ITS Concept of Operations: Distracted Drivers Approaching or Within a Work Zone

August 2015

Prepared for: The Minnesota Department of Transportation
Acknowledgements
This document was prepared for Minnesota Department of Transportation’s (MnDOT) Systems Engineering to Address Work Zone Challenges project.

Project Champion
Rashmi Brewer, is the MnDOT project champion for this effort. MnDOT stakeholders were heavily involved in identifying the key challenges with using Intelligent Transportation Systems to address and enhance safety, operations, mobility and efficiency in work zones. This document covers the concept of operations requirements to address some of these challenges.

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1. Introduction
Safety is MnDOT’s top priority as demonstrated in the Toward Zero Deaths (TZD) initiative to lower the number of traffic crashes, injuries, and deaths occurring on Minnesota roads. MnDOT is working to enhance safety for all users; this includes travelers and personnel in work zones who work to improve our roadway system. In the state of Minnesota, 21 severe crashes occur in work zones per year on average statewide.

A significant number of crashes occurring in work zones involve an inattentive driver. Since 2011, inattentive drivers have been involved in 30.1% of severe crashes in work zones in Minnesota. This is the second highest focus area identified in the 2014 Minnesota Strategic Highway Safety Plan. Distracted, or inattentive, drivers entering a work zone are a liability to workers present, nearby vehicles and themselves. The Stakeholders have identified a need to have a system that would increase awareness of drivers traversing a work zone.

1.1 System Overview
The typical system components utilized in a work zone include: multiple queue warning systems, portable changeable message signs (PCMS), permanent CMS, static and dynamic warning signs, and / or variable speed limits to inform drivers of the approaching work zone and work zone conditions. The use of these system components helps to achieve the goal of improved safety for all users as stated in the MUTCD Chapter 6A.05 “Of equal importance to the public traveling through the Temporary Traffic Control (TTC) zones is the safety of the workers performing the many varied task within the work space.” It continues in 6A.06 to state that in addition to “the efficiency of a road user flow...a concurrent objective of the TTC is to allow efficient construction and maintenance of the highway.” The goal of these TTC zones is to maintain a level of mobility with a standard of safety which allows all parties to utilize the system and create the least impact on all users. However, crash history shows that additional or improved systems are needed to address the continued presence of distracted drivers in work zones.

Solving this problem will require a three-tiered approach involving: Engineering, Education, and Enforcement. Of these three, Engineering and Enforcement via existing and future systems will be reviewed. The goal of these systems will be to enhance safety and mobility in work zones. Research conducted through trials will also be an integral part of this process as different combinations of devices, alerts, and messages will need to be tested to determine which combination provides the best results before MnDOT can design and implement TTC. Additionally, advancement in connected vehicle technology will also provide more options to provide information and alerts to drivers if they are identified as distracted.

MnDOT has prepared the Minnesota IWZ Toolbox as a guideline for Intelligent Work Zone System Selection. The IWZ Toolbox contains multiple configurations to enhance safety, mobility, and efficiency for all users by providing Travel Time Information, Travel Delay Information, Speed Advisory Information, Congestion Advisory, Stopped Traffic Advisory, Dynamic Merge, Excessive Speed Warning, and Truck Entering or Crossing systems. Figure 1 below is an example Congestion Advisory Signage Configuration from the IWZ Toolbox solutions.
It is expected as connected vehicles become more prevalent that additional systems will be available to better detect, alert, and retain the attention of drivers when presented with a temporary change in driving conditions such as work zones. However, until that time, the systems in the IWZ Toolbox will continue to be supplemented by ITS devices currently available to reach the goal of reducing severe crashes in work zones by utilizing devices which will aid in the following actions: identify vehicles of concern, warn workers on-site, provide notification to TMCs, and alert law enforcement.
1.2 Stakeholders
The deployment and operations of an ITS technology to identify distracted drivers will be driven by the needs of the stakeholder groups who will interact with them. The stakeholder needs have been documented for four primary groups:

- **Drivers** on any roadway where construction occurs
- **Industry and Field Personnel** who may design, construct, and work on road construction throughout the state of Minnesota
- **Transportation Agencies** at the state and local level that will oversee, monitor, identify work zone related challenges, and research conditions in the work zones
- **Law Enforcement** who may observe operations, driver compliance, and safety of solutions in the work zones

MnDOT is working to enhance safety in work zones and to reduce severe crashes related to distracted driving. This Concept of Operations provides a foundation for defining a problem, clearly describes the characteristics of the system to address the issues, and details ways of improving the current systems in place. The remainder of this Concept of Operations documents the needs of the noted stakeholder groups, describes an operational concept from a stakeholder perspective, outlines systems components, and presents common operational scenarios for identifying distracted drivers, and alerting drivers as well as workers to potential dangers.

2. Needs
Stakeholders have identified recurring work zone challenges and have developed the need to address these challenges to help enhance safety on Minnesota’s roadways. Each challenge corresponds with an operational and system need that will determine what the system must accomplish. The following table summarizes these challenges and needs.

**Table 1 Stakeholder Needs for the Challenge**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>ID</th>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles unintentionally leave the travel lanes and enter the restricted work zone.</td>
<td>1</td>
<td><strong>Drivers</strong> traveling in a work zone need an alert when their vehicle enters a restricted area.</td>
</tr>
<tr>
<td>Driver distraction results in elevated safety issues For changing travel conditions.</td>
<td>2</td>
<td><strong>Drivers</strong> traveling in a work zone need an alert when their focus is not fully on operating their vehicle.</td>
</tr>
<tr>
<td>Drivers are inattentive and do not pay attention to the messages or warnings.</td>
<td>3</td>
<td><strong>Law Enforcement Officials</strong> patrolling a work zone need an alert when a driver is identified as distracted.</td>
</tr>
</tbody>
</table>
3. Operational Concept

The operational concept describes what must be done and the stakeholder roles in work zones to address the challenge in work zones. The following concept describes a sequence of operational events and the activities of each stakeholder group. The concept describes how stakeholders should interact with the system and references the initial stakeholders.

3.1 Driver Perspective

3.1.1 Dynamic signs in conjunction with static versions to increase likelihood of bringing the driver’s attention back to the road as they approach a work zone. (2)

3.1.2 When crossing into a restrictive area, a physical, visual, and audible notification is provided to the driver via automotive technology (lane departure or object detection) or work zone ITS device (CMS/ warning lights and audible alerts). (1, 2)

3.1.3 As a driver approaches a work zone, the vehicle provides a notification requiring acknowledgement from the driver which temporary limits the use of entertainment devices inside of the vehicle. (Connected Vehicles Scenario) (2)

3.2 Transportation Agency Perspective

3.2.1 Transportation agencies will require an ITS configuration that uniformly provides advisory messages and alerts to enhance worker safety by improving traveler awareness. (1, 2, 3)

3.2.2 To support driver responsiveness of ITS alerts across jurisdictions, transportation agencies will deploy a system with uniform placement, sign combinations, and alerts throughout their jurisdiction. (1, 2, 3)

3.2.3 Transportation agencies will ensure compliance by the industry of the standards set in place. (1, 2, 3)

3.2.4 Transportation agencies will use information obtained by the system to enhance and update the standards to remain current. (1, 2, 3)

3.2.5 MnDOT’s Regional Transportation Management Center (RTMC) will receive a notification when a driver crosses into a restricted area in a work zone. (1, 2, 3)

3.3 Industry and Field Personnel Perspective

3.3.1 To ensure driver responsiveness, industry will place a sufficient amount of ITS infrastructure along the work zone so that system responds to drivers identified as distracted or inattentive in accordance to applicable MN MUTCD guidance and standards. (1, 2, 3)

3.3.2 Industry will make improvements to the system based on information obtained by the detection devices. (1, 2, 3)

3.3.3 Industry will understand the system’s performance through data records of system failure and vehicle detection to maintain proper function of system. (1, 2, 3)
3.3.4 Industry will have training, documentation, and technical ability to mobilize and relocate the system installation to best fit work zone(s). (1, 2, 3)

3.3.5 Industry will use multiple methods to get power and communication to devices/systems. (1, 2, 3)

3.3.6 Field personnel will monitor function of alerts/messaging and placement of the signs used for the system to ensure they follow warning sign standards and guidance in the MUTCD. (1, 2, 3)

3.4 Law Enforcement Perspective
3.4.1 Law Enforcement working in the work zone will receive real time notifications when a driver is identified as inattentive or distracted. (3)

4. System Components
The system components include all the physical parts of the system that work together to provide alerts to the drivers. The following is an overview of typical system components to address this work zone challenge:

- Detection: Vehicles approaching and passing through an active work zone, and vehicles crossing into the restricted areas in a work zone. Detection may include non-intrusive detection devices and can be easily installed and relocated in changing work zones.
- Warning: Dynamically activates when vehicles swerve between lanes and/or crosses into a restricted area inside of the work zone.
- System Communication: Manages communication used to transmit data between the components, and may include cellular, radio, or other landline and wireless forms.
- Data Management: Archives system performance data which may be accomplished by a variety of on or off site databases.
- System Monitoring: Operates, detects, and reports fluctuations in system performance, system errors, or system failures in real time.

4.1 System Component Support and Responsible Parties
The system will consist of system components needed to address needs identified in Section 2 and the operational concepts described in Section 3. Each component requires deployment, operations, and maintenance activities. This section details the deployment, operations, and maintenance functions that the industry or transportation agencies will be required to do.
<table>
<thead>
<tr>
<th>Component</th>
<th>Support Required</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall System</strong></td>
<td>Determine extents of where the system should be installed based on the work zone duration, lane configurations, and construction conditions (3.2.2) Design and deploy the system in accordance with relevant standards (3.2.1) (3.2.2) (3.2.3) (3.2.4) Incorporate inspection and maintenance of the system into standard practices and requirements (3.2.3)</td>
</tr>
<tr>
<td><strong>Detection</strong></td>
<td>Determine suitable locations for detection devices to monitor the restricted areas within a work zone (3.2.4) (3.3.1) (3.3.2) Install detection equipment and connect power (3.3.4) (3.3.5) Install and integrate detection with system communication to connect detection to the warning, data management, and system monitoring (3.3.3) (3.3.4)</td>
</tr>
<tr>
<td><strong>Warning</strong></td>
<td>Install warning equipment and connect to power and other system requirements (3.3.4) (3.3.5) Inspect periodically to determine if warning is functioning properly (3.3.3) If warning is not functioning properly, follow procedures to troubleshoot and restore functionality (3.3.3)</td>
</tr>
<tr>
<td><strong>System Communication</strong></td>
<td>Install and connect system communication equipment with other system components (3.3.4) Inspect periodically to determine if communication is functioning properly (3.3.3) If system communication is not functioning properly, follow procedures to troubleshoot and restore functionality (3.3.3)</td>
</tr>
<tr>
<td><strong>Data Management</strong></td>
<td>Install and connect data management equipment with other system components (3.3.3) Periodically download data and archive from storage device following procedures (3.3.3) Inspect periodically to determine if data management is functioning properly (3.3.3) (3.3.4) If data management is not functioning properly, follow procedures to troubleshoot and restore functionality (3.3.3) (3.3.4)</td>
</tr>
<tr>
<td><strong>System Monitoring</strong></td>
<td>Install system monitoring equipment with other system components (3.3.3) Inspect periodically to determine if system monitoring is functioning properly (3.3.3) If system monitoring is not functioning properly, follow procedures to troubleshoot and restore functionality (3.3.3)</td>
</tr>
</tbody>
</table>
5. Operational Scenarios

The following operational scenarios elaborate how the identified challenges will be addressed with the implementation of the system. The examples below will apply to all work zones and is not limited by the type facility, number of lanes closed, number of individuals on site, or amount of equipment.

Adaptation of tunnel cameras, used for tracking constant movement, for analyzing vehicle drifting within the driving lane as well as erratic lane changes.

A new type of detection device is currently tested or used by multiple police agencies. Radio Frequency guns, similar to radar guns, are being used to scan for RF emanating from vehicles. The Radio Frequency being scanned are those used for texting and phone calls.

The potential exists for the development and use of navigational phone apps by drivers to notify them of changing traffic control, encouraging increased attention on the part of the driver.

Future operational scenarios include interactions with connected vehicles (CV). Sensors within some higher model luxury automobiles can alert the driver of lane drift, eyes off the road, or sleepiness. It would therefore seem plausible that in future CV applications in work zones could include an interface with these onboard sensors to alert identified distracted drivers.
References

