

Intelligent BRT in Tehran

P. Parvizi, S. Mohammadi

Abstract—an intelligent BRT system is necessary when communities looking for new ways to use high capacity rapid transit at a reduced cost. This paper will describe the intelligent control system that works with Datacenter. With the help of GPS system, the data center can monitor the situation of each bus and bus station. Through RFID technology, bus station and traffic light can transfer data with bus and by Wimax communication technology all of parts can talk together; data center learns all information about the location of bus, the arrival of bus in each station and the number of passengers in station and bus. Finally, the paper presents the case study of those theories in Tehran BRT.

Keywords—TehranBRT, RFID, Intelligent Transportation

I. INTRODUCTION

THIS paper presents a design of an intelligent BRT system to improve BRT service in Tehran, such as minimizing the delay of BRT buses by changing management on traffic lights and BRT stations that increasing speed and reducing travel time; that minimizes the count of active BRT buses that causes reducing the cost [1], [2].

In addition, a brief background of Tehran BRT can be found in section 2, the tools used are described in section 3, the methodology employed and the idea for improvement described in section 4 and conclusion can be found in section 5.

II. BACKGROUND

A. What Is BRT?

BRT is a high quality, high capacity rapid transit system that in many ways improves upon tradition rail transit systems. Vehicles travel in exclusive lanes, thus avoiding traffic. Passengers walk to comfortable stations, pay their fare in the station, and board through multiple doors like a train. Service is very frequent and often passengers can choose between express and local routes, an option not available on most train systems.



Fig. 1 BRT

Peyman Parvizi. He is now with the Department of Mechatronics, Islamic Azad University South Tehran Branch. (Email: St_p_parvizi@azad.ac.ir)

Dr. Sasan Mohammadi. He is now with the Department of Mechanics, Islamic Azad University South Tehran Branch. (Email: s_mohammadi@azad.ac.ir)

B. Tehran BRT

In Iran, the BRT system has been implemented in Tehran. Tehran Bus Rapid Transit has been officially inaugurated by Tehran's mayor in order to facilitate the motor traffic in Tehran on January 14, 2008. Tehran has five BRT lines. The first stretch of Tehran BRT corridor from Azadi square to Tehran-pars has been operational since Jan (2008).

TABLE I
TEHRAN BRT LINES

| Line | STATUS | Start point | End point | Stations | Distance (KM) |
|------|--------------------|----------------------|-------------------|----------|---------------|
| 1 | ok | Azadi Terminal | Tehran-Pars | 26 | 18.7 |
| 2 | ok | Azadi Terminal | Khavaran Terminal | 26 | 18.7 |
| 3 | ok | Elm-O-Sanat Terminal | Khavaran Terminal | 18 | 14.3 |
| 4 | Under construction | Parkway | South Terminal | 21 | 21.5 |
| 5 | Under study | Elm-O-Sanat Terminal | Dehkadeh Olympic | 16 | 22 |
| 6 | Under construction | Babayee Highway | Ponak | | 19 |
| 7 | Under construction | Railway station | Tajrish | 27 | 17.5 |
| 8 | Under study | Besat Highway | Basij | | 6.2 |
| 9 | Under study | Besat Highway | Babayee Highway | | 17 |
| 10 | Under construction | Ponak | Azadi Terminal | | 6 |

The total length of BRT in Tehran is about 100 Km that will be increased to 300 Km in future.



Fig. 2 TehranBRT

III. TOOL USED

The BRT buses and bus stations will be equipped with; APC (Automatic Passenger Count System), RFID (Radio Frequency Identification) and GPS (Global Positioning System) [3], [4].

A. Automatic Passenger Count System

APC is an advanced technology solution that helps transit improves. APC technology puts infrared sensor at the bus doors and bus station gates to count passengers as they board and leave.

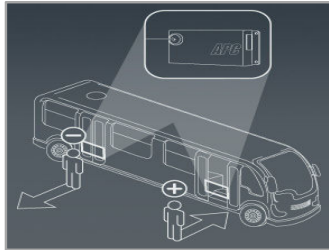


Fig. 3 APC

APC collects ridership data on every bus, per door per every bus station, and per every gate basis. Counted passengers are stored on the bus and bus station and downloaded into a data center where the information can be readily correlated to scheduled runs , routes , stops , time (arrive – leave) , date and destination.

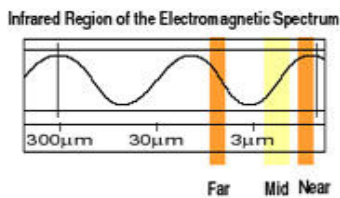


Fig. 4 Infrared Sensor

B. Radio Frequency Identification

RFID is an electronic method of exchanging data over radio frequency waves. There are three major components for a RFID system: Transponder (Tag), Antenna and a Controller. RFID tags can be active, semi-passive (=semi-active) or passive [5].

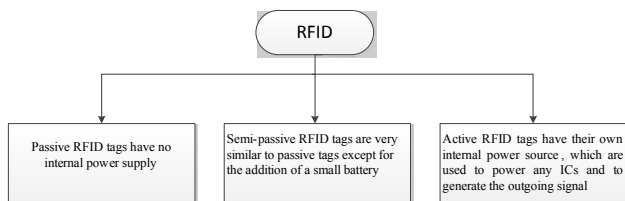


Fig. 5RFID Types

1) Passive RFID tags have no internal power supply. The minute electrical current induced in the antenna by the incoming radio frequency signal provides just enough power for the CMOS integrated circuit (IC) in the tag to power up and transmit a response. Most passive tags signal by backscattering the carrier signal from the reader. This means that the antenna has to be designed to both collect powers from the incoming signal and to transmit the outbound backscatter signal.

- 2) Semi-passive RFID tags are very similar to passive tags except for the addition of a small battery. This battery allows the tag IC to be constantly powered. This removes necessity the aerial to collect power from the incoming signal. Therefore, Aerials can be optimized for the backscattering signal. Semi-passive RFID tags are faster in response and therefore stronger in reading ratio compared to passive tags.
- 3) Active RFID tags or beacons, on the other hand, have their own internal power source, which are used to power any ICs and to generate the outgoing signal. They may have longer range and larger memories than passive tags, as well as the ability to store additional information sent by the transceiver. To economize power consumption, many beacon concepts are operated at fixed intervals.

A RFID-Reader is also required on bus stations and traffic lights to receive the signal from the BRT buses. The RFID-Reader requires the exact position of the intersection to make decisions; the code in each RFID-Reader is unique [6], [7].

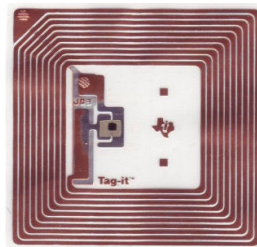


Fig. 6RFID

C. Global Positioning System

GPS has been developed by the United States' Department of Defense. It uses between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals. This enables GPS receivers to determine their current location, time and velocity.

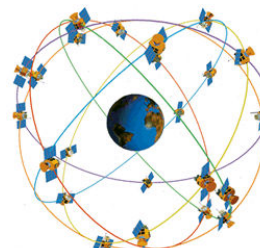


Fig. 7GPS

TABLE II
COMPARE (RFID&WiFi&GPS)

| | RFID-active | WiFi | GPS |
|------------|-------------|------|---------------|
| PowerUsage | LowtoMedium | High | Medium |
| Datarate | LowtoMedium | High | NotApplicable |
| Coverage | Medium | High | VeryHigh |
| Security | Medium | High | NotApplicable |

IV. METHODOLOGY EMPLOYED

This algorithm used with buses, bus stations and traffic lights, which have the hardware as described in Tools used. Modes of operation: the algorithm runs in different modes. First data center call a bus and the intelligent cycle will be started [8], [9].

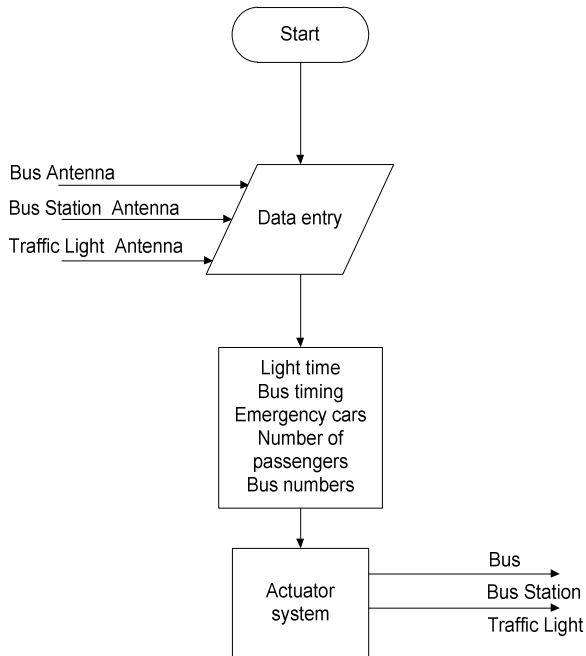


Fig. 8 AFlowchart Of System

- 1) Traffic light Act:
 - Green mode
 - Red mode
 - Idle mode
- 2) Bus Act:
 - Speed change
 - Stop
 - Acceleration mode
 - Deceleration mode
 - Passenger count
- 3) Bus Station Act:
 - Choice terminal for bus
 - Choice terminal for passenger
 - Passenger count



Fig. 9 Bus Signals

A. Bus station mode

When the distance between bus and bus station is less than 50 meter, bus sends a signal to the bus station and bus station listens for BRT interrupts – capacity, direction, speed and number of passengers that bus sends then bus listens for BRT bus station interrupts – free gate number, capacity and number of passengers in station [10], [11].

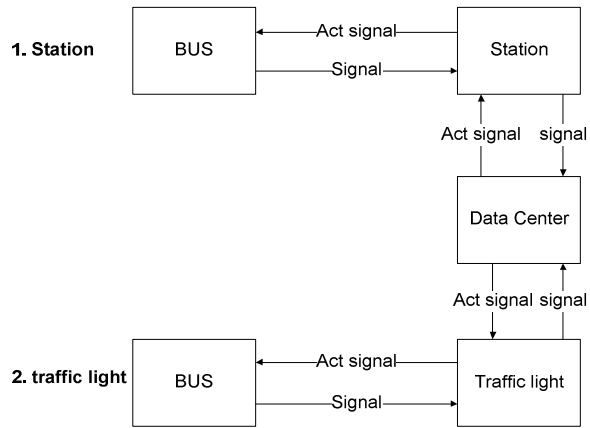


Fig. 10 AFlowchart Illustrating The Flow Of Algorithm

B. Traffic light mode

When the distance between bus and traffic light is less than 50 meter, bus sends a signal to the traffic light and traffic light listens for BRT interrupts – capacity, direction, number of passengers then the bus listens for traffic light interrupts emergency mode, stop or keep riding [12], [13].

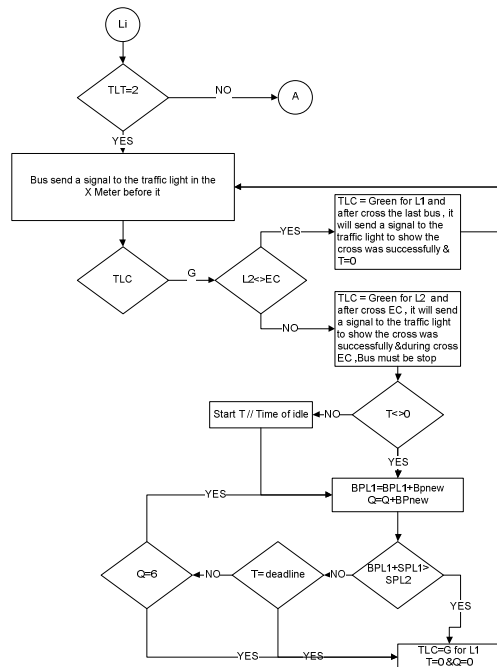


Fig. 11 Base Traffic Light Algorithm

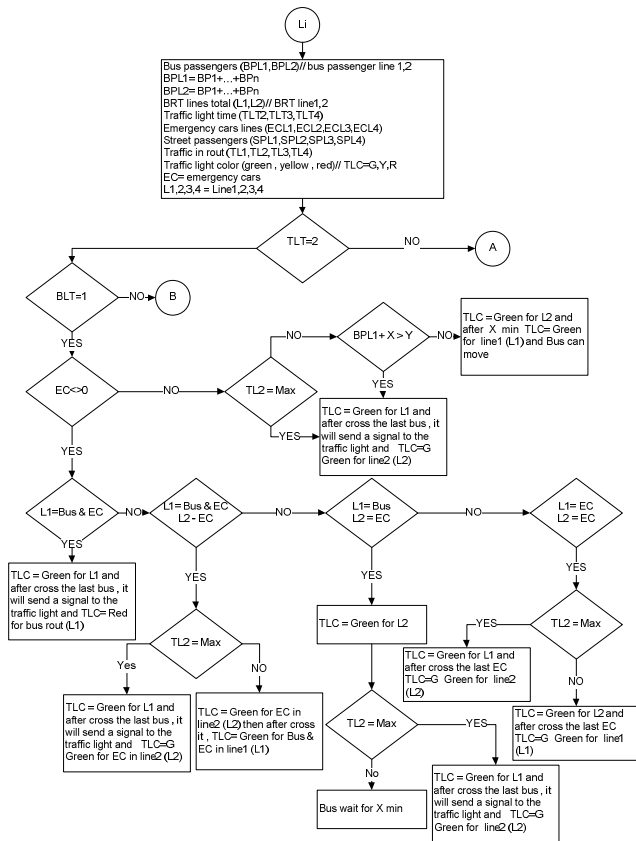


Fig. 12 Traffic Light Algorithm

V. CONCLUSION

With this research, this data will be accessible for Datacenter:

- 1) All of passengers in each station equal to all of passengers in waiting
- 2) All of passengers in each bus in equal to of passengers in transfer
- 3) Ability to analyze the critical stations
- 4) Ability to Schedule traffic lights information
- 5) Ability to record diary

To get a good result we need data that are without defects in determination centers. With given information above two important points are enforceable:

- 1) Just in time determination
- 2) Future forecasting with diary data

Benefits:

- 1) Speed will be increased in BRT
- 2) Cost of transformation will be decreased
- 3) Time of delay to be decreased in stations
- 4) Time of delay to be decreased behind traffic lights
- 5) Passengers will be distributed among the buses

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