

# Cost Effective Bus Route Information System

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**Abstract** – *At present, there is no Bus Route Information System operational in Sri Lanka. Even though this is fairly common in other countries, the initial high capital investment required has delayed the introduction of such a system locally. A cost effective solution is the only way to speed up such service in a developing country like Sri Lanka. This paper describes our prototype implementation of a cost effective real time Bus Route Information System for public transport system. This system provides related information such as route number, type of the bus service whether A/C, non A/C, semi luxury, emergency alerts and bus arriving time to the commuters during before and after transit period which helps passengers to take effective transit decisions. Passengers can access this bus information from on street displays at bus stops. Cost effectiveness comes from the semi-automated nature of the solution which requires a driver to be pro-active in providing status information. This contrasts with the high capital cost associated with the deployment of a fully automated GPS based solutions. Displays at the bus stops will be updated according to the received information from each and every driver interface devices.*

**Keywords:** *Bus Route Information System (BRIS), Driver Interface and Display Unit (DIDU), Bus Information Display (BID)*

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## 1 INTRODUCTION

In Sri Lanka, there is no real time bus route information available to the commuters. Due to the lack of a proper bus monitoring system, bus drivers tend to take buses according to their own schedules. Even if there are predefined timetables driver may not adhere to due to reasons like traffic jams, excessive stoppage at bus stands to collect more passengers to meet the revenue target for the day etc. This causes increased waiting time and an uncertainty in bus arrival for the commuters.

By introducing a proper bus monitoring system, the government can offer a better and efficient bus service for the commuters. Proposed system has two main interfaces, namely, Driver Interface and Display Unit (DIDU) and Control Centre and Bus Information Display (BID). DIDU is used to transmit information via Short Message Service (SMS) to the control centre and BID unit which is fixed at the bus stops. These display panels receive information from DIDUs and panel flashes bus route number, expected time of next bus arrival, bus service type (AC / non AC / semi luxury etc.) and emergency alerts which are helpful to bus passengers to plan their journeys. Compared to existing Bus Route Information Systems (BRIS), proposed system uses a very low cost

communication method which is suitable to our country. This system is operated using SMS technology and it is very easy to implement and expand the network. The rest of this paper is organized as follows: Section 2 is the literature survey related to this project. Section 3 gives a detailed description of the project with design details. Section 4 provides the implementation and testing results and finally the conclusion and future work.

## 2 LITERATURE SURVEY

Today many countries use BRIS to offer better service to passengers (Bangare et al., 2013; Ganesh et al., 2012; Nagaraj et al., 2011; Next Bus 2013). These systems make use of GPS technology and sophisticated software to track buses along their route and calculate their arrival time for specific stops. Unfortunately in Sri Lanka there is no such a system for passengers resulting in many difficulties due to uncertainties associated with the bus arrival times.

The passenger transportation service can be interrupted due to traffic variations and it is a daily problem faced by all transit providers. **NextBus** (Next Bus 2013) is an advanced vehicle tracking system which uses global positioning satellite information to predict when the next bus will arrive at any given bus stop, thereby eliminating waiting times and any need for schedules for all transit riders. NextBus was designed to keep customers on schedule even if their bus or train in Singapore. Without NextBus, the commuting experience of many passengers is disappointing because of the difficulties in predicting the arrival of the next bus. A GPS tracking unit can determine the precise location of any individual or vehicle carrying the GPS receiver. Data about location and other aspects can be stored in various forms, depending on the type of tracking unit. Tracking is accomplished through the use of Global Position System (GPS) receivers. Data communications provided through the use of Cellular Digital Packet Data (CDPD), a public data network. GPS provides the basic location (latitude and longitude) of the vehicle. CDPD transmits the location, vehicle ID, current route assignment and other data to the tracking system.

The core of the NextBus system is the predictive servers located at the NextBus Network Operations Center, or NOC. Hosted in secure facilities, these servers perform all of the calculations needed for predictions, serve up the data to riders and agencies, and communicate with the vehicles. Communication with the vehicles can be by a variety of methods from private radio to public data networks. The servers also provide the web pages seen by agencies and riders, as well as host the SQL database with all of the information needed to generate reports, maps, and predictions. This system is highly advanced and country like Sri Lanka cannot afford this kind of a system due to the high implementation cost.

## 3 SYSTEM DESCRIPTION

Proposed system consists of two interfaces, Driver Interface and Display Unit (DIDU), Control Centre and Bus Information Display (BID) (Refer Fig. 1). DIDU is used to transmit information via SMS to the control centre and BID unit fixed at the bus stops. These display panels consists of GSM modem to receive information. It flashes bus route

number, expected time of next bus arrival, bus service type (AC / non AC / semi luxury etc.) and emergency alerts which are helpful for the bus passengers to plan their journeys.

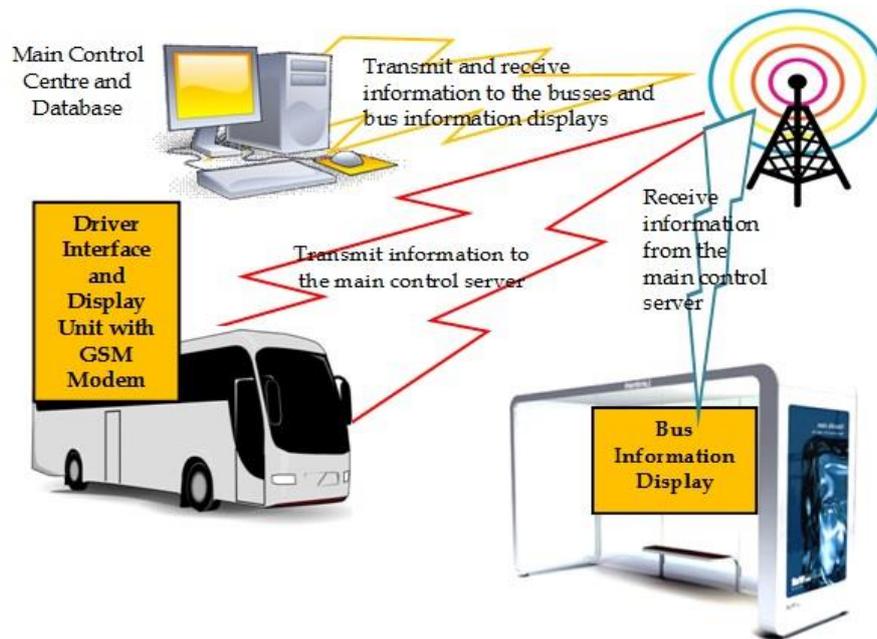


Fig. 1 Proposed system

### 3.1 Methodology

This BRIS, by design, facilitates staged implementation and can be easily extended to any number of bus stops. The prototype system is developed only for few bus stops. Data transfer between control centre and DIDU is done using a GSM modem. Data transfer between control center and BID at the bus stop is also done by the same technique. AT89S52 micro controller is used as the main control centre and database instead of a PC. It acts as a small PC which can be configurable to communicate with bus information display. Each display consists of AT89S52 micro controller to filter the received information.

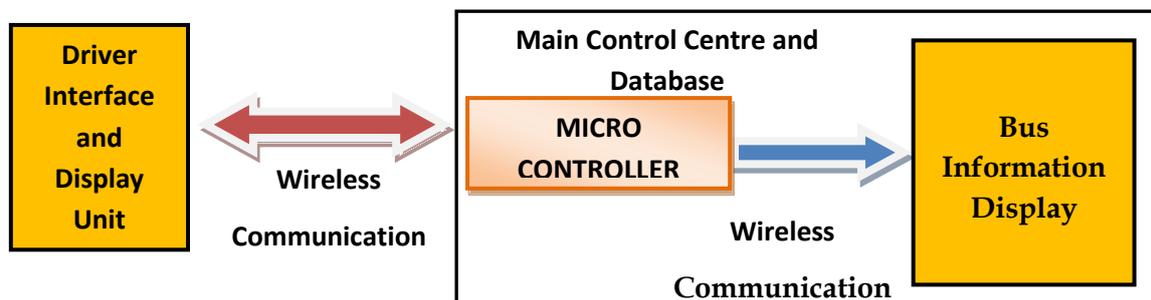


Fig. 2 Communication diagram of the proposed system

### 3.2 System Interfaces

This system is not based on the GPS and tracking of the vehicle is done by the DIDU. Initially some data is stored in two systems, DIDU and BID. Driver must drive the bus

according to the information (Time table) in the driver interface and display unit. If the driver cannot reach the bus stop at the given time, he can alert the system by entering the expected new bus arrival time. Displays at the bus stops will update according to the received information from the DIDU from buses.

### 3.3 Driver Interface and Display Unit

#### 3.3.1 Features and functions of the DIDU

- a. Bus driver can alert the system whether bus is at the bus stop or not by pressing the Arrived / Delay button in the keypad (Fig. 4). This information helps to track the location of the vehicle and the driver needs to press this button each and every bus stop.
- b. An emergency breakdown situation, bus driver can alert the system by pressing the breakdown button on the interface.
- c. Bus driver can alert the system about the current bus stop number by pressing the 4x4 keypad.
- d. LCD displays the next bus stop number and the time for the next bus stop. Bus driver must drive the bus according to this pre defined information.
- e. If bus driver cannot reach the bus stop at given time, he can approximate the delay time and send delay time to the BID. If the driver cannot predict the delay time, he can update the display in the bus stop as bus is going to be delayed (In case of high traffic situation).

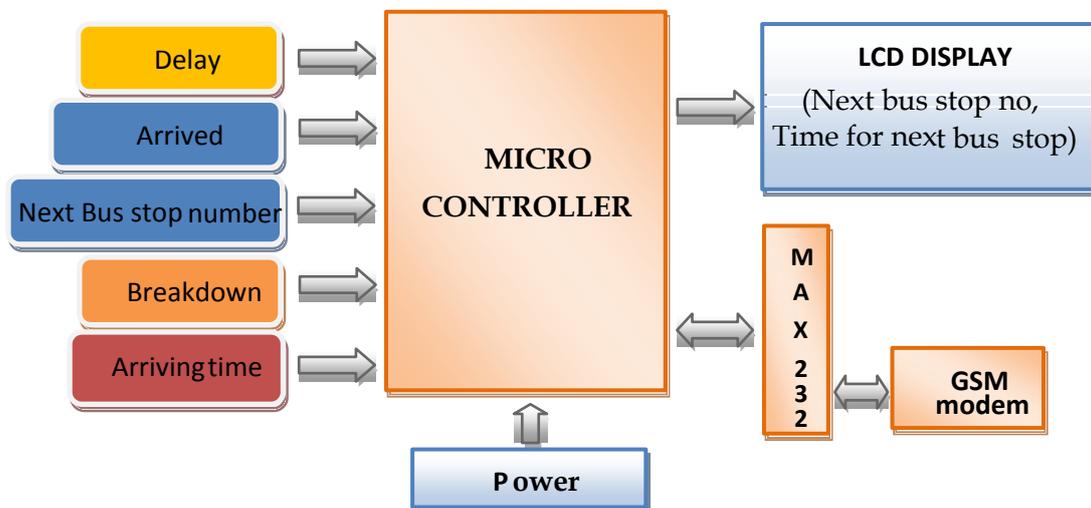


Fig. 3 DIDU block diagram

#### 3.3.2 Instructions which needs to be followed by the driver when operating DIDU

*Step 1:* Switch on device

*Step 2:* Wait until "Enter Info:" appears

*Step 3:* Enter "0" in keypad; this will select the appropriate scheduled timetable which needs to be followed by the driver. Driver must drive according to the

information on the LCD. Wait until the time appears for bus stand and drive the bus to the bus stand

*Step 4:* Wait until display appears "Enter Next Bus Stop Number:". Enter next bus stop number, driver needs to enter next bus stop number as 1,2,3,4.... sequence. If he avoids the sequence, system will not operate until he enters the correct next bus stop number.

*Step 5:* Wait until display appears bus stop number and time for the next bus stop. For an example "BS 1 at 7.10pm" and "ACHIEVE Y/N?". If the driver can reach the next bus stop number at the scheduled time, driver needs to press the "YES (\*)" button on keypad. Then information is sent via a SMS to the next bus stop. Driver needs to drive the bus according to the scheduled time. Sent information is always displayed on the display like "Info. Sent: Time", driver needs to drive the bus according to the information on the display. Second line of the display will appear as "ACHIVE Y/N?" again, which means driver can approximate the time again when he is unable to attend the bus stop at a given time. For that, driver needs to press the "NO (#)" button on the keypad and wait until "Approx Time:" appears. Enter approximate time and press "SEND INFO. (C)" button on the keypad and wait until "Info. Sent" appears. Driver can alert the system using above mentioned procedure at any time when he is unable to go to the bus stop at a scheduled time.

*Step 6:* When bus is arrived at the bus stop, driver must press the "Arrived" button (A) on the keypad to alert the system that the bus is at the bus stop. Display at the bus stop will update as bus has "Arrived". Wait until display appears "Enter Next Bus Stop Number:"

*Note:* Driver needs to enter the next bus stop number only when he is ready to go to next bus stop. Above steps repeated again and again (Step 4 and 5).

*Step 7:* Driver can alert the system by pressing the "BREAKDOWN (B)" button on the keypad when bus breakdown or meet with an accident. This information is transmitted to the next bus stop as "BREAKDOWN". This information will help passengers to take any other alternative decisions. If driver can fix the trouble, he can continue his journey again by updating the next bus stop number and approximated time.

*Step 8:* In high traffic situations, when driver cannot approximate time for the next bus stop, driver can alert the system by pressing the "ARRIVED / DELAY (A)" button on the keypad when display shows the "Approx Time:" where the bus is going to be delayed. Display at the bus stop will update as "DELAY" and this information will help passengers to take any other alternative transport method.

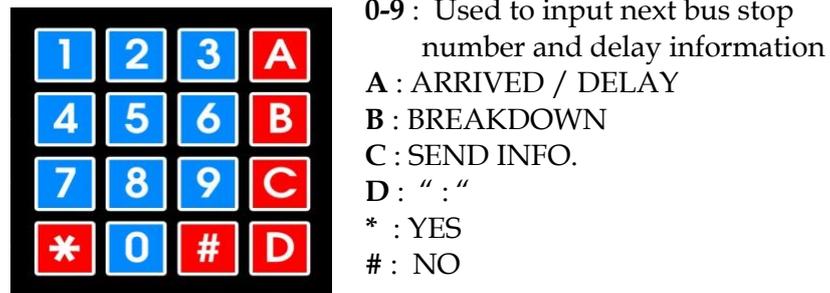


Fig. 4 4x4 keypad arrangements

### 3.3.3 Flow chart - DIDU

The flow chart presents the operation of the DIDU. The semi-automated nature of the system is seen as there are several instances which the driver needs to interact with the system.

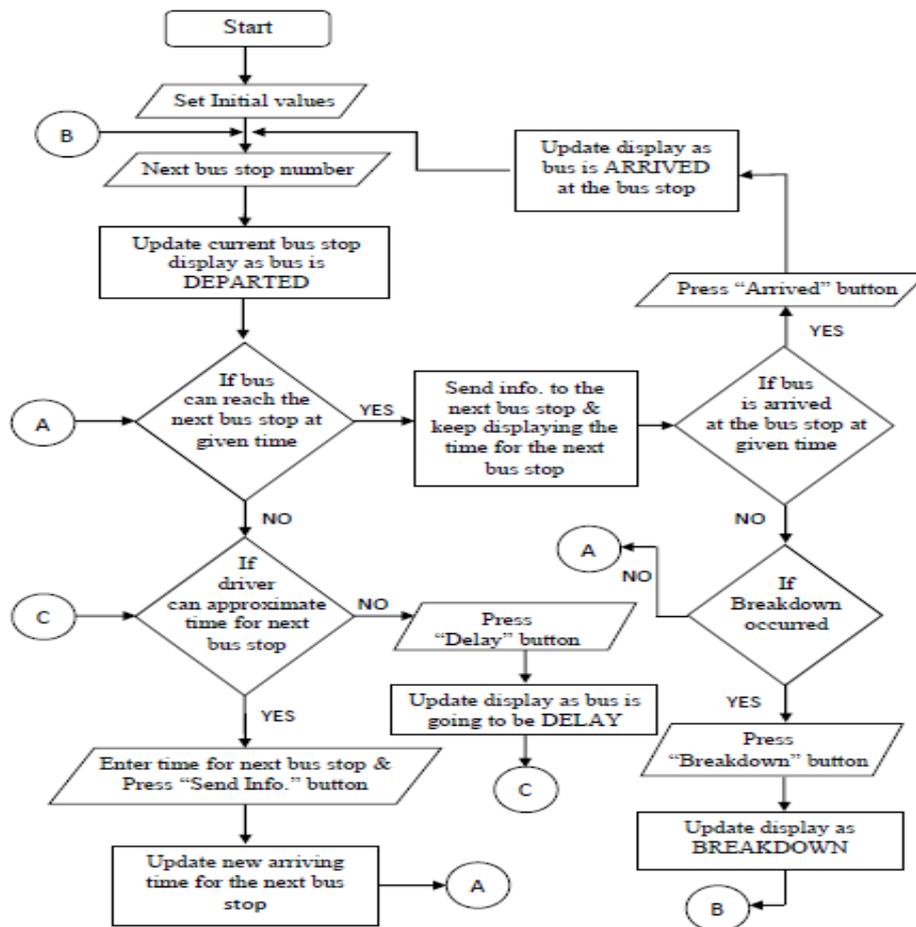


Fig. 5 Flow chart of DIDU

### 3.4 Bus Information Display Unit

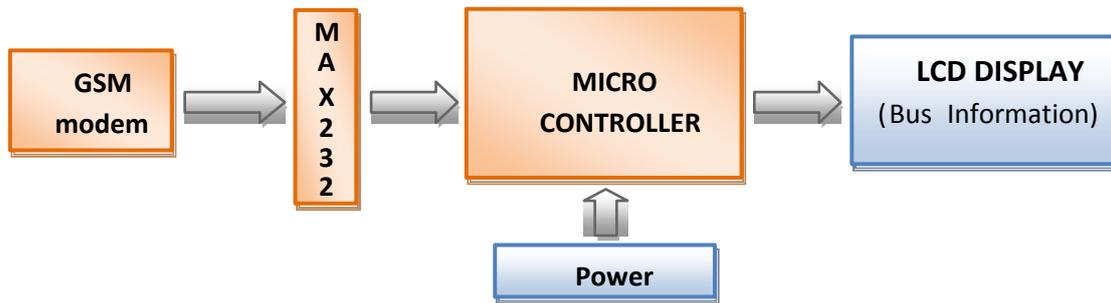


Fig. 6 Block diagram of BID unit

Microcontroller is programmed with some pre defined values and it displays bus arriving time. Display updates every time when it receives new information from the DIDU. If no information is received, display will update according to the initial set values. Every display circuit is unique; DIDU will identify each bus information display using the assigned number (GSM modem SIM card number). It is very easy to setup this display at the bus stop. It is needed to store assigned bus stop number to the DIDU database when scheduling a time table.

Example of a bus information display:

R1	Delay	Route 1	Delay
R2 (A/C)	7.15	Route 2 (A/C)	7.15

Fig. 7 Example of BID unit

#### 3.4.1 Flow chart - BID Unit

The flow chart in Fig. 8 presents the operation of the BID unit.

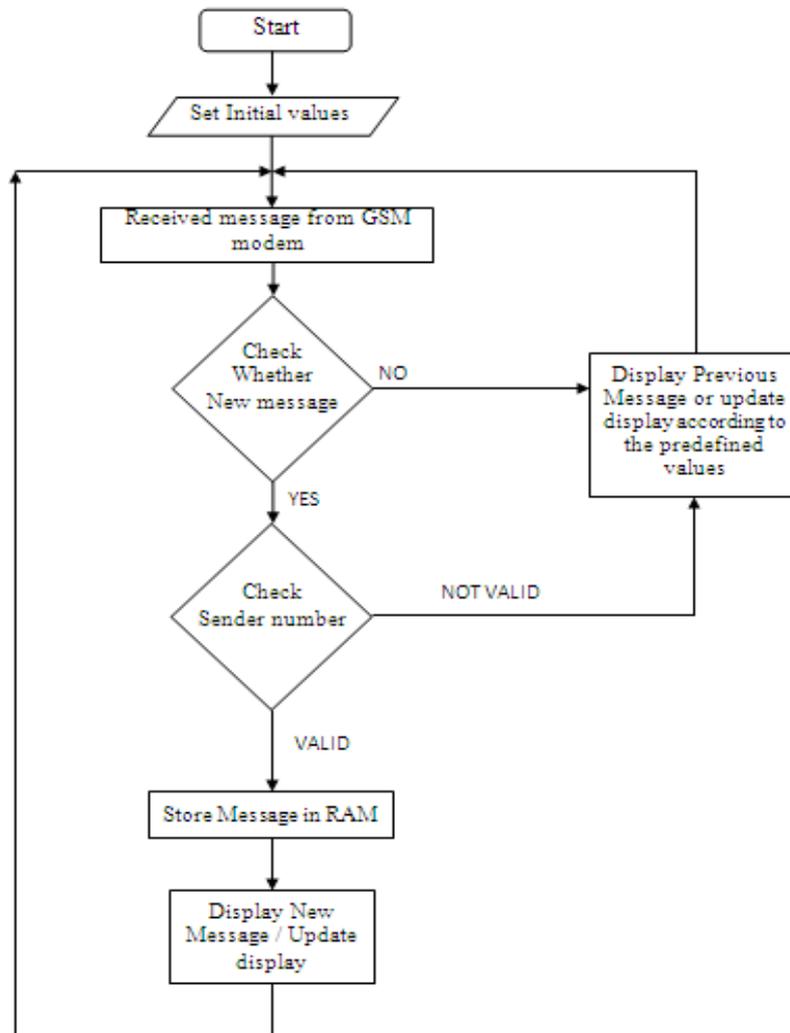


Fig. 8 Flow chart of BID

## 4 IMPLEMENTATION AND TESTING

This section presents the implementation and testing of the prototype BRIS.

### 4.1 Software used for implementation and testing

Keil  $\mu$ Vision 3 Software (Keil  $\mu$ Vision, 1997-2009) - C51 development tools, ISIS Simulation Software were used to develop the prototype BRIS. ISIS software provided the means for the design and simulation of the prototype system.

### 4.2 Implementation Setup (Fig. 9)

By design, BRIS implementation is in stages to facilitate easy expansion. The system can be extended to any number of bus stops. However, the prototype system was developed only for few bus stops and two routes (Route 1 and Route 2). One actual DIDU and one BID unit have been designed instead of designing many duplicated units. Isis Proteus Professional 7.2 software was used to implement virtual DIDU and virtual BID.

Each DIDU and BID has a unique number (SIM card number of the attached GSM modem) to identify each device in the network separately. For the implementation setup, bus stops are numbered at route 1 and route 2 from 0 to 6. Busses are travelling from bus stop number 0 to 6. Network will identify each device from a unique number, so that there should be a proper numbering plan as in Table 1. It can also reduce the 10 digit numbering plan to 4/5 digit numbering plan by attaching this system for a database which also helps passengers to remember bus stop number easily.

**Table 1 Example of network numbering plan**

(a) BID numbering plan

<b>Bus stop number</b>	<b>4 Digit number display at bus stop</b>	<b>BID GSM modem sim card number</b>
0	1000	07xx001000
1	1001	07xx001001
2	1002	07xx001002
3	1003	07xx001003
4	1004	07xx001004
5	1005	07xx001005
6	1006	07xx001006

(b) DIDU numbering plan

<b>Bus Route No</b>	<b>DIDU GSM modem sim card number</b>
Route 1 (Bus 1)	07xx100001
Route 2 (Bus 1)	07xx200001

(c) Numbering plan of Route 1 assuming it has more than one bus.

<b>Bus Route No</b>	<b>DIDU GSM modem sim card number</b>
Route 1 (Bus 1)	07xx100001
Route 1 (Bus 2)	07xx100002

Such numbering plan can be developed to this network by grouping numbers according to the type of the bus, bus routes and location of the bus stop. This will be helpful when expanding the network in future. DIDU and BID needs to be configured with bus arriving time schedules (timetables) and permission according to the above numbering plan.

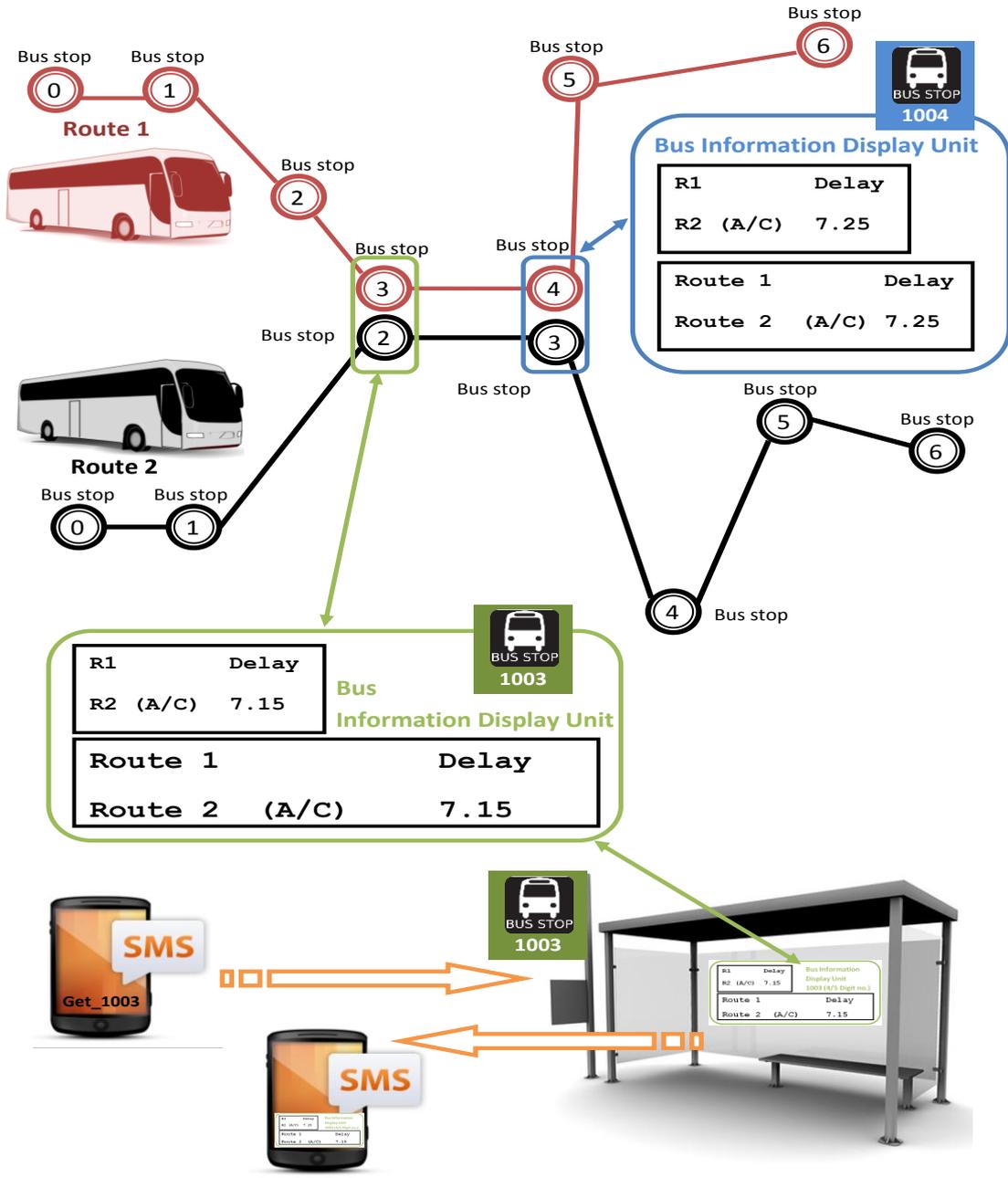
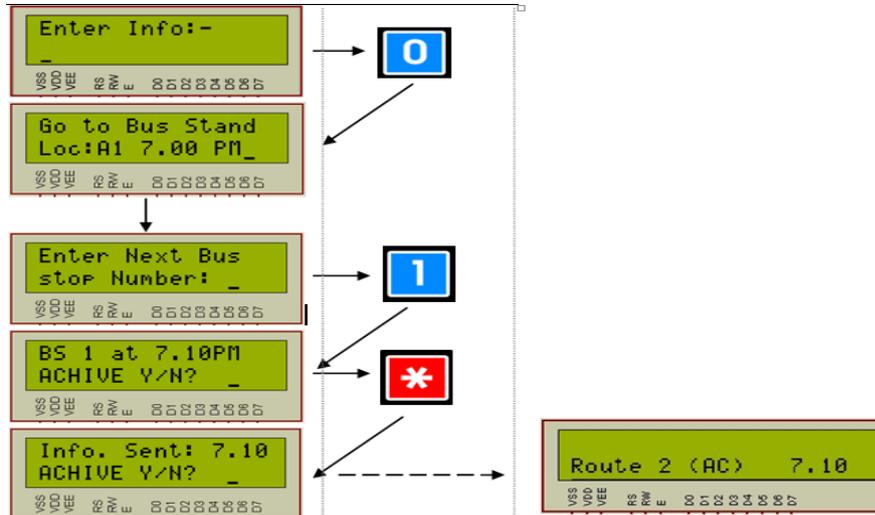


Fig. 9 Implementation setup

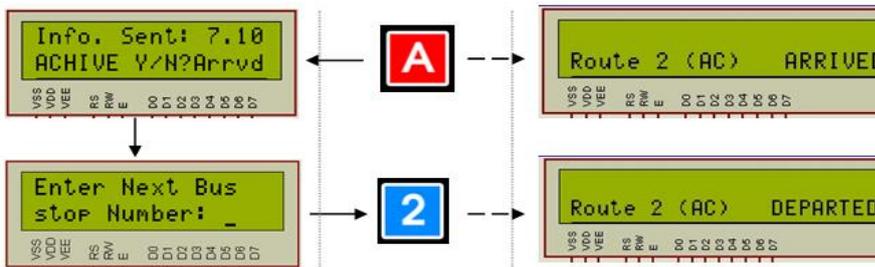
According to the Fig. 10, Route 1 and Route 2 busses go through bus stop 1003 and 1004. BID units display information as in Fig. 10. Passengers can get information which is at the bus stop by sending a SMS with the bus stop number (Ex. Get\_1003) to the BID from their cellular phones. This network environment can be customized according to the preference of users.

### 4.3 System testing and results

Driver Interface & Display Unit		Bus Info. Display at bus stop
LCD status	Keypad entry	

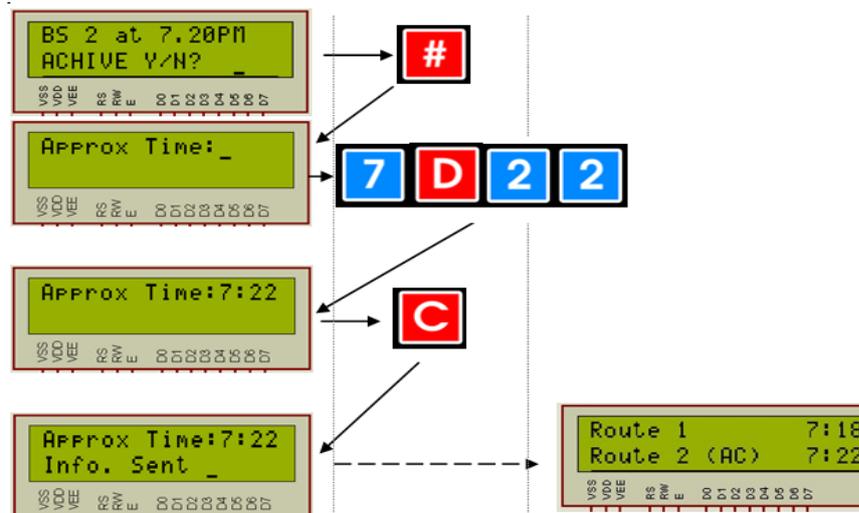


*When bus arrives at the bus stop*



Note: Enter next bus stop number only when bus is ready to go to next bus stop

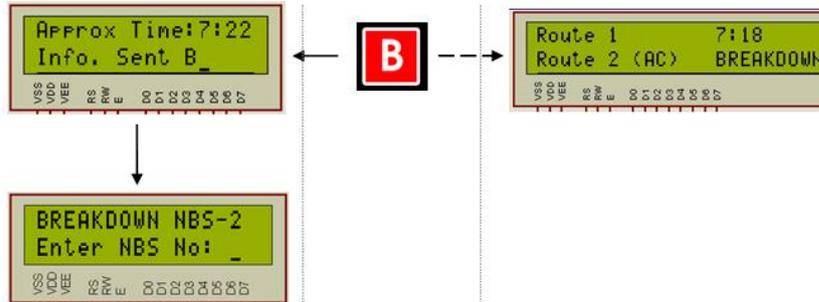
*When driver is not able to reach the bus stop*



Driver can approximate time and update display at the bus stop.

Driver Interface & Display Unit		Bus Info. Display at bus stop
LCD status	Keypad entry	

*When breakdown occurs*



Note: Driver can continue the journey after fixing the trouble by entering the NBS (Next bus stop) number

*High traffic situation (when driver cannot approximate time)*

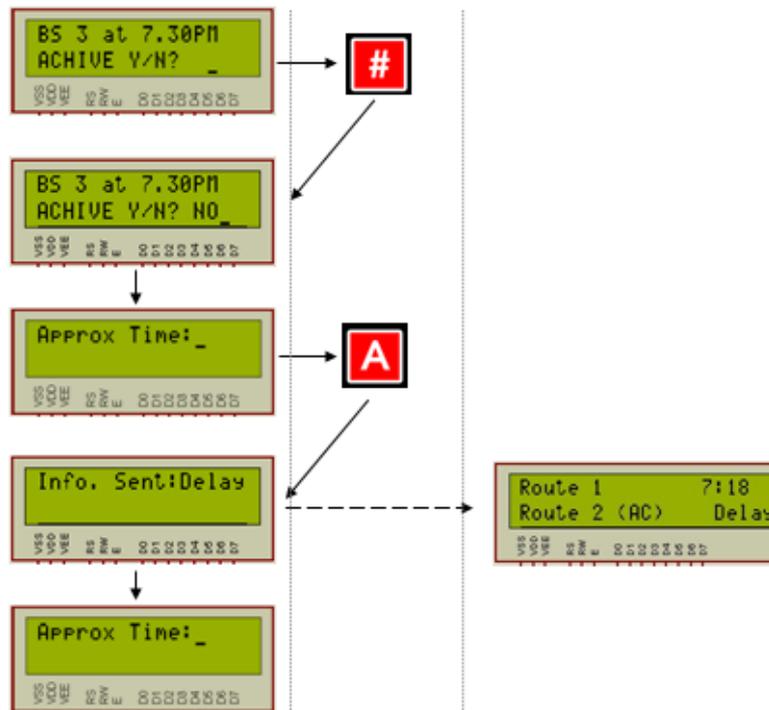


Fig. 10 DIDU and BID - virtual terminal information flow observations

## 5 CONCLUSIONS AND FUTURE WORK

This paper addresses an issue which touches the lives of many daily commuters who make use of the public transportation network, namely, non-availability of accurate arrival/departure information of buses and the resulting accumulated economic loss due to unnecessary wasting of time on the road. A Bus Route Information System with on-

street displays increases the perceived reliability of the transport system because of the dynamic updating of arrival/departure information and the indication of any delay. The direct management benefit of this system is that it can be used to identify bottlenecks in the transportation network. The information gained from the system can be used in combination with passenger data to carry out better planning of the public transport network according to the needs of its users.

Compared to existing NextBus information system, this system is operated using very low cost SMS technology and it is very easy to implement and expand the network. One of the main advantages of this system is that establishing a new network structure is not needed for communication between the devices used in this system. This system can use the existing network structure which is used for SMS technology and it is very cost effective than establishing a new GPS network or RF structure. Proposed system is also capable of informing any breakdown or delay information to the people who are waiting for the busses at the bus stop. This information helps to take alternative decisions to the passengers in case of any emergency. This system can be linked to a bus priority system, which can speed up journey times, resulting in increased efficiency and lower costs. Bus information displays at bus stops can also be configurable to display advertisements and notices. Government or any organization can use this method to take an extra income from this system.

With the accuracy of the system increases the number of complaints is likely to decrease. The stress experienced by passengers due to uncertainty of bus arrival times will get reduced as they can access the information about the arrival times of the bus in advance. Since drivers know that they are being tracked they are less inclined to start their services early/late or deviate from the route.

In future, this system can be combined with a database which helps passengers to get information which is at the bus stop displays via SMS or web browsing by using their own cellular phones. This will help passengers to get information without going to the bus stop. By interfacing a voice recognition system to the DIDU it can reduce the risk factor of entering the information while driver is driving the bus. This system can be further improved to display the information of number of available empty seats in the bus. This information will help passengers to take alternative decisions and alternative transport method in case of high crowded situations.

This bus information system can also be applicable to other transport systems like railway transportation system, etc. Transport authorities can offer better and efficient transport services to the passengers by combining all these types together. Importance of this kind of information system is very essential to our country as the existing public transportation system can be greatly improved and benefit of using this system will be credited to both passengers and the government.

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