ITS 332 Networking Lab

Layer 2 Networking

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1 Overview

The simplest computer network that can be created connects two computers directly together via cable (that is, a peer-to-peer network). Creating such a network will introduce you to the methods for physically connecting computers (including cable types), and configuring interfaces for computers to be on the same network.

A more useful, and much more common network is a switched Ethernet LAN, where multiple computers are connected to a switch. You will setup your own LAN, configuring all computers on the network.

This lab concentrates on Layer 2 network technologies, in particular Ethernet. The next lab will look at Layer 3 networks, that is, joining two or more Layer 2 networks together using IP routers.

2 Working in Pairs and Groups

For the peer-to-peer network you work in pairs, as per your seat numbers, e.g. seat 1 works with seat 2, seat 3 works with seat 4, . . ., seat 35 works with seat 36. If your partner is not present (or does not exist), see the instructors.

For the switched network you work in a group of 4, forming a group with the nearest 4 seats next to you (e.g. 1 to 4).

In all cases of working with others, you should share the tasks and make sure all members of the group understand the tasks being performed. Remember, the knowledge from the tasks will be tested in the exams, where you must work individually.

3 Peer-to-Peer Networks

3.1 Background

The simplest network is one that connects two computers together, usually directly via a cable. This requires both computers to use the same Layer 2 network technology, with common options being Ethernet, a serial link, Wireless LAN or Bluetooth.

Connecting two computers with a cable (e.g. Ethernet or serial link) is mainly useful for simple demonstrations (like this lab), simple, high speed file transfer and for troubleshooting. As an example of troubleshooting, if two computers are connected together

Figure 1: Layer 2 Peer-to-peer Network

and can communicate with other then that usually means the LAN cards and network software work correctly - therefore there are other problems if one of the computer cannot successfully communicate when connected to a switched LAN or internet.

Connecting two computers via wireless technologies (e.g. Wireless LAN, Bluetooth, infrared) is commony used for temporary and/or spontaneous sharing of data.

As we will see, connecting two computers (and configuring them to communicate with each other) is quite simple. However, the applications are rather limited as you cannot communicate with anyone else.

Note 1. *(Ethernet, Fast Ethernet, Gigabit Ethernet) Although there are different variants of IEEE 802.3, including Ethernet (10Mb/s), Fast Ethernet (100Mb/s) and Gigabit Ethernet (1Gb/s), we will often use the word Ethernet in the general sense, that refers to either of the variants. In fact, the computers in the lab are configured with Fast Ethernet LAN cards (although can operate at 10Gb/s Ethernet).*

Note 2. *(Other Types of Peer-To-Peer Networks) You may hear of Peer-to-Peer Networks or P2P file sharing to describe many applications and services in use on the Internet today. Although they are based on similar principles (all nodes are equal, no central point of control), the technologies and protocols used are not the same. In this lab we are only dealing with the method of connecting two computer together: any type of application can run on the two computers (Email, Web server, P2P File sharing), although may have limited use with only two people involved.*

3.2 Ethernet Cabling

Ethernet, in particular Fast Ethernet, is a full-duplex communications protocol. That is, device A can transmit to device B *at the same time as* device A is receiving from device B. This is performed by have a set of separate wires for transmit and receive. So in an Ethernet cable there are many individual wires, one set that are used for transmitting and one set for receiving.

In Ethernet networks, there are two types of devices:

1. End-user devices, such as computers and peripherals (even routers, which from a Layer 2 or Ethernet perspective, are just hosts on the Ethernet).

2. Network devices, such as switches and hubs.

To be able to transmit from one device and receive at the other device, the ordering of the transmit and receive sets of wires in the cable must be correct. The socket into

which you plug the Ethernet cable must be wired correctly as well. The wiring in sockets of end-user devices is different than that in network devices. A simple way to understand this is as follows.

Lets assume the transmit wires in the *socket* of an end-user device (e.g. computer LAN card) are at the top, and receive wires at the bottom, as illustrated in Figure 2. And the opposite applies for the socket of a network device (e.g. switch).

Figure 2: Example ordering of Ethernet sockets on computer and switch

Of course, the transmit wires in the socket of one device must connect to the receive wires in the socket of the other device. Hence to connect an end-user device to a network device, the *wires in the Ethernet cable* must go *straight-through* to the other side, as shown in Figure 3.
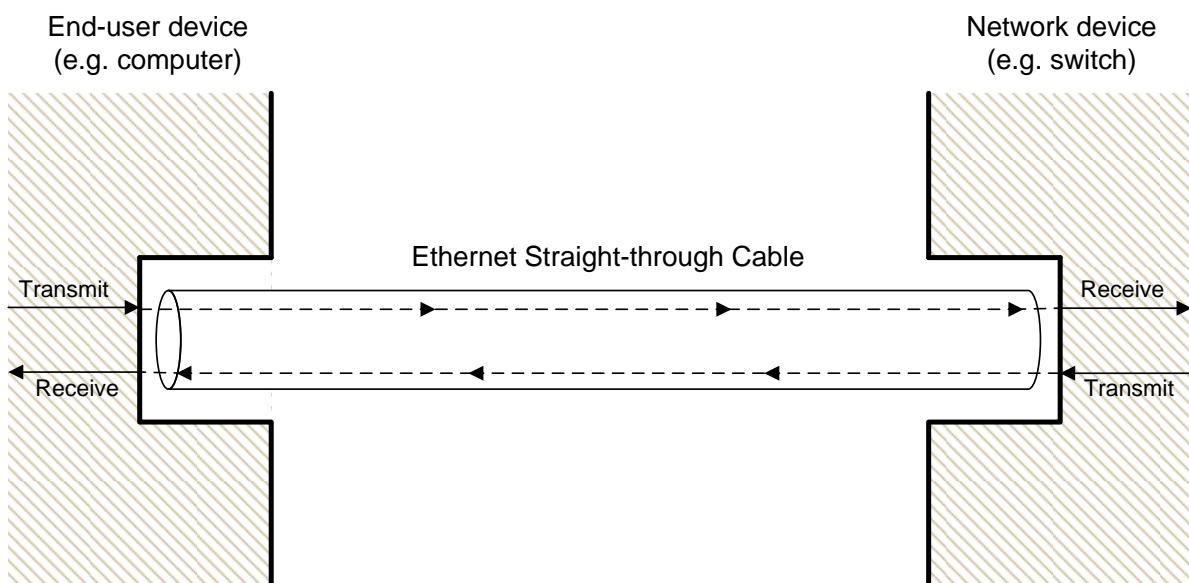
Figure 3: Ethernet straight-through cable connection

However, if we now want to connect an end-user device to another end-user device (such as in the peer-to-peer network, where we connect one computer directly to another), then the wires in the Ethernet cable must *cross-over*, as shown in Figure 4.
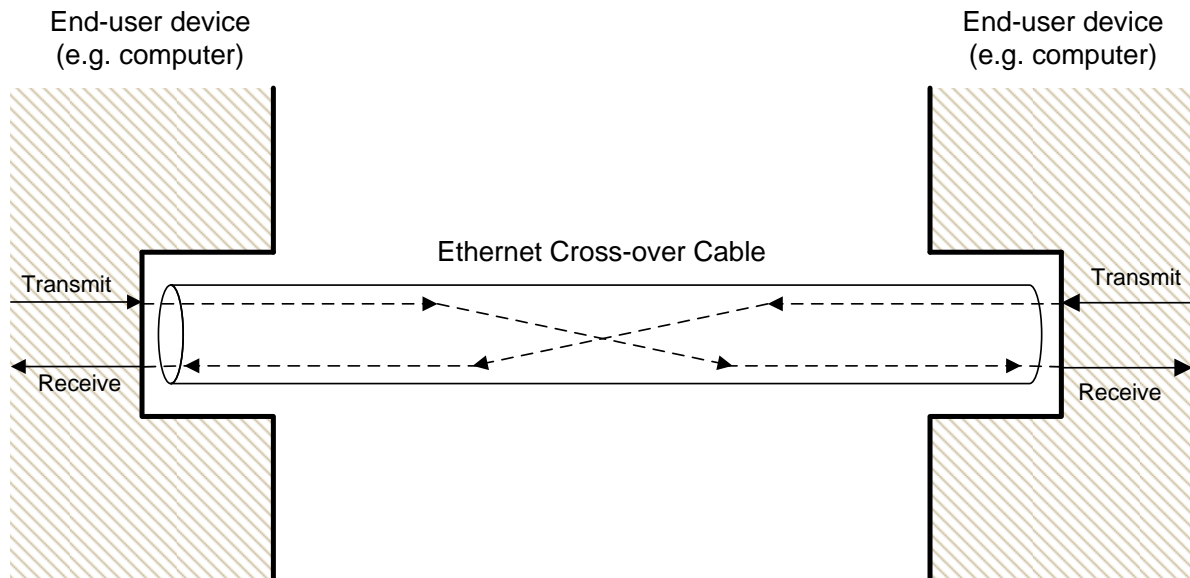

Figure 4: Ethernet cross-over cable connection

In summary, there are two different types of Ethernet cables for connecting devices:

Straight-through cable Connects an end-user device to a network device. For example: PC to switch; switch to router.

Cross-over cable Connects an end-user device to another end-user device. For example: PC to PC; PC to router.
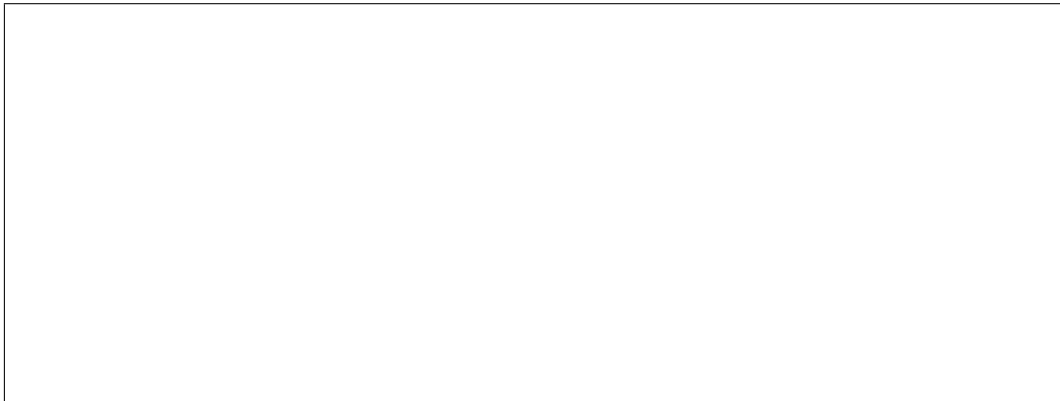
How do you tell the difference between a straight-through and cross-over cable? From the colours of the individual wires that you see at the end points of the cables. For a straight-through cable, if you look at the end-points from the same viewpoint, the colours will be in the same order. For a cross-over cable, the colours will be in a different order.

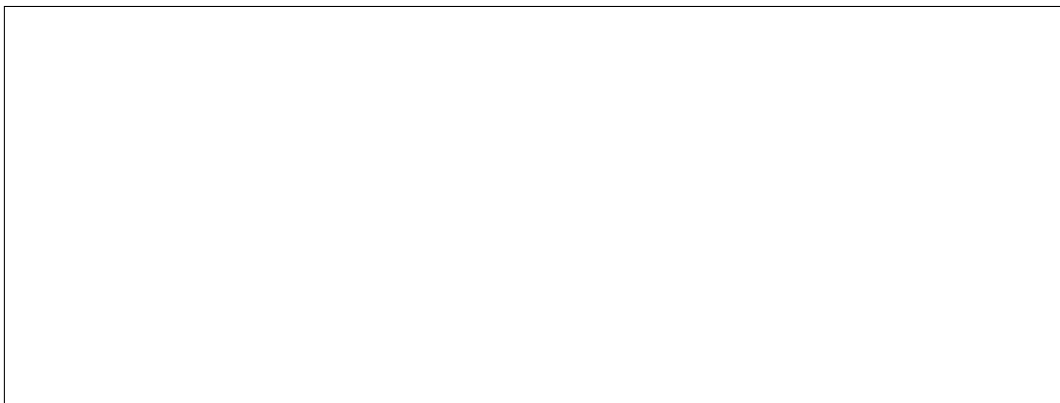## 3.3   Setting up the Network

Create and test a peer-to-peer network between your computer and your partners computer. Use static IP addresses where the last portion of the dotted decimal IP address is your seat number, e.g. if you are at seats 1 and 2, then your IP addresses will be: `X.Y.Z.1` and `A.B.C.2`.

Task 1. *What type of cable did you use to connect the computers? Why?*

Task 2. *Record the IP addresses and related interface information (e.g. masks) for both computers.*

Task 3. *Why did you select the IP addresses (especially the network portion)? What happens if you have different network portions?*
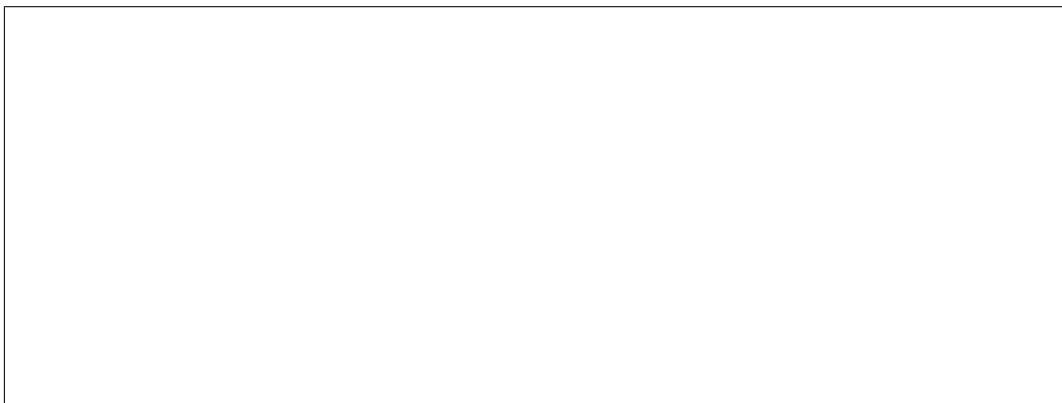
Task 4. *What gateway (router) did you configure for the interface? Why?*

Task 5. *How did you test the connection? Record any relevant results of the tests.*

Task 6. *Use Wireshark to record a portion of traffic between the computers. Is the traffic what you expected (e.g. is there any other traffic on the network)?*

4 Switched Network

4.1 Background

Connecting only two computers has very limited use. Usually a user or organisation has more than two computers to connect together. There are different topologies that can be used to connect computers together, although today the most common is a *star-based*

topology, where the centre of the star is a Layer 2 Switch. Hence, referred to as a *switched network*.
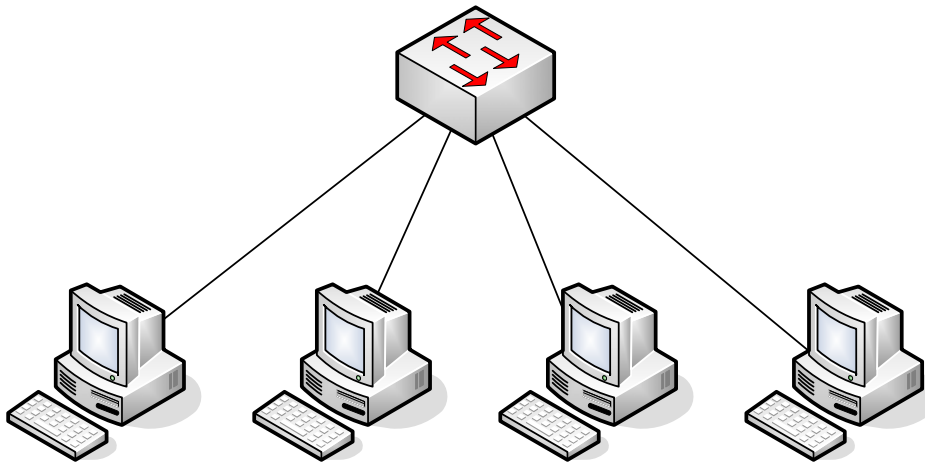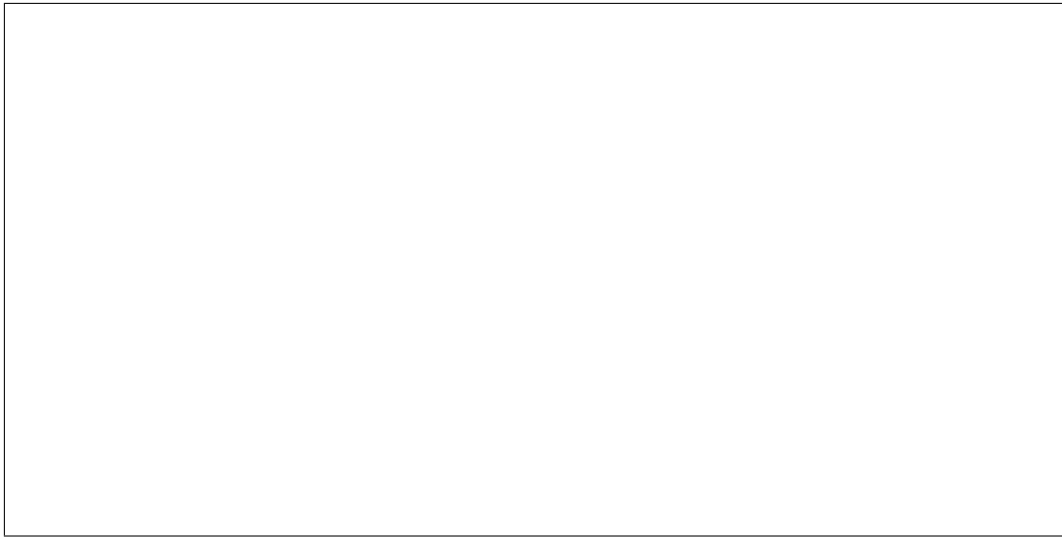

Figure 5: Layer 2 Switched Network

In a switched network, all end-user devices have individual cables to the central switch. In most cases, the connection to the switch is full-duplex. To transmit from one end-user device to another, the transmission goes via the switch. Of course, often users want to communicate with other users not on the same switched network. Hence the switch can also be connected to another switch to connect to another switched network, or to a router, to connect to any network.
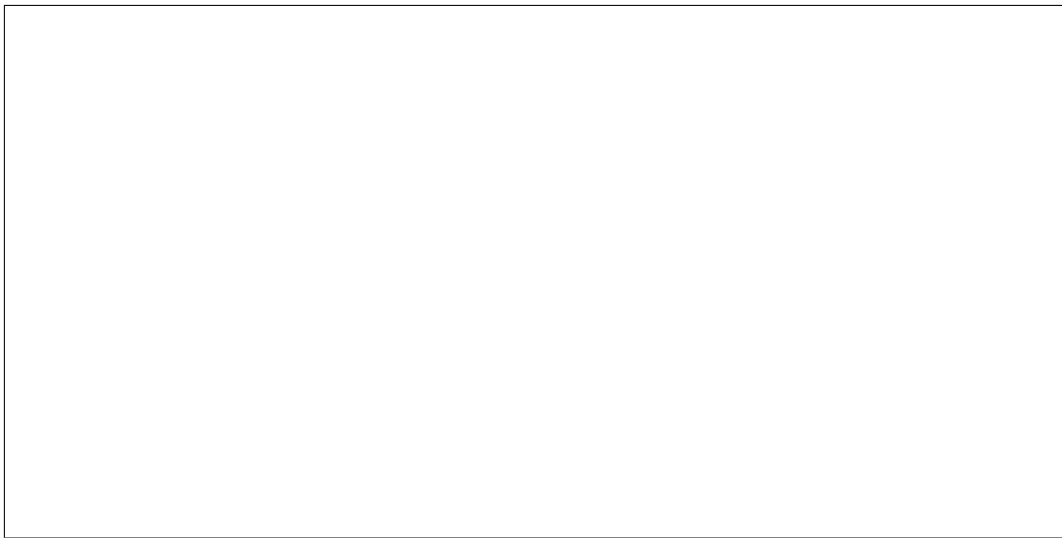
4.2   Setting up the Network

Create a switched network between the computers in your group, using one of the supplied switches. Use static IP addresses where the last portion of the dotted decimal IP address is your seat number.

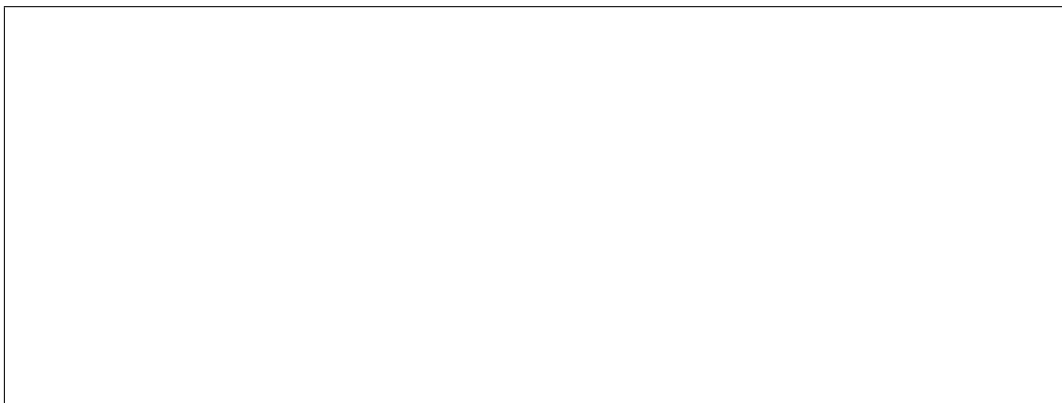**Task 7.** *What type of cable did you use to connect the computers and switch? Why?*

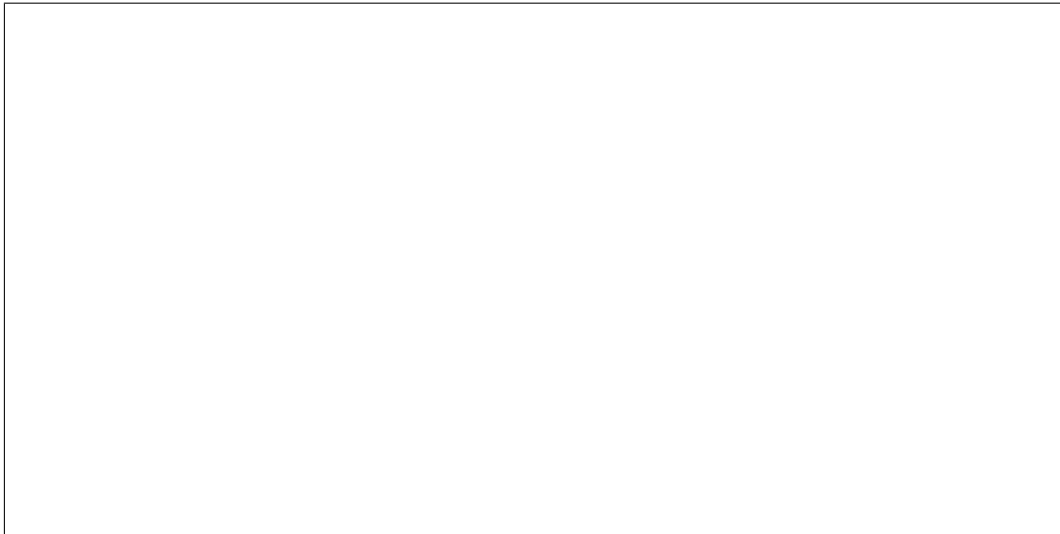**Task 8.** *Record the IP addresses and related interface information (e.g. masks) for all computers.*

Task 9. *Why did you select the IP addresses (especially the network portion)? What happens if you have different network portions?*
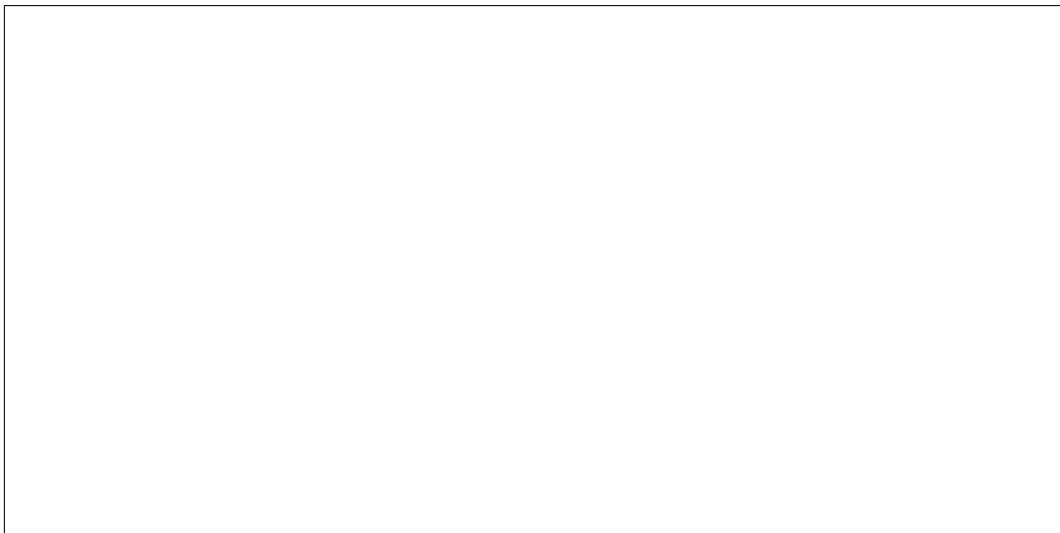
Task 10. *What gateway (router) did you configure for the interface? Why?*
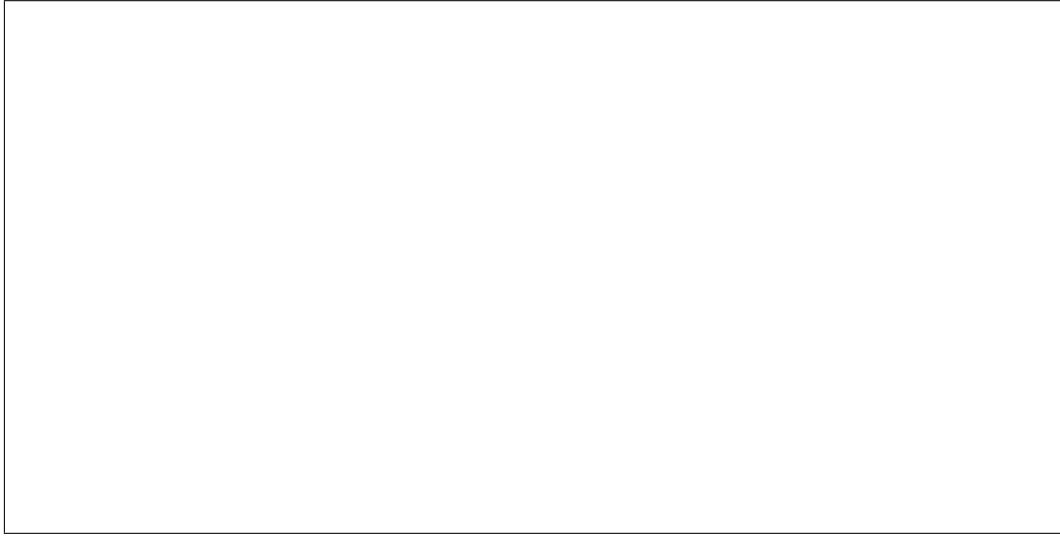
Task 11. *How did you test the connection? Record any relevant results of the tests.*

Task 12. *Use Wireshark to record a portion of traffic between the computers. Is the traffic what you expected (e.g. is there any other traffic on the network)?*

Task 13. *Could you use DHCP, instead of statically configured addresses, in this network? If yes, what would be needed? If no, why not?*

5   Cleaning Up

As other students (both in this lab class and other classes) must use these computers, it is very important you set the computer configuration back to the default. This includes:

- Both interfaces should be configured to use DHCP.

- Ethernet cables connected from each network card to the appropriate switch.

- All personal files deleted from the computer (e.g. source code, results).

Failure to leave your computer in an appropriate configuration may lead to a loss of marks. Leaving source code and results on the computer may result in penalties for cheating!

A   Notes

Record any additional notes here (e.g. important points made by the instructor, summary of things you learned, mistakes you made). You should use this in future labs, as well as in preparation for assessment items like exams.