a git patch or a good old diff -burN

Debug by printing

- dump_stack() will show you all the calls which led where it is called.

- printk() will display a line in the syslog. It's the same arguments than syslog. It may be a good idea to launch a virtual $ tail -f /var/log/syslog in a terminal before doing your tests in the kernel, to see what is going on.

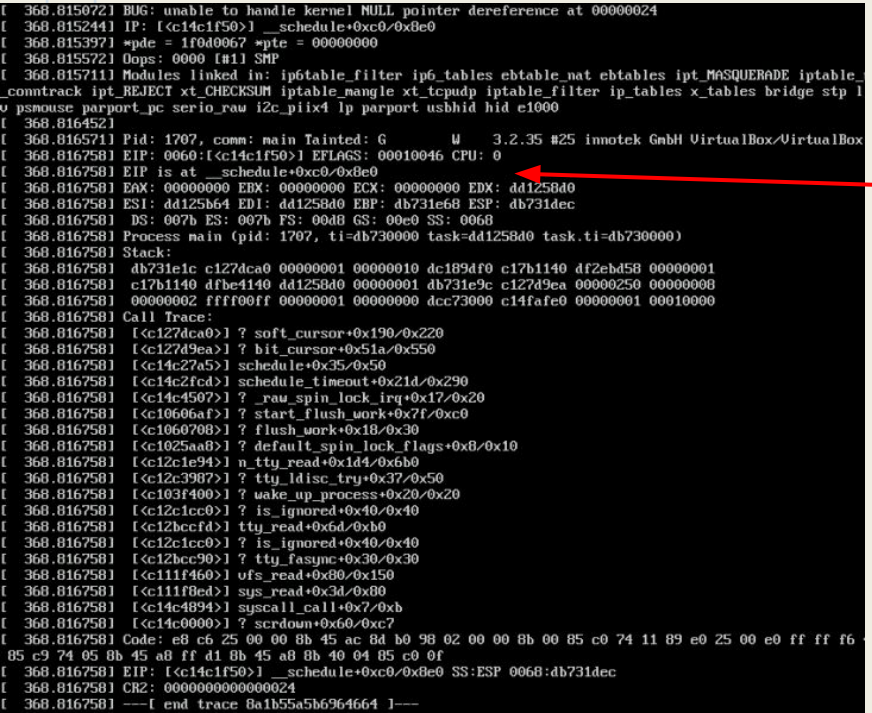
```
host % man tail
TAIL(1)                          User Commands                          TAIL(1)
NAME
       tail - output the last part of files
[...]
       -f, --follow[={name|descriptor}]
              output appended data as the file grows; -f, --follow, and --fol-
              low=descriptor are equivalent
```

Terminal

- printk(KERN_CRIT "bla bla bla"); will display the line in the current terminal, as if it was a very critical error (usefull for debug)
  → More info : http://www.makelinux.net/ldd3/chp-4-sect-2

GDB

If you got an error with a dump_stack like :



__schedule+0xc0

GDB (con’d)

- Find the file containing the function with cscope
- Launch GDB on the binary file (binary.o)
- Type list *(function+offset)

```
host $ cd kernel/
host $ gdb sched.o
GNU gdb (GDB) Fedora 7.6.1-41.fc19
(...)
Reading symbols from (...)done.
(gdb) list *(__schedule+0xc0)
0x18150 is in __schedule (kernel/sched.c:3232).
3229   /* assumes rq->lock is held */
3230   static inline void pre_schedule(struct rq *rq, struct task_struct *prev)
3231   {
3232           if (prev->sched_class->pre_schedule) //The error was a NULL pointer...
3233                   prev->sched_class->pre_schedule(rq, prev);
(gdb) quit
```

Terminal

It’s too slow

In order

- Do not compile in virtual machine
- Are you using make -j(Ncores + 1) to compile on all cores?
- Use rsync -ruv instead of scp for remote copy : it will only copy file that have changed
- Do not rebuild modules if you don’t change modules ! Juste “make ARCH=i386 bzImage -j5” or vice-versa…
- Make shell script to compile your kernel, export variables, install, push files by ssh … and probably another script in the virtual machine to copy thoses files, update initramfs, update grub, … A recompilation should take two or three shell lines from you. I personally pushed the vice to making bash alias which are “s” to launch sshfs and log, “k” to update the kernel and “l” to launch my test program...
- Buy a SSD
- Buy a new processor (Core i5 or i7), but the SSD will make the greatest price/speed tradeoff

Beware of errors !

- Your kernel compiles
  → All .o object files are compiled
- You modify a .c source file and introduce an error
  → All object files are re-generated, except yours
- As the kernel compilation print thousand of lines, you don't see the error
- The kernel is built using the old .o file
- The kernel seems to work…

But if you do a "make ARCH=i386 clean", you won't be able to compile again as your old .o file is not there anymore

Thus, I won't be able to compile…

→ 0 / 20

PC 3

Additional time to compile the kernel, run it, and start project 3 !