Automatic Vehicle Location Fact Sheet: Fixed Route Bus Transit

September 2007

Technology Overview

Automatic Vehicle Location (AVL) systems calculate the real-time location of any vehicle equipped with a **Global Positioning Satellites (GPS)** receiver or other type of receiver-transmitter location technology. Data are then transmitted to a transit center through radio or cellular communications. The AVL information may be used immediately to correct scheduling and other operational deviations and also archived and used for schedule and route planning, reporting, and performance analysis

Use AVL to:

- Improve bus on-time performance and service efficiency
- Reduce passenger wait time
- Provide customers with real-time service information
- Enhance on-board safety
- Improve response times to incidents and emergencies
- Improve communications between supervisors, dispatchers, and operators
- Plan schedules and routes

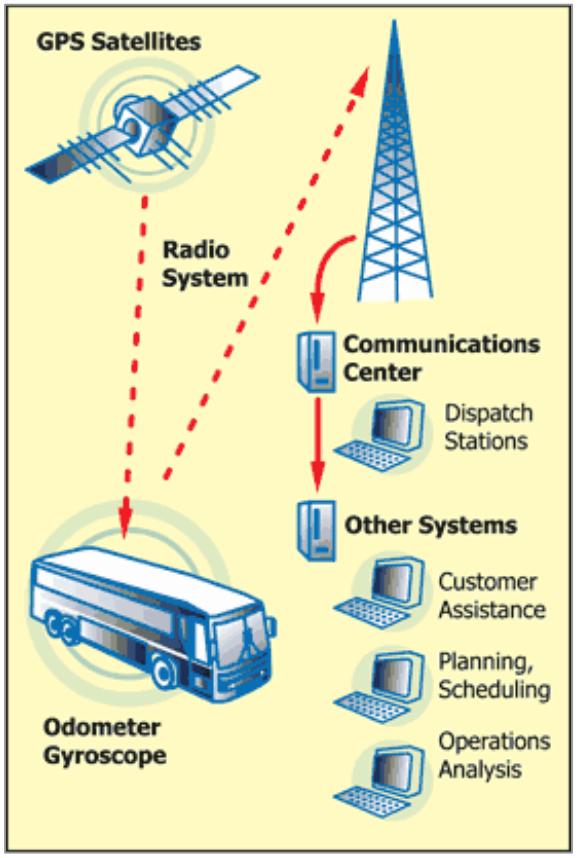


Illustration of an AVL and real-time communications network.
(Source: AVL Successful Transit Applications)

AVL systems span a wide range of costs and levels of sophistication. **Small fixed route bus agencies** with less than 100 vehicles or agencies on limited technology budgets can consider web-based, off-the-shelf systems for real-time fleet location monitoring. Comprehensive, customized integration of AVL with other systems is most appropriate for **large fixed-route bus agencies**.

Common Technology Combinations

Daily Operations

AVL and **communications systems** are used by fixed-route bus agencies to monitor on-time performance, reduce bus bunching, and improve adherence to schedules. AVL also enhances **transit signal priority (TSP)** performance by detecting buses as they approach intersections. Impacts to cross-street traffic are minimized since only approaching vehicles are granted priority

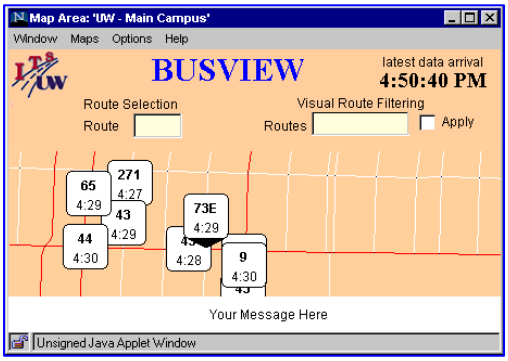
Safety and Security

Many AVL data systems incorporate **silent alarms**, which allow drivers to covertly alert transit management and police of emergency situations aboard a specific vehicle. In addition, the vehicle location is displayed on a

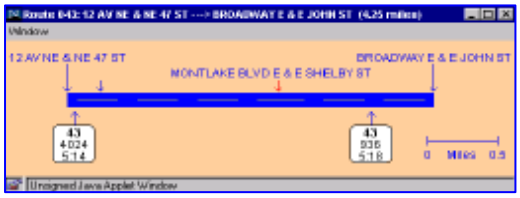
geographic information system (GIS) map to facilitate any necessary incident response resulting from a silent alarm, radio communication, or other in-vehicle emergency notification system.

Systems Planning and Fleet Management

AVL data can be combined with bus-stop and facility-inventory data and mapped on **GIS**. These data can also be linked to **automatic passenger counters (APC)** to gather ridership information by location and time. **Archived data** are then used for assessing routes, schedules, and facility and fleet requirements. This analysis can be incorporated into the facility capital planning and operations planning processes.



King County, Washington
Metro – University of Washington
Busview screen (top)
Bus route progress bar (bottom)



Traveler Information

The AVL system can enable real-time information to be provided on an agencies website, which could also include an automated **trip planner system**. When linked to an electronic **traveler information infrastructure**, such as **variable message signs** at transit centers, an AVL system will provide information on expected arrival times. The AVL system can also be integrated with **in-vehicle automated stop announcements**, which can enhance ADA compliance by the transit agency.

Electronic Fare Payment

An AVL system will collect fare information by location for financial management. An AVL-**electronic fare payment** combination can be applied to trigger **electronic fare boxes** acceptance of different fare amounts across fare zones.

Maintenance Management

An AVL system can be integrated with **onboard vehicle component monitoring** for real-time diagnostic status information. Any irregular readings could alert maintenance or operations supervisors to contact the operator of any transit bus that records the "out-of-tolerance" warning.

Is This Technology Right for My Agency?

Before deploying and utilizing an AVL system, fixed route bus agency officials should consider the following tasks and concerns during the various project development stages:

Implementation of an AVL system can take 2-3 years depending on the complexity of the system, required integration, and size of the transit

Planning

- Develop a structured procurement plan, performance-oriented requirements, and specifications
- Involve staff from various departments and outside stakeholders such as contractors.

- Visit peers at other transit agencies to ascertain the full uses of an AVL system, as well as costs and other issues to consider in the concept and planning stage.

Implementation

The implementation process, from planning to the time that the system becomes operational, can take two to three years for large, fixed route bus agencies and about a year for small fixed route bus agencies. The process includes:

- Training drivers and dispatchers.
- Ensuring adequate staff for data analysis.
- Providing adequate data-storage capacity.

Integration

It is advisable to integrate any new AVL system with existing communication and data systems. However, before doing so, there are logistical questions that should be answered:

- Is there room available within the vehicle for additional systems and connections?
- Are new systems being procured that could include AVL technology, such as automatic passenger counters or a new communication system?

Benefits and Costs

Benefits

Some Reported Benefits

- Use of AVL-Computer Aided Dispatch (CAD) improved on-time performance by 9-23% in large cities.
- Denver's Regional Transportation District (RTD) decreased schedule-related complaints by 26%.
- Metropolitan Atlanta Rapid Transit Authority (MARTA) saved $40,000 per year in data-collection costs.
- Successful AVL and CAD implementations can reduce fleet size by 2-5%.
  - Baltimore's Maryland Transit Administration (MTA) reduced its fleet size to meet the same level of service, resulting in savings of $2-$3 million per year.
  - Kansas City Area Transportation Authority (KCATA) saved $1.6 million with its fleet reductions resulting from AVL-CAD implementation

AVL can help transit agencies to reroute buses around heavily congested corridors.

Other Possible Benefits

- Decreased emergency-response times (improved incident-response time by 50% reported).
- Reduced street-supervision labor. AVL enables more targeted use of field supervision and schedule checkers.

Costs

Price

AVL project costs for deployment by fixed route bus agencies has ranged from $25,000 to $15 million, with a median project cost of $1 million. The cost per vehicle will likewise vary greatly, primarily dependent upon the planned functionality of the AVL system and the integration with other existing or new technologies. A very basic web-based location monitoring system cost as little as $250 per vehicle, while one bus transit agency reported its AVL-GPS system that was integrated with an expanded onboard location annunciation system ran $33,000 per fixed route bus. The median AVL system implementation cost per vehicle fall between $7,000 and $8,000. In recent years, these per vehicle costs have dropped significantly.

Modifications to transit dispatch centers to accommodate the input from a new AVL technology range between $10,000 and $50,000 per center.

Operations and Maintenance (O&M)

Annual O&M costs for onboard AVL equipment and AVL communication infrastructure on the transit bus routes and at the transit dispatch/operations center average 2-5% of the original capital cost.

Telecommunication service fees may be required to relay AVL data on a cellular network.

Staff Requirements

When the AVL technology is integrated with the **Computer-Aided Dispatch and Scheduling (CADS) Syst**em and/or the **Geographic Information System (GIS)**, the transit center dispatchers will need from training on how to utilize the new or expanded systems. This dispatcher training can range from two days to two weeks.

Transit bus operators can receive two to four hours of training on the use of the AVL system, which will probably include using a **Mobile Data Terminal (MDT)**.

A data analyst may need to be hired to manipulate the AVL data into useful information for the fixed route bus agency. On average, a fully-loaded transit data analyst would cost $75,000 per year.

AVL Deployments by Fixed Route Bus Transit Agencies

Agency	Contact Information	Number of Buses	Context / Success of Deployment
Denver Regional Transportation District (RTD)	1600 Blake St. Denver, CO 80202 303-628-9000	1,335 buses	Use of AVL, combined with an upgrade in the radio communications system and MDTs, improved on-time performance and incident-response and increased ridership. High costs.
Metropolitan Atlanta Rapid Transit Authority (MARTA)	2424 Piedmont Rd. Atlanta, GA 30324 404-848-5000	556 buses	Use of AVL and CAD resulted in operating savings and data collection, but high implementation costs.
Ann Arbor Transportation Authority (AATA)	2700 S. Industrial Hwy Ann Arbor, MI 48104 734-973-6500	82 buses	Deployed integrated AVL-CAD, MDT, remote diagnostics, and silent alarms on fleet in stages. Improved on-time departures, but not arrivals. Initially, major errors in vehicle location data.
County of Lackawanna Transit (serving Minneapolis/St. Paul)	North South Rd. Scranton, PA 18504 570-346-2061	32 buses	Deployed basic AVL system in about 9 months

Additional Resources on AVL

- Real-Time Bus Arrival Information Systems Return-on-Investment Study (August 2006), http://www.fta.dot.gov/documents/Final_Report_-_Real-Time_Systems_ROI_Study.doc
- Advanced Public Transportation Systems: State-Of-The-Art Update 2006 (March 2006), http://www.fta.dot.gov/documents/APTS_State_of_the_Art.pdf
- Best Practices for Using Geographic Data in Transit: A Location Referencing Guidebook - Defining Geographic Locations of Bus Stops, Routes and other Map Data for ITS, GIS and Operational Efficiencies (April 2005); Report No.: FTA-NJ-26-7044-2003.1; http://www.fta.dot.gov/assistance/research/research_4611.html
- Handbook of Automated Data Collection Methods for the National Transit Database (October 2003), http://www.nctr.usf.edu/pdf/473-11.pdf
- Uses of Archived AVL-APC Data to Improve Transit Performance and Management: Review and Potential - TCRP Web Document 23 / Project H-28 (June 2003); http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_webdoc_23.pdf
- Guidance for Developing and Deploying Real-Time Information Systems for Transit (April 2003); http://ntl.bts.gov/lib/23000/23600/23663/RTTIS_Final.pdf
- Guidebook for Selecting Appropriate Technology Systems for Small Urban and Rural Public Transportation Operators - TCRP Report 76 / Project B-17 (2002); http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_76.pdf