CAT Coalition Infrastructure-Industry Working Group Meeting

May 27, 2021

1:30-3:00 pm (Eastern)

AASHTO ITS AMERICA ite

Today's Agenda

- Welcome and Introductions
- I-I WG Work Plan Activity Updates: Primer of Terms and AV Scan
- Update from Focus Area WG – IOO/OEM Forum:
  Connected Intersections Consistent Procedures for Operations
- SAE Harmonization of Standards Effort
- Announcements and Closing Remarks
  - CAT Coalition and Partner Announcements or Updates: US DOT, ITS America, ITE, AASHTO
  - Ongoing Commitment to Outreach and Knowledge Transfer

I-I Working Group: Recap of Activities

- The role of this Working Group is to:
  - Support pre-competitive industry research that will advance infrastructure development and maintenance
  - Connect IOOs with industry
  - Support the natural evolution of infrastructure to accelerate CAVs
  - Clarify terms, definitions and target audiences
- Last meeting recap:
  - I-I WG Work Plan Activity: Primer of Terms
  - KPMG's AV Readiness Index
  - Update on Physical Infrastructure Enhancements to Support AV Deployment
- Link: https://transportationops.org/CATCoalition/infrastructure_industry_WG

I-I WG Work Plan Activities: Primer of Terms and AV Scan

Jeremy Schroeder, Athey Creek

Primer of Terms Resource

- Discussed on March I-I WG Webinar and distributed in April for review

- Definitions are not intended as a preferred definition or to be exclusive of variations or interpretations used by other organizations.
  - We do not intend this as an authoritative source, but as a introduction and reference to bridge the gap between IOO and OEM terms that are used
- Definitions are intended to serve as a starting point for practitioners to have a common understanding of terms used either by IOOs, original equipment manufacturers (OEMs), or both
  - We acknowledge similar work that has been conducted by other working groups

Last Call for Comments on Primer

- Resource distributed to WG members in April for review
  - Are there terms that are missing that should be included?
  - Are there terms that should be removed?
  - Is there a definitive resource that should be used as a reference?
  - ***Definitions are intended as a starting point reference for readers, not intended as authoritative or an endorsement***

- ***Please submit any comments or additions ASAP to Jeremy***
  - Primer will be posted soon on CAT Coalition resources webpage: https://transportationops.org/CATCoalition/resources

AV Scan Activity

- Currently developing four sets of questions as a broader follow-up to the 2020 AV Shuttle Survey
  1. Private Sector AV
  2. Public Sector: AV Shuttles
  3. Public Sector: PDDs
  4. Public Sector: Other AVs

- Plan to distribute next month
  - Intent is to distribute to different groups so that the same person is not tasked with completing multiple question sets

IOO-OEM Forum Product: Connected Intersections Consistent Procedures for Operations

Blaine Leonard, Utah DOT

Connected Intersections Background

- Definition by ITE: an infrastructure system that broadcasts signal, phase and timing (SPaT), mapping information and position correction data to On-Board Units and Mobile Units
- IOO-OEM Forum identified a need: inherent and intended flexibility in standards and system architecture documents used in V2I data exchanges, which may limit or prevent national interoperability
- “Clarifications for Consistent Implementation” resource developed by IOO-OEM Forum, which led to USDOT/ITE Connected Intersections (CI) effort
  - https://www.ite.org/technical-resources/standards/connected-intersections

Need & Purpose of Resource

- Identifies and begins to clarify approaches to operations and disruption scenarios that will regularly or periodically occur with fully operational Connected Intersections (CIs)
  - Short- or long-term maintenance, road work, or closures, power outages, etc.
  - Conflict monitoring is critical to signal operations; an equivalent approach for Connected Intersections is also needed
- Identifies need for ongoing activities as Connected Intersections are deployed and operated
  - Does not identify or prescribe roles
  - Builds on USDOT/ITE Connected Intersections and RSU Standardization efforts
- Identifies situations and considerations for when operational decisions are needed

Resource Status

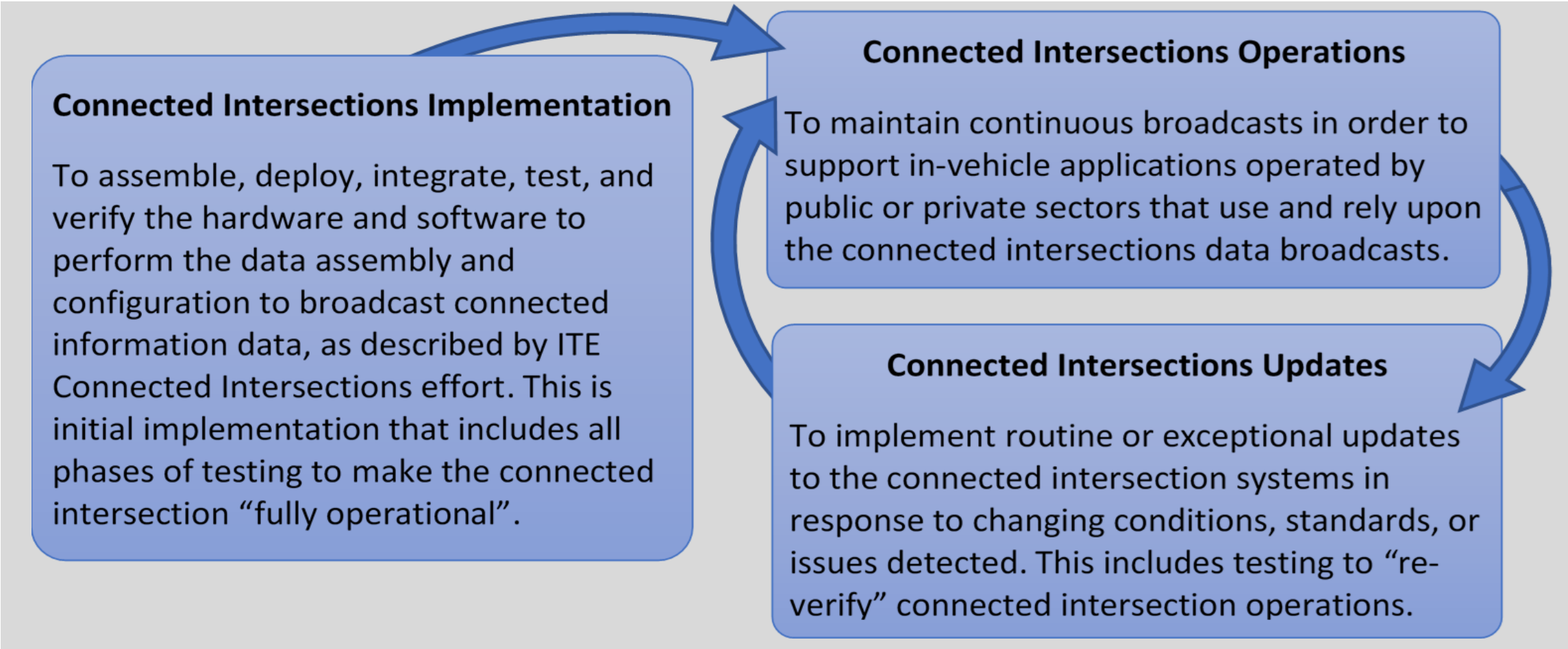
- Initial draft developed and reviewed by the IOO/OEM Forum SPaT/RLVW Working Group
- Posted to the CAT Coalition website as a dated draft document
  - Plan is to update and evolve the document
  - We'd appreciate input from this working group (email Blaine or Jeremy)
  - Available at: https://transportationops.org/sites/transops/files/CI%20Consistent%20Procedures%20for%20Operations%20v1.2%20041920 21.pdf

Resource Content

- Current structure of the resource
- We will highlight several sections today

Table of Contents

Connected Intersections: Role of Operations



Four Principles for Connected Intersection Operations

- ***Principle #1: No Broadcasts of Incorrect Messages.*** Incorrect information risks doing greater harm than if no message were broadcast at all. Any broadcast message should always contain correct information.

- ***Principle #2: Restore Correct Broadcasts Progressively as Soon as Practical.*** Functionality of CIs should be restored in a progressive, gradual, reliable approach that results in messages containing correct information being broadcast as soon as is practical.

- ***Principle #3: Anomalies Must Self-Report to Ensure Accurate Messages.*** Anomalies (i.e., CI broadcast does not match the current signal controller mast head displays or the MAP and/or RTCM message is incorrect) should be self-reported by individuals causing the outage (e.g., a utility closing an approach lane to the intersection) when possible. Self-reporting anomalies by automated processes or system detection is also a preferred option.

- ***Principle #4: Clearly Identify Fully Operational Connected Intersections.*** Cis should be considered "in deployment" until fully tested, verified, and secured; upon which they should be considered "fully operational".

Evolving Tactics for Operating Connected Intersections: Normal Operations

- ***SPaT Operations.*** Operating and maintaining the connection between the signal controller and the RSU to ensure content is continuously generated for broadcast to connected vehicles.
- ***MAP Updates.*** Creating and implementing an approach that any time the intersection geometry is altered or the assignment of signal groups changes, the MAP message is updated, tested, verified, secured, and uploaded to be broadcast by the RSU.
- ***Position Correction Operations.*** Operating the selected approach to generate and secure location position correction messages (e.g., RTCM messages) continuously without interruption.
- ***Malfunction Monitoring.*** Operating malfunction monitors to detect situations when the signal controller data does not match SPaT broadcasts. Emerging approaches are expected to be developed and tested in the coming years, which may include:
  - Expansions of existing malfunction monitoring equipment and systems that monitor traffic signals today.
  - New approaches, like comparisons of basic safety message (BSM) data received from connected vehicles in an around the intersection against current signals.
- ***Security Operations***. Operating security credentialling business practices to ensure credentials are being created on a continuous basis, as needed.

Evolving Tactics

In 2021, not practical for IOOs to immediately respond to all types of outages that may impact the quality of CI broadcasts.

The number of vehicles operating in-vehicle applications does not justify prioritization of resources to such a response.

Over the coming 10-20 years:

- More intersections are likely to become connected, with increasing numbers of products to support easier more efficient management of the broadcasts;
- More vehicles are likely to be equipped with in-vehicle applications;
- The role of in-vehicle applications is likely to change, possibly beyond supplemental warning systems to supporting partial or automated driving functions, increasing the reliance on the data broadcast by the infrastructure; and
- The operations that IOOs perform will evolve with potentially an increased emphasis on maintaining the operational status of infrastructure broadcast.

Evolving Tactics for Operating Connected Intersections: During Outages and Disruptions

Possible tactical approaches that may be chosen by an agency for various types of disruptions, include:

- ***Take no action.*** Wait for the temporary disruption to end. In situations where a lane is closed temporarily, the lane may reopen shortly after and no action may have been performed in response to the outage.
- ***Pause Broadcasts.*** Implement a temporary stop/pause in broadcasting the messages. In situations where a physical activity impacts the intersection, the RSU broadcast may be paused while either the MAP or SPaT messages are not valid.
- ***Supplemental warning***. It may be more efficient to continue to broadcast SPaT/MAP messages while adding an indication in either the SAE J2735 message or the security WSA message to indicate the messages are not valid;
- ***Broadcast Road Safety Messages (RSMs).*** RSMs describing the maintenance or construction work zone event could be broadcast to help indicate to passing vehicles that the intersection operations may be disrupted.
- ***On-site Responder Broadcasts***. Alerts could be broadcasts by vehicles (e.g., law enforcement or first responder vehicles) at the intersection (e.g., stationary location, flashing beacons activated) that would help indicate to passing vehicles that intersection operations may be disrupted.

Evolving Tactics for Operating Connected Intersections: Preliminary Tracking Approach

Industry and broader community of stakeholders need general understanding of number and location of “fully operational” connected intersections.

1. **Self-reporting process coupled with a web-enabled platform** to support reporting and viewing is needed for tracking deployments of “fully operational” CIs.
   a. Tracking is **not intended to be a real-time depiction** (fully functioning vs. those with a temporary malfunction), but a **representation of the number of sites “fully operational” CIs**.
2. **High-level count of Connected Intersections by state and/or metro area**, at a minimum
3. **Tracking may also consider number of Cis operating at different thresholds of standards or capabilities**.
   a. CIs using the latest standards vs. earlier standards;
   b. CIs with additional capabilities like queue length detection and green window reporting (for applications);
   c. CIs “in deployment” that require additional testing to be “fully operational”.

Four Use Cases Describing Possible Disruptions

- Complete unplanned malfunction such as a loss of power (e.g., to everything versus specific elements like RSU and/or controller);
- Partial malfunction where the RSU is operational but data is not guaranteed;
- Maintenance, construction, incident, or planned special event; and
- A geometry change at the intersection

5.4 Geometry Change at the Intersection

<table>
<tr>
<td>Activity:
• An additional turn lane is added to the intersection. Signal timing (and signal groups) are adjusted to reflect the change.
• There is a construction period and a period where the MAP message is updated.</td>
<td>Signal Controller Status:
• Signal may continue to operate as timed during construction, with flaggers directing traffic when needed.
• Signal timing changes will be implemented just prior to the opening of the new lane.</td>
<td>SPaT Message:
SPaT Message is still derived from the controller data. When the new timing plan is implemented, SPaT data will immediately be output.

MAP Message:
MAP message (initial geometry) will exist and may be broadcast and valid during the construction period.
A new MAP message will be needed to reflect the additional lane and connections.</td>
</tr>
<tr>
<td colspan="3">Considerations and Possible Solutions:
• This represents a combination of several use cases above:
  • There will likely be times when intersection work is active, that the original MAP message is inaccurate and the broadcast should be paused.
  • There will likely be times when intersection work is inactive and all lanes are open (e.g., evenings) when the broadcast of SPaT/MAP is appropriate.
• There will be a need to test the newly configured intersection to verify the SPaT/MAP are properly represented upon reopening the intersection.</td>
</tr>
</table>

Feedback Requested

- Any initial thoughts or reactions?
- Available at: https://transportationops.org/sites/transops/files/CI%20Consistent%20Procedures%20for%20Operations%20v1.2%2004192021.pdf
- Email comments and feedback to Blaine or Jeremy

SAE Harmonization of Standards Effort

Tim Weisenberger, SAE

SAE ADS Standards Roadmapping Initiative

Roadway Automation Readiness Roundtable

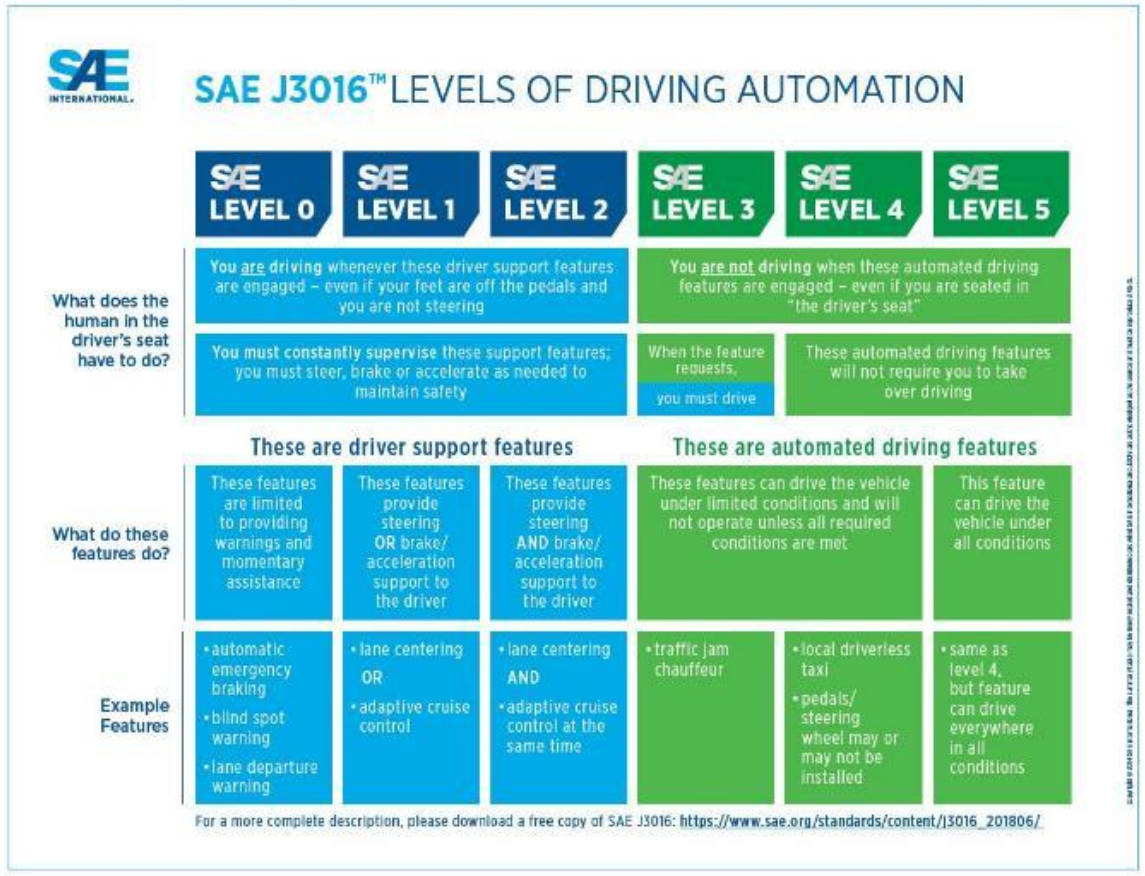
May 24, 2021

Tim Weisenberger

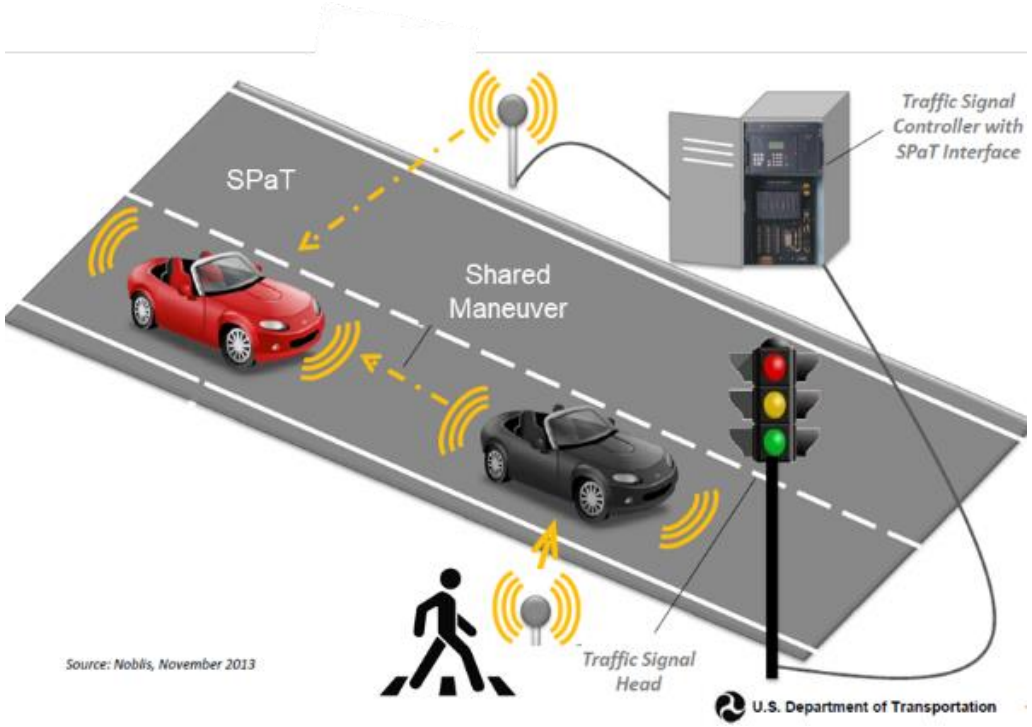
SAE International Ground Vehicle Standards

Automation with Cooperation

Automation + **Cooperation**



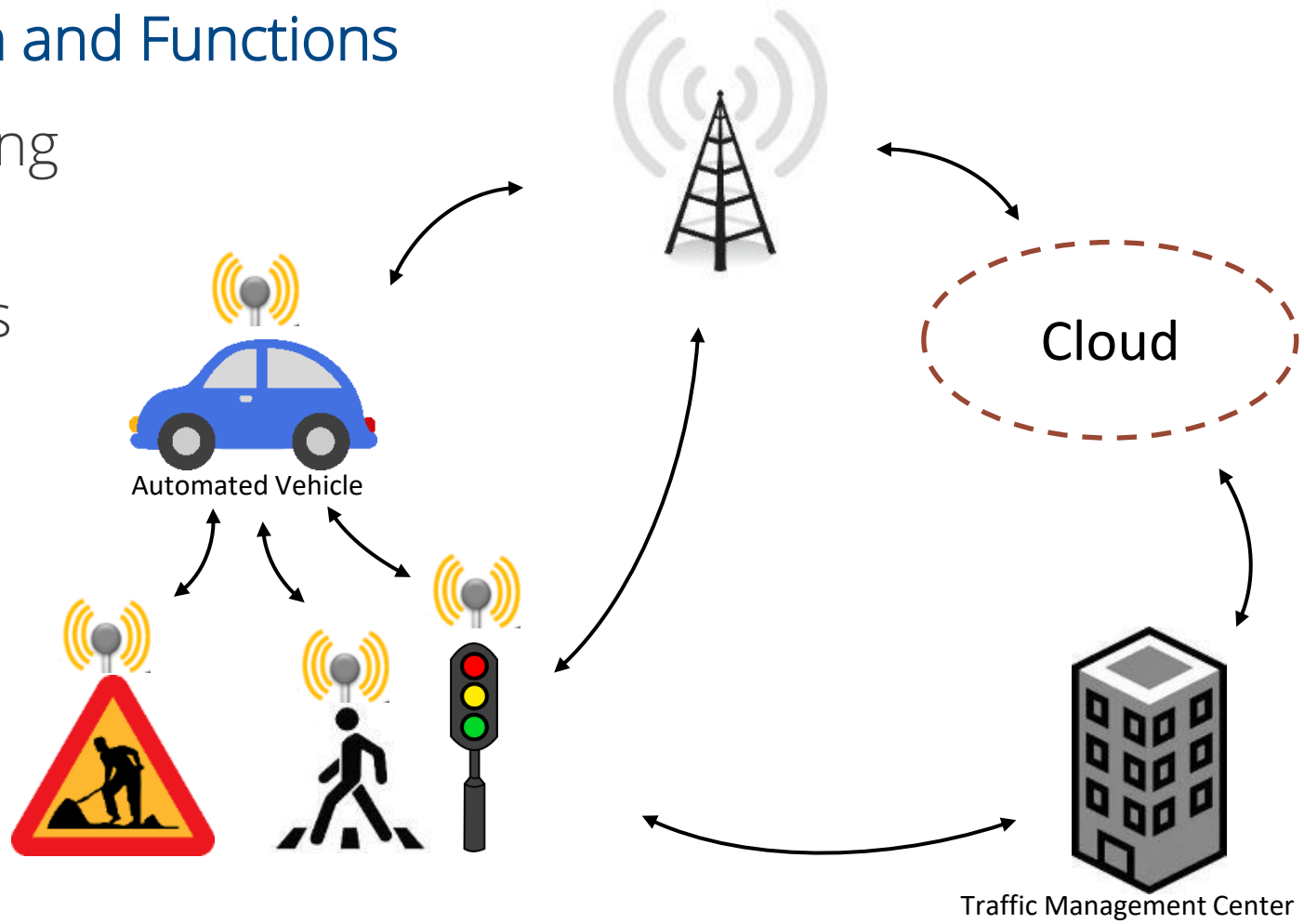
SAE J3216



Key Concepts: Traffic Infrastructure Cooperation

Traffic Infrastructure Information and Functions

- Traffic signal phase and timing
- Dynamic speed limits
- Road conditions, road works
- Dynamic temporary maps
- Lane drops
- Etc.



SAE International Standards Roadmap

SAE ADS Standards Roadmap Introduction

Why build an ADS standards roadmap?

Technologies are emerging at varying timescales

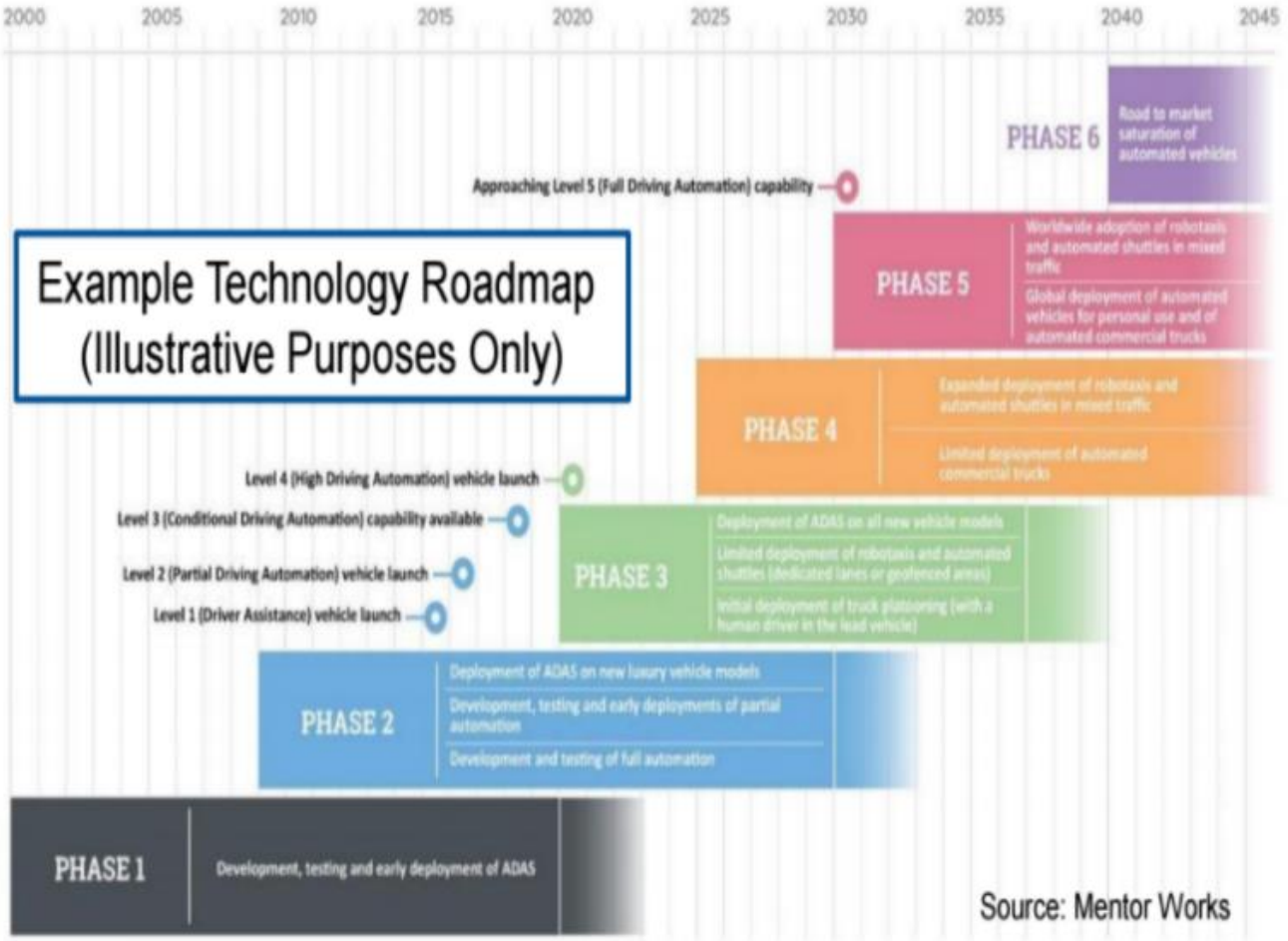
Standards can accelerate safe deployment

Many standards are underway and it is increasingly difficult to track all of them

SAE has developed a tool to capture standards needs and coordinate on addressing gaps

Acts as a living roadmap

Intended to incorporate changes over time based on crowdsourced input



Collecting Input: Organizing Standards Needs into Categories

Deployment Phase

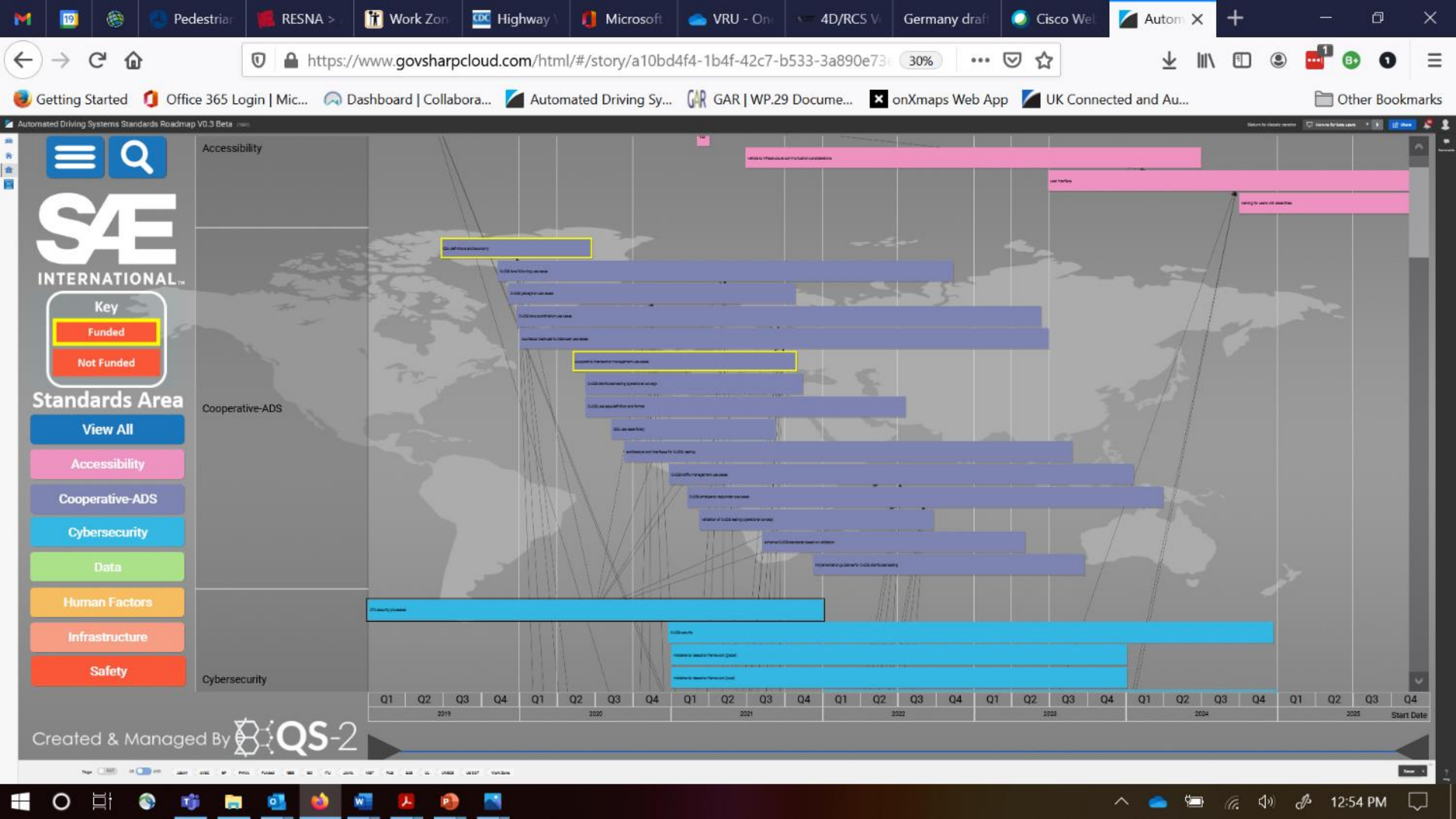
- Design
- Development
- Demonstration
- Deployment

Functional Area

- Cooperative-ADS
- Cybersecurity
- Data
- Human Factors
- Infrastructure
- Safety

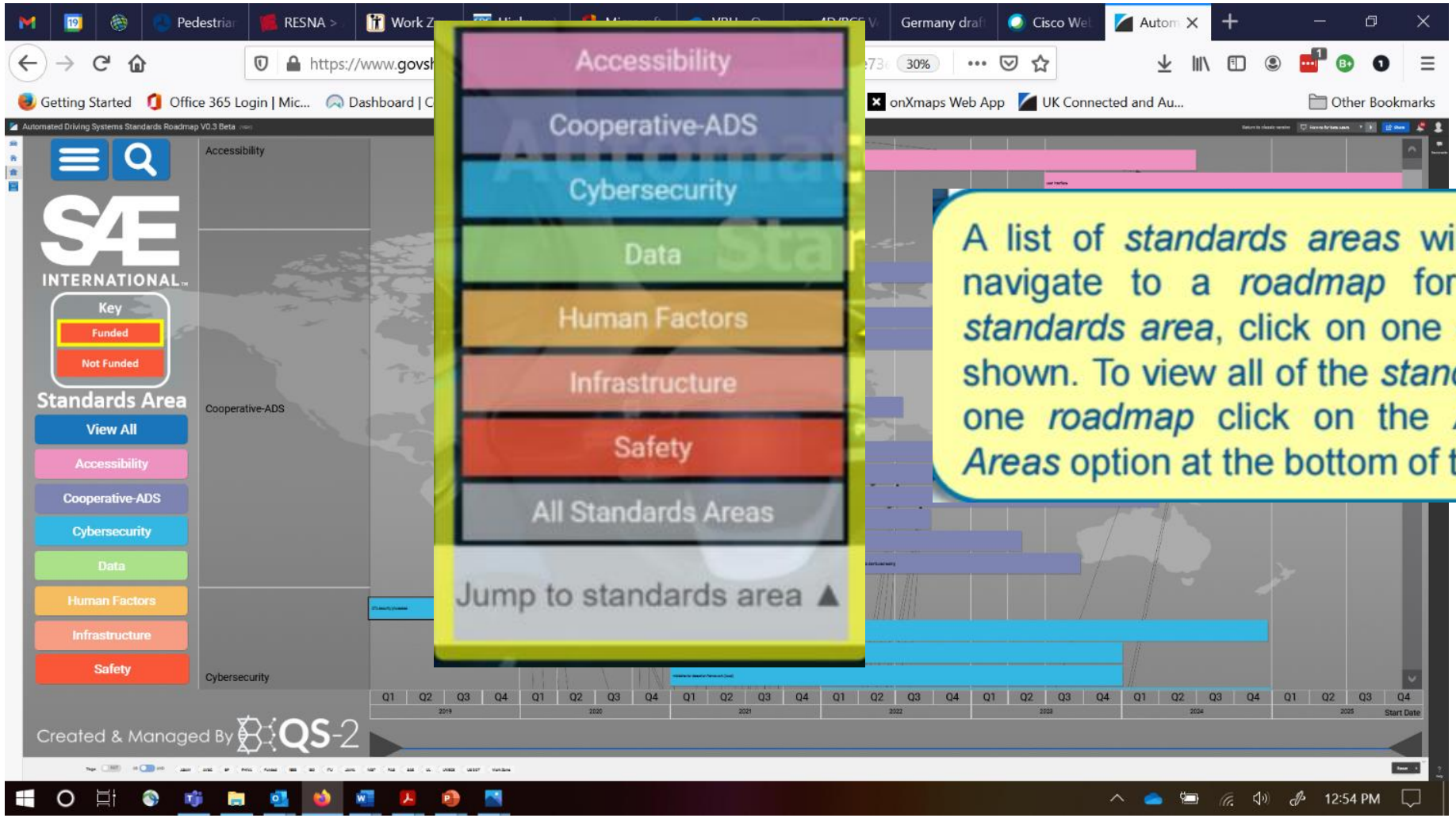
Standards Functionality

- Definitions and Architecture
- Data Format
- Design
- Maintenance and Inspection
- Functional / Performance
- Protocol (Communications)
- Security
- Testing / Test Targets
- Training


Automated Driving Systems Standards Roadmap V0.3 Beta
SAE INTERNATIONAL
Key
Funded
Not Funded
Standards Area
View All
Accessibility
Cooperative-ADS
Cybersecurity
Data
Human Factors
Infrastructure
Safety
Accessibility
Cooperative-ADS
Cybersecurity
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
2019 2020 2021 2022 2023 2024 2025
Start Date
Created & Managed By QS-2

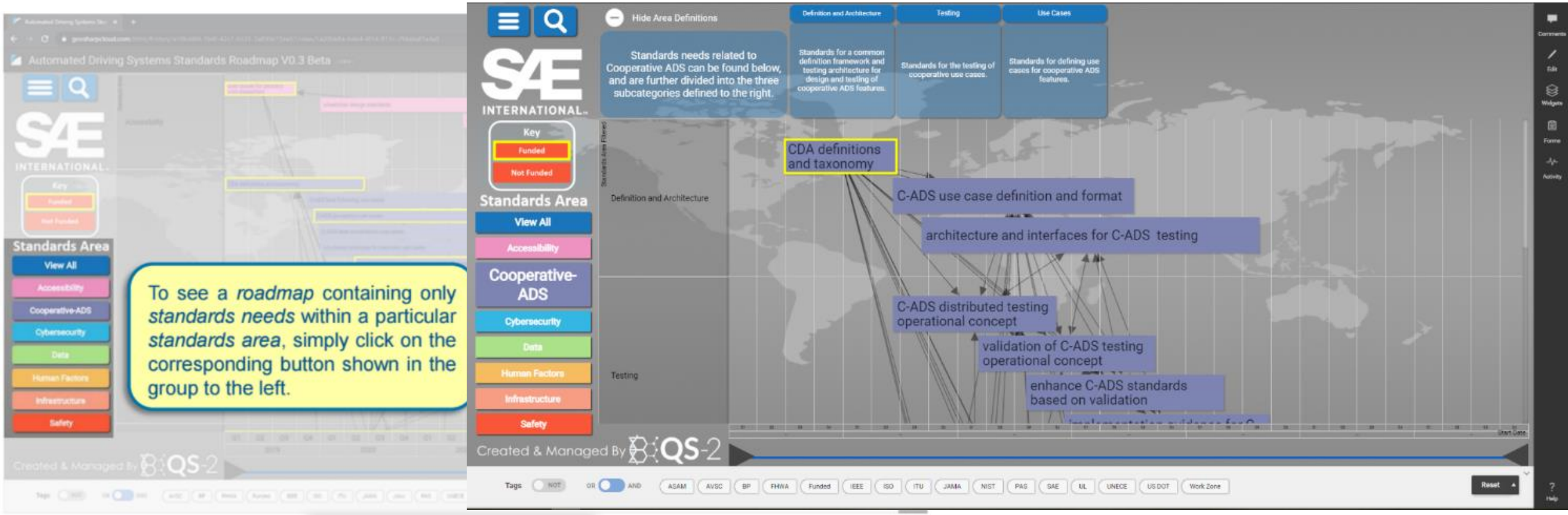
Navigating Roadmap -Roadmap Overview

Navigating Roadmap- Main Menu

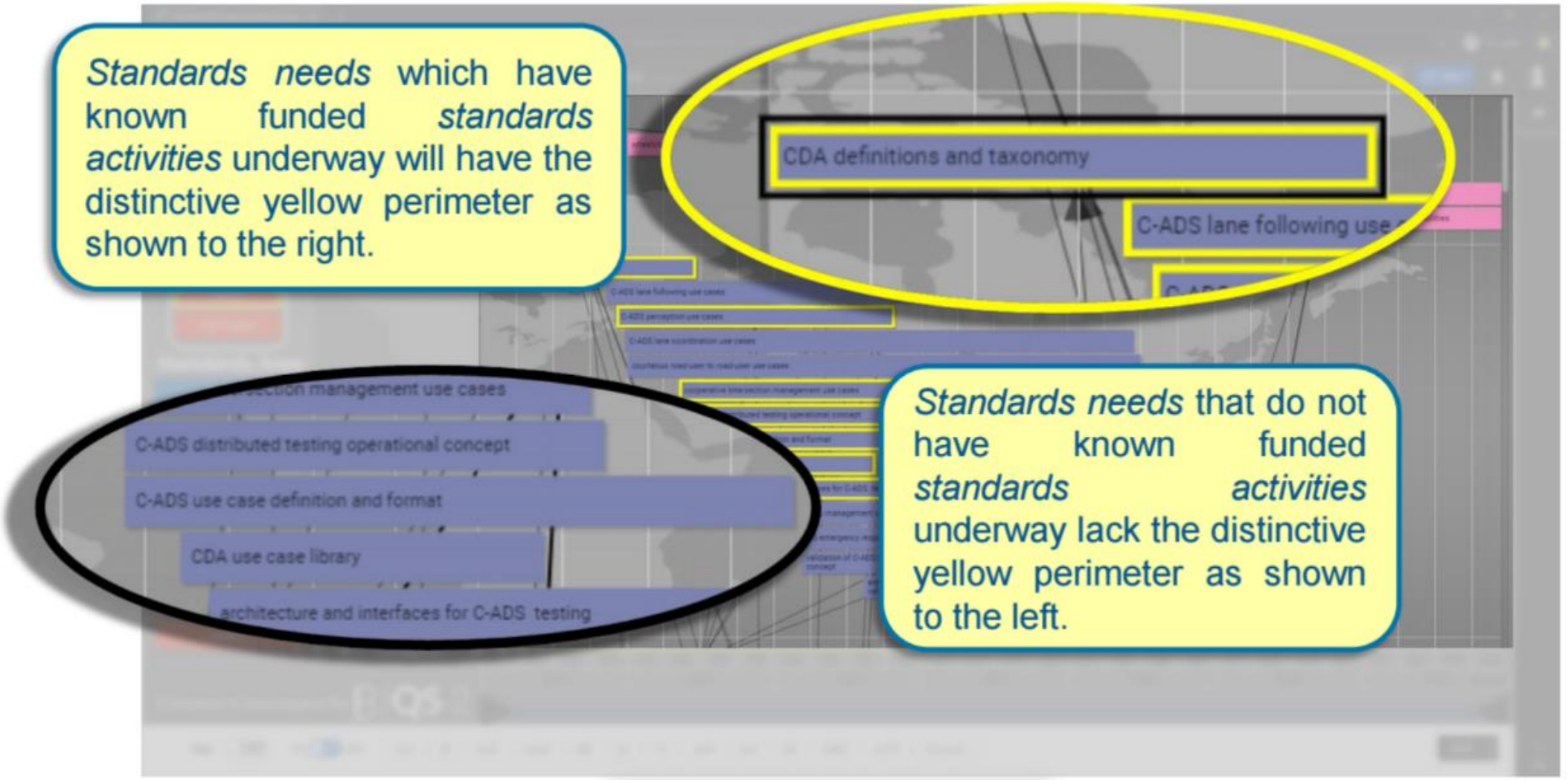


Navigating Roadmap -Standards Areas

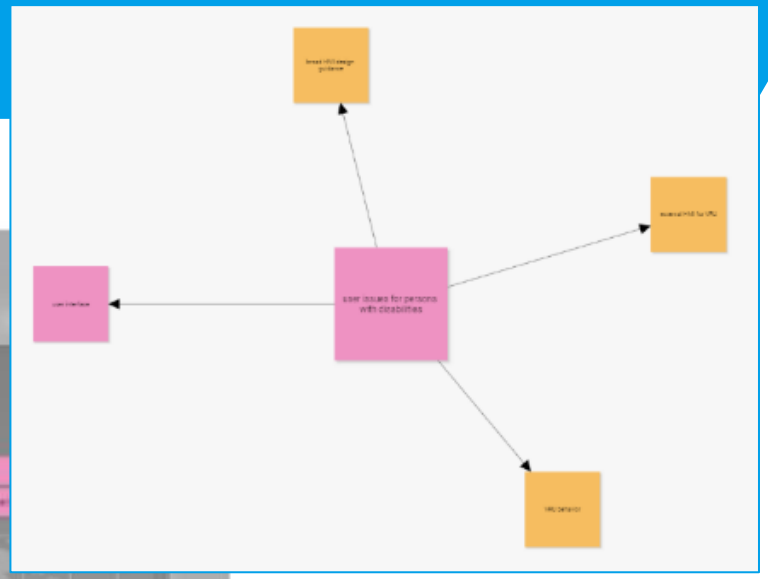
Relationships and sub-areas



Navigating Roadmap -Funding Indication



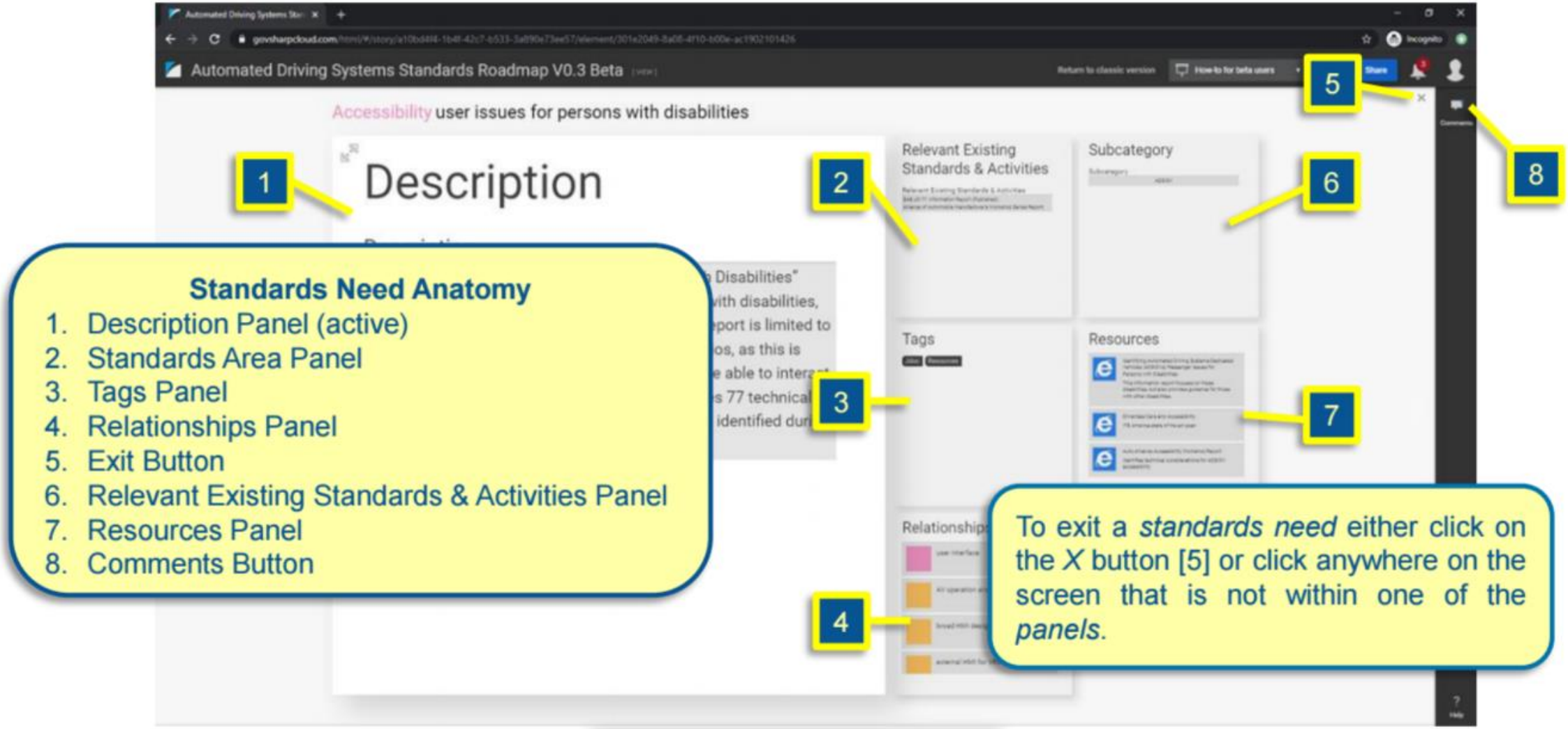
Navigating Roadmap -Relationships



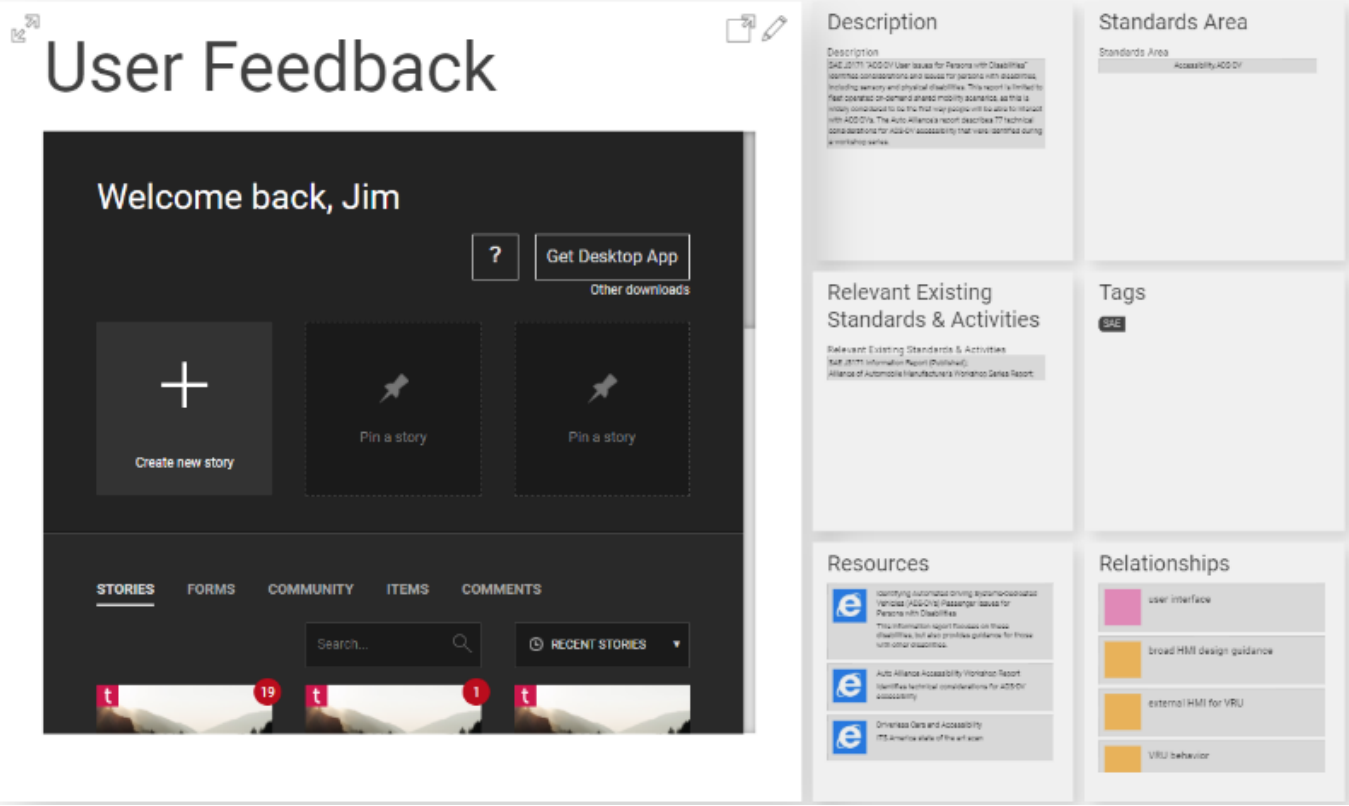
The ADS Standards Roadmap identifies *relationships* between *standards needs*. These *relationships* are represented by the arrows between *standards needs*.

Click on a *standards need* to view more information on its *relationships*.

Navigating Roadmap -Inside Each Element



Navigating Roadmap -User Feedback



SAE Feedback Forms

General Feedback Form

Roadmap Item 15

General Feedack

Please Provide Your First Name

Please Provide Your Last Name

Please Provide Your Organization

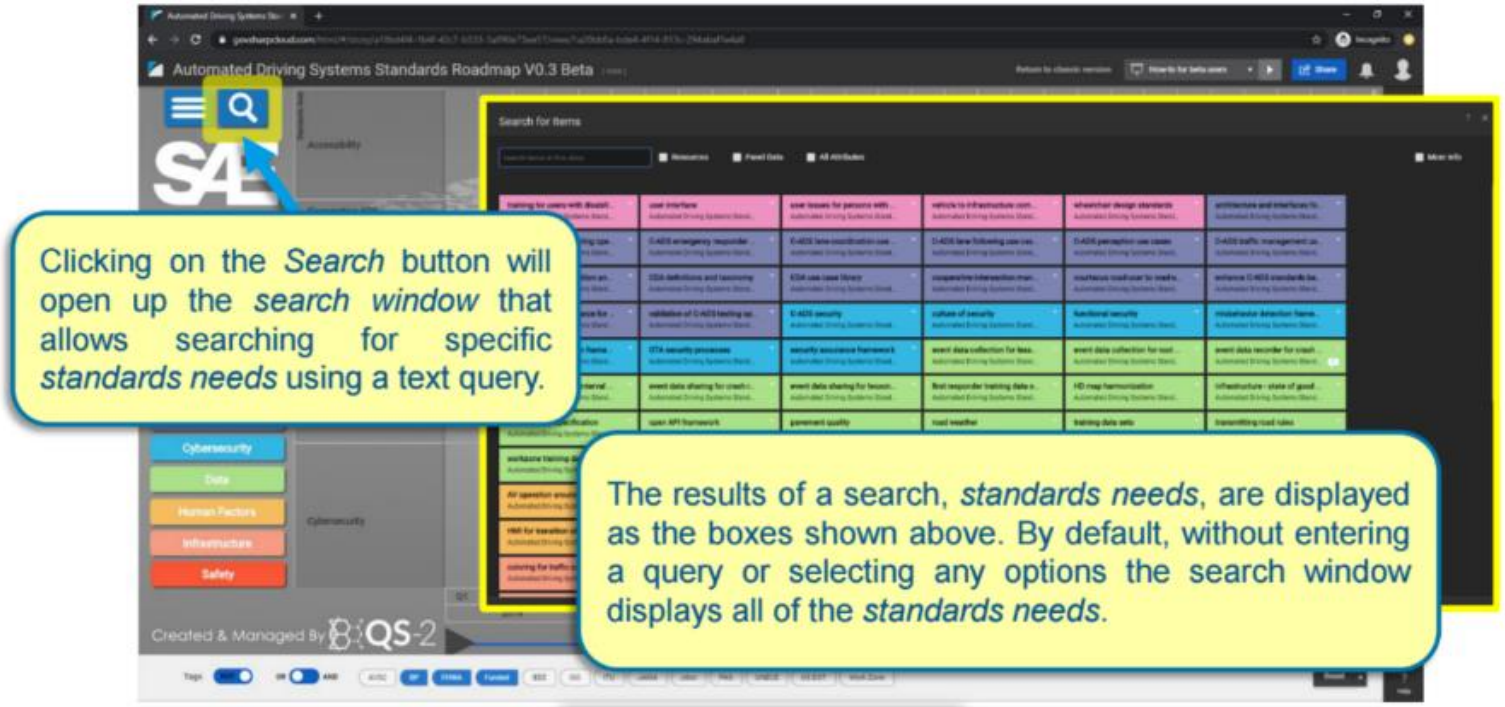
Please Provide Your Email

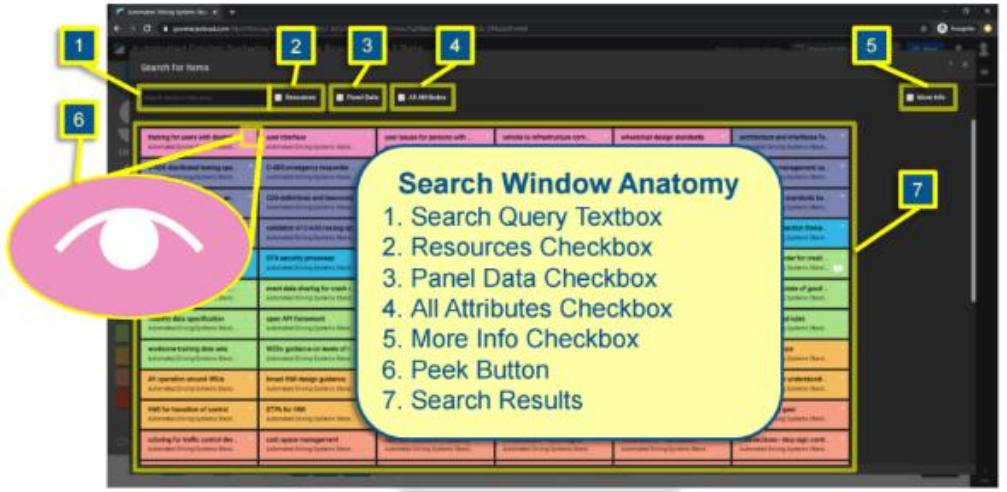
Please Choose a Feedback Category

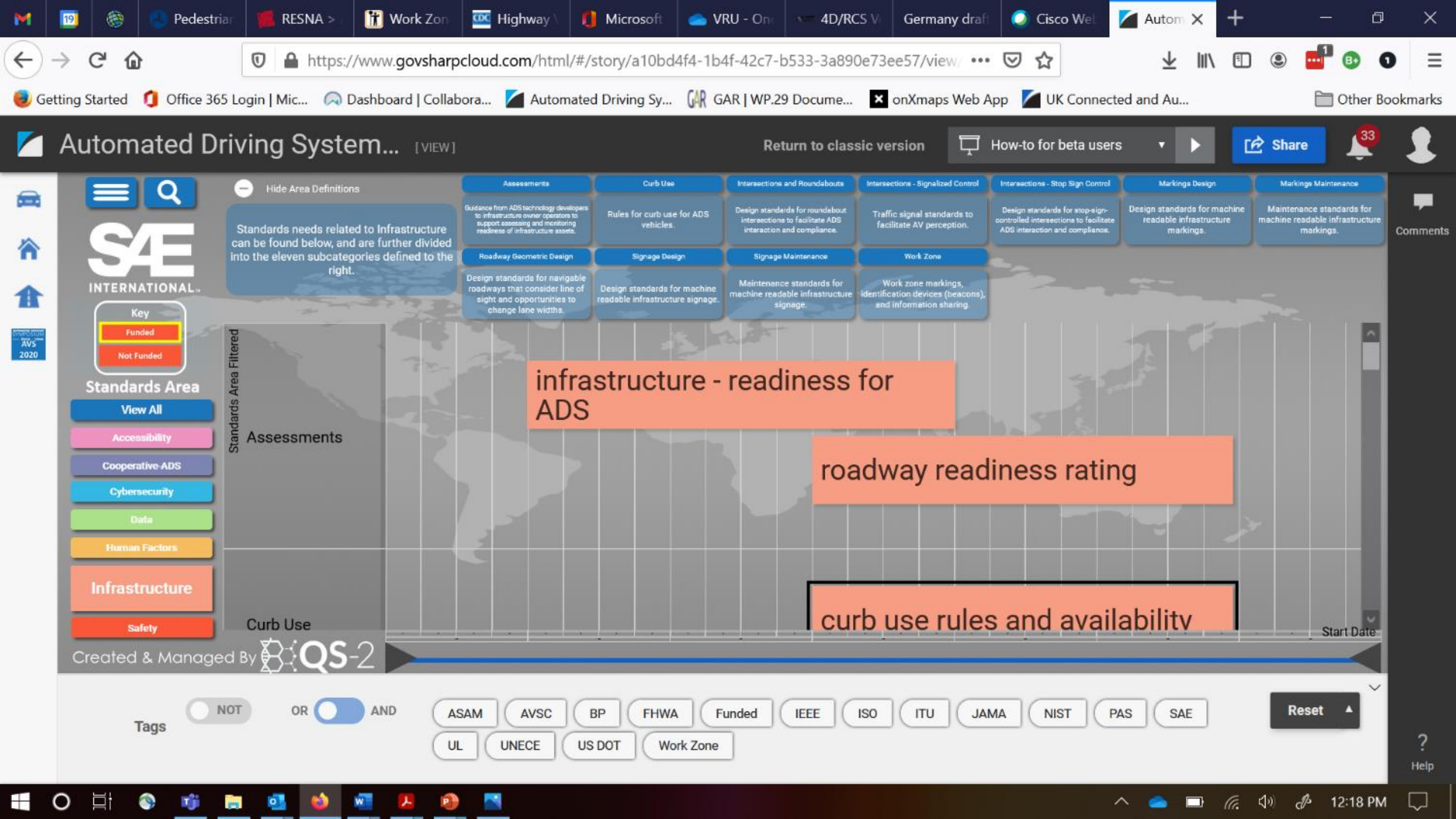
Please Provide Detailed Feedback

Submit Clear

Navigating Roadmap -Search Capability



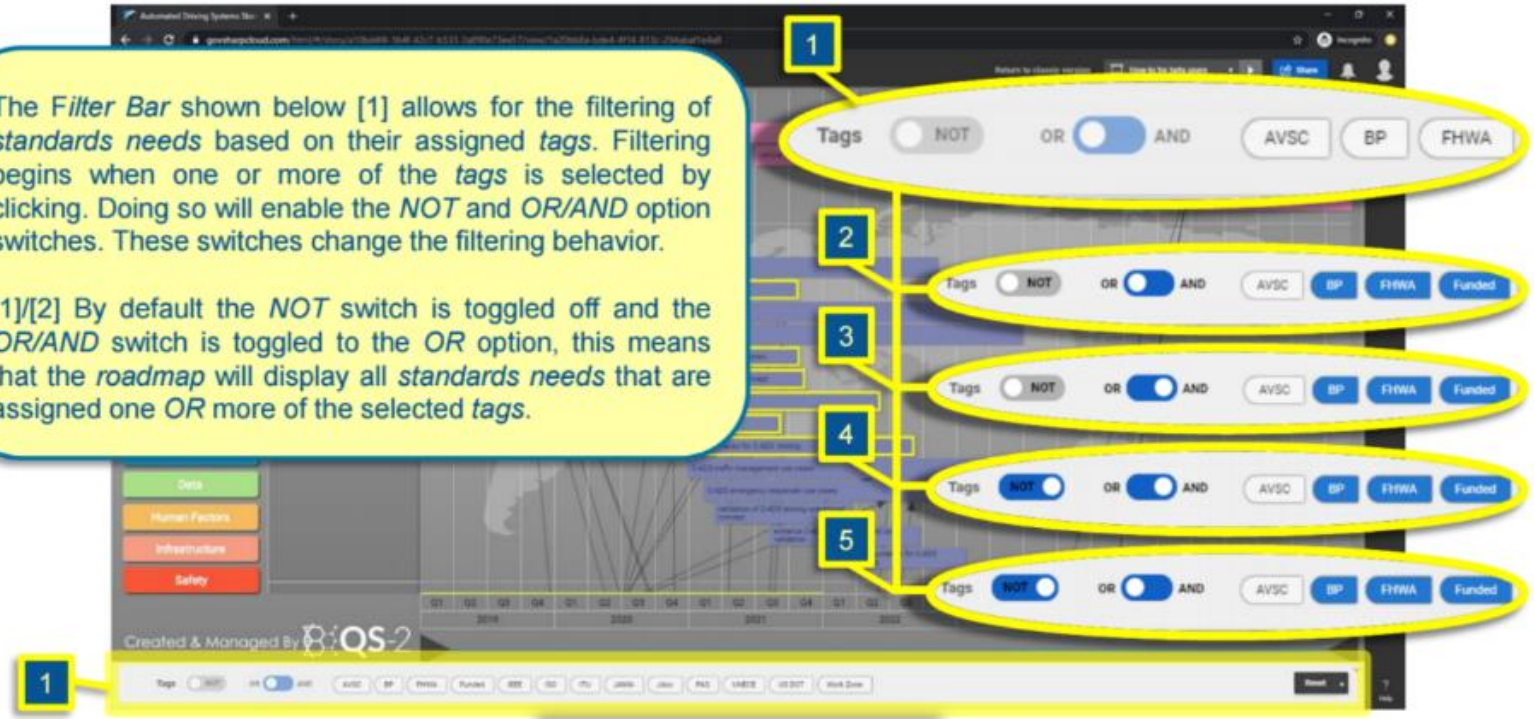



Automated Driving System... [VIEW]
Return to classic version
How-to for beta users
Share
33
Hide Area Definitions
Standards needs related to Infrastructure can be found below, and are further divided into the eleven subcategories defined to the right.
Assessments
Guidance from ADS technology developers to infrastructure owner operators to support assessing and monitoring readiness of infrastructure assets.
Curb Use
Rules for curb use for ADS vehicles.
Intersections and Roundabouts
Design standards for roundabout intersections to facilitate ADS interaction and compliance.
Intersections - Signalized Control
Traffic signal standards to facilitate AV perception.
Intersections - Stop Sign Control
Design standards for stop-sign-controlled intersections to facilitate ADS interaction and compliance.
Markings Design
Design standards for machine readable infrastructure markings.
Markings Maintenance
Maintenance standards for machine readable infrastructure markings.
Roadway Geometric Design
Design standards for navigable roadways that consider line of sight and opportunities to change lane widths.
Signage Design
Design standards for machine readable infrastructure signage.
Signage Maintenance
Maintenance standards for machine readable infrastructure signage.
Work Zone
Work zone markings, identification devices (beacons), and information sharing.
Comments
Key
Funded
Not Funded
Standards Area
View All
Accessibility
Cooperative ADS
Cybersecurity
Data
Human Factors
Infrastructure
Safety
Standards Area Filtered
Assessments
infrastructure - readiness for ADS
roadway readiness rating
Curb Use
curb use rules and availability
Start Date
Created & Managed By QS-2
Tags
NOT
OR
AND
ASAM
AVSC
BP
FHWA
Funded
IEEE
ISO
ITU
JAMA
NIST
PAS
SAE
UL
UNECE
US DOT
Work Zone
Reset
Help

Navigating Roadmap -Filtering by Tags

The *Filter Bar* shown below [1] allows for the filtering of *standards needs* based on their assigned *tags*. Filtering begins when one or more of the *tags* is selected by clicking. Doing so will enable the *NOT* and *OR/AND* option switches. These switches change the filtering behavior.

[1]/[2] By default the *NOT* switch is toggled off and the *OR/AND* switch is toggled to the *OR* option, this means that the *roadmap* will display all *standards needs* that are assigned one *OR* more of the selected *tags*.



[3] If *OR/AND* is toggled to the *AND* position it will change the way in which the *standards needs* are filtered, but only if more than one tag has been selected, otherwise the behavior will remain unchanged. Toggling to the *AND* position means that now, in order for a *standards need* to be displayed, it must have been assigned all of the selected *tags*.

[4]/[5] *NOT* can be toggled for both options of the *OR/AND* switch. Toggling *NOT* to the *ON* position shown in [4]/[5] will result in inverted filtering behavior.

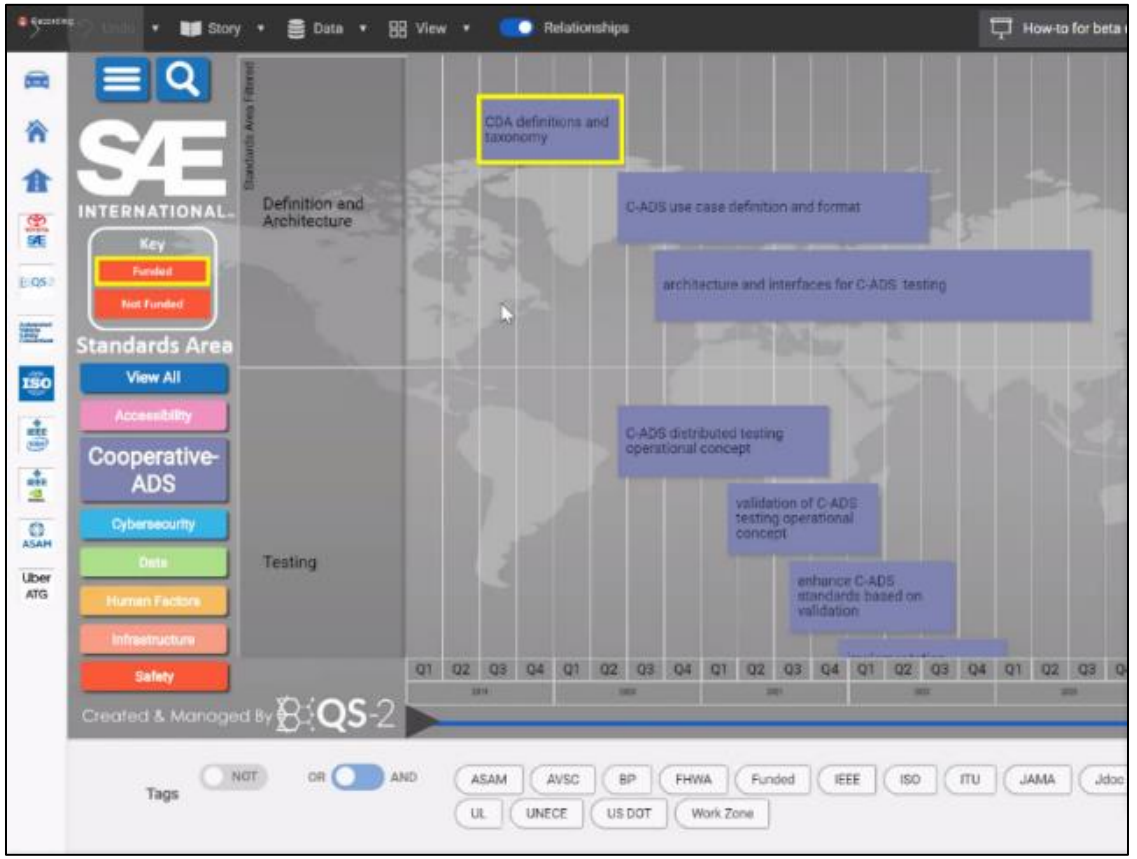
[4] With *NOT* toggled *ON* and *OR/AND* toggled to *OR*, the *roadmap* will display only *standards needs* that are not assigned any of the selected *tags*.

[5] With *NOT* toggled *ON* and *OR/AND* toggled to *AND*, the *roadmap* will display only *standards needs* that are not assigned all of the selected *tags*.

What's Next

New features:

- Additional user feedback options
- Improved relationship visuals
- Expanded content and resources



Upcoming Professional Events

- SAE/AUVSI Business of Automated Mobility (BAM); June 23-24
  https://www.bam-forum.org/home
- Automated Road Transportation Symposium (ARTS21); July 12-15
  http://www.trb.org/Main/Blurbs/181880.aspx

Get Involved Today!

Email - adam.duran@qs-2.com to register

Addressing Industry Transformation Through Standards

Automated Vehicles

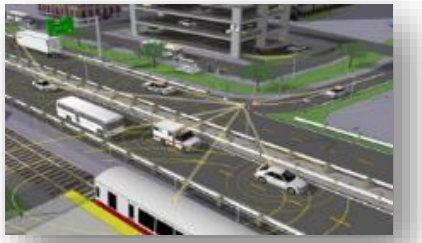
Shared & Digital Mobility

EV, Fuel Cell & Battery

Advanced Driver Assist

Micromobility

Wireless Charging



Infrastructure Needs Related to Automated Driving

Cyber Security

Human Factors

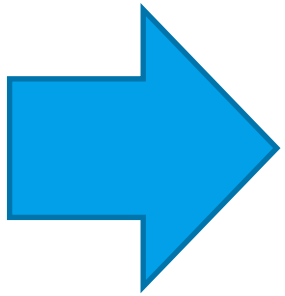
Standards in Disruptive Technologies

Require new methods…

Collaborative, Pre-competitive R&D

+

Open, Collaborative Standards Committees



Broadly Accepted Industry Best Practices and Timely and Appropriate Standards

Related SAE Standards Development

SAE standards are…

- Open to all
- Transparent, collaborative, and consensus-based
- Driven by industry experts

Automated Driving

- ORAD Committee
  - Definitions TF
  - Infrastructure Needs Related to Automated Driving

V2X Communications

- V2X Core Technical Committee
- C-V2X Technical Committee
- Infrastructure Applications Technical Committee

CADS Committee

SAE Pre-Competitive Research

SAE Industry Technologies Consortia (SAE ITC)

- Automated Vehicle Safety Consortium

SAE Cooperative Research Program (CRP)

Solutions by Industry for Industry

- Unique, pre-competitive R&D projects
  - Joint Ventures of industry companies
  - Agile development of targeted research

Thank You

Tim Weisenberger, tim.weisenberger@sae.org
Program Manager, Emerging Technologies

Edward Straub, DM, Edward.Straub@sae.org
SAE Director, Office of Automation

Announcements and Closing Remarks

Brief Updates and Announcements from Partners

Ongoing Commitment to Outreach and Knowledge Transfer

- Suggestions from WG Members on Ways to Enhance Impact:
  - Proposed new WG Members
  - Communications with/involvement in other initiatives outside the CAT Coalition
  - Knowledge resources to include on CAT Coalition website
  - E-mail suggestions to schroeder@acconsultants.org

Next Infrastructure-Industry WG Meetings

- Thursday, July 15, 1:30-3:00 pm (Eastern)
- Thursday, September 30, 1:30-3:00 pm (Eastern)
- Thursday, November 18, 1:30-3:00 pm (Eastern)