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Design and Implementation of GSM-Based Passenger Bus Locator for Designated and Non-Designated Bus-Stops

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Abstract:

In this study, the Global System for Mobile communications (GSM) based passenger bus locator is designed, developed, implemented to solve real world problems and evaluated based on functionality, accuracy and operability. The device is composed of two different Modules, A and B. Module A is used to locate the location of the bus using GSM 908 with Global Positioning System (GPS) receiver built in and to send the location of the bus to the ones requesting via Short Message Service (SMS) or text message. For tracking, the GPS collect the data or coordinates to be process in the Microcontroller; the data that is being collected by the GPS is being compared to the pre-determined coordinate programmed in the microcontroller. The nearest coordinate similar to the program with a corresponding location must be sent to the user after requesting. Module B is used as a server to accept all the request inquiries of the commuters and to have a common recipient to accommodate all users to send in the Module A. Furthermore, the evaluation of the devise is assessed by randomly selected respondents too show that the device is acceptable.

Keywords — **Global System for Mobile communications, Global Positioning System, Microcontroller, Short Message Service**

I. INTRODUCTION

Bus service is one of the major transportation used by the public here in our country. Buses operate throughout the country, and they come in all forms and sizes, from small rusty boxes to large, luxury coaches that run through the highways and roads of the Philippines. For most people not owning a private automobile, the "public utility bus" (PUB) is the only practical way to travel on medium or long distances, since jeepney (PUJ) are usually limited to local routes, (Boquet, 2010). Many buses here in Philippines have full amenities.

On board comfort rooms, even Wi-Fi is present. The government has plans to modernize the country's public bus transport system which includes requiring bus operators to install a GPS monitoring device in their buses for commuter's safety. Waiting on a bus or any other forms of transportation is stressful especially those who are working, studying and to those who have important journey (Ferrer, 2015). Without any notion or idea of the location of the bus, commuters tend to be nervous and fearful on the negative outcomes. Upon studying this field the proponent developed

an idea to create a communication system that involves bus liners and commuters for the purpose of monitoring and awareness of the approaching bus along the hi-way.

The proponents design a device that can track a bus with a device attached to it in which tracking is done by sending a SMS message to the device and verifies the code by the microcontroller to validate and perform its requested operation. The prototype is intended to be used as a tracking device and also an information dissemination device to the commuters. The prototype is mainly composed of a GPS module, GSM module and Microcontrollers. GPS module is used as a receiver to access the GPS satellite and transmit the information that is fed to the microcontroller/Arduino for processing. The Microcontroller/Arduino is used to process the information gathered from the GPS verify the sent message received by the GSM module and parse it to check the kind of operation to be done.

The feature of this prototype is to track bus liners by using GPS receiver installed in the bus together with the other components of the prototype. From a cell phone, by sending a SMS code message to the microcontroller/ device, to be process together with the data gathered by the GPS receiver, and the device deliver the response to the commuter the information the GSM module send the location of the bus by its longitudinal and latitudinal position by SMS.

Bus transportation is the leading transportation used by commuters in the route of Agora Terminal, Cagayan de Oro City to Balingoan Terminal, Misamis Oriental. Commuters preferred to avail those services because of its safety and convenience. In remote areas, commuters are relying on buses to travel in their desired destination for work, school or even to do leisure things. Buses are the most common way to move people over short and medium distances in towns and cities, as well as in rural areas (Rizon, 2012). Upon studying this field especially commuters, they tend to be anxious and restless while waiting on the bus especially when commuters are in a hurry. Without any notion of the location, commuters tends to get confuse and hard to decide what transportation will be an alternative to ride on. Also, not being able to communicate the bus, gives the commuters a state of being unacquainted of the bus that is traveling along the way. Another factor that also needs to be addressed is commuters who are waiting along the hi-way during night time and early dawn. Commuter waiting are subject to harmful elements such as robbers and other forms of crime. So, upon studying this field, the proponent is expecting to face problems dealing with the desired output off the study.

a. What would be the design of the devise in order to achieve the desired output of the study?

b. What are the components to be used for the development of the device in order to obtain the expected output of the device?

c. What are the methods to be used in implementing it?

d. What are the evaluation parameters in order to prove that the functionality, accuracy and operability are achieved?

II. METHOD

The chosen methodology requires a study that enumerates the design, development, implementation and the evaluation of the bus locator device. In this chapter, all the gathered information has to be discussed and evaluate the application and composition of the device and the process of the functionality of the study.The theoretical framework of the study shown in Fig. 1 reflected the research framework utilizing the input, process, and output (IPO).

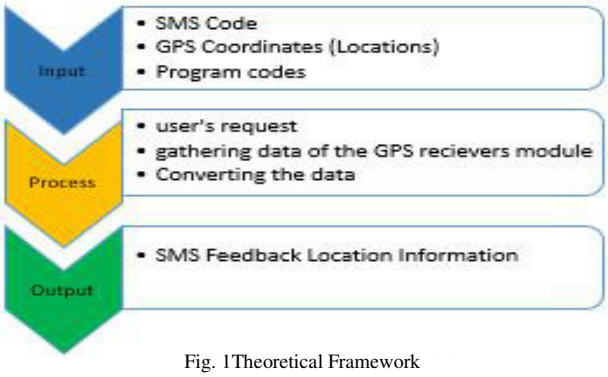

Fig. 1Theoretical Framework

A. *Design and Development*

The GSM Based Bus Passenger Locator Device

The Bus Locator Device was design into two Modules, Module A and Module B or the main GSM. The blocks have a different function but these blocks are communicably connected into each other. The researcher's finds that a design with a single composition device could be difficult to be work alone and communicate directly into the passengers. This kind of process could cause problem because there were too many bus to be installed by block A, and each Block A has a SIM number. These means that in order to locate all the bus, the passenger neededsend a code message in all bus which haves a different SIM number. The researchers conclude to design another device that could communicate between passengers and bus in order to have a precise and unambiguous process based on the study.

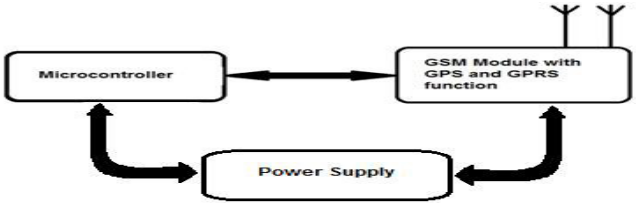

Fig. 2 Block Diagram of Module A

Figure 2, Shows the design of the module which composed of microcontroller, GSM Module with GPS function and power supply. The function of this block is to provide a location to the requested passenger. With the used of GSM with GPS function, the module could provide a coordinates of the current position of the device and communicates passenger through SMS function. The microcontroller declares a locationbased on the provided coordinates from the GSM module and validates SMS message.

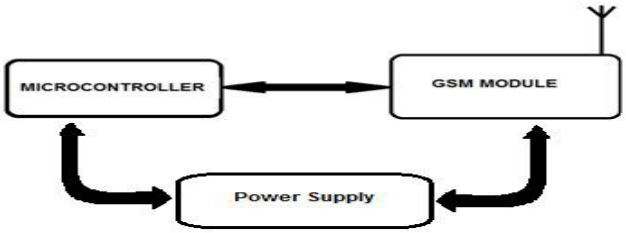

Fig. 3Block Diagram of Module B

Figure 3, Shows the design of the block which is composed, the microcontroller and GSM module. The function of this block is to deliver the request message from the passenger through the block A which was being installed in the bus. The GSM Module communicates passenger through SMS function. The microcontroller provides a protocol to have a clear function process. This Module, reads the request message and provide the exact code that must be send from the passenger, If the Block reads the message as incorrect this block gives a feedback to the passenger knowingly that passenger have the incorrect code message.

The GSM based bus passenger locator device implements its design to describe about the capability and efficiency of the device in order to provide the exact the location of the all working bus by through sending the exact code.

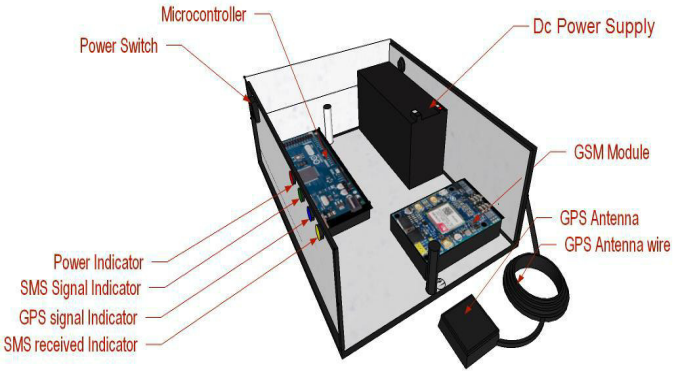

Fig. 4 The Design of the Module A

Figure 4, the researchers designed a box that suits all components of the device. It shown in figure below, the switch control the power usage of the device and 4 kind of indicator to know the function of the device. The red LED indicates the power of the device, Blue for the GPS signal which only light up as long as it gets the coordinates or the current location of the device, green LED is for GSM Signal Indicator that has a 3 seconds delay light up, and yellow for the SMS Indicator, the characteristic of this indicator is when it gets a SMS message from the passenger it lights up then turn off when the device is already replied to the Module A. The

researchers choose that the GPS antenna has a length of 3.5 meters put it in the roof of the bus to easily get coordinates to the satellite. These devices provide the communication through sending and receiving SMS messages and a DC voltage supply of 12V with 1.5 amps. The block B is the one who get coordinates and convert into its location; it is also the one who reply to the passenger after texting from the main GSM or the Module A.

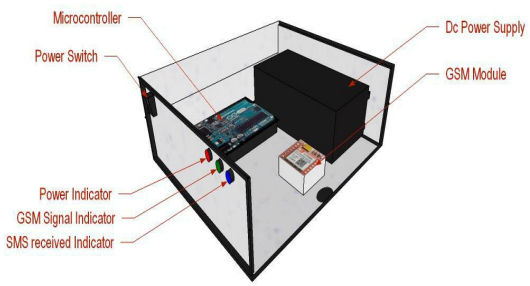

Fig. 5 The Design of the Module B

Figure 5, Show the design of Module A that has a control switch to control the power usage of the device, and a 3 LED's indicator which is Red, Green and blue, the Red indicates the power of the device. The the Green indicates the GSM signal. And the Blue Indicates when the module receive a message.

B. Implementation

The implementation of the device must have a chosen location. The chosen location is from Agora Terminal, Lapasan, Cagayan de Oro city to BalingoanTermnal, Balingoan, Misamis Oriental. The chosen location is the route Pabama Tours. In order to gather data based on the result, thechosen location must have a satisfying mobile signal in all municipalities that have been covered in the location and must have been implemented in a good weather day.

The researchers studies about the code that inputted of the passenger. It concludes to program the device by having the route of Cagayan de Oro city terminal to Balingoan, Misamis Oriental terminal. With this route, the researchers provides the "CTB and BTC" code in order to relate passenger. CTB means the bus taking a route from Agora terminal, Cagayan de Oro city to Balingoan, Misamis Oriental and BTC for the bus taking a route from Balingoan, Misamis Oriental to Agora terminal, Cagayan de Oro city. The researchers provide 84 locations covered of the route, these means that every kilometer has it corresponds location that be converted from the acquired coordinates of GPS function in GSM module The researchers also studies about the feedback message of the block A and block B in order to relate passenger.

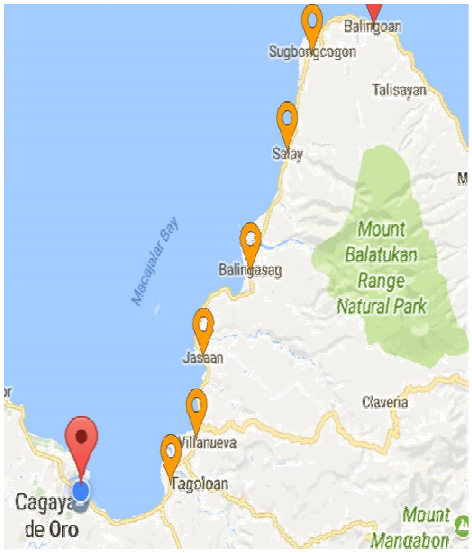

Fig. 6The Chosen Location of the Study

Figure 6, Shows the chosen location of the study which also shows the covered municipalities and the barangays of the municipalities nearly in the route of the bus. Based on the study, the implementation start in the first pin point of the figure which is the Agora terminal, the expecting code require to send is CTB and the implementation in Balingoan Terminal expect to require a code of BTC.

Fig. 7 The Content of the Feedback Message of Module A

Figure 7, Shows the possible feedback message of the device with a content of the type of the bus, the bus number, the location and the route of the bus. With this kind of message, the passenger easily to understand and satisfy about the information that been given in the device.

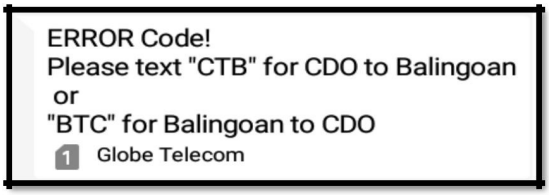

Fig. 8 The Chosen Feedback Message when the Code is Incorrect.

Figure 8, the chosen feedback message of incorrect code is easily to know the passenger about the sent code was incorrect and providing the exact the code of the route of what passenger takes.

C. The Evaluation

GSM Based Bus Passenger Locator device help to develop bus transportation service. This study helps the passenger to locate the bus and to manage their time in some situations. By texting the exact code, the devices send a feedback with a content of the location of all bus that take on the route. Within this device it help many passengers to satisfy curiosity and reduce anxiety of the passenger. In such cases, passenger might become a victim of crime in a moment by missing consciously the location of the bus and by knowing the location of bus, the passenger the passenger can estimate the arrival time of the bus nearly in their places.

The GSM Based Bus Passenger Locator Device was evaluated using efficiency statistics utilizing a point rating scale that measures the acceptability of GSM Based Bus Passenger Locator Device in accordance to the following criteria:

An assessment instrument bearing test questionnaires measures the ratings of various criteria through purposive sampling. The respondents of the assessment were the students and instructors of University of Science and Technology of Southern Philippines (USTP). USTP respondents were preferred for they were the ones identified to be frequent users of GSM Based Bus Passenger Locator Device in theuniversity. The survey responses were measured was using five point rating scale which has the following adjectival rating as shown in Table 1.

TABLE.1
ADJECTIVAL EVALUATION RATING

Adjectival Rating	Scale Range
1 Very Poor	1.4 Below
2 Poor	1.5 2.4
3 Fair	2.5 3.4
4 High	3.5 4.4
5 Excellent	4.5 Above

III. RESULTS AND DISCUSSION

The results and findings of the study are based on the stipulated methodology involved in the conduct of the study that highlighted the design, development, and evaluation

A. Design and Development

In Figure 9, it shows the design and the actual picture of the component being integrated of the Module A. Module A comprises of the following components namely: the GSM 808, Arduino Mega Microcontroller and a Battery. The system is design to be installed in the bus for navigational purposes; once the device is installed the device is ready for the implementation. This Module is capable of receiving geographical coordinates due to its GPS receiver package in the GSM 808. Moreover, one of its major function of the Module is that it is capable of sending information such as location of the bus, type of bus, and the plate number. The type of bus and the plate number is inputted in the program once the bus is confirmed for implementation. This Module represent as a receiver and a sender. It receives the information coming from the satellites for location navigation and it also receives the user's inquiry for location of the bus. And lastly,

the main output of this Module is capable to send the information gathered to the ones requesting.

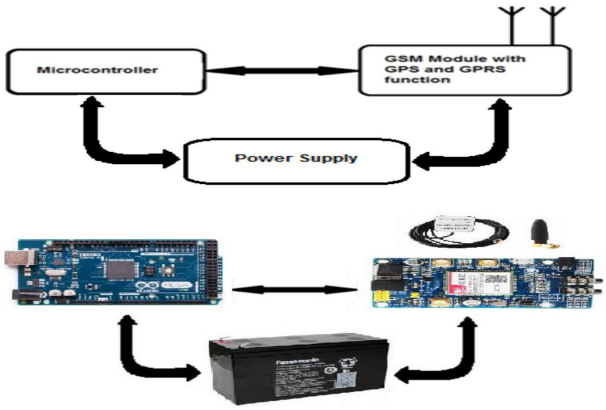

Fig. 9Module A (Integration)

In Figure 10, it shows the design and the actual picture of the component being integrated in the Module B. Module B comprises of the major following components namely: GSM SIM800, Arduino Mega Microcontroller and a Battery. This Module is capable of accommodating the inquiries of the user via SMS. The proponent designs this module to have a common ground of the user.

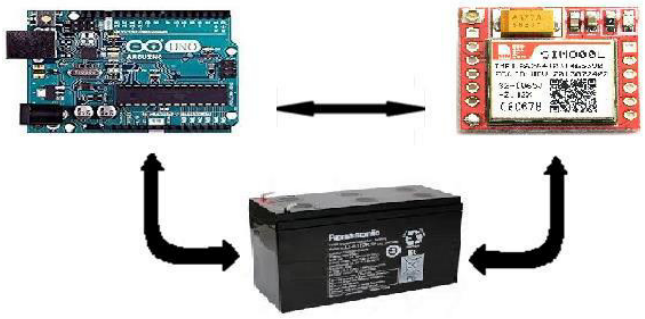

Fig. 10Module B (Integration)

B. The Implementation of IEC 61131-3

The implementation of the prototype is covering the area starting Agora Terminal up to Balingoan Terminal. The purpose of the implementation is to prove that the device should response on the actual location base on the response of the SMS to the user. Moreover, the location that is sent to the user via SMS is pre-defined in the program, each kilometer of the route has specific coordinate that is also predefined in the program. With all means, the data (coordinates) received by the GPS receiver is compared to the nearest data (coordinates) programmed in the device to give the location accurate to the SMS response to the user.In Table 2, shows different location acquired by the prototype. The tests are performed in the route starting in Agora Terminal to Balingoan Terminal. Each of the location is tested five times and gathered its response time to the user. The locations covered by the route is predetermined in the program, 0km = Agora Terminal to 84km = Balingoan Terminal. Every kilometer of the location corresponds different coordinates the coordinates received by the GPS module is converted and compared to the nearest coordinate in the program in the prototype. In some areas It depends on where the location of the bus is (open or closed area), the device response time takes longer when the bus is in a closed area and faster when it is in an open area. The average time it takes to reply to the user is 29.58 seconds. The server response time takes longer when the network is having traffic but in normal operation, the server response time takes only about 4.2 seconds. Adding both responses time gives the total time it takes to receive the tracking request from the time a request is sent. Tests done in locations listed above are tested in one spot. The table shows that there is a difference between the coordinates that are tested in same location.

LOCATION	COORDINATES	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4	TRIAL 5
Agora	8.489433, 124.657895	20 sec.	27 sec.	16 sec.	22 sec.	34 sec.
Gusa	8.477312, 124.676814	26 sec.	26 sec.	21 sec.	18 sec.	20 sec.
Tablon	8.476444, 124.718403	29 sec.	17 sec.	12 sec.	24 sec.	27 sec.
Tagoloan	8.529181, 124.755410	25 sec.	22 sec.	16 sec.	29 sec.	23 sec.
Villaneuva	8.593496, 124.772028	27 sec.	18 sec.	34 sec.	29 sec.	25 sec.
Jasaan	8.633469, 124.767029	42 sec.	27 sec.	26 sec.	25 sec.	17 sec.
Balingasag	8.759585, 124.781712	36 sec.	30 sec.	28 sec.	24 sec.	32 sec.
Lagonglong	8.820392, 124.793803	29 sec.	16 sec.	37 sec.	26 sec.	29 sec.
Salay	8.853617, 124.790072	37 sec.	25 sec.	26 sec.	33 sec.	37 sec.
Kinoguitan	8.977963, 124.790371	24 sec.	41 sec.	26 sec.	35 sec.	17 sec.
Binuangan	8.913282, 124.784592	37 sec.	39 sec.	28 sec.	27 sec.	18 sec.
Balingoan	9.003794, 124.845479	31 sec.	31 sec.	31 sec.	31 sec.	31 sec.

TABLE 2
GATHERED DATA OF THE CTB/BTC
LOCATION AND RESPONSE TIME

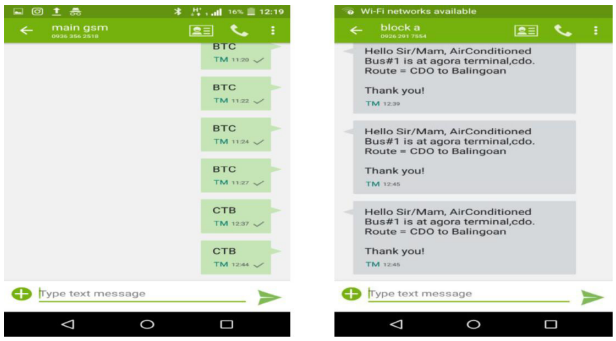

Fig. 11 SMS Response

In Figure 11, this shows the sample of the inquiry of the user by texting specific codes, CTB routing Cagayan de Oro to Balingoan terminal and BTC routing Balingoan Terminal to Cagayan de Oro City. The display response of the Module A to the user via SMS through cellphone. The information to be sent to the user includes the location, type of bus and the route of the bus. In addition, the SMS received by the user helps them to fully aware of the location of the bus. Its benefits are to know the exact location of the bus and give information to the passenger that a bus is outward/inward bound in certain the municipality.

C.The Evaluation

The results and descriptions are all based on the gathered survey questioners of the GSM Based Passenger Bus Locator during the implementation in the route starting Agora Terminal to Balingoan Terminal. These make emphasis on the accuracy, operability, and functionality of the prototype. During the implementation period, the researcher gathered only fifty data results. The accuracy is based on the experienced of the user/ commuter to the device. The device is evaluated on its accuracy based on the response of the device through SMS compare to the actual location of the device. For functionality, the survey result is based on the experienced of the user/ commuter to the device. The device is evaluated on its functionality especially on the response time of the devise

together with the information of the bus sent to the user. And for the operability, the actual result rating of the prototype is based on the operability of the device. In this part of the survey the proponent gathered the data on the technicality of the device on how the user is able to obtain the information based on the SMS code setting to be followed by the user and how the device is being operated. The development of the device is judged based on the operability on the steps of acquiring the information of the location of the bus.

For the data analysis, the proponent made a survey to verify the general objective of the study and to determine the evaluation based on functionality, accuracy and operability.

Table 3, Shows the tabulation result from the data being gathered from the respondents. And this table determines the results regarding on the parameters being used by the researchers.

TABLE 3
TABULATION RESULT FROM THE DATA GATHERED

Parameters	**No. of Respondents**	**1**	**2**	**3**	**4**	**5**	**Mean**
Based on your experienced with the device,							
in what level of strength does the device	**50**			**5**	**39**	**6**	**4.78**
response on its functionality?							
In what level of strength does the device							
give the accurate location based on the	**50**				**5**	**45**	**4.9**
response message via SMS?							
In what level of strength does the device							
proved based on the operability?	**50**				**8**	**42**	4.84

In the Table 4, shows the mean results of each of the parameters: Accuracy, Functionality and Operability of the implemented prototype. Each parameters used by the proponents are based on the selected random respondents. The respondents are asked to undergo interview to test the device and all the

Parameter	Mean
Accuracy	4.84
Functionality	4.78
Operability	4.9

results are tallied to come up with the results.

TABLE 4
TABULATION RESULT FROM THE DATA GATHERED

IV. CONCLUSIONS AND RECOMMENDATIONS

Based from the findings of the study, the following conclusions derived from the observations of the devices functionality, operability and accuracy.

a. Throughout the implementation and testing of device, the operability of the device is based on the experienced of the users on how it is being accessed and operated. The operability of the device got the highest mean of 4.9 which gave a result that is highly acceptable. The proponent concluded that the device is a user friendly and easy to operate.

b. The accuracy of the device is based on the experienced of the users and the closely related result on programmed data whichcovers the SMS response and Google Map data. The accuracy of the device gave a mean of 4.84 which is highly acceptable. The proponent concluded that the device is accurate in giving location via SMS

The GSM Based Passenger Bus Locator has gone to series of testing the proponent is recommend to individuals to improve the Functionality of the

device. The following are suggestions to further increase the effectiveness of the device.

a. It is highly recommended to individual to improve the tracking functionality of the device, the proponent suggest to upgrade the GPS modules capacity in accessing the data coming from the satellites.

b. It's highly recommended also to put large amount of internal memory to the microcontroller to improve its functionality in terms of bucking up the data received from the end user and the data received by GPS from the satellites.

c. And lastly, the proponent recommends to future innovators to improve the functionality to bereal time. Meaning, the time of arrival is included to the information given by the device.

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