A Decision Modeling Framework for Data Center Applications

Aaqif Afzaal Abbasi*, Amber Sultan, Syed Baqar Hussain, Tayyaba Anees
School of Systems and Technology, University of Management and Technology, Lahore, 54770 Pakistan
***Correspondence**: aaqif.afzaal@yahoo.com; amber.sultan.ahmed@gmail.com; baqar1@gmail.com; tayyaba.anees@umt.edu.pk

Citation | Abbasi. A. A, Sultan. A, Hussain. S. B, Anees. T, "A Decision Modeling Framework for Data Center Applications", IJIST, Vol. 8 Issue. 3 pp 1228-1236, June 2026
Received| April 21, 2026 **Revised|** May 24, 2026 **Accepted|** May 31, 2026 **Published|** June 13, 2026.

The emergence of computing and storage paradigms in recent years, especially cloud computing, has led to the development of a series of data center-related technologies and applications. These applications integrate system and application resources to the fullest, thereby enabling a smooth delivery of storage and services. In legacy systems, where hardware is assisted by built-in software, it is difficult to utilize the hardware's resources. Therefore, the software-defined networking concept was introduced, which separates the control plane from the data plane. This made network programming easier to modify and manage. In this paper, we present a decision modeling framework that can be used to administer network resources using the Analytical Hierarchy Process (AHP). The proposed metrics were used to calculate performance parameters such as throughput, delay, and response time. We also provided simulation results to evaluate the efficiency of the proposed system, which shows an overall 35 percent improvement compared to the conventional decision model.

Keywords: Analytical Hierarchy Process; Cloud Computing; Data Centers; Resource Management; Software Defined Networking

Introduction:

Cloud computing benefits users in experiencing cloud applications through a user application [1][2]. Cloud computing is such an amazing computing technology that leverages integrated flexible network resources, including varied clouds, network technologies, storage, and mobility, etc., to serve several devices across the globe. This purpose is fulfilled through either Ethernet or the Internet, regardless of the underlying technology, by using the principle of pay-as-you-use. The increasing usage of cloud-based applications is expected to rise due to the flexibility for the service providers as well as for the users.

Modern cloud applications are also used for social networking, processes, and user information to make the service experience better. In view of the current trends in computing architecture, it is unlikely that such challenges will be solved in the future. This is, in fact, not merely a temporary technological deficiency but intrinsic to computing hardware/ software, and a barrier that needs to be overcome to realize the full potential of computing. Extensive surveys on cloud computing, such as [3], can be found in the literature. The concept of offloading data and computation in cloud computing is used to address the inherent problems by using resource providers other than the cloud applications.

Cloud computing comprises several parameters that determine satisfactory performance. These parameters involve Authentication, Authorization Accounting (AAA), Energy efficiency, service availability, and operators' service level agreements (SLAs). Together, these requirements can help in providing efficient management of cloud services. In areas of Mobility management, cloud computing lacks an intelligent mobility management system that can support effective service delivery. Authors in [4] describe protocols for the management of cloud-based networks, Internet Protocol (IP), and satellite networks.

The cloud resource gaps existing in a distributed cloud infrastructure are presented in [5]. This architecture is an extended work of [6] where an overlay-based network supports dynamic deployment of services and on-demand prototyping. The Software Defined Network (SDN) allows managing network services through the abstraction of lower-level functionality performed through decoupling the system that makes decisions about where traffic is sent and forwarding traffic to the selected destination [7]. Authors in [8] propose Procera, an SDN-based network control framework. Procera helps operators to use a high-level functional programming language in cloud environments to design network policies that react to various types of network events.

Developing such a framework is essential to managing the network traffic in a very timely, accurate, and reliable way. Although no wireless technology can address the diverse requirements of cloud users, an optimal mechanism is needed to address the issues evolving from vertical handoff between two networks. This decision mechanism depends heavily on the application based QoS, bit error rates, signal strength and coverage area, etc.

In SDNs, the control plane is decoupled from the data plane through which an intelligent and centralized infrastructure can be abstracted for the applications. Load balancing can be performed either by using specialized software or protocol, or by installing a specialized gateway or load balancers, etc. Since SDN manages the network through a centralized controller, the distributed traffic onward can be managed more efficiently.

Authors in [9] propose a structured technique named the analytic hierarchy process (AHP) to organize and analyze complex decisions based on mathematical and psychological parameters. By using AHP, users first decompose their decision problem into a hierarchy of more easily realized sub-problems. These sub-problems are then analyzed independently. These hierarchical elements can be related to any tangible or intangible aspect of the decision problem. After building the hierarchy, various elements are evaluated systematically. It compares them to one another. It compares two elements at a time, with respect to their impact on an element above them in the hierarchy. Network management is done using a policy-based approach due to its flexibility. The network details can be separated to facilitate dynamic control in SDNs. The policy-based management framework is defined by the Internet Engineering Task Force (IETF) [10]. It manages a policy rules repository and applies relevant policy rules whenever a policy event is triggered. These rules later shape up to create configuration actions and send them to the policy execution point (PEP). These PEPs are responsible for executing actions in response to the triggered policy events. The QoS architecture in [11] introduced and adopted the IETF policy framework.

Objectives:

Network policy management is a complex task. The objective of the research is to ease the concept of network management by simplifying the decision-making process for resource utilization. This also eases the policy implementation using a standardized process.

Contributions:

The paper presents a cloud decision modeling framework through SDNs, AHP technique for efficient decision making. We present an AHP-based resource management policy through SDNs. It enables network operations transformation from SDN's operator-intensive management to automated decision-making processes. The novelty in the work is using an AHP-based API to administer cloud management features. We also evaluate the proposed layout in a parameter-restricted environment. We suggest that a structured decision process, such as AHP, can simplify network management in MCC environments.

Paper Outline:

The rest of the paper is organized as follows. Section 2 explains the developments, and Section 3 presents related work, Section 4 presents the discussion, Section 5 describes the performance evaluation, and Section 6 concludes the paper.

Related Work:

In the service provider market, mobility is one of the fastest-growing segments. The convergence of cloud infrastructure helps in scaling network resource-hungry applications. Virtual resources provide the required network bandwidth and desired service level. In [12], the authors suggest minimizing signaling traffic during routing phases. SDN requires the use of high-performance hardware switches that separate the control plane and the data plane. They can be implemented by using various software architectures. LTE/4G can manage a huge amount of data traffic and follows an IP-based model. For cloud infrastructures, performance is dependent on data centers' efficiency. For infrastructure, core equipment must meet 3GPP specification standards.

Preserving a customized computing environment as one move to different locations is an enduring challenge in computing [13]. The infrastructure is now integrating clouds to employ networking functions. This provides flexible and manageable architectures such as Cloud RAN [14]. The mobility design depends upon the software data plane providing flexible services managed in a virtualized environment. Technologies like LTE can utilize Mobility services in a better way. SDN is deployed to use network resources with more scalability and flexibility in line with the continued demand for data-intensive user applications. In addition to that, SDN will also help to develop new service architectures for more operational efficiency and to generate revenue opportunities for a sustained period.

Designing an intelligent user mobility management technique is one of the key issues encountered in a cloud while providing a seamless service. In the paper, we focused on the methods used to support and manage mobility in cloud computing systems. In order to evaluate the location, several infrastructure-based techniques are used, such as WiFi, GPS, and Radio Frequency. Being uneconomical due to heavy energy consumption, peer-based techniques can be used with limited power constraints. [15] mentioned to use mobility traces to establish 'communities' which are moving together and have stable environments for task distribution. Mobility tracking can help in fault tolerance to identify an unstable node beforehand, and precautionary measures can be taken by promoting task redundancy at the system level. Mobility is one of the reasons for the cloud dysconnectivity. In [16], the authors describe a cloud disconnection solution through the Hadoop fault-tolerant mechanism.

The major task in mobility management for MCC is defining the blurred boundaries between the cloud services and mobility infrastructure providers. The heterogeneous nature of MCC leads to new challenges in highly complex QoS provisioning environments. Technologies are required to provide scalability at the enterprise level and to ensure safety across the various phases of application development, as well as during implementation. The availability of devices as a resource provider [17] is determined by their mobility. Hence, devices/users with a high degree of mobility are termed as less reliable due to their being prone to disconnection. The availability condition is recorded for determining changes in resources and was used with a Markov chain model for determining state transitions.

The collaboration through a static network varies in comparison to a network. In static networks, devices are considered to have stable connectivity, whereas this is not the case in the cloud. The connectivity issues and signal distortion in a cloud environment require excessive service availability monitoring. For delivering user-experience-focused applications, testing of intensive API-based applications can give insight analysis about user experience, application performance, log analytics, crash reports, etc. Thus, this will help in automating and supporting these applications on millions of devices. In [18], the authors propose the development of distributed applications in a pervasive environment by constructing a virtualized set of pervasive computing devices for satisfying data user requirements. The proxy migration has been useful so far in establishing QoS and policy implementation. Being successful for computing devices, it still cannot be used for a cloudlet. Authors in 'Follow Me' [19] proposed a decentralized and localized location sharing system. Limited resource availability is one of the major obstacles for various applications to provide seamless user experience for such services, which require higher processing and energy beyond hardware capabilities [20].

Discussion:

To deliver cloud services, enterprises are moving their applications to the cloud. Mobility management has transformed the challenges of the new economy into significant opportunities. There is a dire need for solutions to power innovation, accelerate the development of new applications, drive productivity, and offerings, etc. It can help businesses to work on improving the technology and business shift of cloud mobility. Authors in [21] propose a novel Cloud-centric Architecture for Rich Experience Networking (Carmen), a distributed system to manage connectivity of a set of devices belonging to a particular individual, called Personal Grid. The proposed Carmen enabled MPG to collect context from the users and to coordinate key system resources across the MPG and the cloud.

The Internet of Things (IoT) can facilitate data centers to deploy internet-connected devices using Machine-to-Machine (M2M) interactions. The developments in big data analytics and embedded computing [22] are on the rise in the IoT phenomenon. Permitting users to access available resources through smart devices could support them in using intensive services. In core, the user's access to resources like computational power or social networking requires extensive distributed processing. In [23], the authors discuss a Service platform for cloud resource hosting. It is aimed to support the execution of distributed tasks in the opportunistic networks. The primary contribution of the architecture is to leverage the social behavior of humans for efficient opportunistic interaction between a variety of sensors and resources embedded in the local environment.

In [24], pocket-switched networking has been exploited to achieve the full benefit of hardware resources. A service delivery platform that enables communication between collocated devices is captured. This creates ease of management in networks characterized by intermittent connectivity. In [25], enhanced functionality is provided by using opportunistic computing. In opportunistic computing, the cooperation of devices serves as a significant platform for sharing and composing distributed resources, thus providing an enriched functionality platform. Sociable Sense [26] presents an approach for users to enumerate their intensive sensing task management activities to the cloud in fixed networks for increased latency, bandwidth costs, and energy savings. In [27], the authors propose a system to collect and index updates in social networks. To address the management of issues in clouds and managing resource-intensive systems [28], there exists a large scope in user data usage and storage management.

The securely managed applications access integrated with fine-grained control policies allows content retrieval and collaboration through file synchronization. These controls are also applicable when access to enterprise content repositories is required. The cloud store integration can be made available to end-users through policy-based access. Similarly, email management with secure access ensures group and policy-based controls to protect sensitive email content.

System Design:

We propose a framework based on the AHP principle. It can address QoS issues in management for clouds. Cloud resource management is considered to provide a constant quality of service under severe environments. It also includes a location update. The management can be enhanced by using user profile replicas at various server locations, making it readily available and reducing lookup costs. An Application Programming Interface (API) can implement the policy management task for the SDN controller. In managing clouds through SDNs, the administrator needs to have an overall view of the network state. AHP can help SDNs in defining network policy for application priority selection, scheduling, and resource management.

AHP is a structured technique to help administrators/ decision-makers choose the best option from available decision listings. This process converts values into numerical values. Finally, the priorities for decision alternatives are tested. The system used AHP priority weights assignment as where W represents criteria weights. The consistency is determined using the eigen value ($MW = \lambda_{max} W$ is solved). The eigenvector provides priority and eigen value measure of consistency index (CI) derived from the departure of λ_{max} from n is compared with corresponding average values for random entries yielding the consistency ratio (CR)

The proposed framework defines various parameters of application selection for a cloud user with their selection criterion. The parameter selection, AHP-based hierarchy construction, weight assignments were followed using the standard AHP class. These parameters can be assigned weights in priority. For using AHP, the main challenge is to identify it into criterion. The decision methodology is based on AHP. It makes use of Hierarchy. The AHP uses a structured format for decision modeling. It is composed of a goal and a group of alternatives to find the goal. The intensity of importance is 1,3,5,7,9 for equally, essentially, very strongly, and absolutely important. Whereas 2,4,6,8 are intermediate values between adjacent scale values. The decision for scheduling can be achieved by performing different operations on the derived values. It provides a comparison of pre-defined weight sets with priorities on a many-to-one mapping relationship. AHP is a proven technique for decision-making in businesses and processes. Our proposed system used evaluator, allocator, and selector for evaluation criterion, resource allocation units, and cloud service selection, respectively, at level 1 of services presentation. In level, it uses the connectivity log archive and derived function value to address network services connectivity-related constraints. The policy generation is partially enabled to fine tune user requirements. Finally, by adjusting parameters, users can refine the decision-making process. The block diagram of the proposed technique is presented in Figure 1.

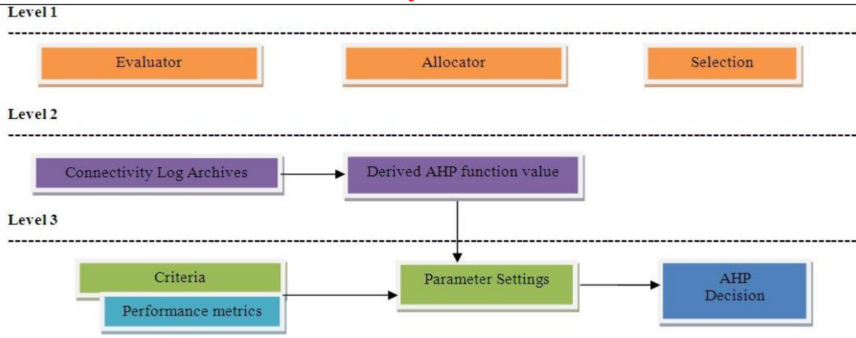

Figure 1. The proposed system

We developed an AHP-based decision module using MATLAB and trained it with results derived from our simulation in Optimum Network Performance (OPNET) software simulation. Cloud-based systems have elasticity in terms of resource availability. This allows them to address the resource utilization gaps. The parameters were tested seven times through the profile-based approach. The methodology is represented as Profile and Analytical Content (PAC). It is the proposed methodology for selecting a network profile according to the network traffic state in OPNET and the AHP-defined values. The heuristics were loaded on a network of 6 SDN-enabled switches. The traffic routes and the amount of traffic are restricted. In the testing, we ignore the overheads generated by the system because it is a limited-scale experimentation.

Performance Evaluation and Results:

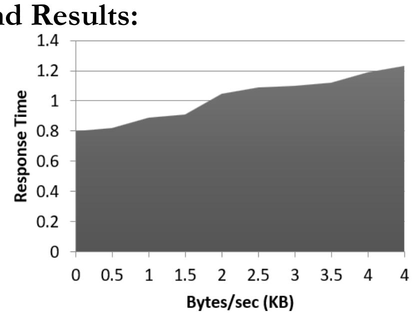

Figure 2. Stability feature in response time

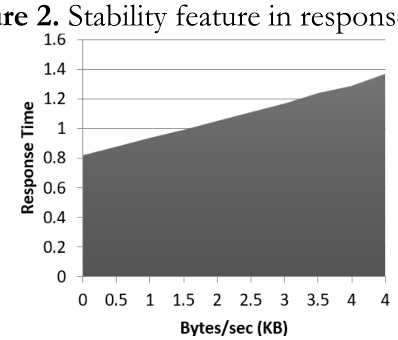

Figure 3. System response time using the proposed scheme

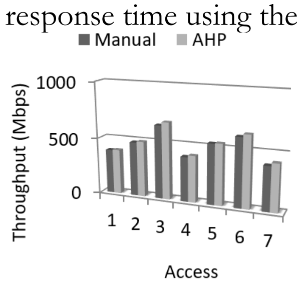

Figure 4. Measuring throughput using conventional and proposed methods

Results show that decisions made through our scheme have improved performance in terms of resource optimization and network management. It may be noted that the study excludes machine learning and optimizers which make it an evaluation in a controlled environment. In Figure 2, a decision brings stability in terms of response time as the selected values have common objectives. Similarly, in Figures 3 and 4, system response time and throughput are compared using the conventional and proposed schemes. The smooth vertical rise in Figure 3 indicates that when a priority-based selection is made, the response time has a sequential increase. In Figure 4, the throughput comparison reveals that the AHP-based method has outperformed the traditional methodology. In the next stage of experimentation, we increase the bandwidth to check the system throughput. We measured throughput and delay for increased bandwidth, as shown in Figures 5 and 6, respectively. We further calculated the system delay under increased bandwidth consumption. Finally, the overall system performance illustration is presented in Figure 7, which shows the improvement of our system efficiency in comparison to the conventional application selection process where response time jumped from 0.8 to 1.2 in a lapse of 4 bytes/ sec. From the results, it is evident that the response time is reduced when an application with a higher priority is allocated a higher bandwidth.

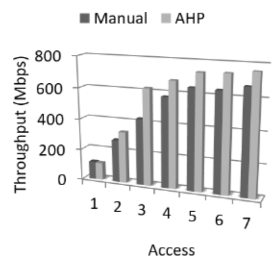

Figure 5. Measuring throughput using the proposed method for increased bandwidth

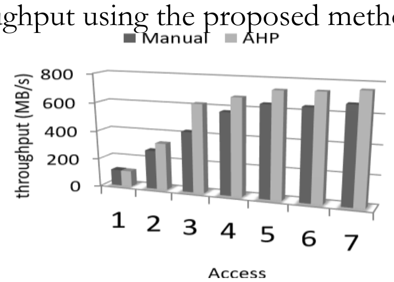

Figure 6. Delay calculation using throughput, given increased bandwidth

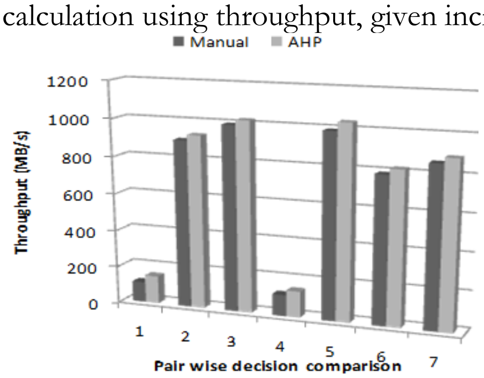

Figure 7. Overall comparative analysis

Conclusion:

With the rapid increase in use of cloud-based applications and services, the IT infrastructure providing these services often faces resource contention. To provide users with the best available services, a decision structuring process is needed. In conventional data centers, vendor-specific appliances are installed, which often make decisions on the basis of vendor-dependent software. In software-defined networking, the hardware is considered bare metal, and the software control is with the administrator. In this paper, we use AHP to structure a decision process to handle concurrent application requests. It can make a decision based on the criteria set by the administrator and, based on these criteria, allocate priority to the applications. We tested the proposed scheme against a manual priority-based solution for efficiency under limited-scale conditions and parameters. The results demonstrate the efficiency of the proposed system over the conventional system in limited-scale conditions. In future, we plan to implement the API using inference with a large dataset on real-world datacenters.

References:

[1] Francesco Pizzato, Daniele Bringhenti, Riccardo Sisto & Fulvio Valenza, "Intent-Driven Network Isolation for the Cloud Computing Continuum," *J. Netw. Syst. Manag.*, vol. 34, 2026, [Online]. Available: https://link.springer.com/article/10.1007/s10922-025-09986-1

[2] "Ubi-Flex-Cloud: ubiquitous flexible cloud computing: status quo and research imperatives | Request PDF." Accessed: Jun. 16, 2026. [Online]. Available: https://www.researchgate.net/publication/360717514_Ubi-Flex-Cloud_ubiquitous_flexible_cloud_computing_status_quo_and_research_imperatives

[3] Tarek Ali, Mohammed Al-Khalidi, "Information Security Risk Assessment Methods in Cloud Computing: Comprehensive Review," *J. Comput. Inf. Syst.*, vol. 66, no. 1, 2026, doi: https://doi.org/10.1080/08874417.2024.2329985.

[4] Loris Belcastro, Fabrizio Marozzo, Alessio Orsino, Domenico Talia, Paolo Trunfio, "Navigating the Edge-Cloud Continuum: A State-of-Practice Survey," *arXiv:2506.02003*, 2025, [Online]. Available: https://arxiv.org/abs/2506.02003

[5] X. Q. Pham, T. D. Nguyen, T. Huynh-The, E. N. Huh, and D. S. Kim, "Distributed Cloud Computing: Architecture, Enabling Technologies, and Open Challenges," *IEEE Consum. Electron. Mag.*, vol. 12, no. 3, pp. 98–106, May 2023, doi: 10.1109/MCE.2022.3192132.

[6] S. Drissi, M. Chergui and Z. Khatar, "A Systematic Literature Review on Risk Assessment in Cloud Computing: Recent Research Advancements," *IEEE Access*, vol. 13, pp. 76289–76307, 2025, doi: 10.1109/ACCESS.2025.3561123.

[7] M. Polverini, A. Cianfrani, M. Listanti, T. Caiazzi, and M. Scazzariello, "In-Network Q-Learning-Based Packet Forwarding for Delay Sensitive Applications," *IEEE Netw.*, vol. 39, no. 3, pp. 127–133, 2025, doi: 10.1109/MNET.2025.3552929.

[8] Wael Hosny Fouad Aly, Hassan Kanj, Nour Mostafa, Zakwan Al-Arnaout, Hassan Harb, "No binding machine learning architecture for SDN controllers," *Bull. Electr. Eng. Informatics*, vol. 14, no. 3, 2025, [Online]. Available: https://beei.org/index.php/EEI/article/view/8483

[9] Willy Kriswardhana, Bladimir Toaza, "Analytic hierarchy process in transportation decision-making: A two-staged review on the themes and trends of two decades," *Expert Syst. Appl.*, vol. 261, 2025, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0957417424023583

[10] Marwan Darwish, Evangelia Anna Markatou, "A Policy-Based Conjunctive Scheme for Digital Forgetting of Co-Owned Data," *ACM Trans. Priv. Secur.*, vol. 29, no. 3, 2026, [Online]. Available: https://dl.acm.org/doi/10.1145/3811817

[11] Nazmus Sadat, Rui Dai, "A Survey of Quality-of-Service and Quality-of-Experience Provisioning in Information-Centric Networks," *Network*, vol. 5, no. 2, p. 10, 2025, doi: https://doi.org/10.3390/network5020010.

[12] S. Wang, W. Wu, J. Luo, J. Zhou, and T. Zhang, "Integrated Control Policy for Heterogeneous Traffic in Container Terminals With Unsignalized Intersections," *IEEE Trans. Intell. Transp. Syst.*, vol. 26, no. 7, pp. 10795–10807, 2025, doi: 10.1109/TITS.2025.3560067.

[13] A. Boroumand, M. Hosseini Shirvani, and H. Motameni, "A heuristic task scheduling algorithm in cloud computing environment: an overall cost minimization approach," *Clust. Comput. 2024 282*, vol. 28, no. 2, pp. 137-, Nov. 2024, doi: 10.1007/S10586-024-04843-3.

[14] F. Wu *et al.*, "Multi-Variate Time Series Prediction of Traffic and Users for Dynamic RRH-BBU Mapping in C-RAN," *IEEE Trans. Mob. Comput.*, vol. 24, no. 10, pp. 10557–

10572, 2025, doi: 10.1109/TMC.2025.3570851.
[15] Jolien Cremers, Benjamin Kohler, Benjamin Frank Maier, Stine Nymann Eriksen, “Unveiling the social fabric through a temporal, nation-scale social network and its characteristics,” *Sci. Rep.*, 2025, [Online]. Available: https://www.nature.com/articles/s41598-025-98072-2
[16] “Understanding and Detecting Fail-Slow Hardware Failure Bugs in Cloud Systems | USENIX.” Accessed: Jun. 16, 2026. [Online]. Available: https://www.usenix.org/conference/atc25/presentation/dong
[17] H. C. Fu, Y. Qiao, L. P. Bai, N. Q. Wu, B. Liu, and Y. F. He, “Development of Fault Detection Systems: The Hadoop Ecosystem Implementation,” *IEEE Robot. Autom. Mag.*, vol. 30, no. 2, pp. 22–33, Jun. 2023, doi: 10.1109/MRA.2023.3263973.
[18] Idoia Gamiz, Cristina Regueiro, Oscar Lage, Eduardo Jacob & Jasone Astorga, “Challenges and future research directions in secure multi-party computation for resource-constrained devices and large-scale computations,” *Int. J. Inf. Secur.*, vol. 24, no. 7, 2025, [Online]. Available: https://link.springer.com/article/10.1007/s10207-024-00939-4
[19] Y. Han, D. Niyato, C. Leung, C. Miao, and D. I. Kim, “A Dynamic Resource Allocation Framework for Synchronizing Metaverse with IoT Service and Data,” *IEEE Int. Conf. Commun.*, vol. 2022-May, pp. 1196–1201, 2022, doi: 10.1109/ICC45855.2022.9838422.
[20] A. H. Khan, “Spiking Neural Networks: A Comprehensive Survey of Training Methodologies, Hardware Implementations and Applications,” *Artif. Intell. Sci. Eng.*, vol. 1, no. 3, pp. 175–207, 2025, doi: 10.23919/AISE.2025.000013.
[21] Fulya Horozal, Philip Reimer, “Tool Support for Architectural Pattern Selection and Application in Cloud-Centric Service-Oriented IDEs,” *ACM Int. Conf. Proceeding Ser.*, 2023, [Online]. Available: https://dl.acm.org/doi/10.1145/3624486.3624494
[22] A. M. Ghosh and K. Grolinger, “Edge-Cloud Computing for Internet of Things Data Analytics: Embedding Intelligence in the Edge With Deep Learning,” *IEEE Trans. Ind. Informatics*, vol. 17, no. 3, pp. 2191–2200, 2021, doi: 10.1109/TII.2020.3008711.
[23] Mark Stillwell, David Schanzenbach, “Resource allocation algorithms for virtualized service hosting platforms,” *J. Parallel Distrib. Comput.*, vol. 70, no. 9, 2010, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0743731510000997
[24] Pan Hui, Augustin Chaintreau, “Pocket switched networks and human mobility in conference environments,” *Proc. ACM SIGCOMM 2005 Work. Delay-Tolerant Networking, WDTN 2005*, 2005, [Online]. Available: https://dl.acm.org/doi/10.1145/1080139.1080142
[25] M. Conti, S. Giordano, M. May, and A. Passarella, “From opportunistic networks to opportunistic computing,” *IEEE Commun. Mag.*, vol. 48, no. 9, pp. 126–139, Sep. 2010, doi: 10.1109/MCOM.2010.5560597.
[26] Kiran K. Rachuri, Cecilia Mascolo, “SociableSense: exploring the trade-offs of adaptive sampling and computation offloading for social sensing,” *Proc. Annu. Int. Conf. Mob. Comput. Networking, MOBICOM*, 2011, [Online]. Available: https://dl.acm.org/doi/10.1145/2030613.2030623
[27] E. Raggi, K. Thomas, T. Parsons, A. Channelle, and S. van Vugt, “Social Networks and Cloud Computing,” *Begin. Ubuntu Linux*, pp. 337–348, 2010, doi: 10.1007/978-1-4302-3040-3_15.
[28] Sukhpal Singh, Inderveer Chana, “QoS-Aware Autonomic Resource Management in Cloud Computing: A Systematic Review,” *ACM Comput. Surv.*, vol. 48, no. 3, 2015, [Online]. Available: https://dl.acm.org/doi/10.1145/2843889