International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

A Contemporary Agricultural Approach Utilizing Fog-Cloud Computing and the Internet of Things

Dr.Prasad Dharnasi, Gebremedhin Chameno Chalite, Dr. P Vamsi Krishna Raja

Associate Professor, Department of Computer Science and Engineering, Holy Mary Institute of Technology & Science, Hyderabad, Telangan, India.

Vice President of Arba Minch University (Sawla Campus),

Arba Minch, Gamo Gofa Region, Ethiopia.

Professor and Director R&D in Computer Science and Engineering, Pydah College of Engineering,

Patavala, Kakinada, Andra Pradesh, India

ABSTRACT: Agriculture is the major source for the large population in Bangladesh to earn money and carry out their livelihood. Precision agriculture is an approach to farm management that uses to measure agri-related information like temperature, humidity, soil PH, soil nutrition levels, water level etc. It is already adopted in alternative countries, however, we tend to still got to involve IoT and cloud computing technologies for the higher production of crops. Using IoT and cloud computing technologies can control the cost, maintenance and monitoring performance. Here the architecture for the smart agriculture was presented based upon the Concept of the cloud computing and IOT. Fog computing basically extends cloud computing and services to the edge of the network and reduce the amount of data transported to the cloud for processing, analysis and storage. Together they are capable to provide the required information with a significant reduction in cost. In this paper, we propose an IoT and fog computing based modern agricultural system model, which reduces the transmission cost, latency, delay etc. The proposed architecture also enhances the data transmission efficiency that is impossible to achieve by fog or cloud computing alone.

KEYWORDS: Fog Computing, Clouding Computing, IoT, Efficiency, Agriculture.

I. INTRODUCTION

Fog computing and internet of things (IoT) are two new emerging technologies in information technology (IT) industry. The internet of things (IoT) is the most wanted technology in this era. Worldwide spending on the Internet of Things (IoT) is forecast to reach $772.5 billion in 2018, an increase of 14.6% over the $674 billion that will be spent in 2017. A new update to the International Data Corporation (IDC) Worldwide Semi-annual Internet of Things Spending Guide forecasts worldwide IoT spending to sustain a compound annual growth rate (CAGR) of 14.4% through the 2017-2021 forecast period surpassing the
$1 trillion mark in 2020 and reaching $1.1 trillion in 2021 [8].

Modern agricultural system is one kind of Cyber-Physical System(CPS) emerge as engineered system that offers integrations of computation, networking and physical processes, enabling seamless interaction between cyber services and physical components[16]. Building on the discipline of computing, sensing, communication and embedded system technologies will gather data sensed by various sensors then transfer the data to the fog node containing summarized database where data will be analysed and make a decision for the agricultural system.
The Food and Agricultural Organization of the United Nation (FAO) predicts that the global population will reach 8 billion people by 2025 and 9.6 billion people by 2050. In order to keep pace, food production must increase by 70 percent by 2050 globally [9].

To face challenges of food production, we need to develop methods to produce more output with the limited available natural resources. IoT and fog computing both can be used to increase the quality, quantity, sustainability and cost effectiveness of agricultural production. The high quality-of-service (QoS) of agriculture systems challenges the

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

unstable and long-delaylinks between cloud data center and agriculture devices which can be obtained using fog computing.

Since smart devices are usually inadequate in computation power, battery, storage and bandwidth, IoT applications and services are usually backed up by strong server ends, which are mostly deployed in the cloud promising solution to deliver services to end users with elastic resources at low cost and at low delay service.

Cloud computing cannot solve all problems due to its own draw backs such as unacceptable latency, delay, lack of mobility support and location-awareness [2]. To solve these issues the new technology, fog computing, is emerged. We want to design such a modern agriculture system which reduces service delay.

In case of propagation delay we have assumed the propagation speed 3×10^8. The distances between request node and fog node or cloud node are assumed (1-1500) km. The waiting threshold of each fog node is 2 unit time. Simulation has been run for only 10000 workloads. Process times are assumed randomly. Fog node is fixed. We have mentioned request type but no request type defining model has been proposed here.

II. RELATED WORK

The smart agriculture based on cloud computing and IOT was proposed by Fan Tongke [5]. Here the architecture for the smart agriculture was presented based upon the concept of the cloud computing and IOT. The author provides the idea of building plant factory and automatic control production but didn't propose a model how data would be sensed, analysed and delivered to the fog node for computing and decision making. To achieve the dynamic distribution of resources and balance of the load was combined by agriculture information cloud.

Ji-Chun Zhao et al. [12] studied the applications of IoT in agriculture. The authors proposed a monitoring system based on internet and wireless sensor networks. An information management system was designed to provide the data for research in agriculture. The authors developed software for monitoring of the fields like data acquisition about the fields, data processing models, and system configuration module. The developed application provides accurate control for the monitoring of the green house.

Agrawal and Lal Das [13] discussed the possible future applications and challenges faced by the IoT technology. They presented some key challenges in IoT applications such as: standards, privacy, security, authentication and identification, trust and ownership, integration, coordination, and regulation. They stated that the use of RFID (Radio Frequency Identification), Wireless Sensor Network (WSN) and mobile communication technologies would reduce the gap between theoretical and practical implementations of IoT applications.

Chen and Jin [14] proposed the 'Digital Agriculture' based upon IoT. The working of the digital agriculture is divided into two steps: in the first phase, the information about the temperature, the wind, the soil contents, etc. is collected by different sensors. In the second phase, ZigBee transfers information. The agricultural products has labelled with EPC code. The EPC code reader reads the code of the products.

Zhou and Zhou [15] proposed a management model based on IoT for visualization and traceability of agricultural products. The aim was to ensure food safety and promote sustainable development of modern agriculture. The authors used the products logistic information along with Internet of Things for effective products supply chain management.

Ashkan Yousefpour, Genya Ishigaki and Jason P. Jue [19] introduces minimization of delay in the Internet of Things using a service delay model. Advantage of this scheme is that it is not limited to any particular architecture (like cellular network) and IoT, fog, cloud nodes are not restricted to be of any type or capacity. This framework works by allowing fog nodes to collaborate with each other to fulfil the request sent from IoT by load sharing. If a fog node can accept a request based on its current load it processes the request but when the fog node is busy processing many tasks it may offload the request to another fog node. Decision to offload a task is based on factors like amount of computation need to perform on a task, queuing status and processing capability of a fog node. Reachable table is used to find the best fog node which comprises of the least propagation time and estimated waiting time. The author describes different policies for exchanging Request between IoT nodes, fog nodes and cloud nodes those can influence to minimize the delay

International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

III. SYSTEM DESIGN

a) Fog Computing

Fog computing, also known as fog networking, is a decentralized computing architecture in which business logic and computing power are distributed in the most logical, efficient place between the things producing data and the cloud. Fog computing essentially extends cloud computing and services to the edge of the network, bringing the advantages and power of the cloud closer to where data is created and acted upon. The main idea behind Fog computing is to improve efficiency and reduce the amount of data transported to the cloud for processing, analysis and storage. But it also used for security, performance and business logical reasons [7].

A simple three level hierarchy is adopted in our fog-cloud system as illustrated in Figure 3.1. In this framework, each terminal device is connected to a nearby fog device. Fog devices are interconnected and each of them is linked to the cloud [10].

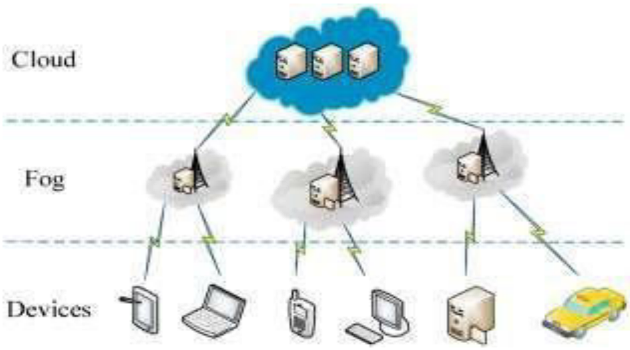

Figure 3.1: System model in fog-cloud computing environment [10].

Finally, fog computing can process and reduce data volume at a very early stage, thus cut down delay and save bandwidth as increasing production in the industry.

b) Internet of Things (IoT)

The Internet of things (**IoT**) is the network of physical devices, vehicles, water supply system, dam, oil and gas pipes, home appliances and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to connect and to operate certain programs and realize remote control [11]. The central computer can realize concentrated management and control of machine, equipment and personnel based on the internet and improve production and life through more detailed and dynamic means. This is useful for integration and harmony between human society and the physical world and is regarded as the third wave of information industry development following computer and internet [5][4]. Major IoT technologies include radio frequency identification technology,sensor technology, sensor network technology and internetwork communication, all of which have been involved in the four links of IoT industrial chain, namely, identification, sensing, processing and information delivery [5][5].

IoT is an intelligent technology which includes identification, sensing and intelligence. Life and even intelligence of life itself can also be regarded as part of IoT technology. It is used in pattern identification fields like measurement and computing as well as computer and communication fields like sensing, communication, information collection and processing [5]. The definition of IoT changes as the time of fog computing comes. It is now defined as IoT=fog computing + ubiquitous network + intelligent sensing network. Fog computing management platform is the most important things of fog computing and relevant data. It involves management of accession of cloud computing customization application by users of IoT, computing and processing what is involved in customization service; organizing and coordinating service nodes in the data center. Ubiquitous network includes 3G, LTE, GSM, WLAN, WPAN, WiMax, RFID, Zigbee, NFC, Bluetooth and other wireless communication protocol technology. It also include optical cable and other wire communication protocol and technology [5][10]. The principal of fog computing for IoT is shown in figure 3.2.

International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

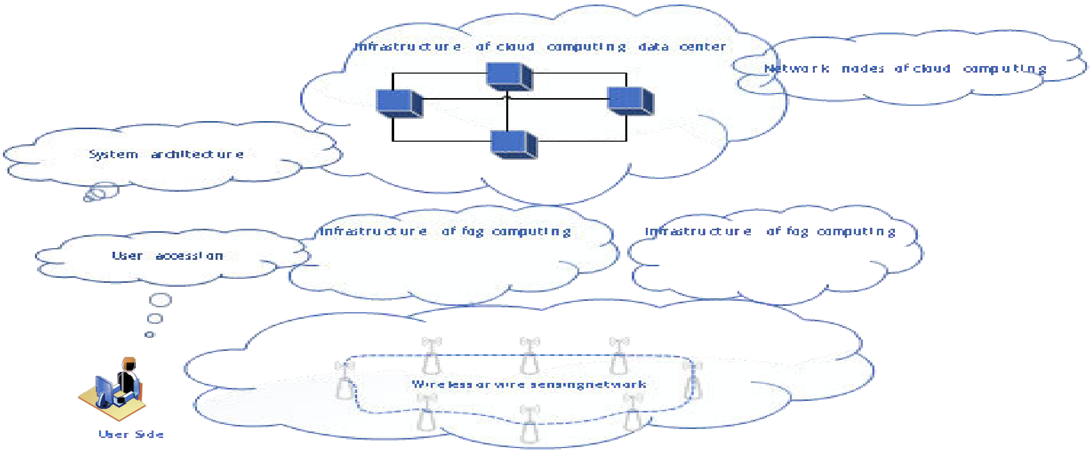

Figure 3.2: The modified principal of fog computing for IoT

c) Architecture to support agricultural operation

System architecture consists of four layers: input layer, storage layer, analysis layer and instruction layer shown in the figure 3.4. First two layers are in user end and the others layers are the part of fog computing end. The figure 3.3 shows overview of the process.

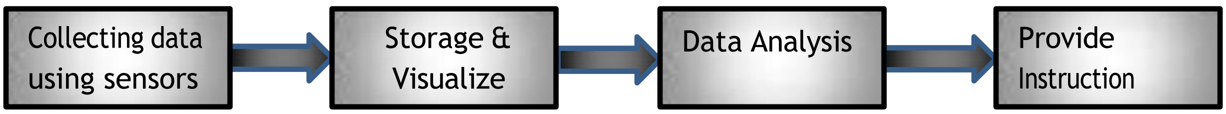

Figure 3.3: Basic overview of the process

d) Smart Agriculture System:

The Modern Agriculture system can be divided into three layers such as Cloud layer, Fog layer and the third one is system layer. The system layer can be divided into two sub- layers are application layer and other one is things layer. A Cloud server can be composed of several processing units, such as a rack of physical servers or a server with multiple processing cores. It also contains a data warehouse where work experiences, work information and analysed data can be stored. The central data warehouse can be used to assist the processing unit which can make or draw an acceptable instruction. This layer basically processes the heavy weighted requests. A Fog layer can be composed of several number of fog nodes with light processing unit, storage capability etc. It also contains an agriculture knowledge base (KB). The Knowledge Base (KB) can be used to assist the processing unit to make or draw a useful instruction rapidly. This layer basically processes the light weighted requests.

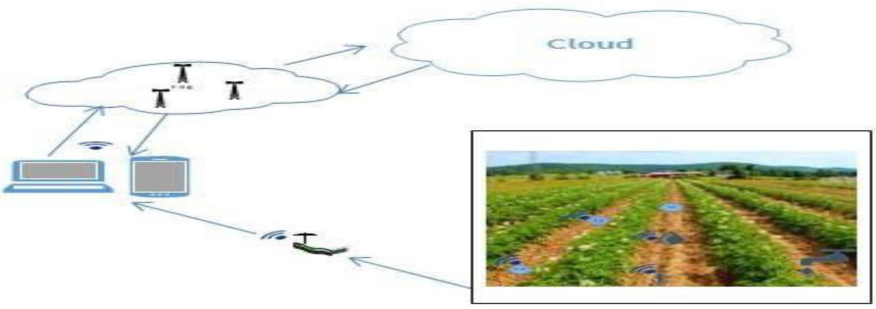

Figure 3.4: Modern Agriculture System based on fog-cloud

International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

IV. ANALYTICAL MODEL AND ALGORITHM

a) Analytical Model:
In this section, we introduce the analytical model to evaluate the service delay in the proposed framework.
Service Delay
Recall that IoT nodes process requests locally, send it to a fog node, or send it to the cloud.

Definition: Service delay is the time required to be performed a task. It can be defined as the summation of propagation time, processing time and waiting time of a request.
Thus, service delay dj for IoT node j can be written as: Farm Land

d_i =₱^{C}+Dpj + Wj (1

d_i =₱^{F}+Dpj + Wj (2)

d_i =₱^{FC}+Dpj + Wj (3)

Where ₱^{C} propagation time of j^{th} request when the IoT node sends its requests directly to the cloud layer. ₱^{F} propagation time of jth request when the IoT node sends its requests directly to the fog layer. ₱^{FC} propagation time of jth request when the IoT node sends its requests to the cloud layer via fog layer. Dpj processing time of jth request and Wj is waiting time of jth request.

Propagation Delay
In Equation (1) we have the IoT-cloud delay term ₱^{C} when the IoT sends its requests directly to the cloud layer. This term is effective when the request has to be sent to the cloud for archival purposes, or when there is no fog layer and the IoT node communicates directly to the cloud.

This term can be defined as:

₱$^C = \frac{\delta+\sum_{k\in S} \delta_C}{C}$ (4)

Where δ is the distance between IoT node and cloud node. δc is the inter cloud distance. S is total number of cloud node and c is the propagation speed.

In Equation (2) we have the IoT-fog delay term ₱^{F} when the IoT sends it's requests directly to the fog layer. This term is effective when the request has to be sent to the fog for archival purposes, or when there is no cloud layer and the IoT node communicates directly to the fog. This term can be defined as:

₱$^F \frac{\delta_f}{C}$ (5)

Where δf is the distance between IoT node and fog node. Here, we assume the inter fog node distance is negligible. c is the propagation speed.

In Equation (3) we have the IoT-fog-cloud delay term ₱^{CF} when the IoT sends it's requests to the cloud via fog layer. This term is effective when the request has to be sent to the fog or to the cloud node depending on the request type, or when all the fog nodes are busy then IoT node communicates directly to the cloud.

This term can be defined as:

₱$^{FC} = \frac{\delta+\sum_{k\in s} \delta_c}{c}$ (6)

When the request type is heavy.

₱ $= \frac{\delta_f+ \sum_{k\in s} \delta_C+\delta_{fc}}{C}$ (7)

Where δfc is the distance between cloud node and fog node. Here, we assume the inter fog node distance is negligible. c is the propagation speed.

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

Processing time

In the Equation (1),(2) and (3), for the request j, the processing time or processing delay can be defined as:

$$D_{pj} = P_j = (aP_{j-1}+b) \bmod m \quad (8)$$

Where P_{j-1} is initial processing time. P_j is current processing time. It will generate a sequence between 0 and m, where $0<m<3$. a and b are integer constants.

Waiting time

In the Equation (1),(2) and (3), for the request j, the waiting time or waiting delay can be defined as:

$$W_j = \sum_{l=0}^{L} P_l \quad (9)$$

Where W_j is waiting time of jth request. L is the length of queue of the fog/cloud node in which the request is inserted. P_l is the processing time of the l-th request in the queue

b) Delay Algorithm

We have designed three delay algorithms based on cloud, fog and fog-cloud computing respectively.

Delay Algorithm for Fog Computing

Here we design such an algorithm which calculates the service delay of a request sent from the IoT node. In this algorithm the coordinates of IoT node and Fog node are considered as random number and processing time also considered as random number. Then send the request to the cloud node using Send Request to fog Node (**SRFN**). Each cloud node has a queue to place the requests. If the Fog Node Waiting Time (**FNWT**) of the node is less than or equal to the THRESHOLD then the request would be processed at that node otherwise the request would be transferred to the nearest cloud node by Get Nearest Fog Node (**GNFN**). Then the service is calculated by the summation of process time, propagation time and waiting time. The load in the cloud layer is calculated by counting all the requests in the Fog Queue (**FQ**).

Algorithm

1 Calculate delay of request in fog computing

```
procedure CALCULATE DELAY (A)
for each integer i in Fog Node do
x=RAND ();
y=RAND ();
MakeCoordinates () fNode(x, y)
end for
c=RAND ();
d=RAND ();
processTime = RAND ();
SendRequest To Fog Node (c, d, serviceTime, A)
if FogNode.Est.waiting Time <=THRESHOLD then
process (A)
else
Get NearstForNode ();
process (A)
end if
Delay (A) =process Time | Compute Distance (Node(x, y), A(c, d))/PS | waitingTime;
Load= VisitedFogQueue.LENGTH ();
end procedure.
```

Delay Algorithm for Cloud Computing

Here we design such an algorithm which calculates the service delay of a request sent from the IoT node. In this algorithm the coordinates of IoT node and Cloud node are considered as random number and processing time also considered as random number. Then send the request to the cloud node using Send Request to Cloud Node (**SRCN**). Each cloud node has a queue to place the requests. If the Cloud Node Waiting Time (**CNWT**) of the node is less than or equal to the THRESHOLD then the request would be processed at that node otherwise the request would be transferred to the nearest cloud node by Get Nearest Cloud Node (**GNCN**).

International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

Then the service is calculated by the summation of process time, propagation time and waiting time. The load in the cloud layer is calculated by counting all the requests in the Cloud Queue (**CQ**).

Algorithm 2 Calculate delay of request in cloud computing

```
procedure CALCULATE DELAY (A)
    for each integer i in CloudNode do
  x=RAND ();
  y=RAND ();
        MakeCoordinates () fNode(x, y)
  end for
  c=RAND ();
  d=RAND ();
  processTime = RAND ();
SendRequest To Fog Node (c, d, serviceTime, A)
if CloudNode.Est.waiting Time <=THRESHOLD then
process (A)
else
Get NearstForNode ();
process (A)
end if
Delay (A) =process Time | Compute Distance (Node(x, y), A(c, d))/PS | waiting Time;
Load= VisitedFogQueue.LENGTH ();
end procedure.
```

Delay Algorithm for Fog-Cloud Computing:

Here we design such an algorithm which calculates the service delay of a request sent from the IoT node. In this algorithm the coordinates of IoT nodes, Fog nodes and Cloud are considered as random numbers and processing time also considered as random number. If the request type is heavy then it would be sent to the cloud. If the request type is light then it would be sent to the fog nodes.

In the fog nodes some requests might be failed due to be unable to satisfy the THRESHOLD condition. These failed requests would be sent to the cloud.

Algorithm 3 Calculate delay of request in fog-cloud computing

```
procedure CALCULATE DELAY (A)
  for each integer i in FogNode do
  x=RAND ();
  y=RAND ();
  MakeCoordinates () fNode(x, y)
  end for
  for each integer k in CloudNode do
  x=RAND ();
  y=RAND ();
MakeCoordinates () fNode(x, y)
end for
c=RAND ();
d=RAND ();
serviceTime = RAND ();
    if A is Heavy= True then
SendRequestToCloudNode (c, d, serviceTime, A)
Apply Algorithm 2
else
SendRequest To Fog Node (c, d, serviceTime, A)
Apply Algorithm 1
end if
if AllFogQueueIsVisited=True and EstimatedWaiting >=THRESHOLD then
SendRequestCloud (A)
end if
end procedure.
```

International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

V. SIMULATION RESULTS

In this section we evaluate the proposed model through simulation. Here we simulate the algorithms described in the previous section. Each sample point in the graphs is obtained using 100000 requests using algorithm simulation. The network topology is a graph with 5000 IoT nodes, 100 fog nodes, and 3 cloud servers. If an IoT node generates type Light request between the IoT node and its corresponding fog node is assumed to be through IEEE

802.15.4 with transmission rates 250 Kbps. If an IoT node generates type Heavy request between the IoT node and its corresponding fog node is assumed to be through IEEE 802.11a/g with transmission rates 54 Mbps [19]. Assumed Simulation parameters are mentioned in the below table 5.1:

Figure	Propagation Speed	THRESHOLD(s)	Distance(km)
Figure 5.1	$3*10^8$	2	100-1500
Figure 5.2	$3*10^8$	2	1-10
Figure 5.3	$3*10^8$	2	1-1500

Table 5.1: Assumed simulation parameters

The simulation result of fog computing based modern agriculture system is depicted in the figure 5.1.

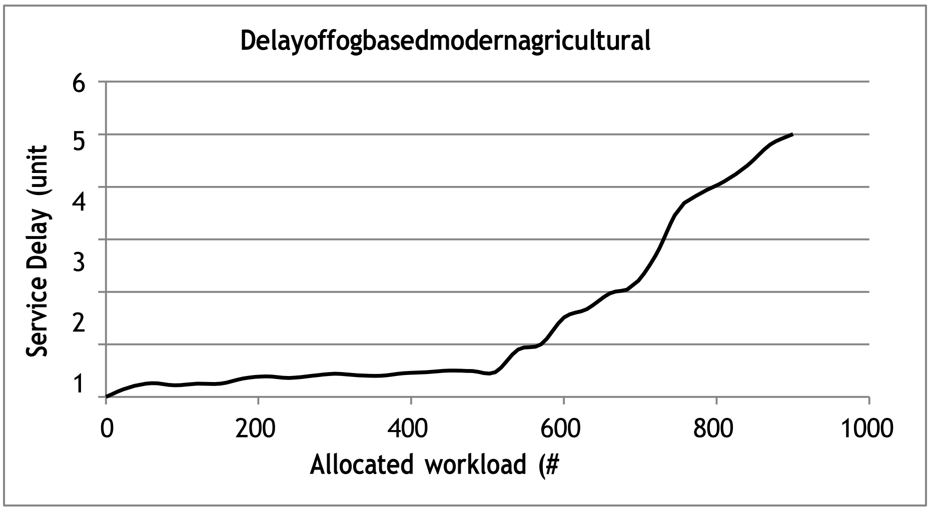

Figure 5.1: Simulation result of fog based agriculture system

It is shown here the service delay rate of the system is more increasing when the workload is more than 5000. However, when the workload is more than 6500 then the requests would be out of process as the threshold is 2 units second.

The simulation result of cloud computing based modern agriculture system is depicted in the figure 5.2.

International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

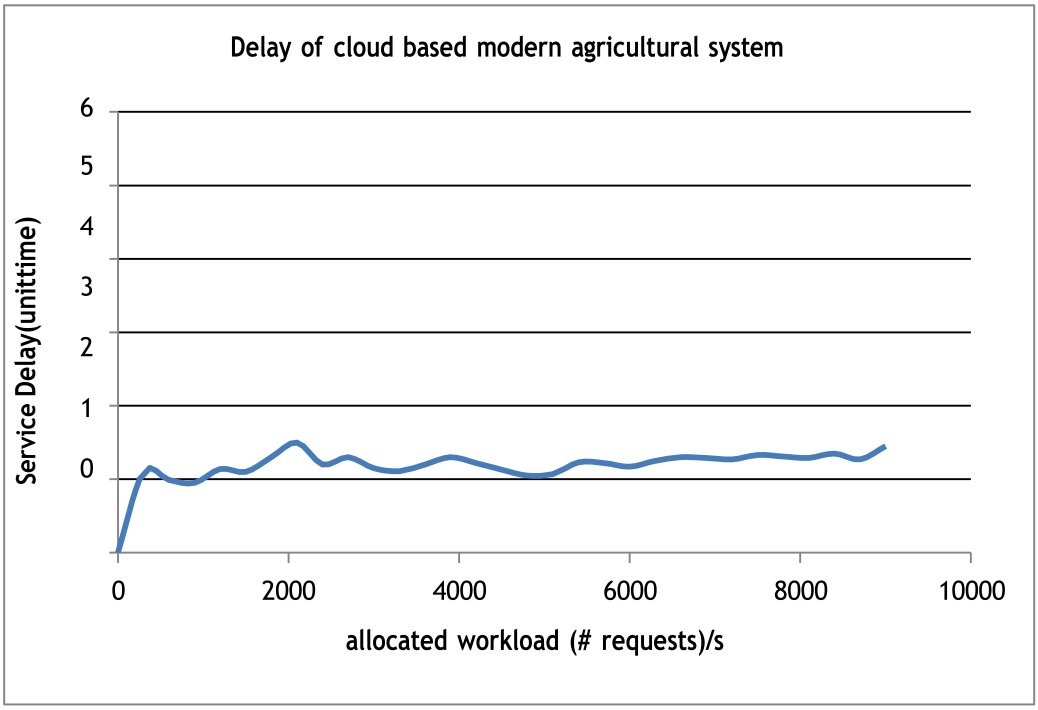

Figure 5.2: Simulation result of cloud based agriculture system

The service delay rate is higher than the fog based system. The more time is required to perform a task. However, no request would be failed. All the requests would be processed in the cloud server.

The simulation result of fog-cloud computing based modern agriculture system is depicted in the figure 5.3.

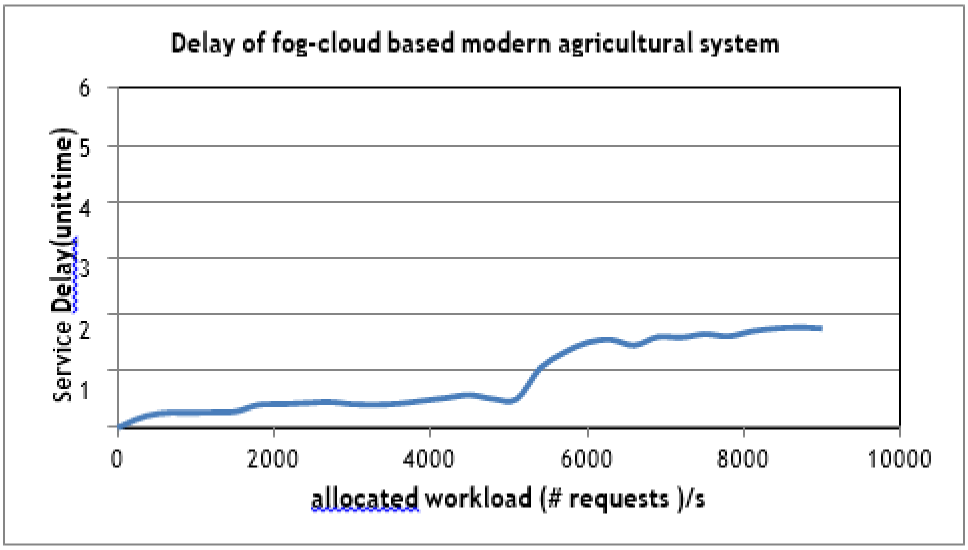

Figure 5.3: Simulation result of fog-cloud based agriculture system

It is the combination of fog and cloud computing. It reduces service delay time than cloud based system but slightly greater than fog based system. Here, the failed requests in fog based systems would be processed in the cloud. So, no request would be lost and increases the performance of fog based agricultural system

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

Now the comparison among the proposed system's simulation can be represented at a glance. The characteristics of them are depicted in the figure 5.4.

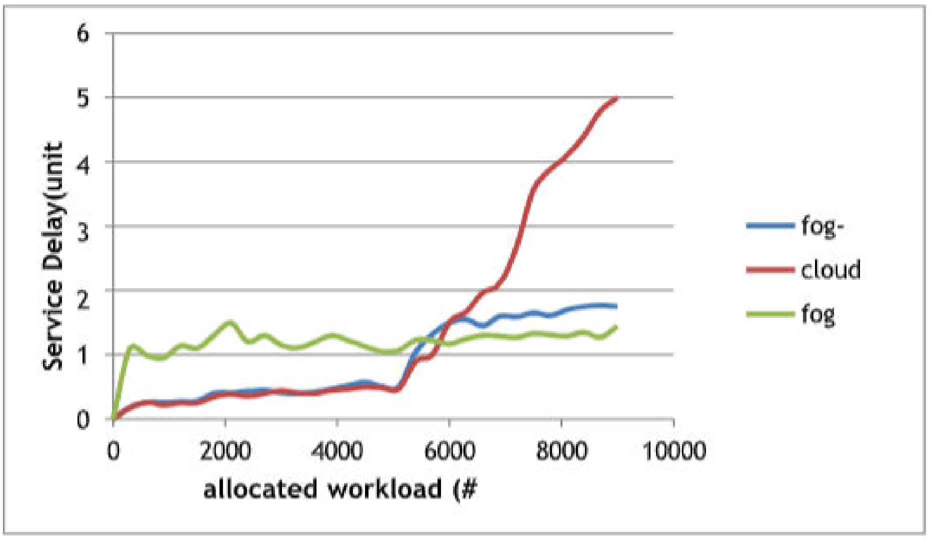

Figure 5.4: Comparison of simulation result among fog, cloud and fog-cloud system

In the figure 5.4, if we notice that the better performance is showed by fog computing for less than 5000 workloads. If the workload is more than 5000 then most of the requests have been out of service which expresses less efficiency. But if we notice on fog- cloud model the efficiency problem have been solved here. So, fog-cloud model is better than cloud or fog computing model.

VI. CONCLUSION

In this paper**,** we proposed a modern agricultural system model based on IoT and fog computing which reduces the cost, latency, delay etc. using fog instead of cloud computing. It also enhances efficiency using fog-cloud instead of fog and cloud computing. Combination of fog computing and IoT is more suitable in Wireless sensors and Actuators Networks (WSANs) because fog computing reduces delay than cloud computing shown in result. Hardware resources in agricultural information network are integrated into resource pool. Large amount of data obtained by using RFID, wireless communication, automatic control, information sensing techniques of IOT are handled with agricultural information cloud, truly realizing modern agriculture. We have mentioned request type but no request type defining model has been proposed here. Simulation has been run for only 10000 workloads. Process times are assumed randomly. Fog node is fixed.We will work in future on "Data protection model and simulation.

REFERENCES

1. Luiz F. Bittencourt, Javier Diaz-Montes, Rajkumar Buyya, Omer F. Rana, Manish Parashar "Mobility-Aware Application Scheduling in Fog Computing" IEEE CLOUD COMPUTING PUBLISHED BY THE IEEE COMPUTER SOCIETY, 2325- 6095/17/$33.00,2017
2. Shanhe Yi, Qun Li "Fog Computing: Platform and Applications" https://www.researchgate.net/publication/301691282
3. Lin Gu, Deze Zeng, Song Guo, Ahmed Barnawi, Yong Xiang " Cost Efficient Resource Management in Fog Computing Supported Medical Cyber-Physical System" IEEE Publication, DOI 10.1109/TETC.2015.2508382, IEEE Transactions on Emerging Topics in Computing
4. Mitsuyoshi, Eiji Kawashima, Tomihiro Yamazaki " Application of Cloud Computing to Agriculture and Prospects in Other Fields" FUJITSU Sci. Tech. J., Vol.46, No. 4,pp. 446-454(2010)
5. Fan TongKe "Smart Agriculture Based on Cloud Computing and IOT" Journal of Convergence Information Technology (JCIT) Volume 8, Number 2, Jan 2013, doi: 10.4156/jcit. vol8.issue2.26
6. "Virtualization and Cloud Computing Group". "Virtualization and Cloud Computing" [M].Beijing: Publishing

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 7, Issue 6, November–December 2024||

DOI:10.15662/IJARCST.2024.0706032

House of Electronics Industry, China, 2009.
7. Luiz F. Bittencourt, Javier Diaz-Montes, Rajkumar Buyya, Omer F. Rana, Manish Parashar "Mobility-Aware Application Scheduling in Fog Computing" IEEE CLOUD COMPUTING PUBLISHED BY THE IEEE COMPUTER SOCIETY, 2325- 6095/17/$33.00,2017
8. Lin Gu, Deze Zeng, Song Guo, Ahmed Barnawi, Yong Xiang " Cost Efficient Resource Management in Fog Computing Supported Medical Cyber-Physical System" IEEE Publication, DOI 10.1109/TETC.2015.2508382, IEEE Transactions on Emerging Topics in Computing
9. Mitsuyoshi, Eiji Kawashima, Tomihiro Yamazaki " Application of Cloud Computing to Agriculture and Prospects in Other Fields" FUJITSU Sci. Tech. J., Vol.46, No. 4,pp. 446-454(2010)
10. Fan TongKe "Smart Agriculture Based on Cloud Computing and IOT" Journal of Convergence Information Technology (JCIT) Volume 8, Number 2, Jan 2013, doi: 10.4156/jcit. vol8.issue2.26
11. "Virtualization and Cloud Computing Group". "Virtualization and Cloud Computing" [M].Beijing: Publishing House of Electronics Industry, China, 2009.
12. https://crossertech.com/blog/posts/2017/january/fog-computing-explained/
13. https://www.infoworld.com/article/3244649/cloud-computing/3-things-to- know- about-iot-and-fog-in-2018.html
14. Kiran R. Bidua, Dr. Chhaya N. Patel "Internet of Things and Cloud Computing for Agriculture in India" International Journal of Innovative and Emerging Research in Engineering Volume 2, Issue 12, 2015
15. Murugeshwari, B., Amirthavalli, R., Sri, C. B., & Pari, S. N. (2023). Hybrid key authentication scheme for privacy over adhoc communication. arXiv preprint arXiv:2304.14652.
16. "A Secure and Verifiable Outsourced access Control Scheme in fog-cloud Computing"
17. https://en.wikipedia.org/wiki/Internet_of_things
18. Zhao, Ji-chun, Jun-feng Zhang, Yu Feng, and Jian-xin Guo. "The study and application of the IOT technology in agriculture." In Computer Science and Information Technology ICCSIT, 2010 3rd IEEE International Conference on, vol. 2,
19. pp. 462-465. IEEE, 2010.
20. Agrawal, Sarita, and Manik Lal Das. "Internet of Things—A paradigm shift of future Internet applications." In Engineering (NUiCONE), 2011 Nirma University International Conference on, pp.1-7. IEEE, 2011.
21. Chen, Xian-Yi, and Zhi-Gang Jin. "Research on key technology and applications for internet of things." Physics Procedia 33, pp. 561-566, 2011.
22. Prasad, Rajkishore, Kumar Rajeev Ranjan, and A. K. Sinha. "AMRAPALIKA: An expert system for the diagnosis of pests, diseases, and disorders in Indian mango." Knowledge-Based Systems, Vol. 19, no. 1, pp. 9-21, 2006.
23. S. Khaitan and J. McCalley, "Design techniques and applications of cyber physical systems: A survey," Systems Journal, IEEE, vol. PP, no. 99, pp. 1–16, 2014.
24. Fog Computing and the Internet of Things Extend the Cloud to Where the Things Area © 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.
25. Ruilong Deng, Rongxing Lu, Chengzhe Lai and Tom H. Luan "Towards Power Consumption-Delay Tradeoff by Workload Allocation in Cloud-Fog Computing"
26. IEEE ICC 2015- Mobile and Wireless Networking Symposium
27. Ashkan Yousefpour, Genya Ishigaki, and Jason P. Jue, "Fog Computing: Towards Minimizing Delay in the Internet of Things" Systems Journal, IEEE 2018.
28. M. Sharifi, S. Kafaie, and O. Kashefi, "A survey and taxonomy of cyber foraging of mobile devices," IEEE Communications Surveys Tutorials, vol. 14, pp. 1232–1243, fourth Quarter 2012.
29. B. Li, Y. Pei, H. Wu, and B. Shen, "Heuristics to allocate high performance cloudlets for computation offloading in mobile ad hoc clouds," Journal of Supercomputing, vol. 71, no. 8, pp. 3009–3036, 2015.
30. Murugeshwari, B., & Sujatha, R. (2014). Preservation of Privacy for Multiparty Computation System with Homomorphic Encryption. International Journal of Emerging Technology and Advanced Engineering, 4(3), 530-535.
31. Sudhan, S. K. H. H., & Kumar, S. S. (2016). Gallant Use of Cloud by a Novel Framework of Encrypted Biometric Authentication and Multi Level Data Protection. Indian Journal of Science and Technology, 9, 44.
32. Santhoshini, G., & Anbazhagan, K. (2014, February). An object based software tool for software measurement. In International Conference on Information Communication and Embedded Systems (ICICES2014) (pp. 1-5). IEEE.
33. Vimal Raja, G. (2021). Mining Customer Sentiments from Financial Feedback and Reviews using Data Mining Algorithms. International Journal of Innovative Research in Computer and Communication Engineering, 9(12), 14705-14710.
34. Anand, L., & Neelanarayanan, V. (2019). Feature Selection for Liver Disease using Particle Swarm Optimization Algorithm. International Journal of Recent Technology and Engineering (IJRTE), 8(3), 6434-6439.