Providing First Responders Critical Real-Time GIS and AVL Information

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Abstract

The City of Colorado Springs facilitates delivery of critical spatial information to fire apparatus, dispatch centers, incident command and emergency operation centers simultaneously. This is an enhanced Automated Vehicle Location (AVL) system that provides updates from different departments and agencies in real-time. It provides first responders valuable insight into current resource and situation status changes. The system provides routing on the fly, manages traffic signal preemption and displays these actions in the vehicle, which facilitates more effective response. Vital information is displayed via a touch screen monitor to the responder with very little interaction required. The system automatically presents information needed to understand the location and nature of the incident. This allows teams to focus and prepare for the actual situation. By integrating multiple systems--traffic, fire, addressing, utilities, CAD, networks, wireless and GIS data and analysis--traditional AVL becomes greatly enhanced.

Introduction

Using Federal grant funds for Congestion, Mitigation and Air Quality (CMAQ), the City's Traffic Management Center embarked on an AVL system for Transit, Public Works and Fire. The design and development of the project started in 2003 with substantial implementation by March of 2005. The Fire Department identified and implemented additional enhancements specific to emergency response. Primary among these are traffic signal control, routing for apparatus and a highly capable in-vehicle computer with a touch screen interface.

Equipment

The system's equipment can be broken down into two major categories: in-vehicle and core infrastructure. The in-vehicle equipment is comprised of GPS receivers, City-built custom computers, 802.11b and 900MHz radios, touch screen displays and custom communication and mapping applications. (Figure 1)

The core infrastructure is comprised of central servers that receive and store vehicle location data, geospatial data, a routing engine that determines optimal emergency response routes and an ITS (Intelligent Traffic System) to control traffic signals. Additionally the system interacts with the City's CAD (computer aided dispatch) system, traditional and wireless networks as well as radio masters and repeaters.

Figure 1

System Description

The system works in the following manner: 1) Fire vehicles transmit their location over a wireless infrastructure to a central server approximately every 4 seconds. 2) When an emergency call is received by 911, the caller's address is located on a map by a MapObjects location engine (exact address match, geocoding, map grid validation) 3) A computer algorithm running NetEngine finds the optimum route between the caller's location and the fire apparatus assigned to the call and transmits this information to the emergency responder's computer. 4) A MapObjects based application in the fire apparatus displays the location of the incident, the location of the fire apparatus, the street network and the route for which traffic signals will be turned green. 5) After the fire apparatus responds through green traffic signals, the signal returns to normal operation. 6) The in-vehicle computer automatically zooms and pans the map to show more information such as building footprints and fire hydrants as the fire apparatus approaches the incident. 7) If there is building/business information available (such as emergency contact, Knox box information, hazardous materials, fire system information, or inspection history) from the Fire Prevention database for the incident address, the responder can view this information through a single touch on the display. (Figure 2)

Figure 2

Improvements in the system can occur on a daily basis. This includes updating GIS data, tuning the routes to match the crew's recommendations, improving the timing of the signal pre-emption algorithm and maintenance of information in databases. While the value of the system has been proven, the potential for enhanced capabilities and the delivery of more information is limitless.

Benefits

This system has demonstrated tangible benefits for the City of Colorado Springs and its citizens. It has improved the efficiency of Fire response by accurately identifying the locations of incidents. Whether en route or on scene crews have the ability to see information around the incident such as hydrant locations, access, building footprints, staging points, etc. Crews also enjoy the ability to see the location of all fire companies responding to their call. This has proven beneficial to incident commanders by allowing them to visualize both the situation and the resources that are staged around it.

Personnel working in unfamiliar and developing parts of the metro area have indicated the assistance of the system is critical in locating calls and navigating to the address. Crews have also conveyed that their safety has increased because of the implementation of the signal preemption portion of the system. As they cross intersections with lights and sirens – they have been able to navigate safely because the traffic signals have been set up to hold opposing and oncoming traffic.

Other unexpected improvements have been decreased stress levels for the crews and an improvement in fuel efficiency. A change in response driving has been effected from “hard on the breaks, hard on the gas” with near misses in intersections to a “steady speed response” with calm traffic. Fire crews have enjoyed the ability to easily and reliably locate addresses at night without the need for spotlights. These changes have resulted in an improvement in responder and citizen safety.

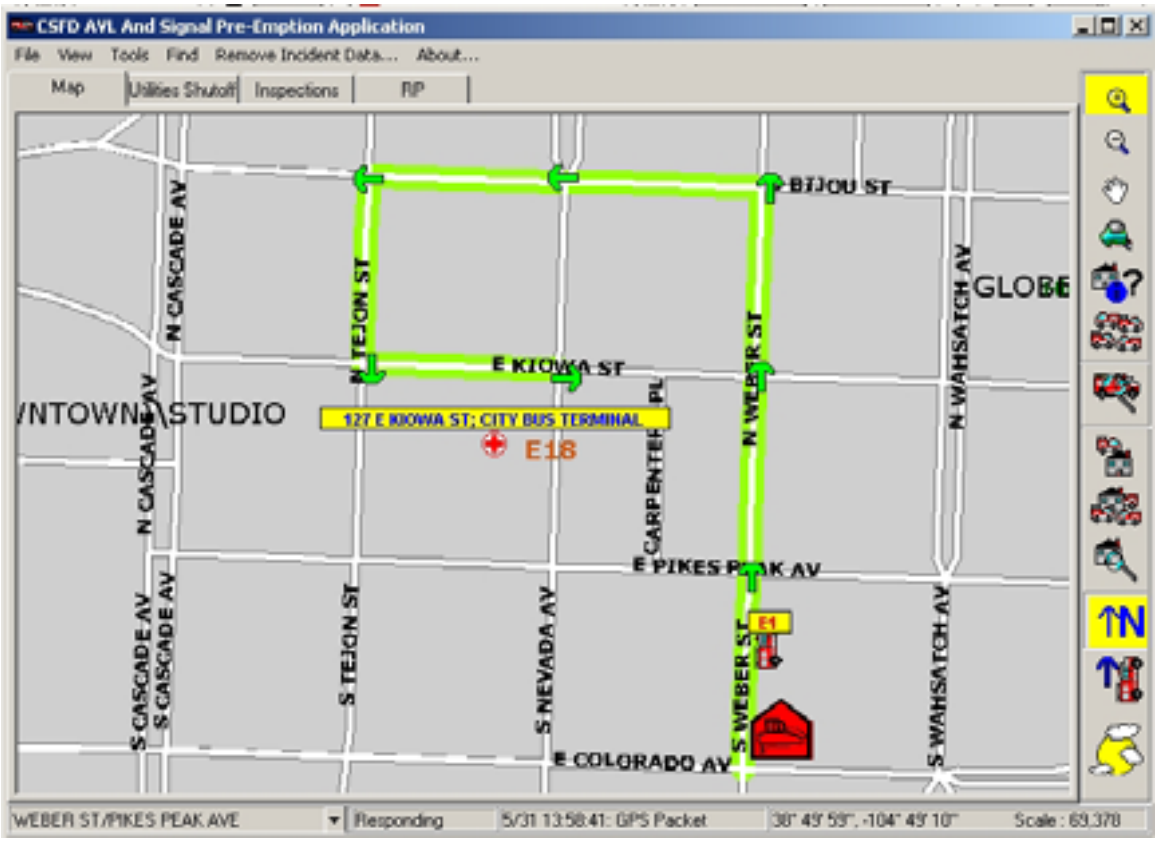

Figure 3

Figure 3 shows an in-vehicle display of apparatus being dispatched. Notice the highlighted route in green and the green arrows indicating traffic signals being pre-empted. This route takes into account turn penalties and Kiowa and Tejon streets being one way.

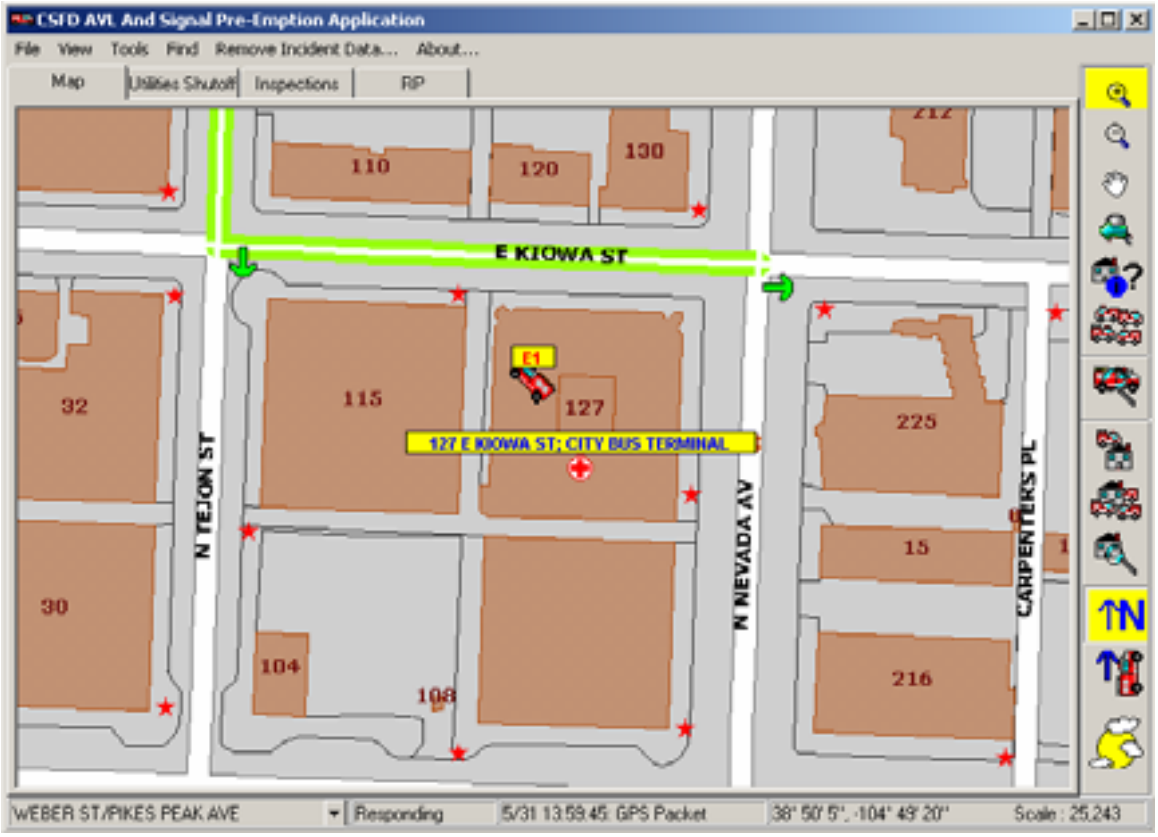

Figure 4

Figure 4 shows an in-vehicle display when zoomed into the map. Notice the building footprints, hydrant locations (red stars), curb lines as well as building numbers. Additional information is available with tabs above the map.

Other Benefits

Central Access - Since the incident and vehicle data is available on central servers, apparatus location and incident locations can be viewed by incident commanders or managers to communicate a common operational picture and facilitate incident management and move-ups. Through a web application (Figure 5), incident commanders or managers can view the current location of City resources and active emergency calls. This “big picture” helps to identify the need to reposition resources as well as communicate the scale of a large incident. A history of vehicle position updates can be retrieved to show a trace of the apparatus position over any period of time to recreate the details of a response.

Figure 5

Non-emitter signal pre-emption - Another innovative aspect of the system is the introduction of a non-emitter based approach to signal pre-emption. Rather than rely on on-board transmitters and detectors on traffic signals, the system uses vehicle location and control by a central server to pre-empt traffic signals for emergency responders. This approach also allows for the system to pre-empt signals around a corner whereas an emitter system only works on signals in the line-of-sight of the emitting device. The potential for abuse by unauthorized personnel in possession of a personal emitter has also been eliminated.

Development and Testing

The most valuable participative element of the system has been the hand-in-hand development between the City's technical personnel and the Fire Department line personnel. Rather than acquiring a commercial off-the-shelf product for the Department to use, the project has involved CSFD personnel in building a system that meets their specific needs. Thus, initial and on-going involvement of CSFD personnel is a key feature of the project. The look and feel of the application and its default operation has been tailored to improve its use by

emergency responders. The current operation and planned enhancements have been shaped by the invaluable participation of CSFD line personnel.

The largest area of community and citizen participation has been in the tuning of the signal pre-emption algorithm. While there was extensive testing of the algorithm to determine the optimum route and signal timing, the real operation of the system has been refined through citizen and emergency responder feedback. Emergency responders have provided valuable information about preferred routes over those suggested by the algorithm. With this feedback, we have been able to modify the algorithm or the data driving the algorithm to match the preferred route. Participation from the citizens has been valuable in correcting problem areas either with the pre-emption algorithm or the signal system itself. While some feedback has helped to identify problems, other feedback has conveyed satisfaction when informed the signal operation was consistent with improving the safety and timeliness of emergency response.

Conclusion

Improvements have been achieved in emergency responder safety and citizen safety. The nature of emergency driving is also being improved and that is having a positive effect on the safety and effectiveness of response. With the delivery of more information to fire personnel, better decisions can be made in the field and a more complete view of the incident environment is possible.

This system is highly innovative and creative in that it utilizes many existing systems: GPS, traffic signals, CAD, GIS, and Fire Prevention databases. By integrating these systems with interfaces, wireless communication and in-vehicle computers, the near real-time delivery of incident information to emergency responders in a visual format is achieved.

Acknowledgement

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