
Connected Intersections (CI) Committee Meeting

Mon April 19 (3:00 PM – 5:00 PM EDT)

Anti-Trust Guidance (Narla)

- The Institute of Transportation Engineers is committed to compliance with antitrust laws and all meetings will be conducted in strict compliance with these antitrust guidelines. Further if an item comes up for which you have conflict of interest, please declare that you have a conflict of interest on the matter and recuse yourself from action on that item.
- The following discussions and/or exchanges of information by or among competitors concerning are prohibited:
 - Prices, price changes, price quotations, pricing policies, discounts, payment terms, credit, allowances or terms or conditions of sale;
 - Profits, profit margins or cost data;
 - Market shares, sales territories or markets;
 - The allocation of customer territories;
 - Selection, rejection or termination of customers or suppliers;
 - Restricting the territory or markets in which a company may sell services or products;
 - Restricting the customers to whom a company may sell;
 - Unreasonable restrictions on the development or use of technologies; or
 - Any matter which is inconsistent with the proposition that each company must exercise its independent business judgement in pricing its service or products, dealing with its customers and suppliers and choosing the markets in which it will compete.

Agenda (Goudy, Thai)

1. Call to Order
2. Anti-Trust Guidelines
3. Roll Call of Committee members
4. Meeting Purpose and Objectives
5. Progress to Date
6. Report from each Task Force
7. Validation Sites
8. Phase Two
9. Project Schedule

Roll Call of Committee Members (Thai)

- John Thai, City of Anaheim
- Raj Ponnaluri, Florida DOT
- Christina Spindler, Wyoming DOT
- Ray Starr, Minnesota DOT
- Ed Seymour, Texas A&M Transportation
- Faisal Saleem, AZ Maricopa County DOT
- Whitney Nottage, Q-Free/Intelight
- Steve Bowles, 360 Network Solutions
- Roy Goudy, Nissan
- Mike Schagrin, McCain
- Mike Shulman, Ford Motors
- Vivek Vijayakumar, General Motors
- Michael Stelts, Panasonic
- Jim Misener, Qualcomm
- Doug Schmidt, Aptiv
- Jay Parikh, CAMP/IOO-OEM Forum
- Justin McNew, JMC Rota
- Steve Sprouffske, Kapsch

Meeting Purpose and Objectives (Thai)

- Purpose:
 - Update the CI Committee on the progress
- Objectives
 - Present the System Design Details document and the progress of each Task Force
 - Present the next Steps
 - Validation Phase
 - Follow-on Activities

Progress To Date (Thai)

- Each Task Force meeting regularly
- Task Force Chairs and Subject Matter Experts (SMEs) meeting every Friday for progress and coordination
- Established Validation Subcommittee

Progress To Date (Thai)

- Last CI Committee Meeting – February 22
- SDD Walkthrough held March 8-11
- Revised SDD document distributed March 31 for comments
- Final SDD Document distributed April 19
 - On Teams site
 - Will be on project webpage

Testing/Conformity Task Force

Jay Parikh / Christina Spindler (co-chairs)

T&C Field Test

- Purpose / Objective
- Testing Approach
- Captured Message Format
- Message Capture, Analysis and Visualization
 - SPaT/MAP Analysis & summary report
 - MAP message visualization
- Next Steps

CI Field Verification – Purpose and Objective

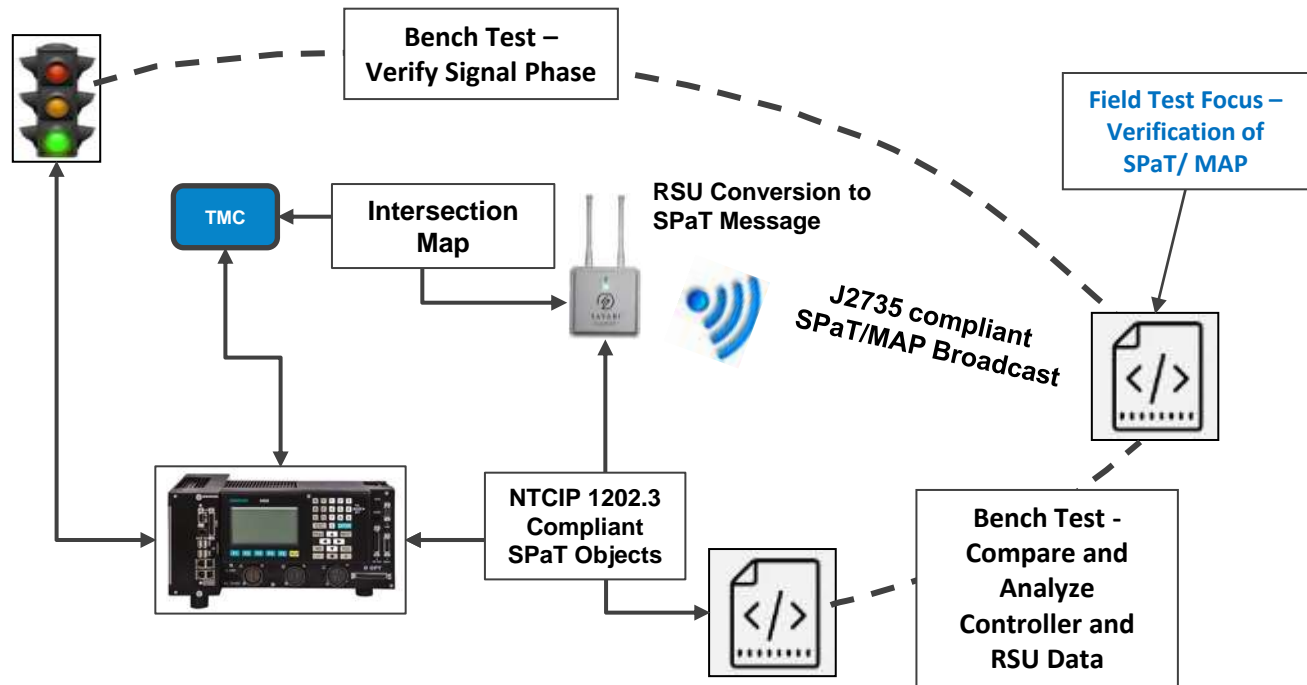
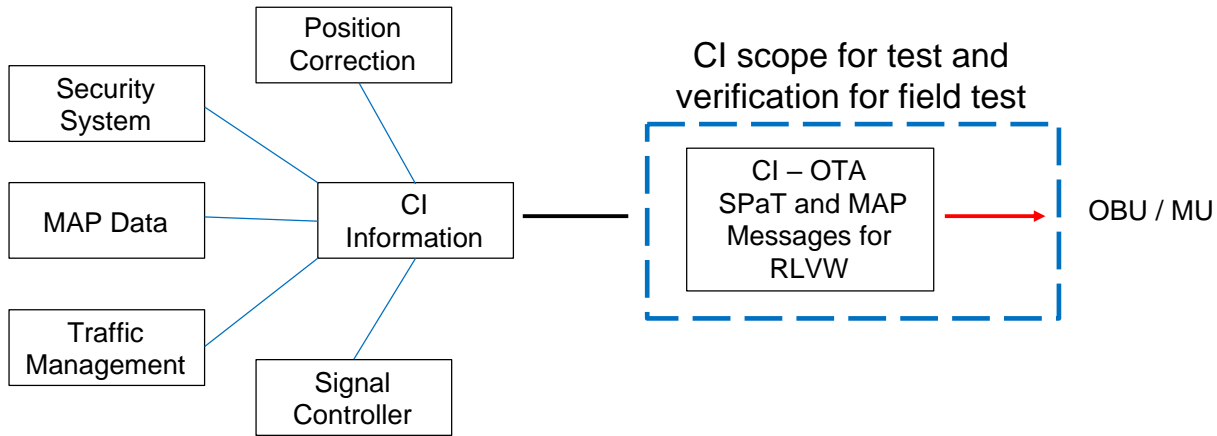
– Purpose:

- Field verification/conformance of equipped intersections' Over-The-Air (OTA) broadcast of SPaT and MAP messages per CI implementation guide

– Objective:

- Verify structure of data frames and data elements defined for SPaT/MAP for the Red-Light Violation Warning (RLVW) application as per J2735
- Verify data values in SPaT/MAP are valid within limits as specified in SAE J2735

CI Test Environment for Field Verification



SPaT / MAP Message Payload in JSON

Unix Epoch in Milliseconds Message ID SPaT Message Payload in JSON

```
1614112834300,19,{'"messageId":19,"value":{"intersections":[{"id":{"id":167},"revision":109,"status":"0000","moy":78493,"timeStamp":34382,"states":[{"signalGroup":1,"state-time-speed":{"eventState":"stop-And-Remain","timing":{"minEndTime":24708,"maxEndTime":24708}}},{"signalGroup":2,"state-time-speed":{"eventState":"stop-And-Remain","timing":{"minEndTime":24358,"maxEndTime":24358}}},{"signalGroup":3,"state-time-speed":{"eventState":"stop-And-Remain","timing":{"minEndTime":24708,"maxEndTime":25178}}},{"signalGroup":4,"state-time-speed":{"eventState":"stop-And-Remain","timing":{"minEndTime":24358,"maxEndTime":24358}}},{"signalGroup":5,"state-time-speed":{"eventState":"stop-And-Remain","timing":{"minEndTime":24688,"maxEndTime":24688}}}}]}'0
```

Signed Message Indicator

Unix Epoch in Milliseconds Message ID MAP Message Payload in JSON

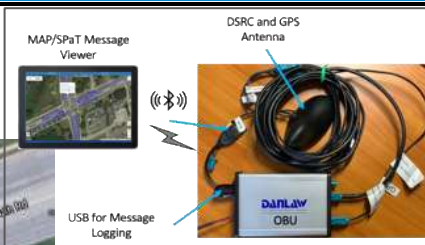
```
1614112838845,18,{'"messageId":18,"value":{"msgIssueRevision":0,"layerType":"intersectionData","layerID":1,"intersections":[{"id":{"id":167},"revision":1,"refPoint":{"lat":422297898,"long":-837195685,"elevation":279},"laneWidth":306,"laneSet":[{"laneID":3,"ingressApproach":1,"laneAttributes":{"directionalUse":"80","sharedWith":"1c80","laneType":{"vehicle":{"value":"01","length":8}}},"maneuvers":"a400","nodeList":{"nodes":[{"delta":{"node-XY3":{"x":-1420,"y":-405}}},{"delta":{"node-XY1":{"x":-38,"y":-1}}},{"delta":{"node-XY4":{"x":-3300,"y":-73}}},{"delta":{"node-XY5":{"x":-5585,"y":-147}}},{"delta":{"node-XY6":{"x":-15423,"y":-365}}},{"delta":{"node-XY6":{"x":-13136,"y":-389}}}],connectsTo":[{"connectingLane":{"lane":11,"maneuver":"8000"},"signalGroup":6},... {"laneID":15,"laneAttributes":{"directionalUse":"00","sharedWith":"0340","laneType":{"crosswalk":"c400}},"maneuvers":"8000","nodeList":{"nodes":[{"delta":{"node-XY3":{"x":-1064,"y":-881}}},{"delta":{"node-XY3":{"x":-148,"y":1624}}]}}, {"laneID":16,"laneAttributes":{"directionalUse":"00","sharedWith":"0340","laneType":{"crosswalk":"c400}},"maneuvers":"8000","nodeList":{"nodes":[{"delta":{"node-XY3":{"x":715,"y":-1380}}}, {"delta":{"node-XY3":{"x":-1340,"y":-43}}]}}, {"laneID":17,"laneAttributes":{"directionalUse":"00","sharedWith":"0340","laneType":{"crosswalk":"c400}},"maneuvers":"8000","nodeList":{"nodes":[{"delta":{"node-XY3":{"x":1193,"y":-751}}}, {"delta":{"node-XY3":{"x":-72,"y":1645}}]}}, {"laneID":18,"laneAttributes":{"directionalUse":"00","sharedWith":"0340","laneType":{"crosswalk":"c400}},"maneuvers":"8000","nodeList":{"nodes":[{"delta":{"node-XY3":{"x":-710,"y":1239}}}, {"delta":{"node-XY3":{"x":1398,"y":44}}]}]}]}]}'0
```

Signed Message Indicator

SPaT / MAP Message Capture, Analysis and Visualization

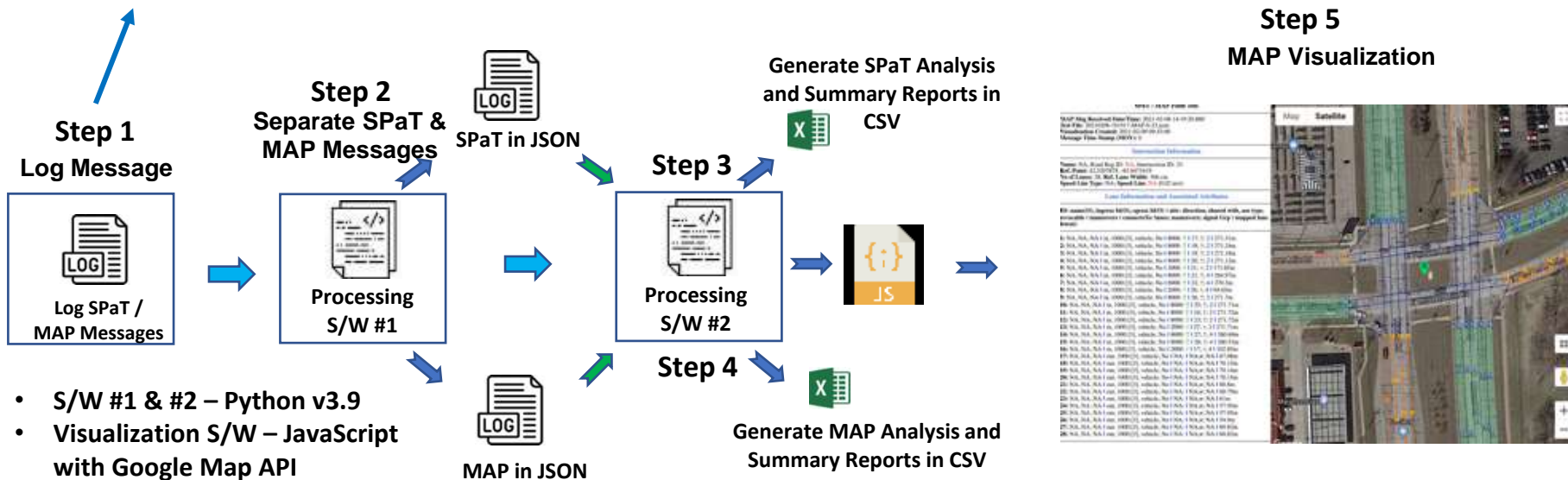


Test Vehicle



SPaT/MAP Message Capture in JSON

1. Log messages
2. Separate SPaT and MAP for processing
3. Process and generate analysis in CSV
4. Generate summary reports
5. Generate Visualization



SPaT Analysis Report in CSV

- List of all required data elements
- Message received timestamp
- Time difference between:
 - consecutive messages received
 - consecutive messages generated by RSU
 - message received time and generated time
- Min and Max end time remaining in current phase from time mark for each signal group

Test Name: SPaT Message																						
SPaT File: ../Field_Test_Data/AA_Test/20210223-201422-SPaT-0-155.json																						
Date & Time: 2021/02/23 - 20:14:27.456 (UTC)																						
<<< START OF SPaT MESSAGE >>>																						
epoch_TS_in	epoch_UTC	epoch_diff_r	Msg_ID	TS_MOY	Intr_Name	Intr_Reg_ID	Intr_ID	Msg_Rev	Intr_Status	Intr_MOY	Intr_TS_mss	Intr_Time	MSG_TS_Df	RX_Time_Df	Sig_Grp_1	Event_State	Sig_Phase_1	Start_TM_1	Start_Time	MinEnd_TM	MinEnd_Tim	Min_EF_Ren
1.6141E+12	2021/02/23	100	19	NA	NA	NA	155	42	0	78467	27779	54d - 11:47:2	100	74	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	49.547
1.6141E+12	2021/02/23	102	19	NA	NA	NA	155	43	0	78467	27879	54d - 11:47:2	100	76	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	49.445
1.6141E+12	2021/02/23	99	19	NA	NA	NA	155	44	0	78467	27981	54d - 11:47:2	102	73	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	49.346
1.6141E+12	2021/02/23	98	19	NA	NA	NA	155	45	0	78467	28081	54d - 11:47:2	100	71	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	49.248
1.6141E+12	2021/02/23	103	19	NA	NA	NA	155	46	0	78467	28181	54d - 11:47:2	100	74	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	49.145
1.6141E+12	2021/02/23	98	19	NA	NA	NA	155	47	0	78467	28281	54d - 11:47:2	100	72	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	49.047
1.6141E+12	2021/02/23	100	19	NA	NA	NA	155	48	0	78467	28387	54d - 11:47:2	106	66	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.947
1.6141E+12	2021/02/23	102	19	NA	NA	NA	155	49	0	78467	28487	54d - 11:47:2	100	68	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.845
1.6141E+12	2021/02/23	99	19	NA	NA	NA	155	50	0	78467	28585	54d - 11:47:2	98	69	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.746
1.6141E+12	2021/02/23	100	19	NA	NA	NA	155	51	0	78467	28685	54d - 11:47:2	100	69	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.646
1.6141E+12	2021/02/23	101	19	NA	NA	NA	155	52	0	78467	28792	54d - 11:47:2	107	63	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.545
1.6141E+12	2021/02/23	100	19	NA	NA	NA	155	53	0	78467	28892	54d - 11:47:2	100	63	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.445
1.6141E+12	2021/02/23	98	19	NA	NA	NA	155	54	0	78467	28990	54d - 11:47:2	98	63	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.347
1.6141E+12	2021/02/23	100	19	NA	NA	NA	155	55	0	78467	29090	54d - 11:47:2	100	63	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.247
1.6141E+12	2021/02/23	103	19	NA	NA	NA	155	56	0	78467	29195	54d - 11:47:2	105	61	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.144
1.6141E+12	2021/02/23	100	19	NA	NA	NA	155	57	0	78467	29295	54d - 11:47:2	100	61	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	48.044
1.6141E+12	2021/02/23	98	19	NA	NA	NA	155	58	0	78467	29388	54d - 11:47:2	93	66	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	47.946
1.6141E+12	2021/02/23	99	19	NA	NA	NA	155	59	0	78467	29488	54d - 11:47:2	100	65	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	47.847
1.6141E+12	2021/02/23	101	19	NA	NA	NA	155	60	0	78467	29578	54d - 11:47:2	90	76	1	protected-M	Prot-Green	NA	00:00.0	9174	0:15:17.400	47.746

SPaT Analysis Summary Report

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Test Name:	SPaT - Test Location:					# of Msg:	2123	Test Time:	0:15:09.058				
SPaT File:	SPaT - 20210223-201422-SPaT-0-155_Summary_Report.csv					#of Sig Grp:	2	Sig Groups:	[1, 2]				
Date & Time	2021/02/23 - 20:14:27.456 (UTC)												
	SAE J2735 SPaT Data Frames and Elements					M/O/C in	Pass/Fail	M/O/C in CI	Pass/Fail	Invalid	Data Range	Data Range	Remark
						SAE J2735	J2735	Impl - RLVW	CI Impl RLVW	Data	Low	High	
messageId=DE_DSRC_MessageID=19 (SPaT UPER)						M	Pass	M	Pass		0	32767	
timeStamp=DE_MinuteOfTheYear						O	Fail	M	Fail	78467	0	5274040	Invalid or incorrect value
name=DE_DescriptiveName (only for debug)						O	--	O	--				
intersections=DF_IntersectionStateList						M	Pass	M	Pass				
name=DE_DescriptiveName (only for debug)						O	--	O	--				
id=DF_IntersectionReferenceID						M	Pass	M	Pass				
region=DE_RoadRegulatorID						O	--	M	Fail		0	65535	Missing data
id=DE_IntersectionID						M	Pass	M	Pass		0	65535	
revision=DE_MsgCount						M	Pass	M	Pass		0	127	
status=DE_IntersectionStatusObject						M	Pass	M	Fail	0	513	65532	Invalid or incorrect value
moy=DE_MinuteOfTheYear						O	--	O	--		0	5274040	
timeStamp=DE_Dsecond						O	--	M	Pass		0	65535	
enabledLanes=DF_EnabledLaneList						O	--	C	--				C-When revocable lane is active
states=DF_MovementList=1 to 255 x DF_MovementState						M	Pass	M	Pass				
movementName=DE_DescriptiveName (only for debug)						O	--	O	--				
signalGroup=DE_SignalGroupID						M	Pass	M	Pass		0	255	
state-time-speed=DF_MovementEventList						M	Pass	M	Pass				
eventState=DE_MovementPhaseState						M	Pass	M	Pass				
timing=DF_TimeChangeDetails						O	--	M	Pass				
startTime=DE_TimeMark						O	--	C	--		0	36001	C-If available
minEndTime=DE_TimeMark						M	Pass	M	Pass		0	36001	
maxEndTime=DE_TimeMark						O	--	M	Pass		0	36001	
likelyTime=DE_TimeMark						O	--	--	--		0	36001	
confidence=DE_TimeIntervalConfidence						O	--	--	--		0	15	
nextTime=DE_TimeMark						O	--	C	Fail		0	36001	Missing data
Notes:	Columns A-F SPaT objects as defined in SAE J2735												
	Column G	M - Mandatory, O - Optional, or C - Conditional objects for SPaT as defined in J2735 specification											
	Column H	Pass (present), Fail (absent) or -- (Not Applicable) for the objects in SPaT messages as per column G											
	Column I	M - Mandatory, O - Optional or C - Conditional objects for SPaT as defined in the CI Implementation Guide for RLVW application											
	Column J	Pass (present), Fail (absent) or -- (Not Applicable) for the objects in SPaT messages as per column I											
	Column K	Invalid or incorrect data value for the object or the value is outside the range as listed in columns L and M											
	Column L	Valid lowest numeric data value as defined in J2735. Blank indicates - data frame or alphanumeric object											
	Column M	Valid highest numeric data value as defined in J2735. Blank indicates - data frame or alphanumeric object											
	Column N	Remark											

MAP Analysis Summary Report

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Test Name: MAP - Test Location													
MAP File: MAP - 20210223-201422-MAP-0-06_Summary_Report.csv													
Date & Time: 2021-02-23 20:14:53.384 (UTC)													
						M/O/C in	Pass/Fail	M/O/C in O	Pass/Fail	Invalid	Data Range	Data Range	Remark
		SAE J2735 MAP Data Frames and Elements				SAE J2735	Impl - RLVA	O RLVA			Low	High	
		messageId=DE_DSRCMsgID=18 (MAP-UPER)				M	Pass	M	Pass		0	32767	
		messageRevision=DE_MsgCount				M	Pass	M	Pass		0	127	
		intersections=DF_IntersectionGeometryList=1 to 32 X DF_IntersectionGeom				O	--	M	Pass				
		id=DF_IntersectionReferenceID				M	Pass	M	Pass				
		region=DE_RoadRegulatorID				O	--	M	Pass		0	65535	
		id=DE_IntersectionID				M	Pass	M	Pass		0	65535	
		revision=DE_MsgCount				M	Pass	M	Pass		0	127	
		refPoint=DF_Position3D				M	Pass	M	Pass				
		lat=DE_Latitude				M	Pass	M	Pass		-90000000	90000001	
		long=DE_Longitude				M	Pass	M	Pass		-90000000	90000001	
		elevation=DE_Elevation				O	--	M	Pass		-4096	61439	
		laneWidth=DE_LaneWidth				O	--	M	Pass		0	32767	
		speedLimits=DF_SpeedLimitList=1 to 9 X DF_RegulatorySpeedLimit				O	--	M	Pass				
		type=DE_SpeedLimitType				C (if Incl)	Pass	M	Pass				
		speed=DE_Velocity				C (if Incl)	Pass	M	Pass		0	8193	
		laneSet=DF_LaneList=1 to 255 X DF_GenericLane				M	Pass	M	Pass				
		laneID=DE_LaneID				M	Pass	M	Pass		0	254	Unknown, 255=future use
		laneAttributes=DF_LaneAttributes				M	Pass	M	Pass				
		directionalUse=DE_LaneDirection				M	Pass	M	Pass		0	1	
		sharedWith=DE_LaneSharing				M	Pass	M	Pass				
		laneType=DF_LaneTypeAttributes (revocable)				M	Pass	M	Pass				
		maneuvers=DE_AllowedManeuvers				O	--	M	Pass		0	4096	12 bits
		nodeList=DF_NodeListXY=Choice of DF_NodeSetXY OR DF_ComputedLan				M	Pass	M	Pass				
		nodes=DF_NodeSetXY=2 to 63 X DF_NodeXY				M	Pass	M	Pass				
		delta=DF_NodeOffsetPointXY				M	Pass	M	Pass				
		node-X1=DF_Node_XY_20b				O.4 (1..*)	Pass	O.4 (1..*)	--				
		x=DE_Offset_B10				C (if node-XY)	Pass	C (if node-XY)	--		-512	511	
		y=DE_Offset_B10				C (if node-XY)	Pass	C (if node-XY)	--		-512	511	
		node-X2=DF_Node_XY_22b				O.1 (1..*)	Pass	O.4 (1..*)	--				
		x=DE_Offset_B11				C (if node-XY)	Pass	C (if node-XY)	--		-1024	1023	
		y=DE_Offset_B11				C (if node-XY)	Pass	C (if node-XY)	--		-1024	1023	
		node-X3=DF_Node_XY_24b				O.1 (1..*)	Pass	O.4 (1..*)	--				
		x=DE_Offset_B12				C (if node-XY)	Pass	C (if node-XY)	--		-2048	2047	
		y=DE_Offset_B12				C (if node-XY)	Pass	C (if node-XY)	--		-2048	2047	
		node-X4=DF_Node_XY_26b				O.1 (1..*)	Pass	O.4 (1..*)	--				
		x=DE_Offset_B13				C (if node-XY)	Pass	C (if node-XY)	--		-4096	4095	
		y=DE_Offset_B13				C (if node-XY)	Pass	C (if node-XY)	--		-4096	4095	
		node-X5=DF_Node_XY_28b				O.1 (1..*)	Pass	O.4 (1..*)	--				
		x=DE_Offset_B14				C (if node-XY)	Pass	C (if node-XY)	--		-8192	8191	
		y=DE_Offset_B14				C (if node-XY)	Pass	C (if node-XY)	--		-8192	8191	
		node-X6=DF_Node_XY_32b				O.1 (1..*)	Pass	O.4 (1..*)	--				
		x=DE_Offset_B16				C (if node-XY)	Pass	C (if node-XY)	--		-32768	32767	
		y=DE_Offset_B16				C (if node-XY)	Pass	C (if node-XY)	--				
		attributes=DF_NodeAttributeSetXY				O	--	O	--				
		data=DF_LaneDataAttributeList=1 to 8 X DF_LaneDataAttribute				O	--	O	--				
		DF_LaneDataAttribute=Choice				O	Pass	C (if data is i	--				
		speedLimits=DF_SpeedLimitList=1 to 9 X DF_RegulatorySpeedO				O	--	C (if data is i	--				
		type=DE_SpeedLimitType				C (if speedLi	Pass	C (if data is i	--				
		speed=DE_Velocity				C (if speedLi	--	C (if data is i	--				
		width=DE_Offset_B10				O	Pass	C (for differe	--				
		elevation=DE_Offset_B10				O	Pass	C (for differe	--				
		computed=DF_Computed Lane				O	Pass	C (for comp	--				
		referenceLaneID=DE_LaneID				C (if comput	Pass	C (for comp	--				
		offsetXaxis=Choice				C (if comput	Pass	C (for comp	--				
		small=DE_DrivelineOffsetSmall				O.2 (1..*) (if	Pass	O.7 (1) (For i	--				
		large=DE_DrivelineOffsetLarge				O.2 (1..*) (if	Pass	O.7 (1) (For i	--				
		offsetYaxis=Choice				C (if comput	Pass	C (for comp	--				
		small=DE_DrivelineOffsetSmall				O.3 (1..*) (if	Pass	O.8 (1) (For i	--				
		large=DE_DrivelineOffsetLarge				O.3 (1..*) (if	Pass	O.8 (1) (For i	--				
		rotateXY=DE_Angle				O	Pass	O (for comp	--				
		connectsTo=DF_ConnectsToList=1 to 16 X DF_Connection				O	Pass	M	Pass				
		connectingLane=DF_ConnectingLane				C (if connect	Pass	M	Pass				
		lane=DE_LaneID				C (if connect	Pass	M	Pass				
		maneuvers=DE_AllowedManeuver				O	Pass	O	--				
		signalGroup=DE_SignalGroupID				O	Pass	M	Pass				

Notes:

- Column A-F MAP objects as defined in SAE J2735
- Column G M - Mandatory, O - Optional, or C - Conditional objects for MAP as defined in J2735 specification
- Column H Pass (present), Fail (absent) or -- (Not Applicable) for the objects in MAP messages as per column G
- Column I M - Mandatory, O - Optional or C - Conditional objects for MAP as defined in the CI Implementation Guide for RLVA application
- Column J Pass (present), Fail (absent) or -- (Not Applicable) for the objects in MAP messages as per column I
- Column K Invalid or incorrect data value for the object or the value is outside the range as listed in columns L and M
- Column L Valid lowest numeric data value as defined in J2735. Blank indicates - data frame or alphanumeric object
- Column M Valid highest end of data value as defined in J2735
- Column N Remark

MAP Message Visualization

SPaT / MAP Field Test

MAP Msg Received Date/Time (UTC): 2021-02-23 20:14:53.384
 Test File: 20210223-201422-MAP-0-86.json
 Visualization Created: 2021-04-08 14:31:02
 Message Time Stamp (MOY): 0

Intersection Information

Name: NA, Road Reg ID: NA, Intersection ID: 86
 Ref. Point: 42.3050173, -83.6928826
 No of Lanes: 28; Ref. Lane Width: 305 cm
 Speed Lim Type: NA; Speed Lim: NA (0.02 m/s)

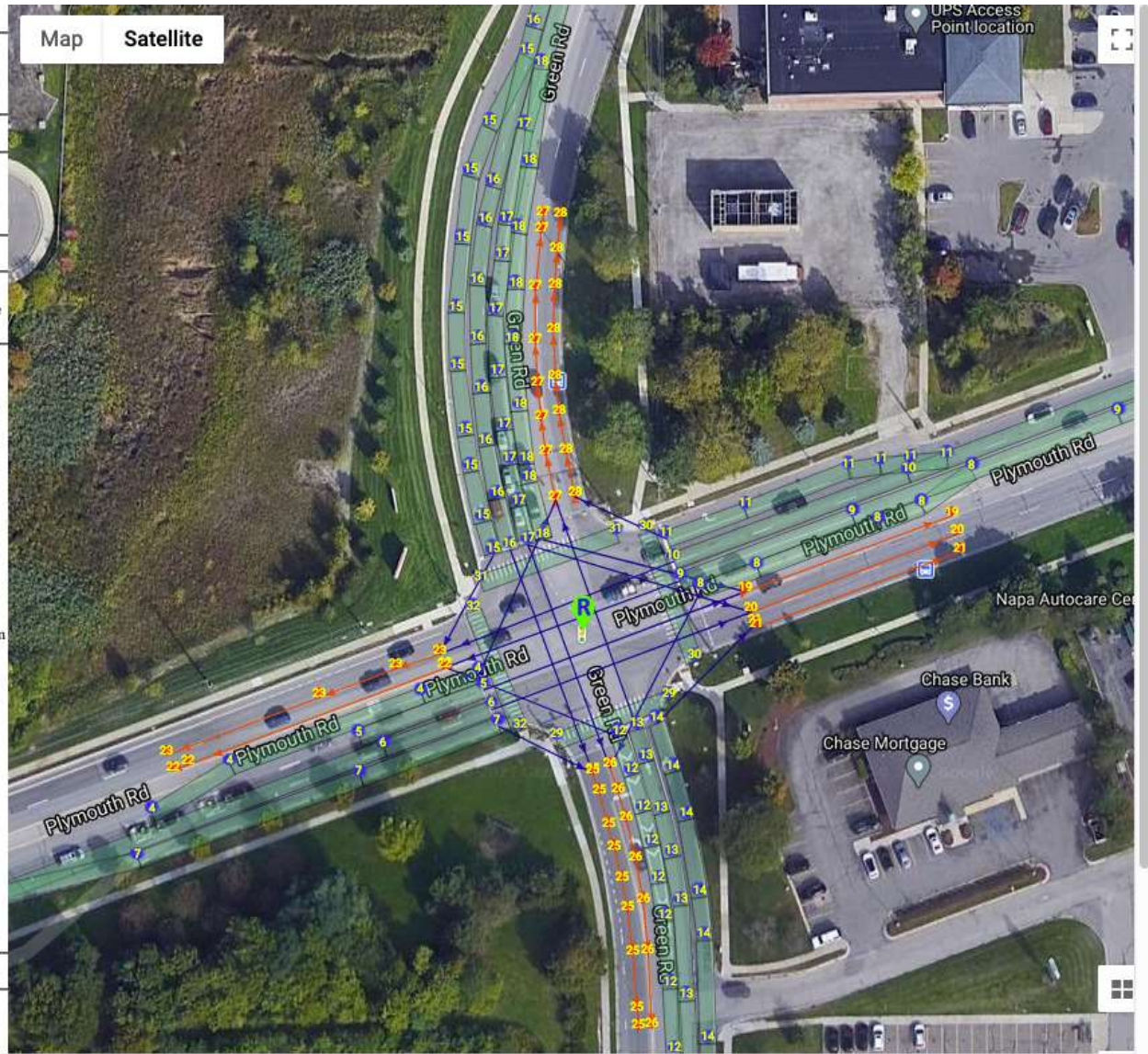
Lane Information and Associated Attributes

ID: name(O), ingress Id(O), egress Id(O) | attr: direction, shared with, use type, revocable | maneuvers | connectsTo: lanes; maneuvers; signal Grp | mapped lane len(m)

- 4: NA, 1, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 4000: ↑ | 27; ↓; 5 | 65.53m
- 5: NA, 1, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | 19; ↑; 2 | 24.67m
- 6: NA, 1, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | 20; ↑; 2 | 401.38m
- 7: NA, 1, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 2400: ↑ | 25; ↑; 2 | 99.52m
- 8: NA, 3, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 4000: ↑ | 26; ↓; 1 | 54.71m
- 9: NA, 2, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | 22; ↑; 6 | 275.3m
- 10: NA, 2, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | 23; ↑; 6 | 275.55m
- 11: NA, 2, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 2400: ↑ | 28; ↑; 6 | 54.1m
- 12: NA, 6, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 4000: ↑ | 22; ↓; 3 | 72m
- 13: NA, 6, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | 27; ↑; 8 | 225.88m
- 14: NA, 6, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 2400: ↑ | 21; ↑; 1 | 94.95m
- 15: NA, 5, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 2400: ↑ | 23; ↑; 4 | 94.86m
- 16: NA, 5, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | 25; ↑; 4 | 202.6m
- 17: NA, 5, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | c000: ↑ | 20,26; ↓; 7,7 | 201.64m
- 18: NA, 5, NA | in, 1d80:[3,4,5,7,8], vehicle, Yes | 4000: ↑ | 19; ↓; 7 | 87.34m
- 19: NA, NA, 7 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 40.42m
- 20: NA, NA, 7 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 40.43m
- 21: NA, NA, 7 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 40.86m
- 22: NA, NA, 8 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 53.47m
- 23: NA, NA, 8 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 53.31m
- 25: NA, NA, 10 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 47.95m
- 26: NA, NA, 10 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 48.59m
- 27: NA, NA, 9 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 52.71m
- 28: NA, NA, 9 | out, 1d80:[3,4,5,7,8], vehicle, Yes | 8000: ↑ | NA; NA | 51.87m
- 29: NA, NA, NA | in, 0340:[6,7,9], xwalk, Yes | 8000: ↑ | NA; NA | 21.81m
- 30: NA, NA, NA | in, 0340:[6,7,9], xwalk, Yes | 8000: ↑ | NA; NA | 25.32m
- 31: NA, NA, NA | in, 0340:[6,7,9], xwalk, Yes | 8000: ↑ | NA; NA | 26.37m
- 32: NA, NA, NA | in, 0340:[6,7,9], xwalk, Yes | 8000: ↑ | NA; NA | 23.49m

LEGENDS

NA = Not Available; in = ingress; out = egress
 ↑ = Go Straight; ↓ = Lt. Turn; ↑ = Rt. Turn; ∞ = U Turn; ∇ = Yield



Next Steps

- Test and analysis tool, procedures and specifications to be shared with agencies
- Compile information on testing and analysis for agencies who wish to conduct self assessment
- Develop template for validation / implementation guide / lessons learned for agencies
- ITE project outcome can incorporate lessons learned from bench/lab and Ann Arbor field tests
- Verification subcommittee weekly meetings
 - Status and Q&A with agencies

Questions

Traffic Controller Issue Task Force

Kevin Balke / Roy Goudy (co-chairs)

Focus of the Traffic Controller Issues (TCI) Task Force

- Issues that have to do with Traffic Signal Controllers (TSCs) and Traffic Control Operations
 - Resolve gaps and ambiguities that have already occurred
 - Make recommendations, identify needs, develop requirements, and specify design to provide SPaT data in a consistent manner across TSC manufacturers

Traffic Controller Issues Task Force

1. Accomplishments since February 22nd Plenary Meeting
2. Enhancing Design Descriptions
3. Latency and Synchronization
4. Next Steps
5. Q&A

TCI Task Force Accomplishments since February 22 Plenary Meeting

- Held TCI Task Force Meetings
- Ad-hoc meetings both within the TCI Task and with other Task Forces to work through issues
- Continuing work on a volunteer basis to improve the document

Enhancing Design Details – Previous Version

4.3.2.2.4 TSC Infrastructure Cabinet Flash (Exception Flash) Indication

The design for the TSC Infrastructure Cabinet Flash (Exception Flash) Indication depends on what format is used to exchange SPaT information from the TSC infrastructure to the RSU.

4.3.2.2.3.1 TSC Infrast. Cabinet Flash (Exception Flash) Indication (NTCIP 1202 v03A)

When sending NTCIP 1202 v03A data, NTCIP Object spatStatus Bit 2 is enabled (=1) when NTCIP Object unitFlashStatus is other (=1), localManual (=4), or mmu (=6). Otherwise, NTCIP Object spatStatus Bit 2 is disabled (=0)...

4.3.2.2.3.2 TSC Infrast. Cabinet Flash ... (V2I Hub ICD) ...

4.3.2.2.3.3 TSC Infrast. Cabinet Flash ... (SAE J2735) ...

Enhancing Design Details – Expanded Version

4.3.2.2.4 TSC Infrastructure Cabinet Flash (Exception Flash) Indication

The design for the TSC Infrastructure Cabinet Flash (Exception Flash) Indication depends on what format is used to exchange SPaT information from the TSC infrastructure to the RSU.

Cabinet Flash is any type of flash that is initiated and terminated by sources external to the controller. There are two types of Cabinet Flash:

- “Monitor Flash” is Cabinet Flash controlled by the monitor ...
- “Local Flash” is Cabinet Flash controlled by human-operated switches ...

The end of Cabinet Flash is indeterminate because the controller does not know when the monitor is going to be reset or when the flash switch is going to be moved from “FLASH” to “AUTO”. Therefore, time change details during Cabinet Flash cannot be supplied.

Example Design Details – Enhanced (cont.)

4.3.2.2.4 TSC Infrastructure Cabinet Flash (Exception Flash) Indication (cont.)

...

During Cabinet Flash, signal indications are determined by cabinet wiring (jumpers or flash program blocks)...

Certain cabinet architectures such as NEMA TS 1 do not define Flash Sense inputs to the controller. IOOs using these cabinets are cautioned that, without special accommodations, controllers running in these cabinets do not know that Cabinet Flash is active and may continue to cycle normally and erroneously provide normal time change details and movement phase states to OBUs/MUs during Cabinet Flash.

Latency and Synchronization

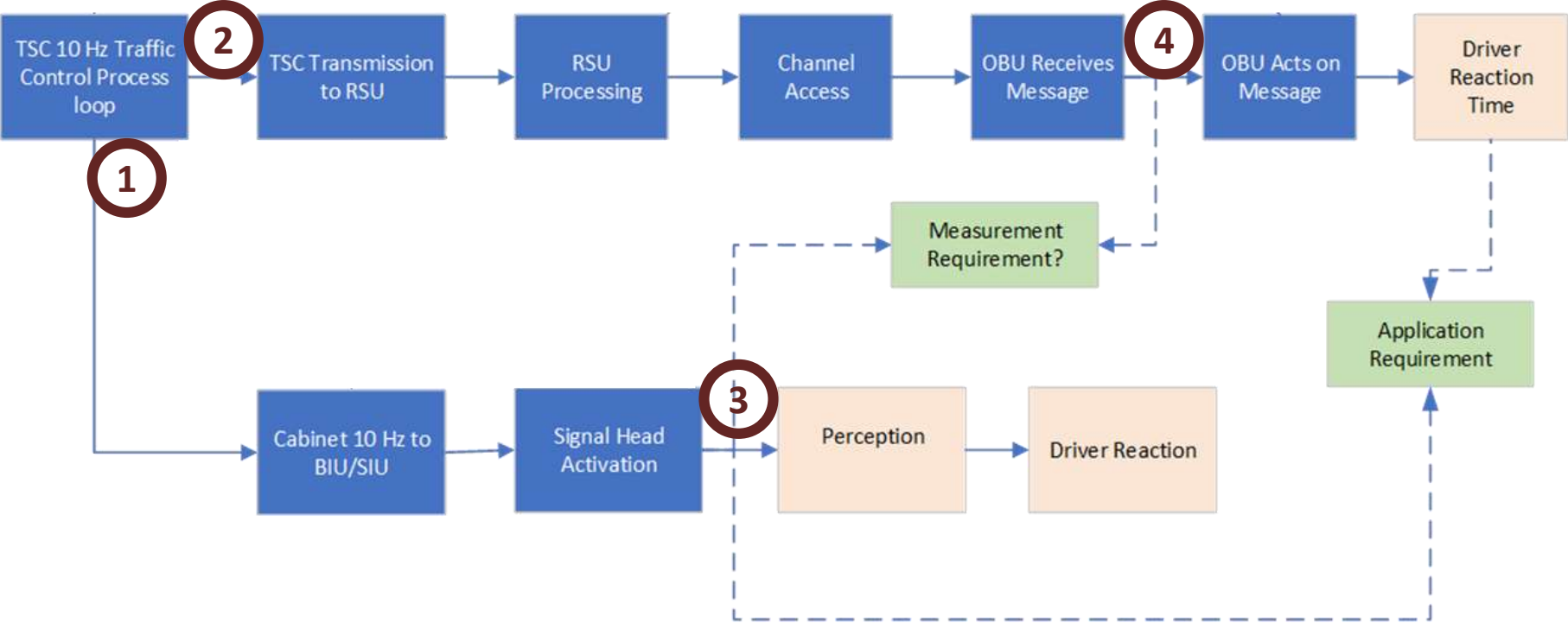
Latency

The time delay between the cause and the effect of some physical change in the system being observed

Synchronization

The operation or activity of two or more things at the same time or rate

Latency and Synchronization



Ideally 3 and 4 occur at the same time

Latency and Synchronization

- Latency (as of now)
 - TSC to OBU 380 ms
 - TSC to Signal Heads 200-400 ms (still investigating)
- Synchronization
 - Depends on the two latencies
 - A new message comes every 100 ms
 - What is close enough?
- Discussed using the Assured Green Period (AGP) to address latency concerns – More discussion needed

Recommendation from Traffic Controller Manufacturers Subcommittee

- Enhance the Advanced Transportation Controller (ATC) Application Programming Interface (API) to manage the SPaT messaging to the RSU
- API Reference Implementation (APIRI)
 - Open Source Software (OSS) available to industry
 - API software already manages interface between the TSC and the input/outputs of the cabinet system field devices
- Potentially reduce latency, increase synchronization
- Facilitates interoperability and increases compatibility of controller units in CI environments

Next Steps for the TCI Task Force

- Continuing with design detail enhancements
- Continuing work on latency and synchronization

Traffic Controller Issues Task Force

Q&A

SPaT/MAP Task Force

Michael Maile / Ray Starr (co-chairs)

SPaT/MAP Task Force

- Met on March 18 to Address Issues from Walk Through
 - Confirmed Revision Counter operation and added info
 - Confirmed Road Regulator proposal
 - Use of SPaT Status object to indicate no MAP or SPaT available
 - Suggested SAE should add field in SPaT message identifying what revision of MAP message it is linked to
 - Clarified Intersection Reference Point preferred to be within the intersection box and referenced to a known point outside the intersection
 - Clarified how to show a diverge point in the MAP message, such as the start of a turn lane
 - Clarified language for vertical curves in the MAP message
 - Clarified use of shared lanes in the MAP message

SPaT/MAP Task Force

- Considered gaps and needs for potential follow-on activities (covered later today)
 - Some items the ITE CI Implementation Guide requires are not possible with existing standards (movement next state)
 - Some items the ITE CI Implementation Guide requires are not available with current equipment and software (Assured Green Period using BSMs)
 - More complete test procedures are needed to verify the CI is providing messages that are accurate and that meet the ITE CI Implementation Guide requirements

SPaT/MAP Task Force

– Status & Next Steps

- Ending regular weekly task force meetings
- Follow progress of validation sites
- Meet as needed to address SPaT/MAP issues as they arise during validation
- Address recommendations at the end of validation

Positioning Task Force

Justin McNew / Jim Misener (co-chairs)

Positioning Task Force

– Accomplishments since February 22 Plenary Meeting

- Completed SDD of RTCM-related contents
 - Mandatory use of Multiple Signals Message (MSM) version 4
 - GPS plus one other constellation (GLONASS, Galileo, Beidou)
 - Station information transmitted no more frequently than once per second
 - Corrections information (MSM 4 messages) transmitted between 1 and 10 times per second (tunable)
 - Use of MSM 5 and higher (in addition to MSM 4) is optional
- Added implementation guidance based on RSU range and vehicle speed
- Added more detail to requirements for the V2X radio interface

– Status

- Transitioning to support mode for validation phase
- Meeting cadence reduced to once per month

– Next Steps

- Determine and request desired feedback from test sites
- Next TF meeting on May 17

Security Task Force

Jimmy Upton / William Whyte (co-chairs)

Security Task Force

- Accomplishments since February 22 Plenary Meeting
 - Completed input to SDD

SDD Security Documentation Requirements

– High-level:

To verify that the security compliance assessment documentation is complete and correct, the security compliance assessment documentation is inspected, and this may be accomplished by self-declaration. The compliance assessment documentation should include:

- All known attack methodologies and mitigations that might lead to the RSU transmitting incorrect SPaTs, and their mitigation, including:
- All known attack methodologies that might lead to the TSC infrastructure outputting incorrect SPaT information message, and their mitigation
- All known attack methodologies and mitigations that might lead to the RSU transmitting incorrect MAPs, and their mitigation
- All known attack methodologies and mitigations that might lead to the RSU transmitting incorrect positioning corrections (e.g., RTCM corrections)

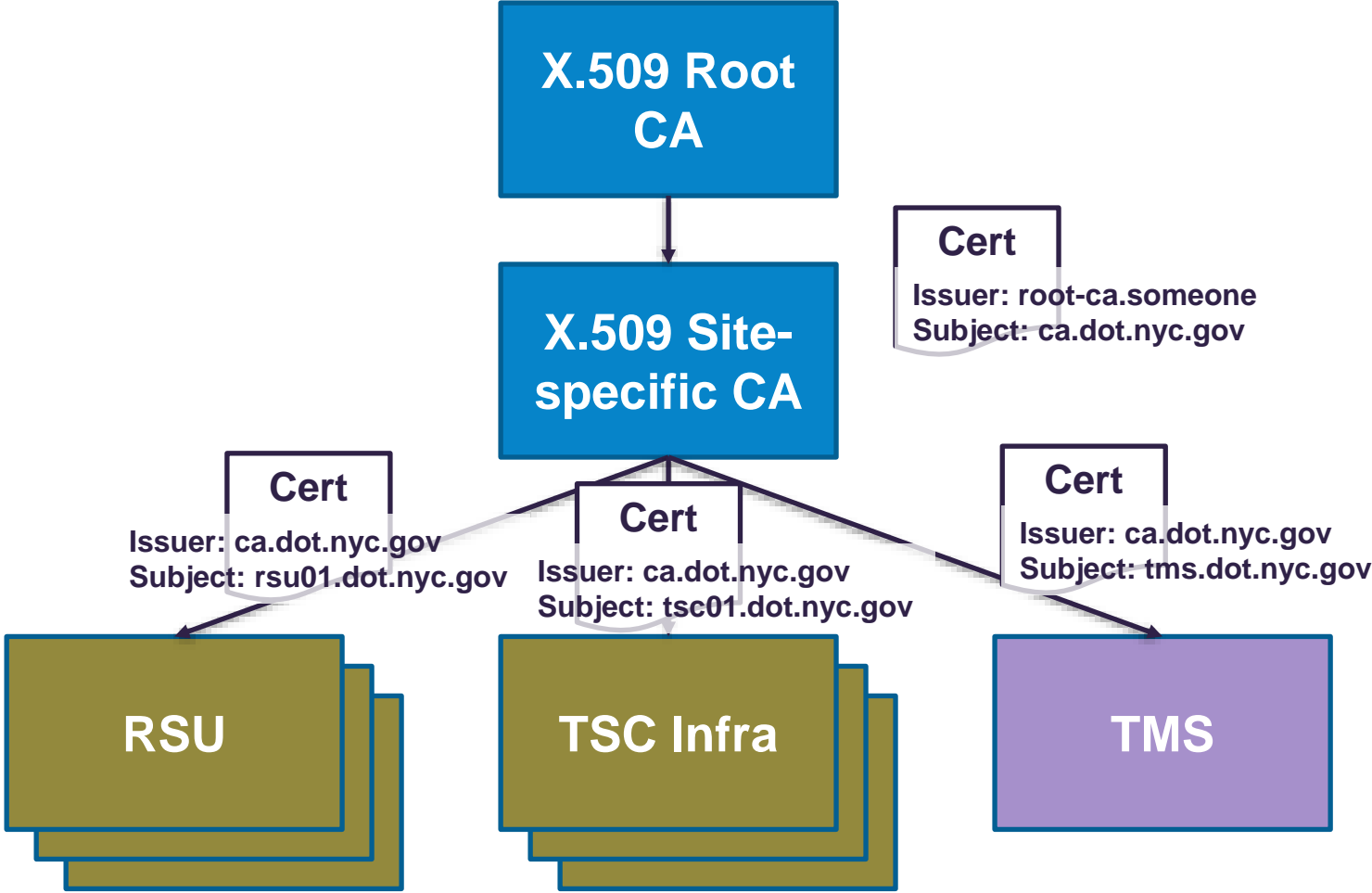
SDD Security Documentation Requirements Details

- Auditing of devices for detection and treatment of security incidents
- SPaT message trustworthiness
- RTCM data trustworthiness
- Network security
- CI Operation security practices
- TSC Infrastructure Security Standards
- Security against Cyber-Attack
- Uniqueness of the SubjectAltName used to identify acceptable TLS counterparties
- Protection against TSC reconfiguration from the RSU
- MAP Data Integrity
- RSU Protection beyond RSU Standard v1.0
- TMS Device protection
- Operational Logging
- Trustworthiness of RSU Software and Firmware Updates
- Trustworthiness of TSC Software and Firmware Updates

SDD Security Documentation Requirements – Future Direction

- These security documentation requirements are anticipated to change over time. While self-declaration is currently acceptable, the security compliance assessment documentation requirements themselves may change over time (for example, becoming more specific), and self-declaration may be replaced by a certification process involving an external party. As such, the IOO shall identify which version of the CI Implementation Guide the security compliance assessment documentation conforms with. Doing so may mitigate deployment delays associated with compliance security assessment documentation that may not conform to later requirements. Annex D.2 provides an example process of how an IOO may prepare its security compliance assessment documentation.

Connection RSU-TSC Infrastructure, RSU-TMS 1: Certificates



Connection RSU-TSC Infrastructure, RSU-TMS 1: Connection



– Cert subject matches pattern?

- tsc*.dot.nyc.gov
- tsc20.dot.nyc.gov

– Cert issuer =?



– Cert subject matches pattern?

- rsu*.dot.nyc.gov
- rsu20.dot.nyc.gov

– Cert issuer =?



Next steps

- Security not being actively validated during validation phase
- Security TF leaders involved in validation subcommittee
 - Role: education about security approach / get feedback on security design material

Finally...

- ...thanks Michaela!

Validation Phase (Spindler)

– Evaluation Subcommittee

- Roy Goudy, John Thai, Kevin Balke, Jay Parikh, Christina Spindler, Ray Starr, Michael Maile, Patrick Chan, Randy Roebuck, Steve Sprouffske, Ralph Boaz, Jim Misener, Jimmy Upton, William Whyte, Virginia Lingham, Tom Timcho

– Validation Sites

- Caltrans, City & County of Denver, City of Anaheim, Clark County (WA), DriveOhio, Florida DOT, Georgia DOT, Maricopa County DOT, Panasonic, San Diego, University of Alberta, UMTRI, Utah DOT

– Meeting Weekly: Thursdays, 12 PM – 1 PM ET

- April 29 through July
- Discuss issues, provide guidance, report progress

Validation Phase (Spindler)

- All: Identify ambiguities and gaps in the CI Implementation Guide
- All: Provide comments and suggestions for the current and future versions of the CI Implementation Guide
- Field data collection and analysis from 4 sites
- Specific sites may be asked to provide:
 - A description of the changes and issues to be resolved to conform with the CI Implementation Guide
 - An estimate of the resources (level of effort, amount of time)
 - An evaluation of a specific topic or item in the CI Implementation Guide: Security, position correction, controller issues, RSU implementation

Follow-on Activities (Narla)

- Work items for a potential follow-on activities
 - May not start until 2022
- Use Annex F of SDD as starting point
- Potential areas (Dr. Shulman):

There are both technical and organizational needs that must be addressed before production vehicle deployment.

 - **Technical:** Verification of message content, assured green period, functional safety monitor, complete security solution, C-V2X test tools, positioning requirements ...
 - **Organizational:** procedures for lane closures, outages and other disruptions.
 - **Organizational:** procedures for updates and adding new applications

Follow-on Activities (Goudy)

– Additional Areas

- SPaT/MAP - Support for Movement Next State
- Develop Test Plans and Test Cases
 - SPaT/MAP accuracy and precision
- Consider other safety and mobile applications
- Messages received by the infrastructure (e.g., BSMs)
 - May be needed for Assured Green Period
 - Security impacts (current framework only considers messages broadcasted by the RSU)
- Address additional gaps and ambiguities with traffic controllers

Project Schedule (Goudy)

- Final SDD Document distributed April 19
- Validation Phase: April – July
- Publish Final Implementation Guidance Document (Complete September 17 2021)
- Next CI Committee Meeting
 - May 17, 2021, 3:00 – 5:00 PM EDT
 - June 21, 2021, 2:00 – 5:00 PM ET (Plenary Meeting)

Participation (Thai)

- ITE Project Website
 - <https://www.ite.org/technical-resources/standards/connected-intersections/>
- To participate in a Task Force, send an e-mail to:
 - standards@ite.org
- Please indicate which task force(s) in the e-mail
- Participation limited to no more than 3 task forces

Closing Remarks

- USDOT
- ITE

Adjourn

– Thank you!