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A Review on Advancement of Fog over Big Data Using Load Balancing

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Abstract- The fog extends the cloud to be closer to the things that produce and act on IoT data. These devices, called fog nodes, can be deployed anywhere with a network connection: on a factory floor, on top of a power pole, alongside a railway track, in a vehicle, or on an oil rig. Any device with computing, storage, and network connectivity can be a fog node. Examples include industrial controllers, switches, routers, embedded servers, and video surveillance cameras. IDC estimates that the amount of data analyzed on devices that are physically close to the Internet of Things is approaching 40 percent.1 there is good reason: analyzing IoT data close to where it is collected minimizes latency. It offloads gigabytes of network traffic from the core network, and it keeps sensitive data inside the network. Analyzing IoT data close to where it is collected minimizes latency. It offloads gigabytes of network traffic from the core network. And it keeps sensitive data inside the network.

Keywords- load balancing, fog computing, IoT

I. INTRODUCTION

Fog applications are as diverse as the Internet of Things itself. What they have in common is monitoring or analyzing real-time data from network-connected things and then initiating an action. The action can involve machine-to-machine (M2M) communications or human-machine interaction (HMI). Examples include locking a door, changing equipment settings, applying the brakes on a train, zooming a video camera, opening a valve in response to a pressure reading, creating a bar chart, or sending an alert to a technician to make a preventive repair. The possibilities are unlimited.

II. HOW DOES FOG WORK

Developers either port or write IoT applications for fog nodes at the network edge. The fog nodes closest to the network edge ingest the data from IoT devices. Then—and this is crucial—the fog IoT application directs different types of data to the optimal place for analysis.

- The most time-sensitive data are analyzed on the fog node closest to the things generating the data. In a Cisco Smart Grid distribution network, for example, the most time-sensitive requirement is to verify that protection and control loops are operating properly. Therefore, the fog nodes closest to the grid sensors can look for signs of problems and then prevent them by sending control commands to actuators.

- Data that can wait seconds or minutes for action is passed along to an aggregation node for analysis and action. In the Smart Grid example, each substation might have its own aggregation node that reports the operational status of each downstream feeder and lateral.

- Data that is less time sensitive is sent to the cloud for historical analysis, big data analytics, and long-term storage (see sidebar). For example, each of thousands or hundreds of thousands of fog nodes might send periodic summaries of grid data to the cloud for historical analysis and storage.

1. What Happens In The Fog And The Cloud

FOG NODES: ● Receive feeds from IoT devices using any protocol, in real time

- Run IoT-enabled applications for real-time control and analytics, with millisecond response time, Provide transient storage, often 1–2 hours, Send periodic data summaries to the cloud

2. The Cloud Platform

Receives and aggregates data summaries from many fog nodes

- Performs analysis on the IoT data and data from other sources to gain business insight
- Can send new application rules to the fog nodes based on these insights BENEFITS OF FOG COMPUTING

Extending the cloud closer to the things that generate and act on data benefits the business in the following ways:

Greater Business Agility

With the right tools, developers can quickly develop fog applications and deploy them where needed. Machine manufacturers can offer MaaS to their customers. Fog applications program the machine to operate in the way each customer needs.

Better Security

Protect your fog nodes using the same policy, controls, and procedures you use in other parts of your IT environment. Use the same physical security and cyber security solutions.

Deeper Insights, With Privacy Control

Analyze sensitive data locally instead of sending it to the cloud for analysis. Your IT team can monitor and control the devices that collect, analyze, and store data.

Lower Operating Expense

Conserve network bandwidth by processing selected data locally instead of sending it to the cloud for analysis.

Response Time

This issue is described by the interval starting from the acceptance of a request (or task) to the response to a request for a server in a fog environment.

Cost

It is the payment of money to ask for an action that is required to do.

Energy Consumption

It refers to the energy consumption amount in a fog network. Energy consumption can be decreased by an effective load balancing algorithm.

Scalability

It shows how the system is capable of accomplishing a load balancing algorithm with a couple of hosts or machines.

Security

It is the quality side of service that procures nonrepudiation and confidentiality via authentication involving parties and message encryption.

Flexibility

Fog nodes that always connect to a system pro tempore incline to leave periodically, so, to reflect both nodes, which are newly joined, and nodes revocation, this algorithm has to be flexible.

Resource Utilization

It represents the maximum utilization of the resources available in a cloud system.

Deadline

It is the latest time when a service request in the fog system can be completed.

Processing time

The duration in which a service request in the fog system is executed entirely.

Reliability

It is the ability of a fog network to perform its required requests in a defined time and a specified condition.

Throughput
We can refer to the maximum requested service rate that might be processed in the fog system as throughput.

III. RELATED WORK

In this section, we study the existing review works for load balancing in fog/edge computing (Section 3.1) based on a systematic exploration 3.1 Review Studies for Load Balancing Methods in Fog/Edge Computing No systematic review was found on load balancing algorithms in fog computing.

Thus, the decision was made to investigate the review studies existing on load balancing mechanisms in fog/edge computing to conduct this systematic review. The studies were summarized in Table 1 as review studies based on surveys [1], [2], [3], [4] and SLR in Fig-1 [5]. Chandak and Ray [1] presented a survey of load balancing techniques in fog computing.

They also introduced some of the evaluation parameters and simulation tools used for load balancing methods in the fog system. In addition, Baburao, et al. [2] surveyed some of the techniques of service migration, load balancing, and load optimization in fog computing. Pydi and Iyer [3] reviewed load balancing methods in edge systems, including security-based, traffic load based, optimization-based, heuristic based, joint load based, multi-access based, allocation-based, dynamic load based, and distributed-based techniques.

They introduced some of the evaluation factors and tools. Also, the authors discussed some of the future trends and research gaps. Singh et al. [4] reviewed load balancing methods based on energy efficiency in the fog environment. Furthermore, Kaur and Aron [5] surveyed load balancing approaches systematically in a fog environment.

Table 1 presents a summary of studied articles that depicted some parameters like the type of reviews, main ideas, year of publications, the process of article selection, open issues, and covered years of every study. As for the search string and research methodology, the work of Kaur and Aron [5] is the closest to ours; nevertheless, we specifically examined load balancing algorithms in fog computing. We also presented a different taxonomy and reviewed recently published articles up to 2021.

Table 1 Related Reviews of Fog/Edge Load Balancing

Study Type	Ref.	Scope	Publication Year	Article Selection Process	Open issue	Covered Year
Surveys	[30]	Fog	2019	*	*	*
	[31]	Fog	2019	*	*	*
	[32]	Edge	2020	*	√	*
	[33]	Fog	2020	*	*	*
SRLs	[34]	Fog	2021	√	√	2013-20
	Our Study	Fog	2022	√	√	2013-21

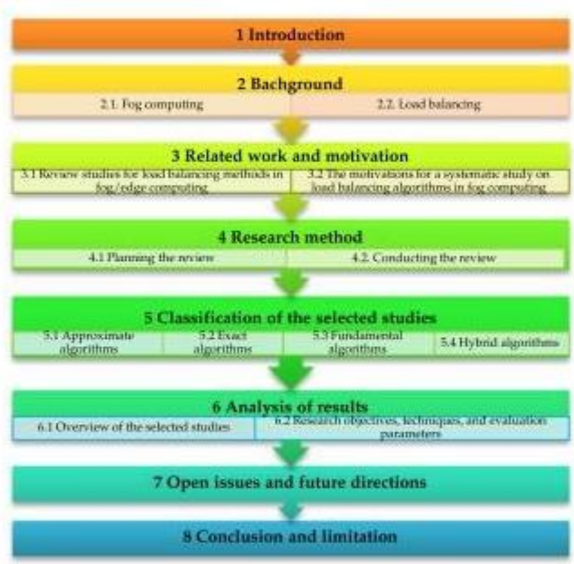

Fig:1 Structure of SR

IV. CONCLUSION

In this study, a qualitative and quantitative piece of research was conducted based on an SLR method on load balancing algorithms in fog computing. Applying studies published recently, between 2013 and 2021, the authors offered the SLR based method in this literature by using the exploration query. In addition, 49 studies focusing on load balancing algorithms in fog computing were examined. According to RQ 2, the used algorithms in the load balancing of fog computing were categorized into four groups, with the highest percentage of research done in approximate algorithms with 33%, fundamental algorithms with 29%, exact algorithms with 24%, and hybrid algorithms with 14% of all types of used algorithms. According to RQ 3, statistically, the percentage of evaluation metrics presented that the response time metric has the highest application in the assessment of the load balancing algorithms by 31%, and energy comes next with 18%. Based on RQ 4, for evaluation tools, it was observed that Cloud Analyst and MATLAB have the highest percentage of applying the simulation environment of case studies in load balancing algorithms, with 16% each.

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