ISSN: 1913-3715 Volume 16, Number 4, April 2023

Scientific Research Publishing

International Journal of Communications, Network and System Sciences

ISSN: 1913-3715

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ISSN 1913-3715 (Print) ISSN 1913-3723 (Online)
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Scientific Research Publishing

Int. J. Communications, Network and System Sciences, 2023, 16, 53-65
https://www.scirp.org/journal/ijcns
ISSN Online: 1913-3723
ISSN Print: 1913-3715

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Volume 16 Number 4 April 2023

International Journal of Communications, Network and System Sciences (IJCNS) Journal Information

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Int. J. Communications, Network and System Sciences, 2023, 16, 53-65
https://www.scirp.org/journal/ijcns
ISSN Online: 1913-3723
ISSN Print: 1913-3715

The Future of Cloud Computing: Benefits and Challenges

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How to cite this paper: Islam, R., Patamsetti, V.V., Gadhi, A., Gondu, R.M., Bandaru, C.M., Kesani, S.C. and Abiona, O. (2023) The Future of Cloud Computing: Benefits and Challenges. *Int. J. Communications, Network and System Sciences*, **16**, 53-65.
https://doi.org/10.4236/ijcns.2023.164004

Received: February 12, 2023
Accepted: April 14, 2023
Published: April 17, 2023

Abstract

The purpose of this paper is to provide a better knowledge of the cloud computing as well as to suggest relevant research paths in this growing field. Also, we will go through the future benefits of cloud computing and the upcoming possible challenges we will have. Intext Cloud, performance, cloud computing, architecture, scale-up, and big data are all terms used in this context. Cloud computing offers a wide range of architectural configurations, including the number of processors, memory, and nodes. Cloud computing has already changed the way we store, process, and access data, and it is expected to continue to have a significant impact on the future of information technology. Cloud computing enables organizations to scale their IT resources up or down quickly and easily, without the need for costly hardware upgrades. This can help organizations to respond more quickly to changing business needs and market conditions. By moving IT resources to the cloud, organizations can reduce their IT infrastructure costs and improve their operational efficiency. Cloud computing also allows organizations to pay only for the resources they use, rather than investing in expensive hardware and software licenses. Cloud providers invest heavily in security and compliance measures, which can help to protect organizations from cyber threats and ensure regulatory compliance. Cloud computing provides a scalable platform for AI and machine learning applications, enabling organizations to build and deploy these technologies more easily and cost-effectively. A task, an application, and its input can take up to 20 times longer or cost 10 times more than optimal. Cloud products' ready adaptability has resulted in a paradigm change. Previously, an application was optimized for a specific cluster; however, in the cloud, the architectural configuration is tuned for the workload. The evolution of cloud computing from the era of mainframes and dumb terminals has been significant, but there are still many advancements to come. As we look towards the future, IT leaders and the companies they serve will face increa-

singly complex challenges in order to stay competitive in a constantly evolving cloud computing landscape. Additionally, it will be crucial to remain compliant with existing regulations as well as new regulations that may emerge in the future. It is safe to say that the next decade of cloud computing will be just as dramatic as the last where many internet services are becoming cloud-based, and huge enterprises will struggle to fund physical infrastructure. Cloud computing is significantly used in business innovation and because of its agility and adaptability, cloud technology enables new ways of working, operating, and running a business. The service enables users to access files and applications stored in the cloud from anywhere, removing the requirement for users to be always physically close to actual hardware. Cloud computing makes the connection available from anywhere because they are kept on a network of hosted computers that carry data over the internet. Cloud computing has shown to be advantageous to both consumers and corporations. To be more specific, the cloud has altered our way of life. Overall, cloud computing is likely to continue to play a significant role in the future of IT, enabling organizations to become more agile, efficient, and innovative in the face of rapid technological change. This is likely to drive further innovation in AI and machine learning in the coming years.

Keywords

Cloud Computing, Computing Service, Private Clouds, Public Clouds, Hybrid Clouds, Multi-Clouds

1. Introduction

The concept of cloud computing has roots in the 1960s, with the development of time-sharing, which allowed multiple users to access a single computer simultaneously. However, the modern concept of cloud computing, which involves the delivery of computing resources over the internet, was first proposed in the late 1990s. The term "cloud computing" was first used by computer scientist Ramnath Chellappa in a paper published in 1997, in which he described the emerging paradigm of delivering computing services over the internet. However, it was not until the mid-2000s, with the rise of virtualization and the development of web services, that cloud computing began to take off as a commercial concept. Other early cloud providers included Google Cloud Platform (GCP) and Microsoft Azure, which both launched in 2008. Since then, cloud computing has become increasingly ubiquitous, with a wide range of cloud services and providers available to organizations of all sizes. The on-demand availability of computer system resources, particularly data storage (cloud storage) and processing power, without direct active management by the user is known as cloud computing. Functions in large clouds are frequently dispersed over several sites, each of which is a data center. Cloud computing typically uses a "pay as you go" model, that can help reduce capital expenses but may also result in unexpected operat-

ing expenses for users. Cloud computing depends on resource sharing to achieve coherence [1].

According to Figure 1, there is a cloud computing metaphor, "The group of networked elements providing services need not be individually addressed or managed by users; instead, the entire provider-managed suite of hardware and software can be thought of as an amorphous cloud." [1] There are four main types of cloud computing:

Private clouds: A private cloud is a type of cloud computing environment that is dedicated to a single organization or business. It is typically used by large enterprises or organizations that require high levels of security, control, and customization over their IT infrastructure. In a private cloud, the computing resources, such as servers, storage, and networking, are virtualized and provided as a service to users within the organization. The private cloud can be hosted on-premises in the organization's own data center, or it can be hosted off-premises by a third-party cloud provider.

Public clouds: Public clouds are cloud computing environments that are often built using IT infrastructure that is not owned by the end users. Alibaba Cloud, Amazon Web Services (AWS), Google Cloud, IBM Cloud, and Microsoft Azure are a few of the biggest public cloud service providers.

Hybrid clouds: A hybrid cloud is an IT environment made up of several environments that appear to be connected by LANs, WANs, VPNs, and/or APIs to form a single, unified environment. Hybrid cloud characteristics are complex, and different requirements may apply [2].

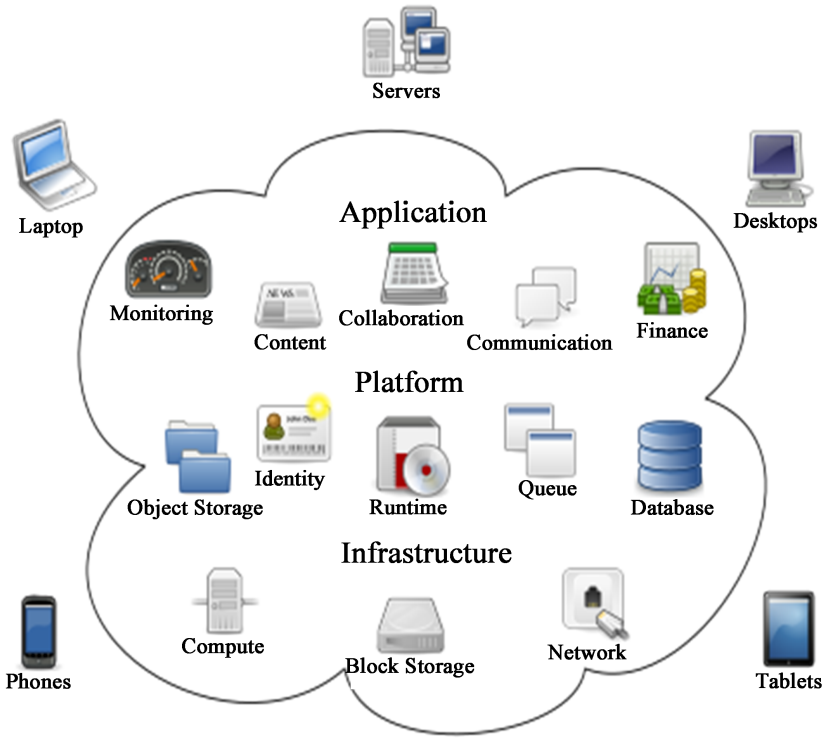

Figure 1. Cloud computing basic structure.

Multi-clouds: A multi cloud architecture consists of multiple cloud services from various public or private cloud vendors. Although not all multi clouds are hybrid clouds, all hybrid clouds are multi clouds. When numerous clouds are linked together by integration or orchestration, they become hybrid clouds. There are also three main types of cloud computing services [2]:

- Infrastructure-as-a-Service (IaaS).
- Platforms-as-a-Service (PaaS).
- Software-as-a-Service (SaaS).

2. Literature Review

Cloud computing is a new paradigm for hosting and delivering services over the Internet that has recently evolved. Cloud computing is appealing to business owners because it eliminates the need for customers to plan for provisioning and allows organizations to start small and scale up only when service demand increases [3]. Even though cloud computing provides enormous prospects for the IT sector, cloud computing technology is still in its infancy, with numerous difficulties yet to be addressed. We give a survey of cloud computing in this work, covering fundamental concepts, architectural principles, cutting-edge implementation, and research problems [3]. Furthermore, because the cloud operates on a pay-as-you-go basis, each configuration (cluster size VM type) has an operating cost as well as an execution time. As a result, a task can be optimized for lowest cost or shortest time, which are two distinct configurations. The selection of the appropriate cloud configuration for an application is critical to service quality and commercial competitiveness.

A faulty cloud configuration, for example, can cost up to 12 times more for the same performance target. The savings from effective cloud design are considerably greater for recurring operations that run similar workloads on a regular basis. Nonetheless, the best cloud setup must be chosen. For example, getting the cheapest or fastest solution is tough because of the complexity of achieving high accuracy, minimal overhead, and adaptability for many applications at the same time [4].

3. Design of Cloud Computing

One of the most crucial constraints that every cloud infrastructure should experience is transparency. Other important constraints include scalability, security, and intelligent monitoring. Current research on additional significant limits is assisting cloud computing systems in developing new features and techniques with a great potential of delivering more sophisticated cloud solutions [5]. According to **Figure 2**, the cloud architecture is narrated into two parts:

- **Frontend:** The client side of a cloud computing system is referred to as the frontend of the cloud architecture. That is, it contains all the user interfaces and applications that the client uses to access cloud computing services/resources. To access the cloud platform, for example, use a web browser.

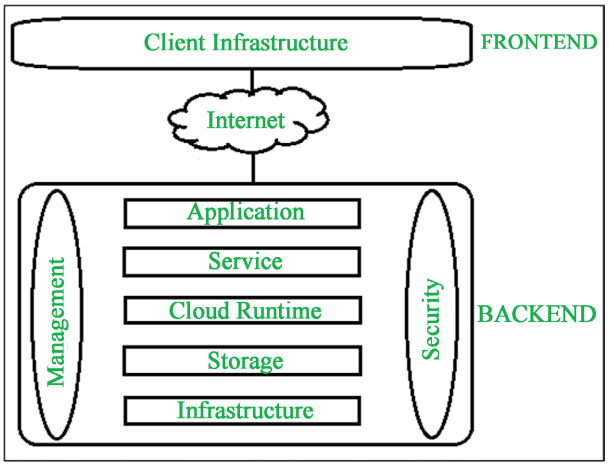

Figure 2. General Architecture of cloud computing.

- **Backend:** The cloud used by the service provider is referred to as the back-end. It includes resources, controls resources, and provides security methods. It also contains massive storage, virtual applications, virtual computers, traffic management techniques, deployment models, and so on [5].

Cloud computing architecture components

- **Client Infrastructure:** Client Infrastructure is a component of the front end. It offers a graphical user interface (GUI) for interacting with the cloud.
- **Application:** The application can be any software or platform that a client wishes to use.
- **Service:** A Cloud Service handles which sort of service you access based on the client's needs.
- **Runtime cloud:** The execution and runtime environment for virtual machines is provided by Runtime Cloud.
- **Storage:** One of the most significant aspects of cloud computing is storage. It offers a massive quantity of cloud storage space for storing and managing data.
- **Infrastructure:** Infrastructure delivers services at the host, application, and network levels. Servers, storage, network devices, virtualization software, and other storage resources are examples of cloud infrastructure.
- **Management:** Management is used to manage and coordinate backend components such as application, service, runtime cloud, storage, infrastructure, and other security issues.
- **Security:** Security is a built-in back-end component of cloud computing. In the back end, it implements a security mechanism.
- **Internet:** The Internet is a channel that connects the front end and the back end [6].

Cloud computing on data confidentiality and security: Cloud computing providers have a responsibility to ensure the confidentiality and security of their customers' data, and they typically implement a variety of measures to achieve this. Cloud providers often use encryption to protect data both in transit and at

rest. This involves encoding data using a cryptographic algorithm, which can only be decoded by someone with the correct decryption key. Cloud providers typically implement access controls to ensure that only authorized users have access to their customers' data. This can involve multifactor authentication, role-based access controls, and other security measures. Cloud providers often implement physical security measures, such as biometric authentication, security cameras, and alarms, to prevent unauthorized access to their data centers. Cloud providers use a variety of techniques to secure their networks, including firewalls, intrusion detection and prevention systems, and vulnerability scanning. Cloud providers are often subject to a range of industry standards and regulations, such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA). Compliance with these standards can help to ensure that data is processed and stored securely. It is important to note that while cloud providers have a responsibility to ensure the confidentiality and security of their customers' data, customers also have a role to play in securing their own data. This can involve implementing their own access controls, encryption, and other security measures, as well as regularly monitoring their cloud environments for potential threats [6].

4. Evaluation of Future Benefits

Success in today's technology-based world needs more than just speed and it is as important as the ability to develop new offerings, assess their potential market uptake, and then roll out the winners while eliminating the loss. The cloud also facilitates automation, which aids in driving innovation. It works in tandem with technologies like as low-code and no-code applications to enable a wider range of individuals to create a wider range of new digital services. Cloud computing enables businesses to rapidly scale and adapt, accelerating innovation, increasing company agility, streamlining operations, and cutting costs. This will not only assist businesses in surviving the current crisis, but it may also contribute to enhanced long-term growth [7].

Figure 3 illustrates, Amazon Web Services (AWS) arose in the early 2000s, and Amazon debuted Elastic Compute Cloud (EC2) in 2006, allowing businesses and individuals to rent virtual computers on which to run their own programs and applications. Google Docs, which allows users to save, edit, and transfer documents on the cloud, was released the same year. IBM, Google, and many institutions collaborated in 2007 to create a server farm for research projects. It was also the year Netflix began its video streaming service, which used the cloud to beam movies and other video content into the homes and computers of thousands (and eventually millions) of users across the world [7].

Cloud computing adoption has skyrocketed in the last decade, at both the consumer and enterprise levels. Microsoft, Oracle, and Adobe have all made significant, concerted efforts to encourage users of their on-premises software offerings to upgrade to their cloud equivalents, which are typically offered on a

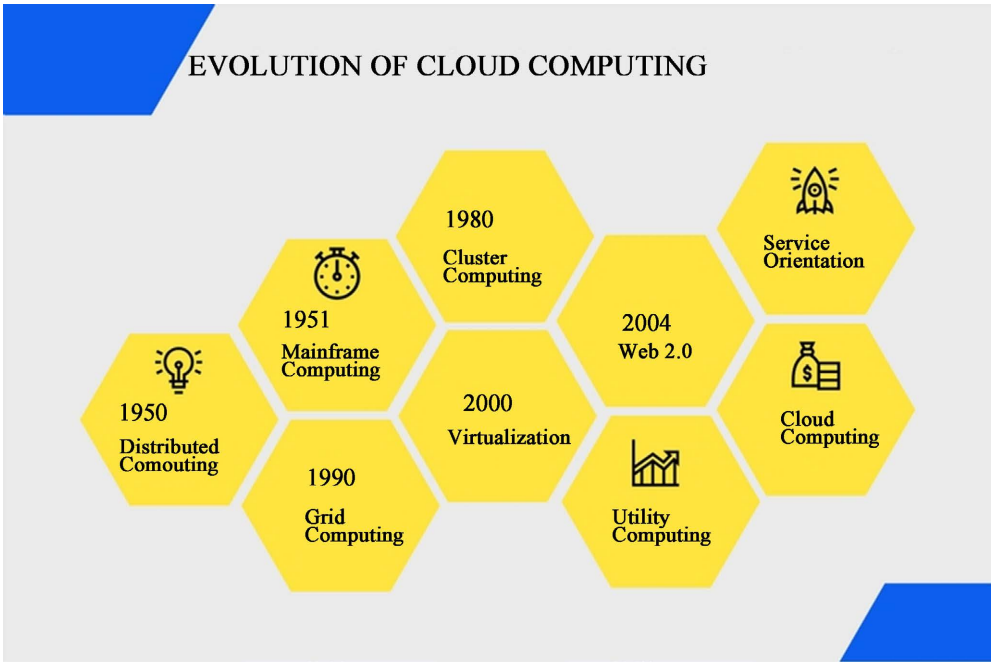

Figure 3. Evaluation of future benefits of cloud computing.

subscription pay-as-you-go basis. At the same time, cloud-native providers emerge with Software as a Service (SaaS) offerings that are (and have always been) only available in the cloud, such as Zendesk, Workday, and ServiceNow. Software like a Service (SaaS) but also Platform as a Service (PaaS), Infrastructure as a Service (IaaS), Backup as a Service (BaaS), and Disaster Recovery as a Service (DRaaS) have evolved. Everything as a Service (or XaaS, as it is marketed by companies like Google and Microsoft that provide such comprehensive resources) is now available [7].

451 According to research, "A small majority of enterprise workloads will run on off-premises IT systems by 2019, and more than one-third of all workloads will run in public cloud settings." Furthermore, according to IDC research, "Cloud computing will account for about half of all IT spending in 2018, rising to 60% of all IT infrastructure and 60% - 70% of all software, services, and technology spending by 2020. As a result, CIOs and CTOs must view cloud computing as a critical component of their organization's competitiveness, and investigate which of their services, operations, and offerings would benefit from being moved to the cloud" [7].

The future of cloud computing is already here in the shape of Edge Computing, in this era of innovation and technological implementation. To address the issue of the exponential increase in the number of devices and data volume, edge computing has introduced the capability of evaluating data closer to the source before it is centralized in the cloud. Apart from significantly reducing data processing time, edge computing will soon assist in turning data into insights through the application of AI and machine learning [7].

Though edge computing has benefited the cloud in terms of data privacy and

latency bandwidth increase, cloud computing continues to provide numerous benefits. Aside from increased flexibility and analytical capabilities, cloud computing benefits include the following [8]:

- Reduces overhead costs by avoiding capital investments in purchasing, installing, administering, and maintaining hardware/software infrastructure.
- Simple scale-up increasing or decreasing storage space, computing power, and bandwidth is as simple as pressing a button.
- Security for the entire system at once is easier to monitor, regulate, and apply security fixes, establish backups, and perform disaster recovery, among other things.
- Simple technology integration using common and futuristic platforms as the foundation, it is feasible to customize and use modular software [8].

Cloud computing enables businesses to grow rapidly scale and adapt, accelerating innovation, increasing company agility, streamlining operations, and cutting costs. This will not only assist businesses in surviving the current crisis, but it may also contribute to enhanced long-term growth. Following are some predictions regarding how cloud computing will affect the future [8]:

Advanced storage capability: Data generation is at an all-time high and is only increasing and keeping such a large volume of data safe is difficult. Most firms still store company and customer data in physical data centers were cloud server suppliers. As more enterprises adopt cloud technology, they will be able to offer more cloud-based data centers at reduced pricing. Prices will be competitive because there are so many cloud service providers on the market today, which will benefit enterprises. This breakthrough will enable smooth data storage without the need for a lot of physical space [8].

Advanced internet performance: Cloud computing has the potential to improve the quality and experience of using the internet (internet of things). Data can be saved in the cloud using cloud computing and IoT for later reference, in-depth analysis, and increased performance. Customers and organizations want applications and services to load promptly and with high quality. As a result, the network's download and upload rates will be faster [8].

Modular software prioritization: As individual programs get more sophisticated and massive and cloud computing technology will eventually necessitate advanced system thinking. Currently, most system software requires substantial customization, which means that even commercial cloud computing solutions require extensive customization in terms of usefulness and security. This new program must be easier to use and more versatile where future applications will store somewhere other than the cloud, software development can be approached from a variety of angles. This may comprise a variety of modules as well as cloud service servers and a good way to save money on software and storage. It means that in the long run, these software solutions will be much faster and more agile, saving time and money [8].

Advanced cloud services: Cloud computing offers a wide range of services. The most popular are platform-as-a-service (PaaS), software-as-a-service (SaaS),

and infrastructure-as-a-service (IaaS). These services are crucial to achieving company goals. Many studies and assessments have shown that cloud computing will become a dominant technology soon, with SaaS solutions accounting for more than 60% of the workload [9].

Better Security: Data stored on cloud servers is currently secure, but not completely so. Smaller cloud service providers may be unable to provide or comprehend all the precautions required for adequate data security. Future cloud services will use better cybersecurity safeguards and enforce better safety practices to prevent cyberattacks. As a result, companies will be able to concentrate on more important tasks rather than worrying about data security or alternative data storage methods [9].

Cloud technology and safer collaboration: Collaboration is essential in many firms, and cloud computing can enable team members anywhere in the world with fast, simple, and dependable collaboration. Any member of the team can review, change, or receive feedback on the files in the cloud at any moment [9].

Future of cloud computing: The future of cloud computing is bright, as more and more businesses are adopting cloud-based solutions to meet their IT needs. Companies are likely to adopt multi-cloud strategies to avoid vendor lock-in and leverage the strengths of different cloud providers. With the rise of the Internet of Things (IoT) and 5G networks, there will be an increased need for computing power at the edge of the network. Cloud providers are likely to offer edge computing services to meet this demand. Companies will continue to adopt hybrid cloud models that combine public and private cloud environments to balance cost, security, and performance. Serverless computing, which allows developers to run code without managing servers, is gaining popularity. Cloud providers are likely to offer more serverless computing options in the future. Cloud providers are investing heavily in artificial intelligence (AI) and machine learning (ML) to offer AI-powered services that can help businesses automate processes, gain insights, and make better decisions. Overall, the future of cloud computing is likely to be characterized by increased flexibility, scalability, and accessibility, with cloud providers offering a wide range of services to meet the evolving needs of businesses [9].

5. Upcoming Challenges

Despite all the development and potential of cloud computing services, businesses face a variety of cloud computing challenges. We have compiled a list of cloud computing challenges that must be addressed to fully utilize the cloud's capabilities. The possible challenges are following [10]:

Security: The primary worry in investing in cloud services is cloud computing security. It is because your data is stored and processed by a third-party provider without your knowledge. Every day or so, you receive information about a certain organization's broken authentication, compromised credentials, account

hacking, data breaches, and so on which makes the user even more skeptical. Fortunately, cloud companies have begun to make efforts to increase security capabilities. You can also be cautious by checking to see if the provider has a secure user identity management system and access control procedures in place. Also, make certain that it follows database security and privacy protocols [10].

Password security: As more individuals use one cloud account, it becomes more vulnerable. Anyone who knows one user's password or hacks into the cloud will have access to that user's sensitive data. In this case, the firm should employ multiple levels of authentication and guarantee that credentials are kept secure. Passwords should also be changed on a regular basis, especially when an individual resigns and leaves the firm. Access to usernames and passwords should be granted with caution [10].

Cost management: Cloud computing allows users to access application software via a fast internet connection while saving you money on expensive computer gear, software, management, and upkeep. This lowers the cost. However, customizing the organization's demands on the third-party platform is difficult and costly. Another expense is the cost of transferring data to a public cloud, which is extremely pricey for a small firm or project [10].

Internet connectivity: A high-speed internet connection is required for cloud services. So, businesses who are relatively tiny and are experiencing connectivity troubles should ideally first invest in a decent internet connection to avoid downtime. Because internet outages might result in significant economic losses [10].

Lack of expertise: Management has gotten harder due to the increasing workload on cloud technologies and the constant improvement of cloud solutions. A trained workforce capable of dealing with cloud computing tools and services has been in high demand. As a result, businesses must train their IT workers to mitigate this risk [10].

Compliance: Maintaining compliance is another key danger of cloud computing. To preserve compliance, we define compliance as a set of rules governing what data can be transmitted and what must be retained in-house. Organizations must adhere to and respect the compliance guidelines established by various government agencies [10].

Control of governance: Another ethical concern in cloud computing is maintaining proper asset management and maintenance control. A dedicated team should be established to verify that the assets used to deliver cloud services are used in accordance with agreed-upon policies and procedures. The assets should be properly maintained and leveraged to help your organization achieve its goals [10].

Creating a private cloud: It is desirable to implement an internal cloud. This is since all data is kept secure in-house. The challenge here is that the IT staff must build and repair everything from scratch. In addition, the team must verify that the cloud runs smoothly. They must automate as many manual operations

as possible. Tasks should be completed in the correct order. So far, it appears to be tough to set up a private cloud on your own. However, many organizations want to do so in the future [10].

Performance: When clint migrate their business apps to the cloud or a third-party vendor, the business performance becomes dependent on the supplier. Another significant issue in cloud computing is finding the correct cloud service provider. Prior to investing, we should hunt for providers with cutting-edge technologies. The performance of the BIs and other cloud-based systems is also tied to the systems of the supplier. Be cautious when selecting a service and ensure that they have mechanisms in place to deal with difficulties that develop in real time [10].

Interoperability and portability: Another issue with cloud computing is that programs must be easily moved across cloud providers without being locked in an extended length of time. Because of the complexity required, migrating from one cloud provider to another is limited in flexibility. Changing cloud developments introduce a few new issues, such as monitoring data flow and building a secure network from the ground up. Another issue is that consumers cannot access it from everywhere; however, this can be resolved by the cloud provider so that customers can securely access the cloud from everywhere [11].

High availability and reliability: High availability (HA) and reliability are two of the most urgent challenges in cloud computing. The possibility that a system will be up and operating at any given moment in time is referred to as reliability, whereas availability refers to how likely it is that the system will be up and running at any given point in time. Because most organizations rely on third-party services, cloud solutions must be stable and robust. Cloud services continue to lack 24-hour availability, resulting in frequent disruptions. It is vital to monitor the service being offered using internal or third-party solutions. Plans for monitoring SLAs, utilization, robustness, performance, and business reliance on these services are crucial [11].

Hybrid cloud complexity: A hybrid cloud environment is typically a jumbled mass of different cloud application development and cloud service providers, as well as private and public clouds, all functioning at the same time for any firm. These complicated cloud ecosystems lack a uniform user interface, consistent data, and analytical benefits for enterprises. In a hybrid cloud context, cloud computing concerns like as scalability, integration, and disaster recovery are amplified [11].

6. Conclusions

Cloud computing is a new paradigm for hosting and delivering services over the Internet that has recently evolved. It offers many advantages for business owners, but it is still in its infancy and has many difficulties that need to be addressed. The appropriate cloud configuration for an application is critical to service quality and commercial competitiveness. A faulty cloud configuration can

cost up to 12 times more for the same performance target. The savings from effective cloud design are considerably greater for recurring operations that run similar workloads on a regular basis. However, choosing the best cloud setup is challenging due to the complexity of achieving high accuracy, minimal overhead, and adaptability for many applications at the same time. The supply of computing resources via the internet is known as cloud computing. Cost savings, scalability, high performance, economies of scale, and other benefits are all provided. A cloud migration is closely related to data and IT modernization for many businesses. Cloud computing architecture is composed of several components that work together to provide services to clients over the internet. These components include the Client Infrastructure, which offers a graphical user interface for interacting with the cloud, the Application, which can be any software or platform that a client wishes to use, the Service, which handles the type of service accessed based on the client's needs, the Runtime Cloud, which provides the execution and runtime environment for virtual machines, and Storage, which offers a massive quantity of cloud storage space for storing and managing data [12].

Cloud computing has seen a significant increase in adoption in recent years, with major companies like Microsoft and Oracle encouraging users to upgrade to their cloud equivalents and a rise in cloud-native providers offering various services such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Additionally, edge computing has introduced the capability of evaluating data closer to the source before it is centralized in the cloud, which can significantly reduce data processing time and assist in turning data into insights through the application of AI and machine learning [12].

Investing in cloud services comes with a variety of risks and challenges, including security concerns, cost management, internet connectivity, lack of expertise, compliance, control of governance, creating a private cloud, performance, interoperability and portability, high availability and reliability, and complexity in hybrid cloud environments. It is important for organizations to carefully consider these risks and challenges before making the decision to invest in cloud services, and to ensure that they have proper systems and processes in place to mitigate these risks and challenges. Additionally, organizations should also consider the benefits of cloud services, such as cost savings, scalability, and flexibility, when making the decision to invest in cloud services [12].

Delivering computing resources through the internet, such as storage, processing power, databases, networking, analytics, artificial intelligence, and software applications, is known as cloud computing (the cloud). Companies can get the computing resources they require whenever they need them by outsourcing these resources, eliminating the need to buy and maintain an on-site, physical IT infrastructure. This offers adaptable resources, quicker invention, and scale economies. A cloud migration is closely tied to data and IT transformation for many businesses [12].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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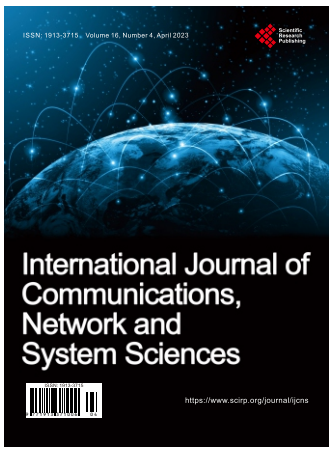

International Journal of Communications, Network and System Sciences (IJCNS)

ISSN 1913-3715 (Print) ISSN 1913-3723 (Online)
https://www.scirp.org/journal/ijcns

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3G, 4G and 5G Technologies	MIMO and OFDM Technologies
Ad Hoc and Mesh Networks	Network Protocol, QoS and Congestion Control
Coding, Detection and Modulation	Network Survivability
Cognitive Radio	Next Generation Network Architectures
Communication Networks Architecture Design	Reconfigurable Networks
Communication Reliability and Privacy	Resource Management
Communication Security and Information Assurance	Satellite Communication
Cooperative Communications	Sensor Networks
Embedded Distributed Systems	Simulation and Optimization Tools
Global Networks	UWB Technologies
Heterogeneous Networking	Wave Propagation and Antenna Design
Microprocessor	Wireless Personal Communications

We are also interested in short papers (letters) that clearly address a specific problem, and short survey or position papers that sketch the results or problems on a specific topic. Authors of selected short papers would be invited to write a regular paper on the same topic for future issues of the IJCNS.

Notes for Intending Authors

Submitted papers should not have been previously published nor be currently under consideration for publication elsewhere. Paper submission will be handled electronically through the website. All papers are refereed through a peer review process. For more details about the submissions, please access the website.

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