Connected Intersections (CI) Testing & Conformity Task Force

Wednesday, April 21 (03:30 PM – 5:30 PM EDT) Virtual Meeting TF - J. Parikh / C. Spindler SME - R. Roebuck / M. Insignares

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

- 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

Why We Need Field Test?

- To test and verify installed connected intersection:
 - As defined in CI implementation guide document:
 - per the SAE J2735 specification
 - per the required data elements specified for SPaT and MAP messages by the SPAT/MAP TF
 - per the required position correction data specified by the Position TF
 - digitally signed messages as per the Security TF
 - Visualize received SPaT and MAP messages for visual confirmation
 - Analyze and corelate received SPaT and MAP messages:
 - From the same intersection
 - Message provides complete geographic map of the intersection
 - all lanes are mapped
 - mapped lane length confirms to the requirement
 - Corelate intersection map with:
 - signal grouping, maneuvers, required lane attributes, etc.

CI Test Environment for Field Verification



Message Logging and Verification Using Test Tool

- 1. DSRC OBU-based device to capture and log OTA SPaT and MAP messages
 - Logged messages are conformant with SAE J2735 ASN.1 in JavaScript Object Notation (JSON) Encoding Rule (JER)
 - SPaT/MAP message log format next slide
 - Message logging does not support C-V2X mode 4 Sidelink PC5 Interface
 - However, if an agency can log messages in JSON as specified, it can be processed using the analysis software
 - At this time, RTCM position correction messages are not supported
- 2. CAMP in a different project, developed software to convert logged PCAP file to JSON compliant message format
 - Conversion software is being tested
- 3. Analysis and Verification Software
 - Based on logged message format
 - Logged message analysis software developed by CAMP to process and generate a pass/fail report for verification
 - Generate SPaT and MAP messages in csv format for analysis and verification
 - Generate Google satellite view based detailed visualization of MAP message for visual verification of intersection geometry

Logged SPaT / MAP Message Payload in JSON



CI Testing & Conformity TF

Indicator

- Select up to 4 intersections for testing per agency:
 - Select intersection type:
 - Standard: 2 to 3 lanes, straight and turn movements
 - Moderately complex: 3 to 4 lanes, straight and turn movements, turn pockets
 - Complex: Moderately complex plus combination of protected and permissive movements, leading and lagging phase, actuated signal operation, etc.
- Message Logging:
 - Log messages for up to 10 minutes in stationary condition to get up to 5 complete cycles – Not required to drive through the intersection
 - If possible, conduct test during peak and off-peak time when different time plans are in effect

SPaT / MAP Message Capture, Analysis and Visualization



Log messages

- Separate SPaT and MAP for processing
- Process and generate analysis in CSV
- Generate summary reports
- Generate Visualization



Step 5 MAP Visualization

SPaT Analysis Report in CSV

- List of all required data elements (as per CI impl. guide)
- Message received timestamp for each message
- Computed time difference between:
 - consecutive message received by the receiver (OBU)
 - consecutive message generated by RSU (from controller SPaT data)
 - message received time (OBU) and generated time (RSU)
- Computed Min / Max end time remaining in current phase from time mark value for each signal group

Instrume								Test News	CD-T Marrie													
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SPaT Analysis Summary Report

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SPaT File:	SPaT - 20210	223-201422-	SPaT-0-155_5	Summary_Re	port.csv	#of Sig Grp:	2	Sig Groups:	[1, 2]					
Date & Tim	e 2021/02/23	- 20:14:27.45	66 (UTC)											
						M/O/C in	Pass/Fail	M/O/C in Cl	Pass/Fail	Invaid	Data Range	Data Range	Remark	
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name	=DE_Descripti	veName (only	y for debug)			0		0						
id=DF	_IntersectionR	eferenceID				м	Pass	м	Pass					
re	gion=DE_Road	RegulatorID				0		м	Fail		0	65535	Missing data	
id=	=DE_Intersection	onID				м	Pass	м	Pass		0	65535		
revisi	on=DE_MsgCo	unt				м	Pass	м	Pass	\sim	0	127		
status	s=DE_Intersect	ionStatusObj	ect			м	Pass	м	Fail	0	513	65532	Invalid or incorrect value	
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states	s=DF_Moveme	ntList=1 to 2	55 x DF_Move	ementState		м	Pass	м	Pass					
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sig	gnalGroup=DE_	SignalGroup	D			м	Pass	м	Pass		0	255		
sta	ate-time-speed	d=DF_Movem	entEventList			м	Pass	м	Pass					
	eventState=D	E_Movement	PhaseState			M	Pass	м	Pass					
	timing=DF_Ti	meChangeDe	tails			0		м	Pass					
	startTime=	DE_TimeMar	rk			0		С			0	36001	C-If available	
	minEndTin	ne=DE_TimeN	Mark			M	Pass	м	Pass		0	36001		
	maxEndTir	ne=DE_Timel	Mark			0		м	Pass		0	36001		
	likelyTime:	=DE_TimeMa	rk			0					0	36001		
	confidence	=DE_TimeInt	ervalConfider	nce		0					0	15		
	nextTime=	DE_TimeMar	k			0		с	Fail		0	36001	Missing data	
Notes:	Columns A-F	SPaT objects	as defined in	1 SAE J2735										
	Column G	M - Mandato	ory, O - Optio	nal, or C - Con	ditional obje	cts for SPaT as	defined in J	2735 specifica	ition					
	Column H	Pass (presen	t), Fail (abse	nt) or (Not	Applicable) f	or the objects	In SPaT mess	ages as per o	olumn G	(D11-01-	- 11 11			
	Column I	M - Mandato	ory, O - Optio	nal or C - Con	ditional obje	cts for SPaT as	defined in th	e Ci împleme	ntation Guide	tor RLVW ap	oplication			
	Column J	Pass (presen	t), Fall (abse	nt) or (Not	Applicable) f	or the objects	In SPall mess	ages as per o	olumn í					
	Column K	Invalid or inc	orrect data v	alue for the o	bject or the	alue is ouside	the range as	listed in colu	mns L and M					
	Column L	valid lowest	numeric data	a value as def	ined in J273	5. Blank Indicat	es - data fra	me or alphani	imeric object					
	Column M	Valid highest	t numeric dat	a value as de	fined in J273	5. Blank Indica	tes - data fra	me or alphan	umeric object					
	column N	Kemark												

MAP Analysis Summary Report

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MAP Message Visualization

SPaT / MAP Field Test	Participation (Second	AND A DECK OF A DECK		The state		•	Boint location
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	Мар	Satellite		Geographic			
Intersection Information				MAK		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
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)							E 1681
Lane Information and Associated Attributes		- de		E 1	Contraction of the second	and the second s	
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)						ana	- Alasa
4: NA, 1, NA in, 1d80:[3,4,5,7,8], vehicle, Yes 4000: 1 27; 1; 5 65.53m				E T			
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6: NA, 1, NA I in, Id80:[3,4,5,7,8], vehicle, Yes I 8000: ↑ I 20; ↑; 2 I 401.38m		以后在 在一些活动					1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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16: NA, 5, NA in, 1d80:[3,4,5,7,8], vehicle, Yes 8000: ↑ 25; ↑; 4 202.6m			States 1 States	AL	Elland		
17: NA, 5, NA in, 1d80:[3,4,5,7,8], vehicle, Yes c000: 11 20,26; 11; 7,7 201.64m		North North	0	tar al		1 M	A PARTY
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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 verification
- 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