

**TRANSPORTATION SYSTEMS
MANAGEMENT AND OPERATIONS**

**Harnessing the Value of
Transportation System
Performance**



U.S. Department of Transportation
Federal Highway Administration

AASHTO

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What is TSMO? (1/2)

Transportation Systems Management and Operations (TSMO)

- Originally defined in MAP-21*, Section 1103(a)(30)(A)
 - “An integrated set of strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system.”
- Supported and enabled by Intelligent Transportation Systems (ITS) technologies

* MAP-21 = Moving Ahead for Progress in the 21st Century Act



What is TSMO? (2/2)

“TSMO is a coordinated approach to managing and operating our roadways as safely and efficiently as possible, focused on maximizing existing infrastructure, addressing the causes of breakdowns in flow, and overall performance of the transportation system. TSMO helps us maximize the safe movement of people and goods across modes with a focus on relatively low-cost, quickly implemented operational improvements within our existing facilities.”

--Scott Marler, Iowa Department of Transportation (DOT) Director

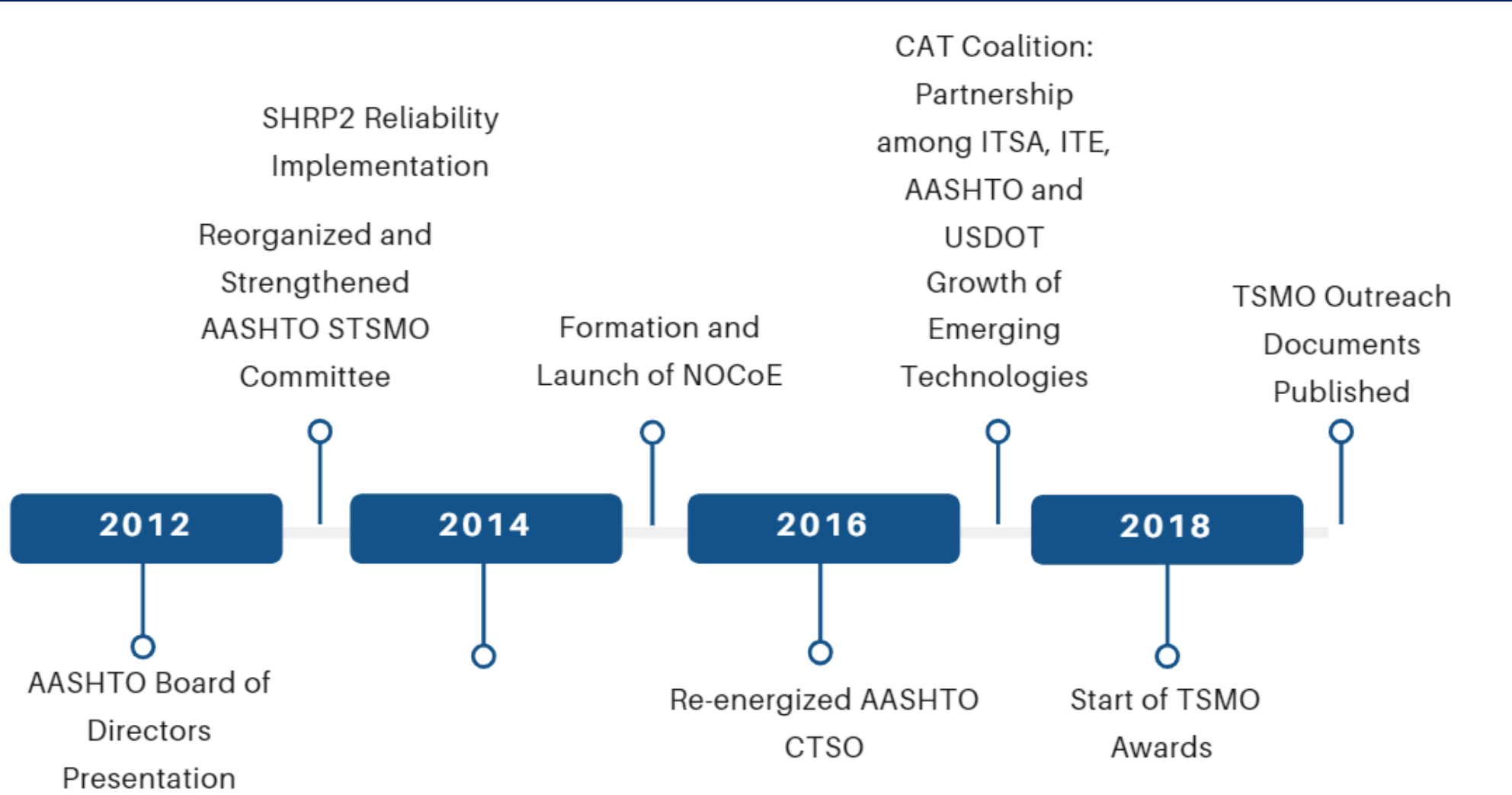


Why TSMO?

- Limited funds
 - Agencies looking for ways to face challenges with less funding
- Advances in technology
 - Transportation agencies can utilize technology and data to solve many operational issues
- Changing customer needs and expectations
 - Greater demand for accountability in spending public funds, which has created more “performance-based” programs
- Better understanding of the causes of congestion
 - It’s not just recurring events like rush hour



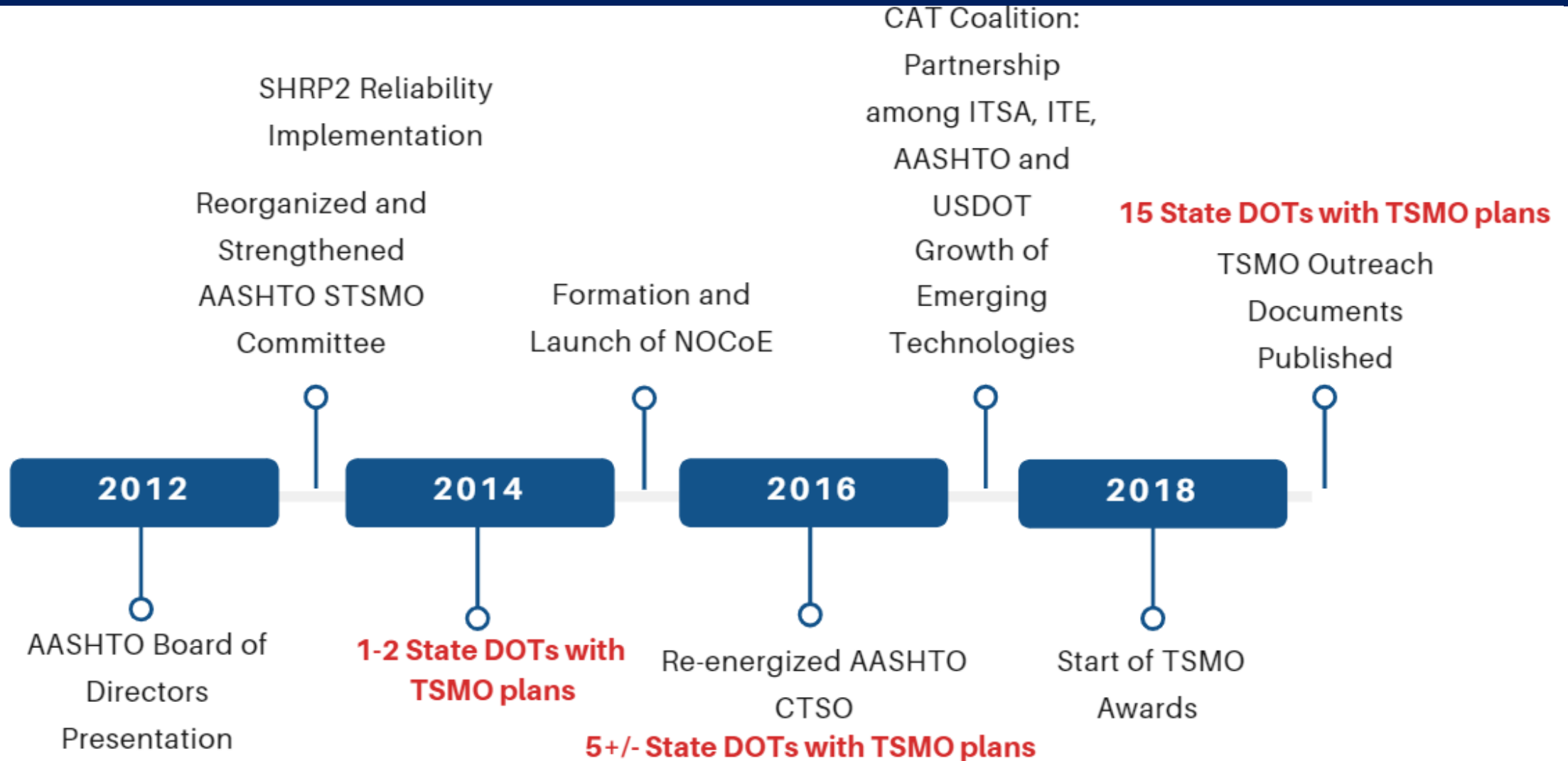
Progression of Operations Related Activities (1/2)



Acronyms:

- AASHTO (American Association of State Highway and Transportation Officials)
- SHRP2 (the Second Strategic Highway Research Program)
- STSMO (Subcommittee on Transportation Systems Management and Operations)
- NOCoE (National Operations Center of Excellence)
- CTSO (Committee on Transportation Systems Operations)
- CAT (Cooperative Automated Transportation)
- ITSA (Intelligent Transportation Society of America)
- ITE (Institute of Transportation Engineers)
- USDOT (U.S. Department of Transportation)

Progression of Operations Related Activities (2/2)



TSMO Strategies and Tactics

- Work zone management
- Road weather management
- Traffic incident management
- Freight management
- Traveler information
- Transit coordination
- Special event coordination
- Integrated corridor management
- Traffic signal management
- Ramp metering
- Part-time shoulder use
- Personal mobility options
- Connected and automated transportation readiness



TSMO Benefits: Examples from State DOTs



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Summary of State DOT Examples

- Delaware DOT – Integrated Transportation Management System
- Utah DOT – Connected Vehicle Transit Signal Priority
- Missouri DOT – Arterial Management Interface
- Washington State DOT – HOV and Express Toll Lanes
- Maryland DOT – Coordinated Highways Action Response Team program
- Virginia DOT – Weather Variable Speed Limits
- Georgia DOT – Incident and Work Zone Management
- Arizona DOT – Innovative Signage and Striping
- Michigan DOT – Active Traffic Management
- Nevada DOT – Traffic Incident Management
- Florida DOT – Integrated Corridor Management



Delaware



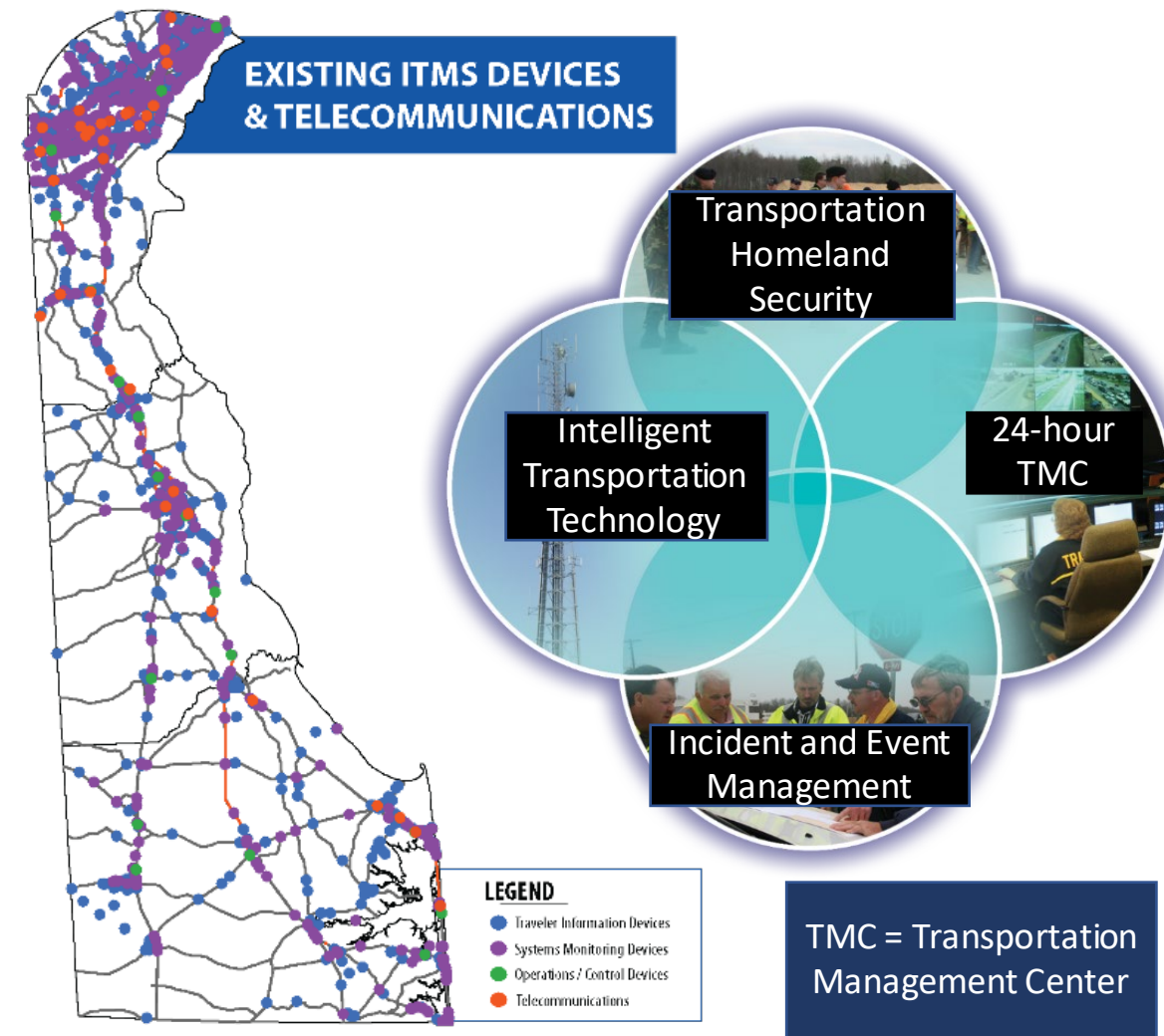
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Delaware DOT (DeIDOT) – Integrated Transportation Management System (1/3)

DeIDOT operates a multifaceted **Integrated Transportation Management System (ITMS)**

- The ITMS provides a robust foundation built on **telecommunications, flexibility,** and an **adaptable** system



Delaware DOT (DeIDOT) – Integrated Transportation Management System (2/3)



Artificial Intelligence in Transportation

- Artificial Intelligence (AI) is used to support comprehensive and timely decision making, since human brains cannot process large data sets.
- AI and Machine Learning (AI & ML) will not only help to alert technicians about traffic incidents, it will also make system adjustments in real-time.
- Operations will be enhanced by supporting the automation or semi-automation of TMC operations in the near future.
- DeIDOT is moving toward an adaptable system that can account for changes in capacity and provide real-time solutions.



Delaware DOT (DeIDOT) – Integrated Transportation Management System (3/3)



Advanced Transportation and
Congestion Management
Technologies Deployment (**ATCMTD**)
Grant - \$4.9 million FHWA with \$4.9
million DeIDOT match was awarded to
DeIDOT in 2019 for the AI-ITMS
Deployment Program

AI-ITMS Program was supported by a Federal ATCMTD grant and incorporates:

- AI & ML for fast anomaly/inefficiency detection, impact analysis, solution development, deployment and knowledge accumulation.
- AI-Traffic Operations & Management Software (AI-TOMS)
- Processing live traffic detector data (update every minute) for anomaly detection
- 24/7 continuous monitoring, instantaneous alert (email, message) and reporting the event



Delaware DOT – AI-ITMS Deployment Program

Deployment program includes:

- Automatic data visualization and camera video confirmation
- Traffic flow prediction
- Interface with simulation model for scenario generation and solution evaluation
- High-resolution signal controller data collection and processing for near real-time signal performance assessment (every 5 minutes)
- Initial deployment ongoing in Urban area, expanding to Connected and Automated Vehicle network



Delaware DOT – Connected and Autonomous Technology

Next phase of ITMS involves deployment of DelDOT's **emerging technology** products, including:

- Connected Vehicle-enabled Weather Responsive Traffic Management (CV-WRTM)
- Signal Phase and Timing (SPaT) Challenge
- Autonomous Shuttle Deployment



Utah



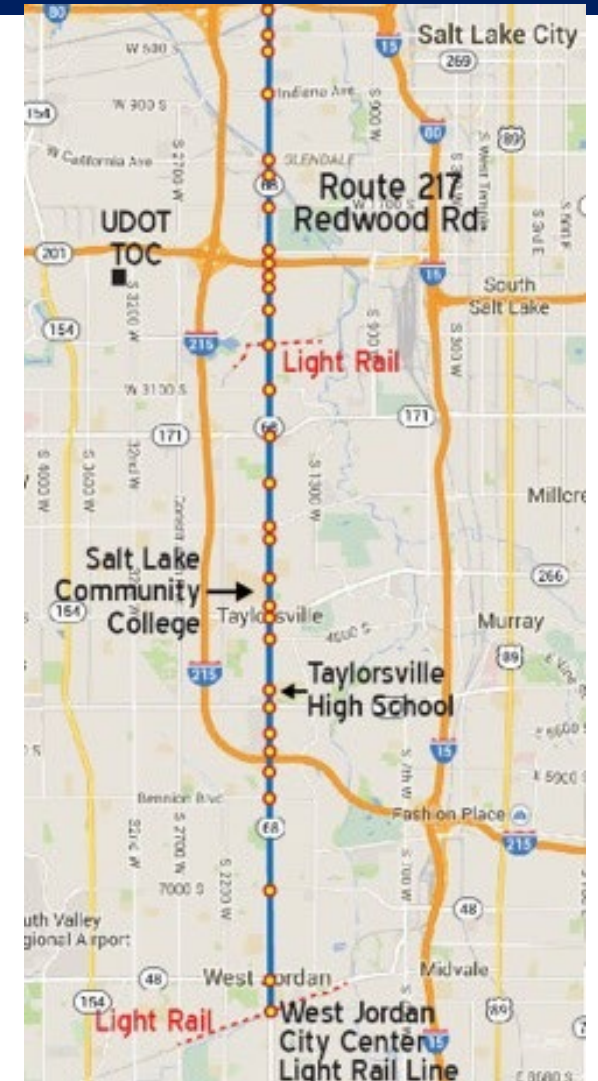
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Utah DOT – Connected Vehicle Transit Signal Priority (1/2)

Project includes:

- Connected Vehicle (CV) Application of Transit Signal Priority (TSP)
- Goal to increase transit reliability (86% to 94%)
- Meets the SPaT Challenge



Source: Utah DOT; Presentation by Blaine Leonard and Jamie Mackey, UDOT, at CTSO Working Group on CAV meeting (2019)





Utah DOT – Connected Vehicle Transit Signal Priority (2/2)

6-7% increase in transit travel time reliability evaluated between February and August 2019

Average Reliability	Southbound PM Peak			Northbound AM Peak		
	No TSP	TSP	Benefit	No TSP	TSP	Benefit
Along Route	85%	91%	+6%	93%	99%	+6%
End of Route	89%	89%	0%	90%	97%	+7%

Source: Utah DOT; Presentation by Blaine Leonard and Jamie Mackey, UDOT, at CTSO Working Group on CAV meeting (2019)



Missouri



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Missouri DOT – Arterial Management Interface (1/2)

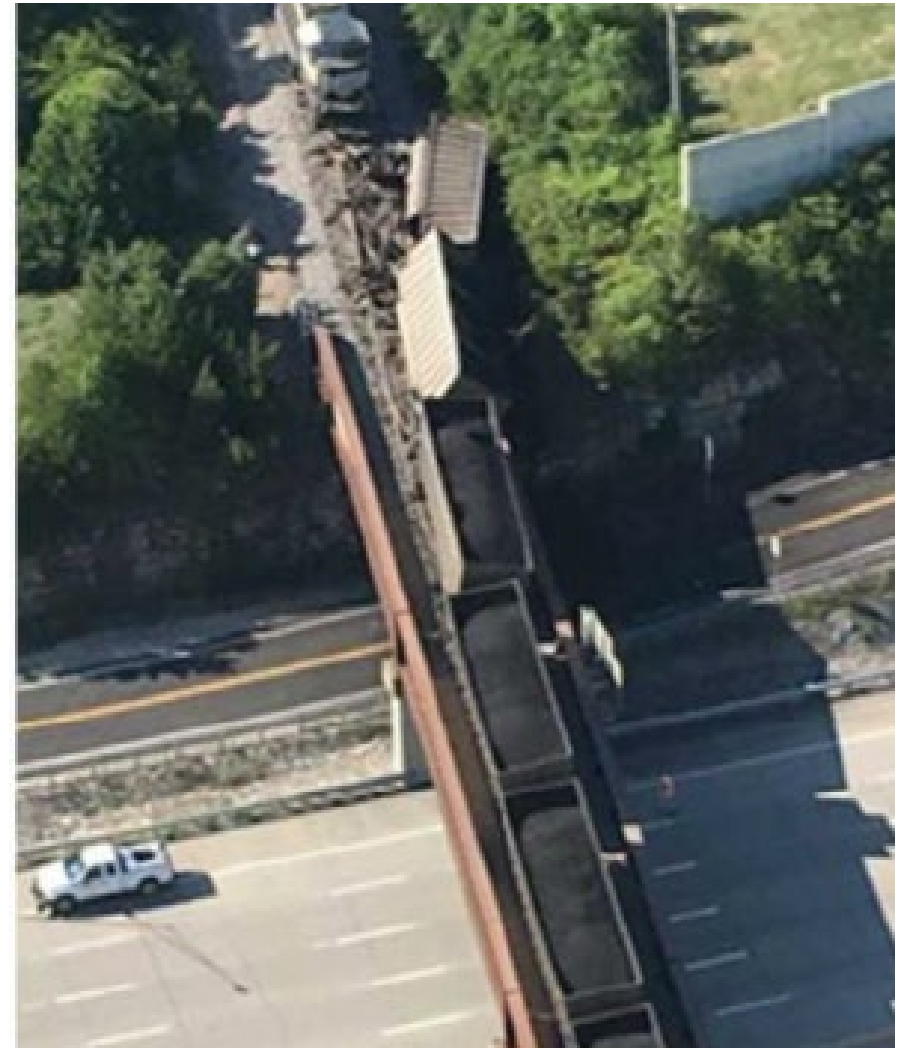
- Existing St. Louis Advanced Traffic Management System (ATMS)
 - Helps first responders and affected motorists deal with incidents
- Newly developed Arterial Management Interface (AMI)
 - Provides ability to quickly determine appropriate signal changes during incidents regardless of working knowledge of the arterial system
- Incorporated TSMO Strategies
 - Arterial Management
 - Traffic Incident Management



Missouri DOT – Arterial Management Interface (2/2)

Benefits of AMI

- Reduced signal change response time from 30 minutes prior to the project to 5 minutes in 2017 after the full project went live in 2017
- Example: On August 26, 2017, a train derailment shut down the widest Interstate in St. Louis area
 - Within 5 minutes, TMC engineer implemented several pre-programmed signal plans around the closure



Source: Missouri DOT; NOCoE Case Study [St. Louis District Arterial Management Interface \(AMI\)](#)



Washington State



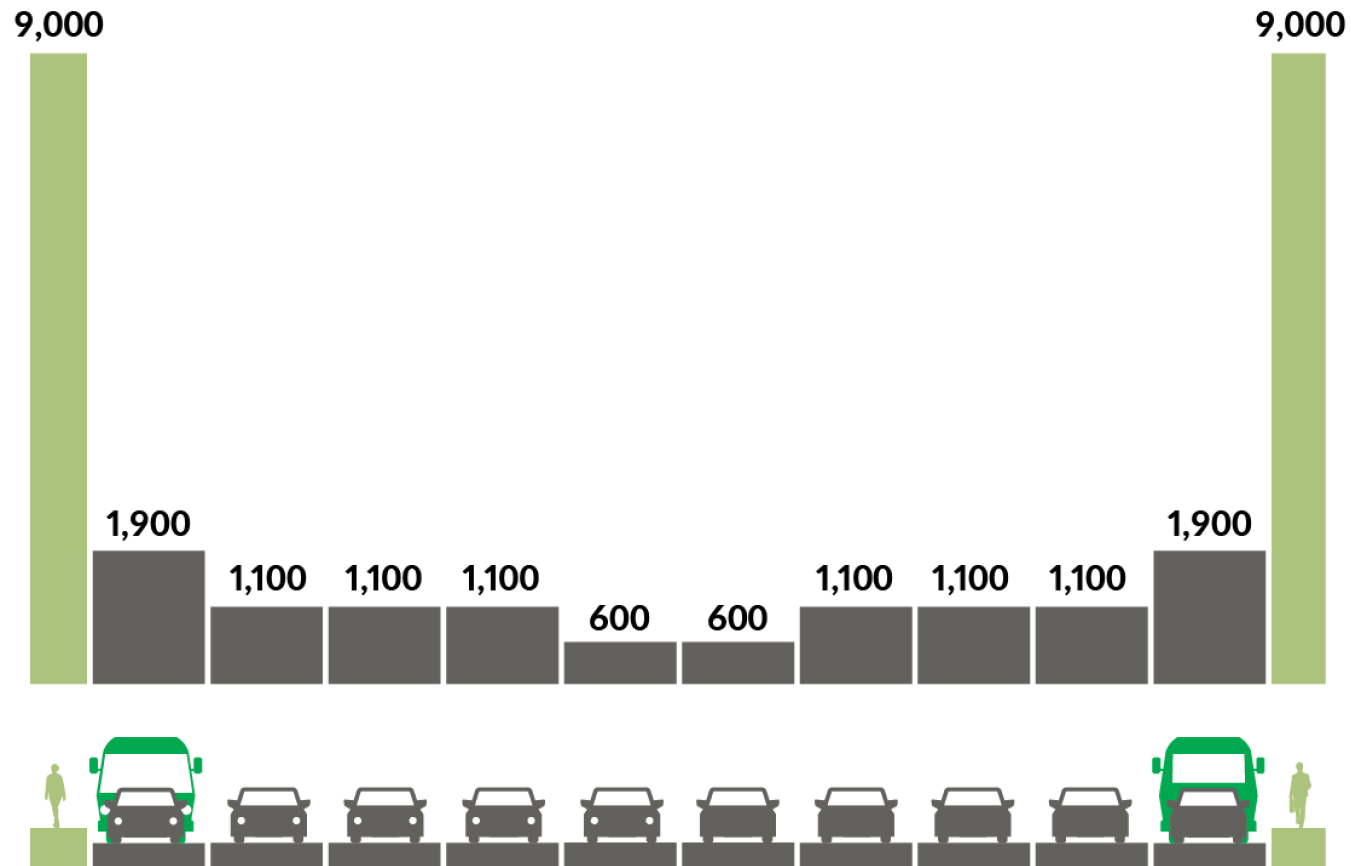
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Washington State DOT – High Occupancy Vehicle (HOV) and Express Toll Lanes (1/4)

Sample representation shows how many people can be moved per lane each hour on a typical 10-lane arterial


How many people can this street serve per hour?
Up to
29,600
Source: NACTO Transit Street Design Guide



Source: sample street from NACTO Transit Street Design Guide

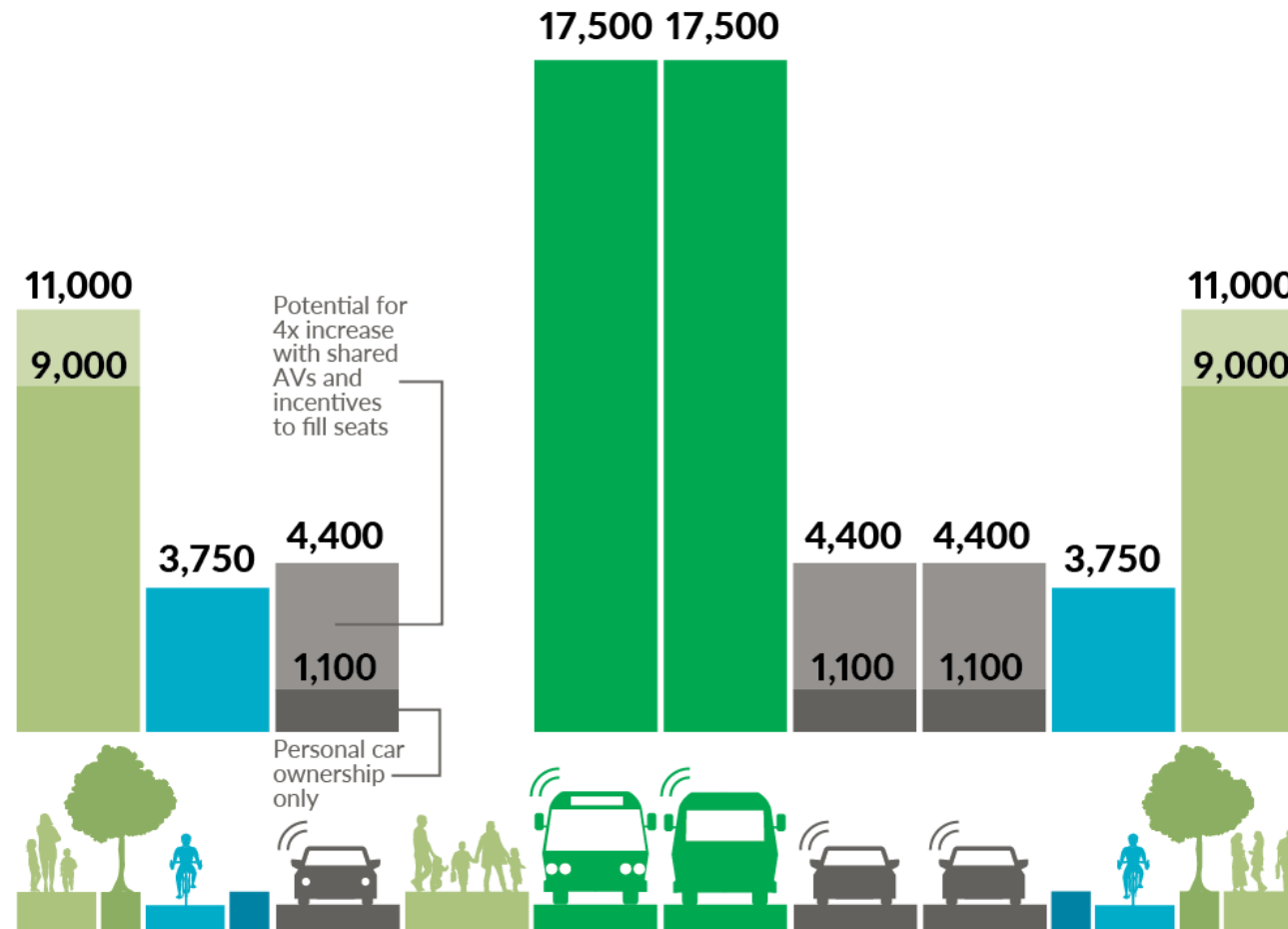


Washington State DOT – HOV and Express Toll Lanes (2/4)

How innovative design and management can move more people


**How many people
can this street
serve per hour?**

Up to
77,000
Source: NACTO Transit Street Design Guide



Source: sample street from NACTO Transit Street Design Guide

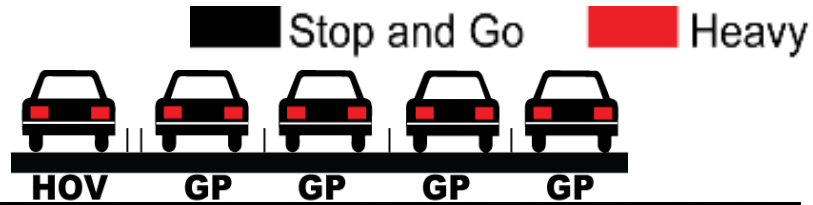


Washington State DOT – HOV and Express Toll Lanes (3/4)

Example of I-5 and I-405 peak hour performance comparison

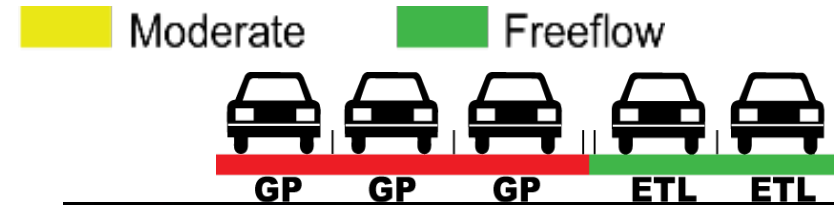
Acronyms:
HOV: High occupancy vehicle
GP: General purpose
ETL: Express toll lanes

I-5 (Northbound at NE 130th St)
Daily Volume: 105,000



Tuesday, July 12, 2017, 4:50 p.m.

I-405 (Northbound at NE 85th St)
Daily Volume: 107,000



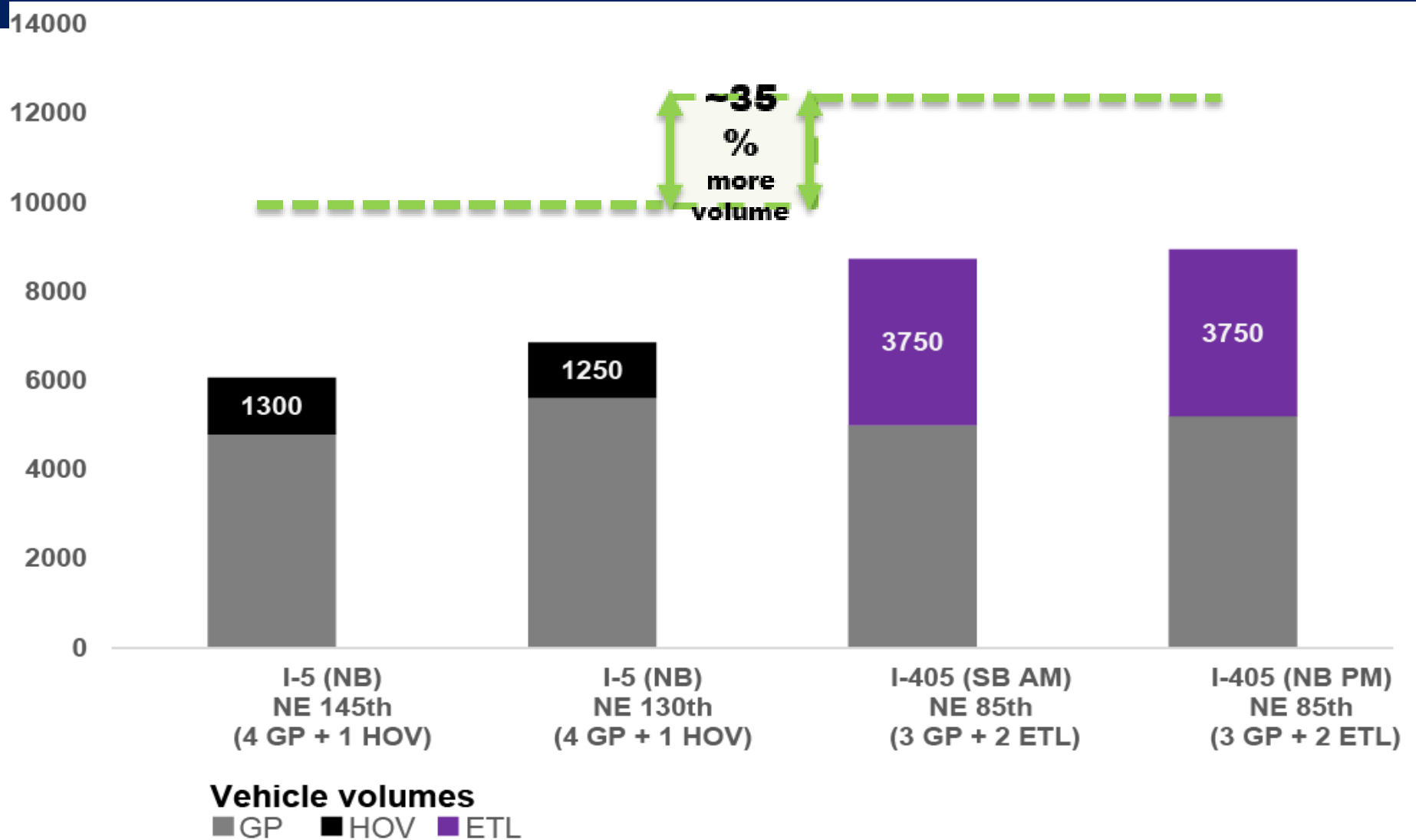
Tuesday, July 25, 2017, 4:30 p.m.

Images courtesy of Washington State DOT

Washington State DOT – HOV and Express Toll Lanes (4/4)

I-405 section with dual express toll lanes moves more vehicles than five-lane I-5 sections with similar daily traffic volumes

Numbers compare before and after project implementation in 2017



Source: WSDOT

Maryland



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Maryland DOT – CHART

Coordinated Highways Action Response Team (CHART)

- Traveler information
- Traffic management
- Motorist assistance
- Statewide operations center
- Traffic incident management

In 2016, CHART handled over 135,000 events, saving more than \$1.5 billion in delay and fuel costs

Source: Maryland DOT; Presentation by Subrat Mahapatra, MDOT SHA, Regional Operations Leadership Forum (2018)



Maryland DOT – CHART and Mobility Program Outcomes

2016 Cost Savings to Customers = \$1.5 billion+

- \$50 million (capital improvements)
- \$1,500 million (CHART)
- \$84 million (signal systems and multimodal strategies)

CHART now assists a motorist every 16 minutes on average and manages traffic at a crash/incident every 22 minutes, preventing an estimated 225–250 secondary crashes a year.

Source: Maryland DOT; Presentation by Subrat Mahapatra, MDOT SHA, Regional Operations Leadership Forum (2018)



Virginia



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Virginia DOT – Weather Variable Speed Limits (1/3)

- Variable Speed Limits (VSL) were deployed on 12-mile section of I-77
- Addresses mountainous terrain in southwestern VA
- Responds to history of severe, recurring fog events

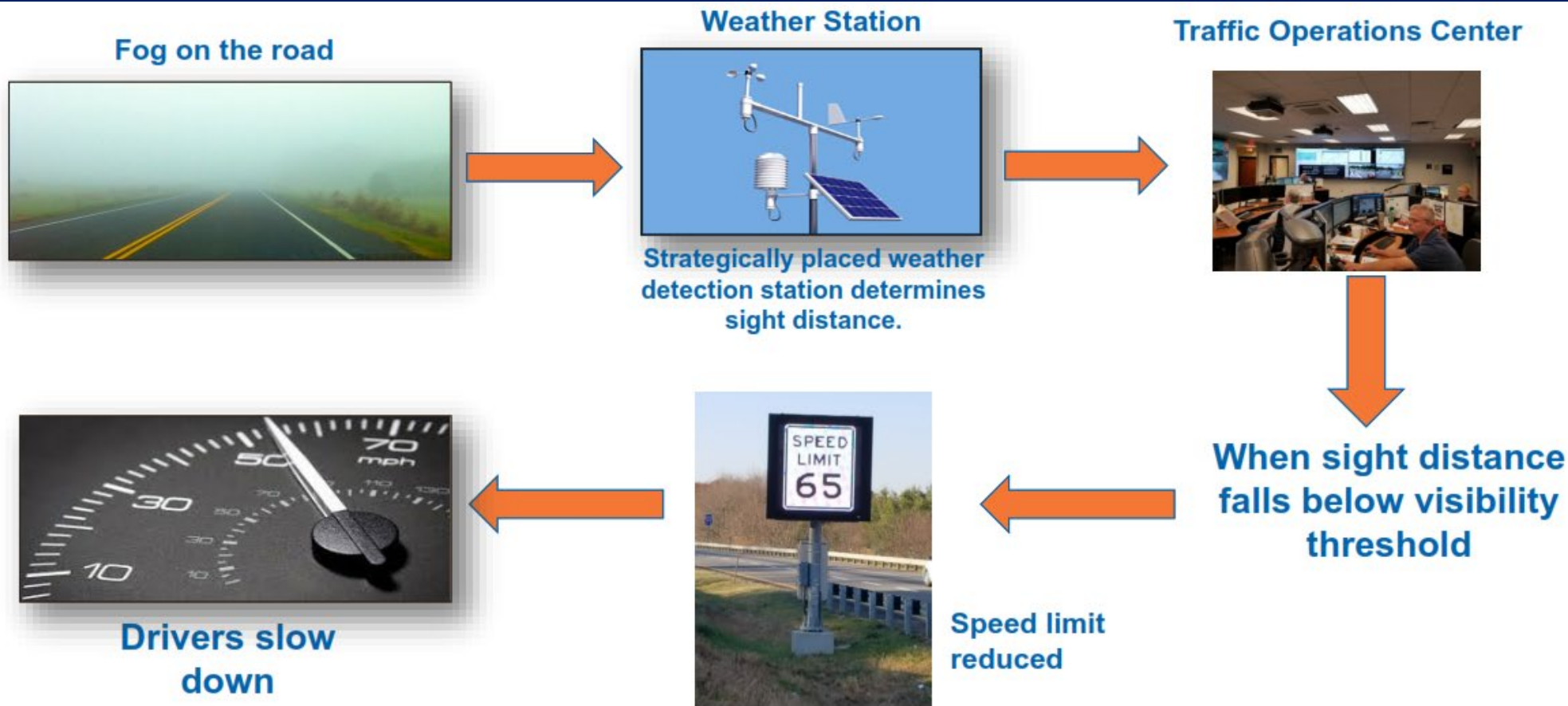


Virginia DOT; *Impacts of the I-77 Variable Speed Limit System on Speed and Crash Characteristics During Low Visibility Conditions* (Gonzales and Fontaine, 2018)

Presentation by Mike McPherson, VDOT, NOCoE 2019 Road Weather Management Peer Exchange



Virginia DOT – Weather Variable Speed Limits (2/3)



Virginia DOT; *Impacts of the I-77 Variable Speed Limit System on Speed and Crash Characteristics During Low Visibility Conditions* (Gonzales and Fontaine, 2018)
Presentation by Mike McPherson, VDOT, NOCoE 2019 Road Weather Management Peer Exchange



Virginia DOT – Weather Variable Speed Limits (3/3)

Early Indication of Benefits:

- Statistically significant reductions in mean speeds
- Drivers drove closer to the safe speed based on available visibility
- Crash rates during low visibility were less than one-half of pre-VSL activation crash rates
- Travel time reliability increased

Virginia DOT; *Impacts of the I-77 Variable Speed Limit System on Speed and Crash Characteristics During Low Visibility Conditions* (Gonzales and Fontaine, 2018)

Presentation by Mike McPherson, VDOT, NOCoE 2019 Road Weather Management Peer Exchange



Georgia



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Georgia DOT – Incident and Work Zone Management (1/2)

March 2017: Response to I-85 bridge collapse in Atlanta

TSMO strategies implemented:

- TMC initial response – service patrols, DMS, social media, website, 511
- TMC long term – traveler information (traffic shifts, detours) and overall coordination
- Contracting incentives for rapid bridge re-construction
- Transit – longer trains, more frequent service
- Traffic signal upgrades, closed-circuit televisions (CCTVs), signal coordination

Source: Georgia DOT; Presentation by John Hibbard, GDOT,
at [2017 AASHTO STSMO Annual Meeting](#) (Sept 2017)



Georgia DOT – Incident and Work Zone Management (2/2)

I-85 DETOURS

Atlanta Travel Advisory: I-85 is closed between I-75 and SR 400. Motorists are advised to use I-75, I-285 and I-20 until further notice.



TSMO strategies with multi-agency coordination resulted in:

- Sharp increases in 511 phone calls, 511 app downloads, website usage
- Changes in traveler behavior
- Overall, 7% reduction in traffic in the region during the 42-day closure period in 2017

Source: Georgia DOT; Presentation by John Hibbard, GDOT, at 2017 AASHTO STSMO Annual Meeting (Sept 2017)

Arizona



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Arizona DOT – Innovative Signage and Striping (1/2)

- Arizona DOT (ADOT) redesigned signage and restriped lanes in 2018 to improve clarity, performance, and safety
- The two-mile segment where westbound US-60 merges with I-10 in the Phoenix metro area had the highest number of serious and fatal crashes on the ADOT system.



Arizona DOT – Innovative Signage and Striping (2/2)

Within one year, the project resulted in:

- 385 fewer crashes
- 66% reduction in crashes of all severities
- 1,969:1 Benefit-Cost Ratio



***Numbers reflect 12 months before the project to 12 months after project was completed (2018-2019)*



Michigan



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Michigan DOT – Active Transportation Management (1/2)

- Michigan DOT used Active Transportation Management (ATM) strategies on US-23 to dynamically manage issues of:
 - Congestion
 - Operations
 - Incident management
- Strategies used include dynamic lane control and shoulder use, variable speed advisories, and queue warning.



Michigan DOT – Active Transportation Management (2/2)

- Since deployment in 2016, commuters now enjoy greater safety and decreased congestion.
- ATM strategies increased reliability by up to 56% and improved corridor speeds by up to 19 mph.



Source: Photo from NOCOE Case Study, July 2019



Nevada



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Nevada DOT – Traffic Incident Management

- Nevada DOT developed a collective platform where all agencies could share real-time incident data to help manage traffic and prevent crashes.
 - Real-time data reaches all involved agencies, multi-discipline first responders, and public users
 - Platform leverages in-vehicle data and artificial intelligence
- 12-Minute reduction in incident response times and reduction in secondary crashes in Southern Nevada (from installation in 2017 through May 2019)



Florida



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Florida DOT – Integrated Corridor Management (1/2)

Implementing Integrated Corridor Management (ICM) by meshing freeway operations with arterial operations

- 2017—Orlando was 2nd fastest growing city and experienced 72 million visitors, according to Visit Orlando
- To improve transportation system, Florida DOT implemented ICM at the District 5 Regional Traffic Management Center
- Goal: To improve travel time efficiency and reliability **and** to perform incident management by meshing freeway operations with arterial operations



Florida DOT – Integrated Corridor Management (2/2)

- How this was done:

- Advanced Traffic Management Systems platforms
- Enabled vehicle detection so data could be collected and used to identify trends

- Results:

- Benefit to cost ratio: between 5:1 to 10:1
- Emissions reduced by 3-22% (thanks to effective traffic signal control)
- Dynamic Shoulder Running reduces travel times by up to 25% while proving to have no adverse effect on safety
- Transit Signal Priority improves bus times by 2-15% with minimal impact to side streets, and Adaptive Signal Control cuts delays by 4-40%

*Numbers reflect timeframe between 2017-2019



TSMO Philosophy

- Get the most out of existing infrastructure
- Do more with less
- Should be conceptualized in the project planning process and be a part of an agency's overall strategic planning
- Not just about congestion
 - TSMO can make infrastructure safer, save money, improve travel experience, enhance productivity, and better connect all modes of transportation along a system



Questions to Consider

- What is your State or region currently working on, in light of TSMO strategies and advancements?
- How are you balancing technology advancements with operational needs and strategies?
- What challenges is your agency facing, relative to congestion and/or integrating TSMO into your agency?
- What have been some recent successes?
- What have been your experiences integrating TSMO with external partners?



For more information, visit:

- Federal Highway Administration (FHWA) Office of Operations
<https://ops.fhwa.dot.gov/index.asp>
- FHWA “Communicating TSMO” webpage
https://ops.fhwa.dot.gov/plan4ops/focus_areas/communicating_tsmo.htm
- AASHTO Committee on Transportation Systems Operations
<https://systemoperations.transportation.org/>
- National Operations Center of Excellence (NOCoE)
<https://www.transportationops.org/>
- NOCoE webpage for making the “Business Case” for TSMO
<https://transportationops.org/business-case>

