STANDARDS ITS TRAINING

WELCOME

U.S. Department of Transportation

Office of the Assistant Secretary for
Research and Technology

Welcome

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Module CV273:

Introduction to SPaT / MAP Messages

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Learning Objectives

Describe the scope of the SAE J2735 Standard

Describe the SPaT Message

Describe the MAP Message

Implementation Considerations

Learning Objective 1

Describe the scope of SAE J2735 Standard

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

Transportation Challenges

Safety

37,113 motor vehicle deaths in 2017

6,452,000 crashes in 2017

Mobility

8.8 billion hours of travel delay

$166 billion cost of urban congestion

Environment

3.3 billion gallons of wasted fuel

Source: US Department of Transportation, 2019 Urban Mobility Report, TTI

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

The CV Environment

Source: US Department of Transportation

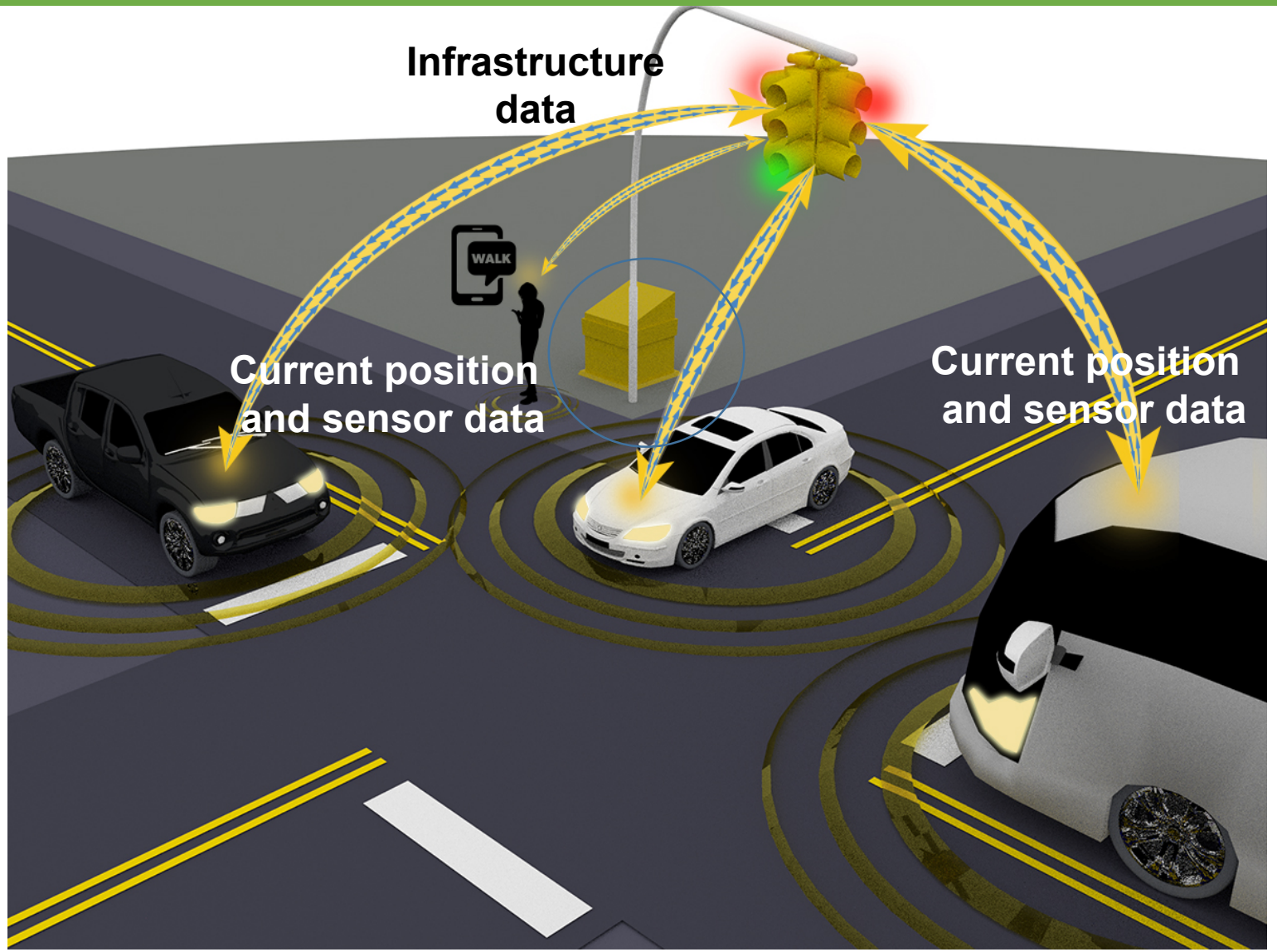
CV environment consists of:

- Connected vehicles
- Connected individuals
- Connected infrastructure

CV Communications

- Wireless
- Mixture of
  - Short-range communications
  - Remote communications

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



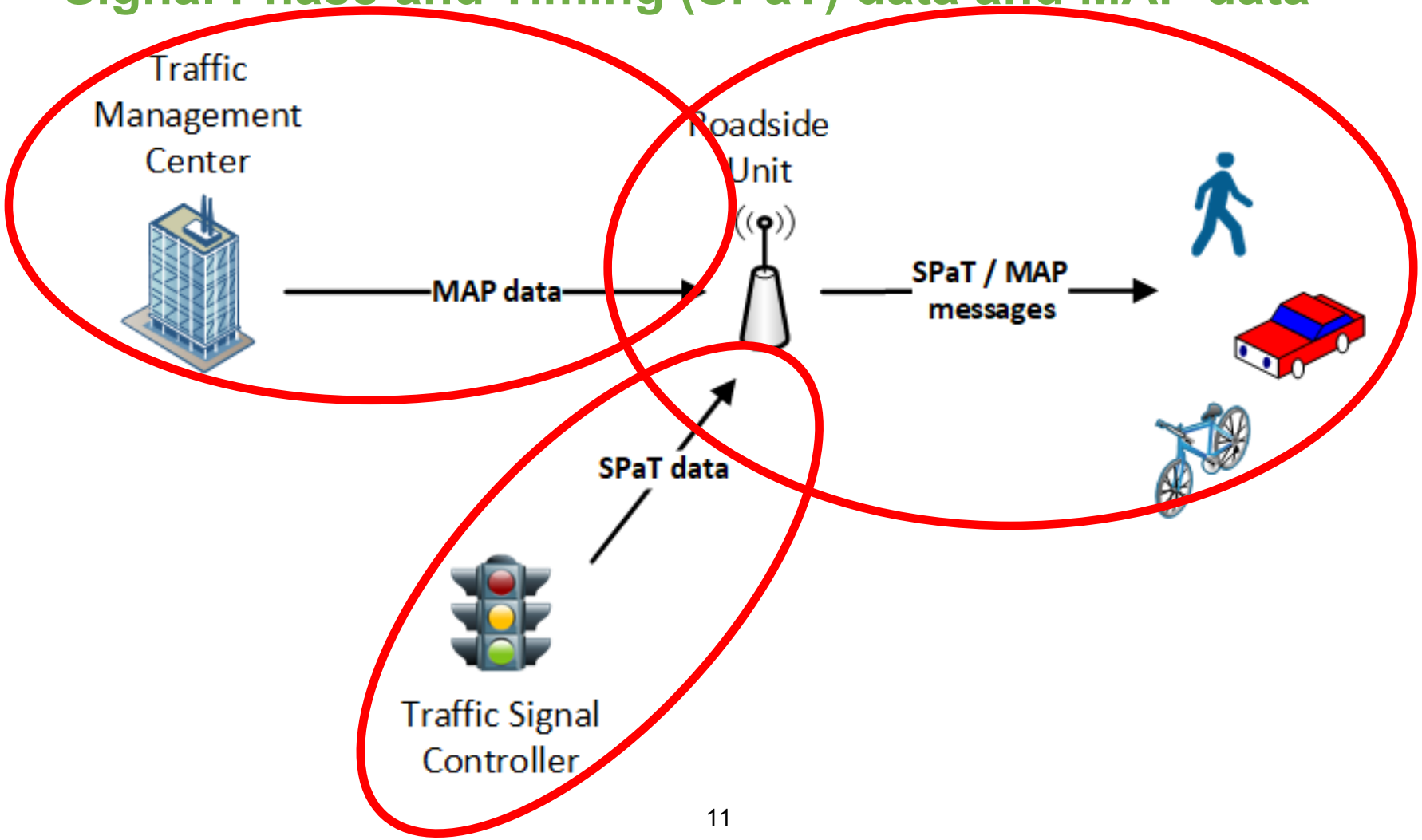
Source: US Department of Transportation

What is a Connected Vehicle Environment, in particular a V2I Environment

Source: US Department of Transportation

What is the Need for SPaT and MAP Information?

- Signal Phase and Timing (SPaT) data and MAP data



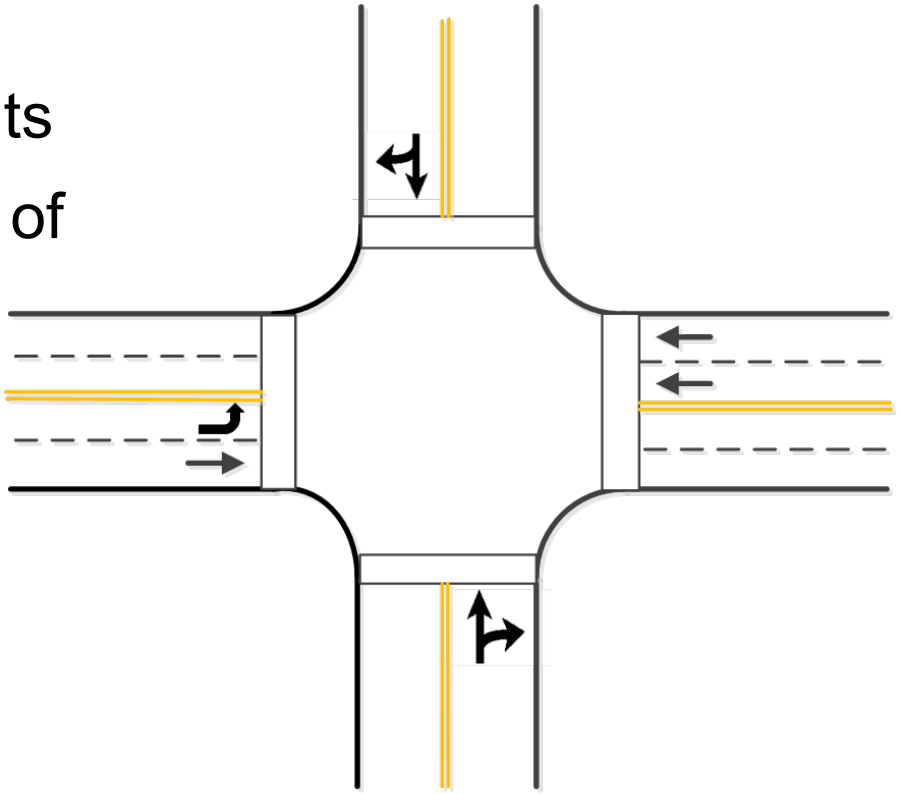
What is the Need for SPaT and MAP Information?

- **Signal Phase and Timing (SPaT) data are used by applications to generate:**
  - **Pedestrian warnings:** allowed pedestrian movements
  - **Driver warnings:** potential red light violations, potential pedestrian conflicts, allowed vehicle movements
  - **Driver advisories:** suggested travel speeds (for mobility and environmental purposes)

Source: US Department of Transportation

What is the Need for SPaT and MAP Information?

- **MAP data can be used by applications to provide benefits at intersections or roadway segments**
  - **Driver warnings:** sharp curves, allowable movements
  - **Driver advisories:** location of lanes
  - **Pedestrian advisories:** location of crosswalks
  - Required to link SPaT data (currently allowable movements) with lanes



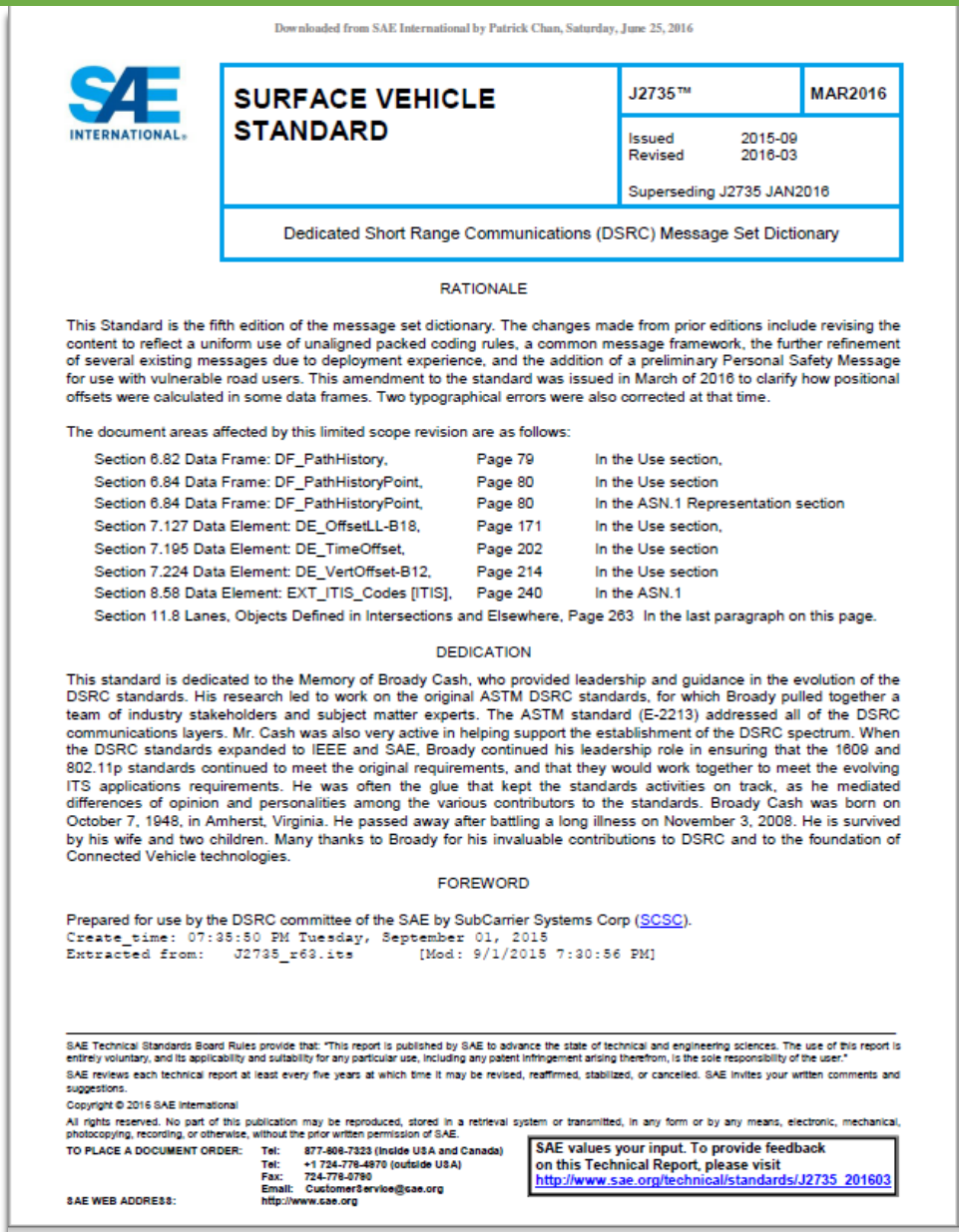
What is the Need for SPaT and MAP Information?

- **Applications:**
- **Red Light Violation Warning (RLVW):** warnings to travelers for impending red light violations
- **Pedestrian in Signalized Crosswalk Warning:** warnings to transit operators when pedestrians are in the intended path of the bus
- **Mobile Accessible Pedestrian Signal System (PED-SIG):** automated calls from a visually impaired pedestrian and cues to safely navigate the crosswalk
- **Eco-Approach and Departure at Signalized Intersections:** recommend speed trajectories as vehicles approach and depart the intersection

Source: US Department of Transportation

What is the Scope and Purpose of SAE J2735?

- **A data dictionary for the CV environment.**
  - Defines messages and data elements
  - Includes vehicle kinematic information, position correction information, traveler information



SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

J2735™ MAR2016

Issued 2015-09
Revised 2016-03

Superseding J2735 JAN2016

Dedicated Short Range Communications (DSRC) Message Set Dictionary

RATIONALE

This Standard is the fifth edition of the message set dictionary. The changes made from prior editions include revising the content to reflect a uniform use of unaligned packed coding rules, a common message framework, the further refinement of several existing messages due to deployment experience, and the addition of a preliminary Personal Safety Message for use with vulnerable road users. This amendment to the standard was issued in March of 2016 to clarify how positional offsets were calculated in some data frames. Two typographical errors were also corrected at that time.

The document areas affected by this limited scope revision are as follows:

Section 6.82 Data Frame: DF_PathHistory,	Page 79	In the Use section,
Section 6.84 Data Frame: DF_PathHistoryPoint,	Page 80	In the Use section
Section 6.84 Data Frame: DF_PathHistoryPoint,	Page 80	In the ASN.1 Representation section
Section 7.127 Data Element: DE_OffsetLL-B18,	Page 171	In the Use section,
Section 7.195 Data Element: DE_TimeOffset,	Page 202	In the Use section
Section 7.224 Data Element: DE_VertOffset-B12,	Page 214	In the Use section
Section 8.58 Data Element: EXT_ITIS_Codes [ITIS],	Page 240	In the ASN.1

Section 11.8 Lanes, Objects Defined in Intersections and Elsewhere, Page 263 In the last paragraph on this page.

DEDICATION

This standard is dedicated to the Memory of Broady Cash, who provided leadership and guidance in the evolution of the DSRC standards. His research led to work on the original ASTM DSRC standards, for which Broady pulled together a team of industry stakeholders and subject matter experts. The ASTM standard (E-2213) addressed all of the DSRC communications layers. Mr. Cash was also very active in helping support the establishment of the DSRC spectrum. When the DSRC standards expanded to IEEE and SAE, Broady continued his leadership role in ensuring that the 1609 and 802.11p standards continued to meet the original requirements, and that they would work together to meet the evolving ITS applications requirements. He was often the glue that kept the standards activities on track, as he mediated differences of opinion and personalities among the various contributors to the standards. Broady Cash was born on October 7, 1948, in Amherst, Virginia. He passed away after battling a long illness on November 3, 2008. He is survived by his wife and two children. Many thanks to Broady for his invaluable contributions to DSRC and to the foundation of Connected Vehicle technologies.

FOREWORD

Prepared for use by the DSRC committee of the SAE by SubCarrier Systems Corp (SCSC).

```
Create_time: 07:35:50 PM Tuesday, September 01, 2015
Extracted from:   J2735_r63.its       [Mod: 9/1/2015 7:30:56 PM]
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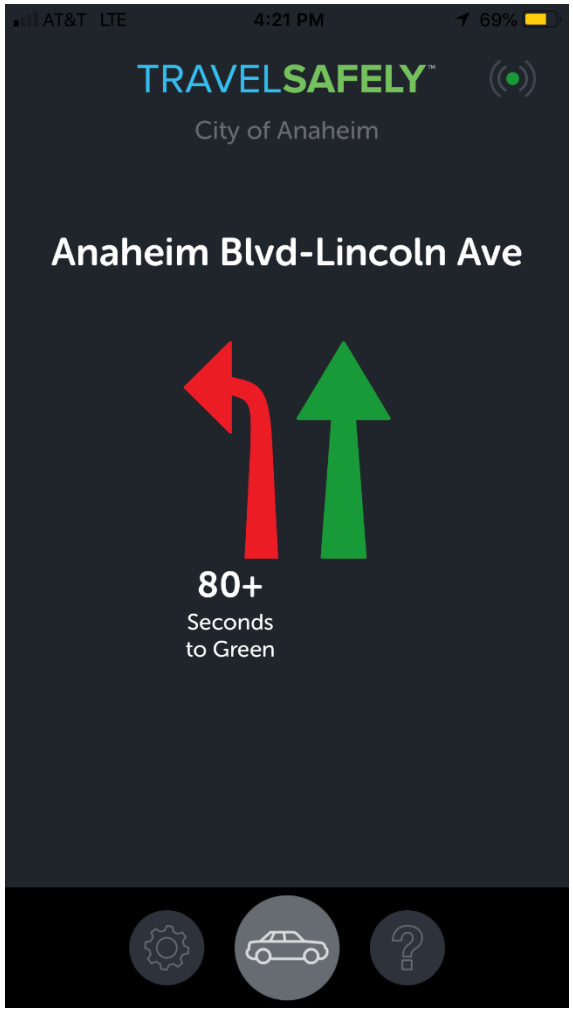
Source: SAE International

What is the Scope and Purpose of SAE J2735?

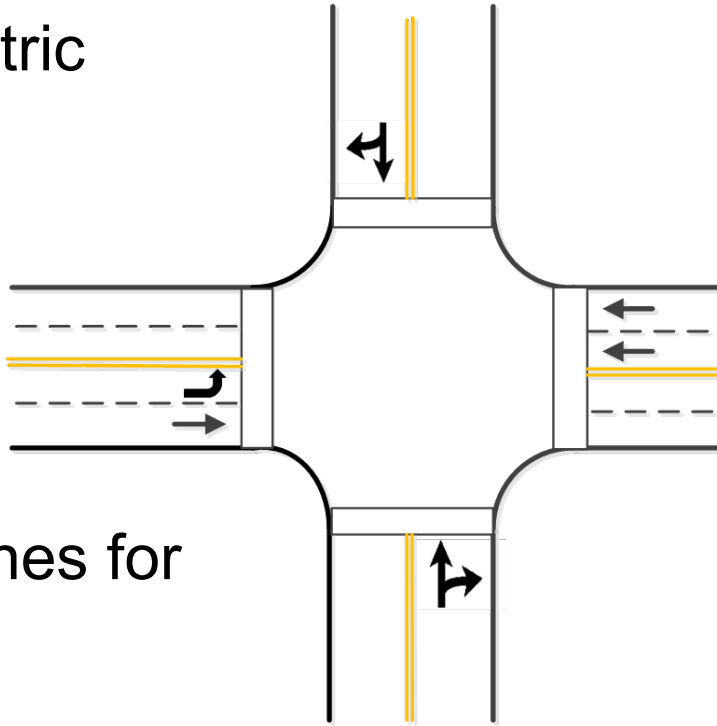
- **Signal Phase and Timing (SPaT)**
  - Provides signal phase and timing data from one or more traffic signal controllers
    - Provides **dynamic** data
    - General controller status
    - What movements (by lane) are currently allowed and when will the movement state is likely to end
  - Tied to the MAP data message



Source: Applied Information

What is the Scope and Purpose of SAE J2735?

- **MAP Data Message**
  - Provides **static** roadway geometric information
    - Lane widths, path, location
    - Lane types – vehicle lanes, crosswalks, barriers
    - Lane attributes – allowable movements, safe landing zones for the visually impaired
  - Indicates what part of the SPaT message applies to the traveler's intended movement



What is the Scope and Purpose of SAE J2735?

- **Signal Request / Signal Status Message (SRM/SSM)**
  - Provides signal priority/preemption request and status messages
  - Uses approach and desired egress lane, and estimated times
  - Must be configured to work reliably and with security protections

Source: US Department of Transportation

What is the Scope and Purpose of SAE J2735?

- **Basic Safety Message**
  - Broadcasted by vehicles about their kinematics and sensor information
- **Traveler Information Message**
  - General traveler information broadcasted from the infrastructure to travelers
- **NMEA Corrections and RTCM Corrections**
  - Contains data used to calibrate GNSS (e.g., GPS) for vehicles and mobile devices to increase the absolute and relative location accuracy.

ACTIVITY

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Question

Which of the following user needs for a signalized intersection is NOT addressed with SPaT data?

Answer Choices

a) Receive currently allowed vehicle movements
b) Receive lane location descriptions
c) Receive suggested vehicle speeds
d) Receive estimated times when signal indications will change

Review of Answers

a) Receive currently allowed vehicle movements

Incorrect. This information is supported by SPaT data

b) Receive lane location descriptions

Correct! Lane location descriptions are provided by MAP message data

c) Receive suggested vehicle speeds

Incorrect. This information is supported by SPaT data

d) Receive estimated times when signal indications will change

Incorrect. This information is supported by SPaT data

Learning Objective

Describe the SPaT Message

What is the Structure of the SPaT Message?

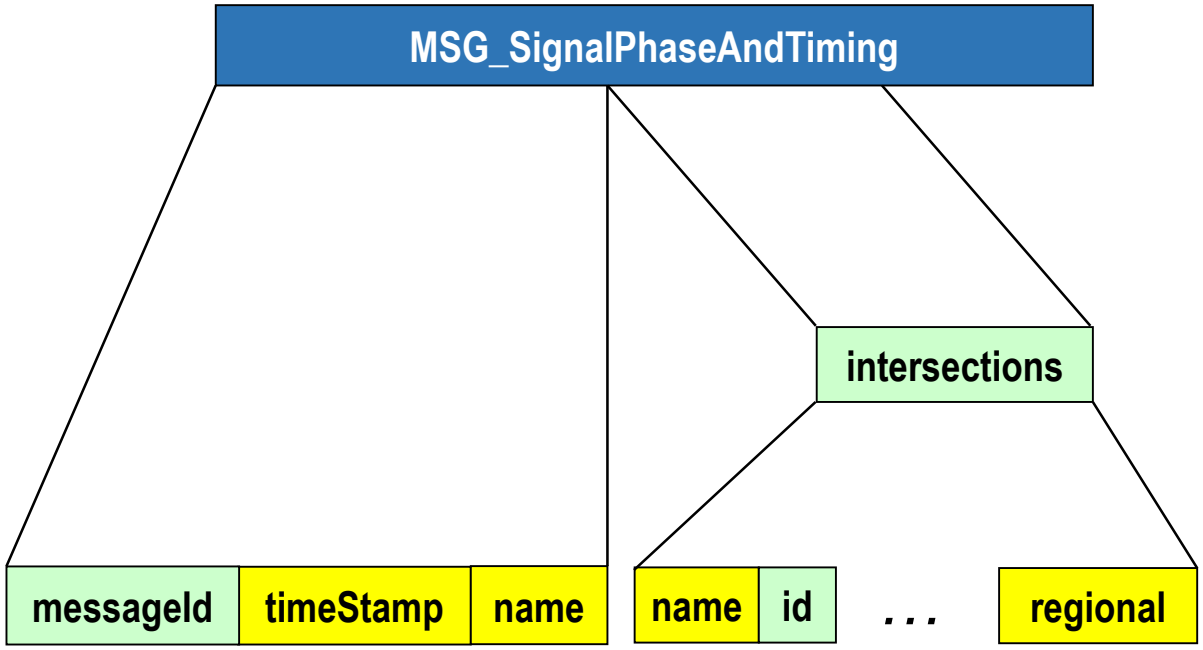
- Previously described **WHY** SPaT data is needed
  - Support in-vehicle and individual applications
- Next several slides describes **WHAT** data is provided in SAE J2735_201603

What is the Structure of the SPaT Message?

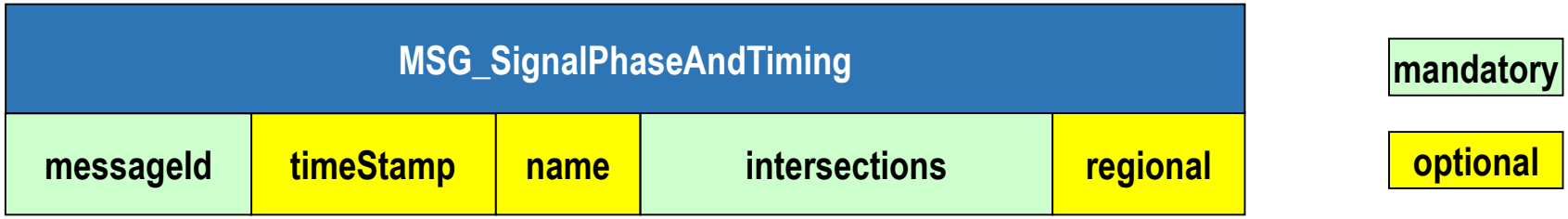
Message (sentence)

Data frames (Phrases)

Data Elements (words)



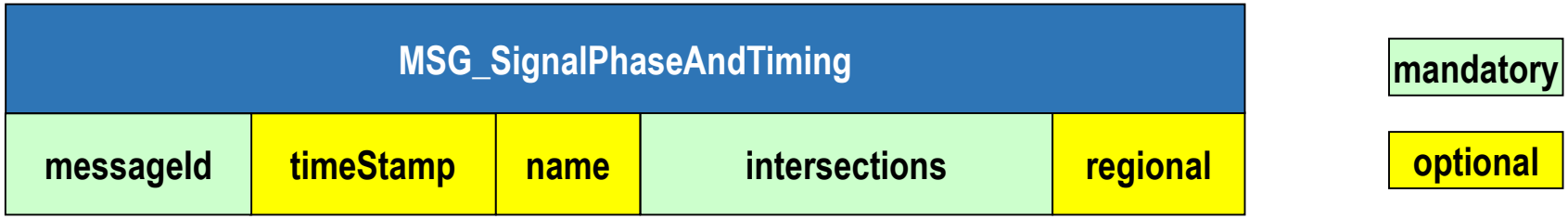
What is the Structure of the SPaT Message?



1..32

- **messageId.** DE_DSRCmsgID = 19
- **timeStamp.** Number of elapsed minutes in the year
- **name.** Name of the group of intersections for testing purposes
- **intersections.** Data for each intersection
- **regional.** Regional extensions

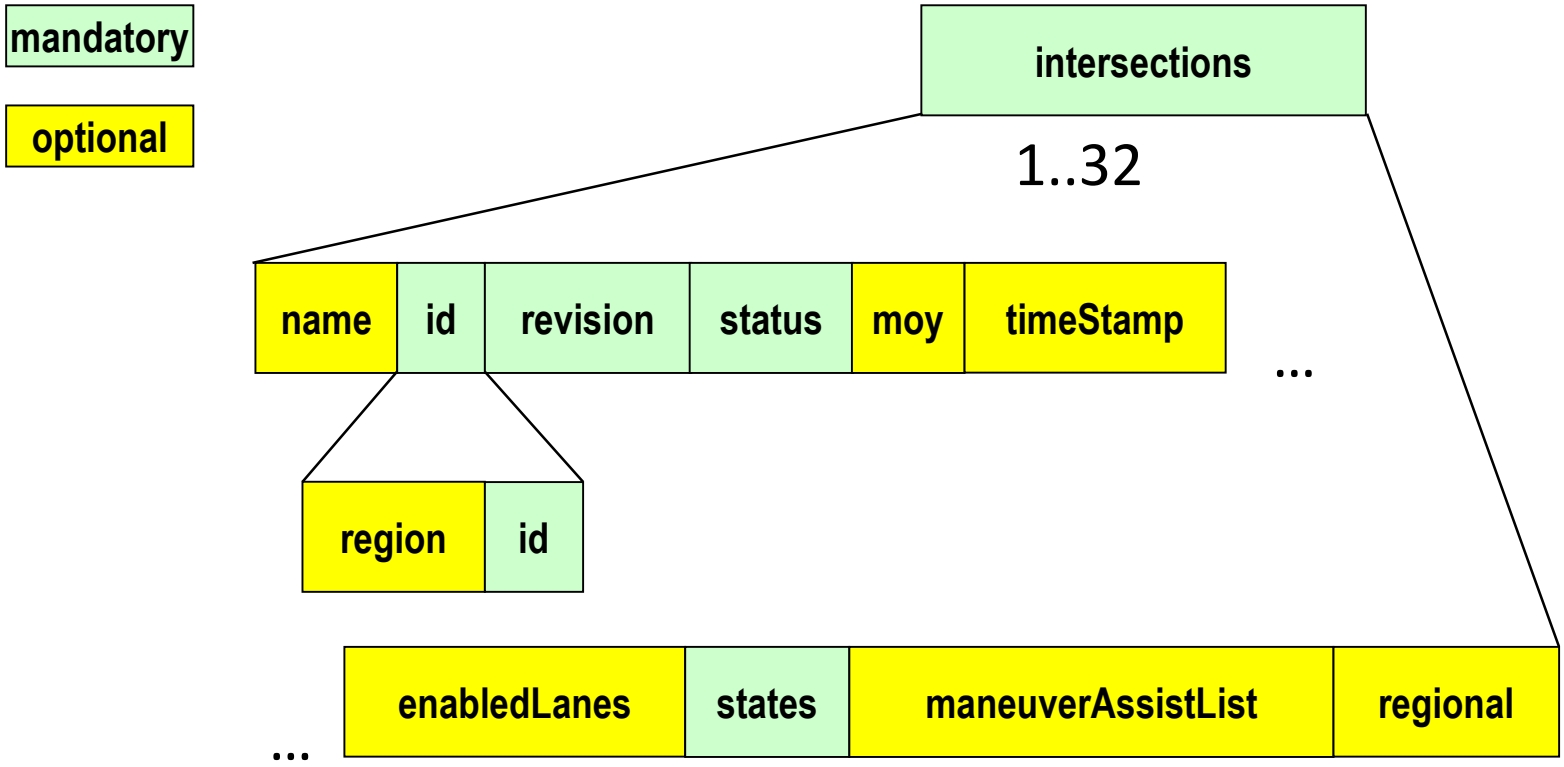
What is the Structure of the SPaT Message?



1..32

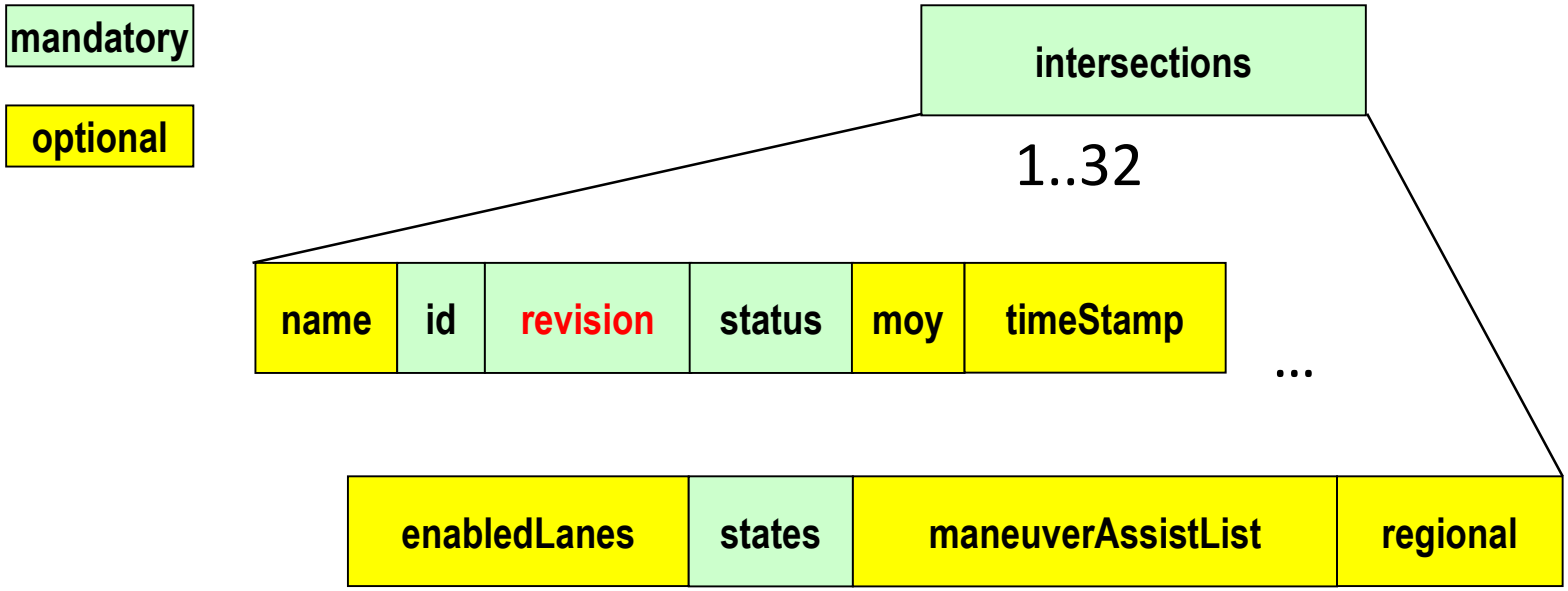
- Each SPaT message can provide signal phase and timing and **dynamic** information for **multiple** intersections.
  - Useful in dense urban areas.

What are the Mandatory Elements of the SPaT Message?



- **region.** Identifier of the responsible agency
- **id.** Regionally unique intersection identifier

What are the Mandatory Elements of the SPaT Message?

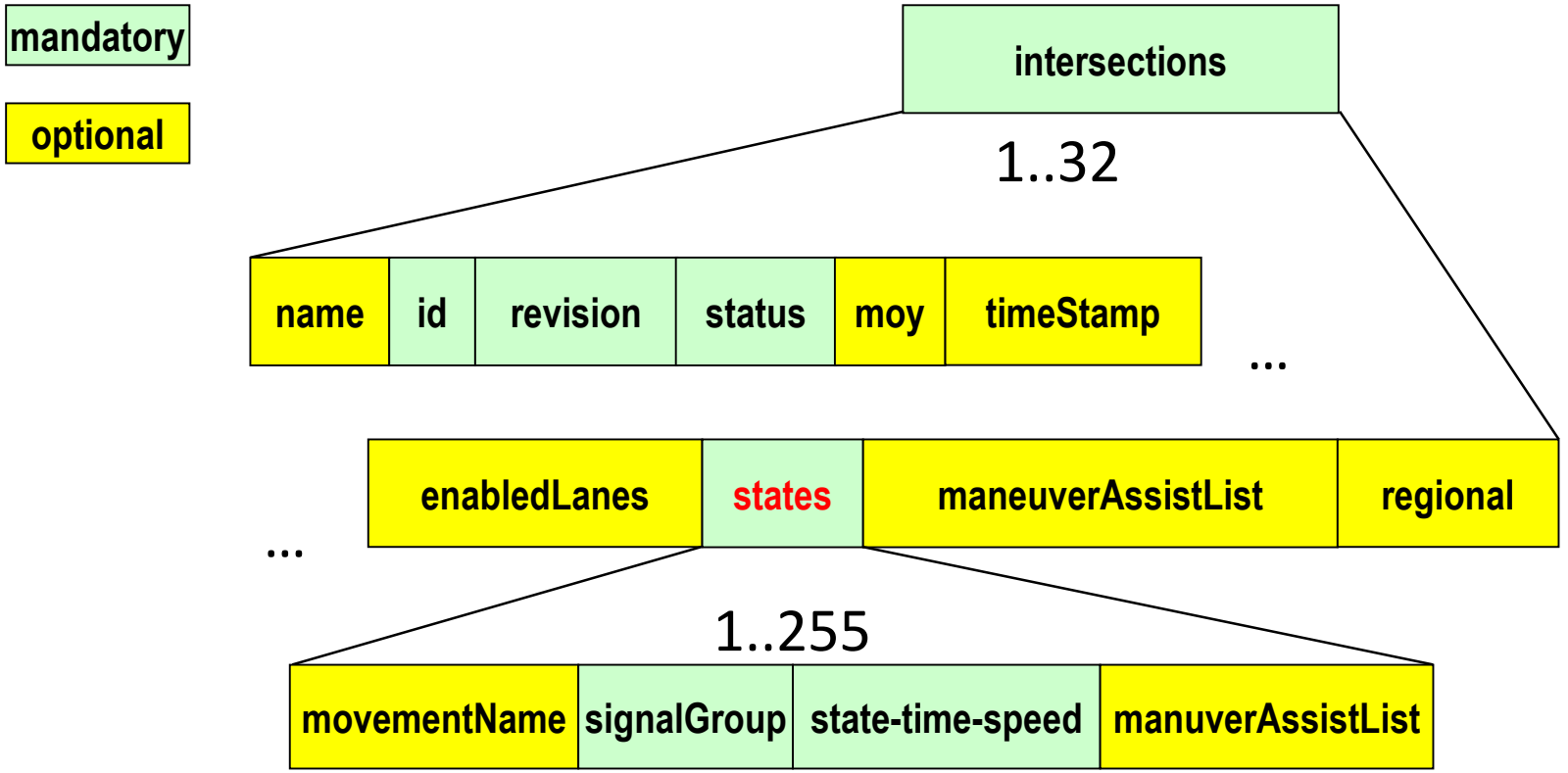


- **revision** is message counter. Increments:
  - Every time message is transmitted, **OR**
  - When the message content changes
- **status** is the general status of the controller, e.g., adaptive, priority, preempt, flash, no valid SPaT data

What are the Mandatory Elements of the SPaT Message?

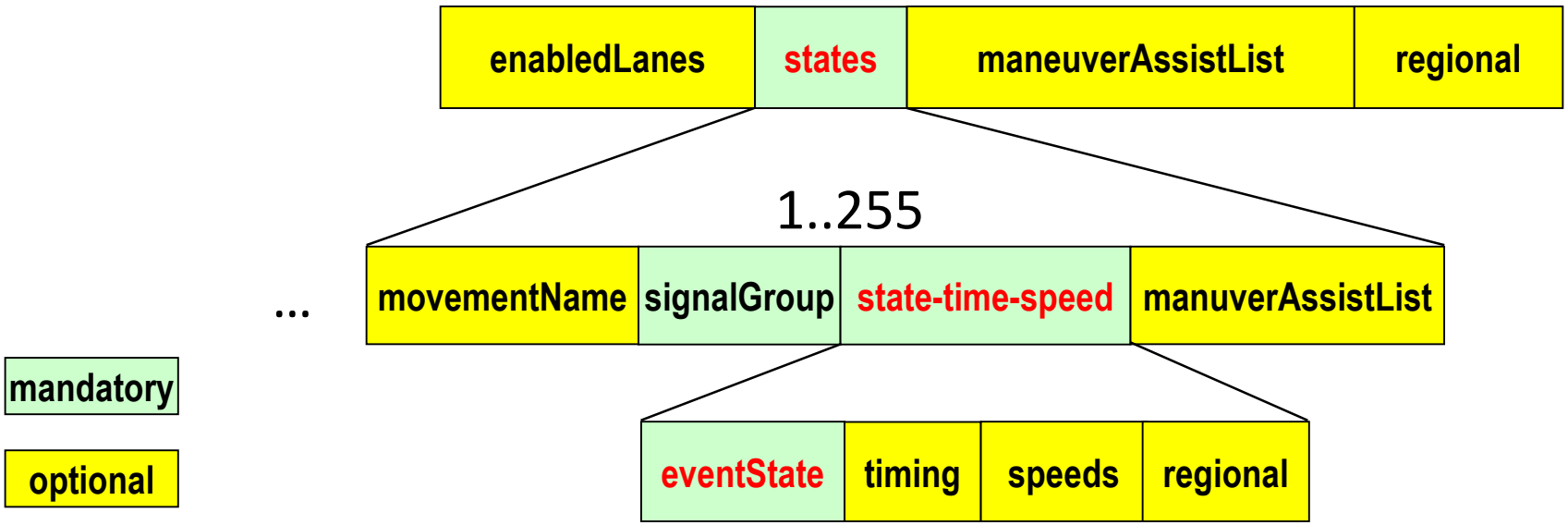
- **Status.** Example potential implementation issues:
  - Definition of providing signal priority.
    - When request is received?
    - When modifications are made to the timing?
  - Definition of preempt mode.
    - When the preempt request is received?
    - Does it include the preempt exit phases?
  - Definition of recent MAP update.
    - Within the last week? Last month?
  - Some status values may be defined in other standards, e.g., NTCIP 1202 v03

What are the Mandatory Elements of the SPaT Message?



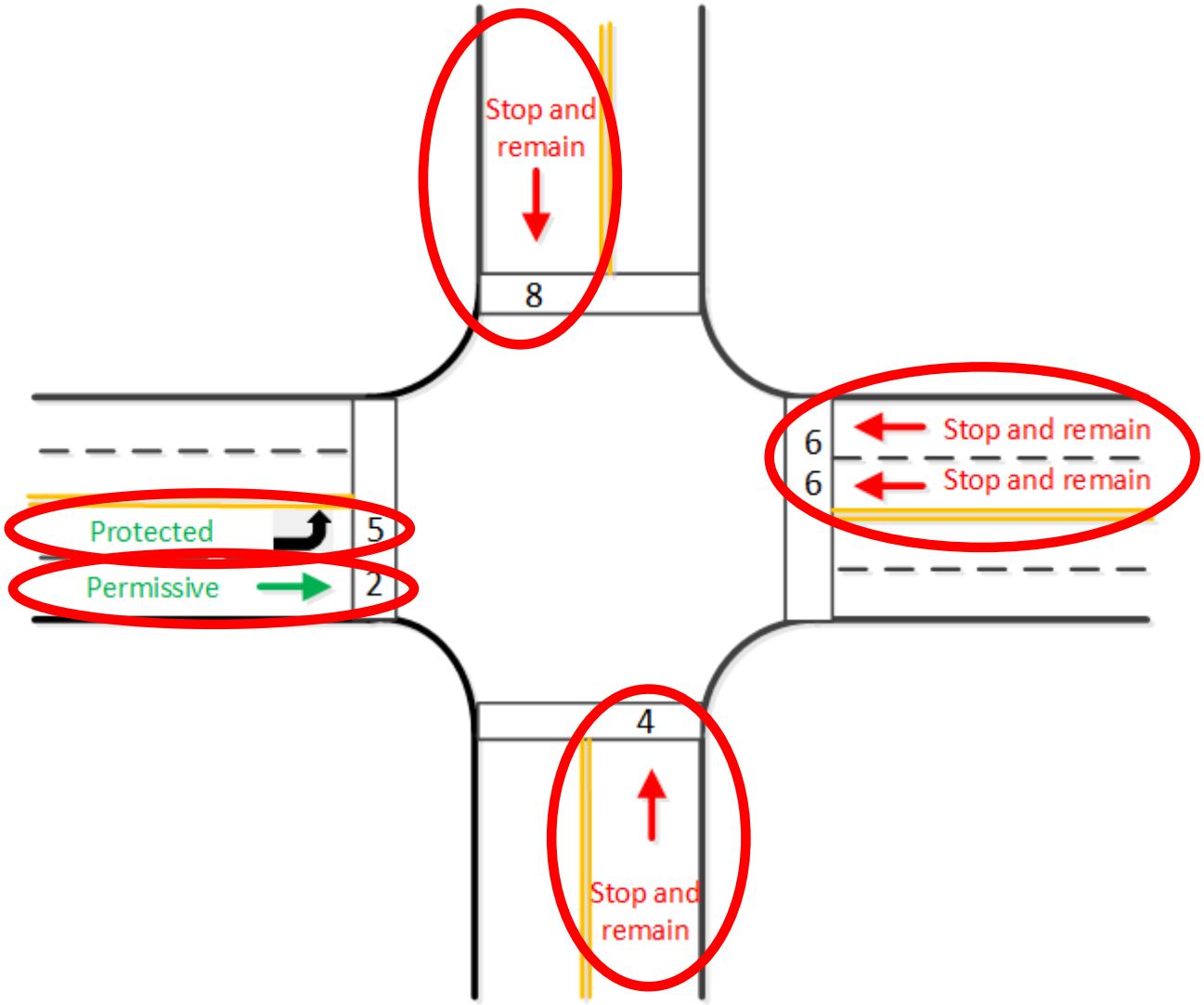
- **states** provide information for each movement at the intersection
- **signalGroup** is an identifier tying the SPaT data to a specific lane-to-lane movement in the **MAP** message

What are the Mandatory Elements of the SPaT Message?



- **eventState.** Unavailable, dark (signal indication is dark), stop then proceed (e.g., flashing red, red turn on red), stop and remain, permissive movement, protected movement, permissive clearance, protected clearance, proceed with caution (e.g., flashing yellow)

What are the Mandatory Elements of the SPaT Message?



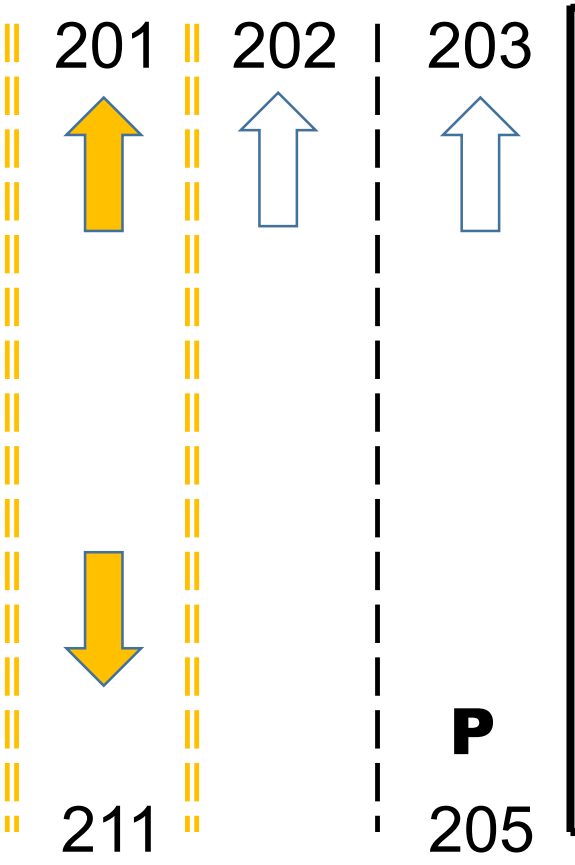
What are the Mandatory Elements of the SPaT Message?

- **Summary**
  - messageId
  - Intersection (optional)
    - id (of the intersection)
    - revision (counter)
    - status (of the controller)
    - state
      - signalGroup (identifier of the movement)
      - eventState (signal state of the movement)

What are the Optional Elements of the SPaT Message?

- **Enabled (revocable) lanes**
  - List of revocable lanes that are **active**
  - Must be defined as a revocable lane in the **MAP** message

What are the Optional Elements of the SPaT Message?

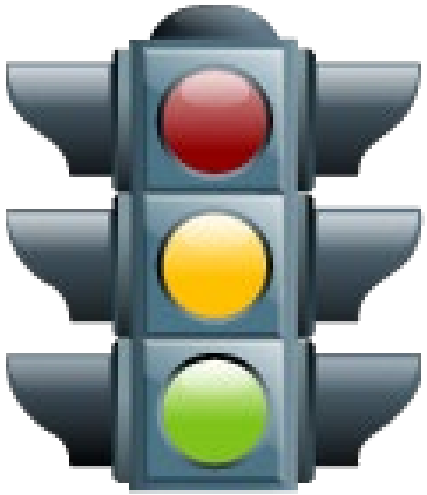


Lane 201, 203, 211, 205 are revocable lanes

- Revocable lanes **may be mutually exclusive**
- Lanes 201 and 211 are reversible lanes
- Lane 203 is an active lane and Lane 205 is a parking lane

What are the Optional Elements of the SPaT Message?

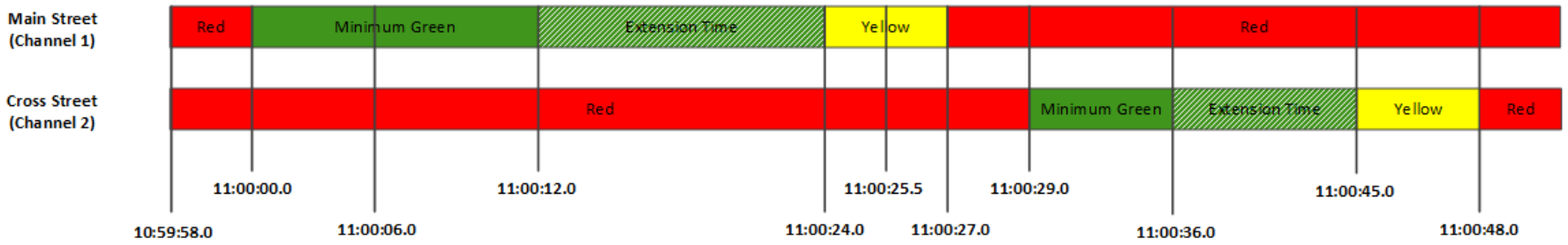
- **timing.** Measured in tenths of a second in the current or next hour.
  - Time **OF** change, not time **TO** change.
  - **NOT** valid if in preempt mode
  - **minEndTime.** Earliest time the eventState may change (mandatory)
    - How to interpret for actuated signals if the minEndTime has already passed?
  - **startTime.** Ambiguous, could be past or future



What are the Optional Elements of the SPaT Message?

- **timing.** (continued)
  - **maxEndTime.** Latest time the eventState may change
  - **likelyTime.** Most likely time the eventState will change
  - **confidence.** Statistical probability of the likelyTime
  - **nextTime.** When the current eventState will likely occur again

What are the Optional Elements of the SPaT Message?



timeStamp	35980	0	60	120	240	255	270	290	360	450	480
SignalGroupID 2											
startTime	35790	0	0	0	240	240	270	270	270	270	270
minEndTime	0	120	120	120	270	270	410	410	410	410	410
maxEndTime	0	240	240	240	270	270	500	500	500	500	500
likelyEndTime	0	150	150	240	270	270	500	500	500	500	500
nextTime	0	410	410	500	500	500	500	500	500	500	500
eventState	3	5	5	5	7	7	3	3	3	3	3
SignalGroup 4											
startTime	35980	35980	35980	35980	35980	35980	35980	290	290	450	480
minEndTime	170	170	170	170	170	170	170	360	360	480	500
maxEndTime	290	290	290	290	290	290	290	450	450	480	500
likelyEndTime	200	200	200	290	290	290	290	450	450	480	500
nextTime	200	200	200	290	290	290	290	700	700	700	700
eventState	3	3	3	3	3	3	3	5	5	7	3

Assumes the following: a) fixed 3.0 second yellow and 2.0 second red for both approaches.

b) likely green time of 15.0 seconds for main street and 16.0 seconds for cross street

c) For illustrative purposes only, upon reaching the end of minimum green, actuations extend green times to the full extension time (maximum green)

EXAMPLE

What are the Optional Elements of the SPaT Message?

- **Advisory speeds** for a movement
  - The **advisory speed** and **distance** from the stop bar the advisory speed is good for
  - Specify the **vehicle class** the advisory is valid for

What are the Optional Elements of the SPaT Message?

- **Information** for a specific lane movements
  - Current **queue length** for this movement
  - **Distance** from the stop bar within which vehicles can expect to **clear** the intersection
  - If a vehicle should stop at the stop bar
  - If a **conflicting pedestrian or bicycle in the path** is detected
  - **Requires** a MAP message

What are the Optional Elements of the SPaT Message?

- Optional elements are **optional** as defined by the SAE J2735 standard
  - **Mandatory** are minimum elements based on the experience of the standards committee
- Optional elements should be broadcasted **IF:**
  - **Required** by a regulation or regulatory agency
  - **Required** by another standard or specification
    - E.g., the Connected Signalized Intersection project

What are the Optional Elements of the SPaT Message?

- Optional elements should be broadcasted **if needed to support a desired application**
  - To support a basic **Red Light Violation** application, the mandatory elements are sufficient
  - To support the **Eco-Approach and Departure at Signalized Intersections** application, the advisory speeds for an approach towards the intersection is needed
  - To support **phase time** remaining in an **in-vehicle** application, the timing information is needed

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Question

Signal timing information for how many intersections can be included in a single SPaT message?

Answer Choices

a) Only one signalized intersection
b) Only one signalized and one non-signalized intersection
c) Up to two signalized intersections along an arterial
d) Up to 32 signalized intersections

Review of Answers

a) Only one signalized intersection

Incorrect.

b) One signalized and one non-signalized intersection

Incorrect.

c) Up to two signalized intersections along an arterial

Incorrect.

d) Up to 32 signalized intersections

Correct! A SPaT message can provide signal timing information for up to 32 signalized intersections

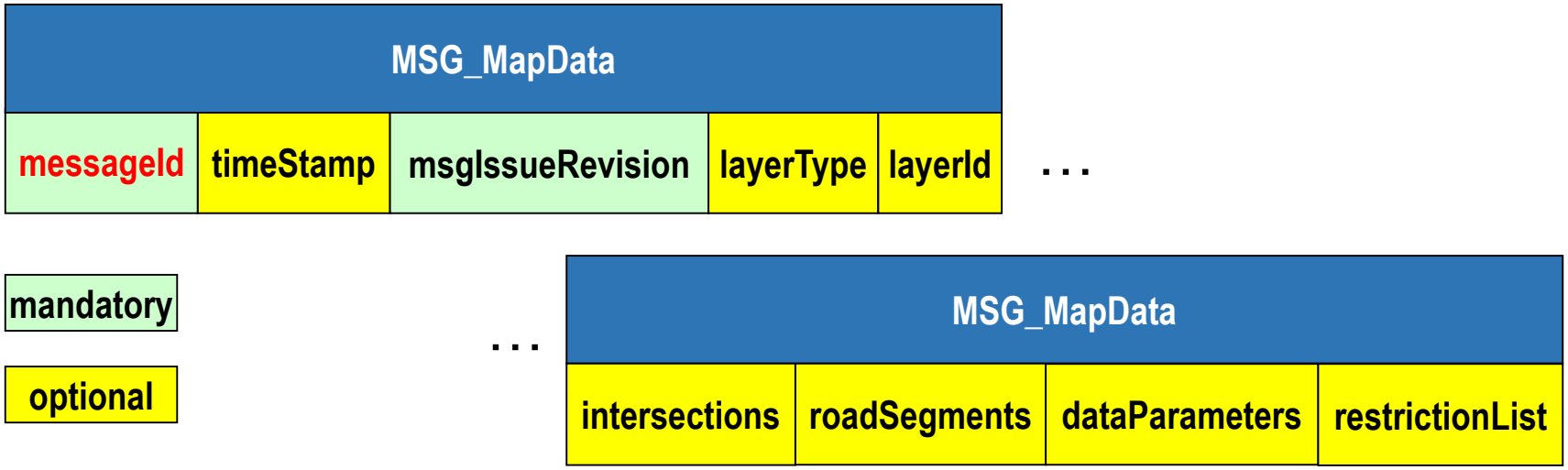
Learning Objective 3

Describe the MAP message

What is the Structure of the MAP Message?

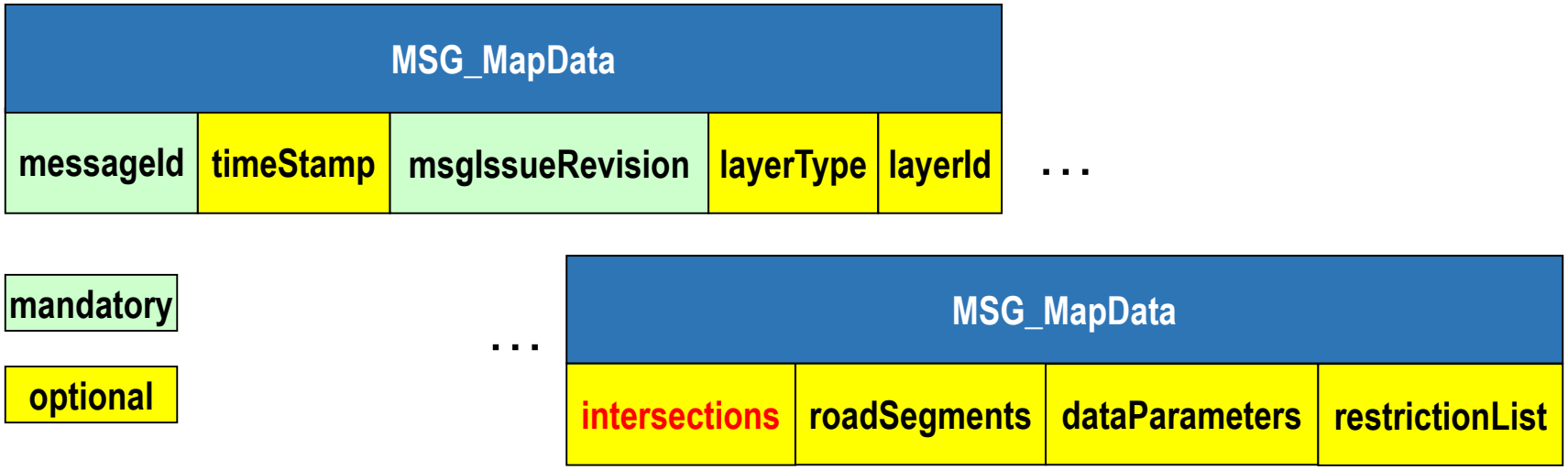
- **MAP** messages provide **static** geographic road information
  - descriptions of lanes and lane types
- Each MAP message can provide roadway geometric information for:
  - Up to 32 **intersections,** and
  - Up to 32 **road segments**

What is the Structure of the MAP Message?



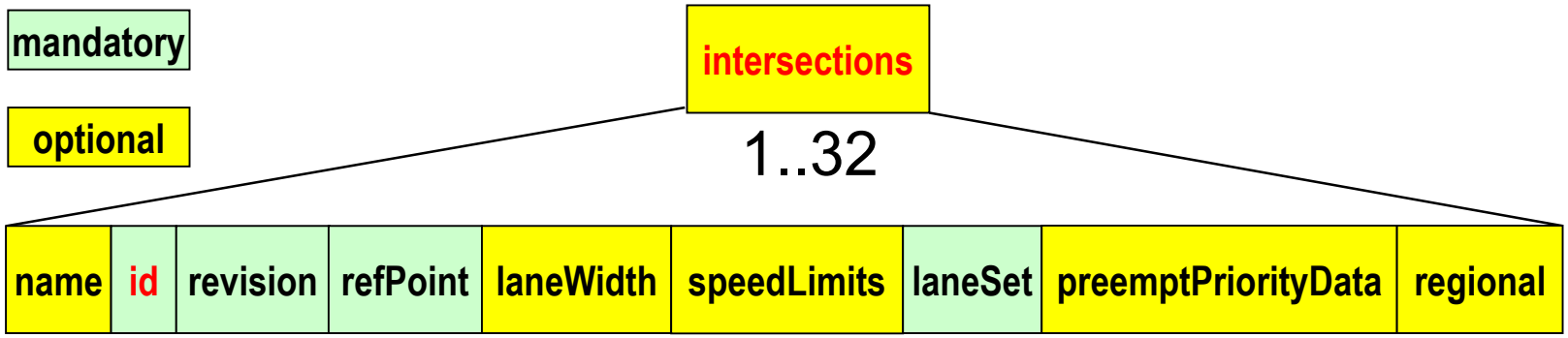
- **messageId.** DE_DSRCmsgID = 18
- **timestamp.** Number of elapsed minutes in the year
- **msgIssueRevision.** Message counter indicating contents changed
- **layerType.** Type of map information, e.g., general, curve, intersection, roadway segment
- **layerId.** Layer identifier

What is the Structure of the MAP Message?



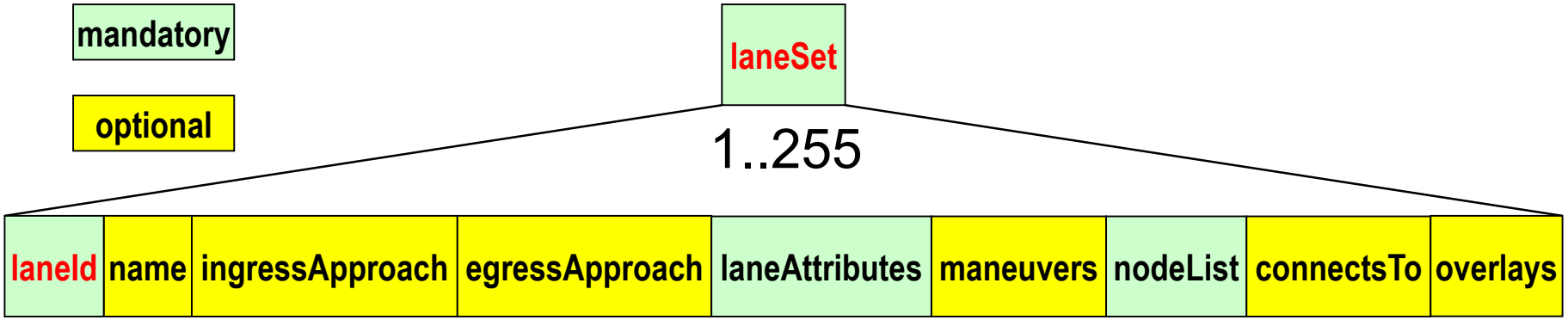
- **intersections.** MAP data for intersections
- **roadSegments.** MAP data for road segments
- **dataParameters.** Metadata about the MAP contents
- **restrictionList.** List of potential user class restrictions

What are the Mandatory Elements of a MAP Message?



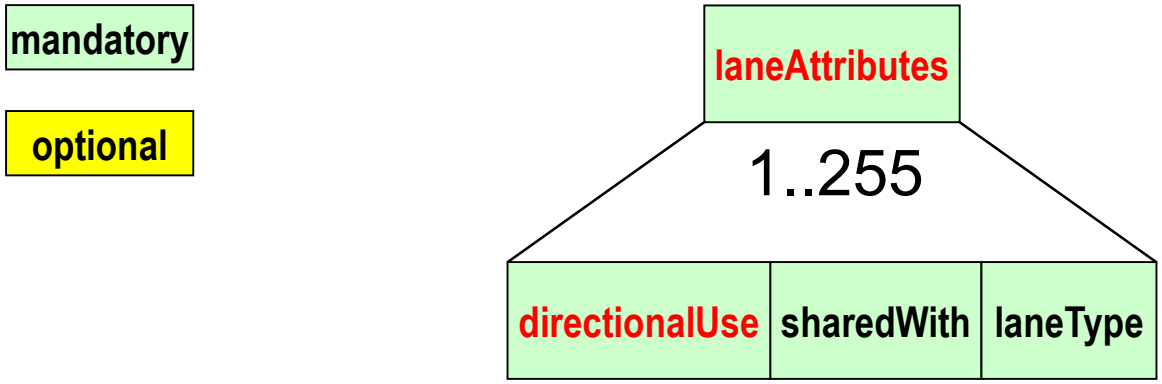
- **id.** Identifier of the responsible agency (optional) + regionally unique identifier for the intersection
- **revision.** Message counter to indicate if the road geometry for the intersection has changed
- **refpoint.** Geographic reference (anchor) point for this intersection. Latitude-Longitude. Elevation is optional.
- **laneSet.** Data describing a lane

What are the Mandatory Elements of a MAP Message?



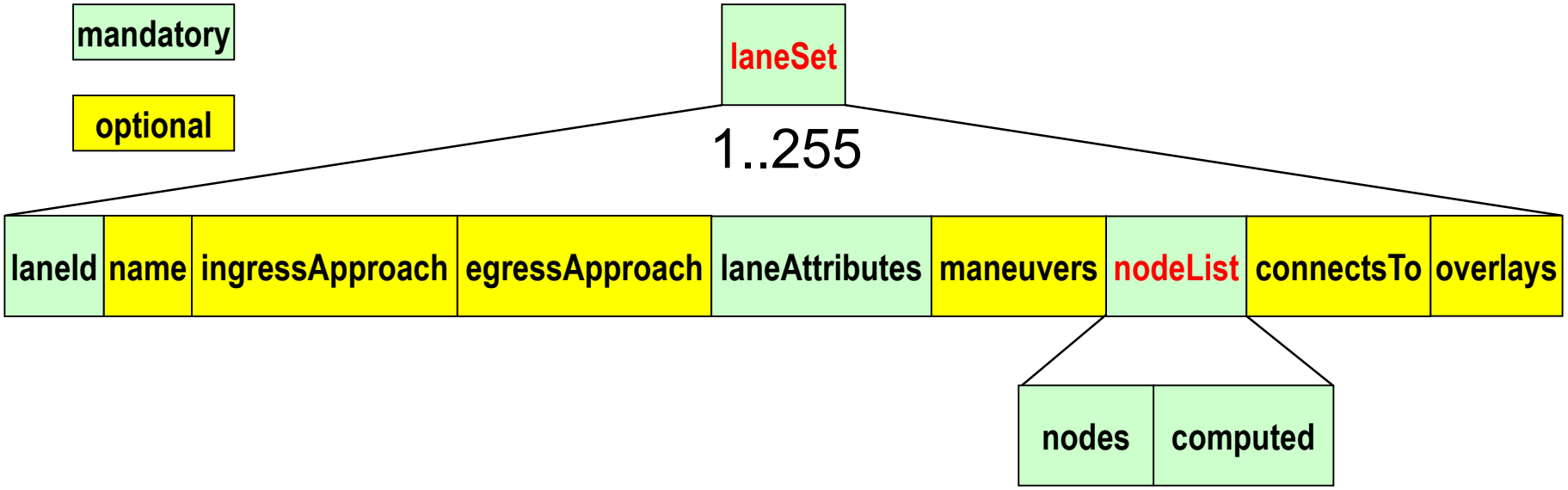
- **laneId.** A lane identifier unique within the intersection
- **laneAttributes.** A data frame containing data about the lane characteristics

What are the Mandatory Elements of a MAP Message?



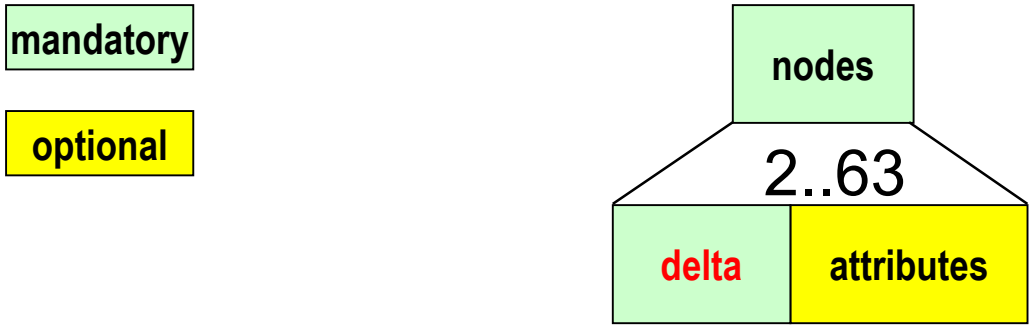
- **directionalUse.** Direction of travel in the lane
- **sharewith.** Indicates the presence of another user type that has equal rights to use the lane
- **laneType.** Defines the type of lane. Valid values include vehicle lane, crosswalk, bicycle lane, sidewalk, (physical) barrier, striped lane, tracked vehicle and parking lane.
  - Also used to indicate if it is **revocable** lane. Used by the **SPaT** message

What are the Mandatory Elements of a MAP Message?



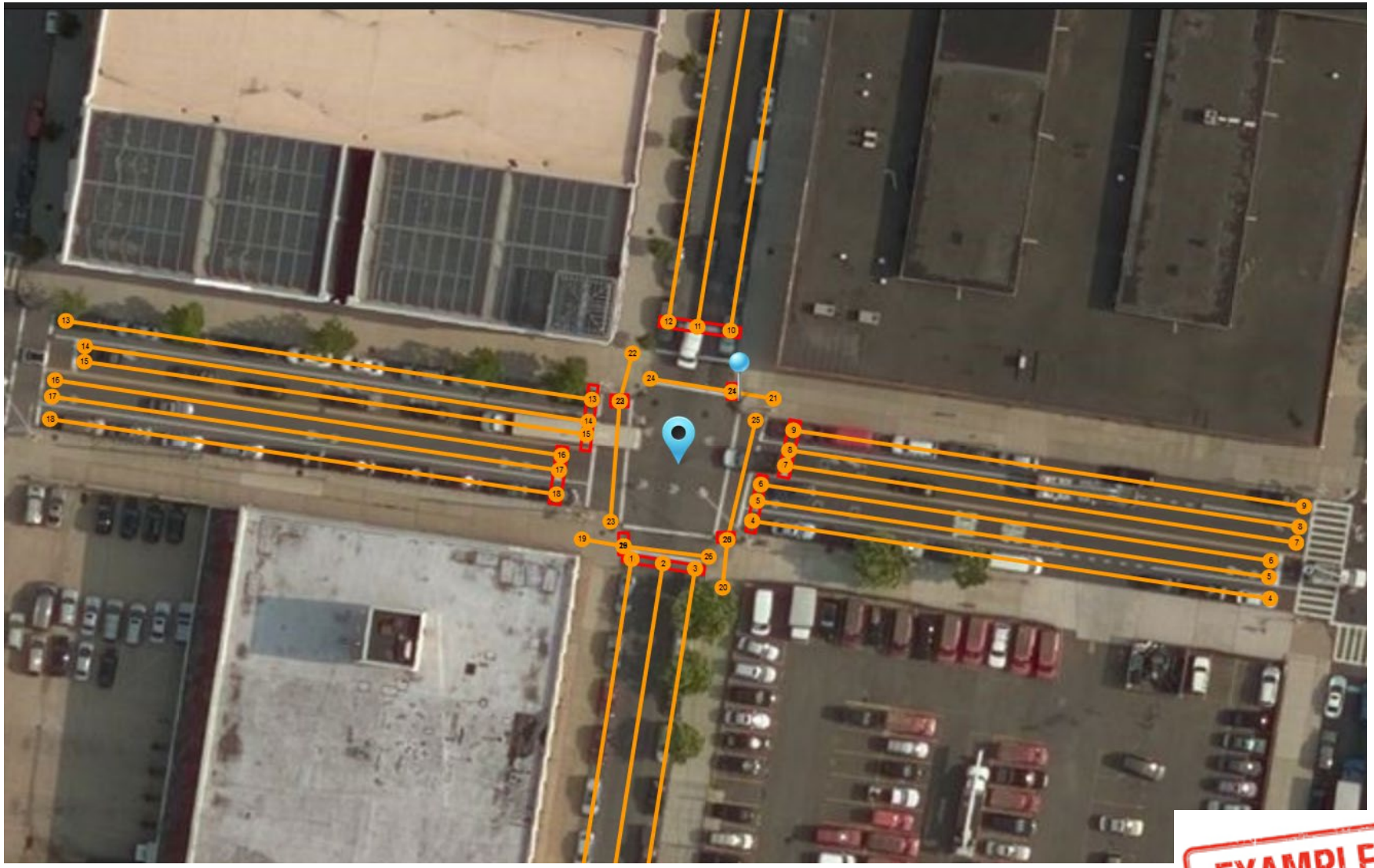
- **nodeList.** Sequence of signed offset node points representing the centerline of the lane. CHOICE of:
  - **nodes.** A sequence of 2 to 63 node points defining the centerline of the lane
  - **computed.** A lane that has similar (lane) attributes as another lane

What are the Mandatory Elements of a MAP Message?



- **delta.** Each node is an X-Y offset from the previous node, in units of 1 centimeter.
  - Each node could also be a latitude-longitude geographic coordinate but not generally used
  - The first node point is the offset from the reference point and typically at the stopline.
  - With lane width represents the lane as a polygon

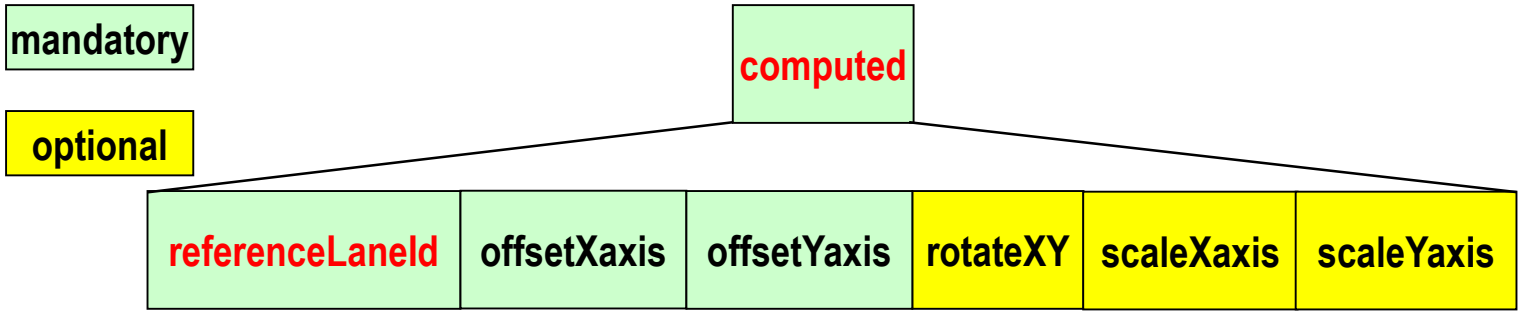
What are the Mandatory Elements of a MAP Message?



Source: New York City Connected Vehicle Pilot

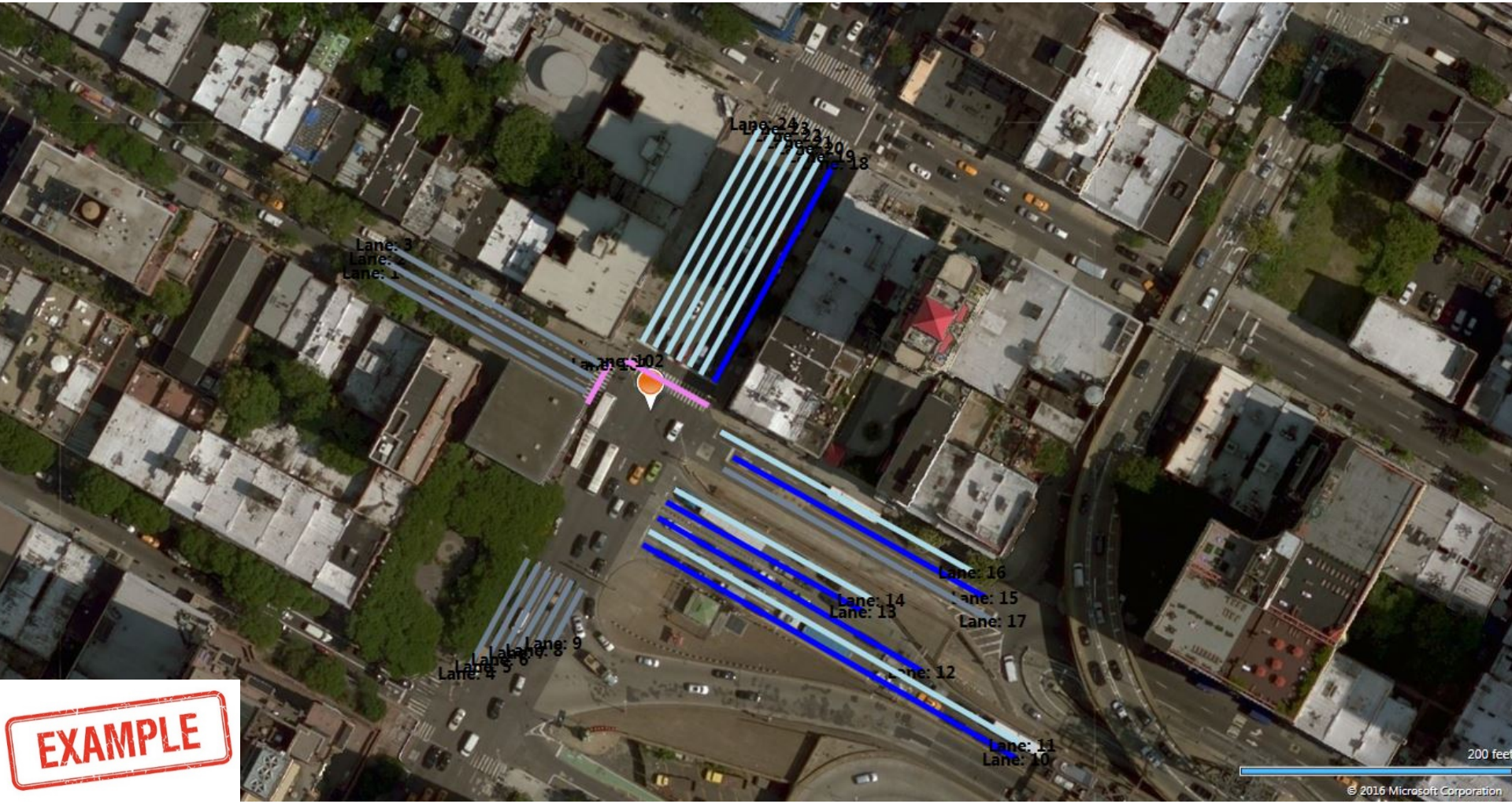
EXAMPLE

What are the Mandatory Elements of a MAP Message?



- **referencedLaneId.** Identifier of the lane that this computed lane is based on.
- **offsetXaxis / offsetYaxis.** Offset of the first node of the computed lane from the referenced lane along the x-axis / y-axis

What are the Mandatory Elements of a MAP Message?



EXAMPLE

Source: New York City Connected Vehicle Pilot

What are the Mandatory Elements of a MAP Message?

- **Summary**
  - messageId
  - msgIssueRevision (of the message)
  - id (of each intersection)
  - refPoint (of each intersection)
  - revision (counter for each intersection)
  - For each lane:
    - laneId
    - laneAttributes
    - nodes (sequence of node offsets)

What are the Optional Elements of a MAP Message?

- **speedLimits.** Regulatory information for a lane or set of lanes
  - **type.** Type of regulatory speed limit.
  - **speed.** Velocity of the object (in 0.02 m/s)
- **Metadata** about the map contents
- **User class restrictions** for lane/movement restrictions (e.g., transit only, emissions compliant, height compliant, pedestrians only)

What are the Optional Elements of a MAP Message?

- **maneuvers.** Allowed maneuvers for the lane
  - **connectingLane.** Lane identifier that a maneuver connects to
  - **remoteIntersection.** Identifier of another intersection that describes the connecting lane
  - **signalGroup.** Identifier of the movement. Used to tie to the SPaT message.
  - **userClass.** Identifies the lane/movement restrictions

What are the Optional Elements of a MAP Message?

- **Node information.** Presents the attributes at a node that describes the path of a lane.
  - **localNode.** Defines up to 8 attributes for this node point. E.g., fire hydrant, traffic island for crosswalks
  - **disabled / enabled.** Defines up to 8 attributes for a segment. E.g., transit stop, parking zone, bike lane on left, rumble strip present
  - **dWidth.** Linear taper in the lane width from the previous node
  - **dElevation.** Linear taper in the lane elevation from the previous node

What are the Optional Elements of a MAP Message?

- **Computed Lane**
  - **rotateXY.** Rotation of the initial node point
  - **scaleXaxis / scaleYaxis.** Defines expansion or contraction of the computed lane along the X-axis / Y-axis

What are the Optional Elements of a MAP Message?

- Optional elements are **optional** as defined by the standard
- Optional elements may be **required** by a regulation, another standard or a specification
- Optional elements should be broadcasted **if needed to support an application**
  - **Maneuver** information, e.g., SignalGroupID data, is needed to support the SPaT message if broadcast
  - **Location of safety zones** (e.g., traffic islands) for pedestrian safety applications may be needed.

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Question

Which of the following attributes for a lane is included in a MAP message?

Answer Choices

a) The centerline locations of a lane
b) The permitted direction of travel of the lane
c) The permitted vehicle types that may use the lane
d) All of the above

Review of Answers

a) The centerline locations of a lane

True. Nodes are used to define the centerline of a lane.

b) The permitted direction of travel of the lane

True. The permitted direction of travel of the lane may be provided in a MAP message.

c) The permitted vehicle types that may use the lane

True. Vehicle class restrictions may be included in a MAP message.

d) All of the above

Correct! All of the above are true.

Learning Objective 4

Implementation Considerations

ISO TS 19091

- Previously described **WHY** SPaT and MAP data is needed
  - Support safety, mobility and environmental applications
- Previously describes **WHAT** data is provided by the SPaT and MAP messages
- Next slides describe **WHEN**, **WHERE**, and **HOW** the data is provided to support interoperability
  - **Standards** help answer some questions
  - May depend on the application

ISO TS 19091

- **ISO TS 19091 - Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections**
  - **Defines** dialogs and **HOW** to exchange messages, data structures, and data elements between roadside units and travelers to support signalized intersection applications
    - Procure, implement and test in a consistent manner
    - Used in Europe
    - May be used as guidance in North America

ISO TS 19091

- The V2I applications addressed 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 for the applications
- Use case types
  - **Priority/Preemption** applications
  - **Safety** applications
  - **Mobility/Sustainability** applications

ISO TS 19091

- **Lists requirements** describing the details of that data
- Deployments that conform to ISO 19091 would build to the same requirements – helps ensure interoperability
  - Functional Requirements
  - Performance Requirements (**WHEN**)

ISO TS 19091

- Defines what specific SAE J2735 messages, data frames or data elements are used to **fulfill** each functional requirement in ISO TS 19091.
  - SPaT
  - MAP
  - Basic Safety Messages
  - NMEA/RTCM
  - SRM/SSM
- See **Module CV271 – Using the ISO TS 19091 Standard to Implement V2I Intersection Applications Introduction**

SAE J2945/x Family of Standards

- **SAE J2945/x Family of Standards** identify the **information** and **performance requirements** for **applications** using SAE J2735 messages
  - How often a message is sent (minimum, typical, maximum)
  - Minimum quality requirements
- Each document identifies the minimum requirements or recommended practices for specific applications.

SAE J2945/x Family of Standards

- **SAE J2945_2017012 – Dedicated Short Range Communications (DSRC) Systems Engineering Process Guidance for SAE J2945/x Documents and Common Design Concepts**
  - Also known as **J2945/0**, defines common requirements for connected vehicle applications
  - Includes systems engineering content (Concept of Operations, requirements, message exchanges, and message content) for the family of standards

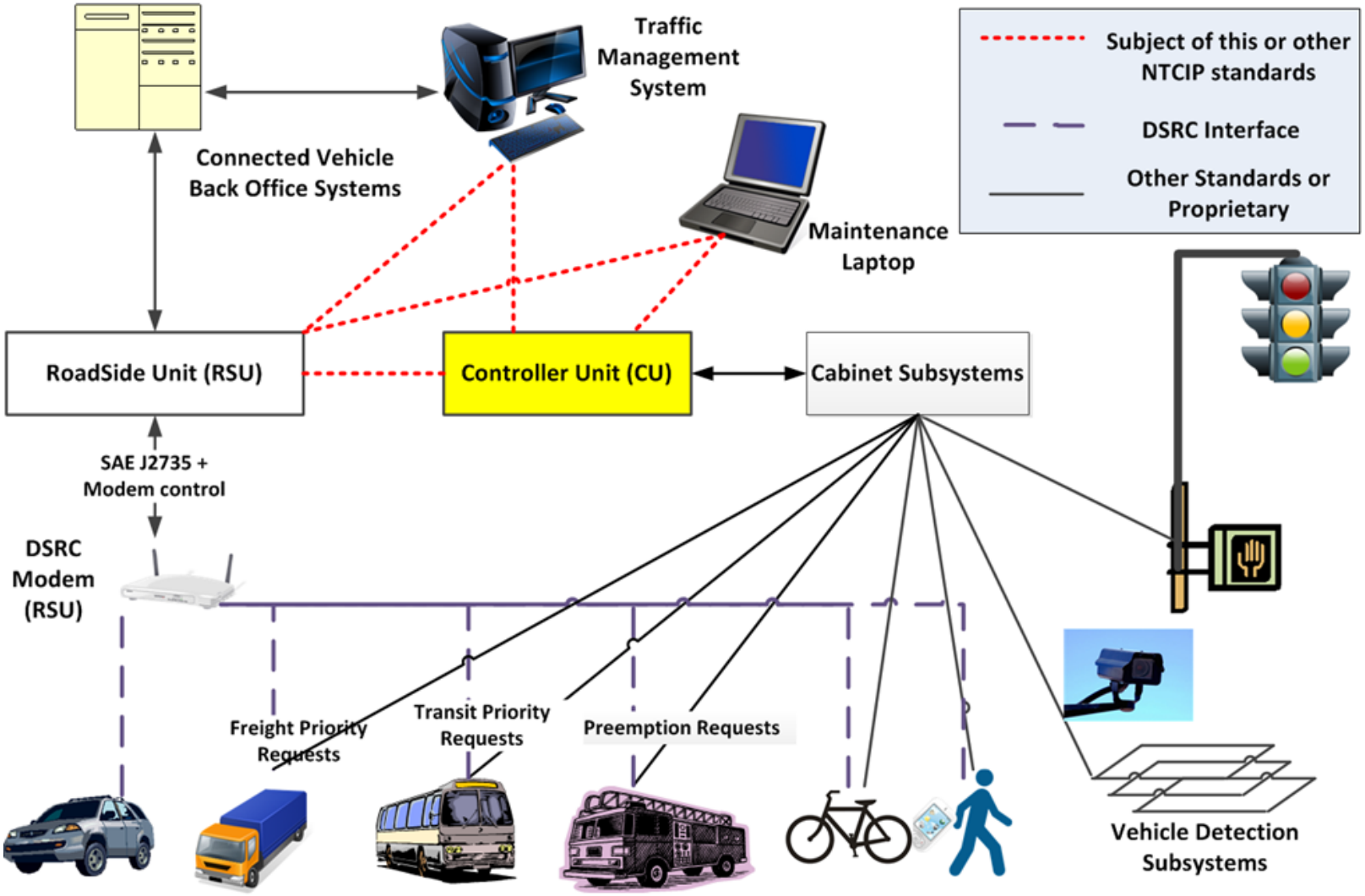
SAE J2945/x Family of Standards

- **SAE J2945/A – MAP/SPaT Deployment – Intersection Operations**
  - Previously SAE J2945/10, contains recommended best practices on using the MAP and SPaT message content to meet operational needs.
  - Currently on hold
- **SAE J2945/B - Recommended Practices for Signal Preemption Message Development**
  - Previously SAE J2945/11, provides reference implementations on how to provide priority and preemption at signalized intersections.
  - Currently under development.

NTCIP 1202 v03

- **NTCIP 1202 v03 – Object Definitions for Actuated Signal Controllers**
  - Standardizes the communications interface between an actuated signal controller and a center
  - Published May 2019 as an update to NTCIP 1202 v02 (published 2005)
  - Adds systems engineering content and accommodates new user needs

NTCIP 1202 v03



NTCIP 1202 v03

- Connected Vehicle user needs addressed by the standard
  - Focus is the interface between the Roadside Unit and the controller
  - Provides **SPaT data** to the Roadside Unit
  - Provides a check that the **SPaT** data matches the **MAP** data
- Supports the entire SPaT and MAP data messages except regional extensions and start time

NTCIP 1202 v03

- **Implementation Issues:**
  - Does the controller **push** or **pull** data with the RSU?
    - If push, should the controller push on change (when a value changes) or periodically (e.g., ten times per second)?
    - If pull, how often should the RSU request the SPaT data from the controller?
      - The controller should still push periodically.

NTCIP 1202 v03

- **Implementation Issues:**
  - Clock differential
  - For additional information about NTCIP 1202 v03, **see A315 modules**

How to Specify SPaT Messages

- Determine what optional data elements to include in your specification
  - Use ISO TS 19091 as a guideline (by use case)
- If using NTCIP 1202 v03, complete the PRL.
  - Requires some of the optional data elements in SAE J2735 to be mandatory.
- **Connected Signalized Intersections (CSI)** project
  - Develop a standard or specification to define key capabilities to support interoperability
  - Started November 2019

How to Specify SPaT Messages

- For both **SPaT** and **MAP** messages, consider the communications media
  - **Dedicated Short Range Communications (DSRC)**
    - Would use **IEEE standards**, which imposes a limit of approximately 1500 bytes
    - Consider latency
    - **Where?** Range of approximate 300 meters
  - **Cellular Vehicle to Anything (C-V2X)**
    - Release 16 expected 2020.

How to Specify SPaT Messages

- For both **SPaT** and **MAP** messages, consider **security:**
  - **Signed** to indicate it's an authentic message from the source it claims to be
  - Could be **signed** at the Roadside Unit or a center
  - For additional information about security, **see other PCB modules**

How to Specify MAP Messages

- **MAP** messages must be included with SPaT messages
  - Contains indexes (**SignalGroupIDs**) connecting **SPaT** movements to ingress and egress lanes
  - The MAP message indicates “where the lane” is.
- **Level of Detail**: Varies depending on the applications supported
  - Level of resolution needed may vary
  - Geographical extent needed may vary
  - What information is needed (report all lanes?)
  - Communications limitations (message size)

How to Specify MAP Messages

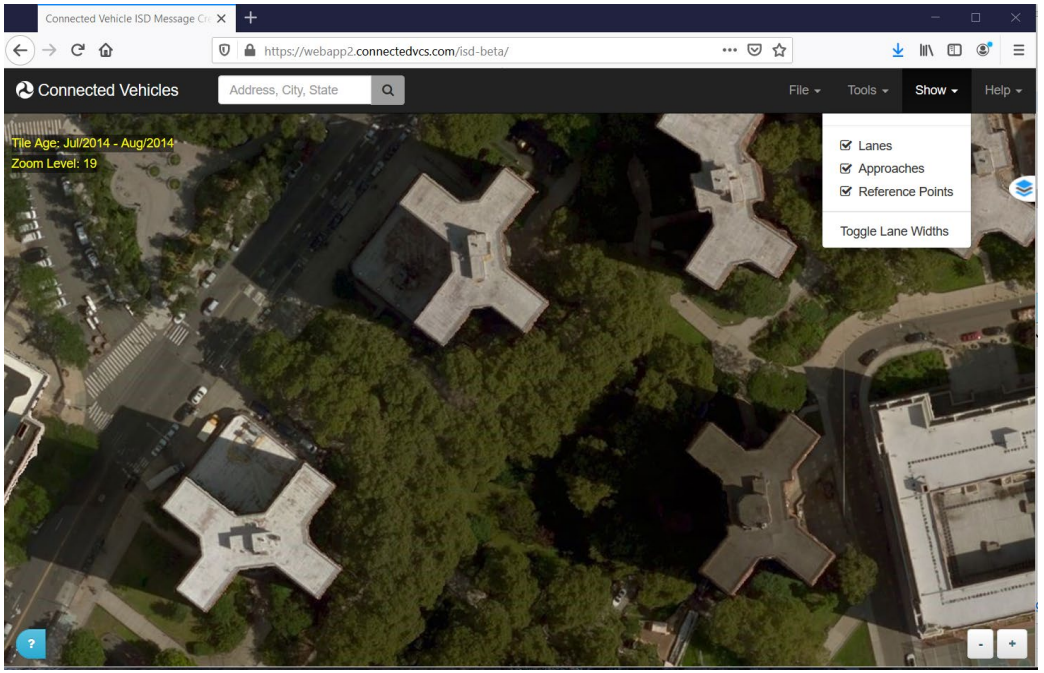
- Typically only 1 to maybe 3 intersections per MAP message
- **SAE J2945/0** contains recommendations:
  - Transmission rates – once every one or two seconds
  - DSRC channels
  - Transmission power levels

How to Specify MAP Messages

- **Implementation Issues**
  - Must be based on WGS84 coordinate system
  - Intersection ID numbering
  - Need to define consistently
    - E.g., How crosswalks are represented varies around the world.
- **Creation of a Guidance Document for MAP Preparation** project
  - Develop a guidance document on how to create MAP messages
  - Expected start date March 2020

How to Specify MAP Messages

- Tools for Developing MAP messages
  - **USDOT J2735 MAP Tool**
  - Can automate map data validation and visualize data to reduce errors



Additional References

- See **Student Supplement**
- ITS Professional Capacity Building Program
  - https://www.pcb.its.dot.gov/stds_training.aspx
- National Operations Center of Excellence
  - SPaT Challenge
    - https://transportationops.org/spatchallenge
- USDOT Connected Vehicle Pilots
  - https://www.its.dot.gov/pilots/

CASE STUDY

STANDARDS ITS TRAINING

U.S. Department of Transportation
ITS Joint Program Office
Image Source: Thinkstock USDOT

Case Study: City of Anaheim

- **Deployed OBUs and RSUs from 3 different vendors**
  - OBUs and RSUs from the same vendor worked
  - A side-by-side comparison of applications on the different OBUs showed different results
    - Times to change may be different
    - Applications did not always work
  - Some applications were expecting optional data elements and did not properly display if the optional data elements were not provided

Case Study: City of Anaheim

- **Lessons Learned**
  - MAP configuration affected the application on the OBU
    - Some applications were expecting optional data elements and did not properly display if the optional data elements were not provided
    - Applications were not properly handling unexpected or non-conforming data packets
  - **Specify** which optional elements are mandatory
  - **Test applications** to handle unexpected or non-conforming data packets

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Question

When broadcasting SPaT and MAP messages, which of the following issues must be considered?

Answer Choices

a) Only one intersection is contained in each SPaT and MAP message
b) All MAP messages must be accompanied by a SPaT message
c) Other standards may limit the number of bytes in a message
d) SPaT and MAP messages must use the same broadcast rate

Review of Answers

a) Only one intersection is contained in each SPaT and MAP message

Incorrect. Each SPaT and MAP message may describe up to 32 intersections

b) All MAP messages must be accompanied by a SPaT message

Incorrect. However, SPaT messages should be accompanied by a MAP message

c) Other standards may limit the number of bytes in a message

Correct! Other standards may impose message size limitations

d) SPaT and MAP messages must use the same broadcast rate

Incorrect. For example, SPaT messages are dynamic and may need to be broadcasted more frequently

Module Summary

Describe the scope of the SAE J2735 Standard

Describe the SPaT Message

Describe the MAP Message

Identify Implementation Considerations

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!