

## **BUILDING SYSTEM OF PERSONNEL MOVEMENT USING GLOBAL POSITIONING SYSTEM (GPS) DESIGN**

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### **Abstract**

Supervision process is an important phase performed by a leader in implementing activities so that the activities can run accordingly to the plan. The implementation of task done by Military personnel need supervision continuously by a leader. The development of advanced technology of electronics and communications in equipment and weapons and implementing navigation system using satellites. By designing a supervisory system to monitor personnel movements using Global Positioning System (GPS) will facilitate leaders to supervise personnel. GPS as a data receiver from satellites in the form of latitude, longitude of position coordinates. Wavecom modem as a data receiver from GPS Module. Delphi 7 Program will process data, then will display Google Maps showing position of the personnel, coordinates, and time of place movement done by the personnel. The network of GSM is needed as a data sender media. Coordinate data displayed in Google Maps in real time corresponds to the personnel position coordinate in reality.

**Keywords:** Coordinate, Global Positioning System, Wavecom Modem

### **1. Introduction**

In the implementation of its duties in the area of operation that is migratory personnel TNI often requires supervision from the leadership. With good supervision the implementation of the task will run well. Currently to know the position of personnel still use the map and compass in most units of the Army. Because the tool used is still manual then the process and the steps of activity and supervision of the operation becomes limited. By using the map and compass the process of determining the position of the calculation is still manually and has a precise accuracy, it will take a longer time.

One of the utilization of electronics and communication technology is to make a monitoring tool of personnel movement equipped using GPS that displays map of location with position point which can be known coordinate of troop position. So the results of positioning and position will be visualized on the laptop, which will facilitate the leadership to conduct supervision of personnel.

By the problems above, we make the title "BUILDING SYSTEM OF PERSONNEL MOVEMENT USING GLOBAL POSITIONING SYSTEM (GPS) DESIGN ", which is expected later will be used easily to help determine the position of personnel. In the surveillance tool personnel movement there are

some parts that need to sync between the data from the GPS sent using Global System for Mobile Communication (GSM) network and then displayed with Delphi 7 program on the laptop.

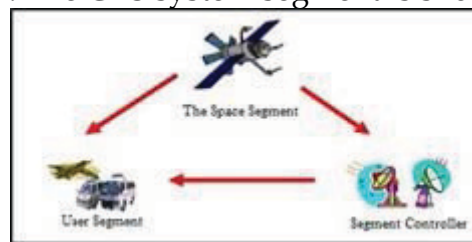
## 2. Methode

### 2.1. Delphi7

Borland Delphi is the next generation of Turbo Pascal, launched in 1983 designed to run on the operating system Disc Operating System (DOS), which is the most widely used operating system at that time. While Delphi was first launched in 1995 is designed to operate under the Windows operating system.

### 2.2. Global Positioning System (GPS)

Global Positioning System (GPS) is a navigation radio and satellite positioning system, with the official name of NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Positioning System) [5]. GPS consists of three major segments of space segment consisting of GPS satellites, control system segment consisting of monitoring stations and satellite controllers, as well as user segment consisting of GPS users include receivers and signal processing and GPS data. The GPS system segment is shown in Figure 2.1.



**Figure 2.1.** Segment GPS System

To determine the position on the surface of the earth, the GPS receiver will compare the time on the signal transmitted by the satellite with the time at which the signal is received by the GPS receiver. The time difference will tell how far the satellite is from the GPS receiver. If using a distance calculation of multiple satellites, a position can be determined from the triangular shape obtained by satellite position. With three or more satellites, the GPS receiver can determine the latitude / longitude position, which is called a 2D fixed position. Whereas with four or more satellites, the GPS receiver can determine the 3D position consisting of latitude, longitude, altitude [7].

#### 2.2.1 How GPS Works

Every area above the earth's surface is minimally affordable by 3-4 satellites. In practice, every new GPS can receive up to 12 satellite channels at a time. The condition of the sky is clear and free from obstacles make GPS can easily capture the signal sent by satellite. The more satellites received by GPS, the higher the accuracy will be given.

How GPS works logically there are 5 steps:

1. Using the satellite triangulation calculations.
2. For "triangulation" calculation, GPS measures distance using travel time radio signals.
3. To measure travel time, GPS requires require high time accuracy.
4. For the calculation of distance, we must know with certainty the position of the satellite and the desire in its orbit.
5. Finally must correct the signal delay travel time in the atmosphere until receiver received. The GPS satellite working scheme sends the signal shown in Figure 2.2.
- 6.



**Figure 2.2.** GPS Satellite Work Scheme Sending Signals

### **2.3. Wavcom Modem**

The Wavcom modem is a special type of modem that uses a SIM card, and to operate using a service provider, such as a mobile phone. When a GSM modem is connected to a computer, the computer can use a GSM modem to communicate over a cellular network, while a frequently used GSM modem to provide mobile internet connectivity, many of the modem types used to send and receive SMS. The Wavcom modem is easily controlled using AT commands and also the facility can quickly connect to the serial port of a desktop computer, laptop or notebook. The Wavcom modem becomes the perfect solution for heavy applications like telemetry or Wireless Local Loop (PLN metering & Public Telephone). Small size makes it easy to put in various areas, indoor / outdoor. This modem is built from the well-known and fast-paced, efficient, and stable M1306B chipset platform with RS232 Serial connection support at baudrate 115200 [10]. An example of a Wavcom modem model is shown in Figure 2.3.

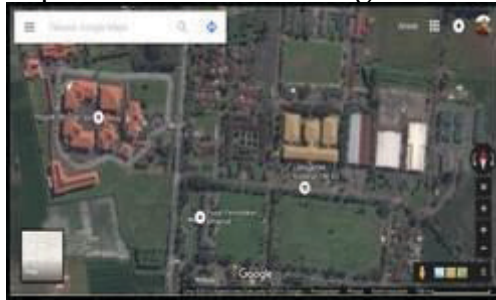


**Figure 2.3.** Wavcom Modem

### **2.4. Google Maps**

Google Maps can be used as directions. Google Maps uses NASA satellites and to date all of the photos on the surface of the earth can be viewed through the Google Earth program. Unlike Google Earth, Google Maps is a Web-based app. For simplified Google Maps, because of its WEB-based features and easier

use as a directional, the Google Maps app uses an Earth surface view system with Terrain or contours, satellite imagery and walkthroughs. Google maps not only provide a map view that can be explored, but also has a search facility that allows to go to a particular location based on address and parameters entered. By entering the address of coordinates longitude and latitude, can find interesting locations, such as monuments, tourist attraction, by typing a certain name [15]. The Google Maps view is shown in Figure 2.4.



**Figure 2.4.** Google Maps Views

### 2.5. Delay

Delay is a delay in the transmission of data from the sender and receiver so that a response can occur in the receiver. The delay test is divided into different time conditions, the unit of delay is second (seconds). Delay in the design of the supervisory system of personnel movement is one of the parameters to be studied. In this research will be done several times the experiment to get the delay of each type of delay testing so that will produce the difference between the shortest delay time, longest delay and average delay of the whole. In determining the value or number of delay it will use equation 2.1.

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4 + x_5 + \dots + x_n}{n} \quad (2.1)$$

Information:

$\bar{x}$  = Average count

$x_n$  = the i-th sample value

$N$  = number of samples

### 2.6. Accuracy and Precision

Accuracy as a difference or closeness (closeness) between the coordinates read from the tool with the coordinates on the actual field. Precision is a measure of how close a series of measurements are to each other. With the hope of several experiments at one point of location to obtain precise results, then done with different location points can be analyzed and taken a conclusion. In the determination of the value or number of Accuracy and Precision it will use equation 2.1.

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4 + x_5 + \dots + x_n}{n} \quad (2.1)$$

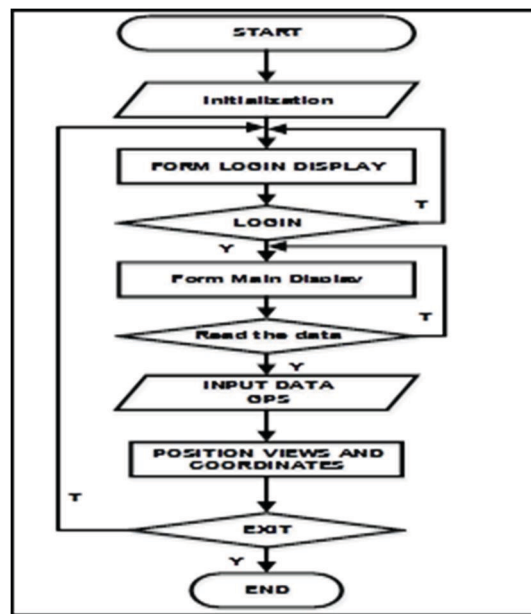
Information:

$\bar{x}$  = Average count  
 $X_n$  = the i-th sample value  
 $N$  = number of samples

### 3. Result and discussion

#### 3.1.1. Flowchart and explanations

Flowchart design is intended for the making of data processing system GPS display coordinate personnel running well, then the program must receive data from GPS. Flowchart of Program for Display GPS coordinate personnel shown in Figure 3.1.



**Figure 3.1.** Flowchart of Program for Display GPS

In Figure 3.1. Flowchart GPS display program is to describe the movement between units.

Flowchart explanation in Figure 3.1.

1. Start To start the program.
2. Initialization is to provide the initial data at the start of the program.
3. Show the login form is the process to open the program start screen.
4. Login to open the new form. If it is wrong then the program will return to the login form.
5. Show main form that is to open main form after login correct.
6. Read data is for comparison of a statement, to proceed to the next process.
7. Input GPS data is to provide initial data for the process.
8. Display position and coordinates is the process of display position and coordinates on the program.
9. Exit is to end the program in progress.
10. End is stop the program.

### 3.1.2. Block Diagram

Monitoring equipment personnel movement has a working system from the delivery of data transmission orders, data processing, and appearance of the program position of the coordinates of personnel. To simplify a tool design it is necessary to design a block diagram of the system globally. The block diagram in question can be seen in Figure 3.2.

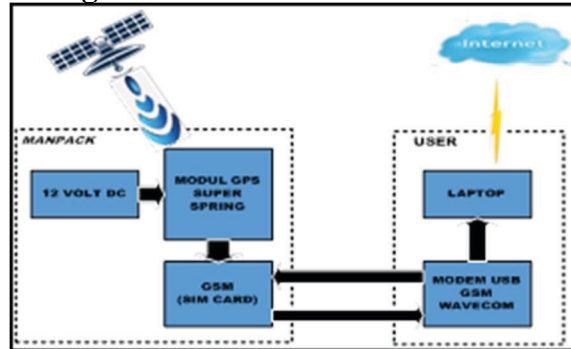


Figure 3.2. Tool Diagram Block

### 3.1.3. Work System Tools

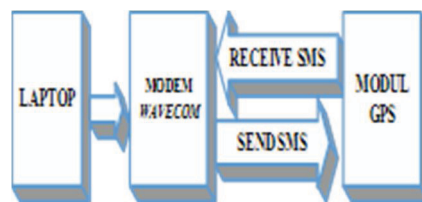
1. Delphi7 installed laptop is programmed to be connected with Wavecom modem, then given command to request coordinate data to GPS.
2. Wavecom Modem will send a message with AT-Command AT + CMGS format = "GOAL NUMBER" (Sim Card on GPS) CTRL + Z WHERE #
3. The GPS module placed on the man pack acts as a data receiving device where the coordinates of the satellite position are latitude, longitude. Upon receiving a message sent by Wavecom Modem, the GPS module will provide sms reply messages containing the latitude, longitude, time and speed data received from the satellite.
4. Wavecom Modems that have received further data messages will be forwarded to Delphi 7 program by using Com Port on Delphi 7.
5. The received data message will then be processed, the data to be retrieved is the value of latitud and longitude to be input on Google Maps.
6. To Display Google Maps on Delphi 7 using Web Browser.
7. Laptop will display Google Maps on the Delphi 7 display program which position, coordinates, and time of movement or displacement of personnel equipped with real-time man packs.

### 3.1.4. GPS Module Testing

GPS testing aims to determine the position or coordinates of an area using GPS (Global Positioning System) installed on the tool. GPS is to monitor the position of personnel when it has moved from position position.



1. Tools used
  - A. Computer.
  - B. USB cable.
  - C. Wavecom Modem.
  - D. Super Spring GPS Module.
2. Testing Procedure
  - A. Construct the test circuit as in Figure 3.5 block.
  - B. Connecting the Wavecom Mode to a computer or laptop via a USB cable.
  - C. Turn on the Super Spring GPS Module.
  - D. On a computer or laptop open the Hyperterminal app.



**Figure 3.5.** GPS Tracking Chart Diagram block

The first step of testing this tool is data from satellites received by GPS in the form of coordinate data. Wavecom Modem will send sms to Superspring GPS module, then Superspring GPS module will reply to sms which contain message coordinate from GPS. Received sms data will be displayed and read on Hyperterminal.

3. Testing results are shown in Figure 3.6.

```

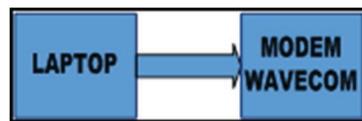
AT
OK
AT+CMGS="082245352992"
> WHERE#
+CMGS: S3
OK
+CMTI: "SM",16
AT+CMGR=16
+CMGR: "REC UNREAD", "+6282245352992", "16/05/22,16:26:19+28"
Last position! Lat: 8.894602, Lon: 112.584953, Course: 157.53, Speed: 0.00Km/h, DateTi
me: 2016-05-22 15:50:54
OK
AT+CMGS="082245352992"
> WHERE#
+CMGS: S4
OK
AT+CMGS="082245352992"
> WHERE#
+CMGS: S5
OK
    
```

**Figure 3.6.** Results of GPS Testing On Hyperterminal

### 3.1.5. Wavecom Modem Testing

Wavecom Modem Testing aims to determine whether the Wavecom Modem used can display character data in accordance with the program created.

1. Tools used
  - A. Computer or Laptop
  - B. USB cable
  - C. Wavecom Modem
2. Testing Procedure
  - A. Structure the test chapters as shown in Figure 3.3.
  - B. Connecting the Wavecom Modem
  - C. On a computer or laptop open the Hyperterminal app



**Figure 3.3.** Wavecom Modem Testing Series

The first step of testing this tool is to send sms to the desired telephone number using AT COMMAND written on Hyperterminal. Replies received will be displayed on Hyperterminal, for sms reading using AT COMMAND format. As shown in Figure 3.3. Using baudrate 115200 bps and flow control selected none.

3. Testing results

```

at
OK
at+cmgs="08567542998"
> mencoba*
+CMGS: 52

OK

+CMTI: "SM",13
at+cmgr=13
+CMGR: "REC UNREAD", "+628567542998", "16/05/22,16:17:30+28"
Pesan di terima
OK
  
```

**Figure 3.4.** Testing Results On Hyperterminal

### 3.1.6.Coordinate View Test

Display coordinates on the application is a display that serves as a place to perform the process of displaying the coordinates of personnel. The coordinate position display of personnel is shown in Figure 3.5.





### 3.1.7. Testing Against Delay

After performing some tests on the delay it can be calculated the average value generated by using the test results data in Table 1.1.

**Table 1.1.** Delay Test Results

NO	TESTING	TIME (s)				
		I (06.00WIB)	II (10.00WIB)	III (13.00WIB)	IV (17.00WIB)	V (21.00WIB)
1	Move 1	17.4	20.8	19.7	17.2	20.7
2	Move 2	18.2	19.7	19.4	19.1	18.2
3	Move 3	20.3	23.4	21.5	19.8	22.8
4	Move 4	18.7	23.8	20.3	19.2	19.5
5	Move 5	18.8	22.4	21.8	21.5	23.7
6	Move 6	19.1	19.9	18.6	20.9	23.9
7	Move 7	16.7	23.1	20.4	21.2	27.2
8	Move 8	20.4	19.7	21.6	18.7	19.8
9	Move 9	20.6	20.9	17.3	19.3	19.6
10	Move10	18.2	17.3	19.8	22.5	21.3

From the data table above then each test can be calculated the average value of delay obtained is as follows:

1. Time 06.00 WIB

$$\bar{x}_1 = \frac{188.4}{10} = 18.84 \text{ Second}$$

2. Time 10.00 WIB

$$\bar{x}_2 = \frac{211}{10} = 21.1 \text{ Second}$$

3. Time 13.00 WIB

$$\bar{x}_2 = \frac{200.4}{10} = 20.04 \text{ Second}$$

4. Time 17.00 WIB

$$\bar{x}_2 = \frac{199.4}{10} = 19.94 \text{ Second}$$

5. Time 21.00 WIB

$$\bar{x}_2 = \frac{216.7}{10} = 21.67 \text{ Second}$$

From the above calculation, then will be searched average value as follows:

$$\bar{x} = \frac{101.59}{5} = 20.318 \text{ Second}$$

### 3.1.8. Testing Against Accuracy and Precision

After performing some tests on the moving location then it can be calculated the average value generated using the test result data in Table 1.2.

**Table 1.2.** Testing Results Accuracy and Precision in Silent Condition

NO	LOCATION	TESTING	TIME (WIB)	DISTANCE (m)
1	A	1	06.04	3.6
		2	13.01	2.4
		3	16.02	4.8
		4	20.09	3.6
2	B	1	06.09	2.4
		2	13.04	3.6
		3	16.06	2.4
		4	20.11	3.6
3	C	1	06.13	2.4
		2	13.07	2.4
		3	16.10	3.6
		4	20.15	2.4
4	D	1	06.17	4.8
		2	13.11	2.4
		3	16.12	2.4
		4	20.18	3.6
5	E	1	06.21	3.6
		2	13.13	2.4
		3	16.16	3.6
		4	20.21	2.4

NO	LOCATION	TESTING	TIME (WIB)	DISTANCE (m)
6	F	1	06.26	3.6
		2	13.16	4.8
		3	16.19	3.6
		4	20.24	4.8
7	G	1	06.30	2.4
		2	13.19	3.6
		3	16.24	2.4
		4	20.28	3.6
8	H	1	06.33	2.4
		2	13.24	2.4
		3	16.27	2.4
		4	20.32	4.8
9	I	1	06.37	3.6

		2	13.29	2.4
		3	16.31	2.4
		4	20.35	2.4
10	J	1	06.40	2.4
		2	13.32	3.6
		3	16.33	2.4
		4	20.38	4.8
11	K	1	06.43	3.6
		2	13.37	3.6
		3	16.37	3.6
		4	20.40	4.8
12	L	1	06.47	3.6
		2	13.41	2.4
		3	16.39	3.6
		4	20.44	3.6
<b>NO</b>	<b>LOCATION</b>	<b>TESTING</b>	<b>TIME (WIB)</b>	<b>DISTANCE (m)</b>
13	M	1	06.51	2.4
		2	13.44	2.4
		3	16.45	2.4
		4	20.47	3.6
14	N	1	06.55	2.4
		2	13.48	3.6
		3	16.49	2.4
		4	20.50	2.4
15	O	1	06.58	2.4
		2	13.52	2.4
		3	16.56	3.6
		4	20.55	3.6

From the data table above then each test can be calculated the average value of distance accuracy and precision obtained are as follows:

- Experiment on Location A  

$$\bar{x}_1 = \frac{3.6 + 2.4 + 4.8 + 3.6}{4} = \frac{13.2}{4} = 3.6 \text{ meters}$$
- Experiment on Location B  

$$\bar{x}_2 = \frac{2.4 + 3.6 + 2.4 + 3.6}{4} = \frac{12}{4} = 3 \text{ meters}$$
- Experiment on Location C  

$$\bar{x}_3 = \frac{2.4 + 2.4 + 3.6 + 2.4}{4} = \frac{10.8}{4} = 2.7 \text{ meters}$$
- Experiment on Location D  

$$\bar{x}_4 = \frac{4.8 + 2.4 + 2.4 + 3.6}{4} = \frac{9.6}{4} = 3.3 \text{ meters}$$

$$\begin{aligned}
 & 5. \quad \text{Experiment on Location E} \\
 \bar{x}_5 &= \frac{3.6 + 2.4 + 3.6 + 2.4}{4} = \frac{10.8}{4} = 3 \text{ meters} \\
 & 6. \quad \text{Experiment on Location F} \\
 \bar{x}_6 &= \frac{3.6 + 4.8 + 3.6 + 4.8}{4} = \frac{15.6}{4} = 4.2 \text{ meters} \\
 & 7. \quad \text{Experiment on Location G} \\
 \bar{x}_7 &= \frac{2.4 + 3.6 + 2.4 + 3.6}{4} = \frac{10.8}{4} = 3 \text{ meters} \\
 & 8. \quad \text{Experiment on Location H} \\
 \bar{x}_8 &= \frac{2.4 + 2.4 + 2.4 + 4.8}{4} = \frac{9.6}{4} = 3 \text{ meters} \\
 & 9. \quad \text{Experiment on Location I} \\
 \bar{x}_9 &= \frac{3.6 + 2.4 + 2.4 + 2.4}{4} = \frac{10.8}{4} = 2.7 \text{ meters} \\
 & 10. \quad \text{Experiment on Location J} \\
 \bar{x}_{10} &= \frac{2.4 + 3.6 + 2.4 + 4.8}{4} = \frac{10.8}{4} = 3.3 \text{ meters} \\
 & 11. \quad \text{Experiment on Location K} \\
 \bar{x}_{11} &= \frac{3.6 + 3.6 + 3.6 + 4.8}{4} = \frac{15.6}{4} = 3.9 \text{ meters} \\
 & 12. \quad \text{Experiment on Location L} \\
 \bar{x}_{12} &= \frac{3.6 + 2.4 + 3.6 + 3.6}{4} = \frac{12}{4} = 3.3 \text{ meters} \\
 & 13. \quad \text{Experiment on Location M} \\
 \bar{x}_{13} &= \frac{2.4 + 2.4 + 2.4 + 3.6}{4} = \frac{10.8}{4} = 2.7 \text{ meters} \\
 & 14. \quad \text{Experiment on Location N} \\
 \bar{x}_{14} &= \frac{2.4 + 3.6 + 2.4 + 2.4}{4} = \frac{9.6}{4} = 2.7 \text{ meters} \\
 & 15. \quad \text{Experiment on Location O} \\
 \bar{x}_{15} &= \frac{2.4 + 2.4 + 3.6 + 3.6}{4} = \frac{12}{4} = 3 \text{ meters}
 \end{aligned}$$

From the above calculation, then will be searched average value as follows:

$$\bar{x} = \frac{47.4}{15} = 3.16 \text{ meter}$$

### 3.1.9. Analysis

After testing the tools that have been made in accordance with the design, then will be analyzed based on test results data obtained.

### 3.1.10. Wavecom GSM Modem Analisist

In the test there is an AT-COMMAND format in the process of sending messages and message readings, as follows:

1. AT is used to early check whether the modem and laptop are connected.
2. AT + CMGS = "destination number", then to send a message that has been written press CTRL + Z.
3. AT + CMGR is used to read incoming messages.
4. CMTI as a sign of incoming messages.

By writing the correct AT-COMMAND format, then there will be no error, otherwise if writing wrong format will occur error.

#### **3.1.11. Modul GPS Analysis**

To be able to send a gps message must first get the command with the format WHERE #, after getting the next command gps will send a message containing the data:

1. Latitude and longitude coordinates darin last position of gps.
2. Moving speed of gps.
3. Time of last position of gps containing date, month, year, and hour.

#### **3.1.12. Coordinate View Analysis**

Coordinate view is the appearance of the coordinates of the GPS on google maps after the coordinates that have been given GPS, to show the location of the GPS location on google maps given a sign with a small brown icon, a sign or icon of the location of the location on google maps can be changed in accordance with the change program.

#### **3.1.13. Analysis Against Delay**

After carrying out the test and calculation of delay 10 times test with value 5 different time condition got result of lowest value 18.84 second at test time at 06.00 WIB, highest value 21.67 second at test time at 21.00 WIB, then overall average value obtained Is 20,318 seconds. Factors that affect the delay difference due to the transmission of data communications dependent on the sms operator to send via the nearest BTS and peak communications or dense use of the provider by the provider provider. In testing this tool provider used by the tester is a provider of SimPati owned by Telkomsel.

#### **3.1.14. Analysis of Accuracy and Precision**

After carrying out the tests and calculations of accuracy and precision in silent conditions, the tests at locations C, I, M and N have the nearest accuracy and precision value of 15 tests with a value of 2.7 meters and testing at location F has the greatest accuracy and precision with a value of 3.9 Meters. Thus proves that the average accuracy and precision value of 3.16 meters. Differences of accuracy and precision distance values occur due to two factors: the first factor of difference of test time affecting atmospheric state, the second factor

geographical position around the location, thus affecting the GPS signal received from the satellite.

After performing tests and calculations of accuracy and precision in mobile conditions, the test was performed 15 times with the lowest value of 18.95 meters in test 11, the highest score of 23.6 meters in test 14, the overall average score of 21.24 meters. The difference in deviation value is because it is influenced by the time and speed values in the testing tool.

#### **4. Conclusions**

Based on the results of planning, making, testing and research of supervisory system of personnel movement using Global Positioning System (GPS), it is concluded as follows:

1. With parameter delay, accuracy and precision of tool testing process and data retrieval can be executed with result of delay test the overall average value obtained is 20.318 seconds. The value of delay is influenced by provider (Telkomsel), if data transmission occurs during peak hours communication delay value will be high, because there queued of sms delivery. Tests of accuracy and precision in a stationary condition obtained an average yield of 2.86 meters. Tests of accuracy and precision in moving conditions obtained results average aberration distance of 21.24 meters. The value obtained is much different from the test on the stationary condition, this is due to the effect of the value of displacement velocity on the testing tool.
2. Data communication from Wavecom modem with GPS module transmitted through GSM signal with SMS format using AT Command command. AT + CMGS = "destination number", then to send a message that has been written press CTRL + Z.
3. Wavecom Modem sends messages with WHERE format #, GPS module as data receiving tool coordinate the position of the satellite in the form of latitude, longitude. Messages sent by Wavecom Modem, GPS module provide sms reply messages that contain data latitude, longitude, time and speed received from satellites. The Wavecom modem that has received the data message and then received data messages will then be processed and displayed on Google Maps.

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