# A COMPARATIVE STUDY OF THREE ICT NETWORK PROGRAMS USING USABILITY TESTING

**PL van der Linde**

Submitted in fulfillment of the requirements for the

degree of Magister Technologiae:

Information Technology

Department of Information Technology

Central University of Technology, Free State

September 2013

# PREFACE

I ...............................................................declare that

(i)    The research reported in this dissertation, except where otherwise indicated,
       is my original work.

(ii)   This dissertation has not been submitted for any degree or examination
       at any other university.

(iii)  This dissertation does not contain other persons' data, pictures, graphs or other
       information, unless specifically acknowledged as being sourced from other persons.

(iv)   This dissertation does not contain other persons' writing, unless specifically acknowledged
       as being sourced from other researchers. Where other written sources have been quoted,
       then:

       (a) their words have been re-written but the general information attributed to them has
           been referenced;

       (b) where their exact words have been used, their writing has been placed inside quotation
           marks, and referenced.

(v)    This dissertation does not contain text, graphics or tables copied and pasted from the
       Internet, unless specifically acknowledged, and the source being detailed in the thesis and
       in the references sections.

Signed:

Supervisor:

# ABSTRACT

*This study compared the usability of three Information and Communication Technology (ICT) network programs in a learning environment. The researcher wanted to establish which program was most adequate from a usability perspective among second-year Information Technology (IT) students at the Central University of Technology (CUT), Free State. The Software Usability Measurement Inventory (SUMI) testing technique can measure software quality from a user perspective. The technique is supported by an extensive reference database to measure a software product's quality in use and is embedded in an effective analysis and reporting tool called SUMI scorer (SUMISCO). SUMI was applied in a controlled laboratory environment where second-year IT students of the CUT, utilized SUMI as part of their networking subject, System Software 1 (SPG1), to evaluate each of the three ICT network programs. The results, strengths and weaknesses, as well as usability improvements, as identified by SUMISCO, are discussed to determine the best ICT network program from a usability perspective according to SPG1 students.*

# ACKNOWLEDGEMENTS

I would like to thank the following persons for their help, support and advice through which the completion of this study would not have been possible:

- My heavenly Father who provided me with the strength and mind to undertake this study.
- My mother, Dina, my father, Pieter as well as my two elder brothers, Erik and John and their families for all their love, support and prayers.
- My supervisor, Mr. Casper Wessels for all his patience, advice and willingness to help me complete this study.
- Mr. Tadeusz Kirakowski from the Human Factors Research Group at University College Cork, Ireland for all my SUMI questionnaire data processing as well as data analysis. Thank you for your prompt correspondence via email and your willingness to answer all my questions I had.
- Dr. Liezel Nel, who provided me with the initial research idea of conducting a usability study.
- Dr. Danri Delport for her contribution with statistical data interpretation.
- Ms. Elmarie Viljoen for editing of my dissertation.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| ANOVA | Analysis of Variance |
| CAT | Computer Applications Technology |
| CCNA | Cisco Certified Network Associate |
| CNA | Cisco Network Academy |
| CUT | Central University of Technology |
| HFRG | Human Factors Research Group |
| ICT | Information and Communications Technology |
| IDS | Intrusion Detection Systems |
| ISO | International Standard for Organization |
| IT | Information Technology |
| LAN | Local Area Network |
| MUSiC | Metrics for Usability standards in Computing |
| NIC | Network Interface Card |
| NSM | Network Security Monitor |
| P2P | Peer to peer |
| P-value | Probability value |
| SET | Science, Engineering and Technology |
| SPG1 | System Software 1 |
| SUMI | Software Usability Measurement Inventory |
| SUMISCO | SUMI Scorer |

# CHAPTER 1: INTRODUCTION

## 1.1. Background

Second-year Information Technology (IT) students studying at the Central University of Technology (CUT), Free State, have not been exposed previously to Information and Communications Technology (ICT) networks. A survey conducted by the researcher indicated that 55.69% of all the second-year IT students took Computer Applications Technology (CAT) as a subject at school level.

Network technologies cover only 5% of the CAT curriculum and assessment policy statement (Department of Basic Education, 2011). This, in any terms, is a very small amount of networking content and one can assume that ICT networks are a new field of study for all IT students. This is a challenge for both the students and the lecturers. Additional learning aids to improve performance must thus be exploited in the System Software 1 (SPG1) networking subject.

SPG1 students follow the Cisco Certified Network Associate (CCNA) curriculum, which is discussed in chapter 2. The researcher introduced three ICT network programs to assist the students in their learning process for the subject. The three programs selected for the study form an integral part of learning about ICT networking. The researcher could not find any previous studies which determined the quality of use of each of the three ICT network programs. This allowed the researcher to investigate whether the three ICT network programs are viable from a usability perspective when used by SPG1 students. Thus, the researcher's interest in establishing which of the three programs was most effective from a usability perspective was born.

The primary purpose of the study is to apply a usability testing technique in order to evaluate the quality of use for each of the three ICT network programs. In this way, the researcher will also be able to determine which of the three ICT network programs is the most efficient in assisting the learning process of ICT networks.

The three programs that formed part of the study included Microsoft Network Monitor, Packet Tracer and Wireshark. The researcher consulted a librarian at CUT, Ms Lizette Storm, to aid his search for usability studies on each program. Microsoft Network Monitor has not been used in any form of usability study, as neither the researcher nor the librarian could find any related research which involved the program prior to the start of the study.

Notably, there were a few studies involving Wireshark. Hnatyshin and Lobo (2008) used Wireshark as a possible learning tool in their research which was conducted on undergraduate computer science students who had networking as one of their subjects. Banerjee, et al. (2010) evaluated the program as a sniffing tool in networks by performing their experiments on a real-time network. Packet Tracer was used as part of a global assessment system in a study conducted by Chapple, et al. (2009).

## 1.2. Problem statement

The unemployment rate is one of the main problems in Africa, more specifically South Africa. The CUT as one of the two institutions of higher education in the Free State Province have an obligation to contribute to the development of skills in the Science, Engineering and Technology (SET) field, of which networks form an integral part.

The cost of training a student in this field is very expensive and network equipment that includes Cisco-branded routers and switches only add to the cost. The cost of one trolley (also known as a pod), consisting of three Cisco 1941 routers and three Cisco 2960 switches, amounts to about R50 000. The CUT owns 20 pods in total, making provision for 150 second-year IT students to be trained. Owing to large student numbers, students are forced to work in groups of three on one pod to be able to do practical work, which isn't ideal.

The finances to acquire and maintain the equipment and pay for the lecturers responsible for the subjects mainly come from government subsidy and subject fees. The subsidy received for a national diploma student from government consists of two parts: a teaching input subsidy and a teaching output subsidy. The teaching input subsidy is referred to as "teaching subsidy" by CUT, and is determined by the enrolment numbers for the subject.

Teaching output subsidy, referred to as "output subsidy", is determined by the number of graduates for the qualification. The pass rate plays a major role in determining this subsidy: the better the pass rate, the more students will complete their qualification and the higher the output subsidy.

Taking the above into consideration, as well as the target of a student pass rate of 80% (CUT, 2011) for all subjects at CUT, all possible resources that can contribute to the improvement of the teaching and learning experience should be used. Therefore, it is critical to determine the usability of each of the three ICT network programs in the learning process of the SPG1 students and compare them with one another.

### 1.3. Hypothesis

By applying the Software Usability Measurement Inventory (SUMI) principles, it will be possible to identify the most usable ICT network program for the SPG1 students at CUT.

### 1.4. Research aim

The research aim of the study is to determine which of the three ICT network programs is the best, from a usability perspective, with regard to the following aspects of the SUMI subscales:

- Efficiency/Effectiveness: The extent to which the students have achieved their learning goals in SPG1, using each of the ICT network programs
- Affect: The extent to which each of the ICT network programs captures the student's emotional responses
- Helpfulness: The extent to which each of the ICT network programs assists the student
- Control: The extent to which the student, and not the ICT network program, sets the pace
- Learnability: The ease with which a student can get started and learn the features of each ICT network program

### 1.5. Limitations of the study

Only SPG1 students were used as part of the study. SPG1 is a semester subject, offered over 16 weeks. Only second-year IT students on the Bloemfontein CUT campus were evaluated because the number of enrolled SPG1 students at the Welkom CUT campus was too small to conform to the requirements of SUMI testing. Each of the three programs utilized in the case study have a fair number of features. The focus were only on features in line with the curriculum and used by the SPG1 students.

For Packet Tracer, the emphasis was on building networks with devices such as computers, routers and switches, connecting them with cables and configuring each device. For Wireshark and Microsoft Network Monitor, the emphasis was on capturing network traffic on the computers in lab 226 and analyzing the captured network traffic. This allowed the SPG1 students to identify the composition of network data travelling on the local area network (LAN) in lab 226.

### 1.6. Chapters of the study

Chapter 2 provides the literature review, where the background of ICT networks, the concept of usability and the concept of SUMI are discussed. Chapter 3 focuses on the design and methodology applied in the study, discussing the SUMI questionnaire and the interpretation of the data gathered from it. The time schedule followed throughout the study is also included as part of chapter 3. Chapter 4 includes an analysis and results of the data captured throughout the entire testing procedure using SUMI. Chapter 5 provides a report and conclusion based on the results found in chapter 4.

# CHAPTER 2: LITERATURE REVIEW

## 2.1. Introduction

This chapter focuses on establishing the background and usage of ICT networks as well as the concept of usability. The researcher discusses the background and concept of SUMI. Background information on packet analyzer programs, Wireshark and Microsoft Network Monitor, are also provided to discover their origin. Unfortunately, the researcher couldn't find any information on the background of Packet Tracer's development; therefore, it is discussed only as part of the learning about ICT networks. Finally, learning about ICT networks using ICT programs such as Packet Tracer, Wireshark and Microsoft Network Monitor are described.

Networking in ICT plays a pivotal role in society and is a technology that is commonly available. Large corporations, universities, cell phone companies and banks are just a few examples of where one would encounter ICT networking fulfilling a vital part in allowing communication to take place, and evolving as time goes by. Telephone calls, emails, social networks, conferencing and televisions are real-world examples of ICT networks in action.

## 2.2. Background on ICT networking

Before covering the different aspects of ICT networking, let us look at where it started. Andrew S Tanenbaum (2002) stated that the last three centuries have each been dominated by a single new technology. The 18th century was the era of the great mechanical systems accompanying the Industrial Revolution. The 19th century was the age of the steam engine. During the 20th century, the key technology was information gathering, processing, and distribution. We saw the installation of worldwide telephone networks, invention of radio and television, plus the birth and enormous growth of the computer industry. Owing to rapid technological advances, these areas all converged; thus, the differences between collecting, transporting, storing and processing information are declining (Tanenbaum, 2002).

According to Tanenbaum (2002), two computers are said to be interconnected when they are able to exchange information. With this in mind, the old model of a single computer addressing an organization's computational needs have been replaced by one in which a large number of separate, but interconnected, computers do the job. These connected computers are called computer networks.

## 2.3. Background on packet analyzer programs

The primary goal of packet analyzer programs is to monitor network devices in order to detect suspicious behaviour and misuse. This concept has been available for the past twenty years, but has seen a rise in popularity and has been incorporated in the overall information security framework.

In his paper, *Computer Security Threat Monitoring and Surveillance,* James Anderson (1980) discussed the idea of network intrusion detection. In this seminal paper he wrote for a government organization, John Anderson (1980) discussed the idea that audit trails contained vital information that could be utilized in tracking user behaviour and misuse on networks.

The work James Anderson performed was the beginning of host-based intrusion detection and Intrusion Detection Systems (IDS). The Haystack Project at Lawrence Livermore Labs produced a different version of intrusion detection for the US Air Force in 1988. The project delivered an IDS which compared analyzed audit data with defined patterns.

Crosby Marks, a former Haystack Project team member and Haystack Labs employee, mentioned that, "searching through this large amount of data for one specific misuse was equivalent to looking for a needle in a haystack" (Banerjee, et al., 2010, p.1).

The idea of network intrusion detection originated from UC Davis's Todd Heberlein. Heberlein was the primary author and creator of Network Security Monitor (NSM), the first network intrusion detection system of its kind (Heberlein, et al., 1990). Commercial development of intrusion detection technologies began in the early 1990s. Haystack Labs was the first commercial vendor of IDS tools, especially with its Stalker line of host-based products.

According to Banerjee, et al. (2010), during the 1990s, commercial IDSs saw slow development and became relevant only in the last half of the decade. However, the intrusion detection market gained popularity and generated large revenues. Gerald Combs coded a program called Ethereal, which allowed him to capture and analyze packets and published the first version in 1998. The title of "Ethereal" was eventually changed to Wireshark in May 2006 due to copyright issues (Banerjee, et al., 2010).

## 2.4. Using ICT Networks

As mentioned previously, ICT networks exist all around us and influence our daily lives in more ways than one. As a commercial user, doing something like online banking usually involves using an ICT network infrastructure that allows you to connect from your computer via the internet to your bank's website.

This action alone involves a number of components which include a range of devices such as routers, switches, hardware/software firewalls and, most likely, database servers which house all client information and client accounts. These are just a few intermediary devices that make up the components of an ICT network. The person responsible for configuring these intermediary devices is referred to as a Network Administrator.

Network Administrators are not only responsible for ensuring that the ICT networking devices are configured correctly, but they also need to contend with putting the relevant security measures in place to ensure that organizational or business systems are not compromised.

## 2.5. Learning about ICT networks

Cisco Systems, Inc. is the worldwide leader in networking for the internet (Cisco, 2013). The company was founded in 1984 by two computer scientists from Stanford University seeking an easier way to connect different types of computer systems (Cisco, 2013).

The Cisco Networking Academy (CNA) is a global education program that teaches students how to design, build, troubleshoot, and secure computer networks for increased access to career and economic opportunities in communities around the world (CNA, 2013).

Various Cisco networking academies exist worldwide and many tertiary institutions offer the CNA as part of their IT qualifications. The CUT is a certified local Cisco academy in the central region of South Africa. The academy at CUT provides training for people who wish to obtain a qualification to become a Cisco Certified Network Associate (CCNA).

Second-year IT students at CUT are exposed to the CNA program through four subjects which cover the CCNA 1, 2, 3 and 4 curriculums. Throughout these four curriculums, the students are taught how to design, build, configure, secure and monitor ICT networks by means of three ICT network programs. Each of these three ICT network programs is discussed in section 2.9.

### 2.6. What is usability?

A great deal of confusion exists regarding the meaning of usability. Although the importance of usability as a priority is recognized today, it is still difficult to integrate it as part of a conventional software engineering organization. One way of conducting usability testing is to perform it in a controlled laboratory environment.

The International Organization for Standardization (ISO) standard 9241 defines usability as "allowing the user to execute his task effectively, efficiently and with satisfaction in the specified context of use" (Abran,et al., 2003, p.331). Usability testing involves measuring the performance of a typical end-user while undertaking a predefined set of tasks on the system being evaluated to assess the degree to which it meets specific usability criteria (Adebesin, Villiers and Ssemugabi, 2009).

Usability can be subdivided into two categories. Category 1 can be classified as product-oriented, which identifies usability with ease of use (which originates from human factors). In category 2, usability is seen as the ability to use a given product for its intended purpose, which ties with a conventional software engineering organization (Bevan, 1995). In contrast with the previous statement, human factors have long argued that usability can be obtained only via the process of user-centred design. Therefore, usability has two corresponding purposes in the design process: as a characteristic it must be implemented into a product and, at the highest level, quality must be an objective of the design process (Bevan, 1995).

8

However, each of the three ICT network programs as been developed already, meaning the students were not involved in the developmental process of each program. With this in mind, the researcher had to find a method which allowed him to determine which ICT network program is the best from a usability perspective in line with the ICT networking the students are learning in SPG1.

## 2.7.   A closer look at usability

Usability plays a pivotal role when it comes to software products. When testing a product in practice, however, not a great deal of attention has been paid to this aspect. Testers evaluating the software might not have proper knowledge or the relevant tools to conduct a usability test. Several studies, for example, by Moolenaar and van Veenendaal (1997), have proven that usability is a very important success factor, which complements functionality and reliability.

Van Veenendaal (1998) stated that, while it might be ideal to test software extensively in a usability lab environment, in most scenarios, a usability test has to be performed with minimum resources. Two techniques that can be used at reasonable cost to evaluate product usability are expert reviews and checklists. Unfortunately, the users aren't involved in this process as they are the real stakeholders who will be affected directly by usability; thus, usability is determined by using a product in its operational environment (van Veenendaal, 1998).

Physical and sociological aspects with regard to using software products must be accounted by the types of users and the tasks they need to carry out while using the software (van Veenendaal, 1998). Usability can be defined as "quality-in-use" according to the definition of the ISO 9241-11 standard which states: "the extent to which a product can be used by specified users to achieve goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241-11, 1998).

Product quality and quality-in-use are two perspectives of usability that are dependent on each other. Obtaining quality-in-use depends on meeting the criteria for using products in the real world.
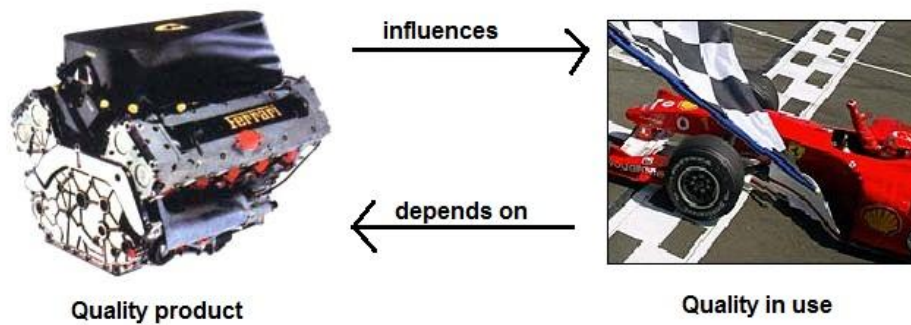
*Figure 2.7.1* Indicating a real world example of a quality product (All F1 Info, 2013) influencing quality in use (BBC Sport, 2004)

In accordance with ISO 9241, test scenarios can be applied to test usability. According to van Veenendaal (1998), usability testing with specific test cases is a drastic move and not really necessary. From a perspective where usability is not evaluated, van Veenendaal (1998) stated that one needs to implement a technique that involves users, is reliable and, at the same time, uses limited resources.

## 2.8. What is SUMI?

According to Jameson (2000), SUMI measures how usable a software product is according to the perceptions and attitudes of the users. It produces a set of reliable and valid numbers which are indicators of the usability of the software being rated. It can be used either as part of a survey or in laboratory environment (Jameson, 2000). The researcher implemented SUMI on each of the three ICT network programs, measuring the SPG1 students' usability satisfaction of using each program.

SUMI consists of a 50-item questionnaire (see chapter 3) which has been set up to meet the criteria of psychometric practice (van Veenendaal, 1998). Each question can be answered with "agree", "undecided" or "disagree".

The type of questions presented to the user includes the following:

- I enjoy the time I spend using this software

- If this software stops it is not easy to restart

- Working with this software is mentally stimulating

- I feel in command of this software when I am using it

- There is too much to read before you can use the software

- Using this software is frustrating

- Learning how to use new functions is difficult

The SUMI questionnaire is available in a variety of languages, including English (UK and US), Dutch, French, German, Greek, Italian, Spanish and Swedish. In order to evaluate software, SUMI should be used by users who have had little or no experience of using the software. For the purpose of this study, three groups of SPG1 students completed a SUMI questionnaire on each of the three ICT network programs after being exposed to each program for a duration of two weeks.

In order to obtain a valid and effective sample, SUMI requires a minimum of 10 to 18 users to evaluate a particular software package. Based on the answers the users provide via the questionnaire, the usability scores are then calculated for each of the SUMI subscales (see page 12). SUMI, however, requires either a prototype or working version of a particular program. SUMI is thus suitable to evaluate the usability of the three ICT network programs: Cisco Packet Tracer, Wireshark and Microsoft Network Monitor.

A key factor of SUMI is the development of its standardization database which consists of more than 2000 different kinds of applications. SUMI can be used to evaluate any kind of application as long as the application provides user input by means of keyboard, mouse or pointing devices (van Veenendal, 1998).

According to van Veenendal (1998), SUMI provides the ability to do a product-against-product comparison, or each product can be compared to SUMI's standardization database to determine how well the product compares against the average state-of-the-market profile.

SUMI combines a global usability figure in conjunction with five different subscales according to which it evaluates a user's questionnaire response (van Veenendaal, 1998). As mentioned previously, the five subscales include the following:

- **Efficiency:** The extent to which users can achieve their goals or interaction with the product in a direct and timely manner
- **Affect:** The extent to which the product captures the users' emotional responses
- **Helpfulness:** The extent to which the product seems to assist users
- **Control:** The extent to which users feel they, and not the product, are setting the pace
- **Learnability:** The ease with which users can get started and learn new features of the product
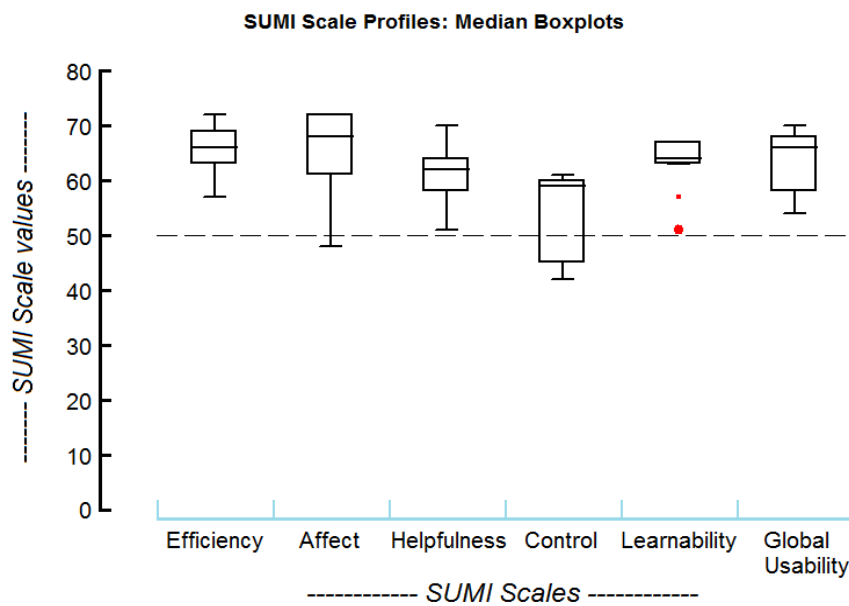


***Figure 2.8.1*** *A sample profile of a SUMI report showing the five subscales*

Figure 2.8.1 depicts the scores of a sample test with the spreading of the subscale scores (measured by the standard deviation) in contrast to the average score of the reference database, which is indicated by the value 50. The analysis of these scores indicates that the sample profile is of a positive nature, with the exception of the control subscale score.

To date, SUMI is the only questionnaire for the assessment of the usability of software which has been developed, validated and standardized on a European basis (van Veenendaal, 1997). SUMI's subscales are referenced in the international ISO standards, based on usability (ISO 9421-10, 1994) as well as software product quality (ISO 9241-11, 1995).

Evaluating a product with SUMI provides a clear objective measurement from users' perspective with regard to the suitability of using the software for their tasks. Furthermore, SUMI can also be customized to test certain aspects of the software based on user opinions.

SUMI must be carried out by people who perform realistic and representative tasks. Usability context analysis as performed by the National Physical Laboratory (1995) helps identify and specify the systematic methods of the users, the various tasks they will perform and the conditions under which the tasks will be carried out. The researcher's students utilized all three ICT network programs in context by performing identified tasks with each program in a controlled laboratory environment of a practical ICT network lab at CUT.

## 2.9.  Packaging SUMI

According to Kirakowski (1994), when SUMI was released, it was packaged with a user guide, manual scoring stencils, other scoring items utilities and SUMI Scorer (SUMISCO), the scoring program which is used to evaluate SUMI questionnaire responses. SUMISCO evaluates all the scoring activities included in the SUMI package and allows file exporting to word processors and spreadsheets to illustrate the statistical data generated by the program (Kirakowski, 1994). The contents of the SUMI package have been extensively tested for quality-in-use purposes at the Human Factors Research Group (HFRG) laboratories (Kirakowski, 1994).

The user guide has been edited in accordance with comments received from industry partners and other data providers throughout SUMI's development (Kirakowski, 1994). Output generated by SUMISCO has also been adapted to adhere to user expectations (Kirakowski, 1994). SUMI was initially developed by the European Metrics for Usability standards in Computing (MUSiC) project (Bevan, 1995).

SUMI was validated during an industry validation programme in the last phase of the MUSiC project (Bevan, 1995). SUMI's metrics were rated as the most useful of all the MUSiC tools (Kirakowski, 1994). SUMI was also praised by industry partners for ease of use of interpreting the outputs (Kirakowski, 1994). The validation programme, which was carried out by an independent partner within MUSiC, is reported in a short project report by Sweeney and Maguire (1994).

## 2.10. The validity of SUMI

Three different types of validity studies have been performed on SUMI. The first study involved industry partners of the MUSiC consortium which used SUMI as part of the industry-scale validation of the MUSiC usability evaluation toolset (Kirakowski, 1994). A short discussion of this activity is provided in the MUSiC project's final report (Kelly, 1994).

Secondly, a number of laboratory-based studies have been carried out by the HFRG and, thirdly, studies have also been carried out for industry clients on a consultancy basis (Kirakowski, 1994). To an extent, laboratory studies are low in ecological validity, whereas consultancy studies are, in most cases, commissioned on the principal of honouring confidentiality agreements and isn't disclosable in public (Kirakowski, 1994).

To supplement empirical validation, theory-based validation has been performed by comparing SUMI subscales with the ISO 9241 part 10 dialogue principles. Results from this comparison are discussed in the next section.

## 2.11. Comparison with ISO 9241 part 10

Comparing the SUMI subscales with the seven dialogue principles of ISO 9241 part 10, one can see clearly that four of the SUMI subscales correspond with the dialogue principles. This allows an analyst to measure a minimum of four dialogue principles directly and empirically, providing a reference to the opinions of an end-user sample (Kirakowski, 1994).

The seven dialogue principles of ISO 9241 part 10 include the following (SAP Help Portal, 2013):

- **Suitability for the task**
  - A dialog supports suitability for the task if it supports the user in the effective and efficient completion of the task. The dialog presents the user only those concepts which are related to the user's task.

- **Self-descriptiveness**
  - A dialog supports self-descriptiveness if each dialog step is immediately comprehensible through feedback from the system or is explained to the user when requesting the relevant information.

- **Controllability**
  - A dialog supports controllability if the user is able to maintain direction over the whole course of the interaction until the point at which the goal has been met.

- **Conformity with user expectations**
  - A dialog supports conformity with user expectations if it corresponds to the user's task knowledge, education, experience and commonly held conventions.

- **Error tolerance**
  - A dialog supports error tolerance if, despite evident errors in input, the intended results can be achieved with either no or minimal corrective action. Errors should be explained to the user for him or her to correct them.

- **Suitability for individualization**
  - A dialog supports suitability for individualization if the dialog system is constructed to allow for modification of the user's individual needs and skills for a given task.

- **Suitability for learning**
  - A dialog supports suitability for learning if it guides the user through the learning stages, minimizing the learning time.

Kirakowski (1994) highlighted the following similarities between the five SUMI subscales and the seven dialogue principles:

SUMI's Helpfulness scale and the ISO principle of Self-Descriptiveness are related when comparing the descriptions of both. SUMI Control and ISO Controllability are also related, as well as SUMI's Learnability and the ISO principle of Suitability for Learning. SUMI Efficiency and ISO principle of Suitability for the Task are related strongly.

Perhaps not as direct, SUMI's scale of Affect is related with the ISO principle of Conformity with User Expectations when the wording of both the Affect scale and the corresponding ISO principle are compared. The ISO principle in this scenario may also contain a component of SUMI's Efficiency. The two remaining ISO principles of Error Tolerance and Suitability for Individualization cannot be related to a specific SUMI subscale.

Even though SUMI's Helpfulness scale may be considered to relate to aspects such as error recovery, the actual wording of items in the Helpfulness scale suggests that end users are more concerned with helpfulness problems beyond those related to specific errors. SUMI doesn't feature a scale that relate directly to the ISO principle of Suitability for Individualization.

Some items, which refer to this specific concept, were omitted early during the development phase of SUMI because they neither provided a coherent factor by themselves nor contributed to any of the five emergent factors that became known as the SUMI subscales.

## 2.12. Description of ICT programs

### 2.12.1. Packet Tracer

Packet Tracer is a network program developed by Cisco that simulates a real ICT networking environment. Packet Tracer allows students to build and configure their own virtual ICT networks.

During the first CCNA curriculum the students learn about ICT networking traffic and the decisions that ICT networking devices, such as routers, need to make in order to forward the network traffic to the relevant destination.
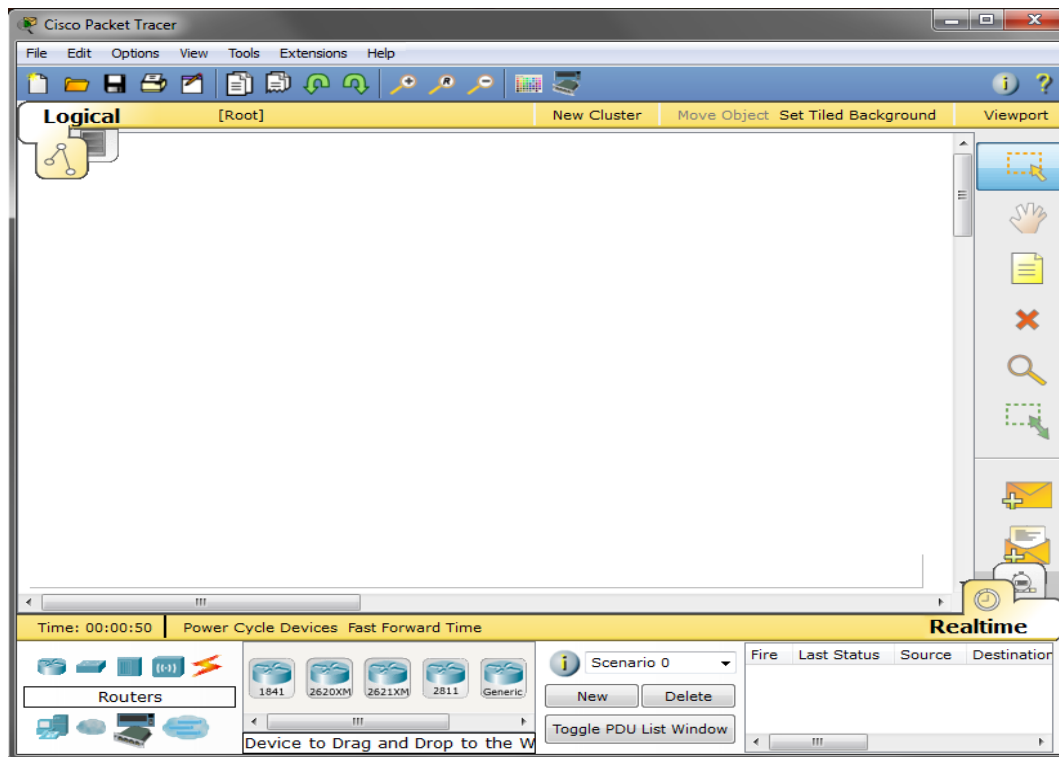


***Figure 2.12.1.1*** *Packet Tracer's main graphical user interface*

Packet Tracer provides simulation, visualization, authoring, assessment, and collaboration capabilities, and facilitates the teaching and learning of complex technology concepts. Packet Tracer supplements physical equipment in the classroom by allowing students to create a network with an almost unlimited number of devices, which encourage practice, discovery and troubleshooting (Cisco Course Catalog, 2012).

Real computer networks that are experienced both in-person/hands-on and remotely remain the benchmark for understanding network behaviour and developing networking skills.

Packet Tracer was created to help address the digital divide in networking education, where many students and teachers lack access to equipment, bandwidth and interactive modes of learning networking.
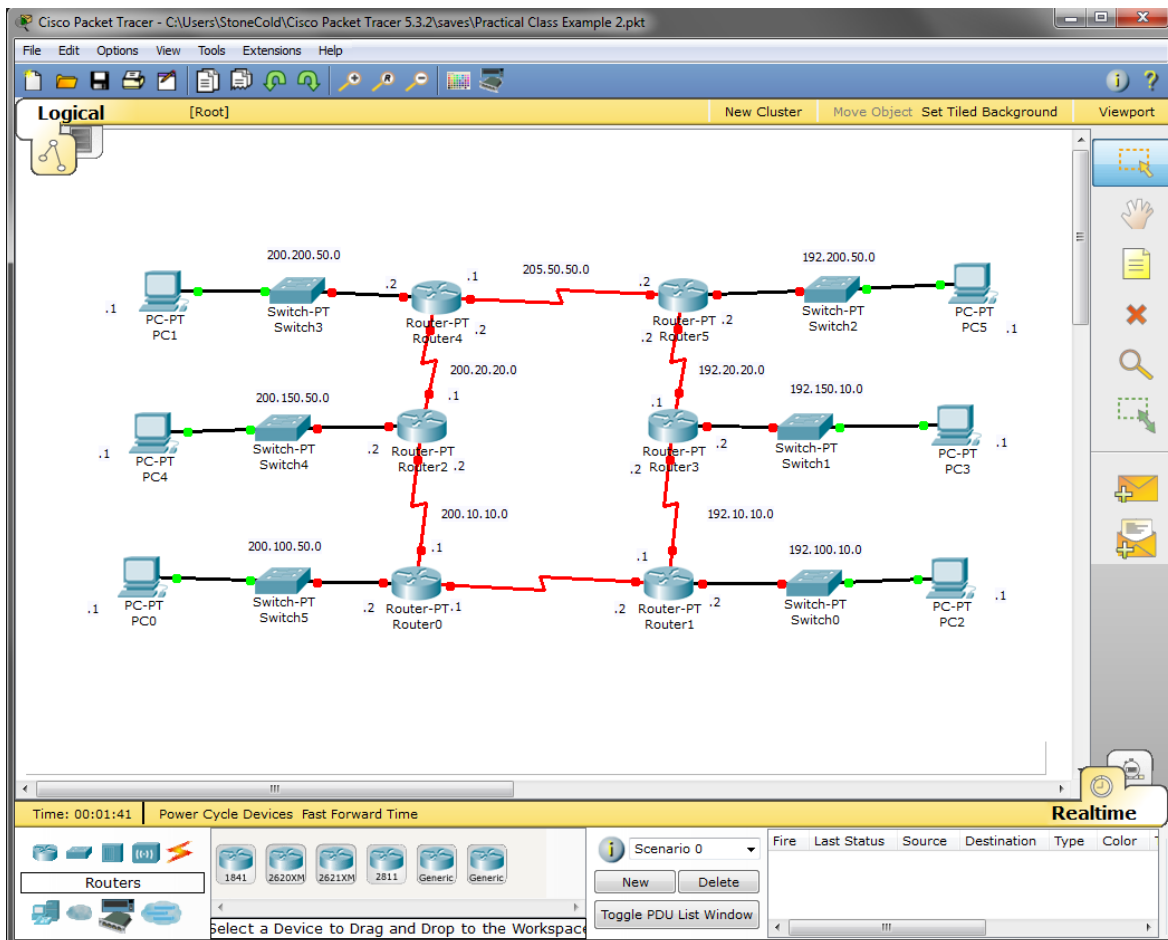


**Figure 2.12.1.2** *An example network constructed in Packet Tracer*

### 2.12.2. Wireshark

In order to gain deeper understanding of ICT network traffic, students utilize programs that allow them to capture and analyze ICT network traffic. The analysis of network data packets is critical in understanding how an ICT network operates.

It allows a network administrator to ensure that an ICT network is secured from outside intruders that could access a specific ICT network. Two programs that provide this functionality are Wireshark and Microsoft Network Monitor.

Wireshark is a network packet analyzer which allows the user to capture and interactively browse the traffic running on a computer network. It has a rich and powerful feature set. It runs on most operating systems including Windows, OS X, Linux, and UNIX (Wireshark FAQ, 2012). A network packet analyzer captures network packets and displays the packet data in detail.
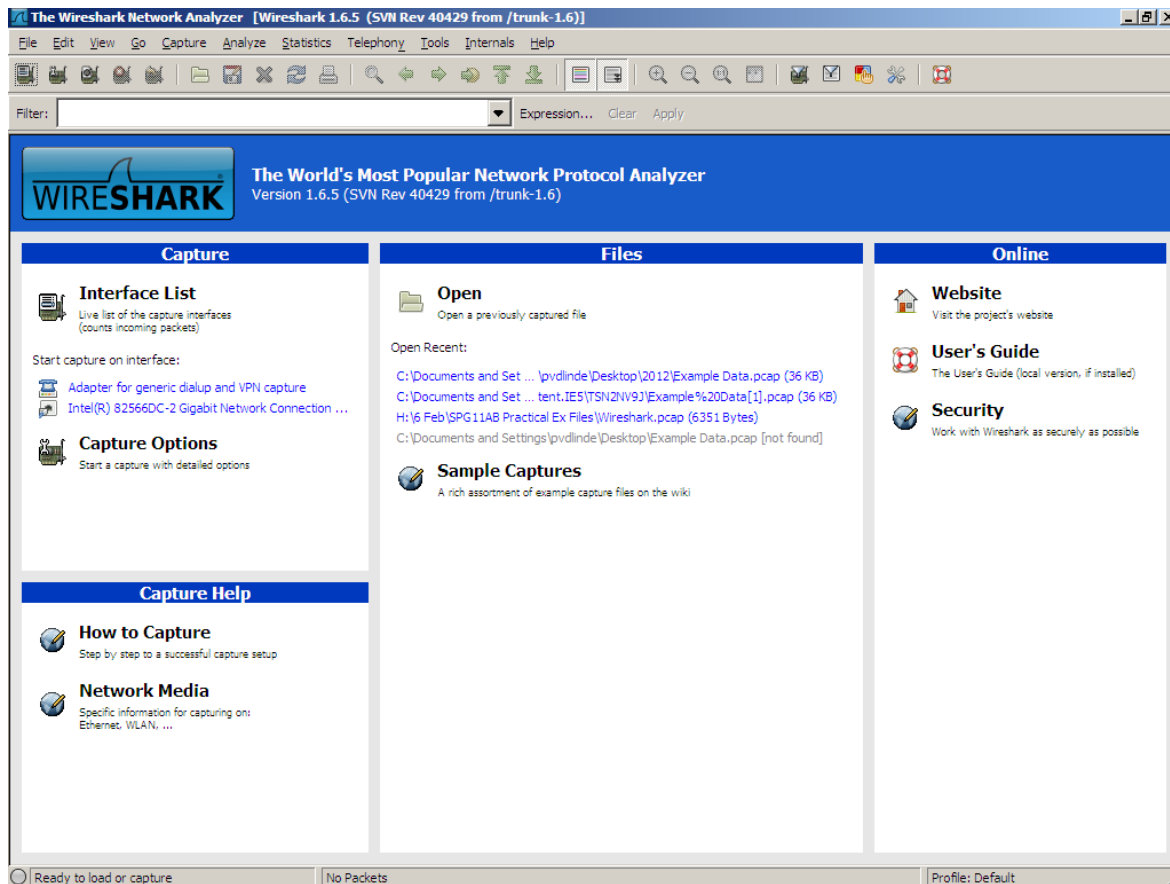


*Fig 2.12.2.1* *Wireshark's main graphical user interface*

A network packet analyzer is a measuring device used to examine what is going on inside a network cable.

It is the same concept as a voltmeter, which is used by an electrician to examine what is going on inside an electric cable. The Wireshark developers consider the program as one of the best open-source packet analyzers available today (Wireshark FAQ, 2012).
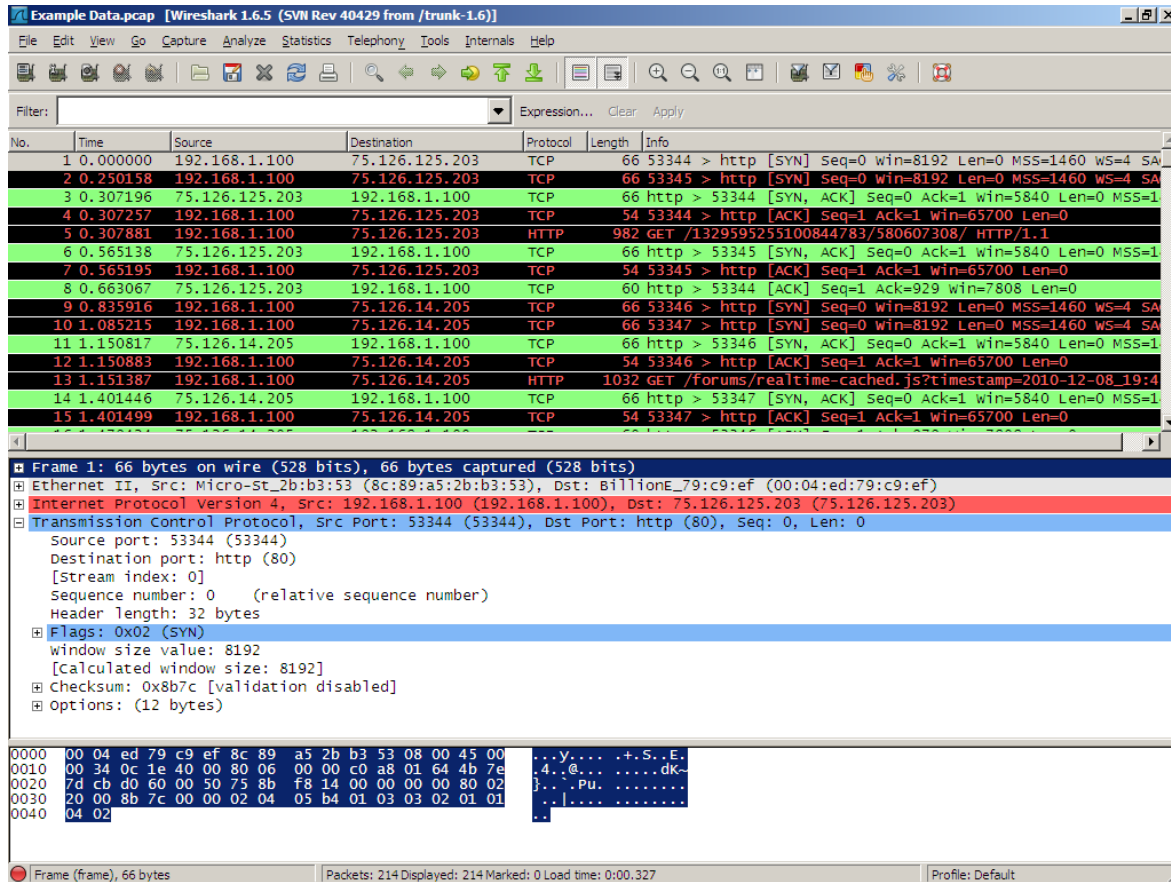


**Fig 2.12.2.2** *An example of captured data in Wireshark*

In the past, such tools were either very expensive or proprietary, or both. However, with the advent of Wireshark, all that has changed.

### 2.12.3. Microsoft Network Monitor

Microsoft Network Monitor is also a packet analyzer and allows the user to capture, view and analyze network data and decipher network protocols. It can be utilized to troubleshoot network problems and applications on the network (AlternativeTo, 2012).
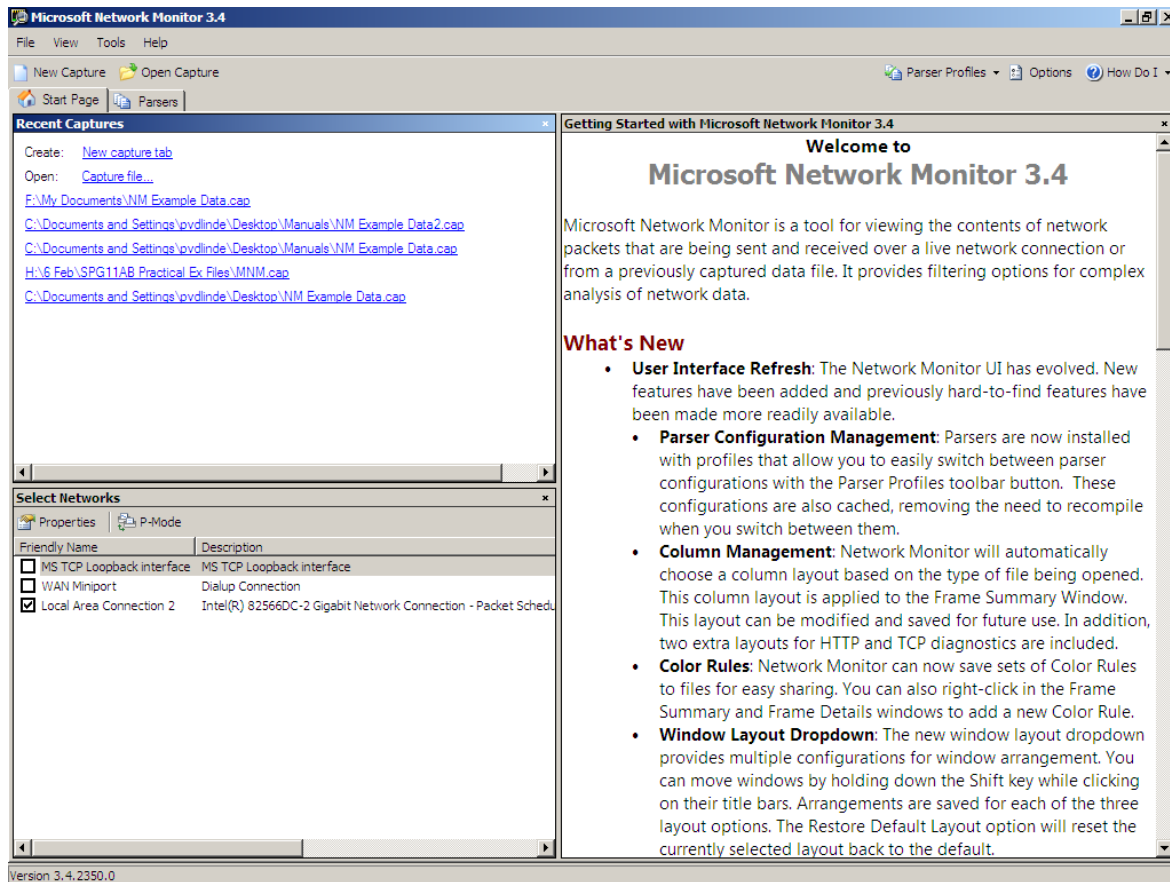
**Fig 2.12.3.1** *Microsoft Network Monitor's main graphical user interface*

Microsoft Network Monitor collects information using a process known as capturing. This tool can be used to capture statistics on all the frames it detects on the network or on a specific subset of frames.
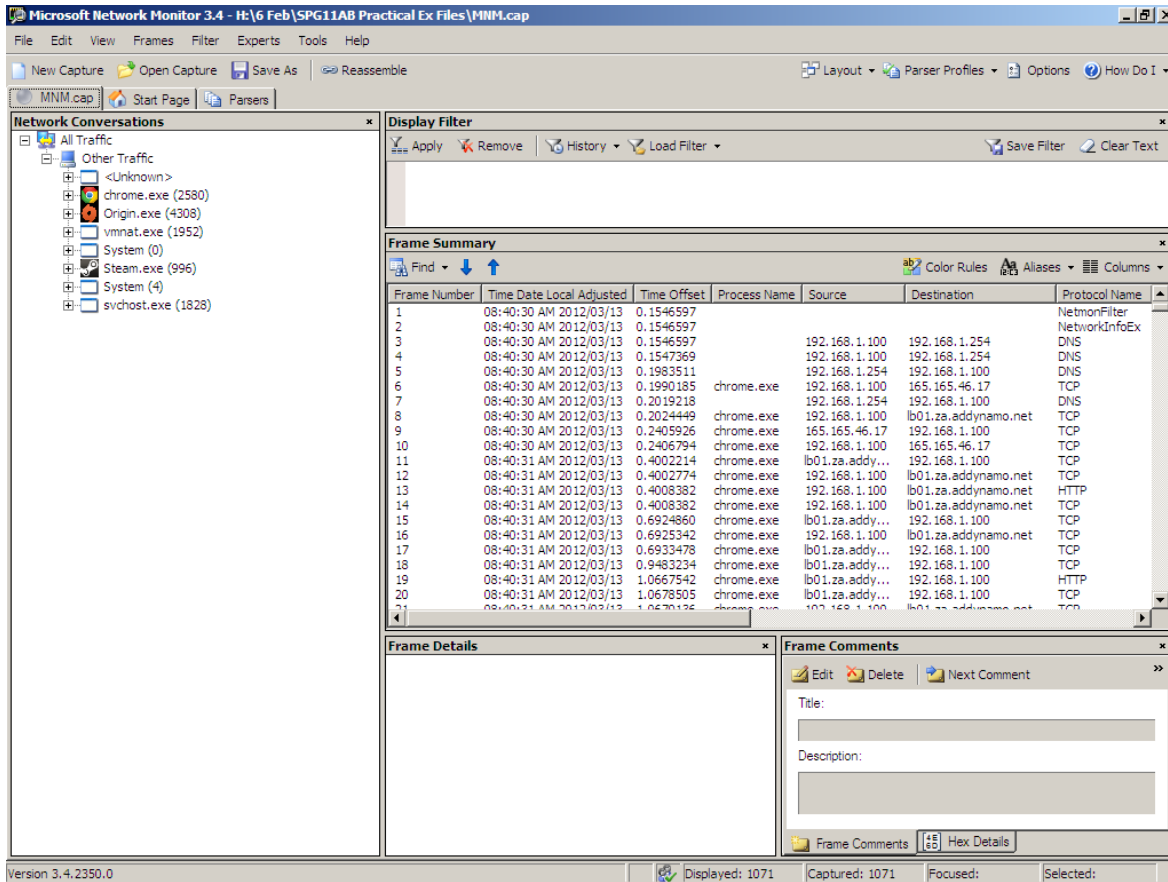
**Fig 2.12.3.2** *An example of captured data in Microsoft Network Monitor*

Furthermore, it is a tool used for viewing the contents of network packets that are being sent and received over a live network connection or from a previously captured data file. It provides filtering options for complex analysis of network data. Wireshark and Microsoft Network Monitor provide quite a number of different functions such as:

- helping network administrators troubleshoot network problems
- helping network security engineers examine security problems
- debugging protocol implementations
- using them to learn ICT network protocols

22

The predominant function for this study is the latter, i.e. helping people learn about ICT network protocols. ICT network protocols link with the routing decisions that networking devices need to make with regard to forwarding traffic across a network.

## 2.13. Conclusion

In this chapter, the researcher discussed the background of ICT networks and the history of packet analyzer programs (Wireshark and Microsoft Network Monitor). The usage and learning of ICT networks followed, which described a need to establish the usability of the three programs in the context of learning from the SPG1 students' perspective.

A discussion of usability and the concept of SUMI highlighted the fact that the SUMI questionnaire is an easy, cost-effective way to conduct usability testing which suited the nature of the study.

The fact that SUMI can be utilized in a laboratory environment meant that it would be a perfect fit for the researcher's study, seeing that his SPG1 students perform their practical in a laboratory environment. This allowed the researcher to distribute the SUMI questionnaire to the students because they had a limited amount of experience and exposure to each ICT network program, which was another reason for applying SUMI (Jameson, 2000).

# CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

## 3.1. Introduction

The methodology of this research is based on a usability study, in which the researcher sought to evaluate the usability of three ICT network programs. In order to measure the usability of the three ICT network programs, the process of usability evaluation was conducted by using the SUMI questionnaire.ICT network programs allow prospective network administrators to learn more about the world of ICT networking and communication between computers. No costs were incurred to obtain the three ICT programs. Both Wireshark and Microsoft Network Monitor can be downloaded for free from the internet. Packet Tracer is freely obtainable via the CNA website, but one has to be part of CNA program to download Packet Tracer.

## 3.2. Research design

The researcher originally designed a questionnaire in which five different categories were highlighted. Each category had three different characteristics which the students had to rate with a mark of 1 to 10 for each characteristic. With this method of data collection for usability testing, the researcher soon realized that would cause a number of problems throughout the research process. For example, the majority of the students gave extreme ratings of either 0/10 or 10/10 for each characteristic per category. Therefore, significant results were not attained after the questionnaire responses were processed. Then the researcher found the SUMI questionnaire that can be used for testing usability, a method that was further developed by the HFRG at the University College Cork, Ireland (Kirakowski, 1994). The SUMI questionnaire consists of 50 multiple-choice questions which are considered quantitative, while the free-form questions are considered qualitative. Thus, SUMI is seen as both a qualitative and a quantitative questionnaire. The questionnaire is subdivided into three areas:

- 25 questions relate to a general usability factor
- 25 questions relate to the five subscale values
- five questions relates to free-form statements in which the students provide their opinions

Below is the SUMI questionnaire the researcher used to conduct usability testing on each of the three ICT network programs:

<p style="text-align:center; color:red;">**Software Usability Measurement Inventory**</p>
<p style="text-align:center; color:red;">**SUMI**</p>

---

**NB** The information you provide is kept completely confidential, and no information is stored on computer media that could identify you as a person.

This questionnaire has 50 statements. Please answer them all. After each statement there are three boxes.

- Check the first box if you generally AGREE with the statement.
- Check the middle box if you are UNDECIDED, or if the statement has no relevance to your software or to your situation.
- Check the right box if you generally DISAGREE with the statement.

In checking the left or right box you are not necessarily indicating strong agreement or disagreement but just your general feeling most of the time.

There are also five general questions at the end.

---

**Password:**

| *Statements 1 - 10 of 50.* | **Agree** | **Undecided** | **Disagree** |
|---|---|---|---|
| This software responds too slowly to inputs. | ○ | ○ | ○ |
| I would recommend this software to my colleagues. | ○ | ○ | ○ |
| The instructions and prompts are helpful. | ○ | ○ | ○ |
| This software has at some time stopped unexpectedly. | ○ | ○ | ○ |

| | Agree | Undecided | Disagree |
|---|:---:|:---:|:---:|
| Learning to operate this software initially is full of problems. | ○ | ○ | ○ |
| I sometimes don't know what to do next with this software. | ○ | ○ | ○ |
| I enjoy the time I spend using this software. | ○ | ○ | ○ |
| I find that the help information given by this software is not very useful. | ○ | ○ | ○ |
| If this software stops it is not easy to restart it. | ○ | ○ | ○ |
| It takes too long to learn the software functions. | ○ | ○ | ○ |

| *Statements 11 - 20 of 50.* | Agree | Undecided | Disagree |
|---|:---:|:---:|:---:|
| I sometimes wonder if I am using the right function. | ○ | ○ | ○ |
| Working with this software is satisfying. | ○ | ○ | ○ |
| The way that system information is presented is clear and understandable. | ○ | ○ | ○ |
| I feel safer if I use only a few familiar functions. | ○ | ○ | ○ |
| The software documentation is very informative. | ○ | ○ | ○ |
| This software seems to disrupt the way I normally like to arrange my work. | ○ | ○ | ○ |
| Working with this software is mentally stimulating. | ○ | ○ | ○ |
| There is never enough information on the screen when it's needed. | ○ | ○ | ○ |
| I feel in command of this software when I am using it. | ○ | ○ | ○ |

26

I prefer to stick to the functions that I know best.　　　　　　○　　　　　○　　　　　○

| Statements 21 - 30 of 50. | Agree | Undecided | Disagree |
|---|---|---|---|
| I think this software is inconsistent. | ○ | ○ | ○ |
| I would not like to use this software every day. | ○ | ○ | ○ |
| I can understand and act on the information provided by this software. | ○ | ○ | ○ |
| This software is awkward when I want to do something which is not standard. | ○ | ○ | ○ |
| There is too much to read before you can use the software. | ○ | ○ | ○ |
| Tasks can be performed in a straight forward manner using this software. | ○ | ○ | ○ |
| Using this software is frustrating. | ○ | ○ | ○ |
| The software has helped me overcome any problems I have had in using it. | ○ | ○ | ○ |
| The speed of this software is fast enough. | ○ | ○ | ○ |
| I keep having to go back to look at the guides. | ○ | ○ | ○ |

| Statements 31 - 40 of 50. | Agree | Undecided | Disagree |
|---|---|---|---|
| It is obvious that user needs have been fully taken into consideration. | ○ | ○ | ○ |
| There have been times in using this software when I have felt quite tense. | ○ | ○ | ○ |
| The organisation of the menus seems quite logical. | ○ | ○ | ○ |

| | Agree | Undecided | Disagree |
|---|---|---|---|
| The software allows the user to be economic of keystrokes. | ○ | ○ | ○ |
| Learning how to use new functions is difficult. | ○ | ○ | ○ |
| There are too many steps required to get something to work. | ○ | ○ | ○ |
| I think this software has sometimes given me a headache. | ○ | ○ | ○ |
| Error messages are not adequate. | ○ | ○ | ○ |
| It is easy to make the software do exactly what you want. | ○ | ○ | ○ |
| I will never learn to use all that is offered in this software. | ○ | ○ | ○ |

| *Statements 41 - 50 of 50.* | Agree | Undecided | Disagree |
|---|---|---|---|
| The software hasn't always done what I was expecting. | ○ | ○ | ○ |
| The software presents itself in a very attractive way. | ○ | ○ | ○ |
| Either the amount or quality of the help information varies across the system. | ○ | ○ | ○ |
| It is relatively easy to move from one part of a task to another. | ○ | ○ | ○ |
| It is easy to forget how to do things with this software. | ○ | ○ | ○ |
| This software occasionally behaves in a way which can't be understood. | ○ | ○ | ○ |

28

This software is really very awkward.   ○   ○   ○

It is easy to see at a glance what the options are at each stage.   ○   ○   ○

Getting data files in and out of the system is not easy.   ○   ○   ○

I have to look for assistance most times when I use this software.   ○   ○   ○

---

**What, in general, do you use this software for?**

**How important for you is the kind of software you have just been rating?**

○  Extremely important

○  Important

○  Not very important

○  Not important at all

**How would you rate your software skills and knowledge?**

○  Very experienced and technical

○  I'm good but not very technical

○  I can cope with most software

○  I find most software difficult to use

**What do you think is the best aspect of this software, and why?**

**What do you think needs most improvement, and why?**

<br>

*When you've answered all the questions,
please click the 'Send' button.*

Send

The free-form statements included questions pertaining to the following for each ICT network program:

- What is the program used for?
- What are the best aspects of the program?
- What improvements can be made to the program?
- Rating the user's software skills and knowledge
- Rating the importance of using the software being evaluated

Responses to the free-form statements (questions) were analyzed using content analysis. Free-form statements with more than one theme were split and analyzed as two separate statements. This was done to bring out the major themes for each of the ICT network programs.

A time schedule (see 3.5) was set up for the students and was followed strictly to expose them to each program individually, assess them on each program, and evaluate the usability of each program using the SUMI questionnaire.

The exposure to, assessment of, and completion of the SUMI questionnaire for each ICT network program took place in a controlled laboratory environment. The students worked in a laboratory where they performed practical exercises in conjunction with each program. Completion of the SUMI questionnaire per program took roughly 10 minutes each per group.

### 3.3.  SUMI score analysis

In order to determine the statistical significance between the responses captured from the three groups, the responses were analyzed by means of the analysis of variance (ANOVA) multi-factorial model. The analysis was performed by a program called SUMISCO. The multi-factorial ANOVA model allowed the researcher to compare the means of the responses for each of the ICT network programs to see whether they are significantly different from one another or whether they are relatively the same.

The three ICT network programs were evaluated against the five SUMI subscales with a between-subjects error term for the scales and interaction effects. In essence, an error term means that the statistical model (in this case, ANOVA) will not be completely accurate, and will yield different results during real-world applications (Investopedia, 2013a).In this study, the researcher measured three groups on the five subscales of the SUMI questionnaire.

An error term was associated with/used in three different areas:
- the five subscales present in each of the three groups
- the differences between the three groups
- the interactions between the three groups and five subscales

The Global subscale (which can be seen indirectly as the $6^{th}$ SUMI subscale) was used to represent a single variable of *perceived quality of use* instead of a simple average of all the items of the questionnaire. The Chi square distribution of the students' responses in relation with expected values in the SUMI database was used to determine the "strength" statistic present in the strength and weakness analysis.

To further distinguish them from each ICT network program, the SUMI scores were measured according to the p-value (probability value). The p-value is associated with a test statistic which, in this study, refers to the five SUMI subscales. In short, a p-value indicates the probability that the null hypothesis is true. The null hypothesis attempts to show that no variation exists between variables, or that a single variable is no different than zero (Investopedia, 2013b).In the case of ANOVA, the null hypothesis means that there is no difference between the terms being compared.

Without sampling the entire population, one cannot assume that any two terms are different by anything more than chance, but that the *probability* of a real difference exists. Strong evidence of a difference will push the p-value lower or closer to 0.

A low p-value indicates that the difference is less likely due to chance. Ninety five (95%), or p=0.05, is the usual limit set on rejecting the null hypothesis. One will occasionally see 99%, p=0.01, or 90%, p=0.1 used, but the vast majority of researchers/statisticians use 95%.

P-values indicate only that there is a difference; they don't indicate the magnitude or the direction of the difference. An analysis of the p-value according to the SUMI scores are given as part of the summarized report in chapter 5 (see 5.3).

### 3.4. Research method

Browsing the SUMI website (SUMI, 1999a), the researcher discovered that the HFRG does SUMI analysis for free, based on an academic license. This allowed the researcher to make use of the HFRG's services to utilize SUMI as usability testing method for his study.

The researcher sent an email to Doctor Jurek Kirakowski, the director at the HFRG, to enquire about utilizing SUMI for his study. Jurek acknowledged that the three ICT network programs would be prime candidates for SUMI testing and then referred the researcher to his son, Tadeusz Kirakowski, who is in charge of the academic licensing for SUMI testing at the HFRG (SUMI, 1999b).

The researcher started email correspondence with Tadeusz on 12 April 2013 (week 8 of time schedule, see 3.4) in which he enquired about the requirements for conducting the SUMI test for each program. Tadeusz first explained that the researcher would require three passwords, one for each program, in order to identify each program on the SUMISCO database. Tadeusz could then retrieve the responses for each program's questionnaire from the SUMISCO database by using the password assigned to each program.

Once the researcher had the passwords, he needed to identify when he would conduct the SUMI usability test for each program. The researcher decided to conduct the test during week 9 (see time schedule, 3.5). The students had no difficulty in answering any of the questions and, by the end of the week; all three practical groups evaluated one program each using the SUMI questionnaire.

After the testing was completed on the morning of 3 May 2013, the researcher asked Tadeusz to verify the number of responses that were captured for each program. There were 42 responses for Packet Tracer, 46 for Wireshark and 48 for Microsoft Network Monitor. Even though the number of responses was uneven among the three programs, the researcher required a maximum of only 18 responses for each program in order to obtain a valid sample for each program.

Once the researcher had verified the number of responses captured, Tadeusz proceeded to analyze the captured data, which he emailed to the researcher on 13 May 2013.

## 3.5. Participants

One hundred and fifty (150) students were registered for SPG1 at the time of the study. SPG1 is a compulsory subject for all second-year IT students. Practical classes were conducted in two labs, namely lab 226 and lab 228. Students were divided into three practical groups. Each group had two practical sessions per week. Students attending in lab 226 would swop with the students in lab 228 and vice versa for both sessions during the week. For example, group A had practical sessions on Tuesday and Thursday. Students attending class in lab 226 on Tuesday would attend class in lab 228 on Thursday and vice versa.

The researcher used lab 226 for the research process to expose the students to the three ICT network programs, namely Packet Tracer, Wireshark and Microsoft Network Monitor. The students in lab 226 were given an assignment for the two periods. Instructions were discussed at the beginning of the class. Labs 228, equipped with all the practical Cisco equipment and cabling, were used by the researcher to conduct a class for the other half of the group of students.

Student assistants were present in both labs each week. The student assistant in lab 226 was given an attendance list, which the students had to sign at the end of each class in order to force them to utilize the entire session and not leave class early. The researcher had an attendance list with him in lab 228 which the students in lab 228 signed after the sessions.

The students in lab 226 worked by themselves for the majority of each session per week. If the researcher finished earlier with the class in lab 228, he would go back to lab 226 in order to answer any questions the students had. The only exception was when the researcher lectured in lab 226 during week 8 (see time schedule, 3.6), when revision was done on all three programs before the students wrote the first practical test. Whenever the opportunity presented itself, the researcher alternated between the two classes to assist and answer the students' questions.

## 3.6. Time schedule

A strict time schedule was followed throughout the entire study. The time schedule below provides a description of the practical work the students did each week for the duration of the semester.

**Table 3.6.1** *Time schedule indicating study duration and evaluation*

| Week | Month | Date | Work description | Notes |
|------|-------|------|------------------|-------|
| 1 | Feb | 04-08 | Introduction week | Subject introduction was given |
| 2 | Feb | 11-15 | Packet Tracer exposure | Students work with Packet Tracer for the first time |
| 3 | Feb | 18-22 | Packet Tracer exercise | Students do Packet Tracer exercise |

| 4 | Feb/Mar | 25-01 | Wireshark exposure | Students work with Wireshark for the first time |
|---|---------|-------|--------------------|------------------------------------------------|
| 5 | Mar | 04-08 | Wireshark exercise | Students do Wireshark exercise |
| 6 | Mar | 11-15 | Microsoft Network Monitor exposure | Students work with Microsoft Network Monitor for the first time |
| 7 | Mar | 18-20 | Microsoft Network Monitor exercise | Students do Microsoft Network Monitor exercise |
|   |   |   | RECESS | N/A |
| 8 | Apr | 08-12 | Revision on all three programs before first practical test | The researcher showed the students the solutions of the exercises |
| 9 | Apr | 15-19 | Main test week: Main Theory and Main Practical Test 1 | Students write the first practical test based upon all three programs |
| 10 | Apr | 22-26 | Revision exercises for all three programs | Students do each program's exercise for a second time |
| 11 | Apr/May | 29-03 | SUMI questionnaires completed | Students complete the SUMI questionnaire for each program |
| 12 | May | 06-10 | Final Practical Exam | Students write the final practical exam |
| 13 | May | 13-17 | Final Online Theory Exam | Students write the final online theory exam |
| 14 | May | 20-24 | May assessment commences | Students' results published on 27 May |

In section 3.7 the entire time schedule is broken down week by week with a detailed description of all the activities for each week.

### 3.7.  Time schedule: Week by week

### 3.7.1.  Week 1 – Introduction week

Classes commenced on 4 February 2013, during which the researcher gave an introduction session in the students' theory class. During this session the researcher gave the students an idea of the work to be covered for the semester. The researcher placed emphasis on the three ICT network programs, which comprised the practical component of the subject, and also explained the theory part, which covers the CCNA1 curriculum of the CNA program.

### 3.7.2.  Week 2 – Packet Tracer exposure

Packet Tracer was the first program that the students started with. As the researcher mentioned in chapter 1, due to time constraints, the students had only two weeks' exposure per program.

During the first week of Packet Tracer exposure, the students learned about two different aspects. First, the students learned about the user interface and, secondly, how to build and configure a simulated network using the program. Packet Tracer is a graphical user interface-driven program in the sense that one must have proper knowledge of the user interface in order to utilize the program effectively. As mentioned in chapter 2 (see 2.12.1), Packet Tracer supplements physical equipment in the classroom by allowing students to create a network with an almost unlimited number of devices, which encourage practice, discovery and troubleshooting (Cisco Course Catalog, 2012).

### 3.7.3.  Week 3 –Packet Tracer exercise

During the second and final week of PT exposure, the researcher gave the students an exercise that consisted of two parts (see Appendix G). In the first part, the students had to build and configure a basic network. The basic network consisted of PCs that had to be connected in a peer-2-peer (P2P) configuration. In the second part, the students had to build a more advanced network in which they had to configure routers in order to complete the exercise.

### 3.7.4. Week 4 – Wireshark exposure

Week 4 saw the students getting exposure to the second program, Wireshark. During the first week of Wireshark exposure, the students first learned about the user interface, as in the case with Packet Tracer. The students focused on how to select a network interface card (NIC) via Wireshark on which to capture traffic. Wireshark exposure concluded with students capturing data between two computers on lab 226's LAN, after which the students analyzed the captured network traffic.

### 3.7.5. Week 5 – Wireshark exercise

The Wireshark exercise was divided into two parts (see Appendix H). During part 1, the students were instructed to connect two lab computers with each other by means of a cross-over network cable. By connecting two lab computers, the students created a P2P connection, which was taught in the theory class. Then the students had to configure each computer with the relevant IP and subnet mask addresses.

The next phase required the students to open Wireshark and configure the program to stop capturing after a certain number of packets have been recorded. Once the students have finished configuring the program, they started the capturing process by clicking on the "Start new live capture" button.

After initializing the capturing process, the students issued a ping command from the one computer to the other. While the ping command was being performed, Wireshark captured the packets travelling between the two computers. When the capture process ended, the students had to answer questions based on the packets that were captured.

The second part of the exercise consisted of questions that students had to answer based on a captured data set compiled by the researcher. This exercise allowed the students the opportunity to practically configure a P2P network, use Wireshark to capture traffic and analyze pre-captured data.

### 3.7.6. Week 6 – Microsoft Network Monitor exposure

During week 6, the students were exposed to the third program, Microsoft Network Monitor. In the first week of Microsoft Network Monitor exposure, the students learned about two different aspects: the user interface, and then how to select a NIC via Microsoft Network Monitor to capture traffic on. Next, the students captured data on the lab's LAN by creating a P2P network between two computers, after which they analyzed the captured network traffic generated between the two computers.

### 3.7.7. Week 7 – Microsoft Network Monitor exercise

The Microsoft Network Monitor exercise was divided into two parts and was composed in the same style as the Wireshark exercise (see Appendix I). During part 1, the students were instructed to connect two lab computers with each other by means of a cross-over network cable. By connecting two lab computers, the students created a P2P connection, which they have learned in the theory class. Next, the students had to configure each computer with the relevant IP and subnet mask addresses.

The next phase required the students to open up Microsoft Network Monitor and configure the program to stop capturing after a certain number of packets have been recorded. Once they have finished configuring the program, the students started the capturing process by clicking on the "Start Capture" button.

Once again, the students issued a ping command from the one computer to the other. While the ping command was being performed, Microsoft Network Monitor captured the packets travelling between the two computers. After the capture process ended, the students had to answer questions based on the packets that were captured. The second part of the exercise consisted of questions the students had to answer based on a captured data set the researcher supplied.

This exercise allowed the students the opportunity to practically configure a P2P network, and use Microsoft Network Monitor to capture traffic and analyze pre-captured data.

### 3.7.8. Week 8 – Recess

The CUT closed for recess on 27 March 2013 and reopened on 15 April 2013. During the recess period, the researcher evaluated all of the students' theory tests and the second part of the practical test, which was based on Wireshark and Microsoft Network Monitor.

### 3.7.9. Week 9 – Revision on all three programs before first test

During this particular week, the researcher discussed the solutions of each exercise for all three programs. Also, the students were given the opportunity to ask questions about specific issues per program.

### 3.7.10. Week 10 – Main test week: Theory and Practical Test 1

The Faculty of Engineering and Information Technology at the CUT had a test week during the first quarter of the first semester. No classes were scheduled during the test week and the students wrote tests for each subject during this week.

On 15 April 2013 the students wrote the first practical test from 9:00 till 11:00. The test consisted of two parts. The students had one hour to complete part 1 of the test, which was based on Packet Tracer. The Packet Tracer test consisted of a network topology that was preconfigured with all the network devices (routers and switches) the students had learned at this stage. The students were given instructions based on certain configurations that had to be made on individual devices, which formed part of the network topology presented in the test.

Packet Tracer allowed the researcher to create a test which automatically evaluated each student's test and, once the test time has expired, the test automatically locked itself and only showed the result. The researcher and student assistants wrote down the PT mark and the students had to sign for the mark recorded after the test was finished.

The second part of the test was based on Wireshark and Microsoft Network Monitor. For this part, the students were given a paper test which contained both the questions and space to answer the questions.

The students were given pre-captured sample files, one on Wireshark and another on Microsoft Network Monitor, which had to be analyzed via both programs respectively. Questions were compiled for both pre-captured sample files. Once finished with the practical test at 11:00, the students returned later in the afternoon to take the theory test at 15:00.

### 3.7.11. Week 11 – SUMI questionnaires completed

During this week, the researcher conducted the usability evaluation. The three groups of SPG1 students completed the SUMI questionnaire based on each program throughout the week. Each group evaluated one program each to minimize any inconclusive results. As the researcher mentioned in chapter 2, the usability testing was conducted in a controlled laboratory environment, lab 226, where the students received initial exposure to all three ICT network programs and also conducted assessments based on each program.

### 3.7.12. Week 12 – Final practical examination

The students took the second and final practical test on Thursday, 9 May 2013, from 16:30 till 18:30. Like the first practical test the students did during week 10, the test consisted of two parts.

Part 1 focused on Packet Tracer for which the students were given one hour to complete. The Packet Tracer test consisted of a network topology that was preconfigured with all the relevant network devices. The students were given instructions based on certain configurations that had to be made on individual devices which formed part of the topology.

Packet Tracer allowed the researcher to create a test that automatically evaluated the students' submissions and displayed their results afterward. The researcher and student assistants recorded the Packet Tracer mark and the students had to sign for it. The second part of the test was based on Wireshark and Microsoft Network Monitor and comprised a paper test which contained both the questions and space to answer the questions.

The students were given two pre-captured sample files, one on Wireshark and another on Microsoft Network Monitor. Questions were compiled for both pre-captured samples respectively.

### 3.7.13.  Week 13 – Final online theory examination

The students wrote their final online theory examination on Thursday, 16 May 2013, from 16:30 till 18:00. They had to complete a compulsory course feedback section on the CNA website that asked general questions about the CCNA curriculum and how the classes were presented. The CNA website evaluated the students' theory test as the students submitted it via the website. The students' marks were recorded into a grade book that is accessible to the researcher and to each student individually.

### 3.7.14.  Week 14 – May/June examination commences

The students' main examination commenced on 20 May 2013. The researcher published the students' final marks on 30 May 2013.

### 3.8.  Conclusion

In chapter 3 the researcher discussed the research design, which included information about the SUMI questionnaire, the analysis of its contents and the statistical data that was obtained during the testing procedure. In the researcher's opinion, there were no possible limitations during the study. However, one could argue the fact that the students were exposed only for two weeks to each program, which could influence the outcome of the questionnaire results, although no proof exists that being exposed to a program for only two weeks will not deliver conclusive results with SUMI.

# CHAPTER 4: RESULTS – PRESENTATION AND DISCUSSION

## 4.1. Introduction

Chapter 4 discusses the results and the strength and weakness analysis of the five SUMI subscales. Table 4.2.7.1 provides a summarized output of the average scores of the SUMI scales. The researcher concludes the chapter with suggestions as to possible improvements for each of the three ICT network programs as identified by the students via the free-form statements.

## 4.2. Combining research results with literature review

Usability plays a vital part when it comes to software products. When testing a product in practice, however, not a great deal of attention has been paid to this aspect. For this study, the students were the testers evaluating the software they have been using to learn about ICT networks. None of the students had proper knowledge or the relevant tools to conduct a usability test, seeing that they're not experts in the field of usability testing. For this reason, SUMI provided an easy and cost-effective way for the students to evaluate the usability of the three ICT network programs.

Conducting usability testing with SUMI allowed the researcher to:

- establish which of the three ICT network programs is the best from a usability perspective when compared to one another using the SUMI subscales, contents, and strength and weakness analysis
- establish whether the three ICT network programs can contribute to better understanding and learning of ICT networks
- establish whether the quality of use of the three ICT network programs are up to standard

As mentioned in chapter 2 (see 2.8), SUMI combines a global usability figure in conjunction with five different subscales on which the researcher evaluated the students' questionnaire responses.

The strength rating from the strength and weakness analysis (which is discussed as part of the six SUMI subscales below), is a probability rating and is measured as a percentage value. The strength statistic shows the probability (based on the chi squared distribution) that the students' responses to a specific SUMI question, differed overall from chance. In contrast, the 6 SUMI subscale metric scores represent points on a scale and therefore aren't represented as percentages.

### 4.2.1.    Global

The Global scale consists of 25 items out of the 50 on the questionnaire, and focuses heavily on a *general usability* factor. The Global scale was produced in order to represent the single construct of *perceived quality of use* better than a simple average of all the items of the questionnaire (Kirakowski, 1994).

According to Kirakowski (1994), the properties of the standard normal distribution indicate that over 68% of the software will find a score on the SUMI scales within one standard deviation of the mean, which lies between 40 and 60. This implies that software ranked above (or below) these points is already, by definition, well above (or below) average. All three ICT network programs scored above the global average for SUMI, but were found to be significantly different from one another at the p<0.05 significance level.

When comparing all three ICT network programs against one another on the global scale, Packet Tracer was ranked first, Wireshark second and Microsoft Network Monitor third. The researcher can conclude that all three ICT network programs showed a good degree of *quality of use* based on the global scale.

### 4.2.2.    Efficiency

Efficiency is defined as *the extent to which the user can achieve his goals of his interaction with the product in a direct and timely manner*. The efficiency metric scores are all statistically significant and, therefore, can be taken as rankings for the scales, i.e. Packet Tracer is the most efficient and has the greatest affect. Wireshark is second and Microsoft Network Monitor is third. All are above the norm, however.

In the strength and weakness analysis, all three ICT network programs scored high (99%) on agreement with question #28: "The software has helped me overcome any problems I have had in using it". This reflects the high scores for efficiency across all systems.

Microsoft Network Monitor is the only system not to feature question #39: "It is easy to make the software do exactly what you want" (Microsoft Network Monitor = 97.7% agreement, Wireshark = 99.9%, Packet Tracer = 99.9%). Question #34, however, gave an undecided decision for Wireshark, leaving users feeling they may not have been economical with their key strokes.

Packet Tracer's interface would indicate a lower score on efficiency. Packet Tracer has a connection in the content analysis between what the students use it for and what its best aspect is. In the end this could be among the reasons as to why students found it to be more efficient than Wireshark and Microsoft Network Monitor.

### 4.2.3. Affect

Affect relates to *the extent to which the product captures the user's emotional response.* The affect metric score is compiled via the questionnaire responses on certain questions related to emotional response. The questions pose a variety of emotions ranging from satisfaction, mental stimulation, frustration, tension and awkwardness. A few examples of the emotional response questions include the following:

- Working with this software is satisfying
- Working with this software is mentally stimulating
- Using this software is frustrating
- There have been times in using this software when I have felt quite tense
- This software is really very awkward

The feeling that Microsoft Network Monitor was quite awkward (question #47 agree=99.9%) and that there is a lack of consistency in the information provided through the system (question #43 agree=99.9%) could account for its relatively low score on affect.

On the other hand, the students felt that Packet Tracer had taken their needs into consideration (question #31 agree=99.9%), that the software was easy to use (question #39 agree=99.9%) and that, overall, the users enjoyed using the software (question #46 agree=99.9%). Wireshark users felt that working with the system was also satisfying (question #46 agree=99.9%) and that the user had been considered in the design of the software (question #31 agree=99.9%).

Packet Tracer was rated as the program which captured the highest emotional response, with an average metric score of 64.50. Wireshark was ranked second with an average metric score of 59.27 and Microsoft Network Monitor ranked third with an average metric score of 53.59.

### 4.2.4. Helpfulness

Helpfulness is defined as *the extent to which the product seems to assist the user*. In the researcher's opinion, helpfulness can be twofold with regard to this study. First, it can refer to the program's ability to assist the user by providing adequate help on a certain program feature. Secondly, it can refer each program's ability to help the users (students) learn about the functioning of ICT networks.

Help features can include either context sensitive help (also known as "popup text", which appears when hovering with the mouse over a certain button/option) or the program's built-in help function which lists all available features the program supports and how to use each feature.

From the strength and weakness analysis for all three ICT network programs, question #15:"The software documentation is very informative" shows a strong rating for all three programs for the overall quality of the documentation (Packet Tracer = 99.8%, Wireshark=95.7% and Microsoft Network Monitor =99%).

The next three sections will show each program's help functionality and how they compare with one another.

### 4.2.4.1. Helpfulness for Packet Tracer
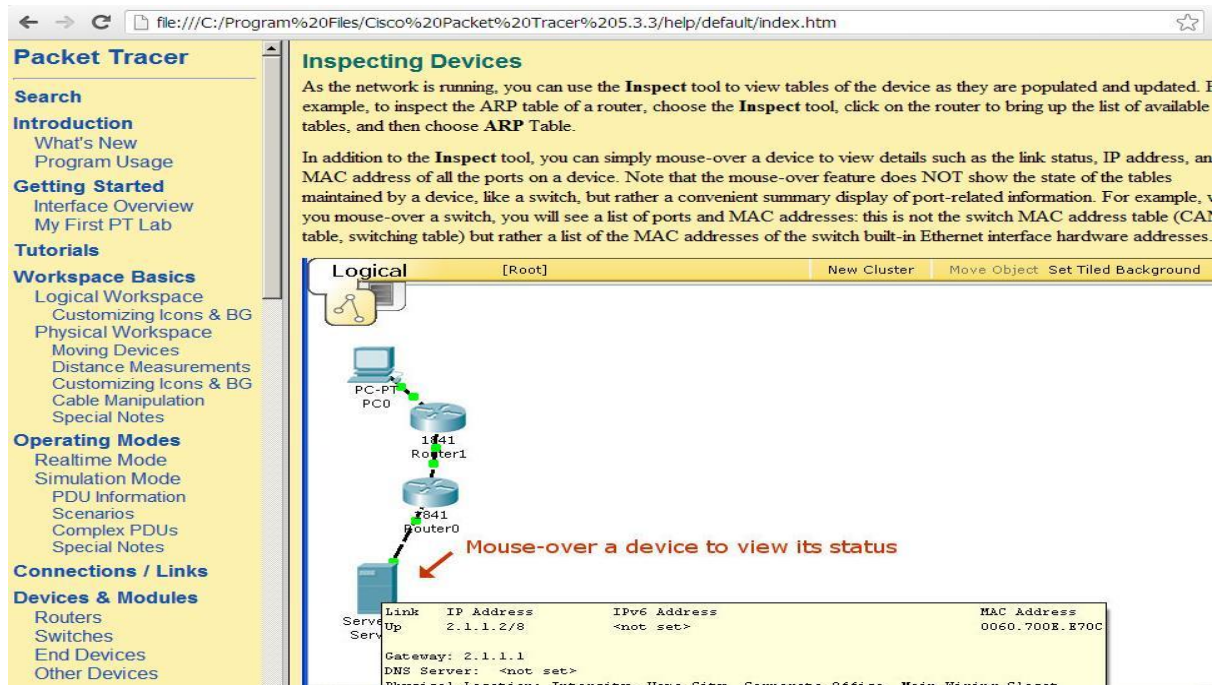


**Figure 4.2.4.1** *Packet Tracer's HTML help function open in Google Chrome*

Packet Tracer's help feature is accessed from within the program's help menu. The help feature opens in a web browser on the user's computer (figure 4.2.4.1). Each page of the help feature is an HTML-based webpage and has hyperlinks on a menu on the left-hand side that makes it easy to navigate the different sections of the help feature. The Helpfulness SUMI metric score for Packet Tracer was 62.86.

**4.2.4.2. Helpfulness for Wireshark**
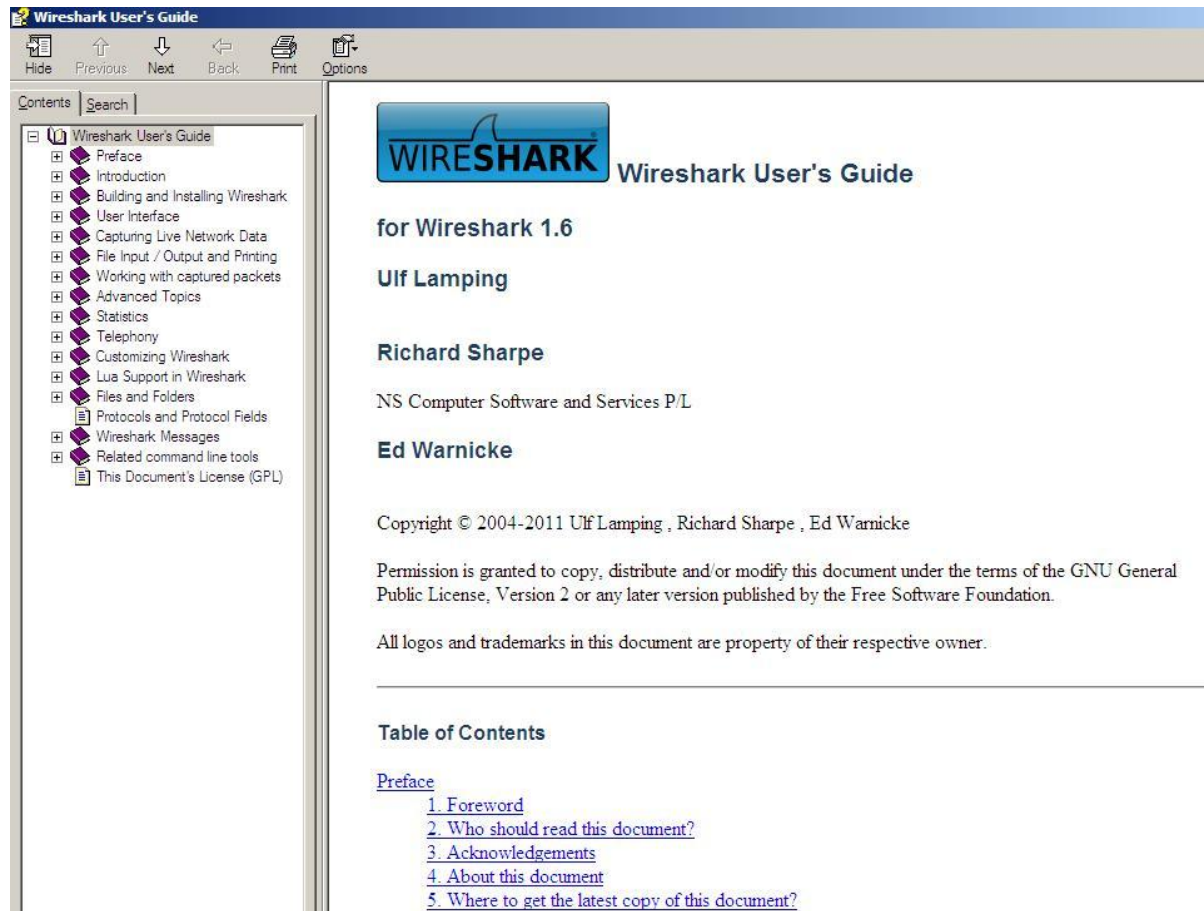


***Figure 4.2.4.2*** *Wireshark's HTML-based help file*

Wireshark features an HTML-based help file that can be opened via the program's help menu. The help file launches separately from the program as "Wireshark's User Guide" (figure 4.2.4.2). Wireshark features a similar type of menu on the left-hand side through which the user can click on any of the available sections to access help on a specific feature. The user also has the ability to search for help on a specific topic. The Helpfulness SUMI metric score for Wireshark was 58.71.

### 4.2.4.3. Helpfulness for Microsoft Network Monitor
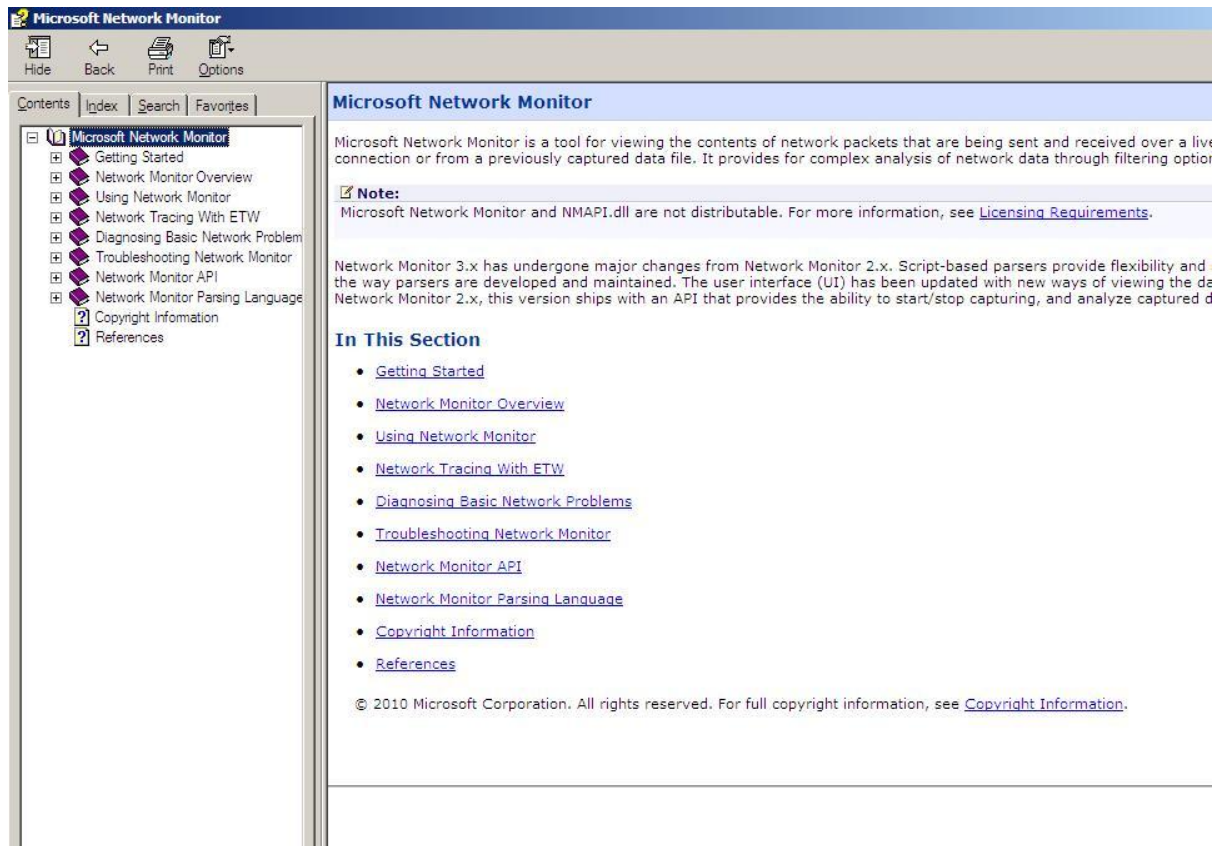


***Figure 4.2.4.3*** *Microsoft Network Monitor's HTML-based help file*

Like Wireshark, Microsoft Network Monitor also features an HTML-based help file that can be accessed via the program's help menu. The help file also launches separately from the program (figure 4.2.4.3) and features a menu system on the left with all the different help topics available for the program. The user also has the ability to search for a specific help topic. The Helpfulness SUMI metric score for Microsoft Network Monitor was 56.48.

Regarding the strength and weakness analysis, question #8:"I find that the help information given by this software is not very useful "yielded a score of 99.9% for Packet Tracer, 92.8% for Wireshark and 64.7% for Microsoft Network Monitor on the disagree option. This means that more students rated Microsoft Network Monitor's help information as problematic.

A possible reason for Microsoft Network Monitor's low score in this category is the fact that the help menu has an additional "How Do I?" menu which provides only seven help topics (see figure 4.2.4.4).
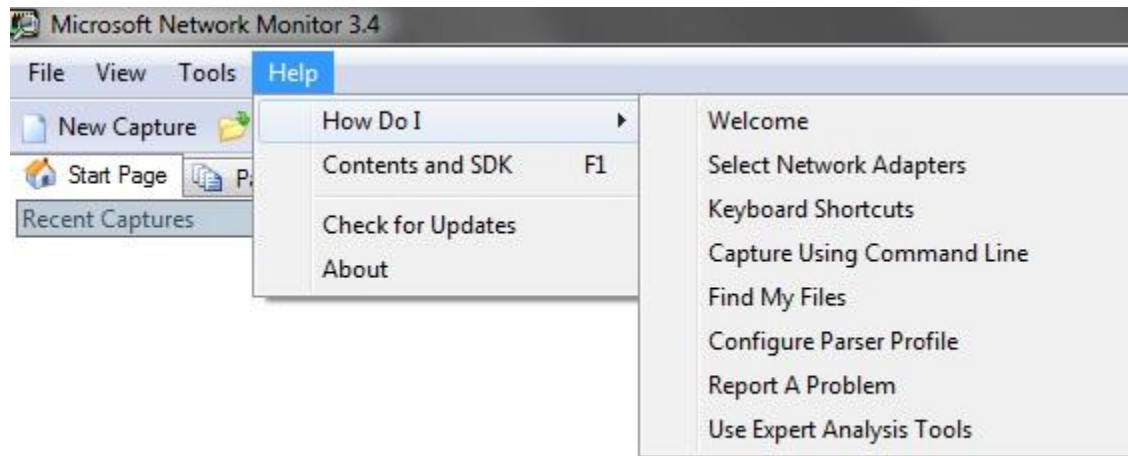


*Figure 4.2.4.4* The "How Do I" help menu with seven help topics

Seeing that this option is listed first on the help menu, one could assume that this would provide relevant help for any given problem at hand. Instead, it only lists seven help topics and a welcome topic which addresses certain elements of the interface. This can be seen as a possible design flaw in the help feature of Microsoft Network Monitor, which could easily be addressed in future revisions by either removing the "How Do I" menu option completely or by reorganizing the help menu list by placing the "Contents and SDK option" first on the help menu.

The strength and weakness analysis question #43:"Either the amount or quality of the help information varies across the system" yielded a score of 19.3% of students agreeing with this statement for Packet Tracer. In contrast, Wireshark and Microsoft Network Monitor scored 96.6% and 99.9% respectively. This further proves that Packet Tracer's helpfulness was the best among all three programs. From table 4.2.7 we can conclude that Packet Tracer was rated as the most helpful program according to SUMI's helpfulness metric.

Wireshark and Microsoft Network Monitor scored very close to each other and can be seen as equal in terms of helpfulness, with the exception of the help information score of Microsoft Network Monitor.

Helpfulness can also translate into learning, which the researcher will cover when discussing the learnability subscale in section 4.2.6.

### 4.2.5. Control

Control according to the literature review is defined as *the extent to which users feels they, and not the product, are setting the pace.*

In the strength and weakness analysis for all three ICT network programs, with regard to question #19: "I feel in command of this software when I am using it", the results indicate that the students felt in complete control of Packet Tracer (agree=99.9%).

Wireshark scored a much lower rating (agree=31.3%), which indicates that some of the students struggled when operating the program. Microsoft Network Monitor (disagree=2.9%) was seen as most problematic of all three ICT network programs for the control metric.

In the researcher's opinion, Packet Tracer is graphically more appealing with regard to control. The user is in charge of building a network by selecting various components to construct topology. Students can see their creation take form with the various networking devices available in Packet Tracer. The students can also arrange and connect the devices in any order they see fit.

Although Wireshark and Microsoft Network Monitor don't allow the user to build any topologies like Packet Tracer, it does allow the user to configure each program according to certain aspects, such as the amount of time required to capture traffic, to filter for certain packet types from captured traffic and to select a network interface on which to capture traffic.

As both Wireshark and Microsoft Network Monitor are similar in function, there was no vast difference in the control metric score between them, with Microsoft Network Monitor scoring 55.79 and Wireshark scoring 57.23. Packet Tracer was ranked first, with an average control metric score of 63.05.

### 4.2.6. Learnability

Learnability is defined *as the ease with which a user can get started and learn new features of the product.* The strength and weakness analysis for all three ICT network programs with regard to learnability delivered quite a number of results.

When the students started working with each of the three programs, question #5:"Learning to operate this software initially is full of problems" indicated that the students disagreed on this statement with regard to Packet Tracer (disagree=99.9%) and Wireshark (disagree=65.3%).

Microsoft Network Monitor scored the lowest for this question; only some of the students disagreed with the statement (tend to disagree=52.9%). Overall, all three programs can be seen as problem free with regard to learning and using each of the three ICT network programs for the first time.

As first-time users of the three ICT network programs, the students agreed that question #35:"Learning how to use functions is difficult" for Microsoft Network Monitor is true (slightly agree=74.4%). In contrast, the functions of Packet Tracer (disagree=97.7%) and Wireshark (slightly disagree=91.2%) proved easier for the students.

With regard to the time taken to learn new functions of each ICT network program, the students disagreed on question #10:"It takes too long to learn the software functions" for Packet Tracer (disagree=91.3%). It proved to be more difficult to learn the respective functions of Wireshark (slightly agree=86.1%) and Microsoft Network Monitor (slightly agree = 42.3%) as the students felt the functions of these two programs are troublesome.

Students disagreed with question #40:"I will never learn to use all that is offered in this software", and were keen to learn all the functions that each program had to offer (Packet Tracer=99.9%, Wireshark=65.3% and Microsoft Network Monitor=13.2%). From the free-form statements (on the uses and best aspects of each ICT network program, see 4.2.8), it is worth mentioning the following with regard to learnability. A total of 61% of the students identified Packet Tracer's best use as "Aids learning of networks" (see figure 4.2.8.2).

A total of 34% of the students identified that Wireshark contributed to "Learning about network traffic" (see figure 4.2.8.3). In contrast, Microsoft Network Monitor scored only 23% with regard to "Aids in learning about network traffic" (see figure 4.2.8.4). The researcher concluded that Packet Tracer was ranked first, with a metric score of 61.64, as it scored the highest among all the ratings for the learnability subscale. Wireshark was ranked second with a score of 56.85, and Microsoft Network Monitor was ranked third with a score of 51.70.

A possible reason for Microsoft Network Monitor's low score is the fact that, from a customizability standpoint, the students felt that the filtering option to distinguish between different network protocols were neither adequate nor user friendly. This shortcoming was identified in the free-form statements the students specified for Microsoft Network Monitor and, therefore, the program contributed the least in terms of learnability.

### 4.2.7. Summarized results of the SUMI subscale values

*Table 4.2.7.1* *Summarized SUMI subscale metric averages for each ICT network program*

|  | Global | Efficiency | Affect | Helpfulness | Control | Learnability |
|---|---|---|---|---|---|---|
| Packet Tracer | 64.86 | 63.40 | 64.50 | 62.86 | 63.05 | 61.64 |
| Wireshark | 60.67 | 60.94 | 59.27 | 58.71 | 57.23 | 56.85 |
| Microsoft Network Monitor | 56.07 | 55.09 | 53.59 | 56.48 | 55.80 | 51.70 |

### 4.2.8. Summary of best aspects and uses per program

The following figures illustrate a thematic breakdown of the free-form questions on the uses and best aspects of each program as identified by the students. The researcher provided a brief discussion underneath each figure.



**Uses of Packet Tracer**
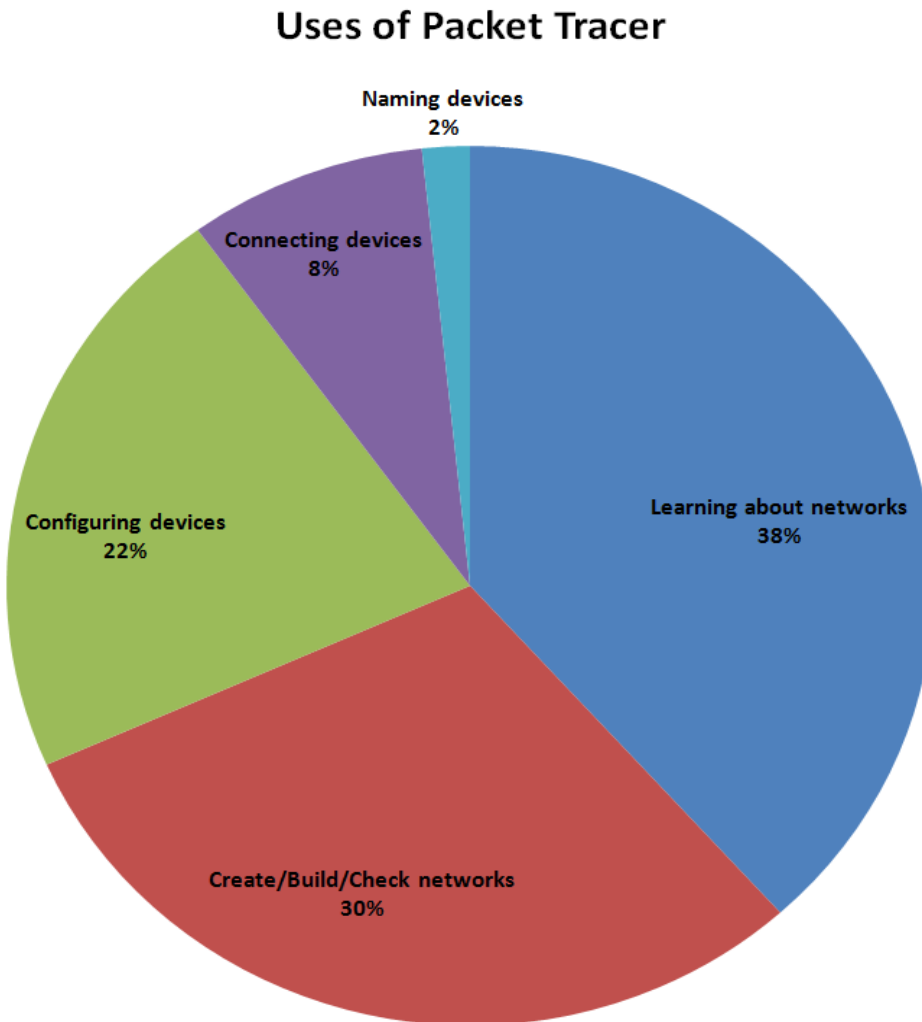
*Figure 4.2.8.1 Different uses of Packet Tracer as identified by students*

One can clearly see that learning and the ability to create and build networks with Packet Tracer make up 68% of the overall responses recorded. Configuring devices, which make up 22% of all the responses, refer to the different Cisco routers and switches as well as PCs that can be configured in Packet Tracer as part of building a virtual topology.

Furthermore, 8% of the students indicated that Packet Tracer also helped them to learn how to connect the different devices to each other. The final 2% indicated that it also helped in specifying names for each device.
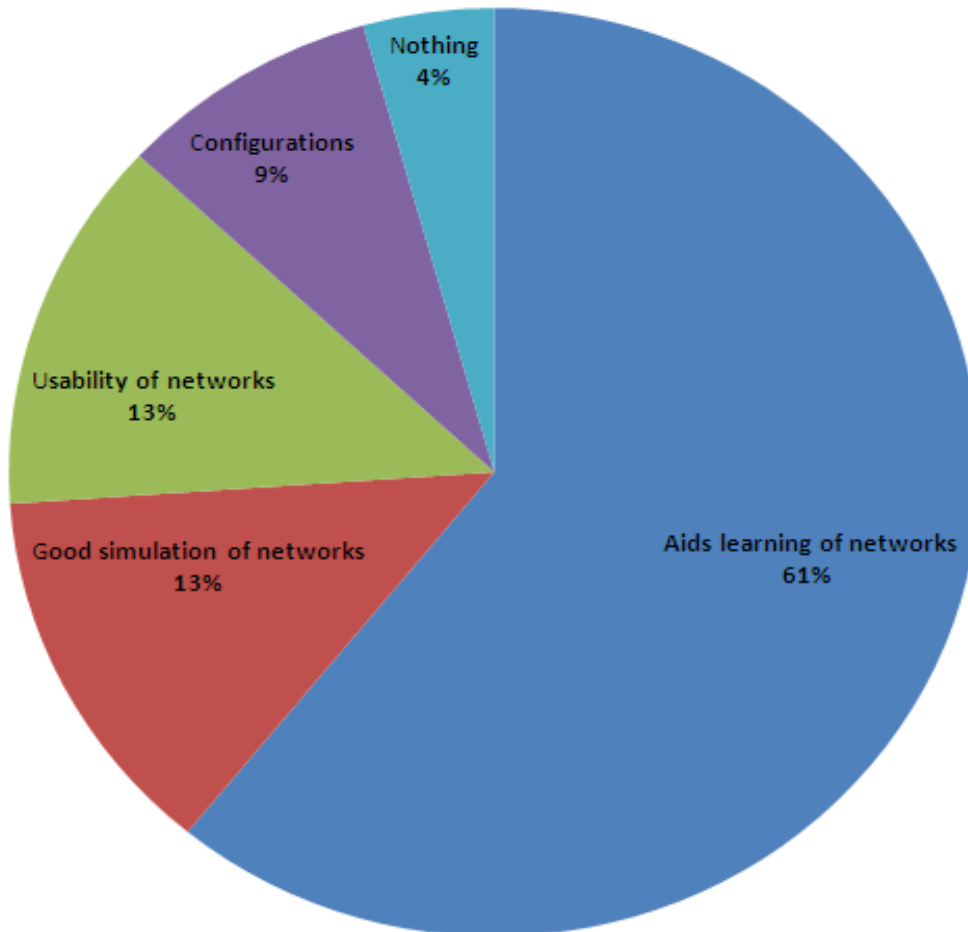


*Figure 4.2.8.2 Best aspects of Packet Tracer as identified by students*

From the chart, it is evident that 61% of the responses indicate that Packet Tracer aids the learning of ICT networks. Packet Tracer also provides a good simulation of networks (13%) by allowing its users to build a virtual topology, to understand how to use networks (13%), and configure the devices (9%). Interestingly, 4% of the responses showed that none of Packet Tracer's aspects was seen as best or useful.

54
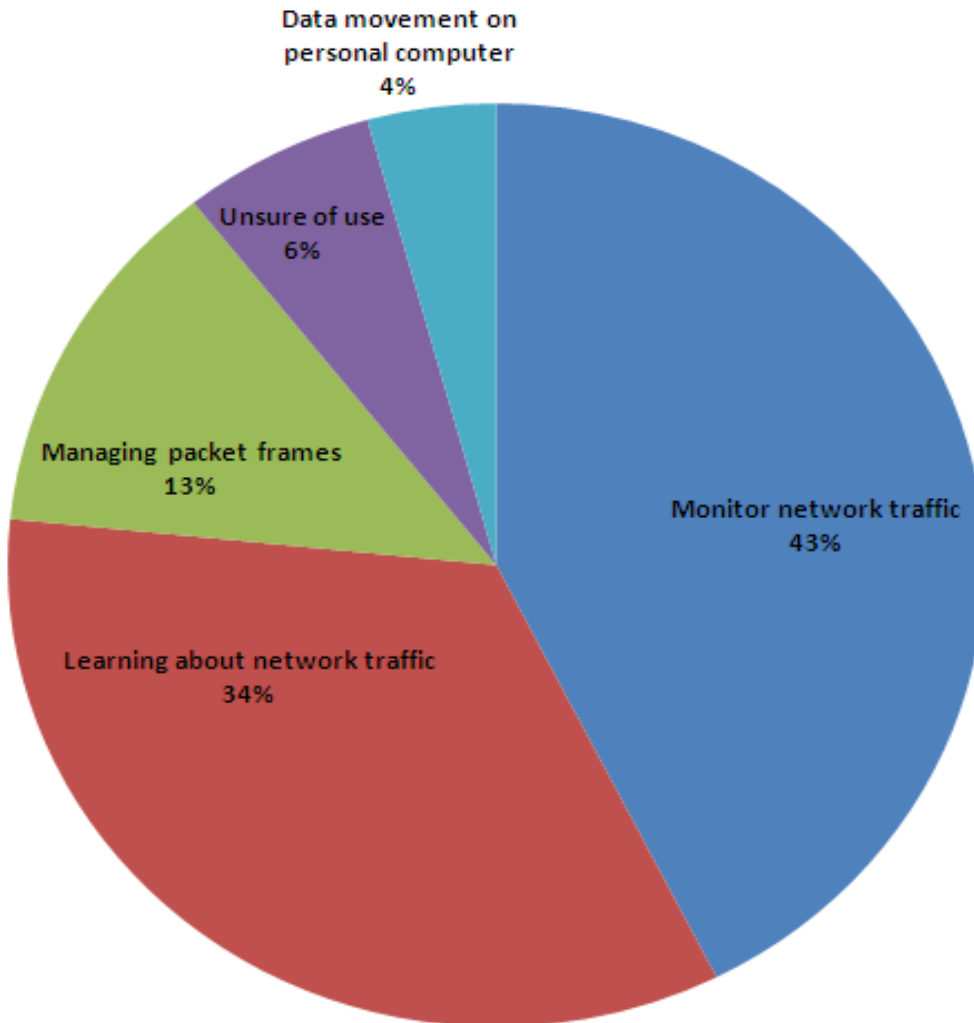
# Uses of Wireshark



**Figure 4.2.8.3** *Different uses of Wireshark as identified by students*

One can clearly see two major uses stand out for this network traffic analyzer program. "Monitoring network traffic" (43%) allowed the students to see various types of packets become captured from the lab's LAN. "Learning about network traffic" (34%) indicates that the program does provide learnability when dealing with network traffic. Another key factor that was identified is the ability to manage packet frames (13%). Wireshark does give the user the ability to filter for certain types of network traffic according to different protocols such as TCP, UDP and HTTP."Data movement on personal computer" (4%) isn't a valid function associated with Wireshark, and 6% of the responses indicated that some students were not sure what Wireshark can be used for.

# Wireshark: Best aspects
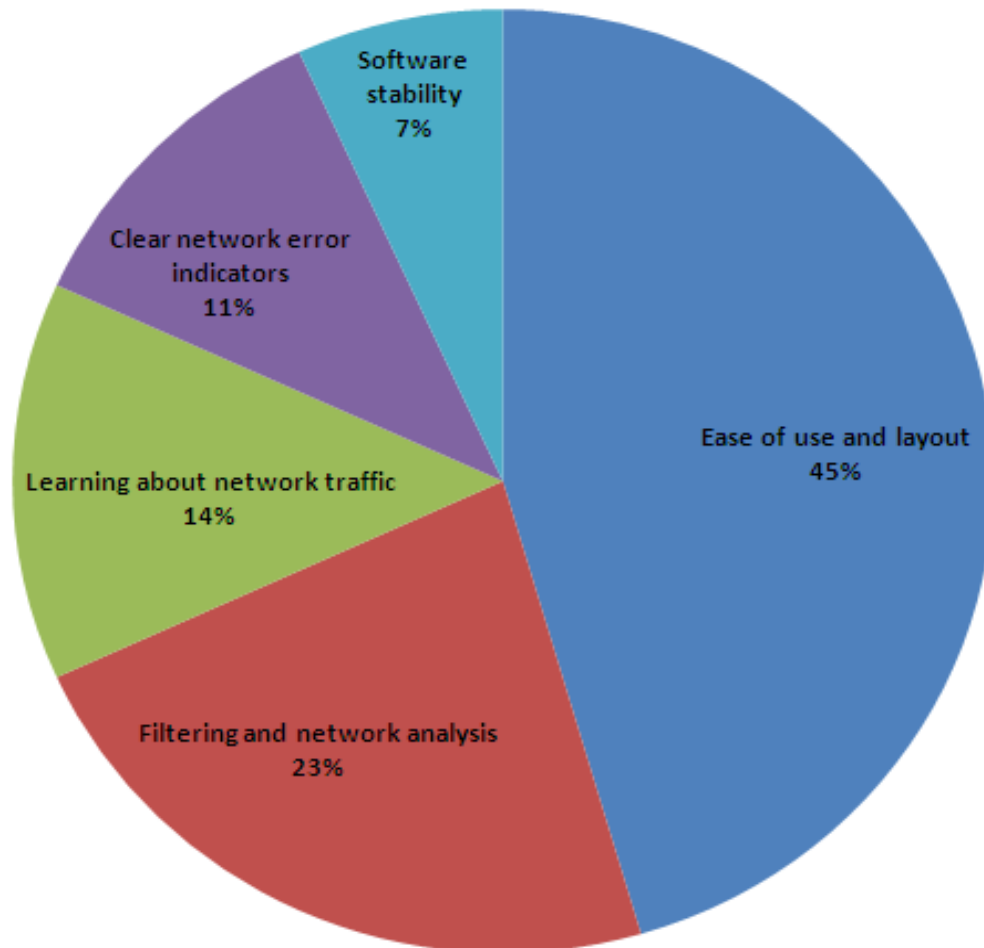


*Figure 4.2.8.4 Best aspects of Wireshark as identified by students*

The students identified Wireshark as easy to use and its general layout as one of the program's best aspects (45%). Wireshark provides the option to filter for network traffic with the built-in filter function and allows one to analyze the contents of each network packet that has been recorded on a network (23%). The students identified that Wireshark allowed them to learn about network traffic (14%). Furthermore, the program allowed the students to identify which packets are problematic (11%) by highlighting them in a different colour. Wireshark was also identified as being very stable and not prone to any crashing when the students worked with the program (7%).

## Uses of Microsoft Network Monitor
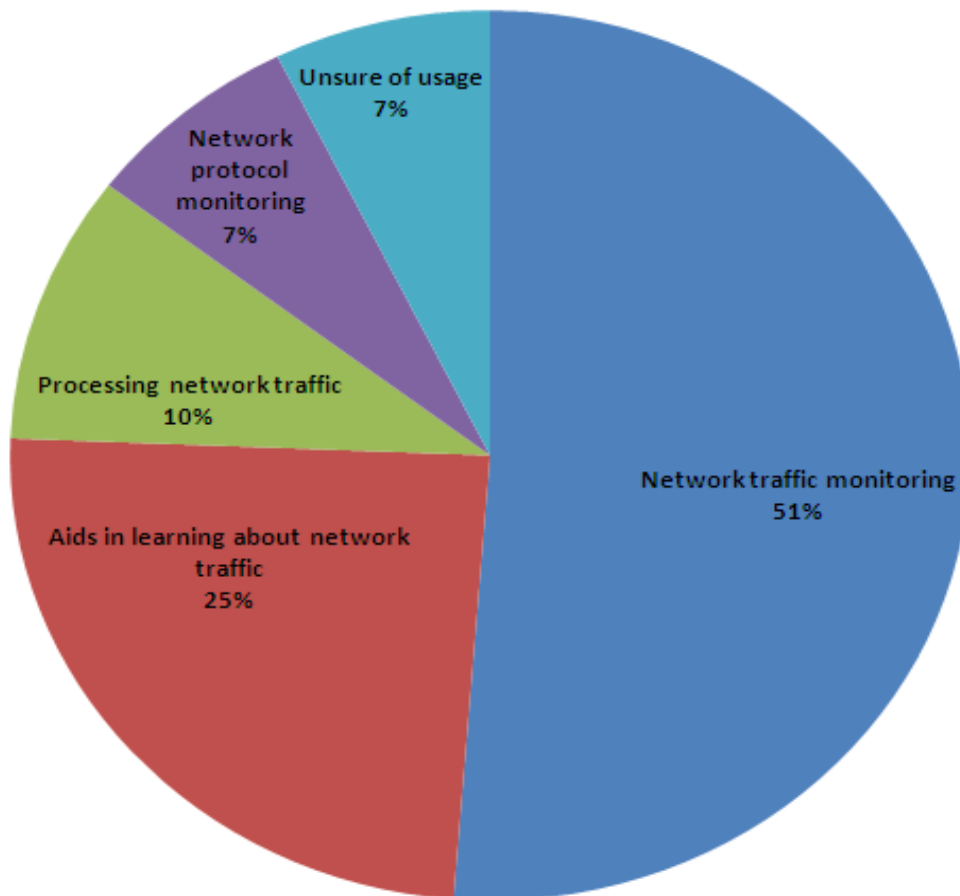


*Figure 4.2.8.5 Different uses of Microsoft Network Monitor as identified by students*

Once again, two major uses stand out clearly for Microsoft Network Monitor as a network traffic analyzer program. "Network traffic monitoring" (51%) allowed the students to see various types of packets become captured from the lab's LAN. "Aids in learning about network traffic" (25%) indicates that the program does provide learnability when dealing with network traffic."Processing network traffic" (10%) further indicates that students interpret the functionality of the program processing network traffic. "Network protocol monitoring" (7%) can be identified as the program's ability to help distinguish between the different network protocols such as the transmission control protocol (TCP), user datagram protocol(UDP) and file transfer protocol (FTP). Seven (7%) of the students were unsure of the functionality of the program.

## Microsoft Network Monitor: Best aspects
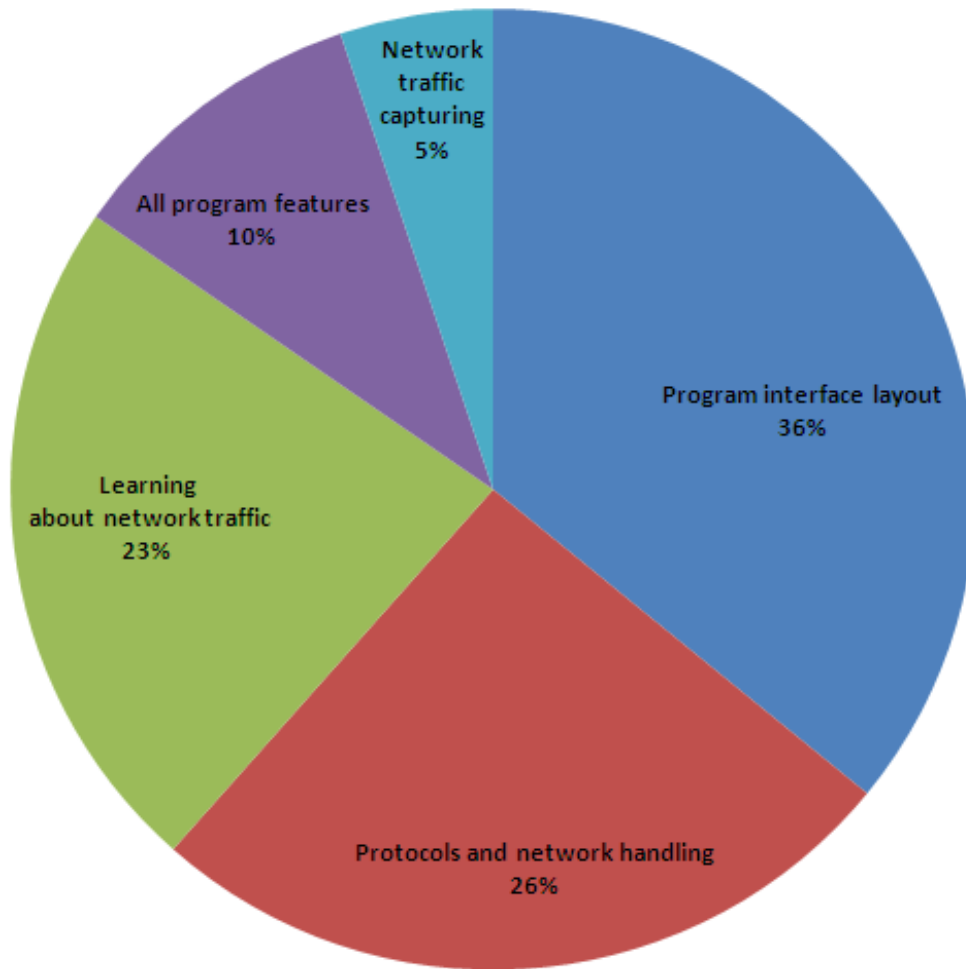


***Figure 4.2.8.6*** *Best aspects of Microsoft Network Monitor as identified by the students*

"Program interface layout" (36%) was identified as the best aspect of Microsoft Network Monitor. The program allows the user to customize the layout of the interface in three different styles. "Protocols and network handling" (26%) is also easily distinguishable in the program due to the simplistic layout of the interface. "Learning about network traffic" (23%) was identified as the third best aspect which, again, promotes learnability of the network traffic and identifies the different types of network protocols. In addition to Microsoft Network Monitor's interface layout, the students responded that "All program features" (10%) can be seen as a best aspect overall. "Network traffic capturing" (5%) rounds off the last key component with regard to the best aspects of the program.

### 4.3. Suggested improvements and recommendations

For each program, the students suggested possible improvements. These improvements form part of the free-form statements the students answered on the SUMI questionnaire. The question: "What do you think needs improvement and why?" was issued to the students and they responded with suggestions. The researcher compiled all the responses for this question and illustrated them by means of a pie chart per program to highlight the key differences between the suggested improvements. In closing, the researcher will summarize the most notable and interesting suggestions for each program.

### 4.3.1. Packet Tracer improvements
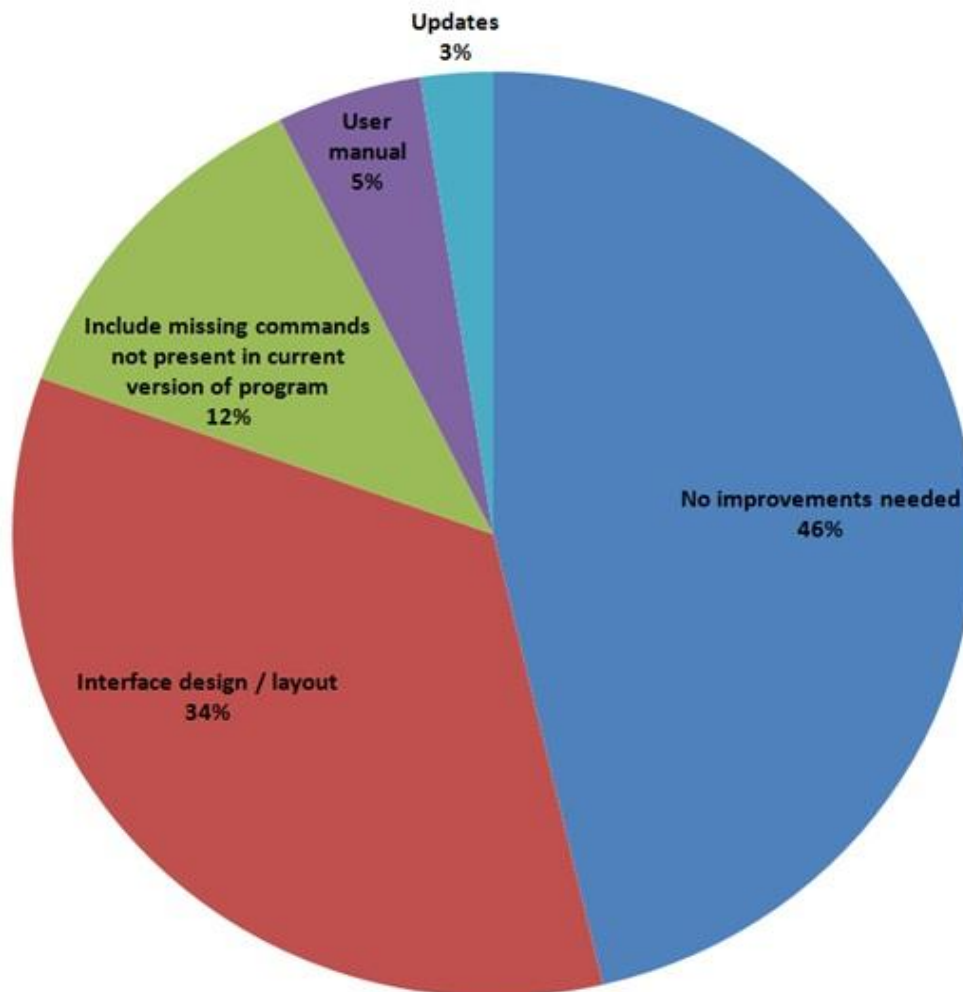


***Fig 4.3.1.1*** *Improvements suggested by students for Packet Tracer*

Nearly half of the students (46%) was satisfied with Packet Tracer in its current state and didn't feel it needed any improvement. A total of 34% thought the interface design and layout could use improvement as some students found the interface to be "dull, unattractive and not user friendly". Some configuration commands that work on the real equipment were not included in Packet Tracer and 12% of the students felt that this aspect needs to be addressed.

A few students (5%) felt that the manual needs to be addressed by "shortening" it somewhat. Some students also felt that the program should be regularly updated to include any new functionality to the program.

### 4.3.2. Wireshark improvements
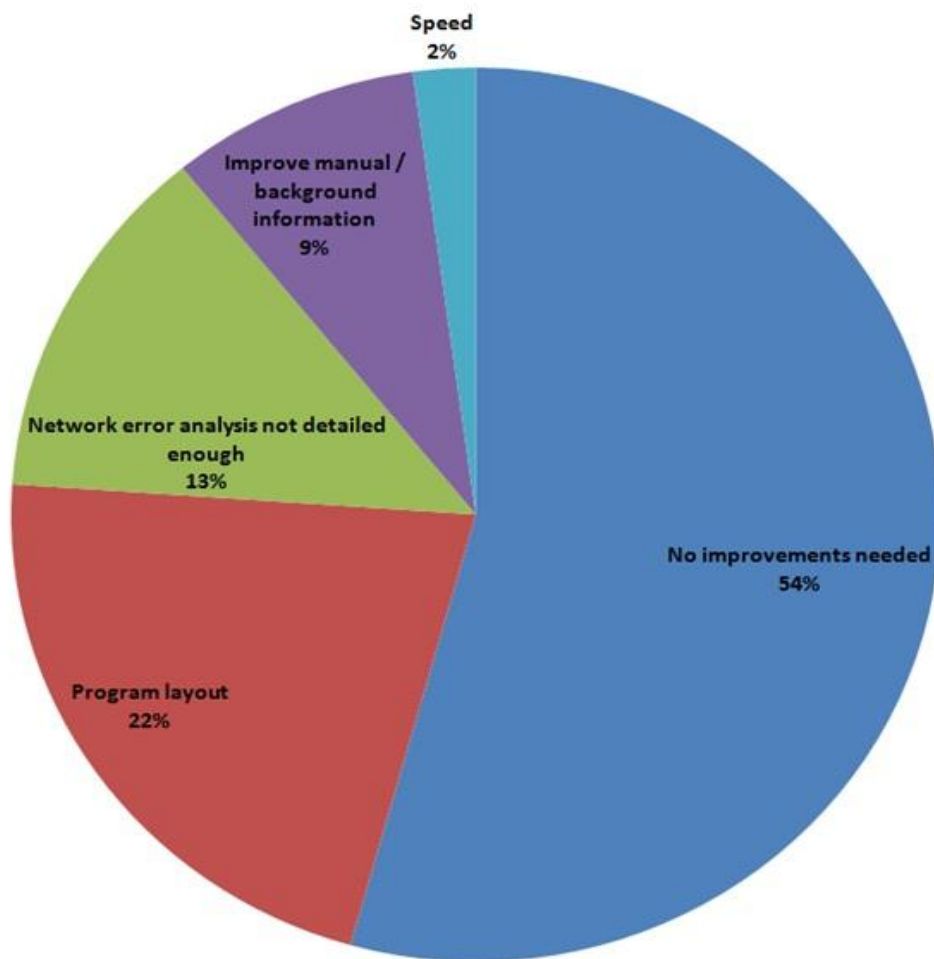


*Fig 4.3.2.1 Improvements suggested by students for Wireshark*

More than half of the students (54%) who evaluated Wireshark felt that the program didn't need any improvement as it is "easy to learn and understand". A total of 22% of the students felt the layout of the program's menu needed improvement as some found it hampering their productivity in using the program. The identification of problematic network packets was difficult to interpret as the network error analysis was not detailed enough (22%) for them to interpret the information displayed by the program. Some students felt Wireshark's manual could use improvement (9%) as well as more background information on how to use the program and how it relates to real-world scenarios. One student (2%) felt that the start-up time of the program is too long and should be improved.

### 4.3.3. Microsoft Network Monitor improvements
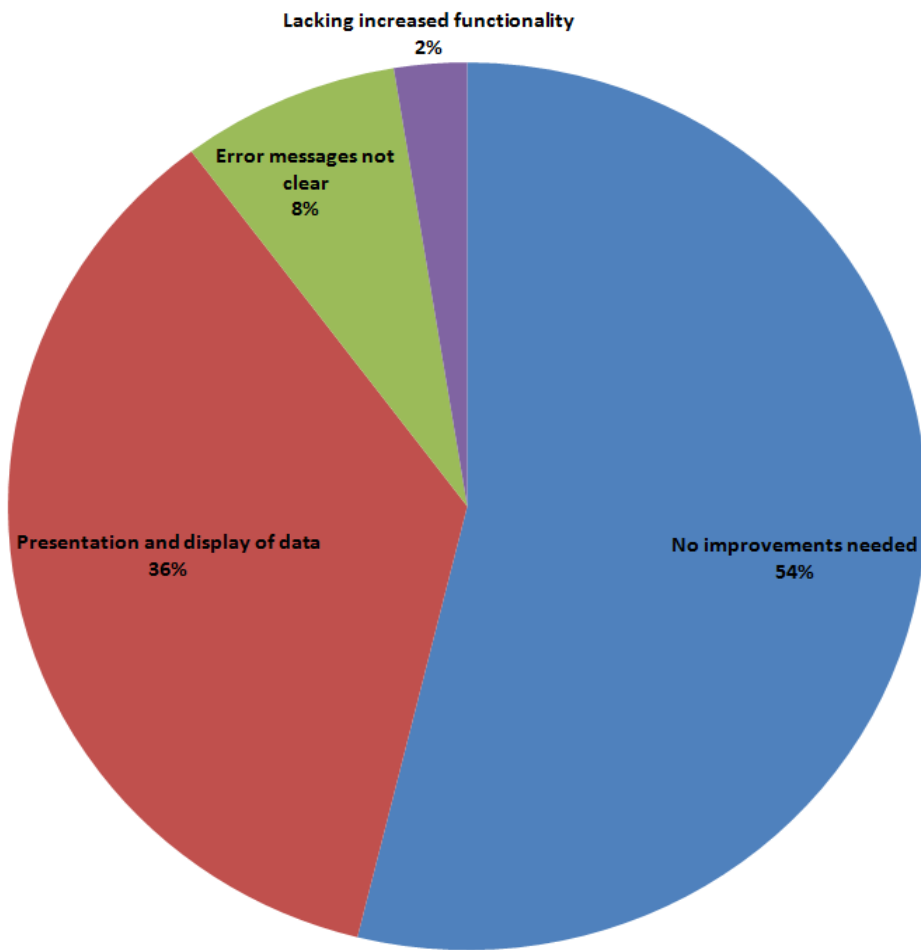


*Fig 4.3.3.1 Improvements suggested by students for Microsoft Network Monitor*

A total of 54% of the students who evaluated Microsoft Network Monitor felt that the program satisfied their needs and made no suggestions for improvement. However, the presentation and display of data (36%) were troublesome. Students felt that the "menus weren't user friendly" and that "colour should be used to differentiate between the various protocols to make it more attractive".

Microsoft Network Monitor's error message displays were not clear as 8% of the students felt the help documentation and error messages were not adequate. One student (2%) felt that the program should have additional functionality to make the program more fun to use.

## 4.4. Conclusion

The researcher started the chapter by discussing the results of the study and how they relate to the literature review. Next, the researcher provided the results of the strength and weakness analysis from the SUMI questionnaires the students completed at the end of the study.

Looking at the summarized SUMI scores in table 4.2.7.1, one can see that Microsoft Network Monitor scored the lowest with regard to affect and learnability compared to the other two programs for these two subscales. This means that Microsoft Network Monitor invoked a greater emotional response and didn't contribute as much from a learning perspective.

In contrast to these negative aspects for Microsoft Network Monitor, all three ICT network programs scored above the standardization average of 50 in SUMI's database for each of the five SUMI subscales. In respect of the Global subscale, all three programs scored above 50 as well, which reflected in a positive for each program with regard to quality of use.

# CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

## 5.1. Introduction

This chapter discusses the analyses of each ICT network program based on the SUMI questionnaires the SPG1 students completed. First, a summary is provided of all three programs, discussing their sample sizes and how they scored based on the SUMI metrics comprising the five subscales discussed in chapter 2. Next, the SUMI scores are analyzed by referencing multi-factorial ANOVA scores, as well as the significance level (p-level), to highlight key differences between the three programs.

The content analysis is then discussed, which is based on the free-form questions (see appendices B, D, F) the students had to answer for each program. The strength and weakness analysis (see appendices A, C, E) indicate the students' responses to the five SUMI subscales, and the general usability factor is also discussed.

All output (5.2 to 5.5 and 5.9) discussed in this chapter is based on reports that were generated by the SUMISCO program and compiled by Tadeusz Kirakowski on behalf of the researcher. For the purpose of this chapter, the ICT network programs are referred to as "systems". The researcher will conclude the chapter with a discussion of the relevance of the study, possible practical implications as well as any aspects that require further research.

## 5.2. Summary of analysis

Three ICT network programs were analyzed for usability. Sample sizes were adequate (Packet Tracer n=42, Microsoft Network Monitor n=44, and Wireshark n=48). All three ICT network programs scored above average on the SUMI scales. All three systems scores were found to be significantly different from one another. Packet Tracer was the strongest performing system across all SUMI metrics. The ability to learn using the system (Packet Tracer) was identified as a very strong positive – through the SUMI metrics (scoring well above the other systems for learnability), the statements identified in the strength and weakness analysis, and the free-form statements. Wireshark was the second highest scoring system, and Microsoft Network Monitor was the lowest scoring.

### 5.3. SUMI scores

Three ICT network programs were evaluated against six SUMI scales with a between-subjects error term for the scales and interaction effects. SUMI is calibrated in such a way that a score of 50 is an average score on the SUMI database, and each increment of 10 represents one standard deviation (see figure 5.3.1).
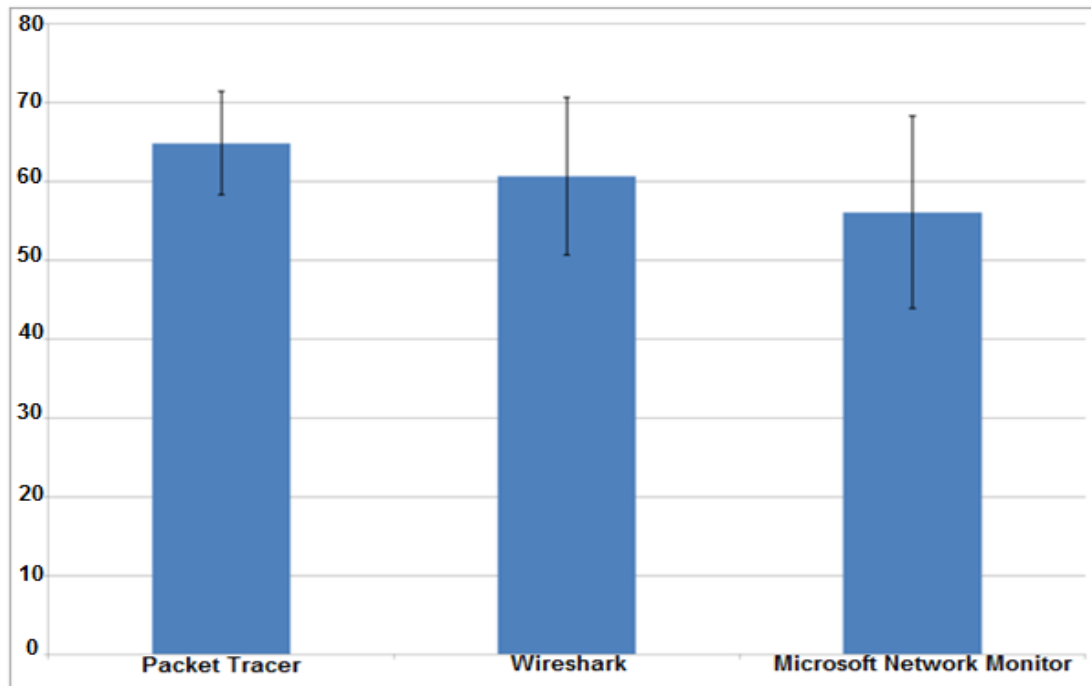


*Figure5.3.1* *Global SUMI scores and standard deviations for the three ICT network programs*

All of the scores were found to be significantly different from one another at the p<0.05 level, with the exception of the comparison of Control score between Microsoft Network Monitor (55.79) and Wireshark (57.23).

Microsoft Network Monitor scored the lowest on the Global metric (56.07+/−12.19) and across all metrics. The score for Control was similar to that for Wireshark. The scores were all still above the average for SUMI.

Packet Tracer scored the highest of all three systems with its Global metric score of 64.86. The students found that this software best met their needs across all SUMI metrics. It is important also to note that users of Packet Tracer predominantly identified themselves as "Very experienced and technical" (n=20/42), with 19/42 identifying themselves as "Good but not very technical".

By contrast, for both Microsoft Network Monitor (n=20/44) and Wireshark (n=18/48), users predominantly identified themselves as "Good but not very technical". This may represent a sampling bias as all three systems are designed for very experienced and technical personnel.

## 5.4. Content analysis

In general, the responses for Microsoft Network Monitor and Wireshark tended to be similar. With regard to Packet Tracer, however, a stronger connection was shown between the statements of what it was being used for and what users believed the best aspects of the system were. The following three sections describe the free-form statements with regard to uses, best aspects and possible improvements the students identified for each ICT network program:

### 5.4.1. What, in general, do you use this software for?

A total of 38% of responses associated Packet Tracer most closely with Learning, while Microsoft Network Monitor and Wireshark were both identified primarily as having network monitoring as their primary usages (51% and 43% respectively), while learning is identified as a secondary use (24% and 34% respectively). The spread of responses was more even in Packet Tracer, with network building (30%) and configuration (22%) being the second and third most common uses.

### 5.4.2. What do you think is the best aspect of this software, and why?

Wireshark and Microsoft Network Monitor had a similar breakdown in answer to this question, with 45% of Wireshark responses referencing the layout or usability, and 36% of Microsoft Network Monitor mentioning the same aspect. Network handling and analysis were identified by 23% as the best feature of Wireshark and by 26% of Microsoft Network Monitor.

The vast majority of Packet Tracer responses identified that the system aids in learning (61%), which was classified as its best aspect. The simulation capabilities and usability of the system was identified as joint-second best aspect. For reference, see figure 4.2.8.2.

### 5.4.3. What do you think needs most improvement, and why?

Respondents across all three systems seemed happy with the systems. In response to this question, the most common answer for all three systems was "nothing" (Wireshark = 54%, Microsoft Network Monitor =54%, Packet Tracer =46%).

Across all three systems, the layout and presentation was the next most common response (Wireshark=22%, Microsoft Network Monitor =36%, Packet Tracer =34%). The general level of satisfaction with the systems is shown through the above-average performance of all of the systems across all scales in SUMI.

### 5.5. Strength and weakness analysis and synthesis

Packet Tracer stood out in questions 1 and 2 in the content analysis, with the greatest match between use and best identified feature (learning in both cases). This was transferred to the strength and weakness analysis with statements such as: "The software has helped me overcome any problems I have had in using it", and "The software documentation is very informative" having strong agreement.

The identification of presentation and display of information as a major area of improvement for Microsoft Network Monitor is also reflected in the strength and weakness analysis, with agreement to statements such as: "This software is really very awkward" and "Either the amount or quality of the help varies across the system". Wireshark received mostly positive responses in the strength and weakness analysis, with users agreeing to statements such as: "It is obvious the user needs have been taken into consideration" and "It is easy to make the software do exactly what you want". Though users tended to agree that they "feel safe if I use only a few familiar functions", the identification of layout as an area for improvement is highlighted here.

**5.6. Relevance of the study**

The purpose of the study was to determine the usability of each ICT network program and if the ICT network programs contributed to a better learning and understanding of ICT networking. Usability testing can be conducted in various ways. A few examples of usability testing include observation, interviews and questionnaires. Research conducted by the researcher clearly indicated that SUMI would be the best method for conducting usability testing for the following reasons:

- SUMI is easy and cost effective to implement for usability testing
- SUMI can be utilised for usability testing for users that are inexperienced or have limited exposure to the software they use
- SUMI has been developed to be used in a controlled laboratory environment

The hypothesis stated that applying the SUMI principles it will be possible to identify the most usable ICT Network Program for the SPG1 students at CUT. SUMI's five subscales, efficiency, effect, helpfulness, control and learnability, including the global subscale, made it possible to identify the most usable ICT network program for the SPG1 students at the CUT.

The research aims focused on the 5 SUMI subscales whereby each subscale was analysed by the SUMISCO program to determine which ICT network program scored the highest for each subscale. The researcher can conclude that SUMI was effective to establish the usability level of each ICT network program for the SPG1 students and thus compared the ICT network programs on usability.

**5.7. Implications for practice**

The outcome of the SUMI questionnaire as well as the answers on the free form questions confirmed that each of the three ICT network programs helped the students to learn about the concepts of ICT networking (see 4.2.6). Packet Tracer allowed the students to learn about devices such as routers and switches, the cables necessary to connect these devices, as well as how to configure the devices. Wireshark and Microsoft Network Monitor helped the students to learn about network traffic monitoring.

When compared directly with one another based on the SUMI questionnaire data, Packet Tracer scored the highest based on the learnability subscale. However, this doesn't mean that Wireshark and Microsoft Network Monitor aren't viable as learning tools with regard to ICT networks in the context of usability. When comparing Wireshark and Microsoft Network monitor directly with each other, Wireshark was identified as the better packet analyzer program as it scored higher than Microsoft Network Monitor across all metrics (see table 4.2.7.1).

The global metric score of 50 indicates that each program's level of quality of use is above the standardization database score of 50 in SUMI's database. Therefore, each program, from a quality usability perspective, is effective for the domain (ICT networking) in which each of them can be applied, especially in the context of learning. The concept of SUMI can be applied to any program available that utilizes any form of input via a keyboard or mouse. The researcher feels that his fellow colleagues can also make use of SUMI to determine whether the programs they use in their subjects are of a high quality and suitable from a usability perspective.

## 5.8. Future studies

Based on the simplicity of SUMI's functioning, the researcher would like to explore inventing his own usability testing technique. Seeing that SUMI was developed as part of the European MUSiC project, the researcher intends to collaborate with HFRG at University College Cork to establish a variant of the same project for the African continent and its people with regards to usability.

## 5.9. Conclusion

By means of SUMI, Packet Tracer was identified by the SPG1 students, as the software that most fitted their needs and also serviced those needs adequately. While all three systems performed above the global SUMI average, Packet Tracer consistently scored significantly above the other two systems across all subscales. It was the only system rated as "extremely important" by a majority of users (n=30/42) who evaluated it.

## 6. References

Abran, A., Khelifi, A., Suryn, W. and Seffah, A., 2003.Usability meanings and interpretations in ISO standards. *Software Quality Journal*, 11(4), p.325-338.

Adebesin, T.F., Villiers, M.R.D. and Ssemugabi, S., 2009. Usability testing of e-learning: an approach incorporating co-discovery and think-aloud. In: *Proceedings of the 2009 Annual Conference of the Southern African Computer Lecturers' Association*. Eastern Cape, South Africa: ACM, p.6-15.

All F1 Info, 2013.*Ferrari Engines: Tipo 048*, photograph. [online] Available at: <http://www.allf1.info/engines/ferrari.php> [Accessed 18 July 2013].

AlternativeTo, 2012.*Microsoft Network Monitor: About*. [online] Available at: <http://alternativeto.net/software/microsoft-network-monitor/about> [Accessed 25 March 2013].

Anderson, J.P., 1980.*Computer security threat monitoring and surveillance*. Fort Washington, Pa.: James P. Anderson Co.

Banerjee, U., Vashishtha, A., & Saxena, M., 2010.Evaluation of the Capabilities of Wireshark as a tool for Intrusion Detection. *International Journal of Computer Applications* 6 (7), p.1 - 5.

BBC Sport, 2004. *Motorsport: Mansell – F1 too boring*, photograph. [online]Available at: <http://news.bbc.co.uk/sport2/hi/motorsport/formula_one/3866933.stm> [Accessed 18 July 2013].

Bevan, N.,1995. Measuring usability as quality of use. *Software Quality Journal*, 4(2), p.115-130.

Central University of Technology (CUT), 2011. *Academic Plan (2012-2015) Phase 1*. [online] Available at: <https://portal.cut.ac.za/intra/downloads/acadplan2015.pdf>[Accessed 14 August 2013].

Chapple, K., Johnson, A., Rosson, J., West, P., Stanley, K., Termaat, B.and Behrens, J.T., 2009.Applying cross-disciplinary threads to a global assessment system with an emphasis on simulation and gaming. In: *Annual Meeting of the American Educational Research Association*. San Diego, CA.

Cisco,2013.*Cisco systems*.[online]Available at:
<http://www.cisco.com/web/ANZ/about/about_whois_head.html>[Accessed 12 March 2013].

Cisco Networking Academy, 2013.*Network academy learning resources*.[online] Available at:
<http://www.cisco.com/web/learning/netacad/academy/index.html> [Accessed 12 March 2013].

Cisco Course Catalog, 2013.*Cisco Packet Tracer*. [online]Available at:
<http://www.cisco.com/web/learning/netacad/course_catalog/PacketTracer.html>
[Accessed 20 March 2013].

Department of Basic Education, 2011.*Curriculum and policy statement*. [online]Available at:<http://www.education.gov.za/LinkClick.aspx?fileticket=jIbU9d%2B63O4%3D&tabid=420&mid=1216>[Accessed 20 March 2013].

Heberlein, L.T., Dias, G.V., Levitt, K.N., Mukherjee, B., Wood, J. and Wolber, D., 1990.A network security monitor. In: *Proceedings of the 1990 IEEE Symposium on Research in Security and Privacy,*p.296-304.

Hnatyshin, V.Y. and Lobo, A.F., 2008. Undergraduate data communications and networking projects using OPNET and Wireshark software. *Association for Computing Machinery Special Interest Group on Computer Science Education Bulletin* 40(1), p.1-5.

Investopedia, 2013a.Definition of "error term". [online] Available at: <http://www.investopedia.com/terms/e/errorterm.asp> [Accessed 10 August 2013].

Investopedia, 2013b.*Definition of "null hypothesis"*. [online] Available at: <http://www.investopedia.com/terms/n/null_hypothesis.asp> [Accessed 10 August 2013].

ISO, 9421-10, 1994. Ergonomic requirements for office work with visual display terminals (VDT's) – Part 10: Dialogue principles.

ISO, 9241-11, 1995.Ergonomic requirements for office work with visual display terminals (VDT's) – Part 11: Guidance on usability.

ISO, 9241-11, 1998. Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability.

Jameson, A., 2000. Human-computer design, advanced course 216.Slides from Class 12 [pdf] Available at: <http://www.dfki.de/~jameson/hcida/slides/hcida12.pdf> [Accessed 11 August 2013].

Kelly, M. ed., 1994. *MUSiC Final Report Parts 1 and 2: the MUSiC Project*. Hampshire, UK: Brameur Ltd.

Kirakowski, J., 1994. *The use of questionnaire methods for usability assessment*. .[online]Available at: <http://sumi.ucc.ie/sumipapp.html>[Accessed 12 April 2013].

Moolenaar, K.S. and van Veenendaal E.P.W.M.,1997.*Report on demand oriented survey*. MultiSpace project [ESPRIT 23066].

National Physical Laboratory, 1995.*Usability context analysis: a practical guide, version 4.0*, UK: NPL Usability Services.

SAP Help Portal, 2013. *The ISO dialogue principles*. [online] Available at: <http://help.sap.com/saphelp_40b/helpdata/en/85/dae37f4bac11d1890e0000e8322f96/content.htm> [Accessed 11 August 2013].

SUMI,1999a.*SUMI: The de facto industry standard evaluation questionnaire for assessing quality of use of software by end users*. [online] Available at: <http://sumi.ucc.ie> [Accessed 12 April 2013].

SUMI, 1999b.*The SUMI questionnaire for academic usage*. [online] Available at: <http://sumi.ucc.ie/academic.html> [Accessed 12 April 2013].

Sweeney, M. and Maguire, M., 1994.*Industry-Scale Validation Programme*, CEC ESPRIT Project 5429 MUSiC Report DV3, p.10.

Tanenbaum, A.S., 2002. *Computer networks*.4thed. New Jersey: Prentice Hall.

van Veenendal, E., 1998.Questionnaire based usability testing. In: *Conference Proceedings European Software Quality Week*, Brussels, November 1998.

Wireshark FAQ, 2012. *Q1.1*. [online] Available at: <http://www.wireshark.org/faq.html#q1.1> [Accessed 22 March 2013].

## 7.    Appendices

## Appendix A: Packet Tracer: Strength and Weakness Analysis

Item: 28   *The software has helped me overcome any problems I have had in using it.*
Verdict: Agree! *Strength: 99.9*

Item: 31   *It is obvious that user needs have been fully taken into consideration.*
Verdict: Agree! *Strength: 99.9*

Item: 39   *It is easy to make the software do exactly what you want.*
Verdict: Agree! *Strength: 99.9*

Item: 24   *This software is awkward when I want to do something which is not standard.*
Verdict: Disagree! *Strength: 99.9*

Item: 7   *I enjoy the time I spend using this software.*
Verdict: Agree! *Strength: 99.9*

Item: 46   *This software occasionally behaves in a way which can't be understood.*
Verdict: Disagree! *Strength: 99.9*

Item: 9   *If this software stops it is not easy to restart it.*
Verdict: Disagree! *Strength: 99.9*

Item: 4   *This software has at some time stopped unexpectedly.*
Verdict: Disagree! *Strength: 99.9*

Item: 3   *The instructions and prompts are helpful.*
Verdict: Agree! *Strength: 99.9*

Item: 29   *The speed of this software is fast enough.*
Verdict: Agree! *Strength: 99.9*

Item: 12    *Working with this software is satisfying.*
            Verdict: Agree! *Strength: 99.9*


Item: 6     *I sometimes don't know what to do next with this software.*
            Verdict: Disagree! *Strength: 99.9*


Item: 5     *Learning to operate this software initially is full of problems.*
            Verdict: Disagree! *Strength: 99.9*


Item: 2     *I would recommend this software to my colleagues.*
            Verdict: Agree! *Strength: 99.9*


Item: 40    *I will never learn to use all that is offered in this software.*
            Verdict: Disagree! *Strength: 99.9*


Item: 1     *This software responds too slowly to inputs.*
            Verdict: Disagree! *Strength: 99.9*


Item: 27    *Using this software is frustrating.*
            Verdict: Disagree! *Strength: 99.9*


Item: 8     *I find that the help information given by this software is not very useful.*
            Verdict: Disagree! *Strength: 99.9*


Item: 19    *I feel in command of this software when I am using it.*
            Verdict: Agree! *Strength: 99.9*


Item: 41    *The software hasn't always done what I was expecting.*
            Verdict: Disagree! *Strength: 99.9*


Item: 17    *Working with this software is mentally stimulating.*
            Verdict: Agree! *Strength: 99.9*

Item: 25　*There is too much to read before you can use the software.*
　　　　Verdict: Disagree! *Strength: 99.9*


Item: 42　*The software presents itself in a very attractive way.*
　　　　Verdict: Agree! *Strength: 99.8*


Item: 15　*The software documentation is very informative.*
　　　　Verdict: Agree! *Strength: 99.8*


Item: 26　*Tasks can be performed in a straight forward manner using this software.*
　　　　Verdict: Agree! *Strength: 99.8*


Item: 38　*Error messages are not adequate.*
　　　　Verdict: Disagree! *Strength: 99.7*


Item: 47　*This software is really very awkward.*
　　　　Verdict: Disagree! *Strength: 99.6*


Item: 49　*Getting data files in and out of the system is not easy.*
　　　　Verdict: Disagree! *Strength: 99.3*


Item: 23　*I can understand and act on the information provided by this software.*
　　　　Verdict: Agree. *Strength: 98.6*


Item: 13　*The way that system information is presented is clear and understandable.*
　　　　Verdict: Agree. *Strength: 98.5*


Item: 34　*The software allows the user to be economic of keystrokes.*
　　　　Verdict: Undecided. *Strength: 98.4*


Item: 35　*Learning how to use new functions is difficult.*
　　　　Verdict: Disagree. *Strength: 97.7*

Item: 44 *It is relatively easy to move from one part of a task to another.*
Verdict: Agree. *Strength: 97.7*


Item: 16 *This software seems to disrupt the way I normally like to arrange my work.*
Verdict: Disagree. *Strength: 96.6*


Item: 11 *I sometimes wonder if I am using the right function.*
Verdict: Disagree. *Strength: 96.1*


Item: 45 *It is easy to forget how to do things with this software.*
Verdict: Disagree? *Strength: 93.8*


Item: 30 *I keep having to go back to look at the guides.*
Verdict: Disagree? *Strength: 93.5*


Item: 18 *There is never enough information on the screen when it's needed.*
Verdict: Disagree? *Strength: 92.4*


Item: 10 *It takes too long to learn the software functions.*
Verdict: Disagree? *Strength: 91.3*


Item: 21 *I think this software is inconsistent.*
Verdict: Disagree? *Strength: 88.3*


Item: 33 *The organisation of the menus seems quite logical.*
Verdict: Tend to agree? *Strength: 87.9*


Item: 48 *It is easy to see at a glance what the options are at each stage.*
Verdict: Agree? *Strength: 87.7*


Item: 32 *There have been times in using this software when I have felt quite tense.*
Verdict: Undecided? *Strength: 86.1*

Item: 36 *There are too many steps required to get something to work.*
Verdict: Disagree? *Strength: 83.3*


Item: 22 *I would not like to use this software every day.*
Verdict: Disagree? *Strength: 77.7*


Item: 37 *I think this software has sometimes given me a headache.*
Verdict: Disagree? *Strength: 63.7*


Item: 50 *I have to look for assistance most times when I use this software.*
Verdict: Disagree? *Strength: 59.6*


Item: 20 *I prefer to stick to the functions that I know best.*
Verdict: Agree? *Strength: 52.7*


Item: 14 *I feel safer if I use only a few familiar functions.*
Verdict: Undecided? *Strength: 52.6*


Item: 43 *Either the amount or quality of the help information varies across the system.*
Verdict: Agree~ *Strength: 19.3*


## Appendix B: Packet Tracer - Free form questions


**Question 1:**"*What, in general, do you use this software for?*"


| ID | Comment |
| --- | --- |
| 1 | For practicing packet tracer exercises to get a better understanding of how the system works. |
| 2 | TO BUILD UP NETWORK TOPOLOGIES AND CONFIGURE ALL THE COMPONENTS CONNECTED IN THE NETWORK |
| 3 | For configuring devices with address and so on |

4       I use it when configuring the devices and naming them

5       SOFTWARE IS MOSTLY USED FOR CREATING NETWORK AND
        CONFIGURING ALL COMPONENTS TO THE NETWORK

6       Creating and checking for connectivity between devices

7       I USE IT FOR MY SCHOOL WORK

8       To simulate the networks that you would use in real life, and to see if the different
        interfaces connects to each other.

9       to connect pcs to a network,build a network,relationships between Pcs

10      I use it for practice purposes.

11      For connecting pcs, routers,switches together to create a network connection.

12      PRACTICING CONFIGURATION OF NETWORKS

13      To practice what i have learned in class at home.

14      network design and configurations as well as network security

15      I USE IT FOR CLASS EXCERCISE

16      To connect networks whether they are local or global

17      to configure networks and to see how it functions

| 18 | I will use it to learn how to connect different networks in different areas |
|----|---------------------------------------------------------------------------|
| 19 | TO UNDERSTAND LEARN HOW NETWORKS COMMUNICATE WITH EACH OTHER USING END DEVICES SUCH AS ROUTERS, SWITCHES AND HUBS, SECURITY AMONG NETWORKS AND NETWORKS PROTOCOLS |
| 20 | Learning packet tracer |
| 21 | In general you use the software to create basic networking environments and configurations for the networks. |
| 22 | TO PRACTICE FOR MY SPG, TO LEARN WORKING WITH NETWORKS, SETTING UP SWITCHES AND ROUTERS ETC. THIS SOFTWARE REALLY HELP ME ALOT. |
| 23 | WE USE THIS SOFTWARE FOR NETWORKING PART AND CONNECTION OF THE NETWORKS AS WHOLE |
| 24 | To create network topologies and configuring virtual Networks, that can be used practically. |
| 25 | LEARNING HOW TO CONFIGURE NETWORKS |
| 26 | LEARNING HOW TO CONFIGURE A NETWORK |
| 27 | practicing newtworking |
| 28 | To create networks using different components or equipments which are very helpful when needed and learning about different protocols |

29    networking, troubleshooting problems on the topology and building the topology
30    for practicing my networking skills.

31    Networking

32    To configure routers,switches and hosts to communicate with each other so they can
      send data between hosts

33    Connecting hosts and checking if the is network between the host

34    TO UNDERSTAND AND CREATE NETWORK'S

35    CLASS EXERCISES

36    FOR DEVELOPING A TOPOLOGY AND LEARNING NEW COMMANDS ON
      HOW TO DEVELOP A SYSTEM

37    PRACTICING PURPOSE FOR THE REAL EQUIPMENT

38    When you are configuring equipment on a visual manner before you do it on the
      real equipment.

39    To practice.

40    CREATING NETWORKS. WIRELESS, SWITCHED AND ROUTED
      NETWORKS. CONFIGURING DEVICES WITH THE RIGHT PROTOCOLS
      AND IMPLEMENTING NETWORK CONNECTIONS.

41    to practice for tests as a system development student

42    to practice for tests as a system development student

**Question 2:**"*What do you think is the best aspect of this software, and why?"*

| ID | Comment |
|---|---|
| 1 | User integration. It needs to be more precise in ways whereby one can easy understand. |
| 2 | THE CONFIGURATIONS |
| 3 | Configuring devices |
| 4 | It easier to learn and it makes the practicals to be simple. |
| 5 | LEARNING HOW TO CONFIGURE THE CONNECTIONS |
| 6 | watching everything come together as i get what i want |
| 7 | EVERYTHING ABOUT IT ITS GREAT ANDI LOVE IT |
| 8 | The fact that it almost is identical to the networks that you would use if you are actually working with the devices. It is a good simulation of what you could use not as a student but in actual networks. |
| 9 | networking,bcozits important that people network even when they not in the same place these days |
| 10 | Its graphics, gives the user a better idea of where to go. |
| 11 | The best part is that the software comes out with the equipment embedded on it so you cannot possibly use the wrong router or switch as they are there, your only job is not connect. |
| 12 | IT IS VERY REALISTIC THEREFORE VERY LITTLE CHANGE WHEN WORKING WITH THE REAL DEAL |
| 13 | You get to practice configurations before performing them in real devices |
| 14 | being able to configure networks and that it is easy to understand |
| 15 | EXPERIENCE, IT PREPARES YOU FOR THE WORKFIELD |
| 16 | Connecting cables, teaches us practical stuff we might need for work purposes |
| 17 | its user friendly, one can easily see what they are doing and it simplifies the theory of configuring networks |
| 18 | none |

| 19 | IT GIVES YOU A LIGHT OF WHAT NETWORKS ARE ALL ABOUT AND MUCH EASY TO UNDERSTAND HOW THEY WORKS. |
|----|---|
| 20 | packet tracer, it is straight forward |
| 21 | very clear structure of the software, made easy to understand and the providing of everything one needs right on the page no steps required to reach something. |
| 22 | THE FACT THAT THE SOFTWARE IS EASY TO USE, AND THE FACT THAT THIS SOFTWARE IS VERY CLOSE TO THE REAL ROUTERS AND SWITCHES. |
| 23 | IS MORE PRACTICAL, INFORMATIVE AND INTERESTING ABOUT NETWORKING AND THE SOFTWARE AS WHOLE |
| 24 | The Topology, the fact that you can see a outline of the network and configuring and testing it to see if network is setup correctly |
| 25 | LEARNING HOW TO CONFIGURE THE NETWORKS |
| 26 | COMMANDS THEY ARE EASY TO UNDERSTAND AN REMEMBER |
| 27 | the layout cos it is to use and understand |
| 28 | Networks,why because it is designed for every user to learn and create their own networks under the impression of learning something new. |
| 29 | Troubleshooting, because it helps fixing the problems on the topology and that what most of the companies like "Telkom, Vodacom, MTmect...." deal with in a real life environment |
| 30 | To learn more about the network topology its based on the visual presentation |
| 31 | Network simulation |
| 32 | It helps teaches you about making routers,switches communicate with PC |
| 33 | Creating the wireless connectivity |
| 34 | GIVES YOU A BETTER VIEW AND UNDERSTANDING ON THE CREATION OF A NETWORK |
| 35 | ITS EASY TO USE |
| 36 | BUILDING A TOPOLOGY BECAUSE THAT'S ALL WE DO |
| 37 | THE SIMILARITY BETWEEN THE SOFTWARE PRESENTATION AND THE |

REAL SOFTWARE

38      You use different standards of equipment to effectively configure them to be able to communicate with each other.

39      It's training is the best aspect for me, if you give time you will definately learn.

40      THE LOGIC IN USING THE SOFTWARE. IT HELPS YOU UNDERSTAND HOW NETWORKS ARE BUILT. FROM THE SMALLEST TO THE LARGEST NETWORKS

41      future purpose as a network administrator

42      to become a network administrator


**Question 3: "***What do you think needs most improvement, and why?***"**

| ID | Comment |
|----|---------|
| 1 | User manual. It just needs to be shortened a bit. |
| 2 | NONE |
| 3 | Notthing |
| 4 | One command on the spanning tree, it did no work when we try do configure in switches |
| 5 | NOTHING HAS TO BE IMPROVED |
| 6 | Nothing |
| 7 | NOTHING ITS NOT COMPLICATED |
| 8 | There isnt any aspects that i can think of that could think of to improve it. |

9      just the interface bcoz it looks dull lol

10      The graphics needs to go along with texts not only when its clicked on but before hand.

11      It works perfectly as it is.

12      SOME REAL LIFE COMMANDS AND FUNCTIONS ARE NOT AVAILABLE AND NEED TO BE ADDED FOR EXTRA KNOWLEDGE.

13      The error messages,sometimes they are hard to understand

14      The interface

15      NONE, I THINK ITS PERFECT

16      Nothing needs to be improved

17      add more functionality, some of the practical work done on devices cannot be done on the software

18      no improvement is needed

19      IT THIS COULD BE DONE ALMOST EVERYDAY PRACTICALLY BECAUSE WORKING WITH THE SOFTWARE ITS QUIET EASY BUT PRACTICALLY CAN BE A LITLE BIT CONFUSING

20      Nothing

21      None, so far from using the software

22      THE SOFTWARE I THINK IS VERY GOOD, DONT KNOW IF IT IS
        NECCESARY FOR ANY CHANGES.

23      NO IMPROVEMENT EVERYTHING IS GOOD SO FAR. THE THING
        THAT THE STUDENT THEY MUST DO IS PRACTICE AND
        UNDERSTANDING OF THIS SOFTWARE

24      Network Cables, to make graphically clearer to diffentiate

25      INTERFACE OF THE SOFTWARE

26      NOTHING BUT GRAPHICS (OPTIONAL)

27      graphic's, this programs lack behind in its graphical user interface

28      The software version. It needs to be updated now and then
29      farmiliariseourself with real equipments such as switch, routers ect.
        ...
30      The Interface, It can be more attractive and user friendly
        .
31      It must include more networking commands

32      Some of the commands that we use while configuring they are to many of
        them

33      None needs to be improved,everything is perfect

34      PROVIDE MORE HINTS,IF AND ERROR OCCURRED IT SHOULD
        PROVIDE A HINT

35      NOTHING

36      FUNCTIONS,TO MAKE WORK MORE SIMPLE

37      THE SOFTWARE NEEDS TO HAVE MORE SIMILAR CONCEPTS AS
        WORKING ON THE REAL SOFTWARE. E.G SOME COMMANDS
        ARE NOT USED

38      Some of the features when configuring switches can

39      The software is basically good, I wouldn't really modify anything.

40      THE USER INTERFACE NEEDS TO BE REVAMPED. IT DOES NOT
        MAKE YOU FEEL LIKE YOUR ACTUALLY CONFIGURING A
        NETWORK. MORE USEFUL TOOLS NEED TO BE ADDED. MOST OF
        THE SWITCHES, ROUTERS AND OTHER DEVICES WERE NOT
        USED IN THIS SOFTWARE

41      there's no much needed, because it has full features that we use to practice
        and write tests with

42      there's not much needed, because it has full features that we use to practice
        and write tests with

## Appendix C: Wireshark- Strength and Weakness Analysis

Item: 41  *The software hasn't always done what I was expecting.*
Verdict: Disagree! *Strength: 99.9*

Item: 4  *This software has at some time stopped unexpectedly.*
Verdict: Disagree! *Strength: 99.9*

Item: 34  *The software allows the user to be economic of keystrokes.*
Verdict: Undecided! *Strength: 99.9*

Item: 29  *The speed of this software is fast enough.*
Verdict: Agree! *Strength: 99.9*

Item: 31  *It is obvious that user needs have been fully taken into consideration.*
Verdict: Agree! *Strength: 99.9*

Item: 18  *There is never enough information on the screen when it's needed.*
Verdict: Disagree! *Strength: 99.9*

Item: 46  *This software occasionally behaves in a way which can't be understood.*
Verdict: Disagree! *Strength: 99.9*

Item: 5  *Learning to operate this software initially is full of problems.*
Verdict: Disagree! *Strength: 99.9*

Item: 39  *It is easy to make the software do exactly what you want.*
Verdict: Agree! *Strength: 99.9*

Item: 12  *Working with this software is satisfying.*
Verdict: Agree! *Strength: 99.9*

Item: 27  *Using this software is frustrating.*
Verdict: Disagree! *Strength: 99.9*

Item: 28    *The software has helped me overcome any problems I have had in using it.*
Verdict: Agree! *Strength: 99.6*

Item: 24    *This software is awkward when I want to do something which is not standard.*
Verdict: Disagree! *Strength: 99.4*

Item: 26    *Tasks can be performed in a straight forward manner using this software.*
Verdict: Agree! *Strength: 99.2*

Item: 3    *The instructions and prompts are helpful.*
Verdict: Agree! *Strength: 99.2*

Item: 2    *I would recommend this software to my colleagues.*
Verdict: Agree. *Strength: 99*

Item: 48    *It is easy to see at a glance what the options are at each stage.*
Verdict: Agree. *Strength: 98.8*

Item: 36    *There are too many steps required to get something to work.*
Verdict: Disagree. *Strength: 98.7*

Item: 21    *I think this software is inconsistent.*
Verdict: Disagree. *Strength: 98.3*

Item: 14    *I feel safer if I use only a few familiar functions.*
Verdict: Tend to agree. *Strength: 97.5*

Item: 32    *There have been times in using this software when I have felt quite tense.*
Verdict: Tend to disagree. *Strength: 97.2*

Item: 1    *This software responds too slowly to inputs.*
Verdict: Disagree. *Strength: 97.1*

Item: 6    *I sometimes don't know what to do next with this software.*
Verdict: Undecided. *Strength: 96.6*

Item: 43    *Either the amount or quality of the help information varies across the system.*
Verdict: Agree. *Strength: 96.6*

Item: 45   *It is easy to forget how to do things with this software.*
Verdict: Disagree. *Strength: 96.2*

Item: 44   *It is relatively easy to move from one part of a task to another.*
Verdict: Agree. *Strength: 96.1*

Item: 13   *The way that system information is presented is clear and understandable.*
Verdict: Agree. *Strength: 95.8*

Item: 15   *The software documentation is very informative.*
Verdict: Agree. *Strength: 95.7*

Item: 20   *I prefer to stick to the functions that I know best.*
Verdict: Tend to agree. *Strength: 95.7*

Item: 8   *I find that the help information given by this software is not very useful.*
Verdict: Disagree? *Strength: 92.8*

Item: 35   *Learning how to use new functions is difficult.*
Verdict: Slightly disagree? *Strength: 91.2*

Item: 17   *Working with this software is mentally stimulating.*
Verdict: Agree? *Strength: 88.9*

Item: 10   *It takes too long to learn the software functions.*
Verdict: Slightly agree? *Strength: 86.1*

Item: 9   *If this software stops it is not easy to restart it.*
Verdict: Disagree? *Strength: 84.5*

Item: 11   *I sometimes wonder if I am using the right function.*
Verdict: Disagree? *Strength: 81.3*

Item: 23   *I can understand and act on the information provided by this software.*
Verdict: Slightly disagree? *Strength: 80.1*

Item: 7   *I enjoy the time I spend using this software.*
Verdict: Agree? *Strength: 80*

Item: 38 *Error messages are not adequate.*
Verdict: Disagree? *Strength: 79*

Item: 42 *The software presents itself in a very attractive way.*
Verdict: Agree? *Strength: 78*

Item: 30 *I keep having to go back to look at the guides.*
Verdict: Disagree? *Strength: 77.2*

Item: 22 *I would not like to use this software every day.*
Verdict: Tend to agree? *Strength: 75.9*

Item: 49 *Getting data files in and out of the system is not easy.*
Verdict: Disagree? *Strength: 75.4*

Item: 40 *I will never learn to use all that is offered in this software.*
Verdict: Disagree? *Strength: 65.3*

Item: 37 *I think this software has sometimes given me a headache.*
Verdict: Slightly disagree? *Strength: 63.8*

Item: 50 *I have to look for assistance most times when I use this software.*
Verdict: Tend to disagree? *Strength: 55.5*

Item: 16 *This software seems to disrupt the way I normally like to arrange my work.*
Verdict: Disagree~ *Strength: 39.9*

Item: 19 *I feel in command of this software when I am using it.*
Verdict: Agree~ *Strength: 31.3*

Item: 47 *This software is really very awkward.*
Verdict: Undecided~ *Strength: 24.9*

Item: 33 *The organisation of the menus seems quite logical.*
Verdict: Undecided~ *Strength: 21.4*

Item: 25 *There is too much to read before you can use the software.*
Verdict: Disagree~ *Strength: 17*

**Appendix D: Wireshark - Free form questions**

**Question 1**: "*What, in general, do you use this software for?*"

| ID | Comment |
|----|---------|
| 1  | Managing Packet Frames |
| 2  | MOUSE |
| 3  | to monitor a network traffic and to see errors on a network |
| 4  | Counting specific frames |
| 5  | Is to check the traffic that has been captured |
| 6  | It captures everything that is happening in your networks. |
| 7  | I use it for understanding purposes. |
| 8  | I use this software to capture traffic of frames....It helps me to see which frames are problematic and witch ones are not |
| 9  | I generally use this software for checking my networks how does it flows and also how the protocol they should behaves |
| 10 | For my subject system software |
| 11 | for controlling the traffic or viewing the available traffics. |
| 12 | checking for data coming and going from your computer |

13      I dont usually use the software, it is my first time using it and its is quite fascinating

14      Networking and internet

15      To study,for my course

16      MONITORING NETWORK ACTIVITIES.

17      network purpose

18      TO CAPTURE PACKETS

19      NETWORKING

20      monitoring and tracking network data

21      Answer given questions about packets

22      To further study my course.

23      To track traffic of the network

24      to monitor a network traffic and to see errors on a network

25      I USE IT TO MONITOR NETWORKS IN CLASS AND TO ANSWER QUESTIONS REGARDING THE DATA PASSED TO THE SOFTWARE

26      FOR MY SCHOOL WORK

27      to monitor the network traffic

28      to monitor the network traffic

29      To retrieve more information about the frames

30      practice specific tasks

31      to manage,identify and capture information

32      Schoolwork

33      I haven't really used this software that much

34      EXCERCISE IN CLASS

35      To manage information of source and destination address

36      I use this software to gain some of the information

37      PRACTICING

38      I use this software to gain some of the information

39      I use this software to gain some of the information

40      to gather all information on how information was sent from which host and
        the destination host as well as protocol used for that

41      TO MONITOR WHERE MY BANDWIDTH IS BEING USED

42      for network frames

43      TO MONITOR THE NETWORK, MONITORING TRAFFIC ON THE NETWORK

44      we use packet tracer to learn how to configure routers in real world equipment

45      FOR MY SCHOOL WORK

46      To monitor network traffic

47      To get the information of all packets that are send between two hosts on the network

48      I dont know really,buti can understand the information given

**Question 2**: "*What do you think is the best aspect of this software, and why*?"

**ID**      **Comment**

1       Filtering, because it lets you deal with the protocol u intended 2 work with directly

2       ALL.

3       the fact that errors are clearly indicated with sufficient information about the errors

4       You can get information of the frame you want

94

| 5 | Its easy to utilize and can get the information which I need easly |
|---|---|
| 6 | Error capturing, because the user will know whats causing the problem. |
| 7 | Gives a user more understanding. |
| 8 | Its ability to capture frames because it shows both the ones that are sent and that are problematic giving us the opportunity to resolve the problems |
| 9 | very interesting and informative because its nice to learn about networks |
| 10 | the complex of it. it makes one more interested to see how it functions. |
| 11 | good presentation of information. |
| 12 | the user interface face, cos its basic and easy to use |
| 13 | its shows the traffic as well as the errors on the network and how they can be rectified |
| 14 | Analysing the questions because it is easy |
| 15 | it's easy to use and understand too. I have not yet encountered any problems using it in class or at home |
| 16 | GIVES A DETAILED REPORT OF WHAT'S GOING ON IN THE NETWORK. |
| 17 | good, because the software is fast enough without errors or mistakes |
| 18 | FILTER FOR LOOKING FOR A CERTAIN PROCTOCOL |

19 THE WAY PROTOCOLS ARE COLOR CODED FOR EASIER REFERENCING

20 being able to monitor network data, because you don

21 Shows you malformed packets

22 good presentation of information.

23 View network traffic. Because it is easy to read and learn

24 Filtering, makes the work more easier

25 BEING ABLE TO VIEW THE FRAME INFORMATION IN DETAIL

26 answering of the questions based on it because its very easy to do so

27 it is user friendly

28 it is user friendly

29 Information is presented in an orderly manner everything is clear

30 Structure makes the command easy to understand

31 its clear

32 The interface-its very easy to understand

33 It seems fairly easy to use

34    PREPARING YOU TO THE WORKFIELD

35    Fast

36    None

37    GAIN OF KHOWLEDGE

38    None

39    None

40    filter menu because it ensures that you go to the direct protocol when you need to work with

41    THE DETAILED SUMMERY OF WHERE THE PACKETS ARE GOING
42    network frames, because they help with protocols

43    ALL. THIS IS VERY GOOD SOFTWARE, NO COMPLAINTS.
44    switches because their very interesting.

45    NO COMMENT

46    Filtering, because it narrow the search making things much easy for a user to read data

47    displaying all the information that is supposed to display.. mainly because that is what it has to do.

48    i cannot say anything at this point bcozidont know what it is meant to do

97

**Question 3:**"*What do you think needs most improvement, and why?*"

| ID | Comment |
|---|---|
| 1 | Nothing |
| 2 | NOTHING, IT IS EASY TO LEARN AND USE AND THAT SAVES TIME, WE DON'T LOOK FOR A LONG TIME TO FIND WHAT WE WANT. |
| 3 | Nothing |
| 4 | nothing, this software is the best |
| 5 | It should show the count of the frames that doesn't have a problem,so that it can b easy to determine the frames that has and problem and the ones that doesn't have not by counting one by one |
| 6 | On the information part, for me i don't understand some of the thing written there it doesn't have a clear meaning. |
| 7 | The information must be to the point and shorter context. |
| 8 | Filtering of protocols because it can be confusing |
| 9 | students need to understandable the whole concept |
| 10 | the view of it. i think it should be more improved so that it can be easier for the user to use the functions and to able to see it in more detail. |

| 11 | Nothing up to so far |
|----|----------------------|
| 12 | nothing the program is fine the way it is, its easy to learn and understand |
| 13 | the way they present data or information, for first time users it can be boring not knowing what to do and where to from here |
| 14 | The interface,because at times it is hard to read |
| 15 | Nothing up to so far |
| 16 | HOW CERTAIN INFORMATION IS DISPLAYED. |
| 17 | for now nothing |
| 18 | NOTHING FOR ME |
| 19 | NOTHING REALLY IT SERVERS IT'S PURPOSE |
| 20 | nothing, the system is easy to understand and to work with. |
| 21 | It doesn't need any improvement |
| 22 | color and alignment of each item. |
| 23 | Problematic packets. Because it doesn't provide a more detailed explanation. |
| 24 | problematic packets, not enough information included for them |

25 REGARDING THE LEVEL OF WORK I DO, I DO NOT SEE A NEED FOR IMPROVEMENT AS IT IS ALREADY EASY TO USE AND DOES THE REQUIRED WORK PROPERLY

26 iwouldn

27 the GUI can be improved, its not necessarily attractive

28 the GUI can be improved, its not necessarily attractive

29 The look of the software in terms of space

30 Nothing

31 i think its fine

32 Nothing-it is fine as it is

33 Well, for now none

34 NONE

35 it must be cleared about errors

36 nothing. it already have lot of improvement in it

37 QUALITY OF THE PAGE

38 nothing. it already have lot of improvement in it

39 nothing. it already have lot of improvement in it

40      i believe that it should be the way it is person just need to work on it more

41      HOW TO CONTROL OR RESTRICT UNWANTED PACKETS FROM BEING SENT

42      nothing its just fine

43      NOTHING, IT IS EASY TO LEARN AND USE AND THAT SAVES TIME, WE DON'T LOOK FOR A LONG TIME TO FIND WHAT WE WANT.

44      packet tracer needs more improvement because when you make mistakes it takes too long to reload again.

45      NO COMMENT

46      How it calculates frames and malformed frames, it would be better if total number of malformed frames is right there for a user to see it not to search for it

47      the organisation of menus, description of menus . o often struggle when i want to perfom certain important tasks and it is lowering my productivity as the future administrator.

48      if i know its purpose, i would answer you

## Appendix E: Microsoft Network Monitor - Strength and Weakness Analysis

Item: 4     *This software has at some time stopped unexpectedly.*
           Verdict: Disagree! *Strength: 99.9*

Item: 47    *This software is really very awkward.*
           Verdict: Agree! *Strength: 99.9*

Item: 28    *The software has helped me overcome any problems I have had in using it.*
           Verdict: Agree! *Strength: 99.9*

Item: 31    *It is obvious that user needs have been fully taken into consideration.*
           Verdict: Agree! *Strength: 99.9*

Item: 43    *Either the amount or quality of the help information varies across the system.*
           Verdict: Agree! *Strength: 99.9*

Item: 29    *The speed of this software is fast enough.*
           Verdict: Agree! *Strength: 99.9*

Item: 41    *The software hasn't always done what I was expecting.*
           Verdict: Disagree! *Strength: 99.6*

Item: 32    *There have been times in using this software when I have felt quite tense.*
           Verdict: Undecided! *Strength: 99.6*

Item: 12    *Working with this software is satisfying.*
           Verdict: Agree! *Strength: 99.4*

Item: 36    *There are too many steps required to get something to work.*
           Verdict: Slightly agree! *Strength: 99.1*

Item: 15    *The software documentation is very informative.*
           Verdict: Agree. *Strength: 99*

Item: 14    *I feel safer if I use only a few familiar functions.*
           Verdict: Tend to agree. *Strength: 98.9*

Item: 24  *This software is awkward when I want to do something which is not standard.*
   Verdict: Disagree. *Strength: 98.8*

Item: 22  *I would not like to use this software every day.*
   Verdict: Tend to agree. *Strength: 98.7*

Item: 1  *This software responds too slowly to inputs.*
   Verdict: Disagree. *Strength: 98.3*

Item: 49  *Getting data files in and out of the system is not easy.*
   Verdict: Slightly agree. *Strength: 97.9*

Item: 2  *I would recommend this software to my colleagues.*
   Verdict: Slightly agree. *Strength: 97.7*

Item: 39  *It is easy to make the software do exactly what you want.*
   Verdict: Agree. *Strength: 97.7*

Item: 9  *If this software stops it is not easy to restart it.*
   Verdict: Disagree. *Strength: 95.5*

Item: 25  *There is too much to read before you can use the software.*
   Verdict: Agree? *Strength: 94.8*

Item: 3  *The instructions and prompts are helpful.*
   Verdict: Agree? *Strength: 94.6*

Item: 46  *This software occasionally behaves in a way which can't be understood.*
   Verdict: Disagree? *Strength: 94.6*

Item: 34  *The software allows the user to be economic of keystrokes.*
   Verdict: Undecided? *Strength: 92*

Item: 23  *I can understand and act on the information provided by this software.*
   Verdict: Slightly disagree? *Strength: 87.5*

Item: 48  *It is easy to see at a glance what the options are at each stage.*
Verdict: Agree? *Strength: 84*


Item: 50  *I have to look for assistance most times when I use this software.*
Verdict: Agree? *Strength: 82.8*


Item: 44  *It is relatively easy to move from one part of a task to another.*
Verdict: Agree? *Strength: 82.5*


Item: 13  *The way that system information is presented is clear and understandable.*
Verdict: Agree? *Strength: 79.9*


Item: 42  *The software presents itself in a very attractive way.*
Verdict: Slightly agree? *Strength: 75.9*


Item: 33  *The organisation of the menus seems quite logical.*
Verdict: Undecided? *Strength: 74.8*


Item: 35  *Learning how to use new functions is difficult.*
Verdict: Slightly agree? *Strength: 74.4*


Item: 16  *This software seems to disrupt the way I normally like to arrange my work.*
Verdict: Agree? *Strength: 73.7*


Item: 8  *I find that the help information given by this software is not very useful.*
Verdict: Disagree? *Strength: 64.7*


Item: 18  *There is never enough information on the screen when it's needed.*
Verdict: Disagree? *Strength: 61.2*


Item: 26  *Tasks can be performed in a straight forward manner using this software.*
Verdict: Agree? *Strength: 56.8*


Item: 7  *I enjoy the time I spend using this software.*
Verdict: Agree? *Strength: 54.3*


Item: 5  *Learning to operate this software initially is full of problems.*
Verdict: Tend to disagree? *Strength: 52.9*

Item: 17    *Working with this software is mentally stimulating.*
            Verdict: Agree? *Strength: 51.9*

Item: 6     *I sometimes don't know what to do next with this software.*
            Verdict: Disagree? *Strength: 50.6*

Item: 20    *I prefer to stick to the functions that I know best.*
            Verdict: Agree~ *Strength: 48.5*

Item: 38    *Error messages are not adequate.*
            Verdict: Undecided~ *Strength: 45.2*

Item: 10    *It takes too long to learn the software functions.*
            Verdict: Slightly agree~ *Strength: 42.3*

Item: 27    *Using this software is frustrating.*
            Verdict: Undecided~ *Strength: 42.2*

Item: 21    *I think this software is inconsistent.*
            Verdict: Undecided~ *Strength: 37.2*

Item: 37    *I think this software has sometimes given me a headache.*
            Verdict: Agree~ *Strength: 20.3*

Item: 11    *I sometimes wonder if I am using the right function.*
            Verdict: Disagree~ *Strength: 18.1*

Item: 30    *I keep having to go back to look at the guides.*
            Verdict: Slightly disagree~ *Strength: 14.8*

Item: 40    *I will never learn to use all that is offered in this software.*
            Verdict: Disagree~ *Strength: 13.2*

Item: 45    *It is easy to forget how to do things with this software.*
            Verdict: Agree~ *Strength: 5.6*

Item: 19    *I feel in command of this software when I am using it.*
            Verdict: Disagree~ *Strength: 2.9*

**Appendix F: Microsoft Network Monitor - Free form questions**

**Question 1**: "*What, in general, do you use this software for?*"

| ID | Comment |
|----|---------|
| 1 | Sends different protocols |
| 2 | you can view , monitor and fix errors on a network |
| 3 | My subject systems software |
| 4 | Monitoring network |
| 5 | TO MONITOR THE NETWORK |
| 6 | VIEW NETWORK TRAFFIC |
| 7 | monitoring and tracking network data |
| 8 | For my course to study |
| 9 | to monitor the network traffic |
| 10 | To capture process Id |
| 11 | Data capturing and networking |
| 12 | For my course to study |
| 13 | FRAMES |

14      FOR MY SCHOOL WORK

15      I use it for microsoft monitor networking

16      MONITORING NETWORK ACTIVITIES.

17      to monitor network

18      to capture frames coming and going from your computer

19      CAPTURE PACKETS

20      More information

21      More information

22      for controlling the traffic or viewing the available traffics.

23      IT MONITORS THE SOFTWARE

24      For checking networks

25      Getting more information about the protocols and frames

26      Schoolwork

27      NETWORKING

28      FHGJGHJ

| 29 | CHECKING NETWORK USAGE AND ON WHAT IT IS BEING USED |
|----|----|
| 30 | NETWORKING |
| 31 | TO PERFORM A TASK GIVEN IN CLASS LIKE ANALYZING DATA GIVEN TO ME |
| 32 | I use it for understanding purposes. |
| 33 | T IS GOOD EASY TO understand |
| 34 | TO MONITOR THE NETWORK FRAMES |
| 35 | Exercises |
| 36 | VIEWING THE PROTOCOLS |
| 37 | To check source ports and destination ports |
| 38 | I haven't used it that much |
| 39 | I DNT KNW |
| 40 | to see how many protocols are there |
| 41 | Networking |
| 42 | Same as wireshark to monitor network traffic |

43      MONITORING ALL NETWORK PACKETS AND ANSWERING
        EXAM ANSWERS...I STILL DON'T UNDERSTAND WHY ARE
        AREUSING IT.

44      MY SCHOOL WORK

**Question 2**: "*What, do you think is the best aspect of this software, and why?*"

**ID**      **Comment**

1       Helps with protocols and traffic

2       the fact that errors are clearly indicated with sufficient information about
        the errors

3       the technicality of it. it is diverse and complex

4       Arranged process id,because u know exactly which process your working
        with

5       EVERYTHING

6       View network traffic. Because it is easy to read and learn

7       using the program to automatically track and display network data, its less
        typing.

8       You get a chance to do things by yourself

9       it is user friendly and the GUI is clear

10      filtering its confusing

11      Data capturing,it is easy to do so

12      it's easy to use and understand too. I have not yet encountered any problems
        using it in class or at home

13      fast and menus are logical

14      answering of the questions based on it because its very easy to do so

15      very informative and interesting...because i love networking alot

16      GIVES A DETAILED REPORT OF WHAT'S GOING ON IN THE
        NETWORK.

17      Filtering, makes the work more easier

18      the user friendliness of the program

19      THE DIVISION OF THE PROCESS IDs

20      None

21      None

22      structure, easy to understand and navigate.

23      dntknw

24      Networks

25    Everything is presented in a good way

26    The interface-it's very easy to understand

27    EVERYTHING THAT YOU NEED TO ACHIEVE NETWORKING
      GOALS IS PROVIDED

28    FHGDHGFB

29    DETAILS OF PACKETS AND WHAT PROCESSORS

30    GOOD, BECAUSE IT IS EFFECTIVE

31    ITS DETAILED VIEW OF A FRAME

32    Helps you understand things better, because it shows you what happens to
      them as you click on them.

33    the way data is presented it is easy to understand

34    To help users find broken packets on the network

35    the software's ability to query certain data

36    THE MANNER IT DISPLAYS

37    Frame comments because you comment everything you want to comment

38    Seems easy to llearn

| 39 | FHGDHGFB ye |
|---|---|
| 40 | Try to make it user friendly and understandable |
| 41 | Well i don't understand most of the thing in this software |
| 42 | Division of traffic |
| 43 | the best aspect is that it can can perform what they say it is supposed to perfom |
| 44 | NO COMMENT |

**Question 3**: "*What, do you think needs most improvement, and why?*"

| ID | Comment |
|---|---|
| 1 | Nothing it is perfect the way it is. |
| 2 | Nothing |
| 3 | introduce more functions to it. to be more fun to use |
| 4 | Nothing |
| 5 | NOTHING, IT IS EASY TO LEARN AND USE AND THAT SAVES TIME, WE DON'T LOOK FOR A LONG TIME TO FIND WHAT WE WANT. |
| 6 | Error displays because Error messages are not adequate. |

7      nothing, the system is easy to understand and to work with.

8      It

9      add a bit of color just to differentiate the various protocols, to make it more attractive

10

11    Nothing,because everything is clear

12    Nothing up to so far

13    Menus

14    iwouldn

15    only understanding and practice

16    HOW CERTAIN INFORMATION IS DISPLAYED.

17    unknown program

18    it could use better user interface

19    NOTHING

20    nothing. it already have lot of improvement in it

21    nothing. it already have lot of improvement in it

22    none.

23        Guidelines

24        nothing i don't know this software much

25        Nothing

26        Nothing-it is fine as it is

27        TRY COLOR CODING THE PROTOCOLS WITH DEFAULT COLORS LIKE WIRESHARK BECAUSE THE UI IS A BIT DULL

28        FEGDSFHGHGHJ

29        USER FRIENDLY E.G MAINLY USED CATAGORIES

30        NOTHING FOR NOW

31        IT DOES EXACTLY WHAT I WANT, DO NOT SEE A ROOM FOR IMPROVEMENT

32        The help task information, and context must be more shorter and to the point.

33        the way they present data or information, for first time users it can be boring not knowing what to do and where to from here

34        nothing its just fine

35        frame displaying, we need a bit of colour to improve visibility

36        NO

37      Display filter

38      Nothing

39      the should try and explain it more bcz last

40      In the frame details the display must be more readable

41      It should give the user clear meaning of what is it all about

42      conversation id


43      from menus to being user friendliness.. it is like it was developed for
        professionals.

44      NO COMMENT

**Appendix G: Packet Tracer exercise**

**SPG11AB**

**Practical Exercise 1: Packet Tracer**

**Instructions:**

Create the following networks on the same work space.

**Part 1**

Create the following two  peer-to-peer networks:

**First network:**

IP address **range**: 192.168.10.0

**You <u>can't</u> assign the "IP address range" as an IP address for either of the two PC's; you'll get an error if you do- An IP address RANGE only refers to a specific network! - The host number (4th octet number) that you need to choose, must be unique on both PC's. Keep this rule in mind for all PC's that you need to configure for this exercise.** )

Subnet mask: 255.255.255.0

**Second network:**

IP address **range**: 172.160.20.0

Subnet mask: 255.255.255.0

**You can choose any host IP addresses for the PC's**. **Completion for both networks involve a ping request from one PC to the other (in both networks respectively)**

**End of Part 1**

**Part 2:**

Build a switched network consisting of the following components:

2x Switches
- Rename the first switch to "**Switch 1**" and the second switch to "**Switch 2"**

8x PC's ( connect 4 PC's on each switch)

- For the 4 PC's connected to "**Switch 1**" use the following configuration information:

IP address range: 196.172.5.0
Subnet Mask: 255.255.255.0

<span style="color:red">**You're allowed to choose any host addresses for the 4 PC's connected to Switch 1.**</span>
- For the 4 PC's connected to "**Switch 2**" use the following configuration information:

IP address <span style="color:red">**range**</span>: 168.95.1.0
Subnet Mask: 255.255.255.0

<span style="color:red">**You're allowed to choose any host addresses for the 4 PC's connected to Switch 2**</span>.

**End of Part 2**

**Appendix H: Wireshark exercise**
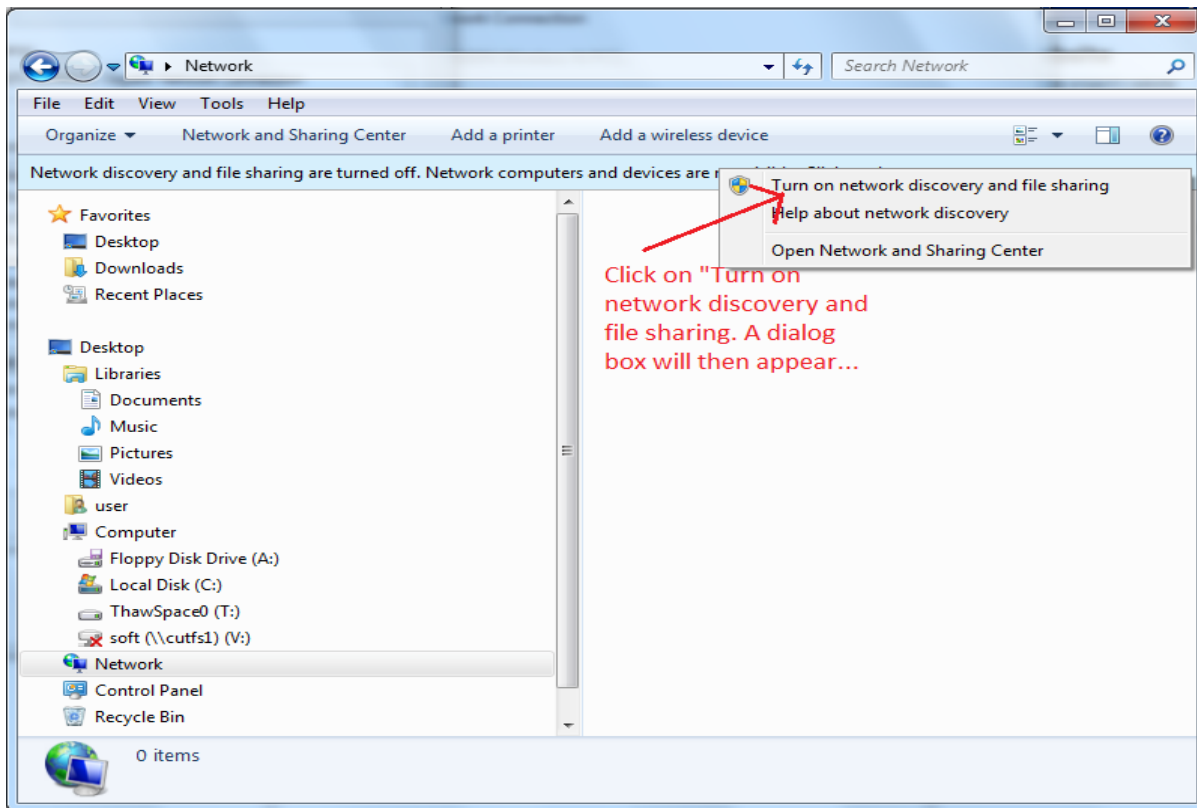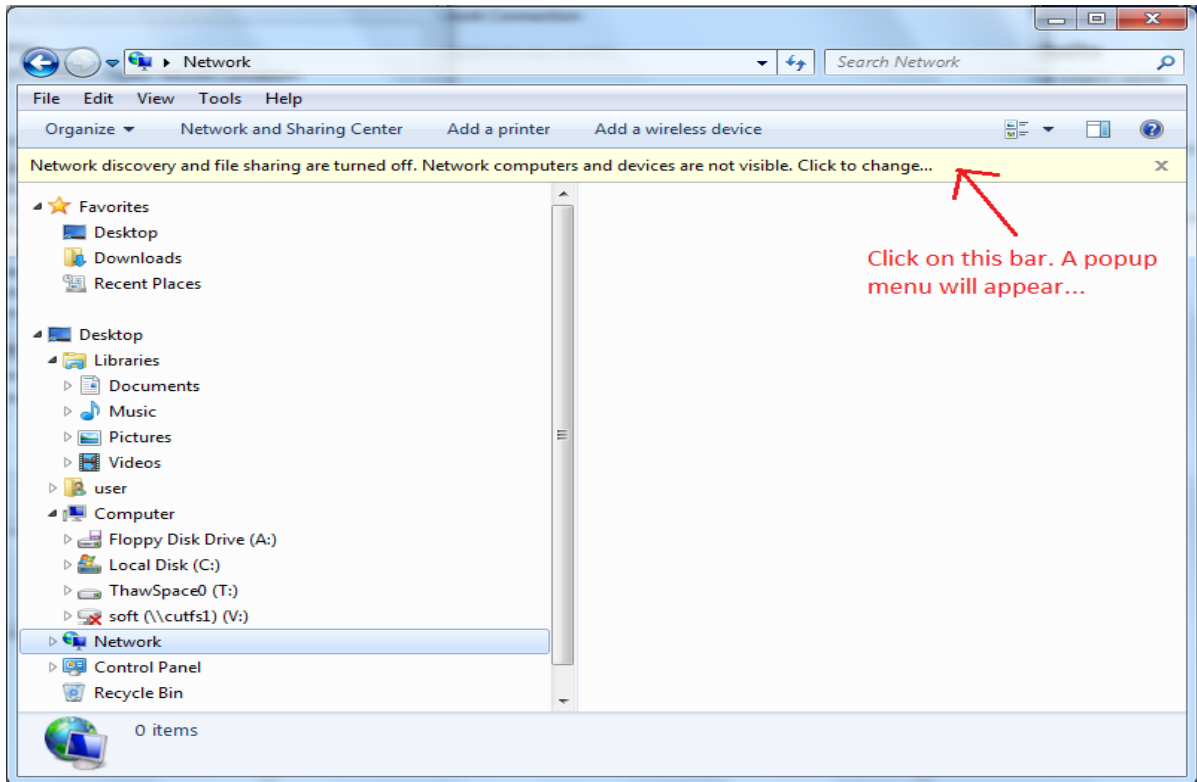
**SPG11AB**

**Practical exercise 1: Wireshark**

**Instructions:**

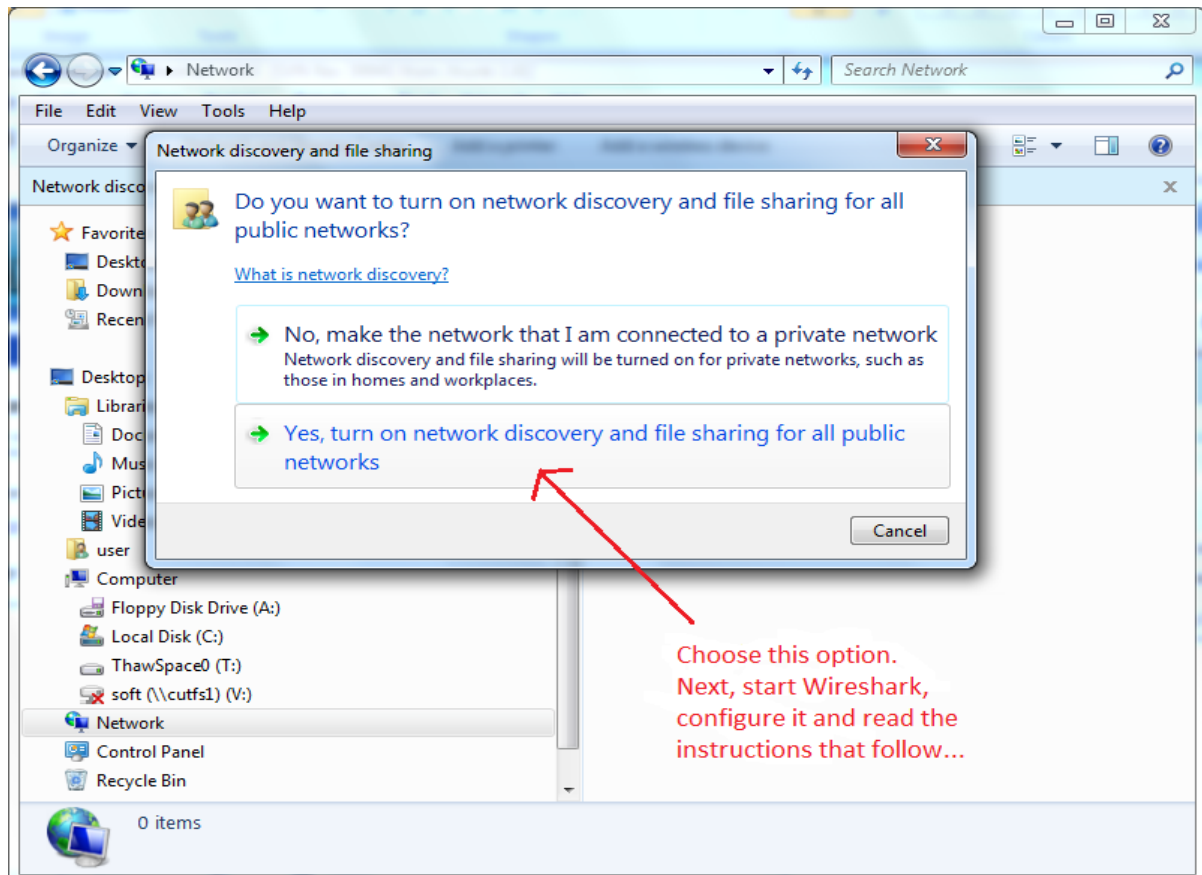**Part 1 - Create your own capture data with a peer-to-peer connection**

**NOTE:   FOR THIS PART OF THE EXERCISE, YOU MAY WORK WITH THE PERSON SITTING NEXT TO YOU. IF YOU ARE SITTING ON YOUR OWN, THE MAKE USE OF THE COMPUTER NEXT TO YOU AS WELL.<span style="color:red">IF YOU HAVE ANY OTHER PROGRAMS OPEN, PLEASE CLOSE THEM. WHILE RUNNING WIRESHARK.</span>**

1. Take a **cross over cable** (1 cable to be shared between 2 people) and connect your computer with the computer next to you. **Cables are available on the wall behind the class room door**.

2. After you connected the two computers with each other, **configure them** with the following **IP addresses** and **subnet masks**:
**192.168.1.1** and **192.168.1.2** with a subnet mask of **255.255.255.0** for both computers.

3. Next, **enable network discovery and file sharing** otherwise you **won't be able to ping the other PC, nor will Wireshark capture any traffic** (see the screenshots below):

a.  Click on the **Start** button,  then click on **Computer** and then click on "**Network**" (highlighted below on the **left**):

See image on next page....

Click on this bar. A popup menu will appear...



Click on "Turn on network discovery and file sharing. A dialog box will then appear...

**And finally:**



After enabling "**Network discovery and file sharing**" , open Wireshark and **DO THE FOLLOWING STEPS ON BOTH PC's :**

1.Set the following capture option for the Ethernet adapter (**Intel(R) 82566DC-2 Gigabit Network Connection Adapter** )

a. Stop the capture after 50 packets

2. Next, open the **Windows command prompt BUT DON'T TYPE ANYTHING YET**.

3. Start the capture in Wireshark and leave it running in the background (**At this stage you shouldn't see any traffic captured in Wireshark, it's normal. If you do see something, don't distress**)

4. Switch back to the command prompt, and now ping the PC of the student sitting next to you.

5. Observe the output in Wireshark while the PC's are busy pinging each other.

120

**TAKE NOTE:** **When you ping the other computer from your own computer, on the other computer's Wireshark you will also notice the ping request being registered or rather "shown".**

**Answer the following questions after the capture has finished** (**these questions are based on the Packet List and Packet Details Panes**):

a. How **many ICMP protocol frames** are listed after performing the ping test ?

b. List the **two source addresses** of the ICMP frames

c. List the **two destination addresses** of the ICMP frames

d. What is the length in **bytes** of one ICMP frames ?

e. What is the length in **bits** of one ICMP frames?

f. Looking at the ICMP frames, they differ from each other in two other aspects besides their source and destination addresses. List the two aspects (hint: you'll find the answers by looking at the "Info" area)

g. Select any of the ICMP frames, and **then list all the protocols present in the frame** using the following notation:

xx:xx:xx:xx where xx represents the protocols you need to list

h. Clicking on either a "**request**" or "**reply**" frame, write down the **source and destination mac addresses** of the source and destination PC's.

i. Select the last ICMP frame, write down the **arrival time** of when the frame was received.

## END OF PART 1

**Part 2 - Analyze an existing captured data set**

(**DO THIS PART ON YOUR OWN - NO TEAMWORK ALLOWED**)

**Go to the download page on the Ciscosrv website and open the "Example Data.pcap" file and answer the following questions:**

1. How **many frames** are captured in total ?

2.  List all **8  types of protocols (excl. BROWSER)** that were captured in the data set

3. Apply a filter for **HTTP traffic** and answer the following questions:

a. How many **HTTP** packets were captured ?

b. How many "**malformed**" packets are listed ?

c. Frame **63** and **212** have **4 things** in common, identify them.

d. Looking at frame **133**, what is the **source port** and **destination port numbers** respectively ?

e. All the frames highlighted in black and red text are **problematic**.  What is the **problem** with each of them and what reason is given for the fault ?

f. Looking at frame **79** what is the **sequence, acknowledgement** and **length numbers** for this frame?

g. Looking at frame **115's Info section**, what does the **"POST"** mean ?

4. Apply a filter for **UDP traffic** and answer the following questions:

4.1 How many valid (without errors) **UDP** frames are captured ?

4.2 Looking at frame **153**, answer the following questions:

4.2.1 What are the **source** and **destination** IP addresses ?

4.2.2 What is the **header length** of the frame ?

4.2.3 Does it have any **fragment offset** values ?

4.2.4 What is the **TTL value** and what does TTL mean ?

4.2.5 List the **source** and **destination** port numbers for this frame.

## END OF PART 2

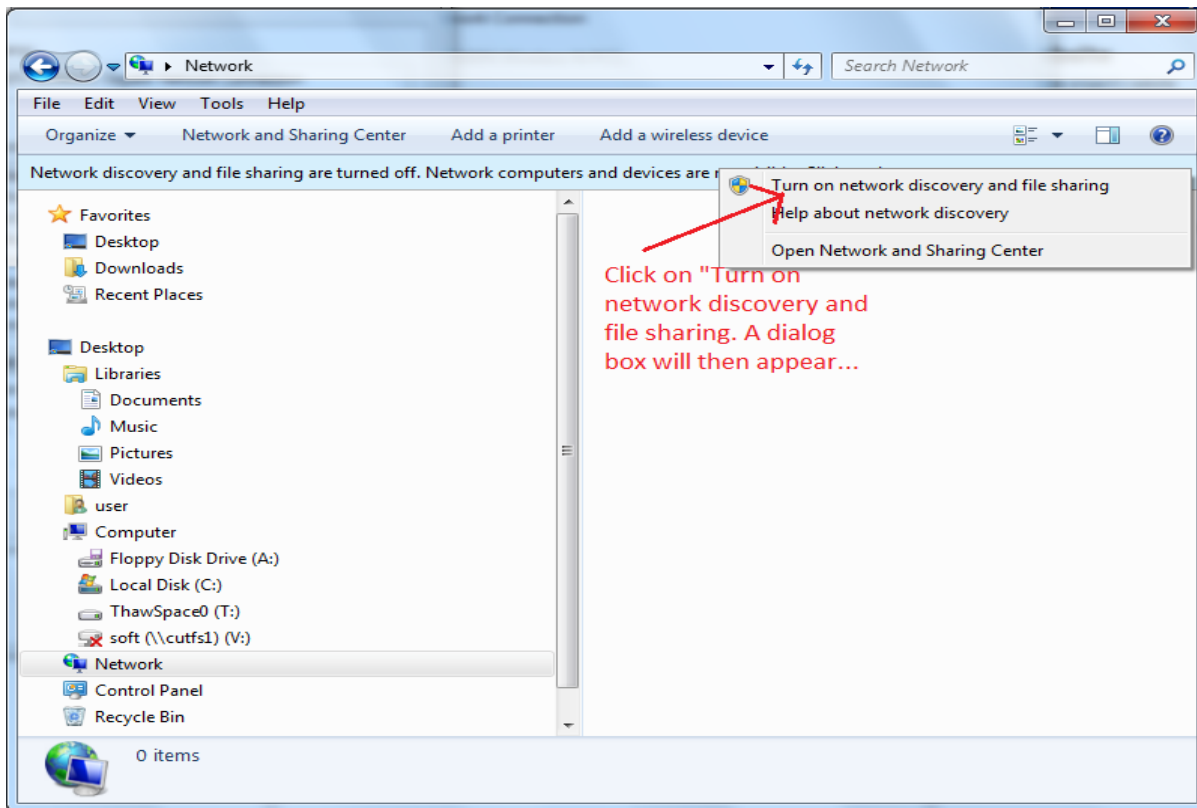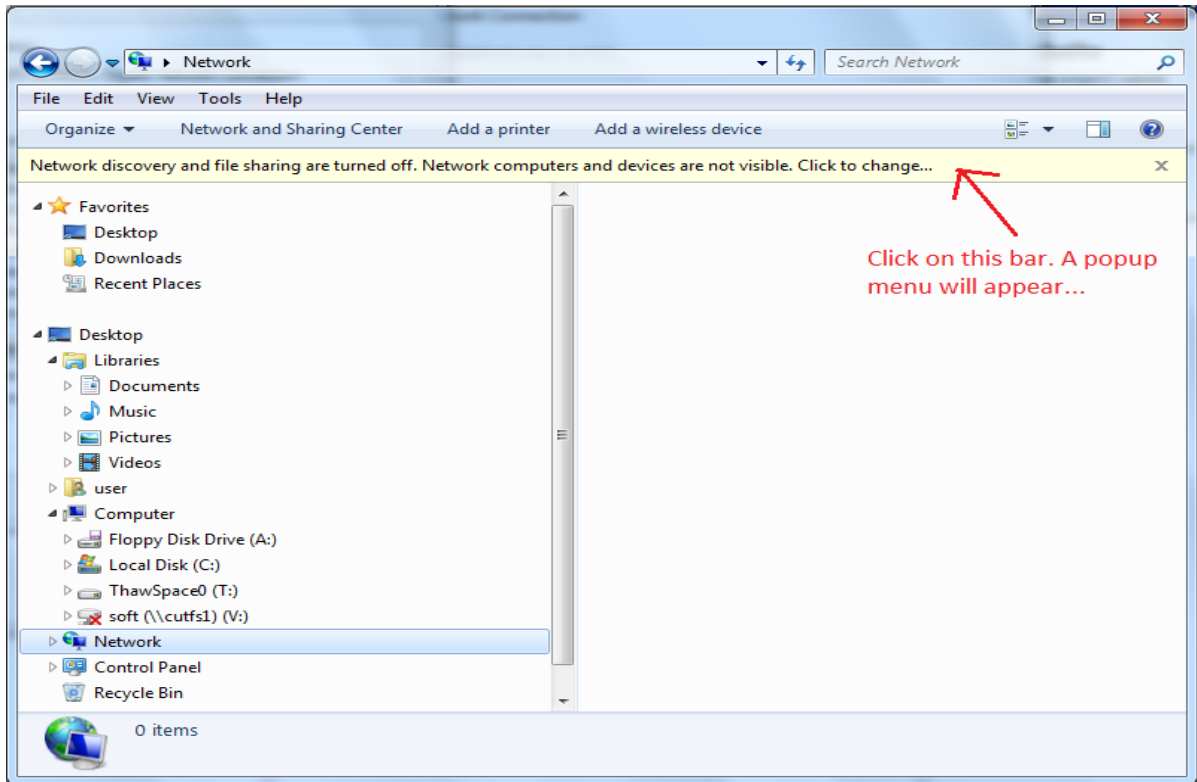**Appendix I: Microsoft Network Monitor exercise**


**SPG11AB**

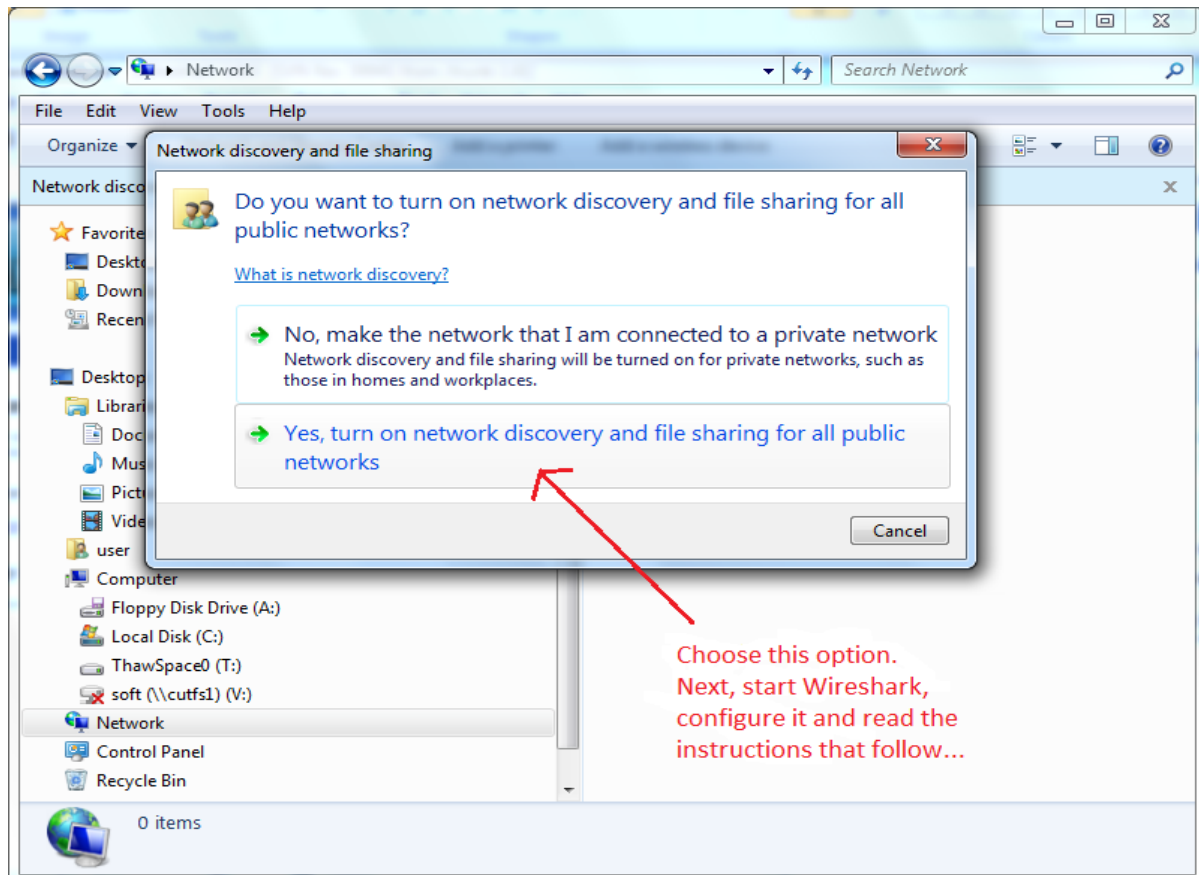**Practical exercise 1: Microsoft Network Monitor**
**Instructions:**


**Part 1 - Create your own capture data with a peer-to-peer connection**


**NOTE:  FOR THIS PART OF THE EXERCISE, YOU MAY WORK WITH THE PERSON SITTING NEXT TO YOU. IF YOU ARE SITTING ON YOUR OWN, THE MAKE USE OF THE COMPUTER NEXT TO YOU AS WELL.IF YOU HAVE ANY OTHER PROGRAMS OPEN, PLEASE CLOSE THEM. WHILE RUNNING NETWORK MONITOR.**


1. Take a **cross over cable** (1 cable to be shared between 2 people) and connect your computer with the computer next to you. **Cables are available on the wall behind the class room door**.


2. After you connected the two computers with each other, **configure them** with the following
**IP addresses** and **subnet masks**:
**192.168.10.1** and **192.168.10.2** with a subnet mask of **255.255.255.0** for both computers.


3. Next, **enable network discovery and file sharing** otherwise you **won't be able to ping the other PC, nor will Network Monitor capture any traffic** (see the screenshots below):


a.  Click on the **Start** button,  then click on **Computer** and then click on "**Network**" (highlighted below on the **left**):

Click on this bar. A popup menu will appear...



Click on "Turn on network discovery and file sharing. A dialog box will then appear...

**And finally:**



**After enabling "Network discovery and file sharing" , open Network Monitor and**

**DO THE FOLLOWING STEPS ON BOTH PC's :**

1. Ensure that you select the "**Local Area Connection**" adapter to capture your traffic. The Ethernet adapter is called "**Intel(R) 82566DC-2 Gigabit Network Connection Adapter**"

2. At this stage, open up the command prompt (if you haven't already) and type "ping" with the other PC's IP address. **DO NOT PRESS ENTER JUST YET**

3. Next, start a **new capture** by clicking on the "**New Capture**" button at the top.

4. Start the capture by clicking on the "**Start**" button (**At this stage you shouldn't see any traffic captured in Network Monitor, it's normal. If you do see something, don't distress**)

5. Switch back to your **command prompt window** and press **Enter** to execute the ping command

6. Observe the output in Network Monitor while the PC's are busy pinging each other.

7. After the ping process has finished (in the command prompt window), stop the capture by clicking on the "**Stop**" button

**TAKE NOTE: When you ping the other computer from your own computer, on the other computer's Network Monitor you will also notice the ping request being registered or rather "shown". Answer the following questions after the capture has finished** (**these questions are based on the Frame Summary and Frame Details panes / areas**):

8. Apply a **red colour filter** for ICMP packets in order to help you identify them and answer the following questions:

a)  How **many ICMP packets** are listed after one ping command has been executed?

b)  What is the **source address** of the PC that sent the ping request

c)  What is the **destination address** of the PC that will be receiving the ping request

d)  Write down the **destination PC's** hostname

e)  How many **protocols** have been recorded at this stage?

f)  Write down the **names** of all the protocols captured at this stage

g)  How many ARP "**Request**" and "**Respond**" frames are listed?

h)  What does **ARP** stand for?

**END OF PART 1**

**PS: If you're not finished with Part 1 after 25 minutes, start with Part 2 immediately because it has more questions than Part 1.**

## Part 2 - Analyze an existing captured data set

(**DO THIS PART ON YOUR OWN - NO TEAMWORK ALLOWED**)

**Go to the download page on the Ciscosrv website and open the "NM Example Data.cap" file and answer the following questions:**

1. If you click on "**All Traffic**", How **many frames** are captured in total ?

2. How **many programs' processes** were captured in this example data set?

3. What are the **process ID's** of the programs ?

   List each one separately per program.


4. Select the **Steam.exe process id** and then answer the following questions:

4.1. How many **conversation id's (ConvID**) are listed ?

4.2. Expand the **first conversation id**, and provide the following:

4.2.1 The **protocol** utilized by conversation id **2**

4.2.2What is the **source port** and **destination port numbers** of conversation **id 2**?


5. Select the **Origin.exe process id** and then answer the following questions:


5.1 How many **TCP** frames were captured ?

5.2 How many **HTTP** frames were captured?

5.3 Looking at the **first HTTP frame**, answer the following questions:

5.3.1 What is the **frame's number** ?

5.3.2 What is the **captured frame length** ?

5.3.3 What are the **source** and **destination** addresses of this frame ?

5.4 Looking at the **second HTTP frame,**answer the following questions:

5.4.1 Select the frame and click on the "**frame commentstab**", what **title** is given to this frame ?

5.4.2 Name **three features** of the **Origin program** by reading the description of the frame comment


6. Select the **Chrome.exe process id** and answer the following questions:

6.1 How many conversation ids are listed for this process ?

6.2 Without applying a colour filter, how many HTTP frames are listed for this process ?

**END OF PART 2**