

VOLVO

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Concept of Operations

C030588 CVII Task 9

Task 9 builds on the base CVII infrastructure developed in Tasks 2, 3, 4, and 5 providing a vehicle alert application for vehicle-to-vehicle (V2V) interactions related to passing and merging traffic using data exchanged via V2V communication.

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1 General Information

This document describes the concept of operations and requirements for Task 9 of the NYSDOT CVII Project.

1.1 Document Contacts

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1.2 Revision History

Issue	Date	Author	Changes
1.0	12/06/2011	Purser Sturgeon II	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 1.0.10 – 07 Apr 2011

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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

BSM	Basic Safety Message
ConOps	Concept of Operations
CV	Commercial Vehicle
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
ITIS	International Traveler Information Systems
N/A	Not Applicable
NYS	New York State
NYS DOT	New York State Department of Transportation
RSA	Roadside Alert Message
SAE	Society of Automotive Engineers
SwRI	Southwest Research Institute
TGW	Volvo Telematics GateWay
V2V	Vehicle-to-Vehicle
VII	Vehicle to Infrastructure Integration
VTEC	Southwest Research Institute

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1.5 Requirement Identifier

Req TASK9-001/1.0: Requirement Identifier

The requirement identifier for this specification shall be TASK9.

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2 Task 9 Concept

2.1 Background

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

Task 9 builds on the base CVII infrastructure developed in Tasks 2, 3, 4, and 5 providing a vehicle alert application for vehicle-to-vehicle (V2V) interactions related to passing and merging traffic using data exchanged via V2V communication.

2.2 Objectives

The objectives of Task 9 are to develop and demonstrate a CVII application which enables the exchange of vehicle status data via the SAE J2735 Basic Safety Message (BSM) and the SAE J2735 Roadside Alert Message (RSA) used in a V2V application to enable V2V interactions and advanced information sharing. The CVII application will alert the commercial vehicle and passenger vehicle driver of the present relative safety of passing and merging maneuvers.

The specific activities required for Task 9 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 BSM from the passenger vehicle(s) and commercial vehicle
 - Receive the BSM within the commercial test vehicle and passenger vehicle(s)
 - Analyze and process the received BSM to determine the relative safety of passing and merging traffic maneuvers
 - Warn the commercial vehicle and passenger vehicle driver when it is determined that passing and/or merging maneuvers are unsafe
 - Provide an HVI consistent with the commercial vehicle environment
 - Complete acceptance test of the application

2.3 System Overview

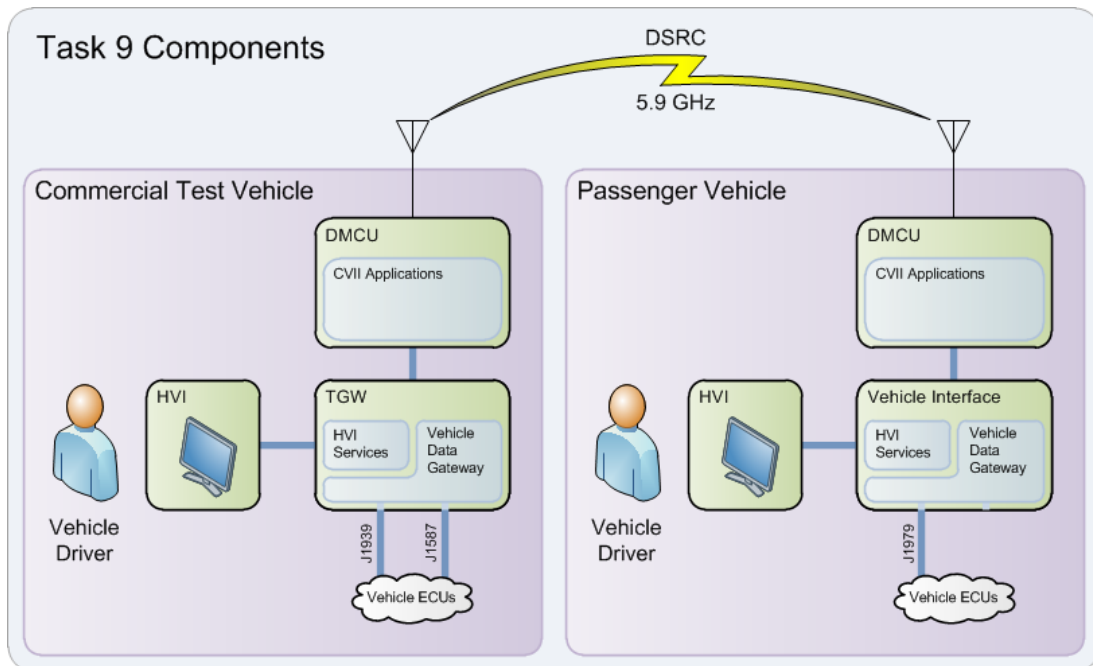
The following components are utilized in Task 9:

- Commercial Test Vehicle includes:
 - DMCU

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- TGW
- HVI
- Passenger Vehicle includes:
 - DMCU
 - Vehicle Interface System
 - HVI

The figure below shows the relationships between the components.



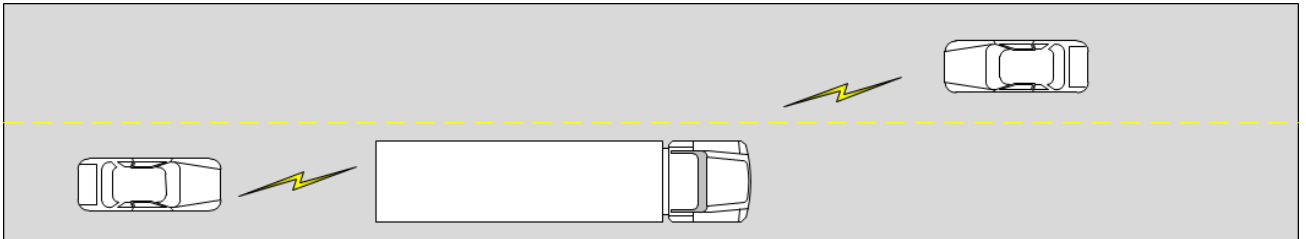
2.4 Operational Scenarios

The Passenger Vehicles and Commercial Vehicle will continually broadcast the BSM while the system is running. The vehicles will monitor BSMs received from nearby vehicles and alert the appropriate passenger vehicle driver(s) when it is unsafe to pass or merge using a message similar to a Traveler Advisory Message. While monitoring BSMs, the commercial vehicle driver will also be notified of vehicles detected in the commercial vehicles blind spot, vehicles following too close behind the commercial vehicle, and of hard braking events ahead of the vehicle. Although this document describes the process of alerting the passenger vehicle driver of times it is unsafe to pass and/or merge, the alert will also be displayed to drivers of DSRC equipped commercial vehicles, and similarly

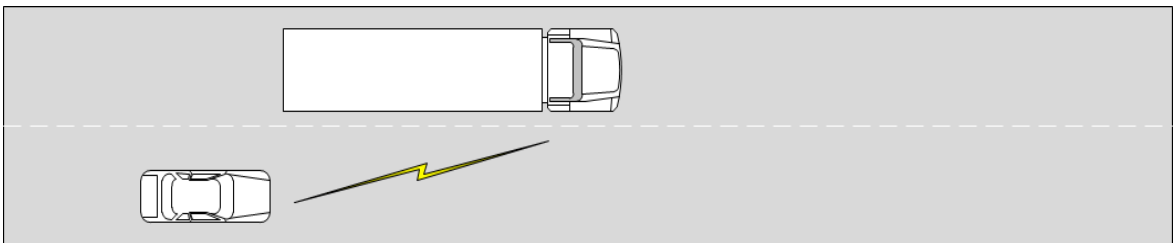
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passenger vehicles will be notified of blind spot warnings, vehicles following too close, and of hard braking events.

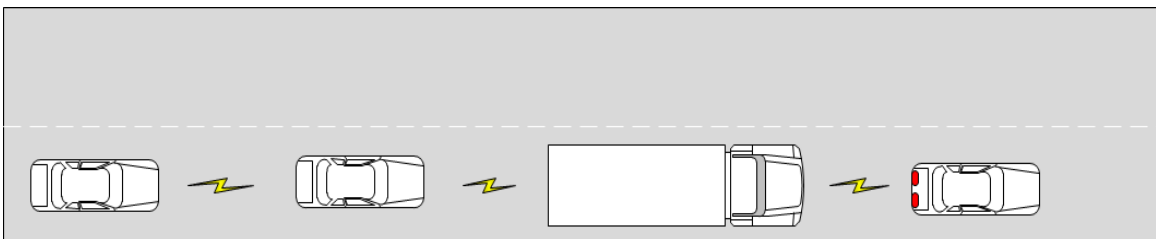
The following figure shows an example passing maneuver in which the driver of the passenger vehicle is unable to see around a commercial vehicle. The commercial vehicle monitors BSMs from vehicles within communications range. If the commercial vehicle detects an oncoming vehicle in the adjacent lane, it will send a message to vehicles following the commercial vehicle indicating that it is unsafe to pass at that time.



The following figure shows an example merging maneuver in which the commercial vehicle is traveling along the highway and about to merge into a lane with a passenger vehicle. The commercial vehicle monitors BSMs received from the passenger vehicle on the highway and determines if it is unsafe to merge based on the size of each vehicle and current speed and acceleration of the vehicles.



The following figure shows a situation where a forward vehicle slows down suddenly. Vehicles following the commercial vehicle are unable to see the vehicle slow down, however they receive a V2V alert from the commercial vehicle notifying the drivers of the vehicle slowing down ahead.

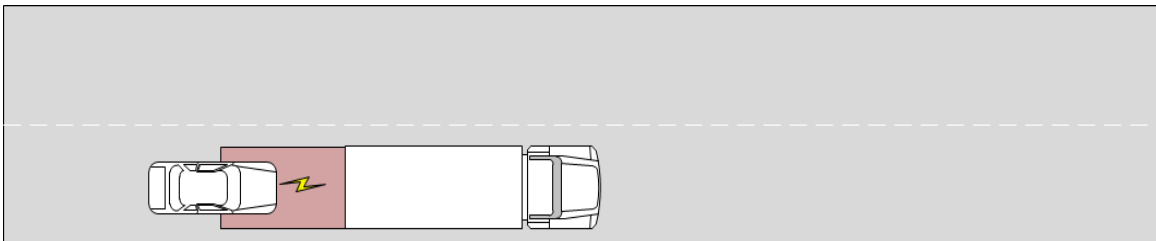


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The following figure shows two different situations in which a vehicle is in a blind spot of a commercial vehicle. In both cases, the commercial vehicle would detect the vehicle in the blind spot based on received BSMs and notify the driver of the commercial vehicle.

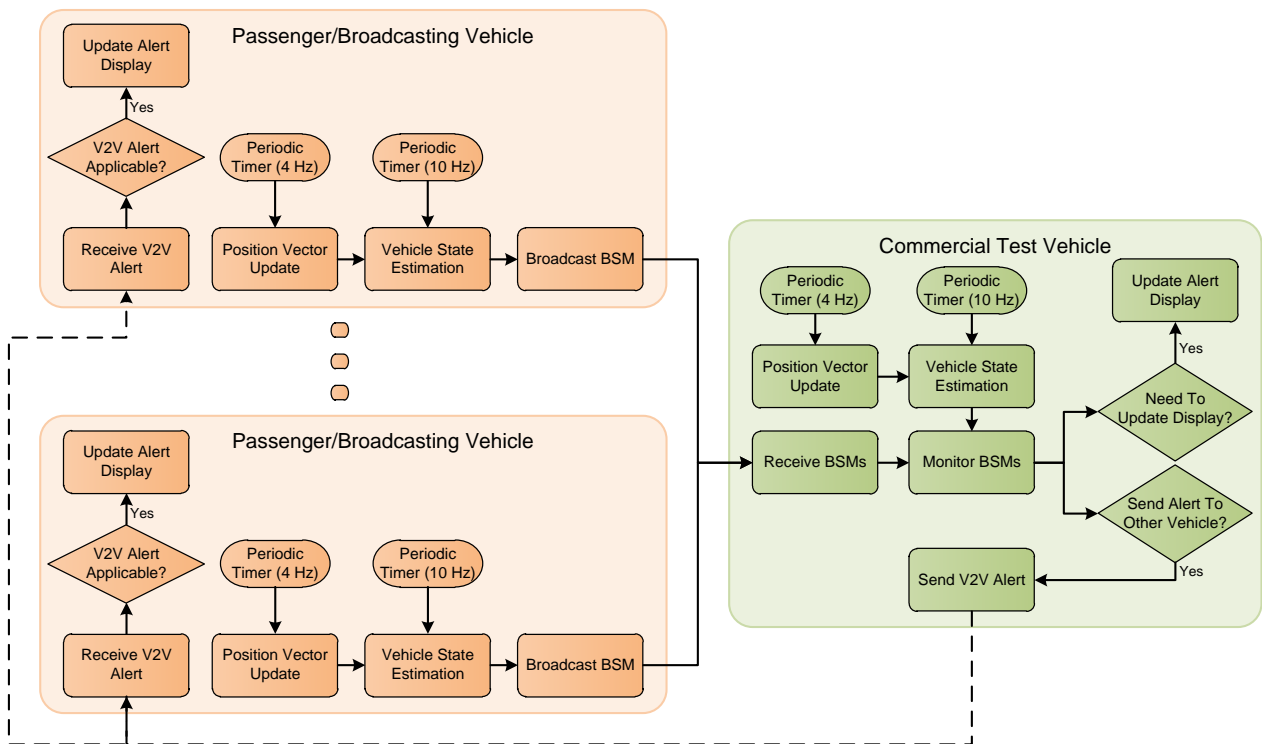


The following figure shows a vehicle following too closely to a commercial vehicle. The commercial vehicle would detect the vehicle behind based on received BSMs and notify the driver of the commercial vehicle.



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The BSM is defined in the SAE J2735 message set to provide a complete, succinct, real-time message that describes a vehicles current dynamics, including speed, heading, and location. The following figure shows the overall flow of the BSM 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)

Use Case:

- A position vector update is generated at a minimum of 4Hz and will allow sufficient accuracy of vehicle position to be determined. The exact positional accuracy required will be determined during initial testing.
- 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 BSM is intended to be broadcast at 10 Hz. This operation is performed in the passenger vehicles as well as the commercial test vehicle.

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- The use case ends.

2.4.2 Broadcast BSM Use Case

Triggers:

- The system in the vehicle is started.

Use Case:

- The DMCU starts up and receives a valid GPS fix.
- The DMCU broadcasts the BSM over DSRC at 10 Hz until the system is stopped.
- The use case ends.

2.4.3 Receive BSM Use Case

Triggers:

- BSM is received within the test vehicle from another DSRC equipped vehicle that is broadcasting BSMs.

Use Case:

- The DMCU:
 - Analyzes the BSM and determines it is from a currently known vehicle.
[Alternative: BSM is from a previously unknown vehicle]
 - Updates the existing BSM for the vehicle.
- The use case ends.

Alternative: BSM is from a previously unknown vehicle

- Stores the BSM for the new vehicle.
- The use case ends.

2.4.4 Monitor BSM – Interest to CV Use Case

Triggers:

- Periodic Timer (10 Hz)

Use Case:

- The DMCU:
 - Monitors the stored BSM(s) to identify a vehicle(s) that is (are) in regions of interest.

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- Determines that there is a vehicle(s) in a region of interest to the commercial vehicle.

[Alternative: No vehicles are detected in the commercial vehicle's regions of interest]

- Sends traveler advisory message to the TGW.
- The TGW displays the warning condition to the driver within the constraints of:
 - Driver distraction management
- The use case ends.

Alternative: No vehicles are detected in the commercial vehicle's regions of interest

- The use case ends.

2.4.5 Monitor BSM – Interest to Passenger Vehicle Use Case

Triggers:

- Periodic Timer (10 Hz)

Use Case:

- The DMCU:
 - Monitors the stored BSM(s) to identify a vehicle(s) that is (are) in regions of interest.
 - Determines that there is a vehicle in a region of interest to the commercial vehicle.

[Alternative: No vehicles are detected in the commercial vehicle's regions of interest.]

- Sends a V2V alert message to the appropriate vehicle(s).
- The use case ends.

Alternative: No vehicles are detected in the commercial vehicle's regions of interest

- The use case ends.

2.4.6 Vehicle Receives V2V Alert Use Case

Triggers:

- Commercial vehicle sends a V2V Alert message to a passenger vehicle in a region of interest.

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Use Case:

- The DMCU:
 - Verifies that the message is applicable to the vehicle based on the vehicles position and movement.
[Alternative: V2V Alert is not applicable]
 - Sends a traveler advisory message to vehicle interface.
- The vehicle interface updates the display.
- The use case ends.

Alternative: V2V Alert is not applicable

- The use case ends.

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3 Task 9 Requirements

3.1 General

Req TASK9-002/1.0: Basic Safety Message

The Basic Safety Message as defined in Reference [3] shall, as a minimum, contain the following information:

- Basic Safety Message:
 - Position Vector
 - Time
 - Longitude
 - Latitude
 - Heading
 - Speed

Req TASK9-003/1.0: V2V Alert Message

The V2V Alert Message shall use the message structure defined for the Roadside Alert Message as defined in Reference [3] which, as a minimum, contains the following information:

- Roadside Alert Message:
 - Event Type
 - Description
 - Priority
 - Applicable Headings
 - Extent
 - Position Vector
 - Longitude
 - Latitude
 - Heading
 - Speed

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3.2 DMCU Vehicle Alert Application

Req TASK9-004/1.0: Roadside Alert ITIS Codes

The DMCU shall support the following ITIS codes as defined in Reference [7]:

- 6922 – increased-risk-of-accident
- 259 – slow-traffic
- 7433 – no-passing

Req TASK9-005/1.0: BSM Broadcast

The DMCU shall support sending a BSM as defined in Reference [3].

Req TASK9-006/1.0: BSM Broadcast Frequency

The DMCU shall broadcast the BSM, defined in Reference [3], at 10 Hz.

Req TASK9-007/1.0: BSM Reception

The DMCU shall be capable of receiving and caching BSMs, defined in Reference [3].

Req TASK9-008/1.0: New BSM

The DMCU shall analyze each received BSM to determine if it is new prior to caching it.

Req TASK9-009/1.0: Applicable BSM

The DMCU shall use the following criteria to analyze each received BSM to determine if it is applicable prior to generating an advisory for it.

- Heading
- Position
- Speed

Req TASK9-010/1.0: No Longer Applicable BSM

The DMCU shall remove BSMs that are no longer applicable from its message cache.

Req TASK9-011/1.0: V2V Alert Reception

The DMCU shall be capable of receiving and caching V2V Alerts, defined in Reference [3].

Req TASK9-012/1.0: New V2V Alert

The DMCU shall analyze each received V2V Alert to determine if it is new prior to caching it.

Req TASK9-013/1.0: Applicable V2V Alert

The DMCU shall use the following criteria to analyze each received V2V Alert to determine if it is applicable prior to generating an advisory for it.

- Heading

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- Position
- Speed

Req TASK9-014/1.0: V2V Alert Message Add/Activate/Deactivate/Remove Notifications

The DMCU shall monitor the cached V2V Alert Messages and provide the vehicle interface with 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 TASK9-015/1.0: No Longer Applicable V2V Alert Messages

The DMCU shall remove V2V Alert Messages that are no longer applicable from its message cache and notify the vehicle interface with deactivate/remove advisory messages appropriately.

3.3 TGW Alert Application

Req TASK9-016/1.0: V2V Alert Traveler Advisory Caching

When a V2V Alert Traveler Advisory is received from the DMCU via the protocol defined in Reference [4], the TGW shall cache the advisory until it is deleted or until the end of the driving cycle.

Req TASK9-017/1.0: V2V Alert Traveler Advisory Priority

The TGW shall prioritize V2V Alert Traveler Advisories above J2735 traveler advisories.

Req TASK9-018/1.0: Driver Distraction Management

To the greatest degree possible, the TGW shall support the driver distraction management principles defined in Reference [5].

Req TASK9-019/1.0: V2V Alert Traveler Advisory Display

Roadside Alert Traveler Advisories shall be automatically displayed to the driver as they are received.

Req TASK9-020/1.0: V2V Alert Traveler Advisory Clearing

The driver shall be capable of clearing a traveler advisory from the display.

Req TASK9-021/1.0: V2V Alert Traveler Advisory Deletion

When a V2V Alert Traveler Advisory deletion is received from the DMCU via the protocol defined in Reference [4], the TGW shall remove the traveler advisory from the cache and, if applicable, from active display.



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