
# WELCOME

U.S. Department of Transportation

Office of the Assistant Secretary for
Research and Technology

# Welcome

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# CV271:
# Using the ISO TS 19091 Standard to Implement V2I Intersection Applications Introduction

# Instructor

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# Learning Objectives

Identify **benefits of standardization** for agencies, system developers, and suppliers

Describe the **scope** of ISO TS 19091 Standard

Describe the **use cases** addressed by ISO TS 19091 Standard

Explain the **relationship** between ISO TS 19091 and SAE J2735

**Applying** ISO TS 19091 Standard content to your project

# Learning Objective 1

Identify **benefits** of standardization for agencies, system developers, and suppliers

# Benefits of Standardization for Agencies, System Developers, and Suppliers

## Interoperability

- The ability of two or more systems or components to **exchange information** and **use** the information that has been exchanged
- **Promotes competition and innovation**
- Example: Wi-Fi with other internet standards

# Benefits of Standardization for Agencies, System Developers, and Suppliers

## Overall Benefits of Standards

| Benefit | Agency | System Developer | Supplier | Public |
|---|---|---|---|---|
| Facilitates regional integration | √ | | | |
| Decreases scope of the testing effort and makes testing easier | √ | √ | √ | |
| Expand market share | √ | | √ | |
| Reduces risk | √ | √ | √ | |
| Allows innovation | √ | √ | √ | |
| Safety, Mobility, Environmental Benefits | | | | √ |
| More consistent provision of services | | | | √ |

# ACTIVITY

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# Question

## Which of the following is NOT a benefit of standardization?

## Answer Choices

a) Supports interoperability

b) Reduces risk

c) Prohibits proprietary solutions

d) Helps with design and procurement

# Review of Answers

a) Supports interoperability

*Incorrect. Standards support interoperability both within and between systems.*

b) Reduces risk

*Incorrect. Standards reduces risk by aiding testing.*

c) Prohibits proprietary solutions

***Correct! Standards allow proprietary extensions to allow for innovations.***

d) Helps with design and procurement

*Incorrect. Standards help with design and procurement by helping system developers to specify functions and communications.*

# Learning Objectives

Identify **benefits of standardization** for agencies, system developers, and suppliers

Describe the **scope** of ISO TS 19091 Standard

# Learning Objective 2

Describe the **scope** of ISO TS 19091 Standard

# What is a Connected Vehicle Environment, in Particular a V2I Environment?

## Identify a Connected Vehicle Environment

- **Vehicles broadcast** their:
  - Current position
  - Current kinematics (speed, acceleration)
  - Sensor information

- **Vehicles receive** information that:
  - Can reduce the likelihood of incidents
  - Can improve mobility (e.g., reduce delays)
- **Could also be a mobile device**, such as a smartphone on a pedestrian or bicyclist

# What is a Connected Vehicle Environment, in Particular a V2I Environment?

## V2I Scenario

- **Vehicle Data:**
  - Latitude, Longitude, Speed, Brake Status, Turn Signal Status, Vehicle Type
- **Infrastructure Data:**
  - Signal Phase and Timing
  - Time when vehicle will be allowed to travel through the intersection (Green)
  - Time when desired movement is no longer allowed (yellow)
  - Priority or preemption request granted

EXAMPLE

# What is a Connected Vehicle Environment, in Particular a V2I Environment?

## Typical Communications Requirements

**Required for Deployment:**
Different manufacturers

**How do we trust each other?**
Authentication.

**How do we communicate?**
Wireless on the same frequency.

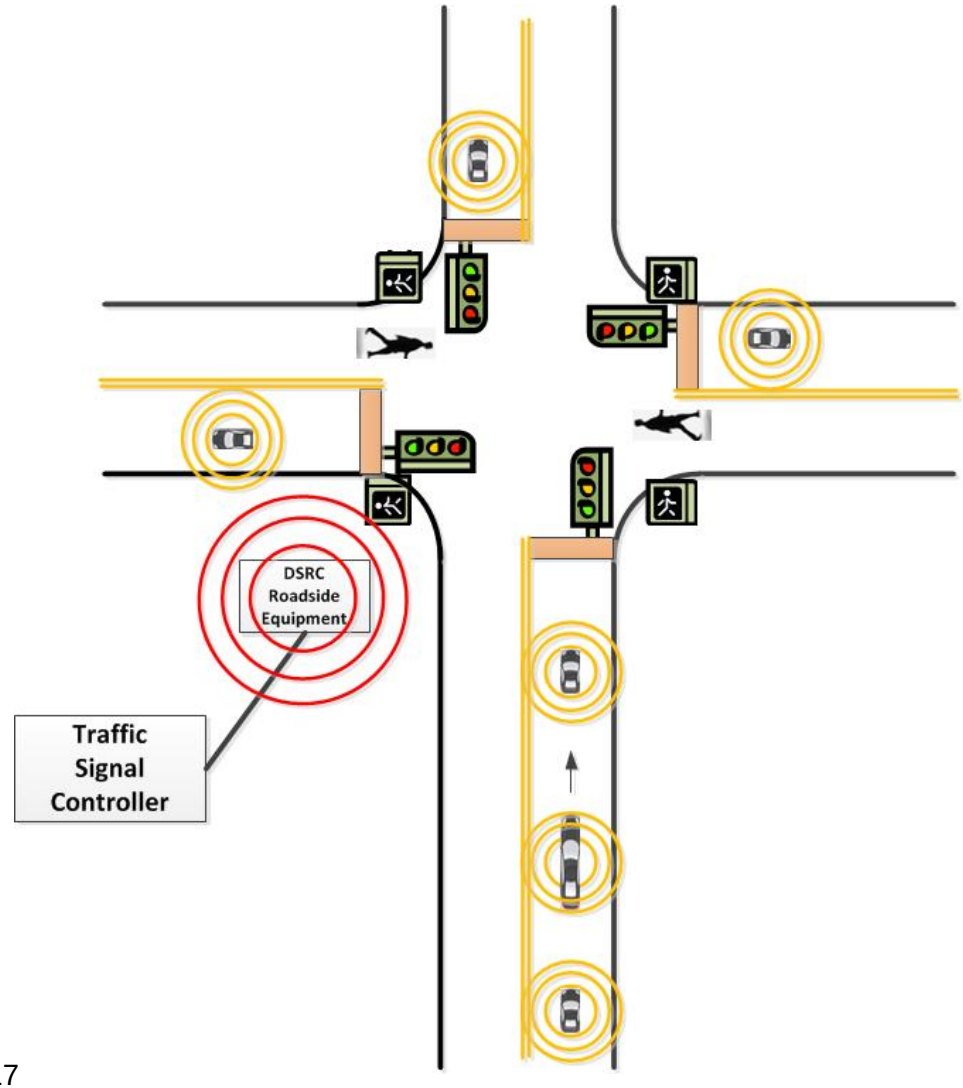
**What language are we using?**
Agree on the grammar and dictionary.

**How many people are talking in the room?**
Talk louder or softer or change rooms or channels

# The Scope and Purpose of ISO TS 19091 Standard

## ISO TS 19091 Standard

- *Intelligent transport systems – Cooperative ITS – Using V2I and I2V communications for applications related to signalized intersections*
- **Expected to be published in 2017**
- **Defines the dialogs, messages, data structures, and data elements to support exchanges** between the roadside equipment and vehicles related to signalized applications
  - Procure, implement and test in a consistent manner



# The Scope and Purpose of ISO TS 19091 Standard

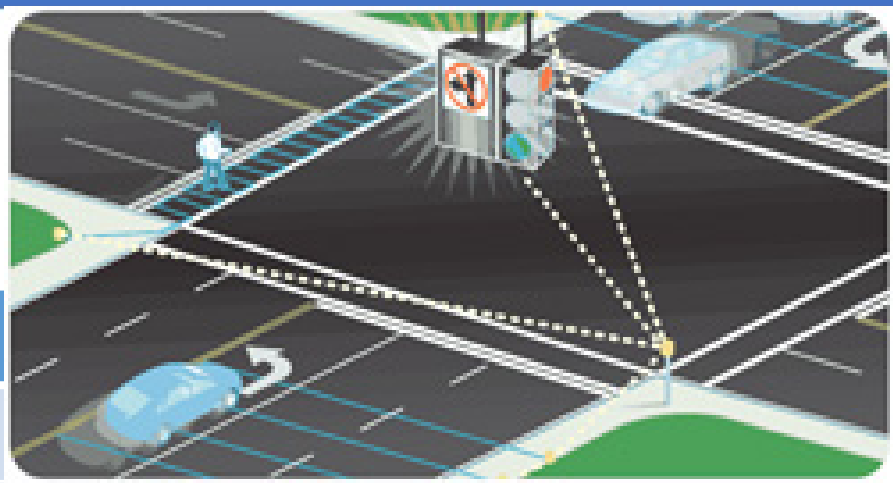
## Applications Supported

**Priority/Preemption** applications

| ID | Use Cases |
|---|---|
| PR1 | Localized Public Transport Signal Priority (TSP) |
| PR1-a | Localized TSP - Near Side Stop |
| PR2 | TSP Along an Arterial |
| PR3 | Localized Freight Signal Priority |
| PR3-a | Localized Freight Signal Priority with a Platoon |
| PR3-b | Arterial Freight Signal Priority for a Platoon |
| PR4 | Emergency Vehicle Single or Multiple Vehicles |
| PR5 | Emergency Vehicle Single or Multiple Vehicles – High Power PSOBE (Public Safety OBE) |
| PR6 | Mixed Emergency Vehicle and other priority eligible |

# The Scope and Purpose of ISO TS 19091 Standard

## Applications Supported



**Safety** applications

| ID | Use Cases |
|---|---|
| SA1 | Dilemma Zone Protection |
| SA2 | Red Light Violation Warning |
| SA3 | Stop Sign Violation Warning |
| SA4 | Turning Assistant – Oncoming Traffic |
| SA5 | Turning Assistant – Vulnerable Road User Avoidance |
| SA6 | Non-Signalized Crossing Traffic Warning |
| SA7 | Crossing Vulnerable Road User Advisory (non-signalized) |

*Reference: ISO TS 19091 Table A.1*

# The Scope and Purpose of ISO TS 19091 Standard

## Applications Supported


**Mobility/Sustainability** applications

| ID | Use Cases |
|---|---|
| MS1 | Basic Local Traffic Signal Actuation |
| MS2 | Platoon Detection for Coordinated Signals |
| MS3 | Congested Intersection Adjustment |
| MS4 | Traffic Signal Optimal Speed Advisory |
| MS5 | Signalized Corridor Eco-Driving Speed Guidance |
| MS6 | Idling Stop Support |
| MS7 | Start Delay Prevention |
| MS9 | Inductive Charging at Signals |
| MS10 | Don’t Block the Box |

# ACTIVITY

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# Question

## Which of the following is NOT an application supported by ISO TS 19091?

## Answer Choices

a) Localized Public Transport Signal Priority

b) Signalized Corridor Eco-Driving Speed Guidance

b) Red Light Violation Warning

c) Forward Collision Warning

# Review of Answers

a) Localized Public Transport Signal Priority

*Incorrect. Public transport signal priority involves signalized intersections and is thus within the scope of the ISO TS 19091.*

b) Signalized Corridor Eco-Driving Speed Guidance

*Incorrect. Eco-driving uses traffic signal information to optimize vehicle trajectory and is thus within the scope of the ISO TS 19091.*

c) Red Light Violation Warning

*Incorrect. Red light violation warning involves signalized intersections and is thus within the scope of the ISO TS 19091.*

d) Forward Collision Warning

***Correct! Forward collision warning is a V2V application and thus not within the scope.***

# Learning Objectives

Identify **benefits of standardization** for agencies, system developers, and suppliers

Describe the **scope** of ISO TS 19091 Standard

Describe the **use cases** addressed by ISO TS 19091 Standard

# Learning Objective 3

Describe the **use cases** addressed by ISO TS 19091 Standard

# The Contents of the Standard

## ISO TS 19091

- Scope
- Normative References
- Terms and Definitions
- Symbols and Abbreviation Terms
- General Description
- Function Description
- Messages
- Conformance

**Contents** Page

# The Contents of the Standard

## ISO TS 19091

- Annex A – Use Cases
- Annex B – Use Case to Requirements Traceability
- Annex C - RTM
- Annex D – Extension procedures
- Annex E, F, G – J2735 Profiles

# The Use Cases Described in the Standard

## Use Case Types

The V2I **applications** covered in ISO TS 19091 are **described by use cases**

- **Defines the operations** between the actors
- **Defines information needs** for communication between vehicles and infrastructure
- **Identifies information needs** for the applications

**Three types of use cases**:

- PR: priority/preemption
- SA : safety
- MS: mobility/sustainability

# The Use Cases Described in the Standard

## Use Case Examples

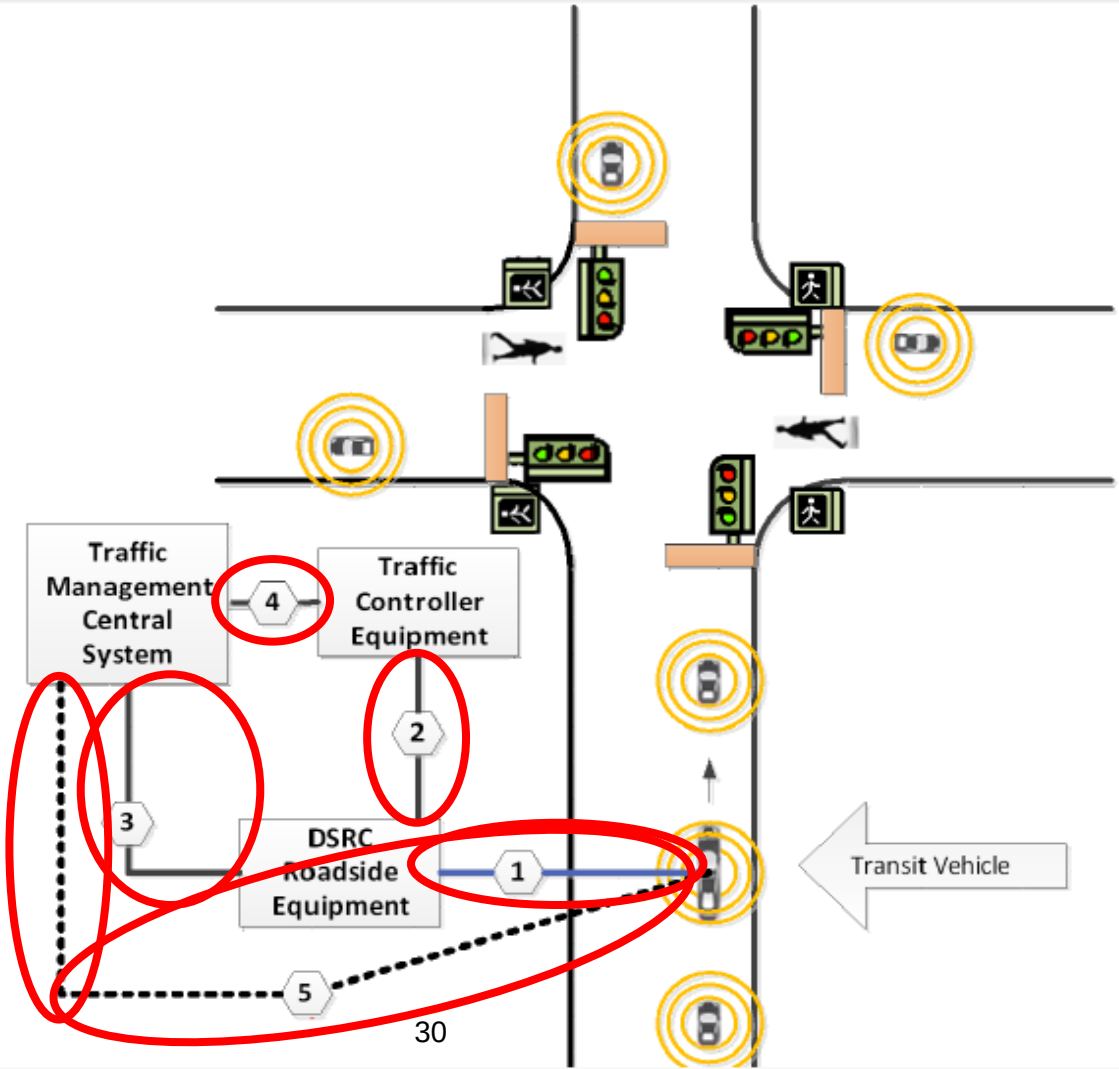
**Table A.2 — PR1: Localized public transport signal priority (TSP)**

| | |
|---|---|
| **Use Case Name** | Basic TSP Scenario - Single Public Transport Vehicle at One Signalized Intersection |
| **Category** | Mobility |
| **Infrastructure Role** | Data Receiver, Traffic Signal Control, Data Transmitter |
| **Short Description** | This use case describes the basic priority control for connected Public Transport vehicles |
| **Goal** | Improved Public Transport efficiency and reliability |
| **Constraints** | Use of DSRC or other medium that will meet the performance requirements for this use case (the RSE and OBE include radio devices that operate in the medium used)<br>Alternate: Wide area broadband communications is available for the public transport vehicle to indicate its TSP request via an alternate media than DSRC through Back-office Processing Center (BOPC). (Data flow #5 supports that situation) |
| **Geographic Scope** | Localized to a specific intersection |
| **Actors** | Public Transport Vehicle Equipped with On-board Equipment (OBE)<br>Road Side Equipment (RSE) & Traffic Signal Controller (TSC)<br>Alternate: Traffic Management Central System (BOPC). |

# The Use Cases Described in the Standard

## Use Case

**Illustration**




EXAMPLE

# The Use Cases Described in the Standard

## Use Case Examples

| | |
|---|---|
| **Preconditions** | 1. The transportation agency(ies) have established a policy for priority control (called N-level priority) and the fleet management (Public Transport) system is prepared to provide priority service for vehicles on routes.<br>2. The traffic signal controller is programmed with a variety of priority control schemes such as early green, green extension, phase rotation, phase skilling, etc.; the traffic signal controller has an intelligent algorithm for providing priority signal timing for priority requests. |
| **Main flow** | Vehicle to TSC - Direct<br>1. The use case begins when an equipped Public Transport vehicle enters the radio range of an RSE (note that if another medium is used, the same assumption applies).<br>2. The OBE (Public Transport vehicle) receives MAP and SPaT from the RSE.<br>3. The OBE sends Basic Safety Messages [BSM] or Cooperative Awareness Message [CAM].<br>4. …<br>5. … |
| **Alternate flow(s)** | 1. [7] The Public Transport vehicle changes speed and the RSE updates priority timing based on travel time estimates.<br>2. (insert between steps 12-13) The RSE updates the Public Transport vehicle served performance measures. |
| | Vehicle to Intersection – Indirect through BOPC<br>1. OBE monitors its vehicle position using an on-board map and location algorithms. Hence, the vehicle determines which intersection(s) is approaching and the likely time of arrival. Precondition: the vehicle must have on-board map information |

# The Use Cases Described in the Standard

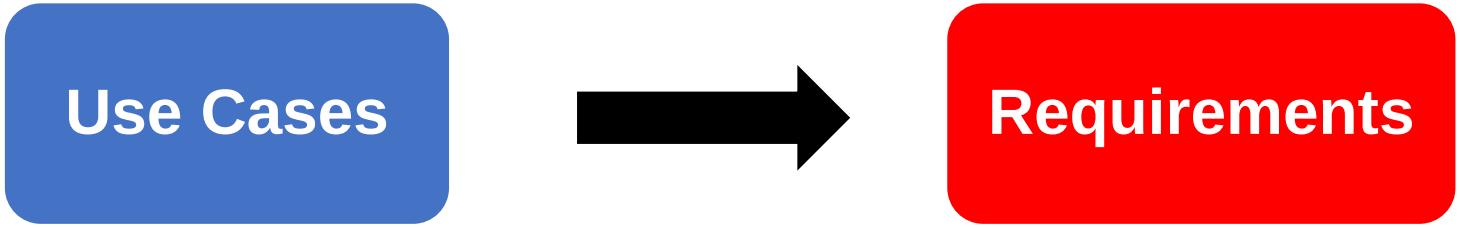
## Use Case

| | |
|---|---|
| **Post-conditions** | The TSC initiates recovery operations to restore normal timing operation which might include appropriate coordination. Some recovery may include split time compensation to clear queues which might have formed on the phases that were adversely affected by the priority request. |
| **Information Requirements** | SPaT<br>Current manoeuvre(s) permitted, remaining time for manoeuvre, yellow clearance time, red clearance time, next manoeuvre to be serviced, queue length or end of queue information, and pedestrian warning<br>MAP<br>Intersection Geometry (MAP base), permitted manoeuvres, and changes to MAP other than base<br>Etc. |
| **Issues** | 1. This use case assumes that the scenarios needed for the Public Transport vehicle are pre-determined and loaded into TSC.<br>2. It also presumes that the Public Transport vehicle knows which of the scenarios that the controller can support should be invoked to meet its specific needs although these might be included in the SSM. Note that this also assumes that the vehicle knows its route and hence knows what exit lane (or manoeuvre) to request.<br>3. Etc… |
| **Source docs/references** | MMITSS, CEN, USDOT J2735™ SE Candidate |

# The Types of Requirements Described in the Standard

## Requirements

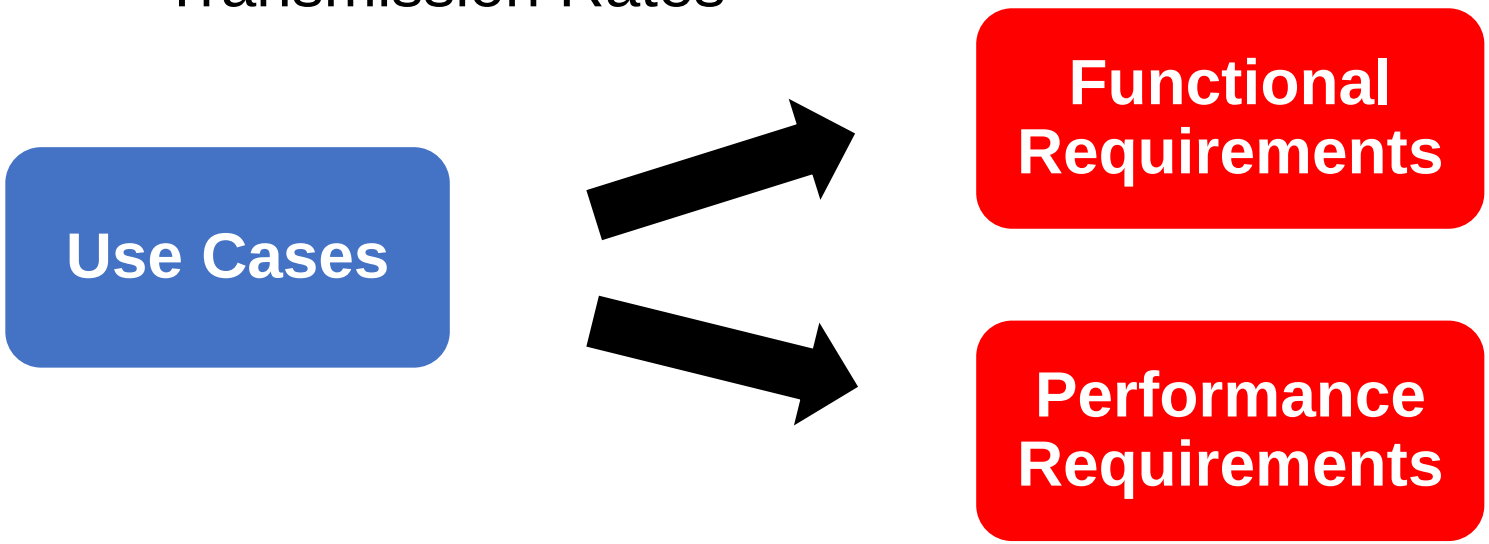
- The use cases describe the information flows between the actors
  - Defines what data is needed and why
- ISO 19091 lists requirements describing the details of that data
- Deployments that follow ISO 19091 would build to the same requirements – helps ensures interoperability



# The Types of Requirements Described in the Standard

## Requirement Types

- Two types of requirements in ISO TS 19091
  - Functional Requirements
  - Performance Requirements
    - Transmission Rates



# The Types of Requirements Described in the Standard

## Functional Requirement Types

**Grouped by**:

- Device
  - Public safety vehicle
  - Public transport and commercial vehicle
  - Signalized intersection
  - Cross Traffic Sensor
  - Vulnerable Road User Sensor Information

- Information
  - Signal Phase and Timing information
  - Signal preemption / priority
  - Signal preemption / priority Status
  - Roadway Geometrics
  - GNSS Augmentation Details

# ACTIVITY

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# Question

## Which of the following is NOT a category of use cases in ISO TS 19091?

## Answer Choices

a) Safety

b) Electronic Payment

c) Mobility/Sustainability

d) Signal Priority/Preemption

# Review of Answers

a) Safety

*Incorrect. Safety (SA) use cases are included in ISO TS 19091.*

b) Electronic Payment

***Correct! Electronic payment is not covered in ISO TS 19091, although it is a category of applications.***

c) Mobility/Sustainability

*Incorrect. Mobility/Sustainability (MS) is a category of uses cases in ISO TS 19091.*

d) Signal Priority/Preemption

*Incorrect. Signal Priority and Preemption (PR) is a category of use cases in ISO TS 19091.*

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Identify **benefits of standardization** for agencies, system developers, and suppliers

Describe the **scope** of ISO TS 19091 Standard

Describe the **use cases** addressed by ISO TS 19091 Standard

Explain the **relationship** between ISO TS 19091 and SAE J2735

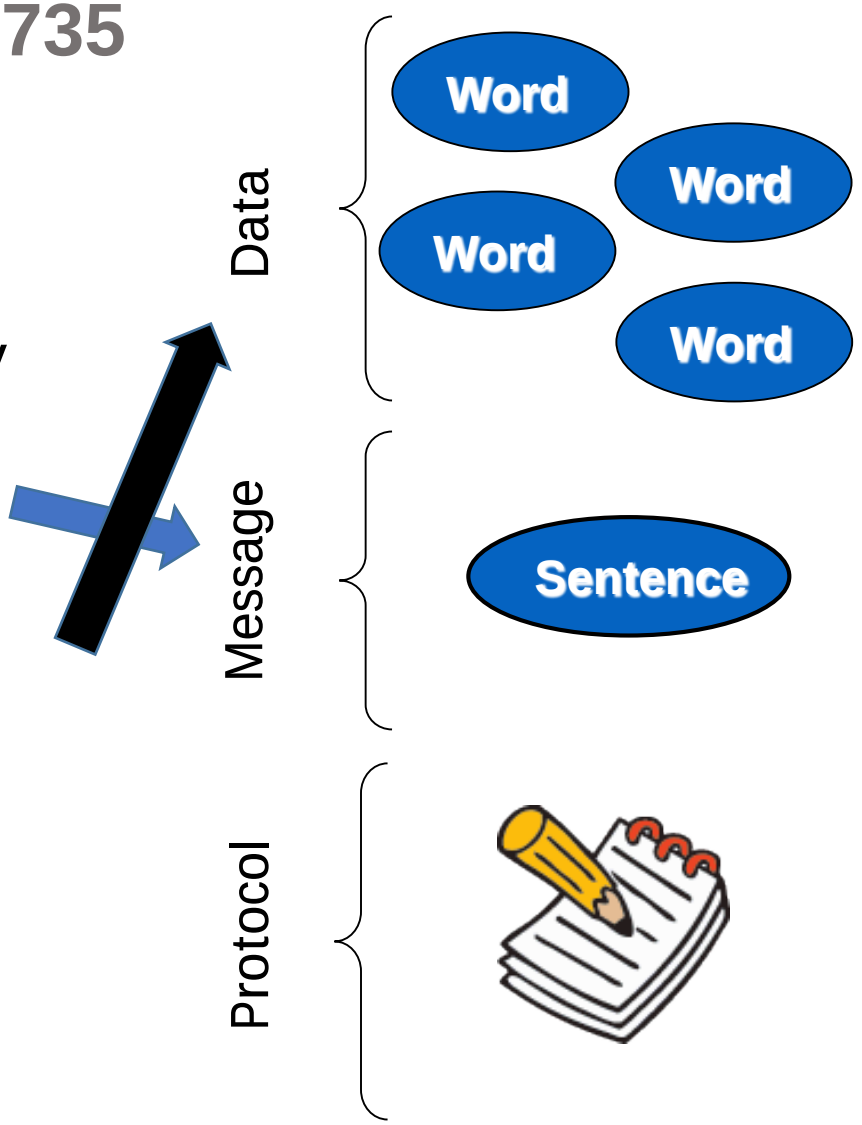
# Learning Objective 4

Explain the **relationship** between ISO TS 19091 and SAE J2735™

# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

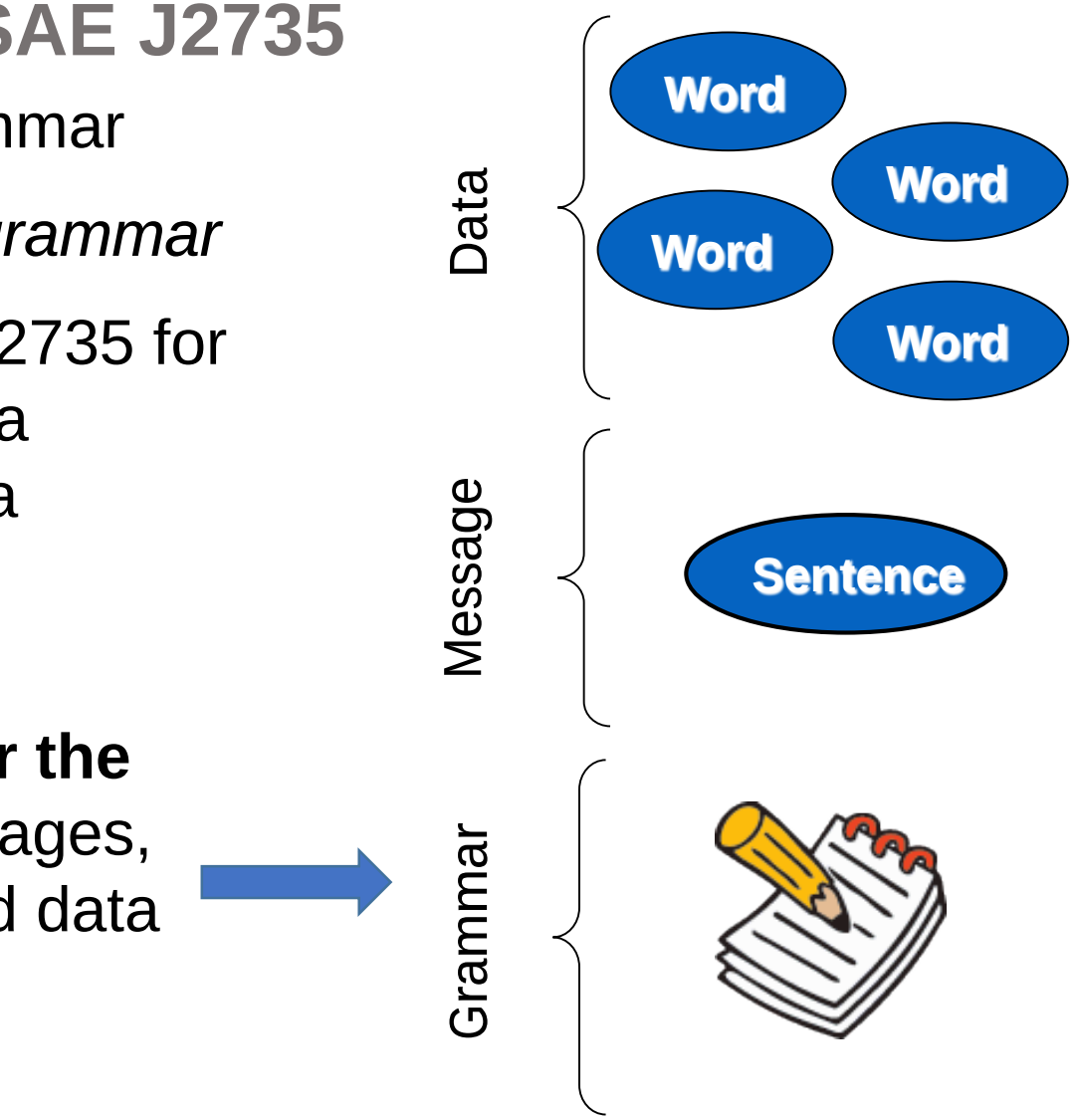
- SAE J2735, *Dedicated Short Range Communications (DSRC) Message Set Dictionary*, is a data dictionary
  - **Specifies the message set** for DSRC
  - Specifies **data frames and data elements**
- Analogy: English language



# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

- Analogy: English grammar
- ISO TS 19091 is the *grammar*
  - References SAE J2735 for the messages, data structures and data elements for V2I applications
  - **Adds the rules for the use** of these messages, data structures and data elements

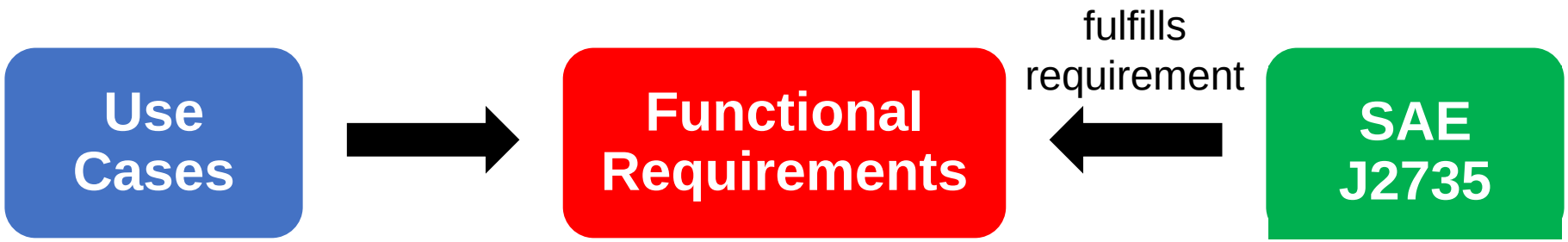


# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

ISO TS 19091

- Works together with SAE J2735 to **define the design to fulfill the functional requirements** in ISO TS 19091
- Provides a matrix that defines the **SAE J2735 design to fulfill each functional requirement** in ISO TS 19091
  - The design may be in the form of a message, data frame or data element



# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

Example:

- **Requirement 6.7.1 Broadcast signal phase and timing information**
  - An RSE shall broadcast a message with signal phase and timing information. Signal phase and timing information may be used to provide connected devices with the current status of a signalized intersection. Together with the intersection geometric information, connected vehicles can determine what maneuvers are currently permitted by lane/approach, and when their permitted maneuver may end.
  - ISO TS 19091 defines the SAE J2735 Signal Phase and Timing Message (SPaT) to fulfill this requirement

# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

**Other SAE J2735 Messages used to fulfill requirements in ISO TS 19091:**

- Basic Safety Message (BSM (P1))
- Signal Request Message (SRM)
- MAP Data Message (MAP). Describes the geometry of the roadway intersection
- NMEA Message (NMEA). Provides differential GPS corrections.
- RTCM Message (RTCM). Provides differential GPS corrections.
- Signal Status Message (SSM)

# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

Example:

- **Requirement 6.7.2 Broadcast signal phase and timing – message identifier**
  - An RSE shall include a message identifier as part of the signal phase and timing message broadcast. A change in the message identifier indicates a change in the message content. This requirement allows a connected device to ignore (not process) messages from an RSE when the content has not changed.
  - ISO TS 19091 defines the SAE J2735 data element MsgCount within the (SAE J2735) SPaT message to fulfill this requirement

# The Relationship of This Standard with SAE J2735™

## ISO TS 19091 and SAE J2735

- SAE J2735 allows DE_MsgCount to be incremented every time a message is broadcasted **OR** when the contents of the message changes
  - ISO TS 19091 standardizes the use of DE_MsgCount for SPAT and MAP messages so it is **only incremented when the contents change**

- Decreases risk of misinterpretations, which may compromise safety

# ACTIVITY

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# Question

## How does ISO TS 19091 use SAE J2735 to specify message contents?

## Answer Choices

a) Fulfill requirements based on ISO 19091 use cases

b) Fulfill requirements found in the SAE J2735 standard

c) Directly satisfy the user needs derived from the ISO 19091 use cases

d) Directly satisfy the user needs in the SAE J2735 standard

# Review of Answers

a) Fulfill requirements based on ISO 19091 use cases

***Correct! SAE J2735 defines the message contents to fulfill requirements derived from the use cases in ISO 19091.***

b) Fulfill requirements found in the SAE J2735 standard

*Incorrect. SAE J2735 is used to fulfill requirements in ISO 19091. SAE J2735 does not contain requirements.*

c) Directly satisfy the user needs derived from the ISO 19091 use cases

*Incorrect. There are no user needs in ISO 19091 and SAE J2735 is used to fulfill requirements, not satisfy user needs.*

d) Directly satisfy the user needs in the SAE J2735 standard

*Incorrect. SAE J2735 defines a message set and does not identify user needs.*

# Learning Objectives

Identify **benefits of standardization** for agencies, system developers, and suppliers

Describe the **scope** of ISO TS 19091 Standard

Describe the **use cases** addressed by ISO TS 19091 Standard

Explain the **relationship** between ISO TS 19091 and SAE J2735

**Applying** ISO TS 19091 Standard content to your project

# Learning Objective 5

**Applying** ISO TS 19091 Standard content to your project

# Use Case to Requirements Matrix

Provides traceability from use cases to requirements.

- **Organized by use case operational type** (PR, SA, MS), then by specific use case
- **Indicates** for each use case whether a requirement is:
  - Mandatory (M or M.#)
  - Optional (O or O.#)
  - Conditional (C)
  - Not Applicable (N/A)
  - Excluded or Prohibited (X)
  - Regional selection (REG:)
  - Internal RSE <-> TSC (Traffic Signal Controller) use only with ‘x’ replaced by the status symbols listed above

# Use Case to Requirements Matrix

## SA2: Red Light Violation Warning

**Table B.5 — Safety related use case to requir**

| Requirements | | Safety related use cases | | |
|---|---|---|---|---|
| ID | Title | SA2 | SA3 | SA4 |
| 6.5.1 | Broadcast Area Geometrics | M | M | M |
| 6.5.2 | Broadcast Roadway Geometrics - Message Identifier | M | M | M |
| 6.5.3 | Broadcast Intersection - Identifier | M | M | M |
| 6.5.4 | Broadcast Intersection - Reference Point | M | M | M |
| 6.5.5 | Broadcast Intersection – Lane/Approach Default Width | M | M | M |
| 6.5.6 | Broadcast Intersection - Egress Lanes | X | X | REG:M |
| 6.5.7 | Broadcast Intersection - Approach Lanes | M | M | M |
| 6.5.8 | Broadcast Intersection – Lane/Approach Number | M | M | M |
| 6.5.9 | Broadcast Intersection – Lane/Approach Centerline Coordinates | M | M | M |
| 6.5.10 | Broadcast Intersection - Vehicle Lane/Approach Maneuvers | M | M | M |
| 6.5.11 | Broadcast Intersection - Pedestrian Lane/Approach Maneuvers | X | X | O |
| 6.5.12 | Broadcast Intersection - Special Lane/Approach Maneuvers | X | X | O |
| 6.5.13 | Broadcast Intersection - Version Identifier | O | X | O |
| 6.5.14 | Broadcast Intersection - Crossings | X | X | O |
| 6.5.15 | Broadcast Intersection – Lane/Approach Width | O | O | O |
| 6.5.16 | Broadcast Intersection - Node Lane/Approach Width | O | O | O |

EXAMPLE

*Reference: ISO TS 19091 Table B.5*

# Requirements Traceability Matrix

Provides traceability between requirements and design:

- Dialogs
- Messages
- Data Frames
- Data Elements

- Used to **determine the design of the communications** for the system
- Used by a tester to **determine what requirements need to be verified, and help design the test cases**

# Requirements Traceability Matrix

- Dialogs
  - For ISO TS 19091, the dialogs consists of broadcast messages (See Section 5.1.3)
    - A device broadcasts the message content to all entities within range
  - The sequence that messages are broadcasted can be found in the use cases
  - Dialogs mostly handled by the DSRC communications stack, but may be other wireless communications technologies (3G, 4G, LTE, etc.)
- Message sets, data frames and data elements are **defined** in SAE J2735.

# Requirements Traceability Matrix

| Rqmt ID | Requirement Title | Msg | Parent Identifier | Parent type | Identifier | Identifier type |
|---|---|---|---|---|---|---|
| 6.5.1 | Broadcast area geometrics | MAP | N/A | N/A | Message Types | MapData |
| 6.5.2 | Broadcast roadway geometrics – message identifier | MAP | MSG_MapData | MapData | msgIssue Revision | MsgCount |
| 6.5.3 | Broadcast intersection - identifier | MAP | intersections | Intersection Geometry | id | Intersection ReferenceID |
| 6.5.4 | Broadcast intersection – reference point | MAP | refPoint | Position3D | lat | Latitude |
| 6.5.4 | Broadcast intersection – reference point | MAP | refPoint | Position3D | long | Longitude |
| 6.5.4 | Broadcast intersection – reference point | MAP | refPoint | Position3D | elevation | Elevation |

*Reference: ISO TS 19091 Table C.1*

# Requirements Traceability Matrix

## Using the RTM

RTM uses the same key defined in the Use Case Requirements Matrix

- Mandatory (M or M.#)
- Optional (O or O.#)
- Conditional (C)
- Not Applicable (N/A)
- Excluded or Prohibited (X)

| Requirement | | Design | Project Implementation | | |
|---|---|---|---|---|---|
| ID | Title | Identifier Type | Conform-ance | Support / Project Rqmt | Additional rqmt |
| 6.5.4 | Broadcast intersection – reference point | Latitude | M | Yes | |
| 6.5.4 | Broadcast intersection – reference point | Longitude | M | Yes | |
| 6.5.4 | Broadcast intersection – reference point | Elevation | O | Yes / No | |

*Reference: ISO TS 19091 Table C.1*

# Requirements Traceability Matrix

## Using the RTM

| Rqmt ID | Requirement Title | Identifier | Conformance | Support / Project Rqmt | Additional Reqt |
|---|---|---|---|---|---|
| 6.15.1 | Minimum transmission rate – broadcast roadway geometrics | N/A | O | Yes / No | Rate of Hz **1 Hz** |
| 6.15.2 | Maximum transmission rate – broadcast roadway geometrics | N/A | O | Yes / No | Rate of Hz **10 Hz** |
| 6.15.3 | Default transmission rate – broadcast roadway geometrics | N/A | O | Yes / No | Rate of Hz |
| 6.16.1 | Minimum transmission rate – GNSS augmentation details broadcasts | N/A | O | Yes / No | Rate of Hz **1 Hz** |

*Reference: ISO TS 19091 Table C.1*

# Application of Annexes E, F, & G

## Regional Extensions

Annexes E, F, G describe **different profiles** for J2735 for use in 3 **different international regions**

- Annex E : North America
- Annex F: Japan
- Annex G: Europe


- **Regional specific requirements** appear in the Use Case to Requirements Matrix
- **Annex D describes the extension mechanisms** for SAE J2735

# Application of Annexes E, F, & G

## Annex E

Use cases, requirements, and traceability matrices for North America

- No additional requirements defined for the MAP, SRM or SSM messages
- **SPAT message** – Defines **two additional *optional* data frames and data elements**
  - Provide an indication that a pedestrian or bicycle call has been requested for a movement through the intersection
  - Provide support for the current signal state of a special lane (e.g., tracked) at the intersection

# Conformance Statement

An implementation is conformant with ISO TS 19091 when:

- The implementation's data content shall **fulfill the mandatory and selected optional requirements** as identified in the requirements traceability matrix (Annex C) or as defined in the selected annexes

**AND**

# Conformance Statement

- The implementation's **message structure fulfills the requirements** of the selected annex

**AND**

- To conform to a requirement in this technical specification, a system or device interface shall **implement all data elements traced from that requirement** (and in the order specified in the technical specification). To be consistent with a requirement, a system or device interface shall be able to **fulfill the requirement using only messages, data frames, and data elements** that (the) conforming system or device interface is **required to support**

# Example

## Transit Signal Priority

- First, go to Annex A and examine the Use Case Table
  - Complete list of use cases covered in ISO TS 19091
  - Select appropriate use cases for deployment
- For our example, assume a transit signal priority application

*Reference: ISO TS 19091 Table A.1*

# Example

## Transit Signal Priority

**Table A.1 — Table of identified use cases**

| ID | Title |
|---|---|
| PR1 | A.2 — PR1: Localized public transport signal priority (TSP) |
| PR1-a | A.3 — PR1-a: Localized public transport signal priority – near side stop |
| PR2 | A.4 — PR2: Public transport signal priority along an arterial (group of intersections) |
| PR3 | A.5 — PR3: Localized freight signal priority |
| PR3-a | A.6 — PR3-a: Localized freight signal priority with a platoon |
| PR3-b | A.7 — PR3-b: Arterial freight signal priority for a platoon |
| PR4 | A.8 — PR4: Emergency vehicle single or multiple vehicles (normal power PSOBE) |
| PR5 | A.9 — PR5: Emergency vehicle single or multiple vehicles (high power PSOBE) |
| PR6 | A.10 — PR6: Mixed emergency vehicle and other priority eligible vehicles |

*Reference: ISO TS 19091 Table A.1*

# Example

## Transit Signal Priority

**Table A.2 — PR1: Localized public transport signal priority (TSP)**

| | |
|---|---|
| **Use Case Name** | Basic TSP Scenario - Single Public Transport Vehicle at One Signalized Intersection |
| **Category** | Mobility |
| **Infrastructure Role** | Data Receiver, Traffic Signal Control, Data Transmitter |
| **Short Description** | This use case describes the basic priority control for connected Public Transport vehicles |
| **Goal** | Improved Public Transport efficiency and reliability |
| **Constraints** | Use of DSRC or other medium that will meet the performance requirements for this use case (the RSE and OBE include radio devices that operate in the medium used)<br>Alternate: Wide area broadband communications is available for the public transport vehicle to indicate its TSP request via an alternate media than DSRC through Back-office Processing Center (BOPC). (Data flow #5 supports that situation) |
| **Geographic Scope** | Localized to a specific intersection |
| **Actors** | Public Transport Vehicle Equipped with On-board Equipment (OBE)<br>Road Side Equipment (RSE) & Traffic Signal Controller (TSC)<br>Alternate: Traffic Management Central System (BOPC). |

# Example

## Use Case to Requirements Matrix

PR1: Localized Public Transport Signal Priority (TSP)

| Requirements | | Use Cases | |
|---|---|---|---|
| ID | Title | PR1 | PR1-a |
| 6.1.1 | Broadcast public safety vehicle information | M | M |
| 6.1.2 | Broadcast emergency response indication | X | X |
| 6.2.1 | Transmit pre-empt request | O | O |
| 6.2.2 | Request signal pre-empt – message identifier | O | O |
| 6.2.4 | Request signal pre-empt – intersection identifier | O | O |

# Example

## Requirements Traceability Matrix

| Requirement | | Design | | | | |
|---|---|---|---|---|---|---|
| ID | Title | Msg | Parent identifier | Parent type | Identifier | Identifier type |
| 6.1.1 | Broadcast public safety vehicle information (Safe1) | BSM (P1) | N/A | N/A | MessageTypes | BasicSafetyMessage |
| 6.1.1 | Broadcast public safety vehicle information (Safe2) | CAM | N/A | N/A | CAM | CoopAwareness |
| 6.1.2 | Broadcast emergency response indication <Safe1> | BSM (P2) | supplemental | SupplementalVehicleExtensions | classDetails | VehicleClassification |

# Example

## Requirements Traceability Matrix

| Requirement | | Design | Project Implementation | | |
|---|---|---|---|---|---|
| ID | Title | Identifier Type | Conformance | Support / Project Rqmt | Additional Reqt |
| 6.1.1 | Broadcast public safety vehicle information (Safe1) | BasicSafetyMessage | M.4(1) | Yes / No | |
| 6.1.1 | Broadcast public safety vehicle information (Safe2) | CoopAwareness | M.4(1) | Yes / No | |
| 6.1.2 | Broadcast emergency response indication <Safe1> | VehicleClassification | M | Yes / No | |
| 6.1.2 | Broadcast emergency response indication | LightbarInUse | M | Yes / No | |

# Example

## Requirements Traceability Matrix

| Requirement | | Design | Project Implementation | | |
|---|---|---|---|---|---|
| ID | Title | Identifier Type | Conformance | Support / Project Rqmt | Additional Reqt |
| 6.2.5 | Request signal pre-empt – approach lane | IntersectionAccessPoint | M | Yes | |
| 6.2.6 | Request signal pre-empt – egress lane | IntersectionAccessPoint | O | Yes / No | |
| 6.2.7 | Request signal pre-empt – vehicle class | BasicVehicleRole | O | Yes / No | |
| 6.2.7 | Request signal pre-empt – vehicle class | RequestSubRole | O | Yes / No | |
| 6.2.7 | Request signal pre-empt – vehicle class | RequestImportanceLevel | O | Yes / No | |

*Reference: ISO TS 19091 Table C.1*

# Example

## Requirements Traceability Matrix

Assuming DSRC

| Rqmt ID | Requirement Title | Message | Conformance | Support / Project Rqmt | Additional Reqt |
|---|---|---|---|---|---|
| 6.14.1 | Maximum transmission rate – request signal preferential treatment | SRM | O | Yes / No | Rate of 1 Hz |
| 6.14.2 | Maximum response time – request signal preferential treatment | SSM | O | Yes / No | 100 ms |
| 6.14.3 | Minimum transmission rate – signal status message | SSM | O | Yes / No | Rate of 1 Hz |
| 6.14.4 | Minimum transmission period – signal status message | SSM | O | Yes / No | Period of 10 s |

*Reference: ISO TS 19091 Table C.1*

# ACTIVITY

STANDARDS ITS TRAINING

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

# Question

**Which matrices allow a system designer to select system requirements based on use cases?**

## Answer Choices

a) Needs to Requirements Traceability Matrix

b) Requirements Traceability Matrix

c) Use Case to Requirements Traceability

d) Test Case to Requirements Traceability Matrix

# Review of Answers

a) Needs to Requirements Traceability Matrix

*Incorrect. There is no NRTM included in ISO TS 19091.*

b) Requirements Traceability Matrix

*Incorrect. The RTM traces requirements to design.*

c) Use Case to Requirements Traceability

***Correct! The Use Case to Requirements Traceability traces requirements to use cases and allows a system designer to select requirements for a deployment.***

d) Test Case to Requirements Traceability Matrix

*Incorrect. There is no TCRTM in ISO TS 19091.*

# Module Summary

Identify **benefits of standardization** for agencies, system developers, and suppliers

Describe the **scope** of ISO TS 19091 Standard

Describe the **use cases** addressed by ISO TS 19091 Standard

Explain the **relationship** between ISO TS 19091 and SAE J2735

**Applying** ISO TS 19091 Standard content to your project

# We Have Now Completed the CV Curriculum

- **Module I261**: Vehicle-to-Infrastructure (V2I) ITS Standards for Project Managers
- **Module I262**: Vehicle-to-Vehicle (V2V) ITS Standards for Project Managers
- **Module CV271**: Using the ISO TS 19091 Standard to Implement V2I Intersection Applications Introduction

# Next Course Module

## Module CV-T160: Connected Vehicles Certification Testing Introduction

Concepts taught in next module (Learning Objectives):

1) Identify key elements of ATC 5201 standard equipment for testing documentation
2) Describe within the context of a systems engineering lifecycle the role of a test plan and the testing to be undertaken
3) Describe the application of good testing documentation for transportation controller equipment based on the ATC 5201 v06 standard
4) Describe the testing of ATC using a sample testing documentation

# Thank you for completing this module.

**Feedback**

Please use the Feedback link below to provide us with your thoughts and comments about the value of the training.

Thank you!