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6980-02941-01-103		1.0	16-Nov-2010	1 (16)
Author Company		Author Department, Name		Author Phone
SwRI		Mike Brown,1.10.60		+1 (210) 522-3104
Customer Company		Customer Name		Customer Phone
New York State DOT		Rick McDonough		+1 (518) 457-5871
Customer Contract Number		Customer Contract Start/Finish Dates		
C030588		21-Jan-2009 to 31-Dec-2010		

Concept of Operations

C030588 CVII Task 5

Task 5 builds on the base CVII infrastructure developed in Tasks 2, 3, and 4 providing a vehicle alert application for vehicle status data exchanged via vehicle-to-vehicle (V2V) communication.

Responsible	Tom Richter
Established Date	22-Feb-2010
Archived until	22-Aug-2020
Classification	OPEN

VOLVO

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6980-02941-01-10	1.0	16-Nov-2010	2 (16)
Author Company	Author Department, Name		Author Phone
SwRI	Mike Brown, 1.10.60		+1 (210) 522-3104
Customer Company	Customer Name		Customer Phone
New York State DOT	Rick McDonough		+1 (518) 457-5871
Document Title		Type of Document	
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1 General Information

This document describes the concept of operations and requirements for Task 5 of the NYSDOT CVII Project.

1.1 Document Contacts

Company	Name	Phone	Email
SwRI	Mike Brown	+1 (210) 522-3104	mabrown@swri.org
VTEC	Tom Richter	+1 (336) 393-2371	tom.richter@volvo.com

1.2 Revision History

Issue	Date	Author	Changes
1.0	11/16/2010	Mike Brown	Initial

1.3 Reference Documents

[1] Contract #C030588 – PIN: CC95.07.121
Commercial Vehicle Infrastructure Integration
New York State – Department of Transportation

[2] 6980-02821-01-02 C030588 CVII Program Plan
Volvo Technology – Tom Richter
Issue 2.1 – 15 Sep 2009

[3] NYS CVII DSRC Message Set
Southwest Research Institute – Purser Sturgeon
Issue 1.0 – 20 Aug 2010
[Based on SAE J2735 DSRC Message Set Dictionary]

[4] DMCU/Vehicle Gateway Interface Definition
Southwest Research Institute – Mike Brown
Issue 1.0.0 – 09 Oct 2009

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SwRI	Mike Brown, 1.10.60	+1 (210) 522-3104

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New York State DOT	Rick McDonough	+1 (518) 457-5871

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[5] 6980-02821-01-04 State-of-the-Art Review on Information and Warning Strategies
Volvo Technology – Paul Piamonte
Issue 1.0 – 09 Oct 2009

[6] 6980-02941-01-05 C030588 CVII Task 2 Concept of Operations
Volvo Technology – Mike Siebert
Issue 1.1 – 12 Dec 2009

[7] SAE J2540-2 – ITIS Phrase List
Society of Automotive Engineers
Issue 2002-02, Revised 2009-11

1.4   Abbreviations

ABS   Anti-lock Brake System

CDL   Commercial Drivers License

ConOps   Concept of Operations

CVII   Commercial Vehicle to Infrastructure Integration

DOT   Department of Transportation

DMCU   5.9 GHz DSRC Mobile Communications Unit

DSRC   Dedicated Short-Range Communications

ECU   Electronic Control Unit

GPS   Global Positioning System

HVI   Human Vehicle Interface

IP   Internet Protocol

N/A   Not Applicable

NYS   New York State

NYSDOT   New York State Department of Transportation

RSE   Roadside Equipment

SAE   Society of Automotive Engineers

TGW   Volvo Telematics GateWay

VII   Vehicle to Infrastructure Integration

VIN   Vehicle Identification Number

VTEC   Southwest Research Institute

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1.5 Requirement Identifier

Req TASK5-001/1.0: Requirement Identifier
The requirement identifier for this specification shall be TASK5.

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New York State DOT	Rick McDonough	+1 (518) 457-5871

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2 Task 5 Concept

2.1 Background

The overall scope of the NYSDOT CVII Project can be found in References [1] and [2].

Task 5 builds on the base CVII infrastructure developed in Tasks 2, 3, and 4 providing a vehicle alert application for emergency vehicle status data exchanged via vehicle-to-vehicle (V2V) communication.

2.2 Objectives

The objectives of Task 5 are to develop and demonstrate a CVII application which enables the exchange of vehicle status data via the SAE J2735 Emergency Vehicle Alert (EVA) message. The CVII application will alert the commercial vehicle and maintenance vehicle driver of alerts received.

The specific activities required for Task 5 are:

- Develop a vehicle alert application
  - Define an extension to the VII message set which is compatible with existing VII applications
  - Generate and send the EVA message from the maintenance vehicle
  - Receive the EVA message within the commercial test vehicle and maintenance vehicle
  - Warn the commercial vehicle and maintenance vehicle driver of alerts received from the maintenance vehicle
  - Provide an HVI consistent with the commercial vehicle environment
 - Complete acceptance test of the application

2.3 System Overview

The following components are utilized in Task 5:

- Commercial Test Vehicle includes:
  - DMCU
  - TGW
  - HVI

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- Maintenance Vehicle includes:
  - DMCU
  - TGW
  - HVI

The figure below shows the relationships between the components.
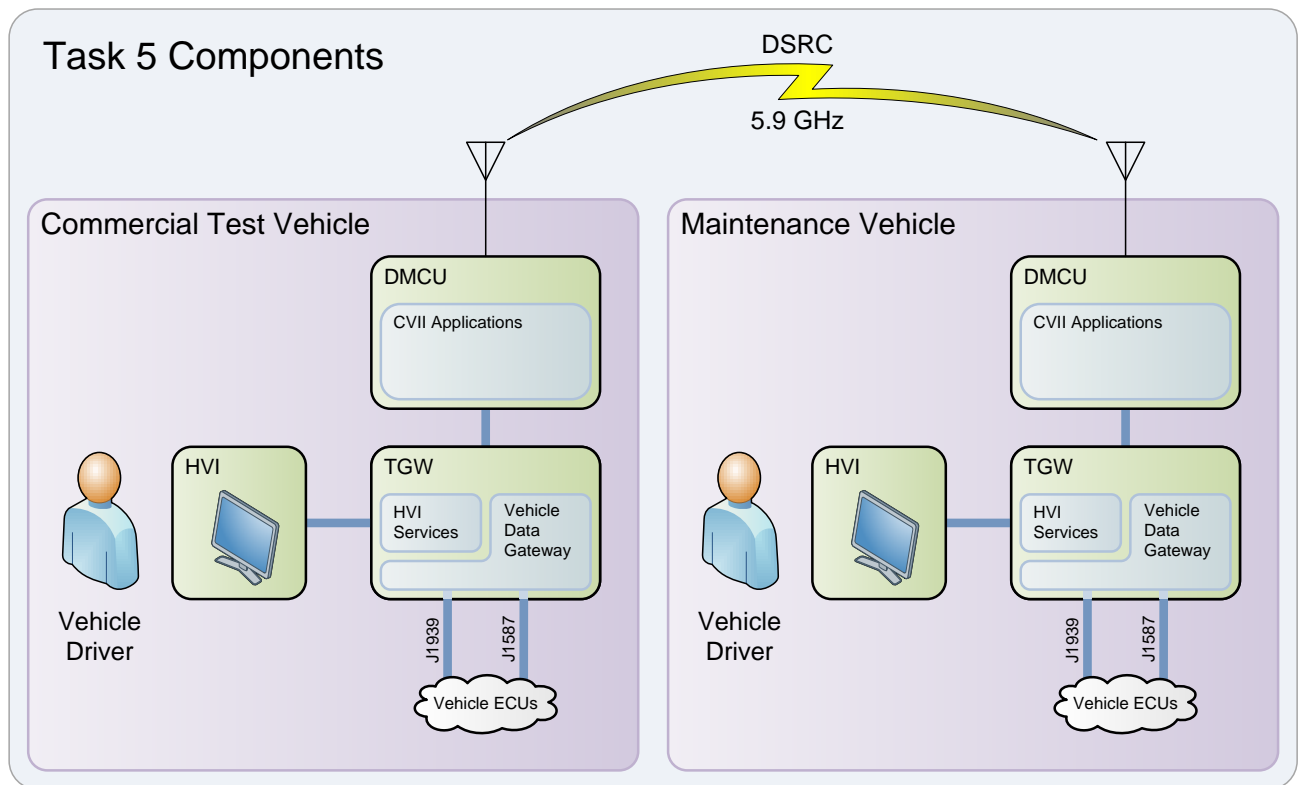

2.4 Operational Scenarios

The Maintenance Vehicle will continually broadcast the EVA message when activated by the vehicle operator or automatically by the vehicle equipment (e.g. snow plow engaged). The commercial vehicle will monitor EVAs received from DSRC equipped maintenance vehicles and alert the driver similar to a Traveler Advisory Message. Although this document describes the process of alerting the commercial vehicle driver of maintenance vehicle conditions, the alert will also be displayed to drivers of other DSRC equipped maintenance vehicles as well as DSRC equipped passenger vehicles capable of receiving, analyzing and displaying EVAs.

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The following figure shows an example alert condition in that the commercial vehicle is approaching a maintenance vehicle with the snow plow down.
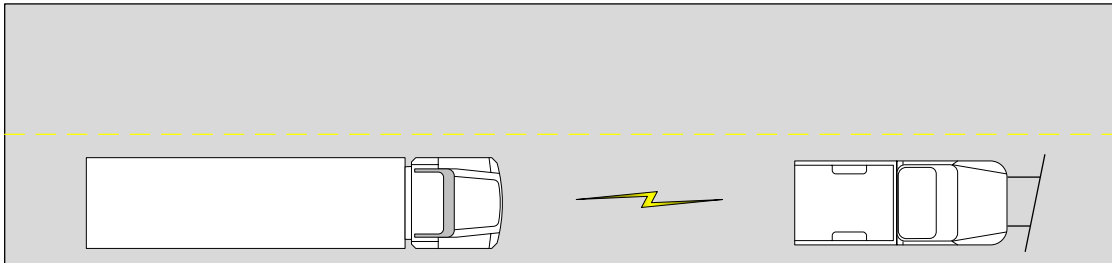
The following figure illustrates another warning condition in that the commercial vehicle is approaching a work zone. The work zone could be stationary or rolling.
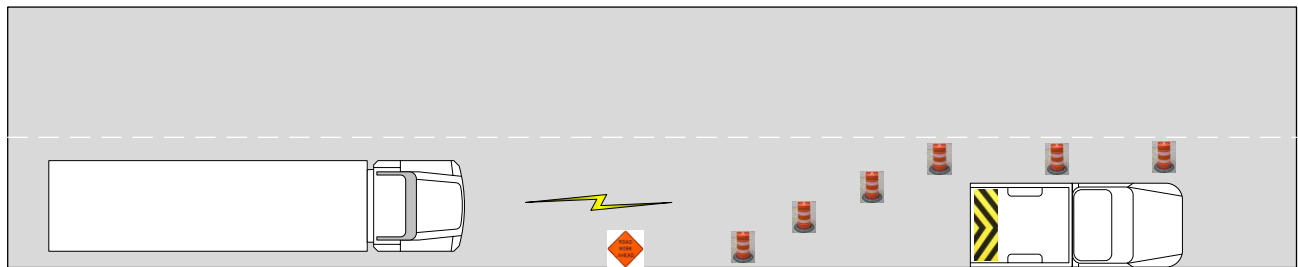
The EVA message utilizes the SAE J2735 Roadside Alert message to provide the bulk of the immediate warning condition data. However, it also provides data on the type of vehicle that is emitting the message along with the groups of vehicles that are affected by the message. The following figure shows the overall flow of the EVA broadcast and monitoring process at a high level.
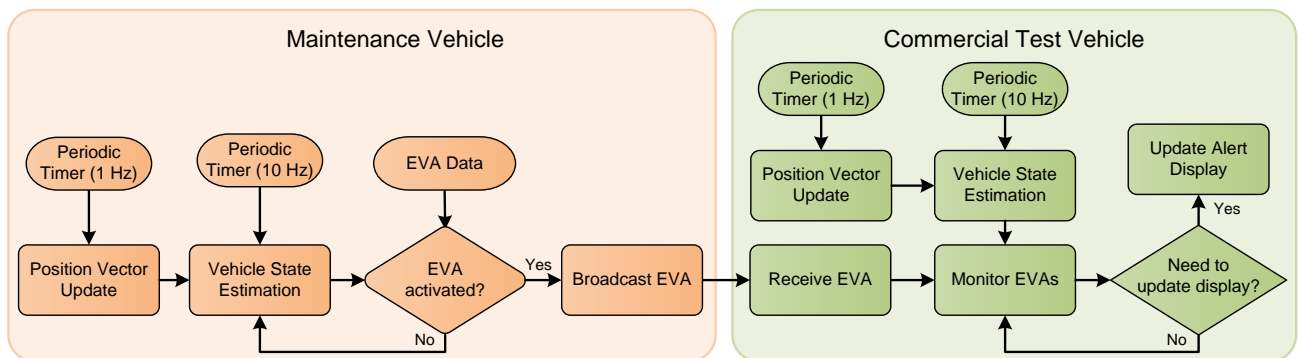
The detailed use cases for the service are detailed in the following paragraphs.

2.4.1   Vehicle State Estimation Use Case

Triggers:

- Periodic timer (default: 10 Hz)

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Use Case:

- The TGW sends a position vector update at a 1 Hz frequency.

- The DMCU uses a dead-reckoning algorithm on the latest position vector updates to estimate the vehicle state at a 10 Hz Frequency. This operation is necessary as the EVA is intended to be broadcast at 10 Hz. This operation is performed in the maintenance vehicles as well as the commercial test vehicle.

- The use case ends.

2.4.2   Manually Activate Emergency Vehicle Alert Use Case

Triggers:

- The operator of the maintenance vehicle provides the data for the EVA message and activates the message broadcast.

Use Case:

- The TGW sends an EVA Activation message to the DMCU.

- The DMCU:

  o Uses the data in the EVA Activation message along with the latest estimated state of the vehicle to generate the J2735 compliant EVA message.

  o Broadcasts the EVA message over DSRC at 10 Hz until deactivated.

- The use case ends.

2.4.3   Automatically Activate Emergency Vehicle Alert Use Case

Triggers:

- An event occurs with the vehicle equipment to activate the EVA message broadcast.

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Use Case:

- The TGW sends an EVA Activation message to the DMCU.
- The DMCU:
  o Uses the data in the EVA Activation message along with the latest estimated state of the vehicle to generate the J2735 compliant EVA message.
  o Broadcasts the EVA message over DSRC at 10 Hz until deactivated.
- The use case ends.

2.4.4 Manually Deactivate Emergency Vehicle Alert Use Case

Triggers:

- The operator of the maintenance vehicle manually deactivates the EVA message broadcast.

Use Case:

- The TGW sends an EVA Deactivation message to the DMCU.
- The DMCU terminates the 10 Hz EVA message broadcast.
- The use case ends.

2.4.5 Automatically Deactivate Emergency Vehicle Alert Use Case

Triggers:

- An event occurs with the vehicle equipment to deactivate the EVA message broadcast.

Use Case:

- The TGW sends an EVA Deactivation message to the DMCU.
- The DMCU terminates the 10 Hz EVA message broadcast.
- The use case ends.

2.4.6 Receive EVA Use Case

Triggers:

- EVA is received within the commercial test vehicle from a DSRC equipped maintenance vehicle.

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Use Case:

- The DMCU:
  - Analyzes the EVA message and determines it is a new EVA message.

    [Alternative: EVA Message is not New]
  - Determines that the message is applicable to this vehicle (e.g. position vector, vehicle type, and vehicle group affected all apply).

    [Alternative: EVA Message is not Applicable]
  - Stores the EVA message.
  - Translates the ITIS codes into advisory text.
  - Sends an add advisory message to the TGW.
- The TGW stores the advisory message in its message cache.
- The use case ends.

Alternative: EVA Message is not New

- The use case ends.

Alternative: EVA Message is not Applicable

- The use case ends.

2.4.7 Monitor EVA Use Case

Triggers:

- Periodic Timer (10 Hz)

Use Case:

- The DMCU:
  - Monitors the stored EVA messages to determine the highest priority message.
  - Determines that the highest priority EVA message has not been activated.

    [Alternative: Highest EVA message already activated]
  - Sends an activate message to the TGW.
- The TGW displays the warning condition to the driver within the constraints of:
  - Driver distraction management
- The use case ends.

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Alternative: Highest EVA message already activated

- The use case ends.

2.4.8 Remove EVA Use Case

Triggers:

- During the Monitor EVA Use Case, a stored EVA message is determined to no longer be applicable.

Use Case:

- The DMCU:

  o Determines that the message has been activated and sends a deactivate message to the TGW.

    [Alternative: EVA Message Not Activated]

  o Sends a deactivate advisory message to the TGW.

- The TGW clears the display.

- The DMCU:

  o Removes the message from its message cache

  o Sends a remove advisory message to the TGW.

- The TGW removes the message from its message cache.

- The use case ends.

Alternative: Highest EVA message already activated

- The use case ends.

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3   Task 5 Requirements

3.1   General

Req TASK5-002/1.0: Emergency Vehicle Alert Message
The Emergency Vehicle Alert message as defined in Reference [3] shall, as a minimum, contain the following information:

- Roadside Alert:
    - Event Type
    - Description
    - Priority
    - Heading
    - Extent
    - Position Vector
        - Longitude
        - Latitude
        - Heading
        - Speed
- Vehicle Group Affected
- Incident Response Equipment (Vehicle Type)

3.2   DMCU Vehicle Alert Application

Req TASK5-003/1.0: Vehicle State Estimation
The DMCU shall support estimating the vehicle state at a configurable frequency between 2 and 20 Hz. (Default: 10 Hz).

Req TASK5-004/1.0: EVA Broadcast Activation
The DMCU shall support receiving an EVA broadcast activation message using the protocol defined in Reference [4].

Req TASK5-005/1.0: EVA Broadcast Deactivation
The DMCU shall support receiving an EVA broadcast deactivation message using the protocol defined in Reference [4].

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Req TASK5-006/1.0: EVA Message Broadcast Frequency
The DMCU shall broadcast the EVA message, defined in Reference [3], at a configurable frequency when activated. (Default: 10 Hz)

Req TASK5-007/1.0: EVA Message Reception
The DMCU shall be capable of receiving and caching EVA messages, defined in Reference [3].

Req TASK5-008/1.0: New EVA Message
The DMCU shall analyze each received EVA message to determine if it is new prior to caching it.

Req TASK5-009/1.0: Applicable EVA Message
The DMCU shall use the following criteria to analyze each received EVA message to determine if it is applicable prior to caching it.

- Event Type
- Heading
- Extent
- Position
- Vehicle Group Affected
- Incident Response Equipment

Req TASK5-010/1.0: EVA Message Add/Activate/Deactivate/Remove Notifications
The DMCU shall monitor the cached EVA messages and provide the TGW with EVA message add/activate/deactivate/remove notifications identical to Travel Advisory Messages defined in the Task 2 Concept of Operations (Reference [6]) using the protocol defined in Reference [4].

Req TASK5-011/1.0: No Longer Applicable EVA Messages
The DMCU shall remove EVA messages that are no longer applicable from its message cache and notify the TGW with deactivate/remove advisory messages appropriately.

Req TASK5-012/1.0: J2540-2 ITIS Phrase Decoding
The DMCU shall support a simple lookup decoding mechanism for applicable ITIS Phrases defined in Reference [7].

3.3 TGW Alert Application

Req TASK5-013/1.0: Operator Activation of EVA Broadcast
The TGW shall send an EVA broadcast activation message to the DMCU when manually activated by the vehicle operator.

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Req TASK5-014/1.0: Automatic Activation of EVA Broadcast
The TGW shall send an EVA broadcast activation message to the DMCU when an event occurs with the vehicle equipment to trigger the activation.

Req TASK5-015/1.0: Operator Deactivation of EVA Broadcast
The TGW shall send an EVA broadcast deactivation message to the DMCU when manually deactivated by the vehicle operator.

Req TASK5-016/1.0: Automatic Deactivation of EVA Broadcast
The TGW shall send an EVA broadcast activation message to the DMCU when an event occurs with the vehicle equipment to trigger the deactivation.

Req TASK5-017/1.0: Activation / Deactivation
The vehicle operator shall be provided a simple mechanism to manually activate and deactivate the EVA message broadcast.

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