A local intelligent transportation case study on dynamic school bus warning signs

It was a typical day at the St. Louis County Public Works Department. The county’s acting traffic engineer, Vic Lund, was driving the county highways when Brian Boder, the resident engineer traveling with him, made an interesting observation. He noted that while their county’s highways had about 20 “School Bus Stop Ahead” warning signs, drivers rarely saw buses near the signs and were probably conditioned to disregard them. The two engineers put their heads together and came up with an idea for a dynamic warning sign—one that would alert drivers when a school bus was actually present, and as a result improve the signs’ effectiveness.

Back at the office, Lund did some additional calculations. Taking into account the fact that school buses are only at each sign a few minutes a day and only on school days, he estimated a school bus is present at each sign just 0.15% of the time during the calendar year. Though there had been no recent incidents of St. Louis County children being hurt as the result of drivers disregarding bus stop warning signs, these types of crashes do happen. From 1997 to 2006, there were 1,475 crashes at or near school bus stops nationwide. Of those crashes, 204 involved a vehicle rear-ending or driving around a stopped bus. However with no local funding available to pursue a dynamic warning sign solution, Lund set aside the idea.

**A Unique Funding Source**

Not long after Lund and Boder came up with the idea for dynamic “School Bus Stop Ahead” warning signs, a unique source of funding came along. The program was called the Local Intelligent Transportation Systems (ITS) Pilot Safety Program—a joint venture funded by the Minnesota Department of Transportation (Mn/DOT) State Aid for Local Transportation, the Mn/DOT Office of Traffic Safety and Operation, the Minnesota Local Road Research Board, and ITS Minnesota.

Under the program, local public agencies could apply for funding to hire an ITS consultant. The consultant would then develop ITS solutions for a specific traffic safety problem. The goal of the program was fostering interest in the development of ITS solutions for the local road system.

The Local ITS Pilot Safety Program seemed like a perfect way to explore the idea for a school bus stop dynamic warning system. “A dynamic school bus warning system really fits with our public works department’s mission of providing safe transportation,” says Lund. “Any engineering or maintenance activity that enhances traffic safety for motorists out on our roads is important to us, so we were eager to pursue this funding source.”

The county applied for Local ITS Pilot Safety Program funding, and was one of three Minnesota local public agencies selected to receive $10,000 in funding to hiring an ITS consultant and pursue their idea for an ITS safety solution.

**A Smooth Process**

For St. Louis County, selecting an ITS consultant was a fairly simple process. The county sent out three requests for proposals (RFPs), and only one consultant of the three responded. Luckily the consultant, the SRF Consulting Group, met all the RFP requirements and was selected to complete the consulting project. Lund guesses that the relatively low cost of the project led to the lower response rates to

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**Fast Facts**

In Minnesota from 1998–2007:
- 157 crashes occurred with the school bus stop arm extended.
- Six of those crashes resulted in incapacitating injuries.
- Two crashes resulted in fatalities.

**Agency:**
St. Louis County, Minn., Public Works Department

**Location:**
Northeast Minnesota

Duluth is the county’s largest city

**Population:**
200,500

**Transportation System:**
3,000 miles of road and 938 bridges
20 “School Bus Stop Ahead” warning signs
Roadways range from urban to rural

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Minnesota LTAP
University of Minnesota
511 Washington Ave. S.E.
Minneapolis, MN 55455

Phone: 612-626-1077
Fax: 612-625-6381
E-mail: mnltap@umn.edu
Web: www.mnltap.umn.edu
With the consultant selection complete, the project process began. “We had an initial kick-off meeting, which included a brainstorming session about where we wanted the project to go and the project deliverables,” says Lund. “From there, the consultant pretty much took off.”

Seeking an ITS Answer
The SRF investigation into possible designs for a dynamic “School Bus Stop Ahead” warning sign identified five potential ITS solutions to this challenge, each with benefits and drawbacks.

Solution One: Two-Way Radio (DSRC)
The first approach identified for dynamic school bus warning signs was dedicated short range communications (DSRC). This is the only solution currently in use—this type of system was deployed in 2007 in the city of Granite Falls, Minnesota. In the two-way radio approach, the bus is fitted with a continuously-broadcasting radio transmitter. When the receiver at the sign picks up this signal, it activates an output controller that flashes the beacons on the sign. The sign is powered by a solar panel and does not require an electrical connection. The cost for this solution is about $3,000 for equipment on the bus and up to $20,000 per sign.

Solution Two: Vehicle Pre-Emption / Priority
Vehicle pre-emption and priority devices are commonly used to allow emergency vehicles to turn a traffic light green and pass safely through an intersection. This approach uses the same technology to allow school buses to activate dynamic “School Bus Stop Ahead” signs. The advantage of this method is St. Louis County traffic engineers are already familiar with these systems. However, there are also many disadvantages including maintenance issues, bulky receivers, and the need for a commercial utility electrical connection. The cost for type of system would be more than $5,500 per sign and about $700 per vehicle.

Solution Three: Radio Frequency Identification (RFID)
Radio Frequency Identification (RFID) is commonly used in electronic tolling applications—such as the MnPASS—but can be used in many other applications as well. This solution uses active tags both at the sign and on the bus. These tags are basically small data radios that communicate with each other. When the bus comes into range, the dynamic sign would begin flashing, and when it passes out of range the sign would stop flashing. The tags are very small and use little power, so no electrical connection would be needed. However, there are no ‘off-the-shelf’ solutions currently available for this approach. After development costs, the system would cost about $2,000 per sign and $1,200 per vehicle unit.

Solution Four: Machine Vision
Machine vision uses cameras for vehicle detection, and it is widely used in traffic management applications. In a dynamic “School Bus Stop Ahead” sign system, the camera would be programmed to activate the sign’s flashers after detecting a school bus, and would deactivate the flashers using either a timer or by detecting the absence of a bus. This approach would not require any equipment on the school bus; however, the camera systems would require a commercial utility electrical connection. The cost for this system would be about $20,000 per sign unit.

Solution Five: GPS Geo-Fencing
A geo-fencing solution would monitor the position of each school bus using GPS. When the bus enters into a specified “virtual fence” area, the nearby “School Bus Stop Ahead” sign flashers would be activated. This system would also allow for the real-time monitoring of the bus fleet. Obstacles to this solution include a high development cost and limited access to the wireless data network—which is required for the system to operate—in northern St. Louis County. After development costs, this system would cost more than $3,000 per sign unit and more than $2,000 per vehicle.

Pursuing a Promising Solution
SRF presented its findings to St. Louis County leaders, where the report was well received. “The report was presented to our county board members at one of their regular meetings and they were unanimously in support,” says Lund. “In fact, they took a non-binding ‘straw poll’ vote voicing their support for pursuing this project. They were very excited about using technology to improve safety.”

The ITS consultant, Lund, and county leaders determined that even though ‘off-the-shelf’ RFID technology for dynamic “School Bus Stop Ahead” signs is not currently available, RFID is the most promising and cost-effective solution. Currently, the county is pursuing additional funding sources to pursue Phase Two, which is to develop three working prototypes and deploy them in the field for testing. Locations under consideration are along a state trunk highway and county highway in St. Louis County. The consultant has spoken with a traffic equipment manufacturer who expressed interest in eventually producing the dynamic “School Bus Stop Ahead” signs as an off-the-shelf technology solution that could be simply and inexpensively implemented by other local transportation agencies.

According to Lund, funding is the primary barrier local transportation agencies face when pursuing ITS technologies like dynamic “School Bus Stop Ahead” warning signs. Lund says the ITS Local Pilot Safety Program was instrumental in helping his county public works department explore their innovative idea. Now thanks to that help, they’re continuing to pursue this important ITS research that may eventually make getting to school safer for kids across the country.