The Connected Responder – A Business Case for the Emergency Responder Agency and a Business Plan for Engaging the Responder Community

TRANSPORTATION SAFETY ADVANCEMENT GROUP
Promoting Technology for Public Safety

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Connected Responder: A Business Plan for the Implementation and Use of Connected Vehicle Technology in the Emergency Responder Community

Introduction

Through a cooperative agreement with ITS America, the Rylex PSC Team developed a comprehensive Connected Responder business case to educate, engage, and inspire crucial Community of Interest (COI) groups to leverage the full potential of Connected Vehicle (CV) technologies. This business case is the product of extensive operational research, technology assessments, subject-matter expert engagements, and collaboration with the Transportation Safety Advancement Group (TSAG). The business case and related project deliverables have been focused on educating the responder community at all levels and fostering a collaborative Connected Responder Community of Interest that will work together to reduce barriers to diffusion and increase the innovative application of Connected Vehicle technology.

The Connected Responder business case recognizes the relatively low level of Connected Vehicle subject-matter expertise within the law enforcement, fire, EMS, traffic incident management, and towing/recovery communities. Conversely, the transportation and automotive engineering communities have advanced considerable technical resources and operational plans. This business plan leverages those existing resources with the compelling operational need to include responders in the Connected Vehicle enterprise.

The emergence of progressive emergency responders and early adopters will require investments in education strategies. Emergency responder subject-matter experts interviewed in the development of this business case amplified the need to provide practitioner-friendly training, fact sheets, videos, and easy to consume material to build interest in Connected Vehicle solutions. Building genuine interest and understanding is a path that will avoid the barriers of skepticism, disengagement, and the reluctance to invest scarce resources in new technologies.

This Connected Responder business case recommends the cultivation of a dialogue with practitioners to share information and ideas related to Connected Vehicle solutions. This focused engagement strategy is required to formalize the exchange of technical and operational information. The Connected Responder business case recommends targeted engagement through existing membership organizations, prominent practitioner publications, and social media forums that are trusted by the responder community. While the time horizon for the deployment of Vehicle to Vehicle (V2V), Vehicle to Infrastructure (V2I), and Vehicle to Pedestrian (V2P) technologies is not immediate, crucial education and engagement investments are needed in the short term to prepare for mid- and long-term opportunities.

Through this document, the team of technical and operational subject-matter expert contributors have provided a comprehensive end-user-focused business plan to guide emergency responder agencies to make informed decisions regarding the utilization and incorporation of Connected Vehicle technologies within their agencies. This plan is a living document that will evolve as operational conditions change, Connected Vehicle technology matures, and the innovation of educated practitioners begins to impact the systems being developed. When properly applied, these Connected Vehicle-related technologies will bolster the strategic plans and goals of all emergency responder organizations. The noble objectives of saving lives, protecting property, and effectively managing scarce fiscal resources will benefit from a robust community of Connected Responders.

Part One – Connected Vehicle Technology Overview

General Description of Connected Vehicle Technology

First responders and transportation professionals understand that traffic incident management consumes considerable time and resources. Ideally, incidents are avoided through well-engineered infrastructure and safety-minded motor vehicle operators. Realistically, dynamic roadway conditions and distracted drivers result in crashes and incidents that deplete the resources of agencies of all sizes. Furthermore, emergency responders and transportation professionals are often directly subjected to injury, death, and property damage from traffic-related incidents. Traffic-related incidents are a leading cause of death and serious injury among first responders and transportation professionals.

Connected Vehicle communications technologies have been developed to control for the most common transportation-related incidents. These communications technologies are being developed to help mitigate certain types of transportation-related incidents. Intersection collisions, rear-end collisions, and side swipes may be mitigated and avoided through Vehicle to Vehicle and Vehicle to Infrastructure solutions. Pedestrians may also realize safety benefits from Vehicle to Pedestrian applications. To maximize the potential benefit of these technologies, they must be understood by police, fire, EMS, transportation, towing, HAZMAT, and all other responders who facilitate safe travel.

It is imperative that first responders appreciate the capabilities and limitations of emerging Connected Vehicle technologies. As the federal government and vehicle manufacturers move to standardize the deployment of these systems in future vehicles, first responders and transportation professionals will be increasingly exposed to V2V, V2I, and V2P systems in commercial, private, and government fleet vehicles. Educated consumers can and will drive innovation. There is no more vested group in reducing unnecessary traffic incidents than that which must manage the aftermath of avoidable losses of life, injuries, and property damage. New levels of efficiency and safety can be achieved when Connected Vehicles are optimized by the public and those who serve them.

Vehicle to Vehicle

The first level of applications to emerge within the Connected Vehicle environment were Vehicle to Vehicle communications. These are simple messages exchanged directly between vehicles within a specified proximity. The messages create an awareness of the other vehicles and basic information (speed, heading, and location) of those vehicles.

Vehicle to Infrastructure

Further expanding the capabilities of Connected Vehicle technology are Vehicle to Infrastructure communications. V2I capabilities provide the opportunity for information that is localized at the scene of the infrastructure to be sent back via other connections to remote locations and for pieces of infrastructure, such as traffic control devices, to be able to communicate with vehicles, assess potential safety issues, and present warnings to drivers.

Vehicle to Pedestrian

Envisioned but yet to be fully developed within the Connected Vehicle environment are Vehicle to Pedestrian applications. These applications will provide communications between vehicles and pedestrians who are in or about to enter the roadway, as well as a warning to pedestrians alongside of roadways when a vehicle is potentially going to leave the roadway and encroach into the area of the pedestrian.

The use of the word pedestrian must be considered more holistically, extending not only to walkers, but to a more global group of vulnerable persons who may potentially interact with vehicular traffic. This could include persons riding bicycles, skateboards, or self-propelled scooters; unlicensed off-road vehicles (dirt bikes and ATVs); etc.

More information regarding specific V2V and V2I applications can be found later in this document.

How Connected Vehicle Technology Works

Architecture

Connected Vehicle technology allows vehicles to communicate with each other and with fixed infrastructure utilizing three components of the core unit: an on-board or roadside unit, the radio, and the application interface. In its current iteration, the information exchanged is the Basic Safety Message (BSM), although future applications of Connected Vehicle technology will begin to integrate other information from vehicle systems and sensors and information from external systems and sensors.

On-Board Unit

The On-Board Unit (OBU) allows vehicles to collect information from other vehicles to develop a Basic Safety Message, communicate these structured messages with each other, and subsequently provide drivers with situational awareness about the vehicles in relation to each other. While the near-future implementations of Connected Vehicle technology will focus on the three core components of the Basic Safety Message, mid- to long-term OBUs will collect information from other vehicle components (e.g. lights, windshield wipers, thermometers, brake sensors, etc.) and process that information for transmission to other vehicles, as well as processing information (e.g. roadway conditions, weather alerts, etc.) from Roadside Units of fixed infrastructure.

Roadside Unit

The Roadside Unit (RSU) communicates with vehicles that have OBUs. An RSU that is connected to some other information infrastructure (hardline, cellular connection, etc.) allows information to be received from vehicles to be transmitted to other locations (such as back to dispatch or operation centers) and information from remote locations to be transmitted to vehicles. An RSU may also collect information from other local sensors (e.g. roadway condition sensors) or traffic control devices (traffic lights, stop signs, railroad crossing controls, etc.) and transmit that information to a Connected Vehicle.

Radio and DSRC

Transmissions between OBUs and RSUs are sent using a radio that transmits the BSM (and other information in the future) using Dedicated Short-Range Communications (DSRC). At the simplest level, DSRC technology allows a vehicle to communicate with another vehicle, a pedestrian with appropriate equipment that may be as far as 1000 feet away, or a fixed piece of roadside infrastructure up to one-half mile away. DSRC is Wi-Fi technology, much like that which is found in home- or office-based wireless networks. DSRC is currently licensed to operate in a portion of the 5.9 GHz spectrum.

Application Interface

The Application Interface is the component that will communicate the potential threat or issue to a vehicle operator. Initial implementations of Connected Vehicle technology will present this information primarily in a visual format; however, future implementations may expand to using other means for alerting vehicle operators of potential threats or issues.

Audio/Visual

Current iterations of Connected Vehicle technology utilize additional equipment within the vehicle cockpit to interface with the driver. This equipment may be similar to a dash-mounted GPS device. The Application Interface will present the interpreted warning or notifications from the OBU and visually display them in a manner understandable to the driver, possibly coupled with audible warnings as well. This may be in the form of simple warning messages (e.g. “warning” or “danger”) as well as the reason (e.g. “vehicle stopped ahead” or “vehicle encroaching in lane”). Additionally, the Application Interface could provide suggested responses (e.g. “slow down” or “use caution”). As technology matures, additional information could be presented through the Application Interface (e.g. “traffic signal will turn red in three seconds” or “emergency vehicle approaching from right”), however, these capabilities are still considered to be in the mid- to long-term future.

Haptic

With the proliferation of in-vehicle capabilities, concern for an overtasked vehicle operator must be addressed. It is possible that the operator may miss an audio/visual alert due to distraction. As Artificial Intelligence (AI) capabilities mature, the use of haptic (or touch-oriented) interfaces may begin to be utilized in order to communicate warnings or gain the attention of vehicle operators. For example, the application interface may integrate with the steering wheel to produce a vibration as means of alerting the vehicle operator of a potential crash scenario. The use of haptic interface is considered to be a long-term future capability.

Basic Safety Message (BSM)

The core of V2V communications at the present is the Basic Safety Message. On-board units, using the DSRC transmitter, send the BSM to other vehicles ten times per second. The BSM contains three key informational components about the vehicle: location, heading, and speed. Other vehicles with on-board units actively engage in listening for BMS information from vehicles within range, compare it against its own vehicle information, analyze the information for any potential threats, and process a warning message to the Application Interface as appropriate. It is important for emergency responder agencies to understand that, at this time, there is no information within the BSM that identifies the vehicle transmitting message.

Operational Examples

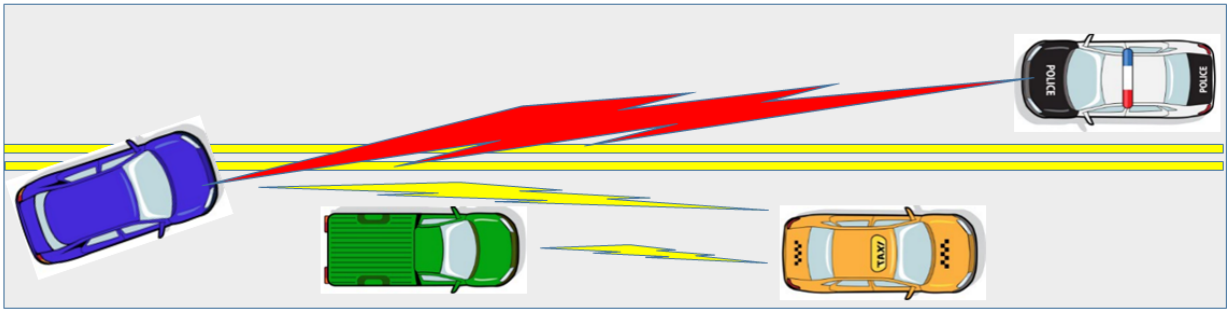
Figure 1 below depicts an operational example of how Connected Vehicle – Vehicle to Vehicle (V2V) technology will communicate and process Basic Safety Message (BSM) information and create warnings for drivers.

Onboard Unit (OBU) – In-vehicle device transmits and receives Basic Safety Messages 10 times per second – determines if warning is necessary

Basic Safety Message (BSM) – Includes speed, location, and heading

Connected Vehicles
Vehicle to Vehicle (V2V) Communications

Application Interface – In-cockpit device which provides warning messages to drivers



OBU from taxi transmits BSU that cab is moving slowly. OBU from blue vehicle transmits BSM that it is changing heading, potentially encroaching into pathway of police vehicle. Application Interface in police vehicle warns that blue vehicle may be encroaching into lane, while application interface in blue vehicle warns that there is an approaching vehicle (police car)

Figure 1

Figure 2 below depicts an operational example of how Connected Vehicle - Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) technology will communicate and process Basic Safety Message information and create warnings for drivers.

Onboard Unit (OBU) – In-vehicle device transmits and receives Basic Safety Messages 10 times per second – determines if warning is necessary

Basic Safety Message (BSM) – Includes speed, location, and heading

Connected Vehicles
Vehicle to Vehicle (V2V) and Vehicle to Infrastrucure (V2I) Communications

Application Interface – In-cockpit device which provides warning messages to drivers

OBUs from ambulance and fire truck transmits BSMs that each vehicle is approaching a controlled intersection (traffic light). The OBU from the ambulance also transmits BSM that it is changing heading, potentially indicating that is turning into pathway of the fire truck. Application Interface in both vehicles issue warnings. Additionally, information can be sent to the traffic signal to prioritize one emergency vehicle over the other for entrance into the intersection.

Figure 2

Standards and Specifications

The development of standards and specifications is critical to ensuring that all vehicles and external infrastructure equipped with Connected Vehicle technology, despite manufacturer or version, will communicate effectively with each other. While significant work has been done with the standards and specifications of DSRC and the BSM, additional work remains in the design and development of the wide range of potential applications and the actual Application Interface, or presentation of the information to a driver.

Additional standards and specifications specific to Connected Vehicle technology applications are required within the emergency responder community as well. As Connected Vehicle technologies become integrated with emergency responder information systems (CAD, RMS, GIS), appropriate standards and specifications for data exchanges will need to be developed. The integration of Connected Vehicle technologies with existing and emerging in-vehicle and wearable public safety technologies will also demand development of related standards and specifications.

Connected Vehicle Reference Information Architecture

A Reference Implementation Architecture is a primary means through which to address technology stakeholder concerns and requirements. This technical reference is the product of collaboration between stakeholders (practitioners) and designers (engineers) to create common language definitions and deployment concepts and approaches and often includes Concept of Operations and System Requirements considerations.

The Connected Vehicle Reference Information Architecture (CVRIA) is a user-friendly online resource providing Connected Vehicle technical standards, applications, and web-based training. This US Department of Transportation, Intelligent Transportation Systems Joint Program Office sponsored web-based library provides practitioners and technologists with a deeper understanding of Connected Vehicle technical and integration requirements. This library can be found online at: http://local.iteris.com/cvria/

The CVRIA "one stop shop" is an essential forum through which to learn and share Connected Vehicle information. The CVRIA is an objective source for technical guidance on Connected Vehicle networks, components, and communication protocols for responders and the information technology needed by the professionals that support them. The CVRIA provides Connected Vehicle enterprise, functional, physical, and communications views of this important advancement in public and first responder safety.

A working knowledge of the CVRIA provides end-users with the tools necessary to leverage emerging Connected Vehicle capabilities and advance new applications based on clearly defined standards. Educated users of Connected Vehicle technologies may accelerate the design, testing, and deployment of new applications based on a working knowledge of Connected Vehicle components and communications protocols. Practical and technical innovations are expected to emerge from the broad community of potential users of the technology. The CVRIA can be found online at: http://local.iteris.com/cvria/

Development of Connected Vehicle Technology and Future Deployment

History of Connected Vehicle Technology Development and Testing

Conversations regarding communication between vehicles began with the Automated Highway System project in the 1990s. The discussions became more substantial in 2003 with the Vehicle Infrastructure Integration Initiative, coupled with the allocation of a portion of 5.9 GHz by the FCC for use in dedicated short-range communications, enabling a practical solution for Vehicle to Vehicle communications.

In 2006, the US Department of Transportation, Intelligent Transportation Systems partnered with the Crash Avoidance Metrics Partnership (a consortium of automakers and auto equipment makers) to examine the viability of the use of GSP and DSRC capabilities between vehicles to identify potential incidents for crashes and issue pre-crash warnings. Research was expanded to examine the potential for Vehicle to Infrastructure communications as well. From 2012 to 2014, official test beds for both V2V and V2I were

conducted during the V2V Safety Application Research Plan and Safety Pilot phase, with positive and encouraging results.

Proposed Rulemaking

In August 2014, NHTSA issued an Advanced Notice of Proposed Rulemaking that will require V2V communication capability for light vehicles (passenger cars and light truck vehicles) and create minimum performance requirements for V2V devices and messages. In December 2016, NHTSA published the Notice of Proposed Rulemaking to the Office of Management and Budget. NHTSA anticipates the Connected Vehicle Rulemaking will be issued in 2018. The anticipated phase-in period could begin as early as 2019.

Connected Vehicle Applications

Numerous applications for the practical use of Connected Vehicle technology have been envisioned, and several have been developed and are being tested. As emergency responder agencies examine the applications of Connected Vehicle technology that are being developed, there will be an immediate recognition of how these applications will provide specific, tangible benefits in the emergency responder environment.

Figure 3 below depicts the Vehicle to Vehicle applications that are closer to maturity and will be seen in the near future. Figure 4 depicts the Vehicle to Vehicle applications that are under development and will be deployed in the mid- to long-term future. Figure 5 depicts the Vehicle to Infrastructure applications that are under development and will be deployed in the mid- to long-term future.

For a more detailed explanation of these Connected Vehicle technologies, reference the Synthesis of Technologies produced by TSAG.

Near Future Vehicle to Vehicle Applications

- Blind Spot Warning + Lane Change Warning
- Control Loss Warning
- Emergency Electronic Brake Light
- Emergency Vehicle Alert
- Forward Collision Warning
- Intersection Movement Assist

Figure 3

Mid to Far Future Vehicle to Vehicle Applications

- Do Not Pass Warning
- Motorcycle Approaching Indication International Icon
- Pre-Crash Actions
- Situational Awareness
- Slow Vehicle Warning International Icon
- Stationary Vehicle Warning International Icon
- Tailgating Advisory
- Vehicle Emergency Response

Figure 4

Figure 5

Other Connected Vehicle Critical Stakeholders

The use of Connected Vehicle technology within the emergency responder community should not focus solely on the vehicles of emergency responder agencies. There are numerous other operational and support functions that will interface with and benefit from information from Connected Responder vehicles. Emergency responder agencies must consider each of these functions when planning for, acquiring, deploying, and maintaining Connected Vehicle technologies.

Governmental

Emergency response agencies that will be planning for, acquiring, deploying, or maintaining Connected Vehicle technologies will need to understand that there are additional stakeholders and functionalities that will interface with their Connected Vehicle

technology program and data. Consideration should be given to how an emergency responder agency's Connected Vehicle technology program will interact with dispatch centers, traffic incident management centers, situational awareness platforms, and public notification systems.

Dispatch Centers

As Connected Vehicle technology matures within the transportation industry as a whole, one of the primary benefits will be more efficient and effective routing to incident scenes and staging of vehicles/resources on scene. Effective routing recommendations can come from traffic congestion information and warning of other roadway or weather dangers. Information from citizen vehicles involved in incidents or crashes can be integrated into Next Generation (NG911) systems. These capabilities will be leveraged within public safety agencies, public safety answering points, and dispatch centers, and will be integrated into Computer-Aided Dispatch (CAD) systems in addition to providing information for dispatchers to pass verbally to responders. This makes the Dispatch Center a critical stakeholder in the acquisition, deployment, and management of Connected Vehicle technology in the emergency responder community.

Traffic Incident Management Centers

Much like the Dispatch Center, Traffic Incident Management Centers will leverage information from both emergency responder vehicles and citizen vehicles to monitor traffic flows, detect congestion and potential incidents, identify need for response, and track resources.

Situational Awareness Platforms

Information from Connected Vehicle platforms will ultimately be able to integrate into situational awareness platforms and dashboards for real-time information sharing within and between agencies and with the public. Emergency responder agencies utilizing situational awareness tools should consider how emerging Connected Vehicle

technologies can be integrated into legacy systems and should appropriately plan for the integration into future situational awareness platforms.

Public Notification Systems

The ability to integrate Connected Vehicle technology into public notification systems will contribute to the efficiency of traffic and incident management. Connected Vehicle technology will be able to integrate into governmental public information systems, such as 511, or other messaging systems (message boards, text and email alerts, etc.) to provide information and warnings regarding current or potential traffic congestion points and issues on a much wider scale for more advanced warning to motorists who may ultimately be headed into the area of interest.

Private Industry

As emergency responder agencies begin to engage in the planning for and acquisition of Connected Vehicle technology, they should also consider external stakeholders within private industry. The development of products and services provided by these external stakeholders should be driven by the needs of the emergency responder community. Thus, continuous interaction and collaboration between emergency responders and private industry remains key. Specific recommendations for engagement can be found in Part Three of this document.

Emergency Responder Vehicle Industry

While it is anticipated that federally issued rulemakings will ultimately mandate the use of Connected Vehicle technology into new production vehicles, there are no near-future timelines for that to occur. Emergency responder agencies should begin to engage now with the emergency responder vehicle industry to encourage or require (through procurement processes) the inclusion of Connected Vehicle technology on vehicle platforms which have not yet been mandated to include the technology.

Connected Vehicle Technology Solution Providers

As Connected Vehicle technology matures, the greatest interaction point the emergency response community will have with private industry will be through the applications and the Application Interface. Emergency response agencies will have unique areas of concern that relate to enforcement activities and operational security. Again, the emergency responder community and its business needs and requirements must be the driving force in how information will be presented to emergency vehicle operators, how operators can interact with that information, and, ultimately, what future applications can be developed.

Potential Integrated Solutions

Emergency responder agencies must consider how Connected Vehicle technology will integrate with other technologies already in use within the responder vehicles or on an incident scene. Connected Vehicle information can cross-cut with other emergency responder equipment in systems, collecting critical information from those vehicles as additional sensors (e.g. leveraging law enforcement in-vehicle cameras or radar systems) and providing information to those systems. This will also include the Application Interface, which will most likely be desired to be integrated into existing in-vehicle computing systems. The rapidly developing use of wearable technologies within the emergency responder community opens significant new opportunities as well. TSAG has developed a Synthesis of Technologies that provides insight for emergency responders as they consider potential integration of Connected Vehicle technology with other emergency response technologies.

Technical Considerations

Within the technical environment of Connected Vehicle technology, there are three primary considerations for the emergency response community: visibility, security, and privacy. These three represent the highest levels of concern and potential objection to the use of Connected Vehicle technology. Although Connected Vehicle technology as it is

designed today addresses these concerns, these areas must remain a focus of attention as the technologies, applications, and integration with other in-vehicle and external systems mature.

Visibility

There are situations that occur within the law enforcement community when a "non-visible" response is appropriate and required. For example, response to a burglar alarm or an incident with high risk for violence against the responding law enforcement personnel requires the responder to maneuver as silently as possible (e.g. without lights and siren). In such cases, DSRC technology, which would normally have a strong benefit to the public in warning them of approaching vehicles, could have a negative impact by potentially warning the perpetrators of approaching vehicles. Policies and DSRC application developers must take into account the unique needs of law enforcement officer safety concerns. This is another area in which DSRC-savvy practitioners can drive innovation, rather than being forced to adopt applications that do not meet their needs and concerns.

Security

Because DSRC is a communication medium, there is a potential for cyberattack on emergency responder vehicles or systems. However, any security vulnerabilities in the Connected Vehicle environment are significantly different than security vulnerabilities in civilian vehicle communications, such as those recently identified and published in the media concerning Chrysler-Jeep vehicles. Attacks on civilian vehicles have been conducted through more generalized "internet-based communications" with civilian vehicles. DSRC will provide a Connected Vehicle environment that is "stand-alone," or segregated, from other vehicle functions and capabilities. Thus, the vulnerability is only to the Connected Vehicle system itself. For example, a system could be engineered that would send "rogue," or false, Basic Safety Messages that would subsequently present false warnings and alerts to other drivers if a person wanted to potentially disrupt or inhibit traffic flow. The emergency responder community must have assurances about the

cybersecurity protections in DSRC and related technologies to ensure that systems cannot be hacked and improper messages (or no messages) cannot be sent between vehicles.

Privacy

In its current iteration and proposed near-term deployments, the use of Connected Vehicle technology should raise no privacy concerns. The Basic Safety Message does not contain any identifying information regarding the vehicle. The BSM transmitted merely identifies that there is another vehicle within range, along with its location, heading, and speed. There is nothing to denote which specific vehicle on the roadway is transmitting that information, thus no way for the vehicle operator or the on-board unit to identify a vehicle through the BSM.

In the long-term future, as more information from in-vehicle equipment is integrated into Connected Vehicle technology, communication of information from vehicle to vehicle, which may be collected real-time and/or post-event for analysis (such as for post-crash forensics or incident scene analysis), will raise concerns in some individuals and special interest groups regarding privacy. Should collection and analysis of information beyond the current Basic Safety Message take place, the responder community will need to ensure that legally defensible DSRC technology policies be required in order to address these concerns among public and private user communities.

Potential Deployment of Connected Vehicle Technology in the Emergency Response Community

As automakers voluntarily begin to integrate Connected Vehicle technology into their new vehicles, the technology will logically begin to penetrate into the emergency response vehicle market. Lifecycle replacements of fleet vehicles will be a natural conduit for adapting or enhancing the use of the technology within the emergency responder community.

Use of Equipment Outside of Mandates/Retrofitting

Emergency response agencies often operate with set life-cycle programs for vehicle fleets, or may have significant fiscal restraints that constrain their vehicle life-cycle replacement programs. In such cases, these agencies may encounter longer timelines for acquisition of CV-equipped vehicles. Additionally, emergency responder agencies often operate heavy motor vehicle equipment which does not yet have targeted timelines for implementation of Connected Vehicle technology.

Emergency responder agencies that have recognized the value of connecting to other vehicles and roadside infrastructure can consider implementation of Connected Vehicle technology through retrofitting current vehicles. This retrofitting will require the purchase of on-board units and Application Interfaces. As the demand for Connected Vehicle equipment rises both within the emergency response community and in the public, the costs to retrofit vehicles will decrease.

Additionally, as Connected Vehicle technology becomes more prevalent within the public through the mandatory deployment within light vehicles and light trucks, there will be corresponding expectation from the public that emergency response vehicles will have the same equipment. Emergency response agencies must consider the liabilities of not outfitting emergency response vehicles with Connected Vehicle technologies. For example, a CV-equipped vehicle driven by a member of the public that collides with a heavy fire truck that was not CV-equipped may spawn a tort claim in which the plaintiff claims that the collision would not have occurred had the Connected Vehicle technology been utilized in both vehicles.

Challenges and Considerations

The most significant constraint will be the speed of consumer adoption of Connected Vehicle technology. Vehicle manufacturers and NHTSA are working to expedite the voluntary and eventually compulsory integration of Connected Vehicle technologies in

commercial and passenger vehicles. [1] The constraints of government regulation implementation and market forces are difficult to predict. If the current enthusiastic manufacturer interest in Connected Vehicle technology on a global level is any indicator, the constraint of government regulations may be negated. Most major manufacturers have committed to safety and communications enhancements for passenger and commercial vehicles without a government mandate.

As previously mentioned, fiscal constraints may hinder the pace of responder adoption of new Connected Vehicle solutions. Retrofitting and integrating Connected Vehicle technologies will have to be sequenced with state, municipal, and private acquisition schedules. Federal grant funds and creative public-private funding strategies may help reduce barriers to responder deployment of Connected Vehicle solutions. The pace of Connected Vehicle integration in transportation infrastructure will also either constrain or expedite the proliferation of Connected Responders. The growth of nodes on the network (infrastructure, vehicle-based, and pedestrian) will be a direct corollary to reduce constraints on Connected Vehicle adoption.

[1] NHTSA, Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application, April, 2014

Part Two – A Business Case for the Use of Connected Vehicle Technology within an Emergency Responder Agency

Addressing Agency Needs

Emergency responder agencies, whether they are government-funded or volunteer organizations (fire departments, emergency medical services, etc.), face growing fiscal constraints that demand optimal management of finite resources. Fiscal austerity demands that the most efficient and effective operational and administrative measures and mechanisms are employed to reduce both direct and indirect costs to agencies. Good stewardship of public funds necessitates that emergency responder executives consider the financial impacts that highway- and vehicle-related incidents can impose on their budgets and determine the appropriate measures to alleviate or lessen these costs.

Emergency responder agencies experience direct costs associated with:

- Repairs to agency vehicles and equipment involved in crashes
- Medical expenses, worker's compensation, disability claims, and related expenses associated with employee injuries
- Tort claims filed by employees (e.g. employees who are passengers in an agency vehicle involved in a crash) as a result of a crash or incident due to an improperly maintained or equipped emergency vehicle
- Tort claims filed by members of the public involved in a crash with an emergency responder vehicle or improperly deployed piece of equipment
- Extensive and expensive repairs to vehicles which could have been avoided, had a maintenance issue been identified at an earlier stage

Emergency responder agencies experience indirect costs associated with:

- Loss of effort by employees who are out on medical leave due to an injury incurred in a crash and additional workloads/loss of efficiencies for those who incur additional duties or responsibilities in their place
- Loss of time and resources from employees and vehicles that are dedicated to responding to incidents in heavy traffic or that spend significant amounts of time investigating and resolving motor vehicle crashes in general
- Loss of efficiency in effectively responding to, staging, investigating, and clearing roadway incidents (additional economic burden to the public (e.g. time spent in traffic, impact to businesses when roadways are closed) must also be considered)
- Additional human efforts and resources required to pass information or otherwise communicate information regarding incidents or potential incidents across agencies, disciplines, and jurisdictions
- Loss of use of agency vehicles or equipment due to a crash or major maintenance issue which could have been resolved or significantly mitigated through early maintenance intervention (these costs may involve the procurement (purchase/rental) of additional vehicles/equipment, temporary replacement vehicles/equipment, or additional wear and tear on existing vehicles/equipment that must be used additional amounts of time to compensate for the unavailable equipment)

Emergency responder agencies are committed to reducing collisions involving emergency responder vehicles, due to their high human and monetary costs. The negative consequences of emergency response vehicles involved in preventable collisions calls for formal risk mitigation steps. These steps can involve investments in training and equipment modifications that avoid the potential for damage.

NHTSA released a report in April of 2014 that evaluated motor vehicle crashes involving ambulances over a 20-year period.[2] The report found that approximately 4,500 motor vehicle crashes involving ambulances occur each year and that 35% of these accidents

[2] USDOT, NHTSA Advances Ground Ambulance Safety by Tracking and Investigating Crashes, 2016.

resulted in injury or fatality to at least one occupant of a vehicle involved. The report also found that nearly 60% of ambulance accidents occur during emergency use. Analysis of motor vehicle crashes from 2000 to 2009 revealed that there were approximately 3,160 firetruck-involved motor vehicle crashes per year. 66% of fatal firetruck crashes involved rollovers. Approximately 70% of firetruck-involved crashes occurred during emergency response. Emergency vehicles, including transportation and towing fleet vehicles, are at a greater risk for collisions with harm to individuals and property. Technological enhancements such as those found in Connected Vehicle systems may dramatically reduce the risk involved in operating these unique vehicles.[3]

Identification and response to vehicle maintenance issues can impact the safety of the responder community and public. An extreme example of this risk was identified in the U.S. Fire Administration's *Firefighter Fatalities in the United States in 2014* report.[4] The report highlighted an incident of a failed mechanical repair on a fire apparatus as the cause of a collision that killed one firefighter and five civilians in a secondary vehicle. While this case is extreme, it reflects the fiscal and practical risks of poorly maintained or undiagnosed mechanical failures for fleet vehicles.

Motor vehicle crashes involving struck emergency responders outside of their vehicles also present significant threat and demand appropriate action. According to the National Traffic Incident Management Coalition, at least two emergency responders are struck each day. An analysis of FBI Law Enforcement Officer Killed and Assaulted (LEOKA) statistics revealed that between 1995 and 2006, an average of one U.S. law enforcement officer was struck and killed each month by a motor vehicle.

The use of Connected Vehicle technologies has tremendous potential to address these threats to responders, their equipment, and the public they serve. When networks of private, commercial, and responder vehicles are equipped to communicate with each other, pedestrians, and infrastructure, the benefits are amplified. Agency leaders, policy

[3] Noah Smith, EMS World, *A National Perspective on Ambulance Crashes*, September 2015
[4] USFA, *Firefighter Fatalities in 2014*, August 2015

makers, and politicians can all contribute to reducing harm to our nation's finest and bravest.

Goals and Objectives

The comprehensive use of Connected Vehicle technology within the emergency responder environment can produce tangible financial benefits for an agency. At a high level, agencies deploying Connected Vehicle technology can expect to achieve the following general goals:

- Reduction of the collateral expenses of collisions through collision avoidance during emergency and non-emergency operations
- Increased fuel efficiency and emergency vehicle routing fidelity through responder vehicle deconfliction, roadway congestion management, responder and motoring public navigation, and direction guidance
- Increased situational awareness and enhanced efficiency of crash reconstruction and traffic enforcement applications through integration of Connected Vehicle technology with the responder equipment ecosystem (automatic vehicle location, remote computer-aided dispatch, vehicle navigation systems, on-board and body-worn cameras, etc.)
- Reduced operational costs through integration with fleet management systems leveraging inventory, operating status, preventative maintenance, and early warning for repairs
- Ultimate ability to appropriately communicate with automated vehicles for enforcement and engagement

Within the environment of specific incident response operations, the use of Connected Vehicle technology will enable the following objectives:

- Enhanced intradisciplinary and interdisciplinary interoperability between emergency responders while en route to incidents

- Enhanced intradisciplinary and interdisciplinary interoperability between emergency responders while on the scene
- Enhanced incident scene pre-arrival, situational awareness, and staging guidance
- Ability to rapidly disseminate critical information regarding incidents and work zones to relevant traffic (approaching vehicles) through public messaging
- Ability to broadcast external warnings to relevant traffic (approaching vehicles) for incident and work zone safety
- Ability to more efficiently coordinate, evacuate, and manage dynamic congestion mitigation efforts
- Ability to integrate with the consumer and commercial mobile application ecosystems for information (e.g. Waze, PulsePoint, etc.) or commercial vehicle monitoring and enforcement (e.g. commercial vehicle log books, HAZMAT transportation, etc.)

Performance Measures

Connected Vehicle performance measures across the full spectrum of Connected Responder operations are focused on life safety, property damage risk mitigation, and optimization of responder fleet vehicle operations. The foremost measurement is quantifiable reductions in responder and citizen injuries and deaths. These measurements may be contrasted against trends involving “disconnected” civilian and responder vehicles. Property damage claims, before and after Connected Vehicle implementation, will be examined to quantify the fiscal and operational impact of Connected Vehicle technologies. Additionally, the operational status of fleet vehicles, maintenance costs, fuel consumption, and out-of-service “down time” analysis quantifies the benefits of proactive Connected Vehicle solutions that curb collisions and preventable systems failures.

In a Connected Vehicle environment, reductions in collisions and congestion are expected to result in similar reductions in deaths and severity of injuries and property damage. The gradual implementation of Connected Vehicles, infrastructure, and pedestrian solutions

in the long-term future may be seen as a barrier for those seeking immediately measurable performance benefits. Returns on investments are anticipated to be substantial as the commercial, passenger, and transportation Connected Vehicle markets mature.[5]

Congestion mitigation and transportation infrastructure optimization are potential performance measurement focal points. In a mature Connected Vehicle environment, infrastructure capacity will be demonstrably optimized as traffic flows more efficiently and congestion-causing incidents are avoided. Areas of performance measurement that will merit greater analysis are evacuation planning efficiency, special event planning efficiency, and work zone safety planning. Harmonizing vehicles and people in motion will reduce the negative fiscal impact that traffic congestion has on individuals, commerce, and government interests.

Micro-level Connected Vehicle performance measurements will be obtained as individual responder fleet vehicles mitigate the risks of collisions and broaden their interoperability with other responder vehicles. Macro-level Connected Vehicle performance measurements will be more challenging, but attainable, as Connected Vehicle networks grow at local, regional, state, and national levels. These micro- and macro-level benefits will be captured at an actuarial level of detail, which will satisfy risk managers and insurance underwriters who quantified similar benefits after significant safety system improvements, such as airbag standardization, vehicle stability control systems, backup camera systems, and mandatory seatbelt usage policies. Advancements in collision avoidance solutions are expected to yield the greatest return on investment for both responders and the general public.

[5] Richard Viereckl, et al. *Connected car report 2016: Opportunities, risk, and turmoil on the road to autonomous vehicles*, 2016.

Connected Vehicle Technology Alignment with Strategic Goals

Strategic plans across the emergency responder community (law enforcement, fire, and EMS) share several common strategic and tactical goals and elements. The deployment and use of Connected Vehicle technology will support these goals and elements. The following common strategic goals (noted in bold) and tactical elements (noted in italics) will benefit from the use of Connected Vehicle technology. Additionally, appropriate and relevant performance measures have been included with each tactical element.

Provide timely, effective, and consistent emergency responses - Improving the response to incidents includes two key components that can be enhanced using Connected Vehicle technology: time to scene and routing efficiency.

Reduced response times - While reducing the amount of time from notification of incident to arrival on scene is critical in all disciplines, it is more specifically measured within the fire and EMS community. The National Fire and Protection Association (NFPA) has published a standard for fire and EMS response time in NFPA 1710 (Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Departments).[6] It should be noted that these are not regulations or mandatory requirements per se, but are generally accepted within the fire and EMS community as industry standards and are often the baseline for performance measures. These standards may be adopted within a more formal structure by OSHA or within state regulations. NFPA has established the following response time guidelines:

- Fire calls - one engine company staffed by four (4) firefighters should arrive on scene within four (4) minutes
- Fire calls - first alarm fourteen (14) personnel should arrive on scene within eight (8) minutes

[6] NFPA, NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments, 2016

- Basic Life Support – arrival on scene within four minutes
- Advanced Life Support – arrive on scene within five minutes

While there are no similar existing standards or recommendations within the law enforcement community, the demand for rapid response is just as important. Arrival times may make a life or death difference. Some agencies have adopted an agency best practice of a median response time of five minutes to the highest priority calls.

Key Performance Measures

- First Unit on Scene: ____ % of first units arrive on scene arrive within ____ minutes
- Effective Full Response Force: ____% of full response force units arrive on scene within ____ minutes

Increase routing efficiency – To assist with achieving a reasonable response time, emergency vehicles must be routed in the most efficient manner. Emergency responders may often find that the normal routes to an incident may be blocked or severely impeded due to the incident itself, indirectly because of the incident (e.g. traffic congestion due to drivers taking alternate routes to avoid the incident), or because of a secondary incident. The ability to determine the most effective route (real-time traffic information from fixed infrastructure) and also enable an emergency responder to efficiently navigate through congested areas (signal preemption, advanced notification to motorists of approaching emergency vehicles, etc.) are fundamental elements to enhancing response efficiency.

Key Performance Measures

- First Unit on Scene: ____% of first units arrive on scene arrive within ____ minutes
- Effective Full Response Force: ____% of full response force units arrive on scene within ____ minutes

Enhance traffic incident management procedures – The ability to efficiently manage a traffic incident, from pre-arrival to on-scene administration, can significantly decrease the total amount of time necessary to clear the incident and re-open roadways. The ability to clear incidents more expeditiously will lead to fewer secondary incidents and lessen the human and economic burdens that result from traffic congestion.

Key Performance Measures

- _____% decrease in total amount of time from notification of traffic incident that closes or impedes a portion of the roadway to roadway reopening
- _____% decrease in total amount of time from notification of traffic incident that closes or impedes a portion of the roadway to full incident clearance

Reduce incidents that result in injury, death and property damage

Utilize the Data Driven Approach to Crime and Traffic Safety (DDACTS) – More and more agencies are embracing the DDACTS program to review information from crashes and develop specific strategies for preventing crashes in the future. Connected Vehicle technology will enable the collection of vehicle and event data necessary for proper evaluation of primary crash causation. This data becomes a key factor to formulating effective response and prevention programs.

Key Performance Measures

- Data from _____% of motor vehicle crashes is collected using Connected Vehicle technology and evaluated within the DDACTS program

Enable efficient motor carrier/commercial vehicle enforcement – Using Connected Vehicle technology will allow emergency responder agencies to enforce commercial motor carrier and commercial motor vehicle laws and regulations. Information traditionally collected

during roadside inspections can be collected while an emergency responder vehicle is operating within the proximity of a target commercial carrier or vehicle.

Key Performance Measures

- Increase commercial motor vehicle/commercial carrier contacts/data collection through Connected Vehicle technology by ____%

Reduce at-fault commercial vehicle- and commercial bus-related crashes – The ability to conduct "rolling inspections" (Vehicle to Vehicle technology) or, more accurately, identify potential equipment failures on commercial vehicles and commercial carriers (Vehicle to Infrastructure) through detailed communication of vehicle equipment status at inspection points will contribute to a decrease in commercial vehicle and commercial carrier-related crashes.

Key Performance Measures

- Decrease commercial motor vehicle/commercial carrier vehicle crashes due to violation of relevant commercial motor vehicle/commercial carrier laws and regulations by ____%
- Increased identification of commercial motor vehicle/commercial carrier safety-related vehicle deficiencies or issues by ____%

Increase the public's perception of safety – Connected Vehicle technology can positively impact the public's perception of public safety through improved response time and reduction in emergency vehicle-involved collisions.

Improve response time - As law enforcement agencies strive to improve the police-community relations culture, response times play an important role. Studies have shown that response times are the most important factor that citizens assess when evaluating overall law enforcement response to incidents.

Key Performance Measures

- _____% reduction in response from time of notification to time on scene

Reduce crashes involving emergency responders and the public – The public can feel threatened by the driving actions of emergency responders, especially when they are expediting to an incident. Reducing crashes between emergency vehicles and the public enhances their feeling of safety, even when emergency vehicles are being operated outside of normal driving patterns. *The National Safety Council Injury Facts – 2015 Edition* notes the following emergency responder-related crashes during 2013[7]:

- 5,747 crashes involving ambulances (3,167 during emergency response)
- 2,508 crashes involving fire apparatus (1,730 during emergency response)
- 34,821 crashes involving police vehicles (10,657 during emergency response)
- 21 persons killed in crashes involving ambulances (7 ambulance drivers or occupants) and 3,236 persons injured
- 12 persons killed in crashes involving fire apparatus (2 fire apparatus drivers or occupants) and 1,430 persons injured
- 87 persons killed in crashes involving law enforcement vehicles (18 involving law enforcement vehicle drivers) and 12,363 persons injured

These crashes can result in significant financial impact on an emergency responder agency through tort claims, settlements, and judgements.

Key Performance Measure

- _____% reduction in agency-related motor vehicle crashes involving the public
- _____% reduction in agency-related motor vehicle crashes which result in the injury or death of members of the public

[7] NSC, Injury Facts, 2015 Edition, 2016

- _____% reduction in the amount of tort claims filed against the agency as a result of agency-related motor vehicle crashes involving the public
- _____% reduction in the amount paid to members of the public involved in agency-related motor vehicle crashes

Enhance employee safety – Each year, numerous emergency responder personnel are injured or killed in duty-related motor vehicle crashes. *The National Safety Council Injury Facts – 2015 Edition* notes the following emergency responder-related crashes during 2013[8]:

- 7 ambulance drivers or occupants killed in crashes
- 2 fire apparatus drivers or occupants killed in crashes
- 18 law enforcement vehicle operators killed in crashes

The number of emergency responders injured in crashes is exponentially higher than the number of fatalities. These incidents take a significant personal, operational, and economic toll on emergency responder agencies.

Reduce on-duty/work-related injuries and employee sick leave usage – The use and deployment of Connected Vehicle technology can significantly reduce the number of emergency responders injured by helping to prevent crashes and can minimize the effect of injuries by assisting in mitigating the overall possible effect of a crash. In such case, a driver may take evasive action due to Connected Vehicle technology, which results in a less severe crash than one which would have occurred without the action. Connected Vehicle technology will prevent single vehicle crashes as well as crashes involving the motoring public.

[8] NSC, Injury Facts, 2015 Edition, 2016

Key Performance Measures

- _____% reduction in the agency-related motor vehicle crashes which result in injury or death of an agency employee
- _____% reduction in workman's compensation cases due to involvement in an agency vehicle-related crash
- _____% reduction in employee medical costs due to involvement in an agency vehicle-related crash
- _____% reduction in employee sick leave usage due to involvement in an agency vehicle-related crash
- _____% reduction in hours spent in a limited or non-active duty status due to involvement in an agency vehicle-related crash
- _____% reduction in overall time to recovery for an employee who was injured due to involvement in an agency vehicle-related crash

Managing agency resources effectively – Agencies are tasked with ensuring good stewardship of their resources, including vehicles. Connected Vehicle technology contributes to reducing agency-related motor vehicle crashes and enhancing vehicle health and maintenance management.

Ensure facilities and equipment are properly maintained and serviced - An effective fleet management program not only ensures that required scheduled maintenance is conducted, but also identifies potential vehicle health issues and addresses them before they become costlier to repair. Good fleet management also identifies driving behavior or events that can cause additional burdens to vehicle repair.

Key Performance Measures

- _____% reduction in major motor vehicle repair costs
- _____% increase in identification of motor vehicle health issues that could have resulted in costlier repairs, had they not been identified earlier

Reduce the recurrence of agency motor vehicle crashes – Agencies are taxed with the cost of repairing agency vehicles involved in crashes (unless an outside driver with appropriate insurance was at fault). In any case, the agency also realizes a burden of "lost availability" while the vehicle is awaiting repair or is being repaired.

Key Performance Measures

- _____% reduction in agency-related motor vehicle crashes
- _____% reduction in at-fault agency-related motor vehicle crashes
- _____% reduction in costs associated with agency-related motor vehicle crashes
- _____% reduction in number of days agency vehicle use is lost due to a motor vehicle crash

Evaluate near-miss situations – Agencies can easily gather and evaluate data on agency vehicles involved in motor vehicle crashes in order to evaluate and implement or amend agency policies and procedures as appropriate. However, agencies have no real methodology, other than the purely anecdotal, to evaluate and assess near-miss incidents on the roadway. Data gathered through Connected Vehicle technology (e.g. intersection collision or lane/roadway departure near-misses) can be used to more holistically conduct assessments and determine whether there is a need to create or amend policies and practices related to vehicle operation.

Key Performance Measures

- _____ near-miss incidents identified
- _____ operational policies or practices identified which need to be corrected or amended

Improve the efficiency and effectiveness of delivery of services by expanding the use of technology – Almost all agency strategic plans address the use of technology to enhance

agency efficiency and effectiveness. This strategic goal is often described in a tactical goal as the use of a specific technology. In this case, the deployment and use of Connected Vehicle technology would be a means to achieve a tactical goal.

Key Performance Measures

- _____% of agency equipped with Connected Vehicle technology

Connected Vehicle technology easily aligns with several of the common goals found within emergency responder agency strategic plans. Connected Vehicle technology provides numerous tangible tactical goals and significant performance measures that can be used within the emergency responder community.

Cost Benefit Analysis

The implementation and management of Connected Vehicle technology will incur cost to an emergency responder agency. The agency must carefully evaluate the global environment of factors when deciding to make new or continued investments. While tangible benefits to which direct financial costs or cost savings can be calculated must be determined in this process, agencies must also fully understand that there are additional indirect (or non-tangible) benefits which are not quantitative in a fiscal manner.

A simple methodology is to examine the general quantifiable expenses related to motor vehicle incidents and compare the total to a general calculation of expense related to the acquisition and management of Connected Vehicle technology. The calculations make an assumption that the average lifespan of an emergency responder agency vehicle is five years. Thus, the calculations evaluate costs over a five-year period.

First, agency expenses due to motor vehicle incidents over a five-year period should be calculated.

Agency Expenses Due to Motor Vehicle Incidents	
Cost of replacement of agency total loss vehicles over the last five years due to crashes	
Cost of agency collision repairs due to crashes over last five years	
Amount of medical benefits paid to employees injured in crashes over last five years	
Amount of sick leave expenses paid to employees injured in crashes over last five years	
Total cost of employee death due to crashes*	
Amount of time spent in limited duty (non-operational) assignments due to employees injured in crashes over last five years times average hourly rate	
Amount of tort claims paid or settled over last five years	
Amount of vehicle repairs due to vehicle health issues that were not identified earlier when a repair would have been significantly less	
Total	

*Calculated using human resources and state or local actuarial data as available to include cost of line of duty death, funeral and burial-related expenses, replacement of employee, governmental-supplied death benefits, etc.

Next, expenses for the acquisition and management of Connected Vehicle technology over a five-year period should be calculated.

Agency Expenses for Connected Vehicle Technology	
Number of agency vehicles to retrofit times cost of retrofit	
Cost of Connected Vehicle technology as part of a new vehicle package	
Associated software or licensing fees for any specific Connected Vehicle application or necessary interface over a five-year period	
Anticipated number of hours necessary to maintain Connected Vehicle technology hardware or software during a five-year period times average salary for responsible employee(s)	
Total	

Next, agencies should calculate the following:

Total cost of agency expenses due to motor vehicle incidents (MVI) minus total cost of agency expenses for Connected Vehicle technology (CVT) to determine a potential cost savings (PCS). This is represented as:

$$MVI - CVT = PCS$$

It must be clearly understood that Connected Vehicle technology will not eliminate or mitigate all agency-related motor vehicle incidents. Operational research should be conducted as Connected Vehicle technologies are piloted and matured. Early research findings will be the bases of MVI reduction forecasting.

Once a reasonable percentage of expected reduction (PER) of MVI can be determined scientifically, that percentage would be added to the calculation to determine a more realistic PCS.

MVI x PER – CVT = PCS

When PCS is represented as a positive number in this formula, there is clearly a cost benefit to the acquisition of Connected Vehicle technology within the emergency responder agency.

Until such time as a scientifically developed PER can be developed, agencies should understand the PCS as a best case, but non-realistic, number. In this case, the agency should evaluate the potential value to the agency as determined by numbers that it would utilize in the key performance measures reflected in Section 5.

In any situation, to determine continued cost benefit of Connected Vehicle technology once acquired and deployed, an agency could utilize the above charts, with time frames adjusted appropriately based on the length of time that the Connected Vehicle technology has been deployed. Agencies would calculate total cost of agency expenses due to motor vehicle incidents since Connected Vehicle deployment (MVI) minus total cost of agency expenses for Connected Vehicle technology (CVT) since deployment to determine a realized cost savings (RCS).

MVI – CVT = RCS

Again, agencies must realize that reductions in motor vehicle incidents can come from a variety of factors. The use of Connected Vehicle technology may not be the sole contributor to these reductions.

Intangible Considerations

Specific intangible implications that should be considered:

- Public perception and trust
- Employee morale

- Effect of injury or death from a motor vehicle incident or crash on family members and members of the community
- Availability of equipment
- Lives saved or incidents resolved due to more efficient and timely response
- Lives saved or damage prevented through effective and efficient commercial vehicle enforcement
- Efficiency of rapid traffic incident management and reopening of roadways, including socioeconomic implications
- Ability to fully evaluate policies and practices with more comprehensive data, including near-miss incidents
- Value of data utilized by other organizations (e.g. traffic engineers, Federal Motor Carrier Safety Administration, National Highway Safety Administration, etc.) to reduce future traffic and motor vehicle crash issues and concerns

The use of Connected Vehicle technology must be evaluated in both a quantitative and qualitative manner in order for an agency to truly assess the value of the acquisition and use of Connected Vehicle technology in an emergency responder agency. Undoubtedly, there will be positive benefit and impact. In some cases, it is the benefit of the values that cannot be calculated, supplemented by those values that can be calculated, that will provide a compelling argument for Connected Vehicle technology.

Part Three – A Plan for Engagement by the Emergency Responder Community in the Development and Deployment of Connected Vehicle Technology

The most significant challenge to the rapid diffusion of Connected Vehicle technologies among responders (police, fire, EMS, transportation, towing and recovery, etc.) is a lack of technical and operational comprehension. Education campaigns that explain the benefits of Connected Vehicle and Connected Responder systems will prepare leaders, policymakers, and end-users to leverage the benefits of these emerging systems.

A secondary barrier for responders is the unsynchronized convergence of Connected Vehicle transportation infrastructure, commercial vehicle systems, fleet vehicle systems, and systems available to the general public. To maximize the benefit of these divergent but interrelated initiatives, the responder community must have an influential and well-informed voice. A forum to communicate common interests and unique concerns is required to move the responder community forward in concert with public and commercial initiatives.

Finally, technical and fiscal barriers must be overcome to ensure that responder personnel, facilities, and fleet vehicles can be either retrofitted or integrated with Connected Vehicle technologies. The conventional approach to isolate effective legacy systems from new innovations must be overcome through migration and integration strategies that do not detract from current operational capabilities. The benefits of Connected Vehicle technology must be embraced from within the responder community if they are to be realized in practice. Well-informed leaders within the responder community can positively influence technology acquisition, fleet acquisition, and system integration budgets. At higher levels of government, transportation funds should be made available to expedite the deployment of Connected Vehicle solutions. Informed thought leaders can advance technical and fiscal partnerships across disciplines to ensure public safety, transportation, towing and recovery, and relevant NGOs are building towards a common platform.

Practitioner-Driven Development

Based on the aforementioned education and engagement strategies, it is expected that practitioner interest in Connected Vehicle technologies will increase. Thought leaders will emerge who can envision Connected Responder solutions as a conduit to reducing risk and increasing operational capacity. Chief Financial Officers, Chief Information Officers, and Chief Executives will recognize the potential return on investment that Connected Vehicle systems offer. Reductions in financial and personnel-related costs of collisions, coupled with the operational benefits of safer transit and incident management conditions for responders, will be a catalyst for adoption and innovation.

The development of applications and protocols associated with V2V, V2I, V2P, and wearable technologies will be advanced by educated end-users. Innovation will occur as grass roots interest in Connected Vehicle technology meets the growing interest that senior leaders develop. At one end of the spectrum, end-users will want to maximize their individual safety and efficiency when working in dangerous environments. At the other end, CFOs, CIOs, and CEOs will want to reduce cost, risk, and exposure to tort claims. The precise path forward is difficult to predict. However, predicting a high level of interest by responders in Connected Vehicle technology is a near certainty.

Ergonomic and Security Concerns

Two common concerns have emerged with the introduction of mobile information technology systems into emergency responder workplaces. The first noted concern is the ergonomic impact that vehicle-based and wearable technology may have on end-users. The often-dangerous conditions in which responders operate raise concerns over distractions and physical harm that can occur from poorly designed hardware and software. Connected Vehicle systems will have to undergo rigorous testing and evaluation to insure the full amelioration of these legitimate ergonomic concerns. Research and development partnerships between practitioners and engineers will maximize the benefit of Connected Responder solutions while minimizing the risk of unintended ergonomic consequences.

The second prevailing concern over mobile technology systems is the security of those systems. Privacy and information security concerns dominate decision making at the CEO and CIO levels of responder organizations. These security concerns are shared by all potential users of Connected Vehicle technology. Consumer and responder Connected Vehicle education efforts must build trust regarding the integrity of these systems to prevent them from being tampered with or disabled. Furthermore, law enforcement subject-matter experts have raised concerns over operational security risks that can occur if members of the public can automatically detect the presence of a connected police vehicle or officer through Connected Vehicle alerts and warnings. Under certain circumstances, such as traffic enforcement, criminal incident response, and criminal investigations, officers may need to be in a stealth mode to prevent detections. Balancing technical and operational security concerns will be a crucial component for Connected Responder applications.

The success of future Connected Responder applications will be dependent upon the involvement of end-users and subject-matter experts during the development and validation stages. The complexities of responder operations necessitate robust partnerships with Connected Vehicle solution developers. The shared goals of reducing collisions and improving the efficient use of transportation infrastructure are upheld by responders and engineers. However, the unique concerns of the responder community to maximize officer safety and criminal interdiction efforts should not be overlooked.

Practitioner Education and Engagement

In recent years, a Connected Responder Community of Interest has informally emerged, as long-standing transportation and emergency responder membership organizations have studied and discussed Connected Vehicle initiatives. The concept of Connected Responders leveraging Connected Vehicle and wearable technology has been advanced through a variety of U.S. Department of Transportation ITS JPO-supported conference presentations, articles in professional periodicals, and research partnerships. Through the development of the Connected Responder business case, entities such as ITS America and TSAG have recognized that education and enforcement strategies must now be

formalized to prepare practitioners to influence and participate in the emerging Connected Vehicle enterprise.

Advancement of the Connected Responder business case can best be accomplished through existing membership organizations. These professional associations have mature governance structures, broad membership access, and high levels of trust across government, academia, and the private sector. Leveraging the influence of these organizations will require investments in useful education, policy, and technical resources that contribute to a greater Connected Responder knowledge base. Rather than informal piecemeal presentations, publications, and episodic meeting agenda items, a formal long-term strategy is needed to address Connected Vehicle and Responder needs. ITSA and TSAG are well-positioned to lead and support a Connected Responder education and engagement with the support of the U.S. Department of Transportation.

Focused engagement with organizations that create or drive standards and specifications within the emergency response community is essential. Emerging Connected Vehicle technologies must be synthesized with or integrated into practitioner-based technical standards and functional specifications, such as standards published by the Association of Public Safety Communications Officials for the law enforcement and public safety dispatch communities, the National Fire Protection Association for the fire and emergency medical services communities, and organizations representing emergency responder information technology solution providers, such as the IJIS Institute.

This engagement must also ensure that data exchanges with Connected Vehicle systems within the emergency responder environment are conformant with the National Information Exchange Model (NIEM) in order to enable full interoperability of Connected Vehicle data within the emergency responder information system ecosystem.

The panel of subject-matter experts convened to develop the Connected Responder business case identified the following individual organizations and coalitions as primary partners for education and outreach engagements:

- American Association of Motor Vehicle Administrators
- American Association of State Highway and Transportation Officials
- Association of Public Safety Communications Officials
- Connected Vehicle Pooled Fund Study
- National Association of Emergency Dispatchers
- National Association of State EMS Officials
- National Fire Protection Association
- National Sheriffs Association
- National Traffic Incident Management Network
- Integrated Justice Information Systems Institute
- International Association of Chiefs of Police
- International Association of Fire Chiefs
- Towing & Recovery Association of America
- Transportation Research Board
- International Association of Emergency Managers
- Vehicle to Infrastructure Deployment Coalition

The aforementioned organizations and coalitions convene general membership conferences and exhibitions that are exceptional forums to disseminate and collect Connected Responder business case information. In concert with these large gatherings are smaller committee and subcommittee meetings. Standardized TSAG-crafted messaging and education materials distributed to these influential groups will raise the knowledge and interest levels of Connected Responder constituencies. When feasible, technology and transportation-focused professional association committees should provide formal membership-level access to TSAG Connected Responder subject-matter experts. Building broad levels of responder interest with contemporary education materials will harmonize the well-intentioned episodic and sometimes disconnected efforts that are currently taking place.

Limited resources to support education and outreach objectives requires an efficient communications strategy led by TSAG and executed by a consortium of responders. The

following approaches were endorsed by a focus group of practitioners to attract the attention and interest of the responder community.

Conference and Meeting Presentations: Standardized basic, intermediate, and advanced Connected Responder education materials for presentations would provide technically accurate, operationally relevant, and realistic Connected Vehicle deployment timelines. Connected Responder presenters should be selected from the community of trusted practitioners. In other words, the presenter should have immediate legitimacy with the audience being engaged.

Fact Sheets and Executive Summaries: Technically accurate and operationally relevant Connected Responder reports and fact sheets should be produced, published, and distributed to potential Connected Responder Communities of Interest. The material should highlight the capabilities of Connected Vehicle technology and the anticipated timeline for integration and adoption. TSAG-branded fact sheets and executive summaries will bolster the organization's reputation as the authority for Connected Responder guidance and reference.

Virtual Focus Groups and Webinars: Through the use of online meeting applications, TSAG can conduct small and large group Connected Responder education and engagement sessions. These low-cost solutions are effective ways to inform and educate practitioners on Connected Vehicle capabilities, use cases, and resources to support future decision making. Interactive focus groups may also be held online to communicate with smaller groups of practitioners to discuss technical and operational issues. When properly led and facilitated, online meetings and education programs can increase the depth and breadth of strategic Connected Responder constituent engagement.

Video Vignettes: Connected Vehicle and Connected Responder program information should be conveyed through brief audience-appropriate videos and animations. USDOT (ITS JPO) has enjoyed significant success with general Connected Vehicle education videos and animations. Similar products focused specifically on responder operations, concerns, and requirements will be instrumental to increasing knowledge and interest.

These multimedia vignettes may be embedded in other outreach channels to add depth and substance to TSAG's education campaign.

Social Media Outreach: The responder community has grown increasingly reliant on social media platforms to gather and disseminate information and resources. These existing forums should be leveraged as distribution channels to broadcast Connected Responder-related materials to large audiences of constituents. Social media distribution channels are affordable and effective forums to build a sense of community while achieving informal collaboration through abbreviated online engagements.

Practitioner Speakers' Bureau: TSAG should maintain a directory of trusted presenters to message Connected Responder-related program information. Speakers should be drawn from the full range of responder domains and leadership levels. These validated representatives may also be used to provide formal testimony and feedback to federal- and state-level elected leaders. TSAG is the most appropriate organizer for Connected Responder and Connected Vehicle thought leaders who understand both the technology and the environment in which it will be deployed. TSAG's non-responder members can support the speakers' bureau with technical guidance.

Conclusion

The successful advancement of a business case for Connected Responders requires modest investments in formal education and outreach. Common messaging with technically accurate, operationally relevant, and realistic time horizons should be coordinated by a single entity or recognized practice team. TSAG is well-positioned to oversee the development and delivery of Connected Responder program information to a national audience of potential contributors. Furthermore, TSAG's diverse membership, comprised of practitioners and technical subject-matter experts, makes the group well-suited to communicate with a broader audience of Connected Responders.

Building Connected Responder education resources and formal Communities of Interest will require modest investments by the U.S. Department of Transportation and private

sector. Responders must be well-informed participants in V2V, V2I, and V2P technologies if they are to ultimately be successful for the general public, commercial entities, and other impacted stakeholders. The important role of responders in a Connected Vehicle enterprise cannot be understated.

Through this Connected Responder business case, specific strategies have been recommended, based on extensive operational research and stakeholder engagement. The following principles and rational engagement approaches will prepare responders for the imminent opportunities and challenges with which they will be confronted:

- Develop a formalized communication strategy with existing professional organizations
- Standardize the Connected Responder message to achieve practitioner learning objectives while setting realistic technical and operational expectations
- Build trust by leveraging the skills and influence of respected practitioners to educate less-informed practitioners
- Showcase success stories and best practices and encourage the replication of statewide Connected Responder working groups to connect and prepare key stakeholders for V2V, V2I, and V2P applications
- Develop, disseminate, and refresh TSAG-branded Connected Responder education materials using proven communications forums and tools (audience appropriate presentations, publications, webinars, fact sheets, executive summaries, video vignettes, and a formal speakers' bureau)

A short-term achievable task to promote the business case for Connected Responders is to develop a toolkit to guide the establishment of state-level Connected Responder Communities of Interest. This toolkit should leverage the governance structure and best practices adopted by AAMVA's Autonomous Vehicle Law Enforcement Working Group, Maryland's Autonomous and Connected Vehicle Working Group, and the I-95 Corridor Coalition. Improving the knowledge base and interest level of practitioners through immediately relevant state-level working groups will result in powerful forces to drive

positive change. Technically conversant practitioners will be organized to apply their experience and innovative capabilities to address real-world challenges at the state level.

Practitioners engaged in the development of this Connected Responder business case began with a wide variety of formal and informal Connected Vehicle subject-matter expertise. The practitioners and contributors gained an appreciation for the profound benefit that Connected Responder applications will offer to enhance individual officer safety and organizational effectiveness. An in-depth analysis of over 100 public safety agency strategic plans revealed a clear nexus between Connected Responder capabilities and common organizational goals and objectives. The findings of this research should be formally messaged to a national audience of potential users, policymakers, and executives (CFOs, CIOs, and CEOs).

In closing, major investments made in Connected Vehicle-related systems will only be successful if the stakeholders who are expected to use them are receptive to their operational benefits. The skeptical community of law enforcement, fire, EMS, traffic incident management, and towing and recovery practitioners requires formal education and engagement by technical subject-matter experts. Public interest in Connected Vehicle technology will also be advanced or suppressed based on the role emergency responder officials play in Connected Vehicle networks. High levels of interest and engagement by emergency responder officials and responders will have a positive impact on public and political support for Connected Vehicle and infrastructure investments. TSAG-led stakeholder engagement will foster optimal conditions of success for Connected Responders and the public they serve. The business case for Connected Responders depends heavily on dedicated and properly resourced leadership and coordination.

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