

USDOT / ITE Connected Intersections (CI) Implementation

Connected Intersections (CI) Testing & Conformity Task Force

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SME - R. Roebuck (OmniAir) / M. Insignares (ConSysTec)

ITE/CI Testing and Conformity Tak Force - Field Validation Test

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

Validation Phase

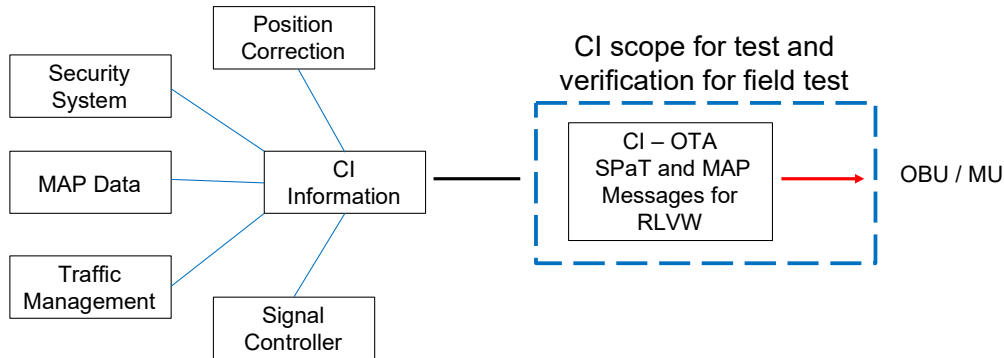
– Objectives

- Field verification/conformance of equipped intersections' Over-The-Air (OTA) broadcast of SPaT and MAP messages per CI Implementation Guide
- Feedback on CI Implementation Guide:
 - Requirements and the design details for broadcasting the SAE J2735 Signal Phase and Timing (SPaT) message, MAP message and RTCM message for position correction are unambiguous and complete for action by an in-vehicle Red-Light Violation Warning (RLVW) application
 - Requirements and the design details are implementable
 - What are the technical and institutional challenges/lessons learned in preparing a CI deployment

Validation Phase

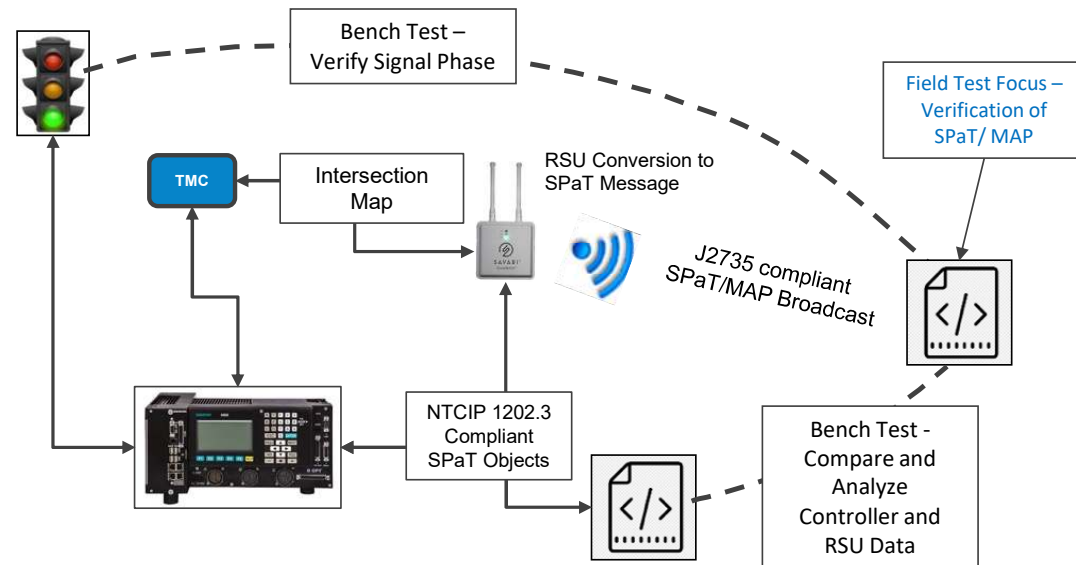
- Formed an Evaluation Subcommittee – Participating organizations + TF Leads
- Validation Sites (13 participants, 15 sites)
 - Caltrans, City & County of Denver, City of Anaheim, Clark County (WA), DriveOhio, Florida DOT, Georgia DOT, Maricopa County DOT, Panasonic, San Diego, University of Alberta, UMTRI, Utah DOT
- Meeting Weekly: Thursdays, 12 PM – 1 PM ET
 - April 29 through July 29
 - Discuss field test analysis and issues, provide guidance and report progress
- Validation field test data collection activities completed in July
- Field test analysis and results by end of August

CI Test Environment for Field Verification



Verification Scope:

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



Field Verification Steps

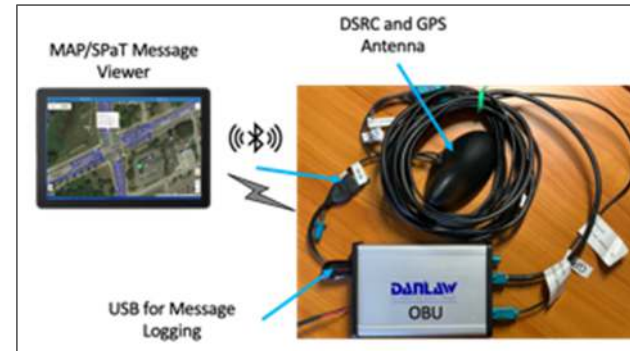
- Log broadcast SPaT/MAP messages from a connected intersection
- Parse and analyze logged messages for the content
- Verify all required data frames/elements are in the message as per the CI implementation guide for the RLVW application
- Verify the structure of data frames/elements as per the J2735 and the values are within the limits specified in J2735
- Generate analysis report for SPaT and MAP in .csv format
- Generate summary report indicating pass/fail for each data frame/elements
- Generate visualization of SPaT/MAP on google satellite view to visually verify the intersection MAP

Log Broadcast SPaT/MAP Messages of a CI



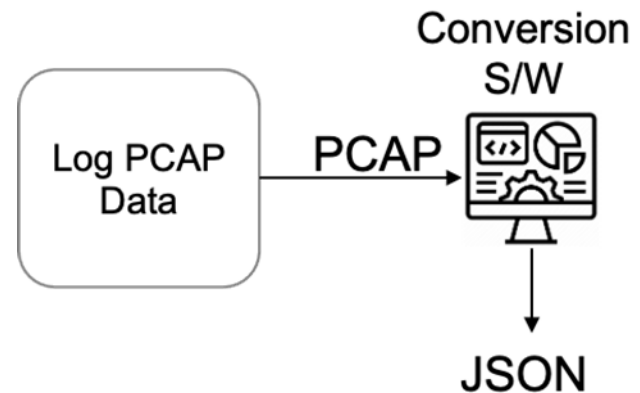
Test Vehicle

Option 1



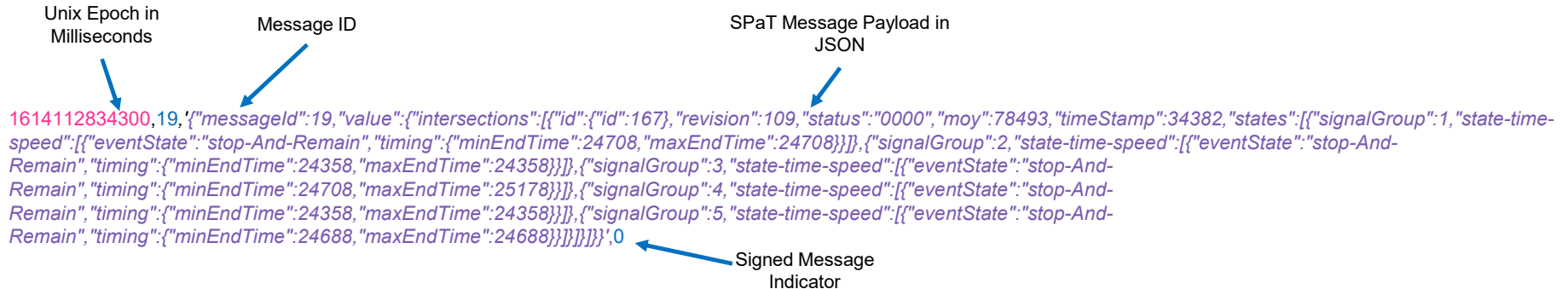
Direct SPaT/MAP Message Capture
in JSON using Kapsch Data
LoggingTool

Option 2

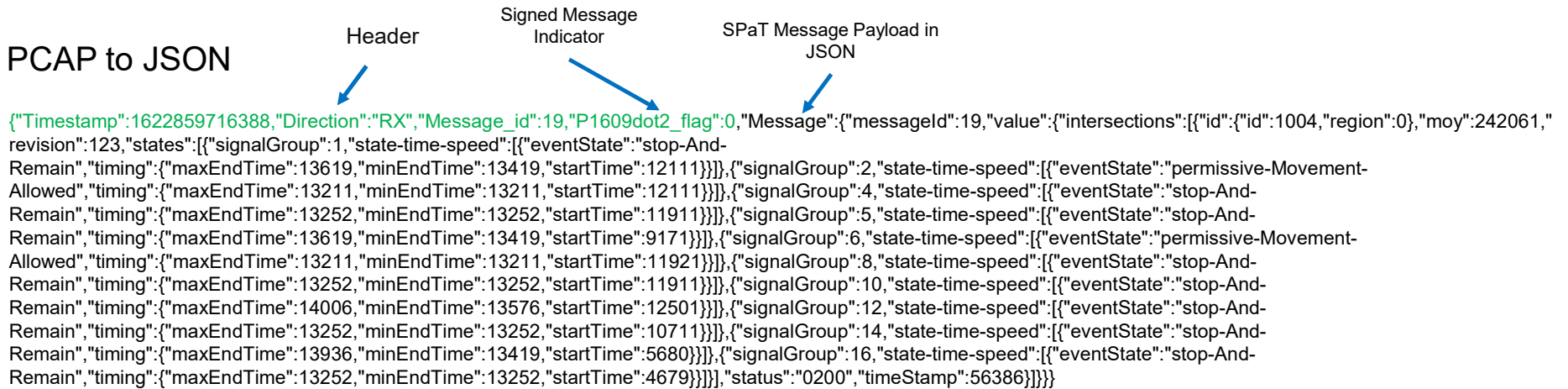


SPaT Message Payload in JSON

Direct Message Log in JSON using Kapsch Tool



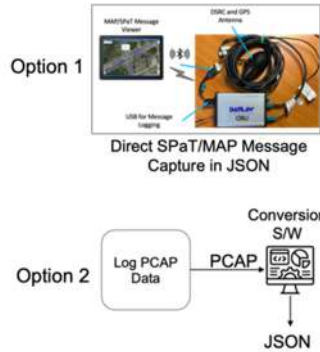
PCAP to JSON



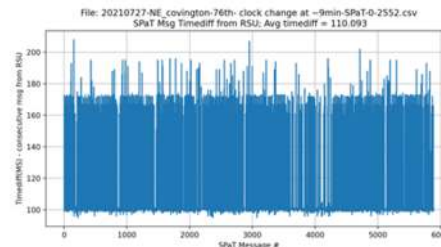
Field Test Data Logging, Analysis, Report and Visualization



Test Vehicle



Generate SPaT Analysis and Summary Reports in CSV



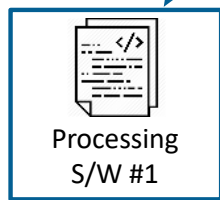
Step 5 – MAP/SPaT Message Visualization



Step 1
Log Field Test Data

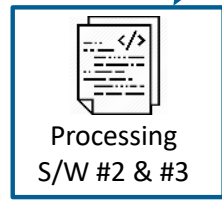


Step 2



SPaT in JSON

Step 3



Step 4



MAP Analysis and Summary Reports in CSV



Current Field Test and Analysis Status

Participants	Msg Log	# of Test Intersections	Remark
Caltrans	PCAP	4	Field test data in PCAP from 4 intersections.
City & County of Denver	PCAP	8	Field test files from 8 intersections. A second batch of data from the same traffic
City of Anaheim			
Clark County (WA)			
DriveOhio			capture
Florida DOT			
Georgia DOT			of being
Maricopa County			
Panasonic			
San Diego			and PCAP
Univ. of Alberta			
UMTRI	JSON	7 + 16 + 4	3 batches of field test data 8 different intersections plus initial test intersections
Utah DOT	PCAP	6	Filed test data from both DSRC and C-V2X equipped intersections in PCAP.
PlugFest – Mcity	PCAP+Kapsch	12	Received Test files in PCAP and Kapsch JSON, not yet processed

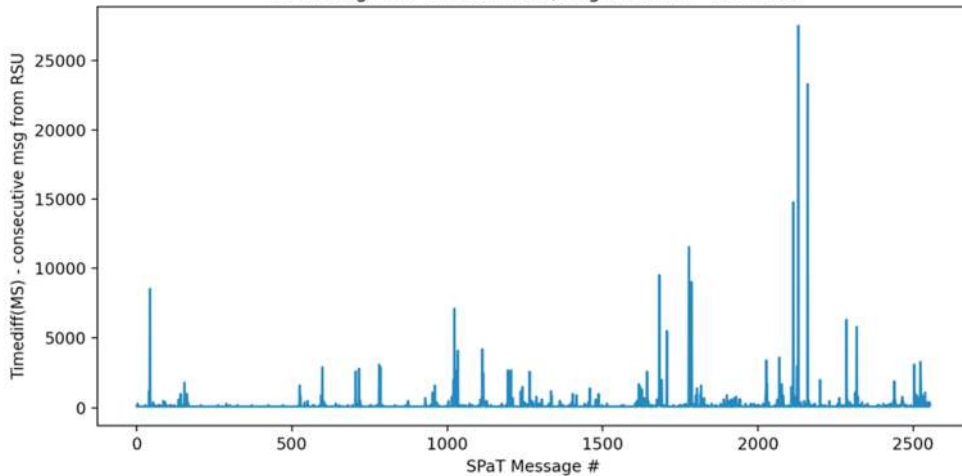
Processed and Analyzed Over 100 Field Test Data Files from 12 Sites

Observations from Field Test Analysis:

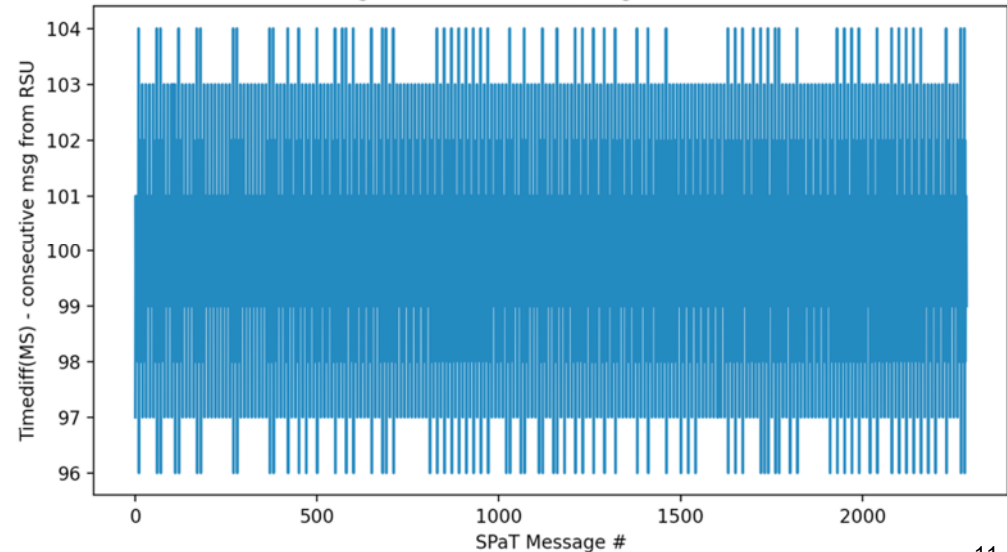
SPaT:

- Time diff between consecutive message from RSU not maintained at 100ms
- Difference in message timestamp generated by RSU and received by OBU timestamp
 - RSU and OBU clocks are not in synch
 - RSU message timestamp and OBU timestamp is used to compute message broadcast and receive time latencies and time remaining for min and max end times
- Need: Signal controller, RSU and OBU clocks in synch (GPS time source)
- Guidance Discussion: Actuated signal operation

File: c2p-01_Quebec-56th-20210511023558.pcap-55115-spat.csv
SPaT Msg Timediff from RSU; Avg time diff = 234.371



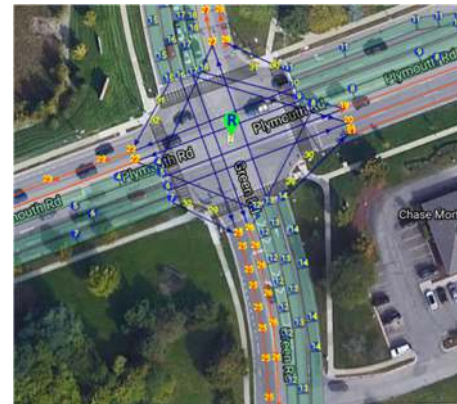
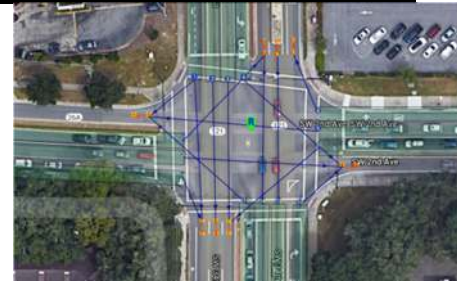
File: ecr_medical.rsu.tx-SPaT-0-1001.csv
SPaT Msg Timediff from RSU; Avg time diff = 99.916



Observations from Field Test Analysis/Visualization:

MAP Message Visualization:

- 1st node point in MAP extends well beyond the stop bar into the intersection / crosswalk
- Missing egress lane definition in MAP; ConnectsTo: lane id connects to itself
- Mapped lanes do not match the actual intersection geometry
 - Intersection is reconfigured since the MAP was generated
- Node points in reverse order
- ConnectsTo: Converging lanes (egress → egress and ingress → ingress)
- Guidance:
 - How to define speed limit at a lane level
 - CV PFS MAP Guidance Document



Next Steps:

- Validation field test data collection activities completed in July
- Field test analysis and result by end of August
- Results of the Field Data Analysis and Feedback will be used to finalize the CI Implementation Guide
 - Task Forces to meet in August if necessary
 - Proposed Draft Final distributed August 6
 - Approval by the CI Committee in mid-August
 - Publication by September 17
- Compile field test validation report
 - Tentative – end of Nov. 2021

Questions