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Fog computing

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Abstract

Due to the IoT, smart city, smart home topics are being popular, the topic of the cloud computation are grabbing more attention on those topics. Therefore, the fog computation is the topic that needs to be concern. Because the fog computation is a part of the cloud computing. Those two are similar they cannot replace each other.

In this paper I will talk about the detail of the fog computation, the connection will used in fog computation, what kind of situation can use the fog computation, some further discuss topic for the fog computation and the paper review of “Fog Computing Architecture, Evaluation, and Future Research Directions”.

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1. Background, motivation and history of topic

1.1 Background

1.1.1 What is fog computing?

Fog computing is a part of cloud computing, mainly were used to preprocess the data from the user, if the data is short enough the fog computing can finish the job locally. Generally, people are using cloud computing to reduce the problem of lack of resource in local computation. However, some of the computation are not that necessary to use that strong computation from cloud computing. Therefore, the fog computing was presented. The fog computing has similar job compare with the cloud computing, but the computation is not from the internet that far away from the user, it is from the local computer or some network which is close to the user, even a mobile phone can do the job.

1.2 Connectivity

1.2.1 IEEE 802.11

Recently IEEE 802.11 specification is one of the common connections to Internet of Thing for the publication. For some cheap old IoT generally support 802.11n for the connection. For some more new design of the IoT those may contain 802.11ac for connection. However, for 802.11ax is a rare design for nowadays IoT.

For difference type of specification in 802.11, nowadays 802.11n is the most basic WIFI connection specification in IoT, the frequency of the 802.11n is 2.4GHz and 5GHz. Moreover, the typical data rate is around 200Mbps [1]. For 802.11ac is a fancier connection for the IoT, it has the same frequency range of 802.11n but the data rate is higher than 802.11n, it is around 400-700Mbps. When the IoT is contain 802.11ac connection specification, the IoT will have the 802.11n connection specification also. For Those 802.11n and 802.11ac, that coverage area is 50m and 70m, respectively.

For some further information 802.11p wireless system is the vehicular network. This can make the vehicle adapt to the wireless environment. Which is such a good specification for something like vehicle crash avoidance in fog computing.

1.2.2 4G LTE 5G

As well known nowadays the world was replace the 4G to be 5G

network. Therefore, [2] have defined a requirement for the 5G network. As the downlink and uplink connection was targeted to be 20 and 10 Gbps, respectively. Also, because the 5G frequency is high, so that the connection density was become large number (10^6 device per km^2).

1.2.3 WPAN Short range Tech

Wireless personal area network (WPAN) is included the technic that related to ZigBee (802.15.4) and Bluetooth (801.15.1). Those technology are suitable for low power transfer. The most common example is using Bluetooth to connect the smart watch, speaker, headphone etc.

Although the range will shorter than WIFI, however if consider about the energy consumption on between those communication technologies, Bluetooth will be the best choice for the mobile user.

Also, NFC is one of the technologies in this section. Due to the NFC is extremely short range. Therefore, if someone wants to steal the data during the data transfer, it is impossible. Therefore, it also can provide a high security environment by using NFC.

1.3 Challenge

1.3.1 Security

For some of the device they are required to place in some specific location. Therefore, the device may exposure to an open area and easy to get hack physically. To use the MacBook as an example[10], the MacBook may get hack easily when someone can connect to the thunderbolt physically, but the hacker is harder to get the information from the mac book wirelessly, because the MacBook has a better security for the wireless security.

In the IoT network, to reduce the cost and the size, generally the IoT will make the price to be low and reduce the size as much as possible. So that, the device may not have much complicate design and security system. From the point of above, the device will get hack or interrupt due to the simple design, so that the hacker can get through to the fog computer from those devices rather than hacking the fog computer which is the point that fog computing needs to be consider for how to prevent the situation occur.

2. Interesting detail about the topic

2.1 Usage

2.1.1 Road Crash Avoidance

From [3], the writers have used the short-range wireless communication device and the GPS combine with onboard computer to achieve the vehicle crash avoidance. This show that if the fog computing were applied in the communication between different vehicle, the fog computing can determine the distance in between two vehicle and give the advice to the driver for slow down the vehicle or do the emergency break.

2.1.2 Emergency

Using the connection in between some of the measure equipment and the mobile, mobile can do the basic computation on blood pressure, heart bit rate, body temperature, then transfer the data through LTE or 5G to the doctor who can help of this kind of situation but not in the place and give some professional advice to the field force who may not have that much knowledge to do the basic emergency treatment. This can increase the survival rate on this kind of situation.

2.1.3 User Equipment Based Fog

2.1.3.1 Health care

The most common thing is the smart watch from nowadays. Those smart watch will send the data to the mobile and get processing from the mobile. It can be recording the data like heart bit rate, blood pressure, sleep time etc. These data generally will save the data to the specific app through Bluetooth to give the user to have a better understanding of their daily life. For further development those can be sent to the hospital that support cloud sever and let the professional doctor to review the data and give some advice to the user.

2.1.2.2 Content Delivery

Stadia [4] which is the game stream from the cloud computing. The function from the Stadia is using the computation resource from the google cloud computer and provide a high framerate gaming screen to the user without buying a high computation computer. However, because the gamer generally has a computer that for their own usage. This function is become less

impressive for the gamer who want to play the game with high framerate. Therefore, the similar idea of using fog computation was comes up, which is using raspberry pi an onboard computer to do the job of streaming a game through WIFI [5]. Those computation were done by the user computer which is not necessary to connect the internet or bring the computer to the living room. Also using this kind of technic, the game latency is low because the bottleneck is only depending on the router and the connectivity speed from the onboard computer.

2.1.2.3 Crowd Sensing

GPS were identified to use for the outdoor locater. However, when the peoples are indoor the GPS are no longer useful. Therefore, HKUST have designed a software that is able to determine the location of user by mixing the signal from WIFI Bluetooth, accelerometer, video and geomagnetic field [6].

Connection

2.2 Some further consideration

2.2.1 Mesh WIFI

As the part in IEEE 802.11 have mention the range of the WIFI and Bluetooth. In fact, both communication technology is unable to provide a wide range area coverage to the western home. Therefore, the idea of the mesh WIFI was come. By using two same routers the WIFI can be combined to be one WIFI system. This helps the user can increase the WIFI coverage area by only buying more router to achieve. So that the fog computation can get a better connection quality in the house to achieve the smart home.[7]

2.2.2 Smart city vs human privacy

The fog computer is targeted to improve the smart city in the developed country or an area that making people living in a more convenient environment. However, that will have a tradeoff about human privacy and smart city. For example, in China the citizen was easily get identify in the road due to the smart city was already applied. From [8] shows those cameras were used to control the behavior of the china citizen, which is good to improve the behavior of china citizen, prevent potential dangerous to the society. On the other way, the citizen was being watch in any second, where to go, what are the citizen was doing,

all the action was recorded and posted to the government. As the closest part to China, Hong Kong [9], the citizen is aware base on the above policy, also the smart lamp was a beacon of the smart city. So that the people were break those lamps during the protest. Which is not hard to see, when the fog computation and smart city is coming, will there any citizen fear about any things include “smart”?

3. Paper Review

This section will talk about the paper “Fog Computing Architecture, Evaluation, and Future Research Directions.”

3.1 Overall

This paper has mentioned about what is fog computing, the difference in between cloud and fog computing, why fog computing is necessary, experiment between cloud and fog computing and further research direction. These topics will have a further review in upcoming section.

3.2 What is fog computing

In this paper, fog computing is a part of the cloud computing, the majority usage is used to reduce the workload for cloud computing. The idea of fog computing is using the network at nearest field so that the fog computing can provide better user experience.

3.3 Network of the fog computing

The target of fog computing was considered to provide network connection, hard drive space and computation. Fog computing can be any network in between cloud and IoT environment network, for example, virtual sensor networks (VSNs), Wireless sensor networks (WSNs), vehicular ad hoc networks (VANETs), and personal area networks (PANs), those networks are able to build a fog computing function for the user. So that the fog computing is not only provide form the cloud computing company, it also can build by user himself.

3.4 Layer of the fog computing

Fog computing have several layers, the most bottom layer is the physical and virtualization layer, this layer was used to connect the IoT, sensor and vehicle, which was connected to the network. The second layer is the monitoring layer, this layer will show the activities of the node and base on the power and tasks, the layer will determine the next task execution time and sequence. This layer also can look at the performance of each task and the performance of each different sensor because the layer measures the power. The third layer is the preprocessing layer, on this layer mainly is doing the data management, such as data trimming, filtering, minimize the unnecessary data to get the best performance for the data transfer to the cloud. Storage layer is

used for data storage, it is like the computer RAM, those data in storage layer are not for long term storage. If the user wants to have a long-term storage would be a better choice. The next layer is the security layer, as the name the security was used to encrypt and decrypt the information in between the fog computing and cloud computing. The final layer is the transport layer, when the data is ready to send the transport will send the data to the cloud computer.

In fact, some of the idea was already applied in more common way. For example, the people were design NAS system to store some long-term storage, a lot of build video was uploaded to some plat form like YouTube. So that there is not a hard imagination for these functions was already built in some of the family network in PANs form.

3.5 Why fog computing is necessary

Due to the cloud computation limitation, such as long latency, using fog computation will be a better choice for those situations, because form the fog computation the physical location will closer compare with the cloud computation. Also, because IoT generally is a small part of component, if all the signal from the IoT environment transfer straight to the cloud computing, it needs to receive all data of good data and bad data, which lead the cloud computer need to have extra computation for those data for further filtering, extra data request time if the data were corrupted etc. Therefore, if adding the fog computing in between two networks, it can have a preprocess stage to get a tidied data for cloud computing which accelerating the process speed, also the requesting time in between IoT and fog will be much smaller than cloud request. Moreover, some of the sensitivity data may only need a small amount of computation but it is not large enough that must run by cloud computing. Therefore, the fog computing able to provide a close loop computation for those data without sending the data to cloud through the open internet to protect the user information will leak by hacking.

3.6 The difference in between cloud and fog computing

This paper has mention about IoT can connect to the cloud so that when user is not familiar with how to use the sensor, cloud computing is able to receive the data from the sensor and process to be a user-friendly interface.

Also, the paper has mentioned about the VANETs for the road safety and traffic efficiency for the user to have the best way to arrive the destination. It can be noticed that the cloud computing is similar as the fog computing, however the cloud computing can used in more large-scale computation such as the traffic efficiency that mentioned above. However, it also has a few example fog computing can do also, like sensor setting and the road safety. Therefore, it can be concluded that Fog computing can finish a part of the cloud computing, but it cannot replace the cloud computing.

3.7 experiment between cloud and fog computing

In this paper the researchers have design an experiment for the comparison between fog and cloud computing. The major performance was designed to compare is the latency, price, capability, and the time.

The testbed was mainly using the program language of C++ and Java and the RAM size configuration between fog and cloud are 512MB and 2048MB, respectively.

And the experiment was tried to run different load for both system and the result shows fog computation is suitable to run a task length which is smaller than 1000 BI, because those give a similar performance. When the task length become longer than 10000BI the cloud computing was start gaining the advantage from the large-scale computation, which having a smaller computation time compare with fog computing.

3.8 further research direction

3.8.1 service scalability

To build the service in between fog and cloud computing for further development, it can add more resource to make the fog computing be wide on horizontal, or add more different node in between fog computing, cloud computing and IoT environment. So that the service of the fog and cloud computing can do more difference service base on the wider coverage in the real world.

3.8.2 Fog scalability

Due to fog computing is a part of cloud computing, the fog computing need to be had a scale in between fog and cloud computing, so that both

systems do not have the overlap situation that fog and cloud can finish the task at similar performance.

3.8.3 Fog Based Dedicated Application

This topic was talking about only use the fog computing to finish the task. For example, in the market, assume a mobile as a for computation device and the app is the software, using the app to get the data base from the cloud without any calculation but using the fog for computation and get the best suggestion to the user, so that the user can protect their privacy and get what they want in the market.

3.8.4 Mobile Fog Computing

Due to the mobile device are increase rapidly, almost everyone have at least one mobile device owned. It is not hard to think about the mobile device can be the main fog computation component for common use. As the paper mentioned the raspberry pi may become a good fog computer for the mobile fog work.

3.8.5 Fog Federation – Inter -Fog Resource Sharing

For the fog computing. It is a good topic to consider a big fog or several small fog will better for the for computation. To use the computer CPU as an example, high single core speed (intel design) cannot represent to the multicore performance (AMD design). So that it is good to find out if there have any benefit on multiple fog work in parallel for difference device, it would be another way for increase the performance rather than use one strong fog computer. In addition, the fog computing of how to shear the job will be a critical question in this topic, because if the efficiency is low in the task shearing, it will cost a huge delay in the task shearing

3.8.6 Tradeoff between energy consumption and communication efficiency

It is a good problem between all networks. For example, there have a IoT which require some computation for the raw data, when the IoT are not contain some basic computation unit, the IoT need to send a large amount of data to the fog computer. So that the result of the processing energy will be zero, but the transmission energy in the antenna will be huge. Therefore, the designer needs to be considered carefully that, should the IoT contain a low energy CPU for some basic calculation to reduce the number of bits for

transmission. It will be a tradeoff between the computation energy and data transmission energy.

3.8.7 Duration of Storing Data Locally

It is quite similar to the situation of computer cache, for the computer cache the computer needs to consider what data need to save in the cache for the CPU read faster. As notice, the computer does not know when the data will use for the CPU and which data will only use once only, so that there has some algorithm for the computer to decide what data need to be erase. For example, the computer may decide to delete the data which have not read long time ago, the largest size of the file in the system, the file at the earliest saved to the storage etc.

3.8.8 Storage security and Communication Security

This is talking about the security for all digital system. Nowadays the short length password is being easier be decrypt, the main reason is the computation capability are increasing, due to the computation capability increase to decrypt the password or decrypt the encrypted signal are going faster. Therefore, the cyber security company or the company who related to build computation unit are using more complicate encryption to prevent the data get decrypt easily or the decryption cost are not worth to decrypt. So that this is a battle between the hacker and the guard.

4. Conclusion

Although the result shows the fog computation are only a small part of the cloud computation, the fog computation still is an important layer to connect both networks between cloud and IoT. In addition, the fog computing has a wide connectivity to the IoT layer, and base on different situation the fog computing can use different communication to connect to the cloud computer.

Due to the fog computing low latency, the fog computing can do the things that in real time system. Which is more suitable to work for the IoT sensor at home or small amount of area.

Although the fog computing can bring a convenient environment, we still need to consider what will be the trade off and consider will these become a thread in our daily life. For example, personal information leak, equipment failure due to the hacking etc. Technology always can provide the convenient environment for the user but there are still have a lot of hidden threads need to be found out and consider, so that the people will not be get control by the electronic.

Also, the fog computation facing the technical challenge are differences with the cloud computation such as the scaling of the fog computation, trade off between energy consumption and communication efficiency etc. This kind of the topic need to be getting deeper to complete fog computation technic. If there have no solution in those area the fog computing will never reach the efficient stage.

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