Connected Transportation Interoperability (CTI) Standards

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Connected Vehicle Developments

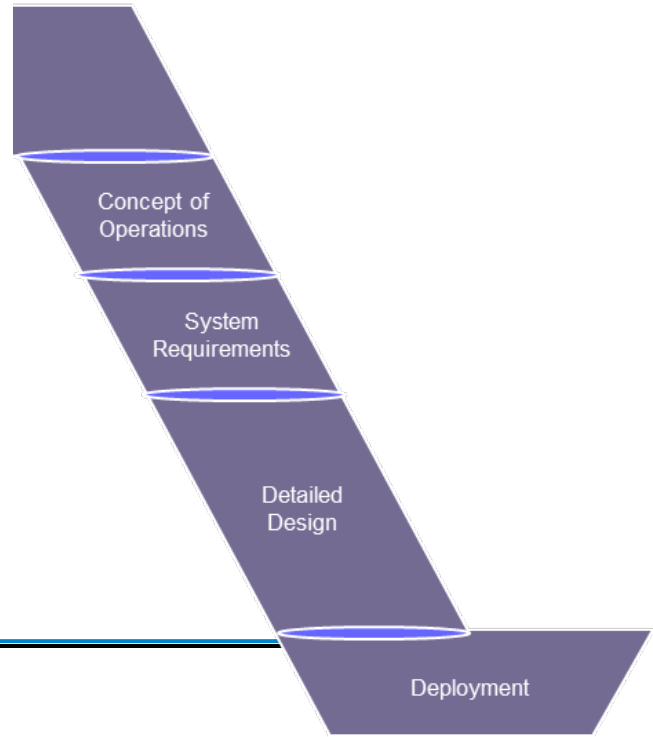
- IOO/OEM Forum identified a variety of ambiguities and gaps associated with SAE J2735 messages related to connected signalized intersections.
  - *Cooperative Automated Transportation Clarifications for Consistent Implementations (CCIs) To Ensure National Interoperability Connected Signalized Intersections v1.9.5 (June 2020),* CAT Coalition IOO/OEM Forum.
- USDOT agreed to move CCIs into a standard
  - Contracted with ITE and SAE to create a standards effort – July 2020
    - Phase 1 led by ITE
    - 18-month effort
    - Over 200 meetings
  - Supported by:
    - American Association of State Highways and Transportation Officials (AASHTO)
    - National Electrical Manufacturers Association (NEMA)

Connected Intersection Committee – Phase 1

– Goal: Create a new family of ITS / CV Standards

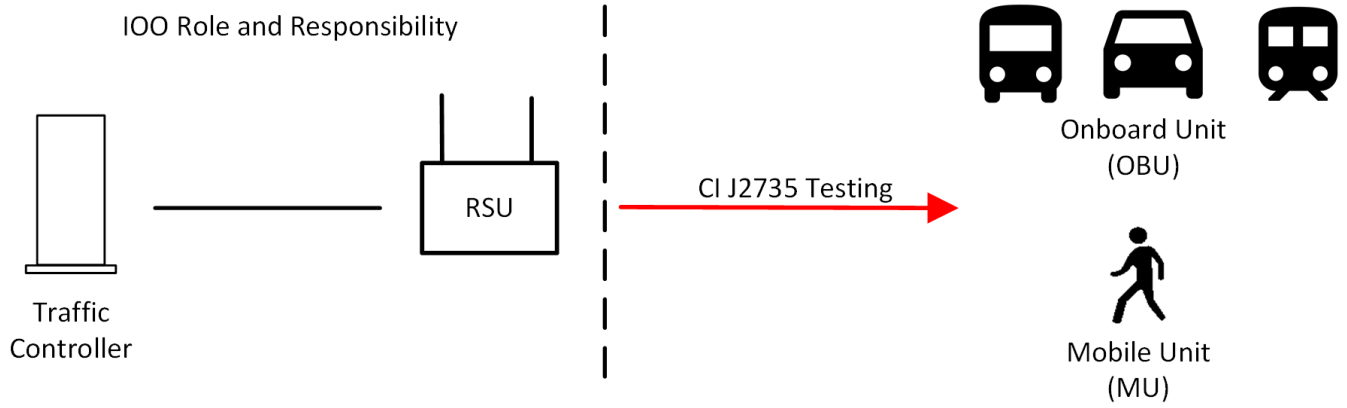
- **Connected Transportation Interoperability (CTI) Standards**
- Jointly developed by stakeholders across the **connected vehicle spectrum**, including infrastructure owner operators (IOOs), the automotive industries, device manufacturers, mobility data providers, and systems integrators.
- Includes standards and technical reports that provide guidance to develop and maintain an interoperable connected vehicle environment.
  - Deployment guidance and concepts necessary to help deploy nationally interoperable CI applications

- Follow the Systems Engineering Process:
  - Concept of Operations: Describes the scope, current problem and needs
  - Requirements: Identify characteristics or constraints that collectively satisfies the needs
  - Design Details: How to fulfill the requirements



Connected Intersection Committee – Phase 1

- Goal: Create a new family of ITS / CV Standards
  - Consistent implementation of trustworthy SPaT, MAP, and RTCM Corrections messages
    - J2735 Messages between the RSU and traveler (OBU/ MU) (red arrow)
    - Included security considerations
  - Address ambiguities and gaps found with early deployments of connected, signalized intersections
  - Focus specifically on Red-Light Violation Warning (RLVW) application



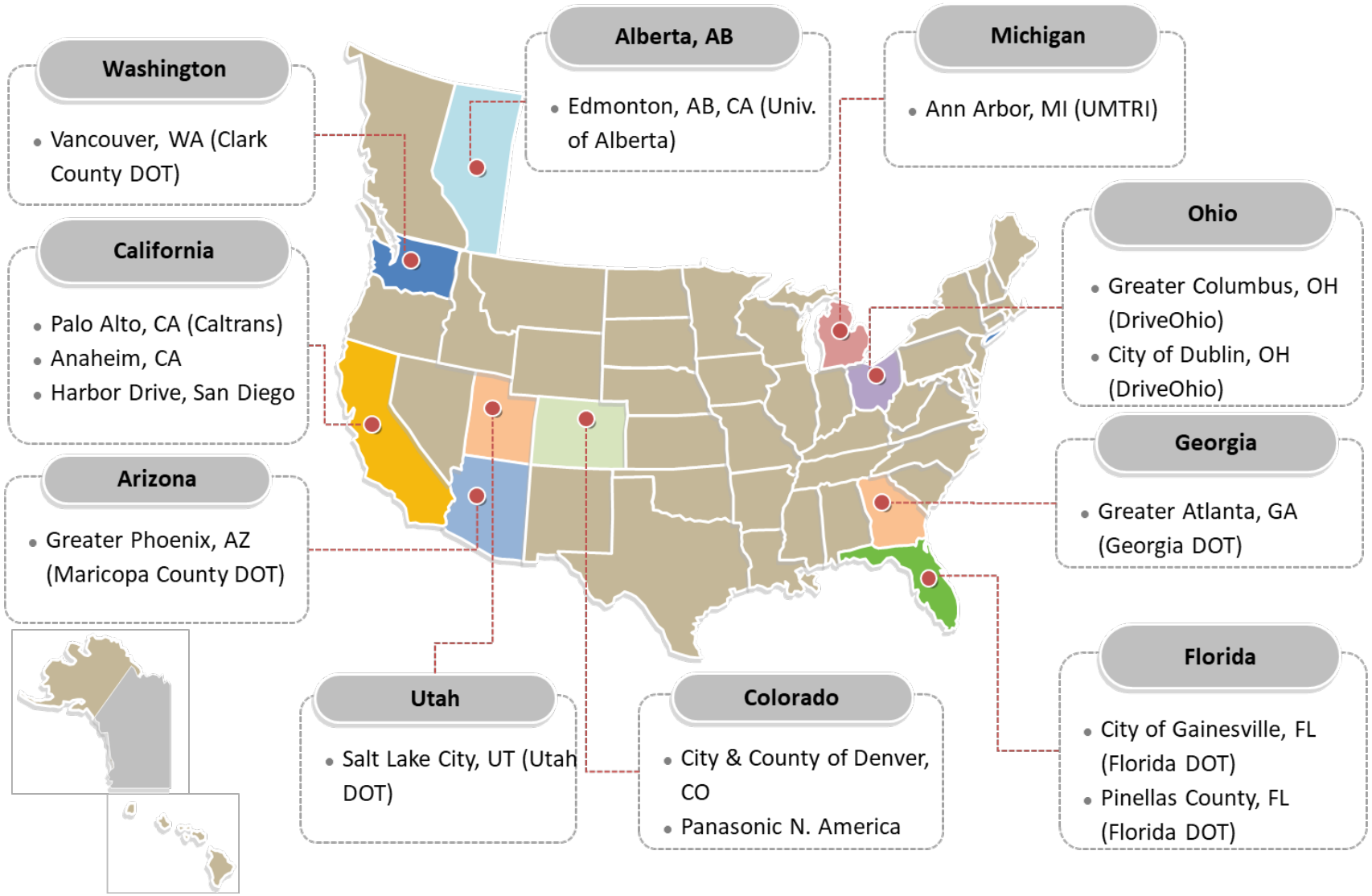
Phase 1 Implementation Guide Development

Connected Intersection Committee Accomplishments

- CTI 4501 v1.00 submitted to USDOT September 2021
- CTI 4501 v1.01 published June 2022
  - Added guidance on how to fulfill the SPaT message requirements using the existing TSCBM objects
  - Added Latency Analysis to convey signal phase and timing information
  - Added Attack Tree Examples and example design choices to mitigate the threats

Phase 1 Implementation Guide Development

- Validation phase
- 15 volunteer validation sites (from 13 different agencies, including one in Canada)
- Provided RSU broadcast data for analysis



Phase 1 Implementation Guide Development

- The analysis of SPaT and MAP messages led to many insights, some of which led to changes to the deployment at the validation site, changes to the guidance in the CI Implementation Guide, or identified areas where future research may be needed.
- The validation phase also provided insights into what future testing may look like to assure the proper performance of a connected intersection.
- CTI 4502, CI Validation Report published February 2022

Roadside Unit Standard

- RSU Standardization Working Group
  - Parallel to the Connected Intersections Committee
  - Also led by ITE
- CTI 4001 - Roadside Unit Standard - Sept 2021
  - Replaces the USDOT Roadside Unit Specification v4.1
  - Platform agnostic (not specifically C-V2X)
- CTI 4001 Amended: V01.01 – Sept 2022

Moving Forward

- Despite this great effort, the work wasn't done. . .
- During the development and validation of CTI 4501, potential activities were identified to update and enhance the existing guidance moving forward
  - Resulted in a CI Phase 2 effort

SAE Connected Transportation Interoperability Committee (CTIC)

Connected Intersections Phase 2

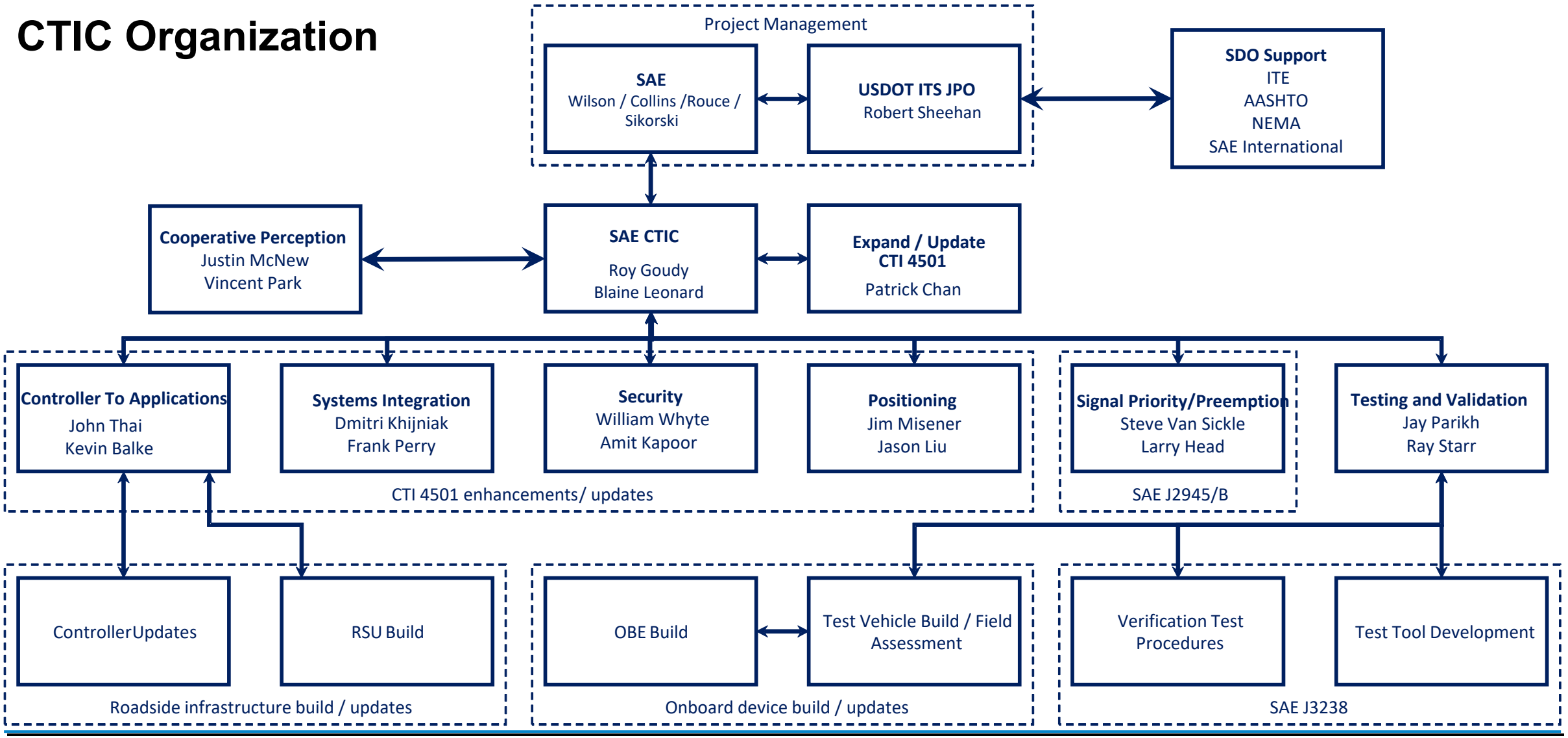
- SAE led the Phase 2 effort
  - Support from ITE
  - Funded by the USDOT
  - Includes safety and mobility stakeholders across the connected vehicle spectrum
  - Project Duration: 24 months (ending Sept ’24)

Objective

- Support the development and publication of expanded and updated non-proprietary, industry-based consensus CI Implementation Guidance Standard, building on the original guidance defined in CTI 4501

SAE Connected Transportation Interoperability Committee (CTIC)

CTIC Organization



SAE Connected Transportation Interoperability Committee (CTIC)

Tasks:

- Support Development of Updated and Enhanced Positioning Guidance
  - Coordinate and provide ITS Infrastructure Stakeholder and SME support to activities to update and enhance guidance related to positioning capabilities within CI applications and use cases
    - Guidelines will describe how interoperability is enabled with consistent implementations in support of lane-level vehicle positioning for V2X infrastructure applications.

- Support Execution of Additional Verification and Validation Activities
  - Coordinate and provide ITS Infrastructure Stakeholder and SME support to verification and validation activities related to CI Implementation Guidance, use cases and applications
    - Testing & assessment methodology to verify the accuracy of MAP using RTCM correction messages including development of test tools
    - Additional field testing to assess the use of the tools to validate intersection operations

SAE Connected Transportation Interoperability Committee (CTIC)

Tasks:

- Support Development of Updated and Enhanced Security Guidance
  - Coordinate and provide ITS Infrastructure Stakeholder and SME support to activities to update and enhance guidance related to security capabilities, guidance and best practices within CI applications and use cases
- Support Development of Signal Priority and Preemption Guidance
  - Coordinate and provide ITS Infrastructure Stakeholder and SME support to activities to develop guidance related to signal priority and preemption within CI applications and use cases

SAE Connected Transportation Interoperability Committee (CTIC)

Tasks:

- Work with ITS Infrastructure Vendors to Develop CI Capabilities in Infrastructure Devices
  - Work with the ITS Infrastructure vendor community to implement new capabilities and concepts defined in CTI 4501 such as the Assured Green Period (AGP)
  - AGP which is a new feature to support an in-vehicle Red Light Violation Warning (RLVW) application. AGP also supplements dilemma zone protection through advance detection.
  - Use cases for testing and validating an AGP will also be included
- Support Technical Task Execution
  - Coordinate and provide ITS Infrastructure Stakeholder and SME support to technical activities such as test tool development, deployment validation procedures/checklists or other technical tasks that may arise during the development of the standards

Current Activities – Documents Being Developed

- **CTI 4501.** CI Implementation Guide v2.0
- **J3305.** Assured Green Period (AGP) to Support Red Light Violation Warning
- **J3258.** V2X Infrastructure Support for GNSS Corrections
- **J3238/1.** Testing & Validation of SPaT information broadcast
- **J3238/2.** Testing & Assessment of MAP using RTCM information broadcast
- **J2945/B.** Recommended Practices for Signalized Intersection Applications
- **J3295.** Cooperative Perception Services Concept of Operations

Current Activities

- **J3238/1&2,** Testing & Validation of SPaT, MAP, RTCM), involves:
  - Defining the requirements for test tools that can be used by infrastructure owners
  - Building the tools
  - Testing and refining the tools at operational signalized intersections
- **J2945/B** Recommended Practices for Signalized Intersection Applications
  - Complements J2735 – which is a data dictionary
  - Demonstrates how messages are constructed and used
  - Focus on larger intersections MAPs
  - Focus on signal priority and preemption applications
    - Signal request message (SRM)
    - Signal status message (SSM)

Resources

- To participate in the committee:
  - https://standardsworks.sae.org/standards-committees/connected-transportation-interoperability-committee
  - E-mail Jennifer Collins: Jennifer.collins@sae.org 1.248.273.2457
  - Committee and Task Forces are open to all (Participant or Full Member)
  - Access to draft documents requires you be a member of the CTIC
  - For technical considerations, contact Patrick Chan: Patrick.chan@consystec.com
- Access to the documents created (connected intersections / RSUs):
  - https://www.ite.org/technical-resources/standards/connected-intersections/
  - https://www.ite.org/technical-resources/standards/rsu-standardization/

Thank you!