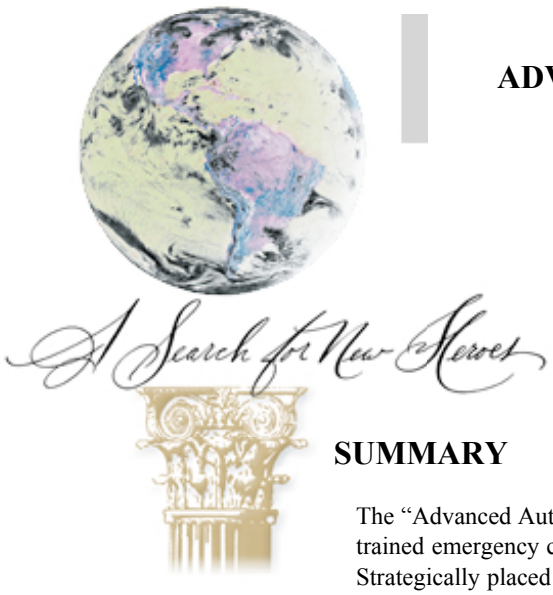

Robert Carrigan,
Chairmen of the Chairmen's Committee

Ron Milton,
Vice-Chairman of the Chairmen's Committee

Dan Morrow,
Chief Historian

ADVANCED AUTOMATIC CRASH NOTIFICATION (AACN)

2005 COMPUTERWORLD HONORS CASE STUDY

TRANSPORTATION

THE "ADVANCED AUTOMATIC CRASH NOTIFICATION" SYSTEM AUTOMATICALLY NOTIFIES SPECIALLY-TRAINED EMERGENCY CALL CENTER ADVISORS OF MODERATE TO SEVERE FRONTAL, REAR OR SIDE-IMPACT VEHICLE CRASHES. SENSORS RELAY CRASH SEVERITY INFORMATION AND METRICS THAT ARE COMMUNICATED TO 911 DISPATCHERS TO ASSIST IN DETERMINING THE APPROPRIATE RESPONSES. **[20055291]**

SUMMARY

The "Advanced Automatic Crash Notification" (AACN) system is designed to automatically notify specially-trained emergency call center advisors of moderate to severe frontal, rear or side-impact vehicle crashes. Strategically placed sensors relay crash severity information and metrics that are communicated to 911 dispatchers to assist in determining the appropriate emergency personnel, equipment and medical facility support needed. AACN helps the emergency and medical professional community to save lives and keep injuries from becoming life-threatening. This technology combines in-vehicle telematics, electronics, crash sensing and human safety engineering. It is the first and only system of its kind to be offered anywhere in the world.

APPLICATION

BACKGROUND - OnStar is a wholly-owned subsidiary of General Motors. Its premise since inception in 1996 is to deliver safety, security and information services to mobile customers through a combination of embedded technologies. Available on more than 50 models from GM and select brands from 5 other auto manufacturers, OnStar is the nation's leading provider of in-vehicle safety, security and communications services using wireless technology and the Global Positioning System (GPS) satellite network. OnStar services include automatic notification of air bag deployment, stolen vehicle location assistance, emergency services, roadside assistance with location, remote door unlock, GM Goodwrench remote vehicle diagnostics, route support and convenience services. OnStar's Personal Calling service allows drivers to make and receive voice-activated wireless calls through a nationwide cellular network and access a wide range of other information services.

OnStar's in-vehicle safety communications system utilizes hands-on-the-wheel eyes-on-the-road capabilities. The world's first broad sample study of the association between vehicle crashes with airbag deployments and embedded cellular technology conducted by GM (as part of its SenseAble Driving Program) confirmed that OnStar's voice centric approach has an outstanding safety record. Out of the 8.1 million embedded telematics calls studied over 4 years only 2 accidents with air bag deployments occurred during the time of a call.

At year end 2004, OnStar passed the 3 million subscriber milestone, pointing at the market's acceptance of this valuable life-saving service.

GOAL of AACN – OnStar's latest technical innovation, the next-generation "Advanced Automatic Crash Notification" (AACN) system, is a significant advancement in the field of vehicle safety and emergency medical response. AACN opens a new era in the use of automotive and communications technology to help save lives and mitigate injuries. It surpasses earlier generations of crash notification systems capable of communicating partial information such as air bag deployments (e.g. Automatic Crash/Airbag Deployment Notification or ACN) in that it provides a 360-degree perspective of a crash including key crash metrics.

METHODS - AACN uses a series of strategically located crash sensors that collectively calculate an accident's severity. The intelligent system discerns between front, side and rear impacts and a broad range of data including near and complete air bag deployment, number of impacts, severity calculations and rollovers (in vehicles equipped with a rollover sensor). It automatically sends select crash details to specially-trained advisors at the OnStar Emergency Call Center, who in turn communicate the information to the geographically appropriate 911 dispatch center -- also known as a Public Safety Answering Point (PSAP). This information can help in assessing the likely severity of injuries, the resources required at the scene of the accident and the medical facility best-suited to treat the victim(s).

CONTEXT - In the U.S., about 43,000 people lose their lives on the road each year and about 2.9 million sustain serious injuries, according to the National Highway Traffic Safety Administration. The non-profit group of public safety, medical, communications, telematics and EMS providers known as ComCARE estimates that, although deaths from vehicle crashes have declined in recent years, deaths at the crash scene prior to the arrival of emergency care responders have doubled in the last 20 years and now exceed 20,000 per year. Many of these lives could be saved and the effects of injuries could be mitigated if the right medical attention is provided in a short time span. This is of particular importance in rural areas where distances are longer and the odds that a passerby can report an accident are lower. According to the National Highway and Traffic Safety Administration, the average length of time between a fatal crash and arrival at an emergency room is about 35 minutes in an urban area and about 52 minutes in a rural area. Although less than 25% of total crashes occur in rural areas, they account for approximately 60% of fatalities.

ACHIEVEMENTS - By helping reduce the time between when an accident occurs, when the victim(s) receive care at the scene and when he/she is transported to the most appropriate medical facility, the AACN embedded system can help in saving lives and possibly mitigating the effects of injuries.

LEADERSHIP - OnStar by GM is the recognized leader among Telematics Service Providers (TSP). In January of 2005, GM announced that by the end of 2007 OnStar will become standard equipment for retail customers in the U.S. and Canada, covering all segments and prices (except for some commercial vehicles).

AACN is OnStar's most advanced in-vehicle safety and security service and among the automotive technologies upon which customers place extremely high value. It responds to customer concerns for enhanced vehicle safety and is supported by leading experts in the emergency and medical fields.

As the first and only system of its kind to be offered anywhere in the world, the implementation of AACN provides OnStar and GM with a competitive advantage and is a powerful differentiator in today's marketplace. GM's commitment to OnStar demonstrates leadership, not only in terms of the development of safety technologies like AACN, but also in moving fast to market.

SCOPE – AACN was initially introduced in 2004 with the launch of the Chevrolet Malibu and Malibu MAXX, yet the number of GM vehicles equipped with AACN is rising rapidly. Today, already there are more than 200,000 AACN-equipped vehicles on the road. By the end of the decade, it is estimated than more than 10 million GM vehicles will be equipped with AACN system.

Beyond market considerations, the advent of AACN also is helping drive the development of a technologically advanced emergency services data network in the U.S. capable of more fully leveraging this technology. A research and pilot program involving OnStar's AACN is currently underway in 14 states.

BENEFITS

OnStar's AACN offers an enhanced level of in-vehicle safety and security to customers. It has broken new ground in the field of emergency and medical services through its ability to provide high-quality, detailed and critical accident information and to help reduce the time between when a crash occurs and when comprehensive care is administered.

The AACN system measures, analyzes, captures and relays to emergency personnel a range of critical technical information. The information provided to Public Safety Answering Points (PSAPs) covers accident severity factors such as principal direction of force, whether the vehicle experienced multiple impacts, the number of front and side airbags deployed and whether there was a rollover (applies to vehicles equipped with rollover sensing). The trauma community has studied extensively automobile crashes and their outcomes to correlate pre-crash and crash characteristics to the type and severity of injuries. AACN provides prompt, accurate and objective information and metrics that, when interpreted by expert medical emergency personnel, can help drive critical decisions such as:

· The appropriate EMS unit required(basic versus advanced life support)
· The mode of transportation (ground versus air ambulance)
· The right medical facility (closest hospital or regional trauma center)
· The mobilization of specialized professionals (neurosurgeons, orthopedists, etc.)
· The preparation of medical resources (emergency room, operating room, etc.)

"When EMS professionals have accurate information about the crash forces involved, the victims will receive more timely and appropriate care," said Dr. Jeffrey W. Runge, MD, NHTSA administrator. "The emergency

medicine community has been anticipating this for a decade, but only now is the technology ripe enough to be of widespread value. This is very important for the 'post-crash phase' of the government's mission to reduce death, injury and human suffering on our roads and highways."

The benefits of AACN are well-complemented by other GM and OnStar safety technologies. Among them is the "Alert Service" where an advisor can honk the vehicle's horn and flash the vehicle's lights so that it can be located quickly by emergency personnel even when out of sight. OnStar also provides Spanish and French-speaking advisors and a multi-language voice recognition system. AACN, in concert with other technologies, can help accelerate rescue and the accurate, prompt delivery of informed medical care.

OnStar's AACN is helping create benefits for the public at large as well. It has triggered the interest and support of key public, private and non-profit organizations that advocate and lead the development of an intelligent national emergency services infrastructure. It is also helping spark the development of related technologies.

For example, OnStar, the Mayo Clinic, the Minnesota Department of Transportation and a number of other government agencies have developed - and are demonstrating - the potential foundation for a national emergency data routing system. This field operations test is focused on developing the capabilities to route electronic information to a central data source that can be accessed and updated by emergency personnel in Minnesota - a leader in Intelligent Transportation Studies. Funded by a $2.8 million grant from the U.S. Department of Transportation and the Minnesota Department of Transportation, the test is expected to help in laying the groundwork for other states to participate and opens the door for an eventual electronic national network.

"This collaboration helps emergency responders provide the most appropriate care to patients as quickly as possible," said Dr. Scott Zietlow, a Mayo Clinic trauma surgeon and advisor on the initiative. He added, "The sooner we receive on-site crash information, the better our chances of saving lives and keeping moderate injuries from becoming life-threatening. In terms of emergency medical care for victims of vehicle crashes, this model is a huge leap forward."

OnStar's AACN is fundamentally changing the outlook for in-vehicle safety and emergency services by getting one step closer to instant and comprehensive accident-related communications between the vehicle, OnStar and the EMS community.

IMPORTANCE

Technology is the absolute enabler of OnStar's AACN advancement in the field of in-vehicle safety and emergency services. The seamless combination of key technologies coupled with a profound understanding of automotive safety drives AACN. Each of its carefully developed subsystems and components are a critical element in its operation and efficiency.

1. Engineering design and manufacturing processes integrate AACN technology during the vehicle's assembly.

2. A GPS receiver helps locate the vehicle.

3. A hands-free, cellular communications system offers the largest geographic footprint in the U.S.

4. The Sensing Diagnostic Module computes and captures vital accident information.

5. A serial data bus networking architecture transmits crash information from the vehicle sensors to the OnStar telematics module.

6. OnStar's telematics module sends information that, after receipt and electronic processing at the OnStar Call Center database, appears on the computer screen of specially-trained OnStar emergency advisors.

7. The use of generally recognized crash information and metrics is intended to facilitate the use of data by emergency service personnel.

At the core of the new AACN technology are sensors connected to a serial data bus vehicle networking architecture. In-vehicle networking or multiplexing allow for a decreased number of dedicated wires, decreased cost and weight, while increasing reliability and serviceability. It also allows flexibility in terms of future contenting and functionality.

A central Sensing Diagnostic Module (SDM) receives a 360-degree perspective of the crash from the dedicated crash sensors via the vehicle's electronic architecture or serial communications bus. The SDM uses a sophisticated algorithm to identify the type and severity of the crash experienced by the vehicle. Internal accelerometers measure the number, magnitude and direction of impact forces in any type of crash. Among the most important pieces of crash data calculated is the Delta Velocity (Delta V), an engineering measure of the forces in the crash. Generally, the higher the Delta V, the more severe the crash.

The criteria used for selecting crash data metrics was based on existing knowledge among leading experts of the principal indicators of the probability for bodily injury. Multiple sources including research studies and national statistics such as the government's Fatal Accident Reporting System (FARS) and the National Accident Sampling Information System (NASS) supported this selection.

The output of the Sensing Diagnostic Module is sent to the vehicle's OnStar telematics module or the vehicle communications platform (VCP) that houses the hardware and software necessary to provide two-way voice and data communications between the vehicle and OnStar Call Center advisors.

In a moderate or severe crash, the vehicle automatically calls OnStar for help. Once a cellular connection is successfully established, a brief data transmission exchange occurs between the vehicle's telematics module and OnStar Call Center systems. The crash information transmitted summarizes key metrics and includes: vehicle location; whether front and/or side airbags deployed; whether there were multiple impacts; whether there was a rollover (when specific rollover sensing is available); as well as the maximum Delta V for the most severe of two impacts; and the related Principal Direction of Force (PDOF).

Within seconds, the system switches from data transmission to voice mode. Advisors immediately communicate with the vehicle occupants via the established embedded cellular connection, to gather additional information such as whether the driver is conscious and coherent. The appropriate Public Safety Answering Point (PSAPs), is then contacted and provided with location; the select, objective technical data and conferenced with the vehicle occupants. Such critical information can allow them to make subjective interpretations such as the probability of severe injuries, the resources required at the scene of the accident and the medical facility best-suited to treat the victim(s).

The AACN technology is supporting the development of broad data transmission technologies and dispatch protocols. Research on AACN incidents across the country can help medical experts refine existing technology and protocols including, for example, the "urgency algorithm," a metric developed by researchers at the William Lehman Injury Research Center at the University of Miami School of Medicine and the George Washington University that estimates the probability of serious injury. AACN data is also expected to help improve vehicle safety technologies.

ORIGINALITY

OnStar's AACN system is the first and only of its kind to be offered anywhere in the world.

This pioneering technology was launched in the U.S. and Canada in 2004. It results from profound knowledge of telematics, vehicle crash dynamics, electronics systems, and human safety research developed over years. The multi-disciplinary expertise of the AACN development team coupled with aggressive business strategies, allowed for the system's early implementation.

Competitors aspire to implement comparable advanced systems capable of presenting a 360-degree perspective of a crash.

By leveraging GM's standing commitment to innovation in safety and technology in the development of AACN, OnStar is at the leading edge of the embedded telematics and the crash notification technology curve.

OnStar's AACN system emerged from a business environment that encourages and helps drive innovation. The subsidiary is among the most active patent applicants throughout General Motors' global operations, next to the highly-recognized R&D, fuel cell and powertrain research organizations. This is a significant achievement given OnStar's brief 9-year history as a GM subsidiary and the fact that GM has a 100-year history of technical innovation resulting in a range of life-saving inventions from the use of barrier crash tests in the 1930's and safety seats in the 1960's to stability control systems and, in recent years, the development of a new generation of instrumented crash test dummies.

SUCCESS

OnStar's AACN is the first crash notification system with this level of technological complexity to reach the market. AACN's ability to communicate more precise information than any other system in the market is a significant technological advancement. It is a major step forward from the first-generation notification technology. The new Advanced Automatic Crash Notification system can automatically report a comprehensive 360-degree perspective of moderate and severe crashes and provide a much greater level of detail.

"The wonder of AACN technology is that it will give us more crash information than ever before – a high tech crash 'photo' – which helps us to take better care of our patients,"said Dr. Rick Hunt, M.D., director of the Center for Disease Control's Division of Injury and Disability Outcomes and Programs, and past president of the National Association of EMS Physicians. Dr. Hunt is among the first EMS physicians to recognize the importance of crash data in medical treatment. He recalls instructing EMS workers in the 1980s to return with instant photos of crashed vehicles so he could correlate damage with possible injuries. "Until then, patients would be brought to the ER and we had no information on the crash at all," he added.

Consider that OnStar receives more than 11,000 vehicle emergency calls a month. Between 700 and 900 of these are triggered by frontal airbag deployments. With the more sophisticated capabilities of AACN, many more of these calls would report detailed critical information in aiding victims. Thus, AACN can respond to a significantly broader range and number of accidents.

OnStar's AACN technology signals significant potential for growth as awareness of the brand and its safety and security capabilities increases and as the volume of GM vehicles equipped with AACN expands.

Currently, more than 200,000 GM vehicles in the U.S. and Canada are equipped with the AACN system and the number is increasing dramatically. OnStar and GM are rapidly increasing the number of vehicle models that have AACN technology. In 2004, AACN was launched exclusively in the Chevrolet Malibu and Malibu MAXX. Another 10 GM models were added to the list of AACN enabled vehicles during the last quarter of 2004. So far, the list of vehicles include the Buick Rainier; Cadillac STS; Chevrolet Cobalt, Chevrolet TrailBlazer and Chevrolet TrailBlazer EXT; GMC Envoy, GMC Envoy XL, Envoy XUV, Pontiac G6 and Saab 9-7x. In January of 2005, OnStar and GM announced that by the end of 2007 OnStar will become standard equipment for retail customers in the U.S. and Canada, covering all segments and prices (except for some commercial vehicles).

It is estimated that by the end of this decade, more than 10 million GM vehicles will be equipped with AACN technology.

OnStar's record and experience, including the introduction of 6 generations of hardware, is a powerful asset in the rollout of AACN. Since 1996, OnStar has experienced more than 50 million customer interactions and nearly 80% of subscribers say they would recommend the OnStar service - which represents a valuable asset for broader interest in the new AACN technology.

Furthermore, the expansion of AACN technology across all vehicle segments – from entry level to luxury -- has the potential to influence the public's broad expectations regarding onboard safety communication and the delivery of emergency medical services as consumers increasingly embrace AACN. An important example of widening consumer appeal for in-vehicle safety technology is OnStar's receipt of the Good Housekeeping Institute's (GHI) "Best Buy" award in December of 2004. It is the first time in the 10-year history of this award that the Institute granted such recognition to a service of any kind and the first ever GHI award to an automotive product or related service.

OnStar is confident that AACN technology will continue to break new ground and eventually will become a standard in-vehicle safety feature demanded by customers.

DIFFICULTY

OnStar and GM have embraced the opportunity presented by AACN and its development had the operational and financial support of multiple organizations across the company (i.e. Engineering, Manufacturing, IT, etc.). However, OnStar's AACN system faces the challenges typical of its status as an emerging technology that is still working to fulfill its potential. Currently, national safety and emergency services are not prepared to take full advantage of AACN or benefit from all of its data response capabilities.

For example, the AACN data can be used to calculate the probability of severe injury. Such a probability can be predicted by an "urgency algorithm" recognized by leaders in crash medicine but not yet utilized across the country. Since many Public Safety Answering Points (PSAPs) cannot take into consideration all objective

crash data such as Delta V while making dispatch decisions, the greater public currently benefits from part but not all of the critical information that AACN captures.

Currently, OnStar's open systems architecture can transmit data via a secure Internet connection to a central router/webserver. From there the data can be relayed for display on the computer aided dispatch and monitoring systems of prepared and authorized emergency services partners so they can instantly leverage and manage the information.

Nationally, Public Safety Answering Points (PSAPs), emergency medical services and other emergency responders do not share common mapping systems, dispatch protocols, open systems, or secure data transmission standards and protocols. The eventual development of interoperable national networks and standards would magnify the impact of AACN technology and allow for further advances such as the creation of secure, dynamic incident records that can be updated real time by various parties as new accident and injury information becomes available.

OnStar is collaborating with leading public, private and non-profit entities in support of the development of this more sophisticated national infrastructure and the common accident reporting protocols. Among the involved entities are: the National Emergency Number Association (NENA), the National Association of EMS Physicians (NAEMSP), the National Highway Traffic Safety Administration (NHTSA), the Association of Public Safety Communications Officials (APCO), the National Reliability and Interconnectivity Council, ComCARE and the State of Minnesota. It is reasonable to estimate that a shared accident reporting infrastructure and common protocols will be operational over the next several years.

Within the realm of technical challenges in the development of AACN, an early and unique challenge was establishing an efficient system testing process. Executing a successful testing and validation process required significant coordination of efforts among GM, multiple suppliers and OnStar. This was particularly difficult given the variety of parts and subsystems and their required integration. In order to reduce the number of costly live barrier crash tests, it was important for all components - from the vehicle sensors to Emergency Call Center software/applications - to work seamlessly throughout all stages of the vehicle development process.

An avoidable mistake during a crash test, stemming from the failure of a technology that could have been tested in advance, potentially could steal financial and human resources needed for the most sophisticated elements and analysis entailed in final live barrier crash tests. Thus, each team was asked to test and validate components and subsystems before entering the final and more comprehensive barrier crash tests. To accomplish this, engineers and suppliers collaborated in developing sensor profiles representing different crash scenarios and failure mode conditions. Teams could perform end-to-tend tests repeatedly to avoid problems during final testing.

Despite past and current challenges, OnStar is confident that AACN technology will continue to break new ground and eventually will become a standard in-vehicle safety feature in all vehicles.