Work Zone Data Exchange and National Activities

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Agenda

1. Introduction: Work Zone Safety
2. FHWA's Work Zone Data Initiative
3. Work Zone Data Exchange (WZDx) Specification and Standardization
   - Specification
   - CWZ Standard (and other similar standards)
4. Smart Work Zone Technologies
5. Federally Funded Work Zone Activities
   - 2021 WZDx Demonstration Grants, 2023 SMART Grants
   - Challenges for WZDx Adoption
6. PATH Work Zone Projects and Future Research for Caltrans

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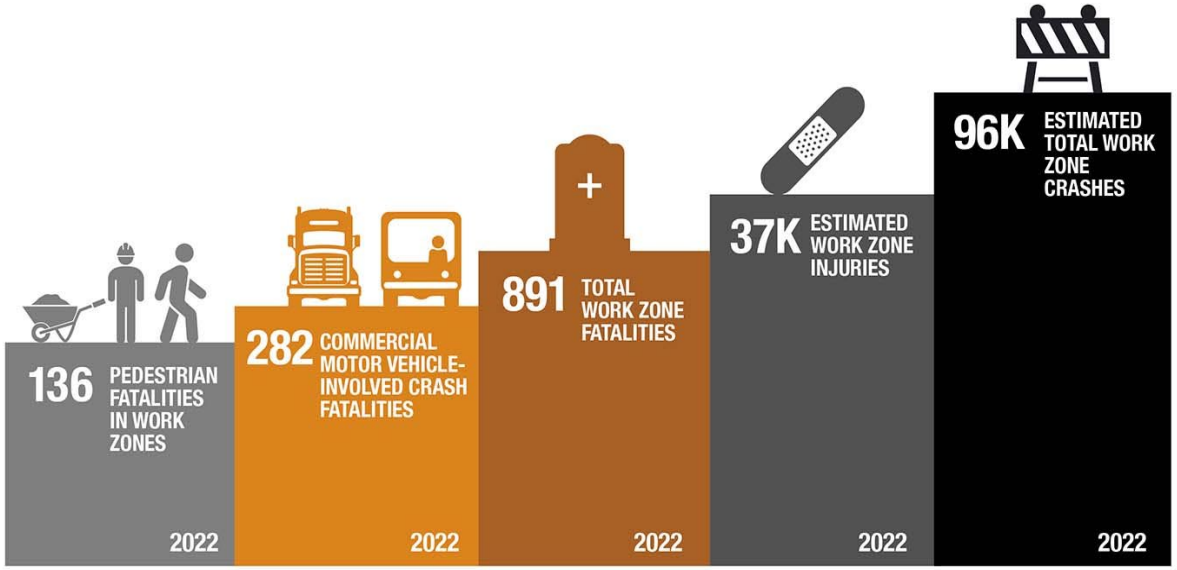
1. Introduction

- Daily changes in traffic patterns, narrowed rights-of-way, and other construction activities often create a combination of factors resulting in crashes, injuries, and fatalities.
- Work zone intrusions are also a growing concern for Caltrans. In California, work zone fatalities increased by 10.8 percent in 2021, in comparison with 2020 (https://workzonesafety.org/work-zone-data)
- Work zone and lane closure information is the most prominent digital information that automated vehicle companies need from the IOOs.



2022 Work Zone Crash Data Summary (Source: National Work-Zone Safety Information Clearinghouse)

Crash data shown here come from 50 states, the District of Columbia, and Puerto Rico

Work Zone Fatal Traffic Crashes on Different Types of Roadways

Based on NHTSA FARS data by type of roadway

Crash Patterns & Economic Impacts

- Pedestrians identified in FARS as being at work or a construction/maintenance/ utility worker. Analyses indicate up to 38% of pedestrian fatalities in work zones are highway workers
- CMVs (buses and trucks with gross vehicle weight ratings of more than 10,000 pounds) are involved in significant numbers (about 30.2%) of fatal work zone crashes each year. Over 50% on rural interstates.
- It is not clear from data what caused the overrepresentation of CMVs. more work zones on roadways with more CMVs, or because work zones are more challenging for CMV drivers?
- In 2022, there were about $36 billion in comprehensive societal crash costs in work zones. Based on INRIX 2022 global traffic scorecard, work zones contribute 10 percent to national congestion estimate.

2. Work Zone Data Initiative

- **Challenge of How To Share Work Zone Information**
  - In order to improve the work zone mobility & safety
  - For all transportation agencies: limited resources of how to share work zone activity information with third parties and connected vehicles.
- **FHWA's Work Zone Data Initiative (WZDI)**
  - Launched in 2017
  - An effort to enable sharing and application of work zone event data across the country.
  - WZDI aimed to develop a standard approach for collecting, organizing, and sharing work zone event of "what/how, where, and when"
  - WZDI products include: Work zone data system framework - a conceptual architecture; Work zone data exchange (WZDx) specification – for voluntary adoption; and Work zone event data dictionary - a comprehensive list of work zone data elements for consideration

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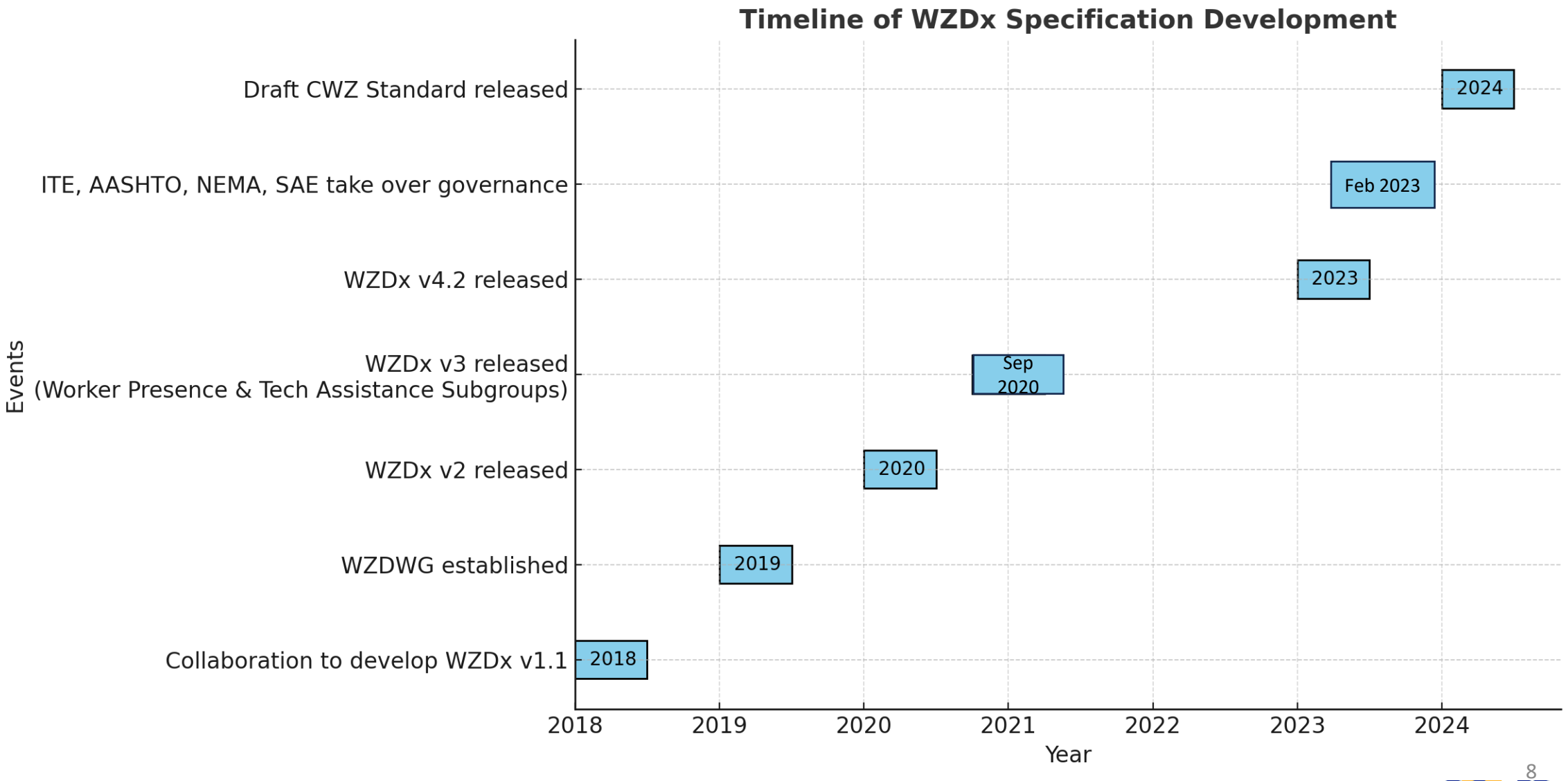
3. Work Zone Data Exchange (WZDx) Project

- **WZDx Project**
  - USDOT's Data for Automated Vehicle Integration (DAVI) initiative
  - Short-term goal of WZDx was to enable harmonized data exchange, available for third party use
  - Long-term goal: get data on work zones into vehicles to help automated driving systems (ADS) and human drivers navigate more safely and efficiently.
- **Multiple Agencies and Organizations**
  - Co-led by the Federal Highway Administration (FHWA) and the Intelligent Transportation Systems Joint Program Office (ITS JPO),
  - Active participation from the Bureau of Transportation Statistics (BTS) and the Federal Motor Carrier Safety Administration (FMCSA).
  - Institute of Transportation Engineers (ITE): Leading the transition of the specification into a formal standard; Society of Automotive Engineers (SAE): Collaborating in the standardization process alongside ITE.
- **State DOTs**
  - State departments of transportation and local agencies contributed by setting up data feeds based on the WZDx Specification (CDOT, ADOT, Iowa DOT ….)

Timeline of WZDx Specification and Standardization



Structural of WZDx Specification

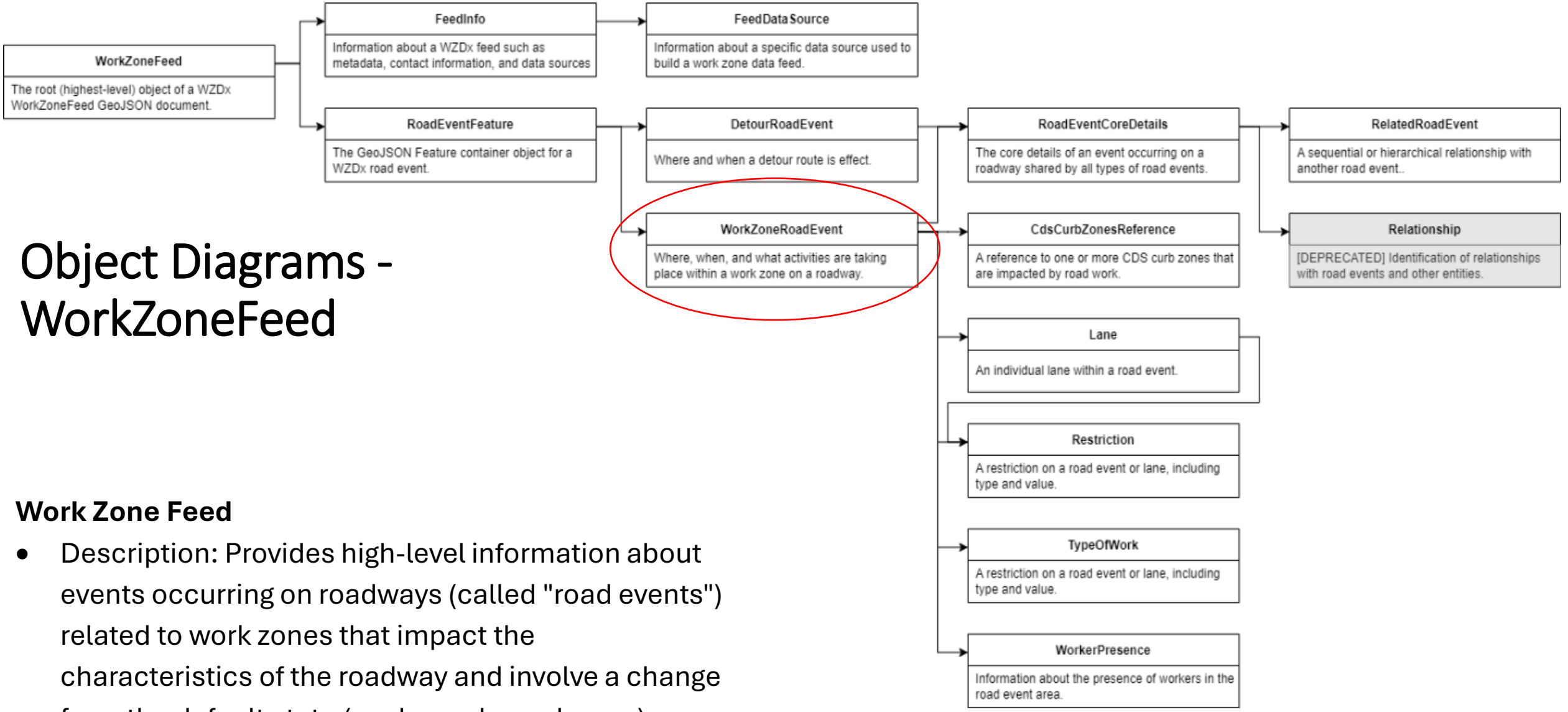
- WZDx defines the structure and content of multiple distinct data feeds.
- Each feed is distributed as a single GeoJSON file

Feed-Level Object	Description
FeedDataSource	Information about a specific data source used to build a work zone data feed.
FeedInfo	Information about a WZDx feed such as metadata, contact information, and data sources.
DeviceFeed	The root (highest-level) object of WZDx Device Feed GeoJSON document.
WorkZoneFeed	The root (highest-level) object of a WZDx Work Zone Feed GeoJSON document.

Structural of WZDx specification - continued

- Each feed object contains many layers of child objects.
- All the objects define the WZDx feed.
- Each WZDx object is described by a table of properties
  - Name
  - Type - The type of data being stored.
  - Description
  - Conformance (required or optional)
  - Notes

Object Diagrams - WorkZoneFeed



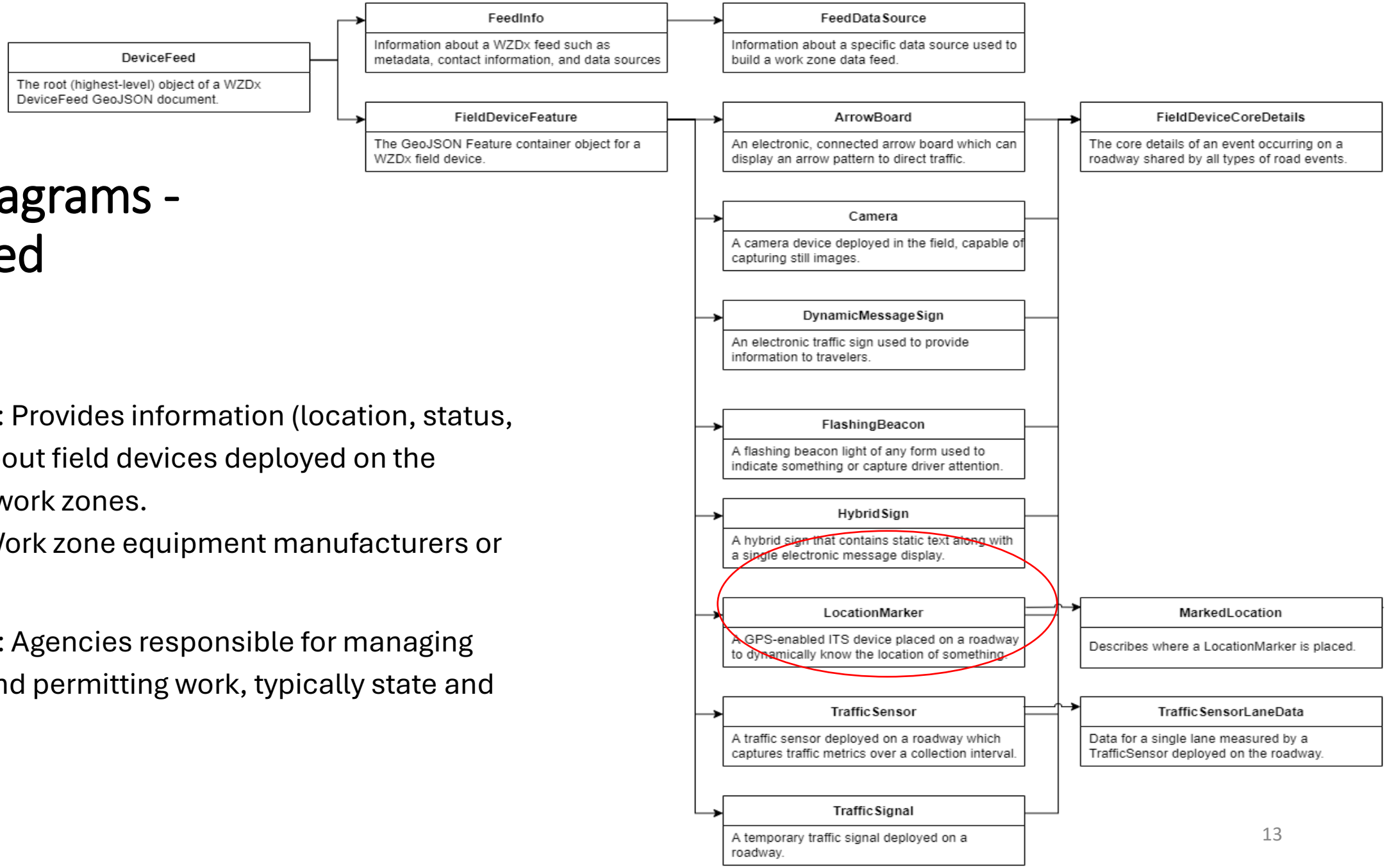
Work Zone Feed

- Description: Provides high-level information about events occurring on roadways (called "road events") related to work zones that impact the characteristics of the roadway and involve a change from the default state (such as a lane closure).
- Producer: Agencies responsible for managing roadways and road work, typically state and local DOTs.

Properties of a WorkZoneRoadEvent object (partial)

Name	Type	Description	Conformance	Notes
core_details	RoadEventCoreDetails	The core details of the road event that are shared by all types of road events, not specific to work zones.	Required	
start_date	String; date-time	The UTC time and date when the event begins.	Required	
end_date	String; date-time	The UTC time and date when the event ends.	Required	
location_method	LocationMethod	The typical method used to locate the beginning and end of a work zone impact area.	Required	
vehicle_impact	VehicleImpact	The impact to vehicular lanes along a single road in a single direction.	Required	
lanes	Array; [Lane]	A list of individual lanes within a road event (roadway segment).	Optional	Please see Business Rules #1 and #2.
beginning_cross_street	String	Name or number of the nearest cross street along the roadway where the event begins.	Optional	
worker_presence	WorkerPresence	Information about whether workers are	Optional	

Object Diagrams - DeviceFeed



DeviceFeed

- Description: Provides information (location, status, live data) about field devices deployed on the roadway in work zones.
- Producer: Work zone equipment manufacturers or vendors.
- Consumers: Agencies responsible for managing roadways and permitting work, typically state and local DOTs.

Properties of a LocationMarker object (partial)

Name	Type	Description	Conformance	Notes
core_details	FieldDeviceCoreDetails	The core details of the field device shared by all field devices types, not specific to the location marker.	Required	This property appears on all field devices.
marked_locations	Array; [MarkedLocation]	A list of locations that the LocationMarker is marking.	Required	

Other Types of Road Events

- The WZDx Specification has also been extended to define data feeds for representing other types of road events, such as restrictions (included in WZDx v4.0 as the RoadRestrictionFeed), crashes, disasters, and strong winds.
- **JSON schema**
  - JSON schema can be used to validate conformance of work zone data with the specification described in the JSON schema.

- More details are available in GitHub. https://github.com/usdot-jpo-ode/wzdx

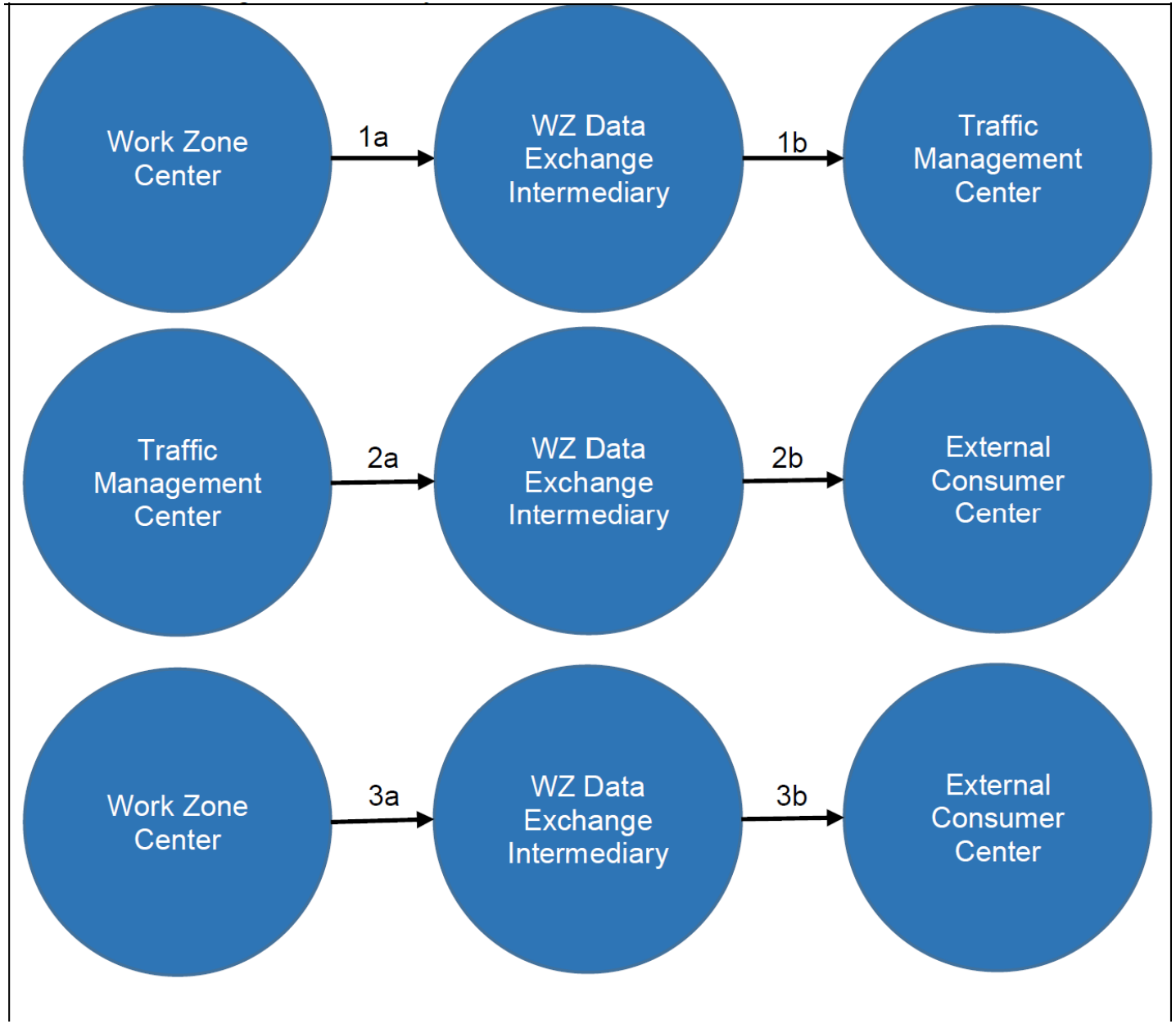
Connected Work Zone (CWZ) Standardization

- A **connected work zone (CWZ)** is defined as a set of technologies that generates or collects work zone information (whether automatically or manually) as well as the infrastructure that broadcasts/distributes this information to the public and to vehicles.
- Most infrastructure owner operators (IOOs) do not have the manpower or technical knowledge to properly deploy and operate these CV-enabled work zones.
- Need for an industry standard that enables national interoperability and provides guidance to IOOs on how to deploy, operate and maintain the CV-enabling devices

CWZ Standard document

- **Interoperable Data Exchanges:** documenting the data formats, data definitions, data structure, and specifications to enable interoperable data exchanges between CWZ systems and components.
- **Operational Scenarios.** Identify and document system actors, including end-users, data consumers, and data providers, and their interactions.
- **Institutional and IOO Guidance Needs**. Identify and document institutional guidance needs, operational policies, constraints, and best practices.
- **Technical Expert Guidance Needs.** Identify and document developer and technical expert guidance needs to enable them to develop project specifications and designs that will result in nationally interoperable data exchanges.

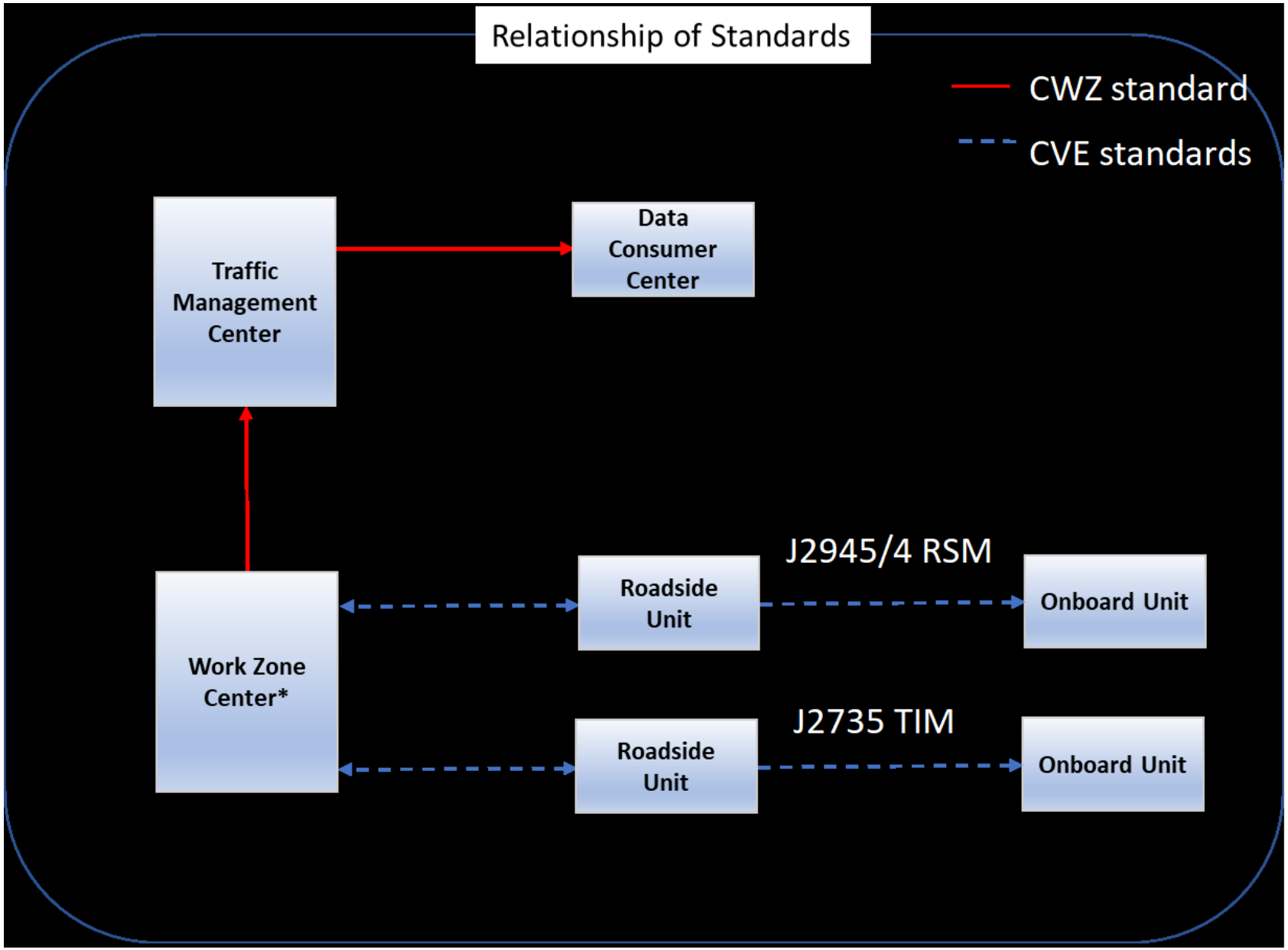
Examples: Work Zone Data Collection and Distribution (data exchange through an intermediary system)



WZDx vs. RSM

- The SAE J2945/4 Standard defines a new structure called **road safety message (RSM)** based on the SAE J2735 traveler information message (TIM) to reflect the lessons learned from various deployments.
- The purpose of the new RSM is to enable road safety application interoperability using infrastructure – to-vehicle (I2V) communications. The five road safety applications include:
  - Curve speed warning (CSW)
  - Reduced speed zone warning (RSZW)
  - ***Lane closure warning (LCW)***
  - Dynamic traveler information (DTI)
  - Incident information (INC)

Relationship between CWZ standard and other Connected Vehicle Environment (CVE) Standards



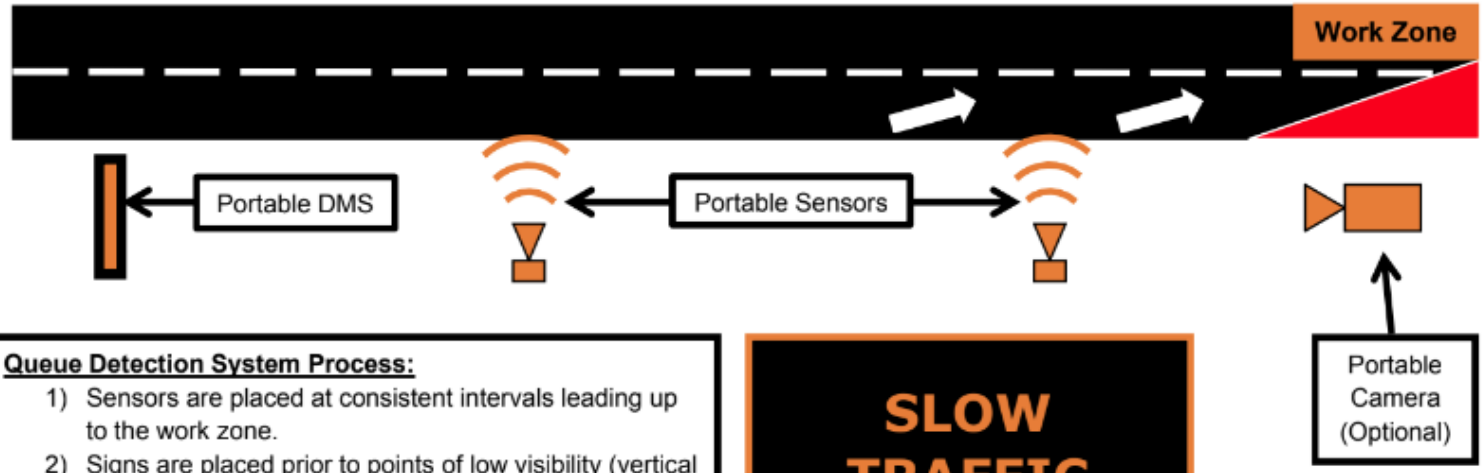
Mapping of CWZ WorkZoneFeed Data Concepts to SAE J2945/4 Data Concepts

CWZ WorkZoneFeed Data Concept	SAE J2945/4 Data Concept	Additional Information and Notes
	3.5.1 Message Content and Structure Requirements	
5.4 RoadEventFeature 5.4.1.1 id	3.5.2 Event Identification In this case the event is the work zone.	
5.4.2.1 WorkZoneRoadEvent 5.4.2.3 RoadEventCoreDetails	3.5.3 Event Context	
5.4.2.3 RoadEventCoreDetails 5.4.2.3.2 event_type work-zone detour	3.5.3.1 Event Type (Section G.2 Cause code) ITISGroup-Closures (3)	
5.4.2.1 WorkZoneRoadEvent 5.4.2.1.18 types_of_work 5.4.2.7.1 type_name maintenance, minor-road-defect-repair, roadside-work, overhead-work below-road-work barrier-work surface-work painting roadway-relocation roadway-creation	3.5.3.2 Event Subtype (Section G.2 Subcause code) accident (513) closed-to-traffic (769) closed-ahead (771) closed-intermittently (772) closed-for-repairs (773) closed-for-the-season (774) blocked (775) blocked-ahead (776) reduced-to-one-lane (777) reduced-to-two-lanes (778) reduced-to-three-lanes (779) collapse (780) road-construction (1025) major-road-construction (1026) long-term-road-construction (1027) construction-work (1028)	A recommendation is provided in Annex D. There are challenges to providing a one-to-one mapping between the CWZ elements and those of SAE. The current state of the practice in some DOTs is to use a script that contains an algorithm to translate between the values shown in the columns at right. Currently, agencies have different and potentially conflicting approaches to expressing the information about a work zone using the SAE ITIS codes as described the center column.

4. Smart / Intelligent Work Zone Technologies

- Definition : Systems that use specialized components (e.g., sensors, communications, software, and electronic equipment) to manage traffic and operations and disseminate information to improve work zone safety and operations.
- Types of smart work zone technologies:
  - Traveler information systems (TIS)
  - Queue warning systems (QWS)
  - Dynamic speed limit (variable speed limit) systems
  - Work zone data collection technologies
  - Work zone location technologies
  - Notification of construction equipment entering/exiting systems

Example: Queue Warning System



Queue Detection System Process:

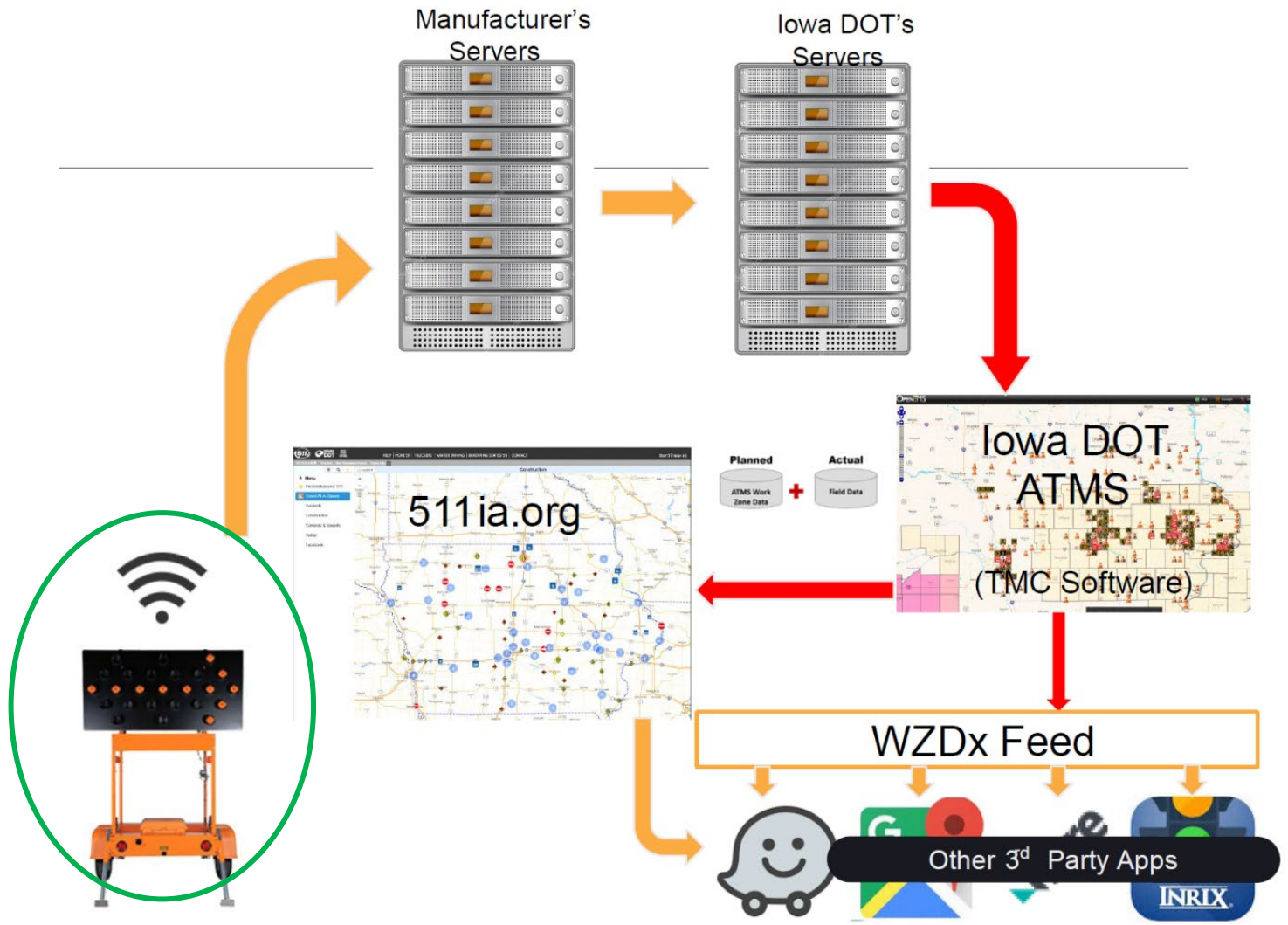
1) Sensors are placed at consistent intervals leading up to the work zone.
2) Signs are placed prior to points of low visibility (vertical and horizontal curves).
3) Optional camera is placed at merge point for additional monitoring
4) Sensors communicate to central server to look for queuing using programmed logic.
5) When slow speeds are detected, logic posts automated alert messages to portable DMS and sends alert e-mails and text messages to project stakeholders in addition to notifying the TMC.

Note:
Queue warning and work zone monitoring systems can make use of the same devices as the PDMS are connected to the TMC. The TMC will update the PDMS displays in the event of an incident.

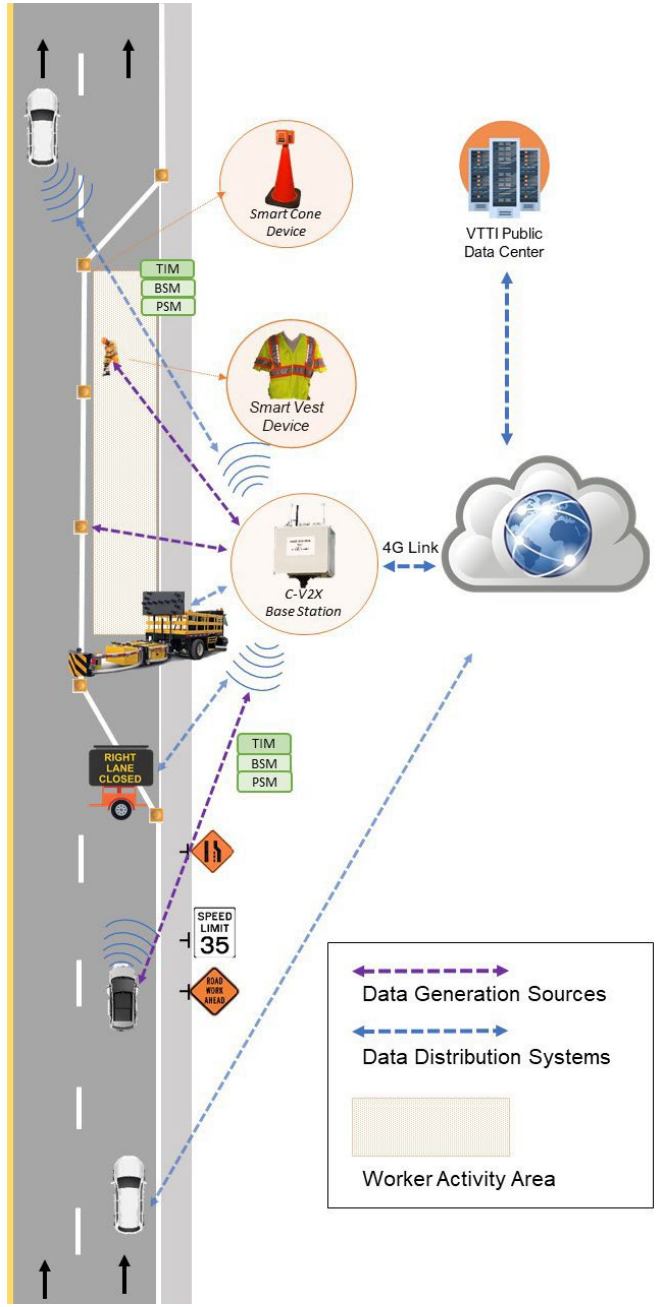
SLOW TRAFFIC AHEAD

STOPPED TRAFFIC AHEAD

Example: Smart Arrow Boards



Smart cones & Smart vest for worker protection



5. Federally Funded Work Zone Projects

- **In January 2021, the U.S. DOT awarded $2,372,254 for WZDx Demonstration Grants to fund 13 projects in 13 States.**
  - A one-time funding opportunity for public roadway operators to make unified work zone data feeds available for use by third parties and collaborate on the WZDx specification development.
- **2023 SMART Grant (2 work zone projects)**

Recipient	Project Name	Funding	Project Type	Project Summary
Wyoming Department of Transportation	Wyoming's Work Zone Statewide Enterprise Data Environment	$1,500,000	Work Zone	Modernize the work zone data environment for streamlined data collection and management.
State Highway Administration of Maryland Department of Transportation	Real-time work zone speed management with multi-source data	$1,610,000	Uncrewed Aircraft System	Collect speed data via uncrewed aerial systems to support real-time speed management in work zones.

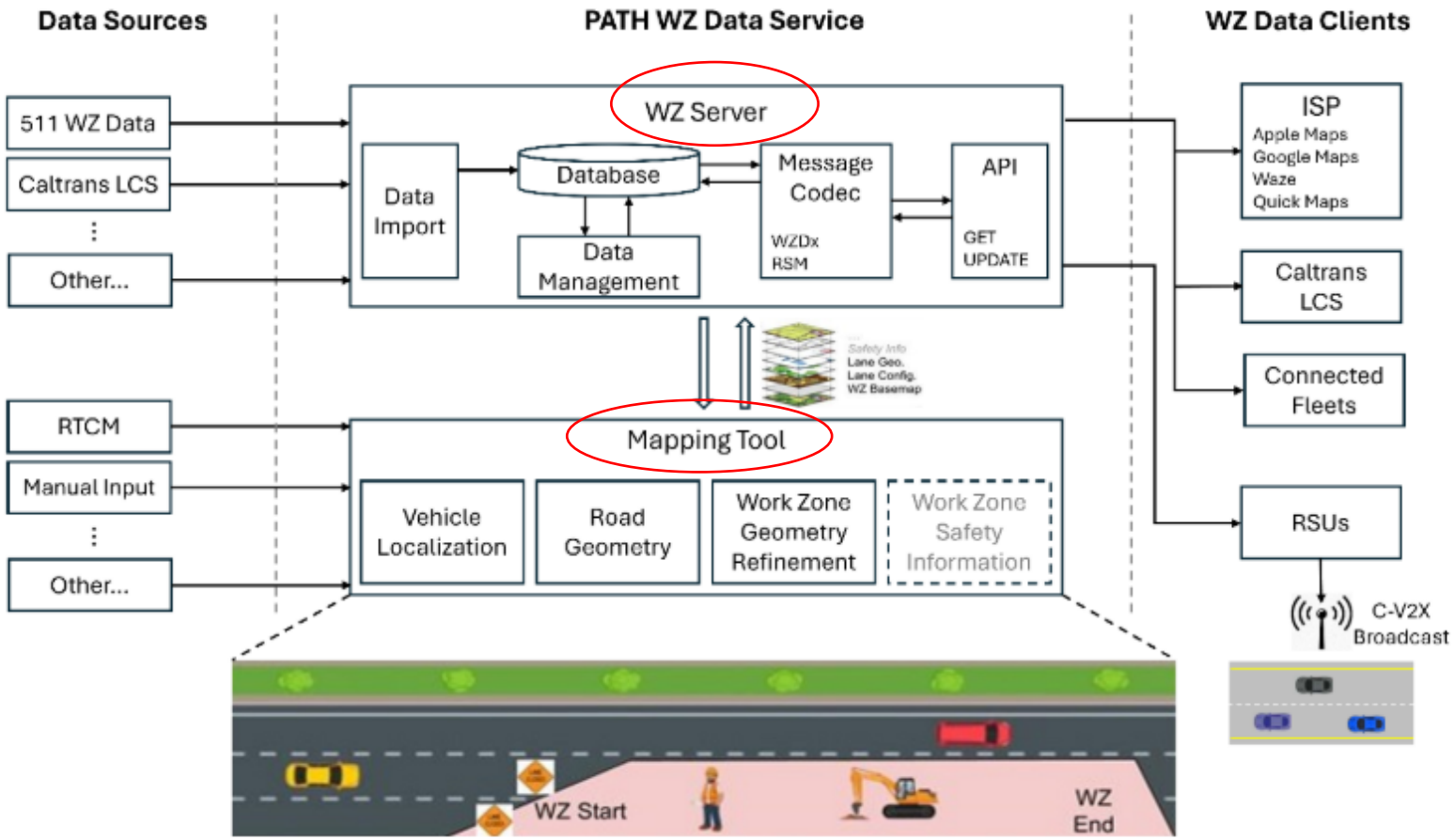
Some Known Challenges

- Only a few agencies have successfully implemented the work zone data specification into production.
- In most agencies, work zone data points are **manually entered** by personnel in various areas of the agency. This manual data creation lends itself to **collecting less precise data** and/or **a higher probability of errors**.
- While the Work Zone Event Data (WZED) needed are relatively straightforward (e.g., timing and location of work zone activities), the **information is not always known far in advance,** particularly for shorter-duration work zones and maintenance activities.
- In addition, **keeping published data up to date** requires planning and some scheduled commitment of resources. Many agencies simply do not have a good mechanism for truly verifying if a planned lane closure becomes an active lane closure.

PATH Work Zone Projects and Future Research Ideas for Caltrans

Improving the Safety and Efficiency of Work Zones in California

PI: Hao Liu



Scope of Work

- Enable detailed geometry data collection with high location precision
- Extract work zone and lane closure info from multiple sources
- Design a database to store work zone data
- Prepare RSM and WZDx-compliant feeds
- Disseminate work zone info

Effect of Using Standardized Work Zone Data to Improve Work Zone Safety (Task 4340)

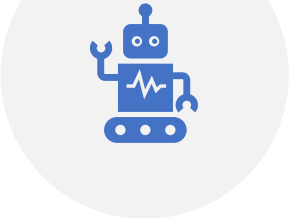
PI: Peggy Wang

- Status: Awarded in 2023, currently under review
- Project Objectives
  - Use standardized work zone data (i.e., WZDx and Road Safety Message – RSM) as the countermeasure to reduce work zone intrusion crashes for both human-driven vehicles and automated vehicles (AVs)
  - Best practices and guidelines of sharing work zone data to vehicle manufacturers
  - Evaluate the vehicle performance and safety effects before and after the adoption

Future Research Topics for Caltrans

Investigate the CMV involved fatal crashes and countermeasures

Identifying and prioritizing use cases to develop a roadmap for future work zone activities



Approaches (sensors, alert system) for worker protection

Demonstration and pilot to understand issues and incrementally find solutions to improve (based on agency priorities and data availability)

Questions & Answers