MODULE - V

Monitoring and Managing the Storage Infrastructure

MODULE 5

Monitoring and Managing the Storage Infrastructure

Module Description

Managing the storage infrastructure consists of numerous activities that includes availability, capacity, performance and security management. Each of these aspects are interrelated and must work hand-in-hand to maximise the return on investment.

In order to appropriately manage the storage infrastructure, monitoring steps out as one of the most important aspect. It helps in providing the current and correct status of several storage components and information that helps in performing the essential management activities. This chapter details the monitoring and other management activities of the storage infrastructure. It also describes emerging challenges in storage infrastructure management.

In this chapter, students will get an insight on the various parameters and components required for performing the monitoring of storage infrastructure. Students will also get to know the storage management activities and their associated examples along with the challenges in performing management activities.

Chapter 5.1

Monitoring and Managing the Storage Infrastructure

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Chapter 5.1

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Aim

To equip the students with the monitoring and managing of the storage infrastructure

Instructional Objectives

After completing this chapter, you should be able to:

- Describe the purpose for monitoring the storage infrastructure
- Explain the parameters and components monitored for storage infrastructure
- Categorise management activities in a storage infrastructure
- Outline the complexity of managing the storage infrastructure

Learning Outcomes

At the end of this chapter, you are expected to:

- Identify the parameter that should be monitored for storage infrastructure
- Outline different types of monitoring storage infrastructure
- Outline the advantage of storage management activities
- Describe how to overcome challenges in managing storage infrastructure

5.1.1 Introduction

With the rapid increase in the amount of applications, increase in the complexity of business processes and the requirement for the information to be available 24 x 7, the demands on the IT infrastructure has proportionally increased. Managing storage infrastructure is the key that enables the organisations to address these challenges and ensure the business continuity without fail.

Information today, can be counted on only if it has been managed and monitored properly. A poorly designed or managed storage infrastructure puts the entire business at risk in case of any catastrophic failures. A proper storage infrastructure management requires an understanding of the components and parameters that are required to be monitored. This ensures availability and desired performance of all the storage infrastructure elements, meeting compliance requirements and higher data protection and security. It also ensures consolidating the resources for their better utilisation, limiting the requirement for excessive technological investment and helps in efficiently leveraging the existing resources.

Apart from this, one should also be aware of the activities that needs to be performed in order to properly manage the storage infrastructure and the possible challenges that one might have to face in doing so.

In the coming topics, we will discuss monitoring, along with its purpose and the parameters and components involved in it. We will also come across different storage management infrastructure challenges and understand the complexity of managing the storage infrastructure.

Let us start by discussing the purpose of monitoring the storage infrastructure.

5.1.2 Monitoring the Storage Infrastructure

Monitoring is one of the most important aspects that constitutes the basis for managing a storage infrastructure. It helps to analyse the status and utilisation of several storage infrastructure components. Monitoring facilitates the optimal use of resources and proactive management and supports capacity planning, trend analysis and root cause and impact analysis. It provides status of several storage components and information to perform essential management activities.

As the business flourishes, monitoring helps in optimising the storage infrastructure resources. This process also includes the storage system's environmental controls and the operating environments for key components, such as storage arrays and servers.

Now, let us understand the parameters that are essential to be monitored in a storage infrastructure.

(i) Parameters Monitored

The storage infrastructure components should be monitored on the basis of the following parameters:

- Accessibility
- Capacity
- Performance
- Security

Let us discuss each of them in detail.

Accessibility

It refers to the availability of a component in order to perform a desired operation. A component is considered accessible when it can function without failure at any given point in time. Monitoring the hardware and software components for accessibility requires checking their availability status by listening to the predetermined alerts from devices. A storage infrastructure uses redundant components to avoid a single point of failure. Failure of a component may cause an outage that may affect the availability of applications. Or it may cause serious performance degradation even though the application may be accessible.

For example, in a multipath data access environment, failure of a host bus adapter (HBA) can restrict the server to a few path for accessing the data devices. An HBA is actually a circuit board or integrated circuit adapter that is required for connecting the host to other network and storages systems. Although, the data devices are accessible via other paths; however, the performance has been degraded due to the unavailability of some paths.

Capacity

It refers to the available amount of the storage infrastructure resource. Inadequate capacity may lead to degraded performance or can adversely affect accessibility of application or services.

Capacity monitoring ensures the uninterrupted availability and scalability of data by turning away outages before their occurrence. ***For example***, if a capacity monitoring report shows that more than 90 percent of the ports are utilised in a network, then proactively adding more switches for installing more arrays and servers on the same network can lead to uninterrupted availability of data.

Capacity monitoring is preventive as well as predictive and is usually leveraged with advanced analytical tools for trend analysis. These trends help in understanding the forthcoming challenges and helps in providing an estimation of time required to meet the challenges.

Some of the examples of capacity monitoring are examining the free space available on a file system, the mailbox quota allocated to users, or the number of ports available on a switch.

Performance

It refers to evaluating how efficiently different storage infrastructure components can perform and help in identifying the bottlenecks. Monitoring the performance generally measures and analyses the system's behavior in terms of response time or the ability to perform at a certain predefined level. Performance monitoring deals with the utilisation of resources that affects the way resources respond and behave.

Measuring performance is a complex task that includes the assessment of various components on several interrelated parameters. Examples of performance monitoring includes the number of input/outputs (I/Os) to disks, network utilisation, application response time and server CPU utilisation.

Security

Monitoring a storage infrastructure for security helps to track and prevent unauthorised access and login failures, that can arise either accidentally or result out of some malicious action. Monitoring the storage infrastructure components for security also helps in tracking down unauthorised configuration changes of storage infrastructure elements.

For example, monitoring security helps to track and report the initial zoning configuration performed and all subsequent changes. The physical security of storage infrastructure components can also be continuously monitored with the help of badge readers, video cameras, or biometric scans.

(ii) Components Monitored

The components that should be monitored for the defined parameters, such as accessibility, performance, capacity and security are:

- Hosts
- Storage networks
- Storage

Let us discuss each of them in detail.

Host

You have already read about host in Module 2, Chapter 1. Let us quickly recall the definition. A host is a computer or any other device that supports the running of applications that are involved in storing and retrieving data. The hosts related to critical applications should be closely and continuously monitored. The accessibility of a host is dependent on the status of the associated hardware components and the software processes running on it. ***For example***, if a host hardware fails, it may result to an application crash, which can further lead to instant unavailability of the data to the user.

- **Monitoring for Accessibility:** To ensure high availability, serves are used in clusters or groups. In a server virtualisation environment, several virtual machines share a pool of resources. These resources are dynamically reallocated ensuring the accessibility of the applications and the ease of management.

  File system utilisation of the hosts should also be monitored. Monitoring helps in estimating the growth rate of the file system and helps in predicting when it can reach 100 percent. Accordingly, the administrator can either manually or automatically, extend the storage space of the file system in a proactive manner. This can be done to prevent a failure that may result from a file system being full. Several provisioning techniques can be used that even enable the allocation of storage on demand as the need arises. So system administrators may also enforce a quota for users by provisioning a fixed amount of space for their files. ***For example***, a system administrator can specify a quota at a user level that restricts the maximum storage space to 10 GB per user, or at a file level that restricts a file size to a maximum of 100 MB.

- **Monitoring for Performance:** The performance of server mainly depends on memory, I/O profile and utilisation of CPU. ***For example***, if a server that is running a specific application experiences continuous CPU utilisation of around 85 percent, then this means that the server may be running out of its processing power. This may lead to slower response time by the server and degraded performance. To correct such problems, administrators can take several steps, such as upgrading the processor or may be adding more processors to the existing, shifting the workload to other servers and restricting too many simultaneous access from the server.

- **Monitoring for Capacity:** The utilisation of memory is measured with the amount of available free memory. Applications, databases and file systems consumes the physical memory of the server, which is random access memory (RAM), for manipulating data. If there is insufficient memory, it can mead to excessive paging and swapping on the disk, which can further affect the response time to the applications. **Swapping** is the process of copying entire process from the physical memory to some secondary storage device. It takes place when the system is out of memory and the process that needs to be executed is stored in some secondary disk. In this case, the existing process in the memory that is executed later is swapped with the process in the disk that needs to be executed now. **Paging** is a memory allocation technique in which the process is allocated the memory wherever it is available and the unit of allocation is the size of the page or frame, which is generally 4 KB. This technique helps in faster reading the data from the hard disk as one contiguous chunk instead of reading the data from multiple different places.

- **Monitoring for Security:** Monitoring the servers for security includes tracking the failures occurred during login and execution of unauthorised software or application processes. Taking any proactive measures against any security threat depends on the kind of threat that has been identified. ***For example***, if an administrator comes across multiple login failures, then he may block the access to the unauthorised user.

Did You Know?

You can check the paging file settings of your computer by launching the sysdm.cpl command from the Start menu or Run box. It opens the System Properties window. Navigate to Advanced > Settings > Advanced > Change to checkout your paging file settings.

Storage Network

A storage network is a network that provides data accessibility by interconnecting and presenting shared pool of storage devices to multiple servers.

- **Monitoring for Accessibility:** In order to ensure unhindered and proper communication between the server and the storage array, it is important to monitor the storage network. The accessibility of the physical and the logical components in the storage network determines the uninterrupted access to data over the network. The physical components of a storage network consist of many elements, some of them are cables, switches, power supplies and ports. The logical components of a storage network include zones and fabrics. If there is any failure reported in the physical and the logical components, the data may become unavailable. ***For example***, any errors in zoning, such as specifying an incorrect World Wide Name (WWN) of a port can result in failure in accessing that port. This can result in preventing access from a host to its storage.

- **Monitoring for Capacity:** It involves monitoring the availability of the ports on a switch, the available number of ports in the entire framework or fabric, utilisation of inter-switched links, individual ports and each interconnected device in the fabric. Monitoring for capacity provides all types of inputs required for future planning and for optimisation of the fabric with additional interconnected devices.

- **Monitoring for Performance:** It is required for assessing the performance of individual component and helps in the identification of network bottlenecks. ***For example***, monitoring the performance of the port is done by to identify how busy the switch port is. Ports that have huge traffic and are heavily used can cause queuing delays on the server. For Internet Protocol (IP) networks, monitoring the performance includes monitoring network errors, network latency, collisions and bandwidth utilisation for I/O.

- **Monitoring for Security:** It provides information regarding any unauthorised change in the configuration of the fabric. ***For example***, any unauthorised changes to the zone policy that can prove a threat to the data security. Any login failures or unauthorised access to switches in order to perform some administrative changes must be logged and monitored.

Did You Know?

A fabric is a fibre channel topology with one or more switching devices.

Storage

A storage array is a storage architecture that consists of several disk drives for storage purposes.

- **Monitoring for Accessibility:** It should be done to monitor the hardware components and various processes of the storage array. In the situation of an individual component failure, the storage arrays that are configured with redundant components do not affect the accessibility. However, failure of any process can disrupt or compromise the business continuity operations. ***For example***, in case of a replication task failure, it affects the disaster recovery capabilities. In the event of any hardware or process failures, some storage arrays provide the facility to send a message to the vendor's support centre, also known as the **call home**.

- **Monitoring for Capacity:** It enables the administrator to respond back to the storage needs as and when they occur. When a new server is given access to the storage array, then information related to the fan-in or fan-out ratios and the availability of front end ports are very useful. **Fan-in** means the number of storage ports that can be accessed by a single initiator through a network. **Fan-out** means the number of initiators that can access a single storage port through a network.

- **Monitoring for Performance:** A number of performance metrics can be used to monitor the performance of the storage array. Such as I/O response time, utilisation rate of the several storage array components and cache utilisation. A high utilisation rate of storage array components may lead to degradation in performance of the storage array.

- **Monitoring for Security:** A storage array is mostly used as a shared resource and hence, is exposed to security breaches. Monitoring a storage array for security helps in tracking down the unauthorised configuration of the storage array or data corruption. It also ensures that the storage array gets accessed by only the authorised users.

(iii) Monitoring Examples

Implementing an end-to-end solution approach is required by the storage infrastructure to actively monitor all the parameters related to its critical components that we just discussed. Early detections of the threats and the instant alerts ensure the safety and protection of important assets. Moreover, it is good to have a monitoring tool that can analyse the impact of failure and perform the root cause analysis of the failure.

Accessibility Monitoring Example

When there are interconnecting components that have dependencies in between them, then the failure of one component may adversely affect the accessibility of one or more interrelated components. Let us consider an example of a storage infrastructure with three servers, H1, H2 and H3. All the three servers are configured with two HBAs. And each of these HBAs are connected to the storage arrays through two switches, SW1 and SW2. The three servers, H1, H2 and H3, share two storage ports on the storage array. In this example, if a single HBA fails on server H1, the server will experience a path failure. However, because of the redundant HBAs, the server H1 can still access the storage device but it may experience degraded application response time, depending on the I/O load.

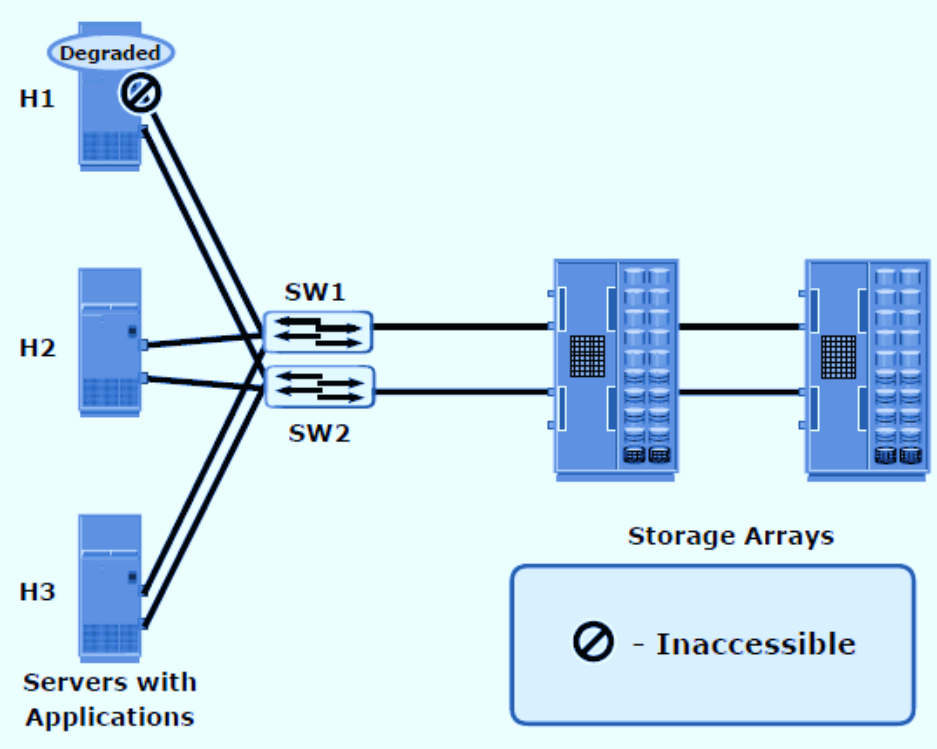

Figure 5.1.1: Single HBA Failure

Capacity Monitoring Example

Let us understand the importance of capacity monitoring with an example. Consider a situation when a file system is not being monitored for its capacity and the file system gets full. This will most likely lead to the applications not functioning properly. However, to overcome such situation capacity monitoring can be configured to issue an alert message at the time of threshold reaching the file system capacity. ***For example***, in this case, when the file system reaches 66 percent of its capacity, then a warning message can be issued. A critical message can be issued when the storage limit reaches 80 percent. Refer to Figure 5.1.2.

Having a capacity monitoring in place enables the administrator to take manual or automatic actions to extend the file system before it is 100 percent full. Monitoring the file system proactively prevents the application outages that can be caused by a lack of file system space.

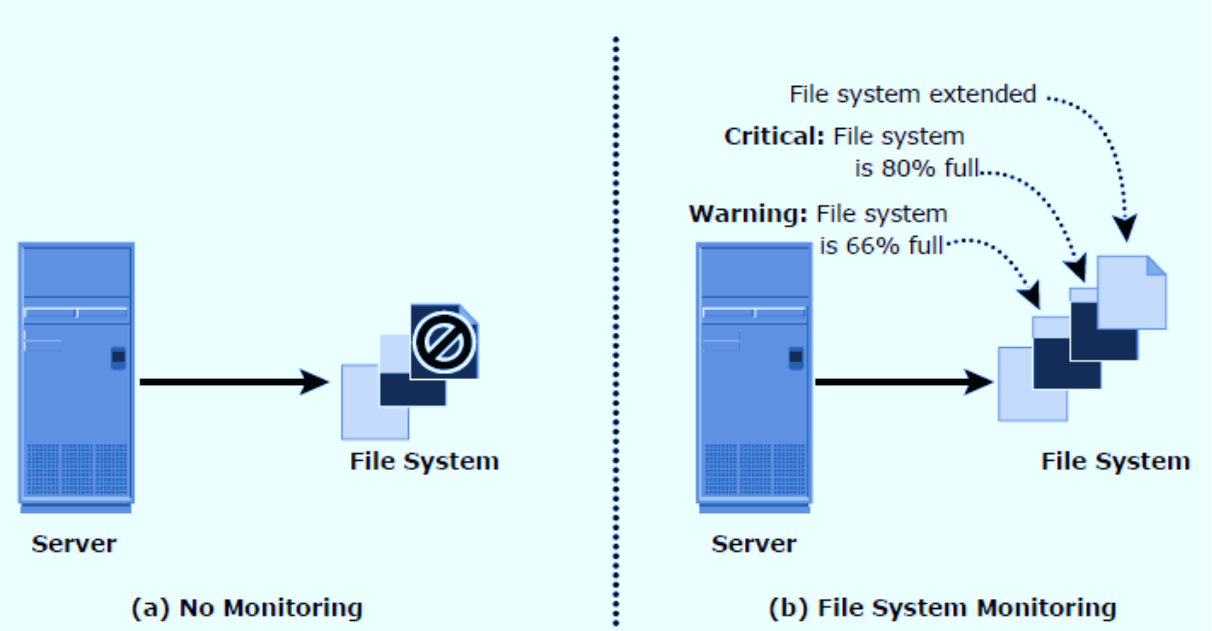

Figure 5.1.2: Monitoring a File System for Capacity

Performance Monitoring Example

Let us understand the importance of performance monitoring with an example. Consider a situation where three servers, H1, H2 and H3, with two HBAs each, are connected to the same storage array through two switches, SW1 and SW2. These three servers share the same storage ports on the storage array. There is a need to deploy a new server which is running applications with high work load. This new server has to share the same storage port as H1, H2 and H3.

Performance monitoring helps in such a case to decide if there is a room to add a new server without adversely affecting the performance of the other servers. By conducting a performance analysis, we can analyse the utilisation of the storage ports. Refer to Figure 5.1.3 that shows the port utilisation of the three servers, H1, H2 and H3. If the port utilisation before deploying the new server appears like the solid line in the image, which is close to the 100 percent utilisation, then it means there is no room to add a new server and the performance of the existing servers can be adversely affected if a new server is added. If the actual utilisation of both the ports before deploying the new server is close to the dotted line in the image, this means there is room to add the new server.

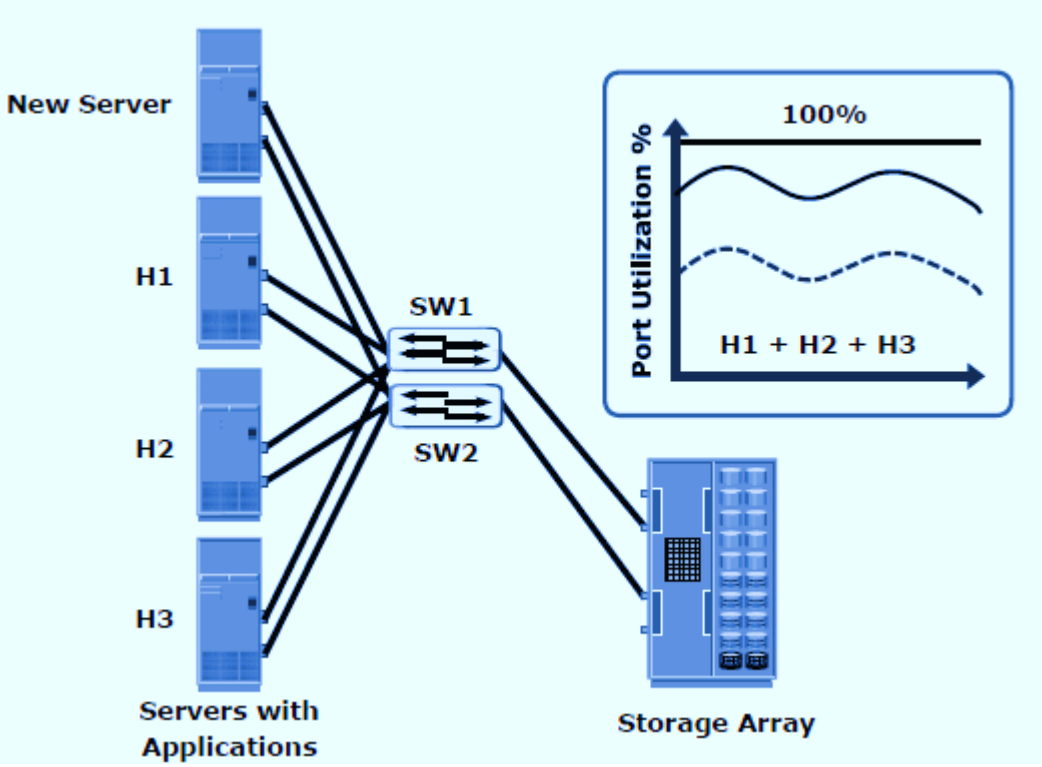

Figure 5.1.3: Monitoring for Performance

Most servers offer tools that helps in the interactive monitoring of the server CPU usage. ***For example***, Windows Task Manager displays the memory and CPU usage. These interactive tools are useful only when a few servers need to be managed. A storage infrastructure requires performance monitoring tools that are capable of simultaneously monitoring multiple servers.

These monitoring tools should bear the capability of sending alerts whenever the CPU utilisation exceeds a specified threshold.

Security Monitoring Example

Let us consider an example to understand the importance of security monitoring. While performing a host security monitoring, login failures at the hosts can be considered as an example for security monitoring. Such login failures may be either accidental that may be caused by incorrect typing, or could be a deliberate attempt to access a server in an unauthorised way.

Many servers generally allow two successive incorrect login attempts, in case the user typed something incorrectly or forgot the credentials at the first attempt. However, they prohibit additional attempts after three consecutive incorrect login attempts. In most of the environments, the login information is recorded in a system log file. In a monitored environment, three consecutive incorrect login attempts trigger a warning message related to a possible security threat.

(iv) Alerts

An integral part of monitoring is alerting of events. There are various conditions that are observed during monitoring, such as power failure or disk or memory failure. These conditions may have an impact on the availability of services that demand immediate administrative attention.

The administrator uses the monitoring tools to assign different severity to different conditions in a storage infrastructure. An alert is generated and sent to the administrator when a condition with a particular severity arises. Such situations might also trigger a script or open an incident ticket for initiating a corrective action.

Alerts can be classified from being an informative alert to a fatal alert.

An **information alert** mainly consists of useful information that may require attention but generally, does not require any immediate intervention by the administrator. ***For example***, alert message displayed after creation of a zone or a logical unit number (LUN).

Warning alerts are the kind of alerts that require administrator's attention to check the alert condition so that it does not affect accessibility. ***For example***, when an alert is received regarding a disk approaching towards a predefined threshold value, the administrator may decide to replace the disk before it gets full.

Fatal alerts are the kind of alert that demand immediate attention by the administrator. It is so because the alert condition may be capable of affecting the overall performance or availability in case it is not taken care of immediately. ***For example***, if there is an alert about a disk fail, it should be immediately replaced to save any data availability issues.

Alerts are assigned a severity depending on their impact. Continuous monitoring, hand-in-hand with automated alerting, enables the administrators to quickly and proactively respond to failures. Alerting also provides information in prioritising an administrative response to the events.

Self-assessment Questions

1) What are the parameters that are monitored in a storage infrastructure?
   a) Accessibility
   b) Capacity
   c) Performance
   d) Security

2) While monitoring, if the one of the storage reports shows the disk drive to be full as 90 percent of its capacity, which parameter is being monitored?
   a) Accessibility
   b) Performance
   c) Capacity
   d) Security

3) What are the components that needs to be monitored as per the given parameters?
   a) Storage network
   b) Storage
   c) Ports
   d) Host

4) Which of the following type of alert message you will receive after the successful installation of a software?
   a) Information alert
   b) Error alert
   c) Warning alert
   d) Fatal alert

5.1.3 Storage Management Activities

All the management tasks that are performed in a storage infrastructure can be broadly categorised into the following:

- Availability management
- Capacity management
- Performance management
- Security management
- Reporting

Let us discuss each of these management activities in detail.

(i) Availability Management

Availability management mainly deals with the accessibility of the resources. The most important aspect when performing the availability management is to establish a proper guideline for all the configurations. This is done in order to ensure that the availability of resources is based on the kind of service required by the application.

For example, the highest availability standard is required when a server is deployed to support a critical business function. This is generally achieved by deploying more than one HBAs, multi-pathing software that have path failover capacity and server clustering. The server that needs to be deployed must be connected to the storage array with the help of at least two independent fabrics and switches possessing built-in redundancy. The server is provided the storage devices with redundant array of independent disks (RAID)-protection capabilities, using at least two front-end ports. You have already read about RAID in Module 3, Chapter 2. Also, these storage arrays should possess built-in redundancy for multiple components and support backup and local and remote replication.

Virtualisation technologies have also played a great role in significantly improving the availability management task. With virtualisation in place, resources can be dynamically added and removed to ensure availability.

(ii) Capacity Management

Capacity management revolves around adequacy. The aim of capacity management is to ensure the adequate amount of resources for all the services depending on their service-level requirement.

Capacity management compares the allocated storage to the forecasted storage on a regular basis and provides a capacity analysis. This planned versus actual analysis helps in understanding the future needs in terms of capacity. It also provides a trend analysis of actual consumption of storage and the rate of consumption. This analysis must be rationalised against the storage acquisition and deployment timetables.

An example of capacity management would be **storage provisioning**. The process of storage provisioning involves logically assigning storage to meet the business's need for storage capacity, efficiency and performance.

Capacity management also keeps a check on the future needs of resources by setting up monitors and analytics to gather such information.

(iii) Performance Management

Performance management revolves around the optimal operational efficiency of all the components. Performance analysis is an important activity that should be performed in order to identify the performance of the storage infrastructure components. Conducting this analysis provides the information if a component meets the expected performance standards and levels.

When an application or a server is deployed in the existing storage infrastructure, various performance management activities are initiated. All the components must be validated against adequate performance capabilities as required by the service levels. ***For example***, activities on the servers, such as designing the database, volume configuration, application layout configuration of multiple HBAs and intelligent multi-pathing software, must be fine-tuned in order to optimise the expected performance levels.

(iv) Security Management

Security management revolves around the safety and security of the storage infrastructure components. It prevents the storage infrastructure components from unauthorised access and configuration.

For example, when an application or a server is deployed, the security management tasks consists of managing the user accounts and access policies that provides authorisation to the user to perform role-based activities.

In a storage area network (SAN) environment, the security management includes the configuration of zoning for restricting the unauthorised access of HBAs to the specific storage array ports. Security management also includes LUN masking at the HBA level, which is an authorisation process of making the LUN available or visible to selected hosts. This process prevents the corruption of data on the storage array by restricting the access of host to a defined set of logical devices.

(v) Reporting

Keeping a track of the resources present in the data center can be a difficult task for the businesses. ***For example***, keeping a count of the number of storage arrays and array vendors, how are the storage arrays being used and which applications are using which storage arrays.

In a storage infrastructure environment, reporting involves keeping a check on the resources and collecting information from various processes or components. All this information gathered by reporting is compiled to illustrate the basic configuration of storage infrastructure components and to generate meaningful data, such as trend analysis, capacity planning, configuration reports, chargeback reports and performance reports.

The reports pertaining to capacity planning includes the current and historic information about the utilisation of storage, database, file system and ports. Configuration or asset management reports consists of details regarding device allocation, fabric configuration and local or remote replicas. It also lists all equipment along with their individual details, such as their purchase date, independent value, maintenance records and lease status. Chargeback reports consists of the information pertaining to the allocation or utilisation of storage infrastructure resources by several departments or user groups. The performance reports provide an insight related to the performance of the several components of storage infrastructure.

(vi) Storage Management Examples

Let us discuss some storage management examples.

Consider a situation of file system space management. In order to prevent a file system from running out of space, the administrators require to offload the data from the existing file system

by performing some specific tasks. These specific tasks include deleting the unused and unwanted files and offloading the less accessed files to a backup media.

In case the data cannot be or should not be offloaded, then the administrators can also choose to extend the file system or the logical volume and increase its size so that the application outage can be avoided. However, the dynamic extension of the file system or the logical volume depends on the specific operating system (OS) or the logical volume manager (LVM) that is currently being used. You have already read about LVM in Module 2, Chapter 2. Let us quickly recall the definition. An LVM is a software that enables the dynamic extension of file system capacity and efficient storage management. It runs on the host computer and manages the logical and physical storage. It is an optional, intermediate layer between the physical disk and the file system.

Refer to Figure 5.1.4 that illustrates the considerations and steps in extending a file system. Various factors are taken into considerations while deciding to extend the file system mentioned in the image. When the considerations are true, the file system is moved towards being extended.

When the file system is being extended, then the replication of volume should also be considered. When the application uses local or remote replication for business continuity purposes and a new device gets added to the volume group, it should be ensured that the new device also gets replicated.

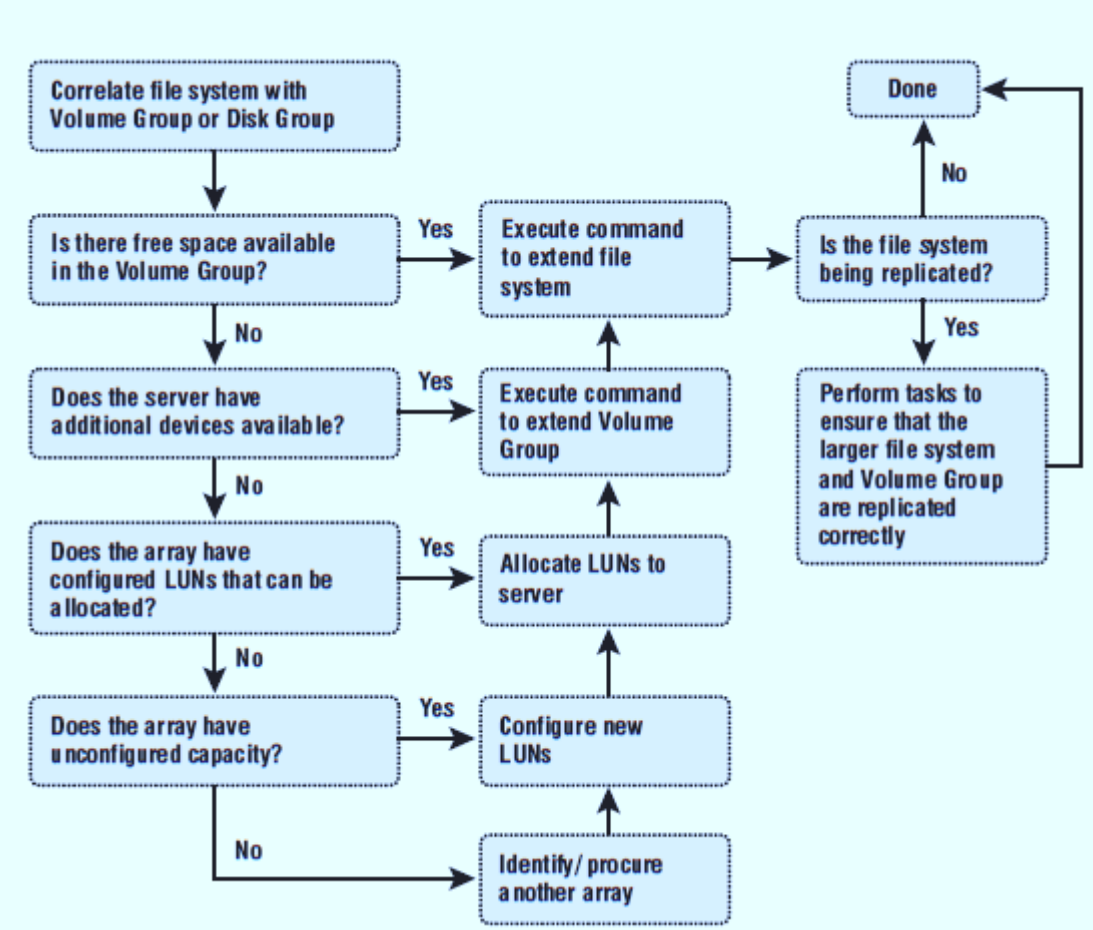

Figure 5.1.4: Extending a File System

Apart from this, there are various other examples, such as ensuring the functioning of HBAs, ports and switches in a network to ensure data accessibility, having multi-path software with path failover capacity in a multi-path data access environment, applying storage provisioning to meet the organisation's need for storage capacity, performance and efficiency, optimising the expected performance levels on a server by fine-tuning the server activities and generating an alert message in case of multiple invalid logins to access a server.

Self-assessment Questions

5) Which of the following are the storage management tasks that are performed in a storage infrastructure?

a) Availability management
b) Reporting
c) Alerting
d) Security management

6) Which of the following storage management activity caters to adequacy?

a) Performance management
b) Security management
c) Capacity management
d) Availability management

7) Which of the following storage management activity deals with establishing a proper guideline for all the configuration to ensure availability based on service levels.

a) Availability management
b) Performance management
c) Capacity management
d) Security management

8) Which of the following reports consists of the information pertaining to the allocation or utilisation of storage infrastructure resources by several departments or user groups?

a) Capacity planning report
b) Asset management report
c) Performance report
d) Chargeback report

5.1.4 Storage Infrastructure Management Challenges

The number and variety of storage arrays, servers, networks, applications and databases have shown such a rapid growth in the recent past. It has evolved to become more complex. Monitoring and managing such complex storage infrastructure environment can be a very challenging task. There are a variety of storage devices that vary in performance, capacity and protection methodologies. Some of the biggest challenges faced by businesses in the area of storage management infrastructure are:

- **Managing rapid data growth:** One of the biggest challenge in managing storage infrastructure is and has always been, dealing with the explosive data growth. The organisation must have the right strategies put in place to tackle this challenge. However, the challenge is that it is not always possible to project in advance how and when the data growth rate will shoot.

- **Changing standards:** The storage industry has witnessed a varying range of standards from Fiber Channel to Internet Small Computer System Interface (iSCSI). The organisation need to adhere to every change that sweeps in with the new standard. The challenge in the storage infrastructure area can be keeping in sync with the changing standard and adapting new standards.

- **Interoperability concerns:** Such is the nature of the storage management infrastructure that not every product from every vendor works well with the other, despite so many claims. Sometimes, interoperability concerns also arise from the legacy systems. In fact, integrating diverse OS that are all a part of the storage management infrastructure can be a challenge in itself.

- **Variety of tools:** Different vendors provide their own vendor-specific tools to manage and monitor the service provided by them. However, in such an environment of multiple tools in use, it becomes a challenge to understand the holistic and overall status of components and provide any sort of impact, cross-compliant failure and behaviour analysis.

- **Distributed storage and architecture:** Users may run different applications, but, most of the time, the data that is required can be the same. This brings in a need of distributed architecture, which can at times be a challenge to manage. ***For example***, managing remote storage with the least amount of personnel involvement can be a challenge.

- **Personnel:** A complex storage infrastructure demands a large number of qualified management infrastructure personnel. Some storage management solutions also require a rather high server-to-administrator ratio, making it harder to find enough skilled personnel.

- **Budget limitations:** When planning a storage solution, budget constraints should also be considered. Sometimes, businesses have a restrictive budget to spend on such activities and hence the best solution that caters all the needs could not be afforded.

Ideally, monitoring and managing storage system infrastructure should be done in a holistic manner so that the correlated information from all the components can be pulled at one place. In this way, the analysis and actions can be taken based on an end-to-end view of the environment and proactive corrective measures can be taken.

Self-assessment Questions

9) Which of the following is the correct expansion for iSCSI?
   a) Internet Serial Computer System Interface
   b) Instant Small Computer System Interface
   c) Internet Small Computer System Interface
   d) Instant Serial Computer System Interface

10) Which of the following challenges are faced in the area of storage management infrastructure?
   a) Managing explosive sheer volume of data
   b) Inadequate funds
   c) Lack of skilled personnel
   d) Interoperability concerns

11) Managing a remote location storage with the least amount of personnel involvement is which type of challenge?
   a) Inadequate funds
   b) Lack of skilled personnel
   c) Distributed storage and architecture
   d) Interoperability concerns

Summary

- Monitoring helps to analyse the status and utilisation of several storage infrastructure components.
- The parameters essential to be monitored in a storage management infrastructure are accessibility, capacity, performance and security.
- Accessibility refers to the availability of a component in order to perform a desired operation.
- Capacity refers to the available amount of the storage infrastructure resource.
- Performance refers to evaluating how efficiently different storage infrastructure components can perform and help in identifying the bottlenecks.
- Security monitoring on servers involves tracking of login failures and execution of unauthorised applications or software processes.
- The components that should be monitored for the defined parameters are host, storage network and storage.
- Swapping is the process of copying entire process from the physical memory to some secondary storage device.
- Paging is a memory allocation technique in which the process is allocated the memory wherever it is available and the unit of allocation is the size of the page or frame, which is generally 4 KB.
- In the event of any hardware or process failures, some storage arrays provide the facility to send a message to the vendor's support centre, also known as the call home.
- Alerts can be classified as information, warning and fatal alert.
- Storage management activities can be broadly divided into availability management, capacity management, performance, management, security management and reporting.

- In a storage infrastructure environment, reporting involves keeping a check on the resources and collecting information from various processes or components.
- Some of the challenges faced in the storage management infrastructure area are managing rapid growth of data, changing standards, interoperability concerns, variety of vendor-specific tools, lack of skilled personnel, distributed storage and architecture and budget constraints.

Terminal Questions

1. Why do we need to monitor the storage infrastructure? Support your answers with examples.
2. What are the parameters required to be monitored in a storage infrastructure?
3. Discuss with example how will you monitor the storage network for all the parameters involved in monitoring.
4. What are the complexities in managing the storage infrastructure?

Answer Keys

Self-assessment Questions	
Question No.	Answer
1	a, b, c, d
2	c
3	a, b, d
4	a
5	a, b, d
6	c
7	a
8	d
9	c
10	a, b, c, d
11	c

Activity

Activity Type: Online **Duration:** 30 Minutes

Description:

Ask the students to research on latest technologies to monitor storage management and prepare a presentation.

Case Study

A performance problem has been encountered and reported on a database. Monitoring confirms that at 12:00 am, a problem surfaced and access to the database is severely affected until 3:00 pm every day. This time slot is critical for business operations and an investigation has been launched. A reporting process that starts at 12:00 pm contends for database resources and constrains the environment.

What monitoring and management procedures, tools and alerts would you establish to ensure accessibility, capacity, performance and security in this environment?

Bibliography

e-References

- Shrivastava, A. *Managing information storage: Trends, challenges and options 2011-2012* (1st ed.). Retrieved from https://www.emc.com/collateral/emc-perspective/h2159-managing-storage-ep.pdf
- Rouse, M. (2005). *Pagefile. WhatIs.com*. Retrieved 27 July 2016, from http://whatis.techtarget.com/definition/pagefile
- Nichols, C. (2009). *Storage Management Infrastructure Challenges. Unitiv.com*. Retrieved 27 July 2016, from http://www.unitiv.com/it-solutions-blog/bid/25223/Storage-Management-Infrastructure-Challenges

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- Figure 5.1.2: Source: Information Storage and Management: Storing, Managing and Protecting Digital Information
- Figure 5.1.3: Source: Information Storage and Management: Storing, Managing and Protecting Digital Information
- Figure 5.1.4: Source: Information Storage and Management: Storing, Managing and Protecting Digital Information

External Resources

- Somasundaram, G. & Shrivastava, A. (2009) *Information storage and management* - Storing, managing and protecting digital information. *Indianapolis, Ind.: Wiley Pub.*

Video Links

Topic	Link
Monitoring and Managing storage infrastructure	https://www.youtube.com/watch?v=M9GSCS9cE5s
Overcoming storage infrastructure challenges	https://www.youtube.com/watch?v=h-cZicdVQd8
Storage infrastructure	https://www.youtube.com/watch?v=x2mEqPE8Uk4
Capacity management	https://www.youtube.com/watch?v=w0cD26CLBA0

Notes: