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

Final Functional and Performance Requirements

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16. Abstract

This document provides the high-level functional and performance requirements for the Prototype Development and Demonstration of a R.E.S.C.U.M.E. system. The requirements included in this document are based upon those that can be found in previous R.E.S.C.U.M.E. reports, particularly the R.E.S.C.U.M.E. Concept of Operations (Final Report — November 19, 2012; FHWA-JPO-13-063) and The Report on Functional and Performance Requirements, and High-Level Data and Communication Needs (Final Report — February 7, 2013; FHWA-JPO-13-064) both prepared previously by Battelle. As such, this document uses a copy of the system requirements and associated definitions from these prior documents as the basis for the tailored requirements associated with this next phase of the R.E.S.C.U.M.E. project as contained herein. This document reviews these previously specified functional and performance requirements and provides additional information clarifying these requirements for the prototype development and demonstration.

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This report builds on the previous work captured in the R.E.S.C.U.M.E. Concept of Operations (Final Report — November 19, 2012; FHWA-JPO-13-063) and the report on Functional and Performance Requirements, and High-Level Data and Communication Needs (Final Report — February 7, 2013; FHWA-JPO-13-064) both prepared previously by Battelle. As such, this document uses the system requirements and associated definitions from these prior documents as the basis for the tailored requirements associated with this phase of the R.E.S.C.U.M.E. project contained herein.

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Chapter 1. Scope

1.1 Identification of System

This report documents the Detailed Requirements for the Prototype development and demonstration of the Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) bundle, with a focus on the Incident Zone (INC-ZONE) and Responder Staging (RESP-STG) applications. These two applications comprise a tightly integrated bundle that is a key research activity within the Dynamic Mobility Applications (DMA) portion of the Connected Vehicle Program. This document focuses on functional and performance requirements for these applications. These requirements provide a platform for the development of a prototype system architecture and subsequent system design document that will together provide the necessary details for the design, build, and demonstration the two R.E.S.C.U.M.E. bundle applications.

1.2 Terminology

The meanings of the auxiliary verbs used in this document are defined as follows:

- Shall — Compliance with a requirement, specification or a test is mandatory
- Should — Compliance with a requirement, specification, or a test is recommended
- May — Expresses a permissible way to achieve compliance

The meanings of the verification methods are as follows:

- Inspection — *Inspection is observation using one or more of the five senses, simple physical manipulation, and mechanical and electrical gauging and measurement to verify that the item conforms to its specified requirements*
- Demonstration — *Demonstration is the actual operation of an item to provide evidence that it accomplishes the required functions under specific scenarios*
- Test — *Test is the application of scientific principles and procedures to determine the properties or functional capabilities of items*
- Analysis — *Analysis is the use of established technical or mathematical models or simulations, algorithms, or other scientific principles and procedures to provide evidence that the item meets its stated requirements*

1.3 Introduction

The initial task in the Prototype Development Demonstration of the INC-ZONE and RESP-STG applications within the R.E.S.C.U.M.E. bundle is the review of previously developed requirements and development of prototype specific system requirements for the R.E.S.C.U.M.E. prototype development and demonstration project. To achieve this, both an assessment of the prior systems engineering work, tailored to meet the specific requirements of this prototype development, along with any new user needs and associated requirements necessary to fulfill the stated goals of the prototype, are included herein.

1.4 Approach

The content of this document was generated through the incorporation of previously documented information related to the R.E.S.C.U.M.E. applications, as well as the results of additional requirements analysis and design work performed specific to this implementation of an R.E.S.C.U.M.E. Prototype system. As noted in the Task Order Proposal Request (TOPR), only the incident zone (INC-ZONE) and Responder Staging (RESP-STG) applications will be included in this demonstration – though a framework for an Evacuation application will also be developed as part of this project. While it is not intended to duplicate previous efforts, this document has been prepared to be standalone in its content. However, this document does assume the reader has familiarity with R.E.S.C.U.M.E., the DMA program, and the overall Connected Vehicle initiative.

1.5 Document Organization

As previously noted, this document comprises a single report which identifies the prototype-specific system requirements as defined for R.E.S.C.U.M.E. Prototype development and demonstration activities. This report is comprised of the following major sections:

- A brief concept of operations discussion for the demonstration activities.
- An evaluation of the applicability of previous R.E.S.C.U.M.E. requirements as it relates to the proposed demonstration.
- Development of the prototype-specific needs and requirements.

The structure of this document is consistent with the Institute of Electrical and Electronics Engineers (IEEE) Standard 1233-1998 IEEE Guide for Developing System Requirements Specifications and Federal Highway Administration's (FHWA) System Engineering Guidebook (SEGB) that adapted IEEE-1233. It has been tailored to include the relationship to the previous R.E.S.C.U.M.E. requirements development work, as indicated by the government task order.

Chapter 2.0 documents the high level concept of operations and represents an adaptation of the General Description section of the previously published *Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) Concept of Operations*[1] as for the specific R.E.S.C.U.M.E. Prototype development activities.

[1] *Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) Concept of Operations* — November 19, 2012 WA-JPO-13-063.

Chapter 3.0 documents the assessment of the applicability to the prototype demonstration for each of the previously defined R.E.S.C.U.M.E. requirements.[2]

Chapter 4.0 captures the new functional and performance requirements that were specific to the government scope of work related to this project, and the ability to support the prototype demonstration and evaluation.

[2] *Report on Functional and Performance Requirements and High-Level Data and Communication Needs*; Final Report — February 7, 2013; FHWA-JPO-13-064, Prepared by Battelle.

Chapter 2. Overview of the R.E.S.C.U.M.E. Concept of Operations

This section contains the description of the proposed applications within the R.E.S.C.U.M.E. bundle as originally documented in the Concept Development and Needs Identification and as adapted to reflect the specific prototype applications that will be demonstrated as part this current phase. This information is only included to facilitate understanding and provide a broad perspective of the requirements identified herein without requiring the reader to refer back to other documents. However, for brevity, the reader should understand that a much more thorough and detailed description of the R.E.S.C.U.M.E. bundle and applications is provided elsewhere.

2.1 R.E.S.C.U.M.E. Bundle's Role in the Dynamic Mobility Initiative

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. Applications of a similar nature have been "bundled" together to form large program components referred to as Dynamic Mobility Application Bundles (Bundles). The R.E.S.C.U.M.E. Bundle is one such component, as are other application bundles related to Integrated Dynamic Transit Operations (IDTO), Intelligent Network Flow Optimization (INFLO), Enable Advanced Traveler Information Systems (Enable ATIS), and Freight Advanced Traveler Information System (FRATIS). An overview and detailed description of the envisioned operations and interaction of the other DMA Program bundles is discussed elsewhere.[3] Each bundle incorporates several related applications and is also tied to one or two 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. U.S. DOT expects the applications to support its goal of providing safety, mobility, and environmental benefits along with more specific operational advances.

The R.E.S.C.U.M.E. Bundle is expected to communicate and interact with the other bundles using 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 V2X interactions) enables the DMA bundles to communicate directly with each other using vehicles with CV technologies as a communications bridge.

[3] http://www.its.dot.gov/dma/dma_vision2.htm

As originally conceived, the R.E.S.C.U.M.E. Bundle was to contain four inter-related 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 and Evacuation (EVAC). Through the development of the Concept of Operations and from stakeholder input, the U.S. DOT has subsequently narrowed the research for the R.E.S.C.U.M.E. Bundle by eliminating the AACN-RELAY application and acknowledging that more research on the framework for an Evacuation application is needed prior to development and demonstration of a prototype. A summary of this evaluation, the focusing of the R.E.S.C.U.M.E. Prototype Demonstration on the INC-ZONE, RESP-STG applications, and the framework analysis for EVAC are documented in the R.E.S.C.U.M.E. Bundle Test Readiness Report.[4]

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

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 both 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. A range of data 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, traffic information, pre-defined traffic diversion plans, if available, satellite imagery, geographic information system (GIS) map graphics, camera images, current weather data, and sensor readings. The on-scene positioning of vehicles on-scene and en-route will be provided as layers in a GIS display of the incident scene.

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

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, accidents, or other 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 unplanned 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

[4] Response, Emergency Staging, Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.) Test Readiness Assessment, Prepared by Battelle as a final report under Contract Number DTFH61-06-D-0007, Task No: BA07-100.

drivers as well as incident zone personnel. A third aspect is a warning system for on-scene workers when a vehicle approaching or in the incident zone is operated outside of safe parameters for the conditions.

Chapter 3. Assessment of Existing Requirements

This section identifies the subset of the originally defined R.E.S.C.U.M.E. Functional and Performance requirements that are expected to be fulfilled as part of R.E.S.C.U.M.E. Prototype demonstration. These requirements are organized in the same manner and include the same cross-references as the original requirements, but include additional columns to capture the applicability to this specific prototype demonstration. In order, the columns and a brief description are as follows:

- Rqmt. No – Requirement Number as defined for each applications area.
- Requirement – Text of the requirement.
- User Need ID – References ID of User Need captured in the original system requirement documentation.
- Included in Prototype – Indicates whether or not these previously developed R.E.S.C.U.M.E. requirements will or will not be included.
- Notes / Comments – Documents ether specific conditions on meeting a requirement or justification for excluding those requirements that cannot be fulfilled under this effort.

In addition to these carry over elements, additional information is included for each of the two applications that are included in the prototype development and demonstration[5], as noted below.

3.1 Existing Requirements for 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

[5] The EVAC application will not be prototyped or demonstrated but is included in this phase for the objective of more fully identifying and developing a conceptual framework for an EVAC application.

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 traffic information, satellite imagery, GIS map graphics, camera images, current weather data, traffic conditions, and the positions of on-scene and en-route first response vehicles.

Table 3-1. Previously Identified RESP-STG Stakeholder Needs

User Need ID	RESP-STG User Need
RE-1	Enhance emergency responder's analytical and decision-making capabilities to foster safe and expedient responses to crashes.
RE-2	Improve emergency responders situational awareness while they are en-route by providing additional data in-vehicle including satellite imagery; GIS map graphics, camera images, current weather data, traffic conditions, dynamic routing guidance, sensor readings, and real-time modeling outputs.
RE-3	Facilitate more expedient clearance of incidents.
RE-4	Enhance coordination among emergency responders across multiple jurisdictions and disciplines.
RE-5	Generate route guidance instructions to facilitate more expedient arrival and departure of response vehicles from the crash site.
RE-6	Generate staging plans that enhance the safety of crash victims, emergency responders and the traveling public, and that minimize traffic impacts and enhance mobility.
RE-7	Provide the ability to determine what resources have been dispatched, their location and anticipated arrival time.
RE-8	Enhance responder and civilian safety by providing and distributing additional information during HAZMAT incidents.

Source: Battelle

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-1	The RESP-STG Communications function shall receive and transmit data between RESP-STG and INC-ZONE using a reliable transport mechanism.	RE-1, RE-4	Yes	This will be accomplished through cellular as part of the CapWIN system and as implemented using in-vehicle, rugged mobile computers.
RS-2	The RESP-STG Communications function shall receive and transmit data between RESP-STG and EVAC using a reliable transport mechanism.	RE-1, RE-4	Yes	The EVAC application is not included in the prototype demonstration. However, the ability for communications between RESP-STG and EVAC will be demonstrated through the advanced traveler-information notification aspect of the INC-Zone application.
RS-3	The RESP-STG Communications function shall receive and transmit data between RESP-STG and the Information Broker using a reliable transport mechanism.	RE-1, RE-4	Yes	This will be accomplished through cellular connectivity as part of the CapWIN system and as implemented using in-vehicle, rugged mobile computers.
RS-4	The RESP-STG Visual Display Function shall develop a spatial representation of the incident zone from information received from the RESP-STG functions and present information on a graphical display per guidance in ATIS/CVO (FHWA-RD-98-057), or equivalent.	RE-1, RE-7	Yes	A spatial representation of the incident zone will be displayed as part of the CapWIN incident visualization screen. This will include lane closures, vehicle positions, and alternative routes for diverting traffic (Freeway incident traffic management [FITM] Plans).
RS-5	The RESP-STG Visual Display Function shall permit a System Administrator to establish multiple Master displays of selected information for customizable purposes and assign these Master Display unique labels. *Note: examples could include a Master Display for a speeding violation, a minor traffic incident, and an accident involving HAZMAT vehicle.*	RE-1, RE-7	Yes	Any user of the CapWIN system can view an overview of the surrounding area with accidents and incidents placed upon a GIS map. On the map view you can "hover over" any incident and obtain more detailed information, including its type. CapWIN also has the incidents as a list that can be viewed by type of incident. As the responder pulls up the incident scene, a roadway representation is automatically provided in CapWIN. This can be modified by the responder (or anyone else who has access to the CapWIN system for that incident) to adjust as needed to the roadway geometry.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-6	The RESP-STG Visual Display Function shall permit an authorized User to add or remove selected information from the display by manually turning on or off a unique layer.	RE-1, RE-7	Yes	This will be accomplished by allowing users to obtain more detailed information if desired through interaction with their screen. A map layer will be provided that will enable some "toggling" of information such as aerial photos, etc.
RS-7	The locations of all on-scene responder assets shall be included on the display as a configurable layer.	RE-1, RE-5, RE-7	Partial	The location of on-scene responder assets will be displayed relative to lane closures, but the specific orientation of each vehicle will not be presented (e.g., vehicles will be represented by "dots" on a map/lane layer. The types of on-scene responder assets will be color coded to provide a quick visual distinguishing mechanism for the responders.
RS-8	The RESP-STG Visual Display Function should present the visual information on a platform that can be carried by a single person when on an active incident scene without the need for an external power connection.	RE-1	Yes	Accomplished through use of a rugged laptop mounted in the responder vehicle.
RS-9	The RESP-STG Visual Display Function shall provide an alert when any of the following conditions are met: New information is received from any of the actively displayed information sources A high priority message is received from any of the information sources not selected for display	RE-1	Partial	Any time a responder receives a message within the CapWIN system; there is both a visual and audible alert. New information will be automatically "pushed" to the RESP-STG application through CapWIN's normal procedures.
RS-10	The alert shall include a visual indication that information has been updated or is available	RE-1	No	New information will be automatically "pushed" to the RESP-STG application through CapWIN's normal procedures and the visual displays are automatically updated but a separate alert will not be issued.
RS-11	The alert should include an audible indication that information has been updated	RE-1	No	New information will be automatically "pushed" to the RESP-STG application through CapWIN's normal procedures, but an audible alert will not be issued.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-12	The RESP-STG Visual Display Function shall allow the User to choose to immediately refresh the information from a selected information source.	RE-1	Yes	This is a built in component of CapWIN's system
RS-13	The RESP-STG Vehicle and Equipment Staging Function shall consolidate information from available sources into a single viewing platform for display to the User though the Visual Display Function.	RE-1, RE-2	Yes	Information will be presented in a fashion that is consistent with CapWIN's existing system.
RS-14	The RESP-STG Vehicle and Equipment Staging Function shall access through the Information Broker the following fixed information assets: Geographic Information System overlays Road maps Topography maps Database of still photographs Database of satellite imagery Video cameras	RE-1, RE-2	Partial	Hazmat is not included in the Prototype Demonstration; therefore, we are not including Topographical Maps. We recognize that topographical information has potential uses beyond supporting Hazmat spills such as providing additional information for responder staging. However, for this prototype demonstration the benefit from adding another GIS layer to an existing GIS display is limited.
RS-15	The RESP-STG Vehicle and Equipment Staging Function shall access through the Information Broker the following variable information assets: HAZMAT plume modeling and identification of impacted roads Type and position of emergency responder vehicles at an incident scene Locations of medical care facilities Weather data	RE-8	Partial	HAZMAT plume modeling and identification of impacted roads and weather data are beyond the scope of the prototype demonstration. Information on the type and position of emergency responder vehicles at an incident scene will be provided as will locations of medical care facilities as an optional layer on the CapWIN Incident map.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-16	The RESP-STG Vehicle and Equipment Staging Function shall access through the Information Broker the following traffic information assets: Current traffic speed	RE-2	Yes	This will be included as an optional data layer on an overview GIS map. Speed will be represented through color coding (Red, Yellow, and Green).
RS-17	Based on the available data, the RESP-STG Vehicle and Equipment Staging Function shall suggest to an emergency responder who has not yet arrived on-scene: What direction to approach the incident scene Where to stage the response vehicle	RE-6	Partial	Providing dynamic routing *recommendations* is beyond the scope of the prototype demonstration as is staging of responder vehicles as these are more operational than technology-based decisions. However, emergency responders will be able view the relative positions of on-scene assets and traffic diversion plans, which will provide them the information that will allow them to make these decisions. Information on lane closures and traffic conditions will be provided via the CapWIN overview of the transportation system and the Incident Zone Scene view. The incident commander will have the ability to specify staging locations via the CapWIN Incident Log and through direct messages to specific responders. To maintain the integrity and usability of the visual screens, especially the GIS Incident Scene view, CapWIN will only display the actual positions of where responder vehicles actually are staged.
RS-18	The RESP-STG Vehicle and Equipment Staging Function shall detect the vehicle location using GPS and update system representations.	RE-6, RE-8	Yes	The system will use a combination of GPS and user input to geo-locate individual on-scene assets.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-19	The RESP-STG Vehicle and Equipment Staging Function shall show the locations and estimated time of arrival at the incident scene of en-route emergency responders.	RE-8	Partial	Dynamically determining the estimated time of arrival for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration as these vehicles can be operated outside of normal vehicle operations. We cannot reliably estimate an ETA because this vehicle operates outside of the rules normally used in navigation software products. For instance, this vehicle can invoke signal pre-empts, or legally run a red light, travel the wrong way on a one-way street, etc. However, once a responder has indicated that they are responding their location relative to the incident/accident will be available as an optional data layer on CapWIN's incident map. The en-route responder can manually provide an ETA estimate through utilization of the CapWIN Incident Log or through direct messages to specific responders such as the incident commander.
RS-20	The RESP-STG Dynamic Routing Function shall provide real-time navigation instructions from a selected starting point to a selected destination using real-time and predictive algorithms.	RE-3, RE-5	Partial	Dynamically determining real-time navigation instructions for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration because these vehicles are not subjected to the same constraints as passenger vehicles. For example, they can utilize one-way streets and other roads that may be typically prohibited or restricted for public use. However, once a responder has indicated that they are responding their location relative to the incident/accident will be available and updated as an optional data layer on CapWIN's incident map.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-21	The navigation instructions shall route around unplanned (but previously reported) road closures.	RE-3, RE-5	Partial	Dynamically determining real-time navigation instructions for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration. However, road closure information for the incident and surrounding areas will be made available to responders. Additionally, once a responder has indicated that they are responding their location relative to the incident/accident will be available and updated as an optional data layer on CapWIN's incident map.
RS-22	The navigation instructions shall include options to select roads that are reported to have been cleared of snow by snowplow reports.	RE-3, RE-5	No	Dynamically determining real-time navigation instructions for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration. The addition of snow and snowplow reports is also beyond the scope.
RS-23	The navigation instructions should use real-time traffic volume data to determine travel times and account for predicted congestion of traffic near an incident scene as more vehicles approach the incident scene over time.		Partial	Dynamically determining real-time navigation instructions for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration. However, real-time traffic conditions will be provided to responders. Additionally, once a responder has indicated that they are responding, their location relative to the incident/accident will be available and updated as an optional data layer on CapWIN's incident map.
RS-24	The RESP-STG Dynamic Routing Function shall access video feeds from assets in and around an incident zone, including: Transportation Manager Center closed circuit television (CCTV) Traffic helicopters or airplanes Emergency responder vehicles	RE-3, RE-5	Partial	If available, video feeds from TMC and emergency responder vehicles will be provided. Integration with aircraft is beyond the scope of the prototype demonstration.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-25	The video feeds shall be processed to assess traffic congestion and the results shall be incorporated into the travel time estimates.	RE-2, RE-3, RE-5	No	Processing of video feeds is beyond the scope of the prototype demonstration. However, traffic information will be provided and this information is likely to utilize road sensors and roadside infrastructure.
RS-26	The navigation instructions shall include options to avoid roads that are predicted to be impacted by hazardous fumes at the time of passage. *Note: HAZMAT plume modeling and identification of impacted roads will be performed by the Information Broker.*	RE-2	No	Dynamically determining real-time navigation instructions for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration. Additionally, HAZMAT plume modeling and identification of impacted roads is beyond the scope of the prototype demonstration.
RS-27	The RESP-STG Dynamic Routing Function shall receive from the Information Broker a list of medical facilities capable of treating the injuries sustained by the incident victims that are within a customizable distance from the incident scene.	RE-5	Yes	A GIS layer that includes medical facilities will be displayed as an optional layer on the CapWIN incident map. This layer will include an indication as to what type of facility (e.g., full-service ER, urgent care center, etc.) is being represented.
RS-28	The RESP-STG Dynamic Routing Function shall enable information about the incident victim(s) to be sent to the Information Broker for assessment of the recommended, available medical care facilities.	RE-5	No	Providing recommendations for medical facilities based upon availability and injuries incurred is beyond the scope of the prototype demonstration.
RS-29	The RESP-STG Dynamic Routing Function shall estimate travel times to the listed medical facilities.	RE-5	Partial	Dynamically determining the estimated travel times for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration. However, the medical facilities and the responder's vehicles will be co-displayed as elements in a map layer of CapWIN's Incident Map.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-30	The list shall be sortable and shall include the following information regarding the medical facility: Triage level capability Confirmation of space available Distance from the incident scene Estimated travel time	RE-5	No	Providing recommendations for medical facilities based upon availability and injuries incurred is beyond the scope of the prototype demonstration.
RS-31	The RESP-STG Dynamic Routing Function shall provide navigation instructions to the medical facility selected by the User.	RE-5	Partial	Dynamically determining real-time navigation instructions for emergency vehicles operating outside of normal vehicle operational parameters is beyond the scope of the prototype demonstration. However, the medical facilities and the responder's vehicles will be co-displayed as elements in a map layer of CapWIN's Incident Map.
RS-32	The RESP-STG Emergency Responder Status Reporting Function shall maintain a continuously updated inventory of all information sources available at the incident scene and shall provide access to those assets when requested via the Information Broker.	RE-5	Yes	

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-33	The RESP-STG Emergency Responder Status Reporting Function shall transmit the following traffic- or emergency-responder-related information to the Information Broker when instructed: Estimated Time of Arrival Summary of Equipment/Personnel Staging Intentions Arrival Approach (Directionality, Route) Route Taken Traffic/Travel Conditions Encountered	RE-5	No	This is beyond the scope of the prototype demonstration.
RS-34	The RESP-STG Emergency Responder Status Reporting Function shall transmit the following traffic-related information to the Information Broker when instructed: Lane closure information in the proximity of the incident zone Recommended traffic diversion locations	RE-1, RE-2	Yes	Lane closure information in the proximity of the incident will be provided through CapWIN's system. Recommend traffic diversion locations will be based upon existing FITM plans and displayed as map-layers on the CapWIN Incident Map.
RS-35	The RESP-STG Emergency Responder Status Reporting Function should transmit the following traffic-related information to the Information Broker when instructed: Traffic helicopters or airplanes Emergency responder vehicles	RE-1, RE-2	Partial	The inclusion of traffic helicopters and/or airplanes is beyond the scope of the prototype demonstration.

Table 3-2. Assessment of Existing RESP-STG Functional and Performance Requirements (Continued)

Req. ID	RESP-STG Functional Requirement Description	User Need ID	Included in Prototype	Comments
RS-36	The RESP-STG Emergency Responder Status Reporting Function shall transmit the following emergency-response-related to the Information Broker when instructed: Types of on-scene emergency vehicles Locations of on-scene emergency vehicles Emergency responder vehicles onboard dash-cams HAZMAT plume location Incident victim details	RE-1, RE-2	Partial	HAZMAT plume location and incident victim details are beyond the scope of prototype demonstration.
RS-37	When en-route to an incident scene, the RESP-STG Emergency Responder Status Reporting Function shall report traffic-related information to the Information Broker to assess the traffic flow encountered by the emergency responder. The information will include: Speed Heading Route to destination Estimated time of arrival, reported in local time	RE-1, RE-6, RE-7	Partial	Traffic information will be included as part of the prototype demonstration, though this information will be obtained from other sources and not based upon the responder vehicles. The relative position of responding vehicles will be made available and an additional optional data layer on CapWIN's Incident map. Estimated time of arrival is beyond the scope of the prototype demonstration. However, the en-route responder can manually provide an ETA estimate through utilization of the CapWIN Incident Log or through direct messages to specific responders such as the incident commander.
RS-38	The RESP-STG Emergency Responder Status Reporting Function shall provide the Information Broker access to any of the available information assets when requested.	RE-1, RE-6, RE-7	Partial	As noted in the comments to previous requirements.
RS-39	The number of information assets that can be viewed simultaneously shall be TBD, depending upon the types of feeds or information being transmitted.	RE-1, RE-6, RE-7	Yes	

Source: Battelle

3.2 Existing Requirements for Incident Scene Work Zone Alerts for Drivers and Workers

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.

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.

Table 3-3. Previously Identified INC-ZONE Stakeholder Needs

User Need ID	INC-ZONE User Need
IN-1	Enhance crash scene or work zone safety by alerting responders about encroaching vehicles.
IN-2	Enhance crash scene safety by warning motorists via in-vehicle device that they impeding on a crash scene or other work zone operation.
IN-3	Enhance crash scene safety by providing motorists with merging and speed guidance via in-vehicle devices.
IN-4	Facilitate the exchange of information to other users such as TMC operators to enhance crash scene or work zone safety.
IN-5	Facilitate the exchange of information to other users such as TMC operators to enhance mobility in proximity to crash scenes and work zones.
IN-6	Provide and receive additional information that is a critical input into developing staging plans.
IN-7	Provide and receive data that is a critical input into route guidance functions.

Source: Battelle

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-1	The INC-ZONE Communications functional shall receive and transmit data between INC-ZONE and RESP-STG using a reliable transport mechanism as defined by the percentage of successful sent/receive communication pairs.	IN-4, IN-5, IN-6	Yes	This will be accomplished through cellular as part of the CapWIN system and as implemented using in-vehicle, rugged mobile computers. Data will be collected during the prototype demonstration to assess the reliability of this medium for this requirement.
IZ-2	The INC-ZONE Communications functional shall receive and transmit data between INC-ZONE and the Information Broker using a reliable transport mechanism.	IN-4, IN-5, IN-6	Yes	This will be accomplished through cellular connectivity as part of the CapWIN system and as implemented using in-vehicle, rugged mobile computers.
IZ-3	The INC-ZONE Communications functional shall receive and transmit data between INC-ZONE and the On-Scene Emergency Responders using a reliable transport mechanism.	IN-4, IN-5, IN-6	Yes	This will be accomplished through cellular connectivity as part of the CapWIN system and as implemented using in-vehicle, rugged mobile computers. This will also be accomplished through use of DSRC and Emergency Responder Radio systems.
IZ-4	The INC-ZONE Communications functional shall receive and transmit data between INC-ZONE and the Traveling Public using a reliable transport mechanism.	IN-3, IN-3	Yes	This will be accomplished through a Mobile Application, and DSRC communications.
IZ-5	The INC-ZONE Communications function shall receive and transmit data between INC-ZONE and the INC-ZONE deployed equipment using a reliable transport mechanism.	IN-2, IN-3	Yes	This will be accomplished through cellular connectivity as part of the CapWIN system and as implemented using in-vehicle, rugged mobile computers. This will also be accomplished through use of DSRC and Emergency Responder Radio systems.
IZ-6	The INC-ZONE On-coming Vehicle Alert and Warning Function shall detect when a vehicle is TBD seconds, minimum, from entering an incident zone.	IN-1, IN-2	Yes	Seconds to be determined as a function of equipment capabilities, but is expected to be at least TBD seconds.

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-7	The detection equipment shall operate when deployed in outdoor environmental conditions.	IN-1, IN-2, IN-3, IN-4 IN-5, IN-6	Yes	
IZ-8	The INC-ZONE On-coming Vehicle Alert and Warning Function will receive position information from all Connected Vehicle-enabled vehicles approaching the incident zone that are broadcasting only position information.	IN-1, IN-2, IN-3	Yes	This will be based upon Connected Vehicle DSRC communications protocols.
IZ-9	The INC-ZONE On-coming Vehicle Alert and Warning Function will receive location and predictive path information from on-coming vehicle broadcasting Enhanced Basic Safety Messages.	IN-1, IN-2, IN-3,	Yes	
IZ-10	The INC-ZONE On-coming Vehicle Alert and Warning Function shall alert the vehicle operator that he is entering an incident zone by sending a high-priority DSRC message from the detection equipment to the Approaching Vehicle.	IN-2	Yes	
IZ-11	The DSRC message from the INC-ZONE On-coming Vehicle Alert and Warning Function shall contain: • Notification that vehicle is entering an incident zone • Recommended incident zone speed limit • Lane closure information	IN-2	Yes	
IZ-12	The in-vehicle alert shall include both audible and visual messages to communicate the DSRC message contents to the vehicle operator per guidance provided in ATIS/CVO (FHWA-RD-98-057), or equivalent.	IN-2	Yes	

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-13	If the INC-ZONE On-coming Vehicle Alert and Warning Function determines the vehicle is being operated in an unsafe manner, then it shall warn the vehicle operator and instructs them to take action.	IN-2	Yes	Unsafe in the context of the INC-ZONE application implies that the vehicle has been identified as a potential threat to the first-responders.
IZ-14	The INC-ZONE On-coming Vehicle Alert and Warning Function shall determine whether or not a vehicle is approaching the incident zone in a safe manner. *("Safe Manner" shall be defined as one in which the vehicle is predicted, through the use of mathematical models, to remain in the control of the operator)*	IN-2	Yes	
IZ-15	The INC-ZONE On-coming Vehicle Alert and Warning Function shall extract the Enhanced Basic Safety Message from the vehicle's onboard equipment for inclusion in the mathematical models.	IN-2, IN-3	Yes	The algorithm will likely also include elements beyond the predictive path component of the Enhanced Basic Safety Method.
IZ-16	The INC-ZONE On-coming Vehicle Alert and Warning Function should extract from the vehicle's onboard equipment, the vehicle's characteristics necessary to mathematically predict the distance required for the operator to stop the vehicle.	IN-2, IN-3	Yes	
IZ-17	The INC-ZONE On-coming Vehicle Alert and Warning Function should obtain local road condition information from the Information Broker necessary to define the road friction characteristics to more accurately mathematically predict the distance required for the operator to stop the vehicle.	IN-2, IN-3, IN-4, IN-5	No	Inclusion of road friction characteristics is beyond the scope of the prototype demonstration.

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-18	The incident information warning to drivers and passengers of the on-coming vehicle shall include audible and visual messages per guidance provided in ATIS/CVO (FHWA-RD-98-057), or equivalent. See Requirement IZ-19 for a description of these warnings.	IN-2, IN-3	Yes	
IZ-19	The incident information warning to drivers and passengers of the on-coming vehicles shall include instructions that the vehicle operator can follow to operate their vehicle operation in a safe manner. Such instructions shall include the following actions as appropriate to the conditions: • Reduce speed • Merge	IN-2, IN-3	Yes	
IZ-20	If the vehicle operator does not take action to operate the vehicle in a safe manner, then a second DSRC high priority message shall be sent to the vehicle operator with instructions to immediately take corrective action.	IN-2, IN-3	Yes	
IZ-21	The corrective action warning to on-coming vehicle operators shall include audible and visual messages, per guidance provided in ATIS/CVO (FHWA-RD-98-057), or equivalent.	IN-2, IN-3	Yes	
IZ-22	The corrective action warning to on-coming vehicle operators shall include instructions that the vehicle operator can follow to return vehicle operation to a safe manner. Such instructions shall include the following actions as appropriate to the conditions: • Reduce speed • Merge	IN-2, IN-3	Yes	

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-23	The corrective action warning should include a tactile indicator to capture the vehicle operator's attention.	IN-2	No	Development and inclusion of a tactile indicator is beyond the scope of the prototype demonstration.
IZ-24	The INC-ZONE Emergency Responder Warning Function shall receive notification from the INC-ZONE On-coming Vehicle Alert and Warning Function that a vehicle being operated in an unsafe manner is approaching the incident zone.	IN-1	Yes	
IZ-25	The INC-ZONE Emergency Responder Warning Function shall transmit an "emergency responder collision" alert of a potentially dangerous situation caused by the unsafely operated vehicle to all persons within the incident zone.	IN-1	Yes	This requirement also implies another requirement to be included in the prototype demonstration: responders that are not within the incident zone will not receive the alerts.
IZ-26	The threshold for determining when the emergency responder collision alert is to be transmitted should be configurable.	IN-1	Yes	This will in a configuration file that will allow the thresholds to be able to be changed, but not in real-time.
IZ-27	The INC-ZONE Emergency Responder Warning Function shall transmit a high priority message containing the emergency responder collision alert to a device that can be worn by an emergency responder. *Note: for the purposes of this document, a device that can be worn by a person is termed a "Personal Alerting Safety System, or PASS.*	IN-1	Yes	This will be accomplished through the first responder's radio system or through a DSRC-based device.
IZ-28	The PASS shall generate a notification that will capture the attention of the emergency responder.	IN-1	Yes	

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-29	The emergency responder collision alert shall be configurable such that the emergency responder can select to be alerted by any or multiple of the following methods: • Visible alerts • Audible alerts • Tactile alerts	IN-1	Partial	Tactile alerts are not included in the scope of the prototype demonstration. Also, for the prototype demonstration it is anticipated that both visible and audible alerts will be provided but that "menu or settings" to programmatically configure these may not be provided.
IZ-30	The INC-ZONE Emergency Responder Warning Function should transmit an emergency responder collision alert of a potentially dangerous situation caused by the unsafely operated vehicle to all persons within the incident zone who are not equipped with a Personal Alerting Safety System.	IN-1	Yes	This requirement also implies another implicit requirement that will also be included in the prototype demonstration: persons that are not within the incident zone will not receive the alerts.
IZ-31	The emergency responder collision alert should be communicated in a manner that could secure the attention of all persons within the incident zone, including emergency responders and the general public. Note: some examples provided here for illustration purposes only include sirens, variable message signs, and strobe lights.	IN-1	Yes	The prototype demonstration will include sounding the horn and headlights of an emergency responder's vehicle (passenger vehicles).
IZ-32	The INC-ZONE Incident Staging Function shall utilize the RESP-STG Visual Display Function, which shall develop a spatial representation of the incident zone from information received from the RESP-STG functions and present information on a graphical display.	IN-6	Yes	Subject to the RESP-STG requirements and comments identified above.

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-33	The INC-ZONE Incident Staging Function shall utilize the RESP-STG Visual Display Function to permit a System Administrator to establish multiple Master displays of selected information for customizable purposes and assign these Master Display unique labels. It shall permit an authorized User to add or remove selected information from the display by manually turning on or off a unique layer. *Note: examples could include a Master Display for a speeding violation, a minor traffic incident, and an accident involving HAZMAT vehicle.*	IN-6	Yes	Any user of the CapWIN system can view an overview of the surrounding area with accidents and incidents placed upon a GIS map layer. On the map view you can "hover over" any incident and obtain more detailed information, including its type. CapWIN also has the incidents as a list that can be viewed by type of incident. As the responder pulls up on scene, a roadway representation is provided in CapWIN. This can be modified by the responder (or anyone else who has access to the CapWIN system for that incident) to adjust as needed to the roadway geometry. The creation of Master Displays is done automatically initially by the software, and then modified by the responders, dispatchers, etc. as needed.
IZ-34	The INC-ZONE Incident Staging Function shall utilize the RESP-STG Visual Display Function to permit an authorized User to add or remove selected information from the display by manually turning on or off a unique layer.	IN-6	Yes	This functionality is built into CapWIN's current laptop-based system.
IZ-35	The locations of all on-scene responder assets shall be included on the display as a configurable layer.	IN-6	Yes	The location of on-scene responder assets will be displayed relative to lane closures, but the specific orientation of each vehicle will not be presented (e.g., vehicles will be represented by "dots" on a map/lane layer. The direction of travel for each vehicle will be provided through positioning them on the lanes.

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-36	The INC-ZONE Incident Staging Function shall invoke the RESP-STG Vehicle and Equipment Staging Function to consolidate information from available sources into a single viewing platform for display to the User though the Visual Display Function.	IN-6	Yes	
IZ-37	The INC-ZONE Incident Staging Function shall invoke the RESP-STG Vehicle and Equipment Staging Function to access through the Information Broker the following fixed information assets: • Geographic Information System overlays • Road maps • Topography maps • Database of still photographs • Database of satellite imagery • Video cameras	IN-6	Partial	Hazmat is not included in the Prototype Demonstration; therefore, we are not including Topographical Maps.
IZ-38	The INC-ZONE Incident Staging Function shall invoke the RESP-STG Vehicle and Equipment Staging Function to access through the Information Broker the following variable information assets: • HAZMAT plume modeling and identification of impacted roads • Type and position of emergency responder vehicles at an incident scene • Locations of medical care facilities	IN-6	No	HAZMAT plume modeling and identification of impacted roads, locations of medical care facilities, and weather data are beyond the scope of the prototype demonstration. Information on the type and position of emergency responder vehicles at an incident scene will be provided.

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-39	The INC-ZONE Incident Staging Function shall invoke the RESP-STG Vehicle and Equipment Staging Function to access through the Information Broker the following traffic information assets: • Current traffic speed	IN-5, IN-6	Yes	This will be included as a data layer on an overview GIS map with traffic speed represented by color code (red, yellow, green).
IZ-40	The INC-ZONE Incident Staging Function shall invoke, based on the available data, the RESP-STG Vehicle and Equipment Staging Function to suggest to an emergency responder who has not yet arrived on-scene: • What direction to approach the incident scene • Where to stage the response vehicle	IN-1, IN-6	No	Navigation is beyond the scope of the prototype demonstration. Staging of response vehicles is an operational consideration rather than a technology-based determination. Positions of on-scene vehicles will be provided, but recommendations on where to stage a specific vehicle will not be provided. The incident commander, or their delegate, will have the ability to specify staging locations via the CapWIN Incident Log and through direct messages to specific responders. These will be visible (the logs) to all of responders in a timeline view.
IZ-41	The INC-ZONE Incident Staging Function shall invoke the RESP-STG Vehicle and Equipment Staging Function to allow the emergency responder to override the suggested approach and staging location.	IN-1, IN-6	No	Positioning of responder vehicles at incidents is largely governed by operational procedures and standard operating protocols. This demonstration project will provide information that could be used to implement changes to these protocols, but recommending a suggested approach and staging location is beyond the scope of the project.

Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-42	The INC-ZONE Incident Staging Function shall invoke the RESP-STG Vehicle and Equipment Staging Function to show the locations and estimated time of arrival at the incident scene of en-route emergency responders.	IN-1, IN-6	Partial	The locations of en-route emergency responders who have identified themselves as responding will be provided. Providing travel time estimates for emergency vehicles is beyond the scope of the prototype demonstration. However, once a responder has indicated that they are responding, their location relative to the incident will become available and visible on the CapWIN Incident Map.
IZ-43	The INC-ZONE Incident Zone Status Updates Function shall invoke the RESP-STG Emergency Responder Status Reporting Function, which shall maintain a continuously updated inventory of all information sources available at the incident scene and shall provide access to those assets when requested via the Information Broker.	IN-1, IN-6	Yes	All information within the CapWIN system is updated in real-time and processed by the Information Broker and made available to other CapWIN users.
IZ-44	The INC-ZONE Incident Zone Status Updates Function shall invoke the RESP-STG Emergency Responder Status Reporting Function to transmit the following emergency response related information to the Information Broker when instructed: • Types of on-scene emergency vehicles • Locations of on-scene emergency vehicles • Emergency responder vehicles onboard dash-cams • HAZMAT plume location • Incident victim details	IN-1, IN-6	Partial	HAZMAT plume location and incident victim details are beyond the scope of prototype demonstration.

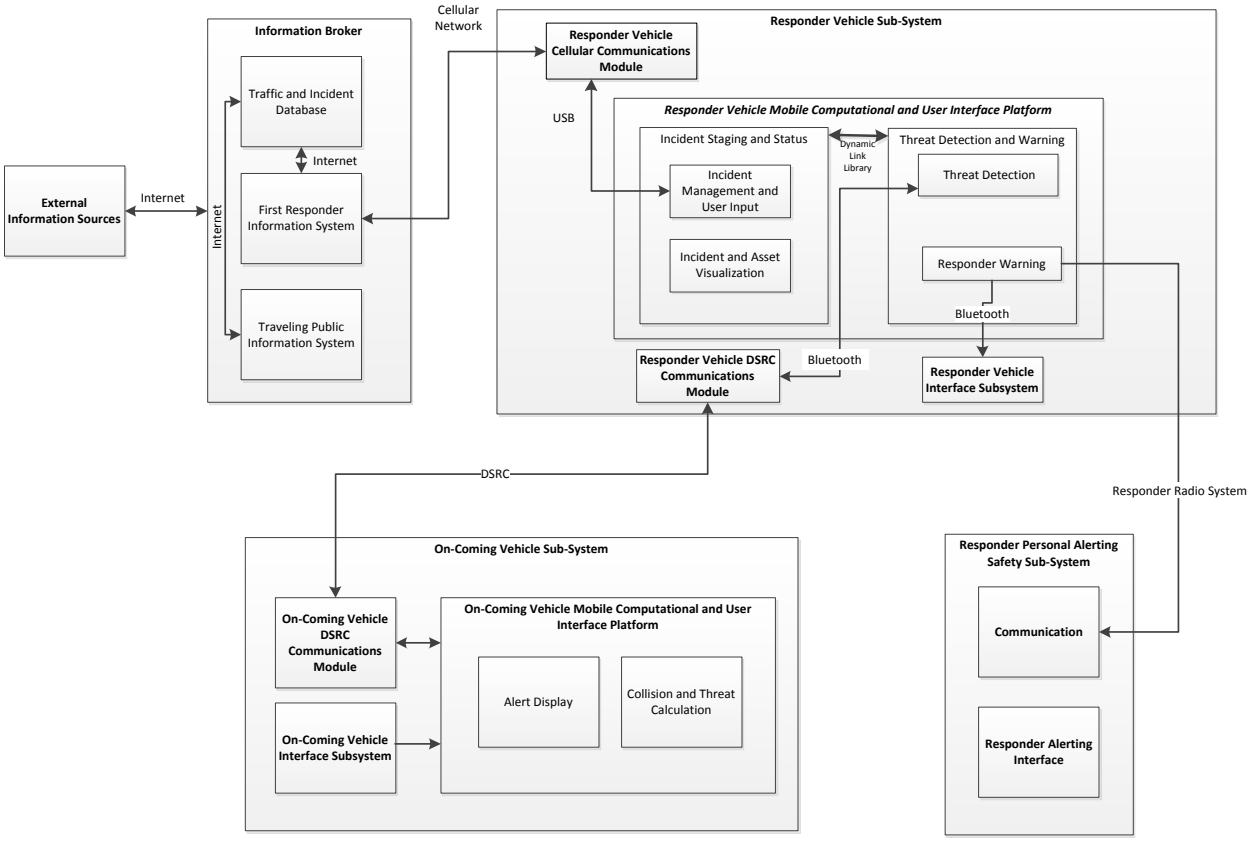
Table 3-4. Assessment of Existing INC-ZONE Functional and Performance Requirements (Continued)

Req. ID	INC-ZONE Functional Requirement Description	User Need ID	Included in Prototype	Comments
IZ-45	When en-route to an incident scene, the INC-ZONE Incident Zone Status Updates Function shall invoke the RESP-STG Emergency Responder Status Reporting Function, which shall report traffic-related information to the Information Broker to assess the traffic flow encountered by the emergency responder. The information will include: • Speed • Heading • Route to destination • Estimated time of arrival	IN-6	Partial	Traffic information will be included as part of the prototype demonstration, though this information will be obtained from other sources and not based upon the responder vehicles. The relative position of responding vehicles will be made available. Estimated time of arrival is beyond the scope of the prototype demonstration. However, once a responder has indicated that they are responding, their location relative to the incident will become available and visible on the CapWIN Incident Map.
IZ-46	The INC-ZONE Incident Zone Status Updates Function shall invoke the RESP-STG Emergency Responder Status Reporting Function, which shall provide the Information Broker access to any of the available information assets when requested.	IN-1, IN-6	Yes	
IZ-47	The number of information assets that can be viewed simultaneously shall be TBD, depending upon the types of feeds or information being transmitted.	IN-6	Yes	Any CapWIN user can view all information associated with an incident.

Source: Battelle

Chapter 4. R.E.S.C.U.M.E. Prototype System of Interest

In subsequent phases of the R.E.S.C.U.M.E. prototype development and demonstration project, a more detailed architecture and system design will be developed. However, this section provides a high-level overview of the conceived functional architecture that outlines the components of the prototype system as well as the required interfaces. Figure 4-1 illustrates the R.E.S.C.U.M.E. Prototype System with the two applications in an integrated diagram with communication channels identified. A brief description of the design elements is included following the figure.



Source: Battelle

Figure 4-1. R.E.S.C.U.M.E. Prototype System Design Overview

As illustrated in Figure 4-1, there are five main systems that will comprise the R.E.S.C.U.M.E. Prototype System. Each of these system elements and their sub-system elements are described briefly below:

- **External Information Sources.** This system element represents the host of information sources that provide information to the Information Broker and includes the other Dynamic Mobility Bundles, external entities such as Traffic Management Centers, the Traveling Public, etc. It is expected that this information will flow from these sources to the Information Broker through a number of mechanisms, but for the prototype demonstration it is assumed that this information is being made available through an Internet protocol.
- The **R.E.S.C.U.M.E. Prototype Information Broker** will consist of three sub-system elements. This system element will serve as the primary source for holding and distributing incident related information.
    - ***Traffic and Incident Database.*** This functionality will be provided by the Regional Integrated Transportation Information System (RITIS), which is already providing a ***central*** repository for incidents, traffic, and other transportation related information for the demonstration area.
    - ***First Responder Information System.*** This sub-element is responsible for pulling (and pushing) information from the Traffic and Incident Database and making the information ***available*** to or gathering the information from first responders. For the R.E.S.C.U.M.E. Prototype System, this sub-element will consist of CapWIN's existing system.
    - ***Traveling Public Information System.*** This sub-system element provides advance notification to travelers regarding traffic incidents. For the R.E.S.C.U.M.E. Prototype System, this sub-system element will be the RITIS traveler information application.
- **Responder Vehicle Sub-System.** This system element is defined by its location within the first responder's vehicle. It consists of four sub-system elements that govern communications, information collection and display, and threat detection and alerting. For the R.E.S.C.U.M.E. Prototype System, this sub-system element will be comprised of CapWIN software running on a mobile data terminal coupled with a DSRC radio and customized R.E.S.C.U.M.E. software also running on the mobile data terminal in concert with the CapWIN application[6].
    - ***Responder Vehicle Cellular Communications Module.*** All CapWIN users have in-vehicle ***systems*** that have embedded cellular connectivity. For the prototype demonstration, this will be accomplished through an aftermarket cellular card.
    - ***Responder Vehicle DSRC Communications Module.*** This sub-system element will consist of a ***Connected*** Vehicle DSRC 5.9 GHz radio that can broadcast and receive connected vehicle messages under the J2735 message set. Communication to the Mobile Computational and User Interface Platform will be accomplished with Bluetooth connectivity.

[6] Inclusion of a collision detection and warning system was restricted to utilization of Connected Vehicle technologies for this prototype demonstration and does not include technologies such as vehicle mounted radar, camera systems, etc.

- ***Responder Vehicle Interface Subsystem.*** This sub-system will be Battelle's VITAL OBD-II Module that will utilize the vehicle's OBD-II port to trigger vehicle-based alerts (e.g., flashing lights and horn). Communication to this module will be accomplished through Bluetooth protocols.
- ***Responder Vehicle Mobile Computational and User Interface Platform.*** For the R.E.S.C.U.M.E. Prototype System this platform will be a ruggedized Toughbook that is running Windows XP as this is the most common platform currently being used by CapWIN users. This computer will have the CapWIN system application installed, which will provide the mechanism for *Incident Staging and Status.* A separate computer program will operate in concert, but independently from the CapWIN system application to perform *Threat Detection and Warning*. Communication between these two applications will be performed through use of Dynamic Link Libraries.
    - *Incident Staging and Status.* This component is essentially a modified version of CapWIN's application residing upon the ruggedized computer.
    - *Threat Detection and Warning.* This element will be an embedded Windows XP application that is responsible for processing the information from the oncoming vehicle and issuing the corresponding alerts to the Vehicle Interface Subsystem and the DSRC Communications Module.

- **On-Coming Vehicle Sub-System.** This sub-system is consistent with DOT's Aftermarket Safety Device in that it obtains telematics information from the vehicle, sends and receives DSRC messages, and provides calculations and alerts to the driver. For the R.E.S.C.U.M.E. Prototype System, this sub-system will consist of a DSRC Communications Module, a Vehicle Interface Subsystem, and a Mobile Computational and User Interface Platform.

    - ***On-Coming Vehicle DSRC Communications Module.*** This sub-system element will consist of a Connected Vehicle DSRC 5.9 GHz radio that can broadcast and receive connected vehicle messages under the J2735 message set. Communication to the Mobile Computational and User Interface Platform will be accomplished with Bluetooth connectivity.
    - ***On-Coming Vehicle Interface Subsystem.*** This sub-system will be Battelle's VITAL OBD-II Module that will utilize the vehicle's OBD-II port to obtain vehicle telematics information.
    - **On-Coming Vehicle Mobile Computational and User Interface Platform.** For the R.E.S.C.U.M.E. Prototype System, this module will be an Android-based smartphone. Communication between this smartphone and the other elements will be performed through Bluetooth.
        - *Alert Display.* This element will consist of the inherent smartphone screen and sound system. It will be used to display and alert the driver of an incident and provide additional alerts if the vehicle is on a path to enter the incident zone.
        - *Collision and Threat Calculation.* This element will be a set of algorithms that will be run in the smartphone that will assimilate the vehicle telematics, GPS location, and other input to determine a risk score for the vehicle entering the incident zone.

- **Responder Personal Subsystem** essentially consists of the responder's normal operational radio system for the R.E.S.C.U.M.E. Prototype System. This radio will likely be a Motorola P25 compliant radio. There is no infrastructure component connecting to this radio system described in the figure even though responder radio systems are certainly linked by an infrastructure backbone because no information related to the prototype demonstration is being communicated through this radio system except for the responder collision warning alert.

Chapter 5. User Needs

User needs have previously been identified and documented for the R.E.S.C.U.M.E. Bundle in the Concept of Operations and were replicated in Chapter 3 of this document. However, during the development of requirements specific to the R.E.S.C.U.M.E. Prototype Demonstration, additional user needs were identified and are summarized in the following table.

Table 5-1. Additional User Needs for R.E.S.C.U.M.E. Prototype Demonstration

User Need ID	R.E.S.C.U.M.E. Prototype Demonstration
PD-1	The Responder Staging equipment and communication system must interact and co-exist within the CapWIN system.
PD-2	Incident, Traffic, and location information should be made available through CapWIN's current system.
PD-3	Responders within the incident zone will receive alerts, those outside of the zones should not
PD-4	The system needs to be easy-to-use and not require additional time for the first responder to implement once they arrive on-scene.
PD-5	The prototype system needs to be able to not only demonstrate capabilities in a test-track setting but also on a limited, 3-5 vehicle real-world test along the I-95 corridor.
PD-6	The R.E.S.C.U.M.E. Prototype System cannot be permanently mounted or otherwise damage a first responder's vehicle.
PD-7	The R.E.S.C.U.M.E. Prototype System needs to support the evaluation activities.

Source: Battelle

Chapter 6. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System

As previously discussed, this requirement document used the previously developed requirements as a starting point for the development of the complete set of requirements necessary for implementing and demonstrating the R.E.S.C.U.M.E. Prototype. This section identifies the new functional or performance requirements that are necessary as a result of the prototype-specific demonstration. These requirements are organized according to the subsystems which they support. Note that the existing requirements and performance specifications summarized in Chapter 3 are not repeated in this Chapter nor are requirements that pertain to the evaluation of the prototype demonstration as these requirements will be documented in a separate document[7].

[7] U.S. DOT has contracted an organization to conduct an evaluation of the R.E.S.C.U.M.E. Prototype Demonstration system. At this time the information that will need to be captured by the development team to support this evaluation is not yet defined.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
1.0 External Information Sources				
PD-1.0-1	The external sources feeding RITIS shall be available for use during the R.E.S.C.U.M.E. Prototype Demonstration	PD-1	Inspection	Ensures that RITIS is operational and can support the demonstration.
PD-1.0-2	Information shall be able to be input from external sources that correspond to demonstration scenarios and not 'live" data.	PD-1	Inspection	Required to prevent CapWIN users from responding to a demonstration scenario.
PD-1.0-3	Any information included from external sources to support the R.E.S.C.U.M.E. Prototype Demonstration under controlled testing shall be recognizable to CapWIN users as test data and not live incident data.	PD-5	Inspection	Required to prevent CapWIN users from responding to a demonstration scenario.
2.0 Information Broker				
PD-2.0-1	RITIS shall be used as the Traffic and Incident Database.	PD-1	Inspection	
PD-2.0-2	CapWIN's emergency responder system shall be used as the First Responder Information System.	PD-1	Inspection	
PD-2.0-3	The Traveling Public Information System should consist of the RITIS traveler information system.	IN-1	Inspection	
PD-2.0-4	Lane closure information shall be included in the Traveling Public Information System	IN-1	Demonstration	
PD-2.0-5	Lane closure information shall be made available to all components of the First Responder Information System and the Traveling Public Information System within fifteen minutes of each change in status.	IN-1	Demonstration and Test	Ensures that the information remains current.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-2.0-6	The First Responder Information System shall have the ability to communicate to the Responder Vehicle Sub-System through a combination of Internet and Cellular protocols.	IN-1	Demonstration	
3.0 Responder Vehicle Sub-System				
PD-3.0-1	All sub-system components shall be contained within or mounted upon the responder's vehicle.	PD-6	Inspection	
PD-3.0-2	Equipment shall be mounted in a manner that is safe but that does not require permanent damage to the vehicles participating in the demonstration.	PD-6	Inspection	Required as vehicles participating in the Demonstration may not retain the demonstration equipment post-demonstration.
3.1 Responder Vehicle Cellular Communications Module				
PD-3.1-1	The Responder Vehicle Cellular Communications Module should be linked to the Responder Vehicle Mobile Computation and User Interface Platform through a direct (i.e., wired) connection such as a USB, modem card, or an embedded cellular chipset.	PD-1	Inspection	
PD-3.1-2	The Responder Vehicle Cellular Communications Module shall have sufficient coverage at the R.E.S.C.U.M.E. Demonstration site to enable real-time data transfers consistent with at least 3G.	PD-1	Demonstration	
3.2 Responder Vehicle DSRC Communications Module				
PD-3.2-1	The Responder Vehicle DSRC Communications Module should be linked to the Responder Vehicle Mobile Computation and User Interface Platform through a Bluetooth, wired, or other low-latency connection method.	PD-1	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-3.2-2	The Responder Vehicle DSRC Communications Module shall be capable of receiving 5.9 GHz Connected Vehicle messages in compliance with J2735 standards.	PD-1	Demonstration	
PD-3.2-3	The Responder Vehicle DSRC Communications Module shall process and transmit the J2735 message to the Responder Vehicle Mobile Computation and User Interface Platform within one second of receiving the message.	PD-4	Demonstration and Test	
PD-3.2-4	The Responder Vehicle DSRC Communications Module shall not require user interface to send and receive J2735 messages.	PD-4	Demonstration	
PD-3.2-5	The Responder Vehicle DSRC Communications Module shall be compliant with U.S. DOT's research QPL and log the DSRC messages	PD-4	Demonstration	
PD-3.2-6	The Responder Vehicle DSRC Communications Module can be powered from the vehicle but shall be able to enter low-power mode when the vehicle is not running to prevent battery drainage.	PD-6	Demonstration	Required to prevent damage to vehicle.
PD-3.2-7	The Responder Vehicle DSRC Communications Module shall be capable of transmitting lane closure information from the Responder Vehicle Mobile Computation and User Interface Platform as a J2735 compliant message.	PD-2	Demonstration	
PD-3.2-8	The Responder Vehicle DSRC Communications Module shall be capable of receiving a J2735 compliant message that contains the Collision and Threat Score for an on-coming vehicle.	IN-1	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
3.3 Responder Vehicle Interface Sub-System				
PD-3.3-1	The Responder Vehicle Interface Sub-System shall consist of Battelle's VITAL OBD-II Module	PD-6	Inspection	
PD-3.3-2	The Responder Vehicle Interface Sub-System shall include the capability to access the responder vehicle's CAN bus through the OBD-II port	IN-1, PD-3	Demonstration	
PD-3.3-3	The Responder Vehicle Interface Sub-System shall have the ability to receive Bluetooth messages from the Responder Vehicle Mobile Computation and User Interface Platform.	PD-6	Demonstration	
PD-3.3-4	The Responder Vehicle Interface Sub-System shall have the ability to process the received Bluetooth message and issue commands to the vehicle's systems using CAN bus protocols.	PD-6, PD-3	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-3.3-5	The Responder Vehicle Interface Sub-System shall support all legislated OBD-II protocols: ISO 15765-4 (CAN) ISO 14230-4 (Keyword Protocol 2000) ISO 9141-2 (Asian, European, Chrysler vehicles) SAE J1850 VPW (GM vehicles) SAE J1850 PWM (Ford vehicles) and Support for non-legislated OBD protocols: ISO 15765 ISO 11898 (raw CAN) GMLAN Single Wire CAN (GMW3089) Ford Medium Speed CAN (MS CAN) SAE J1939 OBD protocol.	PD-3, PD-6	Demonstration	Provides the ability to support all passenger vehicles post-1996 and most heavy duty vehicle (provided J1939 is available as a CAN protocol)
PD-3.3-6	The Responder Vehicle Interface Sub-System shall have the ability to cause the responder's vehicle to sound the vehicle's horn and flash the lights.	PD-3	Demonstration	Provides for a mechanism to alert first responders who do not have a radio system on their person.
PD-3.3-7	The Responder Vehicle Interface Sub-System shall not drain the vehicle's battery when the vehicle is not running.	PD-6	Inspection	Prevents damage to vehicle.
3.4 Responder Vehicle Mobile Computation and User Interface Platform				
PD-3.4-1	The Responder Vehicle Mobile Computation and User Interface Platform shall consist of a ruggedized laptop.	PD-1	Inspection	Requirement to match the equipment used in the prototype to the most common equipment found in CapWIN's user base.
PD-3.4-2	The Responder Vehicle Mobile Computation and User Interface Platform shall operate using a Windows XP Operating System.	PD-1	Inspection	Requirement to match the equipment used in the prototype to the most common equipment found in CapWIN's user base.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-3.4-3	The CapWIN software shall be installed on the Responder Vehicle Mobile Computation and User Interface Platform	PD-1	Inspection	Requires the use of CapWIN software for the Prototype
PD-3.4-4	The CapWIN software shall be able to perform all of the existing functionalities embedded in the application.	PD-1	Demonstration	Requires that the additions be built upon the CapWIN software already in use.
PD-3.4-5	The additional components added for the R.E.S.C.U.M.E. Prototype Demonstration shall not result in noticeable performance reductions from the baseline CapWIN software. That is, additional delays and responsiveness to the CapWIN software as a result of the new functionality shall be no more than 10% greater than the corresponding lag in CapWIN's baseline functionality for every , information request or screen refreshment.	PD-1	Demonstration	Requires that the new software not adversely impact the baseline software.
PD-3.4-6	The Responder Vehicle Mobile Computation and User Interface Platform shall be able to communicate to the DSRC and Vehicle Interface Sub-Systems through Bluetooth connectivity	PD-1	Demonstration	
PD-3.4-7	The Responder Vehicle Mobile Computation and User Interface Platform shall be able to communicate to the Responder Personal Article Protection Sub-system through radio communications	PD-3, IN-1	Demonstration	Requires the integration with existing first responder radio systems.
PD-3.4-8	The Responder Vehicle Mobile Computation and User Interface Platform shall have sufficient GPS accuracy to enable lane-level positioning of the responder's vehicle relative to the incident.	RE-2, RE-6	Demonstration	Reduces the amount of input required by first responders when they arrive on-scene.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
3.4.1 Incident Staging and Status				
PD-3.4.1-1	The Incident Staging and Status element shall be based upon the CapWIN software.	PD-1	Inspection	
3.4.1.1 Incident Management and User Input				
PD-3.4.1.1-1	The Incident Management and User Input Application shall automatically identify, based upon GPS, when the responder is within a pre-defined radius of an incident.	RE-7, RE-2, PD-4	Demonstration and Test	Reduces the amount of input required by first responders when they arrive on-scene. The specific radius will be determined through initial development tests and calculations based upon timing tests with vehicles at various speeds and human reaction times.
PD-3.4.1.1-2	The Incident Management and User Input Application shall include the capability for the responder to indicate that they are “en-route” or “at scene” through a touch screen or keyboard input.	RE-7, RE-2, PD-4	Demonstration	
PD-3.4.1.1-3	When the responder has indicated that they are “en-route” through the user interface, the Incident Management and User Input Application shall communicate this information to the Information Broker who will then distribute this to all CapWIN users.	PD-2, PD-4, RE-2	Demonstration	Provides the ability for all CapWIN users to see the en-route responders on an incident map.
PD-3.4.1.1-4	When the responder has indicted that they are on-scene at the incident through the user interface or based upon GPS positions, the Incident Management and User Input Application shall communicate this information to the Information Broker who will then distribute this to all CapWIN users.	PD-2, PD-4, RE-2	Demonstration	Provides the ability for all CapWIN users to see the on-scene responders on an incident map.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-3.4.1.1-5	The responder's position relative to the incident shall remain visible to CapWIN users until the incident is closed or the responder indicates that they have left the scene either by GPS location or through a user interface input.	PD-2, PD-4, RE-2, RE5	Demonstration	Prevents the loss of visibility of on-scene assets until the incident has been closed or the asset has left the scene.
PD-3.4.1.1-6	The responder shall have the ability to input lane closure information within 10 seconds using the Incident Management and User Input Application.	PD-4	Demonstration	Performance requirement to ensure that the system is not adding additional undue burden on first responders.
3.4.1.2 Incident and Asset Visualization				
PD-3.4.1.2-1	The Incident and Asset Visualization element shall continuously update and refresh the incident scene at least once every 20 seconds.	RE-1, RE-2, IN-6, IN-4	Demonstration and Test	Ensures that the information is being made available and is continuously updated.
PD-3.4.1.2-2	The Incident and Asset Visualization element shall display to the responder the location of lane closures.	IN-6, RE-7	Demonstration	
PD-3.4.1.2-3	The Incident and Asset Visualization element shall display to the responder the location of all responder on-scene vehicles relative to the incident and the roadway.	RE-7	Demonstration	Required for the realization of mobility benefits.
PD-3.4.1.2-4	The Incident and Asset Visualization element shall provide as additional layers the following items if available: Satellite views of the incident with overlays of responder vehicles Views from dash cameras and other infrastructure cameras	RE-7, RE-3	Demonstration	Enhances the potential for mobility benefits by providing visualization in concert with lane closures and a satellite image.
PD-3.4.1.2-5	The Incident and Asset Visualization shall provide a scalable rendition of the incident zone that the responder can adjust to "zoom in" or "zoom out."	RE-1, RE-2, RE-3, IN-6	Demonstration	Allows the incident map to be scalable.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-3.4.1.2-6	Additional layers of information will be made available based upon the zoom layer as discussed in Chapter 3.	RE-1, RE-2, RE-3, IN-6	Demonstration	Allows for additional layers to become visible as a user "zooms out." For example, FITM plans or traffic conditions.
PD-3.4.1.2-7	The Incident and Asset Visualization element shall make lane closure information (and updates) available to the Threat Detection and Warning element within 5 seconds of change in status.	IN-2	Demonstration	Ensures that lane closure information is being communicated in real time.
3.4.2 Threat Detection and Warning				
PD-3.4.2-1	The Threat Detection and Warning sub-system shall operate simultaneously, but independent of the Incident Staging and Status sub-system.	PD-1	Inspection	Requires linkages to data provided by CapWIN on lane closures, but not integration of the software components.
PD-3.4.2-2	The Threat Detection and Warning sub-system shall operate within a Windows XP Operating System environment	PD-1	Inspection	Requires use of OS most common among CapWIN users.
PD-3.4.2-3	The Threat Detection and Warning sub-system shall be able to receive lane closure information from the Incident Staging and Status sub-system.	PD-1	Inspection	
PD-3.4.2-4	The Thread Detection and Warning sub-system shall initiate a J2735 compliant DSRC message and send it to the Responder Vehicle DSRC Communications Module.	IN-2	Demonstration	Provides information to the on-coming vehicle regarding lane closures, traffic conditions, and location of the incident.
PD-3.4.2-5	The DSRC message shall contain lane closure information, current traffic conditions, and location.			

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
3.4.2.1 Threat Detection				
PD-3.4.2.1-1	The Threat Detection element shall process received J2735 messages that contain the Collision and Threat Score from the Responder Vehicle DSRC Communications Modules and determine if a collision alert should be issued to an on-scene responder.	IN-1	Demonstration	Receive messages from on-coming vehicle that provides a scoring for whether they are a threat to the first responder or not.
PD-3.4.2.1-2	The determination of whether or not to issue a collision alert shall be configurable to a system administrator.	IN-1	Demonstration	Allows for modification of alert thresholds.
PD-3.4.2.1-3	The Threat Detection Element shall log the collision alert.	PD-7	Inspection	Required to support the evaluation.
PD-3.4.2.1-4	Under defined scenarios included in the R.E.S.C.U.M.E. Prototype Demonstration the collision alerts shall have false positive and false negative rates less than 10% within each scenario. False positive being defined as a responder receiving a collision alert when the vehicle would in fact not enter the incident zone and strike the responder. False negative would be defined as the responder not receiving an alert when the vehicle would enter the incident zone and potentially strike a responder. Alerts issued to first responders shall not exceed a false positive rate of 10% or a false negative rate of 10% across all scenarios included in the R.E.S.C.U.M.E. Prototype Demonstration.	PD-5	Test	Performance metric. A set of proscribed vehicle paths and driver responses, will be defined for each scenario and used to test the false positive and false negative rates of the collision alerts. The parameters of these tests will vary the trajectories, distances, speeds, etc.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
3.4.2.1 Responder Warning				
PD-3.4.2.1-1	The Threat Detection element shall issue a collision alert to the responder through the responder's radio system.	PD-4	Demonstration	Eliminates the need for the responder to carry additional equipment
PD-3.4.2.1-2	Only one collision alert shall be issued in any rolling five second period.	PD-4	Demonstration and Test	Prevents overload of the responder radio and constant alerting for the same vehicle.
PD-3.4.2.1-3	Each collision alert shall consist of a visual and audible warning that does not exceed 2 seconds in duration.	PD-4	Demonstration and Test	Prevents the radio from being overwhelmed with alerts.
PD-3.4.2.1-4	All responders within the incident zone shall receive the collision alert.	PD-3	Demonstration	
PD-3.4.2.1-5	Responders that are not within the incident zone shall not receive the collision alert.	PD-3	Demonstration	
PD-3.4.2.1-6	The Responder Warning element shall issue send a command to the Responder Vehicle Interface Sub-System when an alert is issued to a responder's radio.	PD-4	Demonstration	
PD-3.4.2.1-7	The command sent to the Responder Vehicle Interface Sub-System will result in the Responder Vehicle Interface Sub-system sounding the vehicle horn and flashing the lights.	PD-4	Demonstration	
PD-3.4.2.1-8	The responder shall have the ability to disable/enable the vehicle-based alerts.	PD-4	Demonstration	Allows the responder to prevent the vehicle's horn and lights from flashing.
PD-3.4.2.1-9	The responder shall have the ability to disable/enable the radio-based alerts.	PD-4	Demonstration	Allows the responder to prevent the radio alerts from being transmitted.
4.0 On-Coming Vehicle Sub-System				
PD-4.0-1	All sub-system components shall be contained within or mounted upon the on-coming vehicle.	PD-6	Inspection	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.0-2	Equipment shall be mounted in a manner that is safe but that does not require permanent damage to the vehicles participating in the demonstration.	PD-6	Inspection	Required as vehicles participating in the Demonstration may not retain the demonstration equipment post-demonstration.
PD-4.0-3	On-coming vehicles will be restricted to passenger vehicles for the purposes of the demonstration.	PD-7	Inspection	
4.1 On-Coming Vehicle DSRC Communications Module				
PD-4.1-1	The On-Coming Vehicle DSRC Communications Module should be linked to the Mobile Computation and User Interface Platform through a Bluetooth, wired, or other low-latency connection method.	PD-1	Demonstration	
PD-4.1-2	The On-Coming Vehicle DSRC Communications Module shall be capable of receiving 5.9 GHz Connected Vehicle messages in compliance with J2735 standards.	PD-1	Demonstration	
PD-4.1-3	The On-Coming Vehicle DSRC Communications Module shall process and transmit the J2735 message to the Mobile Computation and User Interface Platform within one second of receiving the message.	PD-4	Demonstration and Test	
PD-4.1-4	The On-Coming Vehicle DSRC Communications Module shall not require user interface to send and receive J2735 messages.	PD-4	Demonstration	
PD-4.1-5	The On-Coming Vehicle DSRC Communications Module shall be compliant with DOT's Connected Vehicle certification.	PD-4	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.1-6	The On-Coming Vehicle DSRC Communications Module can be powered from the vehicle but shall be able to enter low-power mode when the vehicle is not running to prevent battery drainage.	PD-6	Demonstration	Required to prevent damage to vehicle.
PD-4.1-7	The On-Coming Vehicle DSRC Communications Module shall be capable of transmitting Collision and Threat information from the On-Coming Vehicle Mobile Computation and User Interface Platform as a J2735 compliant message.	PD-2	Demonstration	
4.2 On-Coning Vehicle Interface Sub-System				
PD-4.2-1	The On-Coming Vehicle Interface Sub-System shall consist of Battelle's VITAL OBD-II Module	PD-6	Inspection	
PD-4.2-2	The On-Coming Vehicle Interface Sub-System shall include the capability to access the responder vehicle's CAN bus through the OBD-II port	IN-1, PD-3	Demonstration	
PD-4.2-3	The On-Coming Vehicle Interface Sub-System shall have the ability to receive Bluetooth messages from the On-Coming Vehicle Mobile Computation and User Interface Platform.	PD-6	Demonstration	
PD-4.2-4	The On-Coming Vehicle Interface Sub-System shall have the ability to process the received Bluetooth message and issue commands to the vehicle's systems using CAN bus protocols.	PD-6, PD-3	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.2-5	The On-Coming Vehicle Interface Sub-System shall support all legislated OBD-II protocols: ISO 15765-4 (CAN) ISO 14230-4 (Keyword Protocol 2000) ISO 9141-2 (Asian, European, Chrysler vehicles) SAE J1850 VPW (GM vehicles) SAE J1850 PWM (Ford vehicles) and Support for non-legislated OBD protocols: ISO 15765 ISO 11898 (raw CAN) GMLAN Single Wire CAN (GMW3089) Ford Medium Speed CAN (MS CAN) SAE J1939 OBD protocol.	PD-3, PD-6	Demonstration	Provides the ability to support all passenger vehicles post-1996 and most heavy duty vehicle (provided J1939 is available as a CAN protocol)
PD-4.2-6	The On-Coming Vehicle Interface Sub-System shall not drain the vehicle's battery when the vehicle is not running.	PD-6	Inspection	Prevents damage to vehicle.

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.2-7	The On-Coming Vehicle Interface Sub-System shall have the ability to extract the following telematics information from the on-coming vehicle's CAN bus through the OBD-II port: Module Timestamp Vehicle Based Speed Vehicle Based Longitudinal Acceleration Vehicle Based Longitudinal Deceleration Vehicle Based Lateral Acceleration Vehicle Based Yaw Vehicle Based ABS status Vehicle Based Traction Control Status Vehicle Based Headlight Status Vehicle Based Wiper Status Vehicle Based Steering Wheel Angle Vehicle Based Steering Wheel Angle Velocity Vehicle Based Absolute Throttle Position	PD-3, IN-1	Inspection	Elements that will be used to develop the Collision and Threat Score.
PD-4.2-8	The On-Coming Vehicle Interface Sub-System shall transmit the vehicle telematics information to the On-Coming Vehicle Mobile Computation and User Interface Platform using Bluetooth communication at one-second (or faster) intervals.	PD-3, IN-1	Inspection and Test	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
4.3 On-Coming Vehicle Mobile Computation and User Interface Platform				
PD-4.3-1	The On-Coming Vehicle Mobile Computation and User Interface Platform shall consist of an Android-based Smartphone.	IN-2	Inspection	Limits the demonstration to Android smartphones.
PD-4.3-2	The On-Coming Vehicle Mobile Computation and User Interface Platform shall communicate with the On-Coming Vehicle DSRC and On-Coming Vehicle Interface Sub-Systems using Bluetooth communication.	IN-2	Inspection	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.3-3	The On-Coming Vehicle Mobile Computation and User Interface Platform shall log all vehicle telematics information along with GPS information at a minimum of one-second intervals. The following elements shall be logged: GPS Datetime stamp Latitude Longitude Heading GPS Speed GPS Accuracy Module Timestamp Vehicle Based Speed Vehicle Based Longitudinal Acceleration Vehicle Based Longitudinal Deceleration Vehicle Based Lateral Acceleration Vehicle Based Yaw Vehicle Based ABS status Vehicle Based Traction Control Status Vehicle Based Headlight Status Vehicle Based Wiper Status Vehicle Based Steering Wheel Angle Vehicle Based Steering Wheel Angle Velocity Vehicle Based Absolute Throttle Position	PD-7	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.3-4	The On-Coming Vehicle Mobile Computation and User Interface Platform shall log at one-second intervals the contents of the Enhanced Basic Safety Message, including predicted path.	PD-7	Inspection	Needed to support evaluation.
4.3.1 Alert Display				
PD-4.3.1-1	The Alert Display element shall display a visual alert to the driver that can be seen when the application is running in the foreground.	IN-1	Demonstration	
PD-4.3.1-2	The Alert Display element shall sound an audible alert to the driver that can be heard when the application is running in the foreground.	IN-1	Demonstration	
PD-4.3.1-3	The visual alert shall clear from the screen within 60 seconds without the need for user interaction.	IN-1	Demonstration and Test	Minimizes distracted driving.
PD-4.3.1-4	While the application is running in the foreground, the smartphone shall not enter into sleep mode.	IN-1	Demonstration	Maintains application on screen during demonstration.
PD-3.4.1-5	The visual alert shall remain on the screen for a configurable duration consisting of 1-10 seconds but not to exceed 60 seconds.	IN-1	Demonstration	
PD-3.4.1-6	The audible alert shall be a tone lasting approximately 1 second in duration.	IN-1	Demonstration	
PD-3.4.1-7	The Alert Display element shall be capable of displaying/sounding different alerts depending upon the type of alert required.	IN-1	Demonstration	
PD-3.4.1-8	All received alerts shall be given equal priority.	IN-1	Demonstration	

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-3.4.1-9	Alerts that were received when another alert is still being viewed/heard shall be discarded.	IN-1	Inspection	
4.3.2 Collision and Threat Calculation				
PD-4.3.2-1	The Collision and Threat Detection element shall consist of computer algorithms that accept as input information such as: Connected Vehicle Enhanced Basic Safety Messages (including predictive path) Vehicle telematics information from the On-Coming Vehicle Interface Sub-System.	IN-1	Inspection	
PD-4.3.2-2	The Collision and Threat Detection element shall process information and determine a predictive Collision and Threat Detection score of whether the on-coming vehicle is likely to enter the incident zone.	IN-1	Demonstration	
PD-4.3.2-3	The Collision and Threat Detection score shall be represented as a probability (i.e., 0-100%)	IN-1	Demonstration	
PD-4.3.2-4	A Collision and Threat Detection score shall be calculated at a rate of at least 1Hz (once per second).	IN-1	Demonstration	
PD-4.3.2-5	The Collision and Threat Detection score shall be used as a threshold trigger prompting a specific alert to be presented to the driver using the Alert Display element.	IN-1	Demonstration	
PD-4.3.2-6	The Collision and Threat Detection Score shall be logged to persistent memory.	PD-7	Demonstration	Necessary to support evaluation

Table 6-1. Additional Detailed Requirements Specific to the R.E.S.C.U.M.E. Prototype System (Continued)

Req. ID	R.E.S.C.U.M.E. Prototype Demonstration Functional Requirement Description	User Need ID	Verification Method	Comments
PD-4.3.2-7	All data items utilized for the calculation of the Collision and Threat Detection Score, the Collision and Threat Detection score, and the type of alert (if generated) shall be logged to persistent memory.	PD-7	Demonstration	Necessary to support evaluation
PD-4.3.2-8	A Collision and Threat Detection score shall always be calculated provided the on-coming vehicle is within an incident zone geographical boundary defined by roadway, distance, and heading.	IN-1	Demonstration	
PD-4.3.2-9	A variety of different types of alerts shall be generated based upon the Collision and Threat Detection score, the vehicle telematics information, and information on the incident (see Chapter 2).	IN-1	Demonstration	
PD-4.3.2-10	Once an alert has been issued, another alert will not be issued for a duration of time that shall be a configurable intervals based upon vehicle speed, distance to the incident, vehicle information, vehicle telematics information, and traffic conditions.	IN-1	Demonstration	Prevents a constant alert, but provides for escalation of alerts if corrective action has not been taken.
5.0 Responder Personal Alerting Safety Sub-System				
PD-5.0-1	The responder personal alerting safety sub-system should be based upon existing responder radio systems.	PD-4	Inspection	
PD-5.0-2	The responder should not have to interact with the radio system to receive the alerts.	PD-4	Demonstration	
PD-5.0-3	The alerts shall not impact the responder's ability to utilize the radio.	PD-4	Demonstration	

Source: Battelle

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

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