# A Scan and Control Technique to Estimate the Arrival Time of Buses to Bus-Stops

**D.Muruganandam, V.Yokesh, R.Thandaiah Prabu, S.Suraj**

***Abstract:*** ***People waiting at bus-stops often don't get any information about the arrival timings of the buses and this creates frustration among them. The proposed system deals with the introduction of a bus arrival time estimating system using RFID technology. This involves scanning a unique code stuck up on the side of the bus facing the bus-stop followed by manipulation and transmission of the data to the next bus-stop. The data is manipulated at the receiving bus-stop and is displayed on an LED display board. This system works by the integration of UHF reader, microcontrollers, wireless transceivers and a display board. This paper has its dominance in developing countries like India where the GPS network is not sufficing the needs of the transport linkage in the country.***

***Index Terms:*** ***Arrival time, bus, display board, GPS, microcontrollers, UHF reader, wireless transceivers.***

## I. INTRODUCTION

The situation prevailing at bus stops is that people must wait for arrival of buses without any feedback of arrival. As a result, they must wait for unpredicted time intervals. This wastes the time of people and sometimes leaves them frustrated. There are cases where a crowd of many people anticipate the arrival of a common bus route. In such cases, many people try to get into that same bus as they were waiting for its arrival for a longer period. A **c**ontentious situation arises because of this. There is also congestion inside the bus.

It will be handy to apprise people about the bus routes arriving at the nearest bus stop along with the rate at which they are approaching, that is, the arrival time. By this, they can decide on which mode to commute by, either wait there for the case of shorter intervals of arrival time or resort to other commuting methods for longer intervals. Accuracy can be ensured due to the use of less analog components. People need not have to use the technology but to just see the LED display.

## II. OBJECTIVE

The proposed idea deals with the effective attempt to predict the arrival of buses to the bus stops using RFID scanning technique and wireless data transmission.

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This system also works with the objective of letting people acknowledged about the arrival time of buses to the bus-stops.

This will serve as an upper hand for the welfare of the people. Previously, there have been attempts to estimate the arrival times of buses using GPS. Though practically deployed, there have been some backlogs or the other, leading to inaccuracies in data. Unlike GPS, this system works on scanning and controlling technique. The system is devised to help overcome the problems and inaccuracies faced by previously deployed methods.

### A. Social Relevance and Benefits

This service can be extended to rural areas. The arrival details can even be displayed in regional languages if required and this makes it convenient for the people in such areas. This is mainly because their transportation depends on the public transport. We're no longer reliant on a printed schedule. This system will cater to the service of a group of people. People waiting at the bus-stops just need to see the LED board for results. Improving the rural areas implies improving the society.

## III. DELAY UPDATING METHODOLOGY

Every Metropolitan Transport Corporation (MTC) bus will have a unique 7-character string. An active RFID tag will be stuck up on the side of the bus facing the bus stop as illustrated in Figure 1. This will be scanned by an RFID reader. While working with read-only tags, the EPC of the tag will be coded in such a way that it will correspond to the unique string in equivalent terms during programming. The tags will be stuck at the top-side of the bus, facing the bus-stop.

Reader range is about 6m and reading time is in milliseconds. A transceiver aids for wireless transfer of data. A node communicates between two bus stops when the distance between the stops exceeds the limit of 0.5 to 1 Kilometer. For calculation of time of arrival of bus to nearest bus stop from the transmitting bus stop, a setup consisting of RFID reader, Controller unit and transceiver unit is placed at any proper lamp post or erected structure to monitor the time of arrival in terms of delay.

When the distance between two stops is less than 0.5 Kilometer, no node setup is needed. Data rate of transceiver unit is about 250 Kbps-1Mbps.Range of the transceiver unit is around 200m for normal modules to 1.8 Km for enhanced modules**.** For example, let the time taken to reach bus-stop B from bus-stop A at 40Kmph is 4 minutes (approx.). So, when the code is scanned at A, and the bus doesn't reach the node within the range of 4 minutes, a timer programmed in the microcontroller will start to run.



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So, in terms of delay the time taken to arrive is displayed at bus-stop B. At receiving end, an Arduino receives the code from the source/node. There will be a serial communication between the Arduino and the LED display board. The LED matrix is used to display the route number and the time of arrival of the bus in terms of delay. This setup is also cased in a box with the LED display kept for best vision and clarity. Suitable dimensions are chosen for the display board with suitable color of display.

The power required for the components will be taken from the socket supply unit present in the bus-stops. For the node, power will be drawn from the street lamps. This ensures that performance doesn't get deteriorated due to power deficiency. Also, the microcontroller is made to run with battery meanwhile the RFID reader is powered by an adaptor unit. UHF reader used here will require 9-12V DC.

In most cases, since it is quite tedious to fabricate the desired unique code onto each tag, the EPC format that is present already on the tag is made equivalent to the unique code using string assignment operation during programming and authentication of the code. This means that the route number of a bus will be made equivalent to a string present on a tag and no two tags will have the same EPC.

## IV. INTEGRATION OF COMPONENTS

### A. UHF RFID READER AND ARDUINO

The proposed system uses an Ultra High Frequency (UHF) reader which belongs to the class of active RFID readers. These readers operate at frequencies nearing the gigahertz level. The integrated RFID reader used here will scan the code that is stuck up on the bus. The reader will be powered using an AC adapter whose output is 9V DC (1A). The reading distance is up to 6m and has an RF output power of up to 30dbm. Antenna with 12dbi is present. The reader will be connected to the Arduino via serial communication.

The pin connections are first made from the reader to the Arduino as per the connection guide. The Arduino is then programmed using the software developed for this microcontroller and tested.

### B. ARDUINO AND WIRELESS TRANSCEIVER AT TRANSMITTER SIDE

The data from the Arduino is sent wirelessly from bus-stop A to bus-stop B. Either an NRF module or an XBee module can be used with the Arduino for the data communication from the transmitter to the receiver bus-stop. Both versions of Arduino i.e., UNO R3 and Mega can be used. Either the same version of the Arduino can be used both at the transmitter and the receiver side or one version at transmitter and other at receiver and vice versa. The module comes with an SMA connector for the antenna.

The RF data rate from the transmitter to the receiver is generally around 250Kbps but modules with higher data rates are also available. We use a general module for prototype testing and a higher end module for outdoor testing. The connection between the Arduino and the wireless module is simple. In the software side of Arduino, the necessary header file of serial communication is included for wireless transmitter module. The NRF behaves as a transmitter here.

### C. ARDUINO AND WIRELESS TRANSCEIVER AT RECEIVER SIDE

At the receiver bus-stop, the wireless module will receive the data transmitted and will be manipulated by the Arduino and finally sent to the LED board for display. The connection from Arduino to the receiver unit is similar to that of the transmitter unit.

It is important that both the transmitter and the receiver should be operating at the same frequency and the receiver module shouldn't be slow in operation. Data loss or error will occur if this happens. Both the transmitter and receiver modules use IEEE 802.15.4 protocol.

### D. ARDUINO AND LED DISPLAY

The LED board displays the details of the arriving route number of a bus along with its arriving time. This is the objective of the proposed system. People just need to look at the display board to know the details of arriving route numbers and their arrival times.People need not have to use any technology in this proposed system. The LED board that we use is a 64x 16 module which is composed 64 columns and 16 rows. Serial communication takes place between the Arduino and the LED display board.

The serial port present in the LED display board module is connected to the RS 232 DB 9 shield (version 2) of the Arduino using a two end DB 9 connector cable. The Arduino is programmed for making it operate with the LED display. RS232 communication cable is used.

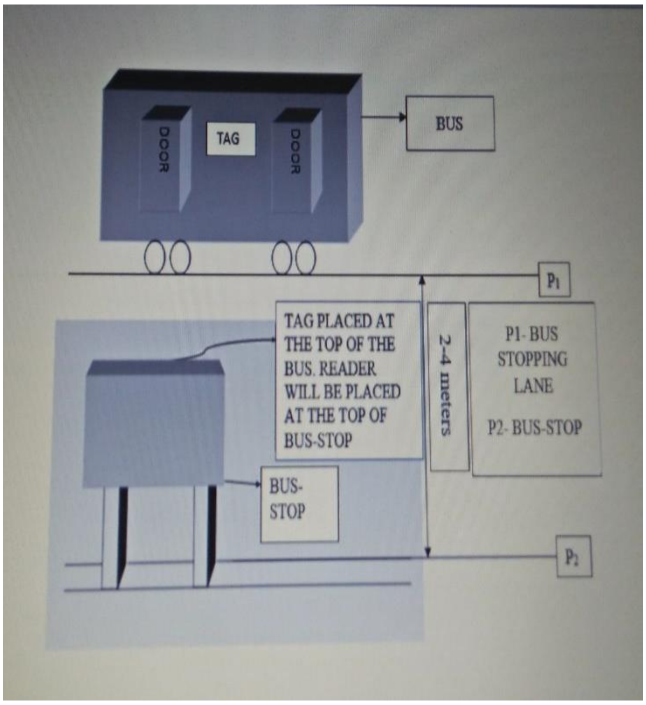


Figure 1 shows the bus-stop with the RFID Integrated reader and a bus with the RFID tag.


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Both the tag and the reader are placed at suitable heights above the ground for proper communication establishment. The whole measuring setup is enclosed using a proper material to prevent any damage.

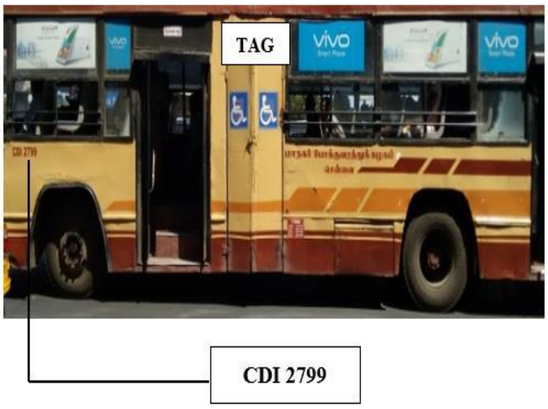


Figure 2 shows the string or characters present on each bus. No two buses will have the same string. The string is like the primary key which uniquely identifies each bus. Let us assume that a bus with the route number A 1 has a string CDI 2799 which is shown in the figure. The EPC present as such on the tag will be scanned by the reader. The scanned code will correspond to the route number A 1.

**Table 1. Code assignment**

| EPC present on the tag mounted on the top of the bus | Equivalent code assignment in the software of Arduino | Information contained in the code (route number) |
|---|---|---|
| 01.000012C.12AB00.000169EBC | CDI 2279 | A 1 |
| 01.1234876.11CE14.00025ACCA | TAI 3304 | 21 G |

The code assignment table shows how the unique string on each bus can be made to correspond to the code on the tag. The tag code is scanned by the reader and the scanned code represents the bus route number. The data is manipulated by the Arduino and sent wirelessly to the next bus-stop B. It is quite difficult to fabricate a new set of tags with desired EPC so, we use the available codes and make them correspond to the desired codes.

## V. A REAL TIME SCENARIO

Let there be bus-stops A, B, C, D and so on up to I. A is the starting point of the bus and I is the terminating point. B, C, D are the intermediate points. Generally, many buses of the same route number are made to ply from time to time for accommodating large number of passengers. Buses of the same route number are operated with a time interval of roughly around 10-15 minutes. It depends on the demand for that particular route. If demand is high, a greater number of buses of the same route number will be run.

With increasing response from the people, more number of buses of the same route number will be operated in a given interval of time. Going by this stance, if a bus, say 21 G starts from A at 10:00 PM, another 21 G will be operated from A at around 10:15 PM. But this may not be the case always. The operation time between two buses may go up to 30 minutes due to many reasons. In such a case, a passenger waiting for 21 G at a stop F may not know when the bus is arriving.

The arrival time of the bus from A to B will be displayed. So, people waiting at B will get a feedback about the arrival time. But this may not be the case for a person waiting at F particularly when there has been no other bus of the same route having reached F for quite some time. The objective is to show the details of the arriving time to the person at F. Once the bus starts at A, after scanning is over, the details will be sent to B. Also, we tentatively know how long it will take for the bus to reach F from A.

This tentative arrival time is based on a typical bus speed. The estimated arrival time and the route number will be displayed at B whilst the tentative time will be displayed at F through hopping technique from node to node during transmission of data. The hopping needs to be done because the wireless transmitters can’t accommodate very large distances. The data needs to be sent from node to node after the transmission limit of the transmitter module is exceeded. In this manner details will be displayed at F.

Figure 3 and 4 illustrates the above-mentioned case at stop F. We theoretically know the time taken by a bus from its starting point to reach the different stops. The time taken can be calculated in terms of a reference speed.


Figure 3 Tentative arrival time display at stop F from A


Figure 4 Updated display at stop F

## VI. UPDATING THE ARRIVAL TIME

The updated arrival time of a bus to the stop F is done after scanning is over at stop E, which is the stop previous to F. If the stops E and F are less than 0.5 Km apart, then no node is required. But nodes may be set for hopping purpose. It depends on the route.


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If the distance between E and F is greater than 0.5 Km, then node will be setup definitely. A node consists of an integrated reader and a timer. It normally takes 4 minutes to reach F from E. Let the bus start from E at 10:00 PM.

Let the time taken for the bus to reach the node be around 2 minutes. If the bus doesn't get scanned at the node within 2 minutes, a timer starts running and the time when the bus gets scanned at the node is noted. If the bus reaches the node at 10:05 instead of 10:02, then the delay is 3 minutes. So, this delay time is added to the calculated arrival time of 10:04 PM. The updated arrival time will be 10:07 PM, which is 7 minutes. Figure 4 shows an example of the updating process.

## VII. SETTING UP THE NODE

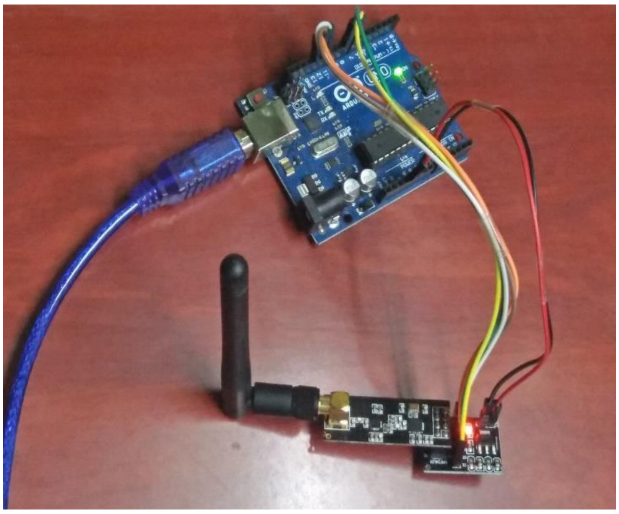
The node is present between two bus-stops. An erect structure such as street light is chosen as the node. The node consists of an integrated RFID reader and a timer unit to keep track of the delay. The timer present in the microcontroller, Arduino is used. This unit is placed at suitable height from the ground relative to the tag stuck on the bus. Proper positioning of the node unit is important for optimal scanning. The power required for the reader and the Arduino can also be taken from the street lamps if required.

Figure 5 UHF Integrated RFID reader

## VIII. ROUTE PLANNING

Since we will be knowing the bus routes (bus numbers) that will be arriving at a particular bus-stop beforehand, we will authenticate the codes for those bus routes onto the tag. As a result, whenever a bus number arrives at a stopping that it is intended to, the code will be scanned and updated. Codes not authenticated into the controller will not be granted access and no updation will be done. In case a new bus number is introduced, the unique code will be authenticated and will be updated.

There are cases where two or more bus-stops are located adjacent to each other by just around1 to2meters separation. In such cases, instead of using separate sets of LED board, a display board common to both the stops can be setup to save resources. One reason for setting up bus-stops close to each other maybe due to the present of prominent landmarks. The only difference is that the dimensions of the LED board might change. So, this will also save the cost of buying a separate display board.



The minimum operating frequency of the reader used is 902 MHz and the maximum frequency is 928 MHz. It is rugged in construction. Temperature range is from -100 C to +600 C.

Figures 5-8 show the components that are used in this estimation system. All these components are integrated to constitute the proposed system. Generally, for prototype testing, the low-end modules of NRF are the best choice. Typical distance accommodated by these wireless modules range from 50 to 250 meters. We will go for high-end modules whose transmission distance extends to few kilometers. These high-end modules are weather resistant.

## IX. LIMITATIONS OF EXISTING SYSTEM

Since GPS is the main tracking system used worldwide, it could not be denied that it is the best tracking system but in a country like India where the transport system is not so programmed and uniform one could not expect GPS to give full accurate results because of so many limitations of GPS.

The main limitations could be the signal reception and its integrity it must possess and also its aerial geometry. Another important limitation is the requirement of backup map of the geographical region. In addition to this the bad alignment of satellite adds up the concern for GPS. So, the conclusion is that this paper promotes a significant tracking system based totally on the limited signal reception and giving maximum accuracy promoting the convenience and the reliability of the customers towards the public transports.

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## AUTHORS PROFILE

In the midst of a healthy and intellectual upbringing, he obtained his bachelor's degree in mechanical engineering from Madras University. Subsequently, he obtained his M.E. in Computer Aided Design. Besides having a strong technical expertise and analytical skills, he acquired his Ph.D. degree.

As an active researcher, Dr.D.Muruganandam is associated with many foreign Universities, along with that he is an Editorial Board Member of 3 Reputed Journals and also a reviewer of 1 International journal. Consecutively he has contributed to the areas of Welding, Engineering Design with his 58 research publications. As a research guide, Dr.D.Muruganandam produced 2 M.S. scholars in various fields. At present, 5 research scholars are pursuing their Ph.D. under his direct supervision In (IIT)Indian School of Mines.

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