Connected Intersections (CI) Committee Meeting

Mon Nov 16 (3:00 PM – 5:00 PM EST)

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. Project Schedule

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.

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, JMCRota
- Steve Sprouffske, Kapsch

Meeting Purpose and Objectives (Thai)

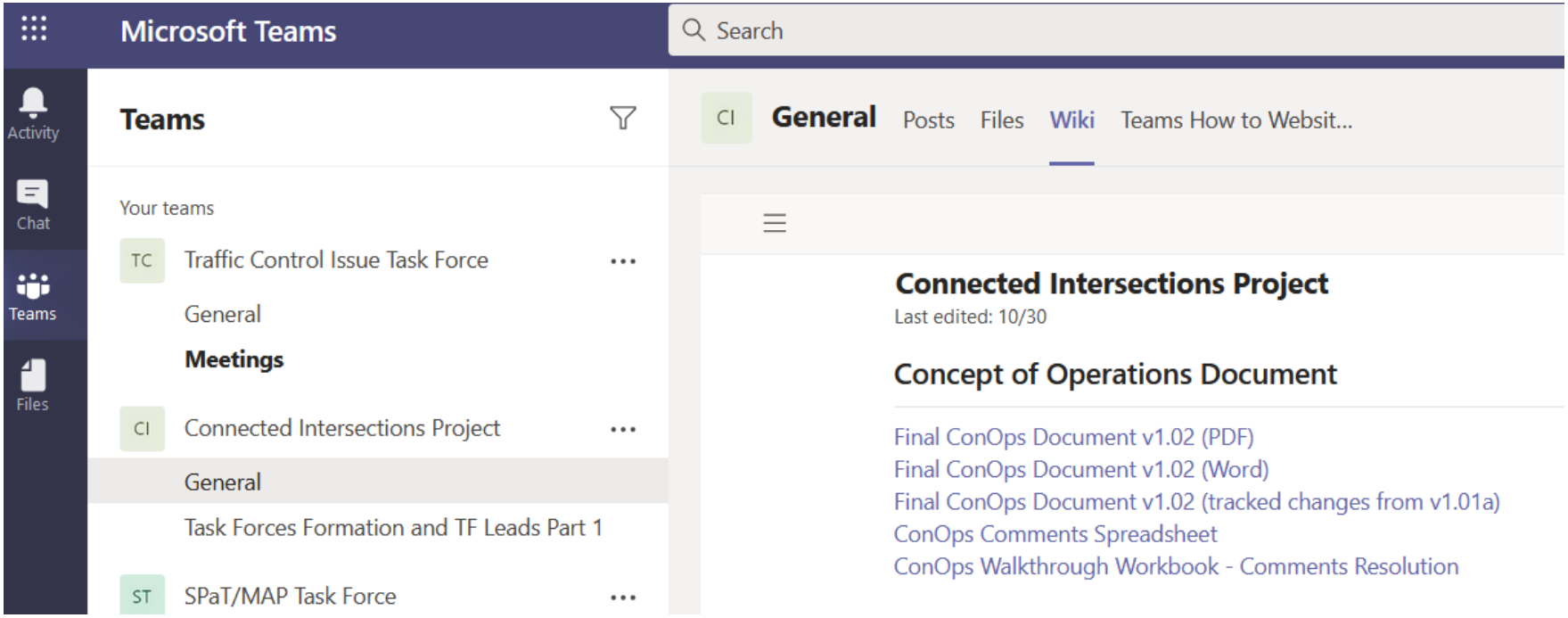
- Purpose:
  - Update the CI Committee on the progress
- Objectives
  - Present the draft Requirements document and the progress of each Task Force
  - Present the next steps

Progress To Date (Thai)

- Each Task Force meeting regularly
- Task Force Chairs and Subject Matter Experts (SMEs) meeting every Friday for progress and coordination
- Also coordinating with other projects
  - Connected Signalized Intersection Verification Project (CSIV)
    - Red Light Violation Warning (RLVW) Application Vehicle System
    - CVPFS Guidance Document for MAP Preparation

Progress To Date (Thai)

- Final ConOps document posted on Teams October 3
- First draft of requirements from each Task Force submitted Friday, November 13



Positioning Task Force

Justin McNew / Jim Misener (co-chairs)

Positioning Task Force

Achieved consensus on basic positioning requirements –

1. The RSU shall broadcast RTK per RTCM10403.3, and with Multiple Signals Messages (MSM) 7. In addition,

a. Station location message numbers 1005 or 1006 shall be transmitted.

b. The antenna and receiver description message 1033 shall be transmitted (per the RTCM recommendation).

c. The system parameter message 1013 shall be transmitted.

Note: Vehicles may use other sources of correction, e.g., PPP.

2. The RSU shall broadcast RTK to OBUs with sufficient range and frequency for vehicles to enable lane matching at a minimum of 10 sec prior to a vehicle reaching the intersection stop bar.

Note: In the CI system design, posted or prevailing speed limits are used to determine the necessary range and frequency (defined as interval between message) to broadcast RTK. Three RTK receptions are required to converge to accurate position.

(cont'd)

Positioning Task Force (cont'd)

3. The RTK broadcast shall be secure so the OBU can verify that the RTK messages are from a trusted source.

(Note to editor: Should be consolidated with or reference requirements from the Security TF.)

4. The RTCM reference station shall be close enough to the RSU to provide adequate accuracy and latency.

Note: RSU may have integrated RTCM capabilities, or the RTCM could be generated by a nearby station.

Work in Progress

- Quality requirements. Needs further discussion
- Effect of map accuracy. Lane matching is dependent on position accuracy and map accuracy/resolution.

Q & A

Security Task Force

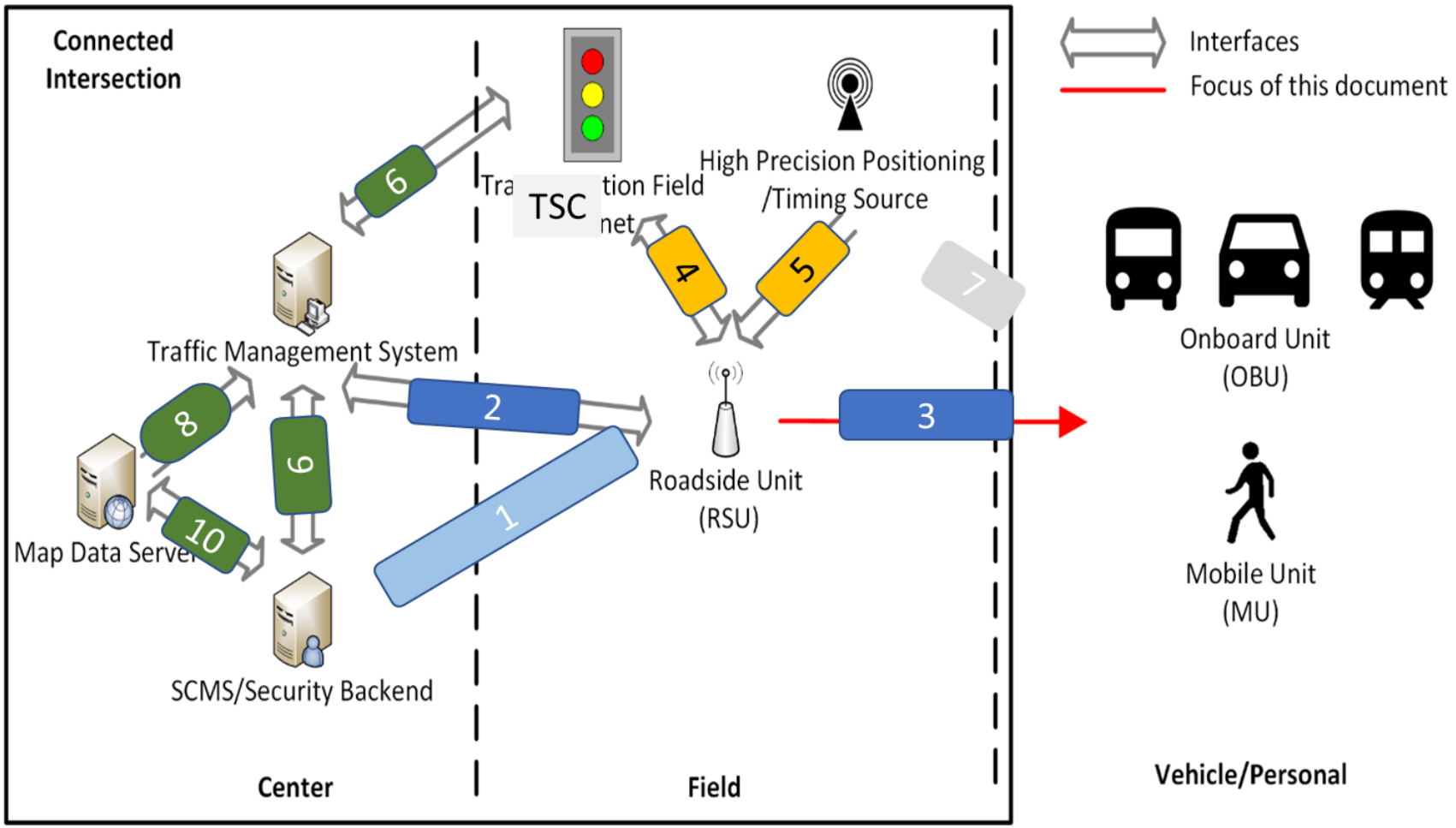
Jimmy Upton / William Whyte (co-chairs)

Security Task Force

Accomplishments since October Plenary Meeting

– Developed requirements material and submitted for integration

Interfaces


Connected Intersection
TSC
High Precision Positioning /Timing Source
Traffic Management System
Map Data Server
SCMS/Security Backend
Roadside Unit (RSU)
Onboard Unit (OBU)
Mobile Unit (MU)
Center
Field
Vehicle/Personal
Interfaces
Focus of this document
1
2
3
4
5
6
7
8
9
10

Security Task Force: Requirements

- Two levels of requirements: high-level and detailed
- High-level requirements follow on closely from user needs
- Detailed requirements identify protocols but not parameters to those protocols
- Design stage will solidify details of use for those protocols
- Example:
  - User need:
    - 2.4.3.1.1 Correct Operations / Data Trustworthiness: ensure that data sources are **trustworthy** and provide **correct data** for use in creating CI messages
    - 2.4.3.2.1 Data Flow / Data Trustworthiness: provide components with sufficient information to **evaluate trustworthiness** of received CI data
    - 2.4.3.2.2 Data Flow / Data Integrity: Ensure that CI **data is not corrupted** or changed as it passes across interfaces
  - High-level requirement
    - The interface between the RSU and TSC shall use a **secure transport protocol** with mutual **authentication** of the identity of both RSU and TSC in terms of ownership and authorization, and **integrity** and **confidentiality** protection of all data exchanged.
  - Detailed requirement
    - The interface between the RSU and TSC shall use a VPN or DTLS, with client certificate, where the server is the RSU. The VPN, if used, shall be based on IPSec or SSL/TLS.

Requirements on CI system as a whole

- The CI system has a responsibility to ensure that the data sent out by the RSU is correct
- This implies that the CI system must consider
  - Correct operation of all back-end systems
  - Correct software on the RSU
  - Correct configuration on the RSU
    - E.g. if configuration is wrong on RSU, RSU might map correct signal phase information to incorrect lanes
  - …
- To be trusted, a CI system must have mechanisms to give assurance that it is secure enough
  - What does “secure enough” mean?
  - Who determines it is “secure enough”?
  - Who signs off on that determination?

“Secure enough”: requirements

- The CI system shall implement mechanisms to ensure that commands or data sent to the RSU cannot result in the RSU sending SPaT messages that are inconsistent with SPaT data received from the TSC.
- The CI system shall implement mechanisms to ensure that commands or data sent to the TSC cannot result in it sending SPaT data to the RSU that is inconsistent with the actual signal behavior
- The CI system shall implement mechanisms to ensure that only correct MAP data is sent to the RSU for transmission

“Secure enough”: validation requirements

- The CI operator shall create a **compliance assessment** documentation indicating how the system trustworthiness and system security requirements are to be met. For example, this documentation shall include an attack tree with mitigations given for all identified attacks, showing:
  - All attack vectors and mitigations that might lead to the RSU transmitting incorrect SPaTs, and their mitigation.
  - All attack vectors and mitigations that might lead to the RSU transmitting incorrect MAPs, and their mitigation.
- A designated **point of certification** (compliance or certification laboratory, or (initially) self-certification) shall act as the point of **decision** whether this compliance assessment is complete and correct in **demonstrating network quality standards**, initially and periodically as per policy.
- **Criteria for completeness and correctness** of the documentation will be provided in the design document and may change over time.
  - The intent is that security documentation will be maintained by the Institute for Transportation Engineers or a future standards organization or authority charged with that responsibility, e.g. NIST, and communicated to the broader community

“Secure enough”: in summary

- “**Secure enough**” will be defined by policy
  - Initial definition will be in design document
  - The stakeholder community will need to identify a **stakeholder group** to maintain the **definition of “secure enough**” for CIs
- **Validation process** will be defined by policy
  - Initial definition will be in design document
    - CI operators will be asked to provide security documentation and attest that it is true
    - Open question: is there any third-party review?
  - The stakeholder community will need to identify a **stakeholder group** to maintain the **validation process**
    - Over time there may be a need for penetration testing / auditing / third-party certification activities
- **Enforcement process** will be defined by policy
  - Will *not* be in design document
  - What are consequences for not being secure enough?
    - Not getting certificates for RSU / MAP signer?
  - What level of responsibility is on SCMS provider to check documentation?

Q & A

Testing/Conformity Task Force

Jay Parikh / Christina Spindler (co-chairs)

Minimum Agency Expectations from Testing

1. The RSU is broadcasting what the controller is doing accurately and in a timely manner.
2. The RSU has a failsafe operation for the following situations:
   - There is a conflict between what the controller is displaying and what the RSU is broadcasting
   - Security credentials are missing or compromised
3. The MAP data is broadcast correctly.

Test Case Development Process

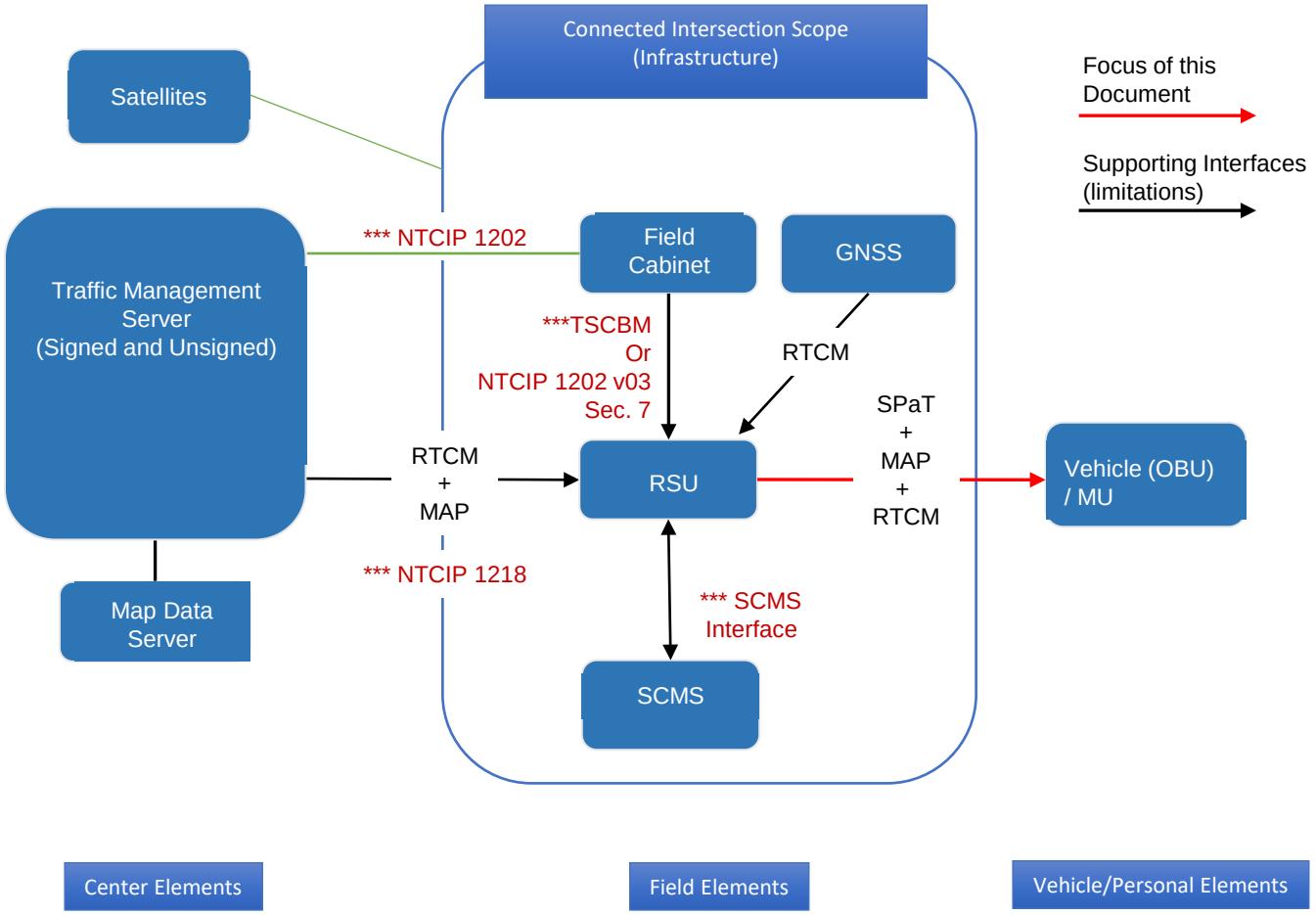
1. The T&C TF have been prototyping (with examples) what the test case development process:
   - To set expectations and provide clarity about the role of test cases and test procedures.
   - To fulfill the testing role as part of the Systems Engineering Process.
   - To provide a basis for discussion and guidance.

CI Testing Scope

In Scope Interfaces

1. **SPaT**
2. **MAP**
3. **RTCM**

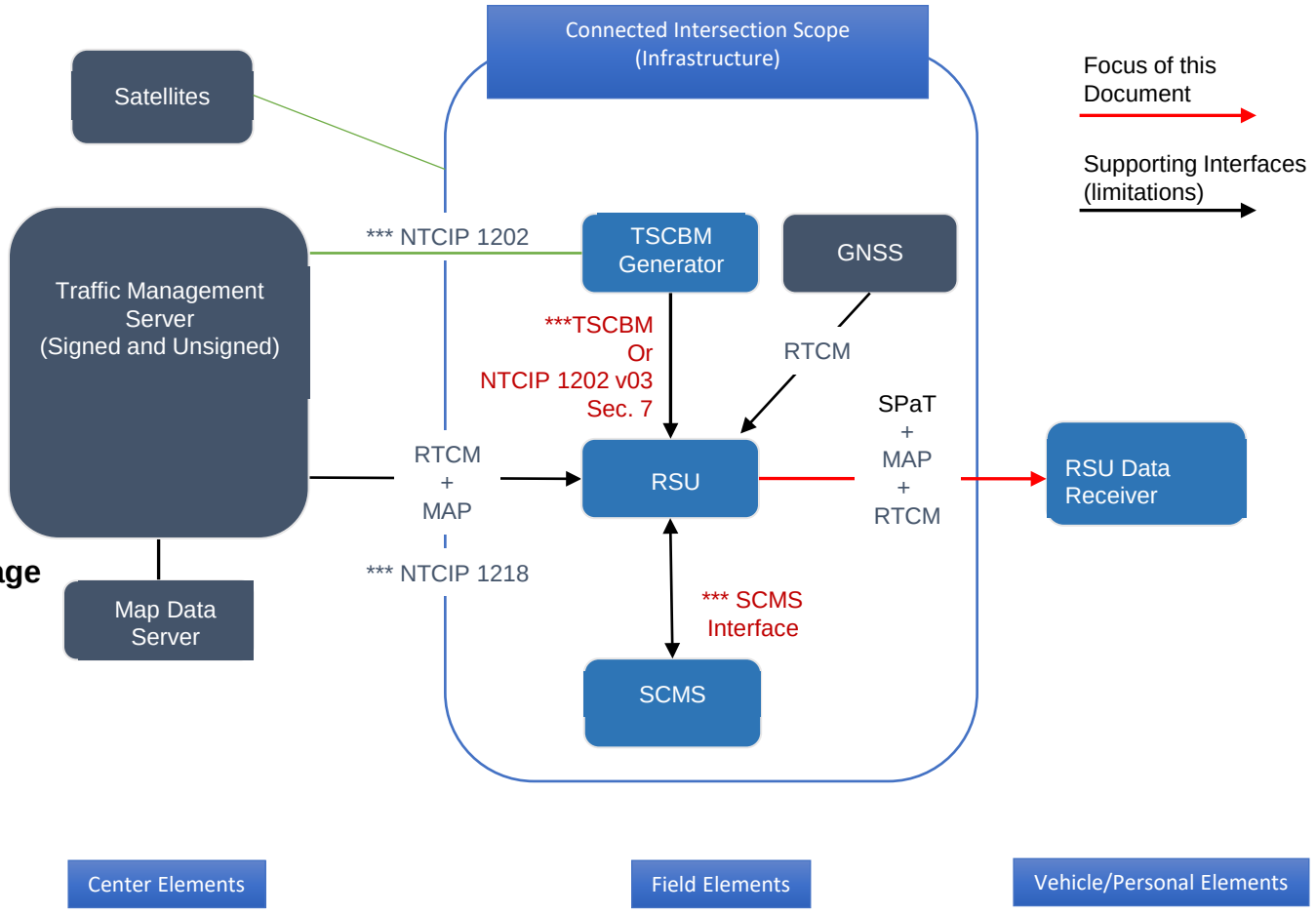
*** Indicates limited to what is minimally necessary to accomplish testing.



CI Testing Scope – SPaT Test Cases

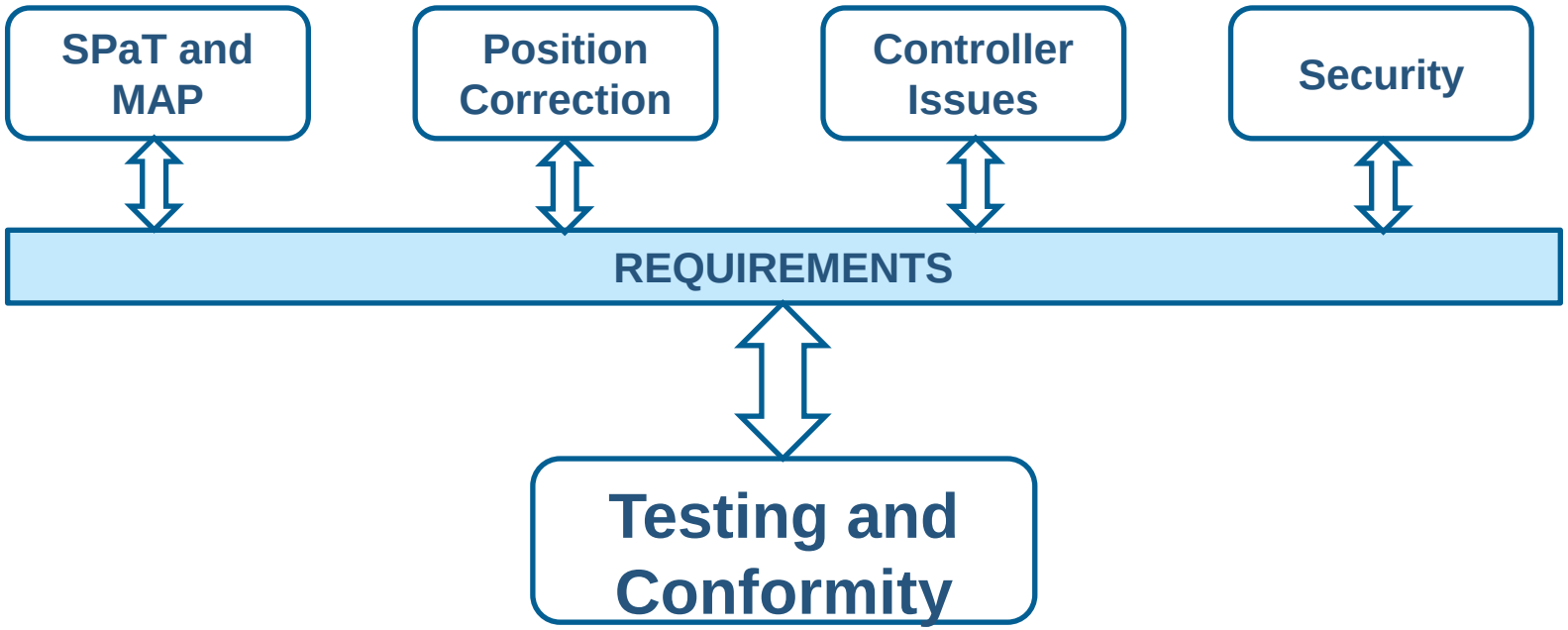
In Scope Interfaces
1. SPaT
2. MAP
3. RTCM -

*** Indicates limited to what is minimally necessary to accomplish testing.



TSCBM - Traffic Signal Controller Broadcast Message
SCMS – Security Credential Management System
GNSS – Global Navigation Satellite System
RSU – Roadside Unit
RTCM – (Radio Technical Commission For Maritime Services) Corrections Message
SPaT – Signal Phase and Timing
MAP – Intersection geometry, associated maneuvers and signal groups

Test Case Development



- Develop test cases
  - Interfaces for testing
  - Refine test cases
  - Update test cases

Test Case Goals

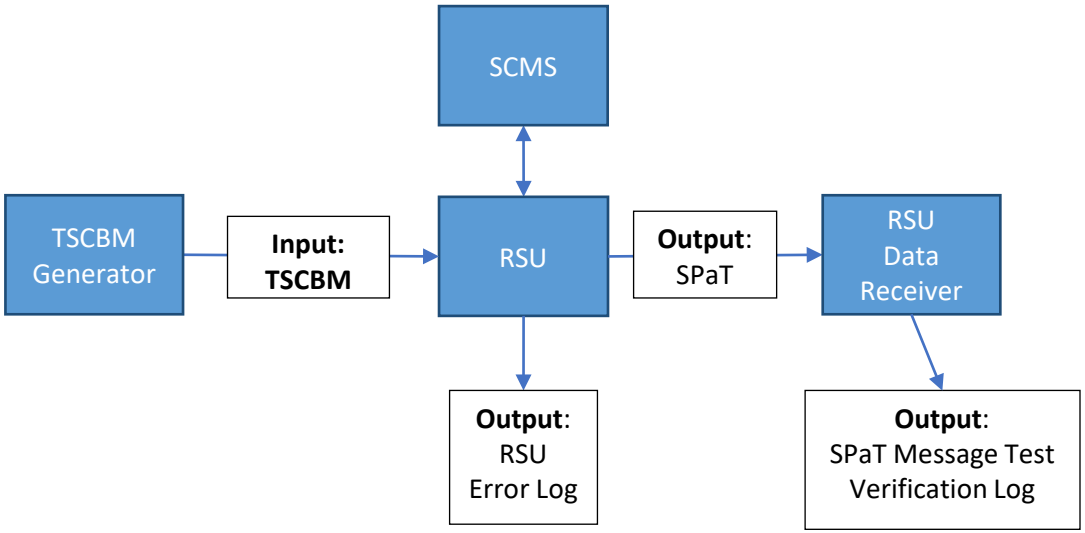
- Clearly identify CI requirements to be tested and traceability to test cases.
- Test cases identify the data (inputs/outputs) that test engineers will need to verify that a test passes or fails.
- We have identified 3 broad categories of Test Cases:
  - Message Level Tests (conformance to standard)
  - Data Stream Capture Tests (correctness of data elements in message)
  - Reference Implementation Tests

Test Case Development Process

1. Identify Interfaces to Test
2. Identify which requirements to test
   - Inspect the interfaces.
3. Refinements: This is an iterative process
   - Make an assessment of each requirement to test.
   - Make adjustments to the requirements if they are not testable.
   - Make adjustments to test cases of add test cases as necessary.
4. Update Requirements to Test Case Traceability Matrix

1. Identify interfaces to Test

SPaT Message Level Testing – Positive and Negative Testing



TC Purpose: Conduct Positive and Negative testing.

Objectives to verify:

1. **RSU broadcasts only valid TSCBM inputs.**
2. **SPaT Messages broadcast are correct.**
3. **RSU does not broadcast TSCBM inputs with missing data.**
4. **RSU does not broadcast TSCBM inputs with incorrect data.**
5. **RSU does not broadcast when it has invalid certificates.**
6. **(Optional) Any SPaT not broadcast is accounted for in the RSU Error Log.**

Any item labeled with Input: or Output: must include a reference to a data specification to be included as an appendix of the test cases document.

2. Identify Requirements to Test

Table 2. CI SPaT Message Level Test Cases - Requirements to be Tested

Needs to Requirements Traceability Matrix (NRTM)						
User Need ID	**User Need**	**FR ID**	**Functional Requirement**	**Conformance**	**Support**	**Additional Specifications**
2.4.2	Messages					
2.4.2.1	Message Performance Needs					
2.4.2.1.1	Uniform			M	Yes	
		3.3.2.1.1.1	SPaT - SAE J2735	M	Yes	
		3.3.2.1.1.2	SPaT - Mandatory Data Elements	M	Yes	
		3.3.2.1.1.3	SPaT - Required Data Elements	M	Yes	
		3.3.2.1.1.4	SPaT - Optional Data Elements	M	Yes	
		3.3.2.1.1.5	SPaT PSID	M	Yes	
2.4.2.1.6	Timeliness			M	Yes	
		3.3.2.1.6.1	SPaT - Broadcast Frequency	M	Yes	
		3.3.2.1.6.2	SPaT - Broadcast Latency	M	Yes	
2.4.2.2	Generic Message Data Needs					
2.4.2.2.1	Time Source			M	Yes	

3. Refinements

- Make an assessment of each requirement.
- Requirements may need to be adjusted, if not testable.
- Refine or add test cases if necessary.

Table 2. CI SPaT Message Level Test Cases - Requirements to Test Case Traceability Analysis

Req Id	Comment	TC-SPaT-Valid-1	TC-SPaT-Invalid-1	TC-SPaT-Invalid-2
3.3.2.1.1.1		Yes		
3.3.2.1.1.2		Yes		
3.3.2.1.1.3		Yes		
3.3.2.1.1.4	Ambiguous requirement. We can test a 'shall' statement but not a 'may' statement.			
3.3.2.1.1.5		Yes		
3.3.2.1.6.1	This is performance requirement. Create an additional test case.	No		
3.3.2.1.6.2	This is performance requirement. Create an additional test case.	No		
3.3.2.2.1	This is performance requirement. Create an additional test case.	No		
3.3.2.2.2.1		Yes		
3.3.2.2.2.2	Duplicate messages do not increment. Create an additional test case.	No		
3.3.2.2.3.1	moy=DE_MinuteOfTheYear	Yes		

Example Test Case

Test Case	
ID: TC-SPaT-Valid-1	Title: SPaT (Positive Test Case)
Objective:	The test case verifies that a SPaT message is correct. Input and output specifications are provided to verify the message structure and content.
Inputs:	TSCBM (Positive Test Case) has passed with all data verified to be correct.
Expected Outcome(s):	All SPaT data and message structure are verified as correct, including: structure of data, and valid value of data content.
Feature Pass/Fail Criteria:	Pass: Outcome is verified. Fail: Otherwise.
Preconditions:	The input TSCBM message is verified to be correct. SCMS is operational. RSU has valid certificates.

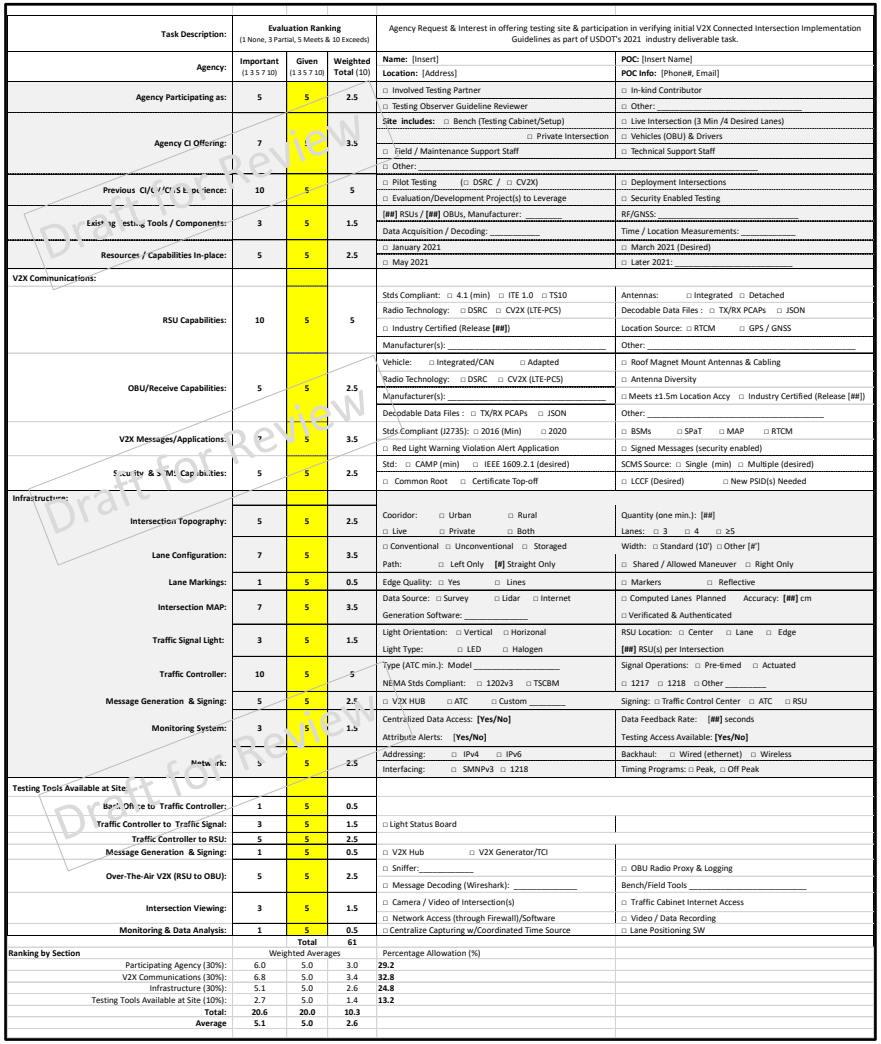
Fie

Task Description:	Agency Request & Interest in offering testing site & participation in verifying initial V2X Connected Intersection Implementation Guidelines as part of USDOT's 2021 industry deliverable task.	
Agency:	**Name:** [Insert]	**POC:** [Insert Name]
	Location: [Address]	**POC Info:** [Phone#, Email]
Agency Participating as:	□ Involved Testing Partner	□ In-kind Contributor
	□ Testing Observer Guideline Reviewer	□ Other: _____
Agency CI Offering:	**Site includes:** □ Bench (Testing Cabinet/Setup)	□ Live Intersection (3 Min /4 Desired Lanes)
	□ Private Intersection	□ Vehicles (OBU) & Drivers
	□ Field / Maintenance Support Staff	□ Technical Support Staff
	□ Other: _____	
Previous CI/CV/CITS Experience:	□ Pilot Testing (□ DSRC / □ CV2X)	□ Deployment Intersections
	□ Evaluation/Development Project(s) to Leverage	□ Security Enabled Testing
Existing Testing Tools / Components:	**[##]** RSUs / **[##]** OBUs, Manufacturer: _____	RF/GNSS: _____
	Data Acquisition / Decoding: _____	Time / Location Measurements: _____
Resources / Capabilities In-place:	□ January 2021	□ March 2021
	□ May 2021	□ Later 2021: _____
Additional Comments:		
V2X Communications:		
RSU Capabilities:	Stds Compliant: □ 4.1 (min) □ ITE 1.0 □ TS10	Antennas: □ Integrated □ Detached
	Radio Technology: □ DSRC □ CV2X (LTE-PC5)	Decodable Data Files : □ TX/RX PCAPs □ JSON
	□ Industry Certified (Release **[##]**)	Location Source: □ RTCM □ GPS / GNSS
	Manufacturer(s): _____	Other: _____
OBU Capabilities:	Vehicle: □ Integrated/CAN □ Adapted	□ Roof Magnet Mount Antennas & Cabling
	Radio Technology: □ DSRC □ CV2X (LTE-PC5)	□ Antenna Diversity
	Manufacturer(s): _____	□ Meets ±1.5m Location Accy □ Industry Certified (Release [##])
	Decodable Data Files : □ TX/RX PCAPs □ JSON	Other: _____
V2X Messages/Applications:	Stds Compliant (J2735): □ 2016 (Min) □ 2020	□ BSMs □ SPaT □ MAP □ RTCM
	□ Red Light Warning Violation Alert Application	□ Signed Messages (security enabled)
Security & SCMS Capabilities:	Std: □ CAMP (min) □ IEEE 1609.2.1 (desired)	SCMS Source: □ Single (min) □ Multiple (desired)
	□ Common Root □ Certificate Top-off	□ LCCF (Desired) □ New PSID(s) Needed

Infrastructure:		
Intersection Topography:	Corridor: □ Urban □ Rural □ Live □ Private □ Both	Quantity (one min.): [##] Lanes: □ 3 □ 4 □ ≥5
Lane Configuration:	□ Conventional □ Unconventional □ Storaged Path: □ Left Only **[#]** Straight Only	Width: □ Standard (10') □ Other [#'] □ Shared / Allowed Maneuver □ Right Only
Lane Markings:	Edge Quality: □ Yes □ Lines	□ Markers □ Reflective
Intersection MAP:	Data Source: □ Survey □ Lidar □ Internet Generation Software: _____	□ Computed Lanes Planned Accuracy: **[##]** cm □ Verificated & Authenticated
Traffic Signal Light:	Light Orientation: □ Vertical □ Horizonal Light Type: □ LED □ Halogen	Location: □ Center □ Lane □ Edge **[##]** RSU(s) per Intersection
Traffic Controller:	Type (ATC min.): Model _____ NEMA Stds Compliant: □ 1202v3 □ TSCBM	Signal Operations: □ Pre-timed □ Actuated □ 1217 □ 1218 □ Other _____
Message Generation & Signing:	□ V2X HUB □ ATC □ Custom _____	Signing: □ Traffic Control Center □ ATC □ RSU
Monitoring System:	Centralized Data Access: **[Yes/No]** Attribute Alerts: [**Yes/No]**	Data Feedback Rate: [**##]** seconds Testing Access Available: **[Yes/No]**
Network:	Addressing: □ IPv4 □ IPv6 Interfacing: □ SMNPv3 □ 1218	Backhaul: □ Wired (ethernet) □ Wireless Timing Programs: □ Peak, □ Off Peak
Additional Comments:		
Testing Tools Available at Site:		
Back Office to Traffic Controller:		
Traffic Controller to Traffic Signal:	□ Light Status Board	
Traffic Controller to RSU:		
Message Generation & Signing:	□ V2X Hub □ V2X Generator/TCI	
Over-The-Air V2X (RSU to OBU):	□ Sniffer:_____ □ Message Decoding (Wireshark): _____	□ OBU Radio Proxy & Logging Bench/Field Tools _____
Intersection Viewing:	□ Camera / Video of Intersection(s) □ Network Access (through Firewall)/Software	□ Traffic Cabinet Internet Access □ Video / Data Recording
Monitoring & Data Analysis:	□ Centralize Capturing w/Coordinated Time Source	□ Lane Positioning SW

Importance Rankings - Field Test Site for Agency

- Agency Assessment Criteria for Field Test Readiness
  Do Not Expect All Desires Met
- Both Field Test Site Criteria and Importance Rankings Forms
  Reviewed by Other Task Forces
- Cover Letter being Generated to Agencies for Participating in Testing Evaluation/Conformance Task
- Investigating Saxton Laboratory Equipment & Test Tools Loan Program whether it can be leveraged & beneficial.



Task Description:	Evaluation Ranking (1 None, 3 Partial, 5 Meets & 10 Exceeds)			Agency Request & Interest in offering testing site & participation in verifying initial V2X Connected Intersection Implementation Guidelines as part of USDOT's 2021 industry deliverable task.	
Agency:	Important (1 3 5 7 10)	Given (1 3 5 7 10)	Weighted Total (10)	**Name:** [Insert] **Location:** [Address]	**POC:** [Insert Name] **POC Info:** [Phone#, Email]
Agency Participating as:	5	5	2.5	□ Involved Testing Partner	□ In-kind Contributor
				□ Testing Observer Guideline Reviewer	□ Other: _____
Agency CI Offering:	7	5	3.5	**Site includes:** □ Bench (Testing Cabinet/Setup)	□ Live Intersection (3 Min /4 Desired Lanes)
				□ Private Intersection	□ Vehicles (OBU) & Drivers
				□ Field / Maintenance Support Staff	□ Technical Support Staff
				□ Other: _____	
Previous CI/[illegible] Experience:	10	5	5	□ Pilot Testing (□ DSRC / □ CV2X)	□ Deployment Intersections
				□ Evaluation/Development Project(s) to Leverage	□ Security Enabled Testing
Existing Testing Tools / Components:	3	5	1.5	[##] RSUs / [##] OBUs, Manufacturer: _____	RF/GNSS: _____
				Data Acquisition / Decoding: _____	Time / Location Measurements: _____
Resources / Capabilities In-place:	5	5	2.5	□ January 2021	□ March 2021 (Desired)
				□ May 2021	□ Later 2021: _____
V2X Communications:					
RSU Capabilities:	10	5	5	Stds Compliant: □ 4.1 (min) □ ITE 1.0 □ TS10	Antennas: □ Integrated □ Detached
				Radio Technology: □ DSRC □ CV2X (LTE-PCS)	Decodable Data Files : □ TX/RX PCAPs □ JSON
				□ Industry Certified (Release [##])	Location Source: □ RTCM □ GPS / GNSS
				Manufacturer(s): _____	Other: _____
OBU/Receive Capabilities:	5	5	2.5	Vehicle: □ Integrated/CAN □ Adapted	□ Roof Magnet Mount Antennas & Cabling
				Radio Technology: □ DSRC □ CV2X (LTE-PCS)	□ Antenna Diversity
				Manufacturer(s): _____	□ Meets ±1.5m Location Accy □ Industry Certified (Release [##])
				Decodable Data Files : □ TX/RX PCAPs □ JSON	Other: _____
V2X Messages/Applications:	7	5	3.5	Stds Compliant (J2735): □ 2016 (Min) □ 2020	□ BSMs □ SPaT □ MAP □ RTCM
				□ Red Light Warning Violation Alert Application	□ Signed Messages (security enabled)
Security & SCMS Capabilities:	5	5	2.5	Std: □ CAMP (min) □ IEEE 1609.2.1 (desired)	SCMS Source: □ Single (min) □ Multiple (desired)
				□ Common Root □ Certificate Top-off	□ LCCF (Desired) □ New PSID(s) Needed
Infrastructure:					
Intersection Topography:	5	5	2.5	Cooridor: □ Urban □ Rural	Quantity (one min.): [##]
				□ Live □ Private □ Both	Lanes: □ 3 □ 4 □ ≥5
Lane Configuration:	7	5	3.5	□ Conventional □ Unconventional □ Storaged	Width: □ Standard (10') □ Other [#']
				Path: □ Left Only [#] Straight Only	□ Shared / Allowed Maneuver □ Right Only
Lane Markings:	1	5	0.5	Edge Quality: □ Yes □ Lines	□ Markers □ Reflective
Intersection MAP:	7	5	3.5	Data Source: □ Survey □ Lidar □ Internet	□ Computed Lanes Planned Accuracy: [##] cm
				Generation Software: _____	□ Verificated & Authenticated
Traffic Signal Light:	3	5	1.5	Light Orientation: □ Vertical □ Horizonal	RSU Location: □ Center □ Lane □ Edge
				Light Type: □ LED □ Halogen	[##] RSU(s) per Intersection
Traffic Controller:	10	5	5	Type (ATC min.): Model _____	Signal Operations: □ Pre-timed □ Actuated
				NEMA Stds Compliant: □ 1202v3 □ TSCBM	□ 1217 □ 1218 □ Other _____
Message Generation & Signing:	5	5	2.5	□ V2X HUB □ ATC □ Custom _____	Signing: □ Traffic Control Center □ ATC □ RSU
Monitoring System:	3	5	1.5	Centralized Data Access: [Yes/No]	Data Feedback Rate: [##] seconds
				Attribute Alerts: [Yes/No]	Testing Access Available: [Yes/No]
Network:	5	5	2.5	Addressing: □ IPv4 □ IPv6	Backhaul: □ Wired (ethernet) □ Wireless
				Interfacing: □ SNMPv3 □ 1218	Timing Programs: □ Peak, □ Off Peak
Testing Tools Available at Site					
Bench Office to Traffic Controller:	1	5	0.5		
Traffic Controller to Traffic Signal:	3	5	1.5	□ Light Status Board	
Traffic Controller to RSU:	5	5	2.5		
Message Generation & Signing:	1	5	0.5	□ V2X Hub □ V2X Generator/TCI	
Over-The-Air V2X (RSU to OBU):	5	5	2.5	□ Sniffer:_____	□ OBU Radio Proxy & Logging
				□ Message Decoding (Wireshark): _____	Bench/Field Tools _____
Intersection Viewing:	3	5	1.5	□ Camera / Video of Intersection(s)	□ Traffic Cabinet Internet Access
				□ Network Access (through Firewall)/Software	□ Video / Data Recording
Monitoring & Data Analysis:	1	5	0.5	□ Centralize Capturing w/Coordinated Time Source	□ Lane Positioning SW
		Total	61		
Ranking by Section	Weighted Averages			Percentage Allowation (%)	
Participating Agency (30%):	6.0	5.0	3.0	**29.2**	
V2X Communications (30%):	6.8	5.0	3.4	**32.8**	
Infrastructure (30%):	5.1	5.0	2.6	**24.8**	
Testing Tools Available at Site (10%):	2.7	5.0	1.4	**13.2**	
Total:	**20.6**	**20.0**	**10.3**		
Average	**5.1**	**5.0**	**2.6**		

Q & A

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
  - Resolving gaps and ambiguities that have already occurred
  - Identifying and documenting traffic operational scenarios that are potentially problematic
  - Make recommendations, identify needs, develop requirements, and specifying design to provide SPaT data in a consistent manner across TSC manufacturers

Traffic Controller Issues Task Force

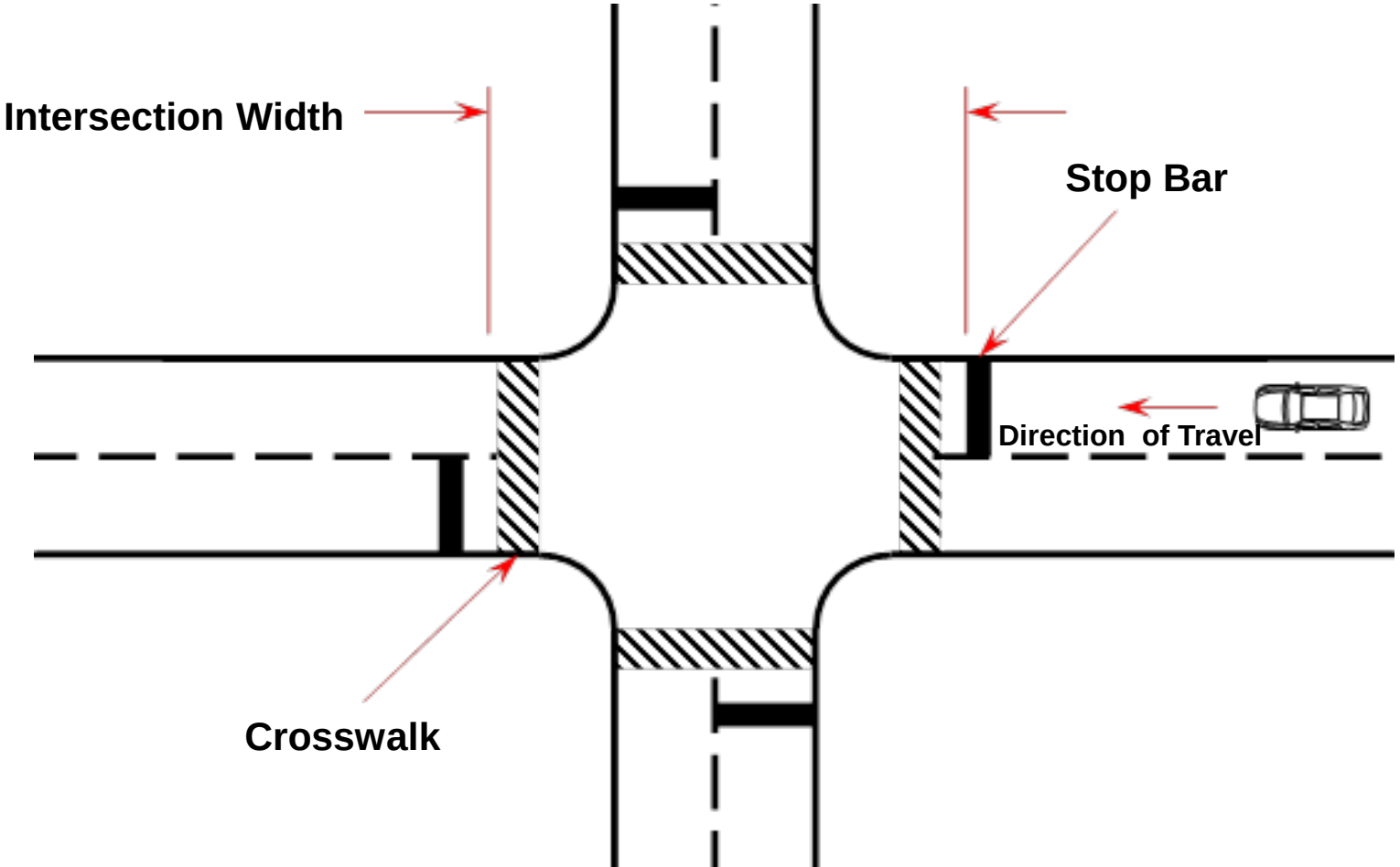
1. Accomplishments since October Plenary Meeting
2. Red Light Violation Warning (RLVW)
3. Developed Draft Requirements
4. Next Steps
5. Q&A

Accomplishments since the October Plenary Meeting

- Held 4 Task Force Meetings
- Held 2 Manufacturers Subcommittee Meetings
- Analyzed signal timing effects of RLVW application
- Developed Requirements from the work of the TCI Task Force

Red Light Violation Warning (RLVW)

– Based on RLVW document, the need is to provide an alert so the driver may clear the intersection while in yellow



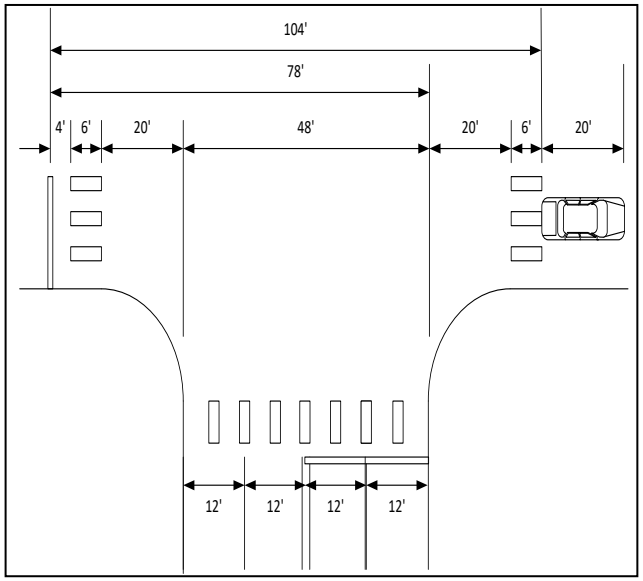
Red Light Violation Warning (RLVW) (cont.)

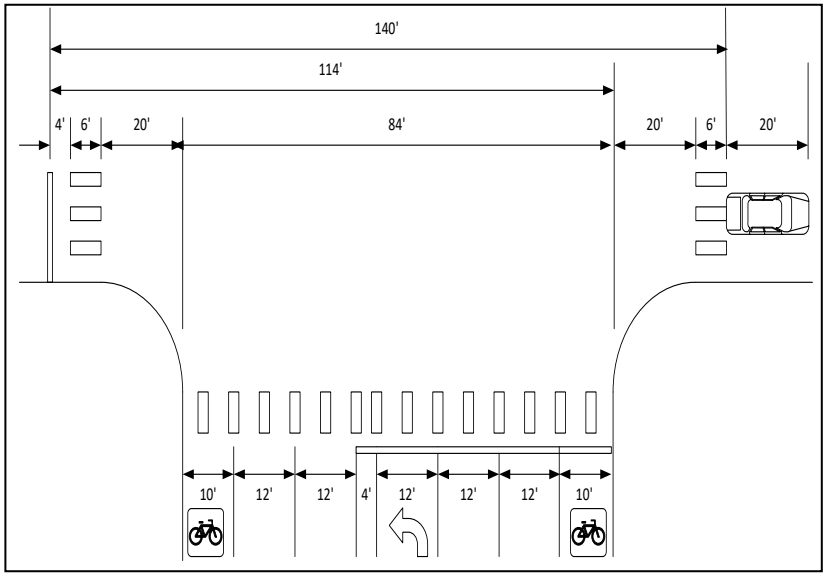
- Assured Green Time (AGT) replacing previous term Advanced Warning End of Green (AWEG)
  - Unless in fixed time operation, controllers provide a range for the end of green where minEndTime < maxEndTime
  - AGT identifies the condition where minEndTime = maxEndTime
- RLVW application based on yellow change interval time + AGT will provide time for drivers to:
  - Stop before entering the intersection or
  - Enter and clear intersection while signal is in yellow
  - Exception – Large intersections with slow speeds

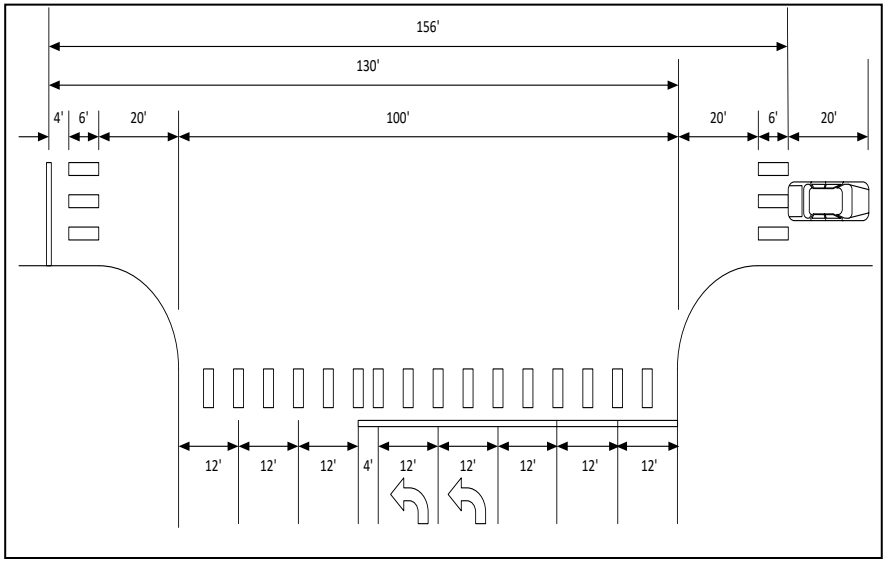
Red Light Violation Warning (RLVW) (cont.)

- Red Light Violation Warning (RLVW) Application Vehicle System Concept of Operations
  - Being developed by Crash Avoidance Metrics Partnership (CAMP)
- Signal Timing Effects of RLVW Application (see following slides)

Intersection Configurations Examined



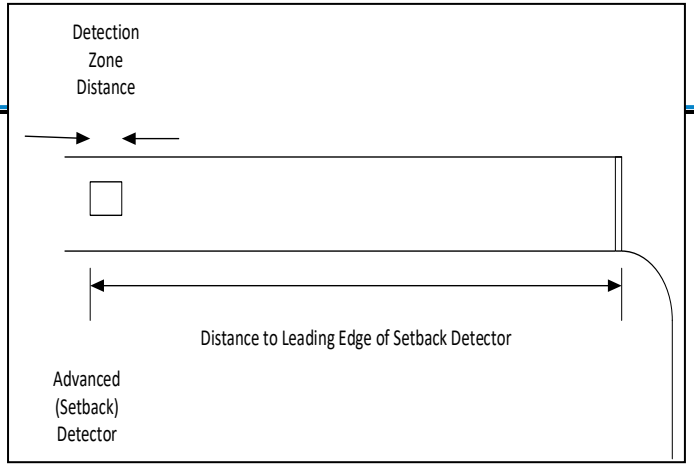




Assured Green Time – No Detection

		No Detection - No All-Red				No Detection - with All-Red			
Speed (mph)	Intersection "Box" Width	MAT	Yellow	All-Red	Assured Green Time	MAT	Yellow	All-Red*	Assured Green Time
35	104	6.1	3.6	0	2.5	6.1	3.6	1.5	1
	140	6.8	3.6	0	3.2	6.8	3.6	1.5	1.7
	156	7.1	3.6	0	3.5	7.1	3.6	1.5	2
40	104	6.2	3.9	0	2.3	6.2	3.9	1.2	1.1
	140	6.8	3.9	0	2.9	6.8	3.9	1.2	1.7
	156	7	3.9	0	3.1	7	3.9	1.2	1.9
45	104	6.3	4.3	0	2	6.3	4.3	1	1
	140	6.9	4.3	0	2.6	6.9	4.3	1	1.6
	156	7.1	4.3	0	2.8	7.1	4.3	1	1.8
50	104	6.4	4.7	0	1.7	6.4	4.7	0.8	0.9
	140	6.9	4.7	0	2.2	6.9	4.7	0.8	1.4
	156	7.1	4.7	0	2.4	7.1	4.7	0.8	1.6
55	104	6.7	5	0	1.7	6.7	5	0.6	1.1
	140	7.1	5	0	2.1	7.1	5	0.6	1.5
	156	7.3	5	0	2.3	7.3	5	0.6	1.7

CV Extension Call – Advance Detection



			Without All-Red Interval								With All-Red Interval								
Speed (mph)	Intersection "Box" Width	Distance to Leading Edge of Setback Detector	Time Occupied Detection Zone	Vehicle Extension*	Time Yellow Starts**	All-Red Interval***	Total Available Clearance Time	Distance to Clear Box from Detector	Travel Time from Detector to Clear Box	CV Extension Request	Distance to Leading Edge of Setback Detector	Time Occupied Detection Zone	Vehicle Extension*	Time Yellow Starts**	All-Red Interval***	Total Available Clearance Time	Distance to Clear Box from Detector	Travel Time from Detector to Clear Box	CV Extension Request
35	104	285	0.6	2.6	3.6	0	6.8	389	7.6	0.8	285	0.6	2.6	3.6	1.5	8.3	389	7.6	NA
	140	285	0.6	2.6	3.6	0	6.8	425	8.3	1.5	285	0.6	2.6	3.6	1.5	8.3	425	8.3	NA
	156	285	0.6	2.6	3.6	0	6.8	441	8.6	1.8	285	0.6	2.6	3.6	1.5	8.3	441	8.6	1.8
40	104	325	0.5	2.6	3.9	0	7	429	7.3	0.3	325	0.5	2.6	3.9	1.2	8.2	429	7.3	NA
	140	325	0.5	2.6	3.9	0	7	465	8	1	325	0.5	2.6	3.9	1.2	8.2	465	8	NA
	156	325	0.5	2.6	3.9	0	7	441	7.5	0.5	325	0.5	2.6	3.9	1.2	8.2	441	7.5	NA
45	104	365	0.4	2.6	4.3	0	7.3	469	7.1	NA	365	0.4	2.6	4.3	1	8.3	469	7.1	NA
	140	365	0.4	2.6	4.3	0	7.3	505	7.7	0.4	365	0.4	2.6	4.3	1	8.3	505	7.7	NA
	156	365	0.4	2.6	4.3	0	7.3	521	7.9	0.6	365	0.4	2.6	4.3	1	8.3	521	7.9	NA
50	104	405	0.4	2.6	4.7	0	7.7	509	7	NA	405	0.4	2.6	4.7	0.8	8.5	509	7	NA
	140	405	0.4	2.6	4.7	0	7.7	545	7.5	NA	405	0.4	2.6	4.7	0.8	8.5	545	7.5	NA
	156	405	0.4	2.6	4.7	0	7.7	561	7.7	NA	405	0.4	2.6	4.7	0.8	8.5	561	7.7	NA
55	104	445	0.4	2.7	5	0	8.1	549	6.8	NA	445	0.4	2.7	5	0.6	8.7	549	6.8	NA
	140	445	0.4	2.7	5	0	8.1	585	7.3	NA	445	0.4	2.7	5	0.6	8.7	585	7.3	NA
	156	445	0.4	2.7	5	0	8.1	601	7.5	NA	445	0.4	2.7	5	0.6	8.7	601	7.5	NA

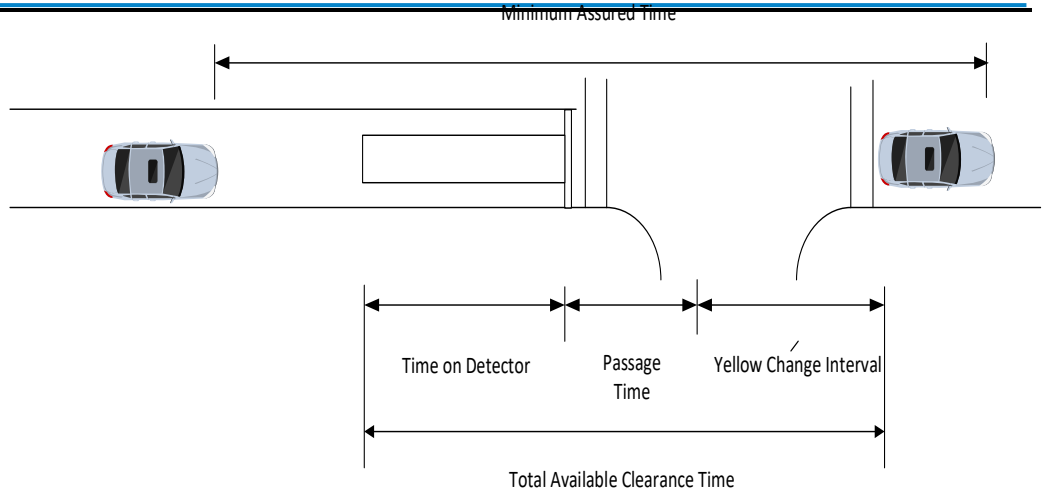
*Source: Exhibit 6-12 in Signal Timing Manual, 2nd Edition, NCHRP 812.

** Source: Exhibit 6-2 in Signal Timing Manual, 2nd Edition, NCHRP 812.

***Source: Exhibit 6-3 in Signal Timing Manual, 2nd Edition (used 110 ft)

The width of the intersection is measured from the stop bar to the extension of the cross-street curb line or the outside edge of the farthest cross-street travel lane.

Stop Bar Detection (Not Including All-Red)



Speed (mph)	Intersection "Box" Width	Yellow Change Interval*	All-Red Interval**	Detection Zone, Feet: 20 Passage Time**	20 Time in Detection Zone	20 Total Available Clearance Time	40 Passage Time**	40 Time in Detection Zone	40 Total Available Clearance Time	60 Passage Time**	60 Time in Detection Zone	60 Total Available Clearance Time	80 Passage Time**	80 Time in Detection Zone	80 Total Available Clearance Time	Time to Clear Intersection Box	Minimum Assured Time	Assured Green Time	Call by CV to Extension Timer: 20 Ft Detection Zone	40 Ft Detection Zone	60 Ft Detection Zone	80 Ft Detection Zone
20	104	3	0	1.9	0.7	5.6	1.4	1.4	5.8	0.8	2.1	5.9	0.3	2.8	6.1	4.3	7.3	4.3	1.7	1.5	1.4	1.2
	140															5.5	8.5	5.5	2.9	2.7	2.6	2.4
	156															6	9	6	3.4	3.2	3.1	2.9
25	104	3	0	1.9	0.6	5.5	1.4	1.1	5.5	0.8	1.7	5.5	0.3	2.2	5.5	3.4	6.4	3.4	0.9	0.9	0.9	0.9
	140															4.4	7.4	4.4	1.9	1.9	1.9	1.9
	156															4.8	7.8	4.8	2.3	2.3	2.3	2.3
30	104	3.2	0	2.1	0.5	5.8	1.6	1	5.8	1.2	1.4	5.8	0.7	1.9	5.8	2.9	6.1	2.9	0.3	0.3	0.3	0.3
	140															3.7	6.9	3.7	1.1	1.1	1.1	1.1
	156															4	7.2	4	1.4	1.4	1.4	1.4
35	104	3.6	0	2.2	0.4	6.2	1.8	0.8	6.2	1.4	1.2	6.2	1.1	1.6	6.3	2.5	6.1	2.5	NA	NA	NA	NA
	140															3.2	6.8	3.2	0.6	0.6	0.6	0.5
	156															3.5	7.1	3.5	0.9	0.9	0.9	0.8
40	104	3.9	0	2.3	0.4	6.6	2	0.7	6.6	1.6	1.1	6.6	1.3	1.4	6.6	2.2	6.1	2.2	NA	NA	NA	NA
	140															2.8	6.7	2.8	0.1	0.1	0.1	0.1
	156															3	6.9	3	0.3	0.3	0.3	0.3

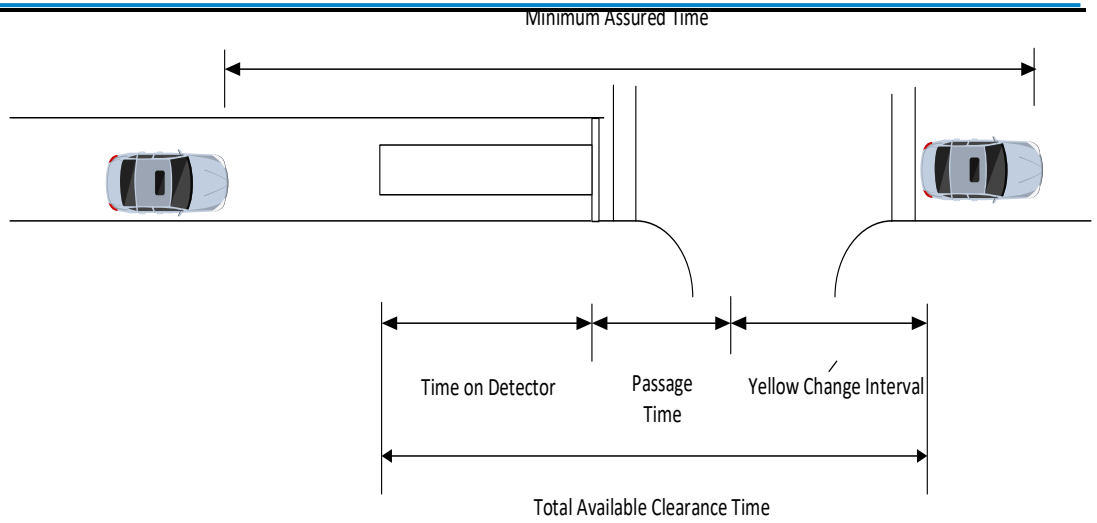
Vehicle Length (Ft)
20

* Source: Signal Timing Manual, 2nd Edition, NCHRP 812.

** From Exhibit 6-3 in Signal Timing Manual, 2nd Edition (used 110 ft)

The width of the intersection is measured from the stop bar to the extension of the cross-street curb line or the outside edge of the farthest cross-street travel lane.

Stop Bar Detection (Including All-Red)



Speed (mph)	Intersection "Box" Width	Yellow Change Interval*	All-Red Interval**	Detection Zone, Feet: 20 Passage Time**	20 Time in Detection Zone	20 Total Available Clearance Time	40 Passage Time**	40 Time in Detection Zone	40 Total Available Clearance Time	60 Passage Time**	60 Time in Detection Zone	60 Total Available Clearance Time	80 Passage Time**	80 Time in Detection Zone	80 Total Available Clearance Time	Time to Clear Intersection Box	Minimum Assured Time	Assured Green Time	Call by CV to Extension Timer: 20 Ft Detection Zone	40 Ft Detection Zone	60 Ft Detection Zone	80 Ft Detection Zone
20	104	3	2.5	1.5	0.7	7.7	1.5	1.4	8.4	1.5	2.1	9.1	1.5	2.8	9.8	4.3	7.3	4.3	NA	NA	NA	NA
	140															5.5	8.5	8.5	0.8	0.1	NA	NA
	156															6	9	9	1.3	0.6	NA	NA
25	104	3	2.5	2	0.6	8.1	2	1.1	8.6	2	1.7	9.2	2	2.2	9.7	3.4	6.4	3.4	NA	NA	NA	NA
	140															4.4	7.4	7.4	NA	NA	NA	NA
	156															4.8	7.8	7.8	NA	NA	NA	NA
30	104	3.2	2	2	0.5	7.7	2	1	8.2	2	1.4	8.6	2	1.9	9.1	2.9	6.1	2.9	NA	NA	NA	NA
	140															3.7	6.9	6.9	NA	NA	NA	NA
	156															4	7.2	7.2	NA	NA	NA	NA
35	104	3.6	1.5	2	0.4	7.5	2	0.8	7.9	2	1.2	8.3	2	1.6	8.7	2.5	6.1	2.5	NA	NA	NA	NA
	140															3.2	6.8	6.8	NA	NA	NA	NA
	156															3.5	7.1	7.1	NA	NA	NA	NA
40	104	3.9	1.2	2.5	0.4	8	2.5	0.7	8.3	2.5	1.1	8.7	2.5	1.4	9	2.2	6.1	2.2	NA	NA	NA	NA
	140															2.8	6.7	6.7	NA	NA	NA	NA
	156															3	6.9	6.9	NA	NA	NA	NA

Vehicle Length (Ft)
20

* Source: Signal Timing Manual, 2nd Edition, NCHRP 812.

** From Exhibit 6-3 in Signal Timing Manual, 2nd Edition (used 110 ft)

The width of the intersection is measured from the stop bar to the extension of the cross-street curb line or the outside edge of the farthest cross-street travel lane.

Example Requirements for TSCs

Req 1. NTCIP 1202 v03 SPaT Information

The TSC shall transmit a SPaT information to the RSU in conformance with the applicable requirements in NTCIP 1202 v03, Section 3.5.4.

- Communications between the TSC and the Roadside Unit (RSU) conform to NTCIP 1202.
- Communications between the RSU and On-Board Units conform to J2735.

Example Requirements for TSCs (cont.)

Req 3.1 SPaT Information Rate

The TSC shall transmit a SPaT information message to the RSU at an average rate of 10 messages per second +/- 1 message per second measured over 10 second period.

- Manufacturers agreed to use the fixed rate method
- Not using the “on-change” method

Req 3.2 SPaT Transmission Rate Tolerance

The TSC shall not exceed 0.2 seconds between transmission of SPaT messages.

- Established a tolerance so the RSU can determine when there is a communication failure

Example Requirements for TSCs (cont.)

Req 8. Cabinet Flash (Exception Flash) Indication

The TSC shall indicate to the RSU when the transportation field cabinet is in a signal flash condition invoked outside of the TSC (e.g., a fault, toggle switch, police panel).

Req 9. Controller Flash (Operational Flash) Indication

The TSC shall indicate to the RSU when the transportation field cabinet is in a signal flash condition invoked outside of the TSC (e.g., a fault, toggle switch, police panel).

- Adjusted grouping of the various flash conditions into two categories
- OBUs need to know if the TSC is / is not operating the intersection

Next Steps for the TCI Task Force

- Continue Requirements Development
  - Requirements Walkthrough in December
  - Revise requirements based on Walkthrough
- Develop draft design content

Q & A

SPaT/MAP Task Force

Michael Maile / Ray Starr (co-chairs)

Accomplishments Since October 19

Recommended Requirements

- MAP node accuracy 0.2 meters
- Node density on curves maintains 0.5 meter laterally
- Nodes by offset / floating map
- Multiple node offset sizes allowed
- Computed lanes supported

Accomplishments Since October 19

Recommended Requirements

- Start time prohibited for current phases
- Connection information required
- Speed limits for each lane
- Robustness when not all data is available
- Quality assurance for complete and proper messages

Status

Completed

- Had the group review the RLVW ConOps
- Presentation on CV PFS MAP Guidance project
- Presentation on AWEG (now called AGT)
- Draft requirements completed

Pending

- Data element spreadsheet
- Parking lot items
- Resolve walkthrough issues

Q & A

Validation Sites (Goudy)

- Potential Validation Sites
  - Draft request for letters of interest (Siva)
  - Draft checklist of minimum requirements for a reference implementation setup

Project Schedule

- Draft Requirements Document – Distribute by Nov 23.
  - Submit written comments by December 4 using spreadsheet
- Requirements Walkthrough
  - December 7 – 10, 11:00 – 5:30 PM EST

Project Schedule

Requirements Walkthrough

- Monday, December 7:
  - Traffic Controller Issues Requirements.
  - SPaT/MAP Requirements. Mostly general message requirements and SPaT Message Requirements
- Tuesday, December 8:
  - Positioning Requirements.
  - SPaT/MAP Requirements. Mostly MAP requirements.
- Wednesday, December 9:
  - Testing/Conformity Requirements.
  - Security Requirements (starting 2:30 PM)
- Thursday, December 10:
  - If needed.

Project Schedule

- Draft Final Requirements Document
  - Distribute before December 25
  - Final Requirements Document around January 15, 2021
- Draft Implementation Guidance Document (Complete April 2021)
  - Design content
- Validation (to be determined April – June 2021)
- Publish Final Implementation Guidance Document (Complete September 2021)
- Next CI Committee Meeting
  - December 21, 2020, 3:00 – 5:00 PM EST

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

Questions & Answer Session

Adjourn

– Thank you!