In Person Monthly Panel Meeting

Connected Intersections Program: Program Management and Technical Support

April 30, 2024

Welcome and
Review of Meeting Agenda

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Agenda

Welcome and Introductions

Project Management Updates

Testing and Final Report

Guidance Document

Next Steps

Project Phase III Scope

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Project Management Updates

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PM Highlights

— Current Contract ends 05/15/24

— Task 3.1.1 Identify CTI 4501 messaging requirements for testing
  — *Identify subset of message requirements to be test at each site: Complete*
  — *Provide Development Discussion documents: Complete*
  — *Site Updates: Complete*

— Task 3.1.2. Perform Testing Activities
  — *Develop data collection plan and itinerary: Complete*
  — *Test (collect data) at each site: Complete*
    — Collected data in GDOT and UDOT the week of 03/11/24
    — Collected data in Ohio the week of 04/08/24

— Task 3.1.3. Assess Data
  — *Process and assess the collected data : In Progress*
  — *Update result in Phase I Final Report: In Progress*

— Task 3.2: Technical Assistance:
  — *Meetings held with each site to review contents of Development Discussion and discuss feasibility of implementing changes: Complete*
  — *Provide technical assistance during the development process: Complete*

— Task 4. SCMS Manager Coordination
  — *Competed*

— Task 5.1: Update to the IOO Guidance Document
  — *Assisted UDOT with comments to the 5GAA Day One Deployment Guide*
  — *Identify areas in the document that need to be updated: in progress*

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Schedule

Task Name	Duration	Start	Finish
NTP	1 day	Tue 8/15/23	Tue 8/15/23
Task 1: Project Management	177 days	Tue 8/15/23	Tue 4/30/24
Task 3. Development Site Selection and Support	**172 days**	**Tue 8/22/23**	**Tue 4/30/24**
TASK 3.1: Testing	**172 days**	**Tue 8/22/23**	**Tue 4/30/24**
Task 3.1.1 : CTI message requirements	**46 days**	**Tue 8/22/23**	**Tue 10/24/23**
Identify CTI 4501 messaging requirements to test (Complete)	45 days	Tue 8/22/23	Mon 10/23/23
Meet w/DriveOhio (Complete)	1 day	Tue 10/24/23	Tue 10/24/23
Meet w/GDOT (Complete)	1 day	Tue 10/24/23	Tue 10/24/23
Meet w/UDOT (Complete)	1 day	Tue 10/24/23	Tue 10/24/23
Site updates	85 days	Wed 10/25/23	Mon 3/4/24
Task 3.1.2. Perform Testing Activities	**11 days**	**Mon 3/11/24**	**Mon 3/25/24**
DriveOhio	1 day	Mon 3/25/24	Mon 3/25/24
GDOT (Complete)	2 days	Mon 3/11/24	Tue 3/12/24
UDOT (Complete)	2 days	Wed 3/13/24	Thu 3/14/24
Task 3.1.3. Assess Data and Update Test Results	10 days	Mon 3/18/24	Fri 3/29/24
Final Report Draft	10 days	Wed 3/27/24	Tue 4/9/24
Final Report Panel Review	10 days	Wed 4/10/24	Tue 4/23/24
Final Report Update	5 days	Wed 4/24/24	Tue 4/30/24
Task 3.2: Technical Assistance	90 days	Wed 10/18/23	Mon 3/4/24
Task 4. SCMS Manager Coordination	177 days	Tue 8/15/23	Tue 4/30/24
Task 5: Guidance Material	**170 days**	**Tue 8/15/23**	**Fri 4/19/24**
Task 5.1: Update to the CI Guidance Document:	**170 days**	**Tue 8/15/23**	**Fri 4/19/24**
Prepare CI Guidance update draft	155 days	Tue 8/15/23	Fri 3/29/24
CI Guidance update draft Panel Review	10 days	Mon 4/1/24	Fri 4/12/24
Submit CI Guidance update	5 days	Mon 4/15/24	Fri 4/19/24

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Task 3 Development Site Selection and Support

Project History

— CI Program project initiated in March 2021

— CTI 4501 - 128 Message Requirements
  — *Which requirements sites are meeting today?*
  — *Where is development needed?*

— Collect and analyze CV data from three sites
  — *Marysville, OH 6 intersections*
  — *West Point, GA   3 intersections*
  — *Park City, UT   6 intersections*

  — *Sites have different combinations of equipment / functionality*

2022 Test Results

— 36 Requirements met at all intersections at all sites

— 26 All intersections at all sites partial pass or did not pass

— 36 Could not be Tested

— 30 Mixed results between sites

  — *20 Requirements where some sites met all, and others met none*

  — *10 Requirements with mixed results*

9

CTI 4501 Req ID	Requirement Title	All Intersections Summary (15) ✓	O	×	?
3.3.3.1.1.1	SPaT Message - SAE J2735	15	0	0	0
3.3.3.1.1.2	SPaT Message - Mandatory Data Elements	15	0	0	0
3.3.3.1.1.3	SPaT Message - CI Mandatory Data Elements	0	15	0	0
3.3.3.1.1.4	SPaT Message PSID	15	0	0	0
3.3.3.1.1.5	MAP Message - SAE J2735	15	0	0	0
3.3.3.1.1.6	MAP Message - Mandatory Data Elements	15	0	0	0
3.3.3.1.1.7	MAP Message - Required Data Elements	0	15	0	0
3.3.3.1.1.8	MAP Message PSID	15	0	0	0
3.3.3.1.1.9	RTCMcorrections Message - SAE J2735	6	0	9	0
3.3.3.1.1.10	RTCMcorrections Message - Mandatory Data Elements	6	0	0	9
3.3.3.1.1.11	RTCMcorrections Message - Required Data Elements	6	0	0	9
3.3.3.1.1.12	RTCMcorrections Message PSID	6	0	0	9
3.3.3.1.2.1	Broadcast SPaT Message	15	0	0	0
3.3.3.1.3.1	Transport Message Size - WAVE	15	0	0	0
3.3.3.1.3.2.1	Nodes by Offsets	15	0	0	0
3.3.3.1.3.2.2.1	Computed Lane - Lane Identifier	0	0	0	15
3.3.3.1.3.2.2.2	Computed Lane - X-Offset	0	0	0	15
3.3.3.1.3.2.2.3	Computed Lane - Y-Offset	0	0	0	15
3.3.3.1.3.2.2.4	Angle	0	0	0	15
3.3.3.1.4.1	Data Coverage - Every Lane	15	0	0	0
3.3.3.1.4.2	Advanced Notification - Time	11	4	0	0
3.3.3.1.5.1	SPaT Message - Broadcast Periodicity	9	6	0	0
3.3.3.1.5.2	SPaT Message - Broadcast Latency	12	3	0	0
3.3.3.1.5.3	MAP Message - Broadcast Periodicity	8	7	0	0
3.3.3.1.6.1	Completeness - SPaT Message	15	0	0	0
3.3.3.1.6.2	Completeness - MAP Message	0	15	0	0
3.3.3.2.1	Time Accuracy	0	0	0	15
3.3.3.2.2.1	SPaT Message - Revision Counter Increment	9	6	0	0
3.3.3.2.2.2	SPaT Message - Revision Counter Not Increment	6	3	4	2
3.3.3.2.2.3	MAP Message - Revision Counter Increment	0	0	0	15

2023-24 Development and Re-testing

— Make system updates to address requirement that were partially or not met
- — *Based on results from first round of testing*

— Development Discussion provided to site leads 10/6/23
- — *Requirement-by-requirement overview of expected development efforts*
- — *Used to determine what system updates could be made over the project development timeframe (4 months)*

Site Meetings

— Development Discussion (prior to development)
  — *GDOT: 10/31/23*
  — *UDOT: 11/1/23*
  — *DriveOhio: 11/16/23*

— Technical Assistance (during development)
  — *GDOT: 12/21/23*
  — *DriveOhio: 1/25/23, 3/26/23*
  — *UDOT: 2/2/24*

Testing

— Data Collection
  — *March 11: West Point, GA*
  — *March 12: Atlanta, GA*
  — *March 13: American Fork, UT; Orem, UT*
  — *March 14: Park City, UT*
  — *April 17: Marysville, OH*

— Stationary and video data capture at all intersections
— Driving data capture at new intersections only

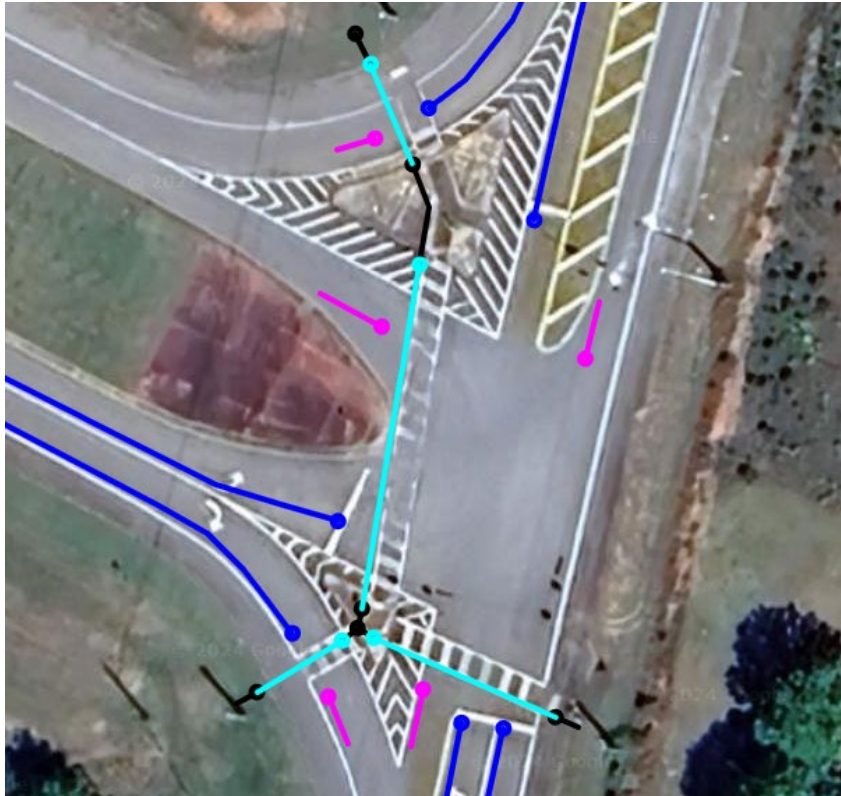# Preliminary Results Improvements (All 3 sites meeting)

— Crosswalk lanes
— Sidewalk Lanes
— Connections between crosswalk lanes and sidewalk lanes
— Reference elevation
— Reference Speed Limits
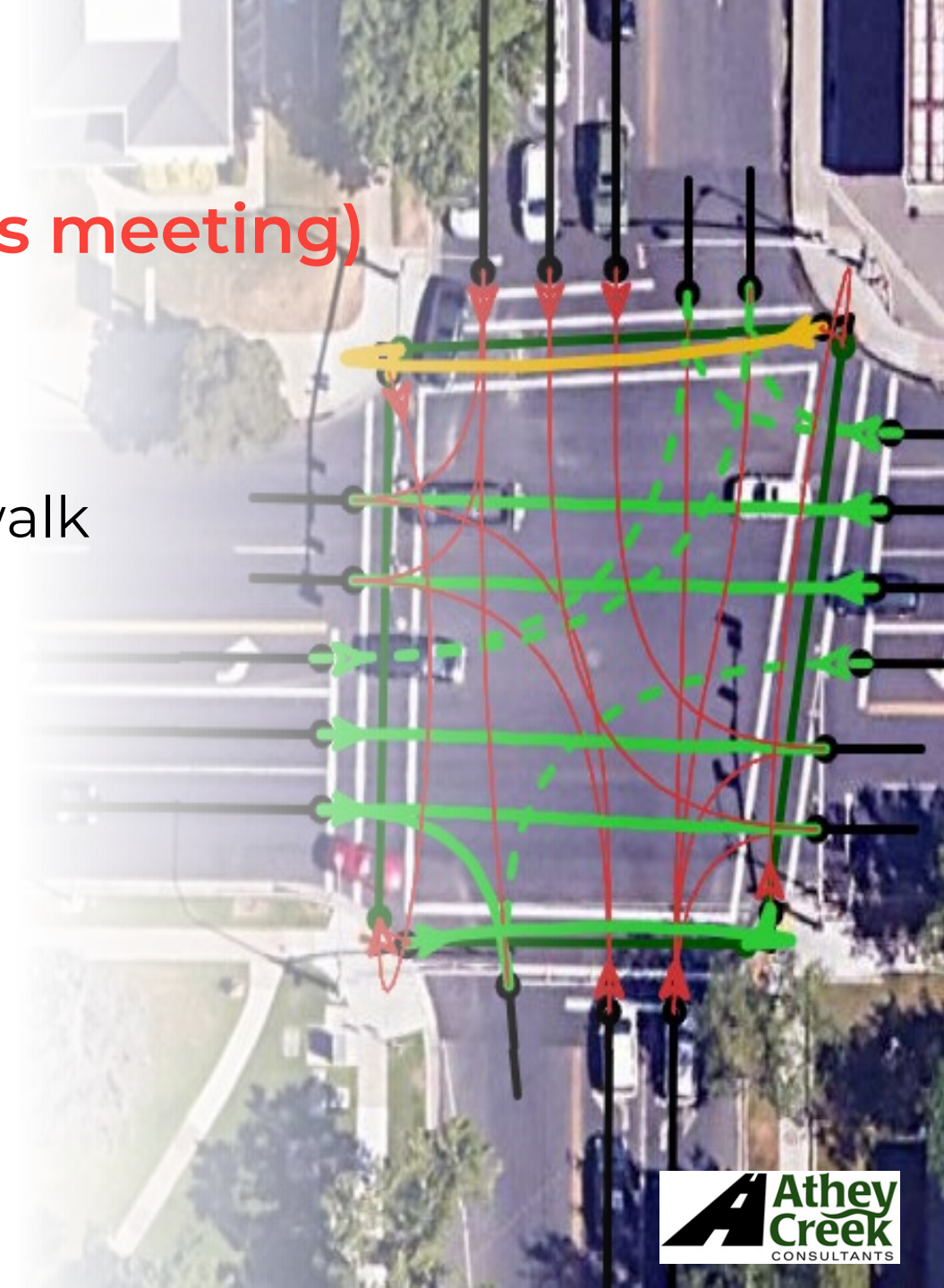
# Sidewalk and Crosswalk Lanes
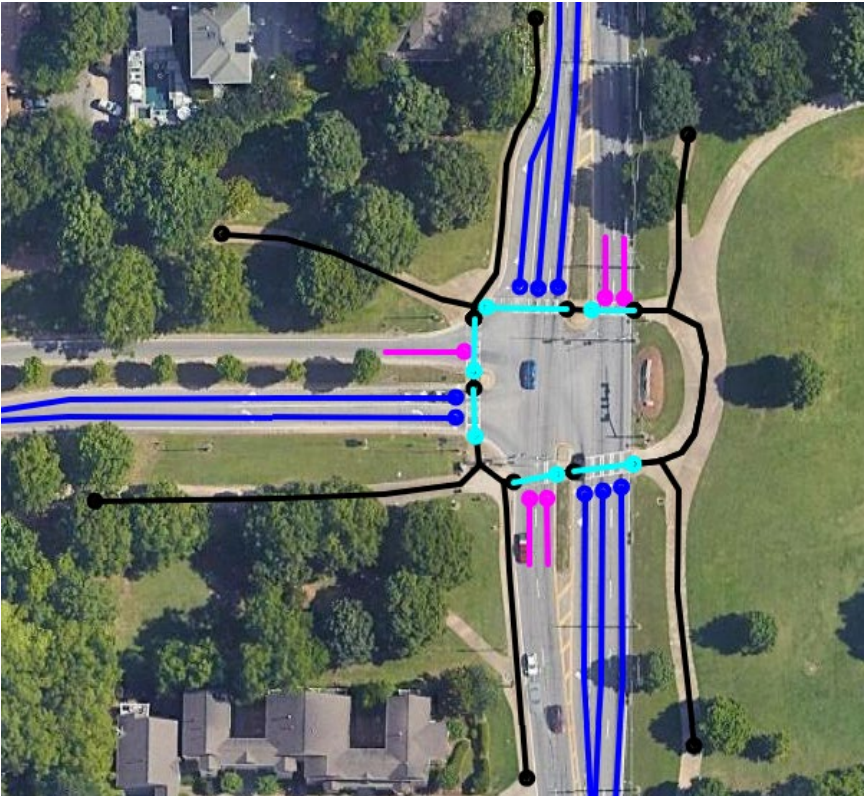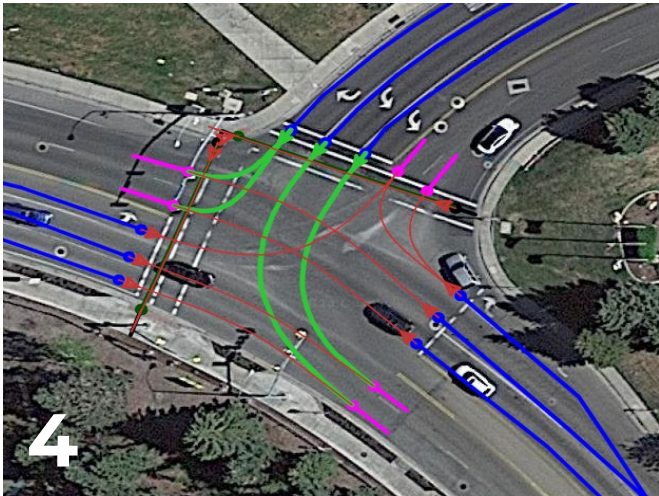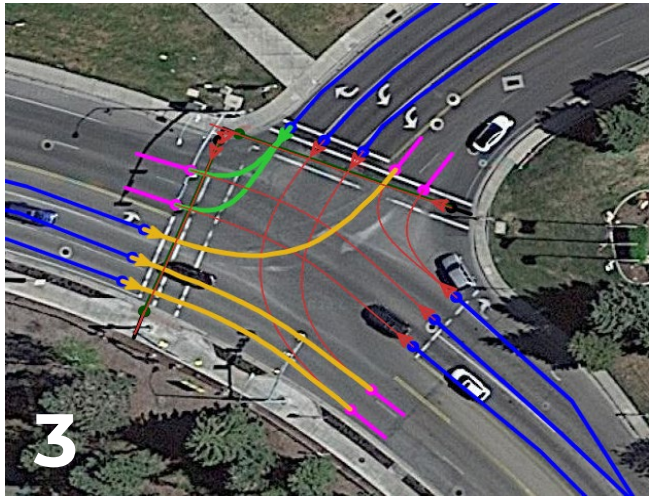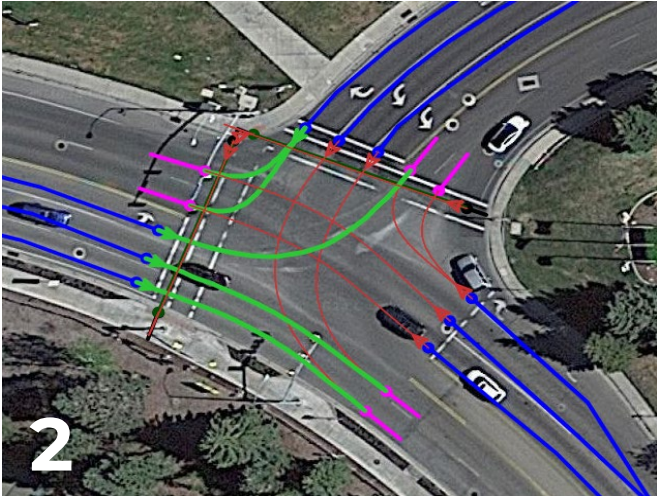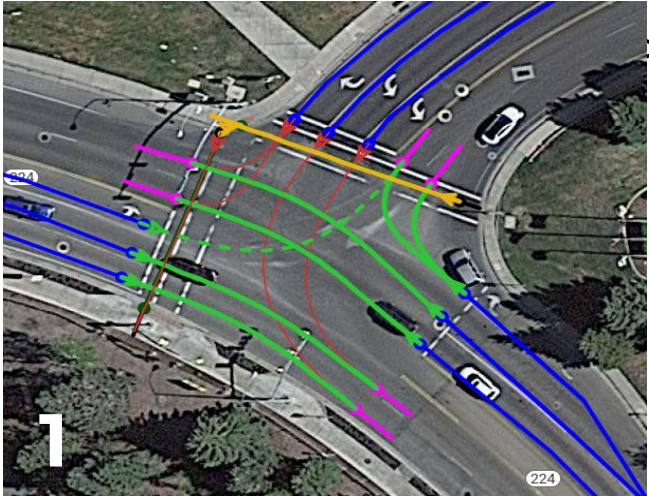

Freedom Pkwy @ Moreland Ave

Kia Blvd @ Warner Rd

Preliminary Results Improvements (2 sites now meeting)

— Road Regulator ID
— Protected-permissive turns in SPaT
— Signal groups for pedestrian phases
— Pedestrian SPaT data
— Direction of Travel for sidewalk/crosswalk lanes
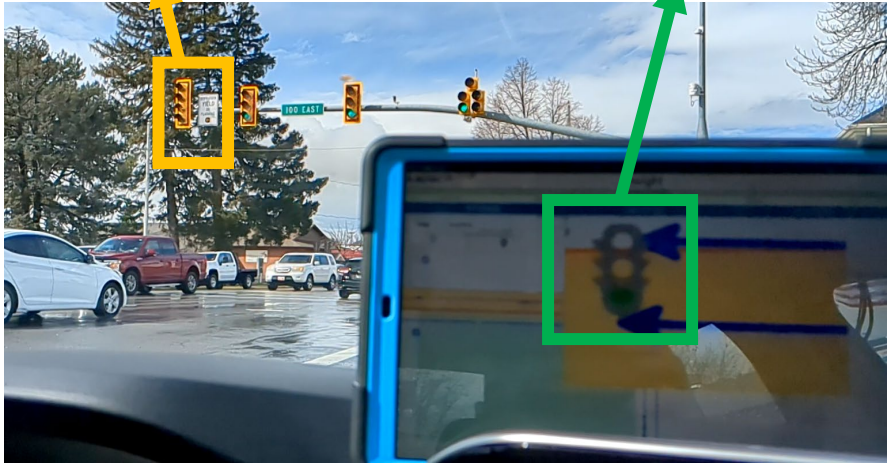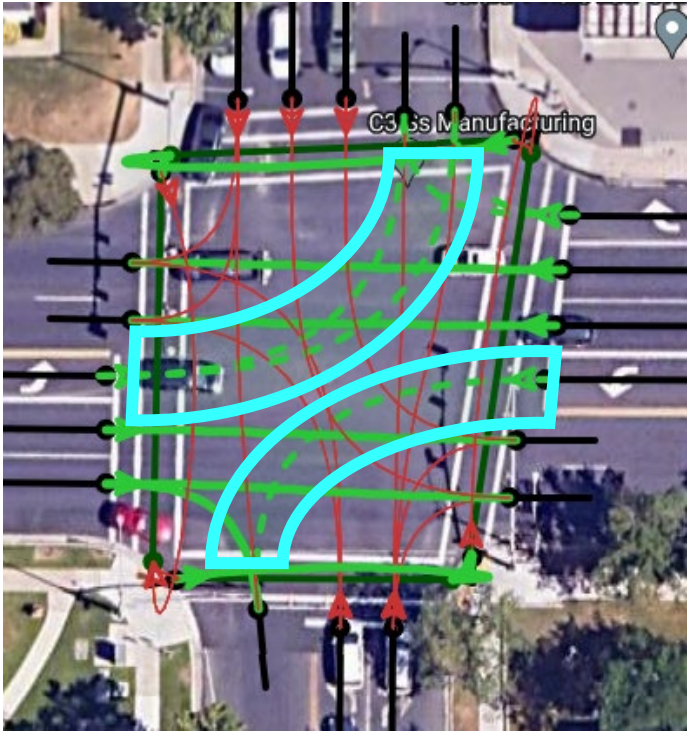— Lane Sharing (all lane types)

Protected-Permissive Turns

SR-224 @ Kearns Blvd (Park City)

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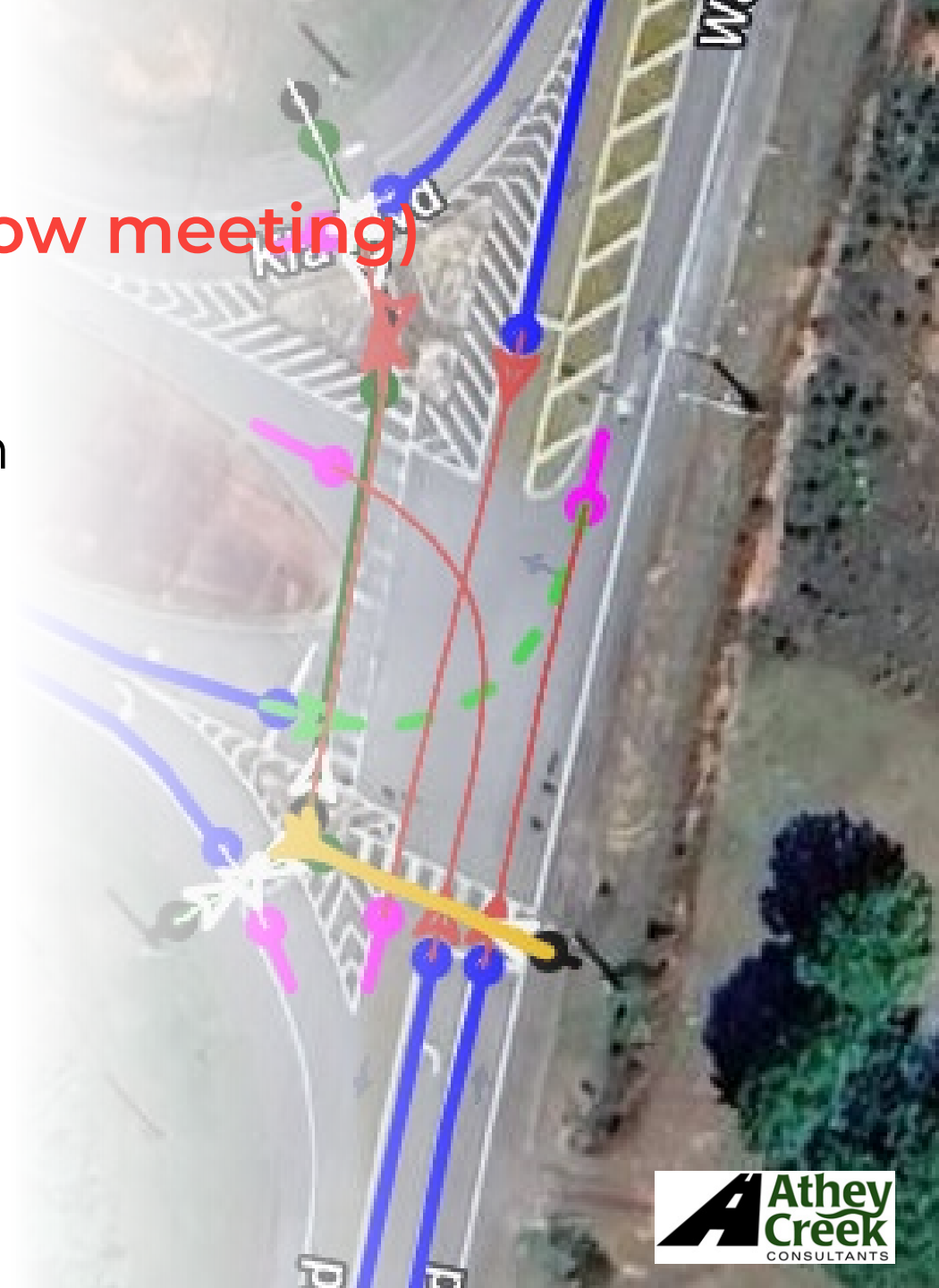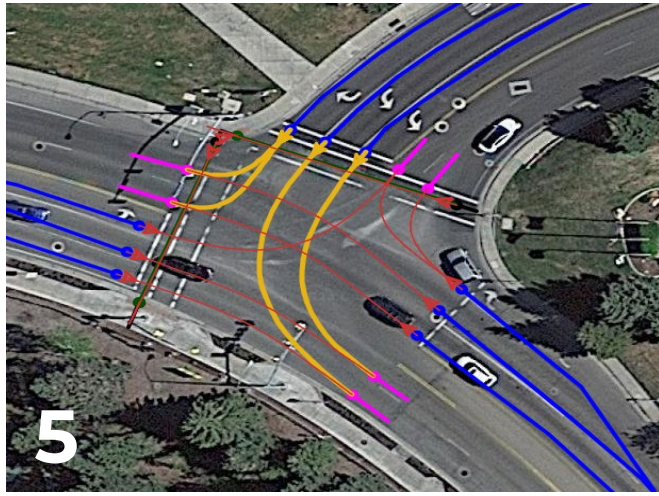
Preliminary Results
Improvements (1 site now meeting)

— Flashing yellow arrow
operation reflected in SPaT

State St @ 100E (American Fork)

Preliminary Results
Improvements (1 site now meeting)

— Speed changes at nodes
— Elevation changes at nodes

```
∨ nodes: 2 items
    ∨ Item 0
        ∨ NodeXY
            > delta: node-XY2 (1)
            ∨ attributes
                ∨ data: 1 item
                    ∨ Item 0
                        ∨ LaneDataAttribute: speedLimits (5)
                            ∨ speedLimits: 1 item
                                ∨ Item 0
                                    ∨ RegulatorySpeedLimit
                                        type: vehicleMaxSpeed (5)
                                        speed: 782
```

```
∨ nodes: 15 items
    ∨ Item 0
        ∨ NodeXY
            > delta: node-XY4 (3)
            ∨ attributes
                dWidth: 75
                dElevation: 10
```

GDOT (Kia @ Kia)

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Preliminary Results Summary

— A lot of progress made on MAP requirements
  — *GDOT demonstrates capability to produce MAP with all CTI 4501-required elements*

— Moderate progress made on SPaT requirements

— 20+ requirements where one or more intersections will show improvement in test results
  — *Number of requirements "not met" by all intersections significantly reduced – previously*

— 9 requirements that previously could not be tested
  — *Addition of crosswalk/sidewalk lanes and FYA intersections*

— Opportunity for sites to share knowledge

Issues Observed

— Latency
  — *Noticeable delay between intersection and test tool*
  — *Affected all intersections at one site*
  — *Rectified after RSU reboot*

— Uptime/Reliability
  — *No data from RSUs (comms / hardware)*
  — *Affected 2 intersections at one site and 1 intersection at another*
  — *Could not collect data from these intersections*

— Signal timing plan change
  — *SPaT/MAP state did not always reflect actual conditions*
  — *Affected 2 approaches at 1 intersection*

Conclusions

— The updated results reflect:
  — *Capabilities of current tools*
  — *Ability to make system functionality updates without significant additional investment (4-month period) to meet requirements*

— Greatest challenges are ahead!

— More substantial development needed to meet other CTI 4501 requirements.
  — *RTCM message types, broadcast rate*
  — *Time change details*
  — *Assured Green Period*
  — *Subsequent Movement States (and associated data)*

Next Steps

— Updated Results available May 10
  — *Format will highlight where improvements have been made*

Requirement	3.3.3.4.1.13		Node Offset from Intersection Reference Point					
Objective	Verify use of smallest offset type							
Method	Use Wireshark to view pcap files. Extract the node offset point xy choice (node-XY-1 through node-XY-6), the x offset value and the y offset value from each specified node point in the MAP message							
Pass Criteria	To be compliant with the requirement, the offset type that should be used is as follows:							
	Offset Type (choice value)		Offset Range			Size		
	node-xy1 (0)		< 5.11m			20 bits		
	node-xy2 (1)		5.12 – 10.23 m			22 bits		
	node-xy3 (2)		10.24 – 20.47m			24 bits		
	node-xy4 (3)		20.48 – 40.96m			26 bits		
	node-xy5 (4)		40.97 – 81.91m			28 bits		
	node-xy6 (5)		81.92 – 327.67m			32 bits		
Results	Int	6	7	8	9	10	11	14	4106
	2022	No Pass	No Pass	No Pass	No Pass	No Pass	No Pass	-	-
	2024	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Explanation	The offset type used is not larger than what is minimally required for the first node for all lanes at all intersections.							

DriveOhio

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CTI 4501 v02

— To be released in Fall 2024

— Use of TSCBM discouraged

— New/updated requirements (144)

    — *Protected vs. permissive*

        — ▸ ROW vs. yield

    — *TimeMark accuracy*

    — *RoadAuthority identifier*

    — *Extended flashing yellow operation*

    — *Prohibited movements*

    — *Movements Allowed After a Stop*

— Added specificity

— Will impact results of this testing

23

24

Task 5 Guidance Document

Objectives for Today

— Connected Intersections (CI) Guidance – brief overview of December 2022 publication

— High-level Summary of Revisions in Current Draft

— Walkthrough of Revisions to Specific Sections

Connected Intersections Guidance Document

— Initially published in December 2022

— Posted on the Connected Vehicle Pooled Fund Study website
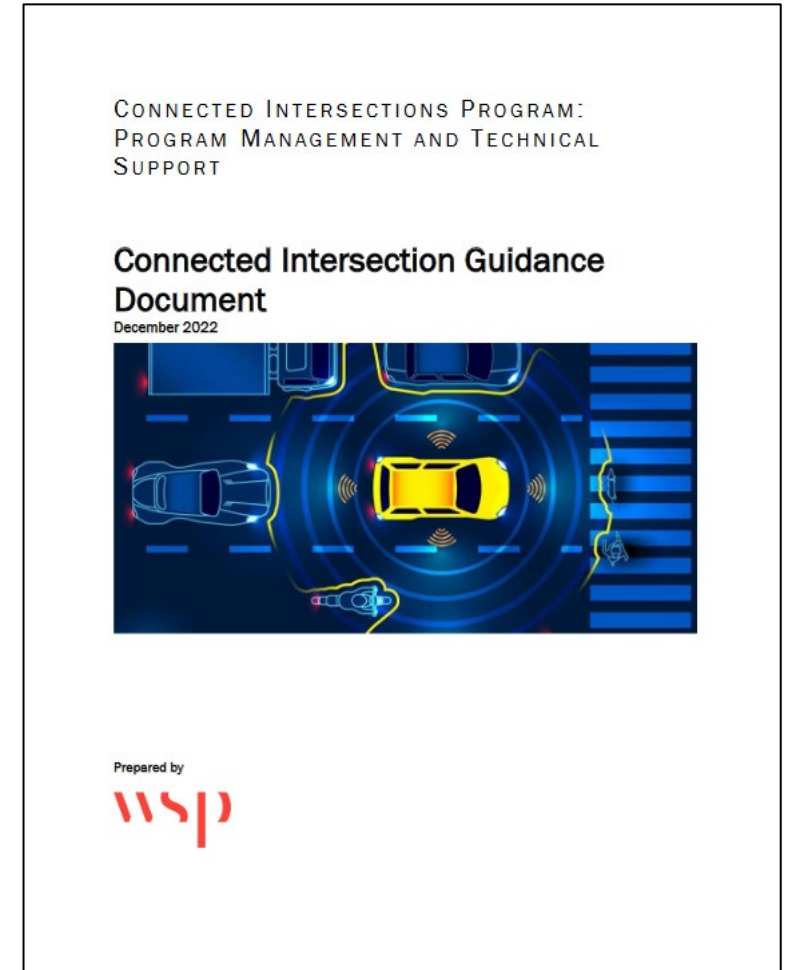
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Connected Intersections Guidance Document

Document Structure

— Revision Summary

— Executive Summary

— Chapter 1: Introduction

— Chapter 2: CI Guidance

— Chapter 3: Conclusions and Next Steps

— Appendix A: References

— Appendix B: Documentation from Guidance Steps

Connected Intersections Guidance Document

Document Structure

— *Revision Summary* ←

— Executive Summary

— Chapter 1: Introduction

— Chapter 2: CI Guidance

— Chapter 3: Conclusions and Next Steps

— Appendix A: References

— Appendix B: Documentation from Guidance Steps

New section describing the significant changes made in Revision #1 (which will be described on the following slides). This section mirrors what is in each CV PFS MAP Guidance Revision

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Connected Intersections Guidance Document

Revision Summary

— Most updates are about new CTI 4501 v02 CI Implementation Guide and affected the entire document:

    — *"Anticipated publication in 2024; applicable version until that time is CTI 4501 v01.01." with link to v01.01*

    — *Updated references to v02; updated text to reflect revisions in v02*

— Revisions to describe NTCIP 1202 v03B

    — *New version, changes identified in subsequent slides*

— Other new and updated references and links to resources

    — *5GAA US V2I Communications Day One Deployment Guide (new resource)*

    — *CV PFS MAP Guidance (new version)*

    — *CTI 4001 RSU Standard (new version)*

    — *SAE J2735 (new version)*

Connected Intersections Guidance Document

Chapter 1: Introduction

— Includes a definition and overview of CIs

— *Describes the key components of CIs* ←

— Describes the stages of CI deployment and operations

— Key standards and guidance

Revised to reflect CTI 4501 v02 RTCM transmission rate updates

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Connected Intersections Guidance Document

Chapter 1: Introduction

— Includes a definition and overview of CIs

— Describes the key components of CIs

— *Describes the stages of CI deployment and operations*

— Key standards and guidance

Revised here and throughout to be consistent with language used by OEMs and Utah DOT SMART Grant effort:
- **Testing** (bench testing and field testing, conducted by IOO), previously Testing and Validation
- **Formal Validation** (for SCMS certification), previously Verification

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Connected Intersections Guidance Document

Chapter 1: Introduction

— Includes a definition and overview of CIs

— Describes the key components of CIs

— Describes the stages of CI deployment and operations

— *Key standards and guidance*

Revised to reflect new and updated resources and standards

Connected Intersections Guidance Document

Chapter 2: CI Guidance

— Contains the guidance in 8 steps that follow general activities that are common when deploying CIs

Updates in titles to reflect changes to "Testing" and "Formal Validation"

CI Guidance Steps

— Step 1: Assemble Data and Information

— Step 2: Determine Capabilities and Options to Meet CI Requirements

— Step 3: Determine Procurement Specifications

— Step 4: Procure System Components

— Step 5: Assemble and Test System Off-line (Bench Testing)

— Step 6: Deployment and Field **Testing** ~~Validation~~

— Step 7: **SCMS Provider Validation** ~~Vehicle Verification~~

— Step 8: Operations and Monitoring

Table 1. Listing of Connected Intersections Guidance by Deployment Step

Step 1 – Assemble Data and Information
Guidance #1.1	Inventory Signal Control Equipment
Guidance #1.2	Understand Intersection Movement Control Types
Guidance #1.3	Assess Network Readiness
Guidance #1.4	Understand Options for Storing MAP Messages
Guidance #1.5	Document Advanced Traffic Management System (ATMS) Capabilities
Guidance #1.6	Understand Position Correction Options
Guidance #1.7	Understand Intersection Makeup
Guidance #1.8	Understand Capabilities to Support Testing and Validerification
Guidance #1.9	Research Federal Communications Commission (FCC) Licensing Process

Step 2 – Determine Capabilities and Options to Meet CI Requirements
Guidance #2.1	Assess Signal Controller Readiness
Guidance #2.2	Explore External Control Local Application Needs and Capabilities
Guidance #2.3	Understand Needed Roadside Unit Capabilities
Guidance #2.4	Assess if Agency Owned Roadside Units Meet Needs
Guidance #2.5	Explore Capabilities of Other Roadside Unit Manufacturers
Guidance #2.6	Understand the Security Credential Management System
Guidance #2.7	Assess Capabilities of Staff and Contractors
Guidance #2.8	Understand Capabilities Needed to Support Remote Management
Guidance #2.9	Develop High Level Connected Intersection Design

Step 3 – Determine Procurement Specifications
Guidance #3.1	Determine Signal Controller Procurement Specifications
Guidance #3.2	Determine External Control Local Application Procurement Specification
Guidance #3.3	Determine Roadside Unit Procurement Specification
Guidance #3.4	Determine MAP Message Procurement or Development
Guidance #3.5	Determine Radio Technical Commission for Maritime Services Procurement Specification
Guidance #3.6	Determine Security Credential Management System Procurement Specification
Guidance #3.7	Determine Test Equipment Procurement Specification
Guidance #3.8	Determine Field Installation Plans and Specifications

Step 4 – Procure System Components
Guidance #4.1	Consider Scalability to Expand Network of Connected Intersections
Guidance #4.2	Consider Upward Compatibility to Evolving Specifications
Guidance #4.3	Consider Scheduling
Guidance #4.4	Follow Agency Practices to Procure Equipment and Services

Step 5 – Assemble and Test System Off-Line (Bench Testing)
Guidance #5.1	Download and Familiarize with Resources to Support Off-line (Bench) Testing
Guidance #5.2	Develop Local Approach to Off-line (Bench) Testing
Guidance #5.3	Assemble and Configure the Off-line (Bench) Test Environment
Guidance #5.4	Collect Data for Off-line (Bench) Test
Guidance #5.5	Analyze Off-line (Bench) Test Data

Step 6 – Deployment and Field ValidationTesting
Guidance #6.1	Install Equipment in the Field
Guidance #6.2	Download and Familiarize with Resources to Support Field TestingValidation
Guidance #6.3	Determine Staffing and Equipment Approach to Field TestingValidation
Guidance #6.4	Develop Local Data Collection Plan for Field TestingValidation
Guidance #6.5	Collect Stationary Observations and Drive Through Deployed Connected Intersection to Gather Data
Guidance #6.6	Complete Requirements Validation Tests
Guidance #6.7	Complete Supplemental Validation Tests (Broadcast Periodicity and Yellow Interval Duration)
Guidance #6.8	Collect and Analyze Data to Validate MAP Message Content
Guidance #6.9	Make Changes to Correct Errors and Retest

Step 7 – SCMS Provider ValidVehicle Verification
Guidance #7.1	Plan for Vehicle VerificationPlan for SCMS Provider Validation
Guidance #7.2	Conduct Vehicle Verification Drive Through TestingConduct SCMS Provider Validation Testing
Guidance #7.3	Make Corrections to Any Identified Deficiencies
Guidance #7.4	Report Fully Validaterified Connected Intersection

Step 8 – Operations and Monitoring
Guidance #8.1	Implement a Message Monitor System
Guidance #8.2	Establish Business Processes for Proactively Identifying Disruptions
Guidance #8.3	Establish Business Processes for Responding to Disruptions
Guidance #8.4	Establish Business Processes for Restoring Operations After Updates or Disruptions
Guidance #8.5	Incorporate Connected Intersections into Asset Management Processes
Guidance #8.6	Engage with Pertinent Groups for Latest Updates

- 54 Guidance
- Arranged in 8 Steps

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Step 1: Assemble Data and Information

— Focuses on preparation to enable CI deployers to better understand existing conditions at the intersection and remaining needs by documenting information.

  — *e.g, includes understanding movement control types, signal control, equipment, network readiness, and agency Advanced Traffic Management System (ATMS) capabilities.*

Step 1:
Assemble Data and
Information

Step 2:
Determine Capabilities
and Options to Meet CI
Requirements

Step 3:
Determine
Procurement
Specifications

Step 4:
Procure System
Components

Step 5:
Assemble and Test
System Off-line
(Bench Testing)

Step 6:
Deployment and Field
Testing

Step 7:
SCMS Provider
Validation

Step 8:
Operations and
Monitoring

Step 1: Assemble Data and Information

Step 1:
Assemble Data and
Information

Step 2:
Determine Capabilities
and Options to Meet CI

Updates in Guidance #1.2 to describe NTCIP 1202v03B, which addresses CTI 4501 updates although products supporting it are not yet available

- If there are any protected/permissive turns during any of the timing plans, this may require additional processing if the NTCIP 1202v03A data elements are still used to communicate the SPaT data. Note that NTCIP 1202v03B supports protected/permissive turn indications without additional processing but not all controllers follow this standard yet; protected turns and permissive turns also do not require additional processing, it is only the combination of protective/permissive that do.

SCMS Provider
Validation

Step 8:
Operations and
Monitoring

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Step 2: Determine Capabilities and Options to Meet CI Requirements

— Builds on Step 1 by understanding the components needed at a CI, and what options (e.g., upgrading existing equipment or procuring new equipment) make the most sense given existing agency systems and capabilities.

  — *e.g., considers the readiness and capabilities of signal controllers, RSUs, and external control local application (ECLA), and increases understanding of security and staffing needs.*
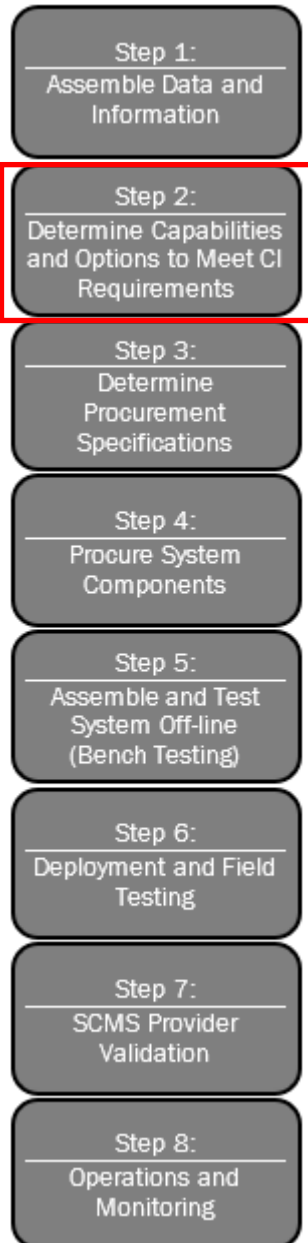
Step 1:
Assemble Data and Information

Step 2:
Determine Capabilities and Options to Meet CI Requirements

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Step 5:
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Step 6:
Deployment and Field Testing

Step 7:
SCMS Provider Validation

Step 8:
Operations and Monitoring

Step 2: Determine Capabilities and Options to Meet CI Requirements

Minor updates

Guidance #2.3: RSU Capabilities - "Note that NTCIP 1202v3B was released in 2023 to meet the requirements of CTI 4501; however, products may not yet be available that support NTCIP 1202v03B."

Guidance #2.6: Understanding SCMS - Added reference to 5GAA Day One Deployment Guide

Step 1:
Assemble Data and Information

Step 2:
Determine Capabilities and Options to Meet CI

Validation

Step 8:
Operations and Monitoring

Step 3: Determine Procurement Specifications

— Leverages documentation completed in Steps 1 and 2 to develop procurement specifications that will support procurement in Step 4 of the CI deployment process.

  — *Expected to be adapted based on local constraints, conditions, and the specific goals for the CI deployment.*

  — *Covers specifications for CI components including RSUs, ECLA, and test equipment, as well as field installation activities.*

Only minor updates to references

Step 1:
Assemble Data and
Information

Step 2:
Determine Capabilities
and Options to Meet CI
Requirements

Step 3:
Determine
Procurement
Specifications

Step 4:
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Step 5:
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Testing

Step 7:
SCMS Provider
Validation

Step 8:
Operations and
Monitoring

Step 4: Procure System Components

— Leverages procurement specifications developed in Step 3 and includes additional considerations while procuring CI system components for a deployment, such as scalability, type of procurement, and staffing needs.

Only minor updates to references

Step 1:
Assemble Data and Information

Step 2:
Determine Capabilities and Options to Meet CI Requirements

Step 3:
Determine Procurement Specifications

Step 4:
Procure System Components

Step 5:
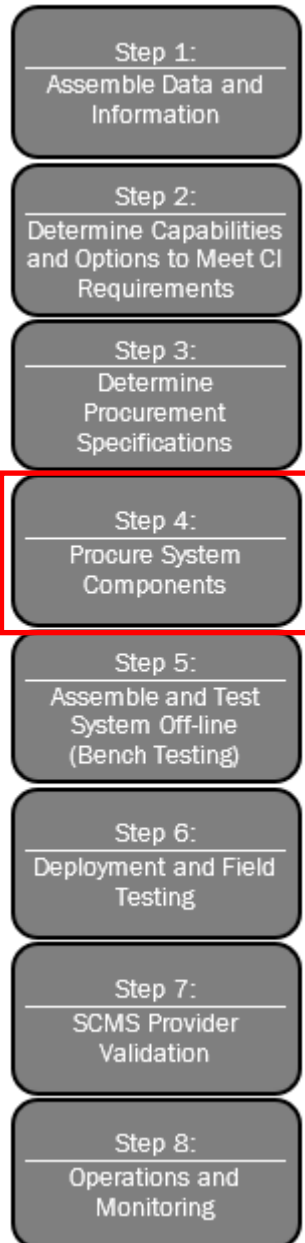Assemble and Test System Off-line (Bench Testing)

Step 6:
Deployment and Field Testing

Step 7:
SCMS Provider Validation

Step 8:
Operations and Monitoring

Step 5: Assemble and Test System Off-line (Bench Testing)

— Help practitioners understand the role of bench testing and support development of a local approach for testing all CI requirements using a combination of bench testing and field validation that is flexible for the local conditions, constraints, and available resources.

— Bench testing includes reviewing testing resources, developing a local approach for bench testing, assembling and configuring the bench test environment, and collecting and analyzing bench test data.

Step 1:
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Step 4:
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Step 5:
Assemble and Test System Off-line (Bench Testing)

Step 6:
Deployment and Field Testing

Step 7:
SCMS Provider Validation

Step 8:
Operations and Monitoring

Step 5: Assemble and Test System Off-line (Bench Testing)

Step 1:
Assemble Data and Information

Step 2:
Determine Capabilities

Updated description of SCMS provider validation based on Utah DOT SMART Grant efforts with CAMP and SCMS Manager

Updates to bench testing references based on availability:
- **Added notes to relevant Guidance about anticipated resources:** *Note that updated CI testing and validation tools are being developed by CAMP as part of the CTI 4501 v02 and Utah DOT "Enabling Trust and Deployment Through Verified Connected Intersections" SMART Grant efforts. These tools are anticipated to be available in early 2025.*
- **Removed CAMP SPaT/MAP Utility resource (not available)**
- **Updated CAMP resource "CI Performance Assessment Supporting Basic RLVW"**

Step 6: Deployment and Field Testing ~~Validation~~

— Describes field testing on operational intersections, which will allow the deploying agency to confirm the actual operation and performance of the specific intersection and to verify that the system is correctly configured for the specific intersection.

— *Includes information about CI equipment installation, a staffing, equipment, and data collection approach to field validation, and collection and analysis of data.*

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Deployment and Field Testing

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Step 6: Deployment and Field ~~Testing~~ ~~Validation~~

Based on understanding from Utah DOT SMART Grant efforts with CAMP and SCMS Manager.

- **Updated descriptions of SCMS provider validation**
- **Modified descriptions of Supplemental Tests for SPaT (Guidance #6.7) and MAP Testing (Guidance #6.8)**
  - **e.g., vehicle driving approach for MAP testing removed**

Same updates to field testing references as those made for bench testing, including notes about testing and validation tools from CTI and Utah efforts.

Step 1:
Assemble Data and
Information

Step 2:
Determine Capabilities

Monitoring

Step 7: SCMS Provider Validation ~~Vehicle Verification~~

— Describes how SCMS provider validation may be conducted to confirm CI operations to receive security credentials and confirm trust for original equipment manufacturer (OEM) production vehicles.

Significant updates to describe SCMS provider validation based on current understanding from Utah DOT SMART Grant efforts with CAMP and SCMS Manager, as well as anticipated test tools and processes for conducting validation.

Step 1: Assemble Data and Information

Step 2: Determine Capabilities and Options to Meet CI Requirements

Step 3: Determine Procurement Specifications

Step 4: Procure System Components

Step 5: Assemble and Test System Off-line (Bench Testing)
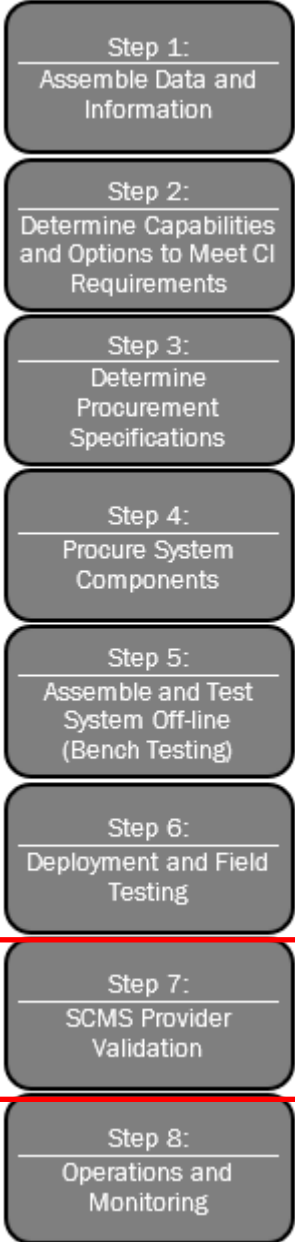
Step 6: Deployment and Field Testing

Step 7: SCMS Provider Validation

Step 8: Operations and Monitoring

Step 7: SCMS Provider Validation ~~Vehicle Verification~~

Updated text based on current understanding of SCMS provider validation in Guidance #7.1: Plan for SCMS Provider Validation

It is unknown who precisely will be responsible for initially collecting data using test tools and processes that are used to validate the intersection, generating the reports from the collected data to confirm whether the CI passes or fails specific validation criteria, and examining the validation reports to confirm the CI is fully validated and can receive security certificates. However, at the time this document is being created, it is envisioned that the agency operating the CI (likely with support from local contractors) would be able to acquire the tools, collect the data, and run the tools to generate the reports. More details will be available following the initial validation performed in Utah. In order to conduct this phase of testing, IOOs are expected to perform some planning activities to prepare for SCMS provider validation.

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Assemble Data and Information

Step 2:
Determine Capabilities and Options to Meet CI Requirements

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Determine Procurement Specifications

Step 4:
Procure System Components

Step 5:
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Step 6:
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Step 7:
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Operations and Monitoring

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Step 7: SCMS Provider Validation ~~Vehicle Verification~~

Also described anticipated roles during SCMS Provider Validation, and clarify distinction between SCMS Providers and SCMS Manager

- **Deploying Agency**: acquire validation tools that are required by SCMS Manager validation procedure; collect or download data from the CI; run data through the validation tools; generate and examine output reports; adapt system, as needed, if the CI does not-initially pass; and send the report to the agency's SCMS provider. Some or all of these activities may be conducted by vendor services.

- **Agency SCMS Provider**: review and approve reports received from deploying agencies.

- **SCMS Manager**: publish processes and procedures for conducting the validation process for a CI to receive security credentials, which include information about test tools to use and acceptable report content and format for approving a CI; update and refine processes and procedures for conducting CI validation, as needed, based on industry consensus, lessons learned, and more robust validation tools, for example.

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Step 7: SCMS Provider Validation ~~Vehicle Verification~~

Updated Guidance #7.2: Conduct SCMS Provider ~~Vehicle Verification Drive Through~~ Validation Testing

Removed references to drive through testing.

Noted that this may involve "validation as a service" and MAP testing may be conducted using contracted LIDAR services

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SCMS Provider Validation

Step 8:
Operations and Monitoring

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Step 8: Operations and Monitoring

— Describes normal CI operations and monitoring that is necessary to ensure ongoing accuracy and functionality of CI equipment and broadcast.

Reference to Utah DOT SMART Grant efforts with CAMP and SCMS Manager and anticipated processes for operations and monitoring.

Significant updates to Guidance #8.1: Implement a Message Monitor System to describe CIMMS Phase 1 effort and outcomes.

Step 1:
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Determine Procurement Specifications

Step 4:
Procure System Components

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Deployment and Field Testing

Step 7:
SCMS Provider Validation

Step 8:
Operations and Monitoring

Step 8: Operations and Monitoring

The CV PFS conducted a project to develop and test a Connected Intersection Message Monitoring System (CIMMS) prototype to provide constant, automated monitoring of SPaT and MAP messages broadcast at CIs. The CIMMS provides near-immediate feedback to users when potential issues with SPAT and MAP are detected and allows for the replay of SPaT and MAP data on a map-based visualization. This is useful for deployers during initial validation testing, as well as over the long-term for identifying irregularities in SPaT and MAP that may arise due to geometry or signal timing plan changes.

The initial development of the CIMMS prototype considered a limited set of message requirements and additional efforts are underway at the time this guidance is being revised to refine and expand the CIMMS capabilities. The initial effort was limited to receiving connected vehicle (CV) messages from an existing CV system, and using SPaT, MAP, and BSMs (driver behavior that provides a proxy for ground truth conditions) to assess the correctness of data within SPaT and MAP messages. This approach in CIMMS reasonably assumes the data in SPaT and MAP messages should be consistent with general vehicular movement as evidenced in BSMs. A screenshot of the CIMMS prototype user interface dashboard is shown in Figure 15, depicting assessments of signal state stops, signal state passage, connection of travel, and lane direction of travel that are used to assess SPaT and MAP message data. In addition to the updates to CIMMS that are currently underway, CIMMS is expected to evolve as new needs are identified, new mechanisms are developed for monitoring, and additional deployments and testing is conducted. Additional message malfunctioning detection approaches may also be developed.

Significant updates on CIMMS Phase 1 effort, outcomes, and anticipated role moving forward.

Step 1:
Assemble Data and Information

Step 7:
SCMS Provider Validation

Step 8:
Operations and Monitoring

Step 8: Operations and Monitoring

Source: Connected Vehicle Pooled Fund Study

Figure 15.   CIMMS User Interface Dashboard

Step 1:
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SCMS Provider
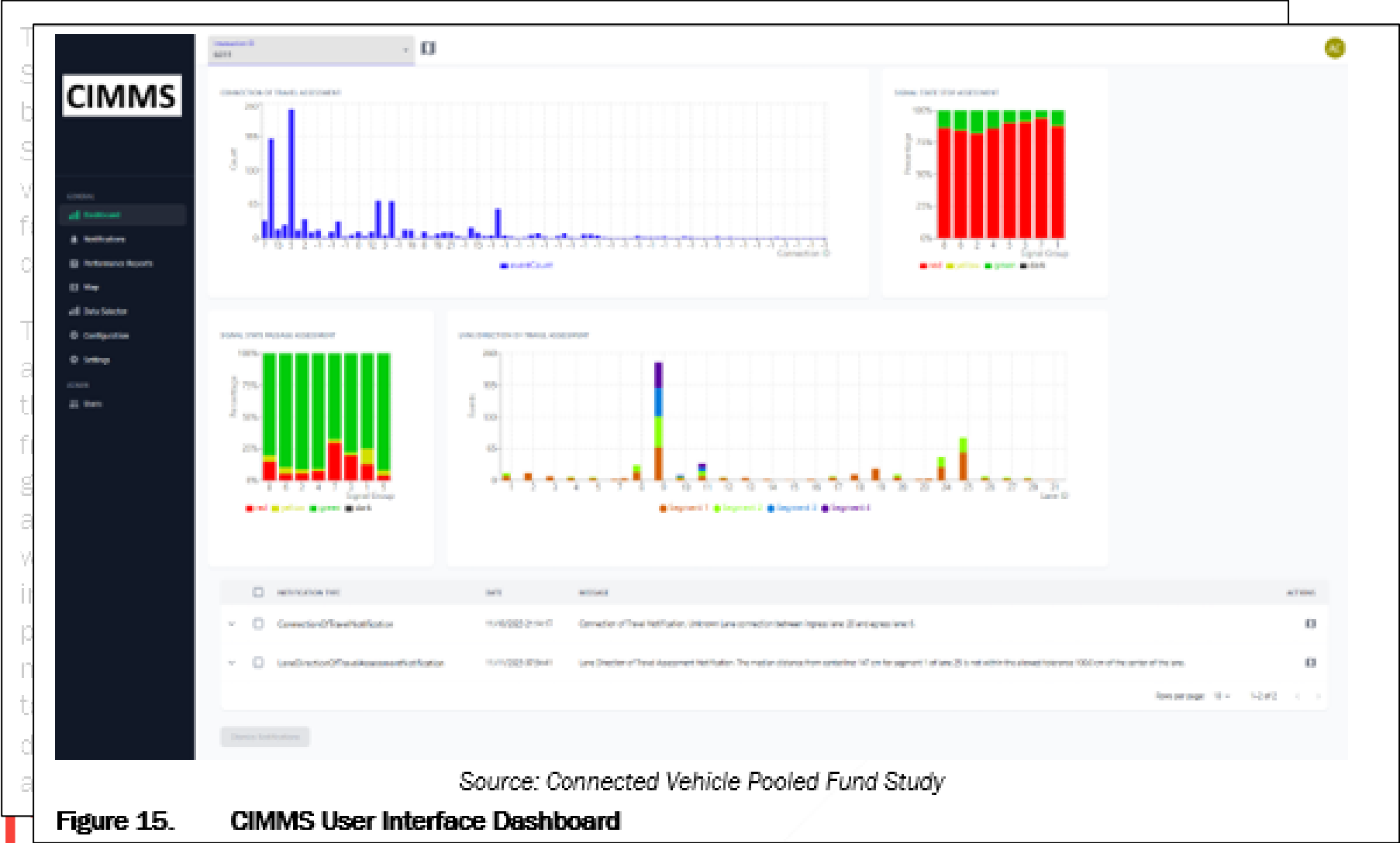Validation

Step 8:
Operations and
Monitoring

Step 8: Operations and Monitoring

Step 1:
Assemble Data and
Information

Step 2:
Determine Capabilities
and Options to Meet CI
Requirements

Step 3:
Determine
Procurement
Specifications

Monitoring

Guidance:

- Deployers are encouraged to monitor the CV PFS CIMMS effort and additional detection approaches of the CV PFS beyond the CIMMS project. The initial project followed a systems engineering approach to design and create a prototype system that was tested in Arizona and Utah in 2023. A second phase of the CIMMS project is underway to enhance existing capabilities for monitoring and evaluating SPaT and MAP messages, to assist IOOs in identifying when or if issues arise with their CIs. The CIMMS source code is available on the USDOT Joint Program Office Operational Data Environment GitHub site for download free of charge. Deployers may use this version of CIMMS to gain experience with its capabilities and requirements while updates are being made and formal processes for implementing CIMMS at CIs are being developed Deployers of CIs can refer to the CV PFS CIMMS Final Report for additional information.

- Deployers are encouraged to reference CI validation products developed by CAMP and SCMS Manager as part of the Utah DOT "Enabling Trust and Deployment Through Verified Connected Intersections" SMART Grant. These are anticipated to be available in early 2025.

Source: Connected Vehicle Pooled Fund Study

Figure 15.   CIMMS User Interface Dashboard

Reference UDOT effort with CAMP and SCMS Manager and anticipated processes for monitoring.

Connected Intersections Guidance Document

Chapter 3: Conclusions and Next Steps

— Includes links to other important resources to have on hand while using the CI Guidance

— Includes note to check for updated versions of guidance and standards

— Includes mechanism to provide feedback on CI Guidance

Updates to links, resources, and standards, as previously noted.

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Next Steps for Guidance Document

— Include updated links to new CV PFS website (MAP Guidance, CI Test Plan, etc.)

— Make final updates based on comments received from CV PFS Members

— Looking ahead to Revision #2 of CI Guidance, future edits will incorporate:

  — *Other updates and links for final CTI 4501 v02 and ITE/SAE CI Phase 2 products*
  — *Description of approach and products from Utah DOT SMART Grant effort related to testing, SCMS Provider Validation, and Operations and Monitoring*

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Next Steps

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Next Steps

— Finalize and submit Test Report

— Finalize and submit Guidance Document updates

— Finalize Project Phase III scope and budget

— Kickoff Project Phase III

— Next CV-PFS Meeting is scheduled for 05/31/24 @ 1pm ET

— Next Panel Meeting is scheduled for 06/18/24 at 3pm ET

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Phase III [Scope](#) Discussion

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Thank You!

Questions?

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