

# OSS Case Study

## *Virtualization with Xen 3.1*

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**Type of solution: (Desktop, Infrastructure, Application)**

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Infrastructure

## Agency Background

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UiTM is Malaysia's premier institution of higher learning that has experienced a phenomenal growth since its inception in 1956. The university has expanded nationwide with 3 satellite campuses, 12 branch campuses, 8 city campuses, 19 affiliated colleges and a smart campus for the future. Its formation is based on a vision of outstanding scholarship and academic excellence that is capable in providing leadership in all fields of internationally recognized professional study. This serves as catalyst for greater strides in the development of the university and the nation.

### Faculty Mission

The mission of the faculty is to strengthen, increase and deploy learning activities, teaching and research in information technology and quantitative sciences field that suite the country's need. Currently, FTMSK consists of 350 lecturers, which include 35 administrative staffs.

### Principle Objectives of the Project

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The project has been setup for the purpose of education in university level specifically for Data Communications and Networking students. To be able to teach students effectively in communications courses need expensive hardware and software such as servers, workstations, network operating system and networking devices. Besides, students still have to go to computer labs to practice their skills and do hands on jobs. Hence, this project aim to teach students in various courses in Data Communications and Networking program especially courses that encompass communications and operating systems in efficient way with a minimum cost.

### Key Partners

1. Lecturers who teach 'Data Communications and Networking' program, coded as CS225.

Role: Act as the provider to supply information, syllabus and knowledge that can be input to setup this project.

2. Lab technician who manage the computer lab.

Role: Give information and guidelines on how to engage experiments in communications and networking using real networking devices. This information can form the significance of the project.

3. Students from Data Communications and Networking Program.

Role: Provide non-technical information such as right attitude and motivations to learn courses in Data Communications and Networking. They are also needed to testify this project towards its enhancement in the future.

### Primary OSS Technologies

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There were two primary OSS technologies used to setup this project; openSUSE 10.3 and Xen 3.1. Both of them were widely used by OSS communities and has great reputation. Beside that, they had provided good technical support for those who were interested to deploy and test their products.

#### openSUSE 10.3

openSUSE is a community project sponsored by Novell and AMD to develop and maintain a general purpose Linux distribution. After acquiring SUSE Linux in January 2004, Novell decided to release the SUSE Linux

Professional product as 100% open source project, involving the community in the development process. The current stable release is version openSUSE 10.3. Like other distributions, it includes both a default graphical user interface (GUI) and a command line interface option. It allow the users to select which GUI they are comfortable with (either KDE, GNOME and XFCE), and supports thousand of software packages across the full range of open source development.

### Xen 3.1

Xen is a free software virtual machine monitor for IA-32, X86, and, IA-64 architectures. It allows several guest operating systems to be executed on the same computer hardware at the same time. A Xen system is structured with the Xen hypervisor as the lowest and most privileged layer. Above this layer are one or more guest operating systems, which the hypervisor schedules across the physical CPUs. The first guest operating system called in Xen terminology "domain 0" (dom0) is booted automatically when the hypervisor boots and given special management privileges and direct access to the physical hardware. The system administrator logs into dom0 in order to start any further guest operating systems, called "domainU" (domU) in Xen terminology.

After a long development phase, Xen reaches state 3.1 (previously labeled as 3.0.5) and gains some interesting features:

- i. XenAPI (Providing support for virtual lab management capabilities and configuration metadata).
- ii. Dynamic memory control for non-para-virtualization virtual machines (windows).
- iii. Support for basic save/restore/migrate operations for non-para-virtualization virtual machines (windows)
- iv. Support for 32 bit para-virtualization guest.
- v. Support for virtual disks on row partitions.

## Design Specifications

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Xen use para-virtualization concept in its design. Instead of emulating a full virtual machine, para-virtualization software provides an Application Programming Interface (API), which is used by the guest operating systems to access hardware resources. This requires that the guest operating system is aware that it runs in a virtual machine and needs to know how to access the API. Para-virtualization has several advantages when compared to full virtualization. One of them is the ability to modify resource allocation. As for example, Xen can change the memory allocation of a virtual machine on the fly without any reboot. Figure 1.0 shows the schematic diagram para-virtulaization concept layers.

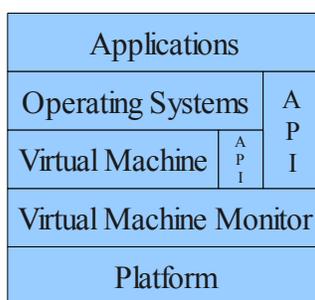


Figure 1.0 : Para-virtualization concept layers

Xen consists of two major components; virtual machine monitor and xen tools. The virtual machine monitor forms a layer between physical hardware and virtual machines. In general, this kind of software is called a *Hypervisor*. Whereas, the Xen tools are a set of command line applications used to administer virtual machines. The virtual machine monitor must be loaded before any of the virtual machines are started. When working with

Xen, virtual machines are called *domains*. The Xen virtual machine monitor includes neither any drivers to access the physical hardware of the host machine nor an interface to communicate directly with an administrator. These tasks are performed by an operating system running in the privilege domain0. The following figure 2.0 is an overview of a Xen system with three domains.

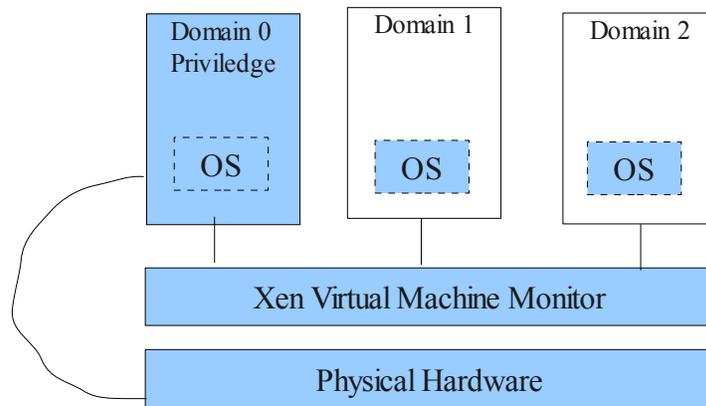


Figure 2.0: Xen System With 3 Domains

A process called *xend* runs in the domain0 Linux installation. This process is used to manage all Xen domains running on a system and to provide access to their consoles. In the Xen terminology, an unprivileged domain is also called domainU. openSUSE 10.3 can be used for privilege (*domain0*) an unprivileged (*domainU*) Xen domains.

## Usage Model

This project is intended for lecturers who teach courses related to communications, system administration and operating system for a BSc degree program called 'Data Communications and Networking', CS225. Even though this project is not compulsory to be used by respective lecturers but many of them found it was interesting and easy to demonstrate some of computer networking concepts. Those who want to use this project, usually will be given a simple training on how to install Xen 3.1 on openSUSE 10.3 Linux distribution. The participants will also receive a DVD consists of openSUSE 10.3 and complete Xen packages together with training notes. Usually a one day training is enough to provide lecturers with necessary information and make them ready to implement this project in their classes. However they can request for extra training if they feel that they still need to be trained. This project afterward will be duplicated to students to make sure its objectives of having efficiently learned courses related to communications and operating system concepts is achieved.

## System Overview

Generally x86 compatible computers can run openSUSE 10.3 but for Xen 3.1, the machine architecture should have a "P6" or newer processor. The multiprocessor machines are supported including basic support for Hyper-Threading (SMT). Support for x86/64 is available since Xen 3.0. In addition a port to the IA64 architecture is approaching completion. Xen also can run on laptops, but there is currently no support for APM or ACPI, hence the user will experience reduced battery life and no suspend/resume.

## Reasons for using OSS

The openSUSE 10.3 and xen 3.1 has been chosen due to minimum cost and provide great features from desktop applications to security and networking tools. The customization can be made since the software

opened its source code thus promoting new ideas and concept. Additionally, many supports can be found on the Internet making them more interesting and easy to be used.

## **How OSS provide solution for agency needs**

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Lecturers were not having difficulty to teach students about the concept of computer networking as well as operating systems theoretically but when it comes to practicality or showing how the concepts worked, lecturers had some limitations to demonstrate their knowledge. The limitations is not because lecturers are not having enough knowledge or skills but they need specific software and hardware such as servers and workstations to show to students of how computer networking can be implemented. Furthermore they also need networking devices such as router, switches, hubs, cables and others to support the demonstration. These materials are not cheap and the university cannot afford to allocate such equipments for each of students for them to handle experiments. In addition, lecturers need also to try various network operating system and supply the students with the correct information. Moreover, it is very expensive to buy proprietary network operating system and the approval process may take longer time. However, with the new technology of virtualization, the problem mentioned previously can be overcome. The open source operating system whether for desktop or server solution comes with very minimum cost and in fact almost all of them are free to be downloaded. The charge is normally for the customer who is looking for technical support. Regarding the virtualization technology, it allows many operating system to be installed in one single machines and harnessing the virtual network adapter to implement the concept of computer networking. As a result, lecturers can easily demonstrating the theory of computer networks or operating systems as well as system administration to the students using virtualization technology such as Xen on top of openSUSE Linux distribution, as domain0.

## **Innovation**

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At one side, there is no specific innovation has been made since this project was using openSUSE Linux and Xen to be customized. The openSUSE 10.3 operating system and Xen 3.1 packages can be downloaded freely from the Internet. However, on the other side, the method of how to present the knowledge of computer networking, client-server, system administration, operating systems and many more related courses to students that being used by respective lecturers can also be considered as innovation. As for example, the steps by steps procedures of how to communicate between multiple clients that use heterogeneous operating system with a single server is sort of useful innovation to people especially newbies in that area.

## **Impact**

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This project has contributed new and great teaching tools to lecturers especially to those who are teaching courses for BSc Data Communications and Networking students. Additionally, it has helped many students specifically in this program to practice their computer networking skills using their own PCs or laptops without concerning to go to computer lab. Furthermore, lecturers as well as students also utilize this project to study the knowledge of Network Security to get prepared for the Hacking Competition which being held in UiTM yearly since 2005.

## **Learning Experiences**

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Installing Xen 3.1 packages from the openSUSE 10.3 platform is not an easy task but yet not so difficult for users. There are differences between Xen application and VMWare application especially when we installed many operating systems and run them simultaneously which shown that Xen has better performance. However the drawback that we had figured out shown that the guest operating system needs to be modified to run with Xen.

## **Current Status of Project**

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This project has been used for one semester (January 2008 - April 2008) by lecturers from the Department of Computer Technology and Networking as well as some students from the BSc Data Communications and Networking program.

## **Testimonials**

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The following lecturers can provide testimonials of the project:

1. Mohammad Yusof bin Darus

Position: Lecturer, Contact Number: 03-55211139

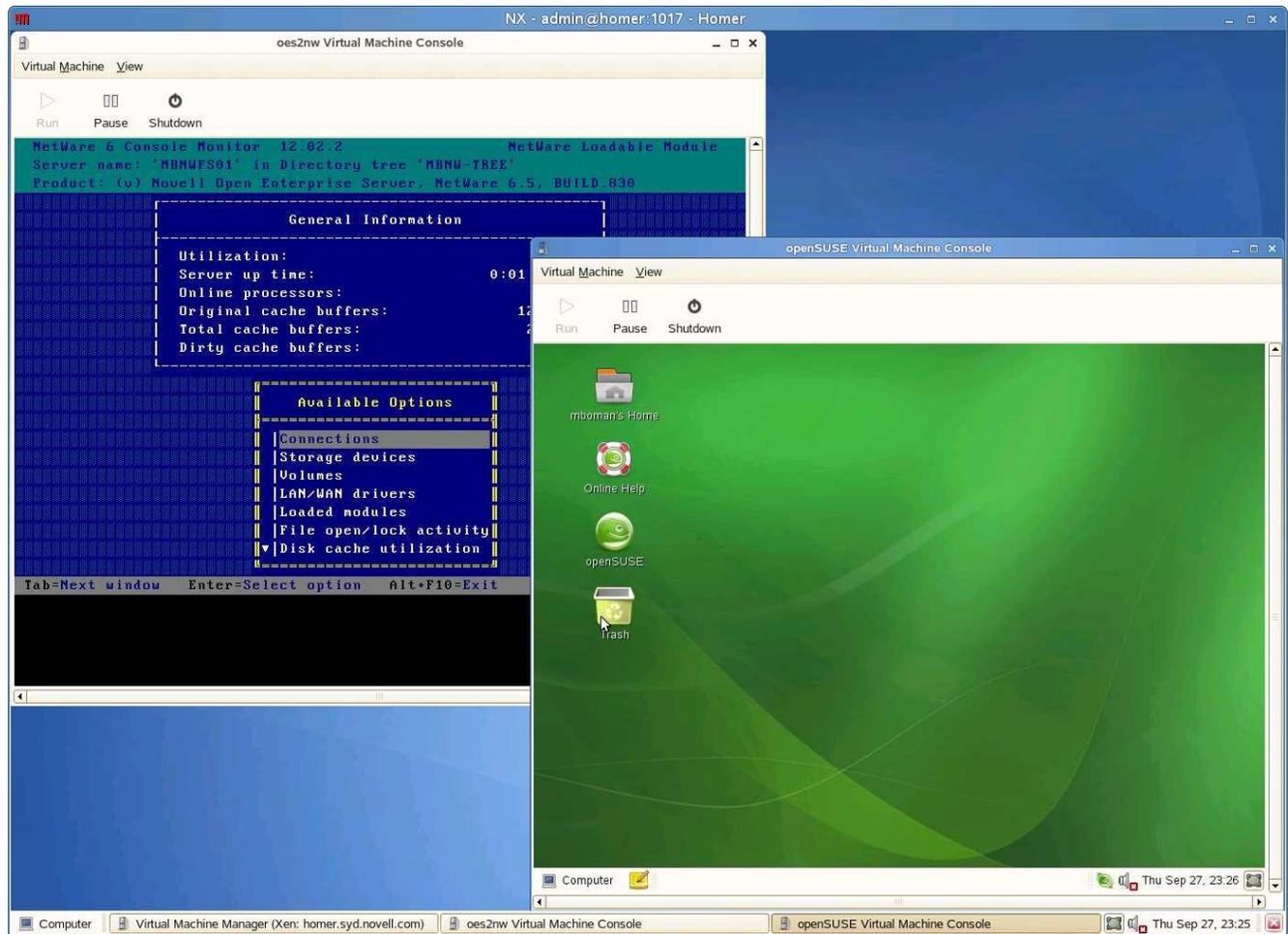
2. Zarina bt Zainol

Position: Lecturer, Contact Number: 03-55211108

3. Norkhusaini Awang

Position: Lecturer, Contact Number: 03-55211108

## Please share any other relevant information.



## Knowledge Products

1. Information about Xen can be found at <http://xen.org/>
2. Information about openSUSE can be found at <http://en.opensuse.org/>
3. Training notes to provided at website.