Experiment / assignment / tutorial No. 3

Title: Case study and implementation of RAID levels.

Batch: **Roll No.:** **Experiment / assignment / tutorial No.:3**

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Objective:

After completing this experiment you will be able to:

- Identify applications of RAID.
- Identify and state advantages and disadvantages of different levels of RAID.

Resources needed: MS-office / Open office

Theory

RAID (an acronym for **redundant array of independent disks**; originally **redundant array of inexpensive disks**) is a storage technology that combines multiple disk drive components into a logical unit. Data is distributed across the drives in one of several ways called "RAID levels", depending on what level of redundancy and performance (via parallel communication) is required.

RAID is an example of storage virtualization and was first defined by David A. Patterson, Garth A. Gibson, and Randy Katz at the University of California, Berkeley in 1987. Marketers representing industry RAID manufacturers later attempted to reinvent the term to describe a *redundant array of independent disks* as a means of dissociating a low-cost expectation from RAID technology.

RAID is now used as an umbrella term for computer data storage schemes that can divide and replicate data among multiple physical drives. The physical drives are said to be *in* a RAID, which is accessed by the operating system as one single drive. The different schemes or architectures are named by the word RAID followed by a number (e.g., RAID 0, RAID 1). Each scheme provides a different balance between two key goals: increase data reliability and increase input/output performance.

RAID Levels and Types

RAID, an acronym of Redundant Array of Independent (Inexpensive) Disks is the talk of the day. These are an array of disk to give more power, performance, fault tolerance and accessibility to the data, as a single storage system. It's not mere combination of disks but all the disks are combined providing standard MTBF (mean time before failure) reliability scheme; otherwise chances are performance would be affected drastically if disks are not combined as a single storage unit.

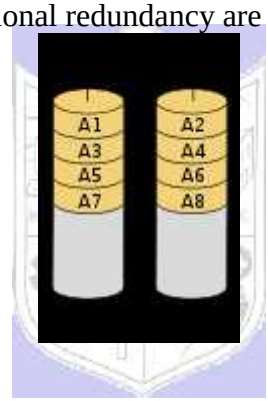
RAID Levels

All the RAID types and models are commonly classified as RAID levels, since RAID represented by a higher number is regarded to be superior, more efficient, high-performance array than the low numbered RAID. Hence, high security feature of RAID also depends on the RAID level you are using. RAID arrays, not only, provide the users with maximum security and reliability but also make sure that if a disk fails no data is lost. The in-depth knowledge about RAID levels would help you through buying of RAID servers.

Let's briefly discuss here the main RAID levels and classes:

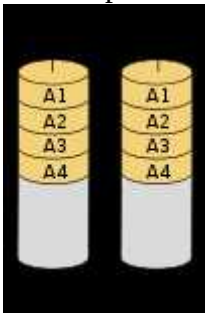
RAID 0 - Striping:

It is the **Stripped Disk Array** with no fault tolerance and it requires at least 2 drives to be implemented. Due to no redundancy feature, RAID 0 is considered to be the lowest ranked RAID level. Striped data mapping technique is implemented for high performance at low cost. The I/O performance is also improved as it is loaded across many channels. Regeneration, Rebuilding and functional redundancy are some salient features of RAID 0.



RAID 1 - Mirroring:

It is the **Mirroring (Shadowing) Array** meant to provide high performance. RAID 1 controller is able to perform 2 separate parallel reads or writes per mirrored pair. It also requires at least 2 drives to implement a non-redundant disk array. High level of availability, access and reliability can be achieved by entry-level RAID 1 array. With full redundancy feature available, need of readability is almost negligible. Controller configurations and storage subsystem design is the easiest and simplest amongst all RAID levels.

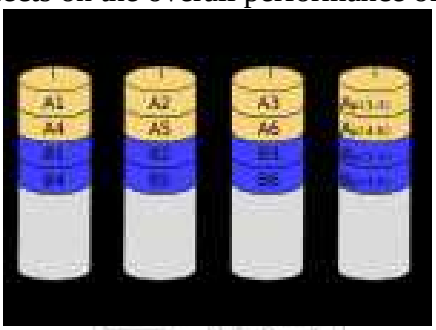


RAID 0+1:

It is the RAID array providing high data transference performance with at least 4 disks needed to implement the RAID 0+1 level. It's a unique combination of stripping and mirroring with all the best features of RAID 0 and RAID 1 included such as fast data access and fault tolerance at single drive level. The multiple stripe segments have added high I/O rates to the RAID performance and it is the best solution for maximum reliability.

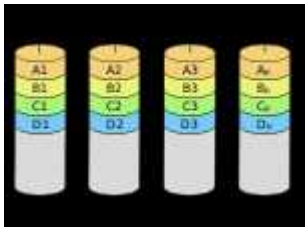
RAID 3:

RAID 3 works on the **Parallel Transfer with Parity** technique. The least number of disks required to implement the RAID array is 3 disks. In the RAID 3, data blocks are striped and written on data drives and then the stripe parity is generated, saved and afterwards used to verify the disk reads. Read and write data transfer rate is very high in RAID 3 array and disk failure causes insignificant effects on the overall performance of the RAID.



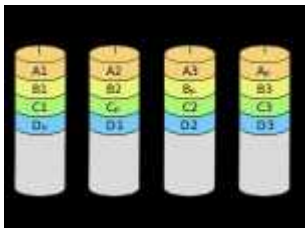
RAID 4:

RAID 4 requires a minimum of 3 drives to be implemented. It is composed of independent disks with shared parity to protect the data. Data transaction rate for Read is exceptionally high and highly aggregated. Similarly, the low ratio of parity disks to data disks indicates high efficiency.



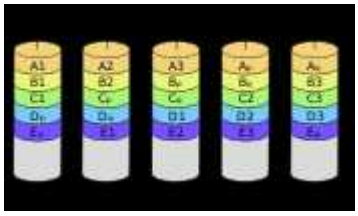
RAID 5:

RAIDS 5 is Independent Distributed parity block of data disks with a minimum requirement of at least 3 drives to be implemented and N-1 array capacity. It helps in reducing the write inherence found in RAID 4. RAID 5 array offers highest data transaction Read rate, medium data transaction Write rate and good cumulative transfer rate.



RAID 6:

RAIDS 6 is **Independent Data Disk array with Independent Distributed parity**.
It is known to be an extension of RAID level 5 with extra fault tolerance and distributed parity scheme added. RAID 6 is the best available RAID array for mission critical applications and data storage needs, though the controller design is very complex and overheads are extremely high.



RAID 7:

RAID 7 is the **Optimized Asynchrony array** for high I/O and data transfer rates and is considered to be the most manageable RAID controller available. The overall write performance is also known to be 50% to 90% better and improved than the single spindle array levels with no extra data transference required for parity handling. RAID 7 is registered as a standard trademark of Storage Computer Corporation.

RAID 10:

RAID 10 is classified as the futuristic RAID controller with extremely high Reliability and performance embedded in a single RAID controller. The minimum requirement to form a RAID level 10 controller is 4 data disks. The implementation of RAID 10 is based on a striped array of RAID 1 array segments, with almost the same fault tolerance level as RAID 1. RAID 10 controllers and arrays are suitable for uncompromising availability and extremely high throughput required systems and environment.

Problem Definition:
Acme Telecom is involved in mobile wireless services across the United States and has about 5000 employees worldwide. This company is Chicago based and has 7 regional offices across the country.
Although Acme is doing well financially, they continue to feel competitive pressure. As a result, the company needs to ensure that the IT infrastructure takes advantage of fault tolerant features.

The company uses a number of different applications for communication, accounting, and management. All the applications were hosted on individual servers with disks configured as RAID 0.

The company changed the RAID level of their accounting application based on your recommendations 6 months ago.

It is now the beginning of a new financial year and the IT department has an increased budget. You are called in to recommend changes to their database environment. You investigate their database environment closely, and observe that the data is stored on a 6-disk RAID 0 set. Each disk has an advertised formatted capacity of 200 GB and the total size of their files
is 900 GB. The amount of data is likely to change by 30 % over the next 6 months and your solution must accommodate this growth. The application performs around 40% write operations, and the remaining 60 % are reads. The
average size of a read or write is small, at around 2 KB.

How would you suggest that they restructure their environment?
A new 200 GB disk drive costs $1000. The controller can handle all commonly used RAID levels, so will not need to be replaced.
What is the cost of the new solution?
Justify your choice based on cost, performance, and data availability of the new solution.

Disk Load for RAID level=
Percentage Read X IOPS + Write Penalty for RAID level X (Percentage Write X IOPS)
Write penalty for each RAID level is specified in table below.
Number of disks for a RAID level = Disk load/Maximum IOPS

RAID levels with write penalties:

RAID level	Write Penalty
RAID 0	0
RAID 1	2
RAID 3	4
RAID 4	4
RAID 5	4
RAID 6	6
RAID 10	2

e.g.
Consider an application that generates 5200 IOPS, with 60% of them being reads. The disk load in RAID 5 is calculated as follows:
RAID level =5
Write Penalty for RAID 5 = 4
Number of input output operations per second are IOPS=5200
Percentage Read=60 %
Percentage Write=40 %
Maximum Input Output operations per second are =180

Disk Load for RAID 5 =
Percentage Read X IOPS + Write Penalty for RAID 5 X (Percentage Write X IOPS)

Disk load for RAID 5 =0.6 X 5200+ 4 X (0.4X5200)
= 3120 + 4 X 2080
= 3120+8320
= 11440 IOPS.

Number of disks for RAID 5=Disk load/Maximum IOPS
= 11440/180 = 64 disks.

Outcomes:

1. Anabilitytoidentify andformulateengineering problems. (e)
2. An understanding of best practices, standards and their applications. (m)

Conclusion: (Conclusion to be based on the objectives and outcomes achieved)

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of faculty in-charge with date

References:

Books/ Journals/ Websites:

1. EMC EducationalServices,"InformationStorage andManagement",Wiley India.
2. RichardBarkerandPaulMassiglia, "StorageAreaNetworkEssentials:ACompleteGuide to Understandingand ImplementingSANs",WileyIndia.
3. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill Osborne, 2003.
4. MarcFarley, "Building StorageNetworks",Tata McGraw Hill, Osborne, 2001.
5. MeetGupta, "Storage AreaNetworkFundamentals", Pearson Education Limited, 2002.