The effect of distance Base Transceiver Station (BTS) on speed of vehicle safety response based on internet of things

M E Martawati*, F Rohman, H F D Kurniawan and I N Abidin

Automotive Electronic Engineering, Department of Mechanical Engineering, State Polytechnic of Malang, Jl. Soekarno Hatta No. 09 Malang, Indonesia

*mmilla20@gmail.com

Abstract. In 2018 the Central of Statistics recorded cases of theft of motorized vehicles and embezzled cars from rentals totalling 2.752 cases, this was due to inadequate safety systems on the vehicle, and there were also several vehicles from vehicle rental services that had used GPS technology (Global Positioning System) which is integrated with the SMS gateway system (Short Message Service) to control the vehicle remotely, but in that system it has many disadvantages such as low speed of time response to turning off the vehicle and requires a large microcontroller memory because it has to store SMS messages and requires resetting in a certain period. The purpose of the study is to build a system in real-time by utilizing the latest technology, namely the Internet of Things so that vehicle owners can easily monitor and control their vehicles through the internet. The method of data analysis uses Anova two-way factor without replication. Data retrieval is done by varying the distance of the BTS and the type of provider to determine the accuracy and speed of response of the vehicle. The result of the study shows that Ublox neo 6M GPS can detect more accurately with Telkomsel Simpati providers with an average distance of 7,6184 meters and for the speed of response of vehicle control remotely Telkomsel Simpati provider with an average of 1,3334 seconds faster and stable.

1. Introduction

In 2018 the Central of Statistics recorded cases of theft of motorized vehicles and embezzled cars from rentals totalling 2,752 cases, this was due to inadequate safety systems on these vehicles, and there were also some vehicles from vehicle leasing services that have used GPS (Global Positioning System) technology which combined with the SMS gateway system (Short Message Service) to control the vehicle remotely, but in the system it has many disadvantages including being unable to monitor vehicle position in real-time but must send an SMS message in advance to find out every current position, and also devices used such as the Arduino Mega 2560 Microcontroller even though it has more memory than Arduino Uno, it will still run out of memory because it stores too many SMS messages and must first reset the microcontroller u can be reused [2]. Besides, in previous studies, the vehicle position tracking system with GPS and GPRS technology based on the website was only able to monitor the position of the vehicle through the website but could not detect the speed and turn off the vehicle remotely [3].

To overcome these shortcomings, it is necessary to build a system in real-time by utilizing the latest technology, namely the Internet of Things. Information from the 6M NEO GPS sensor on the Wemos D1 microcontroller will be sent via wireless fidelity communication to the internet via Mobile Wi-Fi (MIFI) with the latest 4G LTE super-fast network. So that vehicle owners can easily monitor and control
their vehicles, the system can be accessed online through an internet address that is available with a web browser and can also be accessed through an android application that was created specifically for the system. With the hope that the system has been made, the number of vehicle theft cases can be reduced and also vehicle owners who have the system will feel that it has been facilitated in monitoring their vehicles.

2. Proposed system
The proposed of the system, it is necessary to build a system in real time by utilizing the latest technology, namely the Internet of Things. Information from the 6M NEO GPS sensor on the Wemos D1 microcontroller will be sent via wireless fidelity communication to the internet via Mobile Wi-Fi (MIFI) with the latest 4G LTE super-fast network. So that vehicle owners can easily monitor and control their vehicles, the system can be accessed online through an internet address that is available with a web browser and can also be accessed through an android application that was created specifically for the system. With the hope that the system has been made, the number of vehicle theft cases can be reduced and also vehicle owners who have the system will feel that it has been facilitated in monitoring their vehicles.

3. Methodology
The steps taken in designing the design of the Vehicle Tracking system developed include Tracking Location, Calculating Latitude and Longitude data from GPS U-blox Neo 6M, time speed responded with combined Mobile WIFI 4G LTE Network using Internet of things. The tracking system design is discussed in Figure 2.

3.1. Tracking location
Global Positioning System (GPS) is a system for determining the location on the surface of the earth with the help of synchronizing satellite signals. This system uses 24 satellites that send microwave signals to Earth. This signal is received by the receiver on the surface and is used to determine location, speed, direction, and time [4].

---

**Figure 1.** Diagram block.

**Figure 2.** Vehicle tracking process flowchart.
Figure 3. GPS sensor communication with satellite [4].

This GPS tracker which allows the user to track the position of the vehicle, in a Real-Time state. GPS Tracking utilizes a combination of 4G LTE network technology and GPS to determine the coordinates of an object, then translate it in the form of digital maps figure 3.

3.2. Calculate GPS data

To know the accuracy location, data from GPS U-Blox Neo 6M like Latitude and longitude will be show on website and comparing with Latitude and longitude from G-maps where you take a data, substitute that data to movable-type.co.uk site to get difference of distance from point to point.

Figure 4. Calculating GPS data.

3.3. Time speed responded

To know the time speed responded is calculating time when push digital button on website and time changing on device LCD. Determined the difference time data from the website and device LCD in many BTS distance.
3.4. Device training

The device training use Mobile Wi-Fi with running on 4G LTE network on Simpati and Smartfren provider, this device will be combined with Wemos D1 R2 (when got the information from GPS sensor) to sending the information about the vehicle location. to trial for this device and knew the best time speed responses with the difference 4G LTE network provider when sending the newest vehicle location dan controlling the firing system remotely through the website (siipeta.firebaseapp.com).

Figure 5. calculating time speed responded.

4. Result and discussion

In the test, the location or data collection point is drawn in a straight line from the BTS of each provider with each distance that has been varied by conducting experiments three times in 1 variable, so the total testing is carried out as many as 15 times testing for one provider. From these tests the following results were obtained:
4.1. Accuracy location

Table 1. Accuracy location with Smartfren provider.

| PROVIDER SMARTFREN | BTS Distance | BTS Direction | GPS neo 6m | A-gps maps | Accuracy distance | Average distance |
|--------------------|--------------|---------------|------------|------------|-------------------|------------------|
|                    |              |               | Latitude   | Longitude  | Latitude           | Longitude       |
| 500 m              | East         | -7.934221     | 112.617234| -7.934228 | 112.617277        | 0.00771 km     | 0.009135        |
|                    | North        | -7.944157     | 112.619983| -7.944155 | 112.620206        | 0.004741 km    |                  |
|                    | South        | -7.948235     | 112.616533| -7.948130 | 112.616595        | 0.01353 km     |                  |
| 1 Km               | East         | -7.938864     | 112.672812| -7.938851 | 112.672871        | 0.007041 km    | 0.002151        |
|                    | North        | -7.937745     | 112.625752| -7.937755 | 112.625728        | 0.002867 km    |                  |
|                    | South        | -7.954362     | 112.620228| -7.954397 | 112.620237        | 0.004016 km    |                  |
| 5 Km               | East         | -7.952430     | 112.686935| -7.952464 | 112.686936        | 0.003782 km    | 0.012467        |
|                    | North        | -7.898812     | 112.627663| -7.898764 | 112.627657        | 0.005378 km    |                  |
|                    | South        | -7.989592     | 112.621797| -7.989295 | 112.621842        | 0.02824 km     |                  |
| 10 Km              | East         | -7.948878     | 112.731209| -7.948882 | 112.731245        | 0.003989 km    | 0.009331        |
|                    | North        | -7.876893     | 112.625275| -7.876942 | 112.625349        | 0.009804 km    |                  |
|                    | South        | -8.026468     | 112.616272| -8.026342 | 112.616293        | 0.01420 km     |                  |
| 15 Km              | East         | -7.952193     | 112.759828| -7.952183 | 112.759890        | 0.006918 km    | 0.037183        |
|                    | North        | -7.823492     | 112.644925| -7.823366 | 112.644808        | 0.01904 km     |                  |
|                    | South        | -8.065633     | 112.598865| -8.065657 | 112.598088        | 0.08559 km     |                  |
| Average            |              |               |            |            |                   |                  |

Table 2. Accuracy location with Simpati provider.

| PROVIDER SIMPATI | BTS Distance | BTS Direction | GPS neo 6m | A-gps maps | Accuracy distance | Average distance |
|------------------|--------------|---------------|------------|------------|-------------------|------------------|
|                  |              |               | Latitude   | Longitude  | Latitude           | Longitude       |
| 500 m            | East         | -7.952605     | 112.643555| -7.952555 | 112.643565        |                  |
|                  | North        | -7.948510     | 112.639825| -7.948441 | 112.639820        |                  |
|                  | South        | -7.955933     | 112.638340| -7.955940 | 112.638278        |                  |
| 1 Km             | East         | -7.952833     | 112.648015| -7.952764 | 112.648052        |                  |
|                  | North        | -7.944410     | 112.640885| -7.944373 | 112.640960        |                  |
|                  | South        | -7.960967     | 112.636747| -7.960905 | 112.636800        |                  |
| 5 Km             | East         | -7.952340     | 112.683828| -7.952357 | 112.683828        |                  |
|                  | North        | -7.911122     | 112.657065| -7.911127 | 112.657092        |                  |
|                  | South        | -7.991875     | 112.621095| -7.991899 | 112.621123        |                  |
| 10 Km            | East         | -7.950378     | 112.730247| -7.950365 | 112.730206        |                  |
|                  | North        | -7.871535     | 112.679083| -7.871369 | 112.679165        |                  |
|                  | South        | -8.023745     | 112.617523| -8.023678 | 112.617561        |                  |
| 15 Km            | East         | -7.952207     | 112.759870| -7.952162 | 112.759858        |                  |
|                  | North        | -7.832737     | 112.697152| -7.832643 | 112.697181        |                  |
|                  | South        | -8.079903     | 112.591398| -8.079940 | 112.591334        |                  |

Table 3. Data analyze.

| Source of Variation | SS     | df  | MS   | F      | P-value | F crit |
|---------------------|--------|-----|------|--------|---------|--------|
| BTS distance accuracy of place between providers Error | 0.000316 | 4 | 7.91E-05 | 1.076757 | 0.461724 | 6.388233 |
|                     | 0.000266 | 1 | 0.00266 | 3.7178 | 0.126082 | 7.008467 |
|                     | 0.000868 | 9 |       |        |        |        |

Based on the type influence test table above BTS distance and place accuracy above, it can be concluded that:

Because the F-count of 1.107657 with a significance value of 0.461724 is > 0.05, then accept the null hypothesis, meaning that there is no significant difference in the effect of the BTS distance for providers on the delivery of vehicle locations with a 6M neo GPS sensor, because the F-count of 3.7178 with a significance value of 0.126082 is > 0.05, then accept the null hypothesis, meaning that
there is no significant difference in the interaction between the types of Simpati and Smartfren provider interactions on the accuracy of the position of the vehicle.

![Graph showing the accuracy of Simpati and Smartfren providers.](image)

**Figure 7.** Difference accuracy location inter providers.

From the graph above, it can be concluded that the most accurate of the two types of signal provider 4G LTE (Telkomsel and Smartfren), namely Telkomsel, with the overall type of provider with a distance of 5000 meters from the signal source is to produce an average accuracy of vehicle location with measurement position which is 0.002998 km or 2.998 meters. and the farthest distance between the two points is Smartfren with a distance of 15 km produces an average accuracy of the position of the vehicle which is 0.037 km or 37 meters from the measurement position.

4.2. **Time speed responded**

**Table 4.** Time speed responded with Smartfren provider.

| PROVIDER SMARTFREN | BTS Distance | BTS Direction | Time on the LCD | Time on web pages | Difference in response time (seconds) | Average response time |
|--------------------|--------------|---------------|-----------------|-------------------|--------------------------------------|----------------------|
| East               | 500 m        | East          | 07 : 13 : 54    | 07 : 13 : 55      | 1                                    | 1.333333             |
|                    |              | North         | 15 : 40 : 27    | 15 : 40 : 26      | 1                                    |                      |
|                    |              | South         | 15 : 35 : 52    | 15 : 35 : 50      | 2                                    |                      |
| East               | 1 Km         | East          | 07 : 33 : 12    | 07 : 33 : 14      | 2                                    | 1.6666667            |
|                    |              | North         | 15 : 47 : 16    | 15 : 47 : 14      | 2                                    |                      |
|                    |              | South         | 15 : 25 : 30    | 15 : 25 : 29      | 1                                    |                      |
| East               | 5 Km         | East          | 19 : 57 : 28    | 19 : 57 : 25      | 3                                    | 2.333333             |
|                    |              | North         | 16 : 30 : 42    | 16 : 30 : 40      | 2                                    |                      |
|                    |              | South         | 15 : 10 : 27    | 15 : 10 : 25      | 2                                    |                      |
| East               | 10 Km        | East          | 19 : 38 : 44    | 19 : 38 : 41      | 3                                    | 2.66667              |
|                    |              | North         | 16 : 48 : 55    | 16 : 48 : 52      | 3                                    |                      |
|                    |              | South         | 14 : 52 : 58    | 14 : 52 : 56      | 2                                    |                      |
| East               | 15 Km        | East          | 19 : 16 : 34    | 19 : 16 : 31      | 3                                    | 3.333333             |
|                    |              | North         | 17 : 37 : 21    | 17 : 37 : 18      | 3                                    |                      |
|                    |              | South         | 14 : 41 : 49    | 14 : 41 : 45      | 4                                    |                      |
Table 5. Time speed responded with simpati provider.

| BTS Distance | BTS Direction | Time on the LCD | Time on web pages | Difference in response time (seconds) | Average response time |
|--------------|---------------|-----------------|-------------------|---------------------------------------|-----------------------|
| 500 m        | East          | 21:45:41        | 21:45:40          | 1                                     | 1.333334              |
|              | North         | 16:16:07        | 16:16:05          | 2                                     |                       |
|              | South         | 18:37:50        | 18:37:49          | 1                                     |                       |
| 1 Km         | East          | 16:31:16        | 16:31:14          | 2                                     | 2                     |
|              | North         | 19:28:11        | 19:28:09          | 2                                     |                       |
|              | South         | 18:50:05        | 18:50:03          | 2                                     |                       |
| 5 Km         | East          | 19:52:39        | 19:52:38          | 1                                     | 1.333334              |
|              | North         | 16:55:00        | 16:54:58          | 2                                     |                       |
|              | South         | 19:09:10        | 19:09:09          | 1                                     |                       |
| 10 Km        | East          | 20:09:15        | 20:09:14          | 1                                     | 1.666667              |
|              | North         | 17:27:50        | 17:27:47          | 3                                     |                       |
|              | South         | 19:27:02        | 19:27:01          | 1                                     |                       |
| 15 Km        | East          | 20:25:16        | 20:25:15          | 1                                     | 2                     |
|              | North         | 18:36:13        | 18:36:10          | 3                                     |                       |
|              | South         | 20:00:48        | 20:00:46          | 2                                     |                       |

Table 6. Time speed responded data analyze.

| Source of Variation | SS     | df  | MS     | F       | P-value | F crit |
|---------------------|--------|-----|--------|---------|---------|--------|
| BTS distance        | 1.794441 | 4   | 0.44861 | 1.591134 | 0.331866 | 6.388232909 |
| accuracy of place   | 0.899997 | 1   | 0.899997 | 3.192115 | 0.148529 | 7.708647422 |
| between providers   |        |     |        |         |         |        |
| Error               | 1.127775 | 4   | 0.281944 |         |         |        |
| Total               | 3.822213 | 9   |        |         |         |        |

Based on the type influence test table above the BTS distance and tool response time above, it can be concluded that:

Because the F-count of 1.591134 with a significance value of 0.331866 is> 0.05, then accept the null hypothesis, meaning that there is no significant difference in the distance of the BTS provider to the response time of the device.

Because the F-count of 3.192115 with a significance value of 0.148529 is> 0.05, then accept the null hypothesis, meaning that there is no significant difference in effect between interactions between Simpati and Smartfren providers on the response time of the tool.

Figure 8. Comparing time speed responded.

In the graph above the Simpati provider at 1000 meters from the BTS, experienced data transmission time due to the distance taken a measurement data in urban high rise buildings that affect the speed of
the provider in sending data from the device, the Simpati provider will experience an increase in the duration of turning off or turning on the vehicle when greater distance to the BTS.

Smartfren providers at a distance of 500-1000 meters from BTS have a vehicle safety response speed that is more stable despite being in the center of a high rise building due to Smartfren installing repeaters so Smartfren has better stability and speed than Simpati providers, but when moving away from BTS with distance 5000 - 1500 meters Smartfren has decreased the response speed which is much longer than the Simpati provider.

From the graph above, it can be concluded that the fastest of the two types of 4G LTE signals (Telkomsel and Smartfren), namely Telkomsel, with the overall type of provider with a distance of 500 meters from the signal source is to produce the average - fastest response time, namely 1, 333334 seconds and the slowest is Smartfren with a distance of 15 km resulting in an average response time of 3.333334 seconds.

5. Conclusion
Based on research that has been done it can be concluded that:

- The design of this tool uses a Neo 6M GPS sensor to detect the position of the vehicle and then the information is processed by the Wemos D1 R2 microcontroller to be sent to the Database via Mobile WIFI, data from the database data will be displayed to the web through an integrated HTML program.
- From the previous data it can be concluded that the U-Blox NEO 6M GPS can detect position accurately, has a shift point to the actual position with an average value of 0.0076184 kilometers or 7.6184 meters with Simpati 4G provider, meaning faster internet connection then it will be able to speed up the updating and sending of data from the NEO 6M GPS to the website and is still in the 8-10 meter absolute accuracy standard (SNI 19-6724-2002).
- Interaction between BTS distance and type of provider does not affect on deadly response time or activates the gasoline motor ignition system with a significance value of 0.148529 which means> 0.05. The fastest type of provider of the two 4G LTE providers (Telkomsel and Smartfren) namely Telkomsel with a distance of 500 meters from the signal source produces an average response time of 1.33334 seconds and the slowest is Smartfren with a distance of 15 kilometers produces an average response time of 3.3334 seconds.

References
[1] Badan Pusat Statistik 2018 Statistik Kriminal 2018 [Online], retrieved from: www.bps.go.id. Jakarta: Badan Pusat Statistik
[2] Cahyo B D 2018 Analisis Pengaruh Jarak dan Jenis Sinyal GSM Terhadap Waktu Respon Injektor Motor Bensin Jarak Jauh Berbasis Android (Malang : State Polytechnic of Malang)
[3] Junus M 2012 Sistem Pelacakan Posisi Kendaraan dengan Teknologi GPS dan GPRS Berbasis Web (Malang : State Polytechnic of Malang)
[4] Arya A 2019 Prinsip kerja GPS (Global Positioning System), [Online], retrieved from: http://radenseta.blogspot.com/2012/10/prinsip-kerja-gps-global-positioning.html. Accessed on 2 January 2019