

Fog Computing-Network Based Cloud Computing

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Abstract - Cloud Computing delivers us a means to upload data and use applications over the internet. The case for leveraging the computing resources of smart devices at the edge of network was conceptualized almost nine years back. As the number of devices linking to the cloud grows, there is undue pressure on the cloud infrastructure. Fog computing or Network Based Computing or Edge computing allows to move a part of the processing in the cloud to the network devices present along the node to the cloud. Therefore the nodes connected to the cloud have a better response time. This paper proposes a method of moving the computation from the cloud to the network by introducing an android like app store on the networking devices.

Keywords- Cloud computing, Fog computing, Network devices.

I. INTRODUCTION

Fog computing becomes popular because cloud computing is not sufficient to deal with the huge amount of data produced by increasing number of associated Internet-of-Things (IoT) devices. The amount of devices was 15.41 billion in 2015, has reached 20.35 billion in 2017 and is expected to be 30.73 billion in 2020 [2]. Such a staggering number of devices leads to numerous issues, including network congestion, interruption, and privacy concerns if the data is analyzed on the cloud. More specifically, conveying the data to the cloud consumes numerous network resources, congests networks, and leads to long latency. Moreover, the data produced by the devices, such as home surveillance cameras are sensitive. Transferring them to the cloud through the Internet leads to some privacy issues.

To solve these issues, we apply the concept of fog computing, which integrates fog devices, including end devices, edge network devices, and cloud servers Fog computing covers the cloud computing paradigm to the edge of the network, thus permitting a new breed of services and applications. The main features of a Fog Computing environment are

- Low Latency
- Widespread Geographical distance
- Mobility
- Large number of nodes.

Fog Computing provides great support and quick response to the Internet of things environment where we may have many wireless sensor nodes uploading streams of data to the cloud.

II. SYSTEM STRUCTURE

Edge computing is a new trend established by the cellular network operators to improve the whole network efficiency by offloading its operations to nearby clouds. European Telecommunications Standards Institute (ETSI) is one of the main organizations concerned with the edge computing. It announced an Industry Specification Group (ISG) known as edge computing to research and standardize the new technology. Basically MEC can be defined as the way of moving cloud computing abilities to the edge of the mobile networks which would produce a lot of profits that can be summarized in the following points:

- Decreasing the round trip latency of communicated data.
- Delivering high bandwidth.
- Introducing new services and applications by retrieving the network context information, and
- Introducing new services and applications by accessing the network context information.

Moving from the countless, huge and expensive data centers into minor distributed cloud units based on a small hardware platform will open the way for accomplishing the required latency constraint for tactile realization. The suggested construction of

the 5G system is based on reducing round trip latency by moving cloud to the edge of the mobile network. Only one or two communication hops away from the mobile will be effective to achieve the 1 ms latency. Normally, the 5G cellular system can be viewed as a mobile user, cloud unit, core mobile network, current Internet and remote cloud. Searching for the best place for presenting cloud unit researchers follow different ways. Based on the ETSI report of edge computing, there are numerous scenarios for the place of employment of the cloud computing units. There are multiple locations for the edge computing servers such as:

- Cloud servers connected to the LTE macro base station (e NB).
- Cloud units placed in the 3G/4G radio network controller (RNC).
- Cloud units connected to multiple sites (multiple e NB).
- Cloud units at the edge of the core network.

There have been lot of studies done for introducing small cloud units that can be employed in the mobile networks. Some use the term cloudlet to refer to any secondary and minor cloud units. Minor cloud units are such as Nebula and Wang et al.'s micro clouds.

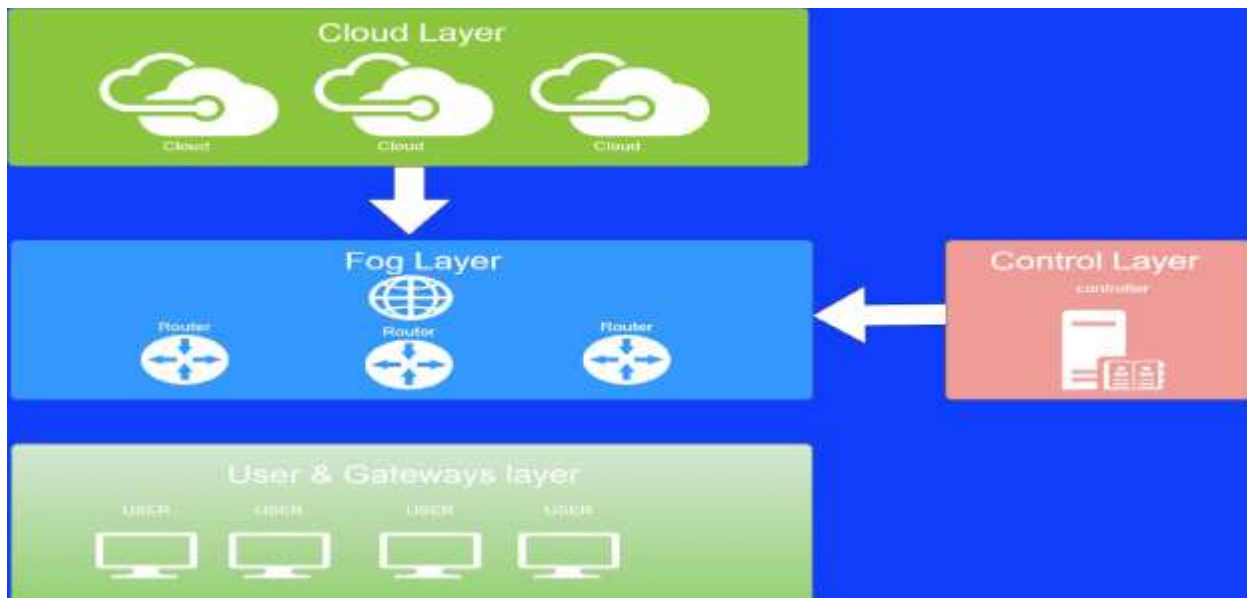


Fig. 1. Cloud computing layers

III. MODEL NETWORK

During the work we simulate the work of the network nodes in terms of fog computing. For work we need:

- ON/OFF switch.
- SDN controller (B4N).
- Traffic generator (50 * Raspberry pi 3).
- zabbix server network monitor.
- KVM.
- Remote clouds

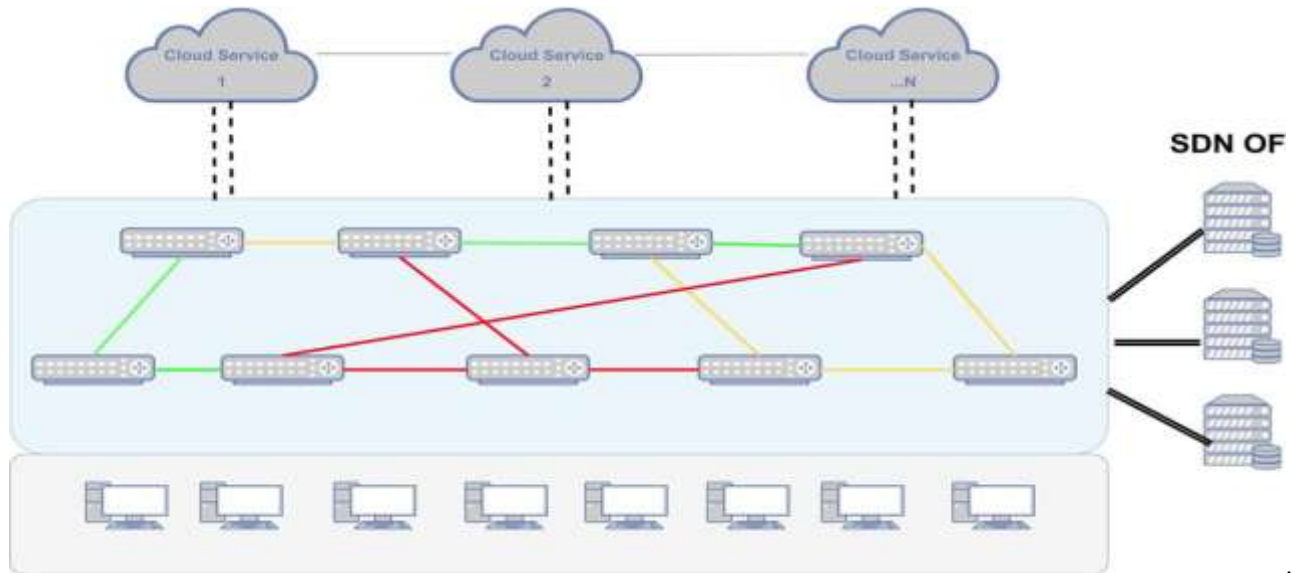


Fig. 2. Model Network structure

IV. FOG COMPUTING PLATFORM

The technology is termed Fog Computing because fog in layman terms is cloud nearer to the ground, in Fog Computing the computation occurs away from the cloud closer to the devices. Fog Computing goals at not trying to take over cloud rather deliver a new breed of services to make cloud more effective to use. Fog Computing is a virtual platform that delivers computing, storage, and networking services between end devices and traditional Cloud Computing Data Centres, naturally, but not exclusively located at the edge of network. The Fog Computing platform also offers better security when compared to the cloud. This is because data thefts are more likely to happen when data is managed at a single place but in Fog Computing the data is managed at various stages and hence the data is more secure.

The difference between cloud and fog computing architectures are shown in figure 3. The traditional Cloud system in which endpoints straight upload their data to the cloud, and in Fog Computing the endpoints upload their data to a Fog Computing enabled network device (in this case IOx) and this IOx uploads processed data to the cloud.



Fig. 3. Cloud and Fog Architecture

V. CONSTRUCTING A FOG COMPUTING ENVIRONMENT

A Fog computing environment can be attained by allowing an app store kind of system on the network devices where in the user can select what data should be managed on the edge and what data should be managed on the cloud. This includes tagging packets which are to be processed on the network device, when the network device obtains this packet it decodes the information present in the packet and sends it to the particular application running on its system for processing, once the results of processing are obtainable the network device creates a packet with a source IP address as that of the node sending the tagged packet and destination address as the cloud.

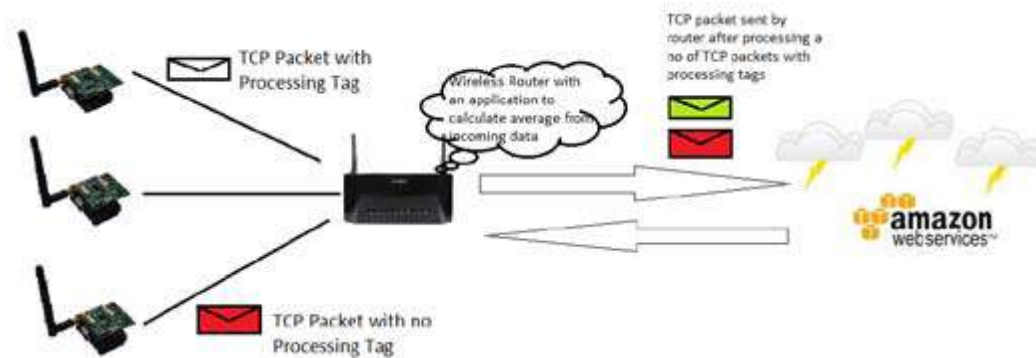


Fig. 4. Typical Fog Computing setup

Fig 4 shows a format where many wireless sensor nodes keep uploading their day to day process to the cloud a node which wants to send only an normal of its operational data to the cloud tags its packets, these packets are managed by the midway wireless router, the wireless router after processing uploads the data to the cloud and untagged packets are sent straight to the cloud without any midway processing.

VI. IMPLEMENTATION OF FOG COMPUTING

In our operation of fog computing we have considered the subsequent scenario where wireless nodes measure the temperature every 5 seconds and uploads the data to the cloud, the cloud then achieves time series prediction over the set of data to estimate the temperature at a upcoming point in time. For our implementation we have used the following:

- Three Arduino boards with temperature sensors and Arduino Wi-Fi Shields.
- one Raspberry pi having two Ethernet ports and a Wi-Fi adapter.

Instead of uploading all the temperature data to the cloud and the cloud acting the time series prediction, in our implementation, the arduino boards tag the temperature data packets, on receiving the temperature data packets the raspberry pi (The Fog Network device) stores the temperature data and does a time series forecast on the data, the predicted data is then sent to the cloud, so that the cloud can display it on web page.



Fig. 5. Raspberry Pi based Fog Device

The Raspberry Pi used here has two Ethernet ports and a Wi-Fi hotspot. The arduino boards connect to the Wi-Fi of the Raspberry Pi, they then measure the temperature of the surroundings every 5 seconds and send it to the router (the raspberry), on receiving the temperature data the raspberry raises a python script that writes the received temperature values in different files (one file per arduino board). The time series prediction method is applied to every single data in each file, the result of the time series prediction is then written into a MYSQL database instance running on the AWS cloud, these values written in MYSQL database are then read by the PHP instance of the cloud For an internet bandwidth of 1Mbps we have the following results.

Table. 1.
Comparison of results between Cloud and Fog

	Traditional Cloud	Fog Computing
Prediction Latency	5 seconds	1.5 seconds
Webpage display latency	8	3 seconds
Internet Traffic	75 Kbps	10Kbps

From our results as tabulated in Table 1 we are able to conclude that Fog based architecture gives better response time as compared to the cloud architecture.

VII. CONCLUSION

It avoids the need for costly bandwidth additions by offloading gigabytes of network traffic from the core network. It also protects sensitive IoT data by analyzing it inside company walls. Ultimately, organizations that adopt fog computing gain deeper and faster insights, leading to increased business agility, higher service levels, and improved safety.

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