INR + LS Lab Assignment: Virtualization*

Arno Bakker
Arno.Bakker@os3.nl

Jeroen van der Ham

Feedback deadline:
November 9, 2017 10:00 CET

Abstract

Virtual machines (VMs) and virtual networks are a great tool for conducting network experiments. In this lab session you will get familiar with Xen. Xen is a hypervisor which supports both para-virtualization and hardware assisted virtualization. To make installation and configuration easy, you will use precompiled packages provided by the Linux distribution. Before starting fully read this document to get an overview of what is to come. Explain and describe every step you took to solve each task.

Preparing the environment

During this lab assignment, you might have to reinstall your server. Backup all data you want to preserve before continuing this lab assignment! If you want to deviate in any way from the suggested setup, you are allowed to do so as long as you first consult with the lab teacher and explain your reason and describe the changes on your wiki. Note that if you are using a non-standard setup, you will not receive any help in debugging any problems that might occur! You may not replace Xen for another virtualization stack (KVM, VMware, HyperV).

Task 1. Make sure that Ubuntu 16.04.3 64-bit is installed on your server. Use the PXE service to start the installation process if needed. Partition your disks such that you have at least 200 GB of unpartitioned space.

Task 2. *Briefly* explain what you think is the main difference between a 32-bit and a 64-bit *operating system*.

Logical Volume Management

LVM (*Logical Volume Managment*) Hasenstein [2001] allows the grouping of storage resources, called *physical volumes*, into larger pools called *volume groups*. Each volume group can be then partitioned just as if it would be a single large drive. These partitions are called *logical volumes*. There are a lot of advantages of using LVM over the basic storage approach. LVM can be also combined with RAID solutions to provide resilience or to increase performance.

*Based on an earlier document by Cosmin Dumitru and Naod Jebessa. Version October 31, 2017.

Task 3. Install the **lvm2** package and create a physical volume using 100 GB of the 200 GB free space reserved before. On top of the physical volume create a volume group called `VolumeGroupXen`. Here you will store the virtual machine images. We will create the logical volumes later.
Hints: `pvcreate, vgcreate, pvdisplay`.

Installing Xen

Before starting with Xen, make sure that you have some idea of how this works. Please read through `http://wiki.xen.org/wiki/Xen_Overview` and familiarize yourself with the terminology and the general concepts.

A Xen installation includes the Xen hypervisor and a set of tools that allow the administrator to configure and manage virtualization specific aspects of the system. Xen can be configured using multiple tool stacks and `http://wiki.Xen.org/wiki/Choice_of_Toolstacks` provides an overview of their features and advantages. We will be using the `xl` tool stack.

Task 4. Install the **xen-hypervisor-4.6-amd64** package and, if needed, configure the system such that the Xen kernel is booted by default. Check with `dmesg` whether the correct kernel booted after rebooting.
Hint: *Like all Debian based systems, Ubuntu stores in /etc/default settings that the user is likely to change*[1]*. Do not forget to run update-grub after changing the bootloader config files.*

You can test that your Xen installation is fully functional by issuing `xl info` and `xl list`.

Networking

The goal of the next set of tasks is to create the networking environment for your virtual machines. First, we create an virtual Ethernet network to which the VMs will be connected. In Linux we can create such a network using a virtual Ethernet bridge.

Task 5. Install `bridge-utils` and use `brctl` to manually create a bridge named `xenbr0`. Do not add any interfaces to it; we will use routing instead of switching to connect the VMs to the Internet.

Task 6. When creating the bridge, Linux will also create a network interface called `xenbr0` that connects your server to that bridge. The IPv4 addresses to use for your VMs are those in the /28 subnet which is routed to your server (see SNE students mailing list). Assign the first free IPv4 address from your /28 subnet to this `xenbr0` network interface using `ifconfig`. The first free address is your subnet is the address at the start of the range plus 1. The starting address of the range is reserved to act as a network address (e.g. 145.100.104.0) in currrent Internet practice. The last address in the range is reserved to act as the broadcast address (see RFC3021). The address you assign will act as the IP gateway address for your virtual machines.

Task 7. Test whether you can reach the address on the bridge interface from outside of your machine. You may have to enable IPv4 and IPv6 routing (*Hint: `sysctl.conf`*). Make sure that you test using `ping -n` from your workstation or any other machine connected to the Internet. Note that reverse DNS for your /28 subnet is also delegated to you. *Make sure you don't have any firewall filters that prevent forwarding IP traffic.*

[1] http://www.debian.org/doc/debian-policy/ch-opersys.html

Task 8. Edit `/etc/network/interfaces` such that `xenbr0` will persist across system reboots. Use the Debian/Ubuntu way!
(Hint: `man bridge-utils-interfaces`)

Xen will detect the `xenbr0` bridge and will automatically connect new virtual machines to it, creating a virtual Ethernet network.

Xen Virtual Machines

Task 9. Install `xen-tools` and use `xen-create-image` to create a Ubuntu virtual machine that has the following characteristics:

- Hostname: **Guest-01**
- RAM: 1024MB
- Disk size: 10GB
- Swap size: 1024MB
- VolumeGroup: VolumeGroupXen
- Distribution: Ubuntu Xenial (Hint: use the right mirror)
- Filesystem: ext3
- Virtual CPUs: 2
- IP: an IP from your own range

Hint: You might find useful to inspect the man page of `xen-create-image` and the contents of `/etc/xen-tools`. Customize `xen-tools.conf` to provide valid network settings so that every newly created virtual machine image will be able to use the bridge that you've created in the previous steps. Also make sure that you can set the root password interactively.
Note this virtual machine will be reachable from the Internet, so don't use dummy passwords and protect your ssh daemon (man hosts.allow).

If all goes well, you will find a configuration file called **Guest-01.cfg** placed in `/etc/xen`. Have a look at its contents.

Task 10. The MAC address starts with `00:16:3E`. Explain why this prefix is used.

Task 11. Start the virtual machine and login to its console and test network connectivity *Hint `xl console hostname`*. Exit by hitting `CTRL + ]`

Task 12. Use `xl` to find information about the running VM and then stop it and start it again.

Task 13. Configure your system such that **Guest-01** is auto-started after a reboot.

Task 14. Briefly explain the following terms: DomU, Dom0, PCI pass-through. Which is which in your situation? Is PCI pass-through used, and if so for what?

Task 15. Is **Guest-01** a fully or a para-virtualized guest? Explain.

Task 16. `deboostrap`, `rinse` and `rpmstrap` can be used to aid in the creation of virtual machine images. In fact, `xen-create-image` can use all of them under the hood. When would you use one over the others?

Task 17. User Mode Linux (Dike [2001]) is another approach to virtualization. Write a short paragraph highlighting at least two differences and two similarities between Xen and UML.

Task 18. How do you think that the virtual machine communicates with the outside network in your setup? Draw a simple network diagram showing at least the network cards, the bridges and any routers that might be present. Don't forget to label everything with IP addresses and names.

References

J. Dike. User-mode linux. In *Proceedings of the 5th annual Linux Showcase & Conference - Volume 5*, pages 2–2, Berkeley, CA, USA, 2001. USENIX Association. URL `https://lwn.net/2001/features/OLS/pdf/pdf/uml.pdf`.

M. Hasenstein. The logical volume manager (lvm). `http://sites.google.com/site/wwwzhy/SuSELVMwhitePaper.pdf`, 2001.