Automatic Crash Notification and 9-1-1: A Success Story

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at the
ESRI User's Conference
August 2004

Abstract

Seconds make the difference between life and death in a vehicle crash. What if Emergency Medical Services could be immediately dispatched to the location? The Greater Harris County 9-1-1 Emergency Network and others have joined to provide Automatic Crash Notification (ACN) to the existing 9-1-1 infrastructure. In a crash the ACN device provides GPS location and other critical data elements. This information is routed to the nearest 9-1-1 call center, and a voice link is established with the vehicle occupants. Even if the occupants are unable to communicate, the location information is used to dispatch the closest emergency response to the vehicle. This technology has shown that existing 9-1-1 infrastructure can use this information. The next step is to provide critical crash data from the ACN device to the nearest trauma center. GIS plays a critical role in ACN. Come see how 9-1-1 and GIS are helping save lives.

Overview

Each year, more than 6 million crashes occur on US highways. Motor Vehicle crashes kill more than 41,000 people, injure about 3.2 million, and cost more than $160 billion each year. Thousands die each year, and far more suffer severe and lasting injuries, because emergency responders do not know when or where a vehicle crash has occurred. Precious minutes and lives are lost because emergency responders cannot automatically locate a vehicle accident in order to dispatch appropriate emergency care. Telematics devices, which incorporate communication and location technology to a motor vehicle, along with other off-the-shelf technologies can greatly reduce these staggering statistics.

The Greater Harris County 9-1-1 Emergency Network and the Ford Motor Company formed a partnership to install advanced telematics devices and sensors in a fleet of 500 police and fire vehicles in the Greater Houston area. This Advanced Automatic Crash Notification (AACN) Project partnership uses advanced telematic devices, enhanced sensors, and a state-of-the-art crash detection module (CDM), in each vehicle. The telematic devices include a GPS to determine location (or the last location prior to losing "sight" of the satellites), sensors to gather a wide variety of information and vehicle orientation, and a Crash Detection Module to gather and transmit all data pertaining to both occupant(s) and vehicle status.

Background

The main objective of the Greater Harris County 9-1-1 Emergency Network's (GHC 9-1-1) Advanced Automatic Crash Notification (AACN) project was to integrate emergency calls from the providers of Telematic services, such as Cross Country Automotive Services and OnStar™, into the "Native 9-1-1 Network Infrastructure". The AACN project has shown how valuable this advanced vehicle crash and occupant data can be to 9-1-1 and emergency response.

This AACN data has proven invaluable in assisting emergency responders in determining severity of crashes, their potential impact on accident victims, and the appropriate emergency response to dispatch to the scene. This project proves ACN service can be implemented into existing 9-1-1 infrastructures with a minimum of cost, and with no impact on legacy systems, networks, and switch environments. This project has also demonstrated how invaluable this type of information is to meeting the needs of an Intelligent Transportation system.

Telematics devices have been in vehicles for some time. Historically these devices have the ability for the vehicle occupants to contact their Telematic Service Provider (TSP) when assistance is requested, or when an airbag is deployed. Current devices provide a minimum of vehicle information and location data. Today's generation of telematic devices is severely limited in their ability to provide other information, essential to responding agencies, to determine severity of crashes and occupant status. The AACN project has overcome these limitations by working closely and forming partnerships with a diverse group of companies and agencies.

Up until the inception of GHC 9-1-1 AACN project, TSP's have been dependent on airbag deployment or drivers to initiate communication for emergencies requiring immediate response. Once voice communication and data is established with the TSP, the TSP's relies on manual lookup and dialing procedures to reach the proper emergency response agency. The TSP's call the 9-1-1 centers on their ten digit administrative lines, which are not treated as priority calls. Emergency calls to administrative numbers for 9-1-1 PSAP's are second in priority to the calls that come directly to 9-1-1 via the well-established "Native 9-1-1 Network Infrastructure".

Another weak spot with the current means of relaying of information from the TSP's to the 9-1-1 call center is maintaining lists of administrative numbers. When one considers the additional need of telephone numbers for the associated police, fire, and EMS agencies, it is easy to see how this tedious process is prone to errors. There are over 4,300 PSAP's alone and over 10,000 different Emergency Medical Service agencies in the US.

Emergency calls on 10 digit administrative lines cannot display data on the 9-1-1 computer systems. With 10 digit administrative lines, any location or accident related information reported by a TSP is strictly by voice. This method is prone to delays from having to repeat and verify all information, which can easily lead to miscommunications and errors. The "Native 9-1-1 Network Infrastructure" allows display of a wealth of information on a 9-1-1 call takers computer screen.

The current TSP to 9-1-1 call center method often results in delays and lag times in dispatching emergency help due to the meticulous verification required during such a call. To compound these problems, the TSP's can never be sure they are transferring their information to the correct responding agency, often resulting in more delays. Another problem is the TSP's spatial data may not match the local spatial data for locations and naming conventions, again resulting in miscommunications and delays.

GHC 9-1-1 AACN project is the First Office Application in the nation for interfacing TSP's and their clients into the National 9-1-1 Native Network Infrastructure. This eliminates the awkward and error prone process TSP's now use to transfer information regarding vehicle emergencies. With the GHC 9-1-1 enhancement, calls from TSP's are transferred directly into the proper 9-1-1 PSAP, with a minimum of human intervention. The project is also the first to use advanced telematics technologies for generating and transmitting precision vehicular, crash, and occupant

data using new Crash Detection Modules (CDM) technology, which is very similar to the "black box" used on commercial airlines.

The CDM integrates triaxial accelerometers, cellular communications equipment, Global Positioning Satellite (GPS) devices, enhanced sensors, and crash recognition and characterization software. The crash recognition and characterization software can analyze crash forces in real time to determine when thresholds, indicating the likelihood of serious injuries, are exceeded.

In the event of a vehicle crash, or when certain crash element parameter threshold are exceeded, the information from ACN and CDM devices are sent to Cross Country Automotive Services in the form of a compressed crash pulse of data. Cross Country Automotive Services is the TSP for this project. This information then goes to appropriate 9-1-1 call center were computer monitors display key crash pulse information.

The Automatic Crash Notification Process

Upon detecting a crash, the ACN device automatically open communications with Ford Motor Companies contracted TSP, Cross Country Automotive Services (CCAS). The device's CDM gathers information from the various sensors and the ACN device transmits a data crash pulse to CCAS. The crash pulse includes vital vehicle information such as speed, delta velocity, direction of forces exerted on the vehicle during the crash, vehicle heading, final resting position of the vehicle, vehicle occupants, seat belt use by occupants, roll over information, and the GPS location of the crash.

Each ACN device has a unique ID that matches a vehicle profile. This profile identifies the vehicle owners, or in this case, the public safety agency, to which the vehicle belongs. This vehicle database also contains information including the color, make, model, vehicle identification number, license plate number and emergency contact information relevant to the owner. Specific medical data can also be part of a database. The vehicle owners, or likely vehicle occupants, medical history, medical conditions, allergies, blood types, or other needs can be passed on to the emergency responders.

Cross Country Automotive Services (CCAS) and GHC's 9-1-1 database provider, Intrado, along with the local telephone services provider, SBC Corporation, developed and established network elements, processes and switch applications which allow the ACN emergency call to be transferred to the closest 9-1-1 PSAP. Using the GPS longitude and latitude (X, Y) information received from the vehicle, CCAS extracts the location and sends this bit of data to Intrado. Intrado uses their Coordinate Routing Database to determine, by a simple point in polygon method, the correct PSAP to receive the call. Once the proper PSAP is determined, Intrado passes back to CCAS the correct routing number to connect with the appropriate 9-1-1 PSAP through SBC. With routing number, the call from CCAS into the Native 9-1-1 Network can begins. This entire process usually takes under eight seconds and requires little human intervention.

Computer displays as CCAS show all information provided by the ACN and CMD devices, key components of this information is sent to the 9-1-1 PSAP. Computer monitors at the 9-1-1 PSAP show the key information from CCAS on a monitor, and a map of the GPS coordinates atop the local GIS base data, on another monitor. Another partner in the AACN project, Plant Equipment, Inc., modified their 9-1-1 computer software to allow CCAS to send XML data streams to the 9-1-1 call centers for display on their 9-1-1 computer systems. Using the local GIS database for the

map display, the PSAP can quickly dispatch the appropriate emergency services to the accident location. By knowing how may people were involved, if the vehicle rolled over, the severity of the accident from delta velocity, the final orientation of the vehicle, and other key data elements, the proper types and number of emergency units can be rushed to the scene.

History of the ACN Project

Conception of and planning for ACN service by GHC and its partners started in November 2001. Official start of the project was in June of 2002 when 500 police and fire vehicles, in Harris and Fort Bend Counties, were configured with ACN Telematics devices. Evaluation of all operations, procedures, and other elements was accomplished over a two-year period with an official termination date of June 2004, although all service elements will be left in place including devices in vehicles after official completion of the project.

The initial success of the ACN project spawned a subsequent stage of ACN Service. The Emergency Roadside Medical Messaging System underwent a successful systems integration test on September 30, 2003. This application allowed subscriber medical data to be transmitted to EMS vehicles in route to the vehicle accident. This application further enhances the response profile of the ACN service introduced in 2002. Uniquely identified, victims of a crash involving an ACN equipped vehicle will have readily available medical data and healthcare provider information stored in a secure database. It will be accessible by EMS personnel for treatment on site at accidents and for Trauma Center medical staff to provide guidance on emergency treatments.

Innovative Aspects

The ACN Project is unique in that the partners involved encompass diverse industries whose goals and objectives would first seem very different. As the primary partners and financiers of the project, GHC 9-1-1 and Ford Motors developed common goals and objectives, and brought into play all their subcontractors. All entities working as a team have made the project a success. The other entities involved in the project are Cross Country Automotive Services (CCAS), Veridian Inc., Intrado Inc., Southwestern Bell Corp., Plant Equipment Inc., and recently Roadside Telematics. Contributions by entities include:

- Intrado developed Positioning Servers and Coordinate Routing Databases capable of routing ACN calls to any 9-1-1 center in the nation. This spatial technology is currently used to route over 50 million wireless 9-1-1 calls each year throughout the nation.
- Intrado and CCAS developed primary and backup network elements and processes to rapidly transmit vehicle crash data to 9-1-1 centers.
- Intrado and SBC coordinated efforts for providing unique switching and routing processes within the 9-1-1 switched networks to route ACN calls to appropriate 9-1-1 Public Safety Answering Points (PSAP).
- CCAS upgraded internal switching elements for uniquely delivering vehicle emergency calls via the Native 9-1-1 Network Infrastructure.
- Ford Motor Company co-funded the project, and with CCAS developed vehicle profile databases uniquely identifying each vehicle in the project.
- Ford Motors and Veridian Inc. developed the enhanced telematics devices and sensors that were configured in each vehicle.

- Greater Harris County 9-1-1 Emergency Network co-funded the project, recruited the 24 police and fire agencies now in the project, and coordinated the installation of devices in their fleets. 500 vehicles have been volunteered by these agencies to be configured for ACN service providing a wide spread geographic footprint for the project's analysis. Recognizing both the officer safety factor of the service and willing to contribute efforts to advance this service for the public, they have been enthusiastic supporters of this endeavor. Working with Intrado, GHC 9-1-1 project-managed the related database enhancements, switching and network interfaces and established procedures, processes and training required bringing the new service into 9-1-1 environments.

All entities established intense training lessons and processes for call handling on a 24 by 7 basis. GHC 9-1-1 trained 1200 PSAP call attendants across 42 different 9-1-1-response centers. CCAS trained all its call attendants. Officer driving the ACN equipped vehicles' were also trained in ACN service by GHC 9-1-1. Initial and continual test plans were established to maintain skill levels and to continually assess the health of the ACN network. Bench testing and testing from ACN simulator equipped vehicles is ongoing.

The Texas Harris and Fort Bend County police and fire departments participating in the project are as follows:

- Memorial Village Police Department
- Friendswood Police Department
- Pasadena Police Department
- University of Houston Police Department
- Humble Police Department
- West University Police Department
- Deer Park Police Department
- League City Police Department
- Jersey Village Police Department
- Baytown Police Department
- Hedwig Village Police Department
- Tomball Police Department
- Pasadena Independent School District Police Department
- Stafford Police Department
- Houston Fire Department
- Fort Bend Sheriff's Office
- Sugar Land Police Department
- La Porte Police Department
- Houston Metro Police Department
- Lakeview Police Department
- Katy Police Department
- Texas Department of Public Safety (DPS)
- Houston Independent School District Police Department
- Rosenberg Police Department

The GHC 9-1-1 ACN Project was designed with the flexibility to support many applications other then vehicle telematics. Any type of emergency services, which can provide spatial

location information, can be integrated to 9-1-1 call centers via this interface. Personal emergency call devices, alarm systems, and similar devices, can easily be integrated as well.

Using off the shelf technologies, the telematics units can easily be modified for use in any type vehicle. Government agencies at all levels would benefit from ACN service by providing a higher level of safety for their employees, quicker emergency, and medical responses in case of accidents. From a homeland security standpoint, it also provides for immediate emergency contact by drivers concerned with reporting endangerment to the community at large and would provide geo-location of where the danger lies. Twenty percent of the nation's accidents occur in rural areas; these accidents are responsible for a stunning sixty percent of fatalities. With advanced ACN systems capable of connecting into the 9-1-1 network, this sixty percent could be decreased.

Status and Accomplishments

Test and actual crash results across the ACN network elements continue to prove the viability of the ACN system as designed. Over twenty major vehicle crashes have occurred that triggered the ACN devices in the cars. Data analysis continues to indicate that all automated processes put in place to transmit data and voice directly to 9-1-1 PSAP's work superbly. Average total automated connect and communications set up time remains between 35 to 60 seconds while dispatch and emergency response scenarios to the precise accident location have occurred within two minutes of the crash detection. Data elements collected from the crash pulse information closely correlate to human driver and accident investigator observations. This indicates that the elements themselves are proving useful in analyzing potential severity of the crashes for use by EMS responding agencies. In one extremely critical crash, the driver was knocked unconscious. ACN service provided all location, vehicle and occupant data to the 9-1-1-dispatch point within seconds expediting the dispatch to this accident with minimum delay.

Call completion results across the ACN network to 9-1-1 response centers is 99.8% encompassing both test and actual incident calls. Remaining calls are handled via the manual dialup backup mode. ACN services across the project's vehicle fleet are proving to be both an accomplishable goal and one with extreme merit for application nationwide.

Lessons Learned

A well-conceptualized, planned, and managed project that takes advantage of proven technologies is capable of providing services, which, in other cases, would appear to require new approaches, technologies, and processes. The ACN project's primary lesson is that the 9-1-1 industry is service oriented and not profit driven. However, the 9-1-1 industry can form partnerships with other industries to provide services that are beneficial to victims in crisis. The partnerships can also develop services with the potential of producing profitable offshoot products and services in a myriad of client applications.

General reaction to the project and its results is extremely positive. Police and fire agencies participating in the project are enthusiastic about the service's potential officer safety factor. Dispatch and response centers now recognize the potential for accurately locating accident sites and are equally interested in the vehicle and occupant data that enhances their ability to analyze severity of crashes.

Both senate and congressional attention at the federal level continues to be interested with this project, and its potential applications for advanced services such as Trauma Center and EMS interfaces and applications. The US Department of Transportation, at the highest directorship levels, is extremely interested in the project's results from a national application standpoint and lauds GHC's endeavors.

Auto, health, TSP and emergency response industries are all vitally interested in the project and hoping this project will help set the standard by which national applications of the service are introduced. The University of Houston's Intelligent Transportation researches, and several others, are interested in how the ACN project tracks closely with their endeavors for public services and homeland security venues. Similar ACN projects are now being planned in two other states, Michigan and Minnesota.

One of the most successful aspects of the project has been the application and use of legacy systems and networks thus proving that new services can be integrated at a minimum cost. Minimum training and procedural changes are required resulting in practically no disruption of current practices and operations.

The ACN system has provided Ford Motors with valuable field crash data, which is being analyzed to fine tune computer modeling programs that can provide injury predictions in real-time to trauma centers and/or EMS technicians. In addition, data from crashes has provided Ford Motors with sufficient information in order to design new generation ACN devices based on digital cellular switching technology.

An internal Ford Motors award consideration was given to the project for both the Global Operational Excellence Award, and the Body Engineering Technical Excellence Award. This AACN

project recently received a best of breed award from the Telematics industry.

The partners in the project continue to exhibit and present the ACN service at seminars and conferences, such as the 2004 Intelligent Transportation Systems Association (ITSA) conference in Minneapolis, MN. A recent presentation was given to Volvo, in Sweden, at their request.

In May of this year (2004), CCAS rolled all their Volvo On-Call Plus line of services to the GHC 9-1-1 ACN service infrastructure. Currently any of their cars within Greater Harris County and Fort Bend County can benefit from Native 9-1-1 calls requiring geo-location information.

The project has not met any major delays, obstacles, issues, problems, or potential negative impacts. Problems that do arise are quickly addressed, and resolved, jointly by all entity project managers. This tight cohesion of diverse industries is not normally associated with these types of partnerships.

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