Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)

Concept of Operations

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16. Abstract

This document describes the Concept of Operations (ConOps) for the Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) application bundle. R.E.S.C.U.M.E. is one component of the US DOT sponsored Dynamic Mobility Applications (DMA) program. The ConOps is a user-oriented document that describes system characteristics for a proposed system from the users' viewpoint. The ConOps document is used to communicate the overall quantitative and qualitative system characteristics to the user, buyer, developer and other organizational elements (e.g. training, facilities, staffing and maintenance). It is used to describe the user organization(s), mission(s) and organizational objectives from an integrated systems point of view. The ConOps was developed based on the requirements defined in IEEE Standard 1362-1998 – IEEE Standard Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document.

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Executive Summary

The US DOT sponsored Dynamic Mobility Applications (DMA) program seeks to identify, develop, and deploy applications that leverage the full potential of connected vehicles, travelers and infrastructure to enhance current operational practices and transform future surface transportation systems management.[1] The DMA Program consists of a set of transformative mobility applications that, when bundled together, impact the transportation system to improve mobility. The Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) is included in the DMA bundles. The R.E.S.C.U.M.E. bundle includes four applications: Advanced Automatic Crash Notification Relay (AACN-RELAY), Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG), Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE), and Emergency Communications for Evacuation (EVAC). It is expected to communicate and interact with the other bundles under two different communication mechanisms. First, the R.E.S.C.U.M.E. bundle is expected to exchange information with other DMA Program bundles through an Information Broker (discussed below). Second, the R.E.S.C.U.M.E. bundle will use CV technology as a communication bridge to transfer information between bundles.

This document describes the Concept of Operations (ConOps) for the R.E.S.C.U.M.E. bundle. The ConOps is a user-oriented document that describes system characteristics for a proposed system from the users' viewpoint. The ConOps document is used to communicate the overall quantitative and qualitative system characteristics to the user, buyer, developer and other organizational elements (e.g. training, facilities, staffing and maintenance). It is used to describe the user organization(s), mission(s) and organizational objectives from an integrated systems point of view.

The ConOps describes the current states of operations in areas that correspond to the applications described, establishes the reasons for change, and outlines the envisioned R.E.S.C.U.M.E. Bundle Applications in terms of the features and operations and the systems that support it. The ConOps was developed based on the requirements defined in IEEE Standard 1362-1998 – IEEE Standard Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document.

[1] http://www.its.dot.gov/dma/index.htm

Chapter 1 Scope

This document describes the Concept of Operations (ConOps) for the Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) Program. A ConOps is a user-oriented document that describes system characteristics for a proposed system from the users' viewpoint. A ConOps document is used to communicate the overall quantitative and qualitative system characteristics to the user, buyer, developer and other organizational elements (e.g. training, facilities, staffing and maintenance). It is used to describe the user organization(s), mission(s) and organizational objectives from an integrated systems point of view.

This ConOps is developed for the U.S. Department of Transportation (U.S. DOT), Intelligent Transportation Systems Joint Program Office (ITS JPO). A ConOps is a user-oriented document that describes system characteristics for a proposed system from the users' viewpoint. The ConOps document is used to communicate the overall quantitative and qualitative system characteristics to the user, buyer, developer and other organizational elements (e.g. training, facilities, staffing and maintenance). It is used to describe the user organization(s), mission(s) and organizational objectives from an integrated systems point of view.[2]

The ConOps describes the current states of operations in areas that correspond to the applications described, establishes the reasons for change, and outlines the envisioned R.E.S.C.U.M.E. Bundle Applications in terms of the features and operations and the systems that support it. The ConOps was developed based on the requirements defined in IEEE Standard 1362-1998 – IEEE Standard Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document.

Identification

This document is identified by the title and effective date.

Document Overview

This ConOps is organized in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 1362™-1998 (R2007), *Guide for Information Technology—System Definition—Concept of Operations (ConOps) Document*.

The remainder of this document consists of the following sections and content:

- **Section 2 (Referenced Documents)** describes the external documentation referenced within this document.

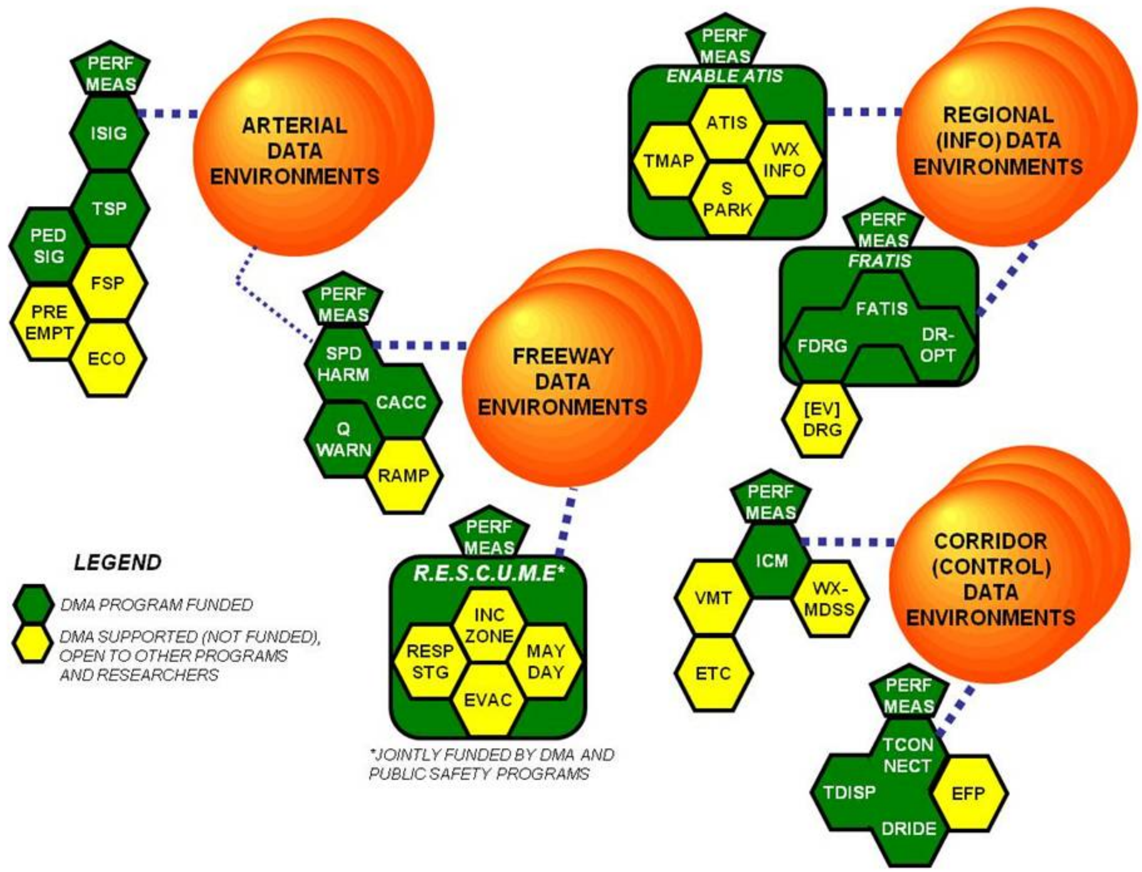
[2] http://standards.ieee.org/findstds/standard/1362-1998.html

- **Section 3 (Current System or Situation)** describes the current situation in the United States for the transportation and emergency management areas that correspond to the four R.E.S.C.U.M.E. application areas.
- **Section 4 (Justification for and Nature of Changes)** describes the need for the proposed changes among the four interacting areas corresponding to the applications. This section identifies deficiencies of the existing situation and the benefits of change.
- **Section 5 (Concepts for the Proposed System)** describes the proposed applications that will result from the desired changes. This is, necessarily, a high-level description, indicating the operational features of the applications when deployed.
- **Section 6 (Operational Scenarios)** contains operational scenarios that illustrate the attributes of the applications. A scenario is a step-by-step description of how the proposed application might operate and interact with its users and its external interfaces under a given set of circumstances. The scenarios tie together all parts of the proposed applications, the users, and other entities by describing how they interact.
- **Section 7 (Summary of Impacts)** describes the operational impacts of the proposed system on the Local, State, Federal, and Other Users Groups and support organizations.
- **Section 8 (Analysis of the Proposed System)** describes the benefits, limitations, advantages, disadvantages and trade-offs considered for the demonstration system.
- **Appendix A** provides definitions of the acronyms used throughout this ConOps document.

System Overview

R.E.S.C.U.M.E. is one bundle of applications of the U.S. DOT's Dynamic Mobility Applications (DMA) program. Each application bundle that comprises the U.S. DOT's Dynamic Mobility Applications (DMA) program is shown in Figure 1-1. The conceptual application bundles are grouped based on similar high-level data needs and functional interaction among applications. The bundling of applications increases transformational impacts and can potentially reduce research and development costs.

Each bundle incorporates several related applications that are displayed as hexagons. Each bundle is also tied to one or two data environments; R.E.S.C.U.M.E. is associated with the Freeway Data environments. These bundles and their applications capitalize on current and future ITS research to advance the state of practice in their respective data environments. The applications enable public sector, multimodal system management, and other capabilities such as data collection and analysis, decision management/support, and problem solving. The U.S. DOT expects the applications to support its goal of providing safety, mobility, and environmental benefits along with more specific operational advances.



USDOT RITA ITS JPO DMA website http://www.its.dot.gov/press/2011/mobility_app.htm

Figure 1-1. Dynamic Mobility Applications (DMA) Program Application Bundles[3]

The DMA applications have all been selected with regard to their potential to capitalize on existing technology and ongoing advances and ability to transition through development, testing, simulation, and deployment. A variety of factors affecting development of the R.E.S.C.U.M.E. ConOps need to be assessed, whether they involve technology, institutional issues, data, interoperability, or other aspects. Stakeholder involvement is essential to capture user needs and expectations in order to target the challenges and validate the proposed solutions. The ConOps explores the current system and its gaps and limitations, determines the concept for proposed changes that will best bridge those gaps and limitations, and uses scenarios to illustrate the benefits of the system that results from those proposed changes. The ConOps will be used to develop functional and performance requirements.

The following material discusses, at a high level, the nature of the four applications that make up the R.E.S.C.U.M.E. Bundle: Advanced Automatic Crash Notification Relay (AACN-RELAY), Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG), Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE), and Emergency Communications for Evacuation (EVAC).

[3] Note that one of the R.E.S.C.U.M.E. Bundle Applications has been subsequently renamed from Mayday to Advanced Automated Crash Notification Relay or AACN-RELAY.

Advanced Automatic Crash Notification Relay

Advanced Automatic Crash Notification Relay (AACN-RELAY) refers to a capability that will allow vehicles to relay an emergency message (i.e., "AACN") from other vehicles involved in a crash or other distress situation. Sensors mounted in the vehicle, record key incident data, transmitted by an automatic crash notification feature, without the need for involvement of the driver or an occupant, in case they are incapacitated. For Connected Vehicle (CV) enabled vehicles, this will be initiated by two concurrent methods to get the crash message to an Emergency Communications Center (ECC, part of which is a public safety answering point, or PSAP) for action by emergency responders. These methods include (1) a call placed by a cell phone embedded as part of the car's AACN system, and (2) the transmission of comparable information by a short-range wireless transmission to be relayed by other CV-enabled vehicles.

> AACN RELAY requirements are included in this document for completeness and consistency. However, USDOT does not plan to pursue development of AACN RELAY during subsequent phases of the DMA Program.

The capability to respond to vehicle emergencies, resulting from single vehicle incidents, will be improved, which is particularly vital in rural or remote areas where there may not be cell phone coverage or passers-by who are aware that an off-road incident has occurred. The ability to dispatch both appropriate resources and triage of victims to an appropriate final destination, based on the severity of injuries, will also be enhanced. The AACN-RELAY application will provide the capability for CV-enabled vehicles to detect other vehicles' AACN alerts and relay them to other CV-enabled vehicles and roadside "hotspots." The transmission of the original AACN message will result in immediate action by the PSAP that has coverage in the location of the incident where the AACN message was originally relayed. The purpose of the AACN-RELAY application is to expand the population of AACN-RELAY capable vehicles and minimize the notification time to emergency responders. This reduces the period between the time of the crash and the arrival of emergency responders to deliver medical attention. AACN-RELAY also provides responders with diagnostics that detail the characteristics of the incident and explains what specifically triggered the transmission of the AACN message.

Incident Scene Pre-Arrival Staging Guidance for Emergency Responders

The Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG) application will provide situational awareness to and coordination among emergency responders—upon dispatch and while en route— to establish incident scene work zones, upon initial arrival and staging of assets, and afterward if circumstances require additional dispatch and staging. It will provide enhanced intelligence and analytics capabilities which will be a valuable input to responder and dispatcher decisions and actions. There is a range of data that will be provided through mobile devices and other types of communication to help support emergency responder vehicle routing, staging, and secondary dispatch decision-making. These data will include staging plans, satellite imagery, geographic information system (GIS) map graphics, camera images, current weather data, sensor readings, and real-time modeling outputs.

Incident Scene Work Zone Alerts for Drivers and Workers

INC-ZONE is a communication approach that will improve protection of incident sites where there have been crashes, other accidents, or events impacting traffic such as stalled vehicles or vehicles pulled over for moving violations. It is important to note that construction work zones and accident incident zones are fundamentally different in nature. Specifically, a work zone is typically pre-planned and usually involves only a single agency (or at most a few agencies) while an incident zone is random and frequently involves inter-agency responses.

Persons found in an incident zone could include crash victims, law enforcement, Emergency Medical Services (EMS), Fire and Rescue, HAZMAT Response Unit, Towing and Recovery assets, and roadway/infrastructure repair workers. One aspect of the INC-ZONE application is an in-vehicle messaging system that provides drivers with merging and speed guidance around an incident. Another aspect is providing in-vehicle incident scene alerts to drivers, both for the protection of the drivers as well as incident zone personnel. A third aspect is a warning system for on-scene workers when a vehicle is approaching or is being operated outside of safe parameters for the condition in the incident zone.

Emergency Communications for Evacuation

Emergency Communications for Evacuation (EVAC) will provide critical information such as dynamic route guidance information, current traffic and road conditions, location of available lodging, and location of fuel, food, water, cash machines and other necessities. EVAC will also identify and locate people with functional needs who are more likely to require guidance and assistance and will identify existing service providers and provide them other available resources

Chapter 2 Referenced Documents

Section 2 lists the documents referenced in this ConOps including title, revision, and date of the documents.

1. Advanced Automated Crash Notification (AACN)/9-1-1 Field Operational Test (FOT) Results and Path Forward Report, Document Number: 232004, Revision B, Prepared for the Minnesota Department of Transportation, 10 March 2006
2. Advanced Traveler Information System Study: Task 3 Findings, 12 May 2009
3. American Association of State Highway and Transportation Officials (AASHTO) – National Traffic Incident Management Coalition National Unified Goal (NUG), Web Page, Last modified 17 April 2012 http://www.transportation.org/Default.aspx?SiteID=41
4. Association of Public Safety Communications Officials (APCO)/U.S. Department of Justice Office of Justice Programs, Priority Data Exchanges for Local Telecommunications Centers, Section 3.2.1, Incident Notifications via Telematics (crash, disabled vehicle, etc.), August 2009
5. Atlantic County, New Jersey 9-1-1 Consolidation Feasibility Study Consolidation Model Assessment, Task 2, June 2007
6. Best Practices in Traffic Incident Management Sponsored by: Emergency Transportation Operations Office of Transportation Operations U.S. Department of Transportation (U.S. DOT), Federal Highway Administration (FHWA), September 2010
7. Changeable Message Sign Operation and Messaging Handbook, FHWA-OP-03-070, August 2004
8. Congressional Research Service (CRS) Report for Congress, Emergency Management Preparedness Standards: Overview and Options for Congress, 4 February 2005
9. Evacuating Populations with Special Needs, Routes to Effective Planning Primer Series, U.S. DOT, FHWA, April 2009
10. Evaluation of Effectiveness of Automated Workzone Information Systems, Transportation Research Board (TRB) Paper 05-2779, 2005
11. Evaluation of the Motoring Public's Acceptance of a Real-Time Travel Time
12. Prediction System in a Freeway Construction Work Zone, Paper No. 02-2372, 2001
13. FHWA Work Zone Mobility and Safety Program Website; 8 December 2011
14. Final Evaluation Report, Evaluation of the AACN/9-1-1 Field Operational Test
15. Prepared for the FHWA and National Highway Traffic Safety Administration (NHTSA), 19 July 2006
16. Good Practices in Transportation Evacuation Preparedness and Response: Results of the FHWA Workshop Series, U.S. DOT, FHWA, August 2009
17. iCone™ Use and Care Manual, Rev 20080405.1, 05 April 2008
18. Institute of Electrical and Electronics Engineering (IEEE) Standard 1220™–2005, Application and Management of the Systems Engineering Process, 9 September 2005
19. IEEE Standard 1362-1998, Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document, 19 March 1998

20. Incident Management Performance Measures, U.S. DOT, FHWA, November 2002
21. Intelligent Transportation System (ITS) and Transportation Safety: EMS System Data Integration to Improve Traffic Crash Emergency Response and Treatment, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota and School of Information Systems and Technology, Claremont Graduate University, January 2009
22. Manual on Uniform Control Devices, 2009 Edition
23. Montana Automatic Crash Notification Project, Tech-Note Deliverable for Revised Task 2/Version 2, Characterization of Pathways for Delivery of Crash Telemetry Data to Montana, 8 July 2011
24. NHTSA, National Center for Statistics and Analysis, Traffic Safety Facts – Rural/Urban Comparison, 2007 Data
25. Prompt, Reliable Traffic Incident Communications, National Traffic Incident Management Coalition, 2006
26. Recommendations from the Expert Panel: Advanced Automatic Collision Notification and Triage of the Injured Patient. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Injury Response, 2008. http://www.cdc.gov/injuryresponse/pdf/aacn-report_final-a.pdf
27. Report on Assessment of Relevant Prior and Ongoing Research for the Concept Development and Needs Identification for R.E.S.C.U.M.E., Version 1.0, 27 January 2012
28. Report on State of Current Practice for the R.E.S.C.U.M.E. Bundle Applications, Version 1.0, 27 December 2011
29. Research and Innovative Technology Administration (RITA) Joint Program Office (JPO) Core System Documents Concept of Operations, 24 October 2011: http://www.its.dot.gov/docs/CoreSystemConOpsRevE2.pdf
30. Standards Recommendation Report, 28 October 2011: http://www.its.dot.gov/docs/CoreSystem_StdsRecommendations_RevA.pdf
31. Simplified Guide to the Incident Command System for Transportation Professionals, U.S. DOT, FHWA, February 2006
32. Smart Work Zone Systems, PDP Associates, 15 July 2008
33. Systems Engineering Guidebook for ITS, Version 3.0, 21 November 2009
34. The National ITS Architecture 7.0, U.S. DOT, Architecture released January 2012; Turbo Architecture released 14 February 2012
35. Title 49, Code of Federal Regulations Part 563, Event Data Recorders, Final Rule, NHTSA, 28 August 2006
36. Traffic Incident Management Handbook, U.S. DOT, FHWA, January 2010
37. Traffic Incident Response Practices in Europe, U.S. DOT, FHWA, February 2006
38. U.S. DOT Proposes 'Distraction' Guidelines for Automakers, NHTSA 01-12, 16 February 2012
39. Using Highways During Evacuation Operations for Events with Advance Notification, Routes to Effective Evacuation Planning Primer Series, U.S. DOT, FHWA, December 2006
40. Workzonesafety.org Website; Safety Products; Equipment Details – iCone page. http://www.workzonesafety.org/safety_products/record/8868.

Chapter 3 Current System or Situation

This section summarizes the current state of practice for the existing applications in order to align the current capabilities with the proposed enhancements for the R.E.S.C.U.M.E. Bundle Applications. Recognizing that there are systems under research and development that include CV technology, for example, the Commercial Mobile Alert System (CMAS) public safety emergency alert system technology, and Signal Phase and Timing (SPaT) Improvements, this section will only present technologies that are operational as of the writing of this document.

Background, Objectives, and Scope

Current practice followed during an incident response is motivated to accomplish the objectives established by members of the National Traffic Incident Management Coalition (NTIMC) as the National Unified Goal (NUG). The NUG strives to achieve responder safety, safe, quick clearance, and prompt, reliable, interoperable communications. These are achieved through the activation of a “planned” strategy for the safe and rapid deployment of the most appropriate personnel and resources to the incident scene.

Information management plays an important role in response by providing time-sensitive, critical information to the appropriate personnel, which is essential in achieving optimum response. Accurate information about an incident, such as location, traffic impacts, type of vehicle involved, presence of an injury or fatality, and other special conditions is essential in determining the proper response. The level of required response is typically determined by an on-scene responder or by a dispatcher at an ECC or Traffic Management Center (TMC). Accurate information available to all emergency responders helps to achieve the overall incident response objectives. These include saving lives through enhanced EMS response, ensuring that responders reach the scene before the traffic backup becomes lengthy, dispatching resources relevant to the emergency call, and restoring mobility to pre-incident conditions.

Operational Policies and Constraints

Vehicular incidents, by nature, are dynamic events with the potential for decreased mobility, and the need to restrict access and egress from the incident for the safety of the responders. Consequently, vehicle-based accidents typically involve several responder organizations who may or may not routinely work together. Regardless, each of these entities has its own policies, regulations, standards, and procedures that are followed for any given incident. These policies and procedures are not always compatible and/or may cause confusion, delay, and conflicts among the various responder agencies in part because the missions of the various responder agencies differ (but also overlap on occasion as well). The concept is important background for any intelligent transportation system that intends to interact with the responder community.

Some of the many policies, procedures, standards, and regulations that apply to the current systems include but are not limited to the following:

- *49 CFR Part 563, Event Data Recorders.* The purpose of this part is to help ensure that event data recorders (EDRs) record, in a readily usable manner, data valuable for effective crash investigations and for analysis of safety equipment performance (e.g., advanced restraint systems). These data will help provide a better understanding of the circumstances in which crashes and injuries occur and will lead to safer vehicle designs.
- *Homeland Security Presidential Directive (HSPD) – 5, Management of Domestic Incidents,* 28 February 2003. The purpose of HSPD-5 is to establish a single, comprehensive approach to domestic incident management. The objective of the United States Government is to ensure that all levels of government across the Nation have the capability to work efficiently and effectively together, using a national approach to domestic incident management. In these efforts, with regard to domestic incidents, the United States Government treats crisis management and consequence management as a single, integrated function, rather than as two separate functions.
- *National Incident Management System (NIMS).* NIMS provides a systematic, proactive approach to guide departments and agencies at all levels of government, nongovernmental organizations, and the private sector to work seamlessly to prevent, protect against, respond to, recover from, and mitigate the effects of incidents, regardless of cause, size, location, or complexity, in order to reduce the loss of life and property and harm to the environment.
- *Presidential Policy Directive (PPD) – 8, National Preparedness,* 30 March 2011. The purpose of PPD-8 is to establish a national preparedness goal that reflects the policy direction outlined in the National Security Strategy (May 2010), applicable Presidential Policy Directives, Homeland Security Presidential Directives, National Security Presidential Directives, and national strategies, as well as guidance from the Interagency Policy Committee process. The goal shall be reviewed regularly to evaluate consistency with these policies, evolving conditions, and the National Incident Management System NIMS).
- *The Health Insurance Portability and Accountability Act (HIPAA)* is applicable because health information is considered private and must be protected in a way that meets the information security standards outlined in the Act. HIPAA applies for relay of victim/patient information, planning for functional needs persons, and developing registries for function needs populations. Participation in database registry must be voluntary.
- The *Post-Katrina Emergency Management Reform Act (PKEMRA)* requires planning for the evacuation and sheltering of individuals with disabilities and other functional needs as well as ensuring the provision of “temporary” public transportation services to those functional needs individuals. PKEMRA also authorizes the planning for and provision of rescue care and shelter to both service animals and household pets.
- The *Common Alerting Protocol (CAP)* provides a general format for exchanging all-hazard emergency alerts and public warnings over all networks. CAP allows a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning

task. CAP also facilitates the detection of emerging patterns in local warnings of various kinds, including an undetected hazard or hostile act. CAP provides a template for effective warning messages based on best practices identified in academic research and real-world experience.

- *National ITS Architecture* means a common framework for ITS interoperability. The National ITS Architecture comprises the logical architecture and physical architecture which satisfy a defined set of user services. The National ITS Architecture is maintained by the U.S. DOT and is available at http://www.iteris.com/itsarch/
- *Federal Highway Administration (FHWA) Policy Memorandum: Use of Changeable Message Sign (CMS),* 19 January 2001. The FHWA supports the use of a CMS as a traffic control device to safely and efficiently manage traffic by informing motorists of roadway conditions and required actions to perform. The appropriate use of a CMS and other types of real-time displays should be limited to managing travel, controlling and diverting traffic, identifying current and anticipated roadway conditions, or regulating access to specific lanes or the entire roadway.
- *FHWA Policy Memorandum: Use of Changeable Message Sign (CMS) for Emergency Security,* 21 March 2003. The purpose of this memorandum is to provide guidance on the use of CMS for displaying emergency or security alert messages.
- *FHWA Memorandum, Information and Action: Dynamic Message Sign (DMS) Recommended Practice and Guidance,* 16 July 2004. FHWA policy states that appropriate use of DMS and other types of real-time displays should be limited to managing travel, controlling and diverting traffic, identifying current and anticipated roadway conditions, or regulating access to specific lanes or the entire roadway.

The operational policies and constraints governing those involved with Traffic Incident Management (TIM) cut across numerous public agencies as well as private companies. From a public agency perspective, funding is a significant constraint. Jurisdictions are funded at varying levels, preventing a consistent life cycle refreshment of equipment and apparatus across organizations. Standard Operating Procedures (SOP) and training for responder personnel vary by jurisdiction. It is important to note that laws and protocols followed by emergency responders are largely set by authorities at the state and/or local level.

Technologies and systems that are currently used are often stove-piped in their purpose and functionality, thus requiring human interaction and coordination for their use, which imposes a constraint on the amount and timeliness of the information that can be communicated. There is a lack of an integrated system that can provide two-way communications with evacuees (especially functional needs populations), real-time data on the progress of an evacuation, and dynamic traffic and route guidance.

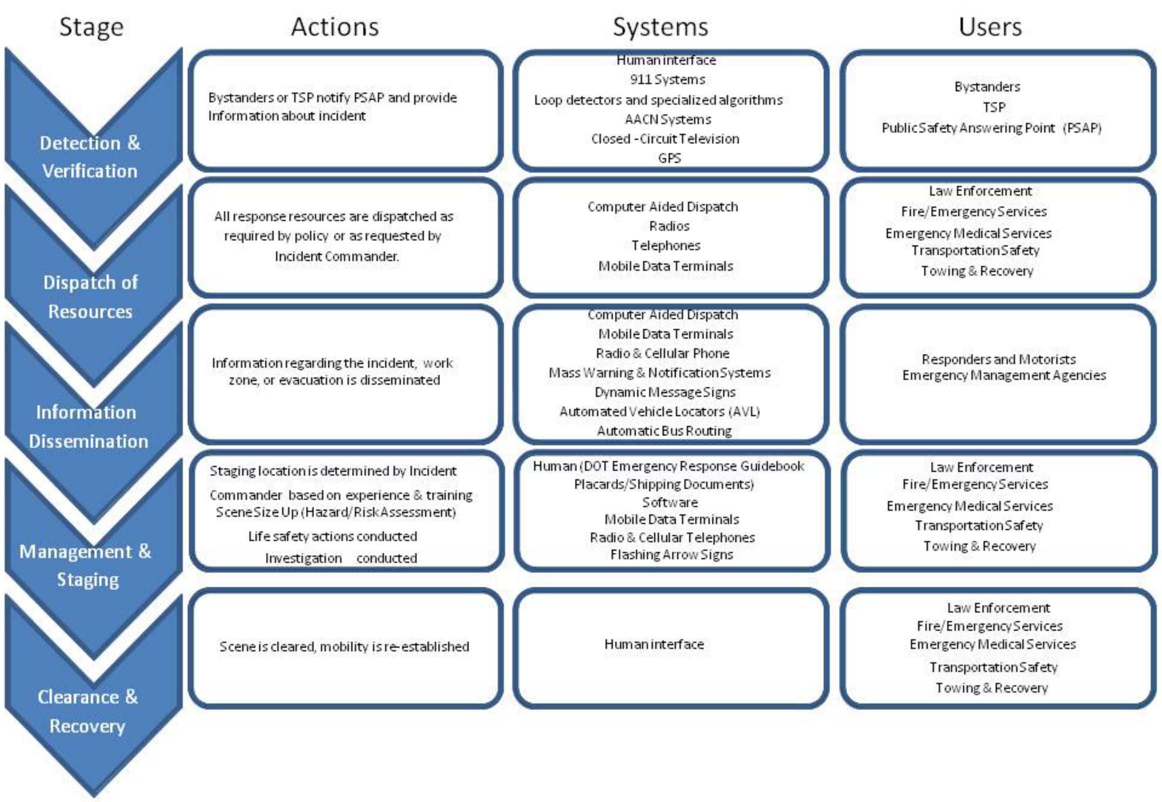
Communicating with the traveling public to inform them of incidents ahead requires adherence to communications and architecture standards as well as providing an interoperable environment that enables multiple devices to communicate with each other.

Description of the Current System or Situation

Current systems generally operate independently and require a large degree of human interaction for decision making. A holistic approach to response and mobility is hampered by current systems that are not integrated. This results in a manual process of transferring information from one system by a human to another system and creates inconsistencies in data transfer, impacting safety and mobility with the delay of information transfer.

Incidents are initiated and progress through a linear series of steps and processes to conclusion using these various systems that can be broken down by function. The information flow during a response begins with detection and verification of an incident, which occurs through various sources, and then followed by a dispatch of resources and information dissemination. Information transmitted to responders provides guidance for staging and preparation for incident management. Information transmitted to affected populations provides guidance and direction for anticipated actions. As the incident progresses, requests for additional resources are made by the Incident Commander in order to safely clear the incident, complete recovery operations and restore mobility. Similarly, an Evacuation Coordinator may initiate requests for additional resources as an evacuation progresses and circumstances change.

Figure 3-1 is an overview illustrating the flow of information in the current system.



Battelle

Figure 3-1. Current System Overview

Current Systems or Applications Comparable to AACN-RELAY

The National Highway Traffic Safety Administration (NHTSA) indicated that as of 2008, more than 65% of all vehicles were equipped with Electronic Data Recorders (EDRs); there are ongoing discussions to determine if these systems should be mandatory in all vehicles.[4] These devices are designed to gather information during a crash similar to "black box" transponders on aircraft that assist the Federal Aviation Administration (FAA) and National Transportation Safety Board (NTSB) with plane crash investigations. The information from these devices is the property of the vehicle's owner and requires either permission from the owner or a court order to obtain it. These EDR devices gather the following information:

- Change in forward crash speed
- Maximum change in forward crash speed
- Vehicle speed
- Accelerator pedal depression depth
- Brake application
- Ignition cycle when the EDR event was downloaded
- Seat belt usage
- Front air bag warning lamp indicator
- Number of crash events
- Time between the first two crash events, as applicable
- Completion of EDR recording

Vehicle-mounted crash detection sensors are currently installed on Ford (SYNCMYRIDE™), GM (On-Star™), BMW (Assist™), and other AACN subscription services for vehicle platforms. These systems have the capability to notify telematics service providers (TSPs) that a crash has occurred, the location of the crash, and various types of crash data to include direction/speed of travel and injury severity prediction. A manufacturer-provided AACN reports a crash to a TSP, which relays the information to the appropriate ECC for responder dispatch. The TSP operator may also attempt to make contact with the driver of the vehicle by accessing the AACN wireless service and make a cellular telephone call to the vehicle to obtain more information on occupants.

The benefit of the AACN system is automatic notification that a crash has occurred. As illustrated in Figure 3-2, the AACN has a GPS receiver that calculates location data from satellites. In the event that a single vehicle equipped with AACN runs off the road and strikes a tree, the collision triggers the AACN to automatically send critical vehicle data to the TSP via cellular transmission. The TSP operator attempts to make contact with the driver of the vehicle via a call to the vehicle's cell phone to obtain information on the condition and number of occupants. This allows the TSP to communicate more detailed information to the ECC so the appropriate level of resources can be dispatched. The TSP operator relays critical vehicle data and location obtained through the system and injury status

[4] http://www.nhtsa.gov/Research/Event+Data+Recorder+(EDR)/Welcome+to+the+NHTSA+Event+Data+Recorder+Research+Web+site

obtained through contact with occupants to the local ECC. This system is only affective if there is cellular service (for communication) and satellite service (for GPS) in the area of the crash.

It is important to note that NHTSA has included provisions in its Vehicle Safety and Fuel Rulemaking and Research Priority Plan 2011-2013 that address AACN. Currently, the agency is working with the Centers for Disease Control (CDC) and EMS providers to examine required data elements and potential benefits and triage capabilities of AACN to transport those seriously injured to a Level 1 trauma hospital. According to the plan, NHTSA will review research results and decide on next steps.[5]

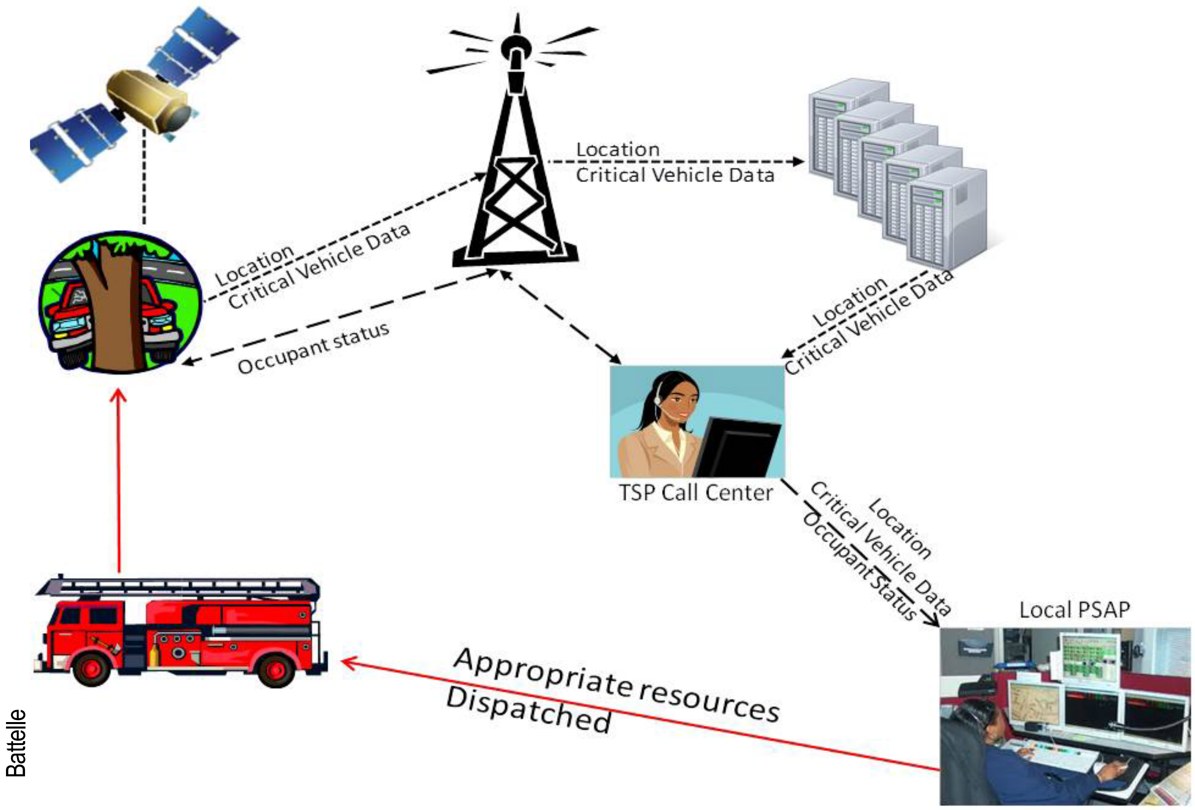


Figure 3-2. Typical AACN Information Flow

Current Systems or Applications Comparable to RESP-STG

Every emergency response agency has established incident response plans that determine the appropriate positioning of apparatus, lane closure policies, and level of response required for a given set of incident types. These plans and policies are developed independently, and each agency has underlying requirements and metrics for evaluation. In accordance with the International Association of Fire Chiefs' (IAFC) "*Guide to IAFC Model Policies and Procedures for Emergency Vehicle Safety*," the industry standard for staging of vehicles that result in lane closures at a crash scene is: *"…use fire apparatus to block at least one additional traffic lane more than that already are obstructed by the*

[5] NHTSA Vehicle Safety and Fuel Economy Rulemaking and Research Priority Plan 2011-2013. March 2011. Pp. 19.

crashed vehicle(s)." In addition, *"Law enforcement officials may also direct the specific positioning, or repositioning, of emergency vehicles on an incident scene in order to maintain traffic flow, reduce bottlenecks, enhance scene safety, and prevent secondary collisions."*[6]

Also important to consider, in terms of the functions, is that RESP-STG is intended to support the National Incident Management System (NIMS). In order to reduce the loss of life, property, and harm to the environment, NIMS provides a systematic, proactive approach to guide departments and agencies at all levels of government, nongovernmental organizations, and the private sector to work seamlessly to prevent, protect against, respond to, recover from, and mitigate the effects of incidents, regardless of cause, size, location, or complexity. NIMS was developed in response to Homeland Security Presidential Directive (HSPD)-5, Management of Domestic Incidents.[7]

Decision making for responder staging, illustrated in Figure 3-3, is driven by the tactical priorities of establishing responder safety, scene safety, and traffic safety. This is not a systems-driven decision-making process. It is human-driven with inputs received from communications with responders on scene and the training, knowledge, and experience of the Incident Commander.

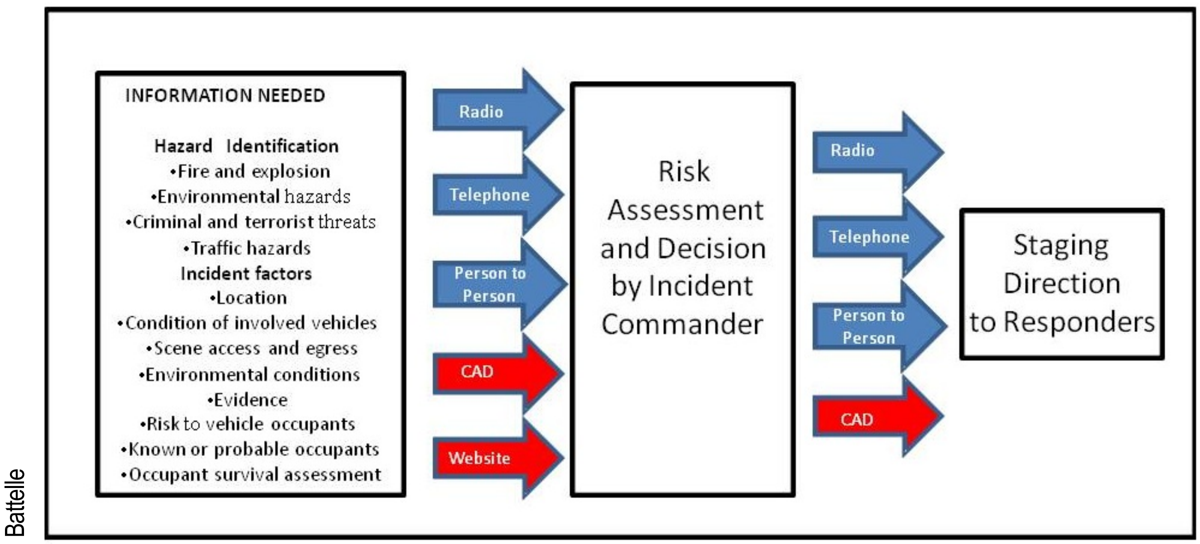


Figure 3-3. Responder Staging Decision Making

6 International Association of Fire Chiefs. *Guide to IAFC Model Policies and Procedures For Emergency Vehicle Safety.* 2007

7 *National Incident Management System.* United States Department of Homeland Security. December 18, 2008.

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Figure 3-4. The Mobile Data Terminal is a Key In-Vehicle Information System for First Responders

ECCs are responsible for dispatch of emergency responder resources. The PSAP in the ECC utilizes Automatic Number Identification/Automatic Location Identification (ANI/ALI) software to identify phone number, name, and location of callers for landline calls and some cellular calls. Computer-aided dispatch (CAD) provides mapping capabilities, resource locations and availability, routes to scene, and GPS-based Automatic Vehicle Location (AVL) allows tracking of dispatched vehicles. ITS technologies provide signal preemption for emergency responders. Internet/data connections are data points for weather, news, and information that are conveyed to Incident Commanders when relevant by the ECC. Responder vehicles are equipped with a communications package that includes radio(s), mobile data terminals (MDTs) that are part of the CAD system or computers, and cellular telephone(s). These devices are used to obtain initial information concerning the incident from the ECC. First responders are only provided routing instructions from the ECC if requested or if there is a known hazard or obstruction. Finally, the National Incident Command System (ICS) provides a framework for on-scene operations and communications.

Current Systems or Applications Comparable to INC-ZONE

Incident Zone management capabilities vary from location to location and groups of users. Currently, incident scene alert system capability is provided through Advanced Traveler Information Systems (ATIS), human factors guidelines, temporary traffic control (TTC) resources, Smartphone applications, and smart work zone technology. Information about an incident zone is communicated through the following alert systems: pre-trip planning technologies, roadside mechanisms, and mobile platforms.

Pre-trip planning technologies include websites that publish traffic conditions, kiosks, and television messaging.

While en route, there are two mechanisms for communicating incident scene information; roadside methods and mobile platforms. Roadside methodologies include variable message signs, radio, flashing arrow boards, and traffic control personnel.

Mobile platforms include ATIS that are comprised of 5-1-1 or other call-in telephone systems, push technologies including Reverse 9-1-1, e-mail, pager, and text alerts. The Personal Localized Alerting Network (PLAN) is a new public safety system that allows customers who own enabled mobile devices to receive geographically-targeted text-like messages alerting them of imminent threats to safety in their areas.

Private-sector travel information services collect and disseminate information produced by the public sector but also have the ability to add privately collected information. Dissemination is through Smartphone applications. These include INRIX®, Route Alert®, Traffic Alert®, Traffic Cam Viewer®, and Sigalert®, among others. Most of these private-sector travel information services operate similarly and are based upon use of cellular or wireless communication protocols to push traffic and travel conditions to mobile devices. For example, the Inrix Traffic – Avoid Traffic® allows a user to see real-time incidents, traffic forecasting, and comparative traffic. Users can view traffic incidents en route such as vehicle crashes, traffic violation stops, construction, and events. The application can help select the best time to leave based on predicted traffic conditions.

Included in pre-trip component of incident dissemination is the Condition Acquisition and Reporting System (CARS). CARS was initially created through a U.S. DOT sponsored pooled-fund study as was developed in 1998. It is an ITS-standards based condition reporting system that allows authorized users to enter, view and disseminate critical road, travel, weather and traffic information. CARS users access the system from any location using a standard web browser (i.e., no local software is required). Currently, seventeen transportation agencies have deployed or are currently in the process of deploying the CARS system.

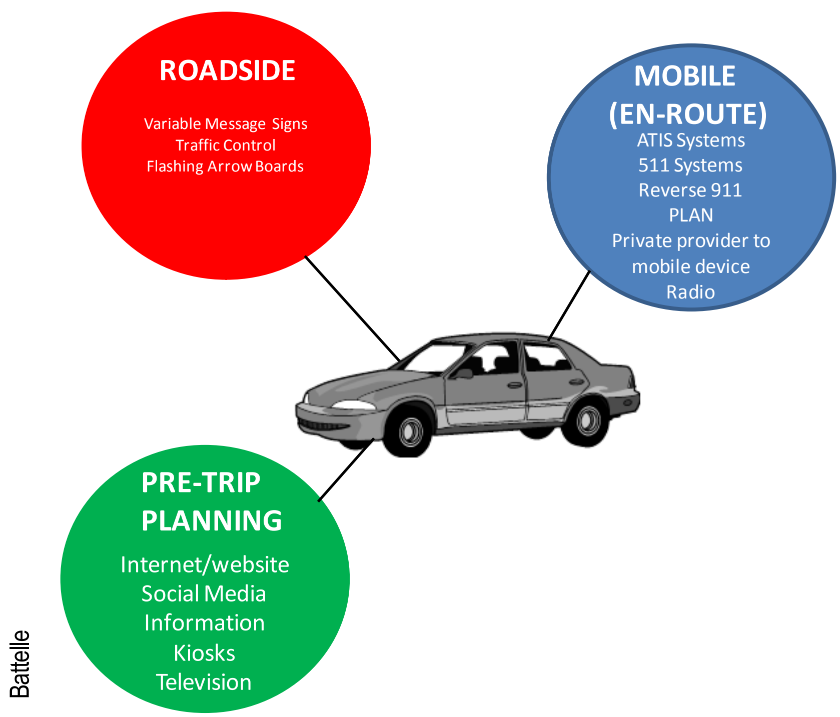

Figure 3-5. Types of Incident Scene Alert Systems

Current Systems or Applications Comparable to EVAC

The execution of an evacuation plan requires coordination among Local, State, Federal, and other non-governmental organizations. For the purpose of examining current systems or applications comparable to R.E.S.C.U.M.E. Bundle Applications, four functional categories of evacuation systems were determined to be relevant. It should also be noted, however, that while generalizations and conclusions can be drawn, the various systems and procedures vary significantly from locality to locality. Figure 3-6 depicts current evacuation support systems.

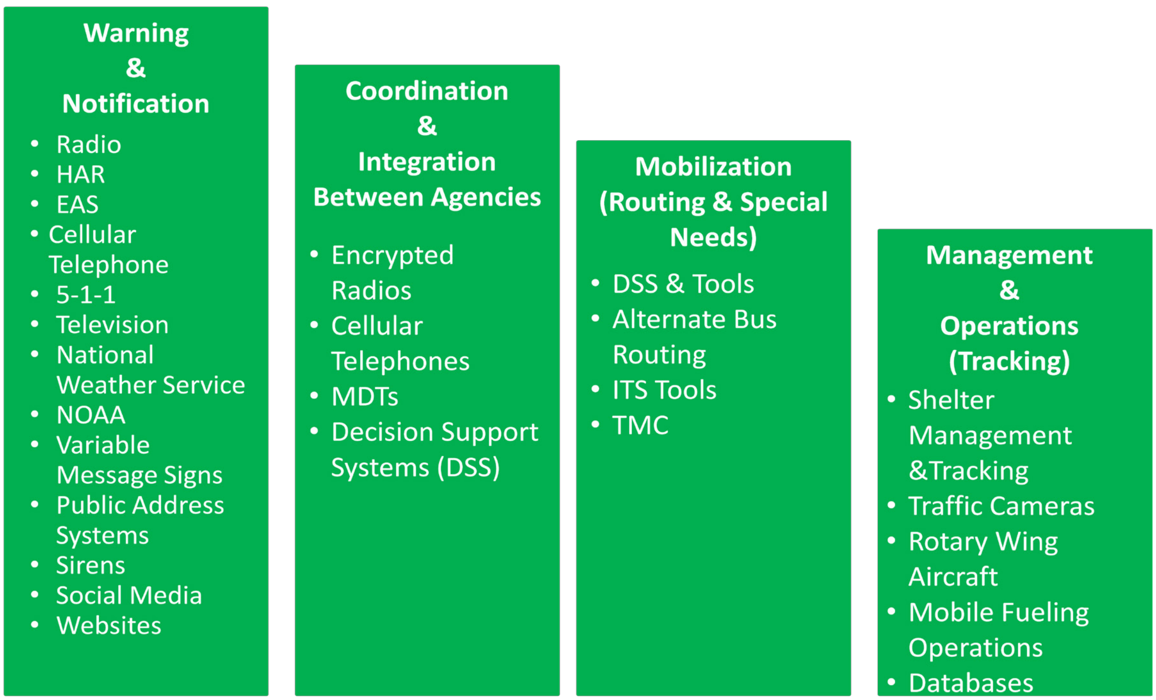

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Figure 3-6. Evacuation Support Systems

Mass Warning and Notifications

When an order to evacuate is issued, mass warning and notification systems are used to communicate with the affected communities. Advanced warning systems used by the National Oceanic and Atmospheric Association (NOAA) for weather-related emergencies provide warning of the approach or potential for danger. The National Emergency Alert System (EAS) is a national public warning system that requires broadcasters, cable television systems, wireless cable systems, satellite digital audio radio service (SDARS) providers, and direct broadcast satellite (DBS) providers to provide communications capability to the President in order to address the American

http://www.fema.gov/commercial-mobile-alert-system

Figure 3-7. Example of a National Emergency Alert System Alert

public during a national emergency.[8] The system may also be used by State and Local authorities to deliver important emergency information, such as AMBER alerts, weather, and evacuation information targeted to specific areas. The Federal Communication Commission (FCC), in conjunction with Federal Emergency Management Agency (FEMA) and the National Oceanic and Atmospheric Administration's National Weather Service (NWS), implements the EAS at the Federal level.

Other mass-warning systems include:

- **Highway Advisory Radio (HAR)** stations are licensed low-power AM radio stations set up by local transportation departments to provide bulletins to motorists and other travelers regarding traffic and other delays.
- **Integrated Public Alert and Warning System (IPAWS)** is a FEMA led effort in response to Executive Order 13407 to transform the national alert and warning system to enable rapid dissemination of authenticated alert information over as many communications pathways as possible. .
- **Variable Message Signs (**VMS also known as changeable messaging signs or CMS and dynamic message signs, or DMS) provide a roadside methodology of conveying traffic information to motorists.
- **Traveler 5-1-1 systems** are a transportation and traffic information telephone hotline in some regions of the United States and Canada. Travelers can dial the three-digit telephone number 5-1-1 on traditional landline telephones and most mobile phones. It is an N11 code of the North American Numbering Plan that is used for special services. The number code has also extended to be the default name of many state/provincial transportation department road conditions websites.
- Local, State, and Federal agencies use the **Internet and social media**, such as Twitter, Facebook, and Four Square to convey information and direction to the public regarding evacuations and other emergencies. Additionally, these same agencies often provide information through their own website, by e-mail or text message alerts.
- **Smartphone applications** have been created by various private companies, organizations, and jurisdictions to assist individuals in evacuation planning and execution. EvacGuide is one of the applications on the iPhone® that provides contraflow maps with instructions, state agency contact information, emergency shelter locations, and emergency radio system information. State and local transportation agencies and other responder agencies have also begun to deploy systems to push information to the public via text messages or through e-mail alerts.
- **The Deployable Aerial Communications Architecture (DACA)** restores communication to the public from government sources to allow for information to be given about evacuation processes and potential movement needed after a disastrous event.

[8] http://transition.fcc.gov/pshs/services/eas/

Coordination and Integration between Agencies

Police and other persons supporting the evacuation use encrypted radios, MDTs in vehicles, cellular telephones, and decision support systems (DSSs) to provide directions, guidance, information, and protection to the evacuees prior to and during the evacuation. Decision Support Systems vary; however, they have similar essential components including a data bank, a data analysis capability, normative models, and technology for display and interactive use of the data and models. Databases contain emergency shelter locations. This information is shared among jurisdictions, but often in the form of static exchanges of information such as e-mailing information back and forth between agencies, requiring human interaction and processing.

Mobilization

TMCs deploy DSSs or other tools to support evacuation, but largely rely upon the TMC operators to identify incidents and other situations that require attention. These same operators typically follow a procedure “playbook” that guides them on how to respond to a particular situation. Often, these procedures include utilizing ITS strategies and tools, such as variable speed limits and hard shoulder running, to lower the speed limit during highly congested evacuation conditions. Increased highway volume availability (via contra-flow) facilitates the unusually high volume of traffic associated with evacuations. Designated evacuation routes ensure the protected populace is efficiently moved away from harm while still having support available if needed.

Other systems and tools utilized for mobility improvements include Alternate Bus Routing (ABR), which combines information from vehicle probes, conventional vehicle detection technologies, and anecdotal reports to determine optimal routing for buses within a defined corridor. The system applies a travel time algorithm to recommend a preferred route for each bus and provides the traffic operations operator-approved route recommendation to the vehicle operator via an onboard communicator. ABR has potential for determining the best routes during an evacuation.

Mobilization of functional needs populations varies by location. For example, the State of Texas has developed a mobilization system for the functional needs population that uses radio frequency identification (RFID) bracelets issued at the embarkation point. Figure 3-8 illustrates the Texas Special Needs Tracking System which includes the RFID bracelets. Other states do not have such a sophisticated system and rely upon pre-evacuation registration lists for the transport of functional needs travelers.

http://www.nctcog.org/ep/subcommittee/regional_exercise/pdf/SpecialNeedsTracking.pdf

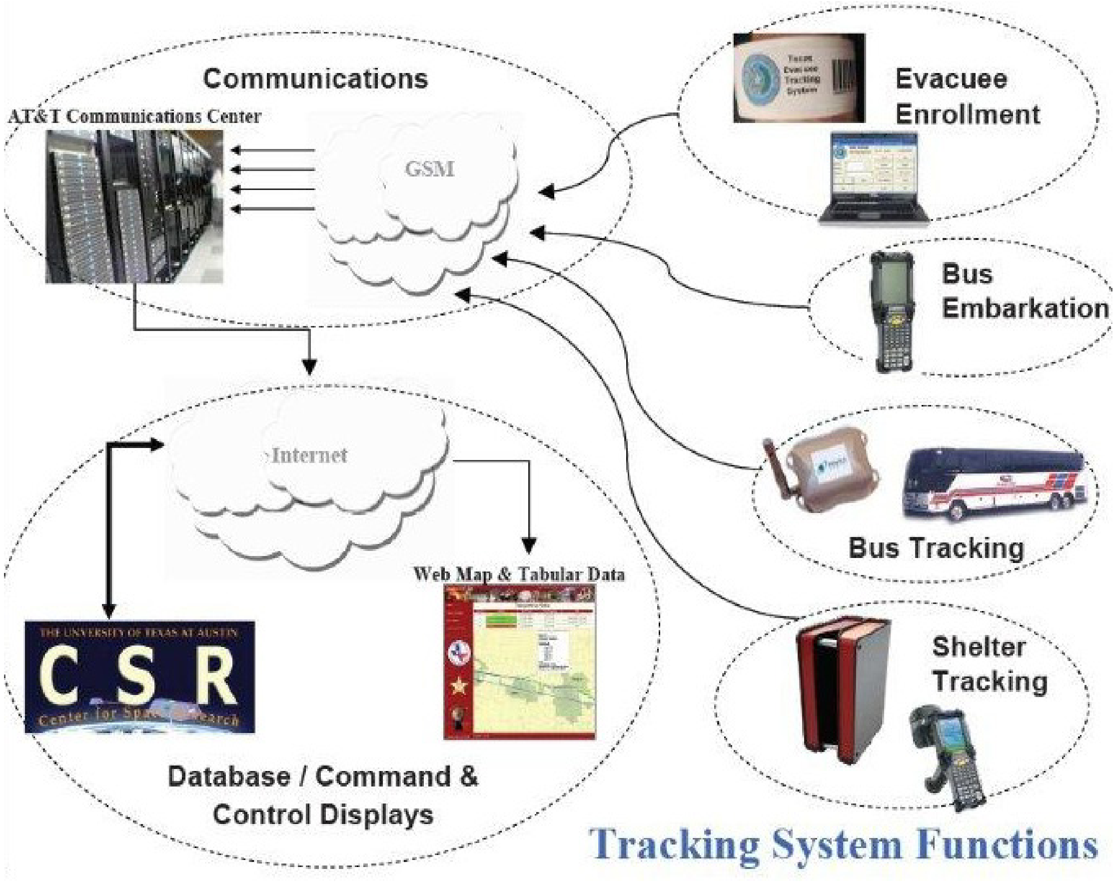

Figure 3-8. Texas Special Needs Tracking System

Management and Operations

Agencies facilitating the evacuation often use a variety of systems including traffic cameras, spotters, and rotary-wing aircraft to monitor the flow of evacuees away from danger; the systems also monitor traffic, identify problem areas, and support decision-making during the evacuation. Databases are used to maintain visibility of the status of shelters, hospitals, fuel supplies, and many other items necessary to provide accurate information and needed assistance to the people evacuating.

While there are numerous stand-along systems, the execution of an evacuation requires significant human interaction for planning, preparation, mitigation, response, and recovery. As an example, the South Carolina Department of Transportation (SCDOT) has an evacuation analysis system that is a web-based situational awareness tool which automates data acquisition from a variety of transportation sources, provides fixed format reports, supports hurricane monitoring, and identifies traffic congestion levels. See Figure 3-9.

http://www.scdot.org/getting/pdfs/Evac_Maps/evac Map_CO.pdf

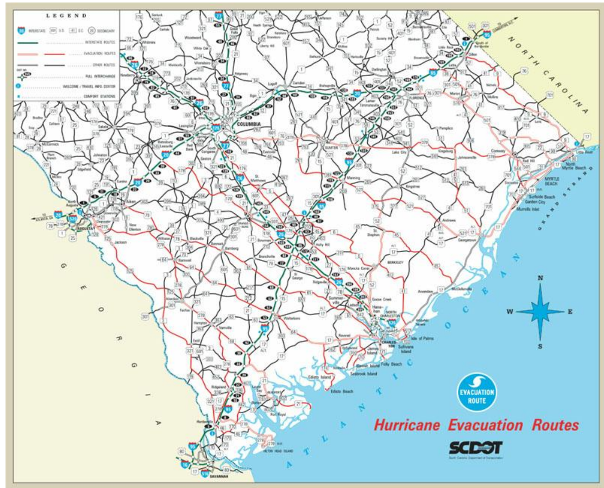

Figure 3-9. SCDOT Evacuation Analysis System

Transportation agencies provide critical data for the evacuation including the status of work zones on the roadway and transit resources for evacuees including those with functions needs. Traffic engineering staff assist with ITS resources, timing traffic signals, and providing traffic control devices such as cones, barriers, and signs, to assist in directing traffic during the evacuation.

User Classes and Other Involved Personnel

There are multiple system users across emergency communications, emergency responders, evacuation communications, incident alerts, work zone alerts, AACN, and incident scene pre-arrival guidance networks.

There are standard reporting chains and processes for requesting assistance before, during, and after an incident. Regardless of reporting, there are organizational relationships that exist at all times. Figure 3-10 shows the relationships between Local, State, Federal, and other User Classes.

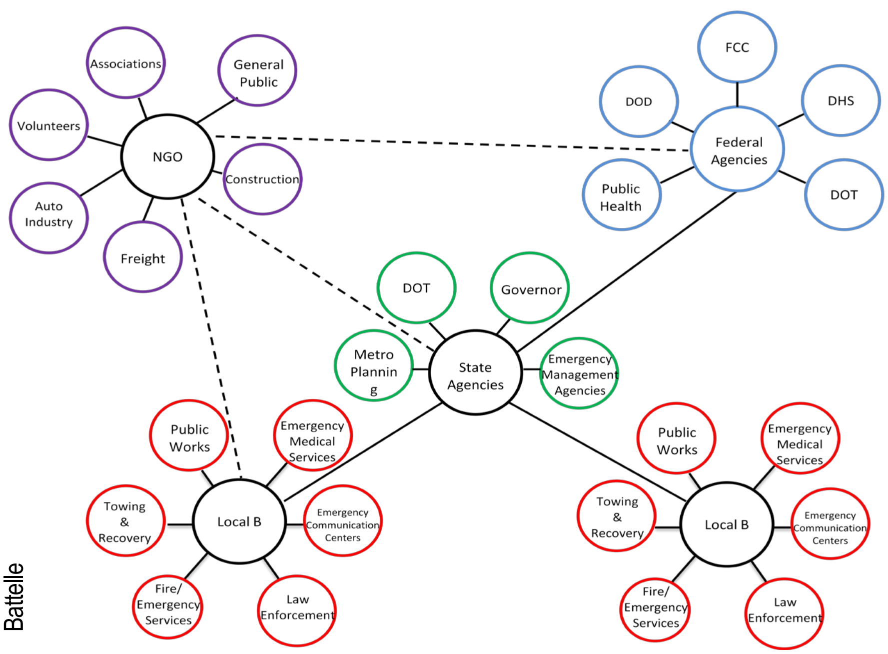

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Figure 3-10. User Class Relationships

User Classes for the existing applications are generalized into Federal, State, Local, and Other, allowing organizations to focus on areas of responsibility in incident preparedness, mitigation, response, and recovery. The “Other” User Class also includes User Classes that cross multiple levels of governmental entities. Details regarding the individual User Groups and organizations within these classes are provided below:

Local User Groups

- **9-1-1 Call Centers/Dispatchers** provide the key information link between 9-1-1 callers and emergency responders. They gather information directly and through technology such as CAD, deploy emergency response, and work with TMC operators to ensure the most efficient routes are taken.
- **9-1-1 Network Service Providers** route calls to PSAPs.
- **City and County Transportation Departments** support emergency preparedness and response, evacuation planning and implementation, work zone planning and implementation, and incident response.
- **Emergency Vehicle Operators** are on the front line of incident and emergency response and are charged with reaching an incident in the safest and most efficient manner.
- **Hospitals** support emergency preparedness and response and provide medical care and response as well as trauma centers.
- **Public Safety Answering Point** is a call center responsible for answering calls to an emergency telephone number for emergency services.
- **Public Works Departments** help to ensure roadways, street, and bridge infrastructure are safe, clean, and attractive and can provide support to emergency and incident response and clearance.
- **Secondary Responders** are personnel who arrive on scene at an incident but are not critical to emergency response. This includes DOT, towing and recovery, utilities, public works, and highway maintenance personnel.
- **Towing and Recovery Companies** provide critical incident clearance support.
- **Metropolitan Planning Organizations (MPOs)** are proactively taking the lead in coordination with other agencies when it comes to evacuation planning and supporting emergency preparedness. In addition, many MPOs are championing collaboration on incident management efforts.
- **Other Local Organizations** such as faith-based groups, are increasingly providing on-demand” transportation services.

State User Groups

- **State Departments of Transportation** (DOTs) are proactively taking the lead in coordination with other agencies when it comes to evacuation planning. DOTs use a variety of mobility-related performance measures in existing work zones to monitor the actual traffic impacts. State DOTs utilize “push” technologies such as VMSs to provide information to travelers in order to reduce congestion around incidents. They also share information and data across agencies to assist in response planning and management of traffic impacts. They support emergency preparedness and response, evacuation planning and implementation, work zone planning and implementation, and incident response.

- **State Emergency Management Agencies (EMAs)** are the lead state agencies for coordination of comprehensive emergency preparedness, training, response, recovery, and mitigation services in order to save lives and reduce the impact of emergencies. They provide a key forum for dissemination of information to help the general public prepare for emergency and evacuation situations.
- **State Governments** support emergency preparedness and response and evacuation planning. In addition, they are responsible for passage of legislation that may impact how incidents are handled – for example, Safe, Quick Clearance Laws.
- **Transit Agencies** are a critical element of the transportation system. Transit agencies support emergency preparedness and response and evacuation planning and response. More transit agencies are also utilizing ITS technologies and in-vehicle telematics to provide travel time information to passengers. They also monitor roadway conditions in order to meet level of service requirements.
- **Turnpike/Toll Authorities** support emergency preparedness and response, evacuation planning and implementation, work zone planning and implementation, and incident response.

Federal User Groups

- **Army Corps of Engineers** is responsible for investigating, developing, and maintaining the nation's water and related environmental resources. They are responsible for devising disaster mitigation plans and implementing infrastructure to reduce impacts of hurricanes and storms, as well as providing trained responders to emergency situations.
- **Centers for Disease Control and Prevention (CDC)** support emergency preparedness and response and captures lessons learned and best practices.
- **Department of Defense (DoD)** supports emergency preparedness and response and evacuation planning and implementation at a National level. In particular, agencies such as the National Guard are often called upon for support during major national emergencies or events such as Hurricane Katrina.
- **Department of Homeland Security (DHS)** supports emergency preparedness and response and evacuation planning and implementation at a National level.
- **Department of Health and Human Services (HHS) Assistant Secretary for Preparedness and Response (ASPR)** leads Emergency Support Function (ESF) #8 – Public Health and Medical Services under the National Response Framework and provides the mechanism for coordinated Federal assistance to supplement State, tribal, and local resources in response to a public health and medical disaster, potential or actual incidents requiring a coordinated Federal response, and/or during a developing potential health and medical emergency.
- **Federal Communications Commission (FCC)** regulates interstate and international communications and addresses public safety, homeland security, national security, emergency management and preparedness, and disaster

management. In addition the FCC has established requirements and rules for 9-1-1 service and providers including Voice over Internet Protocol (VoIP), Enhanced 9-1-1 (E9-1-1), and Next Generation
9-1-1 (NG9-1-1).

- **Federal Emergency Management Agency (FEMA)** supports disaster mitigation, preparedness, response, recovery, and education and provides guidance to states, regions, emergency personnel, and the general public.
- **Federal Highway Administration (FHWA),** through its Emergency Transportation Operations (ETO) programs, provides tools, guidance, capacity building, and good practices that aid local and state DOTs and their partners in their efforts to improve transportation network efficiency and public/responder safety when a non-recurring event either interrupts or overwhelms transportation operations. Non-recurring events may range from traffic incidents to traffic Planned Special Event (PSE) to disaster ETO.
- **Federal Motor Carrier Safety Administration (FMCSA)** activities contribute to ensuring safety in motor carrier operations through strong enforcement of safety regulations; targeting high-risk carriers and commercial motor vehicle drivers; improving safety information systems and commercial motor vehicle technologies; strengthening commercial motor vehicle equipment and operating standards; and increasing safety awareness.
- **Federal Railroad Administration (FRA)** circulates and enforces rail safety regulations; administers railroad assistance programs; conduct research and development in support of improved railroad safety and national rail transportation policy.
- **National Association of State EMS Officials (NASEMSO)** is a national organization for EMS, a voice for national EMS policy with comprehensive concern and commitment for the development of effective, integrated, community-based, universal and consistent EMS systems.
- **National Highway Traffic Safety Administration (NHTSA)** carries out safety programs. Specifically, the agency directs the highway safety and consumer programs and works to help prevent crashes and their attendant costs, both human and financial.
- **Pipeline and Hazardous Materials Safety Administration (PHMSA)** is a U.S. DOT Agency that develops and enforces regulations for the safe, reliable, and environmentally sound operation of pipeline transportation system and shipments of hazardous materials by land, sea, and air.

Other (or Multi-Level) User Groups

- **Association of Public Safety Communications Officials International (APCO)** is the world's largest organization dedicated to public safety communications. It serves public safety communications practitioners worldwide – and the welfare of the general public as a whole – by providing complete expertise, professional development, technical assistance, advocacy and outreach.
- **Auto Manufacturers** are working on enhanced vehicle telematics and connected vehicle (capabilities to enable V2V (Vehicle-to-Vehicle) and V2I Vehicle-to-

Infrastructure) communication, relaying of critical safety messages and warnings, and providing more accurate position and crash data directly to PSAPs and emergency responders.

- **Construction/Maintenance Personnel** are out in the field in work zones. These personnel have to adhere to referenced guidelines for safety precautions and required protective gear.
- **Emergency Management Agencies** support emergency preparedness and response.
- **Emergency Responders** support emergency and incident preparedness, evacuation planning and response, and are dispatched to incident scene locations. They include fire and rescue, law enforcement, EMS, HAZMAT, DOT staff, coroner, and towing and recovery personnel.
- **Emergency Responder Organizations and Associations** support continued development of best practices, innovation, and advancement for new technologies, policies, and procedures that will increase safety of emergency responders and improve emergency response. Examples of organizations include International Association of Fire Chiefs (IAFC), International Association of Chiefs of Police (IACP), National Association of Emergency Medical Technicians (NAEMT), and National Emergency Medical Services Association (NEMSA).
- **Freeway Management Center Personnel** electronically monitor traffic conditions, activate response strategies, and initiate coordination with intra-agency and interagency resources, including emergency response and incident management providers.
- **Freight Management/Trucking** monitors travel conditions to maximize route efficiency and productivity. Delays on the roadway due to an incident, emergency, or work zone can have a significant economic impact on this industry.
- **General Public** uses traveler information through 5-1-1, website, or en-route information to modify route or mode choice in order to avoid congestion around work zones. The public can utilize 9-1-1, 5-1-1, 3-1-1 or radio/news media to report incidents.
- **Insurance Companies** can use information collected by emergency personnel or the general public for purposes of processing claims due to emergencies or crashes. Increased engagement of the insurance companies with vehicle telematics helps them better monitor driver safety and behavior.
- **Internet Service Providers** enable services such as VoIP and other information exchange through Wi-Fi with smart phones.
- **Labor Unions** such as the Fraternal Order of Police (FOP) and the International Association of Fire Firefighters (IAFF) improve the working conditions of public safety personnel through education, legislation, information, community involvement, and employee representation.
- **National Emergency Number Association (NENA)** focuses on 9-1-1 policy, technology, operations, and education issues. NENA promotes the implementation and awareness of 9-1-1 communication systems and works with public policy leaders, emergency services and telecommunications industry partners, and other stakeholder groups to carry out critical programs and initiatives.

- **National Traffic Incident Management Coalition** is a multi-disciplinary partnership forum spanning the public safety and transportation communities to coordinate experiences, knowledge, practices and ideas and promote more efficient management of all incidents that occur on the nation's roadways.
- **Phone Companies** are required to comply with FCC regulations and rules regarding 9-1-1 services.
- **Public and Elected Officials** can be involved in emergency and evacuation planning and response – particularly in disseminating information to the public or in requesting resources and support from neighboring jurisdictions.
- **Private Traveler Information Providers** monitor and report on traffic conditions across the nation either as a free service or fee-based service and provide pre-trip and in some cases en-route information to motorists regarding roadway conditions. These services can supplement and enhance monitoring conducted by DOTs and can help to enhance response route selection and congestion mitigation strategies.
- **Public Health Officials/Agencies** support emergency preparedness and response and evacuation planning. They provide key leadership in understanding potential health risks associated with biological/chemical/HAZMAT threats and mitigation strategies.
- **Public Information Officers** provide a single point-of-contact for media and help to distribute critical information to the public.
- **Regional Planning Organizations/Transportation Commissions** establish regional emergency coordination and contingency plans.
- **Telematics Service Providers** route emergency calls to PSAPs based on the location of the caller and have to adhere to all FCC requirements and regulations in the level of service they provide.
- **Traffic Engineering and Operations Staff** can assist with ITS resources, timing traffic signals, and providing traffic control devices such as cones, barriers, and signs to assist in directing traffic during an evacuation.
- **Volunteer Organizations** such as the American Red Cross provide assistance to the public during by providing aid to victims of devastating natural disasters in order to prevent and relieve suffering.
- **Wireless Service Providers** are required to transmit all 9-1-1 calls to a PSAP, and through enhanced services and next generation 9-1-1 wireless service providers will be required to provide the PSAP with the telephone number of the originator of the 9-1-1 call and location of the cell site or base station transmitting the call. In addition, they will be required as part of phase two of the enhanced 9-1-1 service to provide more precise location information to PSAPs, specifically the latitude and longitude of the caller.
- **Work Zone Planners and Managers** are responsible for work zone planning, design, and determining work zone impacts as well as development of transportation management plans to mitigate impacts.

Incidents are managed at the local level until resources are overcome and additional assistance is needed. Local users consist of emergency response personnel including ECCs, dispatch, law enforcement, fire and rescue, EMS, transportation, public works, and secondary responders such as towing and recovery.

States users include government, emergency management agencies, transportation departments and agencies, and metropolitan planning organizations. These groups may share the data with the local users through information brokers such as a State Level Emergency Operation Centers (EOCs), or local jurisdiction EOCs.

Federal users support local communities and states when an incident occurs that exceeds or is anticipated to exceed State, Tribal, or Local resources. The Federal users are also responsible for maintaining working relationships with the private sector and non-governmental agencies (NGOs). Other Federal departments and agencies have key responsibilities to support national response activities and carry out those responsibilities within the overarching coordinating mechanisms of the National Response Framework (NRF).

Other users include, but are not limited to, non-governmental agencies such as automobile manufacturers, construction and maintenance personnel, freight management and trucking, insurance companies, volunteer groups and organizations, telephone, and wireless service providers, as well as the general public. This class of users provides supplement data and support to facilitate decision-making and response.

Chapter 4 Justification for and Nature of Changes

Section 4 identifies and discusses the need for changes to public safety systems that correspond to the R.E.S.C.U.M.E. Bundle Applications: Advanced Automatic Collision Notification Relay (AACN-RELAY), Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG), Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE), and Emergency Communications for Evacuation (EVAC). Section 4 is a bridge for the transition between current and needed systems. It identifies the factors that require new or modified systems to improve areas in the application, and it justifies the needed changes. Prominent among these factors are the emergence of new technologies, particularly CV technologies, cloud computing, and increasing functionality of mobile devices. The changes that have been identified to bring about the needed system are then prioritized, including a categorization of whether the changes are essential, desired, or optional. Some other changes that were considered but have not been included among the recommendations are examined, as are institutional issues that were uncovered in the research.

Justification of Changes

The deficiencies or limitations of current systems relevant to R.E.S.C.U.M.E. Bundle Application areas are summarized below.

> AACN RELAY requirements are included in this document for completeness and consistency. However, USDOT does not plan to pursue development of AACN RELAY during subsequent phases of the DMA Program.

- **AACN-RELAY.** AACN capability is currently provided by private subscription services whose level of information on an incident varies. Most current AACN systems communicate to ECCs in emergencies via WSPs but may be limited in that capability if there is no cellular coverage at the crash scene or if cellular infrastructure has been damaged, for example by a hurricane or by some other wide-area catastrophic event. The percentage of vehicles with AACN capability is currently relatively small. While some AACN-capable vehicles communicate directly with ECCs and even trauma centers, no current AACN system has the ability to communicate with other vehicles or with roadside equipment to relay information on incidents. The capability to access important information such as (1) medical records of vehicle occupants, or (2) electronic shipping papers giving contents of HAZMAT vehicles is not currently being provided via AACN systems. The vast majority of PSAPs are currently not able to intake and display the variety of data that may be available from an AACN message alert system.
- **RESP-STG.** Emergency responder agencies do not currently have the capability to factor in all potentially important information that could be modeled to help them arrive and position themselves in a way that best supports the needs of the incident

and the objectives of the incident commander. There is often lack of awareness among emergency responders concerning what other responders have been dispatched, where they are, when they will arrive, and what the condition of any victim is. This lack of situational awareness among emergency responders has direct implications and impacts on both safety and the mobility of the traveling public. For example, staging of responder's vehicles is typically performed on-scene by the incident commander as the vehicles arrive, which frequently results in delays in route diversions, blockages of traveling lanes, etc. In the event of a HAZMAT spill where the truck driver is incapacitated, the hardcopy papers are not readily accessible, and the placard cannot be read; critical minutes may elapse before finding out which dangerous chemical they may be facing and what other substances it may be reacting with. This scenario would likely then result in protective road closures under a "worst-case" scenario, which may be significantly over-restrictive on travel for the actual situation. Some jurisdictions are well-funded and able to outfit their incident responders with the latest equipment, while other jurisdictions continue to utilize out-dated equipment due to funding constraints.

- **INC-ZONE.** There is still much to be done to improve communication with the traveling public, emergency responders, and workers in incident zones, to better inform them of accidents ahead. For example, there is no in-vehicle incident messaging system that provides merging and speed guidance around an incident, although commercial navigation devices can and do provide congestion-based re-routing guidance.

  There is no current comprehensive warning system for on-scene workers that is widely deployed. The limited systems that are deployed are localized and have challenges with interoperability. There is a need for adherence to communications and architecture standards and safety policies as well as availability of an interoperable environment that enables multiple devices to communicate with each other.

- **EVAC.** During an evacuation, the technologies and systems that are currently used are fairly "stove-piped" in their purpose and functionality and require significant manual coordination, manipulation, and often duplicate information entries for cross-platform or cross-system utilization. Funding constraints have resulted in jurisdictions building systems in parts, at different times, and not necessarily with the capability for inter-system operability. In particular, there is a noticeable lack of a single, interoperable, integrated system that can be readily adopted by jurisdictions or that provides two-way communications with evacuees (especially functional needs populations), real-time data on the progress of an evacuation, and dynamic traffic and route guidance for both evacuees and responders supporting the evacuation.

Table 4-1 addresses limitations with the current systems and the degree of potential for benefits resulting from the R.E.S.C.U.M.E. cluster of applications to address these problems. As seen in Table 4-1, lack of interoperability among communications systems and lack of shared situational awareness are top priorities for all applications. Utilization of ITS standards will be needed as part of the solutions to both of those top priorities.

Table 4-1. Potential of R.E.S.C.U.M.E. to Address Limitations of Current System

Limitation	R.E.S.C.U.M.E. Potential to Address Limitation (High, Medium, Low, NA-Not Applicable)			
	AACN-RELAY	RESP-STG	INC-ZONE	EVAC
Sufficient information available on functional needs populations to facilitate their evacuation	NA	NA	NA	High
Timely warnings and notifications to general public	NA	NA	Medium	High
Lack of interoperability among communications systems	High	High	High	High
Inadequate emergency responder resource coordination	NA	High	Medium	Medium
Lack of shared situational awareness	High	High	High	High
Relocation of functional needs populations	NA	NA	NA	High
Inadequate emergency and/or transportation services to respond to an event/incident	Medium	High	NA	High
Inadequate notification to incident scene work zone personnel and vehicles approaching the zones	NA	NA	High	NA

Source: Battelle

Description of Desired Changes

The R.E.S.C.U.M.E. Bundle, like the other DMA bundles, seeks to address and improve mobility of the traveling public. These changes will be driven through improved situational awareness and more comprehensive and timely information provided to emergency responders. This will subsequently allow those responders to make more informed decisions regarding incident staging, as well as improve the ability of the responder community to react and clear incidents safely but with reduced impacts to congestion (i.e., clearing incidents safer and quicker, reducing secondary crashes, etc.).

Through the advanced technologies and conceived applications, incidents will be quickly detected and assessed, their effects on the evacuation traffic flow modeled, incident specific information will be communicated with evacuees, and best available resources will be allocated and resolved in a time effective manner. Government officials who conduct evacuations will have a better common operational picture, enhanced by greater communication with vehicles and roadside equipment, public safety personnel in the field, and the public. Dynamic traffic and route guidance will be informed by public safety personnel in the field, who will have portable communication devices such as tablets and smart phones that will supplement radios, cell phones, and MDTs, and provide information to operations centers and TMCs. Mobile devices will provide two-way communication for public safety personnel responding to evacuations and incidents, and for evacuees.

The AACN-RELAY application will allow more complete information to be gathered on an incident and reported to organizational entities when an AACN alert is initiated. Additionally, the AACN-RELAY application will enable notification of incidents in areas without cellular coverage through the Dedicated Short-Range Communications (DSRC) relay mechanism.

Improvements in the RESP-STG application area are needed to allow comprehensive information to be made available electronically to emergency responders dispatched to the scene of a crash, in a way that allows the responders to optimally stage for conditions they will face at the scene. This capability is advisory in nature, as the executive staging decision will be made by the incident commander. A greater degree of situational awareness will be provided to emergency responders. Responders will share access to CAD/AVL and other systems that track emergency vehicles to expand awareness of dispatched assets, their estimated time of arrival, and approach to an incident scene. Modifications to emergency response vehicle computers and/or MDTs will allow more information such as digital mapping, weather conditions, local population densities, and Electronic Patient Care Records (ePCRs). Still or video images of an incident scene, surrounding terrain, and traffic conditions will be available to guide responder and dispatcher decisions and actions. Responders will be able to access tablet computers and Smartphones as well as MDTs.

While at the scene of a crashed HAZMAT truck, retrieval of the truck's electronic shipping papers (ESP) give dispatched responders awareness of the particular dangerous HAZMAT cargo carried by the truck before they stage at the crash scene. Using the information in the ESP, emergency responders will know what substance(s) they are dealing with, what precautions they should take, whether an evacuation is warranted, and how to interact with motor carrier HAZMAT response personnel.

Information on condition of the crash victims, including their identities and any special medical conditions they may have, will be known before responders reach the scene. Responders will be aware of the crash severity and will be able to retrieve the victim's medical record(s) to ensure the victims receive appropriate immediate medical care and are transported to the best medical facility for their recovery. Responders will have appropriate equipment for the conditions faced and thus will not over- or under-respond or depend as heavily on assessment from the first person on the scene. The responders will receive an optimal route model for arrival at the scene, which can be changed in response to evolving, conditions either en route or at the destination. Updated locations of the en route responders will be known to the incident commander (if already on the scene) and to each other.

Enhancement of in-vehicle navigation and telematics systems will improve the awareness of both public safety responders setting up and maintaining an incident zone (INC-ZONE application), and the traveling public impacted by the incident zone. Technology improvements and innovative use of current technologies will enable public safety responders at an incident zone (i.e., crash or traffic violation stop), as well as travelers approaching or already in the incident zone, to elevate their situational awareness and thus increase safety. In-vehicle messaging systems will alert drivers of their approach to, and entry into, an incident zone. CV technology will help relay these alerts to drivers of CV-enabled vehicles. In-vehicle messaging systems will provide alternate route information and — if the driver chooses to continue — information on safe speed and lane/merge guidance. Warning systems based on advanced roadway sensors and/or in-vehicle velocity sensors will provide alerts to drivers who are exceeding parameters for safe driving. Roadside warning systems will detect unsafe roadway conditions as they are developing and provide warnings to responders located in or around the incident zone, perhaps involving personal alerting devices worn on a helmet or clothing.

Changes within the evacuation application area (EVAC) will build on implementation of CV technologies as well as advances in emergency communications and social networking, to facilitate a flow of two-way communication among those who conduct evacuations and the evacuees. One immediate need is improved availability of and access to functional needs populations databases. These databases, containing normal contact information supplemented with detailed medical or support needs as provided by people with functional needs on a voluntary basis, will need to be configured and accessible to public safety personnel conducting evacuations. There will need to be a system providing strict protection of National Provider Identifier (NPI) and protected health information (as defined by HIPAA) but accessibility with proper permissions. Information on functional needs populations and their support requirements, increased through public awareness campaigns, will be made available to public safety personnel through online access to protected, secure databases. Transportation for functional needs persons to appropriate shelters and other types of support will be dynamically allocated, and resource usage will be monitored to maintain awareness of capacities and other resource limitations. Coordination among legacy evacuation support systems, facilitated through planning and advanced communications capabilities, will help eliminate the current stove-piped nature of evacuation operations and streamline coordination which will improve mobility, reduce congestion, and result in more efficient and safer evacuations.

Priorities Among Changes

Although there are four applications contained within the R.E.S.C.U.M.E. Bundle, the priority for implementation of these applications is not equally distributed. That is, the needs and changes designed to achieve the improvements can be efficiently prioritized in relation to the state of technology and the pace of technology advancements, the number of individuals that would benefit from the change, and whether the change could be achieved (and when) without implementation of the R.E.S.C.U.M.E. Bundle.

The lowest set of priority changes associated with the R.E.S.C.U.M.E. Bundle Applications is arguably the simplest in concept and perhaps the easiest to implement: the AACN-RELAY application. Certainly, this application will improve notification of incidents and begin the mobilization of resources to respond to the incident more quickly and more efficiently. This is especially true in rural areas where the mortality rate for crash victims is much higher. However, the current trend within the automotive industry is to continually enhance the in-vehicle “infotainment” system, including increasing connectivity to the Internet and connected services through cellular connectivity. Simultaneously, private cellular providers are continuously enhancing their coverage with more than 98.5%[9] of the United States currently being covered by at least one cellular WSP. In short, the need for AACN-RELAY is diminishing as cellular coverage improves. AACN-RELAY still remains of interest and significant for consideration, however, because of situations such as a cyber-attack, catastrophic weather event, or even simply cases where the US cellular network is compromised or is otherwise rendered inoperable because of an overwhelming cellular demand. This scenario is not as far-fetched as it might appear as was observed following the 2011 earthquake felt in Washington, DC that resulted in the cellular network to be overwhelmed with cellular traffic and unavailable for several minutes following the event.

[9] www.broadbandmap.gov

The highest set of priority changes are those associated with the evacuation (EVAC) application. Generally, systems used during large-scale evacuations are operated independently by the various entities due to systems not being interoperable as well as political and institutional barriers. By integrating these disparate systems and fostering communication between the systems, the EVAC application could provide a mechanism for cross-agency utilization of assets to address the mobility needs of the evacuees. This has the potential to impact a large number of travelers in a widespread area.

Enhancing responder staging and incident zone operations and procedures through technology are also both high priorities as these applications and the proposed changes would be implemented on virtually every vehicle-based incident. Improvements to mobility as well as the safety of the responders could be immediately enhanced through improved situational awareness while maintaining the decision-making by the Incident Commander.

Changes Considered but Not Included

The changes proposed in the R.E.S.C.U.M.E. Bundle are intended to improve mobility by aiding public safety personnel, including those responding to and managing evacuations and transportation incidents and by alerting motorists in the area that are approaching emergency vehicles. The R.E.S.C.U.M.E. Bundle will also aid persons requiring assistance during emergencies and the traveling public, who can benefit from awareness and guidance during roadway accidents/incidents as well as large-scale emergencies.

A foundational element of R.E.S.C.U.M.E. is that it will leverage legacy systems and protocols currently employed by the emergency responder community and public and private organizations involved with traffic and safety planning and operations (e.g., TMCs and EMAs). Although the R.E.S.C.U.M.E. Bundle will provide critical information to an Incident Commander, through RESP-STG or INC-ZONE for example, that information is intended to improve the Incident Commander's situational awareness rather than make decisions for him or her. By no means is R.E.S.C.U.M.E. changing the role of authority in decision-making. Further, R.E.S.C.U.M.E. is not making decisions about how individual responder entities operate.

One option considered, but not included would be to have the R.E.S.C.U.M.E. Bundle Applications reside in an additional module that would need to be installed in responders' vehicles or "live" separately within an Information Broker's information technology (IT) system. However, given the fiscal constraints facing responder agencies as well as the vast number of in-vehicle systems and sources of information, this option for change was not considered as feasible. Instead, the R.E.S.C.U.M.E. Bundle was conceived as residing fully within existing systems. This will minimize the training required for details specific to operating the R.E.S.C.U.M.E. Bundle Applications.

Another decision point for R.E.S.C.U.M.E.'s development is whether or not it would actively engage in enforcement of laws. For example, the AACN-RELAY and the INC-ZONE applications will acquire vehicle speed information that could be used by law enforcement to issue traffic violations. However, because of privacy and judicial issues, that particular functionality was determined to be out of scope and was not considered in the R.E.S.C.U.M.E. Bundle ConOps.

Lastly, emergency responders establish work zones to surround both roadway incidents (e.g., traffic accidents) and routine highway maintenance activities (e.g., pavement re-surfacing). As mentioned previously, construction work zone and an accident incident zone are fundamentally different in nature. Specifically, a work zone is typically pre-planned and usually involves only a single agency (or at most a few agencies) while an incident zone is random and frequently involves inter-agency responses. Because the scope of this ConOps includes involvement of emergency responders, the INC-ZONE application was determined to only address incident zones. Although protection of workers within a work zone could benefit from the INC-ZONE feature, application of INC-ZONE to constructions zones is considered out of scope.

Chapter 5 Concepts for the Proposed System

Background, Objectives, and Scope

This section describes concepts for the proposed system that respond to needs identified earlier in the document. Concepts are described as operational capabilities and are not intended to specify or imply particular designs or implementations.

Background for the Project

Through the DMA Program, U.S. DOT desires to improve current operational practices and transform management of future surface transportation systems. The DMA program is designed to enhance deployment of the technologies and applications that emerge and promote collaboration in research and development (R&D) of the transformative mobility applications that emerge from the process. The DMA Program's current phase involves applications development and testing and coordinated research activities on a portfolio of selected high-priority mobility applications. Prior research in the CV Program and other ITS programs and development of concurrent applications from other DMA projects help inform development of the R.E.S.C.U.M.E. ConOps.

The R.E.S.C.U.M.E. Bundle Applications integration concept incorporates vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), infrastructure-to-vehicle (I2V), and center-to-center communications. The automated V2X communications are predicated on Dedicated Short-Range Communications (DSRC) capabilities and associated infrastructure, but communications is not constrained to DSRC. For example, emergency responders will communicate via radios, MDTs, and other mobile devices such as tablets, and operations centers will communicate with each other largely through land lines.

Project Objectives

The overall project incorporates development of the ConOps, functional and performance requirements, and high-level data and communication needs required to assess readiness for testing. The ConOps development is part of the project's activities to develop a sound concept for the R.E.S.C.U.M.E. Bundle Applications. It involves identification and assessment of key technical and non-technical issues related to field testing the R.E.S.C.U.M.E. Bundle or its individual component applications. It also incorporates stakeholder-gathered information to identify and/or confirm transformative benefits or goals for the application and the corresponding performance measures and user needs.

Project Scope

The scope is to develop the project's four high-priority Dynamic Mobility Applications within a concept of integrated technologies that mutually support each other within the R.E.S.C.U.M.E. Bundle, other DMA applications where there are logical interfaces, and the larger DMA Program. This allows the R.E.S.C.U.M.E. Bundle to fit into the U.S. DOT's concept for collaborative and mutually supporting efforts to advance mobility through evolution of an integrated transportation system.

Operational Policies and Constraints

All operational policies and constraints discussed in Chapter 3 also will exist for the current system. At the same time, additional constraints have been placed on the proposed system, requiring it to "live within" existing responder systems. In other words, the system will have to be fully integrated with existing in-vehicle and infrastructure IT systems to be successful. Requiring additional in-vehicle equipment for the responder community to procure, install, train, and use is unfeasible and would pose a significant barrier to implementation. Further, the existing system will need to operate within the decision-making framework that currently exists. Changing the institutionalized decision-making processes and lines-of-authority would also pose significant barriers to system implementation. Therefore, rather than attempting to change those procedures and lines-of-authority, the proposed system is constrained to be an information provider rather than envisioned as a decision-maker.

Description of Proposed System

The R.E.S.C.U.M.E. Bundle serves a variety of different functions, but all provide a mechanism for the gathering of information to support incident planning and operations. One cornerstone of the R.E.S.C.U.M.E. Bundle is the leveraging of existing systems that are currently being used by the responder community as well as the ability for the components of the bundle to connect and share information through these existing mechanisms as well as through the use of CV technology. Figure 5-1 illustrates the overall system concept for the R.E.S.C.U.M.E. Bundle and includes linkages to other key entities including R.E.S.C.U.M.E. Bundle End Users; the remaining envisioned DMA bundles, and external information consumers. The following briefly describes the major components illustrated in Figure 5-1 and the flow of information from one component to the next. The remaining sections in Chapter 5 provide a much more detailed discussion of the functional components, interactions, and data that are utilized and transferred between the components.

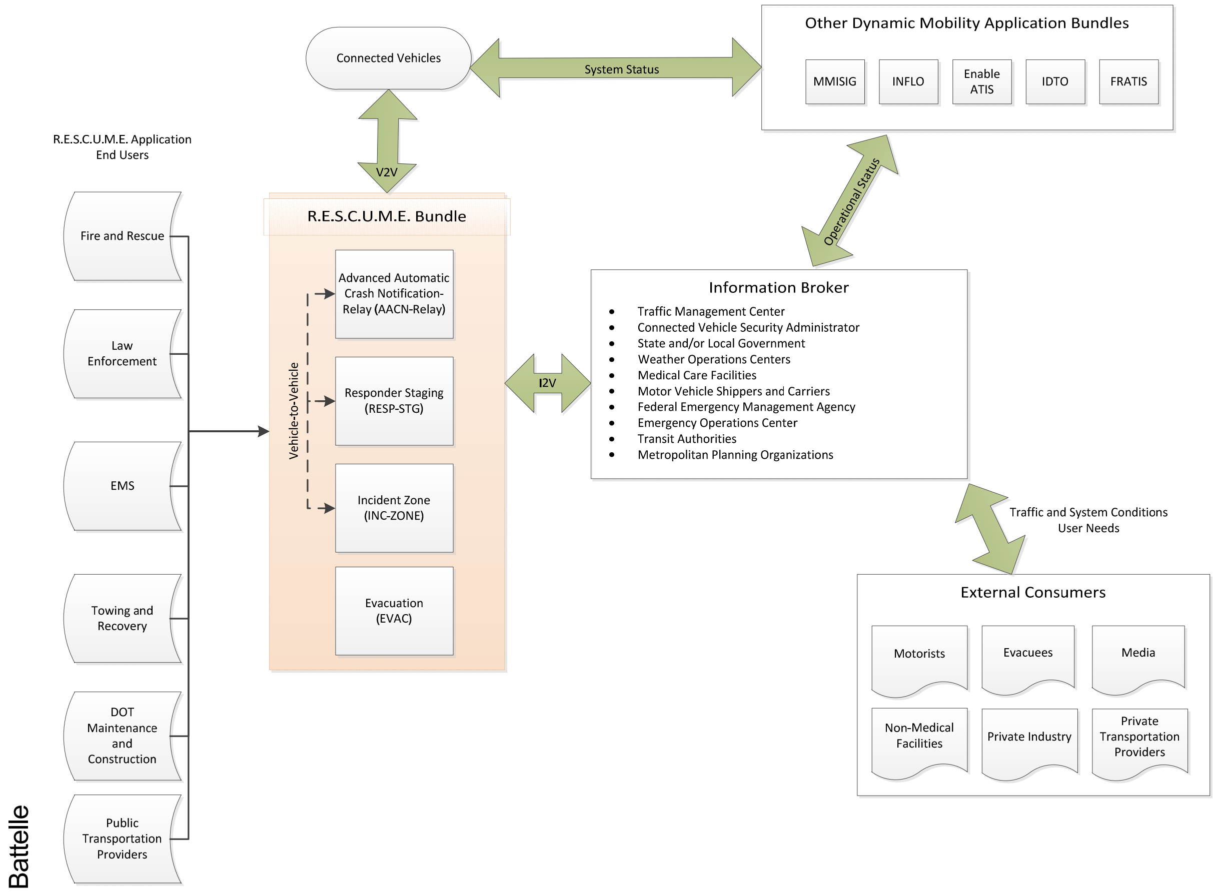


Figure 5-1. System Overview

Dynamic Mobility Application Bundles

The DMA Program consists of a set of transformative mobility applications that, when bundled together, impact the transportation system to improve mobility. The vision of the DMA Program is to expedite development, testing, commercialization, and deployment of innovative mobility applications to maximize system productivity and enhance mobility of individuals within the system. These objectives will be accomplished through the identification, development, testing, deployment, and adoption of transformative mobility applications. The R.E.S.C.U.M.E. Bundle is one such component, as are the remaining elements identified in Figure 5-1. An overview and detailed description of the envisioned operations and interaction of the other DMA Program bundles is discussed elsewhere.[10]

The R.E.S.C.U.M.E. Bundle is expected to communicate and interact with the other bundles under two different communication mechanisms. First, the R.E.S.C.U.M.E. Bundle is expected to exchange information with other DMA Program bundles through an Information Broker (discussed below). Second, the introduction and utilization of connected vehicles (i.e., those vehicles that can send and receive transportation related information through V2V interactions) enables the DMA bundles to

[10] http://www.its.dot.gov/dma/dma_vision2.htm. Accessed 21 October 2012.

communicate directly with each other using vehicles with CV technologies as a communications bridge.

R.E.S.C.U.M.E. Bundle

The R.E.S.C.U.M.E. Bundle consists of four related applications to aid public safety personnel, including those responding to and managing evacuations and transportation incidents. These applications also aid persons requiring assistance during emergencies and the traveling public, who can benefit from awareness and guidance during roadway accidents/incidents as well as large-scale emergencies.

While each of the R.E.S.C.U.M.E. Bundle Applications has a specific purpose and is expected to be utilized by different application end-users, there is a significant overlap in the applications and their functionality. Temporally, a distinction between the applications can be made as each is envisioned to be used at different points in time before, during, and after an incident (see Figure 5-2). It should be noted that all four applications may not be invoked or used for a specific incident, though as the size and complexity of response needed for an incident increases the likelihood that multiple applications would be used also increases. Therefore, the size and complexity of an incident can also be used to distinguish between the applications. For example, in a single vehicle traffic stop, only the INC-ZONE application may be employed. However, in a single vehicle traffic stop with a secondary incident on-scene, the RESP-STG application would be utilized by the additional dispatched responders.

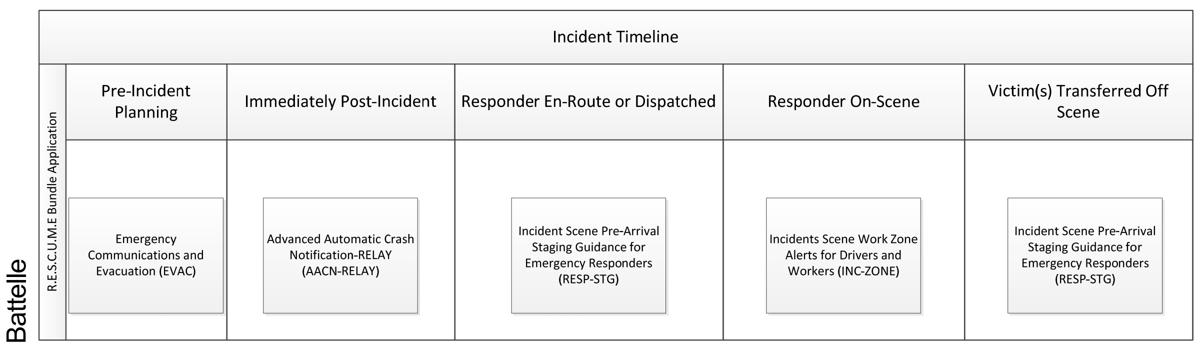


Figure 5-2. Temporal Relationship between R.E.S.C.U.M.E. Bundle Applications

Each of the four R.E.S.C.U.M.E. Bundle Applications is expected to communicate with other entities through the Information Broker (described below). However, as with all DMA Program bundles, it is also very likely that the individual R.E.S.C.U.M.E. Bundle Applications will interact through V2V communications as well. For example, the AACN-RELAY application may communicate directly (via V2V) with en route RESP-STG applications in responder vehicles and provide information that may not have yet been made available through the Information Broker. In other situations, the INC-ZONE and RESP-STG applications would communicate directly to enhance the staging and integration of new responder assets on the scene (i.e., time critical communications when the responders are arriving at the scene).

Advanced Automatic Crash Notification Relay (AACN-RELAY)

AACN RELAY requirements are included in this document for completeness and consistency. However, USDOT does not plan to pursue development of AACN RELAY during subsequent phases of the DMA Program.

AACN-RELAY refers to a capability that will allow CV-enabled vehicles to relay an emergency message (i.e., an Advanced Automatic Crash Notification or AACN message) from other vehicles involved in an accident or other distress situation. This emergency message is automatically generated by internal systems embedded within the vehicle and includes key data on the crash recorded by sensors mounted in the vehicle without the need for involvement of the driver or an occupant, in case they are incapacitated.

The capability to respond to vehicle emergencies resulting from single vehicle accidents will be improved, which is particularly needed in rural or remote areas where there may not be cell phone coverage or passers-by who are aware that an off-road incident has even occurred. The AACN-RELAY application will provide the capability for CV-enabled vehicles to detect other vehicles' AACN alerts and relay them to yet other CV-enabled vehicles as well as roadside communications "hotspots." This relay of the original AACN message will result in its being received by the Information Broker via an infrastructure element (i.e., V2I communication) and routed to the appropriate organization for action. This will in turn enhance intelligence and analytics capabilities. The purpose of the AACN-RELAY application is to improve mobility through reducing the total incident time by reducing the time required for emergency responders to learn of the crash, arrive at the scene and deliver medical attention, and provide responders with as much key information as possible regarding the characteristics of the incident.

The AACN-RELAY approach uses CV technology, particularly DSRC. DSRC is a short to medium range (< 1 km) high-speed (up to 27 Mbps) wireless communications protocol specifically designed for automotive use at vehicle speeds up to 120 mph. In the event of a crash, the crashed vehicle's CV technology will automatically transmit AACN crash data as well as injury severity prediction information via a DSRC message. The DSRC message will be captured and relayed by other CV-enabled vehicles and to roadside "hotspots" that the initial relay vehicle or any subsequent relay vehicles pass. The relayed AACN and crash severity message will then be forwarded from the receiving roadside hotspot to public safety officials at ECCs and/or TMCs. Figure 5-3 summarizes the functional components of the AACN-RELAY application and indicates the type of information that is expected to be received and provided by the AACN-RELAY application and the entities that are receiving and providing the information. Generally, the AACN-RELAY application receives information from a vehicle involved in an incident as well as other AACN-RELAY vehicles, processes this information, and provides it to organizations within the Information Broker as well as other AACN-RELAY vehicles as described below.

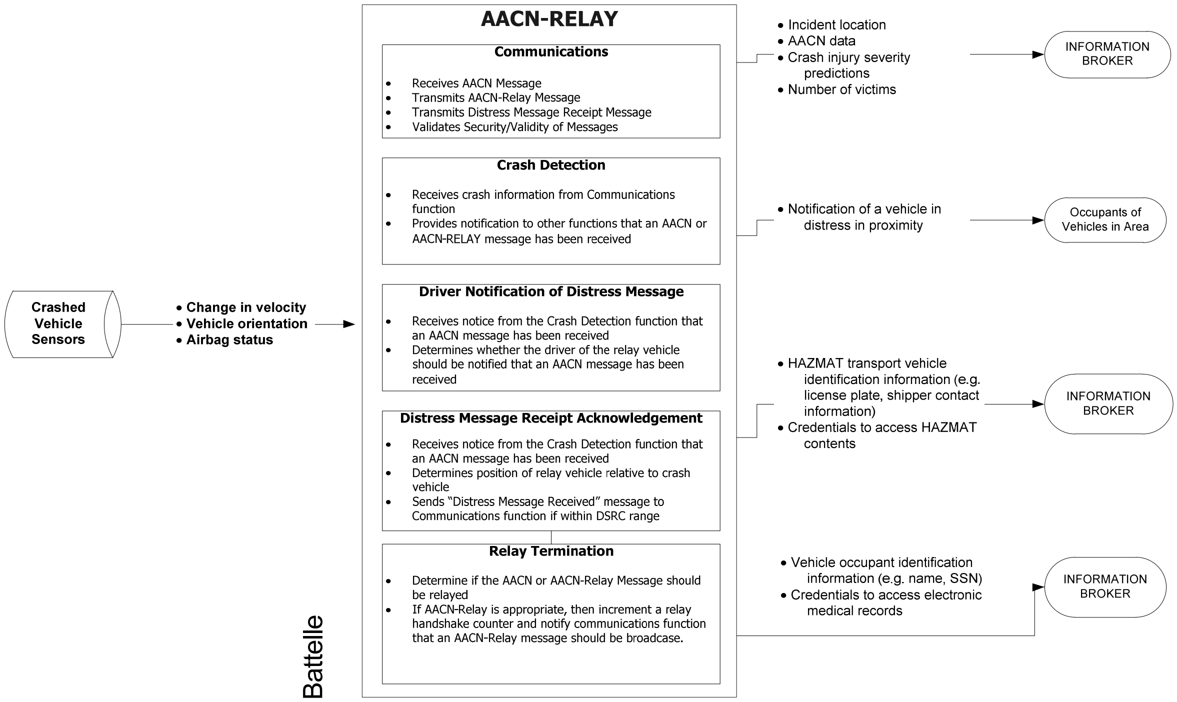


Figure 5-3. AACN-RELAY Functional Architecture

The following describes the functional components of AACN-RELAY application.

Communications

The Communications function enables AACN-RELAY to receive information (i.e., input data) and then transmit the generated output data to its intended data consumer quickly and securely. This includes the processes required to exchange messages with the Information Broker component of R.E.S.C.U.M.E., RESP-STG, and in certain situations INC-ZONE and EVAC.

The AACN-RELAY application is expected to utilize both DSRC and a cellular communications formats, depending upon the availability of the communications mechanisms. DSRC communications would be conducted and transmitted very similarly to a basic safety message. At the same time, a secure Transmission Control Protocol/Internet Protocol (TCP/IP) cellular data message would be attempted to be sent directly to the Information Broker via the communications function. Transmittal of the AACN-RELAY message will be performed continuously until the Relay Function indicates that the transmission should be terminated.

Crash Detection

When a vehicle crashes, sensors embedded in the vehicle note parameters that are consistent with a crash. This recognition initiates the application's communication flow by triggering the AACN reporting mechanism. A computer onboard the crashed vehicle compiles a DSRC message that includes basic crash data such as call-back number, date, time, location, pre-event vehicle heading, vehicle information, and airbag deployment event. The message includes crash severity information such as multiple impacts, crash delta velocity, Principal Direction of Force (PDOF), rollover, crash severity prediction, and video if available in the crashed vehicle. It also includes seat belt restraint use, number of occupants, occupant location, and intrusion (e.g., a door or instrument panel pushed into the vehicle occupant compartment).

Once received by the Communications function, the Crash Detection function processes the message and determines that the relay vehicle has received an AACN message resulting from a vehicular incident. The Crash Detection function then determines whether this AACN message or AACN-RELAY message has been previously received or is a “new” message for the vehicle. It makes this determination by comparing the reported crash information to a temporary database that maintains the recently received AACN and AACN-RELAY messages (the storage of these messages would be removed when the vehicle’s engine is shut off). The Crash Detection function then notifies other functions that a new AACN message has been received if not previously received.

Driver Notification

The Driver Notification function receives a notice from the Crash Detection function that an AACN message has been received and determines whether the driver of the relay vehicle should be notified that an AACN message has been received. Notification would consist of visual and/or audible alerts indicating that an AACN message has been received. Only notifications of receipt of an original message (i.e., from the crashed vehicle and not relayed) will be made. The value of the driver notification is that the driver can independently check whether there is a crash in sight, or if it is dark or foggy, at least notify public safety authorities that he or she is getting an indication of a crashed vehicle at a certain location.

Distress Message Receipt

When the crashed vehicle sends the DSRC AACN message, its transmission is “fire and forget” and there is no embedded acknowledgement in the message (i.e., a return “ack”). However, when the Crash Detection function identifies that an AACN message has been received it will notify the Distress Message Receipt function, which will then compare the position of the relay vehicle to that of the distress vehicle (included in the AACN message). If within DSRC range, the Distress Message Receipt function will generate a “Distress Message Received” message and send this to the Communications function for immediate DSRC broadcast to provide a feedback to the crash victim that their message has been received by another entity.

Relay Termination

The AACN relay capability helps increase the likelihood of the AACN DSRC message reaching the Information Broker’s PSAP component. After the first CV-enabled vehicle passing by the crash scene receives the initial AACN message from the crashed vehicle, it is desirable that the AACN message be relayed by greater numbers of CV-enabled vehicles. This is particularly true in locations where there are relatively few passers-by and few roadside hotspots. When emergency responders arrive at the crash scene, they will turn off the crashed vehicle’s AACN message transmissions. However, it is not intended that the relayed messages proliferate past a certain point either, so there must be a protocol to terminate the relay. There are a number of different options for relay termination. The AACN-RELAY as envisioned in this ConOps would employ a variable termination criterion that is based upon distance from the original incident and the number of previous “handshakes” between relay vehicles, which would be aggregated by each AACN-RELAY equipped vehicle and included in the AACN-RELAY message sent to other vehicles. Table 5-1 illustrates these variable termination criteria.

Table 5-1. Illustration of Variable Termination Criteria as a Function of Distance and Number of Handshakes

	Short (0-1 mile)	Medium (1-10 miles)	Far (>10 miles)
Low (0-5 handshakes)	Active	Active	Active
Medium (5-15 handshakes)	Terminate	Active	Terminate
Large (>15 handshakes)	Active	Terminate	Terminate

Source: Battelle

Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP STG)

The staging of all emergency responders including law enforcement, fire, emergency medical services, HAZMAT, towing and recovery among others is well-established and has many protocols in place to guide all personnel involved, from those receiving the initial calls for assistance; to dispatch, arrival, and staging of the responders and establishment of the incident zone; to secondary dispatch of responders if needed; to transport of victims to medical facilities and towing and recovery operations. However, the basic motivation of the practices followed during an incident response is to ensure responder safety; achieve safe, quick clearance; and provide prompt, reliable, interoperable communications. These are laudable and quite achievable objectives, but it is noteworthy that these objectives cannot be achieved in a vacuum, and that while securing the incident scene and attending to the victims is a critical mission, the needs and safety of the traveling public and responders' en-route to the scene also need to be addressed. By combining the traditional elements and information components of incident management with transportation information sources and data, the transformative impacts on mobility will be achieved through more informed decision-making and reductions in response and clearance times.

Improving situational awareness to public safety responders while they are en-route can help establish incident scene work zones that are safe for responders, travelers and accident victims while being less disruptive to traffic. Situational awareness information can also provide valuable input to responder and dispatcher decisions and actions. The RESP-STG application will provide situational awareness to and coordination among emergency responders—upon dispatch, while en route to establish incident scene work zones, upon initial arrival and staging of assets, and afterward if circumstances require additional dispatch and staging. It will provide valuable input to responder and dispatcher decisions and actions. There is a range of data that will be provided through mobile devices and other types of communications to help support emergency responder vehicle routing, staging, and secondary dispatch decision-making. These data will include staging plans, satellite imagery; GIS map graphics, camera images, current weather data, traffic conditions, dynamic routing guidance, sensor readings, and real-time modeling outputs.

The RESP-STG application is a collection of integrated functions designed to minimize the adverse effects on mobility and safety caused by an incident affecting the roadways. This is achieved by increasing the preparedness and situational awareness of the emergency responders upon dispatch and while en route to an incident scene. Such information includes dynamic routing to the scene to avoid road closures and roads impassable due to snow, details regarding the HAZMAT content of transport vehicles, and victim injury severity predictions. Awareness of this information in advance enables critical, time-saving, and potentially life-saving decisions to be made prior to arrival on scene.

These decisions in turn enable the responders to clear the incidents sooner and to enhance the incident staging to facilitate mobility.

The RESP-STG application will be deployed on existing MDTs within responder vehicles, when they are available. Figure 5-4 illustrates the RESP-STG functional architecture, showing the input data types and providers on the left, the core functional components in the middle, and the data output type and consumers on the right. These inputs are transformed by RESP-STG into the outputs sent to the data consumers to enable them to restore traffic flow to pre-incident conditions.

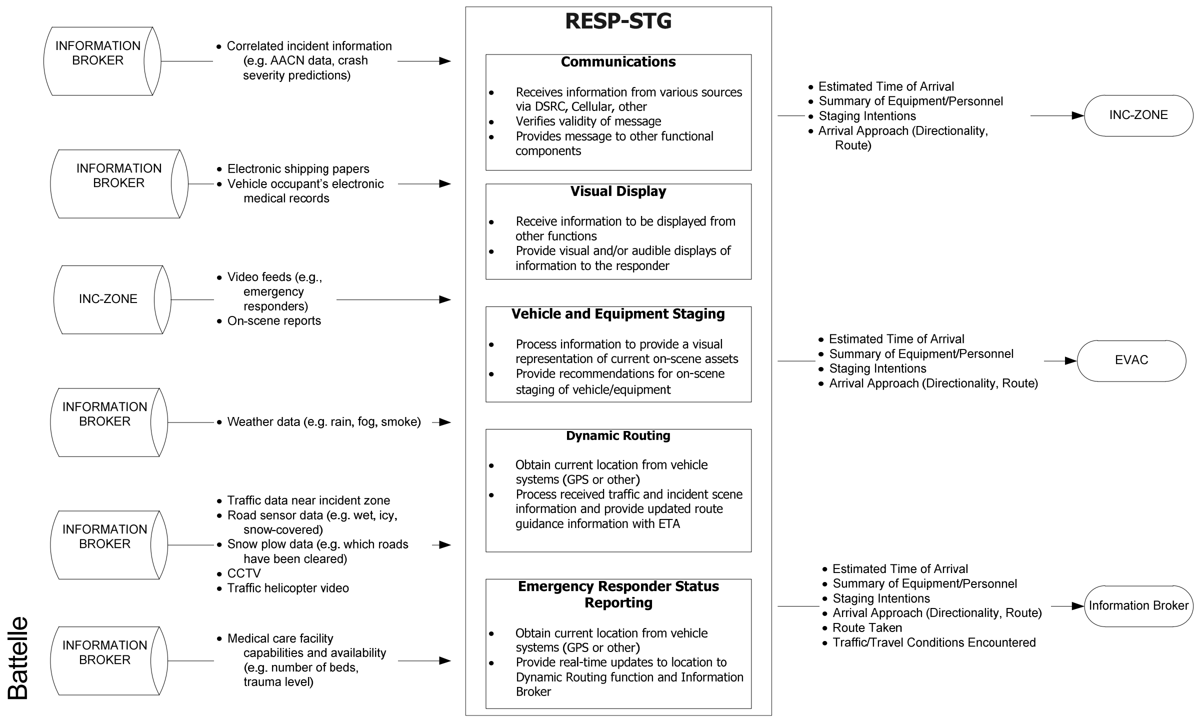


Figure 5-4. RESP-STG Functional Architecture

Communications

The Communications function enables RESP-STG to receive information from various sources over a variety of different communication methods and to transmit information to its intended data consumer quickly and securely. One important activity of the Communications function is to verify the validity of the received message. If needed (or required), the Communications function is responsible for acknowledging received messages.

Visual Display

The Visual Display function performs the straightforward function of providing a visual and/or audible display of the information that is provided to it by the other functions.

Vehicle and Equipment Staging

The Vehicle and Equipment Staging function supplies the en-route responders with additional information they can use to determine where to stage personnel and equipment prior to their arrival on-scene. This function is responsible for accessing a database of still photographs, satellite imagery, GIS overlays, video feeds, and modeling programs (e.g., predicted HAZMAT plumes) to provide a visual representation of the scene to facilitate the staging of equipment. Additional components such as the current traffic conditions and existing vehicles already on-scene are also critical components integrated into the situational awareness picture developed and provided by the Vehicle and Equipment Staging function.

This function receives information from a variety of sources, routed through the Communications function and uses that information together with on-board databases and Internet accessible sources to develop a multi-layered special representation of the incident. The arriving responder's approach and likely staging will be projected onto the incident as an additional layer.

Dynamic Routing

The goal of the Dynamic Routing function is to provide additional information that is not common to existing routing systems to enhance the ability of those systems to quickly and efficiently route the responder. The Dynamic Routing function of RESP-STG provides emergency responders with real-time navigation instructions to travel from their base to the incident scene, accounting for traffic conditions, road closures, and snowplow reports if needed. Supplemental information such as video feeds from TMC closed-circuit television (CCTV) or traffic helicopter cameras will be received, processed, and included in alternative routing algorithms to enhance the routing. For example, the function will receive, through the Communications function, information from the Information Broker that a HAZMAT plume is projected to cross their current route, and an alternative route will be provided.

Emergency Responder Status Reporting

This function continuously monitors the location of the en-route responder vehicles as well as the vehicles already on-scene (via the INC-ZONE and/or Information Broker). The function develops and maintains the current position of the responder's vehicles and provides updates for estimated time of arrival (ETA) to both the Information Broker as well as the INC-ZONE application. Other information such as traffic encountered, speed, heading, and route to destination are also captured and processed by this function. This information is forwarded to the INC-ZONE and Information Broker via the Communications function.

Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)

INC-ZONE is a communication approach that will improve protection of responders at incident sites where there have been crashes, other accidents, or events impacting traffic such as stalled vehicles or vehicles pulled over for moving violations. Unlike permanent route guidance and even construction zones, the dynamic nature of temporary work zones established following an incident (incident zone) can be confusing and disconcerting to drivers. For example, the number of lanes closed may change during the course of the incident and without much prior notification or notice. Enhancing the safety of such work zones requires that real-time notifications be delivered to both the driver of the vehicle operating near the incident zone, and the responders working in the zone, including law enforcement, fire and rescue, EMS, HAZMAT Response Unit, towing and recovery, emergency management, and construction workers (if brought on-scene for emergency infrastructure repairs).

Within the R.E.S.C.U.M.E. Bundle, the INC-ZONE application is the component that will serve to provide additional on-scene information to responders as well as oncoming drivers of events that are occurring in the incident zone such as a lane closure. In particular, one component of the INC-ZONE application will provide responders with real-time alerts of oncoming vehicles that have trajectories or speeds that pose a high risk to their safety. Additional information such as arriving and staging of additional responders would also be provided to assist in staging decisions and response to the incident.

A second aspect of the INC-ZONE application will involve a built-in in-vehicle messaging system that provides merging and speed guidance around an incident to on-coming vehicles. For example, vehicles approaching the incident at speeds that pose a risk to themselves as well as to the incident zone responders will be detected by on-scene portable sensors or other detection methods. They will receive a message generated by the INC-ZONE application notifying them of the dangerous speed and advising a speed reduction. An additional aspect of the INC-ZONE application would be to also notify law enforcement personal of excessive speed so that enforcement of advisories could be enacted. However, this additional aspect of the application is considered to be beyond the scope of this ConOps.

The INC-ZONE application provides real-time situational awareness to on-scene workers, responders, and the traveling public. Unlike the other applications, the INC-ZONE application may reside within equipment contained in responder's vehicles, but components of the application particularly the data collection aspects, may also reside in additional stand-alone equipment such as a mobile traffic cone or even a fixed infrastructure asset. For the purposes of the ConOps, it is assumed that the INC-ZONE application consists of the in-vehicle components of the application, recognizing that some of the data elements utilized by the application are derived from infrastructure and road-side equipment. Figure 5-5 summaries the functional components of the INC-ZONE application. Generally, this is the application that "takes over" when the responders arrive on-scene.

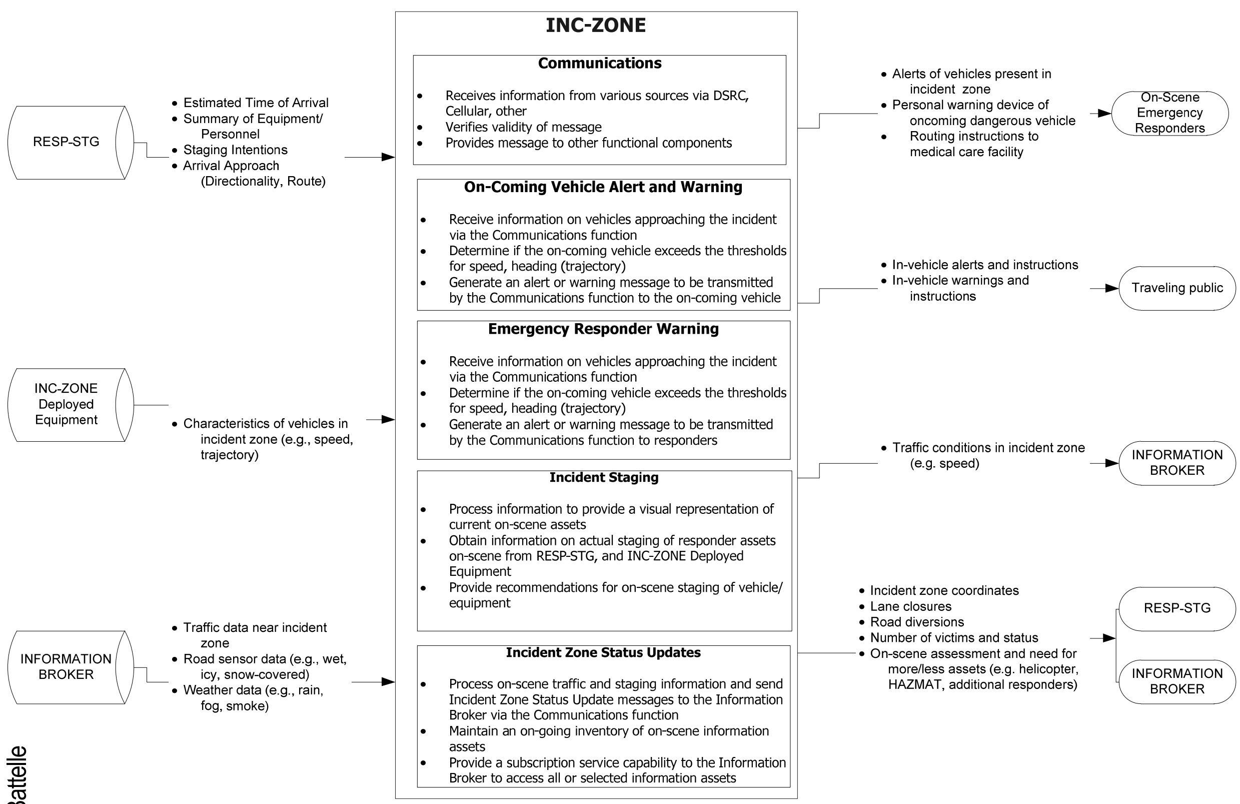


Figure 5-5. INC-ZONE Functional Architecture

Communications

The Communications function enables INC-ZONE to receive information and then transmit the generated output data to its intended data consumer quickly and securely. This includes the processes required to exchange messages with the Information Broker component of R.E.S.C.U.M.E. and with RESP-STG. Such processes include data receipt, data transmission and termination, error detection, and authentication.

On-coming Vehicle Alert and Warning

The INC-ZONE In-vehicle Alert and Warning function uses high-priority DSRC messages to alert drivers that they have entered an incident zone and direct them to change course if they are operating their vehicles unsafely for the incident zones conditions. Recognition of an unsafe vehicle would be accomplished by using specially-designed computer algorithms to analyze vehicle speed and trajectory information as well as other information sources to determine whether an alert and/or warning needs to be presented to the vehicle operator. More specifically, the In-Vehicle Alert and Warning function receives information from the Communications portion of the application that identifies the current road conditions. This information includes recommended speed and lane guidance that are sent to the Communications function by the INC-ZONE application. Processing this information against the vehicle’s current telematics (e.g., speed, heading, distance from scene, etc.) and vehicle characteristics (e.g., weight, height, stopping distance, etc.), the In-Vehicle Alert and Warning function determines whether a message needs to be generated, the priority of the message, and whether it should be visually or audibly presented to the vehicle operator (or both).

Emergency Responder Warning

The INC-ZONE Emergency Responder Warning function uses high-priority DSRC messages to alert incident responders that a vehicle has entered an incident zone and represents a potential threat to the incident responders due to excessive speed and heading (trajectory). The Emergency Responder Warning function receives location and predictive path information from on-coming vehicles broadcasting the Enhanced Basic Safety Message. Location and heading information are received from CV-enabled vehicles that are broadcasting only position information. The INC-ZONE Emergency Responder Warning function also receives, via the Communications function, information from other sources such as mobile sensing platforms that also provide a mechanism for identifying vehicles that are high threats, but that are not equipped with CV technology (i.e., existing or portable radar detectors embedded in VMS, etc.).

The Emergency Responder Warning function first determines that type of information that is received and the source of the information. A series of algorithms then are invoked to determine predicted path and projected speed, together with other information such as current traffic and weather conditions to generate a hazard score. Instances that exceed a pre-determined threshold for the hazard score trigger the generation of an alert or warning message that is sent to the Communications function for immediate broadcast to all emergency responders on-scene. The threshold for triggering a warning should be a configurable setting that could be dynamically changed as traffic, weather, and other related extraneous factors change.

Incident Staging

The INC-ZONE Incident Staging function is essentially the same as that described for RESP-STG with the exception that it is focused upon on-scene assets and includes oncoming vehicles and their predicted hazard scores. This function receives information from a variety of sources, routed through the Communications function and uses that information together with on-board databases and Internet accessible sources to develop a multi-layered special representation of the incident.

Incident Zone Status Updates

The INC-ZONE Incident Zone Status Updates function provides a real-time information feed on the current conditions at the incident scene to arriving responders (RESP-STG) and to the Information Broker. This information includes traffic data (e.g., speed), lane closure details, and diversion locations. However, second-by-second updates of all information are not envisioned as this may result in communications bandwidth limitations. Rather, this component of the application will communicate automatically with the Information Broker to identify information streams that are not accessible through other means (e.g., CCTVs mounted to telephone poles) and provide this information. In short, this function will maintain an ongoing inventory of all information assets that are available to it on-scene and will allow the Information Broker to subscribe to one or more of these elements. This enables the Information Broker to have the ability for distributed processing and communications and avoids information choke points due to the same information being provided by multiple sources. For example, the Information Broker may subscribe to the in-vehicle dash camera feed from one of the on-scene patrol vehicles to observe road closures or blockages while at the same time subscribing to second-by-second traffic speeds from a second responder’s INC-ZONE application. This enables the traveling public who has yet to enter the incident zone to avoid it entirely or to be aware of the likely congestion and reduced speeds ahead.

Emergency Communications for Evacuation (EVAC)

Evacuation of a city, county, or even part of a city is a challenging endeavor. Evacuation may involve a large region with days of advance notice, such as with an approaching hurricane; or it may be rapid and local, for example in response to a leak or potential explosion of a HAZMAT such as a Toxic Inhalation Hazard (TIH) like chlorine gas. Evacuation involves coordination of many agencies and functions including emergency management, public safety responders, public and private transportation providers, and DOTs. Evacuations not only involve the people who have the means and capabilities to evacuate themselves but also the functional needs population. The planning and execution of an evacuation must consider all categories of functional needs. The purpose of the EVAC application is to facilitate coordination for evacuees in both categories and those who support them.

During an incident, the EMA would have the ability to push information such as evacuation orders by evacuation zone to registered users of the system (either those that have pre-registered, or real-time registration during the event) through the EVAC application. The TMC working with the EOC will use the EVAC application to coordinate the listing of available transportation resources to assist with functional needs evacuation. The EVAC application will dispatch and route the transportation resources to the appropriate location, while providing communications update to those functional needs individuals in need of assistance.

For non-functional needs evacuees, the EVAC application will provide evacuation route guidance that accounts for road conditions, traffic conditions, and final destination. If the evacuee intends to go to a shelter or hotel, the EVAC application will provide a shelter matching function to help the evacuee determine where he or she should go based upon shelter availability and capability (e.g., does the shelter accept pets?). Should the evacuee need a resource such as food or fuel along the evacuation route, the EVAC application can provide recommended stops and will incorporate user input feedback to provide information (though not necessarily validated information) on the availability of the needed resource.

Additionally, the EVAC application will provide a Return of Evacuees Function to provide evacuees with information regarding when they can return to their area of the jurisdiction and provide recommended routes taking into consideration road conditions (i.e., roadway infrastructure and traffic lights). All of these functions will support an overall reduction in the amount of time it takes to evacuate a jurisdiction, promote the use of all available evacuation routes to help minimize traffic congestion, and mitigate secondary incidents such as a car running out of fuel along an evacuation route, or too many people showing up at a shelter that is full and staying on the roads longer (adding to the congestion).

The EVAC application will contain multiple functions to support the efficient evacuation of functional needs and non functional needs evacuees within a jurisdiction as well as provide real-time communications of evacuation instructions and routing guidance that accounts for current road and traffic conditions. These functions are accomplished through the integration and use of existing technologies to include communications functions (i.e., mass warning and notification systems), functional needs pre-registration databases, GIS, GPS, CAD, AVL, traffic information, and weather data. For the End Users of the application, the majority of the application functions will be accessed through a website and/or a Smartphone application or family of applications. Therefore, usage of these functions will be predicated on having a Smartphone, having connectivity (through WiFi or service provider), and having the awareness through jurisdiction outreach to know that this application is available and how it can be of value to the evacuee. Figure 5-6 summaries the functional components of the EVAC application.

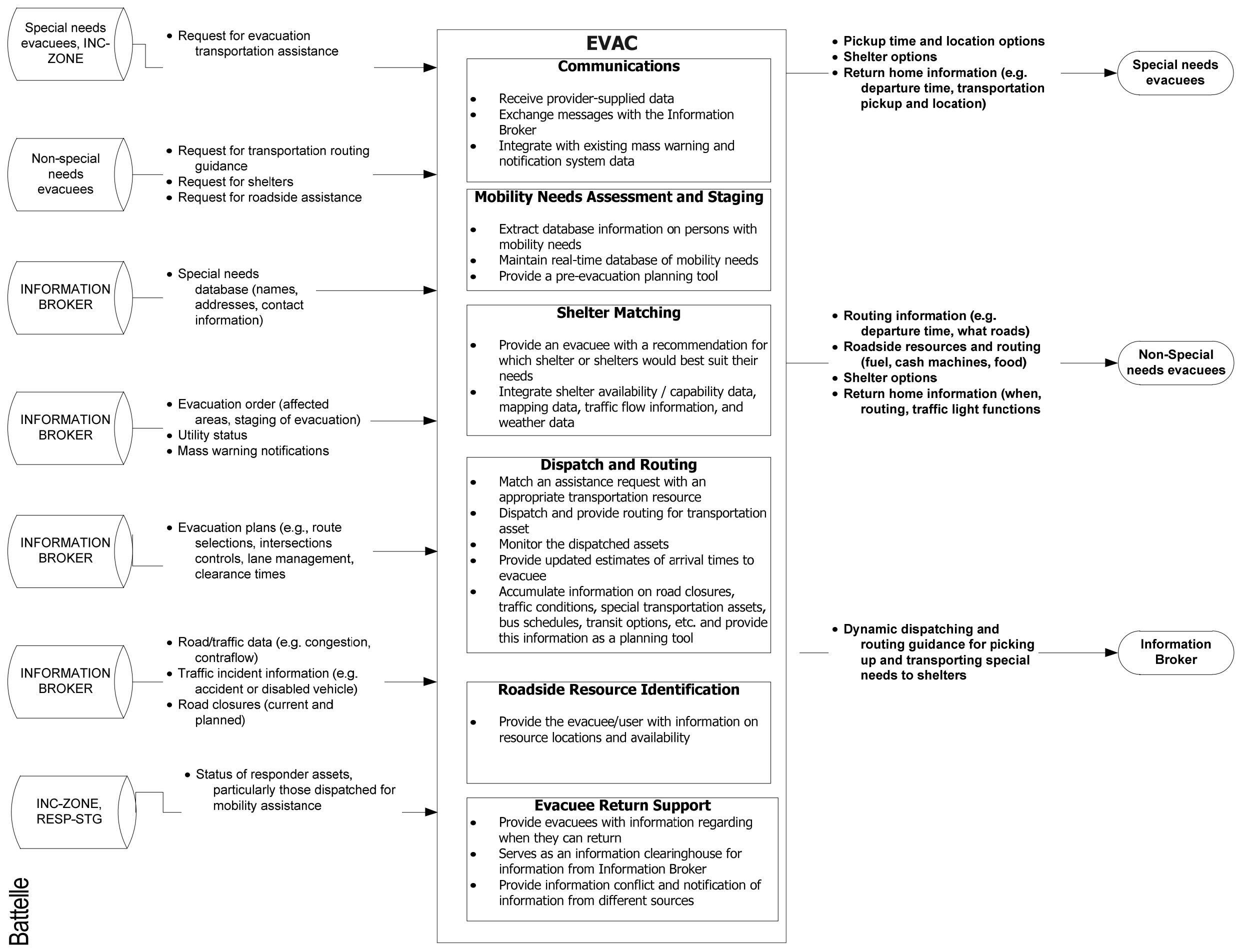


Figure 5-6. EVAC Functional Architecture

Communications

The Communications function enables EVAC to receive provider-supplied data (i.e., input data) and then transmit the generated output data to its intended data consumer quickly and securely. This includes the processes required to exchange messages with the Information Broker component of R.E.S.C.U.M.E., the EOC, TMC, functional needs evacuees and non-functional needs evacuees. Such processes include data receipt, data transmission and termination, data de-confliction to mitigate repeat requests, error detection, and authentication/data validation. The EVAC communications function should be able to integrate with existing mass warning and notification system data (either registered users and/or reverse 9-1-1-type information) to maximize the number of users the EVAC system can reach within a jurisdiction.

Most of the information flowing to and from the EVAC application will flow from the Information Broker and the entities that communicate with the Information Broker. The EVAC application itself will exist within one or more of the existing information systems of those entities that are included in the Information Broker.

Mobility Needs Assessment and Staging

The Mobility Needs Assessment and Staging function of the EVAC application serves to provide information that can be used to determine the segments of the population that require assistance to achieve enhanced mobility. This will include both persons with functional needs as well as persons without functional needs, but for whom there is an urgent mobility need as a result of the evacuation or subsequent incidents.

This component of the application would be responsible for extracting information from several different databases including those databases that provide information regarding persons with functional needs, regardless of whether they have pre-registered or are identified during the evacuation (either by a responder or through self-identification). Pre-evacuation information would be obtained from existing and/or legacy databases while on-going identification of persons with special mobility needs would be gathered and provided through the INC-ZONE application as well as from internal Information Broker entities such as a PSAP, law enforcement, State and Local government entity, etc.

The Mobility Needs Assessment and Staging function will provide a pre-evacuation planning tool that can be used to identify those segments of the population that require assistance and geographic locations and assets that could provide that assistance. However, once the evacuation is underway, it is likely that many of the assets identified during pre-evacuation planning will be diverted to other critical needs and will be unavailable at certain points in time during the evacuation. The Mobility Needs Assessment and Staging function is responsible for monitoring the identified segments of the population to maintain a situational awareness of mobility needs, which are then passed to the Dispatch and Routing for Functional Needs function for planning and deployment of assets.

Shelter Matching

The shelter matching function will provide an evacuee with a recommendation for which a certain shelter or shelters would best suit their needs such as a standard shelter, a functional needs shelter, or a shelter that accepts pets. This information may also suggest hotels/motels as potential sheltering options. The evacuee goes to a website or uses a smart phone application to put in their information such as name, current location, number of people in their “group,” and prompts the evacuee to answer some critical questions such as “are you evacuating with a pet?” “Is someone requiring medical support?” and the mode of transportation. Based upon this information as well as the prevailing travel conditions and predicted shelter loads, the evacuee is matched with a shelter and the system provides the evacuee with route and traffic information.

This function will require integration with shelter availability/capability data, mapping data, traffic flow information, and weather data such as that included in the American Red Cross National Shelter System (NSS). This function will promote effective movement to a matched shelter instead of potentially driving to a shelter only to find out it is not appropriate for the evacuee’s circumstances then having to continue driving to another shelter, adding to road congestion. Additionally, once an evacuee is matched with a shelter, the information can be added to the information managed by the Information Broker to allow for real time tracking of shelter availability.

Dispatch and Routing

One purpose of the Dispatch and Routing function is to match assistance/transportation requests with the appropriate resource, dispatch the appropriate resource, and provide the resource with the most effective route to their destination given current road/traffic conditions.

Through the Mobility Needs Assessment and Staging function, the Dispatch and Routing function is provided with requests for assistance, the type of assistance/resource needed to assist the functional needs individual (or group). This function will then match an assistance request with an appropriate transportation resource using information provided to the Information Broker from the RESP-STG, INC-ZONE, and other entities in the Information Broker. Once an asset is identified, a dispatch recommendation would be submitted via the Communications function to the Information Broker for processing and routing to the appropriate asset. The Dispatch and Routing of functional needs Transportation would monitor the dispatch through updates provided by the RESP-STG and INC-ZONE applications. This function will provide estimated times of arrival and feedback to the person(s) requiring assistance through the Information Broker.

In evacuation situations, some persons will require assistance to accomplish the evacuation and request assistance in the form of a transportation asset. However, from a system congestion and asset management perspective, it may be more beneficial to either direct the individual to the asset (rather than the asset to the individual) or provide the individual with alternatives and options for self-evacuation that may not have been previously identified or known to the individual. The Dispatch and Routing function also serves the purpose of accumulating information such as road closures, traffic conditions, special transportation assets, bus schedules, and transit options and provide this information as a planning tool and resource to evacuees through the Information Broker.

Roadside Resource Identification

This function will provide the evacuee/user with information on resource locations and availability (as reported by other users – not necessarily validated information) including fuel, automated teller machines (ATMs), food, and hotels/motels along their evacuation route. The evacuee can access this information through a Smartphone application or through another device that has an Internet connection. The application will receive inputs, via the Information Broker, from mapping/GPS resources that have listings of resource locations. Other users of the application can make comments through social networking tools to alert other drivers of resource availability. For example, another user could arrive at a gas station and report that the station is out of fuel. The user who is in need of a roadside resource can select their need and will then be provided with route guidance (based upon map data and traffic/road condition data). Providing an evacuee with this type of information can help mitigate a secondary event such as running out of fuel along an evacuation route. This secondary event can disrupt traffic flow and would require dispatching of a resource to assist the evacuee.

Evacuee Return Support

Recovering from an evacuation and returning the evacuees to a jurisdiction can be just as complex as the initial evacuation depending on the extent of the damage. This function will provide evacuees with information regarding when they can return to their area of the jurisdiction and provide recommended routes taking into consideration road conditions (i.e., roadway infrastructure and traffic lights). This portion of the application serves as an information clearinghouse for information provided to the public by the various entities feeding the Information Broker. One important aspect of this function will be to process the information from the various entities intelligently to ensure that the messages are consistent and that the information provided by one entity does not conflict with the information provided by another entity. Should conflicting information be identified, this function has the responsibility for notifying the Information Broker regarding the conflict and providing the details that caused the application to identify the information as being conflicting. The Information Broker will have the ability to deconflict the messages for publication.

Information Broker

As discussed in Chapter 3, there are a number of well-established systems currently being utilized by the responder community. Additionally, there are complementary systems being utilized by other stakeholders, such as TMCs or public service dispatch centers that also relates to emergency response. It is critical to understand that the fundamental concept of the R.E.S.C.U.M.E. Bundle is that it will “live” within these existing systems rather than serve as a replacement to those existing systems. That is, the R.E.S.C.U.M.E. Bundle is conceived of as providing “value-added services” to those existing systems to assist responders in performance of their functions, while at the same time improving the overall mobility of those responders as well as the general traveling public during an incident. Representation of the existing systems and the flow of information among these systems are not detailed in this ConOps, beyond those discussions included in Chapter 3, as they can vary significantly from jurisdiction to jurisdiction. Rather, it is assumed as part of this ConOps that these various systems exist and that the necessary linkages between them also exist and will be used for information exchange. Figure 5-7, therefore, simply lists some of the many organizations that are expected to have existing systems that communicate with other organizations during an incident.

At the heart of R.E.S.C.U.M.E. is an Information Broker entity whose role is to collect, process, and disseminate data among the applications. As envisioned in the R.E.S.C.U.M.E. Bundle, the Information Broker would require and incorporate the functionalities currently provided by entities such as ECCs/PSAPs, TMCs, and EOCs. More than just simply receiving or sending information, this organization or collection of organizations serves as an Information Broker. This includes processing of the received information and determining the entities that need to be informed and providing other decisions on routing of information and data based upon the breadth of the information available throughout the incident. This is not meant to imply that the Information Broker would replace the Incident Commander or subsume the decision-making responsibilities of other organizations. Rather, the Information Broker would have the responsibility for both providing information and facilitating the routing and transfer of information among both internal and external entities. A key aspect of the Information Broker is to rapidly sift through the multitudes of input data; interpret, de-conflict, and correlate the data; and through implementation of algorithms and procedures make decisions on the relevance of data to a particular incident and application and communicate this information to the appropriate entity. Figure 5-7 summarizes the flow of information and the functional architecture of the Information Broker.

As illustrated in Figure 5-7, the information broker receives information from the R.E.S.C.U.M.E. Bundle Applications as well as information from other organizational entities. Once the information is received, it is processed and then distributed to the applications as well as other organizational entities. In short, the primary role of the Information Broker as envisioned is to serve as an information processor and router. The functional elements of the processing are described below for each of the R.E.S.C.U.M.E. Bundle Applications.

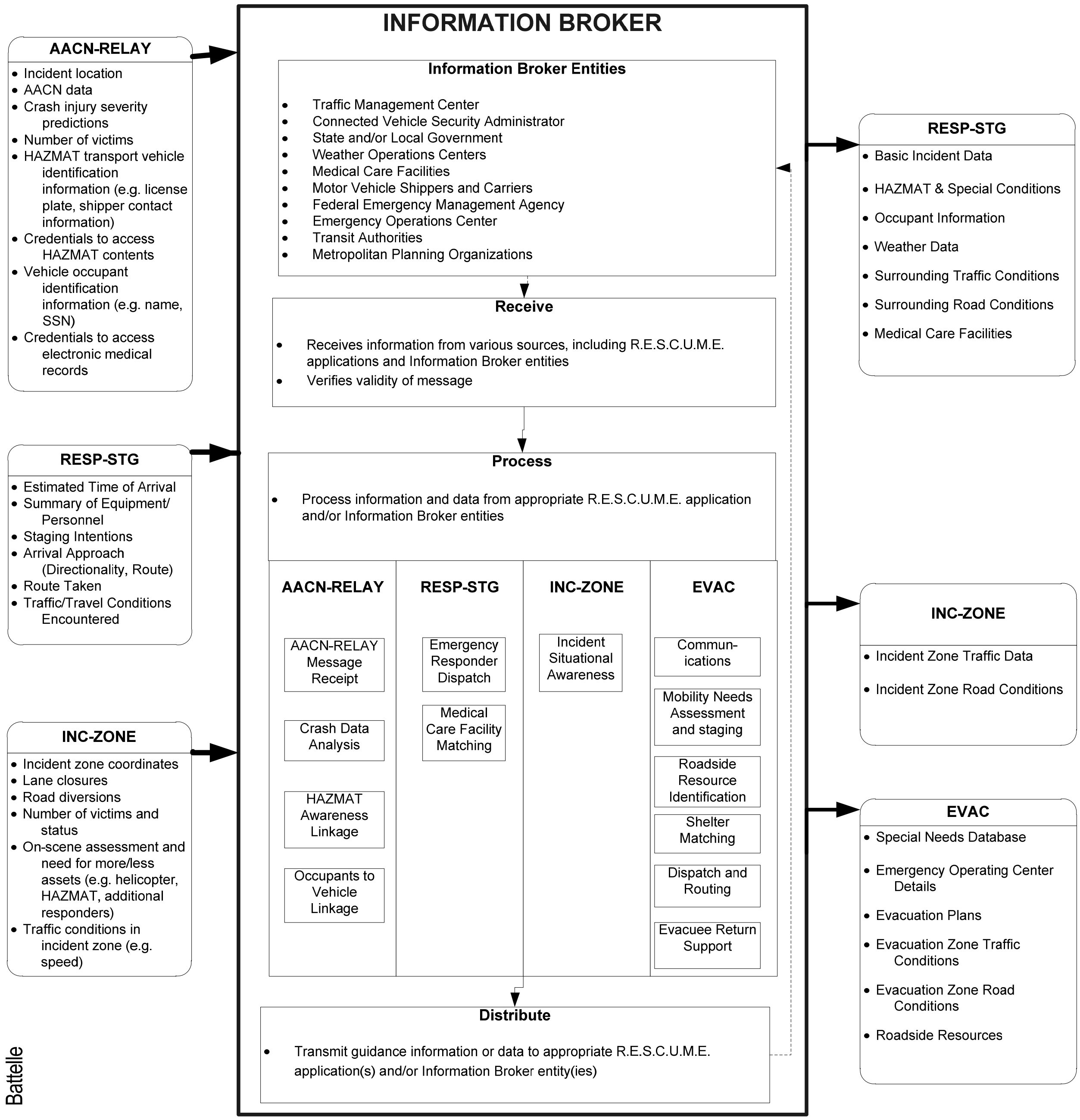


Figure 5-7. Information Broker Functional Architecture

Information Broker – Advanced Automatic Crash Notification Relay

The Information Broker has four processing functions related to the AACN-RELAY application. Collectively, these functions receive information from the AACN-RELAY application and are the processing entities. The four processing functions are:

- **AACN-RELAY Message Receipt.** This function receives, processes, interprets, correlates, and de-conflicts information on the reported crash. The function looks for embedded information indicating there is medical documentation or HAZMAT electronic shipping papers/emergency response forms stored that are associated with a vehicle occupant or the vehicle, respectively. This function then notifies the other functions accordingly and transfers the appropriate portions of the message to those other functions.
- **Crash Data Analysis.** This function will process the captured crash data and will apply algorithms on the AACN data such as vehicle velocity change, PDOF, seat belt usage, crash with multiple impacts, and vehicle type to determine whether the crash data are consistent with a high risk of injury. The result will be packaged and distributed to the INC-ZONE and RESP-STG applications as well as other organizational entities.
- **HAZMAT Awareness Linkage.** This function will process the information received from the AACN-RELAY application including an electronic version of the required HAZMAT shipping papers/emergency response forms or indications that a HAZMAT electronic shipping paper is on file with an organizational entity. This function then issues a request for the electronic shipping papers to that entity and upon receipt it is packaged and distributed to the INC-ZONE and RESP-STG applications. If the vehicle is a truck carrying HAZMAT cargo, the stored data will include information needed to access and retrieve electronic versions of the cargo's required HAZMAT shipping papers and emergency response information correlated to the vehicle and the trip.
- **Occupants to Vehicle Linkage.** The Information Broker is assumed to include, in one of its organizational entities, information on the likely vehicle occupants and their medical conditions (Note: such information does not currently exist in a format that can be accessed, and a future database would likely require voluntary participation). Part of the AACN-RELAY message is expected to include information on the victims that the Information Broker function will use to match against this database and retrieve medical history on the victims that would enhance the emergency response. This information will be compiled and distributed to the INC-ZONE and RESP-STG applications.

Information Broker – Incident Scene Pre-Arrival Staging Guidance for Emergency Responders

The Information Broker has two processing functions related to the RESP-STG application:

- **Emergency Responder Dispatch.** The Emergency responder dispatch function identifies the resources required to respond to a reported incident and then issues a request to dispatch those emergency responders to the appropriate organizational entity. The function analyzes the correlated incident information to determine the type(s) and number(s) of responders that should be dispatched. This incident information includes AACN crash data, crash injury severity predictions, and vehicle type, among others. For example, knowing the vehicle type is a tractor-trailer or a compact car enables the dispatcher to contact the appropriate towing and recovery agency before any emergency responders arrive, likely reducing clearance time.

- **Medical Care Facility Matching.** The medical care facility matching function processes information from the RESP-STG and INC-ZONE applications to provide pre-alerts to medical care facilities (e.g., Level I trauma center) to advise them that incident victims will be arriving. This function interfaces with the Information Broker's medical care facility entity to access a medical care facility's bed availability and ability to stabilize and treat the injuries projected by the crash severity predictions originating from AACN-RELAY. The matching also considers the victims' medical records. This information on the medical care facility that has the best ability to receive the incident victims is then distributed to the RESP-STG and INC-ZONE applications.

Information Broker – Incident Scene Work Zone Alerts for Drivers and Workers

The Information Broker has only one processing function related to INC-ZONE; Incident Situational Awareness. This processing function is responsible for processing the information received by the Information Broker from a variety of sources, filtering the information, and compiling and distributing real-time updates on the activities and conditions at and surrounding the incident zone to the INC-ZONE application and the RESP-STG application.

Information Broker – Emergency Communications for Evacuation

The Information Broker has six functions related to the EVAC application. As discussed above, most, if not all, of the components of this application will reside within the systems operated and maintained by the organizational entities that comprise the Information Broker. The functionality and activities that are conducted through these six functions are discussed above within the description of the R.E.S.C.U.M.E. Bundle Applications description.

External Consumers/R.E.S.C.U.M.E. Application End-Users

External consumers are defined as those individuals and organizations that are consumers of information that is provided by the R.E.S.C.U.M.E. Bundle Applications on items such as traffic conditions, closures, and assets on scene. These individuals and organizations differ from the R.E.S.C.U.M.E. Bundle Application end-users in that they are primarily consumers of the information rather than the individuals and organizations that are utilizing the applications themselves. In many cases, however, this may be a relatively fuzzy line as travelers approaching an incident scene could be considered to be both an application end-user as well as an external consumer. For this ConOps, the responder community is considered as the ultimate "users" while other individuals and organizations that benefit from the use of the INC-ZONE, RESP-STG, and EVAC applications by responders as external consumers.

Modes of Operation

As envisioned, the R.E.S.C.U.M.E. Bundle is conceptualized as a bundle of four applications that would work simultaneously and collaboratively in conjunction with other existing systems, particularly those of the Information Broker entities. However, there will likely be situations where one or more of the applications are not available or operational as well as situations where extraneous factors such as the unavailability of cellular communications or power for roadside equipment impact the operation of the bundle as a whole and the individual applications. Rather than describe the various mechanisms by which the individual applications can interoperate, this section provides a summary of the modes of operation for each application separately.

Advanced Automatic Crash Notification Relay

Five modes of operation are envisioned for the AACN-RELAY application including three modes in which the application is overloaded and/or degraded.

- **Normal Mode.** In normal mode the AACN-RELAY application is installed and operational on all vehicles with connected vehicle equipment. Full connectivity and capability to cellular data network is available to the relay vehicle.
- **Degraded Mode – No Cellular Coverage.** In this mode of operation, the AACN-RELAY application in the relay vehicles does not have the ability to connect to the cellular network. In this mode, the AACN-RELAY application will initiate communications using DSRC methods to another AACN-RELAY equipped vehicle who will subsequently relay the message to the Information Broker through cellular or roadside equipment or to another relay vehicle if cellular coverage via DSRC if cellular capability is unavailable. Under this mode, there is no absolute guarantee that the relay will eventually reach the Information Broker as the relay messages may exceed the termination criteria before a successful transfer through roadside equipment (DSRC) or through cellular.
- **Degraded Mode – Partial Implementation.** It is likely that the AACN-RELAY application will exist only in some vehicles and not in other vehicles for an extended time frame. In this condition, the AACN-RELAY would essentially “ignore” the non-equipped vehicles and proceed as under Normal mode. This may result in incidents that are not identified through an AACN message/AACN-RELAY and may reduce the benefits of the AACN-RELAY application depending upon the penetration rate of unequipped vehicles.
- **Overloaded Mode.** In densely populated traffic situations, it may be possible that the AACN-RELAY mechanism causes a system overload as a result of the need to process a large number of relay messages. In this mode, the AACN-RELAY application should begin to restrict the number of relay messages being received and processed to maintain the capability to provide the basic services for which the in-vehicle system was originally intended. This may result in incidents that are not identified through an AACN message/AACN-RELAY and may reduce the benefits of the AACN-RELAY application depending upon the extent to which incoming messages need to be filtered. The operator of the relay vehicle should be notified that incident information is being filtered.
- **Complete System Failure.** In complete system failure mode, the AACN-RELAY application will be unavailable and incidents cannot be identified through a relay function. Identification of incidents would revert to non-relay centric mechanisms including radio dispatch and cellular calls. Because the AACN-RELAY provides the operator of the relay vehicle with situational awareness of incidents, the operator of the relay vehicle should be notified that the system has failed.

Incident Scene Pre-Arrival Staging Guidance for Emergency Responders

The RESP-STG application provides en-route situational awareness and routing information to responders. There are several modes of operation envisioned for this application including:

- **Normal Mode.** In normal mode the RESP-STG application is installed and operational on all responder vehicles. Full connectivity and access to the cellular data network is available, and the Information Broker is available to the relay vehicle. Real-time information from the vehicle's telematics and positioning systems are available and can be accessed by the application.
- **Degraded Mode – No or Limited Connectivity to Information Broker.** In this mode of operation, the RESP-STG application in the relay vehicles does not have the ability to connect to the Information Broker or has slow connectivity that cannot support the transfer of the data needed by the application. If in a data limited mode, the RESP-STG application would dynamically allow the responder to select and prioritize the information that is accessed from the Information Broker and provided to the responder via the RESP-STG application. The expected download and processing time should be provided so that the responder can make an informed decision on the elements to request.

  In the case where there is no connectivity to the Information Broker, the RESP-STG will continue to operate but will indicate to the responder that data from the Information Broker is not being accessed. When in range of DSRC, particularly the broadcasting INC-ZONE application, the RESP-STG application will utilize DSRC communications to communicate with INC-ZONE to update the situational information.

- **Degraded Mode – Partial Implementation.** RESP-STG may be installed and operational on a portion of the responder vehicles. In this mode, the RESP-STG application will rely upon the Information Broker for information regarding non-equipped vehicles, which would be entered into the system through the normal operations of one of the organizational entities comprising the Information Broker (e.g., an ECC/ PSAP could provide the dispatch location of a police vehicle). The application should provide a visual indication that the information is being provided by a non-R.E.S.C.U.M.E. Bundle source.
- **Overloaded Mode.** In complex incidents with many responders, it may be possible that the RESP-STG application will become overloaded by the information being transferred and processed. In this mode, the RESP-STG application should begin to restrict the incoming and outgoing messages to maintain the capability to provide the basic services for which the in-vehicle system was originally intended. This may result in delayed information delivery and lags in updates to the situational reports. In this mode, the operator should be notified that information is being filtered and allowed to prioritize the information being received/sent.
- **Complete System Failure.** In complete system failure mode, the RESP-STG application will be unavailable and operations would revert to current procedures such as using radio and deferring staging decisions until on-scene staging. The operator of the vehicle should be notified that the system has failed.

Incident Scene Work Zone Alerts for Drivers and Workers

The modes for the INC-ZONE application are similar to those of the RESP-STG application except that notification of degraded, overloaded, and system failure modes should also be made to the on-scene responders.

Emergency Communications for Evacuation

The EVAC application differs from the other applications in that the expected mode of operation for this application is that of partial and limited connectivity depending upon the nature and stage of the evacuation. As such, the following modes of operation differ from those previously described for the other applications and include:

- **Full Connectivity to Information Broker Entities.** In this mode, the EVAC application can freely communicate with all entities connected to the Information Broker using a variety of communication methods, but primarily through an Internet-based network.
- **Partial Connectivity to Information Broker Entities.** In this mode, the EVAC application cannot access information or provide information to all entities connected to the Information Broker. In this case, the Information Broker should continue to operate the processing functions but should notify the remaining entities that communications to some entities has been lost. Specific data elements that are not available should be identified. Historical and outdated information should not continue to be provided.
- **Full Communication Loss to Information Broker Entities.** This mode essentially represents total system failure for the EVAC application as there will be no information to process or route. In this case, the EVAC application should provide a base notification that it has encountered a system failure (if possible).
- **Distributed Processing.** The EVAC application may be divided among several Information Broker entities to maintain processing capability and to have redundant systems. There is nothing inherent in the EVAC application concept that would prohibit implementation of the EVAC application in this fashion. However, when in a distributed processing mode, the EVAC application should include a mechanism for ensuring internal consistency and integrity of the database.

User Classes and Other Involved Personnel

As the R.E.S.C.U.M.E. Bundle was conceived of as an enhancement system rather than a replacement of systems for the responder community and traveling public, virtually all of the User Classes defined in Chapter 3.0 are the same for the proposed system. However, the roles and the manner in which some of these User Classes interact with the system may differ from the existing systems. Moreover, the enhancements introduced by the new systems are targeted to certain User Classes and User Groups and this section focuses on the specific User Groups within those classes, which will benefit by the enhancements of the proposed R.E.S.C.U.M.E. Bundle Applications.

Organizational Structure

See section 3.4.

Profiles of User Classes

The User Classes defined as Local, State, Federal, and other and are the same and those explained in Section 3.4. This section will discuss the specific User Groups and individual entities within those defined classes for the proposed system. User Groups within the classes can be broken down into three categories defined as Information Brokers, End Users, and External Consumers of the system and/or information.

Information Brokers are those groups or agencies that are responsible for the receipt and dissemination of information and can cross all classes. Information Brokers include the State and Local TMCs, Connected Vehicle Security Administrator, Weather Operations Centers, Medical Care Facilities, Motor Vehicle Shippers and Carriers, FEMA, EOCss, Transit Authorities, and MPOs.

End Users are concentrated at the Local and State level, but may cross-over into the Federal area based on function. End Users primarily consist of law enforcement, fire and rescue, EMS, towing and recovery, and DOT maintenance and constructions. These agencies are the primary users of the information from the proposed bundle of R.E.S.C.U.M.E. applications. Law enforcement, fire rescue, and EMS personnel will use the information provided through RESP-STG in order to pre-determine apparatus positioning before arriving on scene and utilize dynamic routing to minimize transit times. They will use INC-ZONE to coordinate on scene activities and staging as well as ensure the safety of on scene personnel. Towing and recovery operators will receive notification of an incident at near the same time as the emergency responders, as well as information on types of vehicles needing assistance though RESP-STG. While on scene, they will use INC-ZONE information to determine appropriate placement for recovery. DOT maintenance and construction workers will utilize INC-ZONE most heavily for information regarding on scene assets and vehicle locations as well as the safety of worker when on scene conducting emergency repairs to an infrastructure component.

Figure 5-8 illustrates the user groups associated with the R.E.S.C.U.M.E. Bundle Applications.

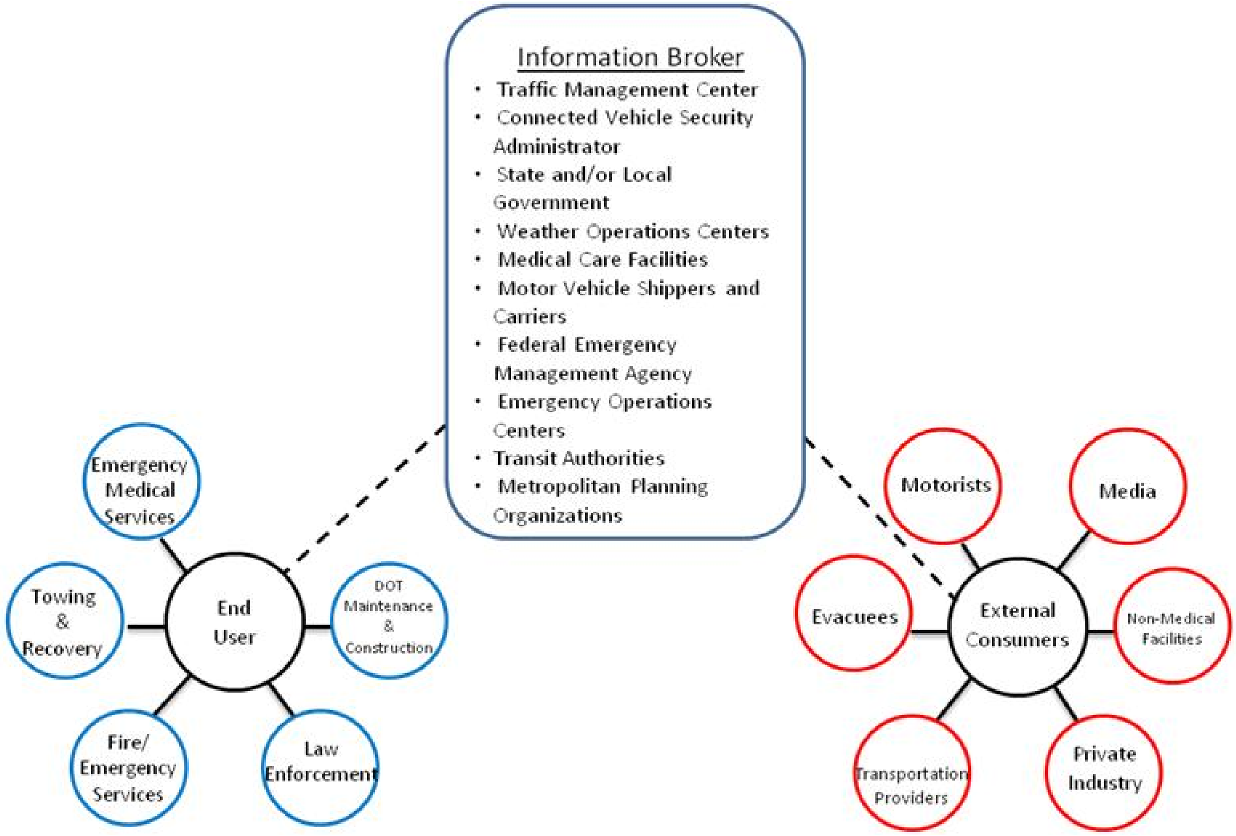


Figure 5-8. User Groups of R.E.S.C.U.M.E. Bundle Applications

External Consumers are those entities that absorb information provided by the system. These groups and individuals are not generally part of the response community but are affected by incidents and therefore need the information provided through the Information Brokers to obtain guidance, awareness, or accomplish tasks. External Consumers include motorists, evacuees, media, non-medical facilities, private industry, and transportation providers.

Support Environment

One key change between current systems and those of the proposed application is the emergence of the Information Broker. The Information Broker will likely result in a new User Class among the Other/Multi-Level users: data storage providers and/or cloud storage providers.

Chapter 6 Scenarios

This ConOps includes six operational scenarios that collectively illustrate how the R.E.S.C.U.M.E. Bundle with its four applications interact to improve mobility, reduce congestion, and to enhance emergency response. Each of the selected scenarios was included for specific purposes, one of which was to demonstrate the dynamic nature of incidents and how response to an incident can be initiated through many different mechanisms. Generally, the scenarios increase in complexity with respect to the incidents and the corresponding response. Obviously, there are many additional scenarios that could be envisioned, particularly by including specifics on the many organizations and entities that could and would respond to a particular incident. However, the focus of these scenarios is on the R.E.S.C.U.M.E. Bundle Applications, so the specific details regarding the organizational entities and their roles have purposefully not been included but are referenced through association with the Information Broker.

To provide context and impart some realism to the scenarios, each scenario presented is patterned from a known historical event. Some liberties have been taken with respect to the sequence of events and outcomes, but the correlation to known and previously documented incidents provides a mechanism for understanding the potential benefits of the R.E.S.C.U.M.E. Bundle. The six scenarios described in this section are summarized in Table 6-1. Note that for brevity, only the first two scenarios include all of the steps of the full AACN-RELAY application, these steps are summarized in the remaining scenarios.

Table 6-1. Summary of Operational Scenarios

#	Objective	Summary	Real-World Event
1	Demonstrate the benefits of AACN-RELAY application for incident detection and notification	Single vehicle incident on rural expressway due to extreme low visibility with potential for multi-vehicle escalation.	During the early morning hours of January 29, 2012, in Alachua County, Florida, an incident occurred that was directly attributable to poor visibility in a low-lying section of I-75 due to smoke from a nearby brush fire.
2	Illustrate the interconnectivity of AACN-RELAY, RESP-STG, and INC-ZONE applications	A passenger vehicle traveling in the middle lane of a multi-lane divided highway swerves right, to cut in front of a tractor trailer, resulting in a collision. The vehicles stop in the right lane, partially blocking the middle lane.	In an incident that occurred in Maryland, traffic was accelerating coming out of a construction zone on 1-95. Vehicles were switching lanes for position. A passenger vehicle in the left lane tried to pass on the right and cut in front of a tractor-trailer causing an accident.

Table 6-1. Summary of Operational Scenarios

#	Objective	Summary	Real-World Event
3	Illustrate the diverse nature of how incidents are initiated and the temporal relationship of the R.E.S.C.U.M.E. Bundle Applications	During a traffic stop, an officer is struck by another vehicle and sustains critical injuries. A bystander notifies dispatch of the incident via the officer's radio. Multiple emergency responders personal are en route to the scene and a medical helicopter has been alerted for transport of the officer.	December 19, 2010 – A Garland, TX police officer was seriously injured after a suspected drunken driver hit him while he stood outside his patrol car on the shoulder of George Bush Turnpike.
4	Illustrate the flow of information between applications and Information Broker including escalation in the level of information detail provided in response to an incident escalation	A bulk carrier, single-body tank truck filled with gasoline is stuck sitting partially on a graded railroad crossing with signal. A train approaches the crossing and strikes the bulk carrier in the front cab area causing heavy damage but no explosion. Debris punctures the carrier body and there is gasoline leaking.	May 25, 2012 – Tacoma, WA – A 30 foot flatbed truck was struck by a train in Puyallup.
5	Illustrate the applications during a planned evacuation event	The Southeastern United States is preparing to be struck by a large hurricane. It is approximately 72 hours in advance of the anticipated landfall and the regional governments have released an order of evacuation message to the public. Functional needs populations need to be evacuated to shelters. Re-routing of evacuees is needed as a result of traffic bottlenecks. Evacuees are in need of information on fueling and hotel availability en-route to safe locations.	The 2004 hurricane season was the worst in Florida's history, with four hurricanes. It is estimated that that one-quarter of Florida's population evacuated prior to at least one of the hurricanes.
6	Illustrate the ability of the applications to provide value during an unplanned evacuation	A normally staggered departure of the working population in a major metropolitan area is condensed into a mass exodus. Snow removal operations are underway with primary roads cleared and secondary roads partially cleared. Numerous single and multiple vehicle crashes occurred as a result of icy conditions.	In February 2010 the U.S. Office of Personnel Management closed Federal Offices early in anticipation of a fast-moving winter weather system.

Source: Battelle

The remaining sections in this chapter provide details on the events and subsequent flow of information for each of the six scenarios.

Scenario 1: Single Vehicle Incident on Rural Expressway due to Extreme Low Visibility Conditions

Objective, Scenario Summary, Overview and Relation to Real-World Event

Table 6-2 summarizes the objective of this scenario, provides an overview, and relates the scenario to a real-world event.

Table 6-2. Summary of Operational Scenario 1

#	Objective	Summary	Real-World Event
1	Demonstrate the benefits of AACN-RELAY application for incident detection and notification	Single vehicle incident on rural expressway due to extreme low visibility with potential for multi-vehicle escalation.	During the early morning hours of January 29, 2012, in Alachua County, Florida, an incident occurred that was directly attributable to poor visibility in a low-lying section of I-75 due to smoke from a nearby brush fire.

Source: Battelle

Prerequisites and Scenario Conditions

There are several conditions and pre-requisites that are assumed to have been in place for this scenario as described below:

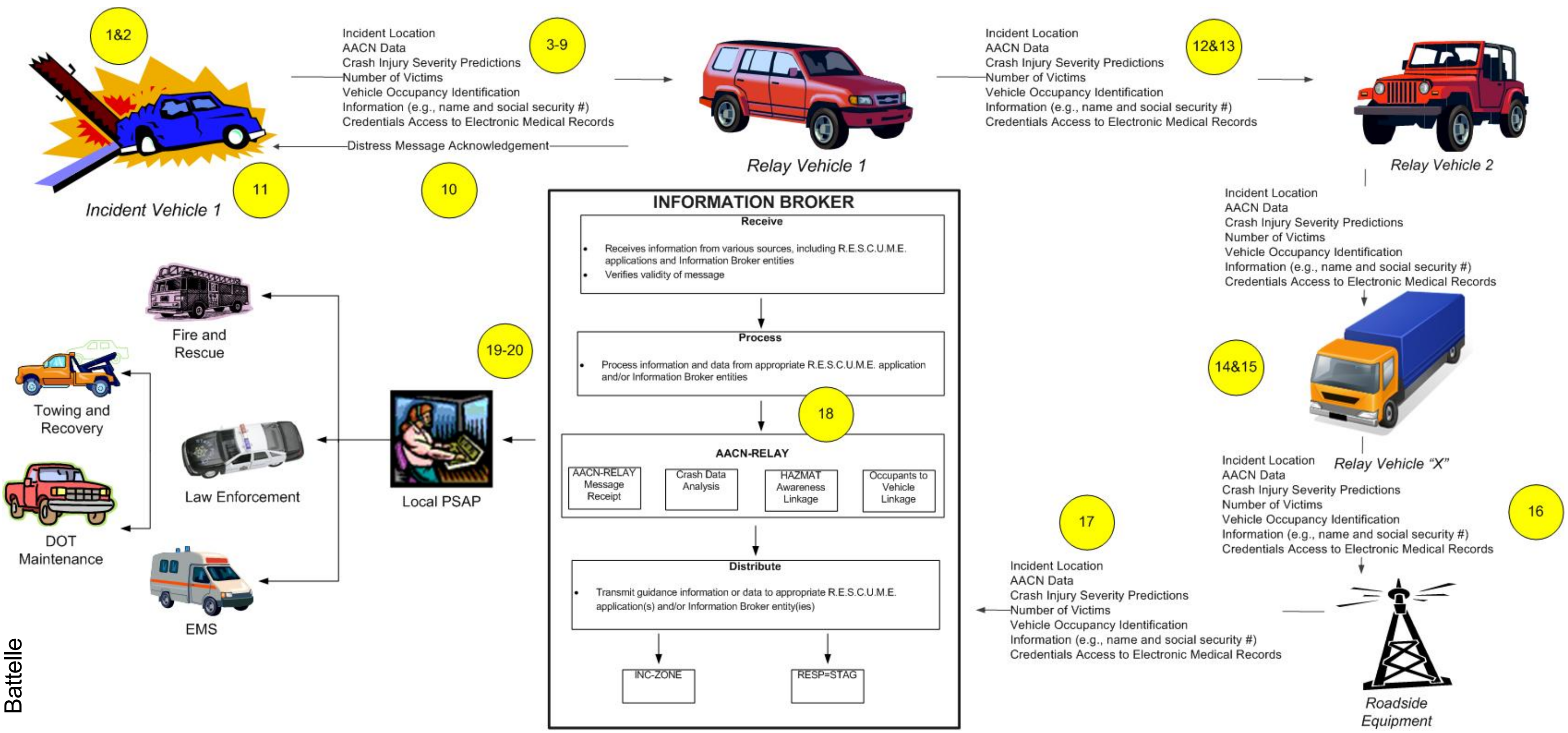
- The scenario takes place on a multi-lane, divided highway in a predominantly rural area with moderate traffic conditions.
- Low visibility conditions are present due to dense smoke or fog.
- Single vehicle incident has the potential for subsequent vehicle incidents due to the low-visibility conditions.
- Vehicles in area are equipped with DSRC communications and have the AACN-RELAY application fully operational.
- No cellular coverage is available.
- Global Positioning System (GPS) is operational and available to all vehicles involved in the scenario.

Description of Events/Processes

1. A single vehicle with four occupants traveling in a low visibility area strikes debris in the roadway causing vehicle's airbags to deploy.
2. The vehicle has extensive damage, is disabled, and blocks the right-most traffic lane.
3. The disabled vehicle (*Incident Vehicle 1*), generates an Advanced Automatic Crash Notification (AACN) message and attempts to broadcast the AACN using cellular and DSRC communications.

4. The communications systems in *Incident Vehicle 1* identify that cellular communication is unavailable. *Incident Vehicle 1* continues to broadcast the AACN message via DSRC.
5. A second vehicle (*Relay Vehicle 1*) approaches the *Incident Vehicle 1* in the same lane traveling in the same direction but does not have visual ability to see *Incident Vehicle 1*.
6. *Relay Vehicle 1's* Communications Function receives the AACN message broadcast from *Incident Vehicle 1.* The Communications function validates the message and delivers the message to the Crash Detection function.
7. The Crash Detection function within *Relay Vehicle 1* determines that this is a new AACN message and notifies the other functions in the AACN-RELAY application in *Relay Vehicle 1* that a new message has been received.
8. The Driver Notification of Distress Message function in *Relay Vehicle 1* determines that the driver of *Relay Vehicle 1* should be notified of the incident and provides a visual and audible alert to the driver.
9. The driver of *Relay Vehicle 1* receives the alert and immediately slows his vehicle and changes lanes to avoid *Incident Vehicle 1*.
10. The Distress Message Receipt Acknowledgement function in the AACN-RELAY application in *Relay Vehicle 1* determines that it is within range and transmits an acknowledgment of the AACN message to the *Incident Vehicle 1*.
11. *Incident Vehicle 1* receives the Distress Message Receipt acknowledgement and informs the vehicle's occupants.
12. The Relay Termination function in the AACN-RELAY Application in *Relay Vehicle 1* determines that the AACN message should be relayed, increments the relay handshake counter to be "1," and requests that the Communications function broadcast an AACN-RELAY message using DSRC and Cellular communications methods.
13. *Relay Vehicle 2* arrives within DSRC range of *Relay Vehicle 1*, but is still out of DSRC range of *Incident Vehicle 1*.
14. *Relay Vehicle 2* receives the AACN-RELAY message from *Relay Vehicle 1* and proceeds to repeat steps 6-13 concluding with setting the relay handshake counter to be "2."
15. Steps 13-14 are repeated for several additional vehicles until Relay Vehicle X, receives the AACN-RELAY message.
16. Relay Vehicle X is within DSRC range of a connected vehicle roadside component and is able to broadcast this AACN-RELAY message to the roadside equipment.
17. The roadside equipment is tied into a Traffic Management Center, one of the entities of the Information Broker.
18. The Information Broker receives the message (AACN-RELAY Message Receipt function) and delivers the message to the other Information Broker AACN-RELAY functions as well as routing the information to the appropriate dispatch and/or responder entities such as the ECC/PSAP.
19. The Crash Data Analysis function in the Information Broker determines an injury score for the accident and transmits this information to the RESP-STG and INC-ZONE applications.
20. The Occupants to Vehicle Linkage function in the Information Broker determines whether it can obtain medical records of the vehicle's occupants and if so, transmits this information to RESP-STG and INC-ZONE applications.

The flow of information in this scenario is illustrated in Figure 6-1.



Battelle

Figure 6-1. Scenario 1 – Single Vehicle Incident on Rural Expressway due to Extreme Low Visibility Conditions

Scenario 2: Tractor-Trailer and Automobile Collision during Rush Hour

Objective, Scenario Summary, Overview and Relation to Real-World Event

Table 6-3 summarizes the objective of this scenario, provides an overview, and relates the scenario to a real-world event.

Table 6-3. Summary of Operational Scenario 2

#	Objective	Summary	Real-World Event
2	Illustrate the interconnectivity of AACN-RELAY, RESP-STG, and INC-ZONE applications	A passenger vehicle traveling in the middle lane of a multi-lane divided highway swerves right, to cut in front of a tractor trailer, resulting in a collision. The vehicles stop in the right lane, partially blocking the middle lane.	In an incident that occurred in Maryland, traffic was accelerating coming out of a construction zone on 1-95. Vehicles were switching lanes for position. A passenger vehicle in the left lane tried to pass on the right and cut in front of a tractor-trailer causing an accident.

Source: Battelle

Prerequisites and Scenario Conditions

- The scenario takes place on a heavily traveled three-lane highway in a metropolitan area with heavy traffic conditions during afternoon rush hour.
- Vehicles in area are equipped with DSRC radios and have the AACN-RELAY application fully operational.
- Cellular coverage is unavailable at the scene of the incident.
- There is no DSRC capable roadside equipment at the scene of the incident.
- Global Positioning System (GPS) is operational and available to all vehicles involved in the scenario.

Description of Events/Processes

1. A passenger vehicle (*Incident Vehicle 1*) traveling in the middle lane of a multi-lane divided highway merges into the right lane with the intention of passing a slow moving vehicle.
2. When merging to the right, the passenger vehicle cuts in front of a tractor trailer (*Incident Vehicle 2*), resulting in a collision.
3. Both vehicles (*Incident Vehicle 1* and *Incident Vehicle 2)* stop in the right lane, with the tractor-trailer (*Incident Vehicle 2*) partially blocking the middle lane.
4. Collision between passenger vehicle (*Incident Vehicle 1*) and tractor trailer (*Incident Vehicle 2*) causes the disabled passenger vehicle (*Incident Vehicle 1*) to generate and broadcast an Advanced Automatic Crash Notification (AACN) using cellular and DSRC communications.

5. The communications systems in *Incident Vehicle 1* identify that cellular communication is unavailable and begins to broadcasts the AACN-RELAY message via DSRC.
6. A second vehicle (*Relay Vehicle 1*) was passing *Incident Vehicle 1* just prior to the crash but was in the left lane traveling in the same direction.
7. *Relay Vehicle 1's* Communications Function receives the AACN-RELAY message broadcast from *Incident Vehicle 1.* The Communications function validates the message and delivers the message to the Crash Detection function.
8. The Crash Detection function within *Relay Vehicle 1* determines that this is a new AACN-RELAY message and notifies the other functions in the AACN-RELAY application in *Relay Vehicle 1* that a new message has been received.
9. The Driver Notification of Distress Message function in *Relay Vehicle 1* determines that the driver of *Relay Vehicle 1* should be notified of the incident and provides a visual and audible alert to the driver.
10. The driver of *Relay Vehicle 1* receives the alert and correlates it to the crash he witnessed (no searching required). He immediately slows his vehicle and pulls onto the right shoulder to offer assistance to the occupants of *Incident Vehicle 1* and *Incident Vehicle 2*.
11. The Distress Message Receipt Acknowledgement function in the AACN-RELAY application in *Relay Vehicle 1* determines that it is within range and transmits an acknowledgment of the AACN message to the *Incident Vehicle 1*.
12. *Incident Vehicle 1* receives the Distress Message Receipt acknowledgement and informs the vehicle's occupants.
13. The Relay Termination function in the AACN-RELAY Application in *Relay Vehicle 1* determines that the AACN message should be relayed, increments the relay handshake counter to be "1," and requests that the Communications function broadcast an AACN-RELAY message using DSRC and Cellular communications methods.
14. *Relay Vehicle 2* arrives within DSRC range of *Relay Vehicle 1*, but is still out of DSRC range of *Incident Vehicle 1*.
15. *Relay Vehicle 2* receives the AACN-RELAY message from *Relay Vehicle 1* and proceeds to repeat steps 7-13 concluding with setting the relay handshake counter to be "2."
16. Steps 13-14 are repeated for several additional vehicles until Relay Vehicle X receives the AACN-RELAY message.
17. Relay Vehicle X is in a zone where cellular coverage is available and is able to broadcast the AACN-RELAY message to the Information Broker via a cellular communication protocol.
18. The Information Broker receives the AACN-RELAY Message Receipt function and delivers the message to the other Information Broker AACN-RELAY functions as well as routing the information to the appropriate dispatch and/or responder entities.
19. The Crash Data Analysis function in the Information Broker determines an injury score for the accident and transmits this information to the RESP-STG and INC-ZONE applications.
20. The Occupants to Vehicle Linkage function in the Information Broker determines if it can obtain medical records of the vehicle's occupants and if so, transmits this information to RESP-STG and INC-ZONE applications.
21. The AACN-RELAY Message is received by the Emergency Communications Center entity of the Information Broker and location is provided via GPS coordinates in data package.

22. Emergency Communications Center dispatches and transmits route data and recommended vehicle positioning based on information from relay message via RESP-STG.
23. Emergency responders arriving on scene receive and use INC-ZONE information for situational awareness about traffic conditions and approaching vehicles while working on the scene.
24. The Incident Commander provides feedback via INC-ZONE regarding estimated scene clearance time so TMC can re-route traffic as needed for congestion.

The flow of data in this scenario is illustrated in Figure 6-2.

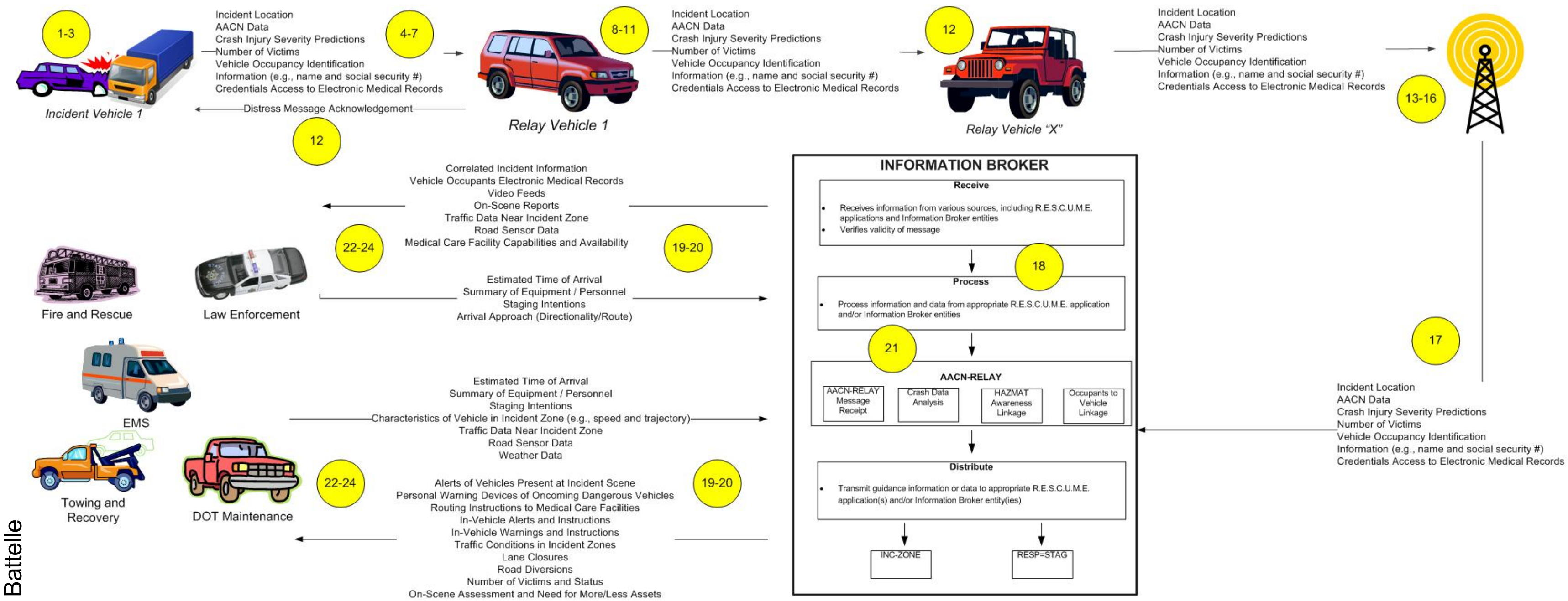


Figure 6-2. Scenario 2 – Tractor-Trailer and Automobile Collision during Rush Hour

Scenario 3: Officer Struck during Traffic Stop

Objective, Scenario Summary, Overview and Relation to Real-World Event

Table 6-4 summarizes the objective of this scenario, provides an overview, and relates the scenario to a real-world event.

Table 6-4. Summary of Operational Scenario 3

#	Objective	Summary	Real-World Event
3	Illustrate the diverse nature of how incidents are initiated and the temporal relationship of the R.E.S.C.U.M.E. Bundle Applications	During a traffic stop, an officer is struck by another vehicle and sustains critical injuries. A bystander notifies dispatch of the incident via the officer's radio. Multiple emergency responders personal are en route to the scene and a medical helicopter has been alerted for transport of the officer.	December 19, 2010 – A Garland, TX police officer was seriously injured after a suspected drunken driver hit him while he stood outside his patrol car on the shoulder of George Bush Turnpike. The five-year veteran was flown to Parkland Hospital with life-threatening injuries.

Source: Battelle

Prerequisites and Scenario Conditions

There are several conditions and pre-requisites that are assumed to have been in place for this scenario as described below:

- The incident takes place on a two-lane surface street in an urban area with light to moderate traffic conditions.
- Cellular coverage is available.
- Global Positioning System (GPS) is operational and available to all.
- Multiple responders are dispatched to the incident.
- A secondary scene is needed for the helicopter landing zone.
- The incident will require temporary road closures.

Description of Events/Processes

1. A law enforcement officer has pulled over a vehicle (*Incident Vehicle 1*) and positions his cruiser (*Responder Vehicle 1*) on the shoulder behind the vehicle. The positioning enables the in-car dash camera that is linked to INC-ZONE to capture the actions of the Officer.
2. Before exiting the cruiser, the Officer activates INC-ZONE using his mobile data terminal and then puts on his incident zone protective device.
3. The Officer then places the roadside sensing device on his vehicle and using INC-ZONE Incident Zone Status Function selects a pre-programmed incident zone size and shape for a single vehicle traffic stop using the graphical interface.
4. The Officer directs the driver of the pulled over vehicle (*Incident Vehicle 1*) to exit the vehicle.

5. The Officer receives a warning that a high velocity vehicle (*Incident Vehicle 2*) is rapidly approaching through his incident zone protective device from INC-ZONE's Emergency Responder Warning function.
6. The Officer reacts by pushing the operator of the first vehicle (*Incident Vehicle 1*) clear of the approaching vehicle (*Incident Vehicle 2*); however, the officer is unable to completely move from the path of the on-coming vehicle and is struck by the vehicle, (*Incident Vehicle 2*) resulting in a broken leg.
7. The Officer's incident zone protective device detects the Officer has been struck and triggers the INC-ZONE application to alert the Officer's Dispatcher via the Information Broker of the situation through INC-ZONE's Communication function.
8. The Dispatcher uses RESP-STG's Visual Display function to access the video feed from the officer's in-car dash camera (*Responder Vehicle 1*) and pushes that to the emergency responders units who are subsequently dispatched to the incident scene.
9. Based on the video feed, the Dispatcher determines that a helicopter is needed and arranges to dispatch the helicopter to the scene using RESP-STG's Emergency Responder Dispatch function.
10. The emergency responders traveling on the road to the scene use RESP-STG's Dynamic Routing function to avoid the building traffic congestion and arrive at the scene quickly.
11. Using RESP-STG Vehicle and Equipment Staging function, the helicopter elects to land up-road from the incident. In preparation for landing, the helicopter operators use RESP-STG's Communication function to send a message to both INC-ZONE and the TMC (Information Broker) directing the highway to be shutdown at the exit and entrance ramps to prevent traffic from entering the scene. This information enables the TMC to send navigation notices to vehicles approaching the area informing them of the road closure and directing them to safe, alternate routes.
12. On-scene responders close requested exits and place their roadside sensing devices and activate their INC-ZONE Oncoming Vehicle Alert and Warning function to notify on-coming traffic of the road closure and diversion.
13. The responders don their protective devices and are prepared to receive alerts from the INC-ZONE Emergency Responder Warning function.
14. The INC-ZONE Incident Zone Status Function updates the current situational awareness database to reflect the road closure and notifies, via the Communications function, the Information Broker and arriving responders via the RESP-STG application.

The flow of information in this scenario is illustrated in Figure 6-3.

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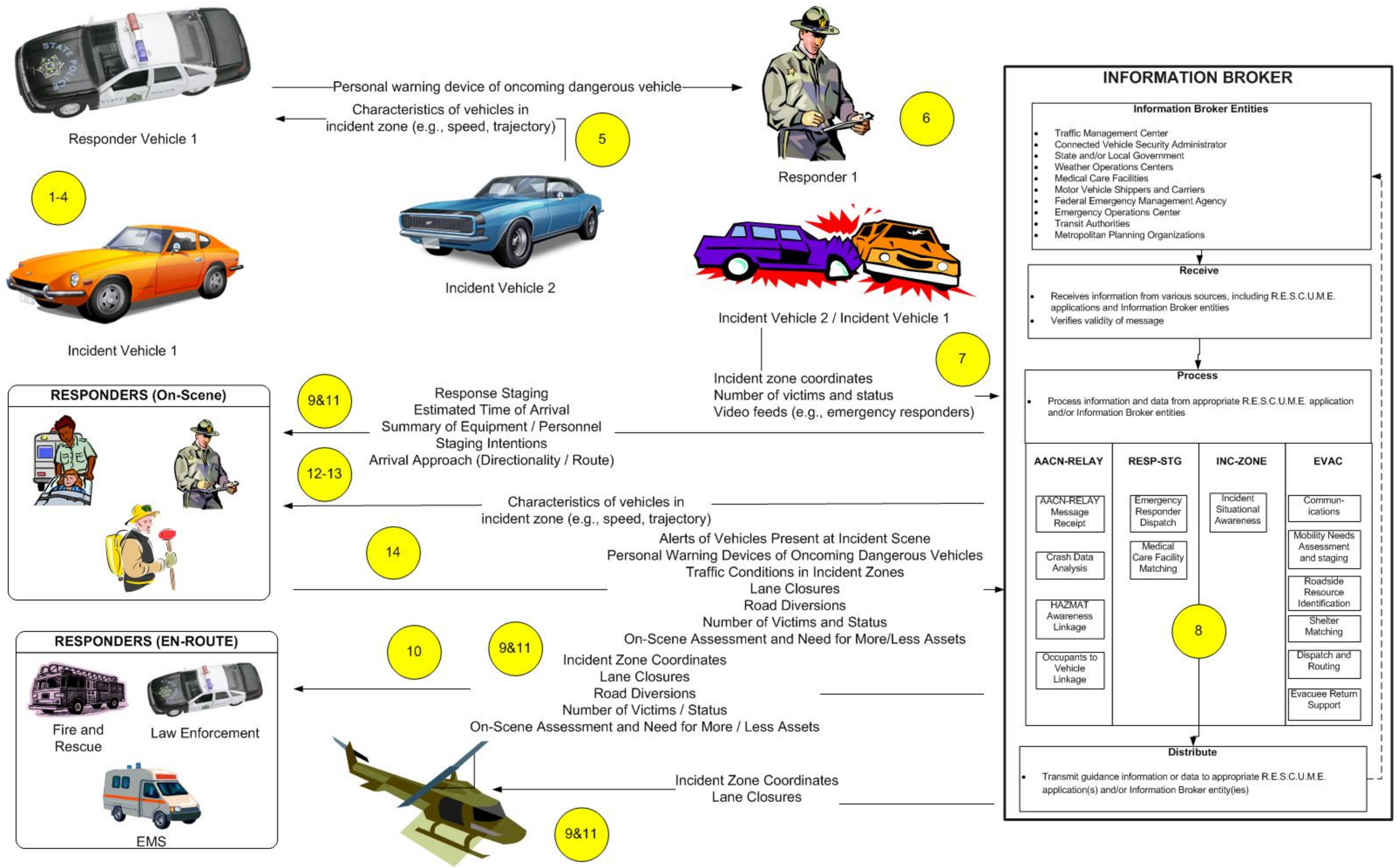

Figure 6-3. Scenario 3 – Officer Struck during Traffic Stop

Scenario 4: HAZMAT Tank Truck and Train Collision

Objective, Scenario Summary, Overview and Relation to Real-World Event

Table 6-5 summarizes the objective of this scenario, provides an overview, and relates the scenario to a real-world event.

Table 6-5. Summary of Operational Scenario 4

#	Objective	Summary	Real-World Event
4	Illustrate the flow of information between applications and Information Broker including escalation in the level of information detail provided in response to an incident escalation	A bulk carrier, single-body tank truck filled with gasoline is stuck sitting partially on a graded railroad crossing with signal. A train approaches the crossing and strikes the bulk carrier in the front cab area causing heavy damage but no explosion. Debris punctures the carrier body and there is gasoline leaking.	May 25, 2012 – Tacoma, WA – A man suffered injuries when the back end of his flatbed truck was struck by a train in Puyallup. The man was driving a 30-foot flatbed truck. He crossed the railroad track and the rear end of the truck was hit by a Union Pacific freight train heading from Seattle to Portland. The impact sent the truck spinning. It landed 20 to 30 feet off the roadway. The railroad crossing is marked and has a stop sign. It does not have crossing gates. It was not immediately known whether the driver stopped at the stop sign before crossing the tracks.

Source: Battelle

Prerequisites and Scenario Conditions

- The tank truck is properly placarded per U.S. DOT HAZMAT Divisions and Classes Gasoline (Placard 1203, ERG 2008).
- The tank truck is a bulk carrier, single-body unit truck.
- The truck is stopped at a signal-equipped at-grade crossing (i.e., where a railway line is intersected by a road or path on one level).
- The signal is a flashing light with bells, with no arms to block path.
- The incident occurrence is in proximity to a major metropolitan airport.
- The roadway is a moderate to heavily traveled multi-lane, divided highway.
- The truck is not equipped with an AACN system.
- Cellular coverage is operational for the area.
- Global Positioning System (GPS) is operational and available to all.

Description of Events/Processes

1. A single-unit bulk gasoline tank truck en-route to a gas station is stuck on a railroad track at a crossing.
2. The flashing lights with bells announce that a train is approaching, but traffic has blocked the truck in both directions and prevents the truck from moving off the track.
3. The train collides with the truck in the cab area. The truck is knocked off the track with the cab area heavily damaged. While it is not overturned, and there has been no explosion, gasoline is leaking rapidly from the tank creating a serious threat at the accident scene.
4. Due to the accident's proximity to a major metropolitan airport and the highway's normally heavy traffic, traffic starts to back up quickly.
5. The operator of the train reports the incident through his radio. At the same time, occupants in the surrounding vehicle initiate an NG911 call on their Smartphones to report the incident and provide text and photos of the incident.
6. The Information Broker receives information that an incident has occurred and that dispatch is requested.
7. Emergency Communications Center identified from the initial reports that the vehicle type is a bulk carrier typical of a large petroleum truck.
8. Emergency Communications Center dispatches more than the usual number of emergency vehicles for a typical crash to *Incident Scene 1* and transmits route data and recommended vehicle positioning based on information from the E911 calls via RESP-STG.
9. Emergency responders en route (RESP-STG) and arriving on scene at *Incident Scene 1* receive and use INC-ZONE information for situational awareness about traffic conditions and approaching vehicles while working on the scene.
10. The Incident Commander requests dispatch of fire trucks from several jurisdictions as a precaution due to the potential danger from the spilled gasoline.
11. Emergency Communications Center notifies the TMC entity of the Information Broker that traffic needs to be diverted well away from *Incident Scene 1.*
12. The Emergency Communications Center dispatches four additional fire trucks to the scene and provides dynamic route guidance with traffic signal pre-emption.
13. Due to the clear and present danger posed by the leaking gasoline tanker, a driver stuck in traffic panics and tries to get her car away from the scene as quickly as possible. She (*Incident Vehicle 2*) collides with another car (*Incident Vehicle 3*) a quarter-mile from the at-grade crossing incident scene.
14. Law enforcement officers in the vicinity designate and Incident Commander for *Incident Scene 2* and notify the PSAP entity of the Information Broker that dispatch of a Fire & Rescue truck and EMS are indicated for *Incident Scene 2*.
15. The Incident Commanders of both *Incident Scene 1 and 2* provide feedback via INC-ZONE regarding estimated scene clearance times so TMC can re-route traffic as needed for congestion.

The flow of information in this scenario is illustrated in Figure 6-4.

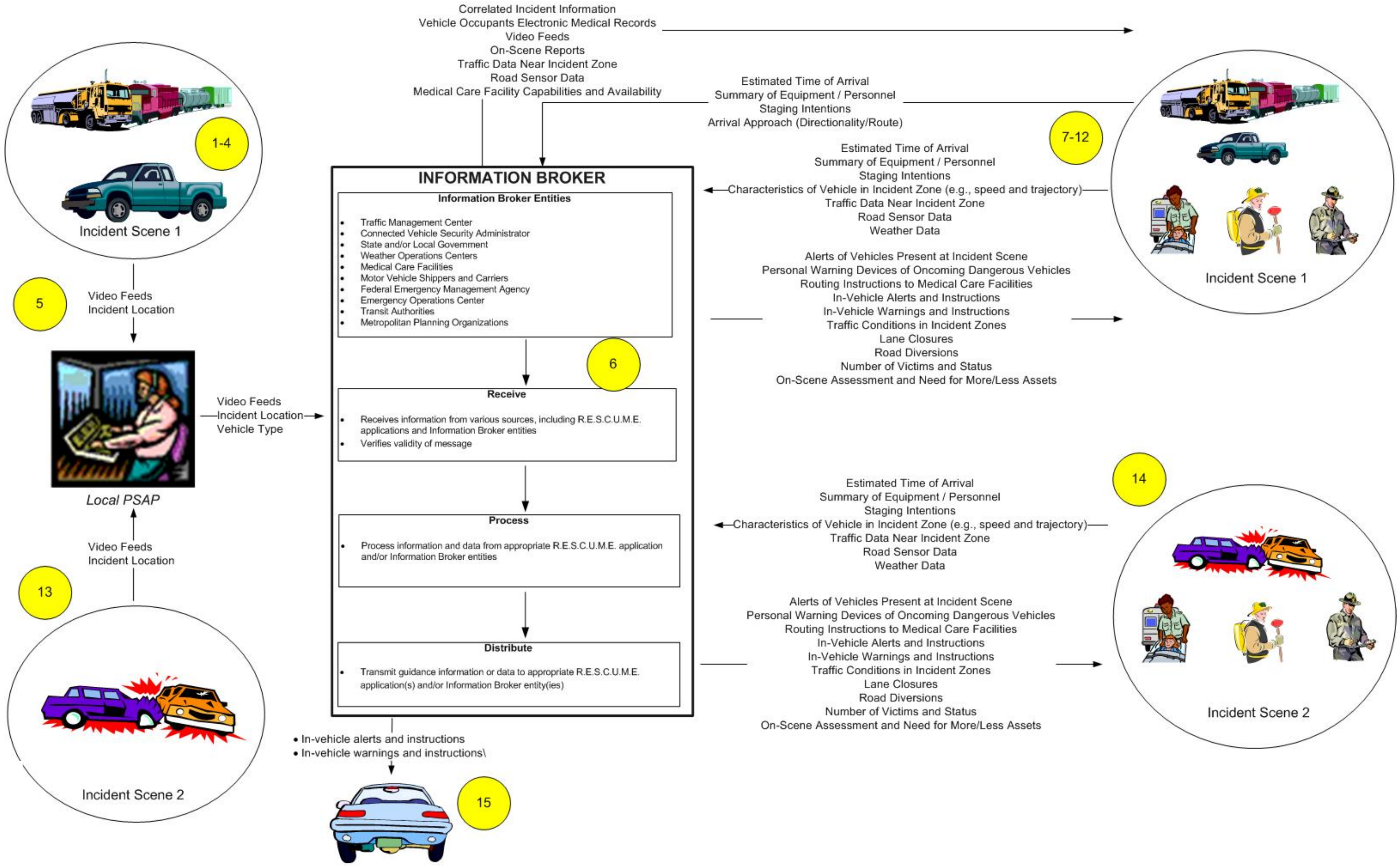

Figure 6-4. Scenario 4 – HAZMAT Tank Truck and Train Collision

Scenario 5: Planned Evacuation Due to Hurricane

Objective, Scenario Summary, Overview and Relation to Real-World Event

Table 6-6 summarizes the objective of this scenario, provides an overview, and relates the scenario to a real-world event.

Table 6-6. Summary of Operational Scenario 5

#	Objective	Summary	Real-World Event
5	Illustrate the operation of the applications during a planned evacuation event	The Southeastern United States is preparing to be struck by a large hurricane. It is approximately 72 hours in advance of the anticipated landfall and the regional governments have released an order of evacuation message to the public. Functional needs populations need to be evacuated to shelters. Re-routing of evacuees is needed as a result of traffic bottlenecks. Evacuees are in need of information on fueling and hotel availability en-route to safe locations.	The 2004 hurricane season was the worst in Florida's history, with four hurricanes. It is estimated that that one-quarter of Florida's population evacuated prior to at least one of the hurricanes; in some areas, well over half the residents evacuated at least once and many evacuated several times. Most evacuees stayed with family or friends and were away from home for only a few days.

Source: Battelle

Prerequisites and Scenario Conditions

There are several conditions and pre-requisites that are assumed to have been in place for this scenario as described below:

- 72 hour advanced warning for weather event is available.
- Functional needs population has registered for notification and tracking.
- Pre-plan for evacuation of region is current and executable.
- Multi-agency coordination and Memoranda of Agreement/Understanding exist.
- Privately owned resources are registered and available for activation.
- Commercial businesses are registered and participating.

Description of Events/Processes

1. A dangerous hurricane is predicted to strike land in 72 hours. The regional EOC issues an evacuation order for all residents living within the impacted area.
2. A small nursing home (*Nursing Home)* receives the evacuation order through the EVAC Communications function and prepares its residents for the evacuation. The nursing home has already made prior arrangements with a private busing company (*Private Bus 1*) to transport the residents out of the area.

3. *Private Bus 1* uses EVAC's Dispatch and Routing function to navigate from its garage to the *Nursing Home*. After picking up the residents, *Private Bus 1* proceeds along the pre-evacuation route.
4. The EVAC Dispatch and Routing function notifies the bus operator (*Private Bus 1*) that the pre-evacuation route includes a bridge that has now been closed due to potential flooding. The EVAC Dispatch and Routing function provides the bus operator (*Private Bus 1*) with an alternative route.
5. *Private Bus 1* follows recommended evacuation route to the functional needs shelter using the EVAC Dispatch and Routing function.
6. Back at the EOC, the Mobility Needs Assessment and Staging function extracts database-maintained information on pre-registered functional needs persons who indicate they would need transportation to shelters in the event of an evacuation.
7. The EVAC Shelter Matching function analyzes the medical needs of these pre-registered functional needs persons and matches them to shelters that have the required capabilities and bed availability.
8. Meanwhile, a functional needs citizen (*Functional Needs Person 1)* receives notification of the evacuation through EVAC's Communications function via his smart phone. Because he had pre-registered with his local authorities to identify himself as a functional needs person (*Functional Needs Person 1*) who does not have transportation, he is prompted to respond whether or not he needs transportation to a shelter. Confirming he does need transportation, he enters his current location, which is at a nearby friend's home so he can be picked up there instead of at his pre-registered address. Because both locations are within the evacuation zone, there is no issue with providing him with transportation.
9. *Functional Needs Person 1* is also informed of the destination shelter via EVAC's Shelter Matching function. This enables them to inform his family of his planned location.
10. The EOC then uses the EVAC Dispatch and Routing function to develop a route to pick up the functional needs person. It also pushes out the scheduled time and location to each functional needs person on the route, including *Functional Needs Person 1*.
11. The EOC dispatches a public transportation resource (*Public Bus 1*) to pickup *Functional Needs Person 1* and other functional needs persons by following the route established by EVAC's Dispatching and Routing function.
12. While *Functional Needs Person 1* waits for *Public Bus 1* to arrive, he monitors the bus' estimated time of arrival on his smart phone. Similarly, the EOC monitors *Public Bus 1's* location on the route.
13. *Public Bus 1* arrives to pickup *Functional Needs Person 1*. *Functional Needs Person 1* confirms that he has boarded *Public Bus 1* using his smart phone, which sends the information to the EOC.
14. *Public Bus 1* then continues to follow his route to additional functional needs persons using EVAC's Dispatch and Routing Function.
15. During this time, the Police Department receives a call from a functional needs person who is unable to evacuate on her own (*Functional Needs Person 2*) and does not know what to do. The Police Department activates the EVAC Mobility Needs Assessment and Staging function and steps through the process to add *Functional Needs Person 2* to the special-needs database.

16. *Functional Needs Person 2's* information is sent to EVAC's Shelter Matching Function and the Dispatch and Routing Function. A shelter with space available is identified and *Special Person 2* is provided with an estimated time of pickup and the location by the Police Department while on the phone. She receives the same information on her smart phone.
17. *Public Bus 1* receives a notice from EVAC's Dispatch and Routing function that an additional functional needs person requires transport and provides an updated navigation route to *Public Bus 1* and its driver to pick up *Functional Needs Person 2*. The function updates the pickup times of all the functional needs persons downstream and pushes that information to those impacted via EVAC's Communications function.
18. As with *Functional Needs Person 1*, *Public Bus 1* arrives to pickup *Functional Needs Person 2*, who confirms that she has boarded *Public Bus 1* using her Smartphone, which sends the information to the EOC.
19. *Public Bus 1* then continues to follow its route to additional functional needs persons using EVAC's Dispatch and Routing Function.
20. While en-route to the shelter on a six-lane divided highway, *Public Bus 1* strikes an object in the roadway and is disabled. This blocks the left shoulder and part of the left lane. An AACN message is transmitted from *Public Bus 1*, via cellular.
21. The AACN-RELAY application in *Public Bus 1* identifies that an AACN event has occurred and that an AACN message has been transmitted via cellular communications. No AACN-RELAY message is generated.
22. When notified of the accident the Information Broker invokes the RESP-STG application and uses RESP-STG's Emergency Responder Dispatch function to identify and send dispatch orders to the required *Emergency Responders.*
23. Since the information indicates a bus has been involved, and that bus is known to be transporting functional needs evacuees, the transportation agency and a towing agency are contacted by the Dispatcher.
24. Based on the vehicle characteristics passed by the AACN message, the transportation agency dispatches a large bus (*Replacement Bus*). Likewise, the towing agency dispatches a heavy tow truck (*Tow Truck*) capable of towing the wrecked bus.
25. Both the *Replacement Bus* and *Tow Truck* use RESP-STG's Dynamic Routing function to travel to the scene, which helps them to minimize delays compounded by the incident.
26. *Emergency Responders* who are en-route use RESP-STG's Visual Display function to view any traffic camera images available near the accident. They use the available images showing increased congestion along with RESP-STG's Dynamic Routing function to guide them to the incident by avoiding as much traffic as possible.
27. When the first emergency responder (*Incident Commander*) arrives on scene, he establishes an incident zone that also closes off the middle lane to traffic and activates INC-ZONE. He then deploys roadside sensors and enters the incident zone details using the INC-ZONE's Incident Staging function.
28. Arriving *Emergency Responders* wear their protective device to warn of unsafe driving conditions of vehicles passing through the zone. They approach damaged *Public Bus 1* bus and attend to the functional needs passengers.
29. While assisting the victims, *Emergency Responders* determine that *Functional Needs Person 1* has injuries that require hospitalization. They load *Functional Needs Person 1* into an ambulance and use RESP-STG's Medical Care Facility Matching function to locate the nearest hospital with both capacity and capability, including its ability to care for patients during

a hurricane. As part of the information exchange, the *Emergency Responders* inform the hospital of the medical conditions of *Functional Needs Person 1's* injury status.

30. Soon thereafter, the *Replacement Bus* and *Tow Truck* arrive on scene. The functional needs persons, including *Functional Needs Person 2* board the *Replacement Bus*. The EVAC Communications function informs the Information Broker of all the functional needs persons who were transferred from *Public Bus 1* to the *Replacement Bus*.

31. Scene details continue to be pushed to the Information Broker's TMC component through the INC-ZONE and other roadside equipment. The traveling public is alerted to the incident scene through the EVAC Dispatch and Routing function alerting them of the incident scene ahead. Because the details from the incident scene indicate lanes are blocked, the EOC and TMC coordinate and use EVAC's Dispatch and Routing function to establish alternate evacuation routes around the incident to reduce the congestion on the original route. These new routes are available from the Information Broker.

32. In the meantime, a man and his dog (*Evacuee 1*), who are also evacuating along the same route as *Public Bus 1,* receive a notification from his vehicle's navigation system that his planned route to his hotel is experiencing heavy congestion and that an alternate route is recommended. Prior to his departure, *Evacuee 1* had used EVAC's Shelter Matching function to find a hotel shelter that accepted dogs and EVAC's Dispatch and Routing function to give him directions.

33. *Evacuee 1* decides to follow the recommended change, but notes that his new route will add significant time and mileage to his evacuation. Concerned that he may not have enough fuel, *Evacuee 1* uses EVAC's Roadside Resource Identification function to locate the nearest gas station and the suggested route to get to it. He also learns from recent traveler comments in the Roadside Resource Identification function that the gas station was reported to have fuel as recently as within the last 15 minutes.

34. *Evacuee 1* follows the recommend directions to the gas station, refuels, and follows the new route provided to him through EVAC's Dispatch and Routing function.

35. Back at the *Public Bus 1's* incident scene, the *Emergency Responders* are completing the transfer of all the passengers onto the *Replacement Bus*. As with *Functional Needs Person 2*, all functional needs persons confirms that they have boarded the *Replacement Bus* using their smart phones, which sends the information to the EOC.

36. With the transfer complete the *Replacement Bus* departs the incident scene for the functional needs shelter and follows the routing instructions provided by the EVAC Dispatch and Routing function.

37. The *Tow Truck* then removes damaged *Public Bus 1* from the scene and clears the roadway of any debris. It then departs from the scene with *Public Bus 1* in tow.

38. With the scene now clear, the *Incident Commander* packs up the INC-ZONE roadside equipment, deactivates the INC-ZONE application, and contacts the Dispatcher for new orders.

39. After traveling for a few hours and finally arriving at his hotel shelter, *Evacuee 1* checks in at the hotel. Upon check-in, the EVAC Communications function pushes his name and location to a database on the Information Broker so he can be found located by authorities after the evacuation, if necessary.

40. Two days later, the hurricane hits the evacuated area causing moderate damage. Consequently, numerous roads are closed between *Evacuee 1*'s hotel and his home.

41. *Evacuee 1* uses the EVAC Return Support function to monitor when authorities clear his neighborhood for citizens to return. He learns that he must wait until noon the following day. *Evacuee 1* decides to depart his hotel for home at that time.

42. At his departure, *Evacuee 1* checks-out of the hotel stating he is returning home. The hotel sends this information to the Information Broker so his plans are known, if necessary for authorities to track him down.

43. *Evacuee 1* uses the EVAC Dispatch and Routing function to then help his identify a safe route home that avoids bridges and roads damaged by the hurricane.

44. *Evacuee 1* arrives home.

The flow of information in this scenario is illustrated in Figure 6-5.

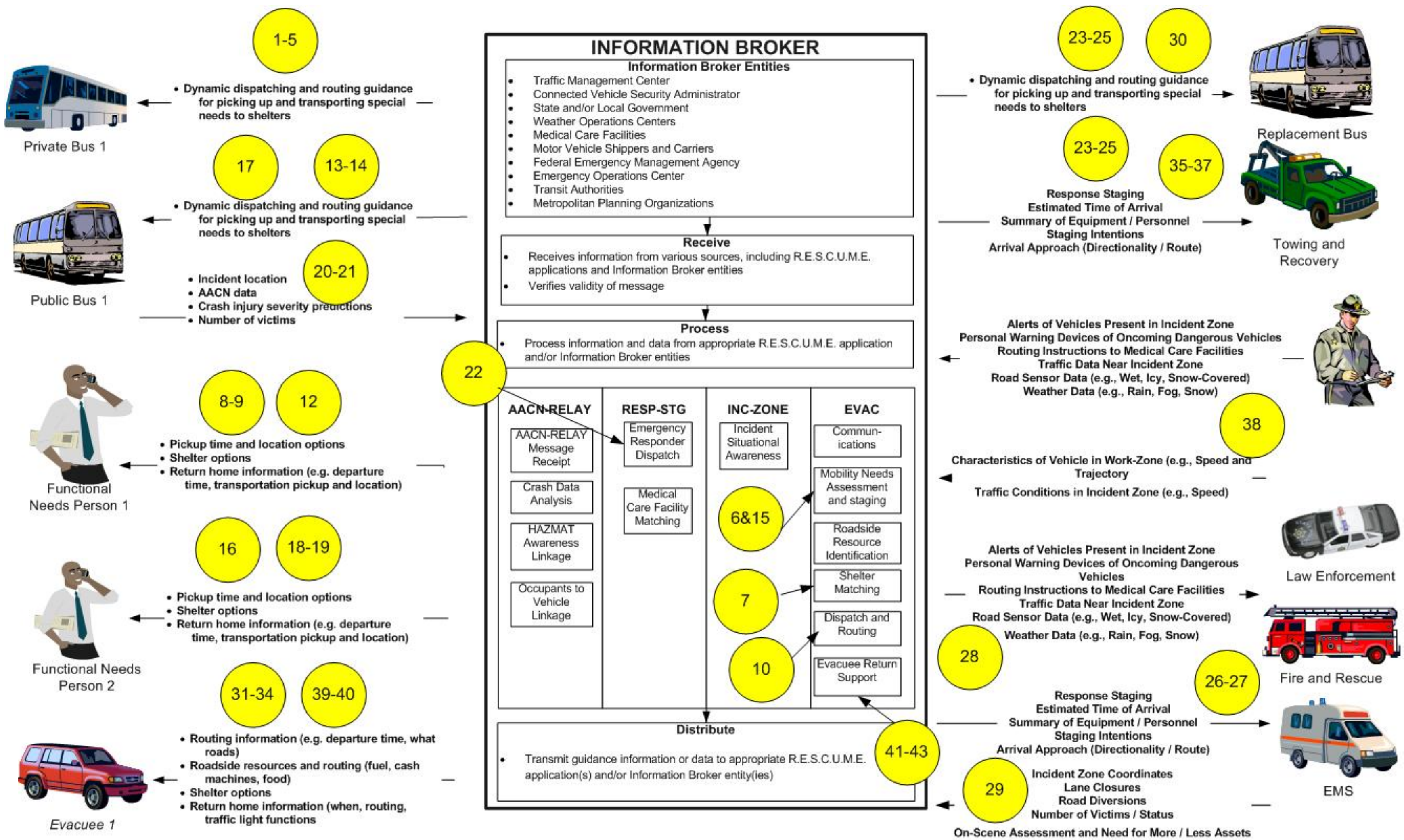

Figure 6-5. Scenario 5 – Planned Evacuation Due to Hurricane

Scenario 6: Quick Reaction Mass Transportation Movement due to Heavy Snowfall

Objective, Scenario Summary, Overview and Relation to Real-World Event

Table 6-7 summarizes the objective of this scenario, provides an overview, and relates the scenario to a real-world event.

Table 6-7. Summary of Operational Scenario 6

#	Objective	Summary	Real-World Event
6	Illustrate the ability of the applications to provide value during an unplanned evacuation	A normally staggered departure of the working population in a major metropolitan area is condensed into a mass exodus. Snow removal operations are underway with primary roads cleared and secondary roads partially cleared. Numerous single and multiple vehicle crashes occurred as a result of icy conditions.	In February 2010 the U.S. Office of Personnel Management closed Federal Offices early in anticipation of a fast-moving winter weather system. A normally staggered departure of the working population in a major metropolitan area was condensed into a mass exodus resulting in clogged roadways and interference with road treatment and clearing activities. Numerous single and multiple vehicle crashes occurred as a result of icy conditions and congested roadways. This was further compounded by a large number of abandoned vehicles which inhibited emergency response, roadway clearing, and treatment operations.

Source: Battelle

Prerequisites and Scenario Conditions

There are several conditions and pre-requisites that are assumed to have been in place for this scenario as described below:

- Magnitude of snowfall results in an unplanned event, with little or no notice.
- Evacuation is limited in nature, consisting of workforce leaving for their homes and not mass departure of people from their homes to an area outside the region.
- Surface streets are in bad condition due to ice and snow where they have not been cleared.
- Highways become rapidly congested as employers release employees after the threat has been recognized.
- Toll-roads exist in the area.
- The region encompasses a large, urban metropolitan area as well as outlying rural areas.
- Traffic on the regional roadways is moderate to heavy traffic on typical days.
- The snowfall begins accumulating in afternoon hours, during hours of daylight.

- Initially there is medium to heavy snowfall, which increases and is accompanied by freezing temperatures.
- There is limited roadway treatment in advance of the announcement by emergency authorities that non-essential personnel should go home.
- Cellular coverage is operational in urban and metropolitan areas only.
- The Global Positioning System (GPS) is operational in the region.
- After the snowfall begins, there are multiple responders en route to incidents.
- There are many temporary road closures as transportation officials struggle to find enough resources for the need of clearing the roadways.
- Pre-planning for evacuation of the region is current and executable.
- Multi-agency coordination and Memoranda of Agreement/Understanding exist.
- Privately owned resources are registered and available for activation.
- Commercial businesses are registered and participating in support to travelers.

Description of Events/Processes

1. Regional authorities recognize the high probability of unexpectedly heavy snowfall.
2. Regional authorities send warnings to residents to expect heavy snow in the next few hours. The EVAC Communications function is used to update all integrated evacuation systems in the region.
3. An Emergency Operations Center (EOC) is established and staff from a variety of different agencies.
4. The EOC staff realize that an evacuation of the metropolitan area is needed and issue directives via the EVAC Communications function to initiate the evacuation prior to the snowfall event.
5. Real-time route guidance is begun to be provided by the EVAC Dispatch and Routing function.
6. The workforce in the urban area departs en masse to get home to comply with the evacuation.
7. When snow arrives, heavy roadway congestion is already developing. Snowfall is extremely heavy.
8. Regional TMCs dispatch and track progress of snowplows and provide this information to the EOC through the information broker.
9. Regional TMCs direct travelers to cleared roads and away from roads known to have congestion or road surface problems using the EVAC Dispatch and Routing function.
10. Regional EOCs initiate a limited evacuation plan, recognizing that travelers are not departing the area but rather heading for their homes (i.e., evacuation of functional needs persons does not apply).
11. The EVAC Shelter Matching function is used by those evacuees who are stranded or choose not to travel to find availability of motel rooms and shelter options.
12. EVAC Roadside resource function is used by travelers to identify gas stations are located that are staying open so drivers can fill up and not run out of gas and cause blockages.
13. A multi-car pileup is called in via 9-1-1 to the PSAP entity of the Information Broker.
14. The Emergency Communications Center initiates RESP-STG and dispatches emergency vehicles via dynamic routing along cleared routes to the scene. Additional units are dispatched based on multiple vehicle crash and likelihood of delays due to road conditions.

15. Occupants in the emergency vehicles use the RESP-STG Vehicle Equipment and Staging to observe real-time conditions at the scene and to create a plan for the staging of their vehicles and equipment.
16. Law enforcement arrives at the incident scene first, becomes the Incident Commander, initiates INC-ZONE, and sets out roadside sensors.
17. The INC-ZONE Status Updates function updates the situational awareness conditions and uploads this information to the Information Broker via the INC-ZONE Communications function.
18. The RESP-STG Vehicle Equipment and Staging function contained within en-route responder vehicles receive an update to the situational awareness from the Information Broker.
19. Arriving law enforcement identify that a patrol vehicle is on-scene and work to establish a perimeter to re-route traffic away from the incident. The INC-ZONE Incident Staging function is used to identify the diversion routes and closed exits, which are communicated to the Information Broker through the INC-ZONE Communications function.
20. En-route Fire and Rescue responders receive an updated situational awareness through RESP-STG Vehicle and Equipment Staging. The RESP-STG Dynamic Routing function identifies an alternative path to the incident to avoid traffic congestion on arterial roads caused by the route diversion.
21. Fire and Rescue arrive on scene along with towing operators and stage their vehicles as planned. The INC-ZONE Incident Status Updates function is used to update the situational awareness.
22. The EVAC Dispatch and Routing function alerts the on-scene Incident Commander of the extensive traffic build-up and congestion on the arterials. Re-prioritizing the tow-trucks, the Incident Commander directs the removal of vehicles from the left lanes of the highway first. The INC-ZONE Staging is updated and the information is communicated to the Information Broker via the INC-ZONE Incident Zone Status Updates function.
23. Because all responders are wearing protective vests and the INC-ZONE application provides the Incident Commander with confidence that safety of the responders can be maintained without the need to block all lanes of traffic, the Incident Commander re-opens the left two travel lanes to traffic.

The flow of information in this scenario is illustrated in Figure 6-6.

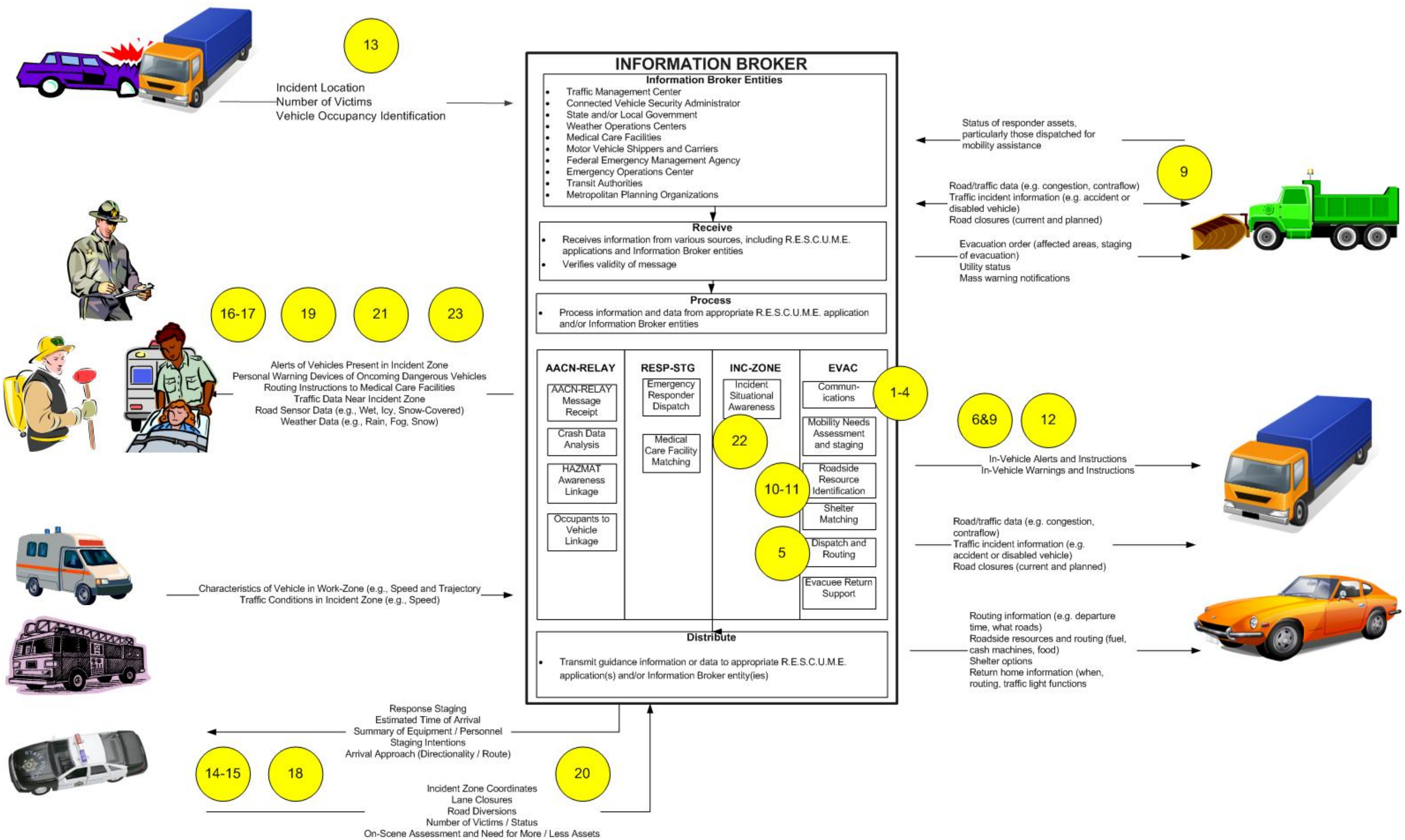

Figure 6-6. Scenario 6 – Quick Reaction Mass Transportation Movement due to Heavy Snowfall

Chapter 7 Summary of Impacts

Operational Impacts

The enhancements provided by the R.E.S.C.U.M.E. Bundle seek to address and improve mobility of the traveling public by improved situational awareness, as well as more comprehensive and timely information being provided to emergency responders. As with any change including new equipment, technologies, or training, there are always operational impacts. The following apply to all applications in the R.E.S.C.U.M.E. Bundle.

- **Changes in procedure (public and/or emergency responders):** User Groups at all levels will have some changes to Standard Operating Procedures, particularly in the method and types of data reported. External Consumer user groups such as motorists and evacuees that are not involved with any written SOP will have new assistive tools to utilize, which will change their responses.
- **Changes in data retention requirements:** Data retention requirements apply to all systems and applications and are mandated by Freedom of Information Act (FOIA) as well as various government requirements for records retention and access. Information containing health information for individuals is also subject to HIPAA and specific reporting and retention requirements.
- **New modes of operation based on emergency, disaster, or accident conditions:** See section 5.4 for modes of operation based on emergency, disaster, or accident conditions including degraded, overloaded or complete system failure.
- **Changes in operational budget:** Operational budgets may be affected by requirement for additional software, hardware, and training not previously identified in long range planning. The return on investment must be weighed by the individual organization to determine the best tools and resources in order to support the mission.
- **Changes in operational risks:** Operational risks are assumed by the organizations whenever employing new and untested technologies. Agencies and organizations may take on an increased liability for failure to report or properly act based on information received.

AACN-RELAY Operational Impacts

AACN-RELAY requirements are included in this document for completeness and consistency. However, USDOT does not plan to pursue development of AACN-RELAY during subsequent phases of the DMA Program.

The following impacts are expected with the AACN-RELAY application:

- **Interfaces with primary or alternate computer operating centers:** V2V and V2I Communication allows for the transmission of crash information from the crash vehicle, to a relay vehicle, to an infrastructure "hotspot," to an ECC without human interaction. This removes the TSP from the equation and provides direct communications to ECC or TMC for dispatch of resources. By removing the reliance on human reporting from the TSP, the information received is based on fact versus human perception or emotion.
- **Changes in procedure (public and/or emergency responders):** In the event of a single vehicle crash, timeliness of notification to emergency responders is improved, and may be improved dramatically for some incidents, particularly those run-off-road incidents in areas where the crash vehicle cannot be visibly seen from the roadway. Drivers receiving notification from the Crash Detection feature are able to make a determination if a crash is present through visual inspection of surrounding area, or at a minimum make notification to an ECC that a crash notification has been received for the specific area. As a result of the information provided through the AACN-RELAY, appropriate resources can be dispatched earlier in the response cycle.
- **Use of new data sources:** The originating data source remains the same with output coming from the AACN system. The new piece is the transmission using V2V or V2I for carrying of information and ultimate transmission to ECC or TMC. This is accomplished through the use of DSRC Wireless Communication Protocol. As a result of the relay feature, AACN notification to emergency responders is made possible in circumstances where AACN cellular communication is not available.
- **Changes in quantity, type, and timing of data to be input into the system:** The enhanced Crash Detection feature includes original AACN data plus injury severity prediction information. Information includes: call-back number, date, time, location, pre-event vehicle heading, vehicle information, and air-bag deployment. Crash severity includes: number of impacts, crash delta velocity, principle direction of force, rollover, and crash severity prediction. In addition, seatbelt restraint use, number of occupants, occupant location, and intrusion are included in the data packet. The AACN-RELAY provides critical detail and unbiased information on the incident, resulting in the proper dispatch of response resources required to effectively handle the event. This is particularly valuable when the AACN message cannot be sent via cellular communications.

RESP-STG Operational Impacts

The RESP-STG is expected to have the following operational impacts:

- **Interfaces with primary or alternate computer operating centers:** ECC and TMC act as Information Brokers and are responsible for the collection and dissemination of data in order to assist the emergency responders in the mission to protect life and property. The analysis of the data received from Information Brokers into the RESP-STG application provides the basis for response route and apparatus positioning recommendations, lane closures, and traffic re-routing recommendations to emergency responders. This allows for increased mobility during an incident.

- **Changes in procedure:** Instead of responders needing to request information for routing and apparatus positioning, a recommendation is provided automatically allowing the Incident Commander to make informed decisions for both response and recovery operations.
- **Use of new data sources:** The data sources for the RESP-STG application exist independently. However, the consolidation of information through the application will provide the Information Brokers with a single view which can be communicated to the Incident Commander in a streamlined method for enhanced decision making. In addition, the information package can be disseminated to other R.E.S.C.U.M.E. applications including INC-ZONE and EVAC in order to streamline planning and execution of response and recovery actions.
- **Changes in quantity, type, and timing of data to be input into the system:** The development of the RESP-STG application provides a consolidated view of various components that do not currently share data. This consolidated view provides a decision making tool for emergency responders that allows for mobility impacts to be taken in consideration.

INC-ZONE Operational Impacts

INC-ZONE has many of the same expected impacts as the RESP-STG including:

- **Interfaces with primary or alternate computer operating centers:** By bringing the INC-ZONE data sources together in a single view, versus multiple stand-alone systems, the Information Brokers are able to provide a more accurate and thorough analysis in a shorter time frame to mitigate incident impacts to responders and motorists.
- **Changes in procedure:** INC-ZONE provides recommended speed and lane guidance for motorists traveling in an incident zone through audible or visual alerts. First responders will need to address use of the application through Standard Operating Procedures and orders which can vary significantly from jurisdiction to jurisdiction.
- **Use of new data sources:** CV-enabled vehicles are required for INC-ZONE data input. Until all vehicles are CV-enabled, the operational capability is limited and does not take into account those vehicles which are not CV-enabled and are potential hazards to responders and workers.
- **Changes in quantity, type, and timing of data to be input into the system:** By processing CV-enabled vehicle data, the safety of responders and workers is improved. As the number of CV-enabled vehicles increases, the amount of data and analysis will increase to provide more real-time information to responders and motorists.

EVAC Operational Impacts

The EVAC application will integrate multiple systems and data inputs and is expected to have the following impacts:

- **Interfaces with primary or alternate computer operating centers:** The EVAC application will integrate multiple systems and data inputs (including functional needs databases, evacuation routes, traffic/road conditions, and GIS data) through the Information Broker to provide a single user interface, whether the user is an evacuee, transportation provider, or Emergency Operations Center (EOC). This data integration will result in greater participation in the system by the users, resulting in an overall reduction in evacuation time, and improved communications and information sharing.
- **Changes in procedure:** Jurisdictions will need to establish Standard Operating Procedures in order to determine which agencies have administrative rights to the system, how the agencies will incorporate the system into their training and exercise cycles, and develop Memoranda of Agreement during pre-planning to facilitate the sharing of information across agencies. Jurisdictions will also need to develop outreach plans and procedures for promulgating the use of the EVAC applications to the end users / evacuees in order to maximize participation in the system.
- **Use of new data sources:** The data sources for this system will come from a combination of already existing data (i.e., mass warning and notification systems, intelligent transportation systems, and functional needs databases), and user generated data through a registration process (either prior to or during an event). The use of these data sources may require compliance with information protection regulations (i.e., HIPAA) and will require the end users/evacuees to sign/accept a user agreement when registering with the system.
- **Changes in quantity, type, and timing of data to be input into the system:** With the increased usage / participation by end users in the EVAC application, there will be significantly more data (demographic data, location data, shelter data), that will need to be processed in real time. For example, shelters will need to provide real-time reporting of their capacity and capability so the shelter matching function is providing the evacuee with relevant and current data. Additionally, for the functional needs function, private medical information will be part of the data set and this will have to be secured in compliance with applicable information protection regulations.

Organizational Impacts

Based on the User Groups of Local, State, Federal, and Other Users, the organizational impacts for the R.E.S.C.U.M.E. Bundle Applications are minimal as these User Groups will not change. However, the responsibilities may change with the additional reporting requirements of data through an Information Broker.

There is no anticipated addition or elimination of job positions based on the R.E.S.C.U.M.E. Bundle. In particular, the bundle does not seek to replace the Incident Commander or other decision-makers from the process and procedures but rather to provide these key decision-makers with additional information that can be used during the decision-making process. However, the role of the TSP in making notification of a crash will be reduced as the AACN-RELAY application becomes operational and widespread.

Additional training for users is anticipated, as with all new technology and software programs. The level of training is dependent on user case and Standard Operating Procedures developed by the organizations employing the tools. Training for the general public will be managed and conducted through public awareness and information campaigns by individual agencies. For the RESP-STG, INC-ZONE, and EVAC applications, training will need to include the planning and execution of exercises, from tabletop to full-scale, in order to test these systems. In addition, the EVAC functional and full-scale exercises should incorporate designated personnel or volunteers acting as evacuees during the exercises to ensure that SOPs and response plans are in line with the capabilities of these new applications and their associated functions.

Contingency operations personnel are designated well in advance of incidents or events and there is little change anticipated with the exception of perhaps additional training required for usage of the R.E.S.C.U.M.E. Bundle Applications.

Impacts during Development

The R.E.S.C.U.M.E. Bundle development process will vary significantly for each of the four applications. The AACN-RELAY application development should be fairly straightforward and should flow naturally from existing AACN technologies as well as on-going research within the connected-vehicle community. Similarly, the EVAC application, while complex in that it seeks to assimilate, process, and disseminate information from/to multiple sources, should also be a straightforward development process as there are existing models both within and external to the transportation community that can be leveraged (e.g., ATIS and other traveler information systems such as 5-1-1). The development of the RESP-STG and INC-ZONE applications will be much more challenging as these applications need to “live” within the existing systems and equipment inherent to a responder’s vehicle. This will create system integration challenges as well as the need to create multiple variants of the application depending upon the equipment that is available within each vehicle.

There are a number of operational and technical decisions that will need to be addressed for each of the applications as well as within each jurisdiction where the R.E.S.C.U.M.E. Bundle is deployed. The following summarizes some of the more salient development considerations for the Information Broker and each R.E.S.C.U.M.E. Bundle Application:

- **Information Broker.** The role and composition of the Information Broker will need to be identified. In particular, questions regarding whether the Information Broker will be a distributed system or managed and operated by a single entity will impact the development of the components of the applications that reside within the Information Broker. Additionally, the communication protocols and message formats for exchange of information to and from the Information Broker will need to be standardized. These decisions should include scientific tests to ensure the stability of the Information Broker functions during adverse events including high data volume as well as during a major evacuation event.

- **AACN-RELAY.** Development of the AACN-RELAY application should be conducted to be consistent with both existing AACN and connected vehicle message-sets and protocols. For example, the AACN-RELAY message should be developed within the J2735 message set standard. Key development decisions for this application will involve determining the specific stopping rules for discontinuing the relay functionality. This will likely require specific testing to simulate a wide variety of conditions, but must certainly include conditions such as an incident during rush-hour on a major urban freeway and a rural, run-off-road, single vehicle incident with low visibility to passing traffic. Other development decisions will involve the criteria and algorithms for determining whether the AACN-RELAY message received by the relay vehicle is a “new” message or has been previously received by the relay vehicle. This will be important component of the relay functionality both to prevent overtaxing the relay vehicle’s DSRC radio, but also to prevent an infinite relay loop from occurring.
- **RESP-STG and INC-ZONE.** Both of these applications will reside in existing responder in-vehicle information systems. As such, the development of these applications should be conducted through a rigorous system development process that includes stages for stakeholder feedback, requirements development, system design, etc. Extensive testing will be required for these applications to ensure that the inclusion of this additional functionality can be accomplished without degrading the functionality of the original equipment. Human Factors research will likely be needed to determine the most appropriate manner and mechanism for communicating the information to the responder given the already information saturated environment within a responder’s vehicle.
- **INC-ZONE.** The crucial development decision related to INC-ZONE other than those discussed above revolves around the criteria for when a responder is alerted to a potential vehicular threat. Extensive testing will need to be conducted to determine the false positive and false negative rates for each proposed criteria. Initial testing could be conducted within a controlled environment, but it will be important to conduct extensive real-world testing to fully capture the range of vehicles and threats that would be encountered. As such, the INC-ZONE application may benefit from a series of pilot projects that provide a wide range of experiences upon which to base the development and finalization of the notification criteria.
- **EVAC.** The EVAC application resides within the Information Broker, and therefore the decisions regarding the Information Broker most heavily impact the EVAC application. There are existing systems that can be studied as a beginning foundation for the EVAC application, but critical decisions need to be made regarding the communications and integration of the EVAC with existing traveler information sources (e.g., how the EVAC application will “de-conflict” messages from multiple sources).

Chapter 8 Analysis of the Proposed System

Summary of Improvements

The proposed R.E.S.C.U.M.E. Bundle Applications will provide transformative improvements to mobility through the innovative sharing and processing of a number of types of information. Existing elements of information related to emergency and incident management will be combined with transportation information in a new approach. The systems working within the applications will be able to collect and process information quicker and the systems will also have access to certain new types of information. The resulting state will benefit transportation officials, emergency responders and other public safety officials, as well as the traveling public. It will do so by increasing their situational awareness at the same time that it provides them more complete information with which to make timely and crucial decisions.

The manner in which the applications work together will draw upon new capabilities. At the heart of the interaction among the four applications is the Information Broker entity, which is the backbone of the functions that collect, process, analyze, correlate, de-conflict, and distribute information for the R.E.S.C.U.M.E. Bundle. The Information Broker also communicates with certain applications in other DMA bundles that have a functional connection to R.E.S.C.U.M.E.

The Information Broker and interfaces that provide application functionality will necessarily require development. However, the applications do not require creation of new devices or fundamental changes to existing operational response approaches. The R.E.S.C.U.M.E. Bundle Applications are intended to "live" within existing systems, not replace them. R.E.S.C.U.M.E. is intended to provide value-added services encompassing the range of users currently involved in emergency response, incident management, roadway clearance, and evacuation. R.E.S.C.U.M.E. Bundle Applications will also help the traveling public reap the mobility benefits from these improved processes, whereas conventional responses to the same incidents or evacuations might otherwise not be able to prevent severe disruptions to mobility given the same conditions.

At a high level, the improved processing combined with new types of information will help provide a more complete Common Operational Picture for large-scale incidents such as evacuations, whether they arrive with warning or not. At the tactical level, the new types of information will help get appropriate emergency response resources to a crash scene quicker and with better knowledge of what responders will be facing, protect responders at an incident scene, get roadways cleared more quickly, and assist evacuees needing help.

Cross-Cutting Improvements

The processing capabilities of the Information Broker will allow its entities to better anticipate and control the effects of incidents on traffic flow, consequently reducing congestion and increasing throughput. Public safety officials will have greater communication with vehicles and roadside equipment, response personnel in the field, and the public. They will have expanded functionality with mobile devices to provide two-way communication to other public safety personnel and evacuees. Through improved communication and allocation of the best resources to an incident, responders can more effectively achieve safe, quick clearance. Public safety officials will have more of a big-picture view, which is particularly helpful for managing evacuations or other complex, large-scale incidents.

AACN-RELAY Improvements

AACN-RELAY requirements are included in this document for completeness and consistency. However, USDOT does not plan to pursue development of AACN-RELAY during subsequent phases of the DMA Program.

When a vehicle crashes, data about the crash will be automatically transmitted to and relayed by other CV-enabled vehicles to ensure an alternate means of communication should cell phone service be unavailable. This will result in greater likelihood of a run-off-the-road crash being detected, especially those occurring in remote areas. Through DSRC communications, motorists will be aware of the accident and can be alert to potential road hazards. In conditions where the run-off-the-road crash may not be evident, AACN-RELAY technology alerts passers-by so they can respond to help the victim(s). The same communication will allow passing law enforcement or other emergency responders personnel to “self-stage” (or initiate staging) when they receive an alert and locate the run-off-the-road crash. Through CV technologies, the population of vehicles enabled with AACN-RELAY technologies will increase beyond limited market penetration of the current Mayday subscription services. The detection, reporting, and assessment of crashes overall will be quicker. The ability to retrieve electronically stored special data such as victim medical records and HAZMAT electronic shipping papers will help public safety personnel tailor the dispatch of emergency responders most appropriately for the circumstances of the crash.

RESP-STG Improvements

Responders to vehicle incidents will be provided with comprehensive information regarding the incident prior to dispatch (incident dynamics, condition of the victims, HAZMAT involved, etc.) reducing total response time. The improved information flow will allow emergency responders to be optimally staged. This capability will utilize the greater information available and will draw upon mapping, modeling, and on-scene video to guide placement of emergency response assets. It will not be necessary to assume a worst case scenario if the dispatch is well-informed. The emergency response assets dispatched can be optimally equipped for the crash rather than having to depend on the Incident Commander to arrive at the scene and then report needs. The responder staging guidance will supplement the Incident Commander’s judgment, providing guidance rather than a prescribed set of responses. Improved communications will increase awareness among other emergency responders as to what other responders have been dispatched and when they will arrive. Ability of emergency responders to know before arrival at the scene what HAZMAT has been spilled will lead to more appropriate response and safer staging which leads to quicker incident clearance. Knowledge of a crash victim’s prior medical record can help EMS personnel render medical care most appropriately so as to do no harm and know what medical facility to transport the victim to that is best equipped to treat their condition.

INC-ZONE Improvements

Secondary incidents will be reduced via INC-ZONE communications. Vehicles moving toward an incident scene will be made aware of the incident and provided with information on lane closures and alternate routing, so that they may avoid the area altogether. Vehicles approaching the incident will be provided safe speed and lane merge guidance. Those that exceed safe operating parameters will be detected and an alert sent to requesting them to return to safe operation immediately. Response personnel on-scene at the incident will be alerted to vehicles in the vicinity that pose a threat to their safety so they can move out of harm's way.

EVAC Improvements

Public safety officials who conduct evacuations will have a better Common Operating Picture. They will be able to employ dynamic dispatching and routing of available resources (e.g., vehicles) across agencies during an evacuation. They will be able to conduct dynamic re-routing of evacuating traffic to alternate evacuation routes, especially in the event that an accident has occurred on the route. EVAC will facilitate an integrated system that provides two-way communications with evacuees, including functional needs populations. Public safety officials will have real-time data on the progress of an evacuation. They will be able to provide dynamic traffic and route guidance both for evacuees and responders supporting the evacuation. EVAC will optimize deployment of incident responders to an incident occurring in conjunction with an evacuation. This will be important for responding to incidents in general but more importantly will help responders approaching any incidents on evacuation routes. It will help improve response times for emergency responders responding to incidents in conjunction with or secondary to an evacuation. Public safety officials will know how many responders (of what type) are needed and have been deployed. There will be improved ability for functional needs persons to register with a database. This registration will ideally be in advance allowing public safety officials to have improved awareness of the location and status of functional needs evacuees. In addition, the registration database will accommodate on-demand requests by functional needs persons during an active evacuation to get transportation assistance. There will be improved ability to locate, pick up, and transport functional needs persons to shelters, making widespread use of mixed agency vehicles for their evacuation. Knowledge of when and where they are en-route to shelters, have arrived at shelters, and have left shelters will be increased, which will ultimately reduce the number of un-needed trips (i.e., those dispatched to accommodate persons what have already been accommodated). Social networks will be used to improve evacuees' awareness of roadside resource availability resulting in improved travel flow and transportation systems resource utilization.

Disadvantages and Limitations

Cross-Cutting

Bandwidth and the capacity and capability of a data processing center will affect the Information Broker. Also, some natural disasters or man-made disasters would have far reaching effects on applications. Examples are large scale power failure, hurricanes, terrorist acts, and cyber attacks. The primary impact is on communications. The Information Broker and entities that process data would ideally need backup systems but might need to revert to more basic technologies in the worst case. For example, during a natural disaster requiring subsequent evacuation, the ability to transmit and receive information through a cellular connection may be quite limited (or even unavailable). To be truly redundant, a series of direct line-of-sight communications equipment would be needed (e.g., broad coverage of an area with self-powered DSRC roadside infrastructure components).

AACN-RELAY

The ability to relay information requires development of a capability that does not currently exist. Connected Vehicle technology needs to be widespread in order for AACN-RELAY to make best use of the technology. The relay capability depends upon availability of roadside equipment, and it remains to be seen how common that roadside equipment will be. Its initial implementation is likely to be at exits to Interstate highways, intersections of other major highways, and perhaps rest areas. For the technology to realize its full mobility and safety benefits, roadside hotspots must be reasonably common, particularly in areas where there are cellular coverage gaps.

Currently the U.S. DOT is conducting research to determine the viability of using SAE J2735 to support the vehicle-to-vehicle communications. The purpose of this standard is to support interoperability among DSRC applications through the use of standardized message sets, data frames and data elements.[11] However, SAE J2735 does not support the type or relaying that is required to support the envisioned functionality of the Advanced Automatic Crash Notification Relay application. It is recognized that changes to standards to accommodate the desired functionality would be a lengthy time-consuming process that could significantly delay prototyping and field-testing of such a system.

It is also recognized that R.E.S.C.U.M.E. could potentially create situations where both responders and others like PSAP call-takers and dispatchers are overwhelmed with information. Factors complicating information overload include the understaffing of PSAPs and the potential for an influx of new useful information generated by the various functions of the R.E.S.C.U.M.E. applications. It will be critical that information generated and shared among the various functions of R.E.S.C.U.M.E. be compartmentalized into information bundles that are “essential”, and that which is “useful”.

RESP-STG

To be truly transformative in how responders approach an incident and therefore enabling improvements to mobility, the RESP-STG application needs to provide information that cannot already be readily obtained by the responder. This information includes medical records and HAZMAT identification. Unfortunately, there are potential barriers to the availability of this information that need to be overcome as discussed below.

The functionality envisioned for RESP-STAG could potentially exceed the current capabilities of CAD systems that are currently used by state and local public safety agencies. As an example, it is possible that some CAD systems being used in a given region to be incapable of accommodating the some multi-media data that is a part of the envisioned functionality. This is an important consideration given new CAD systems are a capital intensive investment for public safety agencies that continually struggle with budget shortfalls. The replacement cycle for such systems can be many years as agencies delay replacement of the equipment in an attempt to extend its useful life, thereby forgoing the enhanced functionality of new systems.

Medical Records

One of the capabilities that can advance the ability of emergency responders to save lives during a crash or other incident such as a motorist’s heart attack while in a vehicle is availability of medical

[11] http://www.standards.its.dot.gov/fact_sheet.asp?f=71 Accessed 21 October 2012

information. Electronic storage and transfer of medical information occurs every day, but the information is private and protected by HIPAA legislation. Making this information available upon demand both to the right emergency response personnel and the medical facilities to which they transport victims requires multiple transmissions. Under those circumstances, maintaining the necessary level of protection of their private information is a challenge. The information will need to be voluntarily provided and electronically stored in advance, and access may only be through certain strict permissions. There will need to be protocols for destroying the information once the emergency has been resolved. Information technology will need to provide safeguards against the information being accessed by unauthorized persons such as hackers.

HAZMAT Cargo Identification

Identification of HAZMAT poses a somewhat analogous challenge. Chemical manufacturers consider the identification and locations of their customer base to be proprietary. They are required to carry hardcopy shipping papers on the transporting vehicles and are authorized to utilize electronic shipping papers for commerce, but some chemical manufacturers are leery of that information residing electronically in a centralized database or being transmitted by the HAZMAT vehicle that carries it. The chemical industry complies with many regulations and has taken voluntary steps to safeguard the transport of HAZMAT. The number of catastrophic accidents such as TIH release or explosion is relatively small. There will be reluctance among some to providing HAZMAT cargo identification electronically, even for emergency response purposes. There will be particular reluctance if complying with a requirement to do so were to involve an “unfunded mandate,” create a competitive disadvantage with regard to other modes of transportation, or create an “unlevel playing field” for voluntary compliers vs. a non-complying competitor in the same transportation mode.

Liability

The responsibility for incident safety resides with the Incident Commander. The RESCUME Bundle Applications provide only recommendations. Determining liability is out of scope for the ConOps but might impose limitations on implementation.

Credentialing of Unsolicited Responders

The R.E.S.C.U.M.E. functionalities, specifically those included in the RESP-STG will need to accommodate unsolicited responders. Unsolicited responders can have a significant impact on the response and management of incidents of any size. Often, self-deployment of response resources can compromise efforts to manage the response effectively.

INC-ZONE

The INC-ZONE application is mostly limited by the nature of DSRC communications and the ability to correctly identify situations where an alert needs to be broadcast (and to whom). A critical function of INC-ZONE is to inform emergency responders working within an incident zone of dangers from vehicles being operated unsafely.

As described in the ConOps, each responder in the incident zone will be outfitted with a personal warning device that will notify them of dangerous conditions. However, based on the approach defined in the ConOps, some limitations exist, which are detailed in the following paragraphs.

DSRC Line-of-Sight

The in-vehicle alert message will be communicated to the vehicle by the roadside equipment deployed by the Incident Commander at the scene. Since the messages are communicated via DSRC technology, the roadside equipment must have line-of-sight visibility with the vehicle approaching the scene to alert the vehicles of the incident ahead. Because of this line-of-sight limitation, DSRC repeaters would be needed to transmit the alert messages around curves in the road as well as over longer distances.

Personal Warning Device

The personal warning device defined in the ConOps will be integrated into the existing gear of emergency responders. The limitation is that different types of emergency responders may require different methods of alerting them to dangerous conditions. For example, the fire-proof clothing worn by fire and rescue responders may muffle any type of audible warning if the warning device is underneath too many layers of clothing. The personal warning device must either involve a single approach that meets the specific operational needs of all responders or it should be tailored to the specific needs of each emergency responder group.

Transmit Warnings to All On-Scene Responders

The warning message of a dangerous vehicle in the incident zone will be transmitted to all emergency responders within the zone, regardless of their locations within the incident zone. The disadvantage of this approach is especially evident when larger incident zones are considered. For example, if a vehicle has entered the incident zone safely, but then after traveling some distance within the incident zone is then operated outside safe conditions, the INC-ZONE application, as defined in this ConOps, will transmit warnings to all emergency responders within the incident zone. This will unnecessarily warn the emergency responders near the incident zone entrance since the danger is downstream from them. Although GPS could be integrated into the personal warning devices to tailor the warnings to only those responders in the predicted line of danger, the uncertainty of the dangerous-vehicles trajectory, minimal time to warn the emergency responders, and the overall advantage of alerting all responders so they can help one another, suggest that identifying individual responders at risk would not be feasible.

EVAC

One of the big challenges with evacuation is identifying functional needs persons, knowing where they are located, and the nature of their needs. Municipalities should (and do) encourage members of the functional needs population to register in advance (where systems are in place to capture this information). Their information entered into the system should be private and protected, but this may also limit the information that is provided by these persons for fear of inadvertent release. The information can be used for emergencies within certain defined limits, but the need to protect it does not diminish even during those times. The capability to help such persons on a situational, interactive basis in situations where private information is flowing through multiple channels is complicated by the need to ensure privacy. Safeguards must be built into the system to maintain flexibility and privacy simultaneously.

Another challenge during an evacuation is the sheer volume of information that must be processed vs. the need for a clear Common Operating Picture for the purposes of command and control and decision-making. While DSS can help analyze data so that public safety officials in charge of an evacuation can best know what is going on and how to react to incidents or other emerging situations, this aspect involves may different facets and is not a simple solution.

It is possible that an evacuee would reject a shelter suggested to them, or that they are mistakenly taken to the wrong type of shelter (e.g., a person with a pet is taken to a shelter that does not accept pets). If so, that would tie up an additional vehicle resource to get the person to an acceptable shelter and complicates the tracking process.

Alternatives and Trade-Offs Considered

Cross-Cutting Alternatives and Trade-Offs

All the organizations that are expected to play key roles in the operations of the R.E.S.C.U.M.E. Bundle Applications have invested significant time and energy into their existing systems. This includes not only the equipment itself, but also the training of system operators and maintenance staff. As proposed in this ConOps, the R.E.S.C.U.M.E. Bundle Applications will leverage legacy systems and protocols currently utilized by transportation and emergency management organizations, rather than requiring the deployment of the applications on new platforms.

Similarly, the proposed R.E.S.C.U.M.E. Bundle will depend heavily upon the Information Broker, which is comprised of existing entities representing Traffic Management Centers, Emergency Communications Centers, and others. The Information Broker receives information from the data producers, processes the data, and then routes data and information from the data producer to the data consumer. These operations were considered for complete inclusion in the individual R.E.S.C.U.M.E. applications; however, since that would have required R.E.S.C.U.M.E. to host many of the same functions already performed by TMCs and ECCs, it was rejected because of the inefficiencies the duplication of functionality would introduce..

It is critical that an entity assume sole responsibility for enabling the functionality of the Information Broker to achieve the envisioned functionality of R.E.S.C.U.M.E, specifically those included in the Incident Scene Pre-Arrival Staging Guidance for Emergency Responders application which can potentially support regional information sharing. This entity would be responsible for guiding information to the appropriate responder. Further, in order to achieve the anticipated benefits, it will be critical for the system to operate in a regionally coordinated environment.

AACN-RELAY

The AACN-RELAY application will collect and transmit key crash data recorded by sensors mounted in a vehicle. Among the data collected is the vehicle speed at the time of the crash. Although it is conceivable that this data could be used by law enforcement to enforce speed limits, for example, this functionality was determined to be outside the scope because of the judicial and privacy concerns that would need to be addressed.

AACN-RELAY will notify relay vehicle drivers that they are receiving a distressed vehicle's AACN message. This presents relay vehicle drivers with the need to make a decision: should they stop and look for the crashed vehicle to help the driver immediately or should they continue on their way to report the incident, for example if there is no cell phone coverage? An alternative approach considered was to withhold relay driver notifications as a means of avoiding potential liability concerns (i.e., the driver had indication of an incident but did not stop). However, since providing the notifications may increase victims' potential for survival , notifications were included as an AACN-RELAY functionality.

RESP-STG

A proposed function of RESP-STG is to provide the PSAP and emergency responders access to the medical history data of accident victims. The approach presented in this ConOps is to allow the public to voluntarily opt-in by granting permission for their medical records to be accessed by the PSAP and emergency responders via a medical records component of the Information Broker. An alternate approach considered was to embed the information into the vehicle's AACN RELAY message (in the event of a crash) and transmit that message to RESP-STG at which point the medical history data could be reviewed. Because the medical records could be quite large, the required bandwidth could overload the system and cause unacceptable delays in delivering that information to the emergency responders. In addition, storing the medical records on a vehicle introduced another layer of privacy concerns that would need to be addressed through policy development.

Similarly, the proposed RESP-STG application enables the PSAP and emergency responders to have access to the electronic shipping papers of a vehicle transporting HAZMAT. As with the medical records, the electronic shipping papers are accessed through the Information Broker. An alternate approach considered would have embedded the HAZMAT information into the AACN RELAY message that would have been available to the PSAP and emergency responders. Due to the expected needs for large bandwidth and anticipated concerns from the trucking industry, this approach was not pursued further.

Another tradeoff that was considered was to make the RESP-STG information more directive rather than supportive. However, because incidents are extremely dynamic events, the experience of an Incident Commander is vital to the safe and effective execution of staging plans. Consequently, the information provided by RESP-STG to an Incident Commander is qualified as advisory in nature, meaning it is another source of information that can be considered by the Incident Commander when making his or her staging decisions.

INC-ZONE

A feature of the proposed INC-ZONE application is that it will use mobile roadside equipment suites to communicate with vehicles via DSRC to read each vehicle's speed as it enters the incident zone. If the vehicle is operating outside calculated safe operating conditions (e.g., it is traveling too fast for an incident zone that has wet roads), then the roadside equipment will issue a warning to that vehicle. Since INC-ZONE will entail sending a DSRC message to the approaching vehicle informing it to slow down, it is conceivable that the vehicle could then transmit a related message to the vehicle behind it that it is slowing down. If this chain of messages that vehicles are slowing ahead is transmitted far enough upstream, this would likely reduce secondary incidents, especially rear-end collisions. This functionality conceivably could be fully implemented as part of INC-ZONE; however, because queue warnings are projected to be included in the INFLO bundle, they are deemed out of scope for this ConOps. Nonetheless, this example shows a clear interface between R.E.S.C.U.M.E and INFLO bundles.

Similar to AACN-RELAY, the INC-ZONE application will be collecting vehicle speed information as the traveling public enters incident zones established by an Incident Commander. Although this information could be used by Law Enforcement to issue speeding citations, the judicial and privacy concerns that would need to be addressed are outside the scope of this ConOps.

An incident zone, in the context of this ConOps, is defined as the zone established by an Incident Commander surrounding a random roadway incident. It is established to protect emergency responders, incident victims, and others working within the zone from dangerously-operated vehicles that are traveling through the incident zone. An incident zone typically involves multiple agencies and is generally small; i.e., only a few vehicles might be involved over a short distance (there are exceptions; e.g., a multi-vehicle pileup caused by fog). Although construction work zones were considered as another candidate application for INC-ZONE, they were deemed out of scope because construction work zones differ fundamentally from incident zones in that construction work zones are planned events normally involving just a single agency (so interagency coordination is not necessary) and are comparably large. Although protection of workers within construction work zones could benefit from the INC-ZONE feature, application of INC-ZONE to constructions work zones is considered out of scope.

EVAC

The EVAC application will provide roadside resource identification to evacuees while they are traveling on selected evacuation routes. This will enable evacuating motorists to find fueling stations when necessary to prevent them from running out of fuel on the road. However, even though EVAC could help a motorist locate and navigate to the fueling station, the question of knowing whether that station actually has fuel is a challenge. The ideal technological approach would be to include real-time reporting of which fueling stations have fuel as well as how much. However, this is overly burdensome to refueling stations as well as other roadside resources (e.g., grocery stores, ATMs). An alternative that is proposed for EVAC in this ConOps is to incorporate social networking feedback from drivers who have recently used that resource. In this example, drivers could upload a comment that a particular fueling station has or does not have fuel. This information will help motorists seek out only those fueling stations that reportedly have fuel.

Appendix A: List of Acronyms

Acronym	Description
AACN	Advanced Automatic Collision Notification
AACN-RELAY	Advanced Automatic Collision Notification Relay (a R.E.S.C.U.M.E. application)
AASHTO	American Association of State Highway and Transportation Officials
ABR	Alternate Bus Routing
ALI	Automatic Location Information
ANI	Automatic Number Identification
APCO	Association of Public Safety Communications Officials
ATIS	Advanced Traveler Information Systems — or — Multi-Modal Real-Time Traveler Information (an Enable ATIS application)
ATM	Automated Teller Machine
AVL	Automatic Vehicle Location
CAD	Computer-Aided Dispatch
CAP	Common Alerting Protocol
CCTV	Closed-Circuit Television
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CMAS	Commercial Mobile Alert System
CMS	Changeable Message Sign
ConOps	Concept of Operations
CRS	Congressional Research Service
DACA	Deployable Aerial Communications Architecture
CV	Connected Vehicle
DBS	Direct Broadcast Satellite
DHS	Department of Homeland Security
DMA	Dynamic Mobility Applications
DMS	Dynamic Message Sign
DoD	U.S. Department of Defense
DOT	Department of Transportation
DSRC	Dedicated Short-Range Communications
DSS	Decision Support System
E9-1-1	Enhanced 9-1-1 (phone service)
EAS	(National) Emergency Alert System

Acronym	Description
ECC	Emergency Communications Center
EDR	Event Data Recorder
EMA	Emergency Management Agency
EMS	Emergency Medical Services
Enable ATIS	Enable Advanced Traveler Information Systems (a DMA bundle)
EOC	Emergency Operations Center
ePCR	Electronic Patient Care Record
ESP	Electronic Shipping Papers
ETA	Estimated Time of Arrival
ETO	Emergency Transportation Operations
EVAC	Emergency Communications for Evacuation (a R.E.S.C.U.M.E. application)
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FOIA	Freedom of Information Act
FOP	Fraternal Order of Police
FOT	Field Operational Test
FRATIS	Freight Advanced Traveler Information Systems (a DMA bundle)
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
HIPAA	Health Insurance Portability and Accountability Act
HSPD	Homeland Security Presidential Directive
I2V	Infrastructure-to-Vehicle
IACP	International Association of Chiefs of Police
IAFC	International Association of Fire Chiefs
IAFF	International Association of Fire Fighters
ICS	Incident Command System
IDTO	Integrated Dynamic Transit Operations (a DMA bundle)
IEEE	Institute of Electrical and Electronics Engineers
INC-ZONE	Incident Scene Work Zone Alerts for Drivers and Workers (a R.E.S.C.U.M.E. application)

Acronym	Description
INFLO	Intelligent Network Flow Optimization (a DMA bundle)
IT	Information Technology
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
MDT	Mobile Data Terminal
MMISIG	Multi-modal Intelligent Traffic Signal System (a DMA bundle)
MPO	Metropolitan Planning Organization
NAEMT	National Association of Emergency Medical Technicians
NEMSA	National Emergency Medical Services Association
NENA	National Emergency Number Association
NG9-1-1	Next Generation 9-1-1 (phone service)
NGO	Non-governmental Organization
NHTSA	National Highway Traffic Safety Administration
NIMS	National Incident Management System
NOAA	National Oceanographic and Atmospheric Administration
NPI	National Provider Identifier
NRF	National Response Framework
NSS	National Shelter System
NTIMC	National Traffic Incident Management Coalition
NUG	National Unified Goal
NWS	National Weather Service
PDOF	Principal Direction of Force
PKEMRA	Post-Katrina Emergency Management Reform Act
PLAN	Personal Localized Alerting Network
PPD	Presidential Policy Directive
PSAP	Public Safety Answering Point
PSE	Planned Special Event
R&D	Research and Development
R.E.S.C.U.M.E.	Response, Emergency Staging, Communications, Uniform Management, and Evacuation (a DMA bundle)
RESP-STG	Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (a R.E.S.C.U.M.E. application)
RFID	Radio Frequency Identification
RITA	Research and Innovative Technology Administration
SCDOT	South Carolina Department of Transportation

Acronym	Description
SDARS	Satellite Digital Audio Radio Service
SOP	Standard Operating Procedure
SOW	Statement of Work
SPaT	Signal Phase and Timing
TCP-IP	Transmission Control Protocol/Internet Protocol
T-DISP	Dynamic Transit Dispatch (an IDTO application)
TIH	Toxic Inhalation Hazard
TIM	Traffic Incident Management
TMC	Traffic Management Center
TRB	Transportation Research Board
TSP	Telematics Service Provider
TTC	Temporary Traffic Control
U.S. DOT	United States Department of Transportation
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Infrastructure or -Vehicle
VMS	Variable Message Sign
VoIP	Voice over Internet Protocol
WSP	Wireless Service Provider

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