

ENHANCED EDGE MODEL FOR BIG DATA IN THE INTERNET OF THINGS BASED APPLICATIONS

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Abstract:

The edge computing that is an efficient alternative of the cloud computing, for handling of the tasks that are time sensitive, has become very popular among a vast range of IOT based application especially in the industrial sides. The huge amount of information flow and the services requisition from the IOT has made the traditional cloud computing incompatible on the time of big data flow. So the paper proposes an enhanced edge model for the by incorporating the artificial intelligence along with the integration of caching to the edge for handling of the big data flow in the applications of the internet of things. The performance evaluation of the same in the network simulator 2 for enormous flow of task that are time sensitive , evinces that the proposed method has a minimized delay compared the traditional cloud computing models.

Keywords: Edge Computing, cloud computing, big data, artificial intelligence, internet of things application, artificial intelligence

I. INTRODUCTION

The internet of things, that allows every tangible thing seen around to be connected over the internet. The internet of things along with the sensor technology is almost used in many applications and in almost all fields in our day to day life. The emergence of the cloud computing for the IOT improved the services of the IOT, by the provision of the permanent storage of the information's monitored and the any time and the anywhere access of the cloud. But due to the delay caused by the processing of the data in the cloud that is remotely located, the edge computing that brings down the cloud services to the user end is highly preferred in the IOT based application that are time sensitive. The fog and the edge computing enable a timely and the easy access of the information's and the services, becomes well suited for the time sensitive data that are generated by the internet of things [2]. The edge model

serves as the promising paradigm for the applications that are computation intensive and time constraints [3].the edge computing with the big data analytics along with the context awareness in the developed wireless networks paves way for the substantial improvements in the portable devices [5] Both the fog and the edge devices remaining as a promising paradigm providing computing capabilities at the user end, reducing the usage of the cloud platforms. The fog computing is devised to compute or process the data within the fog node or the internet of things gateway. The edge computing process the data using the device that is even closer to the sensors or the gateway device that is at a closer proximity to sensor, reducing the time of travelling of the data and the power consumed in the transmission of the data. So the most important benefit of the edge computing apart from the minimization of the time consumption and the power consumption , is the data are more secured as they are not transferred anywhere. So the edge becomes more prominent than the other computing models, but relies on the cloud for the permanent storage of the in formations. The edge may be similar to a private cloud but unlike private cloud does not aim for a particular organization , but supports, group of organization or the industries or any other enterprise within it arena. The edge computing utilizing the local computing facilities and the supporting devices as the edge servers to avail the easy and the timely access enabling an intelligent service has made multiple data computations to shift from the cloud to the edge computing [8]. The edge computing is expressed as an efficient alternative for the cloud in case of the applications with the delay and energy constrains [10]. The edge computing that brings down the services of the cloud at a closer proximity to the user not only reduces the time, but also causes considerable reductions in the bandwidth, improving the security and the privacy of the information's, and extending the life of the battery embedded devices, by reducing the power utilization. [11], despite the capabilities of the edge computing it also suffers from certain challenges in the handling of the enormous data from the internet of things. So the paper proposes the enhanced edge model, engrafting the artificial intelligence in edge computing, making the edge computing intelligent enough to handle the big data flow in the internet of things application.

Remaining of the paper is organized with the 2. The related works, 3.The proposed work 4. Results and discussion and 5. The conclusion

II. RELATED WORKS

Buyya, et al [1], details the principles, paradigms of the fog and the edge computing along with the applications of the same. Yousefpour, et al [2] presents a complete survey of the capabilities of the fog computing and the computed paradigms that are related to it. Along with the challenges incurred and the future enhancements in the fog computing research. Mao et al [3], provides the survey on the state of art mobile edge computing devices, that combines wireless communication and the mobile computing that emphasizes on the resource management combining

the radio- and the computing resources Li, et al [4] the deep learning based internet of things applications with the edge computing with the novel offloading strategy is proposed in the paper. Zeydan, et al [5], the paper proposes the big data caching for the network that adapts to edge from cloud Dubey et al [6] the paper aims in reducing the transmission power consumption and the network bandwidth utilized by the edge computing by introducing the data compression techniques in the health industry where a wide amount of data is collected through the telecommunication utilizing the fog computing. Dastjerdi et al [7] the fog enabled application is discussed in the paper presenting the potentials of the fog computing in the internet of things applications. Ren, et al [8] the paper proposes the promising edge computing model that allows the data computations to be shifted from the cloud to the edge. Taherizadeh et al [9].The paper proposes the comprehensive survey on the monitoring concepts within the edge computing, finding the significant issues in the monitoring of the edge computing. Mach et al [10] the paper discusses the decision of the offloading in the edge and the allocation of the resources and the mobility management in the edge. Shi, et al [11] the paper presents the survey of the vision of the edge computing and the challenges included in it. Hoang, et al [12] explains the dynamic edge caching structure for the mobile network that is based on the 5G. Dai et al [13] the paper explains the advances of the edge caching and the deep reinforcements learning in the vehicular network. Hu et al [14] includes the details of the performance enhancement in the edge computing by the integration of the artificial intelligence.

III. PROPOSED WORK

With the scope of reducing the delay incurred in the time sensitive application, when accessing the information through the remotely located cloud and the incompatibleness of the traditional edge computing in handling the huge amount of the information in the flow from the sensors linked with the internet of things based applications. The proposed work has incorporated the artificial intelligence along with the caching in the edge computing to enable enhancements and intelligence in the handling of the enormous information flow in the IOT based applications.

3.1 SYSTEM MODEL WITH THE AI INCORPORATION IN THE EDGE COMPUTING

The system model with the incorporation of the artificial intelligence in the edge computing, to have an efficient and intelligent edge computing in managing the enormous data flow in the IOT based applications has four layers, with the lowest layer included with the intelligent components used in the sensing, the next higher layer, layer one incorporating the internet of things architecture, the layer two acts intelligent awareness creator, and the top most is the layer contained with the set of tools and the protocols in managing the incoming big data flow. The fig.1 blow shows the AI incorporation in the edge computing.

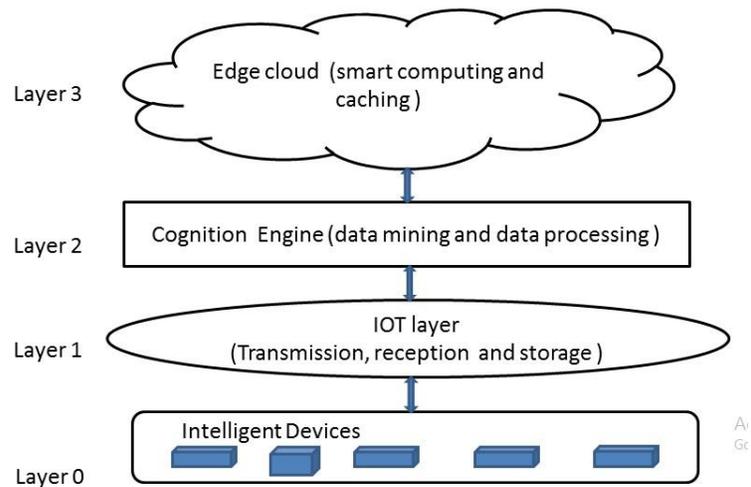


Fig .1 System Model with the AI and the Edge Computing

The lowest layer, the layer 0 includes the intelligent devices that are an embodiment of sensors. The sensor that is the key and the base element of the internet of the things helps in the gathering of the enormous of information and their transmission. There are varieties of sensor such as the portables, wearables, voice sensors, location sensors, movement sensors, stability sensors, acceleration sensor etc.

The next layer, the layer 1 includes the IOT architecture for the various applications concentrating in the transmission and the reception of the information from and to the intelligent devices, the various communications methodologies supporting the information transfer are the local area network, wireless broadband communication (LTE), Wi-Fi, or over internet. The reserve in the IOT is to retain the information's of the frequently incoming and the outgoing devices in the network. The reserve in the IOT architecture provides necessary assistance in the network configurations.

The layer 2 is the cognition engine that enables the enhancement in the edge cloud. The cognitive engine is termed as the core of the artificial intelligence since it provides with the data mining and the data processing techniques for the information gathered. The cognitive engines constitutes the dual engines one for the managing of the data and the other for the managing of the resources, the fig.2 below shows the cognitive engine organization[14].

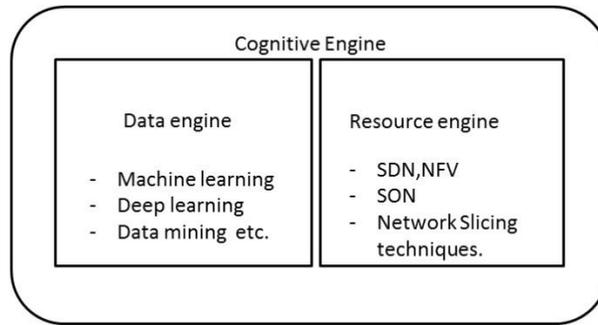


Fig .2 Cognitive Engines Constitutes

The topmost layer is the edge cloud that computes the data in a smart way effectively at a closer proximity to the user devices. The edge computing is comprised with the essential devices and the protocols required in handling the data computation smartly at closer distance from the user devices, some of the components included by the edge computing are the gateways, base stations, switches, routers and gateways. Though edge computing remains as an efficient alternative for the cloud computing, information's requiring complex computations are always carried to the cloud.

So the proposed method utilizing the artificial intelligence determines the delay in the of the both the edge and the cloud computing and assign the delay sensitive computations to the edge and the complex computations that takes more processing time to the cloud computing. For the easy access of the information form the edge the caching is also included to the edge, to improve the performance of the edge computing.

IV. PROPOSED ENHANCED EDGE COMPUTING

In the traditional cloud based model the information gathered are transmitted to the cloud for the processing and then after the processing is over, it is retransmitted back to the user devices. So they might be delay incurred in the uploading of the data to cloud, in the processing of the information and downloading the data back to the user from the cloud. But the edge computing performing a high level of computation using the cognitive engines at a closer distance from the user enables reduce the delay in the down link as it holds substantial bandwidth resources for the data computations with less complexity and limited packet size. The data rate for offloading a computation in edge is determined using the equation (1)

$$data_{rate} = B_w \log_2 \left(\frac{\theta^2 + GT^2}{\theta^2} \right) \quad (1)$$

Where θ^2 represents the power of noise, B_w is the bandwidth, G represents the power gain, T represents the transmission power of the components.

Before the data is sent to be processed, it is decided where to be processed either in the edge cloud (EC) or in the cloud by forwarding from the edge to cloud ($E to C$) is based on the delay incurred in EC and the $E to C$ and the processing time of the requisition, so it becomes necessary to enumerate the delay incurred in the EC and the $E to C$ along with the power requirements and the capacity in handling the data computation. The total delay incurred in the computation is determined using the equation (2) and (3)

$$delay_{E to C} = Dr_{b to E} + \frac{D_r}{data_{rate}_{E to C}} + \frac{D_c}{C_{pow}} + \frac{D_r}{data_{rate}_{C to E}} + \frac{R}{data_{rate}_{E to b}} + TD \quad (2)$$

Where the Dr amount of information sent by the user, $b to E$ represents the information transfer from the user to the edge, D_c represent the complexity in the data, C_{pow} represents the cloud power consumption, $e to c$ represents the data transfer form edge to cloud, $C to E$ represents the computed data transmitted from the cloud to edge, $E to B$ represents the data transmission from the edge to the user, R represents the amount of result obtained as feedback and the TD represents the transmission delay in the wireless link.

$$delay_{EC} = \frac{D_r}{data_{rate}_{b to E}} + \frac{D_c}{E_{pow}} + \frac{R}{data_{rate}_{E to b}} + TD \quad (3)$$

The delay calculation of the $E to C$ and the EC are compared with the dead line constraints of the data to be computed, and also compared for the computational complexities of the data. The data computation with the minimum processing time and complexity that is affordable by the edge is computed in the edge computing and the computations with the increased complexity unaffordable by the edge are transmitted to the cloud for processing. The fig.3 below shows the flow chart of the proposed method. The data processing in the edge is handled by the cognitive engine enables the smart data computation. Moreover the caching facility included in edge further enhances the performance of the network by maintaining the record of the frequently arising requisition and their solutions. This process further reduces the delay incurred in the computation of the data, making the enhanced edge model, more suitable for the deadline defined applications.

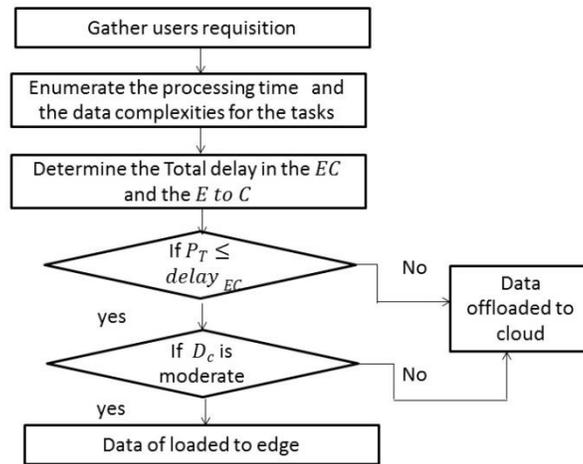


Fig .3 Flow-chart of the Proposed

The delay determined for the E to C and the EC becomes the threshold value for evaluating the where the data has to be computed, the processing time (P_T) of the data is compared with the delay calculated and the data with less processing time and complexities affordable by the edge are computed in the edge and the data with the increased processing time and higher computational complexities are processed in the cloud. The equation (4) is framed in support of the data offloading.

$$\left. \begin{array}{l} P_T \leq \text{delay}_{EC} \text{ then the data of floaded to Edge} \\ P_T \geq \text{delay}_{EC} \text{ the data is of floaded to Cloud} \end{array} \right\} \quad (4)$$

The edge with integrated artificial intelligence enables the edge computing to process the data even with higher complexities, employing either the deep learning or the machine learning techniques. The resource cognitive constituting the SDN, NFV and the self-organizing capabilities enables the edge to have an overall control over the complete network, with the self-organization over the resources utilized in the computation of the information. The network virtualization enabled by the NFV ensures the concurrent computation of the multiple tasks in parallel improving the performance of the edge computing.

V. RESULTS AND DISCUSSION

The results obtained by enumerating the proposed model and the traditional cloud computing and the edge collaborated cloud computing model, show that the proposed method with the caching and the artificial intelligence shows a reduced delay and better quality of services for the users for the deadline defined computation with the less complexities. The fig. 5 below shows the delay incurred in the traditional cloud computing and the proposed model.

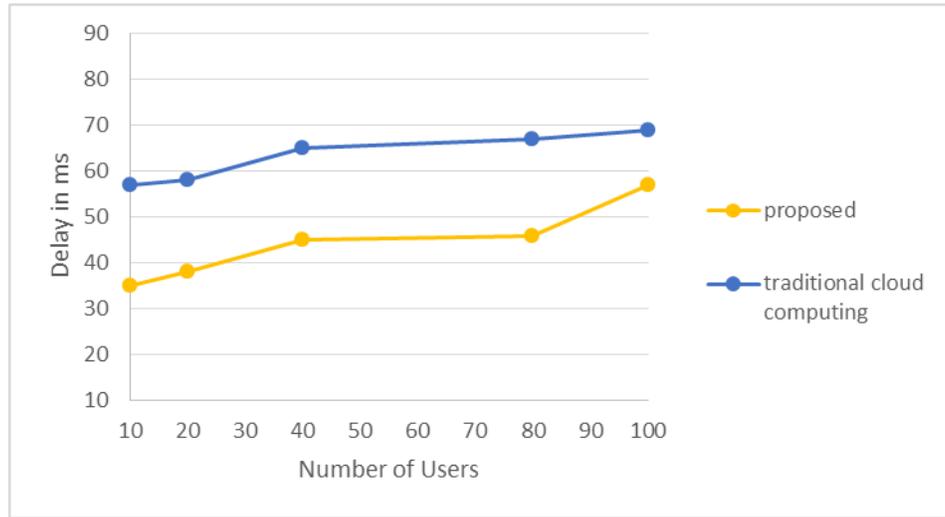


Fig.5 Delay Obtained

The fig .5 shows the delay obtained in the traditional cloud computing and the proposed method, this proves that the enhanced edge model is compatible for the deadline defined tasks with limited complexities. Thus the proposed method behaves as an effective alternative for the cloud computing for the time sensitized tasks and improving the performance of the network, eluding the congestion and the overloading.

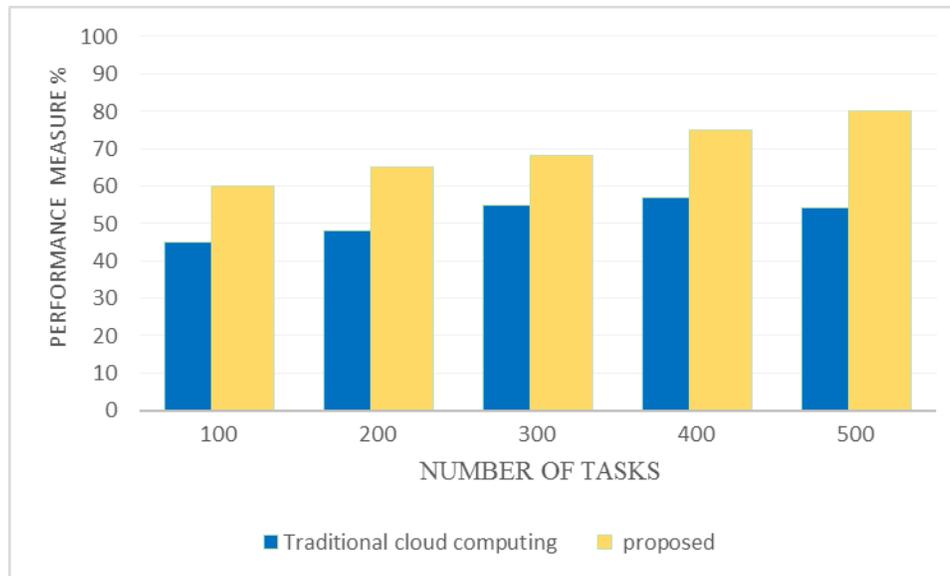


Fig .6 Performance Measure

The fig .6 show the performance improvement in the network attained by the proposed method and the traditional cloud computing, this enhanced model enables to have improved performance compared to the traditional cloud computing, due to the capability of caching and the integration of the cognitive engine.

VI. CONCLUSION

The proposed method with the enhanced edge model for delay sensitive task is developed .Further the performance of the edge model is enhanced integrating the artificial intelligence in it to provide a better computation and the better resource allocation. The caching incorporated to the edge enables it record the frequent requisition and allows the faster access of the information for the requisition that are frequent. The data cognitive engine enables the computation to be effective and the resource cognitive engine allows the network to have an overall control over the network thus increasing the performance of the network and the concurrent computations possible. The prioritizing the delay constrained tasks to the edge computing determining the delay of the edge and comparing it with the processing time of the tasks ,makes the proposed more compatible to the deadline defined tasks. Further the results obtained shows that the proposed method is well suited for the delay constrained data computations.

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