International
Road Dynamics Inc.

Dynamic Lane Merge Systems

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INTERNATIONAL ROAD DYNAMICS INC.
20 YEARS
1980 - 2000

Acknowledgements

- Maryland State Highway Administration
- University of Maryland, College Park
- Michigan Department of Transportation
- Wayne State University

Lane Merging Issues

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- Merging traffic → Traffic conflict
  - Flow disruption
  - Speed variance
  - Driver frustration
  - Safety concerns
  - Increased delay
- Approaches to merge control
  - Merge late
  - Merge early

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Dynamic Merge Control

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Goal : Improve safety and mobility through intelligent traffic guidance

- Static signing may lack relevance
- Traffic conditions are not constant
- Appropriate traffic control is not constant
- Relevant control for current conditions
  - Clear and positive guidance
  - Fairness
  - Safety

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Dynamic Late Merge System

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- **Project Location**

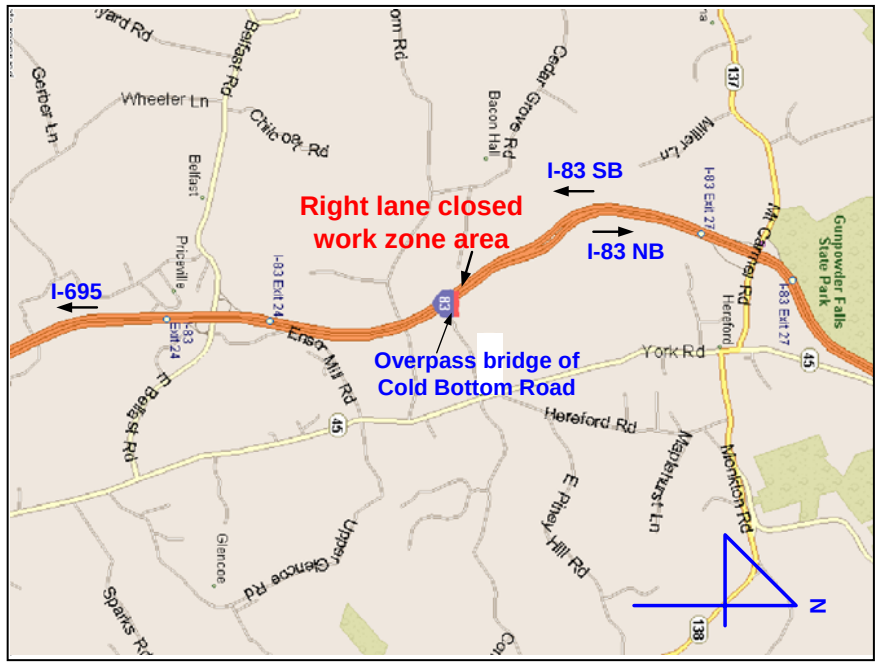
  Southbound I-83 near Cold Bottom Road

- **Project Duration**

  October 13 to November 17, 2003

- **Project Evaluation**

  University of Maryland



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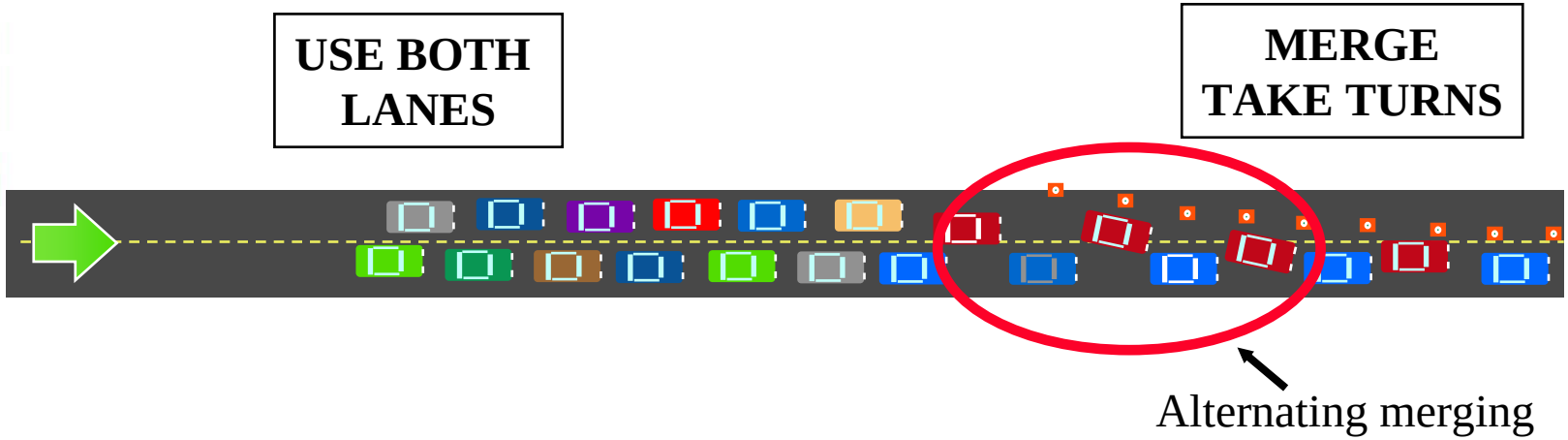
Late Merge Concept



- Use both lanes to taper area
- "Zipper" at taper – vehicles alternate from each lane
- With static signs
  - May improve flow under congested conditions
  - Conflict and confusion during mild congestion

Overview of A Dynamic Late Merge System

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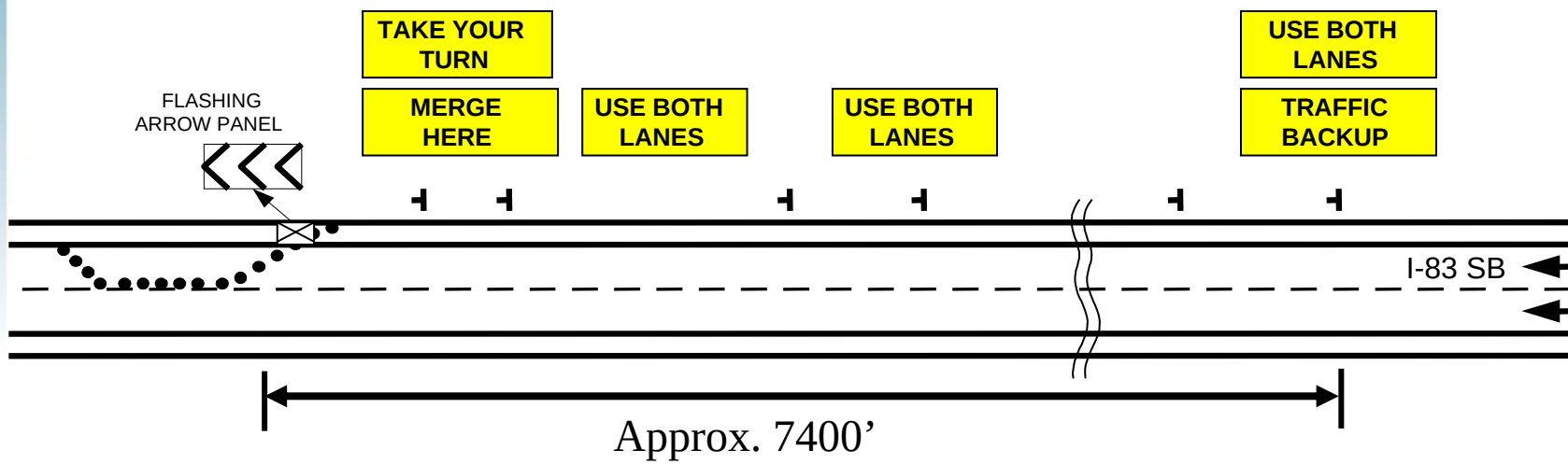

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Overview of A Dynamic Late Merge System

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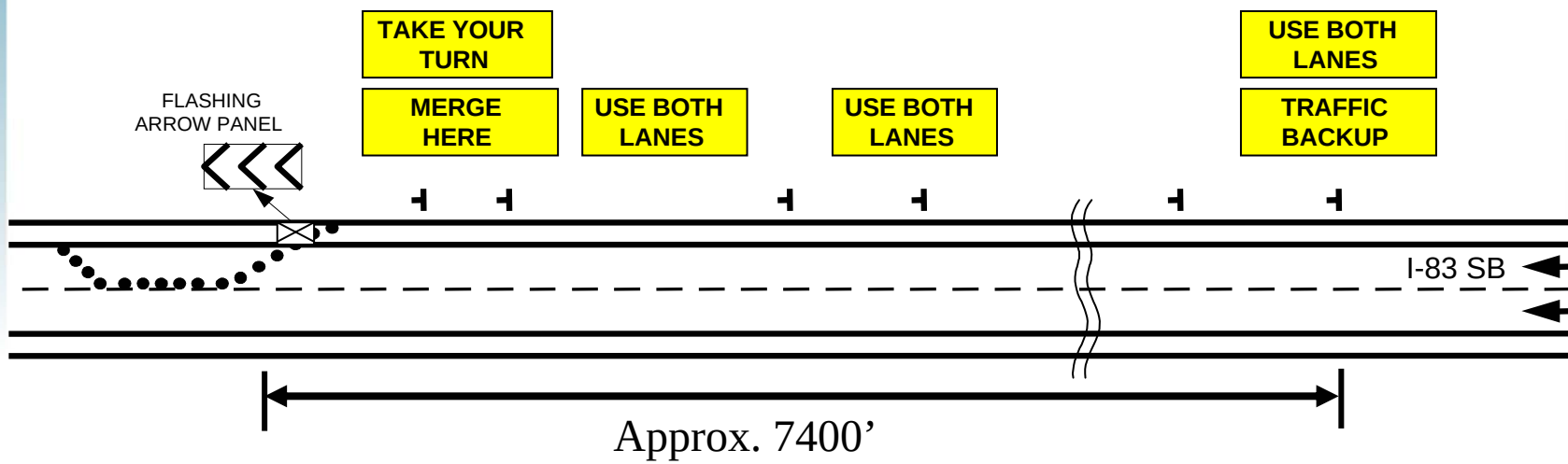

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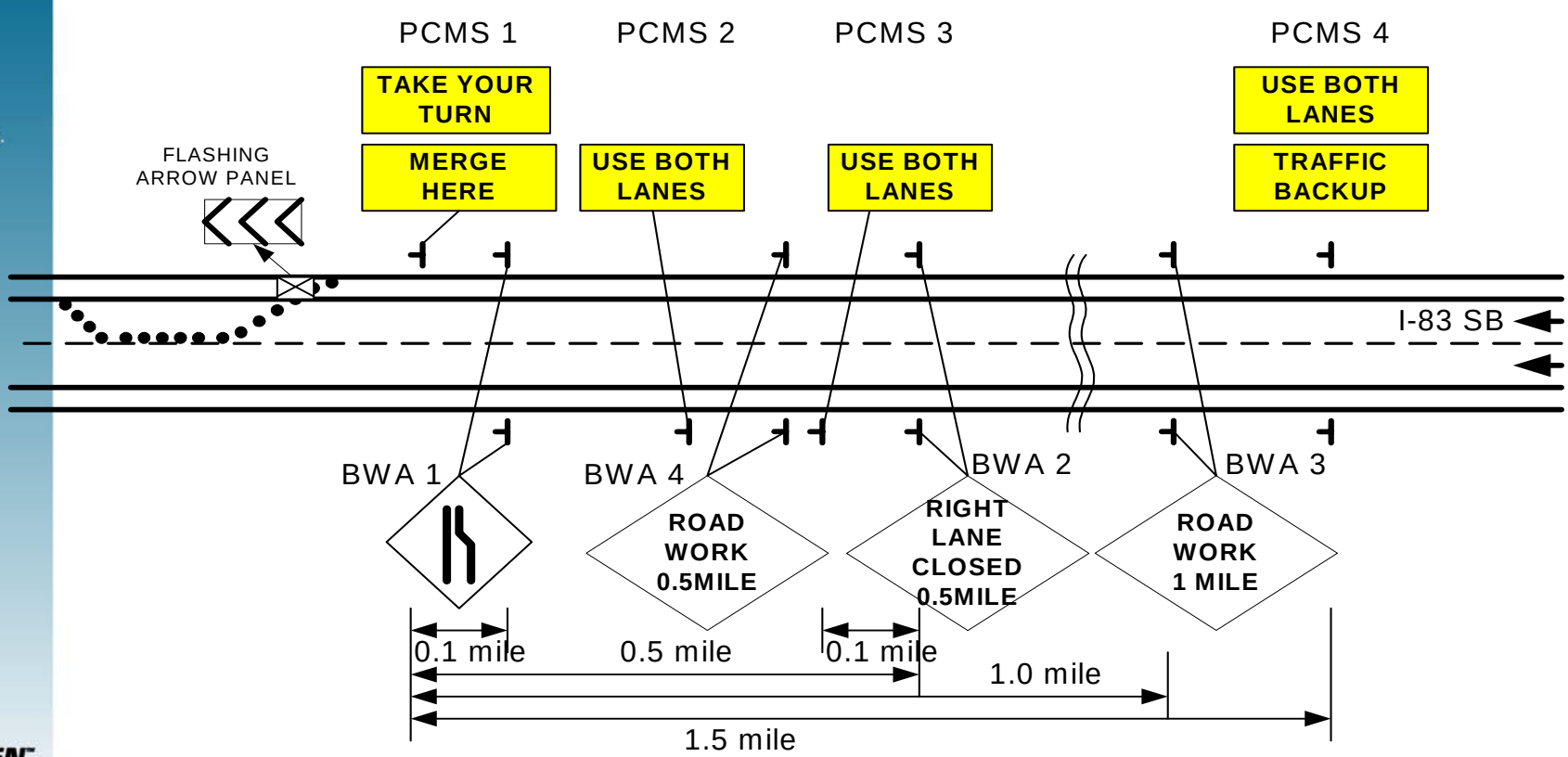
Overview of A Dynamic Late Merge System



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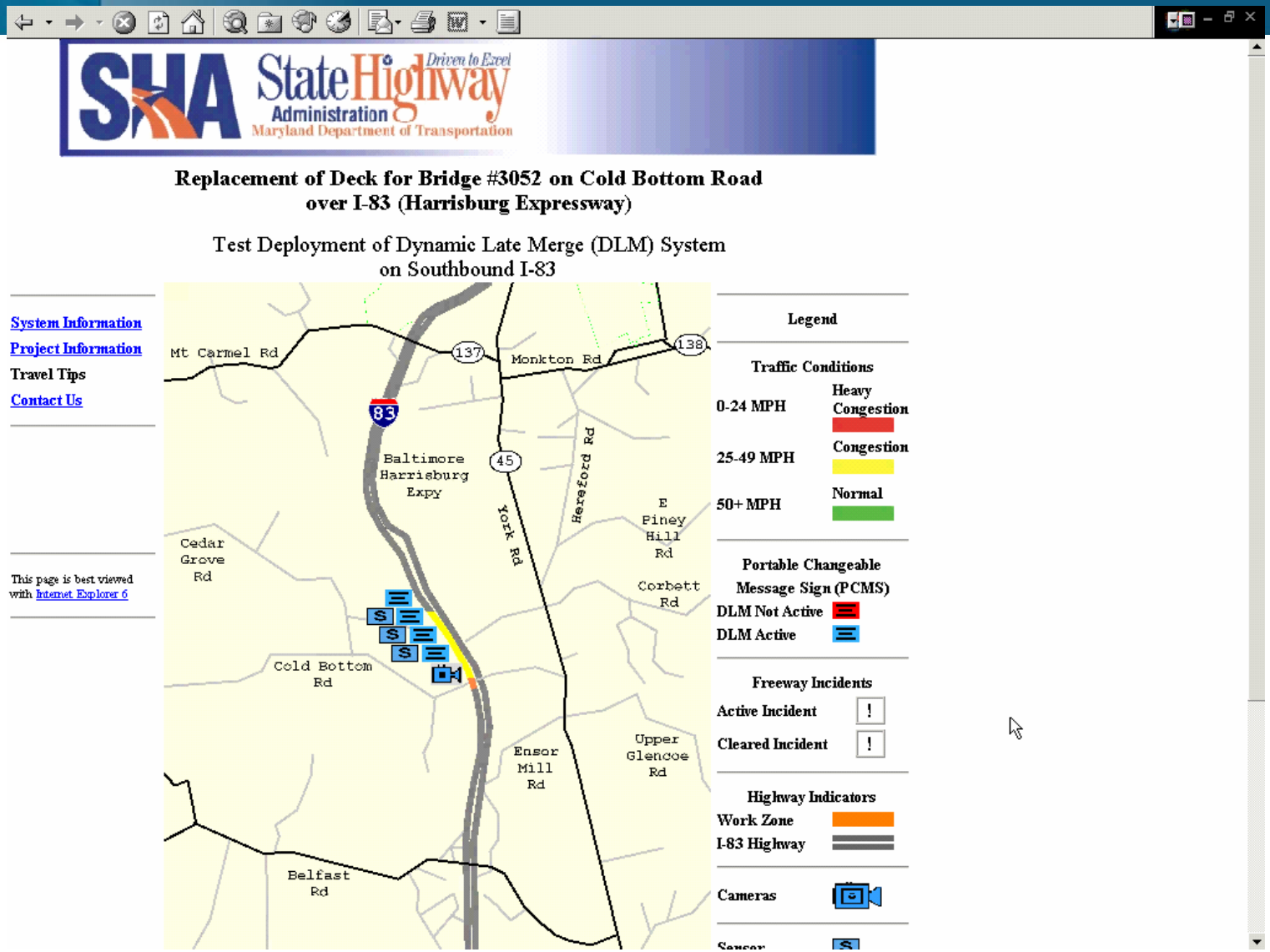
Late Merge System Control

- Four algorithms available for control of late merge implementation
- “All On – All Off” tested on this project

Algorithm	Occupancy	
	Activated	Deactivated
Dynamic On – Dynamic Off (Sign 1 always on)	Any > 15% (Congestion index)	All < 5% (Free flow index)
Dynamic On – Dynamic Off		
All On – All Off		
Dynamic On – All Off		

Public Website



http://tis.irdinc.com/i83construction/public

Video Trailer

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Camera Web Page

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Camera # 1

Move Camera to Saved Position

Position 1
Position 2
Position 3
Position 4
Position 5

Save Current Camera Position

Position 1
Position 2
Position 3
Position 4
Position 5

Image Archive

Start

Auto Archive On

Stop

Pan/Tilt

Zoom In

Zoom Out

Wiper Control

Activate

Close

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Travel Information

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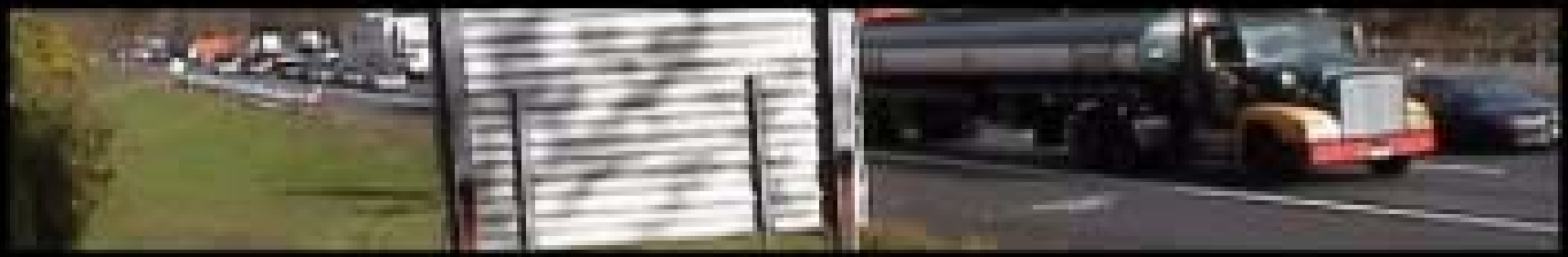

Evaluation of Late Merge System

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Measures of Effectiveness:

- Work zone throughputs (vehicles / hour)
  - The DLM system is expected to show more throughput than under No-control system.
- Lane volume distributions (volume difference)
  - The DLM system is expected to make most vehicles use both lanes uniformly until they approach the merging point.
- Maximum queue lengths (miles)
  - The uniformed lane distributions are expected to lead to a reduction on maximum queue length.

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Evaluation of Late Merge System

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Two Methods:

- Manual counted data analysis
  - Work zone throughputs and lane volume distributions
- Simulation data analysis: to overcome the limitations that the traffic volumes under No-control and DLM control are not identical, and that the view scope of camcorders may not always capture the maximum queue length.
  - Work zone throughputs and maximum queue length

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Evaluation of Late Merge System

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Work zone throughputs

- Manual counts: most work zone throughputs are greater than without dynamic late merge.
- Simulation: work zone throughputs are at least 10 % greater than without dynamic late merge.

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Evaluation of Late Merge System

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Lane Volume Distributions (Volume at open lane) – (volume at closed lane)

Date	Merging Point		Middle Point		Upstream Point	
	Average difference [pcph]	Standard deviation	Average difference [pcph]	Standard deviation	Average difference [pcph]	Standard deviation
10/10/2003	1297	158	199	168	-26	122
10/22/2003	1207	249	122	200	No data	
10/23/2003	1114	159	17	126	-47	125
11/07/2003	901	208	1	146	-69	136
11/10/2003	932	174	-4	150	-162	143

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Evaluation of Late Merge System

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- The lane volume distributions are more uniform than under no-control (both at the middle and merging points).
- More drivers followed the message sign (i.e., “USE BOTH LANES TO MERGE POINT”) displayed on the PCMSs under the congested traffic condition.
- Many drivers decided to merge at the static merge sign located upstream of the taper area.

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Evaluation of System Performance

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- Based on simulation, substantial reduction in queue length

Date	Actual queue (DLM)	Simulated queue (NC)	Reduced %
10/22/2003	1.2 miles	1.3 miles	8.3%
10/23/2003	1.2 miles	1.4 miles	16.7%
11/07/2003	1.8 miles	2.0 miles	11.1%
11/10/2003	0.9 miles	1.2 miles	33.3%

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Evaluation of Late Merge System

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- Advantages of a Dynamic Late Merge Control
  - Increases throughput
  - Leads to a more uniform volume distribution
  - Reduces the maximum queue length
- Disadvantages of a Dynamic Late Merge Control
  - Stop-and-go maneuvers may increase
  - Multiple merging locations experienced

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Early Merge Approach

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Dynamic Early Merge Approach

- Merging during congestion is more difficult
- Merge under free flow and low density conditions
- Deter queue jumpers
- Relevant to current conditions

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Dynamic Early Merge System Operation

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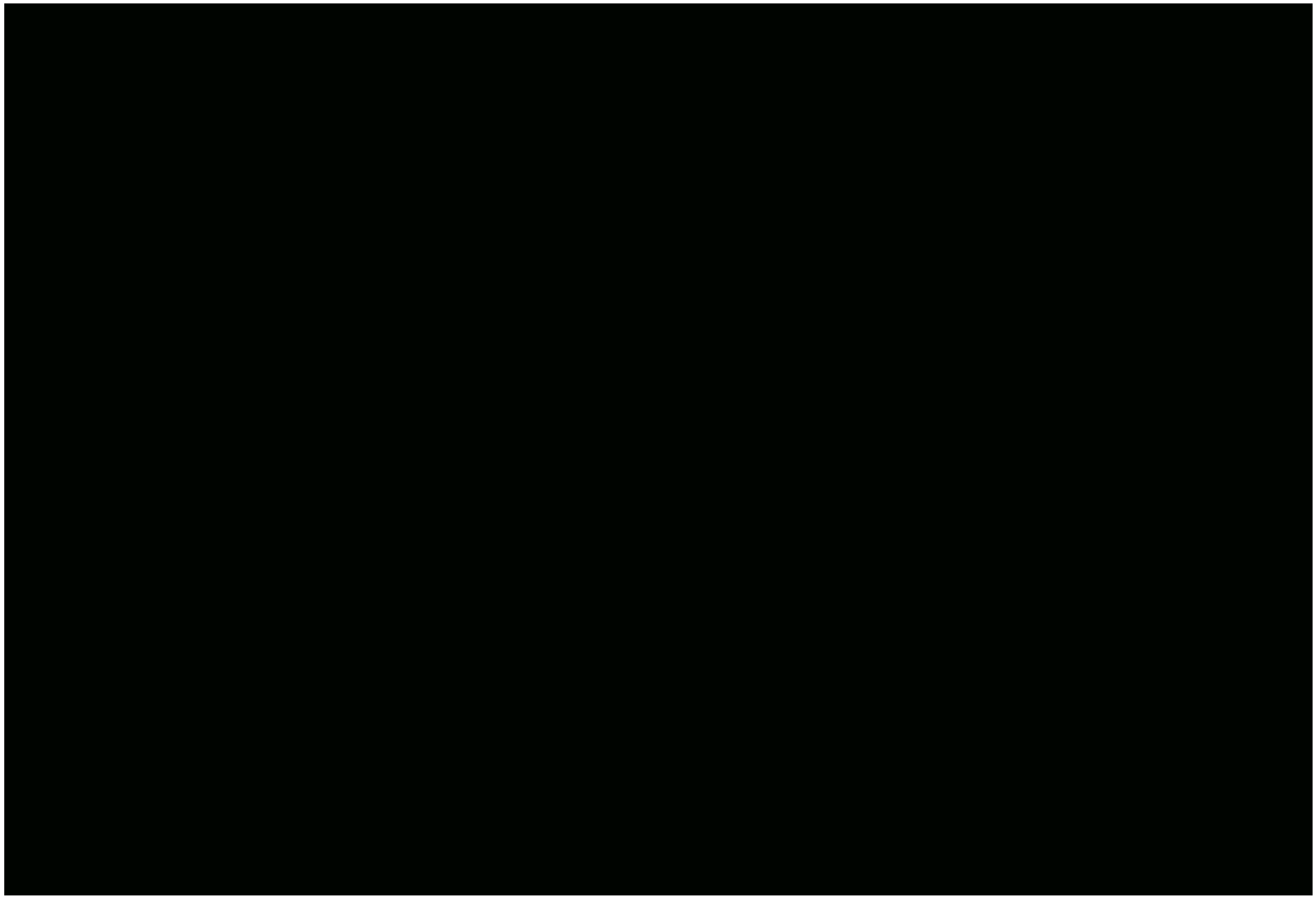

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Dynamic Early Merge Trailer

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I-69 Near Lansing, Michigan

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Typical Layout

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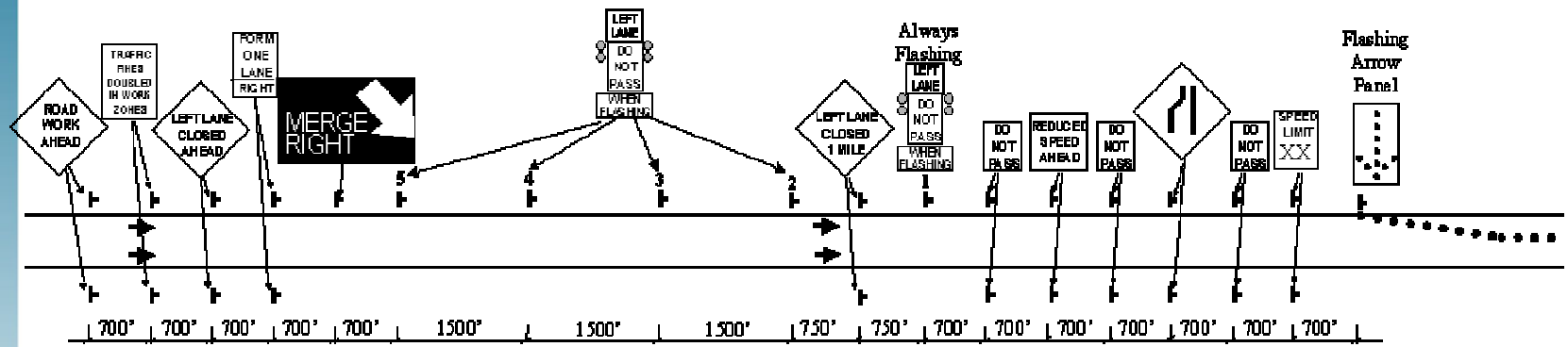

(b) Phase II for a Left Lane Closure

LEGEND

- Type A Warning Flasher (Required at Night)
- Type B High Intensity Light
- Traffic Flow

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Michigan Early Merge Evaluation

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- Two year study completed by Wayne State University in December 2001
- Implementation of dynamic lane merge system at 6 locations to study deployment issues and effectiveness
- Phase I (2000) – Deployment and configuration
- Phase II (2001) - Effectiveness

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Evaluation of Dynamic Early Merge

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- Examined best configuration for positive guidance to motorists
- Measured impact of system on traffic
- Provided recommendations for future deployments
- **Conclusion: "Can be very helpful in reducing aggressive driver behavior, increasing safety and reducing delay at work zones where lane closures are necessary."**

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Evaluation of Dynamic Early Merge

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- The average peak period travel time decreased by over 30%
- The average number of stops and duration of stops were decreased
- The number of aggressive driver maneuvers (late merges) during peak hours were reduced by 50-75%
- B/C (Benefit/Cost) ratio is greater than one, if the value of time of $3.80 per person hour is assumed for travel time savings

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Conclusion

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One goal – improved safety and mobility

- Current and relevant positive guidance to motorists
- Both approaches have potential benefits
- Best approach will depend on specific conditions

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Thank You

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