1 Data Virtualization

Data virtualization is the process of retrieve data from various resources without knowing its type and physical location where it is stored. It collects heterogeneous data from different resources and allows data users across the organization to access this data according to their work requirements. This heterogeneous data can be accessed using any application such as web portals, web services, E-commerce, Software as a Service (SaaS), and mobile application.

We can use Data Virtualization in the field of **data integration, business intelligence,** and **cloud computing**.

Advantages of Data Virtualization

There are the following advantages of data virtualization -

- It allows users to access the data without worrying about where it resides on the memory.
- It offers better customer satisfaction, retention, and revenue growth.
- It reduces costs by removing data replication.
- It provides a user-friendly interface to develop customized views.
- It provides various simple and fast deployment resources.
- It increases business user efficiency by providing data in real-time.
- It is used to perform tasks such as data integration, business integration, Service-Oriented Architecture (SOA) data services, and enterprise search.

Disadvantages of Data Virtualization

- It creates availability issues, because availability is maintained by third-party providers.
- It required a high implementation cost.
- It creates the availability and scalability issues.
- Although it saves time during the implementation phase of virtualization but it consumes more time to generate the appropriate result.

Uses of Data Virtualization

There are the following uses of Data Virtualization -

1. Analyze performance

Data virtualization is used to analyze the performance of the organization compared to previous years.

2. Search and discover interrelated data

Data Virtualization (DV) provides a mechanism to easily search the data which is similar and internally related to each other.

3. Agile Business Intelligence

It is one of the most common uses of Data Virtualization. It is used in agile reporting, real-time dashboards that require timely aggregation, analyze and present the relevant data from multiple resources. Both individuals and managers use this to monitor performance, which helps to make daily operational decision processes such as sales, support, finance, logistics, legal, and compliance.

4. Data Management

Data virtualization provides a secure centralized layer to search, discover, and govern the unified data and its relationships.

Industries that use Data Virtualization

- **Communication & Technology**
  In Communication & Technology industry, data virtualization is used to increase revenue per customer, create a real-time ODS for marketing, manage customers, improve customer insights, and optimize customer care, etc.
- **Finance**
  In the field of finance, DV is used to improve trade reconciliation, empowering data democracy, addressing data complexity, and managing fixed-risk income.
- **Government**
  In the government sector, DV is used for protecting the environment.
- **Healthcare**
  Data virtualization plays a very important role in the field of healthcare. In healthcare, DV helps to improve patient care, drive new product innovation, accelerating M&A synergies, and provide a more efficient claims analysis.
- **Manufacturing**
  In manufacturing industry, data virtualization is used to optimize a global supply chain, optimize factories, and improve IT assets utilization.

2 Hardware Virtualization

Previously, there was *"one to one relationship"* between physical servers and operating system. Low capacity of CPU, memory, and networking requirements were available. So, by using this model, the costs of doing business increased. The physical space, amount of power, and hardware required meant that costs were adding up.

The **hypervisor** *manages shared the physical resources of the hardware between the guest operating systems and host operating system*. The physical resources become abstracted versions in standard formats regardless of the hardware platform. The abstracted hardware is represented as actual hardware. Then the virtualized operating system looks into these resources as they are physical entities.

Virtualization means abstraction. Hardware virtualization is accomplished by abstracting the physical hardware layer by use of a hypervisor or VMM (Virtual Machine Monitor).

When the virtual machine software or virtual machine manager (VMM) or hypervisor software is directly installed on the hardware system is known as hardware virtualization.

The main **job of hypervisor** is to control and monitoring the processor, memory and other hardware resources.

After virtualization of hardware system we can install different operating system on it and run different applications on those OS.

Usage of Hardware Virtualization

Hardware virtualization is mainly done for the server platforms, because controlling virtual machines is much easier than controlling a physical server.

Advantages of Hardware Virtualization

The main benefits of hardware virtualization are more efficient resource utilization, lower overall costs as well as increased uptime and IT flexibility.

1) More Efficient Resource Utilization:

Physical resources can be shared among virtual machines. Although the unused resources can be allocated to a virtual machine and that can be used by other virtual machines if the need exists.

2) Lower Overall Costs Because Of Server Consolidation:

Now it is possible for multiple operating systems can co-exist on a single hardware platform, so that the number of servers, rack space, and power consumption drops significantly.

3) Increased Uptime Because Of Advanced Hardware Virtualization Features:

The modern hypervisors provide highly orchestrated operations that maximize the abstraction of the hardware and help to ensure the maximum uptime. These functions help to migrate a running virtual machine from one host to another dynamically, as well as maintain a running copy of virtual machine on another physical host in case the primary host fails.

4) Increased IT Flexibility:

Hardware virtualization helps for quick deployment of server resources in a managed and consistent ways. That results in IT being able to adapt quickly and provide the business with resources needed in good time.

3 Software Virtualization

Managing applications and distribution becomes a typical task for IT departments. Installation mechanism differs from application to application. Some programs require certain helper applications or frameworks and these applications may have conflict with existing applications.

Software virtualization is just like a virtualization but *able to abstract the software installation procedure and create virtual software installations*.

Virtualized software is an application that will be "installed" into its own self-contained unit.

Example of software virtualization is *VMware software, virtual box* etc.

Advantages of Software Virtualization

1) Client Deployments Become Easier:

Copying a file to a workstation or linking a file in a network then we can easily install virtual software.

2) Easy to manage:

To manage updates becomes a simpler task. You need to update at one place and deploy the updated virtual application to the all clients.

3) Software Migration:

Without software virtualization, moving from one software platform to another platform takes much time for deploying and impact on end user systems. With the help of virtualized software environment the migration becomes easier.

4 Server Virtualization

In computing, a single, physical server can be segmented into multiple isolated and individual virtual servers through some form of software. Each of these virtual servers is fully capable of independently running its own operating system (OS).

Among other reasons, this is done primarily for tighter controls over all server users. Server virtualization means that users can only access resources assigned to their unique instance.

For example, users on a virtualized server can't identify the total number of operating systems, processors, or other virtualized servers on the physical server.

Additionally, they can only use the maximum memory or CPU cycles associated with their instance, preventing them from affecting other users on the server.

How Server Virtualization Works

Servers are computers that process requests from other computers within a network. Classically, one server is dedicated to one task or application. Considering just how many tasks and applications there are, this can add up to an unmanageable number of servers within one network.

Servers take up space and power to run. What's more, some modern servers have more resources (memory and storage) than they need to handle the dedicated tasks or applications required. This underutilization of computing power across many servers can end up using far more energy than is necessary. Essentially, servers need to be managed in a way that allows for efficient energy consumption without sacrificing computing capabilities.

VPS Server Hosting is one example of server virtualization.

Server virtualization mitigates server inefficiencies by using software to divide a single physical server into multiple fully isolated virtual servers. Each of those virtual servers is capable of running independent operating systems and completing tasks by dividing up the resources across the parent server.

Benefits of Server Virtualization

Virtualization can greatly benefit an organization. In addition to streamlining network needs, server virtualization benefits include:

- **Saving Space**: If you're running one task or application per server, they will soon take over your data center. By hosting multiple virtual servers on fewer physical servers, you can potentially save a lot of physical space.

- **Lowering Hardware Costs**: Building physical servers can be costly. Virtual servers are much less expensive to deploy.
- **Improving Resource Efficiency**: Many servers are more powerful than needed for the demands they are tasked with, meaning organizations technically pay for unused resources. Virtualization helps ensure that all resources are being efficiently used.
- **Lowering Energy Costs:** Since virtualization allows you to efficiently use server resources rather than build unnecessary infrastructure, you have fewer servers using energy.
- **Decreasing Demand on IT**: Maintaining a large network of physical servers can be taxing on an organization's IT department. Virtualization can help free up IT worker resources to concentrate on other needs of the business.
- **Speeding Up Setup**: Days or weeks can go by between purchasing hardware for physical servers and implementation. Setting up virtual servers can take minutes.
- **Simplifying Recovery**: Backup systems on virtual machines (VMs) are quick and efficient. This means you can get up and running after a system failure fast with little to no data loss.

Drawbacks of Server Virtualization

Not everything is perfect with server virtualization. Some drawbacks to virtualization include:

- **Increasing Upfront Costs**: Any new hardware and licensing fees can add up to higher upfront costs.
- **Slightly Decreased Performance**: With resources shared, especially with hypervisor-based virtualization, users might see a slightly poorer performance. Tasks could take a little longer to run. However, with advances in server virtualization technologies, this is becoming less of an issue.
- **Server Sprawl:** Because VMs are relatively easy to build, admins can unintentionally overbuild the network, which is known as VM sprawl. When only 10 servers could suffice, 20 VMs could be built.

Types of Server Virtualization

Server virtualization is widespread as a solution across organizations and industries. This is because it solves some big problems like managing server resources, saving on infrastructure costs, and alleviating demand on IT. There are several types of server virtualization that network administrators rely on. Types of server virtualization examples include:

- Full virtualization.
- Para-virtualization.
- Hardware-assisted virtualization.
- OS-level virtualization.
- Hypervisor virtualization.

1. Full Virtualization

With full virtualization, a type of software called a hypervisor splits up the server's resources between completely independent virtual servers that are isolated from each other. The hypervisor handles how resources are allocated between each virtual server. Since the virtual machines are separate, they all run on their own operating systems and can be configured as needed.

Learn more about virtualization for CentOS and Ubuntu, which are both Linux-based OS.

2. Para-Virtualization

Para-virtualization is somewhat related to full virtualization in that a hypervisor can access virtual machines through interfaces that are highly similar to the underlying hardware. Prior to installation inside a virtual machine, para-virtualization involves modifying a guest operating system to allow all other guest OS on the server to share resources and communicate with one another. Because all the VMs are working together, there are fewer demands on the hypervisor, meaning more of the virtualization server's resources are dedicated to the virtual servers.

3. Hardware-Assisted Virtualization

With hardware-assisted virtualization, the division of resources needed to support multiple VMs is already built into the CPU of the host server. This allows virtual machines to communicate directly to the main server rather than entirely through the hypervisor. It's a way to partially cut out the middleman, though a hypervisor is still needed. Since the path between the virtual machines and the physical server is more direct, the hypervisor uses a very significant amount of the server's resources. This makes it seem like the virtual machines are running directly on the server.

4. OS-Level Virtualization

With full virtualization, para-virtualization, and hardware-assisted virtualization, a hypervisor is needed to provide a platform on which virtual servers' operating systems can run. With OS-level virtualization, however, the host server's operating system is set up to allow for multiple instances of virtual machines called containers. The VMs operate in much the same way in OS-level virtualization as in hypervisor virtualization, but the computing overhead of the host operating system is a much higher percentage of the physical server's resources than in a hypervisor-based system. However, OS-level virtualization can be simpler and less costly for a new user to implement.

5. Hypervisor-Based Virtualization

With hypervisor-based virtualization, software (the hypervisor) virtually emulates the hardware of the main server, basically acting like the physical machine on which operating systems can run. The hypervisor allocates resources of the physical server across the various guest virtual machines.

Full virtualization and para-virtualization are types of hypervisor-based virtualization. Hardware-assisted virtualization is a type of hybrid virtualization that is hypervisor-based as well as hardware-based.

Server Virtualization: What to Consider

Virtualized servers can help improve an organization's computing systems in multiple ways. They allow IT to concentrate less time on the internal network, save space in the data center, maximize server resources, and cut costs associated with hardware and energy. On top of all that, setting up a virtual machine is much simpler than setting up a new physical server.

However, server virtualization is often associated with shared server resources or multi-tenant solutions. While multi-tenant servers are more cost effective and can be very powerful, they are often associated with possible challenges like noisy neighbors and additional security or stability issues.

One way to mitigate these risks is to choose a bare-metal virtualization approach. With bare metal virtualization, you are the single tenant using the server's resources, even though there is still a hypervisor managing the virtual servers. Bare metal virtualization can give you all the benefits of cloud computing while minimizing the risks associated with shared server configurations.

Find out all about bare metal virtualization and how it can benefit your organization.

5 Storage Virtualization

As we know that, there has been a strong link between the physical host and the locally installed storage devices. However, that paradigm has been changing drastically, almost local storage is no longer needed. As the technology progressing, more advanced storage devices are coming to the market that provide more functionality, and obsolete the local storage.

Storage virtualization is a major component for storage servers, in the form of functional RAID levels and controllers. Operating systems and applications with device can access the disks directly by themselves for writing. The controllers configure the local storage in RAID groups and present the storage to the operating system depending upon the configuration. However, the storage is abstracted and the controller is determining how to write the data or retrieve the requested data for the operating system.

Storage virtualization is becoming more and more important in various other forms:

File servers: The operating system writes the data to a remote location with no need to understand how to write to the physical media.

WAN Accelerators: Instead of sending multiple copies of the same data over the WAN environment, WAN accelerators will cache the data locally and present the re-requested blocks at LAN speed, while not impacting the WAN performance.

SAN and NAS: Storage is presented over the Ethernet network of the operating system. NAS presents the storage as file operations (like NFS). SAN technologies present the storage as block level storage (like Fibre Channel). SAN technologies receive the operating instructions only when if the storage was a locally attached device.

SAN = Storage area Network

NAS = Network attached storage

Advantages of Storage Virtualization

1. Data is stored in the more convenient locations away from the specific host. In the case of a host failure, the data is not compromised necessarily.
2. The storage devices can perform advanced functions like replication, reduplication, and disaster recovery functionality.
3. By doing abstraction of the storage level, IT operations become more flexible in how storage is provided, partitioned, and protected.

6 OS Virtualization

As in cloud technology, virtualization plays an important role to make things easy and efficiently done, virtualization also need to be done at the OS level also. With the technique of virtualized OS, nothing is required to be pre-installed or permanently loaded on the local storage device. Everything runs from network using a virtual; simulation & that virtual disk is a disk-image (file) that remotely stored on a server i.e. Storage Area Network (SAN) or Non-Volatile Attached Storage (NAS).

It is also called OS-level virtualization is a type of virtualization technology which work on OS layer. Here the kernel of an OS allows more than one isolated user-space instances to exist. Such instances are called containers/software containers or virtualization engines. In other words, OS kernel will run a single operating system & provide that operating system's functionality to replicate on each of the isolated partitions.

Use of OS Virtualization

- Used for virtual hosting environment.
- Used for securely allocation of finite hardware resources among a large number of distrusting users.

- System administrator uses it to integrate server hardware by moving services on separate hosts.
- To improvised security by separating several applications to several containers.
- These forms of virtualization don't require hardware to work efficiently.

The steps for how these virtualization works are listed below:

- Connect to OS Virtualization Server
- Connect to virtual disk
- Then connect this virtual disk to the client
- OS is streamed to the client
- If further additional streaming is required, it is done

Advantages of OS virtualizations

- OS virtualization usually imposes little or no overhead.
- OS Virtualization is capable of live migration
- It can also use dynamic load balancing of containers between nodes and a cluster.
- The file level copy-on-write (CoW) mechanism is possible on OS virtualization which makes easier to back up files, more space-efficient and simpler to cache than the block-level copy-on-write schemes.

Types of Disks in OS Virtualization

There are two types of virtual disk present in operating system virtualization so that the client can connect via the network to the virtual disk.

i. Private Disk

The private disk utilizes by a single client or single organization. In this disk, the company can store the information based on the capability assigned.

ii. Shared Disk

Shared disk uses by multiple clients at the same time. The changes done by the clients are applicable individually and won't affect the settings of another client hear that caches get cleaned when the system is restarted. It will set to default after the system gets a restart.