

Preliminary Assignment

Recommended due date: not for submission

Website URL: <http://webcourse.cs.technion.ac.il/234123>

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All the questions should be asked at the Piazza [forum](#).

IMPORTANT: This is a simple assignment whose goal is to prepare you for the next assignments in the course. The assignment should not be submitted, and is not graded, but we encourage you to work on it carefully and *not make any shortcuts*. This will prevent you from getting stuck with the basics on the next assignments.

1 Introduction

In this assignment you will compile the Linux kernel. The kernel is the main part of any modern operating system, which includes process management, memory management, file system treatment, input/output subsystem, and many other components. In order to exercise working with the kernel, you will make a small change to the kernel sources, compile it and test it. This assignment should prepare you to the next assignments which will require basic knowledge of kernel compilation.

2 Getting familiar with VMware

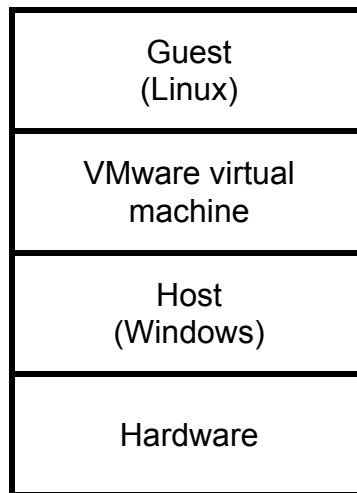
2.1 What is VMware?

Since the kernel is the foundation of the operating system, an error in the kernel's code may render the host computer unusable. Since:

- 1 assignments require you to modify the Linux kernel,
- 2 few of us can write perfect code the first time,
- 3 errors in the kernel can render the machine unusable, and
- 4 we share our lab with people from other courses,

➔ It would be potentially catastrophic for you to modify the actual kernel on one of our lab machines. Also, we don't want to give out the root password on the Linux lab machines.

Instead, we will use the *virtual machine* approach. More precisely, you will run your own personal copy of Linux on top of a virtual machine called **VMware**, which is running on top of Windows that is running directly on your machine's hardware.



In this personal copy of Linux, you will have the root password, and thus be the system administrator, without "endangering" anyone or anything else in the lab.

To work on this assignment, you must thus run VMware, and then boot your own copy of Linux to run on top of VMware. To store your own copy of Linux, we have provided you with what VMware calls a virtual disk – a special file that VMware treats like a disk device. Your virtual disk has been preloaded with a copy of Linux. You may then modify the kernel of this copy of Linux at will.

2.2 Working with VMware

1. Log in to a station with VMware with your regular login and password (A list of stations with VMware can be found on the course website).
2. Copy the folder `c:\vm\linux-234120` to `c:\tempvm`. This folder includes the virtual machine that you will work with. This process might take about 4-5 minutes – be patient.
3. Start VMware.
4. Click File -> Open... go to folder `c:\tempvm\linux-234120` and open file `linux-234120.vmx`.
5. Click "start this virtual machine" (green triangle button) or go to Power menu and choose Power on or press Ctrl-B.
6. *Please ignore requests by VMWare to update the VMWare tools. The updated tools no longer support our linux kernel version.*
7. On login screen type **root**. The password is **234120**.
8. Now Linux is on. In order to shut down the machine use **poweroff** command.

If you're running VMWare on your home computer, you can download the image from the course site with the virtual machine files – just unzip the [file](#) supplied to a directory on your computer, and follow the directions above.

2.3 Shared folder

With shared folders, you can share files between virtual machine (guest) and the host computer. To use shared folders, you must have the current version of VMware Tools installed in the guest operating system (already preinstalled for you) and you must use the Virtual Machine Control Panel to specify which directories are to be shared.

1. Go to Edit menu and choose Virtual Machine Settings (or press Ctrl-D). A dialog window should appear.
2. Click on Options tab in the opened dialog.
3. Click on shared folders.
4. Add the folder where you will hold the files to be shared with the guest machine. These files can be changed kernel source files, screenshots, etc. We suggest setting the shared folder in your home directory (meaning Z:).
5. When Linux is on, the shared folders appear in the /mnt/hgfs folder.

Important: You must save the changed files in the shared folder since the virtual machine you are working on will be deleted after you finish your windows session (i.e. after log off).

3 Kernel compilation

The full explanation of how to compile and install Linux kernel can be found [here](#). We have already compiled kernel for you, so it is not necessary to perform all the steps described in the above manual. Following are brief instructions on how recompile the kernel after you make changes to kernel sources.

1. Sources can be found in `/usr/src/linux-2.4.18-14custom`. All files that you will work with are in this directory.
2. Make your changes to kernel source file(s).
3. Invoke **`cd /usr/src/linux-2.4.18-14custom`**
4. Invoke **`make bzImage`**. The bzImage is the compressed kernel image created with command **`make bzImage`** during kernel compile. The name bzImage stands for "Big Zimage". Both zImage and bzImage are compressed with gzip. The kernel includes a mini-gunzip to uncompress the kernel and boot into it.
5. Invoke **`make modules`**. (Non-obligatory for this HW, but will be necessary in following HW's).
6. Invoke **`make modules_install`**. (Non-obligatory for this HW ,but will be necessary in following HW's).
7. Go to `arch/i386/boot` ('`cd arch/i386/boot`'). Invoke **`cp bzImage /boot/vmlinuz-2.4.18-14custom`**. This command copies kernel image from source directory to `/boot`.
8. Go to `/boot` ('`cd /boot`'). Invoke **`mkinitrd 2.4.18-14custom.img 2.4.18-14custom`** (Non-obligatory for this HW, but will be necessary in following HW's).
9. Invoke **`reboot`**. This command will restart the machine.
10. After rebooting choose "custom kernel" in Grub menu.
11. The system should boot properly with the new kernel.

4 Assignment targets

As we shall study in the following recitations, the operating system command shell runs user programs using the `execv` family of functions (you can learn more about it by running `man execv`). As a consequence, the system call `sys_execve` located in the file `arch/i386/kernel/process.c` is called every time a new program is launched. In order to impress your girl (boy) -friend, you will let the kernel print your id's each time a new program is launched.

You have to add to `sys_execve` a print command that prints the id's of the submitters and the name of the launched program. The printed line should have the format:

```
id1 id2 id3 executing <program name>
```

In order to print from within the kernel use the `printk` function and not `printf`. `printk` is the equivalent of `printf` for kernel code (remember, you can't use libc functions in the kernel).

1. Rebuild the kernel as described in previous section.
2. Test the system. Try to run commands like **ls**, **date** etc. from your text console and make sure that you see the id's line printed. If you are working from graphic environment you should switch to text console with **Ctrl-Alt-Shift-F1**. Press **Alt-F7** to return to graphic mode.

5 Useful Tips

- 1 Refresh your shell skills from MaTaM course.
- 2 Copy/paste in Linux: How do I copy and paste text in Linux? In Linux, to copy text – select it with the left mouse button. The text is automatically copied to the clipboard (you don't need to do Ctrl-c like you do in Windows). To paste the text, click once with the middle mouse button. In case that your mouse has only 2 buttons, middle button can be emulated by simultaneously pressing left and right buttons. In case your mouse has a scroll wheel in the center, this wheel is also a middle button – just press it.
- 3 You can easily create a text file using **cat > filename** command. Use Ctrl-D to finish the input.
- 4 Switching between consoles in Linux: To switch from graphic console to text console you should press Ctrl-Alt-Shift-Fn, where n is a number of console (1...6). To switch from text console to graphic you should press Alt-F7
- 5 Make sure that you run **make** command from `/usr/src/linux-2.4.18-14custom` directory.
- 6 If after the change the system doesn't boot, you can restart and choose

"2.4.18-14" from the Grub menu instead of "custom kernel" and review the changes.

- 7 The simplest method to create a screenshot in VMWare is to choose *File->Capture Screen...* and save the screenshot to a bitmap file which you can print out later.
- 8 Learn the snapshot feature of VMware. This would make your work more effective. You can also use features like drag-and-drop and more using VMWare tools. Consult VMware tutorial for details at:
http://www.vmware.com/pdf/ws45_manual.pdf.
- 9 You can find short emacs description on the course homepage.
- 10 In this assignment, and in all further assignments (except for HW3), you are only allowed to work with RedHat 8 kernel (So we can compile it).

Frequently asked questions:

Q: Which version of VMWare should I use?

A: It doesn't really matter. We have version 4.0.5 in the lab, but if you use newer versions at home it's fine. What is important is that you use the right version of Linux (Red Hat 8.0).

Q: Is it possible to do the exercise without using the CDs from the library?

A: Yes, that's the way it was done in previous semesters. Download Red Hat Linux 8.0, install it on top of VMWare, and use the link that appears in the homework for instructions about compiling the kernel from scratch. However, this will probably take you much more time than using the CD.

Q: Must we use VMWare?

A: No. There are also other similar products, such as Microsoft's Virtual PC 2004, or the free Xen, and you can also try to use a native Linux installation. However, we will not be able to assist you with these products, and problems arising from using such products will not be accepted as an excuse for homework problems or delays of any kind.

Special note regarding installing VMWare in computers that are connected to the dormitories network:

Installing VMWare in computers that are connected to the dormitories computer network has caused network problems previously. To avoid these problems, you **must** apply the following change:

After installing VMWare, run from VMWare group the virtual network editor (*Manage Virtual Networks*). Go to the DHCP tab and stop the DHCP server. make this change permanent (don't start DHCP later).

Failure to shut down the DHCP server will cause connectivity problems for ALL dorms residents!