Enabling 2022

Connected Intersection Communications with Production Vehicles by 2022

1. Background

Engagement with the stakeholders throughout the CAT industry has identified automobile manufacturers planning for the release of on-board V2I intersection-based safety applications in production vehicles beginning in model year 2022. This plan will allow for infrastructure owner-operators (IOOs) to broadcast SPaT and MAP messages that are interoperable with production vehicles to support these applications, through a combination of network and roadside-to-vehicle communications, accomplishing true cooperative connectivity with production vehicles.

This intent of this paper is:

- To define the concept of "Enabling 2022" and identify what needs to be accomplished to achieve Enabling 2022;
- To map the Enabling 2022 needs against existing initiatives as much as possible to identify the gaps that must be performed prior to 2022; and
- To define a work plan of activities to support discussions about who will perform the activities and provide the resources required.

2. Overview of Enabling 2022

There are multiple activities that need to be accomplished to enable communications with production vehicles that can proceed independent of the specific communication protocol employed and approach to security credentialing. In order to meet the 2022 goal, the industry must not wait to address these activities sequentially after the communications spectrum and security topics are resolved. The intent of this initiative is to address these key enablers for deployment, while the spectrum and security topics are being addressed in parallel.

Commented [RS1]: The communication protocol and security are necessary for interoperability and should be included in the Enabling 2022, otherwise 2022 will not be enabled.

The premise of ***Enabling 2022*** is the following:

A. The industry needs a proven effective, reproducible, turnkey approach to testing and verifying the broadcasts of SPaT and MAP data that can be consistently and reliably implemented by IOOs throughout the United States.
    i. Testing procedures and reporting need to be collaboratively developed and ultimately trusted by both the IOOs that will execute the testing and the OEMs that are planning production vehicle deployments of on-board applications.
    ii. Testing procedures should support the testing of both format and content of network communications (over cellular networks) and direct communications (roadside to vehicle).

B. For IOOs to deploy the infrastructure systems to meet the testing parameters, several resources and/or activities are needed to enable the deployments to meet the minimum requirements in the testing and verification process. Some of these are available today, some are in development, and some will need to be created prior to 2022.

The following seven needs have been identified, as a minimum, to enable 2022 connectivity:

1. Unambiguous accepted minimum requirements for the connected intersection broadcast of SPaT and MAP.~~Standards compliant and industry recognized Clarifications for Consistent Implementation (CCI) document for connected intersections~~

~~2. Consistency and appropriate accuracies for MAP messages~~

2. Test Procedures & Tools to verify 'proper' SPaT & MAP transmission over the air.

3. A means to monitor connected intersection operation for continued proper operation and turn off SPaT and MAP if specified errors or conflicts with signal indications are identified.

4. A Reference Implementation executed to demonstrate and validate the end-to-end deployment and testing – with included Functional Safety Assessment;

5. IOO training for successful connected signalized intersection deployments;

6. National ~~Registry of Connected Intersections~~numbering scheme for DE_RoadRegulatorID

7. National approach to ongoing operations and maintenance of connected intersections

8. Accepted SCMS policy and provider(s) for production SCMS

~~7.~~9. Agreement on one or more V2I communication technologies with associated technical requirements.

3. Mapping the 2022 Needs to Ongoing Initiatives and Identifying Gaps

The table below identifies existing initiatives that are partially or fully addressing the seven needs defined in section 2, and the remaining gaps that must be addressed by the CAT Coalition and IOO/OEM Forum.

#	Needed by 2022	Ongoing Initiatives	Gaps / Actions for the CAT Coalition - IOO/OEM Forum
1	Standards compliant and industry recognized Clarifications for Consistent Implementation (CCI) document for signalized intersections	• USDOT/ITE CCI standardization effort is underway; • CAT Coalition IOO/OEM Forum CCI document draft exists & there is ongoing action to advance clarifications as input to the USDOT effort	**Action #1: CCI Efforts.** Continue identifying and resolving ambiguities and share findings with the USDOT/ITE CCI effort.

#	Needed by 2022	Ongoing Initiatives	Gaps / Actions for the CAT Coalition - IOO/OEM Forum
2	Consistency and appropriate accuracies for MAP messages	• CV PFS effort to develop guidelines for MAP creation	**Action #2: MAP Guidelines Coordination.** Coordination with CV PFS MAP Guidelines Project to understand dates and milestones and if a supporting role in sharing the outcomes of the CV PFS project is needed, etc.
3	Test Procedures & Tools to verify 'proper' SPaT & MAP transmission over the air.	• Early Signalized Intersection draft Test Plan developed by CAMP. • Extensive CV Pilot and ATCMTD site testing conducted. • FHWA led interoperability testing.	**Action #3: Test Plan.** Finalize a Connected Intersection Test Plan with detailed testing procedures and test reporting requirements Note: Testing content specific to communications mediums will be excluded until clear national communications approach is known.
4	A Reference Implementation executed to demonstrate and validate the end-to-end deployment and testing – with included Functional Safety Assessment		**Action #4. Reference Implementation and Functional Safety Assessment** -Identify a location, initiate, execute, and document a Reference Implementation to include a functional safety assessment.
5	IOO training for successful connected signalized intersection deployments.	• CAT Coalition Peer Exchange & Outreach Working Group is available to inform the industry of this initiative, when appropriate. • Network of ITE groups and initiatives with proven training and outreach strategies	**Action #5: Develop Enabling 2022 Outreach Strategy.** To organize and supplement IOO training, this plan will describe activities and roles to share the CCI, Test Plan, MAP Guidance, and Reference Implementation Results.
6	National Registry of Connected Intersections	• SPaT Challenge tracking map and self-reports from multiple deployments. • CAT Coalition Strategic Initiatives and Technical Resources Working Groups are available to support industry collaboration and tracking of progress.	**Activity #6: Deployment Tracking**. An activity to coordinate, track and summarize progress towards implementing the Enabling 2022 Plan.

Commented [SR(2]: This could/should be part of #1

Commented [SR(3]: The test plan should test against requirements. #1 should provide clarifications in the form of well-formed requirements that can become the basis of testing.

Commented [SR(4]: One OEM announced plans for C-V2X. Has any other OEM announced plans for DSRC? Maybe start with the assumption of C-V2X.

Commented [SR(5]: It is not clear why a national registry is needed. However, in order to ensure each intersection reference ID is globally unique, we need to have a national scheme for numbering the road regulator ID. Then each road regulator can ensure the intersection IDs they are responsible for are unique. Maybe the numbering scheme also becomes part of #1.

Commented [SR(6]: We need an activity to follow up with the people who are trying to create a numbering scheme. If the process is stalled, maybe we need to nudge it along like we are doing with the CCIs.

#	Needed by 2022	Ongoing Initiatives	Gaps / Actions for the CAT Coalition - IOO/OEM Forum
7	National approach to ongoing operations and maintenance of connected intersections	• Extensive CV Pilot and ATCMTD site testing conducted and O&M planning	**Activity #7: O&M Approach**. An activity to define a common approach to operating, maintaining, testing, and verifying connected intersection operations to ensure consistency with on-board application expectations.

Work Plan to Address the Actions Needed to Accomplish Enabling 2022

The following actions and responsibilities are identified to complete the actions identified above, with supporting details about outcomes/deliverables and schedule.

Gap	Actions / Outcomes / Schedule
Action #1: CCI Efforts. Continue identifying and resolving ambiguities and share findings with the USDOT/ITE CCI effort.	***Actions/Responsibilities:*** • IOO/OEM SPaT/RLVW group to continue to identify areas of ambiguity, as experienced in field deployments. • OEM input synthesized with the help of CAMP; IOO input synthesized through CAT Coalition Project Team • CCI document to be updated roughly quarterly if new ambiguities are identified and resolved. Latest version passed on to the USDOT/ITE effort and CV PFS MAP Guidance effort. ***Outcomes/Deliverables:*** • Quarterly updates to the CCI document posted to CAT Coalition website, shared with USDOT/ITE, and shared through Peer Exchange & Outreach webinars ***Schedule:*** • Six months of active aggressive work to identify and resolve as many additional ambiguities as possible (Feb – July, 2020) • Release a "near-final" version in August 2020 to use for reference implementation and test plan finalization • As additional ambiguities are identified, these will continue to be documented and shared with the USDOT effort
Action #2: MAP Guidelines Coordination. Coordination with CV PFS MAP Guidelines Project to understand dates and milestones and if a supporting role in sharing the outcomes of the CV PFS project is needed, etc.	**Actions/Responsibilities:** • IOO/OEM SPaT/RLVW group to be available to offer input to early drafts of the MAP guidance document. • OEM input synthesized with the help of CAMP; IOO input synthesized through CAT Coalition Project Team • As the CV PFS project (scheduled March 2020-February 2021) identifies the two test sites for testing MAP guidance, consider these sites as possible Reference Implementation sites for other enabling activities (e.g. testing, verification of SPaT). • As the MAP Guidelines are drafted and eventually finalized, include these in the 'suite' of training materials assembled to promote consistent deployments. ***Outcomes/Deliverables:*** • Review and input, as requested, to the CV PFS deliverables • Candidate site(s) for reference implementation ***Schedule*** • In synch and based on the schedule of the CV PFS project • Monthly interactions with CV PFS members participating in the IOO/OEM SPaT/RLVW group

Commented [SR(7]: The IOO/OEM forum previously created SPaT Infrastructure ConOps and Requirements documents. One approach would be to incorporate the findings of CCIs into the ConOps and Requirements. Then we could create test plans based on the requirements. It would also be a more standard type of document versus the CCI document.
Also, this effort may be able to utilize an upcoming CVPFS funded project to help identify and resolve additional ambiguities.

Commented [SR(8]: The results of the mapping project could be incorporated into the ConOps and Requirements.

Gap	Actions / Outcomes / Schedule
Action #3: Test Plan. Finalize a Connected Intersection Test Plan with detailed testing procedures and test reporting requirements Note: Testing content specific to communications mediums will be excluded until clear national communications approach is known.	**Actions/Responsibilities:** • CAMP to update early draft test plan created to reflect the most recent ambiguity resolutions • IOOs in the IOO/OEM Forum to provide initial input and feedback to the test plans – CAMP to update based on initial feedback • CAMP to invite broader input from the OEM community and make updates to test plan as appropriate. • CAT Coalition Project Team to invite broader input from IOOs and other stakeholders through Resources WG & outreach to Pilot Sites – CAMP and CAT Coalition Project Team to update test plan based on further feedback ***Outcomes/Deliverables:*** • Connected Signalized Intersection Test Plan (excluding specifics to communications medium and security) – interim drafts to support stakeholder input • Final Test Plan for use in Reference Implementation and eventual widespread sharing with the industry ***Schedule*** • Six months of active aggressive work to finalize the test plan and seek input from stakeholders (Feb – July, 2020) • Release of Final Test/Verification Plan in August, 2020 to use for reference implementation and sharing with industry.
Action #4. Reference Implementation and Functional Safety Assessment - Identify a location, initiate, execute, and document a Reference Implementation to include a functional safety assessment.	**Actions/Responsibilities:** • CAMP to prepare a safety needs systematic assessment through broader coordination with OEMs as a key input to the Reference Implementation. • IOO/OEM SPaT/RLVW Group to discuss and develop an overall plan for the Reference Implementation during monthly webinars. s in the IOO/OEM Forum to provide initial input and feedback to the test plans – CAMP to update based on initial feedback • CAMP to invite broader input from the OEM community to the Reference Implementation planning. • CAT Coalition Project Team to invite broader input from IOOs and other stakeholders through Resources WG & Strategic Initiatives WG. • CAT Coalition Project Team with CAMP input to create a Reference Implementation Plan. ***Outcomes/Deliverables:*** • Reference Implementation Plan • Reference Implementation executed and documented ***Schedule*** • Development of Reference Implementation Plan in parallel to the development of the Test Plan and MAP Guidelines – completion by August 2020. • Reference Implementation executed and documented between September – December 2020 (final dates TBD).

Commented [SR(9]: An additional related gap is how to ensure the SPaT broadcast matches the intersection signal indications on an ongoing basis. The long term answer would be to incorporate the live SPaT data into the signal cabinet conflict monitor (or malfunction monitor or cabinet monitor depending on which cabinet standard you are using). In the short term, until that happens, we may need a separate computer in the cabinet looking at what the controller is commanding and comparing it with what the RSU is broadcasting. The conflict monitor would be better because it is already wired to the signal indication outputs to observe what is actually being displayed at the intersection.

Commented [SR(10]: At some point we would need a clearer definition of what is a reference implementation. Is it a real intersection somewhere that everyone needs to travel to to test with? Is it software that runs on an RSU and broadcasts known good SPaT/MAP that could be used anywhere? Is it a system in a suitcase? Should there be a reference of the OBU also so that IOOs could use that to test the signal against?

Gap	Actions / Outcomes / Schedule
Action #5: Develop Enabling 2022 Outreach Strategy. To organize and supplement IOO training, this plan will describe activities and roles to share the CCI, Test Plan, MAP Guidance, and Reference Implementation Results.	**Actions/Responsibilities:** • Determine an overall approach to leveraging the CAT Coalition Working Groups (and association's working groups) to accomplish the goal of widespread sharing of the Enabling 2022 Plan • CAT Coalition Project Team members to include outreach in regularly scheduled activities • ITE, ITS America, AASHTO to include outreach in regularly scheduled activities ***Outcomes/Deliverables:*** • Monthly activities to outreach and educate about the Enabling 2022 Plan through regularly scheduled activities and added webinars/meetings as needed. • Goal is 100% awareness by IOOs of the plan • Note: this action will not result in training of IOOs and should be coordinated with other activities/efforts. ***Schedule*** • Planning activities to occur between August – December 2020 • Intensive outreach activities during initial 4 months (December 2020 – March 2021) to provide IOOs with the information needed to allow them to begin final preparations for 2022. • Outreach activities encouraging implementation of the plan through July 2022.
Activity #6: Deployment Tracking. An activity to coordinate, track and summarize progress towards implementing the Enabling 2022 Plan.	**Actions/Responsibilities:** • Determine the appropriate working group(s) (e.g. Strategic Initiatives or Resources) to perform the roll of coordinating and tracking IOO deployment status. • Integrate self-reporting and coordination into monthly/quarterly activities of the CAT Coalition Working Groups • Integrate peer exchanges and lessons sharing, leveraging existing functions such as NOCoE to the extent possible. ***Outcomes/Deliverables:*** • Gold Stars identified on tracking map of IOOs that have completed the testing verification process ***Schedule*** • Planning activities to occur between August – December 2020 • Tracking and coordination between December 2021 and July 2022.

Commented [SR(11]: We need some actions to ensure there is a national numbering scheme by 2022.

Commented [SR(12]: I like Mike Schulman's comment that the gold star could be incorporated into the SCMS process. You cannot get production certificates without providing the SCMS people with documentation of successful testing of the intersection.

Gap	Actions / Outcomes / Schedule
Activity #7: O&M Approach. An activity to define a common approach to operating, maintaining, testing, and verifying connected intersection operations to ensure consistency with on-board application expectations.	**Actions/Responsibilities:** • Define the operational concepts and scenarios for ongoing operations of connected intersections; • Facilitate IOO and OEM agreement on approaches to such situations as: power outages, roadwork, short-term (1-8 hour) closures, medium term (1-3 day) closures, and long-term closures; • Define O&M minimum criteria and requirements, as well as candidate approaches to accomplish this for all IOOs ***Outcomes/Deliverables:*** • O&M Plan for Connected Intersections ***Schedule*** • Concepts and scenarios defined in 2020; • Outreach and consensus building with IOOs and OEMs during 2021; • Finalization of plan in early 2022.