# Managing School Buses on the Information Highway

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*Abstract: The design of a high-tech wireless vehicle tracking and management system is presented by the authors. The system is designed for the transportation industry. In particular, the authors discuss the application of the system for the management of a fleet of school buses. Other possible applications of the underlying technology are also discussed.*

## Introduction

Wireless telecommunications truly is the wave of the future. This technology is available to us today. There has been an increasing number of articles reporting on products aimed for this market. This trend not only affects the next generation of personal digital assistants, or PDAs, but computer chip design as well. While most earlier wireless devices utilized Cellular Digital Packet Data technology, there seems to be a growing interest in the use of radio networks. Radio packets seem to provide faster, more versatile, more accurate, and more dependable coverage than Cellular Digital Packet Data technology.

Working as consultants for Signal Oriented Location and Information Systems (SOLIS), Inc. of Myrtle Beach, South Carolina, the authors developed a prototype wireless communications system for vehicle tracking. Constrained by a limited budget and a tight schedule, the successfully implemented prototype is capable of transmitting messages and vehicle locations from a mobile unit for real-time communication and digital map display at a central (dispatching) office.

## The Transportation Industry

This prototype system was originally designed to be used by a dispatching office where real-time (interactive) monitoring of vehicle positions is required. It uses the U.S. Department of Defense's Global Positioning System (GPS) which is a constellation of satellites that orbit the earth twice a day, transmitting precise timing information. These transmissions can be collected by any GPS receiver at no charge and at any hour. Furthermore, GPS technology provides not only vehicle positions in several formats: geodetic (latitude-longitude), Universal Transverse Mercator (northing-easting), XYZ Cartesian Earth Centered Earth Fixed, etc. These devices also provide additional data such as altitude, heading, speed, and more. All this is available to the dispatching office, enhancing overall management of a fleet of vehicles.

Last November 1994, Carolyn Pesce wrote an article in *USA Today* highlighting a smart bus system implemented by Guidestar at Minnesota. The $6.5M project involved installing GPS receivers on 80 of the city's 1,000 buses. The complete system also includes a few kiosks (information booths) where commuters can determine the estimated time of arrival of their buses. The prototype system developed by the authors uses the same technology designed from off-the-shelf components. Consequently, based on the authors' experience, a similar system could be developed at a fraction of the cost paid by the city of Minnesota.

Monitoring public transportation systems (buses, taxis, vehicles for rent, etc.) is just one of the possible applications of such tracking systems. There are trucking companies, both here in the United States and in Europe, that utilize similar systems. For example, Rockwell Collins Avionics and Communications Division in Cedar Rapids, Iowa, provides such a system called GEO-NET 2000. It is currently being used by major trucking companies in the United States. Most, if not all, of these systems utilize cellular communication rather than radio packet transmission which at this time effectively reaches 90 percent of the population of the United States.

## A Look at School Bus Safety

Every public school district across the United States is confronted with the problem of effectively managing a fleet of school buses. Horry County, South Carolina, which maintains a fleet of 287 school buses, is no exception. Consequently, a vehicle tracking system used to manage the school buses, would be beneficial to system administrators in many ways.

In 1993, Richard Green and Thurston Hatcher wrote an article in Charleston's *The Post and Courier* emphasizing the need for a system that automatically notifies the appropriate authorities of any changes to a school bus driver's Public Safety Department records.

The problem, they said, was that despite the fact that school districts check drivers records between one to four times a year, they do not always learn about violations until long after they happen. Because of this, there is a possibility that one of the school bus drivers on the roads today only recently received a violation.

In a recent telephone interview with John Dozier, Director of Safety and Information for the state Department of Education's Division of Support Services - Transportation, the statistics describing school bus safety in Horry County for the 1993-1994 school year (the total number of buses includes both route and spare buses) was discussed. These figures are given in Table 1.

**TABLE 1**

School Bus Safety in Horry County and the State of South Carolina, in the 1993-1994 School Year

| School Bus Safety | Horry County | State of South Carolina |
|---|---|---|
| Total number of buses | 267 | 5,966 |
| Total number of accidents | 22 | 697 |
| Bus driver's fault | 11 | 366 |
| Other driver's fault | 10 | 295 |
| Both driver's faults | 1 | 36 |

Dozier informed the authors that Greenville County had the most number of school bus accidents of all South Carolina counties. He also pointed out that the 22 recorded accidents for the School Year 1993-1994 in Horry County could further be classified as outlined in Table 2.

The data from the Division of Support Services also indicates that the most common school bus accidents are:
1. Improper backing
2. Improper turning
3. Failure to yield to right- of- way
4. Too fast for road conditions
5. Improper passing
6. Improper use of left on center lane
7. Bus versus bus

Dozier clarified the last category of accidents as those that involve two school buses. These kinds of accidents generally occur in the parking lot.

The data from the Division of Support Services also indicates that the most common school bus accidents are:

**TABLE 2**

Breakdown of School Bus Accidents that Occurred in Horry County,South Carolina in the School Year 1993-1994

| | | | | |
|---|---|---|---|---|
| 22 bus accidents in Horry County | Other vehicle: | | Not a bus | 21 |
| | | | Bus | 1 |
| | Driver: | Sex: | Female | 15 |
| | | | Male | 7 |
| | | Status: | Regular | 18 |
| | | | Substitute | 4 |

Green and Hatcher's article in Charleston's *The Post and Courier* also indicated that some school buses around the state have been equipped with video cameras to monitor student behavior. They indicated that this has, somewhat, made the drivers aware that they could be under scrutiny as well.

Dozier indicated that the frequency of bus accidents where the bus driver was at fault, relative to the number of miles driven, is close to the frequency of accidents for the average driver on the road. The national average for cases where the bus driver was at fault, is one accident every 192,210 miles. The South Carolina figures for the 1993-1994 School Year is one accident every 100,930 miles. One solution to this problem would be a real-time management system.

**Managing a Fleet of School Buses**

How could such a system as that developed for SOLIS, be integrated into a typical school bus management scenario? The overall setup could be configured as depicted in Figure 1.

(1) Buses equipped with GPS receivers can collect data from GPS satellites regarding their current location, speed, heading, etc. This information is transmitted every second and so the most recent data is always available locally.

(2) Furthermore, buses also equipped with wireless radio packet modems will have the capability to transmit GPS data and/or messages through the ARDIS (joint venture of Motorola and IBM) radio network. ARDIS is currently the largest radio network in the United States.

(3) GPS data and messages transmitted through the ARDIS network can be received by destination sites, also equipped with wireless radio packet modems. Any pertinent positional information can be displayed on a digitized map for precise location of vehicles in a fleet.

Furthermore, two-way wireless communication can be achieved between any remote vehicle and the dispatching office.

This system also can be configured so that students can be notified if their bus is approaching. To do this, radio packet modems in the buses will be programmed to broadcast their current positional information at regular intervals. Registered subscribers, using radio packet modems and a computer terminal at home, can then receive these transmissions and display the information on the computer screen. With this arrangement, students can safely wait indoors for the arrival of their school bus. This way, students are not only taken off from the side of the road,they do not have to be out in case of inclement weather.

One of the interesting features the authors had on the prototype system they developed is the capability to switch between real-time monitoring of vehicles or silent tracking. In the first mode, a vehicle's position is displayed on a digitized map as a blip at regular intervals. This interval is initially set by the monitoring office and can be modified remotely simply by sending an appropriate message to the bus: all this without interfering with the bus driver's functions.

In tracking mode, the digital map does not need to be displayed. All GPS information transmitted via ARDIS is simply recorded into a log file. This file can be "replayed" as required to show the route taken by a particular bus. Logged GPS data includes the time each data value was received. This, combined with the corresponding positional information, provides precise location at various time intervals of the day. The accuracy of this information depends, of course, on the frequency of transmitting positional data from the buses. Since GPS information also includes the vehicle's speed, the log file may also be used to systematically check for any speeding violations.

Discussing further details on the prototype and its implementation is beyond the scope of this paper. Readers who are interested in pursuing these technicalities may refer to the authors' publication listed in the References.

**Discussion**

School bus accidents occur from a variety of reasons. Whatever the accident, implementing such a vehicle tracking and communication system provides instantaneous communication for use in case of an emergency. Drivers will be able to report any accidents along with a precise location of where it occurred. A digital map can further pin point the location of the accident so that immediate assistance could be notified and sent. This tracking system also facilitates remote, real time monitoring of bus drivers so that one can observe driving habits. Hopefully, with such a system, bus drivers can be warned about any observed behavior thereby avoiding bus accidents.

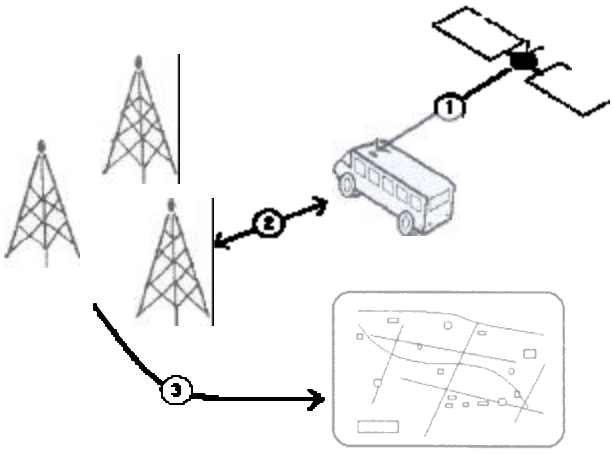
It is possible to integrate the system with that used for the Public Safety Department's records. Drivers' names (or their license numbers) can be matched in a database with the numbers for the radio packet modems on the buses they drive. Alternately, the driver information can be matched with the radio packet modem numbers of their supervisors. Any change in their Public Safety Department records, whose system would also require the use of radio packet modems, will result in a message automatically sent to the corresponding number. This message will update the respective supervisor of any recent changes in a driver's public safety records.

A similar approach can be done with truck driver information so that their supervisors also become aware of any violations.

**Other Possible Applications**

Communication is an essential element of any community's infrastructure. In the business community it can be the factor that promotes growth or accentuates decline. Technological advances in communication revolutionized the way the United States conducts business at home and abroad. More and more people are using facsimile machines, pagers, etc. Despite all this, there is still a need for greater and better communications capabilities to meet the needs of businesses in today's "information era." For example, the same wireless technology can be used to get the latest stock market figures. Internet connection would also provide electronic mail and access to world-wide databases.

**Figure 1**




**Conclusions**

The benefits of a wireless bus management system include, but are not limited to

• real -time tracking of all school buses connected to the

system and the routes each bus is using;
• real-time tracking of each school bus and their travel speed; and
• instantaneous data/message transmission and communication.

The authors feel that implementing such a system would facilitate monitoring of a fleet of school buses and, consequently, improve school bus safety. ▲

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# From the Editor

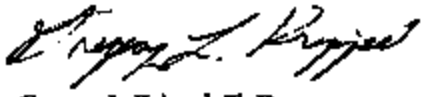
This is the fourth annual issue of the *Coastal Business Review* as published by Coastal Carolina University's E. Craig Wall Sr. School of Business Administration and Computer Science. We have made every effort in the hope that this issue will be as well received as the previous issues have been.

This year we have provided an outlet for meaningful and interesting research with a varied range of articles from authors located in South Carolina and the Southeast.

We have articles of interest to a broad range of South Carolina and Grand Strand businesses. Our lead article may be of particular interest to entrepreneurs as it discusses a vehicle satellite tracking system developed by two professors at the E. Craig Wall Sr. School of Business Administration and Computer Science and a local entrepreneur using readily available software.

We would like to invite readers of this journal to submit a paper for possible inclusion in the 1996 edition.

I thank former editor Jack M. Kendree, II for his invaluable assistance in helping guide me through this 1995 edition.



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# 1995 Editorial Review Board



The deadline for submissions for the 1996 edition is December 15, 1995.
The maximum length of papers submitted should be 20 double-spaced pages.


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