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Cloud-based serverless architectures: Trends, challenges and opportunities for modern applications

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Abstract

The paper looks at how cloud computing, which offers flexible, low-cost, and scalable computer resources, has changed the way modern IT infrastructure works. A lot of people are interested in serverless computing because it is cost-effective, uses automatic resource management, and runs programs based on events. In this study, cloud-based serverless architectures are carefully looked at, with a focus on the main ideas, recent changes, problems, and future possibilities. The paper looks at how Function-as-a-Service (FaaS) developed from earlier cloud models like Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). It also talks about how FaaS works with new technologies like blockchain, AI, and the Internet of Things (IoT). Possible study directions are looked into in areas like sustainability, edge computing, and data-heavy workloads. Important issues like scalability, security, and cost management are also looked

Keywords: Cloud-Based; Serverless; Architectures; Foundation of Cloud-Based; Trends

1. Introduction

Cloud computing is one of the most studied and sought-after topics right now [1]. As was already said, companies have become more interested in cloud computing in recent years because of some unstable and crisis-filled times. In particular, the growth of global trade led to a big increase in the size of supply chain networks and more people buying things online [2]. Because of this, huge amounts of data have been collected because of the need for good information management. As businesses become more digital, information handling has become even more important. Industry 4.0 and the Internet of Things are also very important for companies that want to stay ahead of the competition. In light of this, cloud computing is becoming a base for these companies to build their information systems on. That's why cloud computing is becoming more and more important for businesses and management around the world to help them reach their goals.

The serverless model is a big change in the cloud because clients don't reserve hardware resources like they do in standard models. Their code runs based on events like HTTP requests, cron jobs, and more, and they only charge for the resources actually used. The provider is then in charge of giving out resources and jobs. Serverless is mostly promoted as a public cloud service, but there are solutions being worked on and backed by reputable companies that will allow to create serverless platforms for private clouds. Function as a Service (FaaS), the first form of serverless services, has a lot of problems that can make the cons greater than the benefits for both users and providers. For the provider, some of these problems are resource multiplexing issues. For the customer, these issues are cost and stability issues. Each customer and service provider would save a lot of money and energy if these issues were fixed. In order to fix the issues that stop serverless from becoming the standard way to do cloud computing, this chapter presents the most up-to-date study and a full picture of these issues.

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The design of cloud computing is made up of the following parts: Client technology is part of front-end technology. The cloud has a graphical user interface (GUI) that lets talk to it. An app could be any piece of software or a tool that a client wants to use. Does it need some help? Cloud services choose which service to offer based on what the customer wants. These are the three types of services that cloud computing provides: SaaS, which is sometimes called "cloud application services," is a type of service that can get in the cloud. It doesn't have to download and run most SaaS programs because it works right in the web browser. Here are a few well-known SaaS examples Google and Salesforce are examples of apps Cisco Webex, Dropbox, Slack, and HubSpot are all examples of cloud-based apps [3]. PaaS (Platform as a Service) is another name for software applications that operate on the cloud [4][5]. While both SaaS and PaaS enable online software use, PaaS offers an environment in which it can create own applications, whereas SaaS does not. Windows Azure, Force.com, OpenShift, and Magento Commerce Cloud are a few that spring to mind. The acronym for this is IaaS, or "Infrastructure as a Service." This is another term used while discussing cloud services. Keeps track of the runtime parameters, middleware, and data that programmers utilize. Examples abound, including Cisco Meta pod and Amazon Web Services (AWS) EC2. Virtual machines are able to exist and function within the Cloud Runtime Cloud.

The problems with managing serverless computer tools are then shown. This way of delivering services lets people in many fields, like healthcare, banking, government, and more use the internet for services, math, and storage [6][7]. IT-related parts are provided "as a service" in this computing paradigm. This means that people can receive technology-enabled services over the Internet, like the Cloud, without having to understand, be good at, or manage the technology infrastructure that makes these services possible. This piece talks about the terms, features, and services of cloud computing to give a general idea of what it is. It talks about the basic deployment methods that clients and service providers use to set up and run cloud services [8]. A few of them are private, public, group, and mixed clouds. The three main types of service models software as a service, platform as a service, and infrastructure as a service are also talked about. Along with the pros and cons of cloud computing, its trends and challenges are also thought about [9].

There are a lot of cloud possibilities in education that affect a country's economic growth. It's changing how it teaches in the classroom because kids are getting better at using technology [10]. To keep up with the times, it is important to use the newest tools in the classroom. From anywhere and on any device, staff, teachers, parents, and kids can get to important information at any time thanks to the cloud. When businesses and government agencies use the cloud, they can offer better services while using fewer resources. These problems can be fixed with cloud computing tools for the smart education system. With cloud computing, people can access and control their data over the Internet.

2. Fundamentals of Serverless Architectures

A service-less architecture, which is basically an outsourced option, keeps the infrastructure the same [8]. It would be much cheaper to run the business if it only paid the right amount of computations based on the type and amount of traffic, especially for early and dynamic application load needs that change over time.

2.1. Core Concepts Faas (Function as a Service)

Faas and serverless are often used interchangeably because many serverless services can listen to and react to what Faas does. This is different from Faas, which is a part of serverless and is in the compute class. By giving us information about the different types of services and categories that are available, it will be better able to make sure that the organization meets the customers' architectural needs [11]. The three main types of architecture that are the same for all three companies are compute, storage, information shops, and integration. The main point of this study is to look into how Faas works with different serverless systems. Since Faas is the main topic of this study, some compute services are left out to keep things simple.

2.2. Serverless vs Traditional Cloud Models (IaaS, PaaS, SaaS)

Cloud computing service models come in three main types What do SaaS, PaaS, and IaaS stand for? The whole group is shown in Figure 1. Following, it will go into more detail about each one [12].

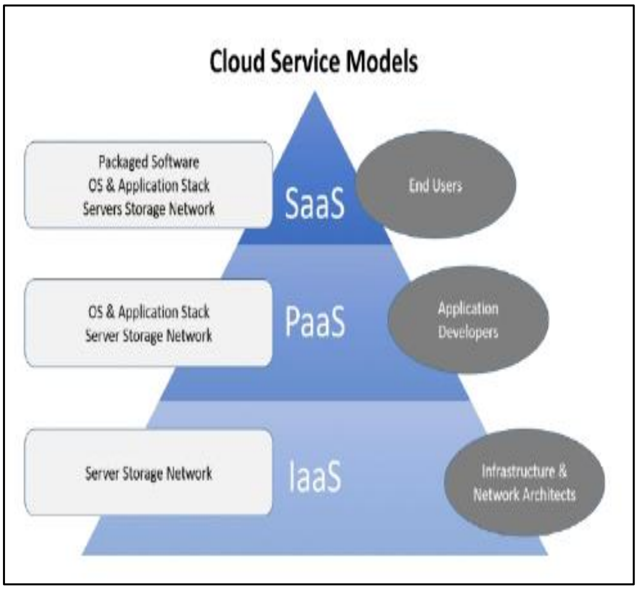

Figure 1 Cloud Service Models (LaaS, PaaS, and SaaS)

2.2.1. (IaaS)

A service provider called IaaS sets up one or more core operational components that run different plans on the virtual server. IaaS stands for "Infrastructure as a Service." It is a centralized, fully automated package that owns and runs a service provider and gives people networking, storage, and computing services when they need them. These things make up Infrastructure as a Service (IaaS), as many people as possible must use the same tools for it to work. The main services are spread out, the price can change, and users pay for them. Users can self-service and auto-supply.

2.2.2. (PaaS)

It's helpful for developers because it can make apps and programs that can be shared over a network without having to set up or handle the production environment. People can rent software-defined computers and the tools that come with them through PaaS. This way, they can run existing software or make and test new versions.

2.2.3. (SaaS)

The network, servers, operating systems, storage, and even certain applications are not under the client's control or management. Because end users can use and administer this cloud-built software, SaaS places a lot of strain on the end-user interface [13]. SaaS includes systems like Google Apps, DeskAway, Wipro w-SaaS, and CRM. SaaS is made up of the following segments) SaaS providers host software for other businesses instead of their own apps on the servers of their clients ii) customers can access the apps whenever it wants and iii) users can access the apps through a web interface that gives them access to all the features and data they need from almost anywhere with an internet connection. Although this setup limits the customer's freedom, it also gives several employees some room for move. For instance, they might give the app to several clients and charge more for each one [14]. Additionally, the SaaS method makes it easier for customers to accept software updates and changes happening at the same time.

3. Trends in Serverless Architectures

Serverless computing, or just "serverless," is becoming a new and interesting way to deploy cloud apps. This is mostly because enterprise application architectures are moving to containers and microservices. Trends says that the phrase "serverless" has become more common in the past few years.

3.1. Integration with Emerging Technologies (AI/ML, IoT, Blockchain)

The aim of artificial intelligence (AI) is to make machines or software do things that the brain normally does, like think or behave. Computers can make their own algorithms without having to be explicitly programmed [15][16]. This can be a set of rules (algorithms) or a system of realization, reasoning, and correction. Many different fields need to be studied in order to understand AI fully. Some of these areas are the Internet of Things, computer vision, robots, and natural language processing. For many good reasons, like making transportation and cities better, the Internet of Things (IoT) is growing into a field that uses technology. Utilizing the Internet of Things (IoT), there are various methods to boost product effectiveness. Blockchain, the Internet of Things, and AI have all been talked about separately up until now. But as IoT becomes more industrialized [17], a lot of sensory devices produce huge amounts of sensory data. That being said, these achievements can and will be used together in the future. IoT could be used to collect and display data, blockchain could be used to define operational rules, and AI could be used to create processes and guidelines for optimizing performance. A lot of blockchain technology and artificial intelligence are used in the Internet of Things seen in Figure 2.

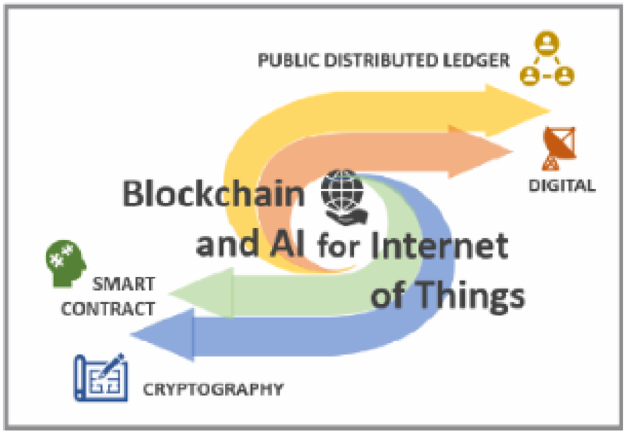

Figure 2 Integration of Blockchain and AI for IoT

3.2. Serverless for Edge Computing and Microservices

Event-driven processing in serverless computing means that functions are only run when certain events happen, instead of running all the time. For processes to go quickly and cheaply, AWS Lambda and other serverless functions are necessary. Edge computing puts processing close to where the data comes from, while cloud computing puts processing in one place. This is especially important for real-time apps in the Internet of Things because it cuts down on delay and bandwidth use [18]. Real-time data handling is important in every field, from healthcare to self-driving cars, so edge computing is being used more and more quickly. It is set up with smaller, separate services, each of which is responsible for a specific task, using a microservices design. Implementing, deploying, and maintaining software with this modular method has many benefits.

4. Key Challenges in Serverless Architectures

According to some, the plan is actually going backwards, but for others, it's the start of a new era in computing. Regardless, both sides agree that some problems need to be solved before it can reach its full potential. A few problems that haven't been fully looked at in previous studies are looked at in this survey. Numerous possible directions for further study are suggested after each problem is carefully examined.

4.1. Scalability and Resource Management

Scalability is the power to make services, apps, and other things available to more and more people. Scalability will be seen as a cloud's report card on how well it works. Most cloud users think that the cloud will take care of all scalability issues on its own because resources are virtualized [19]. This is definitely not the case. It's possible that many computer networks are set up so that some users can use system resources more than others. Explains that managing resources is an important job that must be done in any system that people have made. He says it changes the three most important things used to judge a system: cost, usefulness, and performance. Poor management of resources has a direct and big effect on success and cost. It may also affect system speed in a roundabout way. If a system doesn't work well, some of its features may not be needed or may cost too much [20]. Those things that were already stated are true for cloud computing as well as any other system. In the end, the infrastructure of a cloud computer system is very complicated and shares a whole lot of resources. Cloud computing systems get requests all the time, so things that happen outside of their power could affect them. There are different types of resources, such as virtual, network, and computer resources. Cloud tools that are often used are network, CPU, and disc.

4.2. Security and Privacy Concerns

Scientists are paying more attention to how data is processed, managed, and stored because cloud computing can be used for so many things. If it transfers data, cloud computing makes worry about its safety and privacy [21].The cloud's dynamic abstraction and scaling mean that applications and data that are sent there have no security limits or infrastructure limits[22]. More big security concerns are the fact that cloud computing can be used by multiple people at the same time and that virtualized resources are shared. Cloud service providers like Amazon, Google, and Microsoft have quickly made their cloud computer systems and services better so they can serve more people. Its goal is to look at what is known about how to protect privacy and security in business and scientific processes in the cloud and to point out any gaps or problems in what is already known. Security and privacy concerns will only get worse, though, since cloud databases often hold private and important data [23][24][25].

4.3. Cloud Cost Management

Monitoring is an important part of managing cloud costs. Businesses can find any problems or sudden rises in spending by keeping an eye on cloud usage and costs on a regular basis. Because of this, they can move right away and find out why the costs are going up. Monitoring usage trends can help businesses figure out how to best use their resources and get rid of any that aren't being used or are sitting idle. One more part of cloud cost management is using tools to keep costs down, such as budgeting and tips for unexpected spending. When businesses make budgets, they can set limits on how much they can spend and get alerts when costs get close to or go over those limits. People can avoid any unpleasant financial shocks by taking the initiative to manage their spending.

5. Opportunities and Future Directions

WBR did an online study in 2017 and found that 38% of people planned to add new technology, 45% planned to build a smart manufacturing system into their current equipment, and 17% planned to do both. Voters really want the new way of making things as soon as possible when they answer the poll [26]. By looking at differences between present and future production systems, Qin et al. show how useful and promising intelligent systems can be.

5.1. Sustainability and Green Cloud Computing

Environment issues are better understood by many thanks to organizations like Greenpeace, the US Environmental Protection Agency (EPA), and the Climate Savers Computing Initiative. It's better for the environment and uses less energy. That's what researchers have had to do. People all over the world are becoming more aware of the need to use resources in a way that is good for the earth, which is making cloud computing more popular. A previous study has shown that green cloud computing helps cut down on power use and CO2 emissions [27]. It also makes better use of energy. The reason for this is that the cloud needs thousands of data hubs to handle customer questions. A lot of power is needed for these buildings to work and stay cool. The amount of power used keeps going up every year. When it comes to these issues, green cloud computing tries to make things better. Several techniques and methods are used to lower this cost.

5.2. Serverless in Data-intensive

Processing data at the network edge, close to where the data is being created, is important for many modern applications. These are some of the most common features and requirements for data-heavy edge computing apps, differences in tasks [28][29]. A lot of different functions with different computing needs make up the program (for example, GPU acceleration). Sensitive to location: There are parts of the program that shouldn't be run in the cloud because users are close to the edge. Sensitive to latency. To provide high-quality service with low latency and demands for high bandwidth, the program must have certain parts. In some places, the app may share a lot of information.

6. Literature Review

This section highlights the literature review based on cloud-based server architecture with the overview of server techniques and simulation. And also provides the summary in Table I:

Cho and Kim (2021) discuss an open-source project-based serverless computing method for edge clouds. Using a centralized system and a Serverless Platform in the control plane cluster is one way to use Serverless at the Edge. In a centralized system, on the other hand, the control plane cluster has to detect issues and move functions to other Edges based on their conditions if one Edge doesn't have enough resources or isn't in good enough shape. Picking the right

Edge and deploying to it will take some time. Within the suggested architecture, cross-monitoring brings in monitoring data straight from an adjacent Edge [30].

Lokesh, Kait and Kumar (2024) analyze advancements in cloud architectures, deployment approaches, and service paradigms, unveiling the latest trends. Researchers looked at how advanced technologies like AI, serverless computing, and edge computing affect things. Impediments must be removed by carefully looking at issues related to security, privacy, compliance, and performance. The newest methods and tools for lowering risks, protecting data privacy, and improving cloud performance are shown in the study. The article investigates how cloud-native technologies enhance creativity and organizational agility by analyzing potential opportunities [31].

Zehra et al (2024) comprehensively review state-of-the-art containerization security solutions, focusing on various kernel isolation approaches. It proposes a thematic taxonomy of containerization security, highlighting essential parameters to help developers understand the security needs within a shared kernel environment. This paper describes the current landscape of container security by examining critical developments, challenges, and trends in the existing literature from system calls to kernel isolation. Additionally, it identifies open research issues and discusses industry best practices and emerging developments in container security, aiming to guide future research and implementation strategies [32].

Bayerlein et al. (2023) look into how serverless computing in the cloud might be able to speed up Monte Carlo (MC)-based scatter correction (SC) in PET pictures. Even when picture reconstruction methods are used, SC's longer axial fields of vision, wider acceptance angles, and more lines-of-response can be hard on modern multi-core servers. In their study, they compare how fast an AWS Lambda-based serverless MC simulation works to a current multi-thread rebuilding server that runs on-premises [33].

Amiri, Zdun and van Hoorn (2022) aim of this work is to provide models and real-world data that can be used to accurately estimate dependability and performance effects. Method Give a mathematical model for request loss for reliability modelling. In cloud and service-based settings, different types of dynamic routing architecture patterns are used. These include routing through a central body like an event store, routing through sidecars, and designs with a lot of dynamic routers. Picking the wrong design can make a software system not work as well or as accurately as it should [34].

Eti, Singh and Dheer (2024) provide an architecture and algorithm for efficient and scalable statistics aggregation tailored specifically for cloud-primarily based IoT applications. The proposed structure and set of rules are then evaluated in two unique eventualities and a number of metrics to apprehend the differences between them and their scalability performance. Outcomes show that the proposed answer is able to supplying pretty appearing and scalable statistics aggregation for cloud-primarily based IoT applications [35].

Table 1 Literature Review on Cloud-Based Serverless Architectures: Trends, Challenges, and Opportunities for Modern Applications

Reference	Key Topic	Focus Area	Findings/Insights
Cho and Kim (2021) [30]	Serverless Computing for Edge Clouds	Centralized Architecture with Edge Monitoring	Introduced cross-monitoring using metrics from nearby edges to enhance anomaly detection and redeployment efficiency.
Lokesh, Kait and Kumar (2024)[31].	Cloud Architectures and Deployment Trends	Cloud-Native Technologies, AI, Edge Computing	Explore security, privacy, and performance challenges while emphasizing blockchain, quantum computing, and IoT integration for organizational agility.
Zehra et al (2024)[32]	Cloud Architecture Trends	AI, Serverless, Edge, and IoT	Reviews trends in cloud-native technologies, emphasizing the need to address security, privacy, and performance challenges for efficient deployment.
Bayerlein et al. (2023)[33]	Serverless Computing in Medical Imaging	PET Imaging and Monte Carlo Simulations	Investigates AWS Lambda's efficiency in scatter correction tasks, showing potential computational improvements over on-premises servers.

Amiri, Zdun and van Hoorn (2022)[34]	Reliability Modeling in Cloud Services	Dynamic Routing Architectures	Proposes an analytical model for request loss, emphasizing the performance impacts of different routing patterns.
Eti, Singh and Dheer (2024)[35]	Scalable Data Aggregation in IoT	Cloud-based IoT Applications	Presented architecture for scalable statistics aggregation; demonstrated performance improvements in cloud IoT applications.

7. Conclusion and Future Work

Serverless architectures have become a new way of thinking about cloud computing because they make it easier to control, scale, and save money. In contrast to standard cloud models, serverless computing abstracts infrastructure concerns, letting developers focus on running code while cloud providers dynamically assign resources. Even with these benefits, problems like scaling, security, managing resources, and lowering costs still need to be solved before it can be widely used. This review explored the core concepts, trends, and key challenges in serverless computing, highlighting its growing integration with emerging technologies such as AI, IoT, and blockchain. As serverless continues to evolve, addressing its limitations will be crucial in realizing its full potential as the dominant model for cloud-based application deployment.

Future research on serverless architectures should focus on enhancing security and privacy mechanisms, optimizing resource management for high-performance applications, and improving support for stateful workloads. Additionally, the integration of serverless with edge computing, microservices, and sustainable cloud solutions presents promising opportunities for reducing latency and energy consumption. The development of hybrid serverless models, combining the best aspects of traditional cloud and serverless computing, can help overcome current limitations and enhance enterprise adoption. Furthermore, investigating cost-effective pricing models and performance optimizations tailored to different workload patterns will be essential in making serverless a more viable solution for data-intensive and real-time applications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] M. Omurgonulsen, M. Ibis, Y. Kazançoğlu, and P. Singla, "Cloud Computing: A Systematic Literature Review and Future Agenda," *J. Glob. Inf. Manag.*, vol. 29, pp. 1–25, 2021, doi: 10.4018/JGIM.20211101.oa40.

[2] J. Thomas, "Enhancing Supply Chain Resilience Through Cloud-Based SCM and Advanced Machine Learning: A Case Study of Logistics," *J. Emerg. Technol. Innov. Res.*, vol. 8, no. 9, pp. 357–364, 2021.

[3] N. Patel, "Secure Access Service Edge(SASE): Evaluating the Impact of Convereged Network Security Architectures in Cloud Computing," *J. Emerg. Technol. Innov. Res.*, vol. 11, no. 3, 2024.

[4] N. Banger, P. K, and M. S. J. Shetty, "A Review Paper on Cloud Computing Architecture, Types, Advantages and Disadvantages," *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 2, no. 2, pp. 14–22, 2022, doi: 10.48175/ijarsct-3144.

[5] S. Garg, "AI/ML Driven Proactive Performance Monitoring, Resource Allocation and Effective Cost Management in SAAS Operations," *Int. J. Core Eng. Manag.*, vol. 6, no. 6, pp. 263–273, 2019.

[6] V. Prajapati, "Cloud-Based Database Management: Architecture, Security, challenges and solutions," *J. Glob. Res. Electron. Commun.*, vol. 01, no. 1, pp. 07–13, 2025.

[7] A. Evwiekpaefe and F. Ajakaiye, "The Trend and Challenges of Cloud Computing: A Literature Review," *Acad. J. Interdiscip. Stud.*, vol. 2, 2013, doi: 10.5901/ajis.2013.v2n10p9.

[8] D. Patel, "The Role of Amazon Web Services in Modern Cloud Architecture: Key Strategies for Scalable Deployment and Integration," *Asian J. Comput. Sci. Eng.*, vol. 9, no. 4, 2024, doi: 10.22377/ajcse.v9i04.215.

[9] S. P. Bheri and G. Modalavalasa, "Advancements in Cloud Computing for Scalable Web Development: Security Challenges and Performance Optimization," *JCT Publ.*, vol. 13, no. 12, pp. 01–07, 2024.

[10] M. A. Morsi, E. N. M. Fadoul, E. M. E. Ibrahim, and M. M. I. Mohammed, “Cloud Computing Challenges and Opportunities,” *Univ. Khartoum Eng. J.*, vol. 10, no. 1, Oct. 2022, doi: 10.53332/kuej.v10i1.913.

[11] N. Kratzke, “Function as a Service,” in *Cloud-native Computing*, no. 04, München, 2021, pp. 135–149. doi: 10.3139/9783446472846.010.

[12] V. S. Thokala, “Scalable Cloud Deployment and Automation for E-Commerce Platforms Using AWS, Heroku, and Ruby on Rails,” *Int. J. Adv. Res. Sci. Commun. Technol.*, pp. 349–362, Oct. 2023, doi: 10.48175/IJARSCT-13555A.

[13] C. M. Mohammed and S. R. Zeebaree, “Sufficient Comparison Among Cloud Computing Services: IaaS, PaaS, and SaaS: A Review,” *Int. J. Sci. Bus.*, 2021.

[14] Abhishek and P. Khare, “Cloud Security Challenges: Implementing Best Practices for Secure SaaS Application Development,” *Int. J. Curr. Eng. Technol.*, vol. 11, no. 06, pp. 669–676, Nov. 2021, doi: 10.14741/ijcet/v.11.6.11.

[15] A. Som and P. Kayal, “AI, Blockchain, and IOT,” 2022, pp. 141–161. doi: 10.1007/978-3-031-11545-5_8.

[16] N. Prajapati, “The Role of Machine Learning in Big Data Analytics: Tools, Techniques, and Applications,” *ESP J. Eng. Technol. Adv.*, vol. 5, no. 2, pp. 16–22, 2025, doi: 10.56472/25832646/JETA-V5I2P103.

[17] R. Patel, “Optimizing Communication Protocols in Industrial IoT Edge Networks: A Review of State-of-the-Art Techniques,” *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 4, no. 19, pp. 1–12, 2023.

[18] H. P. Dola, “A Review on Synergies in Modern Architecture : Microservices with Serverless / Cloud and Edge Computing,” vol. 11, no. 11, pp. 332–340, 2024.

[19] G. Panatula, E. G. Devaraj, and S. T K, “Impact of Resource Management and Scalability on performance of Cloud Applications - A Survey,” *Int. J. Comput. Sci. Eng. Appl.*, vol. 6, pp. 1–9, 2016, doi: 10.5121/ijcsea.2016.6401.

[20] V. Prajapati, “Blockchain-Based Decentralized Identity Systems: A Survey of Security, Privacy, and Interoperability,” *Int. J. Innov. Sci. Res. Technol.*, vol. 10, no. 3, pp. 1011–1020, Mar. 2025, doi: 10.38124/ijisrt/25mar1062.

[21] Y. S. Abdulsalam and M. Hedabou, “Security and privacy in cloud computing: Technical review,” *Future Internet*. 2022. doi: 10.3390/fi14010011.

[22] D. Patel, “Zero Trust and DevSecOps in Cloud-Native Environments with Security Frameworks and Best Practices,” *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 3, no. 3, 2023.

[23] G. Modalavalasa and S. Pillai, “Exploring Azure Security Center : A Review of Challenges and Opportunities in Cloud Security,” *ESP J. Eng. Technol. Adv.*, vol. 2, no. 2, pp. 176–182, 2022, doi: 10.56472/25832646/JETA-V2I2P120.

[24] O. C. Obi, S. O. Dawodu, A. I. Daraojimba, S. Onwusinkwue, Onyinyechi Vivian Akagha, and I. A. I. Ahmad, “Review of Evolving Cloud Computing Paradigms: Security, Efficiency, and Innovations,” *Comput. Sci. IT Res. J.*, vol. 5, no. 2, pp. 270–292, Feb. 2024, doi: 10.51594/csitrj.v5i2.757.

[25] S. S. S. Neeli, “Real-Time Data Management with In-Memory Databases: A Performance-Centric Approach,” *J. Adv. Dev. Res.*, vol. 11, no. 2, 2020.

[26] S. Phuyal, D. Bista, and R. Bista, “Challenges, Opportunities and Future Directions of Smart Manufacturing: A State of Art Review,” *Sustain. Futur.*, vol. 2, 2020, doi: 10.1016/j.sftr.2020.100023.

[27] A. Atrey, N. Jain, and N. C. S. N. Iyenger, “A Study on Green Cloud Computing,” *Int. J. Grid Distrib. Comput.*, vol. 6, pp. 93–102, 2013, doi: 10.14257/ijgdc.2013.6.6.08.

[28] T. Rausch, A. Rashed, and S. Dustdar, “Optimized container scheduling for data-intensive serverless edge computing,” *Futur. Gener. Comput. Syst.*, 2021, doi: 10.1016/j.future.2020.07.017.

[29] N. K. Prajapati, “Federated Learning for Privacy-Preserving Cybersecurity: A Review on Secure Threat Detection,” *Int. J. Adv. Res. Sci. Commun. Technol.*, pp. 520–528, Apr. 2025, doi: 10.48175/IJARSCT-25168.

[30] J. Cho and Y. Kim, “A Design of Serverless Computing Service for Edge Clouds,” in *2021 International Conference on Information and Communication Technology Convergence (ICTC)*, 2021, pp. 1889–1891. doi: 10.1109/ICTC52510.2021.9621162.

[31] Lokesh, R. Kait, and T. Kumar, “Insights Into Cloud Computing: Unveiling Trends, Addressing Challenges, and Exploring Opportunities - A Systematic Review,” in *2024 International Conference on Emerging Innovations and Advanced Computing (INNOCOMP)*, IEEE, May 2024, pp. 593–601. doi: 10.1109/INNOCOMP63224.2024.00103.

[32] S. Zehra, H. J. Syed, F. Samad, U. Faseeha, H. Ahmed, and M. Khurram Khan, "Securing the Shared Kernel: Exploring Kernel Isolation and Emerging Challenges in Modern Cloud Computing," *IEEE Access*, vol. 12, pp. 179281–179317, 2024, doi: 10.1109/ACCESS.2024.3507215.

[33] R. Bayerlein *et al.*, "Cloud-Based Serverless Computing Enables Accelerated Monte Carlo-Based Scatter Correction for Positron Emission Tomography," in *2023 IEEE Nuclear Science Symposium, Medical Imaging Conference and International Symposium on Room-Temperature Semiconductor Detectors (NSS MIC RTSD)*, 2023, p. 1. doi: 10.1109/NSSMICRTSD49126.2023.10337966.

[34] A. Amiri, U. Zdun, and A. van Hoorn, "Modeling and Empirical Validation of Reliability and Performance Trade-Offs of Dynamic Routing in Service- and Cloud-Based Architectures," *IEEE Trans. Serv. Comput.*, vol. 15, no. 6, pp. 3372–3386, 2022, doi: 10.1109/TSC.2021.3098178.

[35] M. Eti, S. K. Singh, and M. Dheer, "Scalable Data Aggregation for Cloud-based Internet of Things Applications," in *2024 15th International Conference on Computing Communication and Networking Technologies (ICCCNT)*, 2024, pp. 1–5. doi: 10.1109/ICCCNT61001.2024.10725443..