Performance Analysis Of FOG And Cloud Computing Data Transmission System In IoT Environment

Md. Mohyminul Islam, Muzahida Rahman, Abdul Bari Rabin, Mohammad Golam Sarwar Bhuyan

Abstract: Internet of Things has been acquiring a lot of focus in the era of technological evolution. Current augmentation in various technologies has covered the way for many IoT services that are now being spread out in different sectors. Usages of the Internet of things are simultaneously increasing day by day and those things make a huge amount of data. Now comes a question, how can we transmit this huge amount of data, store data, handle data & secure data? Cloud computing and Fog computing is mostly used in IoT datagram. IoT can enlarge its scope and service provisioning capabilities with the integration of the cloud computing & fog computing paradigm. We proposed a comparison framework that separately illustrated with some factors to compare Fog and Cloud computing data transmission from the edge to the core level of the IoT environment. We collect real-time sensor data through Raspberry Pi and send separately to the Firebase Cloud server and FOG server and estimate the dataset with two factors: latency analysis, Accuracy analysis.

Keywords: CLOUD Computing, FOG Computing, Internet of Things, Raspberry pi.

1. Introduction
An IoT device is a modern computing device that connects wirelessly to a network and has the ability to transmit data; that’s the things of the Internet of Things. Fog computing & Cloud computing, edge computing, & mist computing. Fog computing spread the cloud computing paradigm to the edge of the network, thus enabling a new generation of services and applications. The major characteristics of a Fog Computing environment are Latency, Accuracy, response time, capacity, mobility, error rate, reliability. Fog Computing allows greater support and excellent response time to the Internet of things environment where many wireless sensor nodes uploading a stream of data to the cloud [1, 4]. Fog computing is the concept of a network that spread from the outer edges of where data is created to be stored. Fog is another layer of a distributed network environment and is nearly connected along cloud computing and the internet of things (IoT). This paper discusses the comparison between fog & cloud data transmission with the IoT environment. First, we take real-time data from the temperature sensor which connected Raspberry pi 3B. Then we transmit the data to the cloud & fog server and finally, we compare its latency & Accuracy.

2. Related works
Fog computing or Network-Based Computing or Edge Computing allows to steering a part of the processing in the cloud to the network devices that appeared along the node to the cloud. Consequently, the nodes connected to the cloud have a better repercussion time. Y. Navaneeth Krishnan [2] proposed a method of moving the computation from the cloud to the network by proposing an android as an app store on the networking devices. Mohammad Azam [3] present cloud-IoT integration issues followed by a comparison between fog and cloud computing. They evaluate the performance of fog computing using performance metrics. Presenting Processing of delay, costs, and power, and derive the performance gains acquired in comparison to cloud computing. They identify future research directions for fog computing. Vishal Kumar [4] gives interrelation and characteristics both Fog and cloud computing differs by configuration, arrangement, administrations, and devices for associations and clients. This comparison shows that Fog provides more supple infrastructure and better service of data processing by consuming little network bandwidth in place of considering whole data to the cloud. Flavio Bonomi [5] represents the Fog Computing example, characteristics, and the platform that supports Fog services. The following section takes a close look at a few key applications and services of interest that verify the reason help the Fog as the natural component of the platform necessary support for the Internet of Things. Determination some applications needed real-time analytics with long-term global data mining illustrates the interplay and complementary roles of Fog and Cloud. JASENKA DIZDAREVIĆ [6] Presents a comparative analysis of the main characteristics of IoT communication protocols and the protocols that are widely accepted and implemented in each segment of the system.
(IoT, fog, cloud) and inspection the main performance issues, latency, energy consumption, and network throughput. It’s necessary to the system architects and protocol designers when choosing the communication protocols in an integrated IoT-to-fog-to-cloud system architecture. IoT architectures on behalf of specific challenges in fog computing and cloud computing.

3. Proposed architecture

Proposed analytical architecture subdivided into three levels. The first level or Primary level 3.1 portrays the hardware prototype layer and the higher layer 3.3 mainly describes the analytical or a comparison section of the system.

3.1 Hardware Prototype Layer

The hardware prototype deals with a Microcontroller Raspberry Pi 3B and a Temperature sensor DHT11. Here Raspberry Pi environment "Raspbian" created in Linux for microcontroller installation and connect the DHT11 Temperature sensor with it.

3.2 Data transmission layer

In this layer sensor data are transferred to two servers, one is Firebase Cloud another is the FOG Server. Firebase Cloud is a Google real time database service and FOG is an edge level server from the sensor node. The total data transmission system subdivided into two sections, Cloud data transmission, and FOG data transmission.

3.2.1 Cloud data transmission

To send data in Firebase real-time database a python script can run in ‘Raspbian’. After creating an account in Firebase, sensor environment Adafruit_DHT should be created in Raspbian. This environment accesses the Raspberry Pi into the DHT11 sensor for sending the sensed data. Cloud server temperature and humidity data show in Figure 3.

3.2.2 FOG data transmission

The FOG server is acting as like as Cloud server but it situated very near to the sensor node. In FOG data transmission a FOG server is needed in Linux kernel. Linux kernel accessing the user’s own computer storage as FOG storage. Transferring the synced data to the FOG server only a command can perform. FOG server synced data shows in Fig.4.

3.3 Analysis layer

In this layer the synced data in FOG and Cloud server can be compared with respect to two different factors, one is Latency calculation during transmission and another is Accuracy measurement from two data set.

3.3.1 Latency comparison

Comparing the Firebase Cloud and FOG server performance during data transmission, the latency can be measured. Server performance depends on some factor like RTT (round trip time), Internet traffic, packet uploading delay etc. [7] In
this system all the factors is measured during two individual data transmission process (Fig. 5).

<table>
<thead>
<tr>
<th>Internet Connection Speed</th>
<th>No of packets transferred</th>
<th>Measure</th>
<th>FOG server</th>
<th>Cloud server</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mbps</td>
<td>80</td>
<td>RTT (ms)</td>
<td>1.51</td>
<td>19.626</td>
</tr>
<tr>
<td>Server</td>
<td>Server</td>
<td>Internet traffic (kbps)</td>
<td>10</td>
<td>00</td>
</tr>
<tr>
<td>Server</td>
<td>Source</td>
<td>Packet upload delay (Sec)</td>
<td>1</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**Figure 5: Latency measurement of the FOG and Firebase Cloud server.**

### 3.3.2 Accuracy comparison

Accuracy of the FOG and Firebase cloud server can be measured by multiple linear regression analysis. Linear equation is estimated for Cloud temperature data (Fig.6), $CT_y = 182.27x - 122.08$. Estimated regression coefficient is $CTb1 = 182.27$, constant $CTc = 122.08$ and regression value $CTR^2 = 0.0008$. On the other hand, estimated linear equation for Fog data, $FTy = 1910.6x - 1514.4$. Here the coefficient, $FTb2 = 1910.6$, constant, $FTc = 1514.4$ and the regression value $FTR^2 = 0.0688$.

**Figure 6: Accuracy comparison between FOG and Cloud server temperature data.**

On the other hand, for humidity comparison we also generate the same type of graph for accuracy comparison (Fig.7). Here the linear equation for fog, $FHy = 22485x – 18053$. Estimated regression coefficient is $b1= 22485$, constant $c = 18053$ and regression value $R^2 = 0.3958$. On the other hand, our estimated linear equation for Fog data, $CHy = 3366x – 2629$. Here the coefficient, $CHb2 = 3366$, constant, $CHc = 2629$ and the regression value $CHR^2 = 0.0083$.

**Figure 7: Accuracy comparison between FOG and Cloud server humidity data.**

The result from the regression measurement (Fig.8) says that the accuracy of FOG server temperature and humidity data is mostly high than the Cloud server.

<table>
<thead>
<tr>
<th>Data</th>
<th>Server</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>FOG</td>
<td>High</td>
</tr>
<tr>
<td>Temperature</td>
<td>Cloud</td>
<td>Low</td>
</tr>
<tr>
<td>Humidity</td>
<td>FOG</td>
<td>High</td>
</tr>
<tr>
<td>Humidity</td>
<td>Cloud</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Figure 8: Estimated Result of Accuracy Comparison.**

### 4. Conclusion and future work

In this paper, we presented a comparison of Fog and cloud computing this will help to appreciate the differences between that computing. Cloud computing technology has many development tools that are available for design and implement cloud architecture. Fog computing is a new prototype model and development tool. In this paper we compare only two factors but there have many factors to compare. In future error rate, capacity, response time, reliability etc. also be calculate and present them in a graph or benchmarks. Though the proposed architecture can be accomplished in different scenarios or applications, so more efficient equation can be utilized to increase the adaptability of this architecture. In the future, to cope up with updated technology of the platform this architecture shall be modified.

### References


Author Profile

Md. Mohyminul Islam is an undergraduate student in Computer Science and Engineering from Bangladesh Army University of Engineering and Technology, Bangladesh. During 2017-2018, he related on a research under Internet of Things data security.