Introduction to Cloud Storage

- What is cloud storage?
  - Cloud storage involves exactly what the name suggests – storing subscribers' data with a cloud service provider rather than on a local system
  - The provider hosts, secures, manages and maintains servers and associated infrastructure (most of the servers are virtual machines hosted on a physical server)
  - Subscribers access the data stored on cloud servers through the Internet or a dedicated private connection, using a web portal, website or a mobile app
  - If you store your data on a cloud, you can get at it from any location that has Internet access

Introduction to Cloud Storage

- What is cloud storage?
  - At the most rudimentary level, a cloud storage system just needs one data server connected to the Internet
  - A subscriber copies files to the server over the Internet, which then records the data
  - When a client wants to retrieve the data, he or she accesses the data server with a web-based interface, and the server then either sends the files back to the client or allows the client to access and manipulate the data itself

Introduction to Cloud Storage

- What is cloud storage?
  - Typically, cloud storage systems utilize dozens or hundreds of data servers
  - Because servers require maintenance or repair, it is necessary to store the saved data on multiple machines, providing redundancy
  - Most systems store the same data on servers using different power supplies
  - Many clients use cloud storage not because they have run out of room locally, but for safety/availability

Introduction to Cloud Storage

- Storage as a Service (SaaS)
  - SaaS means that a third-party provider rents space on their storage to end users who lack the budget or capital budget to pay for it on their own
  - It is also ideal when technical personnel are not available or have inadequate knowledge to implement and maintain that storage infrastructure
  - Given the complexity of current backup, replication, and disaster recovery needs, the service has become popular, especially among small and medium-sized businesses

Introduction to Cloud Storage

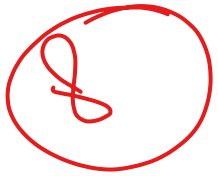
- Storage as a Service (SaaS)
  - The biggest advantage to SaaS is cost savings
  - The end user does not have to pay for infrastructure; they simply pay for how much they transfer (cost-per-GB-stored or cost-per-data-transferred model)
  - A customer uses client software to specify the backup set and then transfers data across a WAN
  - When data loss occurs, the customer can retrieve the lost data from the service provider

Introduction to Cloud Storage

- Deployment models
  - Public storage clouds
  - Private storage clouds
  - Hybrid storage clouds

Introduction to Cloud Storage

- Pros of cloud storage
  - Off-site management
  - Quick implementation
  - Cost-effective
  - Scalability
  - Business continuity

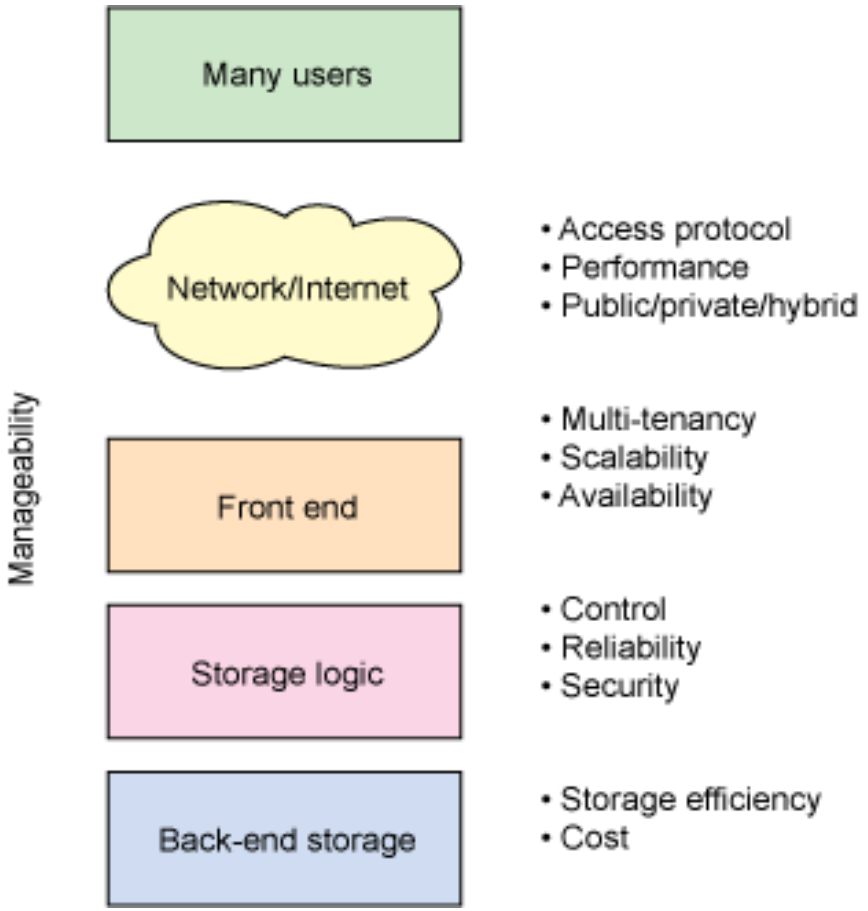


Introduction to Cloud Storage

- Cons of cloud storage
  - Lack of security
  - Lack of administrative control
  - Latency
  - Regulatory compliance

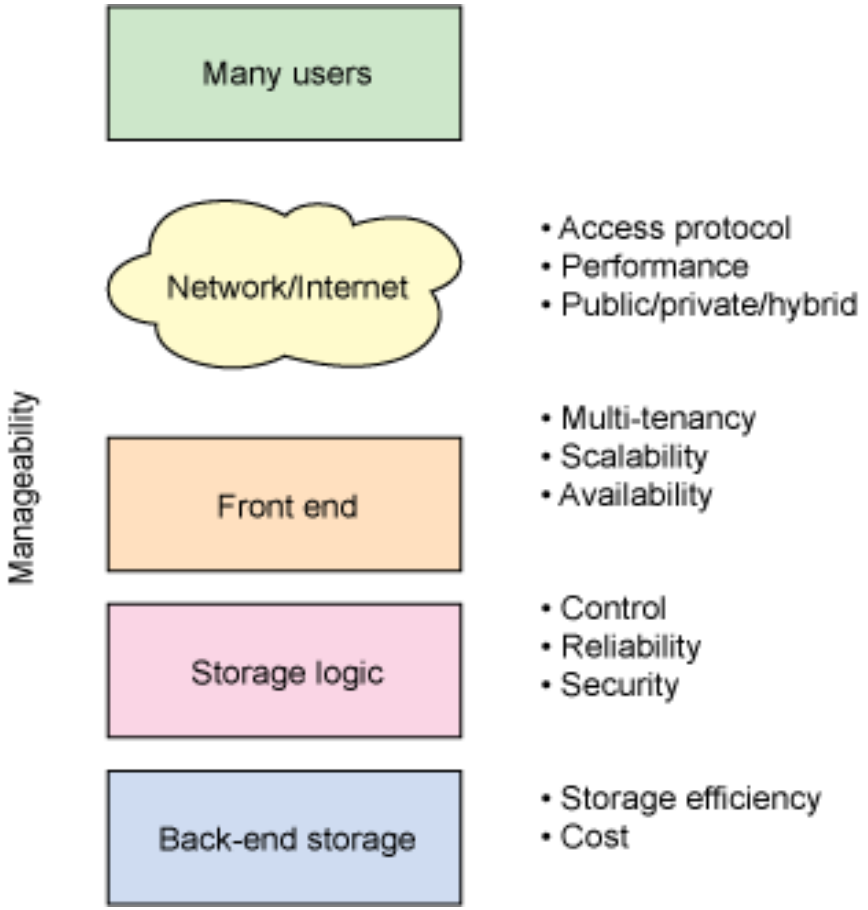
Introduction to Cloud Storage

- Generic cloud storage architecture
  - Cloud storage architectures are primarily about delivery of storage on demand in a highly scalable and multi-tenant way
  - Generically, cloud storage architectures consist of a front end that exports an API to access the storage
  - In traditional storage systems, this API is the SCSI (Small Computer System Interface) protocol; but in the cloud, these protocols are evolving (such as Internet SCSI or iSCSI)



Introduction to Cloud Storage

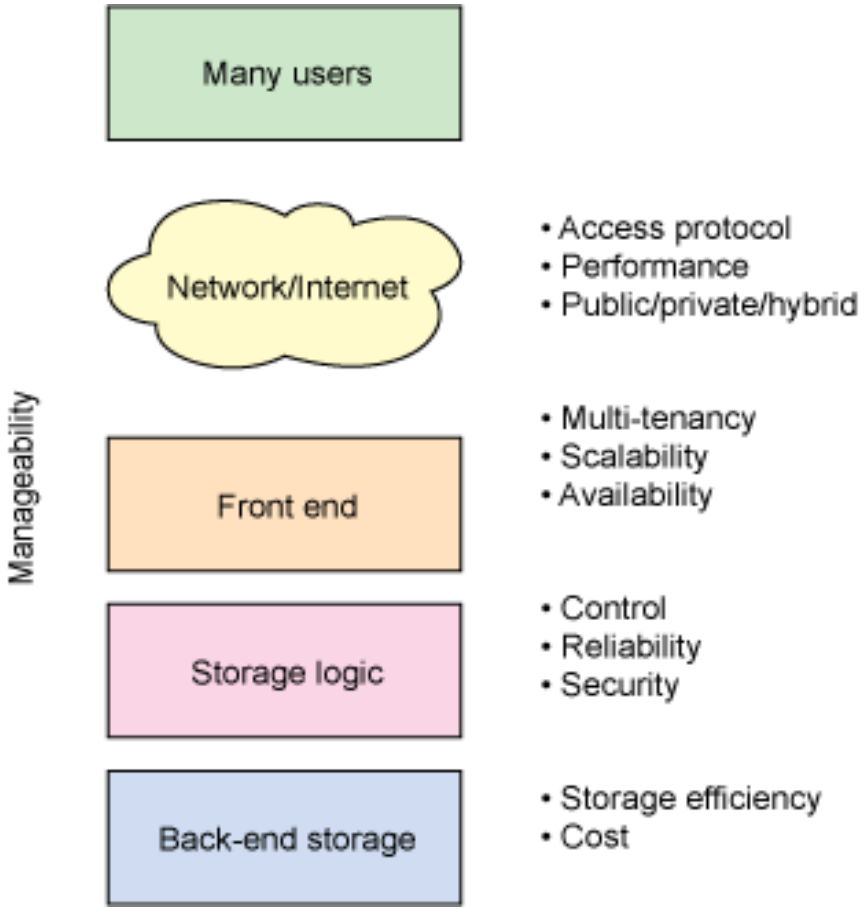
- Generic cloud storage architecture
  - Behind the front end is a layer of middleware called “storage logic”
  - This layer implements a variety of features, such as replication
  - The back end implements the physical storage for data (may be an internal protocol that implements specific features or a traditional back end to the physical disks)



Introduction to Cloud Storage

- Cloud storage characteristics

Manageability	The ability to manage a system with minimal resources
Access method	Protocol through which cloud storage is exposed
Performance	Performance as measured by bandwidth and latency
Multi-tenancy	Support for multiple users (or tenants)
Scalability	Ability to scale to meet higher demands or load in a graceful manner
Data availability	Measure of a system's uptime
Control	Ability to control a system — in particular, to configure for cost, performance, or other characteristics
Storage efficiency	Measure of how efficiently the raw storage is used
Cost	Measure of the cost of the storage (commonly in dollars per gigabyte)



Cloud Storage Characteristics

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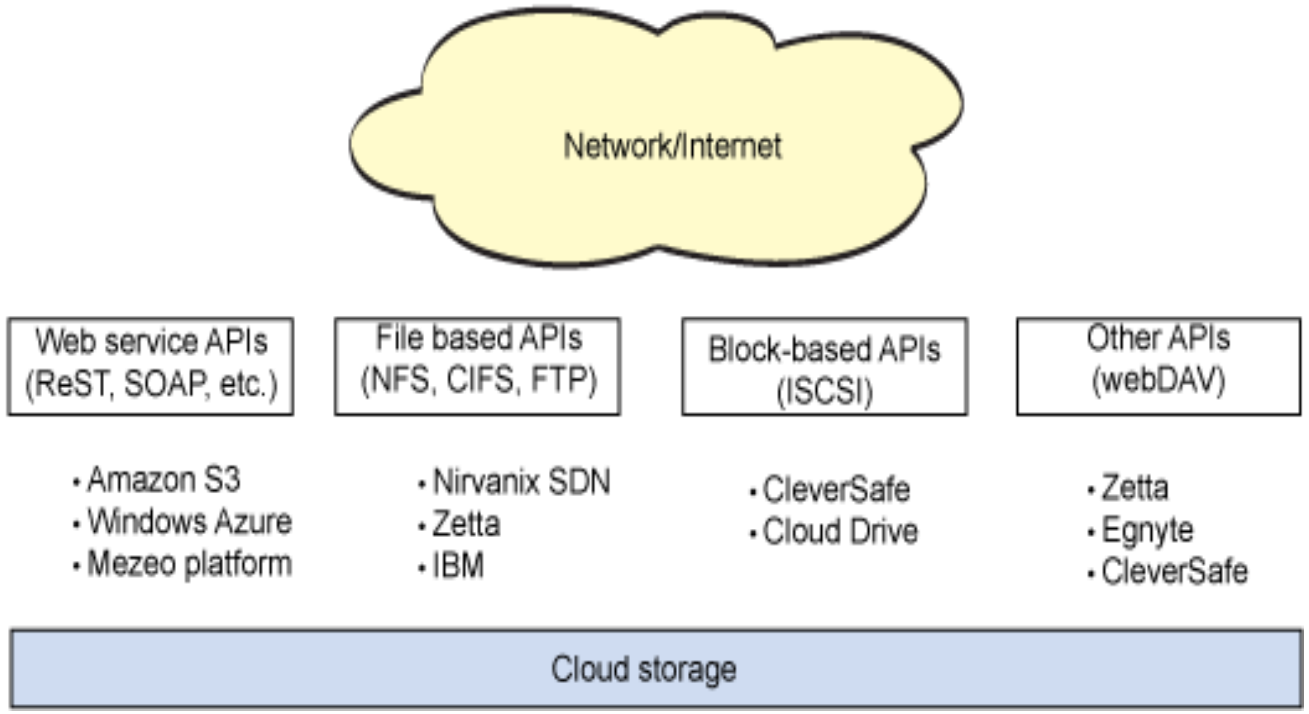
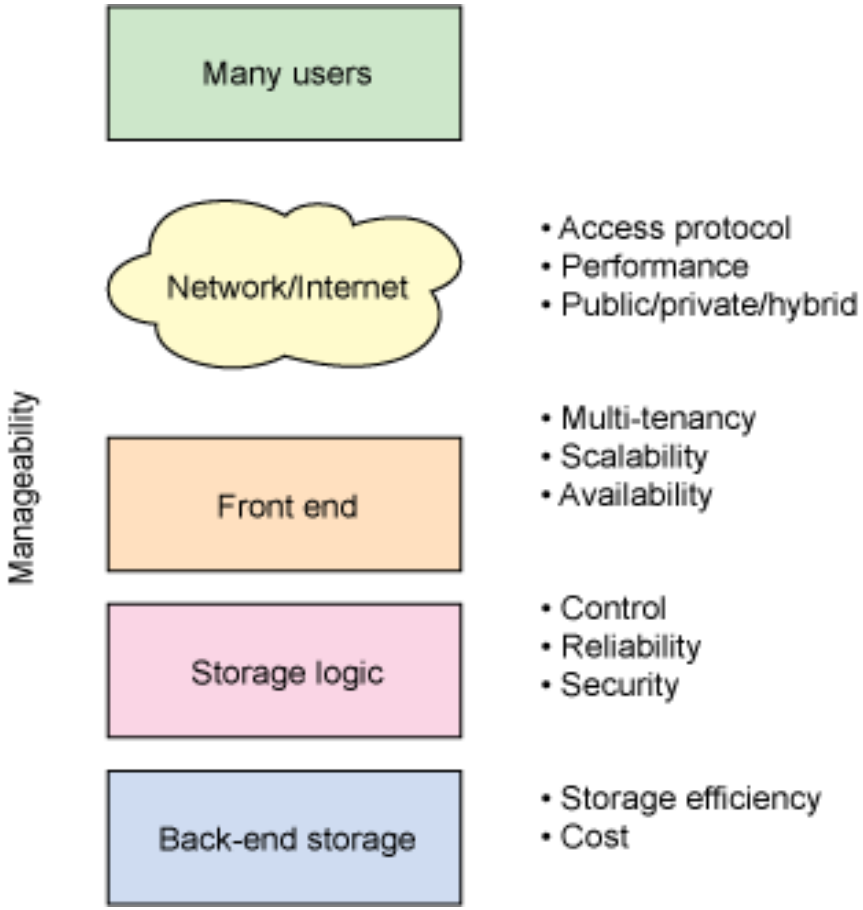
- Access methods





Cloud Storage Characteristics

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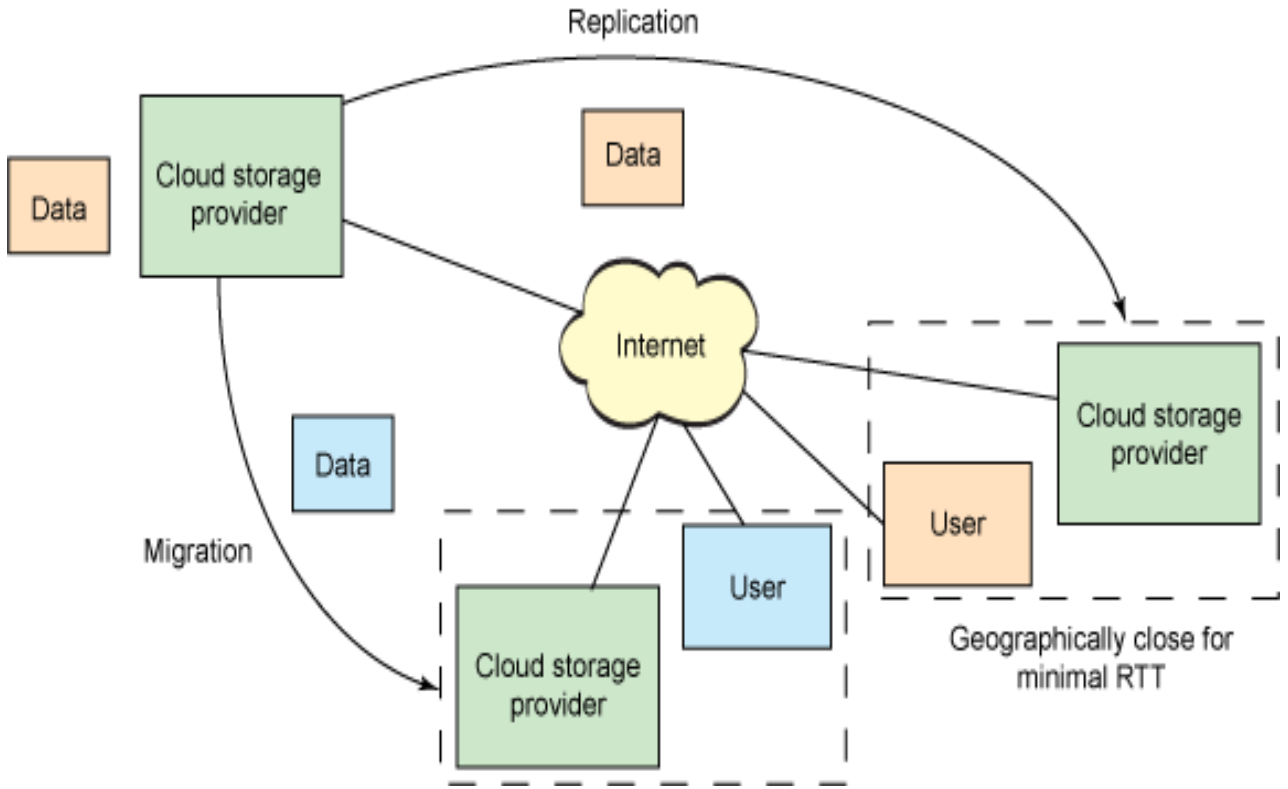
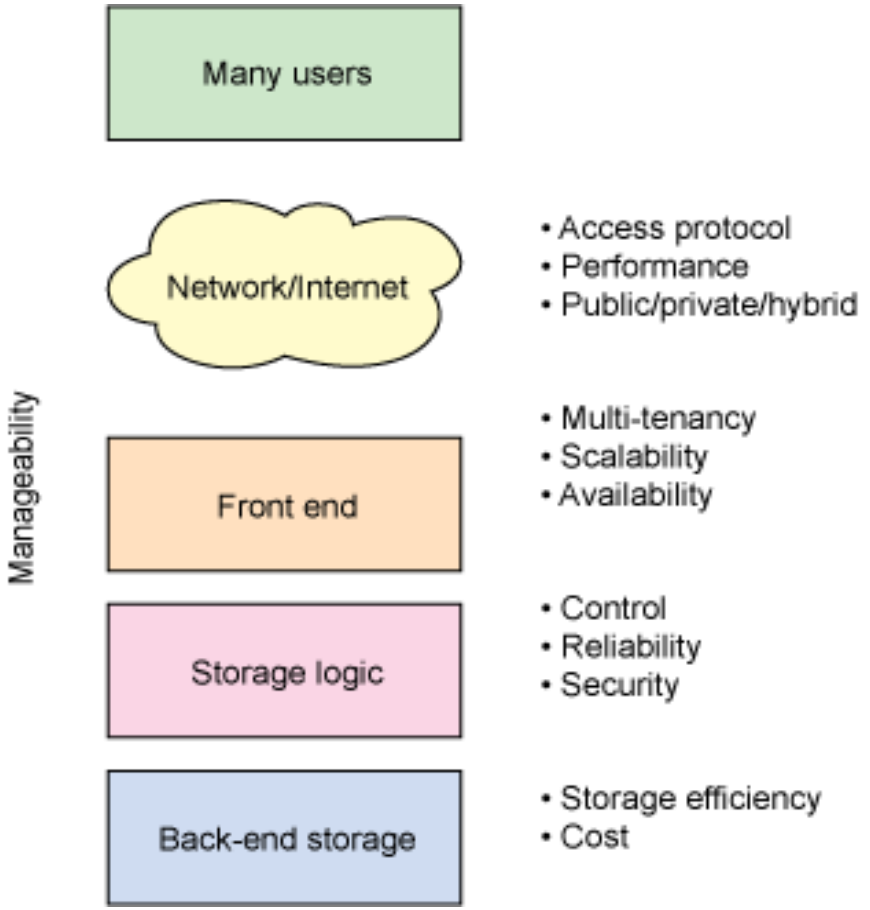
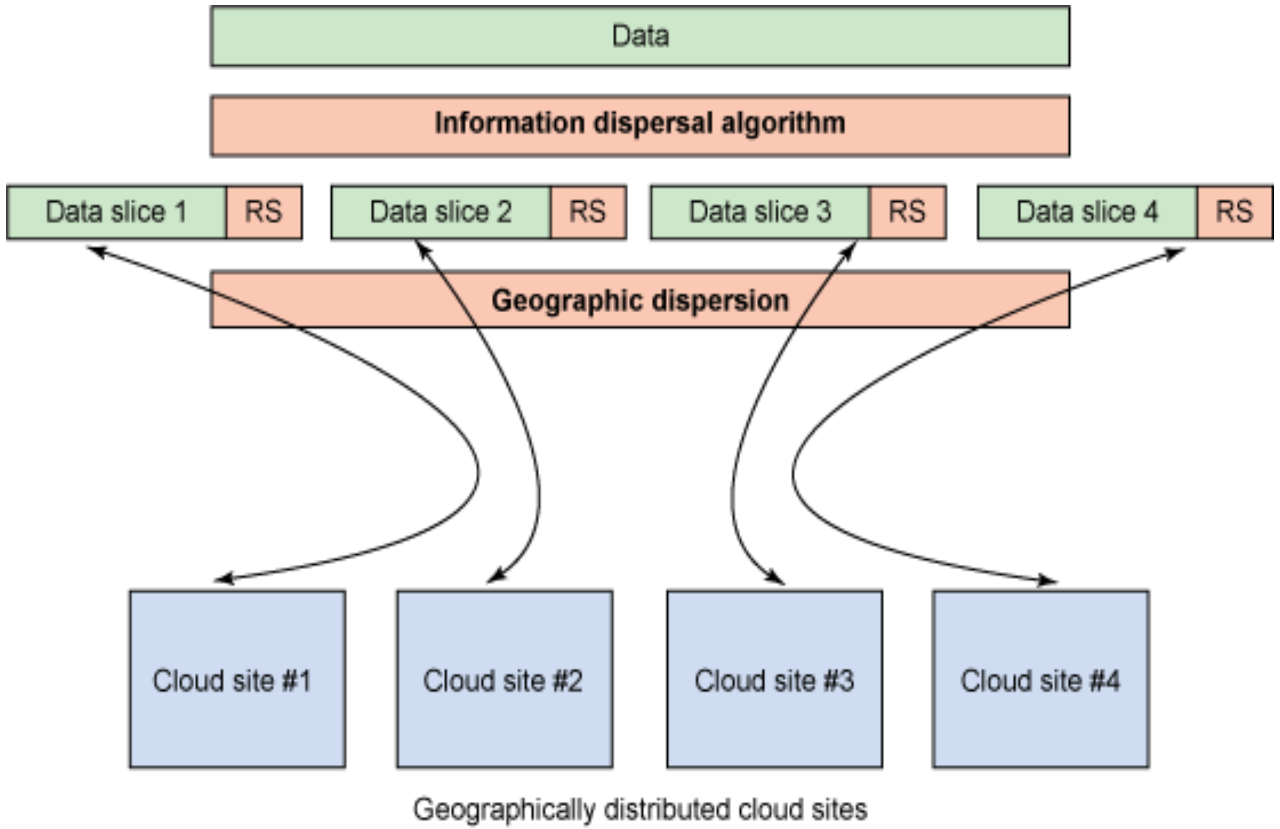
- Geographic scalability

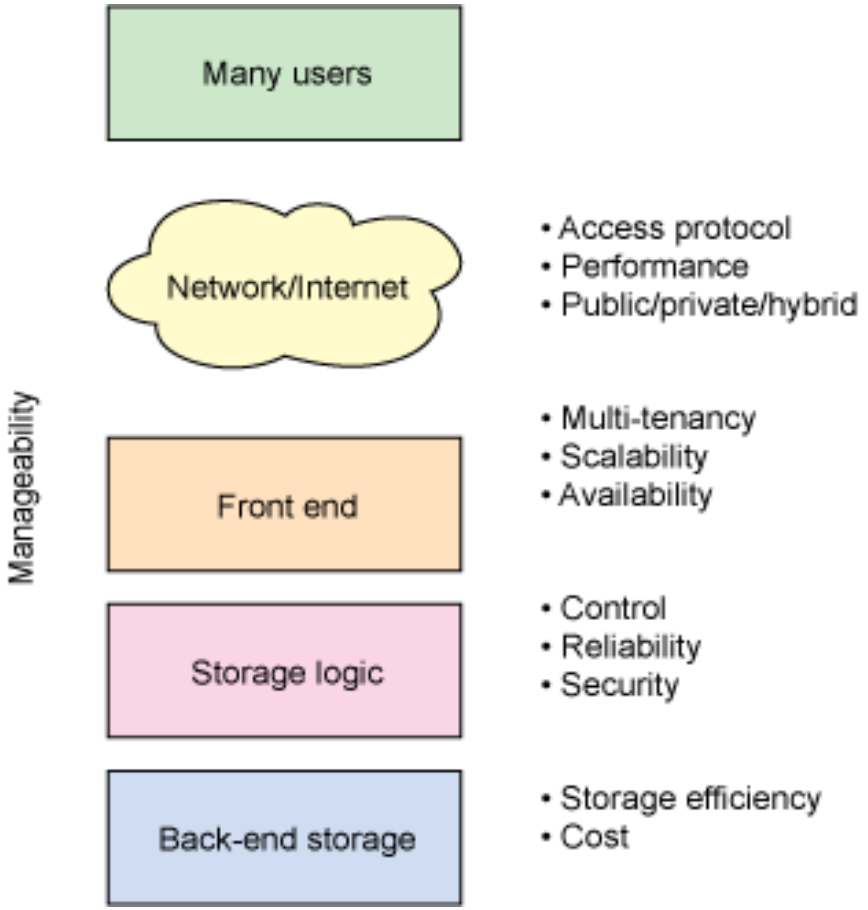




Cloud Storage Characteristics

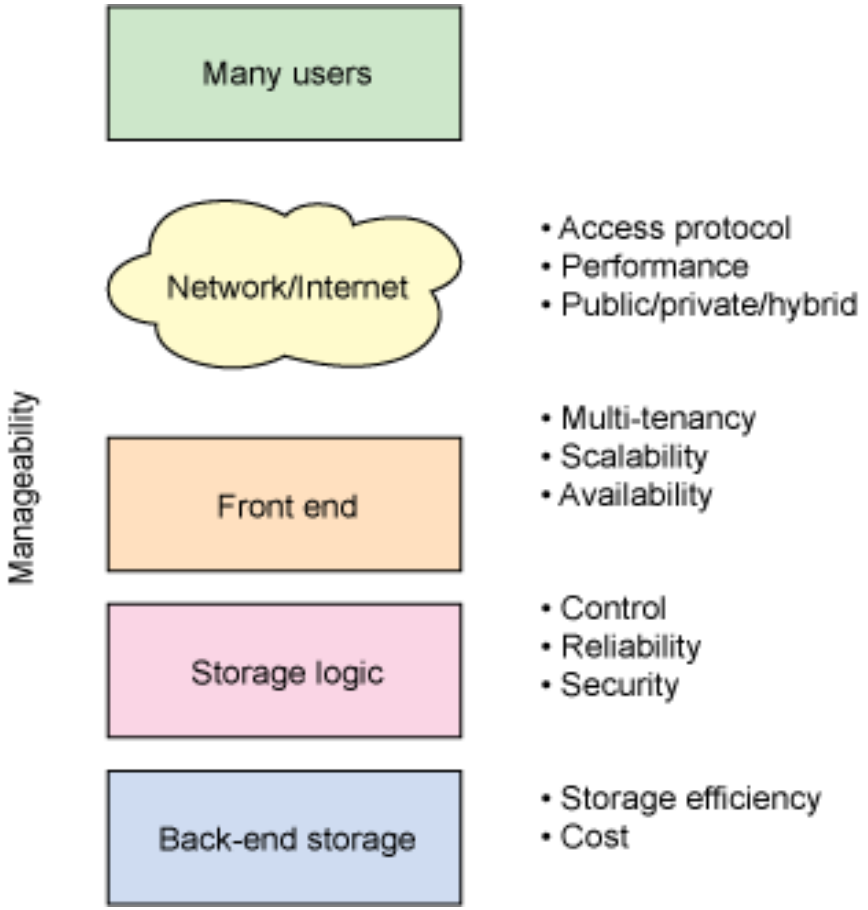
- Availability





Cloud Storage Characteristics

- Storage efficiency
  - To make a storage system more efficient, more data must be stored on a given storage
  - Data reduction techniques reduce the source data such that it requires less physical space
    - Data compression
    - Data deduplication



Introduction to Cloud Storage

- Types of cloud storage
  - File storage
  - Block storage
  - Object storage

Types of Cloud Storage

- File storage
  - File storage saves data in the hierarchical file and folder structure with which most of us are familiar
  - The data retains its format, whether residing in the storage system or in the client where it originates, and the hierarchy makes it easier and more intuitive to find and retrieve files when needed
  - File storage is commonly used for development platforms, home directories, and repositories for video, audio and other files

Types of Cloud Storage

- File storage
  - Normally associated with *network attached storage* (NAS) technology
  - User or application receives data through directory trees, folders and individual files
  - File storage can be very easy to configure, but access to data is constrained by a single path to the data, which can impact its performance
  - File storage only operates with common file-level protocols, such as a New Technology File System (NTFS) for Windows or a Network File System (NFS) for Linux – which could limit usability across dissimilar systems

Types of Cloud Storage

- Block storage
  - In this storage model (traditionally employed in *storage area networks* or SANs), data is organized into large volumes called “blocks”
  - Block storage breaks up data into blocks and then stores those blocks as separate pieces, each with a unique identifier
  - SAN places those blocks of data wherever it is most efficient
  - It can store those blocks across different systems and each block can be configured (or partitioned) to work with different operating systems (each block represents a separate hard drive)

Types of Cloud Storage

- Block storage
  - Block storage also decouples data from user environments, allowing that data to be spread across multiple environments
  - This creates multiple paths to the data and allows the user to retrieve it quickly
  - When a user or application requests data from a block storage system, the underlying storage system reassembles the data blocks and presents the data to the user or application

Types of Cloud Storage

- Object storage
  - Object storage differs from file/block storage since it manages data as objects
  - Objects are discrete units of data that are stored in a structurally flat data environment
  - There are no folders, directories, or complex hierarchies; instead, each object is a simple, self-contained repository that includes the data, metadata (descriptive information associated with an object), and a unique identifying ID number
  - This information enables an application to locate and access the object

Types of Cloud Storage

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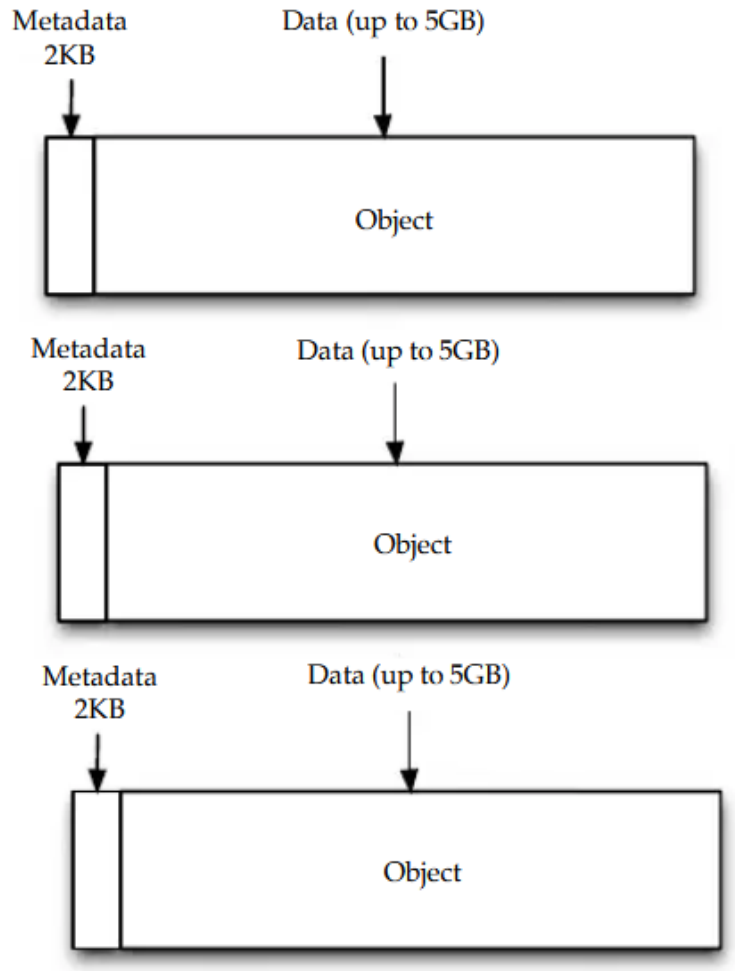
- Object storage
  - Preferred method for data archiving and backing-up unstructured media/web content like email, videos, images, web pages, sensor data produced by IoT
  - Suitable for archiving static files, such as large volumes of pharmaceutical data, music, image and video files (any change to a file results in creation of a new object)
  - Objects store data in the format it arrives in and makes it possible to customize metadata in ways that make the data easier to access and analyze
  - One can aggregate object-storage devices into pools, distribute pools across locations
  - This allows for unlimited scale and improved data resiliency/disaster recovery

Example: Amazon S3

- S3 stores arbitrary objects at up to 5GB in size, and each object is accompanied by up to 2KB of metadata
- Objects are organized by buckets
- Each bucket is owned by an AWS account and the buckets are identified by a unique, user-assigned key
- Buckets and objects are created, listed, and retrieved using REST-style or SOAP interfaces



Security of Cloud Storage

- Encryption
  - A complex algorithm is used to encode information
  - To decode the encrypted files, a user needs the encryption key
  - While it is possible to crack encrypted information, it is very difficult and most hackers do not have access to the amount of computer processing power they would need to crack the code

Security of Cloud Storage

- Authentication
  - This requires a user to authenticate itself (e.g., using an ID and password)
- Access Control and Authorization
  - Client lists the people who are authorized to access information stored on the cloud system
  - Many corporations have multiple levels of authorization (e.g., a front-line employee might have limited access to data stored on the cloud and the head of the IT department might have complete and free access to everything

Security of Cloud Storage

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- To secure data, most systems use a combination of these techniques
- But even with these measures in place, there are still concerns that data stored on a remote system is vulnerable
- There is always the concern that a hacker will find a way into the secure system and access the data
- Moreover, a disgruntled employee could alter or destroy the data using his or her own access credentials