Cloud Computing In Animal Care Social Infrastructure: A Review

Suwarna S. Kedari[1*], Manisha Patil[2], Janardan Pawar[3]

[1,2,3]Computer Science, Indira College of Commerce and Science, Pune, Maharashtra, India.*
Email: kedari.suwarna@iccs.ac.in[1], manisha.patil@iccs.ac.in[2], janardanp@iccs.ac.in[3]

***Corresponding Author:** Suwarna S. Kedari*
*Computer Science, Indira College of Commerce and Science, Pune, Maharashtra, India.
Email: kedari.suwarna@iccs.ac.in

	Abstract
	Cloud computing has become essential in the modern world due to its ability to address various needs and challenges faced by businesses and individuals. Cloud computing accelerates innovation by speeding up the development and deployment of applications through ready-made services and resources. Thus cloud computing provides a dynamic and efficient solution to meet the diverse and evolving needs of today's digital landscape. Cloud computing offers a wide range of benefits across various domains, including healthcare, animal social infrastructure, and beyond. This paper discusses cloud computing, how cloud computing can be used in animal care social infrastructure and challenges of cloud computing.
CC License 	*Keywords: Cloud Computing, Cloud Models, Animal Care.*

I. INTRODUCTION

A recent advancement in information technology- Cloud computing, delivers IT infrastructure and applications to end users as services, utilizing a pay-as-you-go model. Its widespread adoption is attributed to advancements in virtualization, grid computing, Web computing, utility computing, and related technologies, offering a cost-effective means to access high-performance computing and storage infrastructure via the Internet. Cloud service providers offer enterprises flexible, scalable, and resilient infrastructure, enabling streamlined operations and optimal performance, but choosing the right provider amid a rapidly evolving landscape poses complexity.

In the dynamic cloud computing landscape, selecting the right provider is crucial. Few top providers include Amazon Web Services (AWS) for public cloud, Microsoft Azure for developer solutions and Salesforce for CRM solutions. Additionally, VMware leads in multi-cloud services, while Alibaba Cloud excels in elastic computing. Oracle stands out for data management, Rack space for cloud optimization, and Digital Ocean for web applications. Service Now leads in enterprise automation, with NetApp specializing in data intelligence [12].
Cloud Computing acts as a foundational technology, empowering both organizations and individuals to innovate, collaborate, and accomplish objectives with greater efficiency and effectiveness. It provides the solutions for different sectors healthcare, education, finance, animal social infrastructure etc.[13].

II. OVERVIEW OF CLOUD COMPUTING

Cloud computing is based on the concept of dynamically sharing computing resources, like processors and storage, as needed, with minimal management effort. It typically involves ritualizing hardware using commodity hardware; this distinguishes it from other technologies. The main goal is to efficiently process and store large volumes of data.

A. Definition and characteristics.

Cloud Computing can be defined in the following ways: Cloud services are shared services, under virtualized management, accessible over the internet IDC. A standardized IT capability (services, software or infrastructure) is delivered via Internet technologies in pay-per-use, self-service way Forrester [2].

Cloud computing is the delivery of computing services over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations (OPC). Cloud computing, by definition, is a specific method of utilizing scalable IT-related capabilities in an as-needed service over the Internet for multiple users at one time [2].

Cloud computing as defined by the US National Institute of Standards and Technology (NIST) states that: "cloud computing is a model for enabling 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. This cloud model promotes availability and is composed of five essential characteristics, three delivery models, and four deployment models [1].

B. Characteristics of Cloud Computing:

The characteristics of cloud computing based on the definitions provided by the National Institute of Standards and Terminology (NIST) are [1]:

On-demand self-service: Users can effortlessly obtain computing resources without interacting directly with providers.

Broad network access: Network-accessible capabilities support diverse client platforms

Resource pooling: The provider dynamically allocates pooled computing resources in a multi-tenant model based on consumer demand, offering location-independent services with higher-level abstraction for specifying resource locations.

Rapid elasticity: Capacities can flexibly scale up or down based on demand, sometimes automatically, providing consumers an illusion of unlimited and on-demand provisioning.

Measured service: Cloud systems optimize resource utilization through automated control and metering, offering transparency to both providers and consumers across various service types.

C. Service Models [7]:

Cloud service models refer to the three primary categories of cloud computing services, which are:

Infrastructure as a Service (IaaS): Provides virtualized computing resources over the internet, allowing users to rent virtual machines, storage, and networking components.

Platform as a Service (PaaS): Offers a platform that enables customers to develop, run, and manage applications without dealing with the complexities of infrastructure. It includes tools and services for application development and deployment.

Software as a Service (SaaS): Delivers software applications over the internet on a subscription basis, eliminating the need for users to install, maintain, and update the software locally. Users access the software through a web browser.

These service models provide varying levels of control, flexibility, and management responsibilities for users, depending on their specific needs and requirements.

Example of Cloud Computing Services [8]:

Software-as-a-Service (SaaS):
- Email and Office Productivity (document processors, spreadsheets and presentation applications.
- Billing (monitoring and managing customer billing)
- Customer Relationship Management (CRM)
- Financials (processing of expenditure, generating invoices, payroll, and managing taxes)

Platform–as-a-Service (PaaS):
- Business Intelligence.
- Database
- Development and Testing
- Integration
- Application Deployment

Infrastructure–as-a–Service (IaaS):
- Content Delivery Networks (CDNs): handling diverse kinds of content for delivery to any website or mobile app.
- Backup and Recovery
- Compute (server requirements provisioned and configured dynamically)
- Storage (Highly scalable storage ability)

D. Deployment Models [7]:
- **Private cloud:** A private cloud is dedicated to a single organization or business unit, and it can be owned, managed, or operated either internally, by a third party, or through a hybrid combination, with the flexibility of on-premises or off-premises deployment.
- **Community cloud:** A community cloud serves a specific group of organizations with shared concerns, allowing exclusive infrastructure provisioning owned, managed, or operated by community members, third parties, or a combination, with deployment flexibility on or off premises
- **Public cloud:** A public cloud, owned and operated by a business, academic, or government organization or a combination, is provisioned for unrestricted use by the general public and is hosted on the premises of the cloud provider
- **Hybrid cloud:** A hybrid cloud combines distinct private, community, or public cloud infrastructures through standardized or proprietary technology to facilitate data and application portability, allowing functionalities like cloud bursting for load balancing.

Inter-cloud, analogous to a network of networks, involves connecting multiple cloud infrastructures to enhance computing resource availability. It comprises two types: federated cloud and multi-cloud [8].

III. CLOUD COMPUTING FOR ANIMAL CARE INFRASTRUCTURE:

Cloud computing enriches animal care through a lot of tools and services that strengthen veterinary care, educate pet owners, and enhance the well-being of animals. Electronic Health Records (EHR) for pets facilitates comprehensive record-keeping accessible from any location, fostering collaboration among veterinarians. Telemedicine services enable remote consultations, particularly benefiting pets in rural areas or owners with limited access to clinics. Real-time health data transmitted by remote monitoring devices helps track pets' vital signs, aiding in the timely detection of health issues. Data analytics and AI analyze animal health information to tailor care and anticipate outcomes. Cloud platforms offer educational resources and tools for pet owners, encouraging engagement and informed decision-making. The scalability and flexibility of cloud solutions empower pet care organizations to adapt to evolving demands, while community engagement nurtures collaboration and support among pet owners, veterinarians, and professionals. Overall, cloud computing elevates pet care infrastructure, fostering better pet health and reinforcing the bond between humans and animals [14].

Cloud computing service models in cloud can play different roles in animal care social infrastructure, offering various benefits and functionalities.

- **IaaS:** it enables animal care organizations to deploy scalable IT infrastructure without upfront hardware investment, facilitating the hosting of electronic health records (EHR) systems and other applications. IaaS offers flexibility to adapt to changing demands in animal care services.
- **PaaS:** PaaS empowers the creation and implementation of specialized animal care solutions, precisely addressing the requirements of veterinarians, pet owners, and pet care specialists. With PaaS platforms offering development frameworks, databases, and integration tools, organizations can develop and launch customized applications such as IoT-powered animal monitoring systems, telemedicine platforms, and educational resources for pet owners. By streamlining the development process and handling infrastructure management, PaaS enables animal care entities to concentrate on crafting inventive solutions to enhance animal well-being.
- **SaaS:** SaaS offers software applications via the internet through subscription models, removing the necessity for on-site installation and upkeep. These solutions furnish readily available pet care applications accessible on web browsers or mobile devices. These solutions also support accessibility, collaboration, and operational efficiency in animal care, facilitating tasks like managing electronic health records (EHR), scheduling appointments, and monitoring animal health.

Overall, power of cloud service models in animal care social infrastructure will provide scalable, flexible, and cost-effective solutions for deploying and managing animal care applications and services. By using IaaS, PaaS, or SaaS services animal care organizations can enhance veterinary care, pet owner education, and overall animal well-being.

Cloud computing deployment models can serve distinctive roles in animal care social infrastructure, each presenting unique benefits [12]:
- **Public Cloud:** Public cloud services, offered by external vendors online, provide scalability, flexibility, and cost savings. In animal care, they enable easy access to a variety of services and applications without upfront hardware investments. This model supports scalability to meet changing pet care demands and may offer specialized solutions like IoT platforms for remote pet monitoring.
- **Private Cloud:** Private cloud deployment offers dedicated resources and heightened security for sensitive data in animal care, allowing veterinary clinics to maintain control while leveraging cloud scalability. Integration of critical applications like EHR ensures secure management of animal care services.
- **Hybrid Cloud:** Hybrid cloud deployment blends public and private cloud elements, catering to animal care organizations' needs for scalability and data control. Veterinary clinics may securely manage sensitive patient data on a private cloud while utilizing public cloud services for less-sensitive applications, optimizing flexibility and cost-effectiveness.
- **Multi-Cloud:** Multi-cloud deployment diversifies cloud service providers to distribute workloads, enhancing redundancy and flexibility in animal care. Pet care organizations strategically leverage providers based on performance and cost, mitigating vendor dependency and optimizing reliability and performance.

Cloud computing deployment models provide animal care organizations with versatile options to adapt solutions for animal care social infrastructure. Various deployment models like public, private, hybrid, or multi-cloud can be utilized by animal care services in support of animal welfare initiatives.

IV. THE CHALLENGES OF CLOUD COMPUTING

Even though using Cloud computing provides advantages but it also faces challenges arising from the intricate nature of interconnection networks, a multitude of users, user mobility, and the diverse array of application services. Few such issues are discussed here:

Security & privacy: Ensuring information security and data privacy in cloud services, particularly safeguarding sensitive data in sectors like banking and healthcare, governmental institutions [4].

Protection of data: Data protection is vital in cloud usage, with privacy concerns persisting due to unknown repository locations. Traditional models secure data behind firewalls in company-owned data centers [3].

Administrative capabilities: Amidst numerous cloud services, prioritizing infrastructure management, network transformation, and dynamic scaling is vital for many organizations, with potential for further enhancing robustness and load balancing functionality [3].

Regulation and compliance restrictions: Cloud service providers face the challenge of establishing data hubs or storage areas within the country to comply with regulations, which may not always be feasible. Several European countries do not mandate the physical storage of user private and confidential information outside their borders [3][10].

Migration: Migrating existing applications to the cloud poses significant challenges, leading to budget and deadline overruns for many companies, highlighting complexities in the process despite the straightforward nature of migrating new applications [10].

Cost management: Cloud computing offers cost-saving benefits for businesses by providing scalable processing capabilities without significant upfront investments, although challenges in predicting costs are mitigated by competitive pricing and discount strategies from providers [9].

Portability and interoperability: One operational challenge in cloud computing is the difficulty of transitioning from one provider or platform to another, leading to a lockdown period and reduced productivity. This lack of flexibility results in issues such as data migration hurdles, establishing secure networks from scratch, and restricted user access. Addressing these challenges involves understanding data and service laws, negotiating terms with providers, and proactively preventing potential lockdowns or service restrictions [9] [10].

Multi-cloud environment: Multi-cloud environments pose challenges including configuration errors, data governance, security patch management, and granularity issues. Applying consistent data management policies across diverse platforms while maintaining security requirements in multi-cloud scenarios is complex, reflecting the evolving landscape where companies combine public and private clouds [9][10].

V. CONCLUSION

This paper provides overview of cloud computing, its architecture, different cloud models. Paper highlights use of cloud computing solutions in animal care social infrastructure; lastly cloud computing challenges are discussed. Overall, cloud computing transcends boundaries and proves beneficial in various domains like healthcare, animal social infrastructure etc. by providing scalable, accessible, and innovative solutions that drive efficiency, collaboration, and innovation. Further researchers can model different solutions to build better animal care infrastructure.

REFERENCES

1. The NIST Definition of Cloud Computing. Technical report, the National Institute of Standards and Technology, Peter M. Mell. 2011.
2. Cloud Computing Antecedents, Challenges, and Directions, Majed Almubaddel, Ahmed M. Elmogy, ISBN:978-1-4503-4063-2/16/03.
3. Muhammad Asim Shahid, Noman Islam, Muhammad Mansoor Alam, Mazliham Mohd Su'ud , Shahrulniza Musa (2020), "A Comprehensive Study of Load Balancing Approaches in the Cloud Computing Environment and a Novel Fault Tolerance Approach", IEEE Acess Scientific journal, VOLUME 8.
4. Emerging Issues & Challenges in Cloud Computing— A Hybrid Approach Yaser Ghanam, Jennifer Ferreira, Frank Maurer
5. CLOUD COMPUTING PERFORMANCE EVALUATION: ISSUES AND CHALLENGES Niloofar Khanghahi and Reza Ravanmehr
6. Quality-of-service in cloud computing: modeling techniques and their applications Danilo Ardagna, Giuliano Casale, Michele Ciavotta, Juan F Pérez and Weikun Wang
7. NIST Cloud Computing Forensic Science Challenges, Martin Herman, Michaela Iorga, Ahsen Michael Salim, Robert H. Jackson, Mark R. Hurst, Ross Leo, Richard Lee, Nancy M. Landreville, Anand Kumar Mishra, Yien Wang, Rodrigo Sardinas, August 2020

8. Cloud Computing Architecture: A Critical Analysis Isaac Odun-Ayo, Ananya M. , Frank Agono and Rowland Goddy-Worlu

9. https://www.datapine.com/blog/cloud-computing-risks-and-challenges/

10. https://sprinto.com/blog/challenges-in-cloud-computing/

11. https://www.datamation.com/cloud/cloud-service-providers/

12. Cloud Computing for animal medical care, Hisato Minami, Akira Imabayashi, Fujistu Sci. Tech. J., Vol. 47, No. 4, pp.387-397, October 2011

13. A Cloud Computing-Based Model for Wildlife Conservation and Health Care Improvement in Endangered Wild Life Animals, Shahbaz Afzal, G. Kavitha, Amir Ahmad Dar,

14. IOT based Pet Feeder, Raed Abdulla, Ahmed Abdlekader Eldebani, Sathish Kumar Selvaperumal, Maythem K. Abbas, March - April 2020 ISSN: 0193-4120 Page No. 269 – 279.

15. Implementation of an IoT based Pet Care System, Yixing Chen, Maher Elshakankiri, Fifth International Conference on Fog and Mobile Edge Computing. 2020.