Smarter Work Zones
Webinar Series

Webinar #12: Integrating Technology Applications – Massachusetts DOT

Todd Peterson and Neil Boudreau

April 26, 2016 1:00-2:30pm EST

Efficiency through technology and collaboration
Smarter Work Zones

INTRODUCTION AND TODAY’S SPEAKERS
Today’s Speakers

Todd Peterson, P.E., PTOE
Transportation Specialist
FHWA Office of Operations

Neil Boudreau
Director of Traffic and Safety
Massachusetts DOT
Smarter Work Zones (SWZ) Webinar Series

• This is the twelfth in a series of monthly SWZ webinars
• Topics based on what matters most to you!
• Previous Webinar topics include:
  – Corridor-Based and Program-Based Project Coordination
  – Queue Warning Systems
  – Variable Speed Limits
  – Dynamic Lane Merge
  – Work Zone Project Coordination Guide and Examples
  – Integrating Project Coordination & Technology Applications: Iowa DOT
  – Lane Closure and Permitting Systems
• Recordings and materials for previous webinars are available on The National Work Zone Safety Information Clearinghouse website: https://www.workzonesafety.org/swz/webinars

• Coming Up:
  – Webinar #13: Implementing Work Zone ITS Applications: Procurement
    Wednesday, May 11th, 1:00-2:30pm EDT
Purpose of Today’s Webinar

Discuss Massachusetts DOT (MassDOT’s) implementation of Technology Applications using the Work Zone Intelligent Transportation Systems (ITS) Implementation Guide.

Topics include:

1. SWZ Technology Application Initiative
   - Show how the SWZ Technology Application initiative can be used by agencies to enhance their current work zone management practices

2. SWZ Real-World Example
   - Provide a real-world example of how MassDOT implemented Technology Applications using the Work Zone ITS Implementation Guide (FHWA-HOP-14-008).
Smarter Work Zones
SWZ Overview & Technology Application Initiative
What are Smarter Work Zones (SWZ)?

Innovative strategies designed to optimize work zone safety and mobility

• Policies and practices used to incrementally and continuously improve WZ operations
• Tools to reduce WZ crashes and delays
• Tools to enhance WZ management strategies
Two Identified SWZ Initiatives:

**Project Coordination**
Coordination within a single project and/or among multiple projects within a corridor, network, or region, and possibly across agency jurisdictions

**Technology Application**
Deployment of Intelligent Transportation Systems (ITS) for dynamic management of work zone traffic impacts, such as queue and speed management

*Today’s Focus of Discussion*
Technology Application – What is it?

Deployment of ITS for dynamic management of work zone traffic impacts, such as queue and speed management to provide actionable information to drivers and traffic managers.

Capabilities include:

• Improving driver awareness
• Providing dynamic and actionable guidance to drivers
• Enhancing tools for on-site traffic management

Source: FHWA
SWZ Technology Application Goals:

Goal 1A

By December 2016, 35 State DOTs have implemented business processes for work zone ITS technologies as identified in the Work Zone ITS Implementation Guide

- What does this mean?
  - Well-documented agency policies and processes to streamline consideration and use of work zone ITS technologies to minimize traffic impacts
SWZ Technology Application Goals:

Goal 1B

By December 2016, 35 State DOTs have utilized at least one work zone ITS technology application for dynamic management of work zone impacts

• What does this mean?
  – Consideration of the six step process explained in the WZ ITS implementation guide to plan and implement ITS strategies
  – Identify and use ITS strategies such as speed and/or queue management on at least one project for dynamic management of work zone impacts
Work Zone ITS Implementation Guide

- Provide guidance on implementing ITS in work zones to assist public agencies, design and construction firms, and industry stakeholders
- Presented through a 6-step Systems Engineering Approach to WZ ITS implementation
Smarter Work Zones
MASSDOT’S INTEGRATION OF TECHNOLOGY APPLICATIONS
Presentation Overview

• Highlight existing practices, define goals, and develop implementation plan

• Introduce new *Work Flow Process*
  – Design Standards (Steps 1-4)
  – Overview of SOP for contractors (Steps 5-7)

• Technology applications lessons learned
Technology Applications: Existing Practices

MassDOT has used Work Zone ITS applications on 12 projects to date.

Monitoring traffic conditions and providing real-time feedback helps to lessen driver frustration about travel conditions.

MassDOT’s Real-Time Traffic Monitoring System specification is a “living document.”

Sharing SWZ system access/data with partner agencies improves network mobility and credibility for project delivery.
Technology Applications: MassDOT Goals

Pre-EDC3
- Demonstration Phase
  - Multiple project experience

Post-EDC3
- Institutionalized
  - Published standard procedures

Goal: Develop Standard Operating Procedures for planning, design and construction
Technology Applications: How to Achieve Goals

• Need SWZ design standards to help consultants understand *Concept of Operations*

• Update SWZ specifications for each application to define stand-alone requirements to aid consultants for future projects

• Create SOP for Contractors to understand expectations for use of work zone ITS

• Want a process to evaluate real-time data captured and generate work zone capacity values

Source: http://blog.commlabindia.com
Technology Applications: Implementation Plan (1 of 2)

Initial Focus

• Use existing SWZ experience and the Work Zone ITS Implementation Guide to develop design standards

• Update SWZ applications matrix and scoring criteria to reflect Massachusetts experience

• Use current specifications and Guide to develop SOP for contractors who bid on SWZ systems

• Provide training workshop on SWZ systems

Source: Cliparts.com
Technology Applications: Implementation Plan (2 of 2)

Long-Range Focus

- Develop stand-alone Concept of Operations
- Configure SWZ specifications into a “plug and play” format
- Build data warehouse module to capture real-time SWZ data
- Develop real-time data dashboard to evaluate performance

Source: nf5.com
Technology Applications: Where are we?

- **Completed**: “MassDOT Smart Work Zone Design Standards in December 2015”*
- **Completed**: “MassDOT Smart Work Zone Standard Operating Procedures in December 2015”*
- **Completed**: “MassDOT Work Zone ITS Applications”
- **Evaluating**: “MassDOT Scoring Criteria for Work Zone ITS”
- **In-Progress**: New *Concept of Operations* document

*Updated in Feb. 2016
Technology Applications: Work Flow Process (1 of 2)

FHWA Work Zone Intelligent Transportation Systems Implementation Guide: Six-Step Process

Figure 4. Overview of the implementation process.

Source: FHWA
Technology Applications: Work Flow Process (2 of 2)

MassDOT’s Smart Work Zone 7-Step Process

- Step 1: Assessment of SWZ Needs
- Step 2: Planning SWZ Applications
- Step 3: Layout and Design SWZ
- Step 4: Define SWZ Specifications
- Step 5: Deploy, Calibrate and Test SWZ
- Step 6: Operate and Maintain SWZ
- Step 7: Evaluate SWZ Data
Step 1: Assessment of SWZ Need (1 of 2)

Key Questions

- Who are we trying to help with use of ITS in the work zone?
- How to best assess the expected work zone impacts and then determine what the issues/needs are?
- What are the goals of the project and how can SWZ applications be leveraged to support those goals?
- Who are the stakeholders that warrant involvement in the development of a SWZ to support the TMP?
Step 1: Assessment of SWZ Need (2 of 2)

Mobility Applications
- Notification to motorist on work zone operations
- Minimize project congestion through traffic diversion
- Providing real-time travel or delay times
- Dynamic lane merge

Safety Applications
- Warn motorists of stopped or slowed traffic
- Excessive speed warnings
- Vehicle exit/entry or clearance restriction notifications
- Protect workers from vehicle intrusions

Planning and Monitoring Applications
- Video surveillance
- Develop real-time performance reports
- Data-driven enforcement patrols
- Refine allowable work hours
- Evaluate throughput capacity
Step 1: Defining Specific Project Needs

MassDOT’s *Work Zone Transportation Management Procedures* require that projects categorized at Impact Levels 3 or 4 shall include an ITS Monitoring Plan (IMP). Impact Levels 1 & 2 may utilize work zone ITS devices.

<table>
<thead>
<tr>
<th>Project Impact</th>
<th>Extent of ITS Coverage</th>
<th>Mobility Functions</th>
<th>Safety Functions</th>
<th>Planning &amp; Monitoring Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Travel Time &amp; Delay Notifications</td>
<td>Alternate Route Advisory</td>
<td>Congestion Warning</td>
</tr>
<tr>
<td>Level 1 &amp; 2</td>
<td>Work site</td>
<td>O</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Level 3</td>
<td>Work site &amp; vicinity</td>
<td>✓</td>
<td>✓</td>
<td>O</td>
</tr>
<tr>
<td>Level 4 &amp; Significant Projects</td>
<td>Work site, vicinity &amp; approaches</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓ = Recommended for all  
O = Recommended for some cases
Step 2: Planning SWZ Applications

- What is the overall work zone ITS concept of operations?
  - Define expected system operation
  - Define data flow between system components
  - Define how the system will be managed
Step 2: Work Zone ITS Components
Step 2: Project Scoring Criteria (1 of 4)

### MassDOT Scoring Criteria for Work Zone ITS

#### MassDOT Project Location:

<table>
<thead>
<tr>
<th>Base Criteria – Existing Conditions</th>
<th>Project #</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM Peak Hour Congestion [Yes - No] <em>(if yes estimated duration)</em></td>
<td>N/A</td>
</tr>
<tr>
<td>PM Peak Hour Congestion [Yes - No] <em>(if yes estimated duration)</em></td>
<td></td>
</tr>
<tr>
<td>Congestion in both AM &amp; PM [Yes - No] <em>(if yes estimated duration)</em></td>
<td></td>
</tr>
</tbody>
</table>

#### Factor 1 – Impacts on Roadway Geometry: Permanent Setup or Recurring Short Duration

- **Maintain existing cross-section (0 points)**
- **Loss of full shoulder (1 point)**
- **Narrowed travel lanes (3 points)**
- **Loss of travel lane (6 points)**
- **Loss of multiple travel lanes (10 points)**

**Score:**

**0**

#### Factor 2 – Duration of work zone: Long-term stationary work will have a duration of:

- > 2 years (8 points)
- > 1 year (6 points)
- 6 - 12 months (4 points)
- < 6 months (1 point)

**Score:**

**0**

#### Factor 3 – Availability of Alternate Routes for detour or diversion of traffic:

- No viable alternate routes (4 points)
- Alternate route with nominal capacity available (2 points)
- Alternate route with spare capacity available (1 point)
- Several alternate routes available with spare capacity (0 points)

**Score:**

**0**

#### Factor 4 – Queuing – Anticipated duration of Work Zone Queuing above recurring peak hour conditions are estimated to be:

- > 4 hours per day (10 points)
- 2 to 4 hours per day (7 points)
- 2 to 6 hours per day (4 points)
- < 1 hour per day (3 points)

**Score:**

**0**

#### Factor 5 – Delay Time (Average Delay of vehicles above and beyond existing conditions): Note: use MassDOT WZ Delay Form

- Delays in excess of 30 minutes for a duration at least 2 hours (10 points)

**Score:**

February 2016
## Base Criteria – Existing Conditions

- AM Peak Hour Congestion [ Yes - No ] (*if yes estimated duration)
- PM Peak Hour Congestion [ Yes - No ] (*if yes estimated duration)
- Congestion in both AM & PM [ Yes - No ] (*if yes estimated duration)

### Factor 1 – Impacts on Roadway Geometry: Permanent Setup or Recurring Short Duration

- Maintain existing cross-section (0 points)
- Loss of full shoulder (1 point)
- Narrowed travel lanes (3 points)
- Loss of travel lane (6 points)
- Loss of multiple travel lanes (10 points)

### Factor 2 – Duration of work zone: Long-term stationary work will have a duration of:

- < 6 months (1 points)
- 6 - 12 months (4 points)
- > 1 year (6 points)
- > 2 years (8 points)
### Step 2: Project Scoring Criteria (3 of 4)

<table>
<thead>
<tr>
<th>Factor 3 – Availability of Alternate Routes for detour or diversion of traffic:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Several alternate routes available with spare capacity (0 points)</td>
</tr>
<tr>
<td>• Alternate route with spare capacity available (1 points)</td>
</tr>
<tr>
<td>• Alternate route with nominal capacity available (2 points)</td>
</tr>
<tr>
<td>• No viable alternate routes (4 points)</td>
</tr>
</tbody>
</table>

**Factor 4 – Queuing - Anticipated duration of Work Zone Queueing above recurring peak hour conditions are estimated to be:**

<table>
<thead>
<tr>
<th>Time Duration</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 hour per day</td>
<td>3 points</td>
</tr>
<tr>
<td>1-2 hours per day</td>
<td>5 points</td>
</tr>
<tr>
<td>2 to 4 hours per day</td>
<td>7 points</td>
</tr>
<tr>
<td>&gt; 4 hours per day</td>
<td>10 points</td>
</tr>
</tbody>
</table>

**Factor 5 – Delay Time (Average Delay of vehicles above and beyond existing conditions)**

*Note: use MassDOT WZ Delay Form*

<table>
<thead>
<tr>
<th>Delay Duration</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delays less than 12 minutes</td>
<td>0 points</td>
</tr>
<tr>
<td>Delays in between 12 to 20 minutes for a duration of 1 hour or more</td>
<td>2 points</td>
</tr>
<tr>
<td>Delays of between 20 to 30 minutes for a duration of 1 hour or more</td>
<td>5 points</td>
</tr>
<tr>
<td>Delays in excess of 30 minutes for a duration at least 2 hours</td>
<td>10 points</td>
</tr>
</tbody>
</table>
Step 2: Project Scoring Criteria (4 of 4)

Factor 6 – Commercial Motor Vehicle Traffic Impacts:

- Percent Heavy Vehicles <5% (1 point)
- Percent Heavy Vehicles 5-10% (3 points)
- Percent Heavy Vehicles >10% (6 points)

Factor 7 – Impacts of Specific Issues (Based on Judgement: No Impact = 0 / Impact = 1)

- Existing Crash History within the Work Zone limits
- Traffic Speed Variability
- Increased travel time or restricted access to regional traffic generators
- Unusual or Unpredictable Weather Patterns Such as Snow, Ice, and Fog
- Frequently Changing Operating Conditions for Traffic
- Merging Conflicts and Hazards At Work Zone Tapers
- Complex Traffic Control Layout with Multiple Access Points (i.e. Ramps or Side Streets)
- Construction Vehicle Entry/Exit Speed Differential Relative to Traffic
- Limited offset to median or roadside barrier/guardrail
- Lane Diversions - Use of Highway Crossover or Center Work Zone

Total Project Score

*If the total score is:*

- ≥30 – ITS is likely to provide significant benefits relative to costs for procurement
- ≥10 and <30 – ITS may provide some benefits and should be considered as a treatment to mitigate impacts
- <10 – ITS may not provide enough benefit as a treatment to justify the associated costs
Step 2: Work Zone ITS Applications (1 of 3)

Matrix of the different types of WZ ITS Applications based on the Critical Project Characteristics
Step 2: Work Zone ITS Applications (2 of 3)

Critical Project Characteristics

Source: pixabay.com
## Step 2: Work Zone ITS Applications (3 of 3)

### Critical Project Characteristics

<table>
<thead>
<tr>
<th>Critical Project Characteristics</th>
<th>Work Zone ITS Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent planned lane closures are expected, which will create queues that cause high speed differentials between queued and approaching traffic</td>
<td>Queue/speed drop warning</td>
</tr>
<tr>
<td></td>
<td>Real-time traveler information</td>
</tr>
<tr>
<td>Emergency shoulders will be closed through the work zone and frequent stalls and fender-benders are expected to occur that will cause queues because they cannot be quickly moved to the shoulder</td>
<td>Incident management</td>
</tr>
<tr>
<td>Travel times and delays through the work zone will be highly variable and real-time information can improve pre-trip and real-time route choice, departure time, and possibly mode choice decisions</td>
<td>Dynamic lane merge</td>
</tr>
<tr>
<td>Roadway access for emergency response vehicles will be significantly constrained by the project, increasing response and clearance times</td>
<td>Variable speed limit*</td>
</tr>
<tr>
<td></td>
<td>Automated enforcement**</td>
</tr>
<tr>
<td></td>
<td>Construction vehicle entrance/exit warning</td>
</tr>
<tr>
<td></td>
<td>Temporary ramp metering</td>
</tr>
<tr>
<td></td>
<td>Performance measurement</td>
</tr>
</tbody>
</table>
Step 2: Example from I-93 Fast 14 Project

Existing Geometry → 4-lanes each direction cut in half using crossover over 4.5 mile distance

Weekend Traffic Volumes → approaching 6,000 vhp during peaks

Traffic Management → lack of viable alternate routes with capacity

Local Network → Road closures result in several detours

These structures carry **200,000** vehicles per day
Step 2: Fast-14 Project Scoring Results

<table>
<thead>
<tr>
<th>MassDOT Scoring Criteria for Work Zone ITS</th>
<th>Project #</th>
</tr>
</thead>
<tbody>
<tr>
<td>MassDOT Project Location: Medford (Design-Build)</td>
<td>606255</td>
</tr>
<tr>
<td>Interstate 93 - 14 Bridge Superstructure Replacement</td>
<td></td>
</tr>
</tbody>
</table>

**Basic Criteria – Existing Conditions**
- N/A

**Weekend Conditions**
- AM Peak Hour Congestion: [Yes] No [1] *(if yes estimated duration)* +/- 1 hour
- PM Peak Hour Congestion: [Yes] No [1] *(if yes estimated duration)* +/- 1 hour
- Congestion in both AM & PM: [Yes] No [1] *(if yes estimated duration)* Approx 2-2.5 hrs.

**Factor 1 – Impacts on Roadway Geometry: Permanent Setup or Recurring Short Duration**
- Maintain existing cross-section (0 points)
- Loss of full shoulder (1 point)
- Narrowed travel lanes (3 points)
- Loss of travel lane (6 points)
- Loss of multiple travel lanes (10 points)
- Score: 10

**Factor 2 – Duration of work zone: Long-term stationary work will have a duration of:**
- > 2 years (8 points)
- > 1 year (6 points)
- 6 - 12 months (3 points)
- < 6 months (1 point)
- Score: 1

**Factor 3 – Availability of Alternate Routes for Detour or Diversion of Traffic**
- No viable alternate routes (4 points)
- Alternate route with nominal capacity available (2 points)
- Alternate route with spare capacity available (1 point)
- Several alternate routes available with spare capacity (0 points)
- Score: 4

**Factor 4 – Queuing - Anticipated duration of Work Zone Queuing above recurring peak hour conditions are estimated to be:**
- > 4 hours per day (10 points)
- 2 to 4 hours per day (7 points)
- 1-2 hours per day (5 points)
- < 1 hour per day (3 points)
- Score: 10

**Factor 5 – Delay Time (Average Delay of vehicles above and beyond existing conditions)**
- Delays in excess of 30 minutes for a duration at least 3 hours (10 points)
- Score: 10

**Score = 38**
**Good Candidate**
Polling Questions/Questions
Step 3: Layout & Design SWZ

• Layout Guidelines – Identify the following key locations:
  – Start and end points
  – Merge points for lane drop(s)
  – Approaches to project site
  – Upstream decision points
  – Stable points upstream and downstream of bottleneck
• Locate required detection and surveillance equipment
• Add PCMS to disseminate messages at key locations
• Place all equipment locations on a Map with GIS points
Step 3: SWZ Equipment

- Portable Changeable Message Signs (PCMS)
- Portable Camera Trailers
- SWZ Operating System
- Speed Feedback Boards
- Radar/Doppler Sensors
- Bluetooth Sensors
- Probe Data

Source: MassDOT
Step 3: Current I-91 Springfield Project
Step 3: Example Layouts

Impact Level 3

Impact Level 4
Step 4: Define SWZ Specifications

**Lessons Learned**

- Include detailed descriptions of the required equipment and expected functions
- Define expectations for system operations
- Document placement, calibration and testing expectations
- Define expected performance/deliverables
Step 4: Specifications for System Management

**Purpose:** Contractor/vendor shall supply the necessary equipment to monitor traffic, collect data, provide real-time reporting and remote messaging via the vendor supplied and maintained website

**Required Personnel:**

*Project Manager* – Overall project lead to manage RTTM project

*Local Systems Manager* – Experienced in managing day-to-day operation & maintenance of SWZ systems and equipment

*Local Field Maintenance/Repair Technicians* – maintain devices

*Software Specialist* – Configuration of system logic and calibration of algorithms to deliver real-time information
Step 5: Deploy, Calibrate, & Test SWZ

Key Takeaways

- Safe deployment that follows Roadside Design Guide (clear zone)
- Need GPS coordinates for equipment locations
- All devices must be calibrated to field conditions
- Develop testing plan to execute the functionality of the system

Vendor Activities
- Ensure system design and logic is valid
- Develop plan for deployment

Contractor Activities
- Conduct Site Visit
- Revise & Detail Design
- Meet with MassDOT
- Submit Plan

MassDOT Activities
- Provide permission for site visits
- Attend Design Review
- Approve Final Plan

Vendor, Contractor and MassDOT
- Operations Plan is submitted and accepted in writing by MassDOT
Step 6: Operate & Maintain SWZ

Successful Implementation

- Proactive Maintenance
- Reliable Operation
- Training & Support
Step 7: Evaluate SWZ Data

So why do we insist on data collection?

• On-going evaluation of operations to support construction work hours
• Ability to calculate work zone throughput capacity
• Work zone mobility performance measures
• Develop public-facing work zone dashboard
• Planning for future traffic management plans

Source: clarabridge.com
Step 4: Use of SWZ Data

Work Hour Matrix for Lane Closures
Step 4: Use of SWZ Data

Whittier Bridge – Lane Speed Graph
Implementation Plan: How are we doing?

✓ Use existing SWZ experience and FHWA Work Zone ITS Implementation Guide to develop design standards Done

✓ Update SWZ applications matrix and scoring criteria to reflect Massachusetts experience Done

✓ Use current specifications and Guide to develop SOP for contractors who bid on SWZ systems Done

✓ Provide training workshop on SWZ systems Done

• Prepare ConOps document Underway

• Develop “Plug & Play” specifications Starting Soon

• Build data warehouse module to capture real-time SWZ data to evaluate performance Starting Soon

• Develop real-time data dashboard Starting Soon

Source: jobinspirations.com
SWZ Technology Applications: Lessons Learned

• Make use of ITS in work zones part of your traffic management mitigation strategies
• Start planning your Concept of Operations early in project development
• Engage your stakeholders to obtain early buy-in
• Invest the time and effort to generate detailed project specifications

- Require detailed data capture and use the data to demonstrate successes
- Give stakeholders access to monitor the system operation

Source: mentorcloud.com
For More Information:

Neil Boudreau, State Traffic Engineer
MassDOT

neil.boudreau@state.ma.us
Smarter Work Zones

FHWA RESOURCES
SWZ Interactive Toolkit Available!

https://www.workzonesafety.org/SWZ/

Source: FHWA
## Other Resources – Technology Application

Thanks for joining us!

• Upcoming Events
  – Webinar #13: Implementing Work Zone ITS Applications: Procurement
    • Wednesday, May 11, 2016, 1:00-2:30pm EST
  • Registration:
    https://connectdot.connectsolutions.com/e6rwz52leqm/event/registration.html
    – Check The National Work Zone Safety Information Clearinghouse website for updates
      https://www.workzonesafety.org/SWZ/

• Questions or Comments?
  – Jawad Paracha (FHWA Operations, WZ Team)
    jawad.paracha@dot.gov