Prototyping and Evaluating a Smart Phone Dynamic Message Sign Application in the CVI-UTC Testbed

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Introduction

Dynamic message signs (DMSs) have been used by VDOT and other transportation agencies for many years to provide traveler information on freeways and arterials. While DMSs are widely used, many factors limit their effectiveness. First, the very task of reading a DMS is distracting to drivers. Evidence of this is apparent at many locations, where traffic monitoring sensors report a reduction in speed due to drivers braking to read DMS messages. Such distraction also forces DOTs to use short messages on DMSs – hampering the ability to fully inform travelers. Another key concern is that DMSs are fixed assets. They are expensive and can only inform travelers at the location where they are installed. Finally, DMSs are useless in situations in which a driver's view is occluded by other vehicles (such as large trucks), or when the driver is unable to read English.

The purpose of this proposed project is to prototype and evaluate a smart phone application that provides the functionality of a DMS. When a traveler is in range of a physical DMS (i.e. the traveler can see it), the information presented on the sign may be read by the traveler. In the prototype application, a traveler's location is monitored using the phone's internal GPS. When the traveler is in range of a DMS (i.e. in a range of latitude/longitudes) the information is presented to the traveler via an audible message. In the first version of the application, ranges will simply correspond to existing DMS locations, and the audible messages will be the same as the current DMS message.

A key advantage of such a smart phone application is its scalability. New DMSs can be "built" by defining new latitude/longitude zones. Also – messages may be presented in English, Spanish, and other languages based on settings selected by the user. Finally, more detailed information may be presented since it is not line-of-sight dependent. The application will not require "active" driver participation. The driver will simply enable the application at the beginning of a trip. Location data will be passed to a DOT server on a regular basis, when the location is in a DMS zone, the DOT server will transmit the message to be presented to the driver.

The concept behind this prototype application is to provide traffic operations centers (TOC) with a simple new tool that enables true infrastructure/vehicle integration. A strength of this tool is that it is not dependent on a DSRC infrastructure – it may be immediately implemented and reach the vast majority of travelers. It is also a true "mobile" application – meant to be used while a driver is traveling. This distinguishes it from current 511 applications that explicitly state they are to be used only when the vehicle is not in motion.

Simulated Image of Possible CVI Smartphone Application Message System

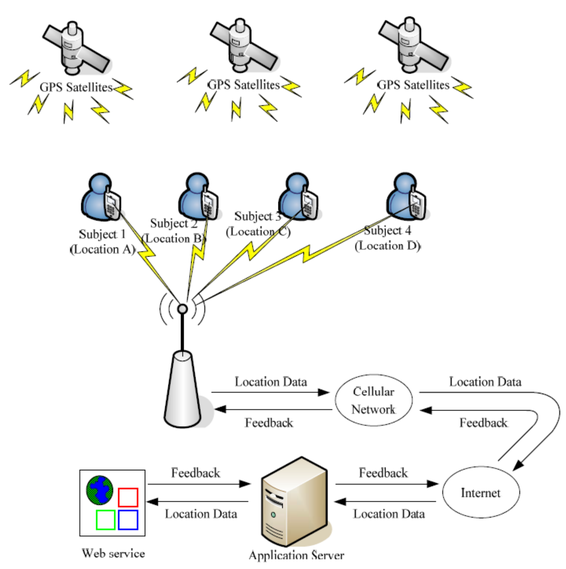
Research Objectives

The objectives of this project are to develop a prototype and conduct a field test of the smart phone "virtual" DMS system. The UTC Virginia test bed will be used to support this work and evaluate the effectiveness of the proposed smart phone Virtual DMS System. Specific objectives of this study can be summarized as follows:

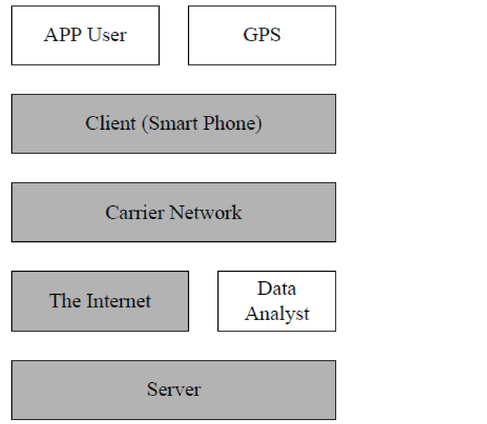
1. Examine the feasibility of such a mobile application by creating a prototype system, using the commercial cellular network to distribute traffic information generated by TOC. The smart phone application in this study will provides the same functionality as a DMS.
2. Demonstrate a connected vehicle application with direct benefit to TOC operations.
3. Evaluate the potential benefit of the proposed system by testing the effectiveness in the CVI-UTC test bed.

System Design

Prototype Virtual DMS System Design and Implementation:
The system will function as follows. First, the users turn on the smart phone application once s/he starts the trip. The location function of the smart phone will be activated and estimate the location of the vehicle at a defined time interval. These location data, along with time information, are then sent back to the server via the cellular network (the second major component). Under the system design, users must have cellular service during the operation of the application. The cellular network can also be used to provide user position information through cell signal triangulation or Cell-ID of the base station if the primary means of obtaining this data (i.e., the GPS satellites) is unavailable. The Internet, the third component, is the transit network for application data between the cellular network and the server. The final element of the system architecture is the server, which compares the real-time location information of each vehicle to the predefined DMS "zone" and sends back relevant DMS messages to the user if appropriate. Note that these messages are referred to as "feedback" in the image below:



Virtual DMS System Architecture



Main System Components of the Virtual DMS System

Server Design

The Server:
The server of the Virtual DMS System is responsible for receiving, analyzing, and providing DMS messages for travel data transmitted by the end-user device. To support data storage for evaluation purposes, a database server that deals with storage and retrieval of trip information will be incorporated in the design.

Polygon message zones will be determined and drawn via GIS to correspond to existing DMS locations. The message zones, as illustrated in the image below, are defined as the area before each DMS sign and where users will receive the DMS messages. Once the vehicles enter the pre-specified message zones, the server will identify it via analyzing the location data from the vehicle and send the message currently displayed on the corresponding DMS sign to the users. Besides, a buffer zone, is defined before the corresponding DMS sign to allow a buffer time for the system operation. The size of message zones and buffer zones will be determined by the team based on factors such as the prevailing operating speeds.

The real-time DMS information will be requested by the server from the Virginia Traffic and Video Data Sharing Site. The server will automatically make the http request for the DMS message information from the website and send back to the user in real-time.

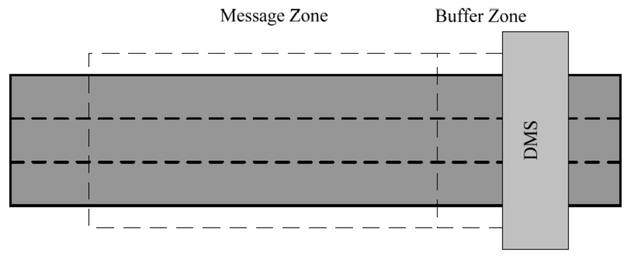


Illustration of the Message Zone and the Buffer Zone