BORANG PENGESAHAN STATUS TESIS^

JUDUL: REDUNDANT ARRAYS OF INEXPENSIVE DISKS (RAID)
CONFIGURATION ON LINUX

SESI PENGAJIAN: 2004/2005

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REDUNDANT ARRAYS OF INEXPENSIVE DISKS (RAID) CONFIGURATION ON LINUX

SOPHIAN RAYMIE MD YUSOP

This report is submitted in partial fulfillment of the requirements for the Bachelor of Information and Communications Technology (Computer Network)

FACULTY OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA
2004

DECLARATION

I hereby declare that this project report entitled

REDUNDANT ARRAYS OF INEXPENSIVE DISKS (RAID) CONFIGURATION ON LINUX

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DEDICATION

Dedicate to my beloved parents, my family and my love. God bless you all. Thank you for the help.

ACKNOWLEDGEMENTS

Firstly, I want to thank to Kolej Universiti Teknikal Kebangsaan Malaysia because held this Sarjana Muda Project. Not forgetting to Pn Wahidah as my supervisor. To all other lecturers and my colleague who always help me if I got something to ask, thank you everyone.

I am very grateful because had successfully finished my PSM 1 and 2 and I had learn many experience and knowledge through the whole months doing this project thesis and developing it.

I would also like to thank my beloved parents who have been giving me support and motivation throughout my project. Without their support I will never be here till the end of my PSM1 and PSM2. Thank you very much and I love you all.

Lastly, I want to say thanks to all people that related to my PSM project either purposely help me or not. Thanks.

ABSTRACT

This report is written based on the developed project. The title of the project is 'Redundant Arrays of Inexpensive Disks (RAID) Configuration on Linux'. It is a way on how to configure server to provide backup system if the are failure occurred to the hard disk. The main problem that can be detected is there is no backup system provides if ant emergency case or failure happen to the hard disk. Besides that, there are also other problems concerning this project development. There are several objectives that become the purpose why this project is developing in the first place. The objectives are such as to make a set of physical disk drives viewed by the operating system as a single logical drive, redundancy of data at a chosen level, recovery from a failure is simple which when a drive fails, the data may still be accessed from the second drive. The methodology used in developing this project is according to the result of investigation of existing methodology. The result from the investigation comes up with the new idea of methodology which is used only in this project. There are five stage of methodology. They are define, analysis, design, implementation and testing. The result from this project is hoped that it will fulfill the requirements required in the thesis writing guide that provided by the Projek Sarjana Muda committee member. As the conclusion, this report informs from the starting of the project development till the end of the presentation.

ABSTRAK

Laporan ini ditulis berdasarkan projek yang dibangunkan. Tajuk projek tersebut adalah 'Redundant Arrays of Inexpensive Disks (RAID) Configuration on Linux'. Ia merupakan cara bagaimana untuk mengkonfigurasi *server* agar dapat menyediakan satu sistem untuk memberi bantuan segera sekiranya berlaku masalah pada satu-satu cakera keras. Masalah utama yang dapat dikenalpasti adalah seperti ketiadaan bantuan segera sekiranya berlaku kecemasan yang memerlukan penyimpanan data yang segera sebelum ia hilang atau terpadam. Selain itu masih terdapat masalah lain yang menyebabkan projek ini di bangunkan. Terdapat beberapa objektif mengapa projek ini ingin dibangukan. Antaranya adalah untuk manjadikan satu set medium penghantaran fizikal di lihat oleh sistem pengoperasian sebagai satu medium penghantaran lojikal, limpahan data adalah pada tahap yang dipilih sahaja, pembaik pulih kegagalan medium adalah mudah dan banyak lagi. Metodologi yang digunakan utk membangunkan projek ini adalah berdasarkan kajian metodologi yang telah wujud. Hasil daripada kajian tersebut maka, terhasillah satu metodologi yang digunakan khusus untuk projek ini. Terdapat lima fasa dalam metodologi tersebut iaitu kenalpasti, analisa, rekabentuk, implementasi and ujian. Hasil daripada Projek Sarjana Muda 1 ini adalah diharapkan agar ia memenuhi keperluan yang digariskan pada panduan menulis laporan tesis yang disediakan oleh jawatankuasa Projek Sarjana Muda. Sebagai kesimpulannya, laporan ini menyatakan dari awal pembangunan projek ini hingga ke akhir di mana ia boleh dipersembahkan dengan sebaik mungkin.

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CHAPTER I

INTRODUCTION

1.1 Project Background

The project that wanted to be built is RAID configuration on Linux. Redundant array of inexpensive disks is a term coined in 1987 by researchers at the University of California at Berkeley to describe a series of redundant architectures used in fault-tolerant disk arrays. Numbered 0 through 5, RAID levels refer to different array architectures that offer various advantages in terms of data availability, cost, and performance.

The basic idea of RAID was to combine multiple small, independent disk drives into an array of disk drives which yields performance exceeding that of a Single Large Expensive Drive (SLED). Additionally, this array of drives appears to the computer as a single logical storage unit or drive.

The Mean Time Between Failure (MTBF) of the array will be equal to the MTBF of an individual drive, divided by the number of drives in the array. Because of this, the MTBF of an array of drives would be too low for many application requirements. However, disk arrays can be made fault-tolerant by redundantly storing information in various ways.

There are five types of array architectures. They are RAID-1 through RAID-5. Each providing disk fault-tolerance and each offering different trade-offs in features and performance. In addition to these five redundant array architectures, it has become popular to refer to a non-redundant array of disk drives as a RAID-0 array.

Today some of the original RAID levels (namely level 2 and 3) are only used in very specialized systems (and in fact not even supported by the Linux Software RAID drivers). Another level, linear has emerged, and especially RAID level 0 is often combined with RAID level 1.

In this project, the RAID will be setup in Linux environment. The purpose is to provide a backup hard disk if there is hard disk failure happen. RAID is an assembly of disk drives, known as disk array that operates as one storage unites. In general, the drives could be any storage system with random data access, such as magnetic hard drives, optical storage, magnetic tapes, etc. When the speed (data transfer rate) is an issue, the fastest SCSI hard drives are typically used.

When describing RAID setups, it is useful to refer to the number of disks and their sizes. At all times the letter **N** is used to denote the number of active disks in the array (not counting spare-disks). The letter **S** is the size of the smallest drive in the array, unless otherwise mentioned. The letter **P** is used as the performance of one disk in the array, in MB/s. When used, we assume that the disks are equally fast, which may not always be true in real-world scenarios.

Note that the words device and disk are supposed to mean about the same thing. Usually the devices that are used to build a RAID device are partitions on disks, not necessarily entire disks. But combining several partitions on one disk usually does not make sense, so the words devices and disks just mean partitions on different disks.

Software RAID devices are so-called block devices, like ordinary disks or disk partitions. A RAID device is built from a number of other block devices - for example, a RAID-1 could be built from two ordinary disks, or from two disk partitions (on separate disks).

This configuration can be used by all organization based on IT and networking. It can help to prepare backup system if unfortunate event happen.

1.2 Problem statement(s)

RAID can help avoid data loss, but it can not prevent it. To understand why, and to be able to plan a better data protection strategy, it is useful to understand the different types of failures, and the way they can cause data loss.

- **Accidental or Intentional Erasure**

  One of the leading causes of data loss is the accidental or intentional erasure of files by user. This includes files that were erased by hackers who broke into the system, files that were erased by disgruntled employees, and files that being erased because of the thinking that they were not needed any more, or due to a sense of discovery, to find out what old-timers mean when they say they fixed it for good by using the wizardly command `su - root; cd /; rm -r *`. RAID will not help recover data lost in this way and to mitigate these kinds of losses, a regular backups needs to be perform.

- **Total Disk Drive Failure**

  One possible disk drive failure mode is *complete and total disk failure*. This can happen when a computer is dropped or kicked, although it can also happen due to old age of the drive. Typically, the read head crashes into the disk platter, thereby trashing the head, and keeping any or everything on that platter from being readable. If the disk drive has only one platter, this means everything. Failure of the drive electronics due to example electrostatic discharge can result in the same symptoms. This is the pre-eminent failure mode that RAID protects against. By splattering data in a redundant way across many disks, the total failure of any one disk will not cause any actual data loss. A far more common disk failure mode, however, is a slow accumulation of bad blocks: disk sectors which have become bad or unreadable. RAID does not protect against data corruption.

- **Power Loss and Ensuing Data Corruption**

  Many beginners think that they can test RAID by starting a disk-access intensive job, and then unplugging the power while it is running. This is usually guaranteed to cause some kind of data corruption, and RAID does nothing to prevent it or to recover the resulting lost data. This kind of data corruption or loss can be avoided by using a journaling file system, and/or a journaling database server to avoid data loss in a running SQL server when the system goes down. Note that databases have their own unique ways of guaranteeing data integrity in the face of power loss or system crash.

- **Bad Blocks on Disk Drive**

The most common form of disk drive failure is a slow but steady loss of 'blocks' on the disk drive. Blocks can go bad in a number of ways: microscopic dust sticking to the platter, gouges in the platter when the head struck it, magnetic media applied too thinly at the factory, or worn off due to contact, etc. Over time, bad blocks can accumulate, and, from personal experience, as fast as one a day. Once a block is bad, data cannot be read from it. Bad blocks are not uncommon. The hard drive electronics can detect a bad block, and automatically reassign in its place a new, good block from elsewhere on the disk. All subsequent accesses to that block by the operating system are automatically and transparently handled by the disk drive. This feature is both good, and bad. As blocks slowly fail on the drive, they are automatically handled until one day the bad-block lookup table on the hard drive is full. At this point, bad blocks become painfully visible to the operating system

- **General System Corruption**

This is an uncommon phenomenon under Linux. While Linux would not crash if the word processor has a bug in it, this kind of a bug can lead to irretrievable data loss, which can be almost as bad. Note that this kind of corruption can also occur due to bad hardware, cabling, or even an electrically noisy environment. A loose cable may slowly corrupt data, although it will usually show itself in other ways, which the device driver will interpret as broken hardware.

1.3 Objectives

RAID configuration on Linux project is built to achieve several objectives. Among the objectives are shown below:

- **Single logical drive.**

  To make a set of physical disk drives viewed by the operating system as a single logical drive.

- **Data distributed.**

  Data are distributed across the physical drives of an array.

- **Data recoverability.**

  Redundant disk capacity is used to store parity information, which guarantees data recoverability in case of disk failure.

- **Immediate availability.**

  Immediate availability of data and, depending on the RAID level, recovery of lost data.

- **Simple recovery.**

  Recovery from a failure is simple. When a drive fails, the data may still be accessed from the second drive.

1.4 Scopes

There are several scopes concerning this project. This project will be developed according to the listed scopes and they are as shown below.

- **Mirroring**

  Two hard disk partitions are used to create one partition, which is the size of the smallest component partition. Each of the component partitions contain the same information, so if one disk fails, the other takes over without any loss of data.

- **Web Browser**

  A software application used to locate and display Web pages. Both of these are a graphical browser, which means that they can display graphics as well as text. In addition, most modern browsers can present multimedia information, though they require plug-ins for some formats. Upload an httpd service in the RAID server. It is used as testing for client to access server even though the IDE of primary hard disk id unplug. For that reason, the server will still can be accessed using the httpd services.

- **Security**

  Software installed in the server for a security concern. The software is the TrinityOS which is a step-by-step on how to build a very functional Linux box with a string security. It has a complete physical and OS-level security recommendations and guidelines. It has a full SSHd (encrypted TELNET) support. It wills also actively updated Linux system security and patching. Actually, this software contains more useful function related to security. That is why it is used in this RAID system.

1.5 Project significance

From this project, many people or organizations will have the benefits if they using the RAID configuration on their computer processor unit or even in server room. It will give the advantages especially to those who always use computer and made their hard disk as the important item in saving their entire task.

Firstly, with the usage of RAID configuration, user can make sure their data is saved even they fronting a disk failure in sudden. The backup hard disk will automatically took the task of saving entire data at no time at all.

Secondly, although there are several hard disks on your CPU or server, it still is viewed as a single logical drive. This will not confuse user when they are saving their data. The data will be saved in a primary hard disk and only if there is a failure then the data will be saved in the backup hard disk. User also has not to worries that their data will be loss if the hard disk failure happens. This is because the data that their trying to saved are distributed across the physical drives of an array.

Third, user will be given a guarantee that their data is not loss and can be recovered back. It is by using a redundant disk capacity. The purpose is to store parity information, which guarantees data recoverability in case of disk failure. The redundancy of data will be at a chosen level only.

Lastly, user can made sure that the recovery from a failure will be simple. When a drive fails, the data may still be accessed from the second drive. Besides that, the recovery will be immediate and also the availability of data will be immediate depending on the RAID level.

1.6 Conclusion

As a conclusion, this is an applicable project that can be developed from the smallest organizations to the worldwide organization. It will be appreciate by those who always depend on their hard disk to save their precious data. There will be no case of losing data again if this configuration used in every place or organization.

After this, the literature review and project methodology will be specified to make this project more knowledgeable and understood.

CHAPTER II

LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

Software RAID implementations are included with many commercial OS releases such as the server editions of Solaris 7 and Windows 2000 and with all of the major free UNIX-like operating systems, including Linux, which is being increasingly deployed for Internet service applications. More importantly, RAID has well-defined availability goals, making it an ideal candidate application for benchmarking availability.

During this chapter, literature about the RAID will be review. Any supporting data will be mentioned to support the idea of developing this project. Besides that, the methodology used on this project will be explained stage by stage. It will refer to the phase that is involved from the introduction document until the project complete.

2.2 Fact and finding

During this part, it will discuss about the approach and related or passed research, reference, case study and other finding of this project. Most of them are from the Internet source. Below are the researches that have been done which may talk about the approach that will be implemented in this project.

In 1987, Patterson, Gibson and Katz at the University of California Berkeley, published a paper entitled "A Case for Redundant Arrays of Inexpensive Disks (RAID)”. This paper described various types of disk arrays, referred to by the acronym RAID. The basic idea of RAID was to combine multiple small, inexpensive disk drives into an array of disk drives which yields performance exceeding that of a Single Large Expensive Drive (SLED). Additionally, this array of drives appears to the computer as a single logical storage unit or drive.

“The primary purpose of RAID is to protect data from underlying hardware failures. With every RAID level above RAID-0 (which isn't actually RAID), should a single disk fail, the RAID volume will be able to remain online and usable, although usually with degraded performance levels. Either the hardware or software volume manager used to construct the RAID volume will have tools to replace a failed drive and rebuild the lost data. A secondary benefit provided by a RAID volume (except in the case of RAID-1) is in presenting a single, large virtual disk that has considerably higher performance and capacity than does an individual disk.“ (Alan Benway **32 SW Expert** July 2000)

Three imaginative fellows at the University of California at Berkeley wrote the concept of RAID in 1988. RAID was then defined to mean "Redundant Array of Inexpensive Disks," although nowadays, the relative term "Inexpensive" has been replaced by the more general term "Independent." This threesome produced what are known as the "Berkeley Papers," wherein a five-step data protection process and five configuration models (plus one other providing increased capacity with no protection) are described. These are RAID levels 1, 2, 3, 4 and 5 (and 0). (Alan Benway **32 SW Expert** July 2000)

RAID 1 is chosen to be built for this project because of a few reasons. Firstly is because it is the basic RAID of all. This is the first RAID in RAID evolution. As the beginning of this project, it has to be started with the basic. Secondly is because of the RAID1 advantages itself. Whether it is not powerful as the other RAID but it still can show the function of what is RAID used for. Then the third reason is because it is more to mirroring which is the main function that want to be applied in this project.

There are a bit differentiation between RAID and a common backup system. The differences are for the RAID system, the back up function is done automatically but not to the common back up system. Moreover, for the RAID system, it will copy all data located in the primary master hard disk but not to the common back up system. It has to be copy one by one manually. This will cause of wasting time.

2.3 Project Methodology

The methodology that will be used for this project is created according to a few existing methodology but not alike. There are five approaches that implemented in this project methodology. They are Define, Analysis, Design, Implementation, and Testing. The methodology must be followed step by step and if there are problems need to be recovered after testing it will be start at the suitable stage again.

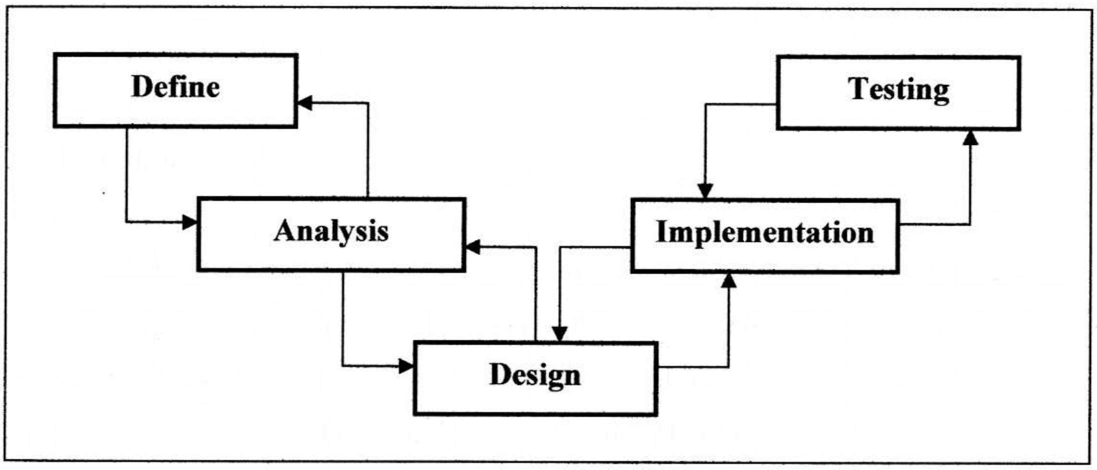

Figure 2.1 Project Methodology Diagram

2.3.1 Define

During this stage, the defining of project background, objectives, scopes and requirements are done. The requirements only mentioned concisely because it will be explained detail later. The task that have been done here is by do some research in