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Progress Report

A GPS-Based System for Internet Publishing of Bus Schedules in Real-Time

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Executive Summary

Puerto Rico is getting ready to implement one of the most important components that characterize a remarkable transportation system and that is a train. To contribute to the success of the train the old transportation modes needs to improve their services helping to the renaissance of a new and efficient public transportation system. The achievement of proposed bus schedules is crucial if we want people to trust in the system. That is way we propose a system that will give to the users real time information available in the internet regarding bus location. This will aloud the users to plan their trip so they can do good use of their time and integrate others transportation modes in their trip.

To implement what we propose we need to explore Internet and GPS in the context of modern transportation systems. Also, we have to study and evaluate the wireless data transmission systems available for a GPS-based system. Right now we have familiarized ourselves with the wireless data transmission systems that have any potentially being considered for implementation in Puerto Rico. Automatic Position Reporting System (APRS), Multi Use Radio Service (MURS) and ComTec are a few of these options. All of them are related to the radio communication system. We still need to choose the one that we will put in practice in this research, which is not necessary, the one that AMA could use in a future.

It is important to understand that this is the begging of giving real time information regarding public transportation in Puerto Rico. Many other alternatives are available instead of the use of Internet for the displaying of the data. The information can be displayed at the bus stops or terminals. These options can be part of future work regarding this research.



Introduction

Mayor Problem

One of the most commonly encountered problems with Puerto Rico's Public Transportation System is its ineffectiveness regarding the achievement of proposed bus schedules. Passengers tend to have to wait longer than they should at bus stops due to the constant, unexpected modifications to this schedule. Public buses have proposed route schedules that are almost never accomplished.

Proposed Solution

We propose to design a Global Positioning System (GPS) based vehicle position system connected to the [www](#)¹ for public access. Users will be able to log onto the web server and request specific information that will help them plan their trip, this being by train, bus, "publico"² or a combination of these. Information such as actual location of some of the before mentioned transportation modes and estimated time of travel between stops will be available. The proposed system will promote the use of public transportation by making it more trustworthy and efficient.

¹ World Wide Web.

² Private Owned busses.



Objectives

This research has as its main objective to promote efficient intermodality between the existing modes of transportation ("publicos", public buses) and the Tren Urbano. To accomplish this the accomplishment of the following is necessary:

- Explore the use of state-of-the-art technologies, such as Internet and GPS in the context of modern transportation systems.
- The study and evaluation of wireless data transmission systems available for a GPS-based system.
- The display in the Internet of current position and status a vehicle using GPS receivers and an accessible wireless data transmission systems.

Research Development

As a means of recollecting all the information necessary to take the project two the implementation phase, we followed the following steps:

- Internet research

Internet navigation was used as the main source of information due to its versatility and wide range of topics and available search engines. From all the information that was gathered we tried to narrow them down in groups of what each of the possible applications satisfied more of what we expected to develop as a part of our prototype.

Much information was found concerning the GPS technology and Networking platforms, which could be used, for our project. Most of



this information was discarded immediately due to high cost of implementation or because of expensive licenses required to operate the equipment being considered.

The information that was truly considered and deeply investigated were:

- Possible implementation in Puerto Rico.
- Systems lying in the range of price smaller than \$3.000.00.
- Systems that could be developed in the time frame established on our schedule.
- Technologies feasible for future implantation or already developed in the metropolitan area.

- **Contacts**

After choosing from all the sources found on the Internet, we proceeded to contact different persons, which had project with similar goals as ours. Companies we were considering buying equipment from were also contacted. Our goal at this moment was to be sure that the equipment thought of being bought would indeed be able to accomplish our design specifications. We contacted these persons via e-mail, telephone, and video conference calls or anyway which was the quickest. A few companies never even responded to our calls.

The following companies are some of our potential contacts:

- AMA of PR
- ComTec (PR)
- Centennial Communications (PR)



- Further investigation

For the information regarding the equipment that not necessarily had support or contact information, we contacted people, which may have had familiarity with such tools. These contacts were directly obtained from the Internet. Among these are Iye webmasters, programmers and a few other technically driven professionals in direct contact with similar project. Some of the technologies considered are:

- Multi Use Radio Service (MURS)
- APRS systems in Puerto Rico and Miami

Preliminary Findings

At this moment we have familiarized ourselves with the wireless data transmission systems that have any potentially being considered for implementation in Puerto Rico. Automatic Position Reporting System (APRS), Multi Use Radio Service (MURS) and ComTec are a few of these options. All of them are related to the radio communication system. ComTect and APRS are the alternative that we are considering to implement. The following is a brief description of each option.

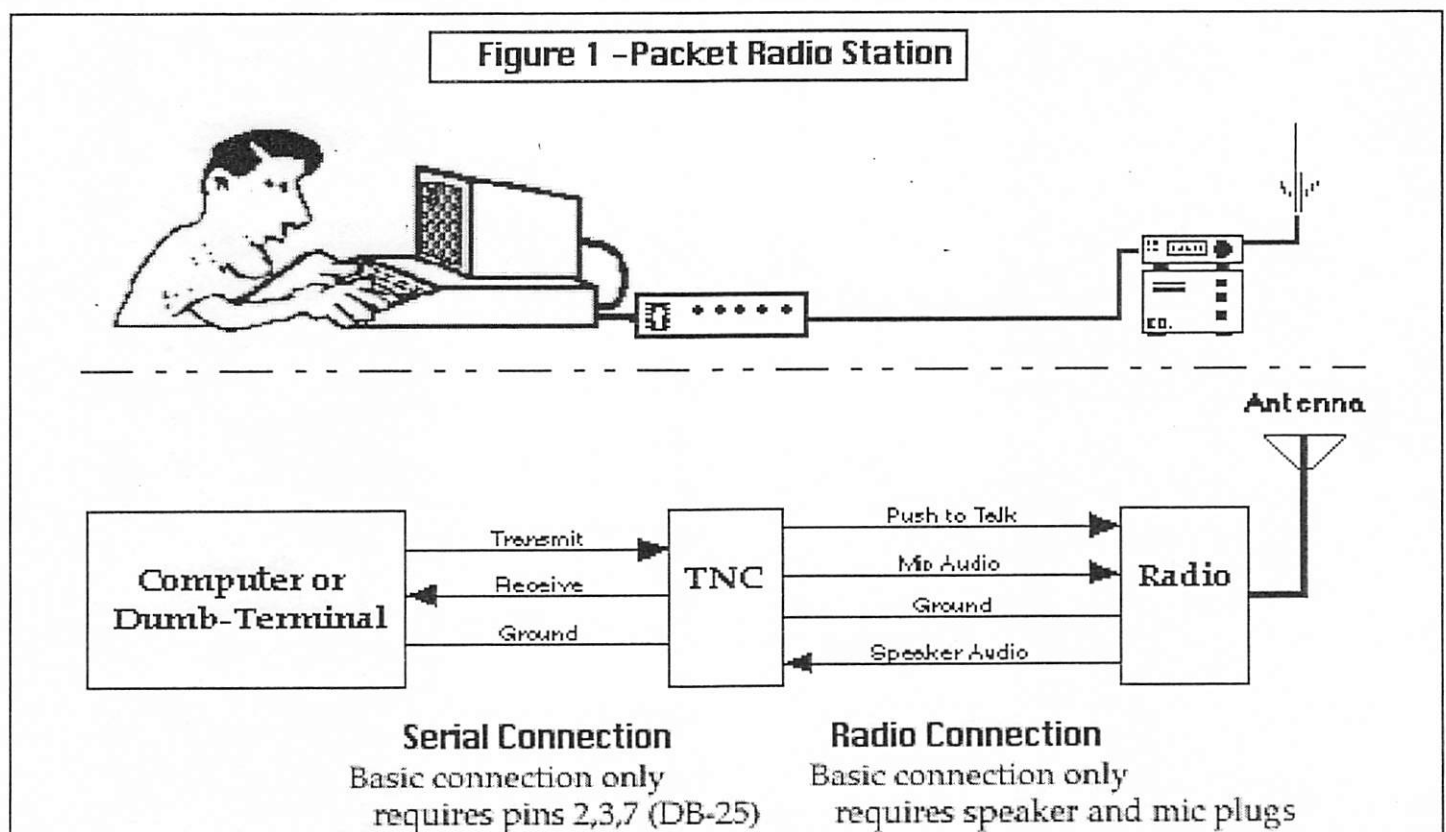
- **Current Alternatives Description**

APRS

The Automatic Position Reporting System is the combination of GPS technology and Amateur Radio. APRS is a system that uses amateur radio to transmit position reports, weather reports, and



messages between users. To transmit data using an APRS system is necessary a Technician Class or higher Amateur Radio License. In Puerto Rico this system is already implemented and data management center is presently located at the Inter-American University. This system is the most commonly used wireless link to obtain position information in APRS is Packet Radio. This is a particular digital mode of Amateur Radio ("Ham" Radio) communications, which corresponds to Computer Telecommunications. A box, called a terminal node controller (TNC) replaces the telephone modem; the telephone is replaced by an amateur radio transceiver, and the phone system is replaced by the "free" amateur radio waves. The following picture shows an illustration of a typical station setup with a schematic diagram of a station wiring.





TNC - contains a modem, a computer processor (CPU), and the associated circuitry required converting communications between your computer (RS-232) and the packet radio protocol in use.

Computer or Terminal - this is the user interface. A computer running a terminal emulator program, a packet-specific program, or just a dumb terminal can be used. For computers, almost any phone modem communications program (i.e. Procomm+, Bitcom, X-Talk) can be adapted for packet use, but there are also customized packet radio programs available.

♦ MURS

The Multi-Use Radio Service is a new low power, short range VHF Citizens Band service in the 150 MHz band. As a VHF Citizens Band service, you do not need an FCC license to operate a MURS station. The MURS service is expected to be filled by everyone from hobbyists to commercial users all competing for local communications that is virtually regulation free. The MURS transmitter channel frequencies are 151.820 MHz, 151.880 MHz, 151.940 MHz, 154.570 MHz and 154.600 MHz. This service is under consideration and Motorola has petitioned the FCC to return the five frequencies of this new unlicensed personal radio service back to the licensed Business Radio Service.

To use MURS we need radio equipment like in the APRS system. The most important advantage of MURS is that we do not need a FCC license, but if Motorola petition is considered this could change.



♦ ComTec

ComTeC is a company that works with the installation of antennas for cellular phones. They have a wireless Automatic Vehicle Location (AVL) unit and they have installed their own communication network for voice and data all over Puerto Rico. All that is part of a system that they developed and is named SkyTracker. We won't be using the SkyTraker, instead we will use ComTeC's new equipment that consists of a small box that goes inside the vehicle. This box contains the GPS transceiver, a fr-modem and a microprocessor..

ComTeq is interested in our collaboration since they are in a testing phase of the new equipment and the system is not entirely working. Our part as their team would be to test equipment and aid programmers in the development of software for the mapping of the received data. This has its benefits as well as its drawbacks. Working with this company would be a great experience, but in the given time frame we might just not have enough time to have the equipment working properly. Another plus is that the company is willing to lend us the equipment free of charge.

All of these options are viable to be implemented in the Public Transportation System of Puerto Rico. They can be used for the AMA buses and the "públicos". The alternatives that we may choose to implement do not necessarily need to be the ones that better pleases the AMA or "públicos" needs.



Preliminary Conclusion and Future Work

From our investigation we can conclude that the project here proposed is a very feasible solution to promote intermodality. The technology implemented or presently being implemented in Puerto Rico support our prototype characteristics. This one of the most difficult barrier that could limit this type of investigation. Our work up to know has been in contingency with what was proposed schedule. After deciding which of the options currently under consideration is the one that suits us the best.

The next phase is to buy the equipment and start the actual testing of the proposed prototype. Since some of the work we had thought of doing is already available we confide that we will have more that enough time to implement a properly working system.

References

- [1] B. Hofmann-Wellenhof and H. Lichtenegger, ***Global Positioning System: Theory and Practice***. Springer Verlag, N: J. (1998).
- [2] J. Kearman and J.P. Kleinman, ***Now You're Talking! Discover the World of Ham Radio***. The American Radio Relay League. Newington, CT (1991)
- [3] R. Dean Straw, ***The ARRL Handbook for Radio Amateurs***. Sevenly-six edition, The American Radio Relay League. Newington, CT (1999)

Internet Links

- [4] <http://www.rcn-conti.lv/p-avls.html>
- [5] <http://www.qsl.net/va3jtr/>
- [6] <http://www.provide.net/~prsg/murshome.htm>