Goals of this lab:

- Learn how to use UML and mln in the lab.

Prerequisites: None
Exercise 1: Learning about UML

There is quite a lot of information about UML on the web. A good starting point is the UML kernel home page at http://user-mode-linux.sourceforge.net/.

1-1 What is the command to run UML (without extra software, such as mln)?
1-2 What does the mem parameter to the UML command do?
1-3 What is the role of uml_switch?
1-4 Explain, very roughly, the difference between TT mode and SKAS mode.
1-5 What is a user block device?

Report: Answers to the questions above.
Commands you are to run in this lab should be run in a terminal window, which you can start by selecting “Terminal” under the “System Tools” submenu of the main KDE menu (click the K at the bottom left of the screen). If you need help running commands, please contact your lab assistant.

Run the command /home/TDDIO5/bin/setup to set up the files needed for this lab.

The setup script will create a new directory named TDDIO5 in your home directory. Within this directory it will place a directory named mln, which contains data for UML instances (see below), a directory named lab-1, which contains files related to this lab and a directory named lab-2, which contains files for later labs.

When the setup script terminates, it will output the root password to the UML instances. Make a note of this information as you will need it later.

**Time taken 2006:** 0.5-3 hours, average 1.5 hours

**Past problems:** None.

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**Part 1: User-mode Linux and the mln tool**

The system installation lab is a special lab used for courses where root access is needed. To the extent possible we rely on virtual machines for the labs. This allows us to do more with less equipment and allows us to maintain a stable work environment on the workstations.

Access to the system installation lab computers is only available to students registered for courses that use the lab. Others do not have access to the lab. At the end of a course, all disks may be erased; it is your own responsibility to back up any files you wish to keep.

**Introduction to UML and mln**

In this course, all labs will be done using virtual machines. A virtual machine is a virtual computer that runs on top of a physical computer. Virtual machines make it possible to run multiple operating system instances on the same hardware. The different instances are for all intents and purposes independent computers; they just happen to run on the same hardware. Virtual machines are controlled by a virtual machine monitor (VMM). There are two kinds of VMMs. Type I VMMs run directly on the hardware, causing all operating system instances on the hardware to be virtualized. Type II VMMs run in a host operating system, not directly on the hardware, so all virtual machines are dependent on the host.

Our virtual machines are implemented using user-mode Linux (UML), which is a type II VMM. UML is a port of Linux to the Linux system call interface (the hardware-dependent bits of Linux have been replaced by bits that make calls to the host operating system), and allows users to run any number of virtual systems (UML instances) without the need for special privileges. The UML system also includes basic facilities for networking virtual machines.

From a user standpoint, a UML instance is just like a real machine. The work environment very much resembles a situation where a number of machines are connected to a console server and only accessible through a single text console or through the network. To simplify matters a bit, we...
have configured all UML instances to be connected to the host workstation’s network (network interface eth0 on the UML instances and network interface tap1 on the host workstation). This makes it possible to ssh to every UML instance even when routing between the instances is not functional.

To simplify setup of networks of UML instances, we use a tool called mln.

Since the UML instances are stored locally on each workstation, you should use the same workstation in all labs. If you switch workstations, you will either have to use ssh to access the machine where your files are located, or copy the files from that machine, or re-run setup and start over from the beginning.

When you ran the setup script, it generated UML instances for this lab, and printed the root password of the instances it created. If you did not make a note of the root password, erase your TDDI05 directory and follow the instructions at the beginning of this lab again.

Exercise 2: Viewing mln output

2-1 Run ls ~/TDDI05/mln to list the contents of your TDDI05/mln directory. Identify the scripts that are used to start and stop UML instances, and the scripts that are used to set up virtual networking.

2-2 Use the cat command (cat filename) to display the scripts. How much memory do the UML instances have?

Report: The answer to 2-2.

Exercise 3: Using the mln tool

3-1 Run /home/TDDI05/bin/mln start -p lab-1 to start the UML instances.

3-2 Run /home/TDDI05/bin/mln stop -p lab-1 to stop the UML instances.

3-3 Start the UML instances again.

3-4 Run /home/TDDI05/bin/mln stop -p lab-1 -H to halt all UML instances instantly.

3-5 The mln command accepts a number of commands besides start, stop and halt. Run mln with the help argument to display a list. Which commands do you think might be useful during this course?

Report: No report is required for this exercise.

Accessing UML instances

When you start a UML instance using mln, a single window is displayed containing the console of the UML. This console is effectively isolated from the host the UML is running on: you can’t expect a GUI-based program to display on the host when running it in the UML console. Accessing the UML through the console is sufficient when you want to run text-based programs or commands, but not when you want to run a program with a GUI.

In this lab, networking is pre-configured.

Exercise 4: Using user-mode Linux

4-1 Start your UML instances using mln.

4-2 Log in to each UML instance as root using the root password.

4-3 Run ifconfig eth0 to see what IP address each UML instance has on virtual networking.

4-4 Connect to a UML instance from the workstation by using ssh -X -l root ADDRESS, where ADDRESS is the virtual networking address.
Run xlogo in the ssh session you just started and check that a window containing an X-Window System logo appears on your workstation. You can use this method to run any graphical program on the UML instance.

4-6 Shut down your UML instances by issuing the mln stop command (as before).

Report: No report is required for this exercise.

Copying files from UML to the host

Sometimes you will want to copy files from the UMLs to the host workstation (for example, if you want to back up a file or copy it so you can print it). As long as the networking is correctly configured, this is easily accomplished using scp. From the host, you can connect to the service interface of any UML using scp and from the UML, you can connect to the host. Read the man page for scp.

Exercise 5: Using scp to copy files from UML to host

5-1 What command would you use to copy the file /etc/network/interfaces from the UML to the host?

5-2 What command would you use to copy the directory /etc/default (and all its contents) from the UML to the host?

5-3 Start your UMLs and make sure you can copy files both to and from the UMLs.

Report: Answers for 5-1 and 5-2.

Troubleshooting user-mode Linux and mln

Neither UML nor mln are perfect. These are some of the common problems and solutions:

Problem: The computer complains about “resource temporarily unavailable” a lot.

Solution: This seems to be due to an overloaded virtual network. Just ignore the message.

Problem: The windows for the UMLs come up with mln start, but then disappear immediately.

Solution: You probably have UMLs running in the background. Use ps to check for processes named linux (or similar) and uml_switch. Kill them all and try again.

Problem: A UML gets stuck halfway through booting.

Solution: If the UML gets stuck before running any startup scripts (typically right after mounting the root file system), your workstation may be running out of memory. We’re not sure why UML behaves like this. You can fix the problem by reducing the amount of memory allocated to the UML (or to other UMLs). If that doesn’t help, it may help to reboot the workstation.

Problem: A UML reports a memory error (out of memory, 0-page allocation problem etc).

Solution: We don’t know for sure why this happens. We suspect that some of the versions of UML that we are using have a memory leak, because stopping the UMLs and restarting them sometimes helps. If that doesn’t help, stop your UMLs, increase the amount of memory that is allocated to the troublesome UML instance and restart. That usually solves the problem. You can also try adding virtual memory to the UML instances.

Problem: mln claims that I already have UML instances started, but I don’t!

Solution: First of all, double-check that you really don’t have any UML instances already running. Use the ps command and look for processes named linux (or similar). Kill them all and try again.

If you really don’t have any UML instances running, it is likely that you terminated your UMLs abruptly (e.g. by logging out without stopping them). In such cases, mln often leaves files behind, which are later used to determine if UML instances are running. To
solve the problem, use the mln clean command (e.g. /home/TDDIO5/bin/mln clean -p lab-2).

If that doesn’t help, clean up the mln files manually by locating the run-time files that mln uses (~/TDDIO5/mln/LABNAME/uml_dir/INSTANCENAME), and deleting them. The following command cleans up all mln files for lab 2:

```
rm -rf ~/TDDIO5/mln/lab-2/uml_dir/*/*
```

Make sure you don’t delete the directories directly under the uml_dir directory (there is one for each UML instance).

⚠️ If you update the start scripts (e.g. to add more memory) ensure that you clean up any backup files that are created and that you do not introduce any stray line breaks in the files. Stray backup files and line breaks tend to result in weird behavior when you try to start your UMLs again.
Complete this feedback form individually at the end of the lab and hand it to the lab assistant when you finish. Your feedback is essential for improving the labs. Each student should hand in a feedback form. Do not cooperate on completing the form.

You do not need to put your name on the feedback form. Your feedback will be evaluated the same way regardless of whether your name is on it or not. Your name is valuable to us in case you have made and comments in the last section that need clarifications or otherwise warrant a follow-up.

For each section, please rate the following (range 1 to 5 in all cases).

- **Difficulty**: Rate the degree of difficulty (1=too easy, 5=too difficult)
- **Learning**: Rate your learning experience (1=learned nothing, 5=learned a lot).
- **Interest**: Rate your interest level after completing the part (1=no interest, 5=high interest).
- **Time**: How long did the part take to complete (in minutes)?

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Please answer the following questions:

- What did you like about this lab?
- What did you dislike about this lab?
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