## Environment

We are using VMware Workstation to provide us with a number of machines running a variety of operating systems. VMware Workstation is a virtualisation environment that allows us to run one or more virtual machines on a single host workstation. The virtual machines may communicate with each other on a virtual LAN segment (subnet), they may also communicate with the outside world by using NAT and the host machine’s IP address. The host workstation must be a powerful PC with several processors and plenty of RAM. Any machine with 4 processors and 4GB of memory available to the OS will run the required software, albeit a little slowly, particularly the Ubuntu server.

The setup for these labs involves one Linux machine running Ubuntu V14.04 and two Windows PCs running Windows PE. Students should be familiar with working with these machines/operating systems before attempting these labs.

Ubuntu 14.04 is an LTS of the OS, but not the latest LTS. The latest is 16.04 LTS and 17.10 Is now releeased (19/10/2017), but not an LTS. We are using the older one because it is fine for this environment.

Windows PE is a special edition of the Windows OS and is not intended as a primary user OS, has minimal services and cannot run the usual windows packages. We are using it because it is lightweight, it runs in only 256MB (instead of 1GB as expected for most other Windows OS). This makes it suitable for our lab work as we are using it only to test the functionality of our Ubuntu Server installations. Windows PE has been configured with a Terminal and a QTWeb web browser on each of the two Windows PE machines. The QTWeb browser is a lightweight, fast, secure and portable browser.

## Copying the VMs and getting VMWare

You must install the VMs for this set of exercises by copying the required files thus…

robocopy  d:\bstone  d:\virtual\your-dir-name  /e

When you copy the "d:\bstone" folder into the "*virtual*" folder. The user account which copies the files will have full access to the copied folder - all other accounts/user will have no access. You therefore must sit at the same computer every week.

You may also copy the original Virtual machines from the hard disks in L125 and work on them in your own time, bringing your work to the lab to have it graded.

To do this use *robocopy* as above but with a different target, your own HD. This is a file copying and management program developed by Microsoft and is more reliable than drag & drop file copying. It handles large amounts of data well. Instructions on how to use it are given from the command line with simple and more complex options available. For simple instructions just type *robocopy* at the command prompt.

It is highly recommended to have an external hard disk with a USB 3 interface for rapid copying of files for you to work on in your own time. USB 3 interfaces very fast and are distinguished by the colour of the insert in the connector and shape of the disk connector shown below. They will run at much the same speed as an internal hard disk.

You may also get a copy of VMWare Workstation for free. For instructions on how to get it, go to…

<http://www.computing.dcu.ie/contact/technical-support/microsoft-imagine-vmware-webstores>

There is a shopping basket, but in this shop, everything is €0.

## Our Setup

The UbuntuServer is configured with two Ethernet cards. One card is connected to the outside world using NAT between the host PC and the VMWare hosted UbuntuServer. This connection works much the same as your PC at home, getting its address from the DHCP server on your Internet provider’s hardware and then using NAT to gain access to the outside world. The VMWare hosting software is thus taking the place of the “box” that is provided to you by your ISP. This connection is used for downloading software from the Internet to be used in these labs. The second Ethernet card is connected to a virtual network (**LAN Segment 1**) managed by the VMWare Workstation software. We aim to have all of our virtual machines connected to this virtual network.

Virtual NIC

Virtual NIC

Virtual NIC

WINPE1

Host PC

NIC

WINPE2

Internet

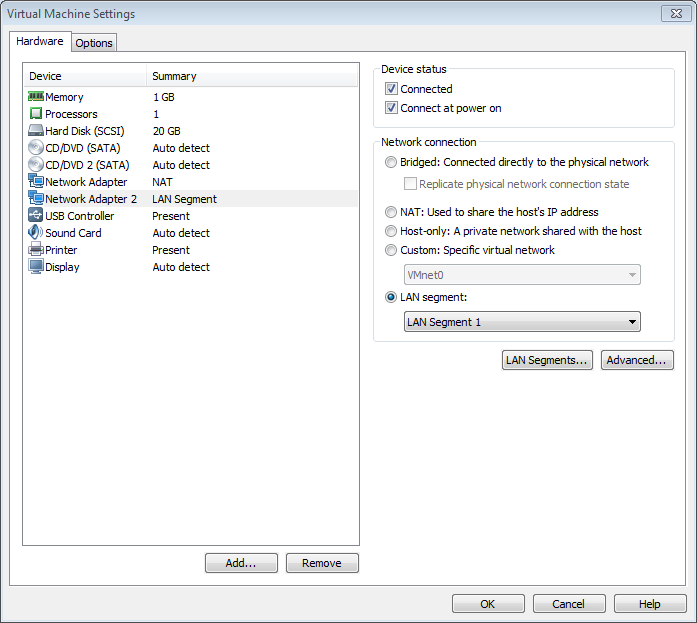
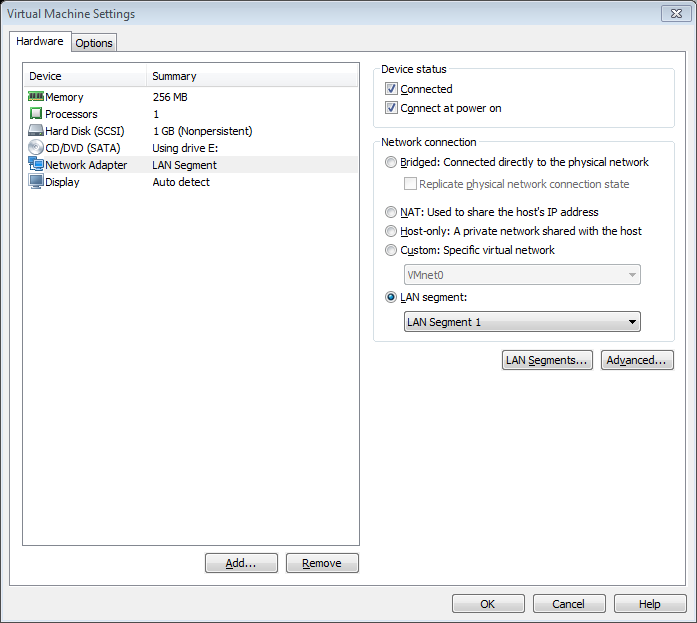
LAN Segment 1

UbuntuServer communicates with outside world on eth0 interface via NAT on the host PC. It communicates on LAN Segment 1 over the eth1 interface.

VMWare environment

UbuntuServer

You can see this if you look at the settings for each VM by right clicking on any of the VMs listed on the left pane of the VMWare Workstation window as below. Note that the virtual machines are all attached to the virtual LAN, **Lan Segment 1**, and that the Ubuntu machine has a network adaptor which uses NAT. The former connects the Ubuntu Server to the outside world and the latter to the WINPE1 And WINPE2 machines.



## Aims

In this lab we set out to establish a DHCP server on the Linux machine, UbuntuServer, and have the Windows PCs contact it for their IP addresses and other information to allow them to operate on the network.

There are two ways of allocating addresses. The first is the way that you get an address when you log into the DCU network, or the network at home with your laptop. You are assigned an address from a range or pool of addresses that this DHCP server can give to visitors to the network. So when you join the network today you will probably get a different address to the one you had yesterday. This is called a dynamic address.

The other way of getting an address is get the same address every time that you join the network. This means that nobody else can be given that IP address. This is called a reserved address. This method of address allocation is useful when a server of some sort wishes to join the network. A server must have an address well known to those wishing to use its services if it is to be visible on the network. This IP address may be used to map to a URL on a DNS server. This IP address should always map to this machine so that when the machine becomes active, the URL is bound to the same IP address every time. For instance the [www.dcu.ie](http://www.dcu.ie) URL always maps to 136.206.1.4, even when using DHCP unless an administrator changes this mapping. If that happens, then the DNS entry will have to be changed, more of this in the next lab on DNS.

You will be allocating both reserved and dynamic addresses in this lab.

## Words of warning

* Do not close the WindowsPE Command prompt or the QTWeb browser.
* Your mouse will get “stuck” in the VMWare window, to release it and get it to the host machine, simultaneously press the “Ctrl” key and the “Alt” key on the keyboard.
* Work on the same machine each week, your previous VMs will be there. If you work from your own machine, make sure you have backups.

## Marking

Each lab is graded out of 5 marks. For this lab, the marking is as follows…

* Part 1: 0 marks
* Part 2: 1 mark
* Part 3: 2 marks
* Part 4: 2 marks

## Procedure

1. First we establish the working virtual environment.
2. Download the Linux software required for the lab.
3. Configure the network interface for the DHCP server
4. Configure the UbuntuServer as the DHCP server
5. Configure the Windows PCs as DHCP clients, one dynamic address and one reserved address.
6. Test the environments for DHCP operation, testing and debugging problems as you go.

Please note any problems that you have along the way and mention them to the lab tutor or me when examined.

## Tools

Sudo will give you elevated privileges to run commands. On Ubuntu, these privileges are highly restricted. You may need to invoke elevated privileges by typing sudo ifconfig, this will allow access to sudo for a short while. You will probably need to do this every few minutes during the lab. A painful work-around, but it does work.

Ipconfig (on Windows) and ifconfig (on Linux) will show us the network configuration on our VMs. On the Windows machines we can also control the acquisition and renewal of IP addresses and display other network information.

Checking Syslog is very useful to help you understand why things are not working. Print out the last part of the syslog file with the following to see why something is not working…

* tail /var/log/syslog

Check out the tail command on the man pages in linux.

* Type man tail to find out how tail works

The man pages are a useful source of information on how things work, for instance

## DHCP configuration file

* man dhcpd.conf

This will list information on the configuration file for DHCP daemon configuration.

Web pages at help.ubuntu.com have all the help you will need to help you to download the software, configure the server, edit files and stare/stop the server as you progress.

## Getting started

1. Power up the host PC and select Windows. Login as usual into the machine.
2. Launch VMWare Workstation from the start menu.
3. There are three virtual machines to work with on this exercise, the UbuntuServer (a Linux VM) and two Windows PCs, named WINPE1 and WINPE2. Power up each of these machines in turn, one at a time and wait until the previous one is active before powering on the next.
   1. If you are asked if you moved or copied any of the VMs, say “**I moved it**”. Anything else will screw up your VM and you will waste a LOT of time undoing the damage. You will probably run out of time and not get a grade for the lab.
   2. **Cance**l any other messages as they come by.
4. The UbuntuServer has an account set up on it with
   1. Username: student
   2. Password: **computing** (all lower case)

# Part 1: Installing the DHCP server on UbuntuServer

We have to get the server software from the Internet. To do this we use the apt-get command. We first make sure that all of our packages are up to date and then proceed to download the DHCP server software. It is important to do this update as it will help avoid conflicts between packages.

* sudo apt-get update
* sudo apt-get install isc-dhcp-server

Here we are using the ISC DHCP server. The software is downloaded and installed by the apt-get package manger. We can use apt-get to install/uninstall all packages on the Linux system.

# Part 2: Setup the IP address for the UbuntuServer DHCP server

You will shortly need to change the default configuration by editing /etc/dhcp/dhcpd.conf to suit your needs and particular configuration.

First though, you also need to edit /etc/default/isc-dhcp-server to specify the interfaces that the daemon dhcpd should listen to (& to do this as a background process)sudo /etc.

sudo gedit /etc/default/isc-dhcp-server &

By default it listens to eth0. We want to make it listen on **eth1**, as eth0 is used to interface the Ubuntu VM to the Internet via the host PC. Without this, the DHCP server would not know which interface to listen on. It must have a static IP address from which it can serve up IP addresses to client machines on the network. If you use eth1 (as we do here) for providing addresses in the 192.168.10.x subnet then you should assign for instance IP 192.168.10.1 to the eth1 interface using [NetworkManager](https://help.ubuntu.com/community/NetworkManager), available on the top right hand side of the Ubunmtu window, the up/down arrows, click it and “edit connections”. Without this step you will get an error from DHCP when starting the service. In our case we are using an IP address of 192.168.10.0 for our virtual network, the UbuntuServer will reside at 192.168.10.1 with the following other configurations…

* server address: 192.168.10.1
* netmask: 255.255.255.240
* broadcast address: 192.168.10.15

When you have set up the interface you can test it with the ifconfig command with the –a switch set. It should give you back the information that you put into the network manager interface.

* ifconfig –a

Question!

* What is the CIDR notation for the UbuntuServer IP address?
  + [Hint: look at the netmask].

# Part 3: Dynamic DCHP address assignment

The network interface, eth1, is now ready to have the server use it to listen for DHCP requests. We now setup the server to listen on this newly configured interface by editing the configuration files that the server will use.

Before we do that…

The web pages under help.ubuntu.com will help you to edit the dhcpd.conf file. The file looks something like this (your IP addresses and masks are different)…

# minimal sample /etc/dhcp/dhcpd.conf

default-lease-time 600;

max-lease-time 7200;

subnet 192.168.1.0 netmask 255.255.255.0 {

range 192.168.1.150 192.168.1.200;

option routers 192.168.1.254;

option domain-name-servers 192.168.1.1, 192.168.1.2;

option domain-name "mydomain.example";

}

See the web page for an explanation of what each line means.

**IMPORTANT**: before you edit this file **make a backup** of the old dhcpd.conf file into something like dhcpd.conf.old in case you make any errors while editing this file. You will have this to fall back on.

We want a configuration to fit the following

* subnet: 192.168.10.0
* mask: 255.255.255.240
* IP address range: 192.168.10.2 to 192.168.10.7
* Router address: 192.168.10.1
* Domain name: Computing.org

Save this configuration. **Make sure you understand the mask and what its importance is!**

You are now ready to launch the server. Have it attach to the eth1 interface and get ready for incoming DHCP requests. You can do this by issuing the following command (remember you probably need to enable sudo by issuing sudo ifconfig beforehand).

sudo /etc/init.d/isc-dhcp-server restart

To test this, switch to a Windows PC, from a command window issue the following commands…

* ipconfig /all
  + This will show you the current IP address and configuration for this PC before we contact the new DHCP server. Note the IP address.
* ipconfig /release
  + This will release the IP address from this machine and if you issue the ipconfig command again you should see the address 0.0.0.0.
* ipconfig /renew
  + This will issue a DHCP request, it will be seen by the server and they will interact to give a new IP address and other network configuration info to the client. Note the IP address.

# Par4 : Reserved address assignment

We will assign a reserved address to the Machine called WINPE2. To do this we need to make a link between the MAC address of the network card on WINPE2 and an IP address. This will allow the server to dole out the same IP address to the machine with that MAC address. You can find this out by using ipconfig on WINPE2.

Re-edit the /etc/dhcp/dhcpd.conf file with this information. Remember the reserved address must not come from the addresses that are in the pooled range or any other address currently in use. It must though come from the same subnet. Check your mask. You will need to specify the following information in the dhcpd.conf file.

* MAC address of WINPE2 (6 byte number)
* The reserved address, 192.168.10.11 (just outside of the pooled addresses)
* Router 192.168.10.1
* Default lease time of 5 mins.
* Domain name is Computing.org
* Domain name server (DNS) IP address 192.168.10.1

Note: we are covering DNS server configuration in a later lab. If you omit this, then you will have to do this before your DNS will work.

Now restart the server again on the UbuntuServer, make sure it started OK, otherwise check /var/log/syslog for errors.

* ipconfig /release
* ipconfig/renew/
* check the IP address allocation for WINPE2.

**Make sure you demonstrate your work before leaving the lab, marks will not be allocated at a later date.**

## Finally

Having completed the task for the lab, tested it and demonstrated to the tutors.

* Power down each of the virtual machines one-by-one. Use the usual “Start” menu ball at the bottom left of the Windows interface.
* Power down the Ubuntu machine with the cog at the top right corner of the Ubuntu interface.
* Close the VMWare Workstation software and logout of the host machine.
* Take backups of you work using ***robocopy***, preferably onto a removable USB 3.0 disk as mentioned above.

Never omit to power down the VMs in this way as the work you do in one week will form the basis of the lab for the following week. Your work done may be lost otherwise and you will have to start from scratch and redo the previous week’s work or reinstall a backup in order to progress to successive weeks.

# The End