Grenze International Journal of Engineering and Technology, January Issue

Exploring Fog and Edge Computing Developments and their Suitability for Mobile Commerce

Mrs. Sreedevi S[1] and Dr Ashwini J P[2]
[1]Assistant Professor, Dept of CSE, JNNCE
Email: sreedevis@jnnce.ac.in
[2]Associate Professor, Dept of AIML, JNNCE
Email: ashwinijp@jnnce.ac.in

***Abstract*— Fog and edge computing, as extensions of cloud computing, have emerged as transformative paradigms to address the unique demands of current generation computing. The technology, even though ground breaking, is restricted to IoT based applications. Another technology which has created a revolution and widely used by most of the population is Mobile Commerce (M-Commerce). This technology can make use of fog/edge computing because of the latter's ultra-low latency, real-time responsiveness, location-awareness, and context-aware computing. This review is an exploration of the technological capabilities of Fog/Edge as of now. The work examines a comprehensive range of research efforts, organized into key themes: resource allocation and workload distribution, architectural innovations, QoS and cost-efficiency enhancements, security and privacy issues, and industry case studies. By processing data closer to mobile users—at the edge or via intermediary fog nodes—these technologies significantly reduce latency, improve operational efficiency, and enhance customer experiences in M-Commerce applications. The survey further outlines the challenges and future directions for adopting fog and edge computing in M-Commerce, emphasizing their critical role in enabling scalable, secure, and context-aware mobile services in a rapidly evolving digital landscape.**

***Index Terms*— Fog Computing, Edge Computing, Cloud Computing, Internet of Things (IoT), Mobile Commerce (M-Commerce).**

I. INTRODUCTION

Fog/Edge computing is a modern approach that decentralizes computational resources by bringing processing and storage closer to end-users at the edge of the network. This reduces latency and optimizes bandwidth, making it highly effective for applications requiring real-time data processing, such as IoT systems and smart services. This technology is considered as next avatar of the cloud computing. The technology even though is revolutionary; the implementation requires lot of resource setup at public places. Due to this limitation the technology is restricted majorly to only IoT based applications.
E-commerce, particularly Mobile Commerce (M-commerce), has transformed global trade by enabling seamless transactions via smartphones. While cloud computing has been fundamental in providing scalable resources, centralized processing, and cost-effective storage for M-commerce, it faces limitations in supporting low-latency interactions and coverage in rural areas with bad network resources.

Grenze ID: 01.GIJET.12.1.88

Applications like instant payments and real-time inventory tracking often experience delays with traditional cloud architectures, especially in bandwidth-constrained or rural environments.

Fog/Edge computing can be a better solution for E-commerce because it processes data locally, minimizing reliance on distant cloud servers. For example, fog/edge nodes in shopping centers can pre-cache product catalogs and manage real-time inventory updates. In 5G environments, fog architectures enable millisecond-level responsiveness for personalized offers and fraud detection. By distributing workloads between edge devices and the cloud, fog computing maintains scalability while optimizing bandwidth.

This approach is particularly valuable in rural regions, where limited connectivity hinders digital inclusion. Fog computing allows localized processing of agricultural market data, enabling farmers to access real-time pricing and supply chain updates even with intermittent connectivity. Initiatives like m-Kisan in India show how fog-aided M-commerce platforms connect rural producers directly to markets, supporting microloan approvals and local inventory management, and reducing energy-intensive data transfers.

Currently, fog and edge solutions are used in domains like smart healthcare, content delivery, and financial fraud detection. Examples include using Modified-TOPSIS algorithms in healthcare to prioritize critical patient data, LFU with time decay for low-latency video streaming in CDNs, and homomorphic encryption with LSTM-based fraud detection for secure mobile transactions. These cases highlight fog computing's strengths in localized processing, reduced latency, and bandwidth optimization, which makes it a promising solution for the evolving needs of E-commerce also.

The review is structured around several key themes: architectural innovations, resource allocation and workload distribution, enhancements in quality of service (QoS) and cost-efficiency, security and privacy considerations, and the real-world case studies. The survey systematically reviews research that addresses how intelligent resource management and innovative fog architectures can reduce latency, optimize computational loads, and support seamless integration with IoT and 5G networks. It also examines studies focused on maximizing QoS and minimizing operational costs through application offloading and delay-sensitive models, as well as those that explore privacy-preserving protocols and security frameworks. Additionally, the survey includes industry case studies that validate the practical benefits of fog computing in M-commerce, such as reduced checkout latency, improved fraud detection, and enhanced user privacy, while also highlighting ongoing challenges like scalability, interoperability, and energy consumption in dense deployments.

The study of architectural innovations in fog/edge computing focus on innovations over the decades in the technology. The main objective of fog/edge is to deploy a multi-layered, decentralized framework which brings computation, storage, and analytics closer to end-users, particularly at the network edge. Works of [3],[6],[33],[35],[18],[28],[19] are selected and grouped under the category of Architectural Innovations for M-Commerce in Fog Computing as they propose fog/edge-specific architectures (e.g., content delivery networks, policy-based orchestration) that directly address M-commerce needs like real-time transactions and mobility. They also focus on task scheduling and 5G mobility management, critical for seamless service delivery. (Few more on Edge)

Fog/Edge computing is restricted by the edge resource availability for the end users. Resource scheduling and offloading techniques are very precious to maintain the quality of the technology. In the next section, we review the works [1],[2],[5],[8],[9],[11],[34] which focus on Optimizing computational loads, energy efficiency, and geo-distributed resource management. These papers provide dynamic resource provisioning strategies (genetic algorithms, convex optimization) in hybrid fog/edge-cloud for placement and workload balancing in general applications. They are grouped under the theme Resource Allocation and Workload Distribution.

With limited resources, maintaining the Quality of Service is a major challenge for all types of applications. The classic definition of fog/edge computing requires the edge nodes to be placed in public places by the government and private vendors, which can be shared by the end users. The provisioning of QoS with such shared resources is our net study. Research works [7],[6],[11],[21] are grouped and addresses a distinct area of Enhancing QoS and Cost-Efficiency in edge computing as these papers propose delay-sensitive offloading models and cost-analysis frameworks which can be tailored for M-commerce. They also validate QoS improvements through vehicular fog computing and edge-based marketing analytics.

With shared resources in public places, the next concern should be security and privacy. As fog/edge layer is just a temporary accommodation prior to commit on cloud format, with public network, the chances of failure transactions are more. Next review [27],[31],[4],[12] concentrates the particular aspects of Security and Privacy. They focus on Mitigating risks in decentralized, data-heavy M-commerce environments. The research works included in this group propose various techniques like encryption, multi-factor authentication, and differential privacy for transactional/data privacy and embed security policies into orchestration layers, ensuring compliance without performance trade-offs.

We have studied the various actual fog/edge implementations in the real world scenario. The last aspect of this study is about Case Studies and Industry Applications of Fog/Edge computing along with the challenges and future Directions. The works [20],[22],[4],[32],[33],[35], [16], [28], [9], [34] focus on Real-world validation of fog computing in retail, healthcare, and IoT commerce. demonstrate fog's impact on AR shopping, inventory management, and personalized promotions. These papers provide cross-domain insights (healthcare, IoT) applicable to M-commerce fraud detection and QoS. We have also identified the M-commerce-specific gaps like interoperability in policy orchestration, energy efficiency in dense deployments etc.

A. Architectural Innovations in Fog/Edge Computing (Add few architectures on edge computing)

Architectural innovations in fog/edge computing are pivotal for advancing M-commerce, as demonstrated by several key scholarly works. The architecture proposed in [3] introduces a fog-based content delivery network that leverages edge caching and information-centric networking to reduce latency and improve the responsiveness of content delivery, which is essential for real-time M-commerce services. This architecture is designed to enhance the performance of Content Delivery Networks (CDNs) using fog computing. Traditional CDNs rely on centralized data centers, which may lead to increased latency during peak demand. In contrast, this fog-based architecture introduces fog nodes placed close to end-users—such as at local ISP facilities or base stations—to handle content caching and delivery. These nodes cache frequently accessed content and can prefetch trending data based on user behavior patterns. The architecture includes a central content management server in the cloud, which oversees content distribution and updates across fog nodes. This setup reduces the load on central servers, decreases bandwidth consumption, and minimizes latency, resulting in faster content delivery and a better user experience. Similarly, [6] explores vehicular fog computing, where vehicles themselves act as distributed fog nodes, enabling location-aware and low-latency services for mobile users—an approach highly relevant for dynamic, on-the-move M-commerce scenarios. Resource allocation and task scheduling, as discussed in [33], are critical for optimizing the performance and efficiency of fog-enabled IoT environments, ensuring that applications can scale and adapt to fluctuating workloads. The device mobility management scheme for 5G networks in [35] further enhances that same kind of architecture can be induced for M-commerce to support seamless service continuity as users move across heterogeneous networks. The OpenFog Reference Architecture [18] provides a standardized, hierarchical framework that underpins these innovations, ensuring interoperability, security, and scalability across diverse fog deployments. Finally, policy-based fog service orchestration for M-commerce [28] enables dynamic, context-aware service management, allowing business policies to drive resource provisioning and service delivery in real time. Collectively, these architectural advancements address the core requirements of mobile and electronic commerce platforms—such as low latency, high reliability, scalability, and context awareness—by bringing computation and intelligence closer to the user and enabling adaptive, efficient, and secure service delivery. This approach benefits a wide range of digital services and applications that rely on responsive, reliable, and scalable user experiences across mobile and online environments.

TABLE I: ARCHITECTURAL INNOVATIONS - ADVANTAGES AND DISADVANTAGES

Reference ID	Advantages	Disadvantages
[3, 6]	Improved data delivery and real-time responsiveness	Limited deployment in large-scale systems
[33, 35]	Scalable and modular design for IoT and 5G	May incur higher initial setup costs
[18, 28]	Clear guidelines and performance benchmarking	Still evolving and lacks standardization
[19]	Industry-aligned reference model	Generalized and may need customization
[36] [37]	Faster response, scalability, supply chain integration	Infrastructure cost, integration complexity

B. Resource Allocation and Workload Distribution

Resource allocation and workload distribution in fog computing are pivotal for optimizing M-commerce performance, as demonstrated by several key studies. Work in [1] establish foundational strategies for dynamic resource provisioning in hybrid cloud/fog environments, using genetic algorithms and convex optimization to balance computational loads between edge and cloud layers. This approach reduces latency by 30% for real-time transactions like mobile payments while achieving 22% cost savings through intelligent workload offloading during peak demand. Building on this, [2] introduces a management layer between fog nodes and the cloud to address system heterogeneity, implementing adaptive clustering configurations that reduce bandwidth consumption by 35% and execution time by 28% in dense IoT commerce environments.

The geographic distribution of resources is critically analyzed in [5], which quantifies how decentralized fog architectures reduce cloud dependency by 60% in scenarios like flash sales, minimizing bandwidth strain through localized data processing. This aligns with M-commerce needs for scalable inventory tracking and dynamic pricing. Additionally, [16]'s two-tier scheduling framework—combining virtual machine allocation with task prioritization—ensures 99.2% QoS compliance for latency-sensitive services such as AR product visualization, while [2]'s sensitivity analysis identifies optimal node clustering patterns to handle abrupt traffic spikes common during holiday sales. Together, these studies underscore the necessity of context-aware resource orchestration, balancing energy efficiency (18% reduction in [2]), real-time responsiveness (16 ms latency in [16]), and operational costs to support seamless M-commerce. Paper [8] employs a modified-TOPSIS algorithm to prioritize IoT application placement based on QoS parameters like latency (≤50 ms) and energy efficiency, improving user experience scores by 37% for AR shopping apps. This approach dynamically balances computational loads across heterogeneous fog nodes, ensuring real-time responsiveness for personalized promotions and inventory updates.

In [9], a greedy placement strategy for microservices reduces raw data transfers to the cloud by 45% through edge-level preprocessing, critical for bandwidth-heavy M-commerce tasks like in-store video analytics. However, its scalability is limited to homogeneous fog nodes, posing challenges for diverse retail IoT ecosystems. [11] introduces a federated fog architecture for marketing analytics, where 70% of customer behavior data (e.g., browsing patterns, location) is processed locally at edge nodes. This minimizes cloud dependency while enabling real-time personalization, though the lack of cost-benefit analysis raises concerns about large-scale deployment viability.

Finally, [34]'s multi-layer fog architecture optimizes IoT application placement across geo-distributed nodes, reducing data transmission by 64% and power costs by 78% in smart city M-commerce scenarios. By aligning workload distribution with user proximity and server capacities, it supports scalable services like real-time inventory tracking and dynamic pricing, albeit requiring vendor collaboration for interoperability. The research work [43] surveys various strategies and algorithms designed to Efficiently allocate computational, storage, and network resources at the edge to handle dynamic and heterogeneous workloads originating from mobile users. Distribute tasks based on parameters such as device capability, network latency, energy consumption, and real-time application requirements. Balance loads among multiple edge nodes to prevent bottlenecks and ensure quality of service (QoS) for latency-sensitive applications like M-commerce.

TABLE II: RESOURCE ALLOCATION AND WORKLOAD DISTRIBUTION - ADVANTAGES AND DISADVANTAGES

Reference ID	Advantages	Disadvantages
[1]	Improved QoS and system responsiveness	High complexity in dynamic environments
[2, 5]	Cost-effective and scalable strategies	Difficult to implement in heterogeneous systems
[8, 9]	Enhanced application performance via intelligent placement	May not adapt well to rapid mobility
[11, 34]	Better load balancing and reduced latency	Resource overhead from heuristic models
[38,39,40]	Efficient offloading and dynamic, fair resource allocation reduce latency and energy use while enhancing user experience	Dynamic workload management is complex and may lead to resource under utilization .

Collectively, these works underscore adaptive resource allocation strategies that prioritize latency, bandwidth, and cost-efficiency, while highlighting trade-offs in scalability and heterogeneity management for M-commerce ecosystems.

C. Enhancing QoS and Cost-Efficiency

To enhance Quality of Service (QoS) and cost-efficiency in fog/cloud computing, recent studies highlight innovative strategies across latency reduction, reliability, and resource optimization. Adaptive Application Offloading [9] combines Particle Swarm Optimization (PSO) and Chemical Reaction Optimization (CRO) to dynamically offload delay-sensitive tasks (e.g., payments, inventory updates) to optimal fog/cloud nodes, minimizing service delays and QoS violations. This approach balances fog-cloud resource utilization through an Integer Non-Linear Programming (INLP) model, integrating deployment, communication, and penalty costs to optimize operational expenses. For reliability, Vehicular Fog Computing (VFC) [6] virtualizes vehicles as fog servers using Vehicle-to-Vehicle (V2V) communication, with a proactive replication mechanism to designate backup nodes. This ensures uninterrupted M-commerce services (e.g., mobile payments) by localizing computation, reducing cloud dependency, and employing energy-efficient lazy replication to maintain QoS while minimizing overhead.

Fog Computing for Big-Data Marketing Analytics [11] emphasizes real-time processing of customer behavior data at the network edge, enabling low-latency personalized recommendations and dynamic pricing. By decentralizing analytics, fog architectures reduce cloud bandwidth costs and enhance privacy, critical for scalable M-commerce workflows. Complementing this, Cost Analysis of Fog Deployment [21] evaluates trade-offs between latency, resource use, and financial expenses using the FogTorc model. Case studies demonstrate that prioritizing fog resources over cloud infrastructure—coupled with network upgrades (e.g., 3G to 4G)—lowers deployment costs while meeting QoS targets.

Collectively, these studies underscore fog computing's role in M-commerce through latency reduction (localized processing for real-time transactions), cost optimization (hybrid resource allocation and predictive deployment), reliability (failure-resistant VFC architectures), and scalability (distributed data handling for dynamic workflows). Future advancements in real-time adaptation and standardized fog pricing models could further refine cost-efficiency and QoS in M-commerce ecosystems.

TABLE III: QOS AND COST-EFFICIENCY - ADVANTAGES AND DISADVANTAGES

Reference ID	Advantages	Disadvantages
[7]	Higher application responsiveness and lower delay	Complexity in real-time offloading decisions
[6, 11]	Reliable performance under varied conditions	High dependency on network quality
[21]	Helps in planning cost-effective deployments	May not consider indirect costs like energy
[36 ,41]	Lowers bandwidth, reduces latency, enables uninterrupted services	Deployment and operational costs are significant for edge solutions

D. Security and Privacy in Fog-Computing

Work of [27][31] acknowledge security as an ancillary requirement within broader architectural and resource management frameworks. For example: Policy integration: Security rules (e.g., encryption, access control) are embedded into orchestration layers to ensure compliance without disrupting performance. Trade-off awareness: The studies highlight how design choices (e.g., centralized vs. distributed orchestration) inherently impact security. Centralized topologies risk single points of failure, while distributed models require secure consensus mechanisms. Thus, while security is not the primary focus, these works emphasize that policy-based orchestration and framework design must inherently address security to ensure reliable and trustworthy fog-driven M-commerce systems.

Study in [4] focuses on optimizing healthcare data processing in fog environments but explicitly identifies unauthorized data access and selective forwarding attacks as major risks in open, distributed fog networks. For healthcare applications, which share parallels with M-commerce in handling sensitive user data (e.g., payment details, purchase histories), the paper advocates for:

- End-to-end encryption to protect data during transmission between edge devices and fog nodes.
- Multi-factor authentication to restrict unauthorized access to fog resources.
- Real-time auditing of fog node activity to detect anomalies.

These measures are directly applicable to M-commerce, where transactional and behavioral data must remain confidential. The study also highlights edge-assisted filtering to preprocess data locally, reducing exposure to cloud-based breaches and minimizing privacy risks.

[12]'s review underscores the inherent privacy vulnerabilities of fog computing due to its proximity to end-users. In marketing applications (a subset of M-commerce), fog nodes collect granular data, such as location patterns and purchase histories, which can be exploited for identity linkage or usage pattern tracking. The paper emphasizes:

- Differential privacy to anonymize aggregated data while preserving utility for analytics.
- Homomorphic encryption to enable secure computation on encrypted data, ensuring privacy during processing.
- Multi-layered security frameworks integrating physical node protection, network-level access control, and application-layer encryption.

TABLE IV: SECURITY AND PRIVACY - ADVANTAGES AND DISADVANTAGES

Reference ID	Advantages	Disadvantages
[27, 31]	Provides policy-based access and orchestration	May require frequent updates to policies
[4, 12]	Protects sensitive user data	Integration with existing systems can be complex
[42]	Localized data control, privacy potential	Attack surface, trust management, data protection challenges

E. Case Studies and Industry Applications

Case studies and industry applications demonstrate the practical benefits of fog computing in M-commerce and related domains. For example, showcases how fog computing enhances mobile user experiences by enabling real-time, location-aware services at the network edge, such as instant access to promotions and seamless AR navigation in smart city environments. Similarly, presents a fog architecture for IoT commerce, where edge nodes process inventory and pricing data locally, resulting in improved accuracy, reduced cloud dependency, and increased profit margins for e-commerce platforms. In the healthcare sector, [4] describes an edge-assisted fog framework that preprocesses sensitive data for remote patient monitoring, which translates to real-time fraud detection and privacy protection in M-commerce. Additionally, highlights the use of fog computing for augmented reality in retail, enabling low-latency AR product visualization and personalized promotions, thereby boosting customer engagement and conversion rates.

Collectively, these case studies [20][22][4][32] validate fog computing's ability to deliver low-latency, context-aware, and cost-efficient solutions across diverse IoT-commerce applications, from real-time analytics and inventory management to immersive AR shopping and secure transaction processing.

Recent case studies and industry applications highlight the practical impact of fog computing in IoT and mobile commerce environments. In, resource allocation and task scheduling are addressed through dynamic load balancing and adaptive scheduling methods in fog-enabled IoT systems.

The study demonstrates how fog nodes, equipped with limited resources, can efficiently manage heterogeneous and fluctuating workloads by employing priority-based scheduling and metaheuristic optimization. These strategies reduce energy consumption, turnaround time, and execution failures, ensuring that M-commerce and IoT applications maintain high Quality of Service (QoS) even during peak demand or in resource-constrained scenarios.

In the context of device mobility and next-generation networks, [33] presents a fog computing-based mobility management scheme tailored for 5G environments. This framework supports seamless device-driven communication, reducing data management overhead and network latency by enabling real-time access to nearby fog servers. The proposed mobility management procedure ensures low energy consumption, delay, and signaling cost compared to traditional LTE/LTE-A networks, thereby enhancing both QoS and Quality of Experience (QoE) for mobile users in dynamic, pervasive M-commerce and IoT applications .

TABLE V: CASE STUDIES AND INDUSTRY APPLICATIONS

Reference ID	Advantages	Disadvantages
[20, 22]	Context-aware support for IoT-Commerce	May face integration issues with legacy apps
[4, 32]	Real-time healthcare and AR services	High processing demand on edge nodes
[33, 35]	Enhanced mobility and scheduling control	Complex deployment in multi-user settings

II. CONCLUSION AND FUTURE DIRECTIONS

While fog and cloud computing have revolutionized the way data and services are delivered, several critical challenges persist that must be addressed for these technologies to reach their full potential.

The lack of standardized architectures and limited interoperability between cloud and fog layers continue to be significant barriers.

Without common standards, it becomes difficult for different systems and vendors to work together seamlessly. This fragmentation can lead to compatibility issues, increased integration costs, and hinder the deployment of scalable, flexible solutions. Achieving standardization and interoperability is essential for enabling smooth data exchange, unified management, and cohesive service delivery across diverse platforms and environments.

Ensuring consistent Quality of Service (QoS) in environments with dynamically changing workloads remains a complex problem.

As user demand fluctuates, maintaining reliable performance, low latency, and high availability becomes increasingly challenging. Resource allocation, task scheduling, and real-time adaptation are required to meet QoS expectations, but unpredictable workload patterns can strain system resources and degrade service quality. Innovative strategies and intelligent management mechanisms are needed to dynamically balance loads and guarantee service levels, especially as applications and user bases continue to grow.

Future research in fog computing should prioritize the development of energy-efficient protocols to reduce operational costs and environmental impact, alongside the integration of AI-driven resource management for smarter, adaptive allocation and scheduling. Strengthening privacy safeguards is also essential to protect sensitive data processed at the edge. Additionally, efforts should be made to extend fog computing platforms beyond IoT, enabling their use in diverse non-IoT applications such as healthcare, finance, and real-time analytics, thereby broadening the technology's impact and utility across various sectors. The review shows the necessity of a standard fog/edge architecture which must be highly adaptive, secure, and efficient to meet all kinds of applications. Also these changes will enhance the possibility of adapting fog/edge platforms for M-Commerce applications.

REFERENCES

[1] Akintoye, S. B. & Bagula, A. (2019). Improving Quality of Service in Cloud/Fog Computing through Efficient Resource Allocation. Sensors, 19(6), 1267. https://doi.org/10.3390/s19061267

[2] Alraddady S, Soh B, AlZain MA, Li AS. Fog Computing: Strategies for Optimal Performance and Cost Effectiveness. Electronics. 2022;11(21):3597. https://doi.org/10.3390/electronics11213597

[3] Alghamdi, F., Mahfoudh, S., & Barnawi, A. (2019). A Novel Fog Computing Based Architecture to Improve the Performance in Content Delivery Networks. Wireless Communications and Mobile Computing, 2019, Article 7864094. https://doi.org/10.1155/2019/7864094

[4] S. S. M. Syed Sabir Mohamed, R. Gopi, V. Thiruppathy Kesavan, and K. Karthikeyan Kaliyaperumal, "Adaptive heuristic edge assisted fog computing design for healthcare data optimization," J. Cloud Comput., vol. 13, no. 1, Art. no. 127, Aug. 2024, doi: 10.1186/s13677-024-00689-7

[5] Jamil, Sara & Qureshi, Rehan & Ahmed, Sohaib & Rehman, Osama. (2024). Impact of Resource Distribution on Performance of Fog Computing Infrastructure. Wireless Personal Communications. 137. 1-20. 10.1007/s11277-024-11272-3.

[6] Gupta, S., & Khaitan nee Gupta, V. (2024). Reliability and performance analysis of vehicular fog computing. International Journal of System Assurance Engineering and Management, 15(9), 4355–4369

[7] Chauhan, Naveen & Agrawal, Rajeev & Banka, Haider. (2023). Adaptive application offloading for QoS maximization in cloud-fog environment with delay-constraint. Peer-to-Peer Networking and Applications. 16. 1-17. 10.1007/s12083-023-01452-6.

[8] Baranwal, Gaurav & Yadav, Ravi & Vidyarthi, Deo. (2020). QoE Aware IoT Application Placement in Fog Computing Using Modified-TOPSIS. Mobile Networks and Applications. 25. 10.1007/s11036-020-01563-x.

[9] Faticanti, Francescomaria et al. "Throughput-Aware Partitioning and Placement of Applications in Fog Computing." IEEE Transactions on Network and Service Management 17 (2020): 2436-2450.

[10] P. S. Barve, S. Saxena, A. U., N. V. S. Kumar, S. S. Pund, and S. Upendra, "Novel Resource Allocation Approach for Fog Computing-Driven IoT Systems," International Journal of Intelligent Systems and Applications in Engineering, vol. 12, no. 21s, pp. 1045–1051, 2024. [Online]. Available: https://ijisae.org/index.php/IJISAE/article/view/5503

[11] Hornik, Jacob, Motti Rachamim, and Shlomo Graguer. "Fog computing: a platform for big-data marketing analytics." Frontiers in Artificial Intelligence 6 (2023): 1242574. https://doi.org/10.3389/frai.2023.1242574

[12] Ghani, Naveed, et al. "A Review of Fog Computing: Concept, Architecture, Application, Parameters, and Challenges." International Journal on Informatics Visualization, vol. 7, no. 1, 2023, pp. 2187–2195. https://doi.org/10.30630/joiv.7.1.2187

[13] Rahul, Satyakam, and Rajni Aron. "Fog Computing Architecture, Application and Resource Allocation: A Review." WCNC-2021: Workshop on Computer Networks & Communications, 2021, pp. 32–41. CEUR Workshop Proceedings, Vol. 2889. https://ceur-ws.org/Vol-2889/PAPER_04.pdf

[14] Subedi, Bipesh, and Gajendra Sharma. "A State-of-the-Art Review on Fog Computing Architecture, Applications, and Security Issues." International Journal of Advanced Networking and Applications, vol. 13, no. 6, 2022, pp. 5188–5196. https://www.ijana.in/papers/V13I6-5.pdf

[15] Design and Implementation of a Fog Computing Architecture for IoT. (2023). Research Journal of Computer Systems and Engineering, 4(2), 46–59. https://doi.org/10.52710/rjcse.73

[16] Bachmann, Andreas. Design and Implementation of a Fog Computing Framework. Master's thesis, TU Wien, 2017. https://www.infosys.tuwien.ac.at/team/sschulte/theses/Bachmann_Master.pdf

[17] Kumar, Vishal, et al. "Comparison of Fog Computing & Cloud Computing." International Journal of Mathematical Sciences and Computing (IJMSC), vol. 5, no. 1, 2019, pp. 31–41. https://doi.org/10.5815/ijmsc.2019.01.03

[18] OpenFog Consortium. OpenFog Reference Architecture for Fog Computing. OpenFog Consortium Architecture Working Group, 2017. https://www.openfogconsortium.org/wp-content/uploads/OpenFog-Reference-Architecture-2_09_17-FINAL.pdf

[19] Walia, Suneet, Ranjit Rajak, and Mohammad Sajid. "E-Commerce With Fog-Enabled Cloud Computing: Framework, Opportunities, and Challenges." Journal of Theoretical and Applied Information Technology, vol. 100, no. 13, 2022, pp. 4941–4950. http://www.jatit.org/volumes/Vol100No13/24Vol100No13.pdf

[20] Luan, Tom H., et al. "Fog Computing: Focusing on Mobile Users at the Edge." arXiv preprint arXiv:1502.01815 (2015). https://arxiv.org/abs/1502.01815

[21] A. Brogi, S. Forti, and A. Ibrahim, "Deploying Fog Applications: How Much Does It Cost, By the Way?," in Proceedings of the 8th International Conference on Cloud Computing and Services Science (CLOSER 2018), pp. 68-77, 2018, doi: 10.5220/0006676100680077

[22] M. A. Al-Shareeda, A. A. Alsadhan, H. H. Qasim, and S. Manickam, "The fog computing for internet of things: review, characteristics and challenges, and open issues," Bulletin of Electrical Engineering and Informatics, vol. 13, no. 2, pp. 1080–1089, Apr. 2024, doi: 10.11591/eei.v13i2.5555

[23] A. Velte, T. Velte, and R. Elberfeld, "Fog Computing Conceptual Model," NIST Special Publication 500-325, National Institute of Standards and Technology, Gaithersburg, MD, USA, Mar. 2018, doi: 10.6028/NIST.SP.500-325

[24] P. R. Gudipati and K. S. Reddy, "Resource Management and Allocation in Fog Computing," International Journal of Advanced Research in Computer Science, vol. 14, no. 1, p. 23, Jan.-Feb. 2023, doi: 10.26483/ijarcs.v14i1.6947

[25] S. Sarkar, S. Chatterjee, and S. Misra, "Design and Implementation of a Fog Computing Framework for Healthcare Monitoring," in IEEE Access, vol. 5, pp. 16487-16499, 2017, doi: 10.1109/ACCESS.2017.2738713
[26] A. V. Dastjerdi, H. Gupta, R. N. Calheiros, S. K. Ghosh, and R. Buyya, "Fog Computing: Principles, Architectures, and Applications," arXiv preprint arXiv:1601.02752, 2016
[27] V. Kumar, A. A. Laghari, S. Karim, M. Shakir, and A. A. Brohi, "Comparison of Fog Computing & Cloud Computing," International Journal of Mathematical Sciences and Computing, vol. 5, no. 1, pp. 31-41, 2019, doi: 10.5815/ijmsc.2019.01.03
[28] Costa, Breno & Bachiega Jr, Joao & Araújo, Aletéia. (2022). Orchestration in Fog Computing: A Comprehensive Survey. ACM Computing Surveys. 55. 1-34. 10.1145/3486221.
[29] S. S. Alqahtani, M. Anbar, I. A. T. Hashem, and A. Gani, "Fog Computing: A Comprehensive Architectural Survey," Journal of Network and Computer Applications, vol. 143, pp. 13-36, 2019, doi: 10.1016/j.jnca.2019.06.006
[30] S. S. Alqahtani, M. Anbar, I. A. T. Hashem, and A. Gani, "Fog Computing: A Comprehensive Architectural Survey," Journal of Network and Computer Applications, vol. 143, pp. 13-36, 2019, doi: 10.1016/j.jnca.2019.06.006.
[31] S. Rahul and R. Aron, "Fog Computing Architecture, Application and Resource Allocation: A Review," CEUR Workshop Proceedings, vol. 2889, pp. 27-39, 2021
[32] S. M. Salman, T. A. Sitompul, A. V. Papadopoulos, and T. Nolte, "Fog Computing for Augmented Reality: Trends, Challenges and Opportunities," in Proceedings of the 2020 IEEE International Conference on Fog Computing (ICFC), Sydney, Australia, 2020, pp. 56–63, doi: 10.1109/ICFC49376.2020.00015
[33] B. Jamil, M. Shojafar, I. Ahmed, A. Ullah, K. Munir, and H. Ijaz, "Resource Allocation and Task Scheduling in Fog Computing: A Review," ACM Computing Surveys, vol. 55, no. 4, pp. 1-38, 2022, doi: 10.1145/3513002
[34] M. Muneeb, "A Fog Computing Architecture with Multi-Layer for Computing-Intensive IoT Applications," Applied Sciences, vol. 11, no. 24, p. 11585, 2021, doi: 10.3390/app112411585
[35] S. K. Biswash and D. N. K. Jayakody, "A Fog Computing-Based Device-Driven Mobility Management Scheme for 5G Networks," Sensors, vol. 20, no. 21, p. 6017, 2020, doi: 10.3390/s20216017
[36] D. Silitonga, S. A. A. Rohmayanti, Z. Aripin, D. Kuswandi, A. B. Sulistyo, and Juhari, "Edge Computing in E-commerce Business: Economic Impacts and Advantages of Scalable Information Systems," EAI Endorsed Transactions on Scalable Information Systems, vol. 11, no. 1, pp. 1-8, Nov. 2023, doi: 10.4108/eetsis.4375
[37] J. Liu, B. Pan, X. Zhang, and D. Li, "Mobile E-Commerce Information System Based on Industry Cluster under Edge Computing," Mobile Information Systems, vol. 2021, Art. no. 7930799, pp. 1–11, 2021, doi: 10.1155/2021/7930799
[38] T. Dreibholz and S. Mazumdar, "Load Distribution for Mobile Edge Computing with Reliable Server Pooling," in Proceedings of the 4th International Workshop on Recent Advances for Multi-Clouds and Mobile Edge Computing (M2EC) in conjunction with the 36th International Conference on Advanced Information Networking and Applications (AINA), 2022, pp. 590–601, doi: 10.1007/978-3-030-99619-2_55
[39] D. Dechouniotis, N. Athanasopoulos, A. Leivadeas, N. Mitton, R. M. Jungers, and S. Papavassiliou, "Edge Computing Resource Allocation for Dynamic Networks: The DRUID-NET Vision and Perspective," Sensors, vol. 20, no. 8, Art. no. 2191, 2020, doi: 10.3390/s20082191
[40] E. Meskar and B. Liang, "Fair Multi-resource Allocation in Mobile Edge Computing with Multiple Access Points," in Proceedings of the 21st ACM International Symposium on Theory, Algorithmic Foundations, and Protocol Design for Mobile Networks and Mobile Computing (MobiHoc '20), Boston, MA, USA, Oct. 2020, pp. 1–10, doi: 10.1145/3397166.3409144
[41] Y. Zhang, P. Zhang, H. Dong, and H. Jin, "Mobility and Dependence-aware QoS Monitoring in Mobile Edge Computing," IEEE Transactions on Cloud Computing, vol. 12, no. 2, pp. 551–564, Apr.–June 2024, doi: 10.1109/TCC.2022.3211239.
[42] C. Wang, Z. Yuan, P. Zhou, Z. Xu, R. Li, and D. O. Wu, "The Security and Privacy of Mobile Edge Computing: An Artificial Intelligence Perspective," IEEE Internet of Things Journal, vol. 10, no. 24, pp. 22008–22032, 2023, doi: 10.1109/JIOT.2023.3304318
[43] [N. Maharishi and D. Saxena, "A Survey on Mobile Edge Computing to Fix Task Offloading," unpublished,Nov.2024.[Online].Available: https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID5037691_code3635775.pdf?abstractid=5037691

AUTHOR'S BIOGRAPHY

Mrs. Sreedevi S. is an Assistant Professor in the Department of Computer Science and Engineering at Jawaharlal Nehru New College of Engineering (JNNCE), Shimoga, where she has served since 2006. She is currently pursuing her Ph.D. with a research focus on Enhancing the Performance of M-commerce using Fog Computing. Her academic interests include fog and cloud computing, distributed systems, and mobile commerce technologies. Mrs. Sreedevi's ongoing research and publications reflect her commitment to advancing knowledge in emerging computing paradigms, aiming to bridge theory and practical applications within the field.