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# A Brief Comparison of Google Cloud and iCloud Services

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## Abstract

The provision of computing resources on demand via the Web with pay-per-use billing is known as cloud computing. Small organizations find cloud computing a very competitive and attractive solution due to its pay-per-use model. Cloud computing delivers many services through the Internet. Services include databases, platforms, data storage, and networking resources hosted at remote data centers. The scalability, flexibility, and cost-effectiveness of cloud computing contributed to its rising popularity. There are several significant players in the cloud computing market, including Google Cloud, Amazon Web Services, Microsoft Azure, etc., each offering a wide range of services and advantages. Considering various factors such as security, cost, reliability, and functionality, choosing the best option presented among different cloud service providers is a challenging task. This paper introduces an overview of cloud computing, its architecture, characteristics, and briefly describes Google Cloud and iCloud services. The main objective of this work is to compare the services provided by the selected cloud platforms. The findings indicated several robust services offered by both Google Cloud and iCloud. The user's requirements are the basis for the selection process.

**Keywords:** Cloud Computing, Google Cloud, iCloud, Cloud Service Provider (CSP), Comparison.

## INTRODUCTION

Applications and data storage have changed significantly as a consequence of cloud computing. Nowadays, practically everything is hosted on a "Cloud" as opposed to executing applications and storing data locally on a computer. The term "cloud computing" refers to a method of delivering IT resources on demand via the Internet with a pay-as-you-go pricing scheme (Goudar, 2012). A service provider and a subscriber are the two different types of people who are involved in this system. Users can deploy applications and access files from any device that has Internet connectivity by using cloud computing (Rafat Ara, 2020). Google's Gmail is an example of a cloud-computing provider. The use of cloud computing has various benefits, including accessibility from anywhere at any time, reduced investment in infrastructure, and faster processing time with better geographic coverage (P. Ravi Kumar, 2017).

Service providers are actually the IT staff of the company, a third party, or a combination of both of them. On the other hand, the term "subscriber," can refer to any person who uses a service provider's offerings (Isaac Odun Ayo, 2018). The term "Cloud Service Providers" (CSPs) (e.g., Google Cloud, Microsoft Azure, Amazon Web Service (AWS)) refers to vendors that provide their custom-

ers with access to cloud computing resources and services that are dynamically used according to client demand (Aaqib Rashid, 2019). Customers can access online services using a web browser over the Internet in several kinds of fields, such as business, education, and governance, whereas information and software are stored on data center-based cloud servers (Singh, 2022). As defined by cloud service models, these services can be grouped into three categories. These categories mainly include Platform as a Service (PaaS), Infrastructure as a Service (IaaS), and Software as a Service (SaaS) (Karan Gulia, 2021). Many companies, like Google, Microsoft, Apple, and Amazon have introduced cloud services to the user. They offered a variety of storage options depending on the client's needs and business requirements (Pallavi Wankhede, 2020). A variety of services, including computing, storage, networking, and databases are available through the Google Cloud platform (Sumit Kumar, 2019). iCloud is capable of offering features such as synching browser data between iOS devices, locating your phone, Apple’s mail service, contacts service, calendar service, news service, and App Data, and storing information about website passwords (Hera Arif, 2019).

The structure of this paper starts with a brief introduction to cloud computing. Then some of the previous studies related to the selected service providers are highlighted in section 2. Section 3 explains some significant characteristics of cloud computing. Cloud computing architecture is presented in section 4. Section 5 introduces a brief definition of Google Cloud and iCloud services. The comparison of the providers is displayed in section 6. The discussion is presented in section 7. Section 8 concludes this work.

## Related Work

Numerous studies and comparisons of cloud service providers have been conducted and published. A summary of these studies is presented in this section. Studies address the primary factors that a company has to take into account before selecting a cloud service provider, as well as the primary reasons for selecting a cloud service provider. (Moss, 2014) To address the fundamental interoperability issues, Cyberdesign Works developed Sanscode, a cross-platform cloud computing solution. The authors pointed out that Sanscode, which supports a lot of iCloud's capabilities and provides a few extra features, might offer a workable alternative solution. The strategy used by Apple's iCloud was examined and compared with Sanscode. (M.Akila, 2018) Conducted a comparison among iCloud, One Drive, Google Drive, Amazon, and Dropbox. They compared and reviewed the advantages, file features, ease of use, accessibility on mobile devices, support, security, file content, cost, ranking, plans, and supported OS system. The result of the comparison was mentioned that the consumers could choose the best cloud service that suited their requirements. (Sethi, 2019) Investigated the iCloud service model and the built-in security features. Service models were explained to the security risks and the security measures, based on that the iCloud system may provide effective service gains. (Iqura Khan, 2019) Presented a comparison between Google Cloud, Amazon Web Services, and Microsoft Azure from the user's point of view. Parameters such as Storage as a Service, virtual machine types, and availability zones were used to compare various CSPs. The conclusion is that the selected CSPs offer a wide range of distinctive virtual machines and storage as a service, also according to the client’s demand to select one of them. (Hera Arif, 2019) Addressed that cloud service providers in terms of services offered as well as the features of the iCloud and Google Cloud. The final point was concluded that both Google Cloud and iCloud provide a variety of services, and the choice would be based on the needs of the user. (Tripathi, 2020) Analyzed some of the cloud computing market leaders GCP, AWS, and Azure's characteristics, including computation, performance, and storage space management. The features of AWS, GCP, and Azure were evaluated and summarized to assist customers in selecting the features that would meet their needs. (Muhammad Ayoub Kamal, 2020) Compared the service, benefits, and prices of AWS, GCP, and Microsoft Azure CSPs and emphasized key service characteristics including computing, infrastruc-

ture, and storage. The study's conclusion was that, although AWS dominates the cloud market in terms of market share and many of its service features, GCP and Microsoft Azure are only marginally superior to AWS regarding pricing and security.

## The Cloud Computing Characteristics

Cloud computing offers very low cost, great performance, vast scalability, and reliability as compared to dedicated storage systems. With the help of cloud computing, users may access their data from anywhere globally and work together in groups and with other users. Cloud computing platforms have several interesting criteria that make them acceptable for upcoming IT services and applications. *The National Institute of Standards and Technology (NIST)* has identified some essential features for cloud computing systems (Aaqib Rashid, 2019) (Tripathi, 2020).

- ***Rapid elasticity*:** Provides scalable services. Users can request authorization in this way if they need additional cloud storage.
- ***Pay as per usage*:** If not completely free, CSP services are very reasonably priced. Pay-as-you-go billing reduces maintenance costs because infrastructure is not required to be purchased. (Rafat Ara, 2020).
- ***Measured Services*:** The pay-per-use model used by cloud service providers enables monitoring, regulation, and optimization of resources and services that users utilize. For instance, how they use electricity, water, or gas, consumers can use these services (Tripathi, 2020).
- ***Broad Network Access*:** Through a variety of hardware (such as laptops, mobile phones, and PDAs), customers can access cloud resources constantly and from any location (i.e., ubiquitously) (Mohammad Ilyas Malik, 2018).
- ***Resource Pooling*:** The cloud is a collection of physical and virtual computing resources. In the sense that the consumer has no influence over or awareness of their location, these resources are not location-dependent.
- ***On-demand self-service*:** Cloud-computing services, including storage, server time, network access, and CUP time, etc., can be automatically distributed according to consumer needs without requiring human interaction (Isaac Odun Ayo, 2018).
- ***Customization*:** A cloud is a reconfigurable environment that may be modified based on user demand in terms of apps and infrastructure (Aaqib Rashid, 2019).
- ***Security*:** This is a crucial issue of cloud computing. Data will not be lost even if a server has failed due to providing a snapshot of the saved data. The data is stored on storage devices according to that it will be impossible for anyone to access or hack (Rafat Ara, 2020).

## Cloud Computing Architecture

Cloud architecture describes how technological components interact to build a cloud, in which resources pooled and shared utilizing virtualization technology (Aman Yevge, 2022). A cloud platform and the applications that operate on are powered by a virtualized architecture that consists mostly of all the technologies, including hardware and software. Cloud architecture consists of four key parts (Kaur, 2018) as shown in Figure1:

- Front-end platform describes the client or device used to access the cloud.
- Back-end platform includes service and storage.
- A cloud-based delivery system enables information to be delivered between the Front-end and the Back-end.
- A network to connect cloud clients, storage, and servers.

**Front-end architecture** includes all technologies that allow clients of the organization to communicate with the applications stored in the cloud. Front–end architecture can be a web browser or local networks of common web apps. As an example, in the case of Gmail, The front-end architec-

ture is the web application that gives the users access to the services that the Gmail architecture offers. Front-end architecture can be divided into three parts:

1. **Front-end software architecture**: this refers to the software that enables users to execute cloud-computing applications on their computers.
2. **User interface**: this is a collection of all the features and a description of how users can use them to perform operations in the cloud.
3. **Client device/ network**: refers to client-side hardware such as PCs, smartphones. These devices do not require a lot of computing power as most of the complex tasks are processed on the cloud.

**Back-end architecture** is the component of cloud computing that supplies the support to run the front-end architecture. It contains components such as hardware and storage and is typically located in a remote server form. Cloud service providers, such as Microsoft Azure and AWS, are in control of the back-end architecture.

The essential components of backend Cloud architecture. (Rafat Ara, 2020)

1. **Application**: includes the server side of the application that is provided to the end user. The resources in the backend are coordinated with the various consumer needs through this layer.
2. **Service**: any operation that is performed on the cloud computing system. Web services, application development environments, and storage are all provided.
3. **Cloud runtime**: where the service runs. It is comparable to an operating system in the cloud that uses virtual machines to enable several runtimes to be operated together on the same server.
4. **Storage**: where all the data requested to run the cloud software resides. It consists of several hard devices in server bays that have been divided by management software.
5. **Infrastructure:** the engine running all cloud software services. It contains a CPU, GPU, and all other components needed for the system to operate efficiently. A lot of cloud service providers also offer accelerators such as Google stencil processing unit, which is accessible to Google Cloud platform customers to conduct AI tasks.
6. **Cloud security**: the main part of cloud software architecture that is increasingly being set to the test more and more given the increase. Some of the methods used to secure cloud architecture include:
    - Offering protection at every layer.
    - Creating resilient design and avoiding redundancy.
    - Including elasticity and scalability.
    - Considering deployment-appropriate storage.
    - Concentrating on notifications and alerts
    - Producing standardization, automation, and centralization.

    This security architecture enables the system to function even when there is a Cyberattack.
7. **Management**: The management component is responsible for setting up coordination and managing backend components such as storage services, runtime cloud infrastructure, applications, and security issues.

**Delivery system** is the third key component of cloud architecture, it allows the information to be delivered between the frontend and the backend and includes Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

**Cloud deployment models**

Though the fundamentals are always the same, cloud architectures are heavily dependent on deployment models selected from the system. There are four basic deployment models in cloud computing. They are described briefly below: (Ouda, 2020):

1. **The public cloud:** the capacity of one divided server hosting multiple distinct partitions, each of which is open for usage and without firewalls separating various cloud instances (Prof. Hiral B. Patel, 2021).
2. **A private cloud:** a divided public cloud that is firewall-protected to prevent non-company personnel from accessing (Critical systems). (Akshat Rajpurohit, 2018).
3. **Multi-cloud**: Multiple different public cloud services obtained from various suppliers are included in multi-cloud architecture (P. Ravi Kumar, 2017).
4. **Hybrid cloud:** In a hybrid cloud environment, a company combines both private and public clouds to achieve the same purpose (Prof. Hiral B. Patel, 2021).

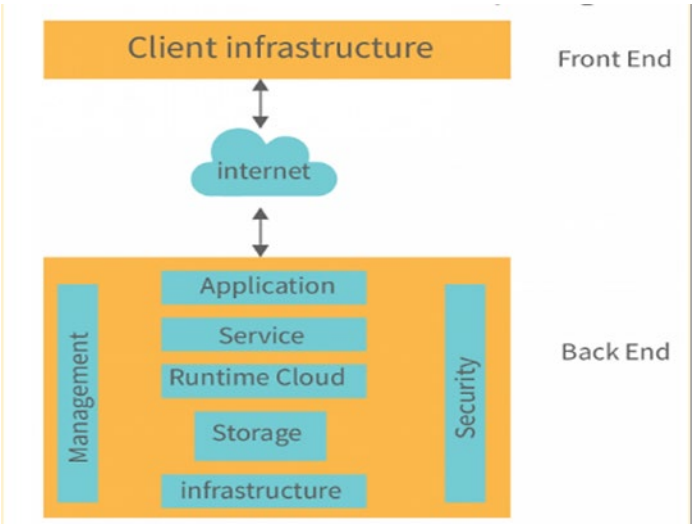


**Figure: (1).** Cloud Computing Architecture diagram (Rafat Ara, 2020)

## Cloud Computing Service Providers

The concept of Cloud Computing came into the spotlight in the year 1950 with access via thin/static clients and the utilization of mainframe computers. After that, in 1961, John McCarthy suggested that computing services would be offered similarly to utilities, such as gas, electricity, water, and telephone, and that services would be readily available on demand (Kaur T., 2019). In 1970, the concept of virtualization improved the shared access mainframe technology (Hajjdiab, 2017). Twenty years later, in 1999, Salesforce.com was one of the first companies that used the idea of delivering enterprise applications through a simple website (Hera Arif, 2019). The public became more familiar with the idea of cloud storage because of the quick adoption of Amazon's web store in 2002 and Google Docs in 2006 (O'Regan, 2016). Cloud computing experienced a significant boom in the late 2000s, with 2009 seeing the introduction of Web 2.0 and browser-based apps such as Google Apps, Windows Azure, and many other well-known companies jumping on board in the years that followed (O'Regan, 2016) (Jianwen Wendy Chen, 2017). Apple introduced iCloud, whereas Google played a significant role and launched the Google Cloud Platform (GCP). Additionally, numerous vendors have started cloud computing research projects. The physical infrastructure for cloud computing, including computers, cooling systems, and hard drives, is hosted in several data centers owned and run by CSPs across the world. Google Cloud and iCloud are examples of these providers.

**Google Cloud Services**

In April 2008, the Google cloud platform launched as a cloud service (Pranay Dutta, 2019). Google delivers services like processing, storage, and networking through its Google Cloud service. Services including Infrastructure-as-a-Service, Platform-as-a-Service, and Software-as-a-Service are available through Google Cloud (Trivedi, 2014). Among Google's products are Google Search and YouTube. Cloud computing services provided by Google are divided into four primary categories. *The first category* is related to Computing. Google's compute engine allows customers to use IaaS or PaaS based on their requirements. Storage falls under *the second category*. Users' data can be stored in a non-SQL and schema-less database using Google Cloud Storage. In addition, users can process complex SQL queries using Google Cloud SQL which is connected with MySQL (Alreshidi, 2019). Big data is the focus of *the third category*. Google uses Big Query for fast and easy analysis of big data, which is highly scalable. The support applications that Google offers fall under *the fourth category* (Hera Arif, 2019). Google has developed several applications that allow customers to view the same files on various platforms. This includes Gmail, Google Suite, and Calendar (Riti, October 24, 2018). Google Cloud integrates several applications and provides numerous services to cloud users. Google has become one of the most significant service providers due to this integration since it allows cloud users to finish their tasks easily (Youssef, 2012). It also saves time and money since developing and maintaining software to provide all of these applications and services is an expensive process and time-consuming. The main benefits of using Google Cloud are automatic data synchronization between devices, and the automatic Backup of the user's data. Google Drive needs a little bit of setup if the user already has a Google account and easily saves attachments from their Gmail directly to Drive with only a few clicks (M.Akila, 2018). As well as there are also significant challenges which are having one-way (256-bit AES) encryption and sharing storage space with Gmail, so if your inbox is overflowing, you will get less cloud storage space.

**iCloud Services**

Apple first announced iCloud as a free cloud computing, synchronization, and storage service in October 2011 (Moss, 2014). From the data point of view, the primary services of iCloud are online storage, file sharing, synchronization between different platforms and devices, and iOS device backup. Backups can be created on any Apple device that uses iCloud service, and a device can also be restored using the previously created backup (Coulston, 2018). iCloud services can be used to back up various applications offered to Apple users. These apps include Calendar, Mail, contacts, reminders, notes, iTunes, App Store, iBooks, Music, Safari, and App Store. This can effectively help users with multiple devices to maintain synchronization with all. Some features of iCloud are Find My iPhone and iPad, photo sharing, reminder services, iCloud drive for data storage, notes, keychain, and web data (Maheshwari, 2016). Another feature that iCloud offers; is the iCloud Keychain, which can help store private data like passwords and credit card numbers; that can be used across numerous devices (Coulston, 2018). Since iCloud Drive only provides 5 GB of free storage, users may need to subscribe to a higher capacity plan if they want more space (Rafat Ara, 2020). The use of iCloud services highlighted some advantages; iCloud is rapidly becoming the standard cloud service among iOS developers. Automatic synchronizing of data among devices, iCloud is more secure due to the multi-factor authentication and encryption mechanism, and tightly integrated (M.Akila, 2018). 256-bit AES encryption is used to secure the most data stored on iCloud**.** This includes backups, calendars, contacts, photos, reminders, short memos, and many more, all stored with effective encryption. For many app developers, iCloud is a cloud for iOS and Mac OS devices and applications. This is considered as the main limitation of iCloud since it is incompatible with other mobile platforms such as Windows Mobile and Google's Android (Moss, 2014). This indicates that data cannot be stored or shared between the different Smartphone systems. Another limi-

tation is that iCloud cannot act as a download target for iOS browsers and Apple does not offer iCloud Drive apps for Android or Windows Phones (M.Akila, 2018).

## Comparing of Google Cloud and iCloud Services

Small enterprises and IT companies are adopting cloud services at an extremely fast rate due to their advantages and reasonable costs. Both share a lot of similar features in common, including productivity apps, file backups, cloud sync, file sharing, etc. However, when it comes to being used on various platforms, things change. Table 1 highlighted some criteria parameters to be compared between Google Cloud & iCloud:

**Table: (1).** Comparison table between Google Cloud and iCloud services (Moss, 2014) (M.Akila, 2018) (Hera Arif, 2019) (Pallavi Wankhede, 2020).

| Criteria parameters | Google Cloud | iCloud |
|---|---|---|
| Owner | Google | Apple |
| Launch year | 2008 | 2011 |
| Operating system support | Windows<br>Mac<br>IOS<br>Android | Apple ecosystem<br>Mac<br>IOS |
| Platform availability | Available as a web app or for installation on a wide range of platforms. | Works perfectly on Apple devices, but the features of the app would be constrained for Windows users. |
| Storage plans | Offers: 15GB free<br>100GB for 1.99$<br>200GB for 2.99 $<br>2TB for 9.99 $ | Offers: 5GB: Free<br>50GB for 1$<br>100GB: $1.99<br>200GB: $2.99<br>2TB: $9.99 |
| Security features | All data uploaded or created in Docs are encrypted in transit and at rest with AES-256 bit encryption and it has only one-way encryption. | Employs advanced data protection which is end-to-end encrypted, and uses two-way encryption for both files that are saved and in transit using 256-bit AES Standard encryption. It constantly encrypts and never exchanges keys. |
| File sharing & collaboration features | Enables you to share files and folders with other people by sending links to view or download the files. Furthermore, as long as they have Google Drive, other users can exchange files regardless of their device or operating system. | Allows to share videos, images, and more with people you choose and offers almost the same capabilities, and to achieve that, it uses other apps like HipChat, Pager Duty, and iCalendar. |
| Synchronization & Sync speed | Regardless of platform or file format, automated synchronization and outstanding performance. | iCloud is the greatest option for automated file synchronization if you have an Apple device. iCloud fails when compared to other platforms. |
| Availability zones/ Cloud locations | World wide | World wide |
| Backup | Backup your data automatically with a few clicks once you have a Google account. | Any Apple device that uses the iCloud service can create backups that already exists and may also be utilized to restore a device. |
| Database Services | Cloud SQL<br>Cloud spanner<br>NoSQL database<br>Cloud Bigtable | SQLkit databases<br>SQLite databases |
| Content | Email, calendar,<br>contacts, documents | Contacts, Email<br>calendar, documents |
| Ease of use and accessibility | Supports | Supports |
| Networking service | Cloud Virtual Network;<br>VPC Virtual Private Cloud<br>Cloud load balancing<br>Cloud DNS<br>Cloud CDN<br>Cloud interconnect | iCloud private relay |
| File size limit | Varies | Varies |
| Virtual machine types | Standard machines<br>High-memory machines<br>High-CPU machines<br>Mega-memory machines | Apple devise can run other operating systems by installing UTM app "virtual machine hosted for iOS" |
| Emphasis | Collaboration | Apple users |

## DISCUSSION

Google Cloud and iCloud offer a set of features and the decision is on a case-by-case basis. Backing Up and synchronization of data is automatically in Google Cloud regardless of platform, as well as iCloud only if you have an Apple device. On Apple devices, iCloud performs well but not on pc. However, iCloud struggles with running other operating systems as a virtual machine, but it is possible by installing the UTM app. The only problem with the UTM app is not listed on the app store, and the only way to install it is to provide a developer certificate. Virtual machines can be hosted on Google's infrastructure, with just a few steps in the Google cloud console to create an instance. Moreover, the Google Cloud Platform produces a free tier that provides limited access to GCP services and resources. Both iCloud and Google Cloud use the Advanced Encryption Standard (AES) algorithm. Google Cloud has only one-way encryption using 256-bit AES while iCloud uses 256-bit AES with end-to-end encryption. The two-factor authentication in iCloud means any information in your account can only accessed with your devices and no third party. iCloud private relay in iCloud hides your IP address and your internet traffic by using two different proxies that protect your privacy. The problems with iCloud private relay which only works with Safari, may make things slower and have some issues with some sites.

Google Cloud VPCs help users to increase the IP space without any workload, which gives them more flexibility and growth options according to their needs. Google Drive is accessible on iOS and Android and is also known as a PWA "a Progressive Web App". PWA utilizes the resources of the browser and needs less storage than the actual software. For Android to be supported in iCloud there should be various third-party apps. Those apps provide contact and calendar sync options when it comes to previewing and playing files. iCloud is unreliable when trying to play or preview a video file, and does not support as many file types. Most likely, Google Drive will be downloaded. In price, almost both are offering the same monthly plan, you have just got to choose which plan meets your requirements. iCloud offers 5GB of free storage but Google Cloud provides 15GB free for users. The upgrading in iCloud starts with 50GB for 1$ and Google Cloud starts with 100GB for about 2$. Although iCloud wins the point for being more secure, Google Cloud earns the greatest option which is running efficiently across all platforms.

## CONCLUSION

Cloud service providers such as Google Cloud and iCloud are vendors that provide services to end-users. To determine which one best suits the demands of the user, we compared some features of Google Cloud and iCloud. This paper presented an introductory background to cloud computing, highlighted some related work, architecture, characteristics, and explored two popular cloud services. It also introduced a comparison between the selected cloud service providers based on some selected parameters summarized in the table. Every service provider has many features that are the same with different terminologies. The services that the customer needs to utilize are the ones that will be determined to be the most appropriate. Each service has a price, and the more distinguished the service, the higher the cost. Comparing the two most widely used cloud platforms and exploring the various services offered by each cloud provider are the primary goals of this work. Both Google Cloud and iCloud provide reliable cloud computing services with their unique strengths. Google Cloud specializes in cross-platform accessibility and collaborative tools. On the other hand, iCloud is the preferred option for higher security. However, overall to conclude, both platforms have achieved success in some features and the selection between them is as per the requirements of the user.

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