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A Survey Paper on Optimization Based SDN Powered by Fog Computing

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Abstract-The demand of cloud computing is increasing day by day due to their wide range of applications. But cloud computing suffered from various demerits like lack of mobility, unreliable latency, and position awareness. These drawbacks are overcome by the fog computing or edge computing which providing elasticity to the resources and reliability to the latency. In this paper we are studied various researches related to the cloud computing and fog computing for different applications. Several challenges are also discussed while implementing edge computing to the network. The chances provided by the fog computing system also elaborated for the future work. Different applications are discussed with their advantages and outcomes of fog computing system. The real time applications like IIOT fog computing provided better computational time. All the characteristics and key features of fog computing are discussed in this work. We get an idea of using fog computing with optimization algorithm for our IIOT applications.

Keywords- *Fog computing, IIOT, cloud computing etc.*

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I. Introduction

It is a general perception that products and ideas about cloud computing has started in 21st century. But, exactly speaking this is not the whole truth. Cloud concepts have existed for many years. A brief review of historical development is described in the following paragraphs. Cloud computing concept started in 1950s with the evolution of mainframe computing. Wherein, multiple users were allowed to access a central computer through dumb terminals, whose sole function was to provide access to the mainframe. Because of the high cost requirement for mainframe computers, it was not feasible for an organization to provide these to every employee. Nor did the need of such high capacity storage and high speed processing for a typical user, which is being provided by the mainframe computers. Providing shared access to a single resource was the economical solution for this sophisticated technology.

The fog computing is the new invention which described as the intermediate layer among the cloud data and IOT devices or sensors. The concept of fog computing was initialized in the year 2012 by CISCO for the IIOT devices applications. Fog computing is reduced the several drawbacks of cloud computing and provided efficient latency in stable manner. The fog computing system contains the traditional accessories like router, base stations, servers, switches etc. and placed near about the IIOT devices. The fog computing improved the scalability, real time interactions and mobility of the network IIOT system. Fog computing reduces the computational cost, latency, power consumption, network traffic etc.

II. Literature Review

Wang et al. (2018)- proposed software defined IIOT structure which identified the computing node adaptive selection in fog computing field. In this study various task processing fog computing system analyzed with the adaptive optimization. The entire task delay in different computing mode and calculate via the controller. A noval CMS model was designed in the SDN controller structure. The controller has the power to select the optimal computing mode for a particular task. The real time based task was processed through the CMS –SDN model and validate the proposed work with simulation platform. The proposed method provided the improved stability, reliability, and satisfaction in industrial application [1].

Tiago et al. (2018)- presented a Fog Computing architecture for recognizing the pipes of a ship. It was placed at the edges of the shipyard network which extend the cloud range. The model was designed by the Navantia ship making company and university of Courna (Spain) through a project under the industry 4.0 technology. A Cyber Physical System is implemented which utilize the (RFID) Radio Frequency Identification to track the pipes of the shipyard and other events. The CPS configuration also optimized with the MES (Manufacturing Execution System). The proposed network provided 481 faster time response than the other cloud computing approaches [2].

Zhang et al. (2018)- proposed the combination of fog and cloud computing with the distributed data stream modeling for WSN which provides better response in IIOT (Industrial Internet of Things) applications. The energy saving and proper communicate to few packets network, the parameters

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of learned model sensors are update which communicate with the larger time period to fog computing network. The experimental work was tested on the real time database which provided quantitative measurement and evaluation. The number of packets approximately 97% decreases which sent over the WSN link. The fog computing node simulates the data accuracy nearly 98%. So the proposed model is beneficial for the IIOT applications [3].

Beier et al. (2018)-proposed the literature analysis of environmental limits of sustainable development point from the IIOT with three key articles, transparency, resource efficiency and sustainable energy. These three environmental topics literature survey analysis in this research and compared with the Chinese industrial company. The comparison provided the sustainable based participant expectations with the applied IIOT applications. The process of comparison performed via the e-mail and direct site interviews. The large and medium size companies from Liaoning Province and small size company contains 109 participant [4].

Wan et al. (2018)- presented the three layer cache architecture of edge computing and heritage networks. The temporal and spatial properties were mapped in different cluster and edge computing servers contain the mobile nodes. The capacity of edge computing nodes is evaluated by proactive caching scheme for the large amount of data downloaded by mobile network locations and trajectories. The proposed method attained the good output performance, less power consumption in real time world applications [5].

Wang et al.(2018)- proposed the energy aware load balancing and scheduling (ELBS) depend on fog computing. The energy consumption model based on workload was developed on the fog node, and then the optimization algorithm is applied to the load balancing in manufacturing cluster. An improved PSO optimization algorithm was used to design the optimal energy consumption model for achieving the best manufacturing group. The distributed scheduling of manufacturing cluster is achieved by the multi agent. The proposed algorithm was tested on the candy packing line and results provide the optimal solution of load balancing and scheduling problem [6].

Liang et al. (2017)- presented a survey on the different applications and methods of IIOT. The edge computing provided the better solution to the difficult and complex problem among the various sensors and nodes. The data computation and storage to the edge end are better than the cloud computing system. The traffic flow is reduced in the edge computing which minimizes the bandwidth requirements in IIOT applications. The edge computing method reduces the transmission latency among the edge server and final users which provided less reaction time for the actual time applications. In this paper the overall configuration of edge computing was studied like edge computing model for IIOT, some examples of edge computing related to the real time applications [7].

Mouradian et al. (2017)-presented a survey on the fog computing applications. The cloud computing has three main facets (IaaS, PaaS and SaaS) and multiple advantages provided but some challenges are faces. These challenges were overcome by the fog computing, which has simple architecture and easier performance evaluation criteria. The advantages and challenges related to the fog computing also discussed in this survey. The fog computing has wide range of IIOT applications; it provided most accurate results in Tactile Internet [8].

Li et al. (2018)-proposed the adaptive transmission model with SDN and EC for the IIOT different applications. The low deadline situation was handled by coarse grained transmission path algorithm. The balanced transmission path estimated via implementation of PDD for all candidate paths, urgent situations controlled by the fine grained scheme with adaptive power. The proposed method validates via simulation and results provided the better schemes for different data flow which minimizes the load on the basic IIOT. The performance of data transmission improved by the WSN, SDN and EC configurations [9].

Liu et al.(2018)- studied the various challenges occurs in the data collection, pre-processing, reconstruction data and variable secure data collection in IIOT case. A model was developed with the integrated efforts of both Fog and Cloud computing to resolve the challenges from the IIOT. The collected data was pre processed by the edge or cloud server, like raw data pre processed by edge then time dependent data are used and stored in local case. The non time dependent data goes to the cloud sever which support the data miming and reconstruction data. The experiment was validated with the simulation and output reflects that improvement in secure data storage and retrieval in IIOT [10].

Zhang et al. (2018)-presented MEC scheme in line with big data planning scheme for CS charging. The GC act as the cloud server provides analytics facilities to the CS service provider. The charging availability of EV was provided by the CS with serving the MEC. The cloud computing provided the big data driven, computing data miming and aggregation. The communication efficiency was improved by providing the MEC through cloud computing in EVs. The jam problem was also minimized by the proposed algorithm. So the smart charging provided to the EVs using the MEC in terms of big data analytics [11].

Wang et al. (2019)-proposed the task scheduling scheme in the fog computing. A hybrid heuristic (HH) scheme was developed for the problems arrived in terminal devices in fog computing system. The proposed algorithm provided the better performance in limited computing resources. The energy consumption was reduced and fog computing makes

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suitable for the real time world applications. The fog computing provided the some advantage for the smart manufacturing like computation, storage and network services. The improved PSO and improved ACO optimization algorithm combined to get the HH optimal solution of the terminal devices. The proposed method provided the best performance via three performance matrices [12].

Yi et al (2015)-presented a survey on the fog computing by discussing architecture, applications and advantages. The applications of fog computing in IIOT, challenges related to the modeling of fog computing, and implementation of fog computing was presented in this study. The future work related to the fog computing also provided in this paper. The fog computing is better than the cloud computing. Fog computing also known as edge computing which uses for the problem of service to end users and elastic resources. The cloud computing was provided the resources distributed in the particular network. Fog computing has the wide range of applications of different resources [13].

Mahmud et al. (2018)-provided a survey on the fog computing challenges arrived intermediate layer between the sensors of IIOT applications. A taxonomy was presented in this study as per challenges of fog computing. The taxonomy survey also detect the various research gap in the field of fog computing. The future scope of fog computing researches reflects in this survey. Past development related to the fog computing and their challenges was analyzed in the survey. The advantages of fog computing in the manufacturing industry and limitation presented in this survey. The fog computing specific applications in the field of IIOT tested with better results. The energy consumption and execution time is reduced in case of fog computing applications [14].

Okay et al. (2018)- presented the basic requirement routing protocol in fog enabled IIOT system. A survey on the routing used in different IIOT applications also presented. A hierarchical approach SDN (Software Defined Networking) fog computing architecture developed for routing fog utilizes IIOT platforms. In this approach the local actions controlled by fog computing and global actions controlled via cloud computing. The experiment was tested with the help of varying the different controllers. The routing delay and data transmission overload minimized via the proposed method. The efficiency of the fog implemented IIOT applications increases as the number of controller increases [15].

Zhao et al. (2018)- proposed RNOPA (ranking based near optimal placement algorithm) which was able to optimize the variable form of mobile devices in IIOT. In this scheme each access point (AP) behaving like unique serve queue which provided the efficient ranking mechanism to the IIOT system. The access delay in case of RNOPA was nearly to the EOPA. This access delay minimized by the SDN approach which also provided the flexible and programmable techniques for the cloud deployment in the IIOT networking. The RNOPA provided the better results than the traditional K-Mean clustering algorithm. The reliability and mean cloudlet of access delay improved with the RNOPA approach. The computational cost was also reduced in RNOPA approach than the KMCA [16].

Huang et al. (2015)- presented a study related to the fog computing applications in modern trend like smart grid, smart traffic light controller in vehicular network, and SDN real time series domain. The challenges faces during the implementation of fog computing like security and privacy were also discuss in this study. A typical attack, man in the middle attack in fog computing were discussed. These attacks affect the privacy and security of fog computing network. Some features related to this attack through CPU and memory consumption on fog computing system were extracted. The authentication and authorization methods are implementing for the fog computing system. The improved security was explained with the authentication technique which reflects the fog and cloud computing security concern [17].

Hussein et al. (2018)- proposed decentralized cloud-SDN structure for the charging of EV. The model knows as the D2P which provided charging and discharging schedule in the smart grid applications. A linear optimization algorithm proposed for the price decision process, grid efficiency and model stability. The optimization algorithm was solved for two purpose, charging and discharging of electrical vehicle and building a model of renewable energy resources. All the micro grid were managed by the centralized approach. So the pricing policy based cloud-SDN improved the stability of the smart grid network. The performance evaluation was done by pricing based equations used in the model [18].

Gudkova et al. (2018)-proposed an edge computing layer on the fog nodes for the IIOT framework network. In this network SDN approach used with a centralized controller and spread with open flow switches. The proposed method operated in the data offloading algorithm which providing several processing and computing task. The proposed methods provided various advantages like latency reduction and greater efficiency of resources utilization. All the results were validating through the simulation process [19].

Li et al. (2019)- proposed rescheduling method for the fog computing in IIOT applications. The work divide into two different categories, in first case the resources data was standardize and normalize, then fuzzy based function combined with the PSO algorithm for the distribution of resources. The proposed method used for the resources scheduling based on the fuzzy clustering scheme. Through the experimental setup for resource scheduling the efficiency was improved and improved satisfaction of users.

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The FCAP algorithm use for the clustering the fog resources, the RSAF algorithm provided the resources scheduling [20].

Liang et al. (2017)- proposed an integrated SDN architecture and virtual radio access network for fog computing. A software known as OpenPipe was design for the network level virtualization. A hybrid model was proposed for the different control levels in fog computing where SDN control the higher level and local controllers deals with the lower level operations. The proposed method was tested via demo in laboratory [21].

III. Analysis

The fog computing is plays a vital role in different IIOT applications. In study [1] CMS-SDN method proposed for the implementation of fog computing around IIOT devices. Similarly RFID approach with MES configuration proposed in [2] for the pipe detection in shipyard area. The combination of both fog and cloud computing was tested in [3] for real time applications. The authors are provided a literature survey in [4, 7, 8, 10, 13, 14, and 17] for the cloud and fog computing applications with challenges and advantages. A three cycle cache architecture of edge computing was proposed in [6], whereas a load balancing approach called ELBS was implemented in [7] with PSO for fog computing system. An adaptive model of SDN with EC was proposed for the fog computing system applications which provided better latency [9]. The Improved PSO with Improved ACO is applied in [12] for the fog computing network. The various configuration of SDN model were proposed in [16-18, and 20] with different configurations during the fog computing system. The fuzzy logic combination with FCPA and RSFN approach tested in [19]. We implement SDN approach with optimization algorithm for the fog computing system network.

IV. Conclusion

In this paper we provided a literature survey related to the fog and cloud computing IIOT applications. The architecture of fog computing is studied in this work. The challenges are faces during the implementation of fog computing discussed. The advantages and disadvantages of computing applications are also discussed. The fog computing system provided the better latency, location mobility and reduces the computational cost of the entire network.

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Appendix

Table 1 Summary of literature review

Author Name	Year	Technique	Advantages	Limitations
Wang et al.	2018	CMS –SDN model for the IIOT applications	Improved the stability, reliability and satisfaction to the industrial manufacturing system	Large number of controllers required
Tiago et al.	2018	CPS-MES approach using fog computing for the optimization of tracking pipes of a shipyard	Faster response than the cloud computing using the same CPS mode	NA
Zhang et al.	2018	Hybrid Fog- cloud computing for distributing the data in WSN IIOT applications	Number of packets decreases 97% and accuracy increases 98%.	NA
Beier et al.	2018	Literature survey on sustainable model development in IIOT applications	Comparison with existing algorithm provided better solution like transpency among the modal	NA
Wan et al.	2018	Cache architecture of edge computing	Provided less power consumption in IIOT real time applications	NA
Wang et al.	2018	ELBS with fog computing using IPSO and IACO	Optimal solution related to the load balance and energy problem	NA
Liang et al.	2017	A survey on edge computing	Traffic controller applications Using edge computing provided better performance in IIOT	NA
Mouradian et al.	2017	Survey on fog computing	Discuss challenges and optimal architecture of fog computing	Security issues
Li et al.	2018	Adaptive transmission model with SDN and EC	Minimizes the overload condition and improved performance in WS SDN applications	NA
Liu et al.	2018	Integrated model developed using Fog and cloud computing	Provided secure data storage and retrieval in IIOT applications	NA
Zhang et al.	2018	CS-MEC approach for EV charging using Fog computing	Provided smart charging to the EV	Big data analytic
Wang et al.	2019	HH scheme in fog computing using	Provided the optimal cost and storage to	NA

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		IPSO and IACO	the fog computing system	
Yi et al	2015	Survey on fog computing	Provided advantages of fog computing like optimal computation cost	NA
Mahmud et al.	2018	Fog computing survey with IIOT applications	Reduced computational cost and execution time is reduced	NA
Okay et al.	2018	SDN based Fog computing architecture	Routing delay and data transmission overload minimizes	NA
Zhao et al.	2018	RNOPA approach of Fog computing	Improved computational cost	NA
Huang et al.	2015	Fog computing applications	Different application like traffic controller, machine controller provided	NA
Hussein et al.	2018	SDN-cloud model for EV charging	Provided stability to the micro grid	NA
Gudkova et al.	2018	SDN for resources utilization with fog computing	Efficiency improved using off loading condition	NA
Li et al.	2019	PSO-fuzzy based rescheduling approach with fog computing	Satisfy the user with rescheduling efficiency improved	NA
Liang et al.	2017	SDN approach for both low level and high level controller in fog computing	Improved the efficiency of both high level and low level controller	NA