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# Design and Implementation of IOT Connection with Websocket Using PHP

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**ABSTRACT**

IOT design and connecting between devices has been developed in recent years. Connection between device has been done from using Bluetooth, internet thru api, restfull api, socket, websocket, mttq and many others method. Api and socket is the most used method in connecting IOT devices. This reasearch tends to implement the websocket in connecting and controlling IOT devices. From the application of this research, the devices can be connected and implement with high speed of average 700ms with loaded netword. According to the results of the test, number of loads and data size can increase the time duration for each communication between IOT devices and websocket server. The larger the data, the more possible the anomaly may accured where the number of connections will experience lagging in command execution between the IOT devices and the controller the bidirectional connection in websocket make the data exchange posibbly fast.

***Keywords:***

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## 1. INTRODUCTION

IOT as a new way in implementing control over devices from a distance has improve in many ways. Connection between device has been done from using Bluetooth, internet thru api, restfull api, socket, websocket, mttq and many others method. IOT has been used in many ways. IOT has been used in a smart grid control [1], emotional detection [2], smart home[3] and smart controlling [4]. The most used communication method between IOT devices and the server are api and websocket. Api and websocket has a wider range usage and large data transfer. If the data to be transferred is relatively small, the best method for this is MQTT[5] where the header data transferred are relatively small for about 2byte. Despite of the small data transferred, MQTT doesn't have a good interoperability among other system. Integration of this method needed to be matched with other method. As MQTT work by using brooker, a service that relay all message into one, the malfunction of broker can result to disability to transmit data. The advantage of MQTT is the low overhead of the protocol and low powered compare to HTTP protocol or websocket.

Other method mention in communication between the IOT devices is using websocket. Websocket has similarity to a MQTT. Both connection method is bi-directional. The difference between the two is that websocket can accommodate larger data compared to MQTT. The MQTT used much complex architecture then websocket. The other advantages of websocket is that the websocket can be implemented in widerange applications. In order to implement MQTT in the browser, websocket is needed to bridge between the MQTT and the browser, thus implementing websocket is a straightforward method in order to implement IOT communication when we need to connect the device across various platforms.

API (Application Program Interface) is other messaging protocol that used HTPP protocol in data exchange. API usually build in RESTFull manner that can be divide into several command that commonly used such as: POST, GET, PUT, DELETE, PATCH. API is not ideal for IOT applications for unpredictable latency and the data tend to be large as the protocol is text based [6]. Most of the text that sent and received did not have special purpose if used in IOT applications but have a special purpose if used in a browser or other HTTP application. The API has a more stable standardization and wide range of usage and more reliable. For the HTTP method used in IOT applications, the devices need to have more memory and better CPU to process request and response in HTTP protocol.

Based on the explanation above, this research will conduct in implementation of IOT connection by using websocket. This research purpose is to measure the time needed in order for the data exchange to be held by using websocket method.

## 2. RESEARCH METHOD

Previous research had been made that used websocket. Panser Brigade Muhammad in his research mention that the speed of websocket is average 709 mili second [7]. Comparing the websocket and Server Side Event (SSE) with average of 497 mili second. Although the result shown that SSE is much faster than the websocket, but implementation of SSE in websocket is not widely known as it not bi-directional communication. Other implementation of websocket is in real time data transfer like in financial stock applications [8].

The design of this application is to connect the IOT devices and cotrolled the devices from a browser. As modern browser has websocket library implemented in their system, accessing a websocket is not a difficult thing todo. In order to better understand the application of websocket in data exchange, deployment diagram of the system shown in Figure 1.

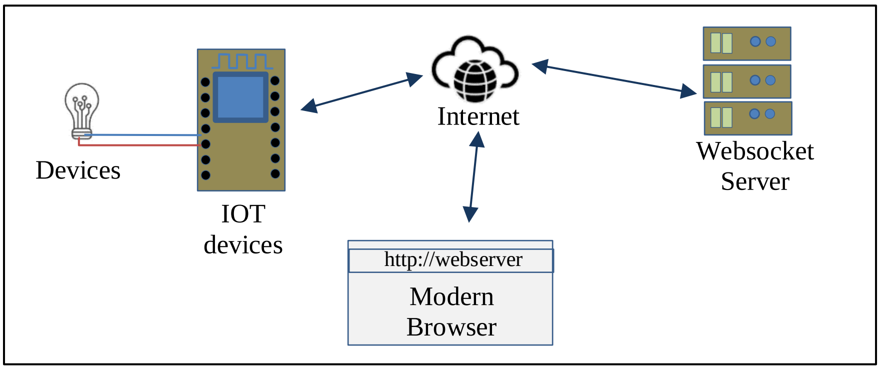


Figure 1. Deployment Diagram of IOT System

Proposed algorithm for this research was done by using the following steps:

1. When the controller in the browser is connected to the websocket, the websocket will inform the other device that the connection is established.
2. When the controller in the browser clicked, the application in the browser sending request to update the status of an output in the IOT
3. The Browser will send the time of the browser when the data was sent
4. When the websocket server is relaying the message to the IOT devices, the IOT devices will return the time used in processing and then return the total time.
5. The controller in the browser then taking the time when the webserver relying the message from the IOT devices
6. The controller in the browser then sending the message to websocket server to save the data to the database.

To differentiate the data which is come and to the IOT devices and server, the data is group into 2 categories such as:

1. To differentiate the command between the sending message, the loggin message, the type of message determine the proses of each IOT or websocket server, and browser controller would behave.
2. Each type will conclude to different action such as updating the status in the browser, updating status of the data in the database, logging the time consume, etc.

The data structure which are sent and received is build into json data. The data structure are as follows:

```
{
    type:'log',
    ts:ts, // time start
    tn:tn, // current time
    tf:m.time //time frame
}

{
    type:'update',
    text:text, // status
    id:id, // controller/ id
    time:time//current time
}

{
    type:'reply',
    ts:time, // time consume
    id:id, // controller/ id
    time:time//current time
}
```

Figure 2. Data Structure in JSON Format

Logging process was done by capturing the data and save the data in the database. This data can be processed and analyst for determining the speed of the websocket data exchange. The table which is used for storing is described in Table 1.

Table 1. Table Structure For Logging Process

| Column Name | Column Type | Information |
|---|---|---|
| logId | Integer | The Primary Key of the table |
| logConnection | Integer | The connection Id of websocket |
| logDuration | Integer | Duration from when the data sent and received in mili second |
| logSentTime | Big Integer | The time when the data was sent in UNIX timestamp, in milisecond |
| logReceiveTime | Big Integer | The time when the data was received in UNIX timestamp, in milisecond |

## 3. RESULTS AND ANALYSIS

In this research, the websocket is tested by using 6 criteria. Each criterion has 3 different parameters. The parameters are data size, number of load or user, and number of minimal testing case.

The data size is the minimal size of the data sent over the network. The data sent over the network is loaded with random number to increase the data sent. This criterion is test weather the IOT devices can process the data and then return the data, and whether the size of the data afffect the speed of data transmission. The number or load or user is the number of connections established in the network to the server. The number of connections is used to test if this criterion would affect the speed of data transmission. The last parameter is the minimal number of testing case where the IOT devices would send and receive data. The testing criteria is described in Table 2.

Table 2. Testing Criteria

| Data Sent Size | Number of Load/User | Minimal Number of Try |
|---|---|---|
| 500 Bytes | 2 | 500 |
| 500 Bytes | 100 | 500 |
| 1000 Bytes | 2 | 500 |
| 1000 Bytes | 100 | 500 |
| 2000 Bytes | 2 | 500 |
| 2000 Bytes | 100 | 500 |

By using the above algorithm, the testing procedure was held and get the results shown in Table 4. To minimize the time frame of communication, the random data sent was hardcoded in the program. This result shown not only the time used in communication, but also the time needed to process the request and relaying the data from the server to the IOT devices and vice versa. The time shown in these results is in mili second. To simulate the process of controlling the devices, the number of IOT devices used are 2. Each of the device has a rule of its own. The first device simulates a person who try to control the IOT devices by sending either 1 or 0, while the other device need to simulate the process of turning on or off a LED connected to IOT device according to the data received from the first IOT device.

Table 3. Testing Result

| **Data Size** | **Number of Load/User** | **Number of Try** | **Data Exchange Duration (in mili second)** | | |
|---|---|---|---|---|---|
| | | | **Maximum** | **Minimum** | **Average** |
| 500 Byte | 2 | 552 | 601.29 | 503.20 | 554.96 |
| 500 Byte | 100 | 608 | 1974.34 | 429.49 | 557.60 |
| 1000 Byte | 2 | 532 | 635.64 | 528.41 | 607.83 |
| 1000 Byte | 100 | 632 | 646.53 | 552.80 | 607.50 |
| 2000 Byte | 2 | 583 | 2271.88 | 642.11 | 696.46 |
| 2000 Byte | 100 | 613 | 5084.69 | 519.65 | 711.93 |

From Table 3, the number of loads can increase the time duration of data exchange. This problem can be solved by creating load balancing server to accommodate several requests. Although this might be the problem, by analyzing the average time duration, the time duration of the results is between 500ms-700ms. This by far is fast enough to bridge the gap between pushing a button and executing the task in the iot devices. In order to further analyze the maximum time used in data exchange, Table 4 shown the anomaly data which is shown in the testing result where the time consumed are more than 1 second.

Table 4. Testing Result Anomaly Data

| **Data Size** | **Number of Load/User** | **Number of Try** | **Percentage** | **Data Exchange Duration (in mili second)** | | |
|---|---|---|---|---|---|---|
| | | | | **Maximum** | **Minimum** | **Average** |
| 500 Byte | 100 | 1 | 0.18% | 1974.34 | 1974.34 | 1974.34 |
| 2000 Byte | 2 | 4 | 0.69% | 2271.88 | 1181.78 | 1463.51 |
| 2000 Byte | 100 | 18 | 2.94% | 5084.69 | 1179.60 | 1471.81 |

From Table 4, the anomaly data for the first result is happen only 1 and overall is 0.18%. This anomaly increased when the data size is increased. There are 4 and 18 data anomaly results with overall 0.69% and 2.94% respectively.

## 4. CONCLUSION

According to the results of the test, number of loads and data size can increase the time duration for each communication between IOT devices and websocket server. The larger the data, the more possible the anomaly may accured where the number of connections will experience lagging in command execution between the IOT devices and the controller. From the result of anomaly where the average time of data exchange is 1471.81 mili second, the likely of the time delay may occurred longer is minimize. Not all the data in IOT communication is larger than 1000byte. From this conclusion, if the websocket is going to be used in IOT devices data exchange, the more data sent, the more time consuming the data will be transmitted. This test is done by calculating the round trip of the process, thus the process in the IOT devices where the data is processed is not measured.

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