CONNECTED INTERSECTIONS PROGRAM:
PROGRAM MANAGEMENT AND TECHNICAL
SUPPORT

# Connected Intersection Detailed Testing Log

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# Detailed Testing Log

Tables below present information for requirements to be tested, including the objective, method, pass criteria, and space for results and explanations. Results should indicate whether the requirement is considered to be met, partially met, or not able to be tested, with supporting information.

| Requirement | 3.3.3.1.1.1      SPaT Message - SAE J2735 |
|---|---|
| Objective | Verify SPaT messageId |
| Method | Use Wireshark to view pcap files and check the value of the messageId. |
| Pass Criteria | MessageId of signalPhaseAndTimingMessage (19) shall be present in messages received from the roadside device. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.2      SPaT Message - Mandatory Data Elements |
|---|---|
| Objective | Verify SAE J2735 required data elements |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement.<br><br>Note: The CAMP online tool accepts a comma-separated value file containing a list of messages received. Each row includes a timestamp, message id, message payload (json), and a signature indicator. The tool produces a report indicating which data elements are included in SPaT messages for each intersection along with if the element is mandatory, optional, or conditional, and if the message is in compliance with SAE J2735. |
| Pass Criteria | All SAE J2735-required data elements must be present in the message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.3      SPaT Message - CI Mandatory Data Elements |
|---|---|
| Objective | Verify CI required data elements |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. |
| Pass Criteria | All CI-mandatory data elements must be present in the message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.4      SPaT Message PSID |
|---|---|
| Objective | Verify SPaT PSID |
| Method | Use Wireshark to view pcap files. The PSID (in 1609.3 header) is displayed as a column. All PSID values are checked to make sure they match the pass criteria. |
| Pass Criteria | A PCAP value of 0x00008002 shall be present in the 1609.3 header. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.5      MAP Message - SAE J2735 |
|---|---|
| Objective | Verify MAP messageId |
| Method | Use Wireshark to view pcap files and check the value of the messageId. |
| Pass Criteria | A messageId of mapData (18) shall be present in messages received from the roadside device |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.6　　　　MAP Message - Mandatory Data Elements |
|---|---|
| Objective | Verify SAE J2735 required data elements |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. |
| Pass Criteria | All SAE J2735-required data elements must be present in the message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.7　　　　MAP Message - Required Data Elements |
|---|---|
| Objective | Verify CI required data elements |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. |
| Pass Criteria | All CI-mandatory data elements must be present in the message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.8　　　　MAP Message PSID |
|---|---|
| Objective | Verify MAP PSID |
| Method | Use Wireshark to view pcap files. The PSID (in 1609.3 header) is displayed as a column. All PSID values are checked to make sure they match the pass criteria. |
| Pass Criteria | A PCAP value of 0xe0000017 shall be present in the 1609.3 header. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.9　　　　RTCMcorrections Message - SAE J2735 |
|---|---|
| Objective | Verify RTCM messageId |
| Method | Use Wireshark to view pcap files and check the value of the messageId. |
| Pass Criteria | A messageId of rtcmCorrections (28) shall be present in messages received from the roadside device. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.10　　　　RTCMcorrections Message - Mandatory Data Elements |
|---|---|
| Objective | Verify SAE J2735 required data elements |
| Method | Use Wireshark to view pcap files. The presence of all SAE J2735-mandatory data elements are checked to determine if they are included in the RTCM message. |
| Pass Criteria | All J2735-required data elements (contained in the required data frames) for the latest approved standard shall be present in the message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.11　　　　RTCMcorrections Message - Required Data Elements |
|---|---|
| Objective | Verify CI required data elements |
| Method | Use Wireshark to view pcap files. In addition to checking the presence of all SAE J2735-mandatory data elements, the lat and long of the anchorPoint data frame are displayed as a column to determine if they are included in the RTCM message. |
| Pass Criteria | All J2735-required data elements (contained in the required data frames) for the latest approved standard shall be present in the message, along with the lat, long, and elevation data elements in the anchorPoint data frame. Other data elements in the anchorPoint data frame are optional. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.1.12      RTCMcorrections Message PSID |
|---|---|
| Objective | Verify RTCM PSID |
| Method | Use Wireshark to view pcap files. The PSID (in 1609.3 header) is displayed as a column. All PSID values are checked to make sure they match the pass criteria. |
| Pass Criteria | A PCAP value of 0x00008000 shall be present in the 1609.3 header. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.2.1      Broadcast SPaT Message |
|---|---|
| Objective | Verify SPaT broadcast.<br><br>Note: Analysis of communication between the traffic signal controller, roadside processing hardware, and the RSU is not performed. |
| Method | Use Wireshark to view pcap files. Message type of SPaT shall be present in the pcap data stream. |
| Pass Criteria | This requirement is considered satisfied if SPaT Messages are being broadcast from the intersection |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.3.1      Transport Message Size - WAVE |
|---|---|
| Objective | Verify message size is within limit |
| Method | Use Wireshark to view pcap files. The message length is displayed as a column. The message length is checked for all messages to determine if the framelength meets the pass criteria |
| Pass Criteria | Wireshark framelength variable of all messages less than 1400 bits in size |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.3.2.1      Nodes by Offsets |
|---|---|
| Objective | Verify use of offsets for defining lane nodes |
| Method | Use Wireshark to view pcap file. Presence of the x and y offset values are checked when offsets are used to define nodes. |
| Pass Criteria | Requirement is considered to be met if x-offset and y-offset are both present (only for offset specification of nodes) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.3.2.2.1  Computed Lane - Lane Identifier |
|---|---|
| Objective | Verify use of lane id element for computed lane |
| Method | Use Wireshark to view pcap files. Presence of the lane ID is checked when a computed lane is used to define nodes. |
| Pass Criteria | Requirement is considered to be met if lane identifier is present (only for computed lane specification) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.3.2.2.2  Computed Lane - X-Offset |
|---|---|
| Objective | Verify use of x offset element for computed lane |
| Method | Use Wireshark to view pcap files. Presence of the x offset is checked when a computed lane is used to define nodes. |
| Pass Criteria | Requirement is considered to be met if x-offset is present (only for computed lane specification) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.3.2.2.3   Computed Lane - Y-Offset |
|---|---|
| Objective | Verify use of y offset element for computed lane |
| Method | Use Wireshark to view pcap files. Presence of the y offset is checked when a computed lane is used to define nodes. |
| Pass Criteria | Requirement is considered to be met if y-offset is present (only for computed lane specification) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.3.2.2.4   Angle |
|---|---|
| Objective | Verify use of angle element for computed lane |
| Method | Use Wireshark to view pcap files. Presence of the angle is checked when a computed lane is used to define nodes. |
| Pass Criteria | Requirement is considered to be met if angle is present (only for computed lane specification) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.4.1          Data Coverage - Every Lane |
|---|---|
| Objective | Verify SPaT and MAP can be received on all approaches |
| Method | Wireshark is used to export lat/lon data from the BSM and SPaT and MAP messages from each intersection. External data processing tools are used to relate SPaT and MAP messages to each BSM using timestamps. A +-500ms window around each BSM is used to search for the number received SPaT messages from each intersection, and a +-1000ms window is used to search for the number of MAP messages received from each intersection. The BSM lat/long is used to display the number of SPaT and MAP messages received on a MAP. A SPaT and MAP reception map is generated for each intersection using all of the BSMs generated during the driving data capture. The areas of reception are compared against the geometry of ingress lanes |
| Pass Criteria | Requirement is considered to be met if both SPaT and MAP messages are received for all locations between the stop line and the upstream-most (final) point defined for each approach lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.4.2          Advanced Notification - Time |
|---|---|
| Objective | Verify SPaT and MAP reception range |
| Method | Wireshark is used to export lat/lon data from the BSM and SPaT and MAP messages from each intersection. External data processing tools are used to relate SPaT and MAP messages to each BSM using timestamps. A +-500ms window around each BSM is used to search for the number received SPaT messages from each intersection, and a +-1000ms window is used to search for the number of MAP messages received from each intersection. The BSM lat/long is used to display the number of SPaT and MAP messages received on a MAP. A SPaT and MAP reception map is generated for each intersection using all of the BSMs generated during the driving data capture. The areas of reception are compared against minimum advance notification distance. |
| Pass Criteria | Requirement is considered to be met if both SPaT and MAP messages are received for all locations between the stop line and the minimum data coverage distance (a function of speed limit, upstream of each stop line) for each approach lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.5.1        SPaT Message - Broadcast Periodicity |
|---|---|
| Objective | Verify SPaT broadcast frequency |
| Method | Wireshark is used to export SPaT message reception timestamps from each intersection. External data processing tools are used to perform a rolling 10-second count of MAP messages is performed every 1 second. |
| Pass Criteria | Requirement is considered met if between 90 and 110 SPaT messages are received for every rolling average period |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.5.2        SPaT Message - Broadcast Latency |
|---|---|
| Objective | Verify SPaT latency. |
| Method | Video data is reviewed to determine the time (relative to the start of the video) that the actual signal head changes and the time that the corresponding event state changes on the test tool. Broadcast latency is considered to be smaller than this value (since this also includes other sources of latency). <br><br> Note that the process used to verify this requirement cannot be used as evidence that the requirement is not being met, as there are other sources of latency captured using this method (e.g., test tool Bluetooth connectivity) that cannot be precisely accounted for. |
| Pass Criteria | Requirement is considered met if the calculated time difference is less than 300 ms. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.5.3        MAP Message - Broadcast Periodicity |
|---|---|
| Objective | Verify MAP broadcast frequency |
| Method | Wireshark is used to export MAP message reception timestamps from each intersection. External data processing tools are used to perform a rolling 10-second count of MAP messages is performed every 1 second. |
| Pass Criteria | Requirement is considered met if between 9 and 11 MAP messages are received for every rolling average period |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.6.1        Completeness - SPaT Message |
|---|---|
| Objective | Verify movement state information is in SPaT |
| Method | SPaT and MAP data are inspected to determine if every allowed movement in every ingress lane into the intersection is controlled and may have one or more movement state, as represented by DE_MovementPhaseState. |
| Pass Criteria | Requirement is considered to be met if every ingress lane connection has a signal group specified, and the signal group in the SPaT message has at least one movement state specified. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.1.6.2          Completeness - MAP Message |
|---|---|
| Objective | Verify all lane information is in MAP |
| Method | MAP message lane centerline geometry data is overlayed on up-to-date satellite imagery. The CAMP Online Tool (https://camp-llc.org/) is used to generate this visualization.<br><br>Note: The CAMP online tool accepts a comma-separated value file containing a list of messages received. Each row includes a timestamp, message id, message payload (json), and a signature indicator. The tool produces a report indicating which data elements are included in SPaT messages for each intersection along with if the element is mandatory, optional, or conditional, and if the message is in compliance with the SAE J2735. |
| Pass Criteria | Requirement is considered to be met if all lanes in the MAP message roughly reflects all approach lanes in the field (note: accuracy of lane points are verified in a different requirement) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.1          Time Accuracy |
|---|---|
| Method | A method for assessing this requirement has not yet been determined |
| Results and Explanation | This requirement **could not be tested** as time data from the traffic signal controller was not collected as part of this effort. |
| Requirement | 3.3.3.2.2.1          SPaT Message - Revision Counter Increment |
| Objective | Verify ability to increment revision counter |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display eventState, startTime, minEndTime, maxEndTime, likelyTime, and nextTime as columns. The data is exported for evaluation in external data processing tool to assess changes in the values in these data elements from message to message and determining if this also corresponds to a change in the msgCount. |
| Pass Criteria | msgCount increments when any of the following message data elements have changed for any signalGroup: eventState, startTime, minEndTime, maxEndTime, likelyTime, nextTime |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.2          SPaT Message - Revision Counter Not Increment |
|---|---|
| Objective | Verify ability to not increment revision counter |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display eventState, startTime, minEndTime, maxEndTime, likelyTime, and nextTime as columns. The data is exported for evaluation in external data processing tool to assess changes in the values in these data elements from message to message and determining if this also corresponds to a change in the msgCount. |
| Pass Criteria | msgCount does not increment when all of the following message data elements have not changed for all signalGroups: eventState, startTime, minEndTime, maxEndTime, likelyTime, nextTime |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.3          MAP Message - Revision Counter Increment |
|---|---|
| Objective | Verify ability to increment revision counter |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). The msgCount in the MAP message header is compared against the msgCount in each intersection data frame. |
| Pass Criteria | msgCount (MAP message frame) increments when the value of any intersection msgCount increases. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.4 MAP Message - Revision Counter Not Increment |
|---|---|
| Objective | Verify ability to not increment revision counter |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). The msgCount in the MAP message header is compared against the msgCount in each intersection data frame. |
| Pass Criteria | msgCount (MAP message frame) does not increment when the value of all intersection msgCounts remain the same. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.5 MAP Message - Intersection Revision Counter Increment |
|---|---|
| Objective | Verify ability to increment revision counter |
| Method | Use Wireshark to view pcap file. The first and last MAP payloads from each intersection are assessed. The first and last MAP payloads are compared, as well as a change in the value msgCount to assess for corresponding changes. |
| Pass Criteria | msgCount (each IntersectionGeometry data frame) increments when the value of any element in the intersection geometry changes other than a timestamp value |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.6 MAP Message - Intersection Revision Counter Not Increment |
|---|---|
| Objective | Verify ability to not increment revision counter |
| Method | Use Wireshark to view pcap file. The first and last MAP payloads from each intersection are identified. The first and last MAP payloads are compared, as well as a change in the value msgCount to assess for corresponding changes. |
| Pass Criteria | msgCount (each IntersectionGeometry data frame) does not increment when the value of all elements in an intersection geometry have not changed, except for timestamp values. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.7 RTCMcorrections Message - Sequence Number Increment |
|---|---|
| Objective | Verify ability to increment sequence number |
| Method | The RTCM payloads and msgCount data element are extracted. The RTCM payloads are compared from one message to the next, as well as a change in the value msgCount to assess for corresponding changes. |
| Pass Criteria | msgCount RTCM message frame) increments when the value of any element changes other than a timestamp value |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.2.8 RTCMcorrections Message - Sequence Number Not Increment |
|---|---|
| Objective | Verify ability to not increment sequence number |
| Method | The RTCM payloads and msgCount data element are extracted. The RTCM payloads are compared from one message to the next, as well as a change in the value msgCount to assess for corresponding changes. |
| Pass Criteria | msgCount (RTCM message frame) does not increment when the value of all elements have not changed, except for timestamp values. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.3.1　　　SPaT Message - Message Time Stamp |
|---|---|
| Objective | Verify inclusion of minuteOfTheYear data element |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display timeStamp as a column |
| Pass Criteria | The timeStamp data element is included the SPaT message, and roughly matches the actual time the message is received. Note: Latency and/or differences between system clocks may result in the timeStamp changing up to several seconds before or after the message is received. For the purpose of evaluating this requirement, this is acceptable. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.2.3.2　　　SPaT Message - Intersection Time Stamp |
|---|---|
| Objective | Verify inclusion of minuteOfTheYear data element |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display moy as a column |
| Pass Criteria | The moy data element in each intersectionState data frame in the SPaT message, and roughly matches the actual time the message is received. Note: Latency and/or differences between system clocks may result in moy changing up to several seconds before or after the message is received. For the purpose of evaluating this requirement, this is acceptable. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.1.1　　　Intersection Signal Timing Information |
|---|---|
| Objective | Verify inclusion of intersectionState data frame |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersections' as a column (provides a count of intersection state data frames in the intersection state list). |
| Pass Criteria | The SPaT Message contains a minimum of one intersectionState data frame in the intersectionStateList. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.1.2　　　Road Regulator Identifier |
|---|---|
| Objective | Verify inclusion and accuracy of roadRegulator identifier |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'region' as a column. |
| Pass Criteria | The roadRegulatorId data element is present in SPaT and MAP messages, and it is the same between all intersections within each test site (unless multiple jurisdictions are involved, where the roadRegulator Id is expected to be the same at intersection with each jurisdiction). |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.1.3　　　Intersection Reference Identifier |
|---|---|
| Objective | Verify inclusion and accuracy of intersection id |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'id' as a column. |
| Pass Criteria | The intersectionId data element is present in the SPaT and MAP messages, and its value is different between all intersections within each test site (unless multiple jurisdictions are involved, where the intersectionId is expected to be different at intersections with each jurisdiction.). Furthermore, the intersectionId should be the same at each intersection at each jurisdiction for both SPaT and MAP messages. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.1　　　　Manual Control |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Manual Control flag is correctly specified in the intersectionStatus data element (bit 0) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.2　　　　Stop Time |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Stop Time flag is correctly specified in the intersectionStatus data element (bit 1) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.3　　　　Failure Flash |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Failure Flash flag is correctly specified in the intersectionStatus data element (bit 2) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.4　　　　Preemption |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Preemption flag is correctly specified in the intersectionStatus data element (bit 3) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.5          Priority |
| --- | --- |
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Priority flag is correctly specified in the intersectionStatus data element (bit 4) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.6          Fixed Time |
| --- | --- |
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Fixed Time flag is correctly specified in the intersectionStatus data element (bit 5) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.7          Traffic Dependent Mode |
| --- | --- |
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Traffic Dependent Mode flag is correctly specified in the intersectionStatus data element (bit 6) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.8          Standby Mode |
| --- | --- |
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Standby Mode flag is correctly specified in the intersectionStatus data element (bit 7) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.9       Failure Mode |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Failure Mode flag is correctly specified in the intersectionStatus data element (bit 8) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.10       Controller Off |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Controller Off is correctly specified in the intersectionStatus data element (bit 9) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.11       Recent MAP Update |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The Recent MAP Update flag is correctly specified in the intersectionStatus data element (bit 10) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.12       New Lane IDs |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The New Lane ID flag is correctly specified in the intersectionStatus data element (bit 11) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.13      No MAP Available |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The No MAP Available flag is correctly specified in the intersectionStatus data element (bit 12) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.2.14      No SPaT Available |
|---|---|
| Objective | Verify correct use of the specified bit in the intersectionStatus element<br><br>Note: Triggering a condition that should cause this bit to change is not performed during data collection. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'intersectionStatus' as a column. |
| Pass Criteria | The No SPaT Available flag is correctly specified in the intersectionStatus data element (bit 13) - as event noted during data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.1      Current Movement State for a Signal Group |
|---|---|
| Objective | Verify actual signal state properly reflected in SPaT/MAP data |
| Method | Use Wireshark to view pcap files. Look at a list of signal groups in the MAP and SPaT messages, and a list of event states in the SPaT message. |
| Pass Criteria | Signal groups defined in the MAP message can be matched to a signal group in the SPaT message. The signal group in the SPaT message has an event state associated with it. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.2      Unknown Current Movement State for a Signal Group |
|---|---|
| Objective | Verify use of the unknown value for the movement state |
| Method | Cannot be tested - it is not known when a signal controller does not know the current movement state. |
| Pass Criteria | N/A |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.3      Flashing Yellow Arrow Permissive Movement |
|---|---|
| Objective | Verify use of the permissive movement allowed value for the movement state |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. |
| Pass Criteria | The event state is 'permissive-movement-allowed' for the flashing yellow arrow signal group when the flashing yellow arrow indicator is active. This is also confirmed though review of the video capture - the test tool provides a green signal indication for the corresponding signal group when the flashing yellow signal head is active. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.4        Protected and Permissive Clearance |
|---|---|
| Objective | Verify the progression of the value of the movement state |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. An external data processing tool is used to evaluate the progression of eventState values for each signal group. |
| Pass Criteria | The state of a vehicular movement is permissive-clearance when proceeding a permissive-movement-allowed signal state  OR  if the state of a vehicular movement is protected-clearance when proceeding a protected-movement-allowed signal state. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.5        Resolve Protected Versus Permissive Movement |
|---|---|
| Objective | Verify that movements that are protected during some portion of the cycle and permissive during other portions of a cycle are properly indicated (e.g., a protected-permissive left turn). |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. An external data processing tool is used to evaluate the eventState values of signal groups for movements that are known to be protected or permissive (such as a left or right turn) to ensure the correct eventStates are provided during the correct parts of the cycle. |
| Pass Criteria | The state of a vehicular movement is permissive-movement-allowed when a green indication is provided when there are potential conflicting movements  AND  if the state of a vehicular movement is protected-movement-allowed when an arrow indication is provided when there are no conflicting movements. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.6        Conflict Causes Permissive |
|---|---|
| Objective | Verify use of permissive states when a conflicting movement is also active or per signal head indication (solid) |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. An external data processing tool is used to evaluate the eventState values of conflicting signal groups when a given signal state for a signal group is protected (permissive-movement-allowed  OR  permissive-clearance) |
| Pass Criteria | The state of a vehicular movement is permissive-movement-allowed when a solid green or yellow indication is provided when there are potential conflicting movements. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.7        No Conflict Causes Protected |
|---|---|
| Objective | Verify use of protected state when conflicting movements are not active or per signal head indication (arrow) |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. An external data processing tool is used to evaluate the eventState values of conflicting signal groups when a given signal state for a signal group is protected (protected-movement-allowed  OR  protected-clearance) |
| Pass Criteria | The state of a vehicular movement is protected-movement-allowed when a green or yellow arrow indication is provided when there are no conflicting movements. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.8      WALK State Enumeration (No Conflict) |
|---|---|
| Objective | Verify use of protected green state when conflicting movements are not active. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. An external data processing tool is used to evaluate the eventState values of signal groups that conflict with a pedestrian signal group when the signal state for a pedestrian signal group is protected (protected-movement-allowed  OR  protected-clearance) |
| Pass Criteria | The state of a pedestrian movement is protected-movement-allowed when a WALK indication is provided when there are no conflicting movements. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.9      WALK State Enumeration (Potential Conflict) |
|---|---|
| Objective | Verify use of protected green state when conflicting movements are not active. |
| Method | Use Wireshark to view pcap files. Apply filter to only look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'eventState' as a column. An external data processing tool is used to evaluate the eventState values of signal groups that conflict with a pedestrian signal group when the signal state for a pedestrian signal group is protected (permissive-movement-allowed  OR  permissive-clearance) |
| Pass Criteria | The state of a pedestrian movement is permissive-movement-allowed when a WALK indication is provided concurrent with a permissive indication for a conflicting traffic movement. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.10      Flashing DON'T WALK State Enumeration |
|---|---|
| Objective | Verify use of protected clearance state when conflicting movements are not active. |
| Method | Video capture of the test tool and pedestrian signal head is reviewed. The pedestrian signal is compared against the test tool event state visualization when the pedestrian signal provides a flashing DON'T WALK indication. |
| Pass Criteria | The state of a pedestrian movement is permissive-clearance when a steady DON'T WALK indication is provided. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.11      Steady DON'T WALK State Enumeration |
|---|---|
| Objective | Verify use of stop and remain state |
| Method | Video capture of the test tool and pedestrian signal head is reviewed. The pedestrian signal is compared against the test tool event state visualization when the pedestrian signal provides a steady DON'T WALK indication. |
| Pass Criteria | The state of a pedestrian movement is stop-and-remain when a steady DON'T WALK indication is provided. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.3.12      Movement State for Signal Groups Identified |
|---|---|
| Objective | Verify that signal group values match between SPaT and MAP messages. |
| Method | Use Wireshark to view pcap files. Apply filter to look at MAP and SPaT messages (j2735_2016.messageId == 18 \|\| j2735_2016.messageId == 19). Display 'signalGroup' as a column. The list of unique signal groups in MAP messages is compared against the unique list of signal groups in SPaT messages broadcast from the same intersection. |
| Pass Criteria | Each signalGroup in the SPaT message is directly related to a signalGroup in the MAP message. There are no signalGroups in the SPaT message that do not have a corresponding signal group in the MAP message, and there are no signal groups in the MAP message that have a corresponding signal group in the SPaT message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.4.1      Next Movement State |
|---|---|
| Objective | Verify inclusion of subsequent movement data |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' and 'maxEndTime' as a column. The time change details of the second (subsequent) movement event (in the movement event list) may be specified as unknown, of if specific values are listed, compared against the time change details of the first movement event to determine if they properly correspond to the current movement event. |
| Pass Criteria | StartTime of the next signal state is specified when the minEndTime is equal to the maxEndTime for the current phase. The minEndTime of the next signalState must be greater than the startTime, and the maxEndTime must be greater than or equal to the minEndTime. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.4.2      Unknown Next Movement State |
|---|---|
| Objective | Verify inclusion of subsequent movement data |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' and 'maxEndTime' as a column. The time change details of the second (subsequent) movement event (in the movement event list) may be specified as unknown, of if specific values are listed, compared against the time change details of the first movement event to determine if they properly correspond to the current movement event. |
| Pass Criteria | The next movement state is specified for a signalGroup and all required data elements in the timeChangeDetails data frame may be specified as 36111 for unknown. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.4.3      No Past State |
|---|---|
| Objective | Verify that time information is not from the past. |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' and 'maxEndTime' as a column. The time change details of the first (current) movement event (in the movement event list) are compared against the timestamp in the message. |
| Pass Criteria | None of the timemarks in the timeChangeDetails should indicate a time that is prior to the current message time (if available). |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.1          Time Change Details |
|---|---|
| Objective | Verify that the timeChangeDetails data frame is specified for each movement event |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' 'maxEndTime' 'likelyTime' and 'nextTime' as a column. The presence of any of these values is checked. |
| Pass Criteria | Any of the data elements within the timeChangeDetails data frame are included for every movement event in a SPaT message. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.2          Unknown Time Change Detail |
|---|---|
| Objective | Verify that all required timeChangeDetails are included

Note: Analysis of communication between the traffic signal controller, roadside processing hardware, and the RSU is not performed. |
| Method | Cannot be tested - it is not known when a signal controller does not know the value of a time change detail. |
| Pass Criteria | N/A |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.3          Minimum End Time |
|---|---|
| Objective | Verify correct progression of the minEndTime data element |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'minEndTime' as a column. An external data processing tool is used to determine if the minEndTime properly progresses for each signal group. |
| Pass Criteria | In the absence of operational interruptions, the minEndTime for the current phase shall not decrease in a given cycle. Yellow Intervals should be constant in length (i.e., minEndTime should not change during the yellow interval) and should be consistent in overall duration within a signal group from one cycle to the next. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.4          Maximum End Time |
|---|---|
| Objective | Verify correct progression of the maxEndTime data element |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'maxEndTime' as a column. An external data processing tool is used to determine if the maxEndTime properly progresses for each signal group. |
| Pass Criteria | In the absence of operational interruptions, the maxEndTime for the current phase shall not increase in a given cycle. Yellow Intervals should be constant in length (i.e., maxEndTime should not change during the yellow interval) and should be consistent in overall duration within a signal group from one cycle to the next. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.5          Unknown Maximum End Time |
|---|---|
| Objective | Verify correct use of the unknown value for maxEndTime |
| Method | Cannot be tested - it is not known when a signal controller does not know the max end time. |
| Pass Criteria | N/A |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.6       No Current Movement State Start Time |
|---|---|
| Objective | Verify not using startTime |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' and 'startTime' as a column. An external data processing tool is used to determine if the startTime is not specified for each signal group associated with the first (current) movement event. |
| Pass Criteria | The startTime data element is not specified for the current phase for each signal group. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.7       Next Movement State Start Time |
|---|---|
| Objective | Verify use of startTime |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' and 'maxEndTime' as a column. The time change details of the second (subsequent) movement event (in the movement event list) may be specified as unknown, of if specific values are listed, compared against the time change details of the first movement event to determine if they properly correspond to the current movement event. |
| Pass Criteria | The startTime data element is specified for any subsequent phases for each signal group. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.5.8       Next State Start Time Equals Current State Minimum End Time |
|---|---|
| Objective | Verify correct value for startTime |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' and 'maxEndTime' as a column. The time change details of the second (subsequent) movement event (in the movement event list) may be specified as unknown, of if specific values are listed, compared against the time change details of the first movement event to determine if they properly correspond to the current movement event. |
| Pass Criteria | The startTime data element for a subsequent phase is equal to the minEndTime for the current phase for all signal Group |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.6.1       Time of Next Allowed Movement |
|---|---|
| Objective | Verify correct values of minEndTime and maxEndTime when signal state changes. |
| Method | Use Wireshark to view pcap files. Apply filter to look at SPaT messages (j2735_2016.messageId == 19). Display 'signalGroup' 'startTime' 'minEndTime' and 'maxEndTime' as a column. The time change details of the first (current) and second (subsequent) movement events are assessed to determine if time change details are properly populated. |
| Pass Criteria | The nextTime data element is present when a value for the startTime is provided for a second (subsequent) movement event for the same signal group. In this case, the nextTime of the first movement event shall be greater than the startTime of the subsequent movementEvent. If the startTime for the second (subsequent) movement is unknown, then the nextTime is not included for the first (current) movementEvent. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.7　　　　Enabled Lanes Indication |
|---|---|
| Objective | Verify use of enabled lanes when intersection conditions change. |
| Method | Use Wireshark to view pcap files. Apply filter to look at MAP messages (j2735_2016.messageId == 18). For each lane, the Lane Attributes-Vehicle data element is identified. If the first bit of this data element is asserted, then the lane is considered revocable. The lane ID for these revocable lanes are determined.<br><br>Apply filter to look at SPaT messages (j2735_2016.messageId == 19). The list of lane IDs in the enabled lane list is displayed as a column. |
| Pass Criteria | If the MAP message for the intersection defines a revocable lane for the intersection AND a revocable lane is currently active ('enabled'), then this requirement is met if the data frame DF_EnabledList is included in the SPaT message for the intersection.  This test is only applicable for intersections where enabled lanes are used and are active. The lanes in the MAP message represented by the lane IDs in the enabled lane list should reflect the ground truth at the time of data collection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.3.8　　　　SPaT Message - Accuracy |
|---|---|
| Objective | Verify all signal phase information is included in SPaT |
| Method | Video capture of the test tool and signal heads is reviewed. The signal indication is compared against the test tool event state visualization. |
| Pass Criteria | Requirement is considered to be met if all phases are being accurately shown in the test tool, and this reflects the actual signal indication of each approach in the field |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.1　　　　Intersection Geometry Information |
|---|---|
| Objective | Verify inclusion of intersection geometry in MAP message |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'intersections' as a column (provides a count of intersection geometry data frames in the intersection geometry list). |
| Pass Criteria | At least one intersection geometry in each MAP message |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.2　　　　Intersection Geometry - Road Regulator Identifier |
|---|---|
| Objective | Verify inclusion and accuracy of roadRegulator identifier |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'region' as a column. |
| Pass Criteria | met given the presence of the roadRegulatorId data element in the SPaT and MAP messages, and it is the same between all intersections within each test site (unless multiple jurisdictions are involved, where the roadRegulator Id is expected to be the same at intersection with each jurisdiction). |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.3　　　Intersection Geometry - Intersection Identifier |
|---|---|
| Objective | Verify inclusion and accuracy of intersection id |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'id' as a column. |
| Pass Criteria | This requirement is considered to be met given the presence of the intersectionId data element in the SPaT and MAP messages, and its value is different between all intersections within each test site (unless multiple jurisdictions are involved, where the intersectionId is expected to be different at intersections with each jurisdiction.). Furthermore, the intersectionId should be the same at each intersection at each jurisdiction for both SPaT and MAP messages. The intersection MAC address will need to be used to make sure SPaT and MAP (with the same IntersectionId) are being broadcast from the same intersection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.4.1　　　Intersection Reference Point - Position |
|---|---|
| Objective | Verify location of reference point |
| Method | Extract the x offset value and the y offset value from each specified node point in the MAP message |
| Pass Criteria | The absolute value of the x-offset and y-offset shall be less than 32767 |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.4.2　　　Intersection Reference Point - Description |
|---|---|
| Objective | Verify inclusion of lat, long, elevation for reference point |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'lat' 'lon' and 'elevation' as a column. |
| Pass Criteria | The latitude, longitude, and elevation data elements are present in the refPoint data frame |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.4.3　　　Intersection Reference Point Accuracy |
|---|---|
| Objective | Verify location accuracy of reference point |
| Method | Extract the intersection reference latitude and longitude from the MAP message |
| Pass Criteria | The requirement is considered satisfied in the x and y offsets are represented using an offset of type Offset_B16 (or lower).

Note: Unless the managing agency has defined where the intersection reference point is supposed to be and it is measurable, verification for this requirement will be contingent upon the verification of requirement of 3.3.3.4.1.4.1 |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.5　　　Default Lane Width |
|---|---|
| Objective | Verify inclusion of reference lane width |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'laneWidth' as a column. |
| Pass Criteria | The laneWidth data element is present in the intersection geometry data frame |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.6          Lane Identifier |
|---|---|
| Objective | Verify lane id values are unique and in correct range |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'laneID' as a column. |
| Pass Criteria | All laneId values in the laneID list are unique. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.7          Center of Vehicle Lane Geometry |
|---|---|
| Objective | Verify vehicle lane coverage |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The location of vehicle lanes is compared against satellite imagery. |
| Pass Criteria | The MAP message lane geometry data is visualized and compared against a visual ground survey or an up-to-date satellite image of vehicle lanes. All ingress and egress lanes should be present in the MAP message. (note: accuracy of lane points are verified in a different requirement) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.8          Center of Crosswalk Lane Geometry |
|---|---|
| Objective | Verify crosswalk lane coverage |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The location of crosswalk lanes is compared against satellite imagery. |
| Pass Criteria | The MAP message crosswalk geometry data is visualized and compared against a visual ground survey or an up-to-date satellite image of crosswalks. All crosswalk lanes should be present in the MAP message. (note: accuracy of crosswalk points are verified in a different requirement) |
| Results and Explanation | This requirement is considered to be. |

| Requirement | 3.3.3.4.1.9          Center of Pedestrian Landings Geometry |
|---|---|
| Objective | Verify sidewalk lane coverage |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The location of sidewalk lanes is compared against satellite imagery. |
| Pass Criteria | The MAP message pedestrian landings (sidewalk) geometry data is visualized and compared against a visual ground survey or an up-to-date satellite image of pedestrian landings. All landings (sidewalk lanes) should be present in the MAP message. (note: accuracy of sidewalk points are verified in a different requirement) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.10          Lane Description |
|---|---|
| Objective | Verify minimum number of points required to define lane |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'nodes' as a column (displays the number of nodes in each lane). |
| Pass Criteria | This requirement is considered satisfied if there are two or more points defined for each lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.11      First Node Point - Ingress Vehicle Lane |
|---|---|
| Objective | Verify first node point is close to intersection |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. Clicking on each node provides information regarding node order. |
| Pass Criteria | The first node point of an ingress vehicle lane is located at the upstream edge of the stop line. In the absence of a stop line, the first node point is located on the upstream edge of a crosswalk marking. In the absence of a stop line and crosswalk marking, the first node point is located using engineering judgement |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.12      First Node Point - Egress Vehicle Lane |
|---|---|
| Objective | Verify first node point is close to intersection |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. Clicking on each node provides information regarding node order. |
| Pass Criteria | The first node point of an egress vehicle lane is located at the downstream edge of the crosswalk marking. In the absence of crosswalk markings, the first node point is located with engineering judgement to represent the point immediately outside the intersection and any path that pedestrians might use to cross the intersection |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.13      Node Offset from Intersection Reference Point |
|---|---|
| Objective | Verify use of smallest offset type |
| Method | Use Wireshark to view pcap files. Extract the node offset point xy choice (node-XY-1 through node-XY-6), the x offset value and the y offset value from each specified node point in the MAP message |
| Pass Criteria | To be compliant with the requirement, the offset type that should be used is as follows: |

| Offset Type (choice value) | Offset Range | Size |
|---|---|---|
| node-xy1 (0) | < 5.11m | 20 bits |
| node-xy2 (1) | 5.12 – 10.23 m | 22 bits |
| node-xy3 (2) | 10.24 – 20.47m | 24 bits |
| node-xy4 (3) | 20.48 – 40.96m | 26 bits |
| node-xy5 (4) | 40.97 – 81.91m | 28 bits |
| node-xy6 (5) | 81.92 – 327.67m | 32 bits |

| Requirement | |
|---|---|
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.14      Node Elevation Offset from Intersection Reference Point |
|---|---|
| Objective | Verify use of elevation offset (if necessary) |
| Method | Use Wireshark to view pcap files. Extract the reference elevation and the elevation offset for the initial node point. This is compared to a surveyed elevation (if available) for accuracy. |
| Pass Criteria | An elevation offset (from the intersection reference point) shall be used to specify the first elevation point of each geometry. If the elevation does not change, this data element shall not be present. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.15      Offset from Previous Node |
|---|---|
| Objective | Verify use of elevation offset (if necessary) |
| Method | Use Wireshark to view pcap files. Extract the reference elevation and the elevation offset for the initial node point. This is compared to a surveyed elevation (if available) for accuracy. |
| Pass Criteria | To be compliant with the requirement, the offset type that should be used for each node is as follows:<br><br><table><tr><th>Offset Type (choice value)</th><th>Offset Range</th><th>Size</th></tr><tr><td>node-xy1 (0)</td><td>< 5.11m</td><td>20 bits</td></tr><tr><td>node-xy2 (1)</td><td>5.12 – 10.23 m</td><td>22 bits</td></tr><tr><td>node-xy3 (2)</td><td>10.24 – 20.47m</td><td>24 bits</td></tr><tr><td>node-xy4 (3)</td><td>20.48 – 40.96m</td><td>26 bits</td></tr><tr><td>node-xy5 (4)</td><td>40.97 – 81.91m</td><td>28 bits</td></tr><tr><td>node-xy6 (5)</td><td>81.92 – 327.67m</td><td>32 bits</td></tr></table> |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.16      Elevation Offset from Previous Node |
|---|---|
| Objective | Verify use of elevation offset (if necessary) |
| Method | Use Wireshark to view pcap files. Extract the reference elevation and the elevation offset for subsequent nodes. This is compared to a surveyed elevation (if available) for accuracy. |
| Pass Criteria | An elevation offset (from a previously defined point) shall be used to specify the first elevation point of each geometry. If the elevation does not change, this data element shall not be present. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.17      Advanced Notification - Ingress Vehicle Lane |
|---|---|
| Objective | Verify length of lane |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The overall length of each ingress lane is provided. This length is compared to the required length (a function of the speed limit on each approach). |
| Pass Criteria | The cumulative distance along the line generated by all points (in the correct order) is greater than the distance (as a function of the speed limit) specified in the requirement. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.18      End Nodes - Crosswalk Lane |
|---|---|
| Objective | Verify location of crosswalk endpoints |
| Method | Processed Survey data (crosswalk ground truth) are compared against MAP message crosswalk lane centerline using a geographic information systems tool. |
| Pass Criteria | The ends of the centerline of a crosswalk correspond with the location of a curb or landing. Order of crosswalk points can be defined in either direction.<br><br>Note: It may be difficult to have the center of a crosswalk located along a curb while accurately defining the width of the crosswalk throughout its entire length |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.19 End Nodes - Pedestrian Landing |
|---|---|
| Objective | Verify location of pedestrian landings |
| Method | Processed Survey data (sidewalk ground truth) are compared against MAP message sidewalk lane centerline using a geographic information systems tool. |
| Pass Criteria | The ends of the landing (sidewalk) correspond with the location of a crosswalk. Order of landing (sidewalk) points can be defined in either direction.<br><br>Note: Center of pedestrian landing is not always at the center of the end of the crosswalk |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.20 Maximum Distance between Nodes |
|---|---|
| Objective | Verify location of lane centerline |
| Method | Processed Survey data (lane centerline ground truth) are compared against MAP message lane centerline using a geographic information systems tool. |
| Pass Criteria | Distance between the MAP lane centerline (line connecting subsequent nodes) and the actual surveyed centerline does not exceed 0.5 meters. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.21 Maximum Number of Nodes |
|---|---|
| Objective | Verify maximum number of points required to define lane |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'nodes' as a column (displays the number of nodes in each lane). |
| Pass Criteria | This requirement is considered satisfied if there are 63 or fewer points defined for each lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.22 Node Lane Width |
|---|---|
| Objective | Verify lane width matches actual lane width |
| Method | Processed Survey data (lane width) are compared against MAP message lane centerline widths using a geographic information systems tool. |
| Pass Criteria | Lane width at each node in MAP message roughly matches actual lane width.<br><br>Note: Validating this requirement is difficult, as the requirement does not specify the acceptable tolerance for the value of the lane width at a given point. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.1.23 Node Accuracy |
|---|---|
| Objective | Verify location of lane centerline |
| Method | Processed Survey data (lane centerline ground truth) are compared against MAP message lane centerline using a geographic information systems tool. |
| Pass Criteria | Satisfied if the distance between each MAP lane node and the actual surveyed centerline does not exceed 0.2 meters. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.1       Direction of Travel |
|---|---|
| Objective | Verify direction of travel |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. Ingress and egress lanes are shown in different colors on the tool |
| Pass Criteria | Ingress lanes in the CAMP tool are colored green and should roughly correspond to lanes approaching the intersection in the satellite imagery. Egress lanes in the CAMP tool are colored red and should roughly correspond to lanes moving away from the intersection in the satellite imagery. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.2       Lane Sharing |
|---|---|
| Objective | Verify accuracy of laneSharing element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane sharing values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane sharing values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Modes are properly specified for each lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.3       Lane Type Attributes |
|---|---|
| Objective | Verify accuracy of LaneTypeAttributes element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane type attributes values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane type attributes values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | The choice selected properly reflects the use of each lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.4       Lane Attributes - Vehicle |
|---|---|
| Objective | Verify accuracy of LaneTypeAttributes element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane type attributes values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane type attributes values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Lane attributes are properly specified for each vehicle lane.  (only for vehicle lane type) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.5       Lane Attributes - Crosswalk |
|---|---|
| Objective | Verify accuracy of LaneTypeAttributes element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane type attributes values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane type attributes values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Lane attributes are properly specified for each crosswalk lane.  (only for crosswalk lane type) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.6       Lane Attributes - Bicycle |
|---|---|
| Objective | Verify accuracy of LaneTypeAttributes element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane type attributes values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane type attributes values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Lane attributes are properly specified for each bicycle lane.  (only for bicycle lane type) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.7       Lane Attributes - Tracked Vehicles |
|---|---|
| Objective | Verify accuracy of LaneTypeAttributes element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane type attributes values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane type attributes values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Lane attributes are properly specified for each tracked vehicle lane.   (only for tracked vehicle lane type) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.2.8       Lane Attributes - Parking |
|---|---|
| Objective | Verify accuracy of LaneTypeAttributes element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane type attributes values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane type attributes values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Lane attributes are properly specified for each parking lane.  (only for parking lane type) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.3       Lane Maneuvers |
|---|---|
| Objective | Verify accuracy of allowedManeuvers element |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane maneuvers values for each lane, and also provides an overlay of each lane geometry on satellite imagery. The lane maneuvers values for each lane are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | The correct maneuvers and restrictions are present for each specified lane. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.4.1       Lane Connections |
|---|---|
| Objective | Verify accuracy of Connections elements |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool provides an overlay of connections between lanes on satellite imagery. The connection (ingress-to-ingress or ingress-to-egress) is compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | There are no travel paths represented as connections that are missing. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.4.2          Connection Egress Lane |
|---|---|
| Objective | Verify the specification of an egress lane for each connection |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool provides an overlay of connections between lanes on satellite imagery. The connection (ingress-to-ingress or ingress-to-egress) is compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | Verify the specification of an egress lane for each connection |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.4.3          Connection Maneuvers |
|---|---|
| Objective | Verify accuracy of allowedManeuvers element for each connection |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the lane maneuvers values for each connection, and also provides an overlay of each lane geometry on satellite imagery. The connection maneuvers values for each connection are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | The correct maneuvers and restrictions are present for each specified connection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.4.4          Connection Signal Group |
|---|---|
| Objective | Verify specification of the signalGroup element for each connection |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool indicates the signal group values for each connection, and also provides an overlay of each lane geometry on satellite imagery. The signal group values for each connection are compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | The signalGroup data element is populated for each specified connection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.4.5          Include Only Permitted Connections |
|---|---|
| Objective | Verify that all connections reflect actual vehicle travel paths |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The tool provides an overlay of connections between lanes on satellite imagery. The connection (ingress-to-ingress or ingress-to-egress) is compared against ground truth in the satellite imagery, street view images, or on-the-ground observations. |
| Pass Criteria | The connection (ingress-to-ingress or ingress-to-egress) is compared against a visual inspection of the intersection. The specified connections reflect actual paths travel through the intersection. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.5.1          Default Speed Limit |
|---|---|
| Objective | Verify inclusion of default speed limit data |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'type' and 'speed' as a column (displays the type of speed limit and the speed value). |
| Pass Criteria | There is at least one RegulatorySpeedLimit entry in the SpeedLimitList. SpeedLimitType and Velocity data elements shall both be specified. A minimum of one entry must indicate a value of 'vehicleMaxSpeed' for the SpeedLimitType. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.5.2      Change in Lane Speed Limit |
|---|---|
| Objective | Verify inclusion of speed limit data (if speed limit is different than default or if speed limit changes) |
| Method | Use Wireshark to view pcap files. Apply filter to only look at MAP messages (j2735_2016.messageId == 18). Display 'type' and 'speed' as a column (displays the type of speed limit and the speed value). |
| Pass Criteria | There is at least one RegulatorySpeedLimit entry in the SpeedLimitList. SpeedLimitType and Velocity data elements shall both be specified. The velocity shall match the actual speed limit for the given lane. A minimum of one entry must indicate a value of 'vehicleMaxSpeed' for the SpeedLimitType.    (Alternatively, if the actual speed limit is the same as the reference speed limit, then the SpeedLimitList may not be included) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.6      Revocable Lanes |
|---|---|
| Objective | Verify correct use of revocable lanes when intersection conditions change. |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The location of vehicle lanes is compared against satellite imagery. Lanes that are known to exhibit different operations at different times are assessed to determine if the enabled lanes bit of the lane attributes data element is asserted. |
| Pass Criteria | The RevocableLanes data are visualized and compared against a visual inspection. All intersection operational states are accounted for.    This test is only applicable for intersections where revocable lanes are needed (i.e., have lane-specific MAP message attributes that may change during the course of normal intersection operations). |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.7      MAP Message – Accuracy |
|---|---|
| Objective | Verify lanes in MAP messages reflect the physical location and dimensions of all travel lanes traversing the intersection. |
| Method | The CAMP Online Tool (https://camp-llc.org/) is used to assess this requirement. The location of vehicle lanes is compared against satellite imagery. |
| Pass Criteria | All ingress and egress lanes should roughly reflect the actual location of the lanes (note: accuracy of lane points are verified in a different requirement) |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.8.1      Matching Intersection Reference Identifier |
|---|---|
| Objective | Verify that roadRegulatorId and intersectionId match between SPaT and MAP |
| Method | Use Wireshark to view pcap files. Apply filter to look at MAP and SPaT messages (j2735_2016.messageId == 18 \|\| j2735_2016.messageId == 19). Display 'region' and 'id' as a column. |
| Pass Criteria | The road regulator identifier and the intersection identifier in both the SPaT and MAP messages broadcast from an intersection match. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.4.8.2    Matching SPaT and MAP Version |
|---|---|
| Objective | Verify contents of the SPaT message broadcast for an intersection are compatible with the MAP message broadcasted for the same intersection |
| Method | Video data is reviewed to determine if the signal state information displayed on the test tool roughly corresponds to the signal indication on the actual signal head. |
| Pass Criteria | This requirement is verified by viewing the simultaneous video capture of the test tool and actual signal head data. The visualized signal event data from the test tool is compared to the expected event state (as would be expected based on indications from the actual signal head) for each movement. If they closely match, this requirement is considered to pass. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.5.1    Positioning Corrections |
|---|---|
| Objective | Verify content of position correction payloads |
| Method | Use Wireshark to view pcap files. Apply filter to look at RTCM messages (j2735_2016.messageId == 28 ). Display '' as a column. The RTCM message payloads are reviewed to determine which RTCM message types are included |
| Pass Criteria | the following RTCM message types are observed: 1005, 1006, 1033, 1013. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.5.2.1    RSU Proximity |
|---|---|
| Objective | Verify proximity of position correction system equipment |
| Method | Determine the location of reference stations in the vicinity of the intersection. Calculate the distance between each reference station and the intersection. |
| Pass Criteria | At least one reference station within 25 miles of the test site, or a calculated value from multiple reference stations is used. |
| Results and Explanation | This requirement is considered to be |

| Requirement | 3.3.3.5.2.2    Minimum RTCM Corrections Broadcast Frequency |
|---|---|
| Objective | Verify RTCM broadcast frequency |
| Method | Wireshark is used to export lat/lon data from the BSM and RTCM messages from each intersection. External data processing tools are used to relate RTCM messages to each BSM using timestamps. A +-500ms window around each BSM is used to search for the number received RTCM messages from each intersection. The BSM lat/long is used to display the number of RTCM messages received on a MAP. A RTCM reception map is generated for each intersection using all of the BSMs generated during the driving data capture. |
| Pass Criteria | RTCM messages received for all locations between the stop line and the minimum data coverage distance (a function of speed limit, upstream of each stop line) for each approach lane |
| Results and Explanation | This requirement is considered to be |