Effect of Workload Server on Server Room Temperature: An IoT-Based Monitoring

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Abstract: A server was the computer device that served one or more computing devices (*clients*). The servers that serve *client* had high-speed processor specifications. Each of the service requests increased the server workload. This increasing workload logically increased the work of the processor so that the processor temperature was increasing. This article described comprehensively the changes of the server room temperature due to the increasing workload of the server. The objective of this study was finding out the effect of the server engine workload on the server room temperature. The method used in this study was the IoT-Based monitoring method. The temperature sensor was used and combined with the Node MCU connected to the website server as a tabulation of the observation data. It was designed to avoid the heat caused by external factors (e.g., humans). The sensors were placed on the server rack. The result of this study was that the increasing workload of the server did not have a significant effect on the server room temperature. The result of this study was expected to be the input for designing the server chassis and the server room

Keywords: Server, Temperature, IoT-Based Monitoring, Workload.

1. INTRODUCTION

A server was the computer device that served one or more computing devices (*clients*). The server loaded the service system according to the purpose of the system[1]. Services were in the form of e-learning services, e-payment services, e-tax services, and other services[2]. Services were accessed by personal computers/devices. The process of requesting a service through a device requesting service (client) was called a request. Meanwhile, the process of providing an answer to a service request was called a reply. Server devices were accessed by more than one client at the same time. This was led to an increased workload on Server devices. The workload on the server was called a workload[3].

Server devices had the same characteristics as ordinary personal computers so that the higher the workload on the processor was, the higher the heat on the processor would occur. The difference was that the load on the server was not able to be limited because it was provided by every node connected to it or that was connected to the services it provided. Meanwhile, personal computers that were commonly used were able to be controlled by their workload because they were only controlled by one user. This caused the heat contained in the server device processor to happen quickly and it happened slowly depending on the access to the services provided by the server. If the processor had high heat, it directly affected the components in the environment[4]. Therefore, it was necessary to identify to what extent the workload affected by the server device on the higher temperature in the room where the device was placed[5].

This article described in detail the result of the study on the effect of server workload on the server room temperature. The purpose of this research is to identify the effect of the server computer workload on the temperature in the room where the server is located. The workload was measured from service requests on the services provided by the server. The form of the effect caused by the access to services was the effect through the operating system, the accessed applications, and the stored / downloaded data by the user. The measured effect was on the room temperature with degrees Celsius. The method applied in this measurement was through the internet of things-based measurement method. The processing device in the MCU node was used to read the temperature through a temperature sensor placed in the server room so that the readings were stored in a database table created on the webserver (MySQL) and the table was displayed with PHP programming on a web page. This paper described in several sections e.g., an introduction, methodology, results and discussion, conclusions, and further study. The introduction contained the background and statement of the problems that were solved in this study. The methodology contained the stages of solving problems with the internet of things method applied in this study. The results and discussion described the result and the discussion of this study referred to the previous studies. While the conclusion contained the answers to the problem statement of this study. The last part was the next study which contained things about opportunities and challenges in the future.

2. STUDY LITERATURE

The energy consumed by the service center (server) is increased and is mostly used for central cooling where the devices are used at the service center. In addition, most information technology-based service centers install a thermostat and set it according to the (conservative) recommendations by the manufacturer. This is due to a limited understanding of how temperature is affected by the operation of the system itself. Other results described in the study of Nosayba El-Syed, et al. [6] which describes the results of his research on dynamic workload scheduling to pay attention to temperature on a multisocket server CPU. The results showed that the approach taken gave an average cooling energy savings of 80% compared to the previous policy. shows that increasing the temperature setpoint by just one degree can save energy consumption by 2-5% energy consumption. So that the hotter the room, the higher the energy consumption. Other research in the field of dynamic workloads and cooling management inefficient data center rooms shows that how energy can be reduced by properly adjusting cooling parameters can increase the operational efficiency of the data center. The balance of power and cooling control achieves a reduction of 24% and this results in a 6% savings in electricity bills throughout the year and data center service performance continues to be good [7]. Likewise with research conducted by Raid Ayoub, et al.[8] which describes the results of his research on dynamic workload scheduling to pay attention to temperature on a multisocket server CPU. The results showed that the approach taken gave an average cooling energy savings of 80% compared to the previous policy.

Research conducted by Sriram Sankar, et al. [9] about the impact of data center temperature on the computing hardware on the server. The results of this study indicate that the observed temperature and failure at the location of the drive in the chassis, the location of the server on the rack, and the rack are in a data center service that is system aware in reducing server failures. So, in this study, a model that can be used to estimate data center service failures is presented on the hard disk caused by high temperatures on the server [9].

Several sources that have been studied, illustrate that the workload problem does not only increase the increase in room temperature but also increases the cost of electricity consumption [10]. However, the various methods used are scheduling the workload on the server, using a predictor system for access to central data services and the predictor results are used as input in the server room cooling management system. The novelty proposed in this study is to describe the results of observations on the server workload and its impact on increasing the temperature in the server room. The next update is the observation that is applied using the internet of things. However, in this case, it does not take into account the energy consumption used for cooling management in the data center room.

3. METHOD

The service work system provided by the server to the nodes connected to it was seen on Figure 1. Several nodes had the possibility of making service requests for a service provided by the server at the same time as the other nodes. The path of submitting requests through several phases was in accordance with the principle of the seven OSI layers on the network[11], which was started from an application that had a node as an introduction to the service interface with users. Furthermore, the request made by the user through the advance introduction was forwarded to the presentation in the form of data and the session. Subsequently, it was divided into the form of segmentation on the transport used in network communications on the network used by the server. It was used as a packet which was determined from the path and the internet protocol used. Then, the packet was forwarded by providing the MAC address and the transmission. Therefore, the workload on the processor increased as a request occurred and the request through the same path also increased the workload on the server either through the operating system, data, and applications contained on the server.

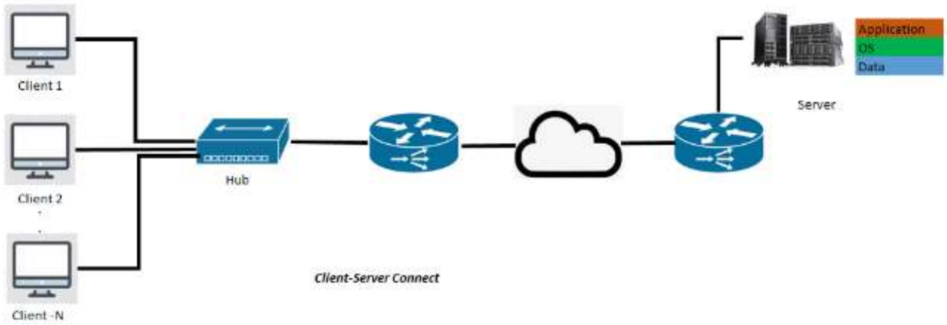

Figure 1: Data Communication Path

The observations were made through the internet of things observation method which utilized the internet network to monitor sensor readings at room temperature. A brief description of the temperature observations was carried out as it was on Figure 2 below.

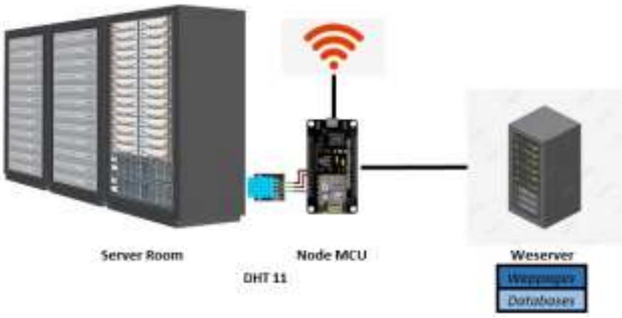

Figure 2: IoT-Based Monitoring

The implementation of this methodology in observing the server room temperature with the scheme showed in Figure 2. In addition, the integration of the scheme provided the instruction code at the Node MCU as follows.

```
void loop() {
  delay(500);
  HTTPClient http;
  float h = dht.readHumidity();
  float tvalue= dht.readTemperature();
  if (isnan(h) || isnan(tvalue)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.println(tvalue);
  String DHTValueSend, postData;
  DHTValueSend = String(tvalue);
  postData = "tvalue=" + DHTValueSend;
  http.begin("http://192.168.43.160/Nodemcu_db_record_view/InsertDB.php");
  http.addHeader("Content-Type", "application/x-www-form-urlencoded");
```

```
    int httpCode = http.POST(postData);
    String payload = http.getString();
    Serial.println(httpCode);
    Serial.println(payload);
    Serial.println("tvalue=" + DHTValueSend);
    http.end();
    delay(4000);
    digitalWrite(Led_OnBoard, LOW);
    delay(1000);
    digitalWrite(Led_OnBoard, HIGH);
  }
```

The DHT sensor connection with the database was through a connection in the PHP programming code as it was seen on the code below.

```
<?php

//Connect to database
$hostname = "*********";
$username = "****";
$password = "";
$dbname = "nodemcu_dht";
// Create connection
$conn = mysqli_connect($hostname, $username, $password, $dbname);
// Check connection
if (!$conn) {
die("Connection failed !!!");
           }
?>
```

The circuit of MCU nodes, sensors, and MCU nodes to a web server and access to the web page was shown on the figure 3 below.

Figure 3: circuit of MCU nodes, sensors, and MCU nodes with a web server

4. RESULT AND DISCUSSION

The result of this study showed that the sensor readings displayed on a web page. The previous study had shown that the readings displayed were real-time sensor readings[12]. The result of this study displayed on the web page taken from the web server on the MySql database. The display on the MySQL database was shown on the figure 4. Sensor readings stored in the database had a period between 1 minute and 8 minutes or depending on the change in temperature read by the DHT sensor. The sensor readings showed that the sensor readings displayed on the web page are accurate and real-time. This showed that the application of the internet of things in monitoring room temperature was correct. In addition, the temperature intervention from external factors were also eliminated in finding the results of the effect of server workload on server room temperature. The previous study had also shown that IoT worked well as a monitoring and control system[13].

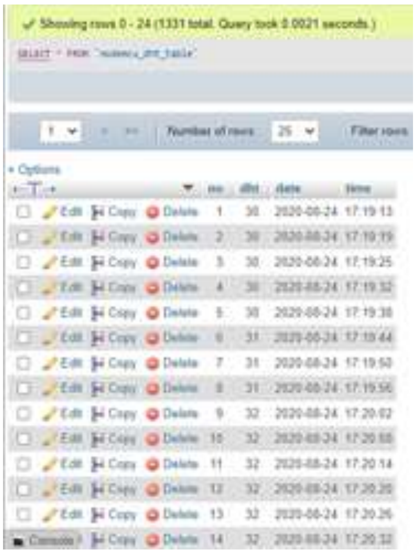

Figure 4: Results of the DHT Sensor Reading Experiment Stored in the MySql Database

After observing changes in server room temperature caused by the workload on the server device, these observations were represented in the graphical form as it was shown on Figure 5 below.

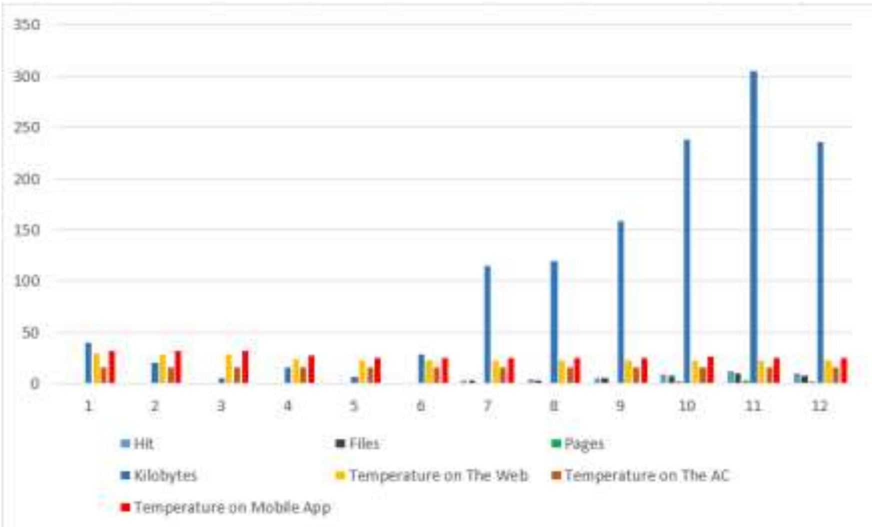

Figure 5: Projected Effect of Server Device Workload on Server Room Temperature

The highest workload on observed server services was originated from uploading-downloading files and hits on services provided on the server device. The server characteristics and academic service servers had different characteristics from servers for other services[14]. Moreover, e-commerce services may also have a higher hit than the uploading-downloading files and the other services [15].

It was seen in the graph that the server room temperature had not experienced a significant change even though the workload on the server had increased. This happened because the services provided by the server requested by the user were still within reasonable limits referring to the processor speed of the server device. This was revealed in the study [16] that it was still within the processor speed limit of a job on condition that the heat generated by the processor to other components was still tolerated.

The results of data processing from several server services such as data download and upload services on academic services, as well as hit events on the service pages provided are as shown in table 1.Table 1 contains a quantitative description of access to services provided by the server. Some indicators that are used as factors that increase server workload are hit rate, file access, opening web pages, and downloading and uploading.

Table 1: Sampling of Workload on Server

Time-n	Hit	Average	%	Files	Average	%	Pages	Average	%	Kilobytes (Upload/ Download)	Average	%
1	310	1.554	0.112%	260	1.3	0.093%	83	0.416	0.030%	8011	40.054	2.877%
2	161	0.806	0.058%	143	0.718	0.052%	34	0.173	0.012%	4216	21.079	1.514%
3	67	0.338	0.024%	57	0.286	0.021%	16	0.083	0.006%	1040	5.202	0.374%
4	99	0.495	0.036%	86	0.434	0.031%	20	0.102	0.007%	3171	15.856	1.139%
5	52	0.26	0.019%	42	0.21	0.015%	19	0.096	0.007%	1271	6.354	0.456%
6	212	1.061	0.076%	180	0.903	0.065%	56	0.284	0.020%	5672	28.361	2.037%
7	664	3.323	0.239%	610	3.052	0.219%	99	0.498	0.036%	23016	115.08	8.266%
8	877	4.388	0.315%	694	3.474	0.250%	229	1.149	0.083%	23831	119.155	8.559%
9	1213	6.069	0.436%	2041	5.209	0.374%	283	1.419	0.102%	31849	159.244	11.439%
10	1745	8.725	0.627%	1474	7.374	0.530%	434	2.17	0.156%	47514	237.57	17.065%
11	2458	12.291	0.883%	2103	10.517	0.755%	678	3.394	0.244%	61894	304.97	21.906%
12	1928	9.644	0.693%	1636	8.182	0.588%	531	2.655	0.191%	47236	236.181	16.965%

5. CONCLUSION

The workload on the server device does not have a significant effect on changes in server room temperature, besides that the highest workload on the academic service server comes from file upload and download services, as well as hits. Where the amount of workload on the server device due to file upload and download occurred at 21.91%, while due to hits was 12.29%. Another influence was followed by access to opening web pages on services provided on the server by 3.39%. The server category that is observed is not the server category that gets the over workload.

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