Bus Tracking & Ticketing using USSD

Real-time application of USSD Protocol in Traffic Monitoring

Siddhartha Sarma*

*Department of Electronics, Instrumentation and Control Engineering, University of Petroleum & Energy Studies, Dehradun

Abstract: Unstructured Supplementary Service Data, a protocol used by GSM cellular telephones to communicate with the service provider's computers. USSD is used for WAP browsing, prepaid callback service, mobile-services, location-based services, menu-based information services, and also as part of registering the phone on the network of a particular service provider. In this project I am using certain algorithms to determine information about any bus in any route served by an operator, whose information can be received by the user, commuter as well as the operator. Information that I can collect as part of the system are location, seat vacancy status, traffic patterns and then the algorithms designed ascertain the need for stop-skipping and rerouting, by designing new routes with view to destinations of passenger onboard and keeping close distance to the former route.

Keyword: bus tracking, ticketing and reservation; unstructured supplementary service data; GSM mobile services; USSD bus ticketing; mobile reservation; USSD reservation; bus tracking; transit services

I. INTRODUCTION

This article elaborates the use of the unstructured supplementary service data (USSD) protocol for use in ticket reservation system in any designated stop-point for public transit system. The system also makes use of an existing GPS based bus tracking system to gather data on position to predicting an estimation of the bus arrival time at a user selected point and sends an USSD alert to the user. Such prediction of the expected arrival time of the next bus at stop points is of significance to operators and users. With the information of passenger on any particular route and arrival time information, transit operators can promptly respond to unexpected service requirements or vehicle delays by announcing other transit options to enable passenger trustworthiness.

Over a duration of a month, operators could spot challenging routes and shifts that persistently run late and take managerial and technical actions as needed for improved performance. The overall quality of transit service could therefore be enhanced, which would ultimately make the public transit facilities more user-friendly and attractive as compared with other in developing nations. Information collected in the entire process – number of passenger for any route, who has reserved his seat; estimated arrival time; available seats and type of bus arriving can also be disseminated to travelers through various mediums such as electronic boards installed at bus stops. This information shall help reduce passengers' worries while waiting for buses and save them travel time because they can time their arrival at the bus stops more close to the schedule and also reserve a seat in any long route.

II. LITERATURE REVIEW

Numerous work has been done in past to address a solution to the prediction of bus arrival time problem and reporting to a commuter, may not be in a stopping point or depot. Multiple efforts on predicting the time has yielded three types of models:

i. models based on historical data,[1]
ii. multi-linear regression models,[1] and
iii. artificial neural network models[1].

Once the data is predicted by the system through any of the models stated, it is communicated to the user either by a portal or a node that is connected by a wireless metropolitan area network in the stopping point.

Previous research by G.Raja and team in fabrication of the system to monitor position of the bus facilitates user in ascertaining expected arrival. The system developed lags a ticketing system. Other team of researchers from NTU, Singapore proposed a solution in which the querying user is served by inputs from an onboard sharing user. It lacks the automation, for smart bus network in obtaining data. Researchers from the Computer Department, University of Pune uses the infrastructure that is not available to every Indian – a smartphone, and web-based GUI. Whereas, the proposed system is an integrated tracking and ticketing system that is proposed which communicates with the user through the USSD protocol – cost-efficient and flexible. It does not require any equipment at the end-user side.

III. OBJECTIVES AND SCOPE

In this research I have developed a new bus arrival time prediction algorithm that combines Global Positioning System (GPS) data with real-time estimates of inter-stopping points travel speeds. The proposed algorithm is implemented in an intelligent system that can automatically detect the running route and direction of a bus and predict its arrival times at the downstream stops under any operating conditions. This research also designs an algorithm to determine the availability of seat on any bus queried by user and the probability of the querying user to get a seat. It also indicates a methodology to determine the real-time location of all busses, availability of seat on any bus, commuter requirements of additional busses and the estimated time of arrival of the next bus at stopping points at the operator control center. Another proposed algorithm to determine current traffic patterns – need for stop-skipping and rerouting, when certain conditions are met – that no passenger disembarks in that stop as well as there is no commuter in the stop, which is to determined manually. In later stages, the last algorithm discussed would implement the use of artificial intelligence, to understand human affinity in disembarking at a stoppage point. This publication details the structure, function, and performance of the proposed prediction system along with the development and validation of the proposed model.

IV. SYSTEM DESCRIPTION

The development of the proposed system requires a three phased approach into a final product, namely research into the subject, modelling of the architecture for tracking and plotting, and implementation of ticketing system. Over here, I shall be briefly discussing the phases involved.

1. Research: This involves meticulous efforts on designing the algorithm in calculating ETA for a bus on any user selected route and probability that a seat maybe available for the user seeking to reserve a seat, on a long route. Design of this algorithm requires that I understand few factors – live traffic pattern between any two stops, passenger waiting for that bus and passengers traveling for longer routes, hence prioritizing a seat.

1.1 **Algorithm 1** is for user to know status of ETA and other bus related information **–** is designed in appendix I, along with design description about the algorithm.

1.2 **Algorithm 2** and **3** is for operator to know location of bus, live traffic patterns and other information about bus service requirements **–** is designed in appendix I, along with design description about the algorithm.

2. Architecture Modelling: Next phase of the system is modelling the architecture for implementation of the designed processes. The central system is the core responsible for tracking the buses in real-time and plotting the location on the city map. Other connected subsystems are application simulators, bus simulator and central data processing server. The architecture is shown in figure. These subsystems are briefly described in the subsequent sections –

2.1 **Tracking & Plotting:** T&P will make use of an onboard GPS device and maps present in command center to plot individual buses plying in the city.

An onboard GSM/GPS device constantly updates the location of a bus plying in service. Servers at command center uses this data in two ways – first a plot is made in a map present in the command center. Secondly, the location data is fed into the subsystem engaged in updating details in various nodes – display boards at respective stopping points. Also, the bus data that any user queries for is addressed by this subsystem backend server.

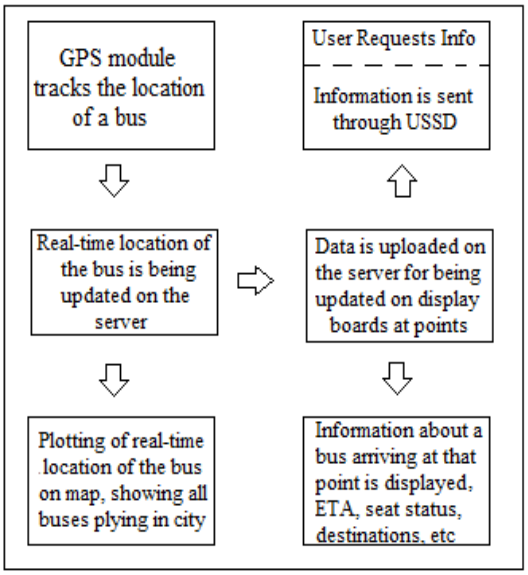

Fig.1: Flowchart explaining the process of T&P

2.2 **Bus Data Acquisition:** The internal bus data acquisition system collects information about the bus and transmits the data to central hub. It also updates commuters onboard of upcoming stopping points.

The subsystem that updates commuters is designed by use of RF technology. Each and every point is tagged by unique RFID tag, the reader on the bus reads this tag and display the current stop and the next stop. Using the APR33A3, recorded sound is played through the multi-channel speakers. The same procedure is adopted in reverse way to display information about the route of the bus currently arriving at any stopping point. Here, the bus is equipped with passive RFID stickers for the purpose of identification at the bus terminals. Each and every bus is assigned with a unique RFID that is transmitted up to some distance around it using RF transmitters, when a bus approaches the bus stop coverage area, the RF signal generated by the bus is received at the stop and indicates the next coming station to the passengers in the display boards at bus stop. When the bus arrives the station, the details of the bus is read through the RFID tag attached to it and the same is transmitted to the following stop for the passengers there to plan their options for travel.[3]

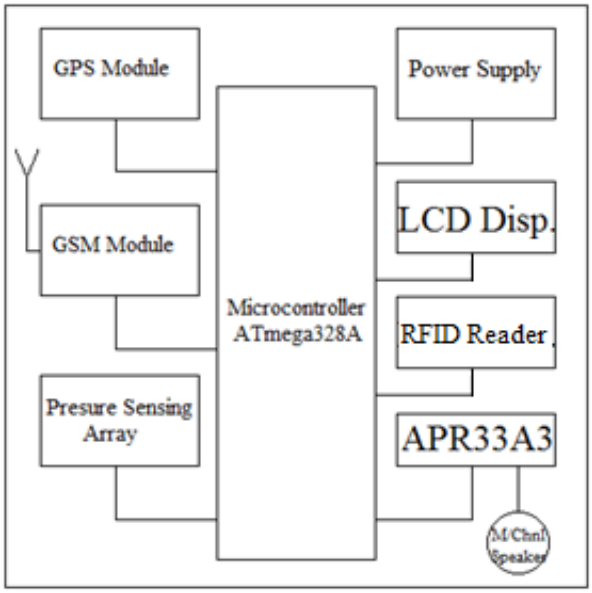

Fig.2: Block diagram of the data acquisition system

This is part of the existing method that is enhanced and by use of GPS technology, the problem of real time tracking is made possible.

3. Implementation Unstructured Supplementary Service Data (USSD**)** [7]**:** USSD is as similar to speaking to someone on a phone as SMS is to sending a letter. USSD has several advantages as a bearer technology, such as:
1. it provides a cost-effective and flexible mechanism for offering various interactive and non-interactive services to a wide subscriber base;

2. supports menu-based applications facilitating more user interactions;

3. it is independent as it is neither a phone-based nor a SIM-based feature. USSD allows simultaneous voice and data communication; and

4. it allows faster communication between users and network applications because messages are sent directly to the receiver allowing an instant response and services available on the home network are also accessible while roaming. Unlike SMS, there are no charges for this.

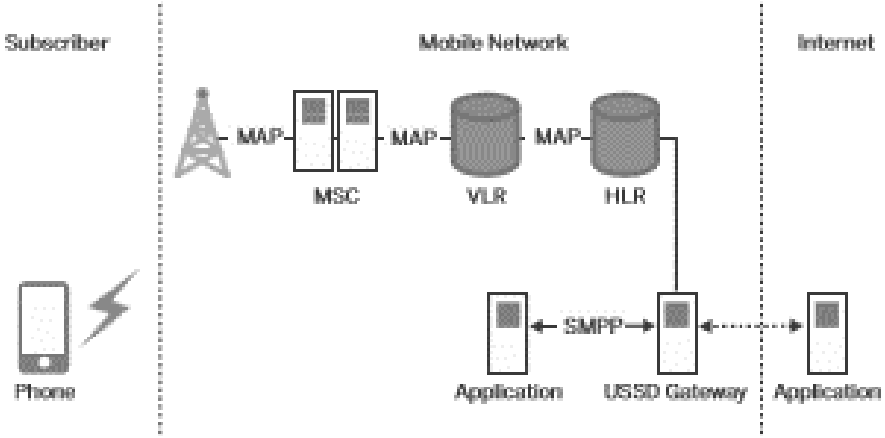

Fig. 3: Elements of USSD communication[7]

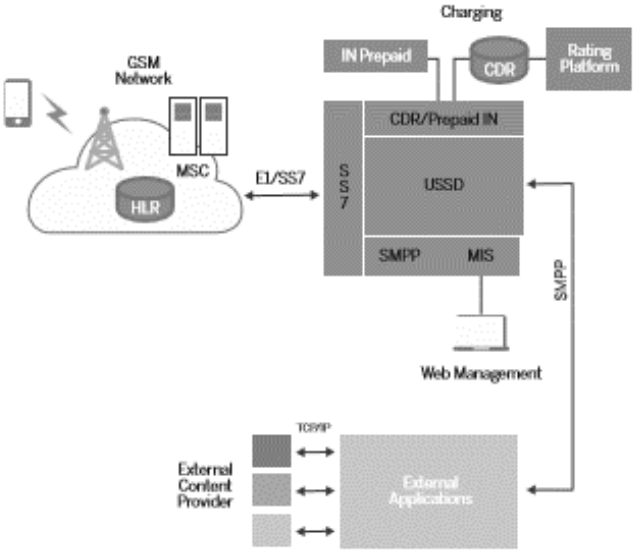

Fig. 4: Architecture for USSD communication[7]

Unlike SMS, USSD message is not stored on customers' mobile, making it secure at the first level. USSD opens a single session between the device and the supporting application at the network operator. The data is also encrypted at the USSD gateway sitting at the network operator, preventing any misuse of the data. This makes it secure at the second step. The end-to-end transaction flow occurs across the encrypted GSM communication layer while the subscriber identity is also hidden. Hence, USSD service is safer than other GSM technologies. However, it presents one risk. In case the GSM encryption is broken, the data can be accessed–which can actually happen with all GSM technologies. To avoid this, the GSM encryption needs to be made more

robust, much like how internet banking has evolved over the years. Excluding this generic threat, USSD appears to be the most suited technology for transaction application.

4. USSD based Ticketing System: USSD being able to offer interactive and non-interactive services to a wide subscriber base along with support menu-based applications facilitates user interactions for selection of particular bus apart from obtaining other relevant information about the specific bus and its journey route.

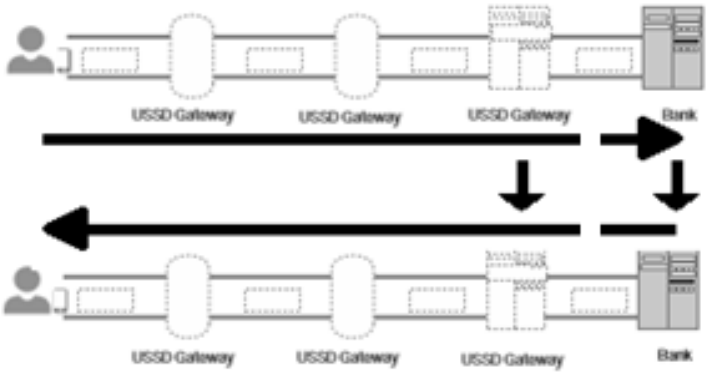

Fig. 5: Process of booking, through USSD service

Booking a ticket through this system can be completed within minutes and it requires no Internet connection or transaction charges for initiating the session. A basic GSM phone is sufficient to book a ticket using USSD, where the booking status along with the unique code is displayed once the transaction is completed. But the user receives his ticket details on SMS instantly, since USSD messages cannot be saved. The SMS can itself treated as a ticket for travel.

Proposed procedure for booking through operator USSD service:

1. register for USSD based mobile ticketing services by dialing a specified number, here *2665#, code for BOOK, this number must be coordinated with GSM service provider and other stakeholders;
1.1 registration to service is required to book tickets, whereas facilities like status enquiry can be availed without registration

2. load cash online on the unique registration ID or recharge through any agent/outlet;
2.1 since cash loading requires bank validation, the USSD gateway transfers the payment call to the bank server for payment processing, or else proceeds to next step
3. Dial *2660# and select relevant options, specific to your journey;
4. select reservation, proceed to payment
    4.1 enter your unique user ID,
    4.2 enter the details of journey, and
    4.3 enter PIN for authorizing payment deductions
5. booking confirmation ID is displayed as well as texted to user through SMS by operator

Payment services can be integrated to National Unified USSD Platform (NUUP) offered on a short code *99#. It is common platform for all banks instead of each bank having to develop this service, while NPCI manages the technology behind the platform – NPCI can integrate a unified ticketing platform for state run or listed bus operators.
The below screen is generated once the user dials the number *2660# on the dialing pad. Similar screens are generated and user proceeds accordingly while sufficing his need for knowledge of the bus service.

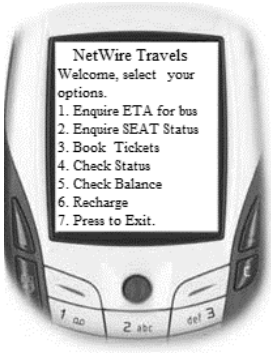

Fig. 6: Sample USSD GUI of an agency here, NetWire Travels – a sample bus operator

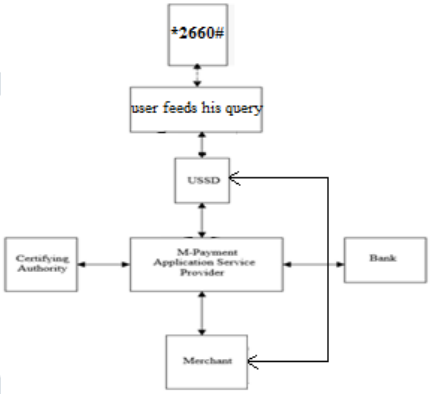

Fig. 7: Flowchart for fitting in USSD payment service

V. CONCLUSIONS

Limitations of Current System and Scope of Further Improvements:

a. This system fails to determine the presence of a commuter, through behavioral analysis, waiting for a bus of a particular route hence that bus needs to be opted.
b. In this system, user fed data is analyzed or human sight data is used to facilitate operation.

The current state of the system can be worked to be made more autonomous by designing it to understand user requirements. Lots of challenges are to be overcome for a successful implementation of USSD based tracking and ticketing system to be widely accepted as a mode of ticketing. Businesses, merchants and consumers have to come forward and make value-producing investments. A monitoring charter and few accepted standards will be the pillars on which mobile ticketing can be built and improved. In future developments in making the system more robust as well as autonomous, artificial intelligence will come in play hence an adoption of standard practice and moderation framework will be the guiding light into the little explored domains.

APPENDIX

1. Design description of algorithm to determine the availability of seat on any bus queried by user and the estimated time of arrival of the next bus at stopping point; and determining the probability of the querying user to get a seat (patentable algorithms)

2.1. Design description of algorithm to determine the real-time location of all busses, availability of seat on any bus, commuter requirements of additional busses and the estimated time of arrival of the next bus at stopping points (patentable algorithms)

2.2. Design description of algorithm to determine current traffic patterns – need for stop-skipping and rerouting, conditioned that no passenger disembarks in that stop as well as there is no commuter in the stop, determined manually (patentable algorithms)
Each bus is having a unique ticket ID, and stops are tagged with RFID chips. This enables querying user to know bus seat status and current location. Using traffic monitoring through satellite or local available technology user is informed of an estimated arrival and seat availability status. Also, stop points shall have touch based kiosk to feed traveler details to the central hub, which shall monitor traffic patter, user demand and supply buses accordingly on any route.

ACKNOWLEDGMENT

I'd like to thank almighty god for keeping us jovial during our course of this research, our reviewers for their valuable comments. Our guides in exploring this subject: professors at University of Petroleum & Energy Studies, for their valuable feedback and moral support; without which I would not have completed this study, we thank him for his efforts. I would thank our parents for funding the publication of this work.

REFERENCES

[1] D Sun, H Luo, L Fu, W Liu, X Liao, and M Zhao; Predicting Bus Arrival Time on the Basis of Global Positioning System Data, Transportation Research Record: Journal of the Transportation Research Board; January 18, 2008

[2] L Tanga, P Thakuriah; Transportation Research Part C –Emerging Technologies. Volume 22, June 2012, Pages 146–161 (www.sciencedirect.com/science/article/pii/S0968090X12000022)
[3] G.Raja, D N Kumar, G Dhanateja, G V Karthik, Y V Kumar; International Journal of Engineering Science & Advanced Technolog, Volume-3, Issue-3, 132-135

[4] Caulfield, B. and O'Mahony, M. "An Examination of the Public Transport Information Requirements of Users", IEEE transactions on Intelligent Transportation Systems, Vol. 8, pp. 21-30, 2007

[5] Public Transport at Singapore : www.publictransport.sg

[6] Bus Transit System in Singapore, Wikipedia: (en.wikipedia.org/wiki/Bus_transport_in_Singapore)

[7] J Sanganagouda, USSD: A Communication Technology to Potentially Oust SMS Dependency, a whitepaper by Aricent (/www.aricent.com/sites/default/files/pdfs/Aricent_USSD_WhitePaper.pdf)

[8] Press Release, Launch of USSD Ticketing Service by IRCTC (pib.nic.in/newsite/PrintRelease.aspx?relid=96881)

[9] Unstructured Supplementary Service Data, Wikipedia: (en.wikipedia.org/wiki/Unstructured_Supplementary_Service_Data)

[10] USSD Gateway, Wikipedia: (wikipedia.org/wiki/USSD_Gateway)

[11] R Muhamma, Resources on Algorithms, Kent State University
http://www.personal.kent.edu/~rmuhamma/Algorithms/algorithm.html)

[12] J Zhou and R Golledge, An Analysis of Household Travel Behavior Based on GPS, presented at IATBR Conference, Gold Coast, Australia July 2000

[13] National Unified USSD Platform, National Payments Corporation of India, August 9th 2014
(http://www.npci.org.in/pro_over.aspx}

AUTHORS

First Author – Siddhartha Sarma, UG Engineering Student in Instrumentation & Control Engineering, Dept. of Electronics, Instrumentation and Control Engineering, at the University of Petroleum & Energy Studies, Dehradun
Email: ssharma.gau@gmail.com and Contact: +91.9678191660