

Summary of Connected Work Zone Data Needs and Suggestions for Standards Coordination

Cooperative Automated Transportation Coalition
IOO/OEM Reduced Speed Zone Warning (RSZW) Working
Group

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1. Introduction

This document is being circulated as a dated draft document, with the intent and anticipation that the document will evolve and improve as additional input is received. Future updates will be posted to the CAT Coalition website.

Maintenance and construction activities for the transportation infrastructure are accomplished by creating work zones. These work zones provide for the safety of the workers while maintaining traffic flow through the impacted areas. In the United States in a typical year, there are approximately 800 work-zone fatalities and work zones typically account for an estimated 10 percent of overall congestion and 24 percent of unexpected freeway delays.¹ Disseminating information to travelers is an effective mechanism to inform them about the work zones and allow them to consider alternate routes. Currently, dynamic message signs, traveler information phone systems, websites, and mobile applications are examples of the dissemination mechanisms widely used to communicate with travelers. Recent advances in establishing the Work Zone Data Exchange (WZDx) standard for communication will support information dissemination by facilitating broader data exchanges united in a common language and exchange protocol.

1.1 Connected Work Zones

Connected vehicle applications provide an additional approach to promote safety and mobility through work zones, this approach is referred to as Connected Work Zones. While traveler information data delivery is generally intended for human consumption, Connected Work Zones are used to communicate safety-level data to in-vehicle applications. These applications may provide driver warnings or driver assistance actions. In the future, as automated vehicles become more common, Connected Work Zones are likely to play an expanded role in supporting the navigation of vehicles through the work zone.

1.2 Infrastructure to Support Connected Work Zones

While the in-vehicle applications will be developed by a combination of original equipment manufacturers (OEMs) and third-party application providers, the infrastructure to support connected work zones will be the responsibility of the infrastructure owner operator (IOO) or their construction contractors responsible for the work zone. The Cooperative Automated Transportation (CAT) Coalition's IOO/OEM Forum drafted a [model concept of operations \(ConOps\) for infrastructure systems to support connected work zones](#) (also referred to as Reduced Speed Zone Warning – Lane Closures). In this ConOps, the goal of the infrastructure system is defined as *“The primary goal of the proposed Infrastructure System deployments is to support broadcasts for the RSZW-LC application and other eventual CV applications to be deployed in passenger and fleet vehicles to ‘connect’ vehicles to the infrastructure in order to promote safety, mobility, and efficiency.”*

2. Infrastructure Systems to Support Connected Work Zones

2.1 Stratifying End User Needs into Levels of Information Content and Delivery

The context of Connected Work Zones is best understood by a description of three levels of roadway information content and delivery to drivers / vehicles:

Traveler information level – the delivery and use of information to travelers to help the plan their route(s) in and around work zones, including pre-trip access and en-route access.

Driver information level – the delivery and use of information to drivers as they are approaching and driving through work zones, typically through in-vehicle applications that process data and deliver the most relevant and needed data to the driver based on their proximity to the work zone.

Driver warning level – the delivery of data that is used by in-vehicle applications to create warning messages to drivers and possibly to perform automated driving assistance to avoid crashes involving work zones. Two-way communications could enable vehicles to send critical information to the infrastructure (e.g., possibly to alert workers in work zones about approaching vehicles).

These information levels are illustrated in Figure 1 below. Subsections below the figure describe the use cases, communication methods, content needs and information levels.

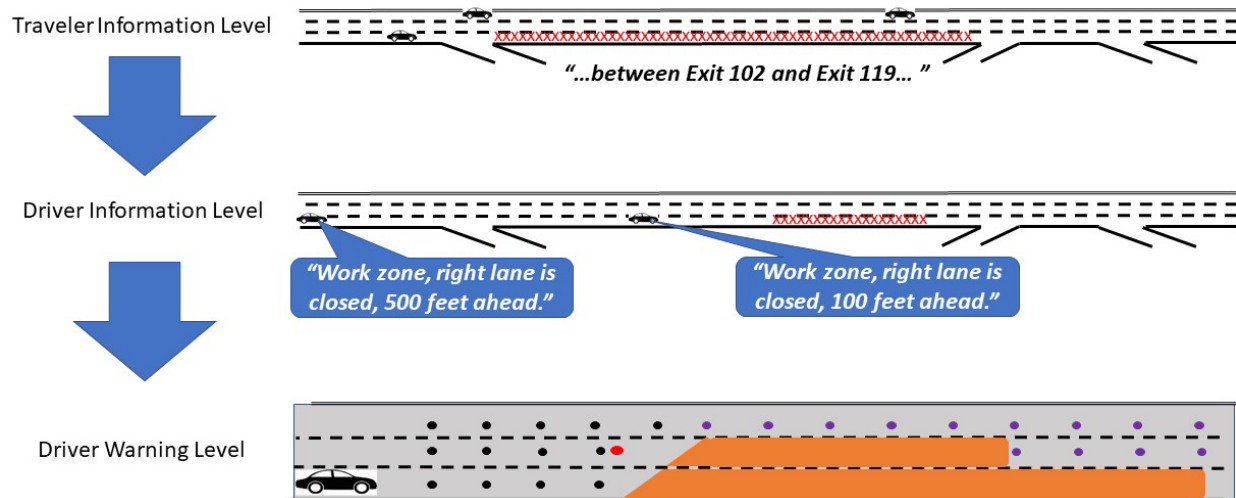


Figure 1: Illustration of Layers of Work Zone Content and Delivery

2.1.1 **Traveler Information Level**

Use Cases for Traveler Information Level Content and Delivery include:

- Travelers will view websites/applications from computers or mobile devices or call 511 phone systems to receive notices of current or future work zone activities that are likely to impact travel;
- Information will support route choice and time of departure decisions.

Methodology of Communication for traveler information level includes:

- Primarily Wide Area communications (e.g., cellular/Internet).

High level summary of **Content Needs** for traveler information include:

- Identification of the road and reference location of start/end of work zone;
- Visual placement on maps (lat/lon);
- High level description of the impact to travel (e.g. "all lanes open"; "some lanes closed"; vehicle restrictions).

High level **Mapping Level needs** for traveler information include:

- Segments (roughly 1/10th mile);
- Location often described as "intersection to intersection" or "freeway exit ## to exit ##" or "Mile Post ## to Mile Post ##".

2.1.2 Driver Information Level

Use Cases for driver information level include:

- In-vehicle applications will use work zone location and activity descriptions to inform en-route drivers of work zones downstream of their current position, alerting them to the likely need to slow or change lanes;
- ADS functionality may disengage when within work zone boundaries.

Methodology of Communication for driver information level include:

- Combination of wide-area broadcast (cellular/Internet) and local area broadcasts (e.g., roadside units broadcasting in 5.9 GHz spectrum).

High level summary of **Content Needs** for Driver Information include:

- Road ID;
- WZ start/end: milepost and/or lat/lon – accurate enough to announce approximate distance to work zone (e.g. “half-mile”, “1000 feet”, “500 feet”);
- Impact description: IDs of closed/open lanes (e.g. “right lane is closed”, “right two lanes closed”).

High level **Mapping Level needs** for Driver Information include:

- Road Level – Start and End points of work zone / reduced lane area (lat/lon).

2.1.3 Driver Warning Level

Use Cases for driver warning level include:

- In-vehicle applications will use work zone location and activity descriptions to warn drivers of needed lane and speed changes as they approach work zones;
- Drivers in open lanes and following speed limits may not be warned;
- Information may include the presence of workers in the work zone;
- ADS functionality may disengage when within work zone boundaries;
- Could possibly support AV partially or with additional data, but details are not yet known.

Methodology of Communication for driver warning level include:

- Primarily Local broadcast (e.g., roadside units broadcasting in 5.9 GHz spectrum), but wide area (network cellular) is possible.

High level summary of **Content Needs** for Driver Warning level include:

- Road ID;
- WZ start/end: Milepost and/or lat/lon;
- Impact description: IDs of closed/open lanes;
- Node points of approach, open, and closed lanes;
- Node points of worker present zones.

High level **Mapping Level needs** for Driver Warning level include:

- Lane Level – Node point representation of open/closed lanes (lat/lon).

2.2 Summary of End User Needs for each Level of Content and Delivery

The IOO/OEM Forum of the CAT Coalition working group on Reduced Speed Zone Warning (RSZW) developed the following preliminary table to begin summarizing the needs for each level of content and delivery defined in the previous section.

Table 1: Preliminary Set of Data Element Descriptions Identified for the Three Levels of Information

Vehicle User Needs	Mapping Level	Required Data Elements (general / by application)	Resolution	Accuracy	Latency	Example / Source
Traveler Information	Segment (roughly 1/10 th mile)	<p>Route Following</p> <p>data elements:</p> <ul style="list-style-type: none"> - Road_name - Road_number - Direction - Beginning_cross_street - Ending_cross_street - Beginning_milepost - Ending_milepost - Beginning_accuracy = Estimated or verified - Ending_accuracy = Estimated or verified - Vehicle_impact (all-lanes-closed; some-lanes-closed; all-lanes-open; alternating-one-way; unknown) 	Low (0.1 mile)	Low (+- 0.1 mile)	High (10 min)	WZDx / TIM
Driver Information	Road Level (start/end points of WZ)	<p>Lane Closed Ahead</p> <p>data elements:</p> <ul style="list-style-type: none"> - Road_name - Road_number - Direction - Lat/lon <start>; Lat/lon <end> 	Med (100 ft)	Med (+- 50 ft)	Med (5 min)	RSZW inform WZDx & SAE J2945
Driver Warning	Lane Level (node points)	<p>Change Lanes / Slow Down</p> <p>data elements:</p> <ul style="list-style-type: none"> - Approach lane node points - Work zone lane node points - Lane close/open node points - Workers Present zone node points - Advisory/regulatory speed limit at node level - Lane marker type at node level - Vertical clearance height at node level - Lane width at node level 	High (1.5 ft)	High (+- 1.5 ft)	Low (1 min)	RSZW warn WZDx & SAE J2945

3. Needed Convergence on a Common Standard and Interpretation of the Standard

3.1 Work Zone Data Initiative and Work Zone Data Exchange

The FHWA Work Zone Data Initiative (WZDI) and USDOT's Work Zone Data Exchange (WZDx) have defined a standard data dictionary and specification for work zone event data, respectively. The number of agencies publishing data in the WZDx specification format is increasing. The current version of the WZDx

specification does not require the detailed lane level mapping elements that are needed by driver warning systems. However, optional lane level details in the WZDx specification may meet the needs of the driver warning level if the IOO can provide the information (e.g., status, restriction, workers present, types of work). Note that the WZDx specification is being iteratively expanded to support additional data elements and user needs; the WZDx specification may support these requirements in the future as prioritized by the public- and private-sector stakeholder community developing the specification.

3.2 SAE Road Safety Message /Traveler Information Message

The SAE RSM standard is intended to include the detailed lane level details that would support driver warning systems. Developed as an SAE standard, it is likely that OEMs creating in-vehicle applications for connected work zones would look to this standard as the approach to receive consistent standard messages from the IOO operated infrastructure systems.

3.3 Convergence Needs and Recommended Approach

The current trend suggests that IOOs are progressing with implementation and use of the WZDx as the primary approach for exchanging work zone data, while OEMs and third-party providers interested in creating in-vehicle applications to deliver driver warnings to drivers are proceeding with their emphasis on the SAE J2945/4 Road Safety Applications standard as the preferred means to receive work zone data from the infrastructure. IOOs likely would prefer not to collect work zone data multiple times or maintain data in multiple formats to support different standards. There is a needed coordination between the WZDx and J2945/4 standards development efforts to avoid IOOs duplicating data collection / maintenance efforts to support work zone information in multiple formats and to ensue messages that support Connected Work Zone applications being considered by OEMs are deployed.

The recommendation is for discussions between the WZDI, WZDx, and SAE RSM efforts specifically to address the coordination needed and to enable Connected Work Zones through an established link between standards.

Recommended participants may include:

- USDOT staff and support contractors supporting the WZDI and WZDx efforts;
- CAT Coalition IOO/OEM Forum RSZW Chairs and Designated Members (representing both public and private sector);
- WZDx Work Zone Data Working Group Chairs and Designated Members (representing both public and private sector); and
- SAE staff or members.

ⁱ https://ops.fhwa.dot.gov/wz/resources/facts_stats.htm