City of Chicago Automated Vehicle Location Tracking Project

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Paper Abstract

This presentation will discuss the operational and technical details of implementing a Chicago's browser-based Automated Vehicle Location (AVL) mapping and reporting system within ArcIMS. Key operational considerations during the initial roll out of the project and how the system has been received within City departments will be discussed. Additional insight will be provided on how to provide the system in an incremental fashion, and how technical considerations were addressed as the system evolved over time during the project's implementation.

Other points of interest will include planned technology enhancements in key functional areas such as: monitoring key vehicle maintenance items; insuring personnel operate City fleet vehicles in a secure manner; enhanced internal reporting, and integrating GPS points with existing enterprise systems.

Introduction

The City of Chicago began exploring the use of GPS technology to track vehicle locations in 2001. A proof of concept implementation identified core requirements of stability, scalability, and ease of use. This prompted the City to conduct an evaluation of large-scale GPS providers and develop an internal browser-based interface to this information. In the fall of 2003, the City of Chicago launched its production AVL system with vendor support from WebTech Wireless and GeoAnalytics.

We will review the Chicago AVL System by first understanding the operational considerations which have driven this project since inception. We will then explore the incremental steps taken to implement this project due to the size and complexity of the undertaking. Lessons learned from the pilot and the proposal stage will be reviewed.

We will then move on to a technical discussion of how the system works within the City's existing GIS environment and incorporates the technology provided by outside vendors. Key decisions on system design to ensure redundancy and internal control will be discussed.

Finally, we will describe in more detail how the Chicago AVL system is used by City Departments on a daily basis, and plans for future enhancements as the system grows in both functionality and volume.

Operational Use

Implementation of automated vehicle locator technology in the City of Chicago is targeted to address the following operational needs:

- Near real-time tracking of vehicle locations
- Tracking completion of snow route plowing
- Vehicle deployment tracking for emergency events
- Statistical tracking of vehicle usage
- Field data to analyze and streamline standard routes
- Alerts and documentation for misuse of vehicles
- Security of city personnel
- Efficient vehicle dispatch

One of the largest and most important operational support efforts coincides with the City's snow removal efforts. This critical operation is managed by the Chicago Streets and Sanitation Department to insure that the vehicles are dispatched in a timely manner during snowstorms. By adding AVL to the snow removal fleet a number of operational concerns could be addressed, such as the location of all snowplows and making sure they were in their proper staging lots. A major concern was monitoring the first two hours of any snow event since it is the most critical time in any snow call out, with drivers arriving at staging lots, moving to the head of their routes, and beginning snow removal operations. With over 7000 miles of roadway and nearly 200 snow routes, the operational challenges are great for any system that will assist the City in keeping street open during large snowstorms.

Chicago's Fleet Management Department is the second heaviest user of the application. In addition to GPS, Fleet Management also installed Driver ID capability in its fuel trucks to protect against theft.

The Chicago Department of Transportation (CDOT) uses the system to track vehicles during construction season. Chicago's solution allows this department to view all vehicles, even on different GPS system, in the same browser interface and reporting facility.

Vehicles from Water Management and Revenue are also online. Additional departments, such as the Chicago Police Department, plan to adopt the use of AVL tracking in the next year.

Evaluation Process

In 2003 the City of Chicago evaluated over 9 industry providers of AVL systems and narrowed the selection to 4 finalists. Selection criteria focused on

- Demonstrated experience with large vehicle quantities on high volume transmittals
- Ability to work with any GPRS telecom provider
- Strength of underlying technical architecture
- Functionality of the tracking and reporting interfaces
- Ability to host the system offsite as an ASP (application service provider)

The four finalists participated in a small pilot project where 10 vehicles were installed with their receivers. Users from 7 departments used and evaluated the competing systems. Each vendor proposed against a detailed matrix of requirements and WebTech Wireless Inc., was selected to supply hardware and ASP database services necessary for the operation of the Chicago AVL system for the initial rollout of 500 vehicles. Lessons learned from this process will be presented.

WebTech Wireless was able to deploy equipment to over 250 vehicles in 4 weeks to launch the system in time for the 2003/2004 snow removal season. Users were able to immediately track vehicles on an interactive map and run basic reports through WebTech's online site. WebTech customized their mapping site to use ArcIMS and custom Chicago geographies.

The City of Chicago separately contracted with GeoAnalytics to develop an internal ArcIMS website that would display vehicles locations by direct access to WebTech's data server. This allows the city to maintain an internal system with more confidential data and customized functions. It also provides redundancy for the department users. In progress is the development of an archive database that will store real-time GPS Positions from WebTech in a City of Chicago internal database.

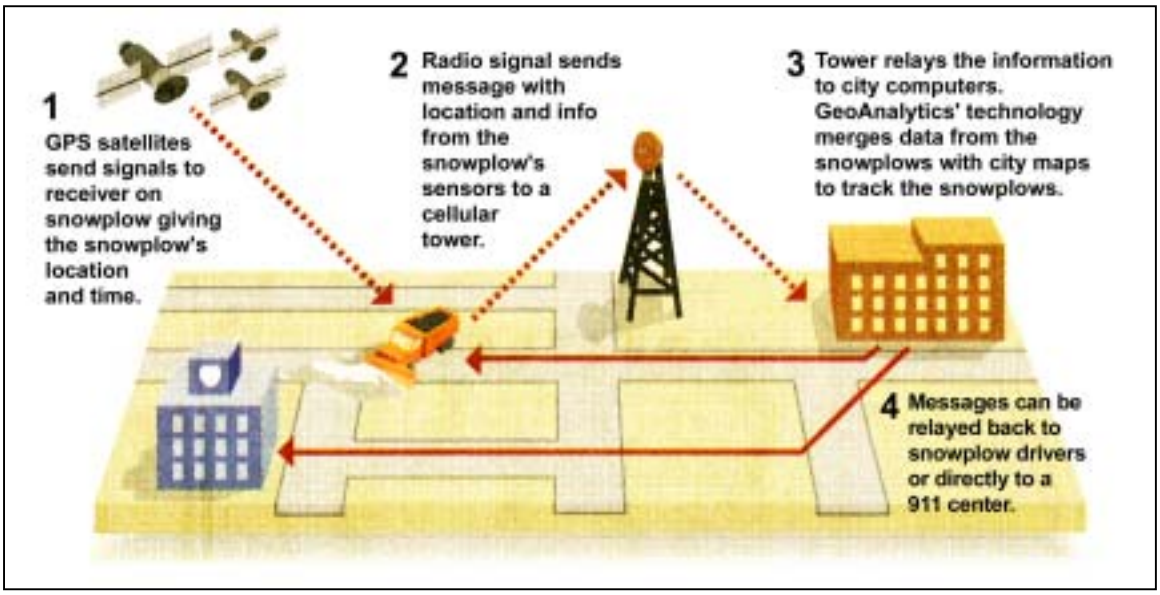
Webtech Wireless Site

Chicago/GeoAnalytics Site

Technical Details – Internal Website

General System Design

The Chicago AVL system incorporates GPS and private wireless communications that send vehicle location and associated information to a relational database. This information is then sent to the ArcIMS mapping interface for real time display of vehicle locations and status reports. Text messages can be relayed to the vehicles, and finally the vehicle location information is stored in an archive database for future analysis.



General Layout of Chicago AVL System

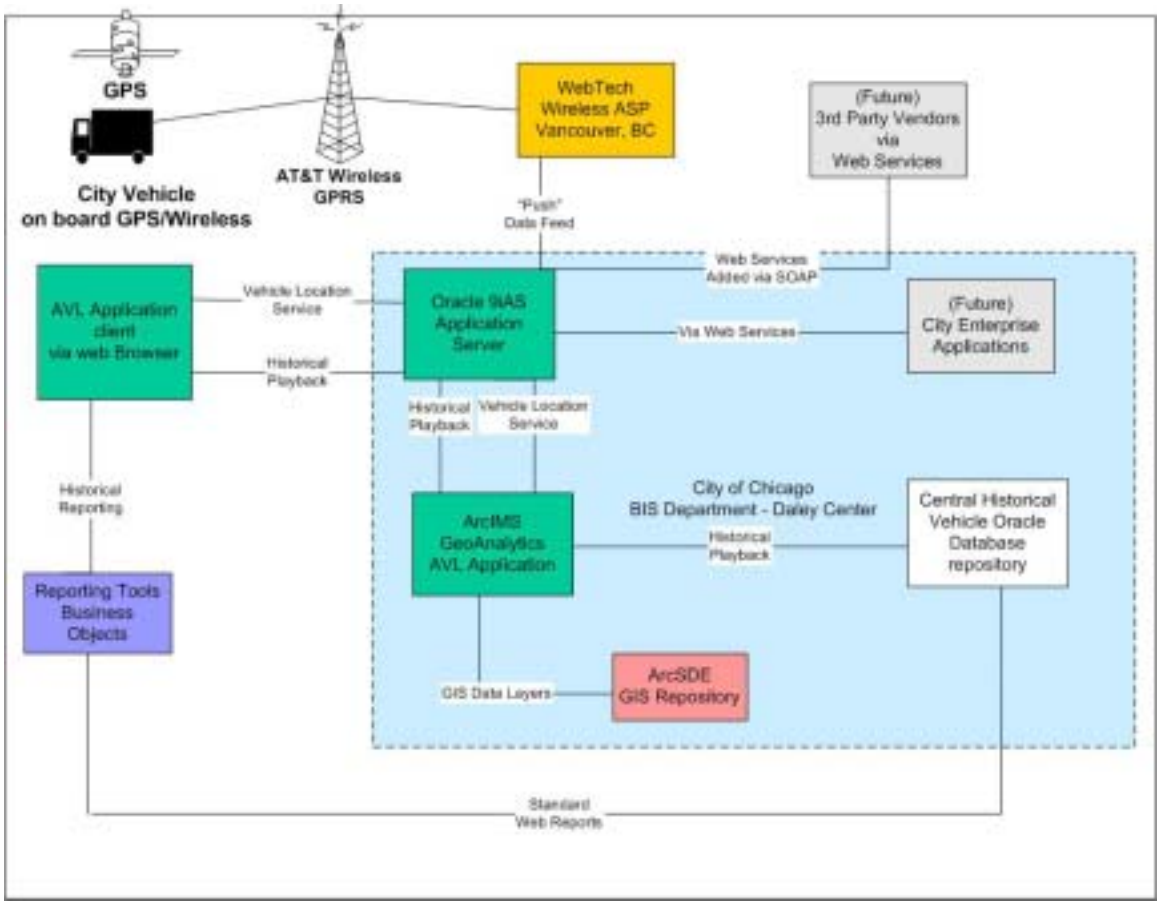
Internal Website Design

The City of Chicago invested in building an internal ArcIMS website that could render not only WebTech's vehicle positions but also GPS positions transmitted by other vendors and mechanisms as necessary. Additional reasons for this internal site include:

- Leverage existing Chicago GIS repository of data
- Ability for Chicago staff to add custom GIS layers on demand
- Dynamic legend that lets departments customize their view
- Redundant user interface as a backup if the vendor's website is down
- Ability to load confidential City data without transmitting to vendor
- Ability to tailor reporting features to departmental needs

- User Interface to view historical data, even after it has been removed from vendor site
- Vendor independence – Ability to render GPS positions from any vendor that can provide the technical interface. Should needs change, new vendors could be incorporated seamlessly into the interface already used by departments.

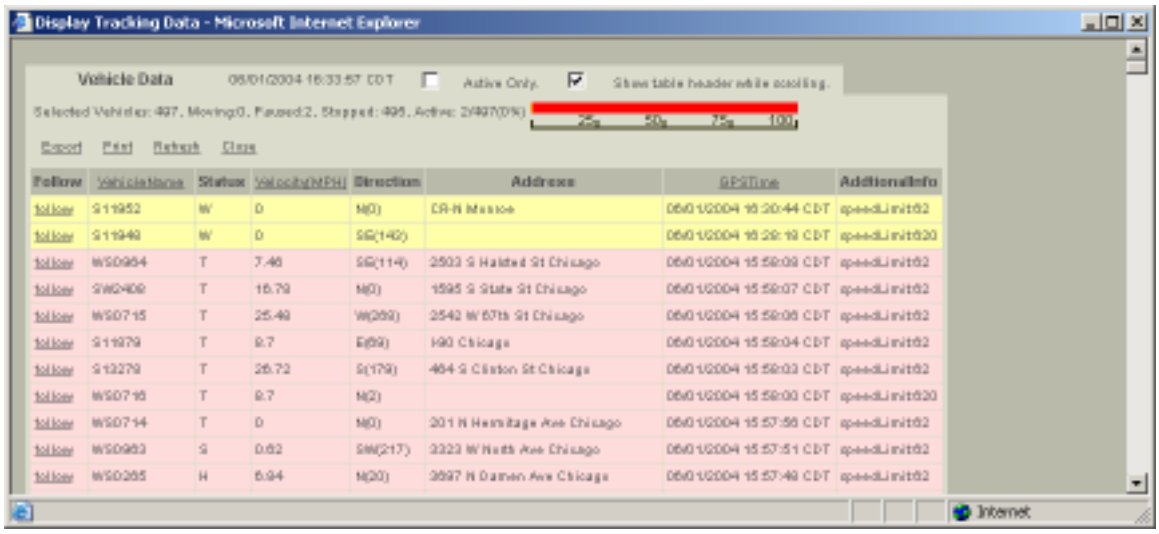
The client consists of a standard web browser. Vehicle data feeds from the vendor' site are translated from native GPS coordinate system to Illinois State Plane 83 which is the coordinate system used by the City's GIS data layers. Positions are rendered using an ArcIMS acetate layer. The City's ArcSDE repository is also used to supply all mapping layers used in the application.



Overall Architecture

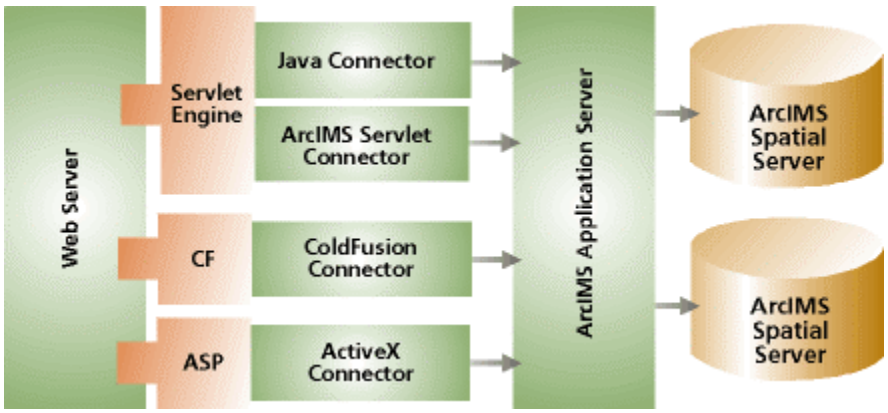
Support for multiple AVL vendors is implemented by providing a standard text-based communication protocol to the Chicago AVL system. The application can now handle a number of database feeds via connections established outside the City's firewall.

The application also provides of the utilization of a number of pop up windows using Java Server Pages (JSP) for such items as real time vehicle lists and other status reporting tables as shown below.



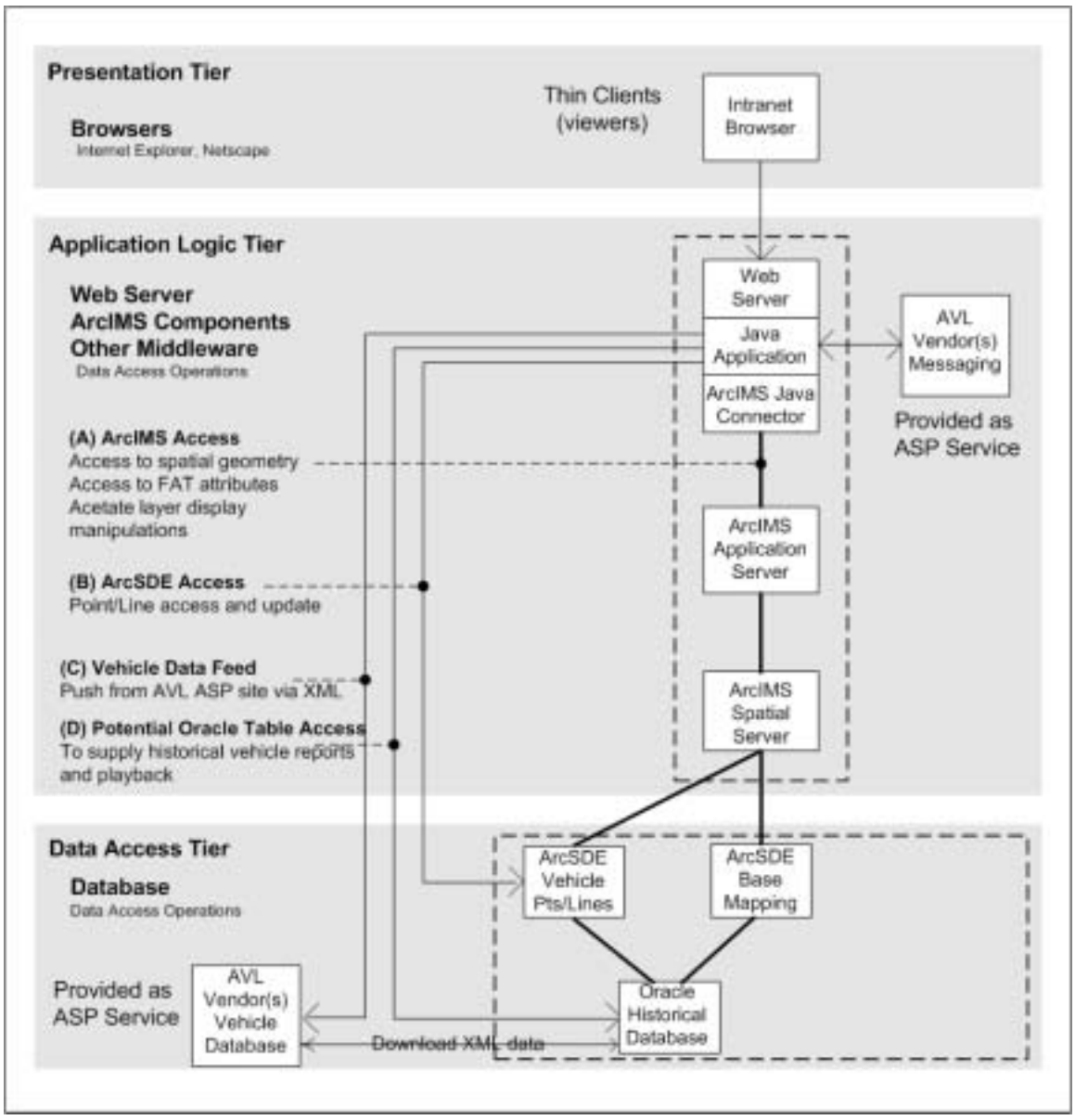
Pop up JSP window for real time Vehicle status reporting

The application completely sits within the ArcIMS footprint. Using the Java connector to connect to Servlet Engine. The figure below shows the standard ArcIMS internal components with the Java Connector and Servlet Engine shown at the top.



Internal ArcIMS components

Server side application requires servelts running on the ArcIMS server to provide nearly all the Chicago AVL functionality. Server side – multi threaded application using servlets working with a series of pools called Vehicle, Text Messaging, and spatial alerts. The pools are monitored on a continuous basis with data being recorded to the vehicle database, or reported directly to the clients via alerts as required.



Server Side Application components

GeoAnalytics ported the application running ArcIMS first into the City's new application server environment – Oracle 9iAS as part of their existing Oracle Enterprise site license.

Future Plans

The City will continue to seek ways to enhance and build upon the functionality of the Chicago AVL system. The City's strategy of maintaining a redundant internal ArcIMS site sets a standard for internal operations without locking into one particular vendor or technology. Planned enhancements for the next year include:

- Implementation of redundant database for historical reporting and integration with enterprise applications. This database will also enhance AVL reporting with the ability to link to business data related to vehicles, departments, and drivers.
- Use of the wireless link imbedded in the GPS device to provide laptop access to Chicago enterprise systems from the vehicles.
- Use of telematic sensor tracking of various vehicle components.
- Display of road closures and construction permits from data retrieved real-time from internal permitting systems.
- Display of the locations of live 311 calls, 911calls, and Dig Requests. This data will allow dispatchers to leverage vehicles already in the field to address these work orders. With the real time mapping of the calls, dispatchers could find the closest vehicle to the service request and decrease response time.