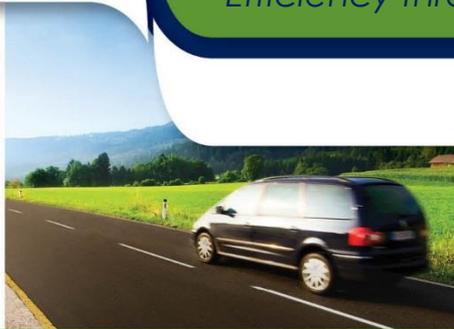


# Smarter Work Zones

## SWZ Program

### DLM Systems

*Efficiency through technology and collaboration*



U.S. Department of Transportation  
**Federal Highway Administration**

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# Smarter Work Zones

## OVERVIEW



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# What are Smarter Work Zones?

*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



# What are Smarter Work Zones (cont.)?

## Project Coordination

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

## Technology Applications

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

**Today's Focus**



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# Types of Technology Applications Include...

- Real-Time Traveler Information
- Queue Warning
- Dynamic Lane Merge
- Incident Management
- Variable Speed Limits
- Automated Enforcement
- Entering/Exiting Construction Vehicle Notification
- Performance Measurement

**For more information check out the SWZ TA website**

<https://www.workzonesafety.org/swz/swztechnology-application/types-of-applications/>



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# Several States are already Utilizing SWZ!

- Over **40 states** have implemented technology applications, including:
  - Formalizing processes for planning and operating technology applications
  - Implementing “on-call” regional ITS SWZ contracts
  - Implementing steps towards institutionalizing technology:
    - Developing systems engineering documents
    - Developing specs to bid on technology
    - Piloting technology applications
    - Evaluating pilot to determine effectiveness for wider implementation
    - Fully implementing technology applications
    - Utilizing project funds to implement ITS – leading to institutionalization



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# Why Implement SWZ?

## Capabilities of Technology Application

- **Improved driver awareness**
  - Changing traffic patterns
  - Downstream congestion
  - Construction vehicle ingress/egress
  - Expected delay / travel time
- **Dynamic and actionable guidance to drivers**
  - “Road work ahead” vs “Traffic Stopped 1 mile ahead”
  - “Road work – expect delays” vs. “Road Work I-95 past Exit 52 Use Alternate Routes”
- **Enhanced tools for on-site traffic management**
  - Speed monitoring
  - Automated speed enforcement
  - Queue formation



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# Why Implement SWZ?

## Benefits of Technology Application

- **Empowers drivers to be proactive in responding to work zones**
  - Awareness of downstream hazards
  - Facilitates real-time decision-making and trip planning
- **Streamlines traffic management functions through partial automation**
  - Speed enforcement
  - Data collection
  - Performance measurement
- **Information increases customer satisfaction**
  - The More you Know...



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# Smarter Work Zones

## DLM SYSTEMS



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# Dynamic Lane Merge (DLM) Overview

- **What is it?**

- Systems that encourage motorists to merge at specific points as they approach a lane closure, depending on current operating conditions
  - Systems alternate merging strategies (early and late merge)

- **How does it work?**

- Uses technology (e.g., sensors) to monitor real-time traffic characteristics
- Conveys instructions through portable changeable message signs (PCMS) placed in advance of a lane closure
- Uses site-specific algorithm
- Detects a change in traffic conditions (e.g., changes in speed, density, and occupancy) to switch merge strategies
- Provides lane use instructions to drivers



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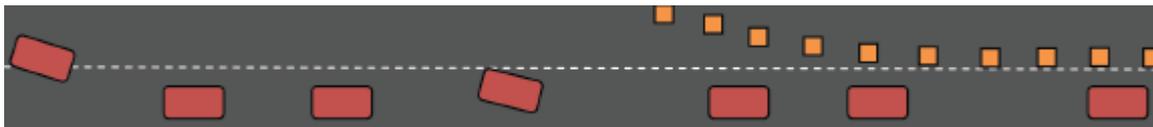
# DLM Strategies

- Early Lane Merge
  - Often used in low-volume conditions
  - Reduces the occurrence of high-speed merging at the point of lane closure
- Late “Zipper” Lane Merge
  - Often used in high-volume conditions
  - Reduces the length of the queue



# Early Lane Merge

- Advises drivers to move out of closed lane well before the forced merge point
- Works best when there is a low traffic volume combined with high average speeds
- Benefits:
  - Reduction of aggressive driving and unsafe merge maneuvers
  - Provide significant advanced warning to allow drivers adequate distance to merge
  - Gives positive instructions on lane usage



Source: [https://www.workzonesafety.org/fhwa\\_wz\\_grant/atssa/atssa\\_dynamic\\_lane\\_merging](https://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_dynamic_lane_merging)



Source: Minnesota DOT

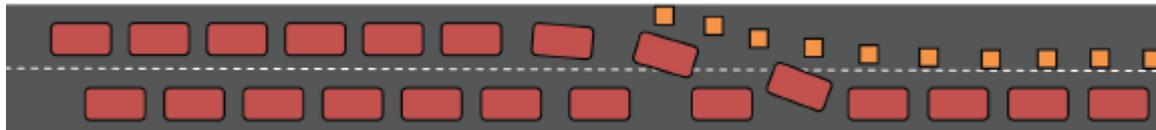


# Late Lane Merge

- Advises drivers to use both lanes up to the merge point
- Works better for high traffic volumes, situations where queueing upstream of work zone is expected to occur
- Benefits:
  - Maximize available storage upstream of work zone for reducing total queue length.
  - Reduces confusion between drivers who think they should merge early vs. drivers that use open lanes as far as possible.
  - Clarifies right-of-way at merge point (“alternate merge”)



Source: Hallmark, Mudgal, Stout, & Wang, 2011



Source: [https://www.workzonesafety.org/fhwa\\_wz\\_grant/atssa/atssa\\_dynamic\\_lane\\_merging](https://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_dynamic_lane_merging)



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# Implementing DLM

- **Where?** Most useful in work zones experiencing fluctuating traffic demands
- **How?** Techniques used to implement DLM:
  - Microwave signals to identify traffic volume
  - Video analysis to track traffic volume, lane occupancy, and queue
  - Doppler radar to determine average speed
  - Pneumatic tubes to calculate traffic volume
  - Computer simulations to optimize dynamic merging algorithms
- **How Much?** Costs vary based on detection technology, number of PCMS, and product manufacturer



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# DLM Considerations

- Considerations prior to implementing a DLM system:
  - Sign placement
    - Road geometry, expected queue length, and average expected speed
    - Driver awareness with roadway
    - Entrance/exit ramp proximity to merging area
  - Police enforcement
    - Proven useful, especially with early merge
    - Focus on reducing aggressive, non-compliant drivers
  - Outreach methods
    - Driver confusion and steep learning curve
    - Public information campaigns on lane closures and how DLM systems work
- Considerations during implementation:
  - Ensure signs are displaying reasonable messages
  - Engage in real-time sign feedback



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# Benefits of Using DLM

- Reductions in speed differentials between open lanes in advance of the lane closure
- Reduced driver frustration by creating a “sense of fairness”
- Reduction in queue lengths
- Reduction in work zone delays



# Examples of DLM Signing

## Dynamic Signing

- **Early Lane Merge**
  - DO NOT PASS/WHEN FLASHING
- **Late Lane Merge**
  - STAY IN YOUR LANE / MERGE AHEAD
  - USE BOTH LANES / TO MERGE POINT
  - TAKE YOUR TURN / MERGE HERE
  - SLOW TRAFFIC AHEAD / USE BOTH LANES
  - STAY IN YOUR LANE / MERGE AHEAD XX MILES
  - TAKE YOUR TURN / MERGE HERE
  - USE BOTH LANES
  - STOP TRAFFIC AHEAD
  - MERGE HERE
  - TAKE TURNS

## Other Signing

- Deployment may also include passive/non-activated mode for when merge strategy is no longer necessary
- Example:
  - LEFT (or RIGHT) LANE CLOSED / XX MILES AHEAD
  - LEFT (or RIGHT) LANE CLOSED



# Examples of Dynamic and Supporting Signs

## Dynamic Signing



## Support Signing



Source: [https://www.workzonesafety.org/training-resources/fhwa\\_wz\\_grant/atssa\\_dynamic\\_lane\\_merging/](https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_dynamic_lane_merging/)

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# Additional DLM Resources

## Guidance

- Guidance for the Use of Dynamic Lane Merging Strategies  
[https://www.workzonesafety.org/training-resources/fhwa\\_wz\\_grant/atssa\\_dynamic\\_lane\\_merging/](https://www.workzonesafety.org/training-resources/fhwa_wz_grant/atssa_dynamic_lane_merging/)
- SWZ Webinar Series Webinar #6: Technology Application Case Studies: Variable Speed Limit and Dynamic Lane Merge  
[https://www.workzonesafety.org/files/documents/SWZ/webinar6\\_slides.pdf](https://www.workzonesafety.org/files/documents/SWZ/webinar6_slides.pdf)

## Description

- Description of a Late Merge System by MnDOT  
<http://www.dot.state.mn.us/trafficeng/workzone/doc/When-latemerge-zipper.pdf>

## Deployment Evaluation

- Evaluation of MnDOT Deployment  
<http://www.dot.state.mn.us/trafficeng/workzone/doc/2004DLMS-Evaluation.pdf>
- Evaluation of MD SHA Deployment <http://trrjournalonline.trb.org/doi/abs/10.3141/1948-10>
- Evaluation of FDOT Deployment [http://www.dot.state.fl.us/research-center/Completed\\_Proj/Summary\\_CN/FDOT\\_BD548-24\\_rpt.pdf](http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_CN/FDOT_BD548-24_rpt.pdf)



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