IA 1 QB Answers

Q1. What is a data center? Explain the key characteristics of a data center with a neat diagram.

Data Center

A data center is a facility that provides shared access to applications and data using a complex network, compute, and storage infrastructure. Industry standards exist to assist in designing, constructing and maintaining data center facilities and infrastructures to ensure the data is both highly secure and highly available. Because they house an organization's most critical and proprietary assets, data centers are vital to the continuity of daily operations.

Key characteristics of data center elements are:

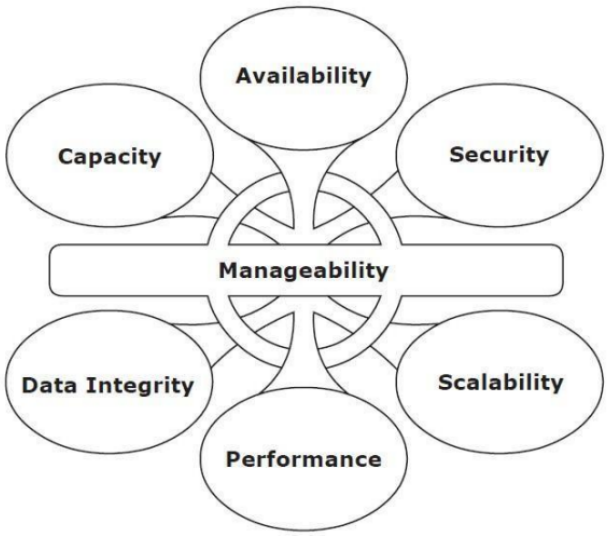


Fig 1.6: Key characteristics of data center elements

1. **Availability:** All data center elements should be designed to ensure accessibility. The inability of users to access data can have a significant negative impact on a business.
2. **Security:** Policies, procedures, and proper integration of the data center core elements that will prevent unauthorized access to information must be

established.

3. **Scalability:** Data center operations should be able to allocate additional processing capabilities (Eg: servers, new applications, and additional databases) or storage on demand, without interrupting business operations. The storage solution should be able to grow with the business.
4. **Performance:** All the core elements of the data center should be able to provide optimal performance and service all processing requests at high speed. The infrastructure should be able to support performance requirements.
5. **Data integrity:** Data integrity refers to mechanisms such as error correction codes or parity bits that ensure that data is written to disk exactly as it was received. Any variation in data during its retrieval implies corruption, which may affect the operations of the organization.
6. **Capacity:** Data center operations require adequate resources to store and process large amounts of data efficiently. When capacity requirements increase, the data center must be able to provide additional capacity without interrupting availability or performance.
7. **Manageability:** A data center should perform all operations and activities in the most efficient manner. Manageability can be achieved through automation and the reduction of human (manual) intervention in common tasks.

Q2 Explain the Architecture and evolution of storage technology with a neat diagram.

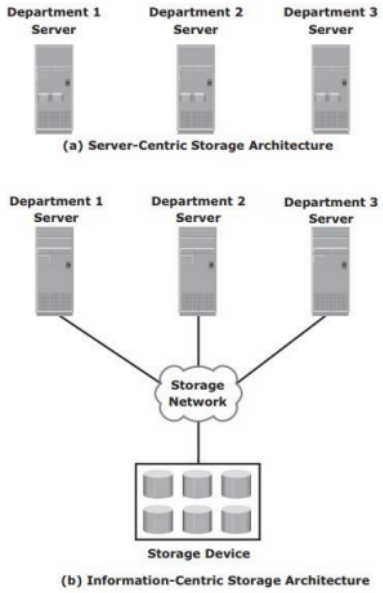


Fig 1.4: Evolution of storage architecture

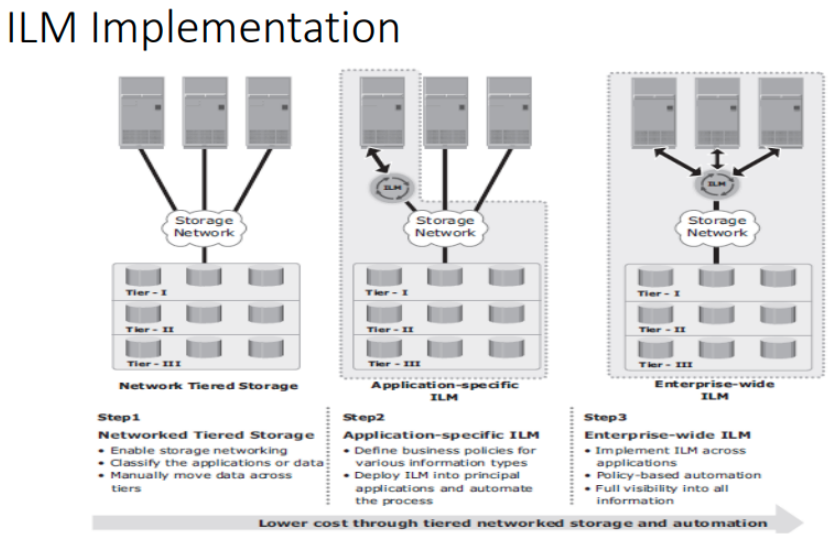
- Historically, organizations had centralized computers (mainframe) and information storage devices (tape reels and disk packs) in their data center.
- The evolution of open systems and the affordability and ease of deployment that they offer made it possible for business units to have their own servers and storage.
- In earlier implementations of open systems, the storage was typically internal to the server. This approach is referred to as **server-centric storage architecture**.
- In this server-centric storage architecture, each server has a limited number of storage devices, and any administrative tasks, such as maintenance of the server or increasing storage capacity, might result in the unavailability of information.
- The rapid increase in the number of departmental servers in an enterprise resulted in unprotected, unmanaged, fragmented islands of information and increased capital and operating expenses.
- To overcome these challenges, storage evolved from **server-centric** to **information-centric** architecture.
- In information-centric architecture, storage devices are managed centrally and independent of servers.
- These centrally-managed storage devices are shared with multiple servers.

- When a new server is deployed in the environment, storage is assigned from the same shared storage devices to that server.
- The capacity of shared storage can be increased dynamically by adding more storage devices without impacting information availability.
- In this architecture, information management is easier and cost-effective.
- Storage technology and architecture continue to evolve, which enables organizations to consolidate, protect, optimize, and leverage their data to achieve the highest return on information assets.

Q3 What are the core elements of a Data Center?

- **Application:** An application is a computer program that provides the logic for computing operations. Eg: order processing system.
- **Database:** A database management system (DBMS) provides a structured way to store data in logically organized tables that are interrelated. A DBMS optimizes the storage and retrieval of data.
- **Host or compute:** A computing platform (hardware, firmware, and software) that runs applications and databases.
- **Network:** A data path that facilitates communication among various networked devices.
- **Storage array:** A device that stores data persistently for subsequent use.

Q4 ILM (Information Life Cycle) Implementation



- **Classifying** data and applications on the basis of business rules and policies to enable differentiated treatment of information.
- **Implementing** policies by using information management tools, starting from the creation of data and ending with its disposal.
- **Managing** the environment by using integrated tools to reduce operational complexity.
- **Organizing** storage resources in tiers to align the resources with data classes, and storing information in the right type of infrastructure based on the information's current value.

ILM Benefits

- Improved utilization by using tiered storage platforms and increased visibility of all enterprise information.
- Simplified management by integrating process steps and interfaces with individual tools and by increasing automation.
- A wider range of options for backup, and recovery to balance the need for business continuity.
- Maintaining compliance by knowing what data needs to be protected for what length of time.
- Content Management
- Federal Compliance
- Faster Access to Information

- Reduced Data Storage Cost

Q5 RAID

RAID (redundant array of independent disks) is a way of storing the same data in different places on multiple hard disks or solid-state drives (SSDs) to protect data in the case of a drive failure.

Hardware RAID

- In hardware RAID implementations, a specialized hardware controller is implemented either on the host or on the array.
- Controller card RAID is a host-based hardware RAID implementation in which a specialized RAID controller is installed in the host, and disk drives are connected to it.
- Manufacturers also integrate RAID controllers on motherboards.
- A host-based RAID controller is not an efficient solution in a data center environment with a large number of hosts.
- The external RAID controller is an array-based hardware RAID.
- It acts as an interface between the host and disks.
- It presents storage volumes to the host, and the host manages these volumes as physical drives.

Software RAID

- Software RAID uses host-based software to provide RAID functions.
- It is implemented at the operating-system level and does not use a dedicated hardware controller to manage the RAID array.
- Advantages when compared to Hardware RAID:
  - Cost efficiency
  - Simplicity benefits
- Limitations:
  - **Performance:** Software RAID affects overall system performance. This is due to additional CPU cycles required to perform RAID calculations.

- **Supported features:** Software RAID does not support all RAID levels.
- **Operating system compatibility:** Software RAID is tied to the host operating system; hence, upgrades to software RAID or to the operating system should be validated for compatibility. This leads to inflexibility in the data-processing environment.

Q6 Explain RAID 3 and RAID 4 in detail

RAID 3

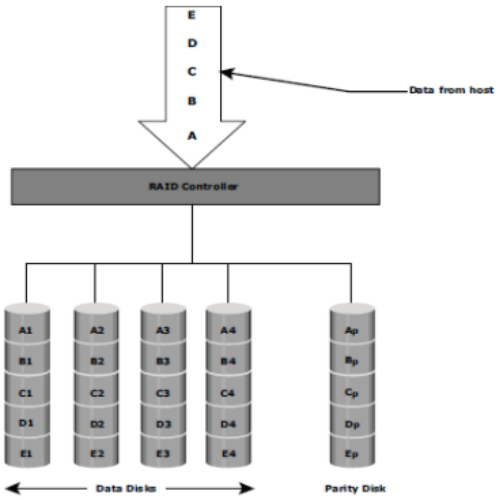


Fig 1.17: RAID 3

- RAID 3 stripes data for high performance and uses parity for improved fault tolerance.
- Parity information is stored on a dedicated drive so that data can be reconstructed if a drive fails. For example, of five disks, four are used for data and one is used for parity.
- RAID 3 always reads and writes complete stripes of data across all disks, as the drives operate in parallel. There are no partial writes that update one out of many strips in a stripe.
- RAID 3 provides good bandwidth for the transfer of large volumes of data. RAID 3 is used in applications that involve large sequential data access, such as video streaming.

RAID 4

- RAID 4 stripes data for high performance and uses parity for improved fault tolerance. Data is striped across all disks except the parity disk in the array.
- Parity information is stored on a dedicated disk so that the data can be rebuilt if a drive fails. Striping is done at the block level.
- Unlike RAID 3, data disks in RAID 4 can be accessed independently so that specific data elements can be read or written on a single disk without the reading or writing of an entire stripe. RAID 4 provides good read throughput and reasonable write throughput.

Q7 Hot Spare

- A hot spare or hot standby is used as a failover mechanism to provide reliability in system configurations.
- A hot spare refers to a spare HDD in a RAID array that temporarily replaces a failed HDD of a RAID set.
- A hot spare replaces or takes the identity of the failed HDD in the array.
- One of the following methods of data recovery is performed depending on the RAID implementation:
    - If parity RAID is used, then the data is rebuilt onto the hot spare from the parity and the data on the surviving HDDs in the RAID set.
    - If mirroring is used, then the data from the surviving mirror is used to copy the data
- When the failed HDD is replaced with a new HDD, one of the following takes place:
    - The hot spare replaces the new HDD permanently. This means that it is no longer a hot spare, and a new hot spare must be configured on the array.
    - When a new HDD is added to the system, data from the hot spare is copied to it. The hot spare returns to its idle state, ready to replace the next failed drive.

Q8 What is the impact of RAID on disk performance?

- When choosing a RAID type, it is imperative to consider its impact on disk performance and application IOPS.
- In both mirrored (RAID 1) and parity RAID (RAID 5) configurations, every write operation translates into more I/O overhead for the disks which is referred to as write penalty.
- In a RAID 1 implementation, each writes operation must be performed on two disks configured as a mirrored pair. The write penalty is 2.
- In a RAID 5 implementation, a write operation may manifest as four I/O operations. When performing small I/Os to a disk configured with RAID 5, the controller has to read, calculate, and write a parity segment for every data write operation.