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Cloud computing needs to explore into sky computing

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ABSTRACT

This paper evaluates key issues in cloud computing and introduces a novel model, known as sky computing, to address these challenges. Cloud computing, a transformative technology, has played a critical role in reshaping modern operations—especially following the COVID-19 pandemic, when many human activities shifted to technology-driven platforms. It offers multiple service models, including Software as a Service, Hardware as a Service, Desktop as a Service, Backup as a Service, and Network as a Service, each tailored to user requirements. However, the rapid expansion of cloud-based technologies and interconnected systems has intensified infrastructure and scalability challenges. Sky computing, or the "cloud of clouds," emerges as an advanced layer above traditional cloud models, enabling dynamically provisioned, distributed domains built over multiple serial clouds. Its core capability lies in offering variable computing capacity and storage resources with dynamic, real-time support, providing a robust and unified platform by integrating diverse cloud resources. This paper reviews related technologies, summarizes prior research on sky computing, and discusses its structural design. Furthermore, it examines the limitations of current cloud computing frameworks and highlights how sky computing could overcome these barriers, positioning it as a pivotal architecture for the future of distributed computing.

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1. INTRODUCTION

Cloud computing (CC) is a contemporary technology that gives convenience to on-demand network access for sharing and pooling resources on the network like storage servers and different application services for both application and hardware [1]. The application serves as facilities on the internet with the hardware and system software working in the data centers for storage and other applications. CC architecture comprises two main parts: Front end and back end, where different components in terms of storage, runtime, service and security work in back-end application and service work in the front end. Cloud architecture not only defines the components but also the relationship between them. These components are connected with the help of the internet [2]. Cloud computing architecture consists of four layers. The inner layer is the hardware layer, and next to the inner layer is the infrastructure layer. The platform layer is above the infrastructure layer, and the application layer is the outermost layer. There are four types of CC used in different fields of life with specific rules and respective specifications. CC has a layer consisting of other characteristics: availability, scalability, cloud security, cloud automation, and virtualization [3]. People are

searching for new technology for achieving their demand for fast access and storage and cloud computing is one of them. Due to the huge data storage and processing time capacity cloud computing gains much attention in different field of life. Furthermore, this technology aims to provide reliable and customized quality of service for end-user demand. It is a concept that offers a dynamically scalable resource for the user in a specific time with the help of internet [4]. Figure 1 shows the standard cloud computing structure where it shows different device are connected with data center. These different device and element are divided into two main sections which are accessor and provider. The roles of accessor are to share and collect data from datacenter. The roles of provider are to provide different kind of services in the form of hardware and software to the cloud datacenter where datacenter control all these activities. Cloud computing architecture comprises of two main parts which are front end and back end where different components in term of storage, runtime, service and security work in back-end application and service work in front end. Cloud architecture not only defines the components but also the relationship between them. These components are connected with each other with the help of internet [5]. Figure 1 presents the growth of different technologies as compared with CC.

Figure 1 presents the growth of different technologies compared to CC; therefore, the cloud needs to change its model and improve different layers and structures. Thus, various researchers [6] present a new model of cloud computing known as sky computing to overcome the different issues faced by cloud structure. The name of sky computing was presented by coined back in 2008. According to him, multi-cloud computing is grouped in the environment. It addresses the provider interoperability and cloud provider in a group form [7]. It has been serving since 2008 by sharing the knowledge of how the global and local resources are managed like big data, workspace, and transformation of help from a traditional system to IT landscape in the form of sky computing. Better adoption and migration in the Sky computing model are performed [8]. For that reason, in this paper, we present the sky computing model and its different layers, which are presented by various researchers and summarize some of the related work about sky computing.

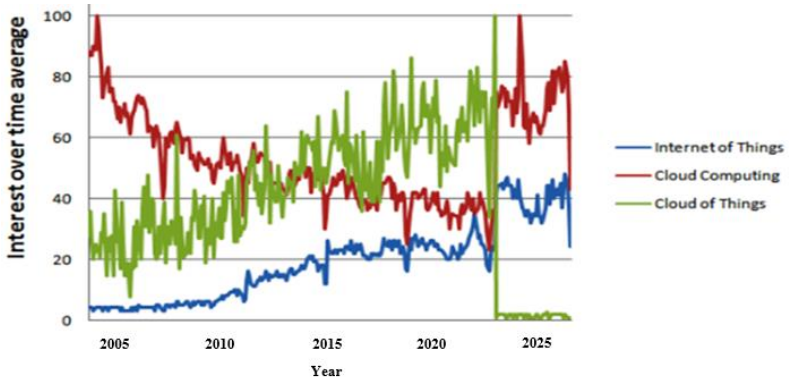

Figure 1. Growth of technologies

2. PAPER CONTRIBUTION

This section highlights the contribution made by the authors in this paper. The paper mainly aims to present the cloud computing issues structure and present information about the new model of CC, known as sky computing, and some related work about this new model. Our main contributions of the paper are summarized as:

- To find out literature about sky computing.
- To define the structure of sky computing.
- To determine the upcoming importance of sky computing.
- Future issues regarding sky computing.

3. DIFFERENT TECHNOLOGIES

In this section, we explain some basic concepts about different computing and compare them with sky computing. *Fog Computing*: It is closer to the things that produce action on IoT data these devices are called fog nodes. These nodes can be developed anywhere with a network connection. Any device containing computer storage and network connectivity can be called a fog computer, such as router switches and embedded servers [9]. Figure 2 shows the fog structure with the different devices.

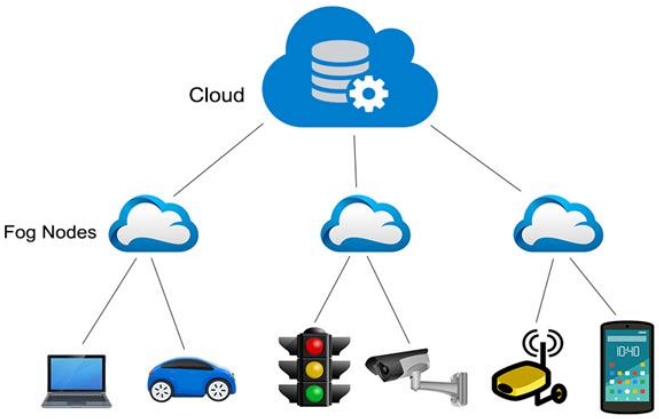

Figure 2. Structure of fog computing

Fog computing is intelligent in the local area. It transmits data to the endpoint to the gateway where it processes and then sends it to the transmission known as fog computing [10]. The different sensor node is used in a fog for sensing purpose, which can interconnect the device. The sensors support additional images from the local area. Sensor nodes are small and limited in processing and can measure and combine information from the environment, and these nodes are used in fog computing [11]. The main character of fog computing is low latency location awareness and mobility very large number of nodes are used. It is implemented at the edge of the network and provides location awareness, quality of services for real-time services [12]. *Grid Computing*: Is the step of a different processor architecture that combines computer resources from a different domain. In the grid computers, the tasks are performed together in the same line [13]. Grid computing is distributed computing in an environment which is dynamic in nature. It uses runtime selection sharing, aggregation and distributed autonomous resources based on availability, capability, performance, and cost [14]. *Mobile Computing*: Is the computing device in which any device is created by using mobile components such as mobile hardware, software, and operating system. It is used for providing services and applications [15]. They are also used for fixed location and refer to access multi-location. The application of mobile computing today has become ubiquitous and pervasive in business and consumer locations. The main advantage of its convenience is that it allows a user to access any time and gets information from anywhere [16]. It consists of wireless network access and uses different kinds of stations to share physical attachments in receiving signals. The wireless network is usually connected with the computer device. Mobile users can access versatile communication with different people [17]. *Green Computing*: This is the study and manufacturing with different resources designed as friendly for the environment. These resources are designed as that they do not affect the environment. It is ruled that implementing computer resources in such a way reduces the energy and social impact of the environment [18], due to the energy and friendly environment green computing getting more and more attention in the modern world. The area of design, disposing of servers and subsystems like monitor, printer and networking device for communication system make them safe and eco-friendly system [19].

Edge Computing: This is not the new concept when several trends are come together and create an opportunity to help and run a massive amount of machine and data into actionable and make closer together is known as edge computing. An edge device is in the cloud, which makes anything or an entry point to a network used in the different centers [20]. It refers to enabling technology that allows computations to perform at the edge of any network and to download data from cloud services and upstream data on behalf of IoT services. It is used for promoting as a strategy to achieve highly availed web services [21]. *Soft Computing*: This is an essential and powerful tool used in the physical and chemical area for grappling with theoretical and analytical problems. These are based on mathematical formulations. Usually, systems make in acceptability, and insurmountable or other issues, but soft computing represent and handles this kind of problems easily. It is also used to solve met heuristics as well as nature-inspired problems [22]. *Internet of thing*: Consists of self-configuration nodes that are connected with dynamic and with global network infrastructure. It is comprised of small things with limited storage and processing system. Internet of an item refers to a broad vision. Things are such ways that everyday objects and place environments are interconnected with the internet [23] as we know that IoT is an important source of big data. The smart city is the main data scores like industry, agriculture, traffic, transport, medical, public department and social, media. In IoT, all the devices are connected, and system architecture should support IoT like a bridge

between the physical and virtual world. The design process of IoT needs to check many factors such as communication, process and commercial models, and security. International telecommunication union (ITU) suggested four-layer concepts in IoT. These are the application layer, network layer, perception layer and middle layer [24]. The application layer is consisting of a various application that offers different services. This is the most upper layer and is visible to the user. There is no universal standard rule for developing an application layer. It can be designed due to its service. Application layer protocols are distributed to multiple users. They can use any information with the help of these protocols [25]. The network layer provides network transmission and information security and delivers a pervasive access environment to the perception layer that provides data transmission and storage awareness. The network layer includes mobile devices, cloud computing, and the internet. The perception layer is involved in the collection of information, and it's an interconnected network layer. This layer consists of all sensor nodes it means all sensing technologies and controlling data acquired include the perception layer, are divided into sub-layer [26]. They can change according to the requirement and demand and become a different layer, and these layers vary according to the development and requirement.

Cloud Computing: This is the modern and busy technology in the distributed computing community. The researchers believe that it changes the industry as a revaluation and is the next-generation architecture of the enterprise. Cloud computing moves software and database to a centralized database for the user [27]. The hardware layer is responsible for managing all physical resources of cloud computing, such as physical servicers, routers, switches, power, cooling system, and different resources. Cloud computing supports elastic service for the user to maximize the resources that internet services providers produce. Due to these characteristics, cloud computing has become the hottest technology.CC consists of virtualization, which is interconnected. It consists of a parallel and distributed system, which can be dynamically presented and provide the computing resource based on some services established between customer and service provider [28]. But all the above characteristics, CC still facing issues that are mentioned in the next section. Considerable benefits there are serious concerns and challenges about this new technology. Which are mentioned in Table 1 and Figure 2. Figure 3 shows the main challenges of cloud computing: performances, managing cost, lack of resource, complain, and security.

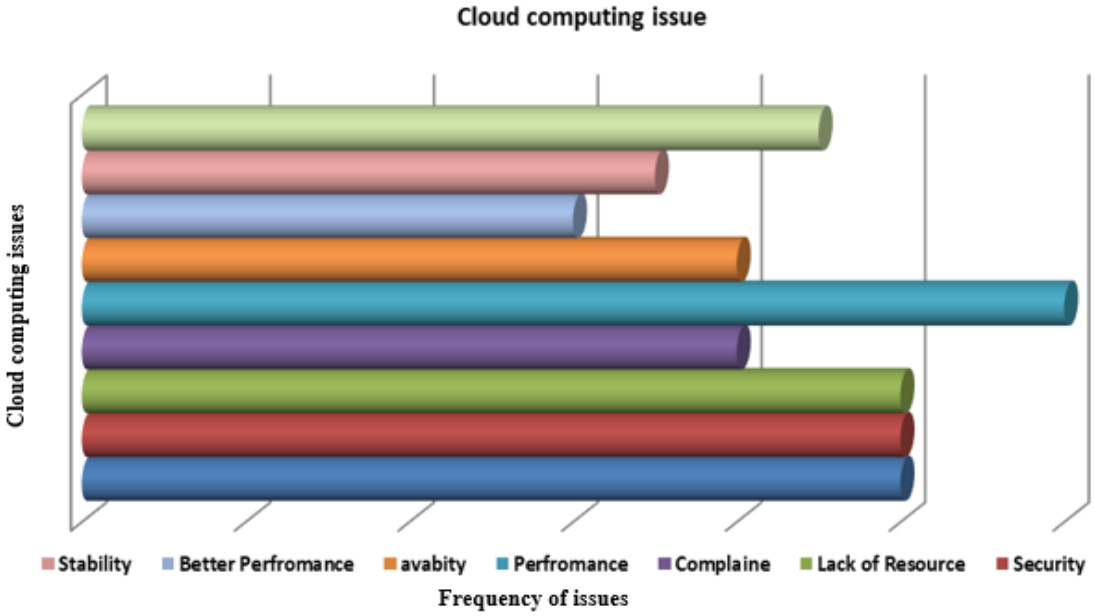

Figure 3. Issue in cloud computing

4. CLOUD COMPUTING CHALLENGES

The approval rating of cloud computing as an emerging technology has been enhanced significantly. These days, many clouds storage and computing providers offer their services regarding IaaS, PaaS, and SaaS. Table 1 present the issues of cloud computing. One of this main issue cloud need to be faced in near future is big data issue Figure 3 present big data issues.

Table 1. Issues in cloud computing

Cloud computing	Challenges
Reliability	Possibility of failure in stand period of time.
Interoperability	Lack of standards for service portability between Cloud providers.
Energy saving	Defining a standard metric for effective power usage and an efficient standard of infrastructure usage
Resiliency	The ability of the system to provide users with standard level of services while experiencing faults and challenges in the system
Resource monitoring	Lack of accurate monitoring mechanism using sensors to collect the data from CPU load, and memory load.
Load balancing	Lack of standard way of load monitoring and load management for different Cloud applications [29].

Figure 4 shows the growth of cloud computing, big data and the web from 2009 to 2025. The graphic shows that big data and web services have increased 100% in every field of life. Based on these results, now it is time to move from the cloud to the Sky computing model. It becomes challenging to manage the system. Cloud discarded many of its drawbacks, becoming more efficient and spreading out between different technologies. Common problems concerned with cloud computing are cost, queues, slow development, and limited capacity. After the evaluation and maturing of cloud computing and cloud integration with different technologies or vice versa, the result creates an opportunity to emerge a new cloud model for different application researchers to present it as a cloud-to-cloud service or sky computing. This kind of model provides high-performance computing, a complex problem-solving class that arises as new business consumers. The expectation is taking advantage of the cloud premises [30]. The new model provides different services like infrastructure, resource platform, and the new model sky Computing will prove powerful back end.

Figure 4. Cloud comparison with other technology

5. SKY COMPUTING MODEL

According to the author [31], [32], the new proposed model sky computing the application integration of different several along with the integration of public and private cloud resources. It provides a good result and defines a user role strategy based on a federated authentication system. The proposed model also provides balanced low cost and performance. Sky computing is a new incipient computing exemplary where assets from multiple clouds amalgamate into. One and provide leverage to create scale and distributed infrastructure, and Figure 5 structure of Sky model [33].

It allows a user to mechanism all the possessions on their own [35]. It is an advanced development in the computing world. Here multiple clouds are integrated to serve the business process in one place. Sky computing is a computing area where resources are leveraged to craft large-scale disseminated virtual clusters. It is challenging due to the difference between different providers [36]. This consists of a special layer that is used for e-commerce. Its security is exceptional because it uses a special method for

verification [37]. It combines many clouds into it and makes a greater number of resources to provide a special number of distributed infrastructures [38]. When different cloud computing merges, there will be problems related to different resources and management latency.

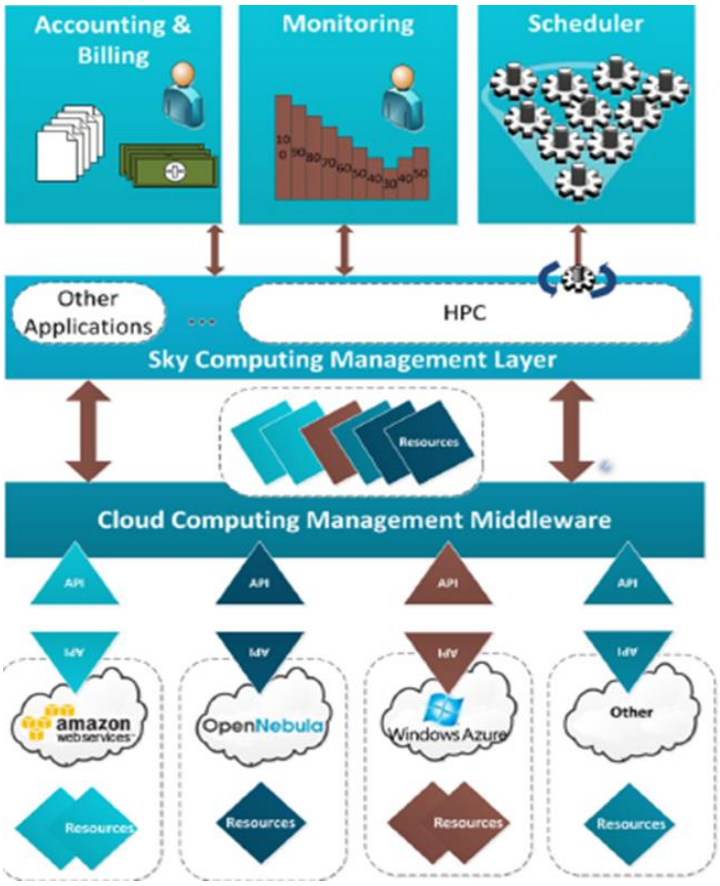

Figure 5. Structure of Sky model [34]

To overcome this kind of problem, there must be a structure capable of receiving instruction and process results from different cloud systems. As we know that each cloud computing has its application programming interface (API) that makes interacts with all resources. With the help of the middleware layer, it controls all the activities concerned with management using the command. Figure 6 shows the structure of Sky computing. Some of the main elements of Sky computing structure are management, accounting, billing and monitoring. They will be included in the first layer, the second management layer, and the third will be the middleware layer [39].

Monitoring system: this is an important part of a Sky computing management system. In a cloud system, both private and public cost money. In public suite cost both user services a multiplying with hardware profile cost. In sky computing, architecture becomes complex by multiplying hardware cost to user resource because there are used many clouds system together. Sky computing used a hybrid system, it contains public and private both billing system at a time and it's also used a healthy monitoring system [40]. Middleware*:* this is an essential and full user part of chain value. It provides an abstraction to develop an application without affecting the explicit of cloud vendors. But in sky computing, middleware relies on the lower layer and resource interface to be stable and dependable. All these resources are controlled and managed by the middleware layer. End-user didn't know about the activity used and from which location they were used [41]. The main challenge is how we control the resource like public-private and interoperating system of all cloud merges together. Like this problem and others middleware layer are used to solve the problems. It controls all these lapis and uses a specific command control these cloud providers as long as they are there. There will be a part of the middle layer known as HP, which is response-able for scheduling and monitoring purposes in sky computing [42].

Different layers are used in sky computing. The upper layer of sky computing is integrated with groundwork as an amenity and the next layer of software as a package. Computing is integrating with infrastructure as a service and the next layer of software as a service. Due to the repaid growth of cloud computing in the market, the cloud provides its own API for a user that it can use anywhere and any place [43]. It means that works are performed individual. It also provides an open slot of opportunity for the integrity of cloud management and the development of the different serial clouds. Security: This is most important because of the provider's single developer design application and provider security contextualization measure. When a user wants to use the resources, the service provider turns the services control over. This function can use with the help of virtualization [44]. Figure 7 present the security of the Sky model system. Different clouds with a certain environment under the principle of trust they configure for remote resources. The setup must relate to trust. If not, then not be configured. So, we need a trusting relationship between them. Dynamic virtual machine or virtual trust need for the trust relationship [45].

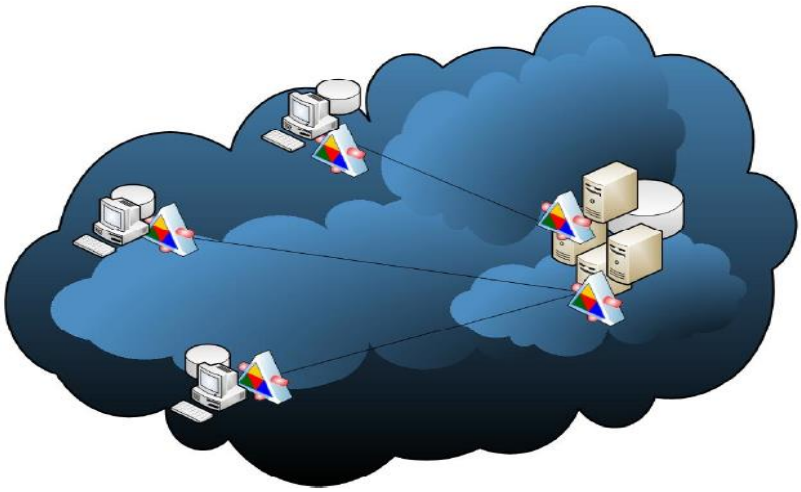

Figure 6. Security system of sky model

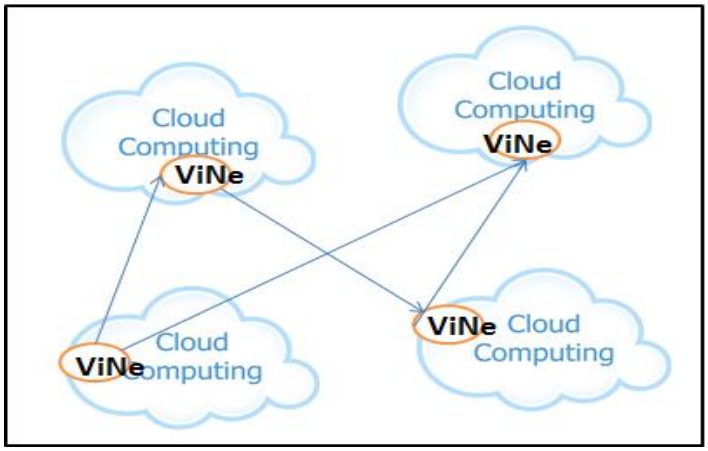

Figure 7. Connectvity system of sky model

Making trust relationships is very difficult for users and providers. It isn't easy to access the API without the privilege and security to configure a network [45]. Connectivity: In the cloud, resources are independently domain constraints like packet filtering, network address, and translation. To overcome this kind of issue in sky computing, researchers are designing and modifying many networks overlay techniques for connectivity, for example, NAT-aware network libraries and APIs, virtual private networks (VPNs), and peer-to-peer (P2P) systems [46]. Performance: overlay network effect the performance of a network.

Improving the network's performance must avoid overlay networks, but it is challenging to do [47]. Service level: sky computing needs to provide services under a heterogeneous environment, such as different resources. To connect different resources from diff erent locations and improve their performance in SCC developed virtual network (ViNe) networking overlay. It contains other ends to end connectivity among different nodes are resources that are private also. It configures dynamically and security as well. The data rate and memory are more significant than others. Some of the main advantages of ViNe Are ViNe-enabled providers, end-user clusters, isolated VMs, dynamic configuration and trust [48]. ViNe is a virtual network that offers end-to-end ViNe that can be established at different levels like the same device, a different device, and a different network. It has a dynamic configuration management system [49]. Figure 7 shows the establishment of the Sky model. It can be labeled as an organization up-layer of clouds, submission variable computing ability and storage resources with vibrant sustenance to real-time strains. Laying a virtual site over disseminated resources, uniting the ability to trust remote sites with a trusted networking situation [50]. After the study of different sections of the Sky computing model, we look at the research paper where different search present different models about sky computing [51].

6. IMPORTANT RESULTS

In this section, we present those papers in which different research present the sky computing model. Provide information about the sky model and its different sections are present in Table 2. Sky computing is a new computing model leveraging resources of multiple cloud providers to create a large-scale scattered infrastructure. The Sky is research creativity capable of making a framework for utilizing different CC's as services across many locations as a Sky model [52]. Figure 8 present the skey computing model and it different elements with their working models.

Table 2. Literature summary

Year	Model	Summary	Ref
2008	Sky computing	Provide information about the new mode	[53]
2009	Sky computing	The basic paper where author present information about sky model	[54]
2010	Cloud and sky	Present information about cloud and next generation about sky	[55]
2011	Cloud and sky	Present security information in both model	[56]
2014	Cloud and sky	Information about cloud and present future model sky	[57]
2016	Sky computing	Present information about different domain of the proposed model	[58]
2019	Sky computing	When Clouds Start Socializing The Sky Model	[59]
2022	Cloud and sky	Present cloud model and it future direction	[60]
2024	Sky computing	Present the layer structure of new model	[61]
2025	Sky computing	The author present neural network for may cloud interaction in to sky	[62]
2025	Sky computing	Author present emerging computing architectures and mention sky	[63]
2025	Cloud computing	Author present Next generation cloud computing	[64]

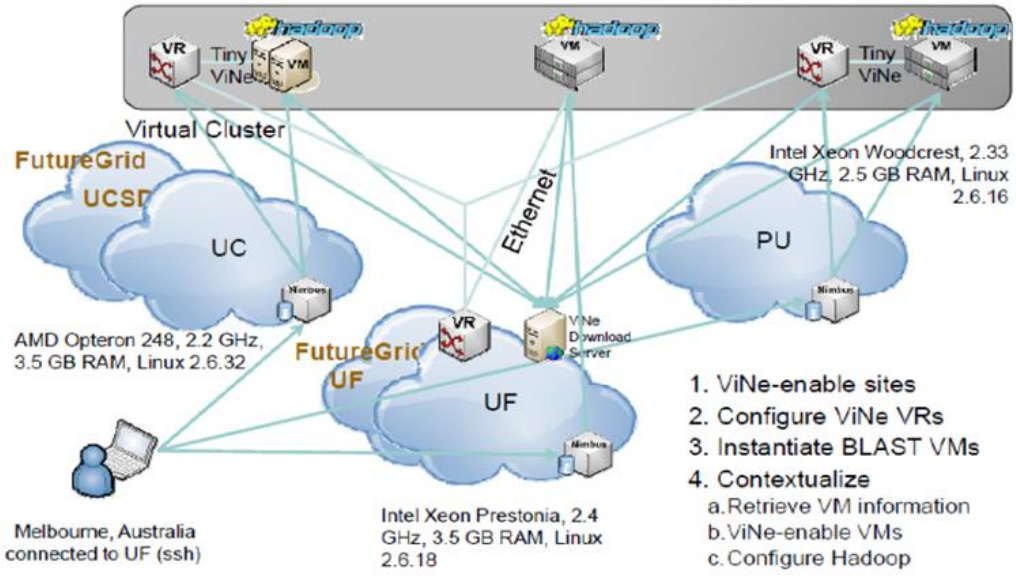

Figure 8. Sky model [65]

The study of related works and the summarization of papers show that different researchers are implementing sky computing as a model. The architecture they join and combine different cloud resources or cloud as a cloud may be private or public and merge them with the help of a middleware controller. This middleware flawlessly distributed resources upon the overhead layers' requests, allowing monitoring and clerical for indicting purposes [66]. Secondly, the researcher chose from the available open-source software to combine parts of the model and make it work one by one. After many examinations and updates, some improvements were made to enhance the system. They were able to declare the result about sky computing. Some of the main results about this model are as follows: The proposed Sky model should open new possibilities for the current cloud computing model. By and huge, the extant business model is cloud-user. Though a wide-open window of opportunities is out, clouds intermingle with other clouds to work together and synergize [67]. Currently, the business-to-business (B2B) business-model that exists between the customary e-businesses. This kind of teamwork essentially involves validating rigorous business strategies and agreements between the clouds themselves and more decisively between the Sky, as a whole, and the end-users. Examples of this kind of business are subcontracting and outsourcing, and partnership [68].

7. SKY MODEL CHALLENGES

The adoption of cloud computing is already concerned with different kinds of challenges and open issues. Due to those issues, cloud providers like Amazon, Microsoft and Google) used other technologies and visions to overcome these issues. When they adopt this new model, they may be faced the above issues. Standardization is also an issue in the sky model because of differences among different clouds and users. This process unavoidably demands standardizing the necessary storage system and processing system [69]. Trust and privacy both are the main issues in the sky computing model also. This is due to concern of cloud connection as well as user site. So, the trust and privacy are more focused in the sky model because it consists of different layers and more connection sections; therefore, need more security options [70]. Services level arrangement (SLA) is an important issue was in cloud computing, and it will be the issue in sky computing. We should remember that predicting the performance of separated cloud services is convoluted enough due to the wide use of virtual machines. So, services level arrangement is also an important issue that exit in the Sky computing model [69]. Designing and implementing issues also exist in sky computing from the study of related work. It seems that different kinds of issues exist on different platforms. Some of them are registered, identifying others, establishing social connections, and eventually interacting with each other [71].

8. CONCLUSION

Sky computing is an advanced computing system model where multiple clouds are joined together for sharing the process of resources and management in one place. Establishing and maintaining sky computing is very difficult. Their connectivity and architecture are also actual demanding. Furthermore, in sky computing, scalability and distribution of computing and their measurement to recover from fault is essential for application and good performance. Sky computing is a newly emerging field in the research area. The Sky is computing working on run environment and distributed environment each node is connected. Future work needs improvements in end-to-end network connectivity, QoS, recovery performance, optimization, security, and multiple cloud improvement. Now it is time to establish sky computing due to big data and IoT devices, so for that reason need more and more research about this model and its implementation.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this paper.

INFORMED CONSENT

This study did not involve human participants; therefore, informed consent was not required.

ETHICAL APPROVAL

This article does not contain any studies with human participants or animals performed by any of the authors; therefore, ethical approval was not required.

DATA AVAILABILITY

This is Review paper not need any kindly of data and other information.

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