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Cloud Computing and Fog Computing: A Survey

Vishal T[1], Yashwanth R[2], Sushmitha N[3], Chandan S[4]

[1]*UG Student, Dept. of Information Science & Engineering, RV College of Engineering, Bangalore, Karnataka, India*
[2] *UG Student, Dept. of Information Science & Engineering, RV College of Engineering, Bangalore, Karnataka, India*
[3]*Assistant Professor, Dept. of Information Science & Engineering, Bangalore, Karnataka, India*
[4]*UG Student, Dept. of Information Science & Engineering, RV College of Engineering,Bangalore, Karnataka, India*

Abstract – *Cloud computing is the most vastly developing and expanding segment of the internet. The increased demand gives rise to new concerns over data security, control, privacy and availability. The development in cloud infrastructure leads to increased number of dimensions such as multi latency, elasticity that complicate the security problem. Also, the demand for high efficiency leads to development of new cloud architectures. The main concerns of any cloud user now are reduce latency, improved security and ease of use leading to ultimately having an improved QoS. Increased use in Internet of Things has also increased the demand for more available cloud computation requirements.*
In contrast, Fog computing is much more localized and is almost always under the complete control of the user and is more immune from outsider attacks. Fog computing can be seen as the scaled down version of a cloud computing system as it has nearly all the properties of a traditional cloud computing system, only in a slightly scaled down form. This includes but not limited to the performance capabilities, storage capacity and other characteristics.

Key Words: **Cloud Computing, Security, Infrastructure, Internet of Things, Fog Computing**

1.INTRODUCTION

Computers in the early 60s required large room and a lot of electricity to run, still gave less processing output. Eventually smaller computers like Macintosh, Windows computers replaced these big machines and were more compact. In the recent years the computer industry saw a repid development in its sector to provide increased efficiency. This increase in the development of computers also leads to the requirement of large data centers to manage the data used by users on the internet. This problem gave rise to the cloud. The cloud solved many problems in the computing industry such as storage issues, computational issues , where a remote computer would do most of the required work. Due to the increase in the use cloud , there Is also an increase in the need for security of the data tranfered over the internet and the data of the users stored on remote data storages.
In this paper the various problems faced by users, developers and businesses are addressed along with a few technologies developed and introduced to overcome these issues and other aspects of the cloud. Also the right way to exploit the cloud resources using the right designing of the cloud infrastructure is also discussed.

On the other hand, fog computing technology can be largely viewed as an extension of cloud servers on the account that they largely exhibit similar behaviours to a traditional cloud storage. For example, fog servers usually have higher capacity than the average system of an end user. They usually have lower latency and higher storage capacity. However, when compared to a cloud storage system, it still falls short on all these fronts. One advantage of fog computing over a traditional cloud data center is that it can they can be installed and operated at multiple locations over a wider area at reasonable costs. In contrast, a cloud facility can be extremely expensive to setup, maintain and run.

2. LITERATURE SURVEY

[1] Introduced osmotic computing which creates microservers that are designed to work in smart environments to use the edge and cloud infrastructure sources. Osmotic behavior is observed when the microservers are deployed into the edge/cloud system decisively. This helps improve the efficiency of highly distributed and federated environments enabling the microservers to be deployed which are interconnected. The name osmotic computing is given as the microservers work in a similar way to the osmosis process in chemistry, in which the diffusion of molecules happens from a region with higher concentration to a region with lower concentration.

[2] Presented the changing cloud infrastructure and makes use of infrastructure from multiple providers and take advantage of the decentralized computing away from data centers. The rise in new trends in the cloud infrastructure is addressed and how new varieties of computing architectures are required to support the future cloud infrastructure. A single cloud provider with a single data center makes it easy to host applications but this also imposes the high demand for power consumption and maybe overhead and data, in this case, may be stored in a very remote location and this poses many challenges to the

security of data. Hence decentralization of data centers and multiple providers is a good option.

[3] Displays the concerns of organizations adopting an IT business model due to security issues in the cloud computing sector. An increase in the number of new dimensions, such as multi-tenancy, elasticity, and layers decency stack, related to the cloud model complicates the security problem associated with cloud computing. The discussion gives in detail a view on the cloud computing security problem from various perspectives such as the business', user, developers, characteristics perspective.

[4] Introduced the concept of storing and sharing the same group data while being anonymous and traceable. Group data sharing in cloud environments has become common in recent decades. This leads to the task of achieving this securely and more efficiently. They proposed a data-sharing scheme in which the key agreement and group signature is given more importance to and support group data sharing in public clouds as well. The group signature can be used to communicate anonymously by the group members and if necessary, can be traced back to.

[5] The increased security issues make businesses think before adopting the cloud computing scheme. Here, they present a cloud computing adoption framework that helps businesses to adopt the correct cloud framework. The scheme is based on three major factors: firewall, identity management, and encryption. This adoption framework overcomes the security issues of, employee privacy, share a link which is used to share data with business partners, cloud file synchronization to make sure endpoint devices(users) have control over the collaborated enterprise data, enterprise directory integration.

[6] There is a wide range of security issues related to cloud computing. Amongst the various issues Distributed denial of service attack is one of the serious issues in cloud computing. They discuss the developments made to the DDoS attack solutions. A comprehensive solution to prevent the DDoS attack is addressed. This is a survey evaluating and discussing the various metrics to evaluate a solution to such an attack. A DDoS attack is usually implemented in a 'pay-as-you-go' model. A Distributed Denial of Service attack is carried out by planting bots in the various servers connected to the cloud and hence blocking the user from being able to perform any operation on the data.

[7]Energy consumption is a highly crucial factor in the world of computing. This is especially important in technologies such as cloud computing which are usually implemented on a large scale. In this situation, fog computing technology can be used to reduce the power consumption and the load on cloud servers. This paper proposes the use of time-based and flow based energy consumption models. Nano servers in fog computing can help the central data centers to serve multiple IoT centric applications which have the data source as the user's end. This in turn leads to energy savings if a part or the entire application is run on the nano data centers.

[8]Although fog computing seems to be a promising technology for the needs of the future, it still has its own drawbacks. The biggest shortcoming of Fog computing is the inability to keep up with growing computational needs, leading to acute performance degradation at the time of high loads. This paper aims to overcome this problem by using the computational capacity of stationary vehicles. This can be especially useful because modern vehicles come with great computational capacities and when used in large numbers, can be used to form useful fog vehicular computing. This can be applied in places like shopping malls, airports and bus terminals where a large number of cars are parked together.

[9]The Fog computing technology has a lot of advantages to it including reductions in latency at the user end and reducing the load on cloud servers. However, some problems faced by Fog Servers include geo-distribution and mobility. Also, the Fog computing has a number of security and privacy issues. This survey paper discusses about the latest developments, shortcomings and optimum use of fog computing technology.

[10] IoT is becoming more and more widespread in everyday life. With the increased use of IoT based technology arises the issue of handling all the IoT related data. And even though cloud computing seems to be the answer for IoTs data handling requirements, it has a few drawbacks including bandwidth restrictions. Also, there will be many time sensitive IoT applications where any latency would be unacceptable. This paper discusses in detail about how Fog computing would better suit these scenarios by eliminating these crucial problems.

[11]As fog computing gets adopted rapidly for many purposes, it is essential to make sure that connection between the cloud server and the fog data center have mechanisms in place to optimize the workload allocation to ensure that the delay is balanced among all the users and also to optimize power consumption. This paper investigates the optimum data transmission delay and power consumption and on ways to improve this. Once these factors are taken into account, simulations are performed to prove that computation resources can be sacrificed to significantly improve the performance of cloud and fog computing.

[12]Although fog computing seems like a promising technology that can overcome the shortcomings of a traditional cloud based system and the end user's system, it is crucial that a feasibility study be performed. This paper evaluates the performance of a fog based system and also compares it to a traditional cloud based system. Many factors including the average response time, volume of traffic latency are taken into account. Also, many other real world factors like ownership, pricing models, customer base, security and privacy of fog computing are discussed in this paper.

[13]Quality of Experience is one of the most important factors of any system. This paper discusses in detail about the quality of service of a fog based system and

how it is directly related to the power efficiency of a fog based system. The paper proposes a concept called as offload forwarding in which multiple neighbouring fog nodes rely on each other to process its unused workload, thereby reducing any additional strain that might affect the performance of the connected cloud data center. An optimization algorithm based on alternating direction method of multipliers is proposed.

[14]Traditional cloud storage schemes have security mechanisms that solely depend on the power of the encryption techniques for the safe keeping of all the data on the cloud server. However, this paper proposes a three tier mechanism, which involves the use of cloud storage, fog node and the local machine. Together, when the data is encrypted, split into three parts and stored across the three levels, it becomes exponentially difficult to illegally access the encrypted data, thereby not depending completely on the encryption algorithm.

Table I. Comparison Table

Author	Year	Approach	Description
Muthu Ramachandran	2015	Security Framework for Business Clouds	The developed a security framework based on a firewall, identity management, and encryption for enterprise file sync and share technologies.
Massimo Villari	2016	Osmotic Computing for Edge/Could Integration	They introduced microserver to improve the functionality of edge and cloud computing.
Amir Vahid Datjerdi	2016	Fog computing to improve Internet of Things' efficiency	They discuss how fog computing's computational and storage features can be used to improve IoT uses.
Fatemeh Jalali	2016	Fog Servers used as nano Datacenters	They discuss how nano servers can use less energy to improve cloud computing.
Ruilong Deng	2016	Optimal Workload Allocation in Fog-Cloud Computing	They formulate a workload allocation problem to suggest optimal allocation between fog and cloud to reduce power consumption.
Gaurav Somani	2017	DDoS Attacks in Cloud	They discuss the developments in DDoS attack mitigation solutions in the cloud.
Blesson Varghese	2017	The Changing cloud infrastructure	They discuss how cloud infrastructure is evolving and how to benefit decentralized computing from data centers.
Mohamed Al Morsy	2017	Cloud Computing model Security Problem	They discuss the new dimensions that have complicated the cloud security issue.
Mehdi Sookhak	2017	Augmentation of Fog Computing Using vehicular cloud computing	They developed fog vehicular computing to augment the storage and computational power to enhance the internet of things.
Mithun Mukherjee	2017	Challenges in Fog security and privacy	They discuss the existing concerns over the privacy and security of the fog server in contrast to the cloud.
Blesson Varghese	2017	Feasibility of Fog Computing	The feasibility and benefits in improving the quality of service by using fog servers
Ying Xiao	2017	QoS tradeoff for fog network with fog cooperation	They study how temporary workload offloading in fog server helps improve QoS and power efficiency.
Jia Shen	2018	Anonymous And traceable group data sharing in the cloud	The developed a method to enable sharing group data on the cloud securely while being anonymous.
Tian Wang	2018	Fog computing to enhance cloud storage privacy.	They develop a new system to improve user data privacy, security, and control when stored in cloud storage

3. CONCLUSION

In conclusion, the cloud computing aspect of the internet is and will be growing and expanding providing users with more features and options to ease their work through cloud storage or use of IoT and with that also comes the issue of

data security which may become vulnerable or indeed strengthen with the development of the cloud.

In addition to this, Fog computing technology has tremendous potential as it has many advantages that a traditional cloud system possesses without too many of the drawbacks. If the two types of systems are used in conjunction with each other, the resulting system will be capable of dealing with irregularities in a polished and smooth way and also have better overall performance.

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