Resource Management in Fog Networking of Cloud Computing using KNN Algorithm

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Abstract: It is necessary to deploy any application in Cloud environment to reduce the investment cost, maintenance cost and licence of hardware/software. Keeping these benefits, it is advised to go for cloud computing environment for any application deployment. The major challenge in this environment is fault tolerance of resources to support for continuous availability of resources to client for working. Especially in IoT applications, we use Fog networking connecting to cloud computing. In this scenario, it is advised to use KNN (K- Nearest Neighbour) resource identification and allocation algorithm to increase the throughput to user requirement. We are presenting an approach to allocate the required resources with optimal distance resource allocation, so as to improve the throughput of user requirement.

Keywords: *Cloud Computing, KNN, Fog Networking, Resource management, Fault Tolerance.*

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I. Introduction

A. Cloud Computing : Cloud computing is the is the present scenario of business and network market which provides the computer resources on demand availability, especially data storage and computing power, without direct active management by the user. The term is generally used to describe the making available and provide resources on request to satisfy the user demands through data centers through the Internet[4]. Large clouds, predominant today, often have functions distributed over multiple locations from central servers.

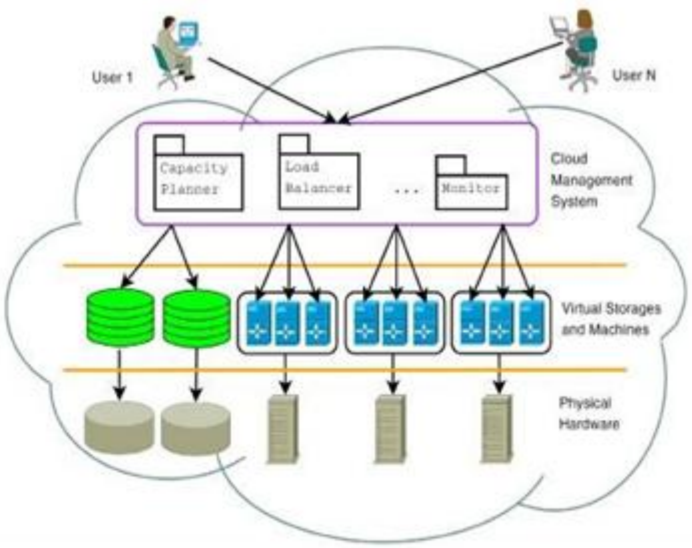

Fig.1: Cloud Architecture

Features of Cloud Computing

- Resources Pooling.
- On-Demand Self-Service. It is one of the important and valuable features of Cloud Computing as the user

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can continuously monitor the server uptime, capabilities, and allotted network storage.

- Easy Maintenance
- Large Network Access
- Availability.
- Automatic System.
- Economical.
- Security.

B. Fog Networks

Fog computing or fog networking, also known as fogging, is an architecture that uses edge devices to carry out a substantial amount of computation, storage, communication locally and routed over the internet backbone[3][2].

Fog computing can be perceived both in large cloud systems and big data structures, making reference to the growing difficulties in accessing information objectively. This results in a lack of quality of the obtained content. The effects of fog computing on cloud computing and big data systems may vary.

Fog networking consists of a control plane and a data plane. For example, on the data plane, fog computing enables computing services to reside at the edge of the network as opposed to servers in a data-centre. Compared to cloud computing, fog computing emphasizes proximity to end-users and client objectives, dense geographical distribution and local resource pooling, latency reduction and backbone bandwidth savings to achieve better quality of service (QoS) and edge analytics/stream mining, resulting in superior user-experience and redundancy in case of failure while it is also able to be used in Assisted Living scenarios.

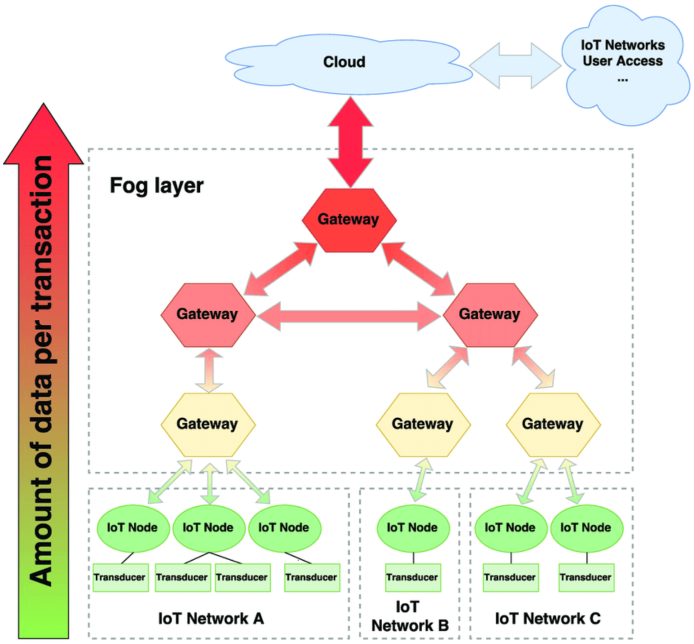

Fig.2: Fog Network Architecture

CHARACTERISTICS OF THE FOG COMPUTING :

Fog computing possess various characteristics, some of them are listed below:

- Heterogeneity: Fog Computing is a highly virtualized platform that yields compute, storage, and networking services between end devices and traditional Cloud Computing Data Centers, typically, but not elite located at the edge of network. Compute, storage, and networking resources are the building blocks of both the Cloud and the Fog .
- Edge location: The origins of the Fog can be traced to early proposals to support endpoints with rich services at the edge of the network, including applications with low latency requirements (e.g. gaming, video streaming, augmented reality.
- Geographical distribution: In sharp contrast to the more centralized Cloud, the services and applications targeted by the Fog demand widely distributed deployments. The Fog, will play an active role in delivering high quality streaming to moving vehicles, through proxies along highways and tracks
- Large-scale sensor networks: To monitor the environment and the Smart Grid are other examples of inherently distributed systems, requiring distributed computing and storage resources. Very large number of nodes, as a consequence of the wide geo-distribution, as evidenced in sensor networks in general and the Smart Grid in particular. Support for mobility. It is essential for many Fog applications to communicate directly with mobile devices, and therefore support mobility techniques, such as the LISP (Locator/ID Separation Protocol), that decouple host identity from location identity, and require a distributed directory system. Real-time interactions. Important Fog applications involve real-time interactions rather than batch processing.

Fog reduces service latency, and improves QoS (Quality of Service), resulting in superior user- experience. Fog Computing supports emerging Internet of Everything (IoE) applications that demand real-time/predictable latency (industrial automation, transportation, networks of sensors and actuators). Fog paradigm is well positioned for real time Big Data and real time analytics, it supports densely distributed data collection points, hence adding a fourth axis to the often mentioned Big Data dimensions (volume, variety, and velocity).

Unlike traditional data centers, Fog devices are geographically distributed over heterogeneous platforms, spanning multiple management domains. That means data can be processed locally in smart devices rather than being sent to the cloud for processing.

C. Fault Tolerance

Fault tolerance is the property that enables a system to continue operating properly in the event of the failure of (or one or more faults within) some of its components. If its operating quality decreases at all, the decrease is proportional to the severity of the failure, as compared to a naively designed system, in which even a small failure can cause total breakdown. Fault tolerance is particularly sought after in high-availability or life-critical systems. The ability of maintaining functionality when portions of a system break down is referred to as graceful degradation [1]. A fault-tolerant design enables a system to continue its intended operation, possibly at a reduced level, rather than failing completely, when some part of the system fails. The term is most commonly used to describe computer systems designed to continue more or less fully operational with, perhaps, a reduction in throughput or an increase in response time in the event of some partial failure. That is, the system as a whole is not stopped due to problems either in the hardware or the software. An example in another field is a motor vehicle designed so it will continue to be drivable if one of the tires is punctured, or a structure that is able to retain its integrity in the presence of damage due to causes such as fatigue, corrosion, manufacturing flaws, or impact.

Within the scope of an individual system, fault tolerance can be achieved by anticipating exceptional conditions and building the system to cope with them, and, in general, aiming for self- stabilization so that the system converges towards an error-free state. However, if the consequences of a system failure are catastrophic, or the cost of making it sufficiently reliable is very high, a better solution may be to use some form of duplication. In any case, if the consequence of a system failure is so catastrophic, the system must be able to use reversion to fall back to a safe mode. This is similar to roll-back recovery but can be a human action if humans are present in the loop.

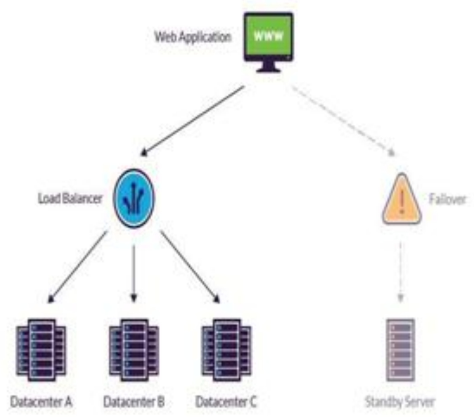

Fig. 3 : Fault Tolerance Structure

Choosing the optimal value for K is best done by first ins value is more precise as it reduces the overall noise but th is another way to retrospectively determine a good K valu validate the K value. Historically, the optimal K for most produces much better results than 1 NN.

II. KNN algorithm: K Nearest Neighbors – Classification

K nearest neighbors is a simple algorithm that stores all available cases and classifies new cases based on a similarity measure (e.g., distance functions) [6]. The k-nearest neighbors (KNN) algorithm is a simple, easy-to-implement supervised machine learning algorithm that can be used to solve both classification and regression pro

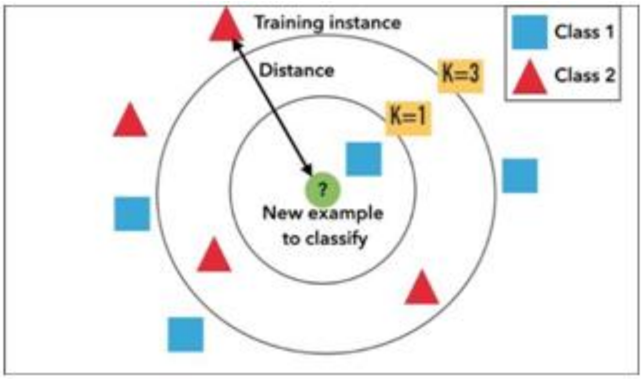

Fig.4: KNN classified objects

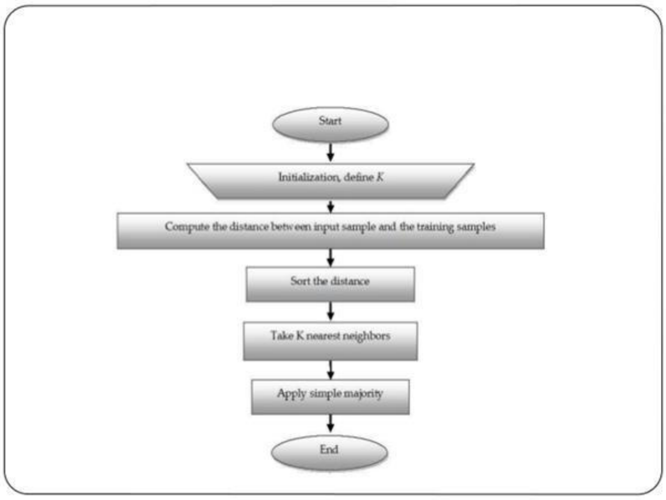

Fig.5: KNN Standard Flow Chart

Resource allocation: In a given network, the interaction between the various controllers determines the allocation of resources. The resources associated with resource allocation strategies are mostly buffer, bandwidth, processors and peripheral devices like printers, scanners, etc.

Resource allocation is important because:

- Fairness in resource allocation helps to ensure that the quality of service standards is met.

- Much needed isolation between different data streams can be achieved.
- From a network and system security perspective, proper resource allocation allows to ensure a high standard of security by countering different denial-of-service attacks.

To ensure good resource allocation in a network, fairness strategies are developed, such as proportional fairness, max-min fairness, utility fairness, etc. Proportional fairness calculates the resource allocation based on the resource amount and demand vector. In the case of max-min fairness, increasing demand helps in allocating a shared resource. It also ensures that the share of resource is not larger than its demand. In the case of utility fairness, the resource allocation is determined by the utility function associated with it [7].

Different algorithms are also developed for resource allocation, such as the simple round- robin allocation. These algorithms are developed based either on the strategies for allocating the resources or on the types of essential/prioritized resources present in the network.

III. Literature Survey

In this paper [2], we noted that technical challenges to manage the limited resources in fog/edge computing have been addressed to a high degree. However, a few challenges still remain to be made to improve resource management in terms of the capabilities and performance of fog/edge computing. It is discussed in the paper for some future research directions to address the remaining challenges.

In the paper [3], the new privacy preserving protocol based on KNN classification method is being applied to resolve the input classification difficulty on the database that was outsourced to the cloud in the encrypted form. The KNN protocol protects the privacy of the data, user's input query, and conceals the data access patterns.

The paper [1] proposes the use of artificial Neural Networks for detecting the faults in cloud environment. The faults are first detected and then suitable fault tolerance technique (pre-emptive migration/ check-pointing) is applied to make the system fault tolerant. The faults will be handled proactively and this will help to resolve the problems associated with fault tolerance techniques.

In the paper [4] the functionality and performance of existing KNN technique is improved with modified Ensemble Learning technique. The data is classified by the machine on the basis of data security parameters selected by the user. It emphasis more focus on highly confidential data HMAC (Hashed Message Authentication Code) function has been added with the existing RSA encryption technique. The proposed system proves to be more accurate and economical. It also saves the user time for encrypting/decrypting different data elements.

The work mentioned fir file encryption in cloud environment [5]. Where the cost and ease of use are the two challenges of cloud computing, there are significant security concerns that need to be addressed when considering moving critical applications and sensitive data to public and shared cloud environments. To address these concerns, transforming the data in cloud through ECC algorithm makes it more secure. Files can be uploaded in encrypted form and using the concept of keys file can be decrypted and downloaded. Here, Security is based on the difficulty of computing discrete logarithm in a finite field, in which one encryption key, known as the private key, is kept secret, while another, known as a public key, is freely distributed. Public key cryptography is computationally more expensive than private key encryption, it makes a single, shared encryption key. Authentication, security, confidentiality, reliability can be easily achieved by implementing the ECC (Elliptic Curve Cryptography) in the cloud computing. It is also mentioned that multi keyword search for searching the documents from the cloud to meet the effective data retrieval for the users, instead of returning undifferentiated results data users to find the most relevant information quickly, rather than burdensomely sorting through every match in the content collection. In practical, more effort and money for easy and understandable and implementation of ECC.

IV. Solution Derivation

A. Proposed Solution and Algorithm

In IoT environment, we need to have several devices connected through internet via cloud computing environment. It is more convenient and efficient to use KNN algorithm to re-cluster the resources. Since all IoT devices are connected through Fog Networking, it is convenient to establish link between cloud resources and IoT devices. The newly proposing algorithm called efficient resource connection to Fog Network elements to use clod as to provide redundant resource allocation for fault tolerance.

The proposing algorithm optimizes the time to connect the required IoT device from its network using Fog Network. The KNN is being used between the gateway and IoT Networks. The KNN reconstructs the cluster of IoT networks to reduce the distance between the IoT network and the required IoT device from a different IoT network [9].

During the process of IoT device access, a request is received from client by cloud, send it to the Fog network (connected with different gateways. The Fog Network detects the required device available location and instructs the KNN to re-cluster the IoT networks, to improve the optimum accessibility of devices. This procedure will

improve the required IoT device availability and easy accessible to client. The algorithm model is as follows.
Step 1 : Request from a client to access an IoT device.
Step 2 : Cloud receives the request and forward to Fog Network for access.
Step 3 : The cloud request is received by Network Gateway and forward it to IoT network through KNN procedure.
Step 4 : The KNN algorithm optimizes the IoT network clusters and provide access through gateway to client.
Step 5: The privacy and security aspects are taken care by IoT device.
Step 6: The step 3 to step 5 are repeated for every request received from the client.
With the help of the above algorithm, we can reduce the redundant devices for resource allocation in the Fog Network. The KNN reduces the adding of network resources and similar IoT devices for the quick access and fault tolerance support.
The proposed architecture solution for efficient resource allocation to IoT client is as follows.

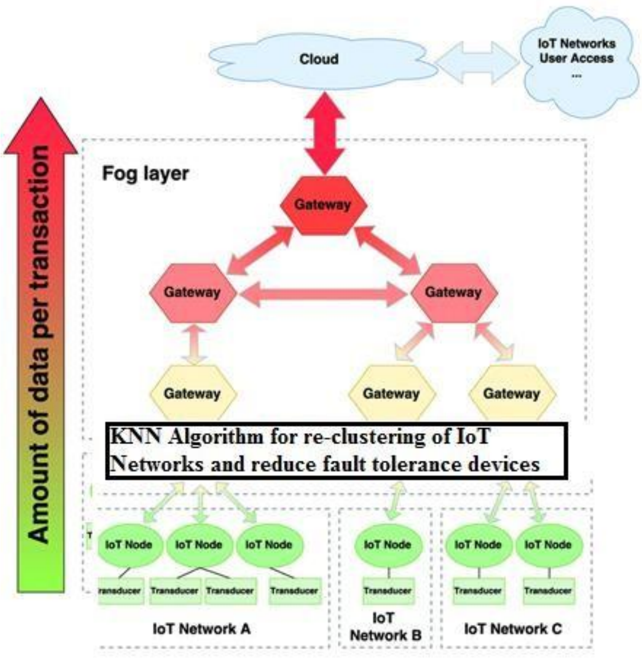

Fig. 6 : Reconstructed Fog Network with efficient re-clustering KNN algorithm

V. Conclusion

The paper which is proposed is helpful to Cloud IoT providers and Cloud IoT clients. Based on the security and future expansion of IoT resources, the algorithm can be enhanced with new optimum features and enhancement. The proposed solution is helpful when the Fog network is established between clients and devices. The authors can contribute to increase security among IoT devices that are in the private or public networks. The future research on this paper can be extended in the area of VMs in Fog network and clustering of similar type of computer/network resources.

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