Vidhyayana - ISSN 2454-8596
An International Multidisciplinary Peer-Reviewed E-Journal
www.vidhyayanaejournal.org
Indexed in: Crossref, ROAD & Google Scholar

48

Integration of Cloud with AI, Mobile and IoT: A Comprehensive Review

Sakshi Patil

School of Computer Science, MIT World Peace University Pune, India

sakshivivekpatil2000.sp@gmail.com

Rutik Indulkar

School of Computer Science, MIT World Peace University Pune, India

rutik1612@gmail.com

Subodh Hande

School of Computer Science, MIT World Peace University Pune, India

handesubodh@gmail.com

Abstract:

Cloud computing offers computing resources over the Internet. Scalability, cost efficiency, virtualization, elasticity features of cloud computing provide various opportunities to service providers, large to medium organizations and individuals to grow their businesses. Due to advancement in technologies that are surrounded by cloud computing, it is impossible to imagine cloud computing domain in isolation. Artificial Intelligence (AI), Internet of Things (IoT), mobile technology, biometric technology, data science, Human Computing Interface (HCI), Digital Image Processing (DIP) based systems are generating gigantic amount of data and demanding extensive number of computations that are beyond the handling capacity of local computing and storage environment. Extensive storage and computation requirements of these technologies are fulfilled by cloud computing environment. Here comes the need of integrating cloud computing technology with other domains. In this paper, we have reviewed integration of cloud technology with one of the three prominent domains such as Artificial Intelligence, IoT and Mobile technologies. Authors have comprehensively analyzed need, benefits and mechanisms supporting integration of cloud with AI, IoT and Mobile technologies.

Keywords: *Cloud Computing, Artificial Intelligence, IoT, Mobile Cloud Computing.*

I. INTRODUCTION

Delivering computer services through the cloud (Internet)., including servers, storage, databases, networking, software, analytics, and intelligence, is known as cloud computing. These resources could be anything from browser-based software programs to third-party servers used to support the computing infrastructure of a business, research project, or personal undertaking. They could also include third-party data storage for pictures and other digital media. Cloud resources are available in a range of delivery methods, each of which provides clients with varying levels of support and flexibility. Infrastructure as a Service (IaaS), Software as a Service (SaaS), and Platform as a Service (PaaS) are the three primary methods for delivering cloud services. Depending on the IT requirements and budget of a company, each of the three models has a particular purpose. But, compared to onsite hosting, they all provide organizations with a lot more flexibility. Depending on the demands of the business, each of these service models can be utilized separately or in combination with another [1, 2].

On-demand self-services, broad network access, quick flexibility, security, sustainability, measured service, resource pooling, etc. are some of the characteristics of cloud computing. These characteristics present a wide range of revolutionary prospects for both individuals and businesses. There are three main benefits to cloud computing 1) Data backup and restoration: Once data is saved in the cloud, using the cloud for data backup and restoration is easier. 2) Enhanced collaboration: Cloud applications enhance collaboration by enabling teams to share information swiftly and easily on the cloud via shared storage. 3)Reduced maintenance costs: Organizations using cloud computing save money on both hardware and software upkeep [3, 4].

Whilst the cloud has numerous advantages, it also has its own set of hazards, expenses, and ethical concerns that must be addressed. All cloud users must consider some of these challenges, whereas businesses and organizations that use the cloud to store client data may find some of them more relevant: Given the use of APIs, cloud-based credentials, and on-demand services that make it simpler for attackers to get unwanted access, cloud resources may have additional security flaws. The condition known as vendor lock-in, in which it becomes difficult or impossible to switch providers after computing processes are built to fit a closed, proprietary system, may put users of proprietary cloud services at greater danger. An organization's computing resources moving to the cloud can be a very complicated process that needs careful planning, governance frameworks, and ongoing monitoring to prevent incompatibilities, data loss, and cost reduction. Resource allocation, data lock-in, scalability, security, interoperability, incast are some of the important issues in cloud computing [5, 10, 11, 12].

A set of tools and technologies known as cloud integration connects various apps, systems, repositories, and IT environments to share data and perform processes in real-time. Cloud integration refers to deployments that are either entirely in the cloud or hybrid; the final objective is to operate as a unified IT infrastructure that streamlines data flow. With the continued growth in the use of Software as a Service (SaaS) solutions, cloud integration has become more and more common. According to studies, more than 90% of businesses use multiple clouds, and conventional product delivery will soon be surpassed by SaaS usage [6]. In this paper, we have comprehensively analyzed cloud computing integration with other technologies such as mobile, IoT and artificial intelligence.

II. CLOUD INTEGRATION WITH AI, MOBILE AND IOT

The process of integrating data from remote SaaS (software as a service) apps and cloud services with local, on-premises servers is known as cloud integration. Solutions for cloud integration are developed to eliminate data silos, boost connectivity and visibility, and eventually improve business operations. Data sharing and information component unification among cloud-based apps are needs that are addressed by data integration tools.

Integrating Cloud with AI: Cloud-based artificial intelligence (AI) is a potent technology that can automate monotonous chores, enhance decision-making, and boost productivity. Machine learning is a branch of artificial intelligence that trains computers to perform human-like tasks like speech recognition and image processing by using algorithms to solve challenging problems [7].

Integrating Cloud with Mobile: Mobile cloud computing (MCC) uses cloud computing to send apps to mobile devices. The term "mobile cloud" describes cloud-based information as well as mobile-optimized software and services. It combines cloud-based services with mobile application development to enable the delivery of cloud services and applications to mobile users [8].

Integrating Cloud with IoT: IoT devices can take advantage of a variety of cloud computing services, including data processing, analysis, and storage. Additionally, cloud computing enables users of IoT devices to perform routine computing chores using services that are entirely offered online. It is very affordable to integrate IoT and cloud computing, particularly in an enterprise setting. The business can employ cloud service providers instead of having to own all the hardware, software, and services [9].

Benefits of Integrating Cloud Services with other domain:

- Flexibility in the sharing, storing, and accessing of information
- Scalability that permits quick adjustments
- All cloud applications and on-premises platforms can be combined.
- Businesses can view and see all of their data through the use of cloud system integration, which also improves functional connectivity.
- Lower operating expenses and higher revenue
- Enhanced customer assistance, loyalty, and retention
- Utilizing cloud data integration, businesses can function more efficiently and quickly with the synchronization of data and applications.

III. ALGORITHMS AND METHODS SUPPORTING CLOUD INTEGRATION WITH AI, MOBILE AND IOT

[A] Algorithms and methods for cloud integration with AI

1)Smart risk assessment modeling approach

The following proposed methodology used to construct a model for performance evaluations using AI approaches and linear regression algorithms (Machine learning). The purpose of this work is to create a reliable and effective practical method for risk assessment in the cloud computing environment. The suggested smart risk assessment modeling strategy is executed in three stages utilizing an ML model. Throughout this study, three methods were used as the foundation algorithms for analyzing the risk variables that are related to the cloud computing environment. The algorithms in dispute include Highly Randomized Decision Trees, K*, and Randomizable Filter Classifier. These algorithms are commonly used for data analysis and have proven to be useful in practice. Machine Learning Techniques used for Cloud Risk Assessment are given as follows.

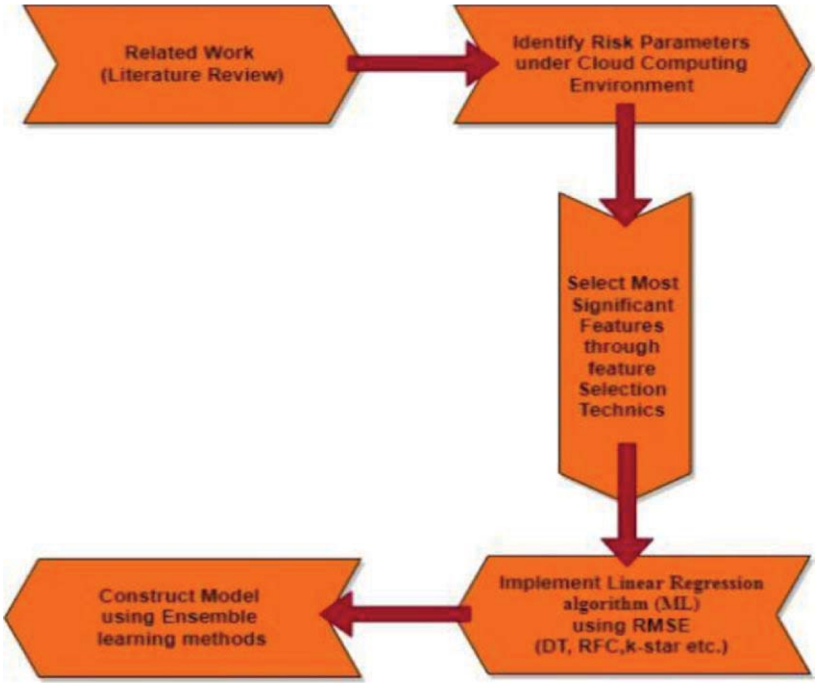


Figure-1: Machine Learning Techniques used for Cloud Risk Assessment

A poll was conducted to finalize risk variables. It asks participants to categorize risk variables into three unique strata based on their likelihood of occurrence and influence on CC. These classes produced the following outcomes:

In each column, the best performance in terms of the RSME (Root Mean Square Error) metric is underlined. In k-mean, the system's performance is evaluated, whereas SVM serves to analyze the system's performance. The RMSE performance of the proposed between the suggested model and the complete dataset percentages shows that an extra training data proportion of around (5% testing and 95% training) gives the best results, indicating better learning. According to the results, the RSME effectiveness of the suggested predictive model is better in the case of decision tree and k* algorithms, whereas the previous was better in the case of the randomizable filter classifier [13].

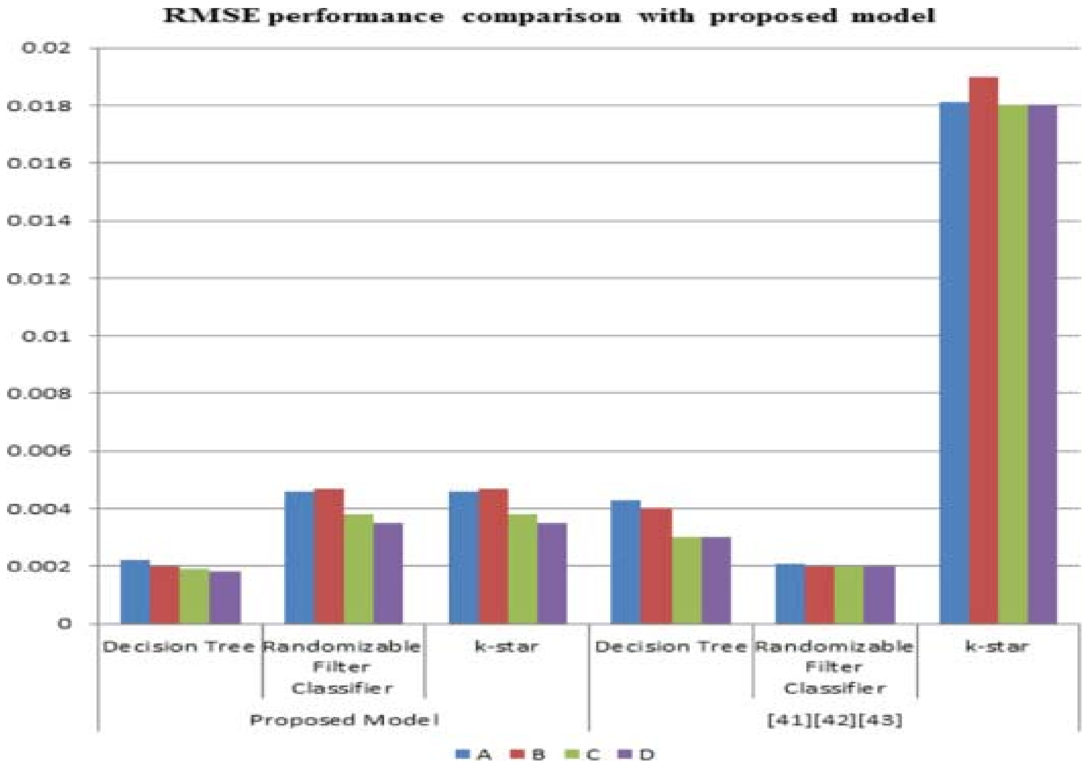


Figure-2: RMSE Performance comparison with other models

2)AI based load balancing method

Load balancing is an essential component of cloud computing and elastic scalability. Load balancing is frequently used to avert system failure by managing input traffic and stopping forwarding extra workload to overloaded resources. There are numerous different types of load balancing systems and approaches. Most research has categorized into two basic categories: static and dynamic. Static approach is based on prior knowledge including capacity of device to store data, processing power, amount of time required for communication, requirement of resources. Dynamic methods for load balancing take into account the present condition of the systems on which their decisions are based. In dynamic method, proactively workload is allocated to underloaded device by taking away from overloaded device. Static load balancing is considered as less efficient but less complicated as compared to dynamic load balancing. Accurate solutions, optimal performance is obtained through dynamic approach.

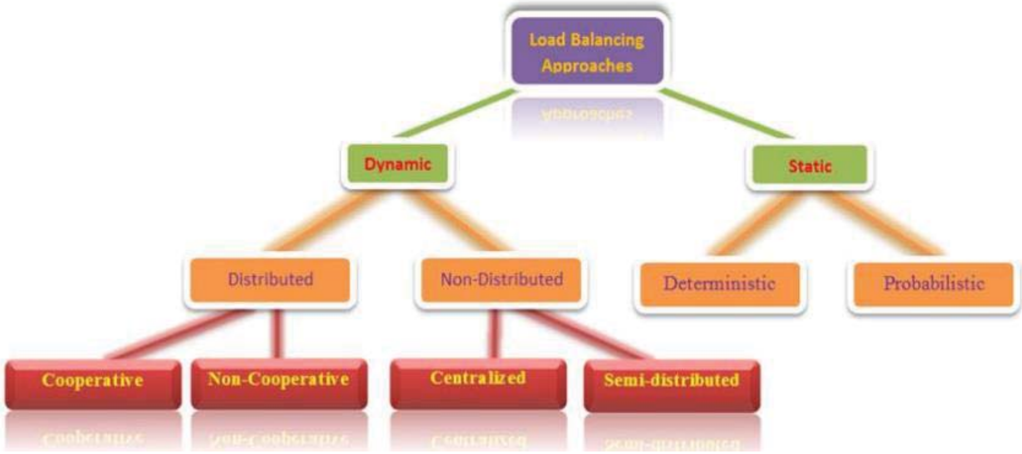


Figure-3: Types of load balancing

AI-based techniques present a solution for balancing workloads in cloud computing environments by exploiting similarities between known artificial intelligence algorithms and methodologies and cloud computing components and concepts. Ant Colony Optimization (ACO) is a novel approach which is used for balancing load in cloud environment. It ensures that the workload will be evenly distributed during peak time. In ACO technique, ants are generated by head device. Ants surrounds across cloud infrastructure to locate nodes that are either overloaded or underloaded. A pheromone table is updated as a result of movement of ants. Resource utilization information is stored into the pheromone table. Furthermore, ant migrations are proposed in two methods, that is forward motion and reverse movement.

Loads will be moved from overloaded nodes to underloaded nodes based on the forward and reverse moves and the pheromone table [14].

3)Long Short-Term Memory (LSTM) prediction methodology

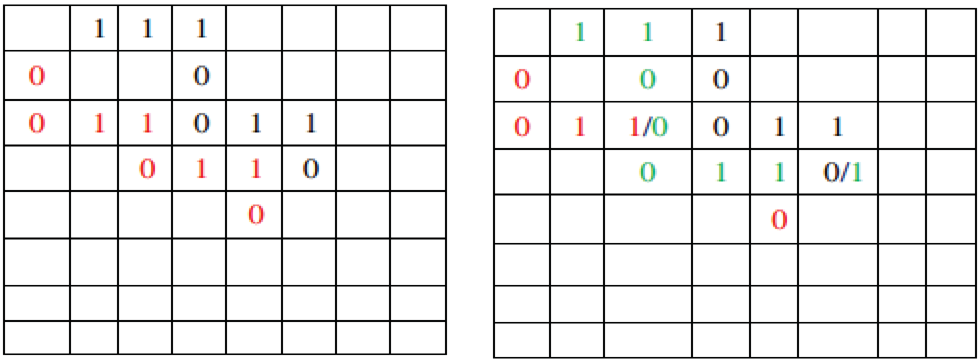
In recent times, network function virtualization infrastructures have used traffic and cloud resource prediction algorithms to allocate bandwidth and cloud resources. Both conventional and cutting-edge prediction techniques have been put forth. For instance, it has been demonstrated that resource allocation using Long Short-Term Memory-based prediction approaches is particularly effective. Since it is impossible to predict traffic properly, forecasting methods estimate traffic with respect to costs of provisioning. Attempting to reduce an asymmetric cost function with a parameter that accounts for the expenses of both over- and under-provisioning. In this work, a traffic prediction strategy using a LSTM is used. However, the idea of the presented solution can be applied to any prediction technique. As compared to prediction strategies based on minimizing the symmetric cost functions of the prediction error, the suggested prediction technique has cost advantages of 40% in an NFV network scenario with the connectivity of four NFVI-PoPs [15].

[B] Algorithms and methods for cloud integration with mobile technology

1). Dynamic programming offloading algorithm for mobile cloud computing

By running some parts of a mobile application on the cloud, computational offloading is a practical way to overcome the mobile device's short battery life. The algorithm quickly locates an almost ideal offloading solution using randomness and a hamming distance termination requirement. This offloading algorithm offloads large number of tasks in cloud environment whenever bandwidth of network transmission is high. This helps to improve overall task execution time and reducing the energy consumption of the mobile device. Dynamic Programming with Hamming Distance Termination (DPH) is the title of the promoted algorithm. The bit-streams that demonstrate which jobs should be offloaded are stored in this method using a N*N table, N indicates number of total tasks. A random bit stream is created in the first stage to choose a first solution. The next horizontal cell in the table will receive the 1s from this stream, while the next vertical cell will receive the 0s. Starting cells are (1, 2) for streams where the first bit is 1 and (2, 1) for streams where the first bit is 0. With this method, unnecessary computations for typical bit strings will be avoided [24].

Figure-4 consists of 2 2D 8x8 tables. To be clear, let's say that N = 8 and that the first random stream is either 00110110 (red numbers) or 11100110 (black numbers), with two samples of each. Assume that 11000111 is the second random bit stream in each scenario which is shown in second 8x8 table on the right side. Since the first bit in the second stream is 1, the starting cell is (1, 2). Figure-4 illustrates the resulting green stream after filled the table according to the aforementioned rules.



	1	1	1				
0			0				
0	1	1	0	1	1		
		0	1	1	0		
				0			

	1	1	1				
0		0	0				
0	1	1/0	0	1	1		
		0	1	1	0/1		
				0			

Figure-4: Bit-stream rules for job offloading

Every time a bit stream is generated at random, energy is computed and execution time used by each cell (or task) in the table, as well as the overall energy and execution time of this bit stream. However, if a random bit stream is generated that shares some cells with a string that already exists in the database, we only calculate the new string's total energy up until the first shared cell before comparing it to the old total energy at this cell. We maintain the new sub-string, delete the old sub-string, and replace the total-energy and cell-energy of this cell with new amounts if the new total energy at this particular cell is smaller than the previous one. Based on the changed values at this common cell, we next update the energy and execution time of the remaining cells for the current bit stream. Alternatively, we shall follow the same approach while maintaining the current stream if the total energy of the existing bit stream is lower than that of the new bit stream at the common cell. We continue to monitor the stream's placement in the database as new streams are generated. We give up and accept a solution with a greater Hamming distance than a from a stream of all 1 with a set threshold. The scenario where all components are run locally is referred to as the "all 1 stream." The algorithm may end, for instance, when 70% of the jobs have been offloaded or after K=20 rounds. This heuristic termination criterion produces effective outcomes.

2)Green Cloud Computing in Mobile Cloud Computing:

Green computing is a field of technology that mainly concentrates on recycling as a means to safeguard the environment's precious resources, including electricity. Fog computing, edge computing which are recent prominent technologies can play an important role by contributing to the mobile computing technology. Resource efficiency and lower energy use can be firmly ensured when fog and edge computing complements to mobile cloud technology. Fog computing actually considered cloud computing’s expanded form. In this fog computing data is transferred from edge devices to the cloud through a layer of fog which is considered as an intermediator between edge and cloud. This helps to enhance some cloud computing features by introducing privacy, reducing latency, and location awareness because it is closer to the end user [23].

here are number of strategies that can be followed towards green computing:

a) Recycling of materials is a method of reusing components, which lowers the quantity of waste produced. There are two categories of recyclers: formal recyclers, who are businesses with government authorization to undertake recycling procedures, and informal recyclers, which are regular people without that authorization.

b) More effective data center conditioning methods: Placing the servers close to the cooling systems so that cold air concentrates on the primary site is one strategy to maximize the use of the cooling systems in addition to the effectiveness of the cooling device.

c) Effective server allocation: We must utilize effective algorithms to ensure that resources are allocated correctly if we are to improve the efficiency of our data centers. This can be accomplished in data servers by assigning servers to run operations in accordance with the speed of data receiving and sending.

d) Green data centers: The utilization of renewable energy is the primary goal of green data centers in order to save the environment.

e) Correct trash disposal requires the proper disposal of any component that cannot be recycled. It is ensured that there will be no or very little environmental effect by making sure such parts are disposed of properly.

3). Resource allocation in mobile cloud computing:

Mobile cloud service providers have the option of billing cloud resources for compute and storage. The radio and computer resources used in mobile cloud computing are resources. The brains of mobile cloud computing are these radio and computing resources. The goal of resource allocation is to allocate resources as cheaply as possible. The number of resources allocated to the user from the available resources is referred to as the resource allocation. This study uses optimization approaches to allocate resources to users. In mobile cloud computing, resource allocation is carried out using three optimization strategies that is linear programming, stochastic optimization and robust optimization [21].

[C] Algorithms and methods for cloud with IoT

There are various algorithms that can be used for cloud computing with IoT, depending on the specific use case and requirements.

1)Data Storage Algorithms:

Data storage algorithms are used to store and manage large amounts of data generated by IoT devices in the cloud. Here are three examples of data storage algorithms that are commonly used for cloud computing with IoT:

Distributed File Systems: IoT devices generates huge data which is to be stored and processed efficiently. Enormous data generated by IoT devices can be stored in cloud data centers. Cloud data centers are also containing computational servers that are used to process huge amount of data generated through IoT devices. Vast amount of data stored across several severs within data center is managed by distributed file system. These systems typically consist of a cluster of servers, each with its own storage capacity, that works together to provide a single, unified file system to clients. Examples of distributed file systems that are commonly used in cloud computing with IoT include Hadoop Distributed File System (HDFS) and Google File System (GFS) [16]. Figure-5 shows distributed file system architecture.

Object Storage: Rather than files data can be stored as object. Each object consists of the data itself along with metadata that describes the object. Object storage systems are designed to provide high scalability, availability, and durability, making them well-suited for storing large amounts of data generated by IoT devices. Examples of object storage systems that are commonly used in cloud computing with IoT include Amazon Simple Storage Service (S3), Google Cloud Storage, and Microsoft Azure Blob Storage [17].

NoSQL Databases: Cloud computing users stores variety of data on cloud data centers. These data include videos, images, text and so on. Storage of this variety of data requires special mechanisms so that it can be managed and accessed efficiently. Semi-structured and unstructured data storage need a service of NoSQL database. These databases typically provide high scalability and performance, making them well-suited for storing and managing large amounts of data generated by IoT devices. Examples of NoSQL databases that are commonly used in cloud computing with IoT include Apache Cassandra, MongoDB, and Couchbase.

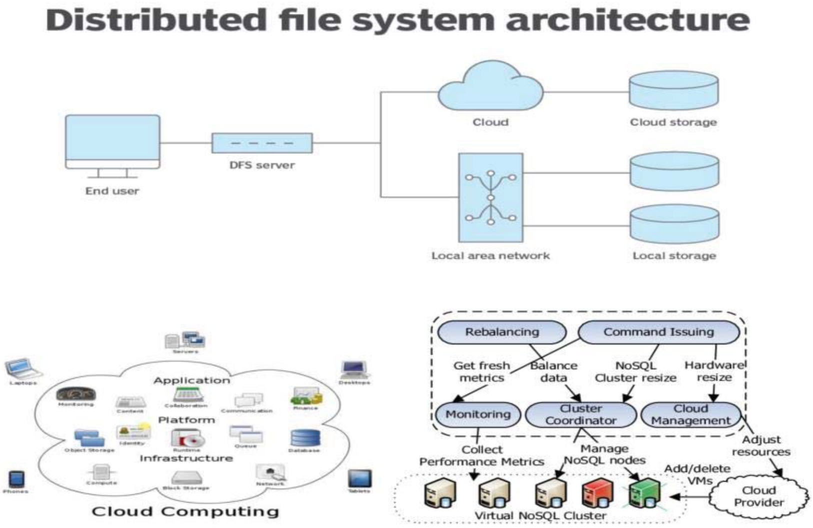


Figure-5 Distributed file system architecture

2)Data Processing Algorithms

Data processing algorithms are used to process and analyze the large amounts of data generated by IoT devices in the cloud. Here are three examples of data processing algorithms that are commonly used for cloud computing with IoT. These data processing algorithms are designed to process and analyze large amounts of data generated by IoT devices in the cloud, to extract insights and provide actionable intelligence to organizations.

Stream Processing: Stream processing is a method of processing real-time data as it is generated by IoT devices, rather than storing it first and then processing it later. This is especially useful in applications such as real-time monitoring, fraud detection, and predictive maintenance, where immediate action is required. Stream processing algorithms typically use techniques such as filtering, aggregation, and windowing to analyze and transform data in real-time. Examples of stream processing platforms that are commonly used in cloud computing with IoT include Apache Kafka, Apache Flink, and Amazon Kinesis [18].

Batch Processing: Batch processing is a method of processing data in large batches, typically stored in files or databases, at periodic intervals. Batch processing algorithms are well-suited for applications such as data warehousing, analytics, and reporting, where historical data is analyzed to identify trends and patterns. Batch processing algorithms typically use techniques such as sorting, filtering, and aggregation to analyze and transform data in batches. Examples of batch processing frameworks that are commonly used in cloud computing with IoT include Apache Spark, Apache Hadoop, and Amazon EMR.

MapReduce: Across the distributed system, to process huge data parallelly it is one of the prominent tools used under cloud computing domain. MapReduce model consists of 2 different phases first is map and second is reduce. Workloads are assigned to map phases for processing. Once map phases process their corresponding workloads, results are assigned to reduce phase. Reduce phase combines all the results submitted by all maps. After integrating results from all map phases reduce phase submits final collective results to the users. Numerous servers in the distributed system parallelly process small chunk of data which is divided by algorithms of MapReduce. Final output is then obtained by combining results submitted by numerous servers of distributed system. MapReduce algorithms are well-suited for applications such as indexing, search, and machine learning, where large amounts of data need to be processed in parallel. Examples of MapReduce frameworks that are commonly used in cloud computing with IoT include Apache Hadoop MapReduce and Google Cloud Dataflow [19].

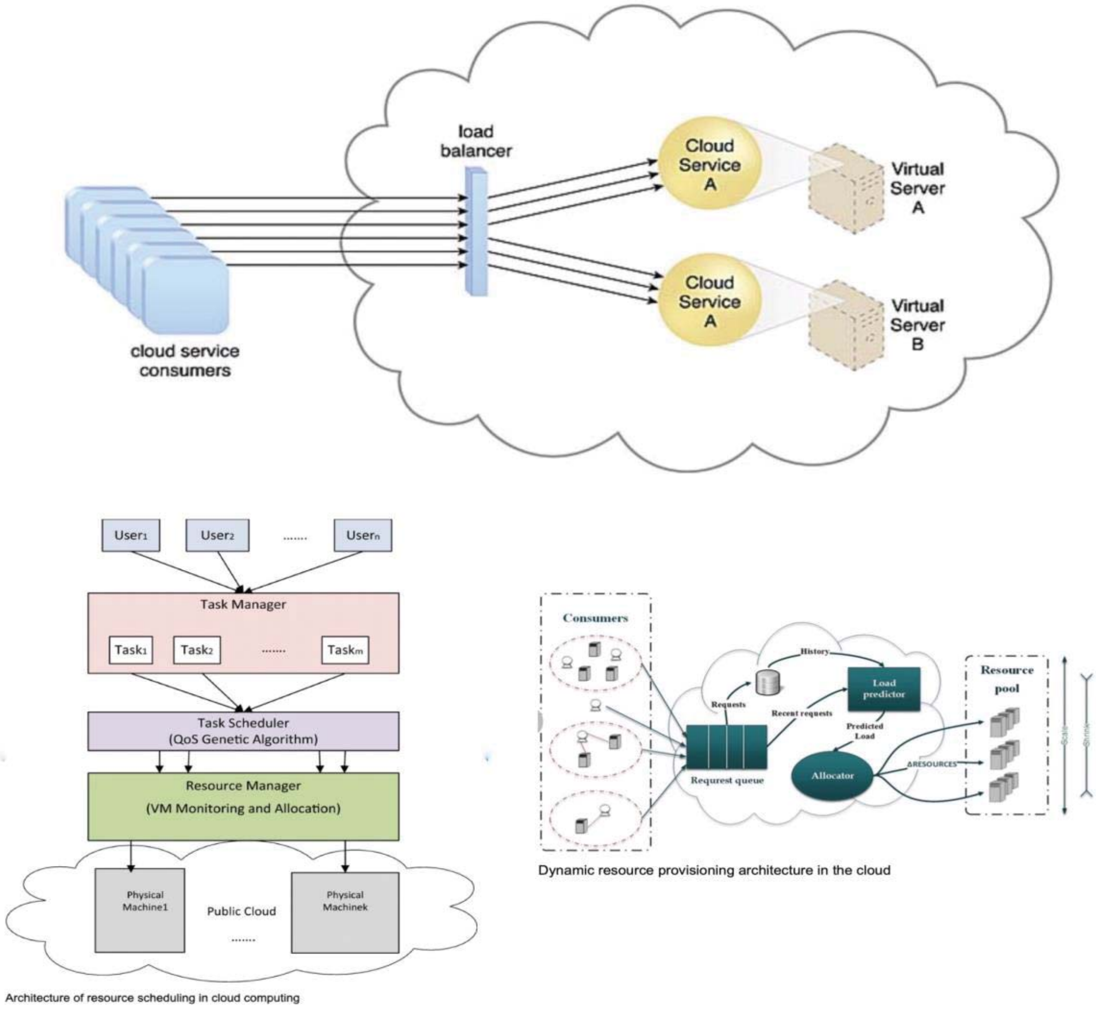
3)Resource Allocation Algorithms

Resource allocation algorithms are used to optimize the utilization of resources, such as processing power, memory, storage, and network bandwidth, in a cloud computing environment with IoT. Here are three examples of resource allocation algorithms that are commonly used for cloud computing with IoT. These resource allocation algorithms are designed to optimize the utilization of resources and improve the performance, scalability, and availability of cloud computing with IoT. The choice of algorithm depends on the specific requirements of the system, such as workload characteristics, resource availability, service-level agreements (SLAs), and cost constraints.

Load Balancing: It is one of the important features of cloud computing domain where incoming traffic is distributed towards various servers. The main aim of load balancing is to ensure that no single server is overwhelmed with requests. Load balancing algorithms can be used to optimize the performance, scalability, and availability of IoT applications that require high throughput and low latency. Examples of load-balancing algorithms that are commonly used in cloud computing with IoT include round-robin, least connections, and weighted round-robin [21].

Resource Scheduling: Resource scheduling algorithms allocate resources to tasks based on their priority, deadline, and resource requirements. Resource scheduling algorithms can be used to optimize the utilization of resources and reduce the waiting time for tasks. Examples of resource scheduling algorithms that are commonly used in cloud computing with IoT include Deadline-Monotonic Scheduling (DMS), Rate-Monotonic Scheduling (RMS), Earliest Deadline First (EDF).

Dynamic Resource Provisioning: Dynamic resource provisioning algorithms automatically adjust the allocation of resources based on the workload and demand of the system. Dynamic resource provisioning algorithms can be used to optimize the efficiency, scalability, and cost-effectiveness of cloud computing with IoT. Examples of dynamic resource provisioning algorithms that are commonly used in cloud computing with IoT include auto-scaling, dynamic scaling, and predictive scaling [21]. Figure-6 shows the collaborative working of load balancing, resource scheduling and dynamic resource provisioning.



Architecture of resource scheduling in cloud computing

Dynamic resource provisioning architecture in the cloud

Figure-6 Resource allocation in Cloud IoT

IV. ANALYSIS AND CONCLUSION

Cloud computing recently gave smart phone augmentation fresh research push, which resulted in the birth of the mobile cloud computing paradigm. The ultimate objective of MCC is to deliver rich mobile computing through seamless communication between front-users (cloud-mobile users) and end-users (cloud providers), independent of heterogeneous, wireless settings and underlying platforms in international roaming. Data processing capacity is now viewed as a key resource in many countries due to the rapid increase in data computation in science and business. We come to the conclusion that there are a few key optimization strategies in MCC that concentrate on the constraints of mobile devices, the quality of communication, the division of application services, the standard interface, the quality of service, and trust, security, and privacy issues. The best method for ensuring application service in MCC is thought to be the deployment of an efficient elastic application division mechanism; this method is complex but offers high-impact outcomes.

The transition to cloud computing has advanced significantly, with the majority of telecommunications firms aiming to modernize legacy networks dependent on network function virtualization with software-defined networking in order to compete and survive in the pressure of a rapidly changing environment. AI is important to add value to the cloud, resulting in improved traffic classification, more precise network fault predictions, time optimization, and improved customer services. Therefore, a better business model has been found using cloud computing and AI. The AI and cloud computing approach, however, works well for telecom firms with a vast client base and several activities running simultaneously. The study makes a minor contribution to our understanding of how huge businesses like telecoms might increase their effectiveness through managerial strategies as well as technical advancements like the combination of cloud computing and artificial intelligence.

The IoT is evolving into a more pervasive computing service that demands enormous amounts of data storage and processing power. The integration of the Cloud into the IoT is highly helpful in terms of overcoming these obstacles because the IoT has limited processing power and storage capacity, as well as significant issues like security, privacy, performance, and dependability. We discussed the need for developing an IoT method based on the cloud in this study. The Cloud-based IoT Architecture, various application scenarios, difficulties in successful integration, and open research paths were also discussed. Numerous case studies will be conducted in the future to evaluate the efficacy of the cloud-based IoT method in healthcare applications.

REFERENCES

[1] Sriram, Ilango, and Ali Khajeh-Hosseini. "Research agenda in cloud technologies." *arXiv preprint arXiv:1001.3259* (2010).

[2] M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. Katz, A. Konwinski, et al., "A view of cloud computing," Communications of the ACM, vol. 53, pp. 50-58, 2010.

[3] Durao, Frederico, Jose Fernando S. Carvalho, Anderson Fonseka, and Vinicius Cardoso Garcia. "A systematic review on cloud computing." *The Journal of Supercomputing* 68 (2014): 1321-1346.

[4] Lu, Gang, and Wen Hua Zeng. "Cloud computing survey." In *Applied Mechanics and Materials*, vol. 530, pp. 650-661. Trans Tech Publications Ltd, 2014.

[5] Fox, Armando, Rean Griffith, Anthony Joseph, Randy Katz, Andrew Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, and Ion Stoica. "Above the clouds: A berkeley view of cloud computing." *Dept. Electrical Eng. and Comput. Sciences, University of California, Berkeley, Rep. UCB/EECS* 28, no. 13 (2009): 2009.

[6] Malik, Akash, and Hari Om. "Cloud computing and internet of things integration: Architecture, applications, issues, and challenges." *Sustainable cloud and energy services: Principles and practice* (2018): 1-24.

[7] El Khatib, Mounir M., Ahmed Al-Nakeeb, and Gouher Ahmed. "Integration of cloud computing with artificial intelligence and Its impact on telecom sector—A case study." *iBusiness* 11, no. 01 (2019): 1.

[8] Fernando, Niroshinie, Seng W. Loke, and Wenny Rahayu. "Mobile cloud computing: A survey." *Future generation computer systems* 29, no. 1 (2013): 84-106.

[9] Patil, Charushila, and Anita Chaware. "Integration of Internet of Things, Cloud Computing." In *IOP Conference Series: Materials Science and Engineering*, vol. 1022, no. 1, p. 012099. IOP Publishing, 2021.

[10] Suryavanshi, Mahendra, and Jyoti Yadav. "Mitigating TCP incast in data center networks using enhanced application layer technique." *International Journal of Information Technology* 14, no. 5 (2022): 2523-2531.

[11] Popović, Krešimir, and Željko Hocenski. "Cloud computing security issues and challenges." In *The 33rd international convention mipro*, pp. 344-349. IEEE, 2010.

[12] Ghanam, Yaser, Jennifer Ferreira, and Frank Maurer. "Emerging issues & challenges in cloud computing—a hybrid approach." (2012).

[13] Abhishek Sharma, Umesh Kumar Singh. “Modelling of smart risk assessment approach for cloud computing environment using AI & supervised machine learning algorithms.” Global Transitions Proceedings Volume 3, Issue 1, June 2022, Pages 243-250

[14] Mohammadreza Mesbahi, Amir Masoud Rahmani. “Load Balancing in Cloud Computing: A State-of-the-Art Survey.” I.J. Modern Education and Computer Science, 2016, 3, 64-78

[15] Vincenzo Eramo, Francesco Giacinto Lavacca, Tiziana Catena and Paul Jaime Perez Salazar. “Proposal and Investigation of an Artificial Intelligence (AI)-Based Cloud Resource Allocation Algorithm in Network Function Virtualization Architectures.” Proceedings of the 22nd International Conference on Transparent Optical Network (ICTON), Bari, Italy, 19–23 July 2020

[16] Caiyun Xu. “Research On Data Storage Technology in Cloud Computing Environment”. In *IOP Conference Series: Materials Science and Engineering 394(3):032074.*

[17] Junhua Zhang, Dong Yuan, Lizhen Cui, Bing Bing Zhou, School of Software, Shandong University, Jinan, China, School of Information Technology, the University of Sydney, Sydney, Australia. “A highly efficient Algorithm towards optimal Data Storage and regeneration cost in multiple clouds”.

[18] Madhavi Vaidya, Shrinivas Deshpande, Vilas Thakare. Design and Analysis of Large Data Processing Techniques. InInternational Journal of Computer Applications (0975 – 8887) Volume 100– No.8, August 2014

[19] Jisheng Cui, Yunsong Liu, Peng Qiu, Hao Yu. Research on Data Processing Algorithm of the Same Time Section in Substation Based on Time Scale Information

Transmission. In 2019 6th International Conference on Information Science and Control Engineering (ICISCE).

[20] Haitham Salman Chyad, Raniah Ali Mustafa, Kawther Thabt Saleh. Department of Computer Science College of Education Mustansiriyah University. Study and Implementation of Resource Allocation Algorithms in Cloud Computing.

[21] Muhammet Tay, Arafat Senturk. Research on resource allocation algorithms in content of edge, fog and cloud. Duzce University, Graduate Instıtute, Computer Engineering Department.

[22] Vasudeva Rao, GMR Institute of Technology. Resource Allocation in Mobile Cloud Computing using Optimization Techniques. In International Journal of Wireless Communications and Networking Technologies.

[23] Atta-ur-Rahman, Sujata Dash, Munir Ahmad, and Tahir Iqbal. Mobile Cloud Computing: A Green Perspective.

[24] Haleh Shahzad, Ted H. Szymanski. A Dynamic Programming Offloading Algorithm for Mobile Cloud Computing.