SUBJECT CODE / NAME : CCS367 / STORAGE TECHNOLOGIES

UNIT I
STORAGE SYSTEMS

Introduction to Information Storage: Digital data and its types, Information storage, Key characteristics of data center and Evolution of computing platforms. Information Lifecycle Management.Third Platform Technologies: Cloud computing and its essential characteristics, Cloud services and cloud deployment models, Big data analytics, Social networking and mobilecomputing, Characteristics of third platform infrastructure and Imperatives for third platform transformation. Data Center Environment: Building blocks of a data center, Compute systems and compute virtualization and Software-defined data center.

INFORMATION STORAGE

Businesses use data to derive information that is critical to their day-to-day operations. Storage is a repository that enables users to store and retrieve this digital data.

DIGITAL DATA AND ITS TYPES

DATA:

- Data is a collection of raw facts from which conclusions may be drawn.
- Handwritten letters, a printed book, a family photograph, a movie on video tape, printed and duly signed copies of mortgage papers, a bank's ledgers, and an account holder's passbooks are all examples of data.

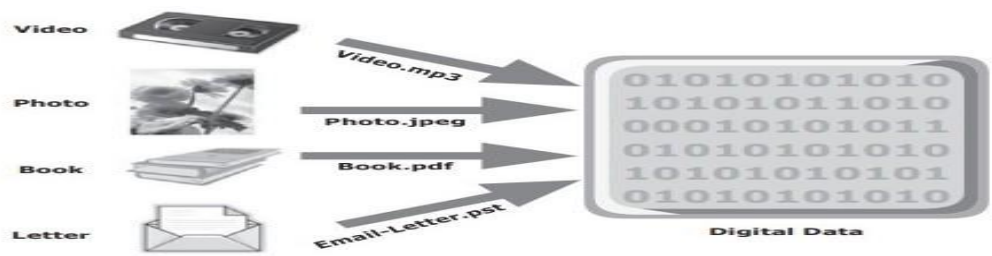


Figure 1-2: Digital data

- Before the advent of computers, the procedures and methods adopted for data creation and sharing were limited to fewer forms, such as paper and film.
- Today, the same data can be converted into more convenient forms such as an e-mail message, an e-book, a bitmapped image, or a digital movie.
- This data can be generated using a computer and stored in strings of 0s and 1s, as shown in Figure 1-2. *Data in this form is called digital data and is accessible by the user only after it is processed by a computer*

➢ With the advancement of computer and communication technologies, the rate of data generation and sharing has increased exponentially.

The following is a list of some of the factors that have contributed to the growth of digital data:

■ ***Increase in data processing capabilities***: Modern-day computers provide a significant increase in processing and storage capabilities. This enables the conversion of various types of content and media from conventional forms to digital formats.

■ ***Lower cost of digital storage***: Technological advances and decrease in the cost of storage devices have provided low-cost solutions and encouraged the development of less expensive data storage devices. This cost benefit has increased the rate at which data is being generated and stored.

■ ***Affordable and faster communication technology***: The rate of sharing digital data is now much faster than traditional approaches. A handwritten letter may take a week to reach its destination, whereas it only takes a few seconds for an e-mail message to reach its recipient.

➢ Inexpensive and easier ways to create, collect, and store all types of data, coupled with increasing individual and business needs, have led to accelerated data growth, popularly termed the data explosion.

Data has different purposes and criticality, so both individuals and businesses have contributed in varied proportions to this data explosion.

The importance and the criticality of data vary with time. Most of the data Created holds significance in the short-term but becomes less valuable over time.

This governs the type of data storage solutions used. Individuals store data on a variety of storage devices, such as hard disks, CDs, DVDs, or Universal Serial Bus (USB) flash drives.

Example of Research and Business data :

■*Seismology*: Involves collecting data related to various sources and parameters of earthquakes, and other relevant data that needs to be processed to derive meaningful information.

■ *Product data*: Includes data related to various aspects of a product, such as inventory, description, pricing, availability, and sales.

■ *Customer data*: A combination of data related to a company's customers, such as order details, shipping addresses, and purchase history.

■ *Medical data*: Data related to the health care industry, such as patient history, radiological images, details of medication and other treatment, and insurance information

- Businesses generate vast amounts of data and then extract meaningful information from this data to derive economic benefits. Therefore, businesses need to maintain data and ensure its availability over a longer period.

Furthermore, the data can vary in criticality and may require special handling.

For example, legal and regulatory requirements mandate that banks maintain account information for their customers accurately and securely. Some businesses handle data for millions of customers, and ensures the security and integrity of data over a long period of time. This requires highcapacity storage devices with enhanced security features that can retain data for a long period.

TYPES OF DATA :

Data can be classified as *structured or unstructured* (see Figure 1-3) based on how it is stored and managed.

- Structured data is organized in rows and columns in a rigidly defined format so that applications can retrieve and process it efficiently. Structured data is typically stored using a database management system (DBMS).
- Data is unstructured if its elements cannot be stored in rows and columns, and is therefore difficult to query and retrieve by business applications.

For example, customer contacts may be stored in various forms such as sticky notes, e-mail messages, business cards, or even digital format files such as .doc, .txt, and .pdf. Due its unstructured nature, it is difficult to retrieve using a customer relationship management application.

Unstructured data may not have the required components to identify itself uniquely for any type of processing or interpretation. Businesses are primarily concerned with managing unstructured data because over 80 percent of enterprise data is unstructured and requires significant storage space and effort to manage

INFORMATION STORAGE :

INFORMATION:

- Data, whether structured or unstructured, does not fulfill any purpose for individuals or businesses unless it is presented in a meaningful form. Businesses need to analyze data for it to be of value.
- *Information is the intelligence and knowledge derived from data.*
- Businesses analyze raw data in order to identify meaningful trends. On the basis of these trends, a company can plan or modify its strategy. For example, a retailer identifies customers' preferred products and brand names by analyzing their purchase patterns and maintaining an inventory of those products.
- Effective data analysis not only extends its benefits to existing businesses, but also creates the potential for new business opportunities by using the information in creative ways. *Job portal is an example.*
- In order to reach a wider set of prospective employers, job seekers post their résumés on various websites offering job search facilities.

- These websites collect the résumés and post them on centrally accessible locations for prospective employers.
- In addition, companies post available positions on job search sites. Job-matching software matches keywords from résumés to keywords in job postings. In this manner, the job search engine uses data and turns it into information for employers and job seekers.

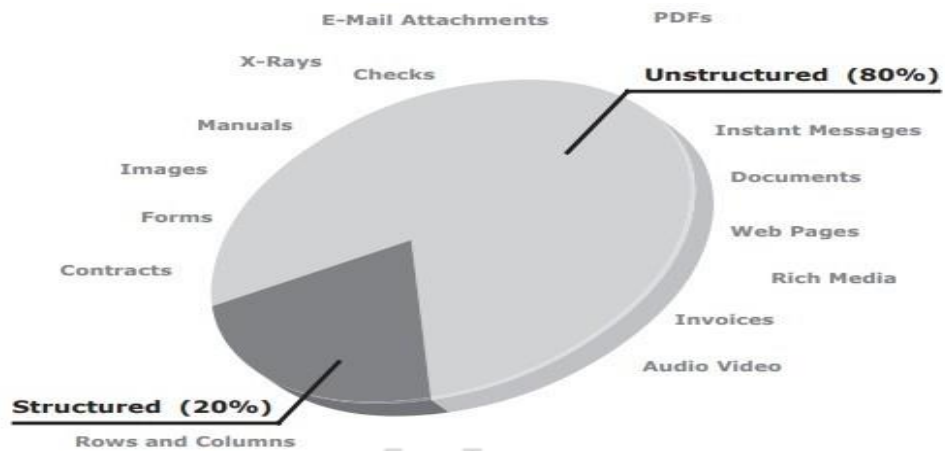


Figure 1-3: Types of data

STORAGE:

- Data created by individuals or businesses must be stored so that it is easily accessible for further processing.
- In a computing environment, devices designed for storing data are termed storage devices or simply storage.
- The type of storage used varies based on the type of data and the rate at which it is created and used.
- Devices such as memory in a cell phone or digital camera, DVDs, CD-ROMs, and hard disks in personal computers are examples of storage devices.
- Businesses have several options available for storing data including internal hard disks, external disk arrays and tape

DATA CENTER INFRASTRUCTURE:

- Organizations maintain data centers to provide centralized data processing capabilities across the enterprise. Data centers store and manage large amounts of mission-critical data.
- The data center infrastructure includes computers, storage systems, network devices, dedicated power backups, and environmental controls (such as air conditioning and fire suppression).
- Large organizations often maintain more than one data center to distribute data processing workloads and provide backups in the event of a disaster. The storage requirements of a data center are met by a combination of various stor- age architectures.

CORE ELEMENTS:

- *Five core elements are essential for the basic functionality of a data center:*

Application: An application is a computer program that provides the logic for computing operations. Applications, such as an order processing system, can be layered on a database, which in turn uses operating system services to perform read/write operations to storage devices.

Database: More commonly, 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.

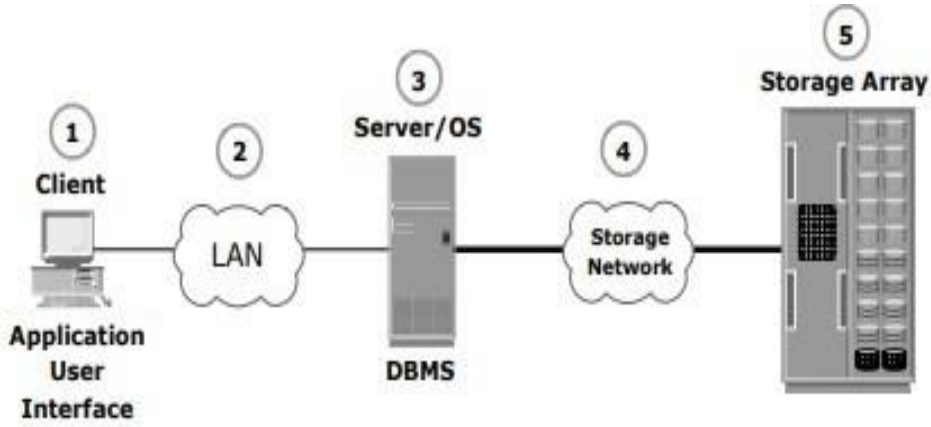
Server and operating system: A computing platform that runs applica tions and databases.

Network: A data path that facilitates communication between clients and servers or between servers and storage.

Storage array: A device that stores data persistently for subsequent use.

These core elements are typically viewed and managed as separate entities, but all the elements must work together to address data processing requirements.

Figure 1-5 shows an example of an order processing system that involves the five core elements of a data center and illustrates their functionality in a business process.



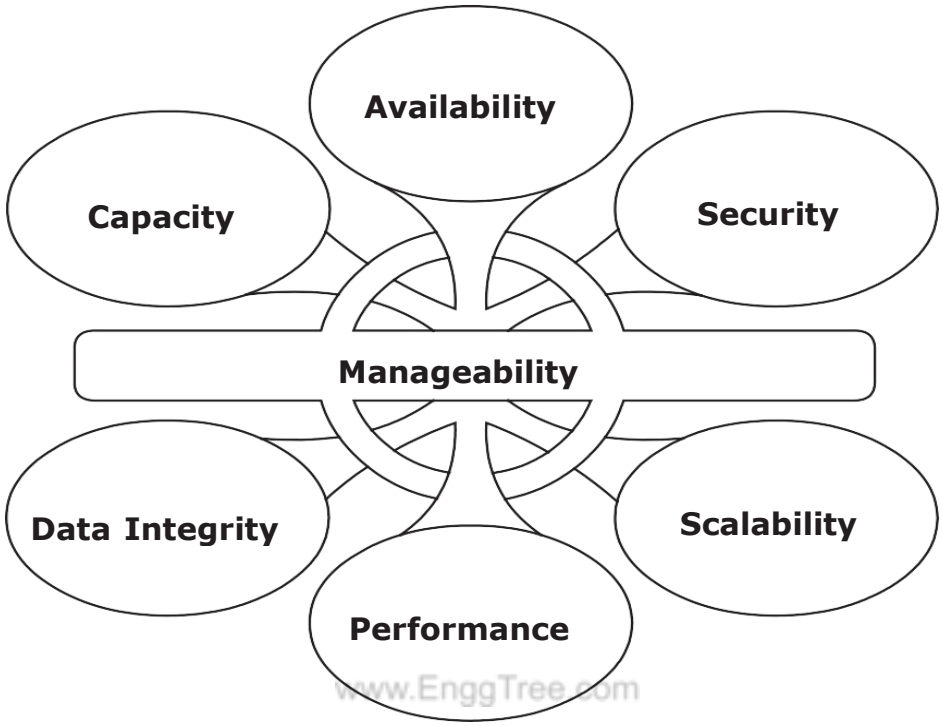
1. A customer places an order through the AUI of the order processing application software located on the client computer.
2. The client connects to the server over the LAN and accesses the DBMS located on the server to update the relevant information such as the customer name, address, payment method, products ordered, and quantity ordered.
3. The DBMS uses the server operating system to read and write this data to the database located on physical disks in the storage array.

4. The Storage Network provides the communication link between the server and the storage array and transports the read or write commands between them.
5. The storage array, after receiving the read or write commands from the server, performs the necessary operations to store the data on physical disks.

Figure 1-5: Example of an order processing system

KEY REQUIREMENTS FOR DATA CENTER ELEMENTS (OR) KEY CHARACTERISTICS OF DATA CENTER ELEMENTS :

- Uninterrupted operation of data centers is critical to the survival and success of a business. It is necessary to have a reliable infrastructure that ensures data is accessible at all times. While the requirements, shown in Figure 1-6, are appli cable to all elements of the data center infrastructure, our focus here is on storage systems.



Key Characteristics of Data Center Elements

Availability:

All data center elements should be designed to ensure acces- sibility. The inability of users to access data can have a significant negative impact on a business.

Security:

Polices, procedures, and proper integration of the data cen- ter core elements that will prevent unauthorized access to information must be established.

In addition to the security measures for client access, specific mechanisms must enable servers to access only their allocated resources on storage arrays.

Scalability:

Data center operations should be able to allocate additional processing capabilities or storage on demand, without interrupting busi- ness operations.

Business growth often requires deploying more servers, new applications, and additional databases. The storage solution should be able to grow with the business.

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.

Data integrity:

Data integrity refers to mechanisms such as error correc- tion codes or parity bits which ensure that data is written to disk exactly as it was received.

Any variation in data during its retrieval implies cor- ruption, which may affect the operations of the organization.

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 with- out interrupting availability, or, at the very least, with minimal disruption. Capacity may be managed by reallocation of existing resources, rather than by adding new resources.

Manageability:

A data center should perform all operations and activi- ties in the most efficient manner.

Manageability can be achieved through automation and the reduction of human (manual) intervention in com- mon tasks.

MANAGING STORAGE INFRASTRUCTURE:

- Managing a modern, complex data center involves many tasks. Key manage- ment activities include:

✓ ***Monitoring*** is the continuous collection of information and the review of the entire data center infrastructure. The aspects of a data center that are monitored include security, performance, accessibility, and capacity.

✓ ***Reporting*** is done periodically on resource performance, capacity, and utilization.

Reporting tasks help to establish business justifications and chargeback of costs associated with data center operations.

✓ ***Provisioning*** is the process of providing the hardware, software, and other resources needed to run a data center. Provisioning activities include capacity and resource planning.

Capacity planning ensures that the user's and the application's future needs will be addressed in the most cost-effective and controlled manner.

Resource planning is the process of evaluating and identifying required resources, such as personnel, the facility (site), and the technology. Resource planning ensures that adequate resources are available to meet user and application requirements.

For example, the utilization of an application's allocated storage capacity may be monitored. As soon as utilization of the storage capacity reaches a critical value, additional storage capacity may be provisioned to the application. If uti- lization of the storage capacity is properly monitored and reported, business growth can be understood and future capacity requirements can be anticipated. This helps to frame a proactive data management policy.

KEY CHALLENGES IN MANAGING INFORMATION:

In order to frame an effective information management policy, businesses need to consider the following key challenges of information management:

- **Exploding digital universe:**

  The rate of information growth is increasing exponentially. Duplication of data to ensure high availability and repurpos- ing has also contributed to the multifold increase of information growth.

- **Increasing dependency on information:**

  The strategic use of information plays an important role in determining the success of a business and provides competitive advantages in the market place.

- **Changing value of information:**

  Information that is valuable today may become less important tomorrow.

  The value of information often changes over time.Framing a policy to meet these

challenges involves understanding the value of information over its lifecycle.

EVOLUTION OF STORAGE TECHNOLOGYAND 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/departments to have their own servers and storage.
- In earlier implementations of open systems, the storage was typically internal to the server.
- The proliferation of departmental servers in an enterprise resulted in unpro- tected, unmanaged, fragmented islands of information and increased operating cost.
- Originally, there were very limited policies and processes for managing these servers and the data created.

To overcome these challenges, storage tech- nology evolved from non-intelligent internal storage to intelligent networked storage (see Figure 1-4). Highlights of this technology evolution include:

- **Redundant Array of Independent Disks (RAID):** This technology was developed to address the cost, performance, and availability requirements of data. It continues to evolve today and is used in all storage architectures such as DAS, SAN, and so on.

- **Direct-attached storage (DAS):** This type of storage connects directly to a server (host) or a group of servers in a cluster. Storage can be either internal or external to the server. External DAS alleviated the challenges of limited internal storage capacity.

- **Storage area network (SAN):** This is a dedicated, high-performance *Fibre Channel (FC)* network to facilitate *block-level* communication between servers and storage. Storage is partitioned and assigned to a server for accessing its data. SAN offers scalability, availability, performance, and cost benefits compared to DAS.

- **Network-attached storage (NAS):** This is dedicated storage for *file serving* applications. Unlike a SAN, it connects to an existing communication net- work (LAN) and provides file access to heterogeneous clients. Because it is purposelybuilt for providing storage to file server applications, it offers higher scalability, availability, performance, and cost benefits compared to general purpose file servers.

- **Internet Protocol SAN (IP-SAN):** One of the latest evolutions in storage architecture, IP-SAN is a convergence of technologies used in SAN and NAS. IP-SAN provides block-level communication across a local or wide area network (LAN or WAN), resulting in greater consolidation and availability of data.

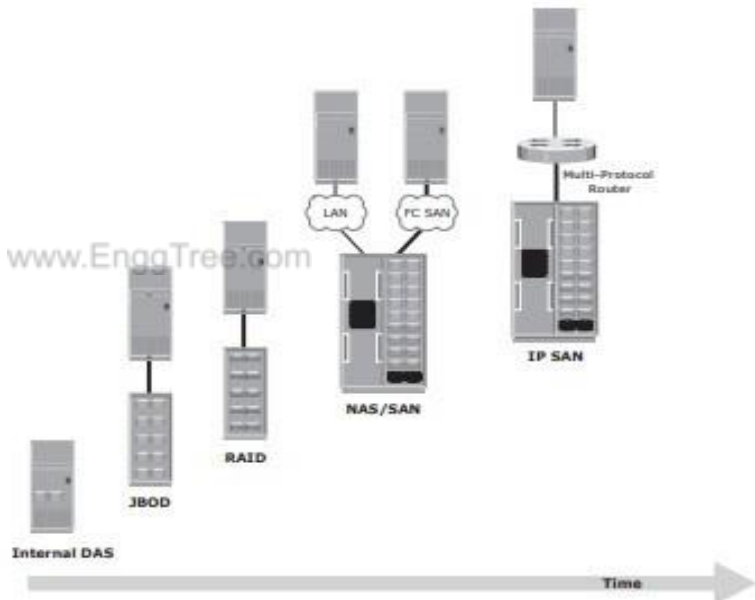


Figure 1-4: Evolution of storage architectures

INFORMATION LIFECYCLE MANAGEMENT:

INFORMATION LIFECYCLE

- *The information lifecycle is the "change in the value of information" over time.*
- When data is first created, it often has the highest value and is used frequently. As data ages, it is accessed less frequently and is of less value to the organization

- Understanding the information lifecycle helps to deploy appropriate storage infrastructure, according to the changing value of information.

  For example, in a sales order application, the value of the information changes from the time the order is placed until the time that the warranty becomes void (see Figure 1-7).

  - The value of the information is highest when a company receives a new sales order and processes it to deliver the product.After order fulfillment, the customer or order data need not be available for real-time access.
    The company can transfer this data to less expensive secondary storage with lower accessibility and availability requirements unless or until a warranty claim or another event triggers its need.
    After the warranty becomes void, the company can archive or dispose of data to create space for other high-value information

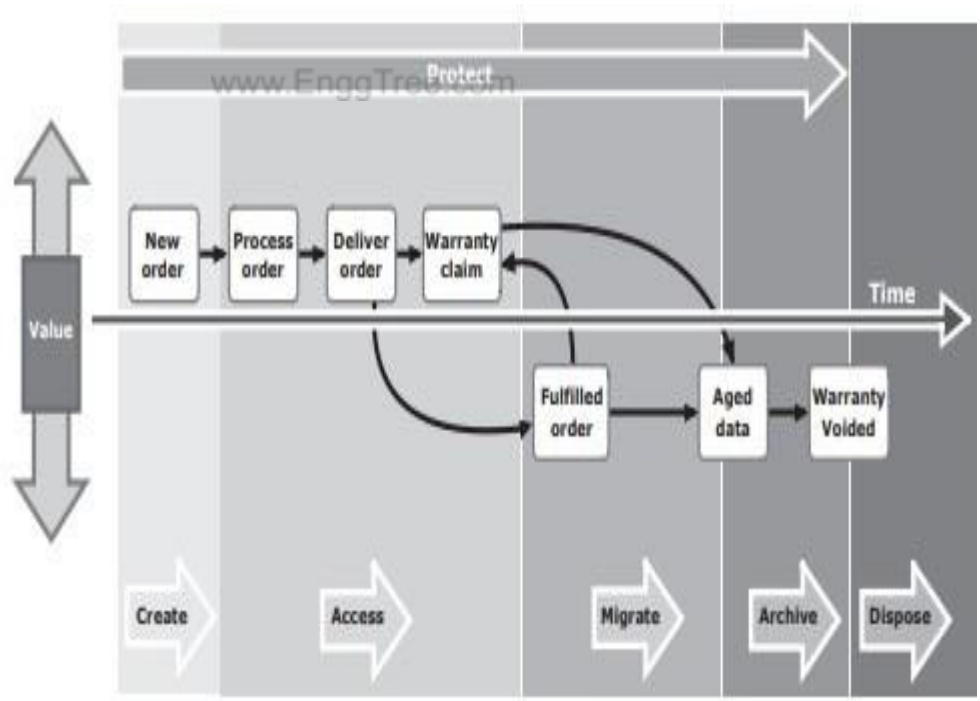


Figure 1-7: Changing value of sales order information

INFORMATION LIFECYCLE MANAGEMENT:

- Today's business requires data to be protected and available 24 × 7.
  Data centers can accomplish this with the optimal and appropriate use of storage infrastruc- ture.
- An effective information management policy is required to support this infrastructure and leverage its benefits.

Information lifecycle management (ILM) is a proactive strategy that enables an IT organization to effectively manage the data throughout its lifecycle, based on predefined business policies.

This allows an IT organization to optimize the storage infrastructure for maximum return on investment.

An ILM strategy should include the following characteristics:

- **Business-centric:** It should be integrated with key processes, applications, and initiatives of the business to meet both current and future growth in information.
- **Centrally managed:** All the information assets of a business should be under the purview of the ILM strategy.
- **Policy-based:** The implementation of ILM should not be restricted to a few departments. ILM should be implemented as a policy and encompass all business applications, processes, and resources.
- **Heterogeneous:** An ILM strategy should take into account all types of storage platforms and operating systems.
- **Optimized:** Because the value of information varies, an ILM strategy should consider the different storage requirements and allocate storage resources based on the information's value to the business.

ILM IMPLEMENTATION:

*The process of developing an ILM strategy includes **four** activities—classifying, implementing, managing, and organizing:*

- ***Classifying*** data and applications on the basis of business rules and poli- cies 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.

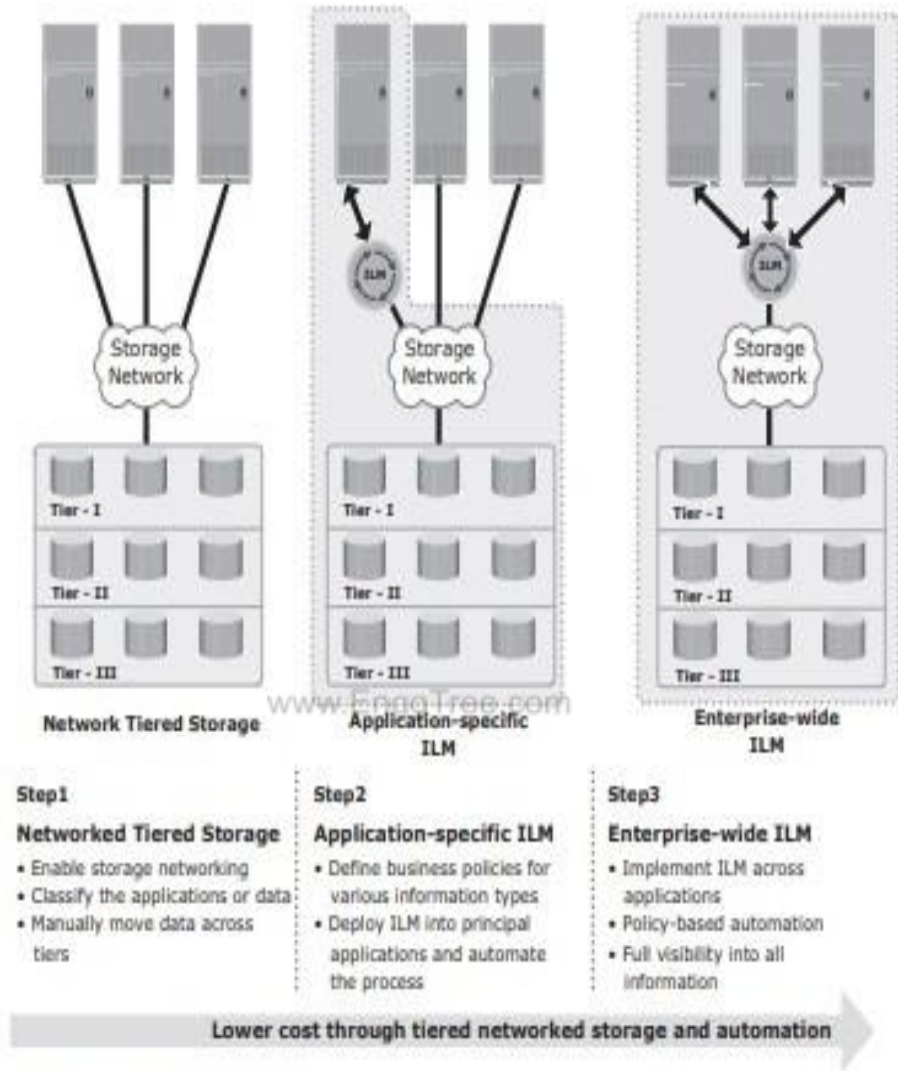


Figure 1-8: Implementation of ILM

Implementing ILM across an enterprise is an ongoing process.

Steps 1 and 2 are aimed at implementing ILM in a limited way across a few enterprise- critical applications.

- Step 1 : the goal is to implement a storage net- working environment. Storage architectures offer varying levels of protection and performance and this acts as a foundation for future policy-based informa- tion management in Steps 2 and 3.
  The value of tiered storage platforms can be exploited by allocating appropriate storageresources to the applications based on the value of the information processed.
- Step 2 : takes ILM to the next level, with detailed application or data classification and linkage of the storage infrastructure to business policies.
  These classification and the resultant policies can be automatically executed using tools for one or more applications, resulting in better management and optimal allocation of storage resources.
- Step 3 : of the implementation is to automate more of the applications or data classification and policy management activities in order to scale to a wider set of enterprise applications.

ILM BENEFITS:

Implementing an ILM strategy has the following key benefits that directly address the challenges of information management:

- ***Improved utilization*** by using tiered storage platforms and increased vis ibility 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.
- ***Lower Total Cost of Ownership (TCO)*** by aligning the infrastructure and management costs with information value. As a result, resources are not wasted, and complexity is not introduced by managing low-value data at the expense of high-value data.

➔ CLOUD COMPUTING AND CHARACTERISTICS:

- *Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. Cloud computing allows you to set up a virtual office to give you the flexibility of connecting to your business anywhere, any time.*
- Moving to cloud computing may reduce the cost of managing and maintaining your IT systems. Rather than purchasing expensive systems and equipment for your business.
- Cloud computing refers to both the applications delivered as services over the Internet and the hardware and system software in the datacenters that provide those services.
- *Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage,*

applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

- A cloud is a type of parallel and distributed system consisting of a collection of interconnected. virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers.

There are many characteristics of Cloud Computing here are few of them:

1. On-demand self-services:

The Cloud computing services does not require any human administrators, user themselves are able to provision, monitor and manage computing resources as needed.

2. Broad network access:

The Computing services are generally provided over standard networks and heterogeneous devices.

3. Rapid elasticity:

The Computing services should have IT resources that are able to scale out and in quickly and on as needed basis. Whenever the user requires services it is provided to him and it is scale out as soon as its requirement gets over.

4. Resource pooling:

The IT resource (e.g., networks, servers, storage, applications, and services) present are shared across multiple applications and occupant in an uncommitted manner. Multiple clients are provided service from a same physical resource.

5. Measured service:

The resource utilization is tracked for each application and occupant, it will provide both the user and the resource provider with an account of what has been used. This is done for various reasons like monitoring billing and effective use of resource.

6. Multi-tenancy:

Cloud computing providers can support multiple tenants (users or organizations) on a single set of shared resources

.

7. Virtualization:

Cloud computing providers use virtualization technology to abstract underlying hardware resources and present them as logical resources to users.

8. Resilient computing:

Cloud computing services are typically designed with redundancy and fault tolerance in mind, which ensures high availability and reliability.

9. Flexible pricing models:

Cloud providers offer a variety of pricing models, including pay-per-use, subscription-based, and spot pricing, allowing users to choose the option that best suits their needs.

10. Security:

Cloud providers invest heavily in security measures to protect their users' data and ensure the privacy of sensitive information.

11. Automation:

Cloud computing services are often highly automated, allowing users to deploy and manage resources with minimal manual intervention.

12. Sustainability:

Cloud providers are increasingly focused on sustainable practices, such as energy-efficient data centers and the use of renewable energy sources, to reduce their environmental impact.

Advantages:

1. Easy implementation
2. Accessibility
3. No hardware required
4. Cost per head
5. Flexibility for growth
6. Efficient recovery

Disadvantages:

1. No longer in control
2. May not get all the features
3. Doesn't mean you should do away with servers
4. No Redundancy
5. Bandwidth issues

➔ CLOUD MODELS :

The Cloud Models are as follows :

- ❖ Cloud Service models
- ❖ Cloud Deployment models.

CLOUD SERVICES :

- ➢ The term "cloud services" refers to a wide range of services delivered on demand to companies and customers over the internet.
- ➢ These services are designed to provide easy, affordable access to applications and resources, without the need for internal infrastructure or hardware.

- From checking email to collaborating on documents, most employees use cloud services throughout the workday, whether they're aware of it or not.
- Cloud services are fully managed by cloud computing vendors and service providers.
- They're made available to customers from the providers' servers, so there's no need for a company to host applications on its own on-premises servers.

There are the following three types of cloud service models -

1. *Infrastructure as a Service (IaaS)*
2. *Platform as a Service (PaaS)*
3. *Software as a Service (SaaS)*

Basis Of	IAAS	PAAS	SAAS
Stands for	Infrastructure as a service.	Platform as a service.	Software as a service.
Uses	IAAS is used by network architects.	PAAS is used by developers.	SAAS is used by the end user.
Access	IAAS gives access to the resources like virtual machines and virtual storage.	PAAS gives access to run time environment to deployment and development tools for application.	SAAS gives access to the end user.
Model	It is a service model that provides virtualized computing resources over the internet.	It is a cloud computing model that delivers tools that are used for the development of applications.	It is a service model in cloud computing that hosts software to make it available to clients.
Technical understanding.	It requires technical knowledge.	Some knowledge is required for the basic setup.	There is no requirement about technicalities company handles everything.
Popularity	It is popular among developers and researchers.	It is popular among developers who focus on the development of	It is popular among consumers and companies, such as file sharing, email,

Basis Of	IAAS	PAAS	SAAS
		apps and scripts.	and networking.
Percentage rise	It has around a 12% increment.	It has around 32% increment.	It has about a 27 % rise in the cloud computing model.
Usage	Used by the skilled developer to develop unique applications.	Used by mid-level developers to build applications.	Used among the users of entertainment.
Cloud services.	Amazon Web Services, sun, vCloud Express.	Facebook, and Google search engine.	MS Office web, Facebook and Google Apps.
Enterprise services.	AWS virtual private cloud.	Microsoft Azure.	IBM cloud analysis.
Outsourced cloud services.	Salesforce	Force.com, Gigaspaces.	AWS, Terremark
User Controls	Operating System, Runtime, Middleware, and Application data	Data of the application	Nothing
Others	It is highly scalable and flexible.	It is highly scalable to suit the different businesses according to resources.	It is highly scalable to suit the small, mid and enterprise level business

ADVANTAGES OF IAAS:

- The resources can be deployed by the provider to a customer's environment at any given time.
- Its ability to offer the users to scale the business based on their requirements.The provider has various options when deploying resources including virtual machines, applications, storage, and networks.

- It has the potential to handle an immense number of users.
- It is easy to expand and saves a lot of money.
- Companies can afford the huge costs associated with theimplementation of advanced technologies.
- Cloud provides the architecture.
- Enhanced scalability and quite flexible.
- Dynamic workloads are supported.

DISADVANTAGES OF IAAS:

- Security issues are there.
- Service and Network delays are quite a issue in IaaS.

ADVANTAGES OF PAAS :

- Programmers need not worry about what specific database or language the application has been programmed in.
- It offers developers the to build applications without the overhead of the underlying operating system or infrastructure.
- Provides the freedom to developers to focus on the application's design while the platform takes care of the language and the database.
- It is flexible and portable.
- It is quite affordable.
- It manages application development phases in the cloud very efficiently.

DISADVANTAGES OF PAAS

- Data is not secure and is at big risk.
- As data is stored both in local storage and cloud, there are high chances of data mismatch while integrating the data.

ADVANTAGES OF SAAS:

- It is a cloud computing service category providing a wide range of hosted capabilities and services. These can be used to build and deploy web-based software applications.
- It provides a lower cost of ownership than on-premises software. The reason is it does not require the purchase or installation of hardware or licenses.
- It can be easily accessed through a browser along a thin client.
- No cost is required for initial setup.
- Low maintenance costs.
- Installation time is less, so time is managed properly.

DISADVANTAGES OF SAAS:

- Low performance.
- It has limited customization options.
- It has security and data concerns.

CLOUD DEPLOYMENT MODEL:

A cloud deployment model defines the cloud services you are consuming and the responsibility model for who manages them. It defines your cloud architecture, scalability of your computing resources, what you can change, the services provided to you, and how much of the build you own.

Cloud Deployment Model functions as a virtual computing environment with a deployment architecture that varies depending on the amount of data you want to store and who has access to the infrastructure.

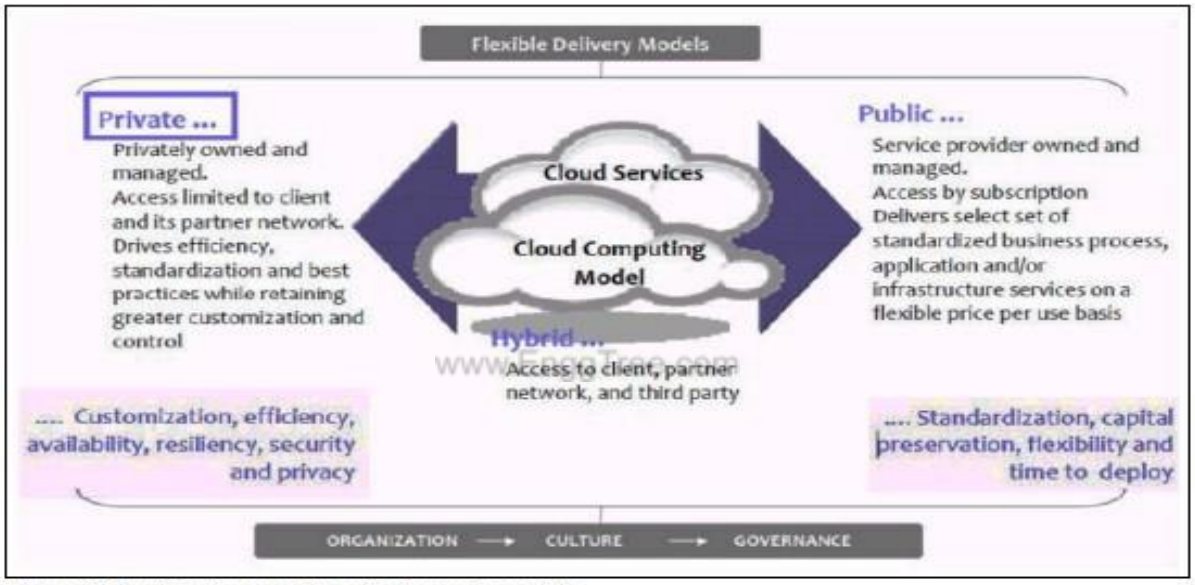


Figure 6-3 Cloud computing deployment models

PRIVATE CLOUD : The cloud infrastructure is owned or leased by a single organization and operated solely for that organization.

Advantages of the private cloud model:

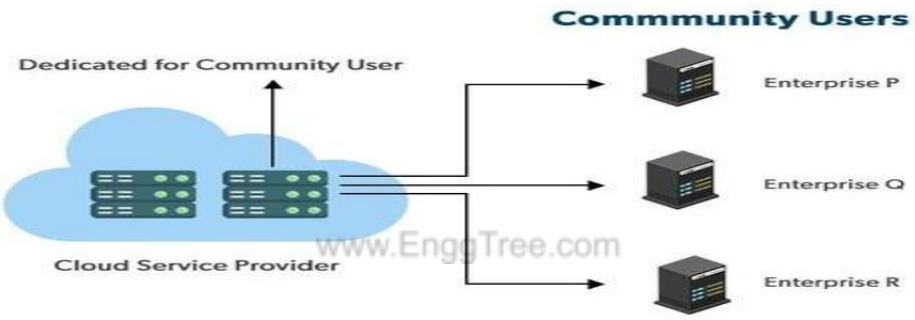
- **Better Control:** You are the sole owner of the property. You gain complete command over service integration, IT operations, policies, and user behavior.

- **Data Security and Privacy:** It's suitable for storing corporate information to which only authorized staff have access. By segmenting resources within the same infrastructure, improved access and security can be achieved.
- **Supports Legacy Systems:** This approach is designed to work with legacy systems that are unable to access the public cloud.
- **Customization:** Unlike a public cloud deployment, a private cloud allows a company to tailor its solution to meet its specific needs.

Disadvantages of the private cloud model:

- **Less scalable:** Private clouds are scaled within a certain range as there is less number of clients.
- **Costly:** Private clouds are more costly as they provide personalized facilities.

COMMUNITY CLOUD : The cloud infrastructure is shared by several organizations and supports a specific community that shares, for example, mission, security requirements, policy, and compliance considerations.



Advantages of the community cloud model:

- **Cost Effective:** It is cost-effective because the cloud is shared by multiple organizations or communities.
- **Security:** Community cloud provides better security.
- **Shared resources:** It allows you to share resources, infrastructure, etc. with multiple organizations.
- **Collaboration and data sharing:** It is suitable for both collaboration and data sharing.

Disadvantages of the community cloud model:

- **Limited Scalability:** Community cloud is relatively less scalable as many organizations share the same resources according to their collaborative interests.
- **Rigid in customization:** As the data and resources are shared among different organizations according to their mutual interests if an organization wants some changes according to their needs they cannot do so because it will have an impact on other organizations.

PUBLIC CLOUD : The cloud infrastructure is owned by an organization that sells cloud services to the general public or to a large industry group.

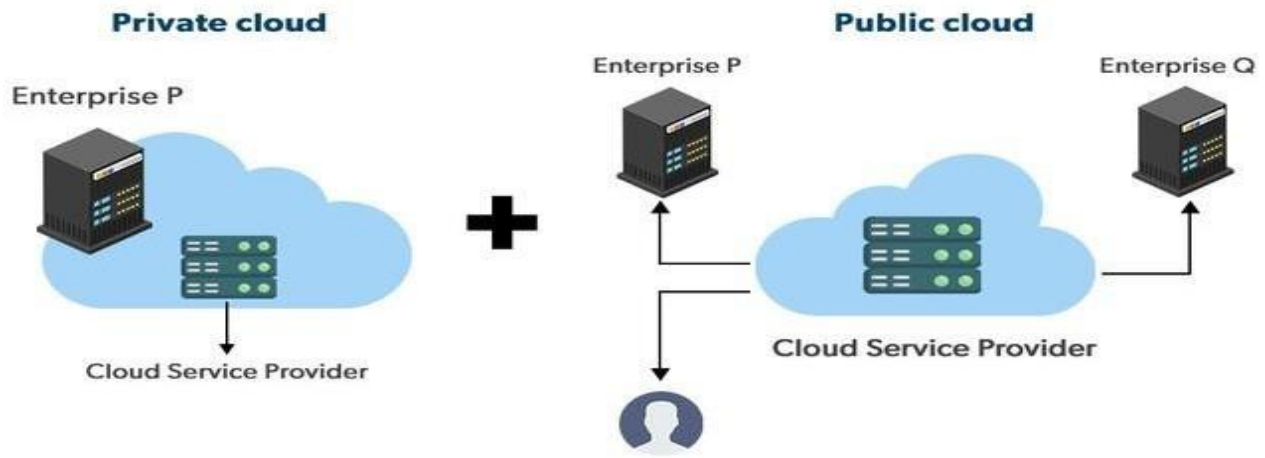
Advantages of the public cloud model:

- **Minimal Investment:** Because it is a pay-per-use service, there is no substantial upfront fee, making it excellent for enterprises that require immediate access to resources.
- **No setup cost:** The entire infrastructure is fully subsidized by the cloud service providers, thus there is no need to set up any hardware.
- **Infrastructure Management is not required:** Using the public cloud does not necessitate infrastructure management.
- **No maintenance:** The maintenance work is done by the service provider (not users).
- **Dynamic Scalability:** To fulfill your company's needs, on-demand resources are accessible.

Disadvantages of the Public Cloud Model:

- **Less secure:** Public cloud is less secure as resources are public so there is no guarantee of high-level security.
- **Low customization:** It is accessed by many public so it can't be customized according to personal requirements.

HYBRID CLOUD: The cloud infrastructure is a composition of two or more clouds (internal, community, or public) that remain unique entities. However, these entities are bound together by standardized or proprietary technology that enables data and application portability, for example, cloud bursting. Figure 6-3 shows cloud computing deployment models



Advantages of the hybrid cloud model:

- **Flexibility and control:** Businesses with more flexibility can design personalized solutions that meet their particular needs.
- **Cost:** Because public clouds provide scalability, you'll only be responsible for paying for the extra capacity if you require it.
- **Security:** Because data is properly separated, the chances of data theft by attackers are considerably reduced.

Disadvantages of the hybrid cloud model:

- **Difficult to manage:** Hybrid clouds are difficult to manage as it is a combination of both public and private cloud. So, it is complex.
- **Slow data transmission:** Data transmission in the hybrid cloud takes place through the public cloud so latency occurs.

➔ BIG DATA ANALYTICS :

- Big data analytics is the process of collecting, examining, and analysing large amounts of data to discover market trends, insights, and patterns that can help companies make better business decisions.
- This information is available quickly and efficiently so that companies can be agile in crafting plans to maintain their competitive advantage.
- Technologies such as business intelligence (BI) tools and systems help organisations take unstructured and structured data from multiple sources.
- Users (typically employees) input queries into these tools to understand business operations and performance.
- Big data analytics uses the four data analysis methods to uncover meaningful insights and derive solutions.
    - *For example, big data analytics is integral to the modern health care industry. As you can imagine, systems that must manage thousands of patient records, insurance plans, prescriptions, and vaccine information.*

THE IMPORTANCE OF BIG DATA ANALYTICS:

- Big data analytics is important because it helps companies leverage their data to identify opportunities for improvement and optimisation.
- Across different business segments, increasing efficiency leads to overall more intelligent operations, higher profits, and satisfied customers.
- Big data analytics helps companies reduce costs and develop better, customer-centric products and services.
- Data analytics helps provide insights that improve the way our society functions. In health care, big data analytics not only keeps track of and analyses individual records but it plays a critical role in measuring outcomes on a global scale.
- During the COVID-19 pandemic, big data-informed health ministries within each nation's government on how to proceed with vaccinations and devised solutions for mitigating pandemic outbreaks in the future.

BENEFITS OF BIG DATA ANALYTICS:

Incorporating big data analytics into a business or organisation has several advantages. These include:

- ***Cost reduction*:** Big data can reduce costs in storing all business data in one place. Tracking analytics also helps companies find ways to work more efficiently to cut costs wherever possible.
- ***Product development:*** Developing and marketing new products, services, or brands is much easier when based on data collected from customers' needs and wants. Big data analytics also helps businesses understand product viability and to keep up with trends.
- ***Strategic business decisions*:** The ability to constantly analyse data helps businesses make better and faster decisions, such as cost and supply chain optimisation.
- ***Customer experience*:** Data-driven algorithms help marketing efforts (targeted ads, for example) and increase customer satisfaction by delivering an enhanced customer experience.
- ***Risk management*:** Businesses can identify risks by analysing data patterns and developing solutions for managing those risks.

BIG DATA IN THE REAL WORLD:

Big data analytics helps companies and governments make sense of data and make better, informed decisions.

• **Entertainment:** Providing a personalised recommendation of movies and music according to a customer's preferences has been transformative for the entertainment industry (think Spotify and Netflix).

• **Education:** Big data helps schools and educational technology companies develop new curriculums while improving existing plans based on needs and demands.

• **Health care:** Monitoring patients' medical histories helps doctors detect and prevent diseases.

• **Government:** Big data can be used to collect data from CCTV and traffic cameras, satellites, body cameras and sensors, emails, calls, and more, to help manage the public sector.

• **Marketing:** Customer information and preferences can be used to create targeted advertising campaigns with a high return on investment (ROI).

• **Banking:** Data analytics can help track and monitor illegal money laundering.

TYPES OF BIG DATA ANALYTICS (+ EXAMPLES):

Four main types of big data analytics support and inform different business decisions.

1. Descriptive analytics:

Descriptive analytics refers to data that can be easily read and interpreted. This data helps create reports and visualise information that can detail company profits and sales**.**

Example: During the pandemic, a leading pharmaceutical company conducted data analysis on its offices and research labs. Descriptive analytics helped them identify consolidated unutilised spaces and departments, saving the company millions of pounds.

2. Diagnostics analytics:

Diagnostics analytics helps companies understand why a problem occurred. Big data technologies and tools allow users to mine and recover data that helps dissect an issue and prevent it from happening in the future.

Example: An online retailer's sales have decreased even though customers continue to add items to their shopping carts. Diagnostics analytics helped to understand that the payment page was not working correctly for a few weeks.

3. Predictive analytics:

Predictive analytics looks at past and present data to make predictions. With artificial intelligence (AI), machine learning, and data mining, users can analyse the data to predict market trends.

Example: In the manufacturing sector, companies can use algorithms based on historical data to predict if or when a piece of equipment will malfunction or break down.

4. Prescriptive analytics:

Prescriptive analytics solves a problem, relying on AI and machine learning to gather and use data for risk management.

Example: Within the energy sector, utility companies, gas producers, and pipeline owners identify factors that affect the price of oil and gas to hedge risks.

BIG DATA ANALYTICS TOOLS:

Harnessing all of that data requires tools. Thankfully, technology has advanced so that many intuitive software systems are available for data analysts to use.

- **Hadoop:** An open-source framework that stores and processes big data sets. Hadoop can handle and analyses structured and unstructured data.

- **Spark:** An open-source cluster computing framework for real-time processing and data analysis.

- **Data integration software**: Programs that allow big data to be streamlined across different platforms, such as MongoDB, Apache, Hadoop, and Amazon EMR.

- **Stream analytics tools:** Systems that filter, aggregate, and analyse data that might be stored in different platforms and formats, such as Kafka.

- **Distributed storage:** Databases that can split data across multiple servers and can identify lost or corrupt data, such as Cassandra.

- **Predictive analytics hardware and software:** Systems that process large amounts of complex data, using machine learning and algorithms to predict future outcomes, such as fraud detection, marketing, and risk assessments.

- **Data mining tools:** Programs that allow users to search within structured and unstructured big data.

- **NoSQL databases:** non-relational data management systems ideal for dealing with raw and unstructured data.

- **Data warehouses:** Storage for large amounts of data collected from many different sources, typically using predefined schemas.

➔ SOCIAL NETWORKING:

Social Networking refers to grouping of individuals and organizations together via some medium, in order to share thoughts, interests, and activities.

There are several web based social network services are available such as facebook, twitter, linkedin, Google+ etc. which offer easy to use and interactive interface to connect with people with in the country an overseas as well. There are also several mobile based social networking services infor of apps such as Whatsapp, hike, Line etc.

Available Social networking Services:

The following table describes some of the famous social networking services provided over web and mobile:

S. N.	Service Description
1.	**Facebook** Allows to share text, photos, video etc. It also offers interesting online games.
2.	**Google+** It is pronounced as Google Plus. It is owned and operated by Google.
3.	**Twitter**

	Twitter allows the user to send and reply messages in form of tweets. These tweets are the small messages, gencharacters.
4.	**Faceparty** Faceparty is a UK based social networking site. It allows the users to create profiles and interact with each othmessages.
5.	**Linkedin** Linkedin is a business and professional networking site.
6.	**Flickr** Flickr offers image hosting and video hosting.
7.	**Ibibio** Ibibio is a talent based social networking site. It allows the users to promote one's self and also discover new t
8.	**WhatsApp** It is a mobile based messaging app. It allows to send text, video, and audio messages
9.	**Line** It is same as whatsapp. Allows to make free calls and messages.
10.	**Hike** It is also mobile based messager allows to send messages and exciting emoticons.

Where Social Networking Helps: (or) Uses of Social Networking:

Following are the areas where social networking has become most popular:

Online Marketing:

Website like facebook allows us to create a page for specific product, community or firm and promiting over the web.

Online Jobs:

Website like linkedin allows us to create connection with professionals and helps to find the suitable job based on one's specific skills set.

Online News:

On social networking sites, people also post daily news which helps us to keep us updated.

Chatting:

Social networking allows us to keep in contact with friends and family. We can communicate with them via messages.

Share Picture, Audio and video:

One can share picture, audio and video using social networking sites.

➔ MOBILE COMPUTING:

- Mobile Computing is a technology that provides an environment that enables users to transmit data from one device to another device without the use of any physical link or cables.

- In other words, you can say that mobile computing allows transmission of data, voice and video via a computer or any other wireless-enabled device without being connected to a fixed physical link. In this technology, data transmission is done wirelessly with the help of wireless devices such as mobiles, laptops etc.

- This is only because of Mobile Computing technology that you can access and transmit data from any remote locations without being present there physically. Mobile computing technology provides a vast coverage diameter for communication. It is one of the fastest and most reliable sectors of the computing technology field.

The concept of Mobile Computing can be divided into three parts:

- *Mobile Communication*
- *Mobile Hardware*
- *Mobile Software*

MOBILE COMMUNICATION:

- Mobile Communication specifies a framework that is responsible for the working of mobile computing technology. In this case, mobile communication refers to an infrastructure that ensures seamless and reliable communication among wireless devices.
- This framework ensures the consistency and reliability of communication between wireless devices. The mobile communication framework consists of communication devices such as protocols, services, bandwidth, and portals necessary to facilitate and support the stated services. These devices are responsible for delivering a smooth communication process.

Mobile communication can be divided in the following four types:

1. Fixed and Wired
2. Fixed and Wireless
3. Mobile and Wired
4. Mobile and Wireless

Fixed and Wired: In Fixed and Wired configuration, the devices are fixed at a position, and they are connected through a physical link to communicate with other devices.

For Example, Desktop Computer.

Fixed and Wireless: In Fixed and Wireless configuration, the devices are fixed at a position, and they are connected through a wireless link to make communication with other devices.

For Example, Communication Towers, WiFi router

Mobile and Wired: In Mobile and Wired configuration, some devices are wired, and some are mobile. They altogether make communication with other devices.

For Example, Laptops.

Mobile and Wireless: In Mobile and Wireless configuration, the devices can communicate with each other irrespective of their position. They can also connect to any network without the use ofany wired device.

For Example, WiFi Dongle.

MOBILE HARDWARE:

- Mobile hardware consists of mobile devices or device components that can be used to receive or access the service of mobility.
- Examples of mobile hardware can be smartphones, laptops, portable PCs, tablet PCs, Personal Digital Assistants, etc.
- Hose devices are inbuilt with a receptor medium that can send and receive signals. These devices are capable of operating in full duplex.
- It means they can send and receive signals at the same time.
- They don't have to wait until one device has finished communicating for the other device to initiate communications.

MOBILE SOFTWARE:

- Mobile software is a program that runs on mobile hardware. This is designed to deal capably with the characteristics and requirements of mobile applications.
- This is the operating system for the appliance of mobile devices. In other words, you can say it the heart of the mobile systems.
- This is an essential component that operates the mobile device.

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APPLICATIONS OF MOBILE COMPUTING:

- Web or Internet access.
- Global Position System (GPS).
- Emergency services.
- Entertainment services.
- Educational services.

ADVANTAGES OF MOBILE COMPUTING :

The advantages of mobile, ubiquitous computing include the following:

Portability:

- Mobile devices are smaller and more portable than traditional computers, making them easy to carry and use in a range of contexts.
- They work disconnected from a power source and without a physical network connection and when disconnected from the network.

Affordability:

- Over time, mobile devices have become less expensive and easier to obtain. Increasingly, people opt for smartphones and tablets as their primary means of online connectivity.
- And it is often cheaper to buy a smartphone than a desktop PC.

Wireless communications:

- Mobile devices let users engage in phone, video and various text and instant messaging applications.

LIMITATIONS OF MOBILE COMPUTING:

Mobile computing is not without issues such as the following ones:

Power:

- Despite increasing battery life, power consumption continues to be an issue, and mobile devices must be recharged regularly.

Connectivity:

- While the mobile infrastructure continues to improve, there are areas where signal strength is poor or nonexistent.

Data security:

- Mobile computing raises significant data security vulnerabilities because business users, especially, may have sensitive data on their devices while traveling or working remotely.
- Companies must implement security measures and policies to keep corporate data secure.

Dependence:

- The flip side to the convenience of mobile devices is that consumers may become overly reliant on them, which can lead to compulsive or unhealthy behaviors such as smartphone addiction.

Distraction:

- Mobile devices can be distracting and potentially dangerous in a hazardous work envronment that requires the employee's attention, such as a construction site.
  They pose dangers if used inappropriately while driving.

➔ THIRD PLATFORM TECHNOLOGIES

First Platform:

First Platform (Mainframe) - late 1950s to present

The first platform is the mainframe computer system, which began in the late 1950s and continues today.

Second Platform:

Second Platform (Client/Server) - mid 1980s to present

The second platform is the client/server system, which began in the mid-1980s with PCs tapping into mainframe databases and applications.

Third Platform:

Third Platform (Social, Mobile, Cloud & Analytics, possibly IoT) - early 2010s to present

The third platform is a term coined by marketing firm International Data Corporation (IDC) to describe a model of computing platform. It was promoted as an interdependence between mobile computing, social media, cloud computing, information/analytics (big data), and possibly the Internet of Things.

A Facebook page on a mobile device.

No single "third platform" product has emerged, but there are a number of proprietary and free software products that enterprises can use to create, deploy and operate solutions that use third platform technologies.

Within an enterprise, a combination of these products that meet enterprise needs is a "third platform" for that enterprise. Its design can be considered part of Enterprise Architecture.

Suitable products include:

- The Eclipse integrated development environment
- The Cloud Foundry cloud application platform as a service
- The Docker container environment
- The Kubernetes container deployment and management environment
- The Apache Hadoop big data framework

THE PILLARS OF THE THIRD PLATFORM :

Social technology

Analytics (big data)

- The concept behind big data is to maximize the utility of all data. An executive at a company that streamlines its business functions with the third platform would have easy access to all of the data, including sales figures, personnel information, accounting data, financials and so on. This data can then be used to inform more areas of the business.
- Big data can be further differentiated once we analyze its three distinguishing features: **variety, volume, and velocity.**
    - *Variety* means that many forms of data are collected, with formats ranging from audio and video to client log files and Tweets.
    - *Volume* represents the fact that big data must come in massive quantities, often over a petabyte.
    - *Velocity* signifies that big data must be constantly collected for maximum effectiveness; even data that is a few days old is not ideal.

Cloud services

- Cloud services are at the heart of the third platform. Having big data and mobile devices is one thing, but without the cloud, there will be no way to access this data from outside of the office.
- This differs greatly from the first platform, where computer networks consisted of large mainframes. All of a company's employees had access to the data in the mainframe but they could only access it through their desktop computers.

- In the second platform, a company's employees could access the data in the mainframe as well as outside data, via an Internet connection.
- The third platform will allow all of a company's IT solutions to be available through the cloud, accessible via a variety of mobile devices. Data storage, servers and many IT solutions, which are on-site, can now be cloud-based.

Internet of Things (IOT)

- The Internet of Things is the network of connected devices that enable computer systems to monitor and control aspects of the physical environment. It has applications in personal and home environments, smart cities, factory automation, transport, and many other areas.
- The incorporation of the Internet of Things in the third platform gives enterprises the ability to interact with these systems and use these applications.
- Sensors and actuators have been used in computer systems for many years. It is the ability to connect to such devices anywhere in the world through the Internet that characterizes the Internet of things.

WHY BUSINESSES WILL NEVER SUCCEED WITHOUT THE THIRD PLATFORM? (or) ADVANTAGES

1) Can't keep up without the Third Platform solutions

The Third Platform consists of trillions of systems, electronics, devices, and sensors. It involves not only the users of apps or services that are interlinked to the devices but also anything with an IP address.

Social networking coupled with continually connected smart devices and a cloud-based servermeans that people have a greater online presence than ever and those businesses which do not accept this fact and adapt accordingly will not be able to either compete or keep up.

The point to note is that Third platform technologies solutions will predict problems, alert, suggest and even implement – in some cases – the solution, before the businesses will even register a problem exists.

Consider for example, sending an electrician to figure out exactly what is causing energy wastage in a building versus an automatic alert providing exact information about the burnt up wires in sector A, room B, slot C of that building.

The Third Platform offers speed, growth, results, innovation, adaptability and consolidation. Together, this will help make businesses -large and small – be more competitive, agile, effective and efficient.

2) You won't be able to go fully mobile or leverage the cloud without the Third Platform

Given that cloud computing is one futuristic solution that offers agile businesses deployment, network virtualisation and safe, scalable and sustainable business operations, businesses worldwide have already started to embrace it.

This trend is set to increase; just last year Forbes highlighted that 83% of enterprises' workloads would be interlinked to the cloud by next year.

3) Consumer interaction will go downhill

Third platform services are structured in a way to boost connectivity. With hyper-competition and relatively similar service offerings, customer-centricity put front and centre will be one way that suppliers could gain genuine competitive advantage.

With the 4 pillars of Cloud, Mobile, Social and Analytics getting established, both Gartner and IDC are prediction a new digital era that Gartner calls the Digital Industrial Revolution. ***IDC refers to 6 innovations accelerators sitting on top of the 4 pillars and accelerating the transformation to Digital.***

The 6 innovations accelerators are:

1. The Internet of Things (IoT)

As evidenced by the wave of new IoT devices and solutions at display at several tradeshows this year, the physical world is soon entering the digital era with future connected cars, houses, wallets, etc.

2. Cognitive systems

Analyzing the vast amount of IoT data created by the connected devices with the next wave of analytics tools (diagnostic, predictive and prescriptive), cognitive systems with observe, learn and offer suggestion thus reshaping the services industry.

3. Pervasive robotics

A new era of automation driven by knowledge gained from the digital world and set in action in the physical world with self-driving cars, drones, robots, etc.

4. 3-D printing of all kinds

Those printers will be creating physical things of all kind from a digital drawing: not only plastic parts (quite common now, my local library even has a 3D printer for plastic parts) and fine resolution metal parts but also food and clothing items, and, eventually, living tissues and organs!

5. Natural interfaces

Beyond mouse and keyboards, using touch and motion, speech (starting to be common on smartphones and cars nowadays) and also vision to connect people to their devices and 3rd Platform solutions.

6. Optimized security technologies and solutions

With the predicted massive amount of new connected IoT devices, a better way to secure access to systems and devices is required to avoid the security breaches we have experienced in 2014.

·CHARACTERISTICS OF THIRD PLATFORM

1. On-Demand Self-Service

You can provision computing services, like server time and network storage, automatically.

You won't need to interact with the service provider. Cloud customers can access their cloud accounts through a web self-service portal to view their cloud services, monitor their usage, and provision and de-provision services.

2. Broad Network Access

You can access services over the network and on portable devices like mobile phones, tablets, laptops, and desktop computers. Anyone, anywhere, anytime can connect, this should be guaranteed at all times.

3. Resource Pooling

With resource pooling, multiple customers can share physical resources using a multi-tenant model. This model assigns and reassigns physical and virtual resources based on demand. Multi-tenancy allows customers to share the same applications or infrastructure while maintaining privacy and security.

Though customers won't know the exact location of their resources, they may be able to specify the location at a higher level of abstraction, such as a country, state, or data center. Memory, processing, and bandwidth are among the resources that customers can pool.

4. Rapid Elasticity

It should be capable of handling massive expansion as no. of resources connected increasing sometimes automatically, so customers can scale quickly based on demand. The capabilities available for provisioning are practically unlimited.

Customers can engage with these capabilities at any time in any quantity.

5. Dynamic and Self-Adapting (Complexity)

Devices should dynamically adapt themselves to changing contexts and scenarios. Assume a camera meant for surveillance. It should be adaptable to work in different conditions and different light situations (morning, afternoon, and night).

➔ Digital Transformation

Digital transformation is the incorporation of computer-based technologies into an organization's products, processes and strategies. Organizations undertake digital transformation to better engage and serve their workforce and customers and thus improve their ability to compete.

A digital transformation initiative can require an examination and reinvention of all facets of an organization, from supply chains and workflows, to employee skill sets and org charts, to customer interactions and value proposition to stakeholders.

➔ IMPERATIVES FOR THIRD PLATFORM TRANSFORMATION :

Five digital imperatives customers need to achieve:

1. Migrate to the Cloud
2. Empower Fusion Teams
3. Unify Data and Apply AI Models

4. Implement Collaborative Business Processes
5. Prioritize Security

Digital Imperative #1: Migrate to the Cloud

- Microsoft CEO Satya Nadella cited a Gartner report that estimates businesses will deploy 95% of new digital workloads on cloud-native platforms to serve as the foundation to be competitive.
- Businesses can scale IT resources on demand while also converting their IT spending model from CapEx to OpEX. The cloud also improves the operational efficiency of internal workflows and speeds up the time it takes to deliver new services to customers and internal users.

Digital Imperative #2: Empower Fusion Teams

- As defined by Gartner, a fusion team is a multidisciplinary team that blends technology with business domain expertise and shares accountability for business and technology outcomes. Given that every company is a digital company in today's economy, leveraging or outsourcing to a fusion team is critical.
- The challenge is, there's more demand for developers in some industries than available in the entire tech industry. To help solve this challenge, the Microsoft Power Platform provides the most complete developer platform. Gartner estimates by 2025, 70% of new enterprise applications will be built with low code or no code tools.

Digital Imperative #3: Unify Data and Apply AI Models

- Gartner projects that by 2025, 10% of all data will be produced by generative AI models. This illustrates how analytics is becoming a critical component for improving product experiences. Companies need to collect and leverage information on how customers use their products to generate insights on how to improve product performance.

Digital Imperative #4: Implement Collaborative Business Processes

- Hybrid work is here to stay—73% of employees want the flexibility to work remotely, and life balance and their well-being are non-negotiable. With this trend, you need to consider the changes inhow people work and how this impacts your business processes.
- Automated collaboration is vital in meeting employee workstyle preferences, and you also need digital fabric to connect people, places, and processes.
- Microsoft Teams is particularly helpful in bridging the gap between people working in-person and remotely. Views in Teams can make it look like everyone is in the same room. With intelligent cameras, individual people in physical rooms are tracked when they're speaking. This ensures every meeting attendee is an active participant.

Digital Imperative #5: Security

- Cybercrime is expected to cost the world $10.5 trillion annually by 2025 so security must be a top priority. At the same time, there are 24 trillion threat signals a day across the globe.
- The Microsoft Cloud helps take on this challenge by bringing together technology and experts to offer the most comprehensive security, identity, compliance, and management solutions possible.
- The solution works across multiple cloud environments, and customers can expect to save more than 60% in cyber security costs on average when they use Microsoft solutions.

- One particularly important new ability that Microsoft has launched is encrypting data while it's in use without changing applications. This quickly safeguards digital assets and will help with compliance for customers in regulated industries.

➔ DATA CENTER ENVIRONMENT

What is a 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 secure and highly available.

TYPES OF DATA CENTERS

- Data centers vary in size, from a small server room all the way up to groups of geographically distributed buildings, but they all share one thing in common: they are a critical business asset where companies often invest in and deploy the latest advancements in data center networking, compute and storage technologies.
- The modern data center has evolved from a facility containing an on-premises infrastructure to one that connects on-premises systems with cloud infrastructures where networks, applications and workloads are virtualized in multiple private and public clouds.

Enterprise data centers are typically constructed and used by a single organization for their own internal purposes. These are common among tech giants.

Colocation data centers function as a kind of rental property where the space and resources of a data center are made available to the people willing to rent it.

Managed service data centers offer aspects such as data storage, computing, and other services as a third party, serving customers directly.

Cloud data centers are distributed and are sometimes offered to customers with the help of a third-party managed service provider.

EVOLUTION OF THE DATA CENTER TO THE CLOUD

- The fact that virtual cloud DC can be provisioned or scaled-down with only a few clicks is a major reason for shifting to the cloud. In modern data centers, software-defined networking (SDN) manages the traffic flows via software.
- Infrastructure as a Service (IaaS) offerings, hosted on private and public clouds, spin up whole systems on-demand. When new apps are needed, Platform as a Service (PaaS) and containertechnologies are available in an instant.

➔ DATA CENTER ARCHITECTURE COMPONENTS OR BUILDING BLOCKS OF A DATA CENTER :

Data centers are made up of three primary types of components:
compute, storage, and network.

Apart from the Data Centers, support infrastructure is essential to meeting the service level agreements of an enterprise data center.

Data Center Computing

- Servers are the engines of the data center. On servers, the processing and memory used to run applications may be physical, virtualized, distributed across containers, or distributed among remote nodes in an edge computing model.
- Data centers must use processors that are best suited for the task, e.g. general purpose CPUs may not be the best choice to solve artificial intelligence (AI) and machine learning (ML) problems.

Data Center Storage

- Data centers host large quantities of sensitive information, both for their own purposes and the needs of their customers. Decreasing costs of storage media increases the amount of storage available for backing up the data either locally, remote, or both.
- Advancements in non-volatile storage media lowers data access times.
- In addition, as in any other thing that is software-defined, software-defined storage technologies increase staff efficiency for managing a storage system.

Data Center Networks

- Datacenter network equipment includes cabling, switches, routers, and firewalls that connect servers together and to the outside world. Properly configured and structured, they can manage high volumes of traffic without compromising performance.
- A typical three-tier network topology is made up of core switches at the edge connecting the data center to the Internet and a middle aggregate layer that connects the core layer to the access layer where the servers reside.
- Advancements, such as hyperscale network security and software-defined networking, bring cloud-level agility and scalability to on-premises networks.

➔ COMPUTE SYSTEMS OF DATA CENTER :

In the data center, compute refers to the processing power and memory required to run applications on a server. It is one of the three major components of data center along with storage and networking. A good compute platform should scale easily and provide flexible connections for Any- Prem workloads: on-premises, hybrid, or cloud.

➔ DATA CENTER VIRTUALIZATION

Data center virtualization is the transfer of physical data centers into digital data centers (i.e., virtual) using a cloud software platform, enabling companies to remotely access information and applications.

Data center virtualization is the process of creating a virtual server—sometimes called a **software defined data center (SDCC)**—from traditional, physical servers.

➔ SOFTWARE - DEFINED DATA CENTER (SDDC)

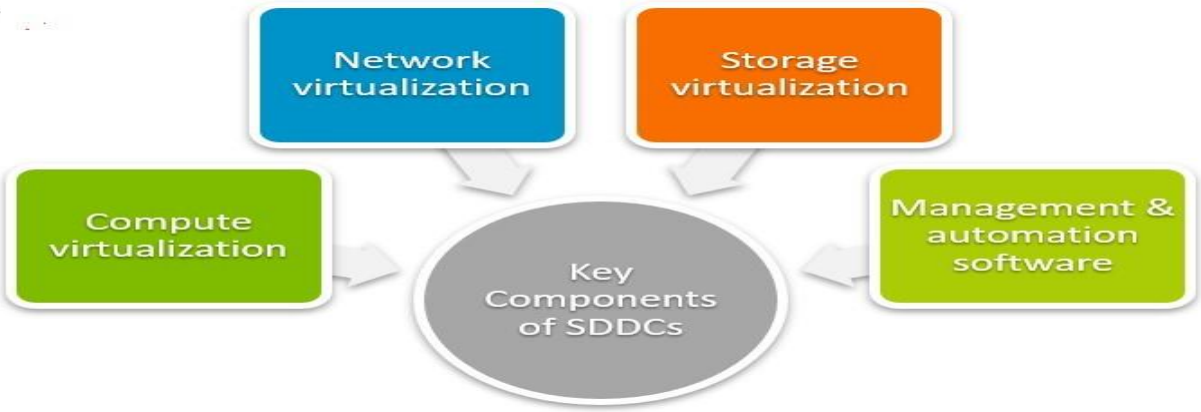
A traditional data center is a facility where organizational data, applications, networks, and infrastructure are centrally housed and accessed. It is the hub for IT operations and physical infrastructure equipment, including servers, storage devices, network equipment, and security devices. Traditional data centers can be hosted:

- On-premise
- With a managed service provider (MSP)
- In the cloud

In contrast, a software-defined data center is an IT-as-a-Service (ITaaS) platform that services an organization's software, infrastructure, or platform needs. An SDDC can be housed on-premise, at an MSP, and in private, public, or hosted clouds. (For our purposes, we will discuss the benefits of hosting an SDDC in the cloud.) Like traditional data centers, SDDCs also host servers, storage devices, network equipment, and security devices. You can manage SDDCs from any location, using remote APIs and Web browser interfaces. SDDCs also make extensive use of automation capabilities to:

- Reduce IT resource usage
- Provide automated deployment and management for many core functions

KEY COMPONENTS OF SDDC



- **Compute virtualization**, where virtual machines (VMs)—including their operating systems, CPUs, memory, and software—reside on cloud servers. Compute virtualization allows users to create software implementations of computers that can be spun up or spun down as needed, decreasing provisioning time.
- **Network virtualization**, where the network infrastructure servicing your VMs can be provisioned without worrying about the underlying hardware. Network infrastructure needs—telecommunications,

firewalls, subnets, routing, administration, DNS, etc.—are configured inside your cloud SDDC on the vendor's abstracted hardware. No network hardware assembly is required.

- **Storage virtualization**, where disk storage is provisioned from the SDDC vendor's storage pool. You get to choose your storage types, based on your needs and costs. You can quickly add storage to a VM when needed.
- **Management and automation software.** SDDCs use management and automation software to keep business critical functions working around the clock, reducing the need for IT manpower. Remote management and automation is delivered via a software platform accessible from any suitable location, via APIs or Web browser access.

You can also connect additional critical software to connect with and customize your SDDC platform. But, for companies just moving to an SDDC, your first goal is to get your basic operations software infrastructure ready for the transition. Customizing can come later.

Benefits of SDDCs

1. Business agility

An SDDC offers several benefits that improve business agility with a focus on three key areas:

- Balance
- Flexibility
- Adaptability

2. Reduced cost

In general, it costs less to operate an SDDC than housing data in brick-and-mortar data centers. Cloud SDDCs operate similarly to SaaS platforms that charge a recurring monthly cost.

This is usually an affordable rate, making an SDDC accessible to all types of businesses, even those who may not have a big budget for technology spending.

3. Increased scalability

By design, cloud SDDCs can easily expand along with your business. Increasing your storage space or adding functions is usually as easy as contacting the data facility to get a revised monthly service quote.