MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS

NCHRP 20-68A U.S. DOMESTIC SCAN PROGRAM

August 6, 2019

Salt Lake City, Utah

AGENDA

1. MDOT SHA Organizational Focus
2. Why TSMO - Making the Business Case
3. MDOT SHA TSMO Program
4. Business Processes & Funding
5. Systems & Technologies
6. Data, Analysis & Performance Measures
7. Transformational Technologies
8. Workforce, Re-Org & Procurement
9. Education & Outreach

TSMO

MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION

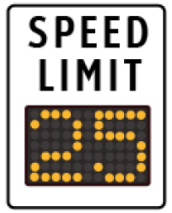
STATE HIGHWAY ADMINISTRATION

MDOT SHA ORGANIZATIONAL FOCUS

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

KEY FOCUS AREAS

Safety



State of Good Repair

Mobility

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TOP ACCOMPLISHMENTS

In the last 4 years, we have treated and improved more than 8,500 lane miles across the state.

That is *MORE THAN HALF OF THE ENTIRE SYSTEM.*

Deployed High Friction Surface Treatment on pavements, yielding a 74% reduction in traffic barrier impacts.

Launched STORM (Statewide Transportation Operations Response Map) app and MARWIS (Mobile Advanced Road Weather Information Sensor).

TSMO – Performance-Based and Integrated Transportation Systems Management and Operations.

Planning underway for Traffic Relief Plan: Managed Lane Study and I-695 Innovative Active Traffic Management with new design for I-70 interchange.

Proposal for the largest P3 in the country at a value of between $9 and $11 billion

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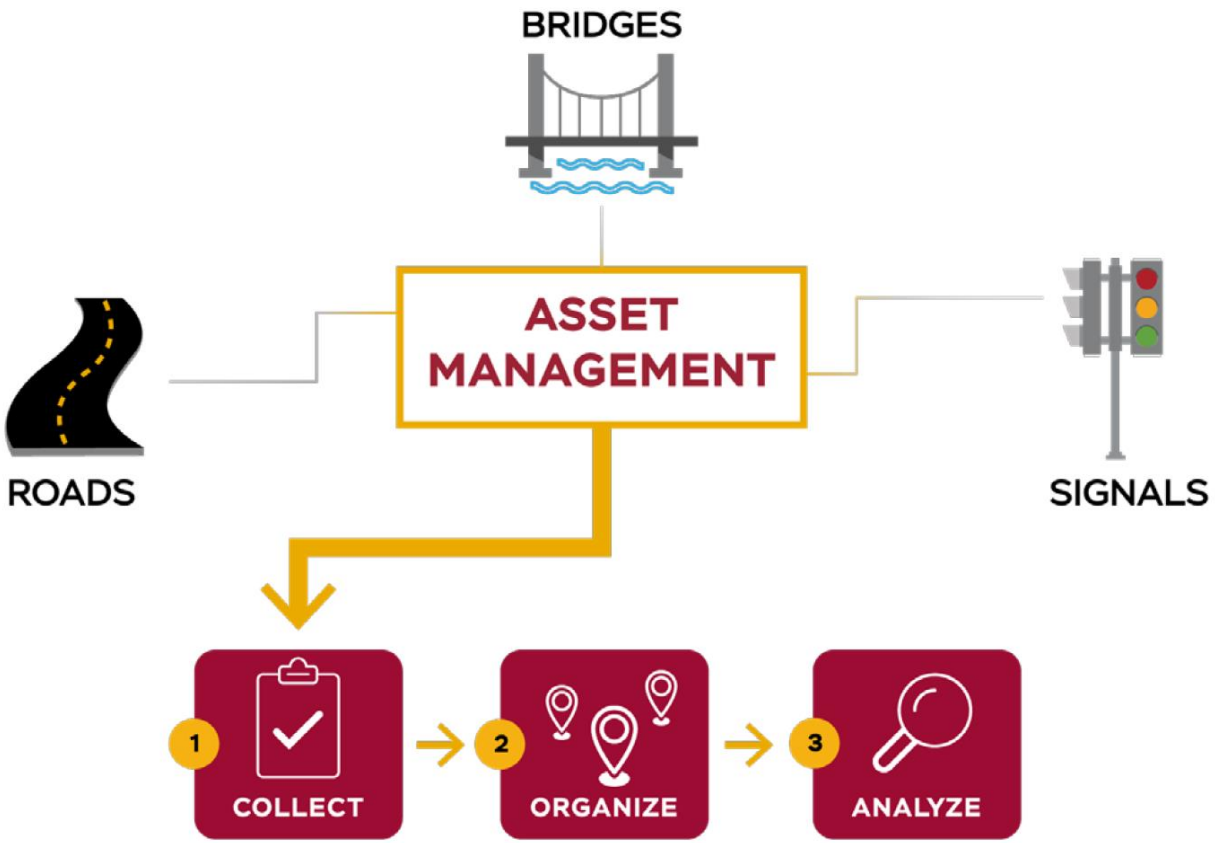
ASSET MANAGEMENT



Zero Poor-Rated Bridges in Maryland

Maintenance 2.0: Form & Function

Adopt-a-Highway Restructuring

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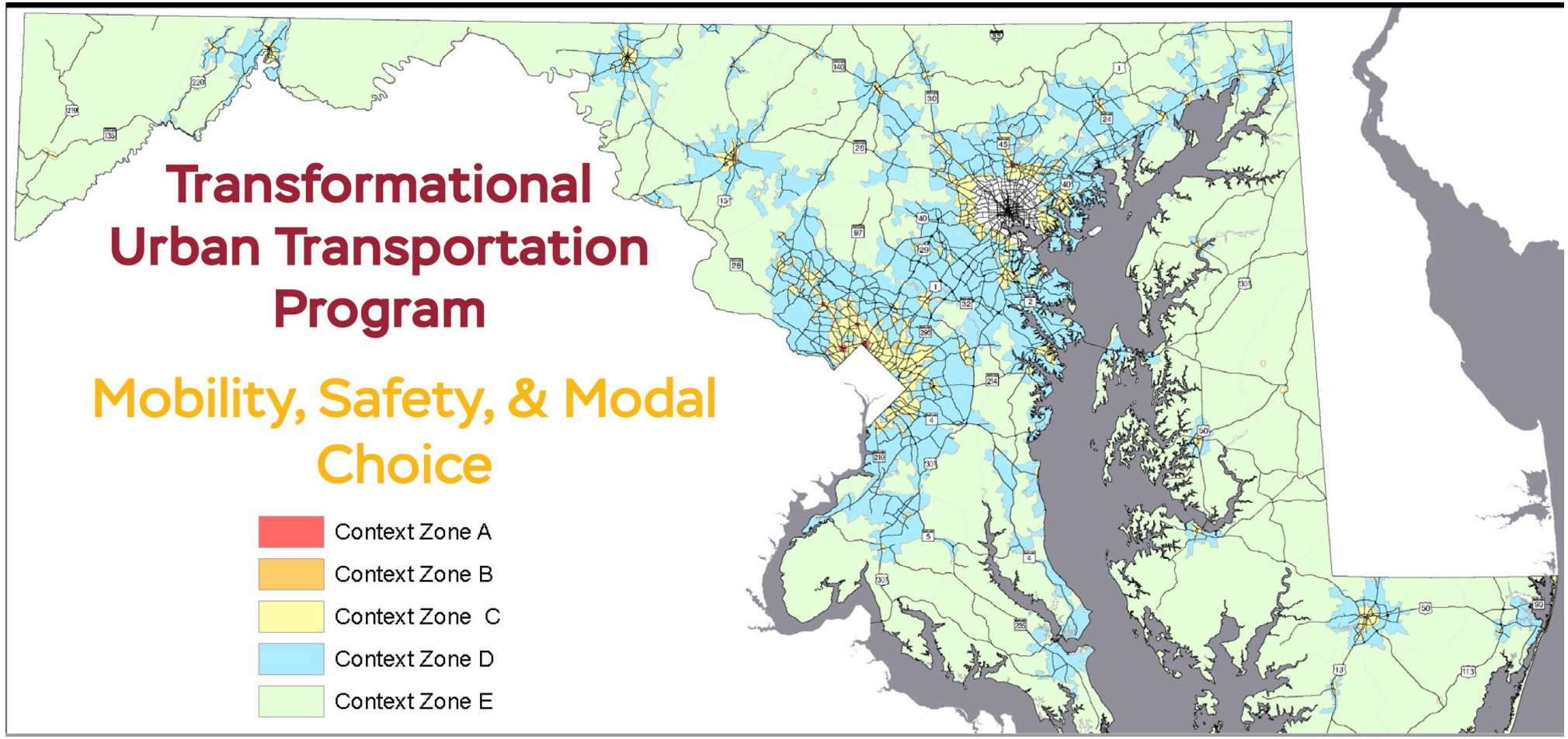
BALANCING SAFETY & MOBILITY



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P3 PROGRAMS

Establishing P3's as a Tool in the Organization to Address:

- Multi-Modal Connectivity
- Environmental Issues
- Movement of Goods & Services
- Financial Constraints
- Congestion

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DOING BUSINESS BETTER

- E-Construction and E-Bidding
- Decreased the average number of months to process A/E contracts to 19 months in CY 2018 (down from 27 months in CY 2017)
- Processing a total of 32 A/E contracts last calendar year

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THINKING DIFFERENTLY

- TSMO provides a new perspective - using existing approaches combined with technology to meet the challenges of building a **Systems of Systems**
- TSMO addresses all four of MDOT SHA's Priorities, with a focus on Customer Experience
- Renewed partnerships and collaboration with industries and stakeholders for transportation of tomorrow

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WHY TSMO?

MAKING THE BUSINESS CASE

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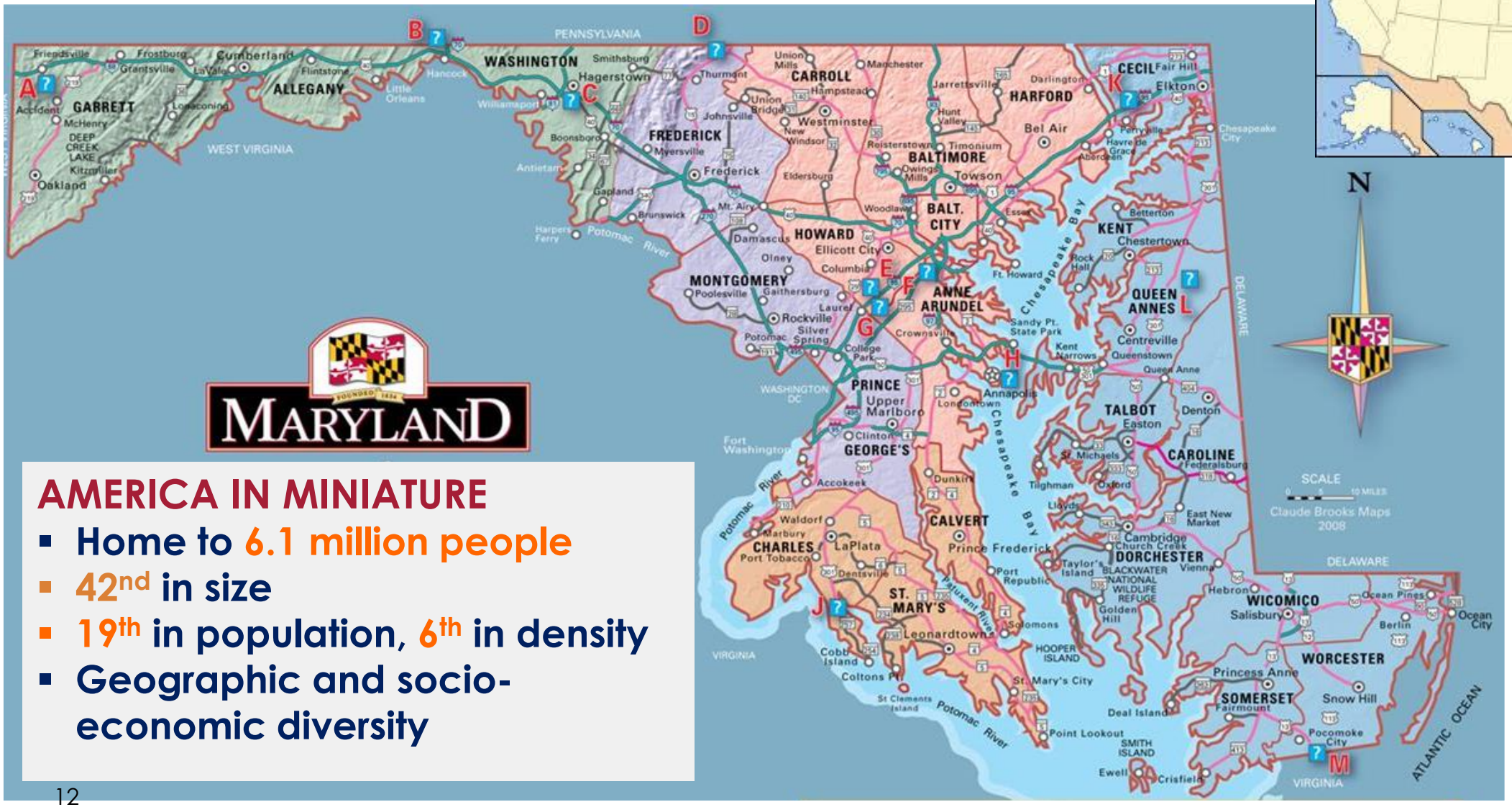
ABOUT MARYLAND



AMERICA IN MINIATURE

- Home to 6.1 million people
- 42nd in size
- 19th in population, 6th in density
- Geographic and socio-economic diversity

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ABOUT MARYLAND DOT (MDOT)

MDOT comprises of six business units and an Authority

- The Secretary's Office
- State Highway Administration
- Maryland Transit Administration
- Motor Vehicle Administration
- Maryland Port Administration
- Maryland Aviation Administration
- *Maryland Transportation Authority*

Unique multi-modal organizational framework for integrated transportation solutions

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION EXCELLERATOR

MDOT Excellerator drives the agency with ten tangible results and performance measures with ONE MDOT Approach

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

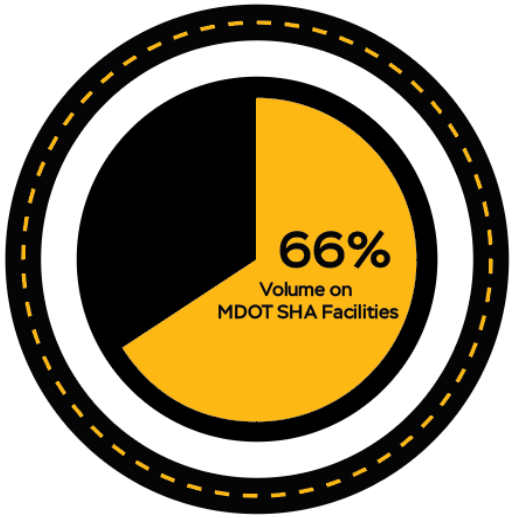
ABOUT MDOT STATE HIGHWAY ADMINISTRATION

MDOT SHA operates and maintains the numbered, non-toll routes in Maryland

- 17,000 lane-miles and 2,576 bridges

- Customer Focused
- System Efficiency & Reliability Key Drivers
- Freight Movement and Economy
- Performance Management

Maryland Roadway Network



Maryland Traffic Volume

Huge Emphasis on

Transportation Systems Management & Operations (TSMO)

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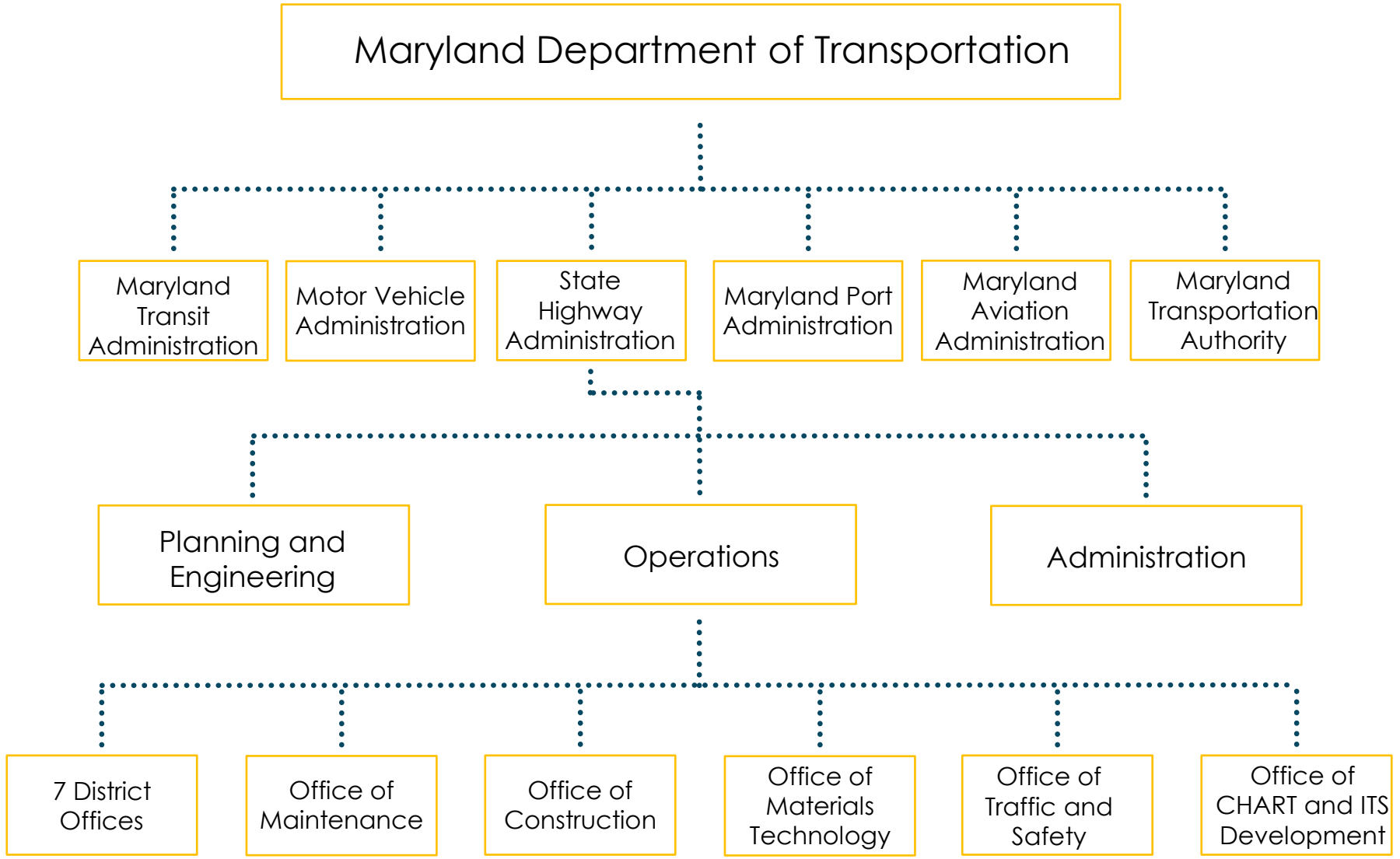
MDOT ORGANIZATION STRUCTURE



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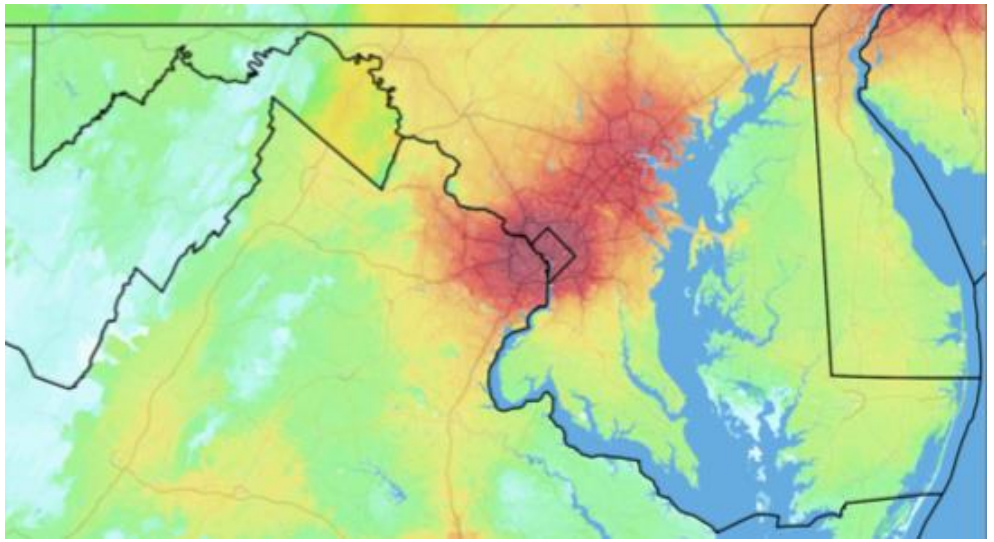
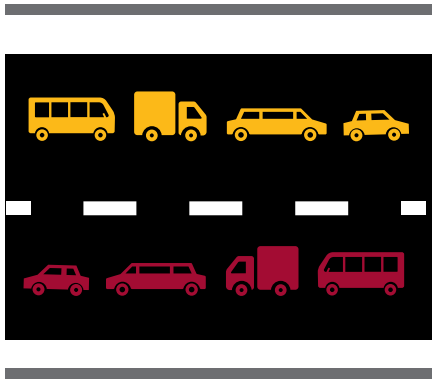
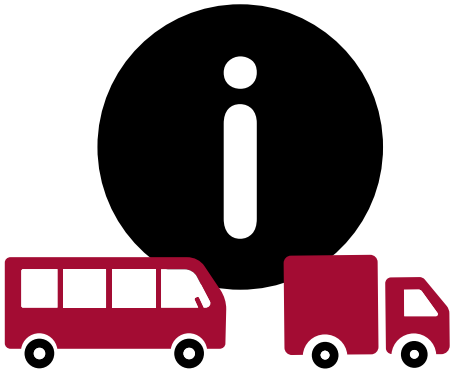
WHY TSMO IN MD? – DEMAND SIDE

- MD VMT and congestion levels at **all time high -** one of the most congested regions in US
- MD will have **1 Million more people** by 2040, which will result in **30% more VMT** and **doubling of truck VMT**
- **Customer Needs and Expectations** are changing – faster, reliable and flexible
- **Technology** is playing a huge role for travel decisions (commute, shop, other)



Need to Think Differently.





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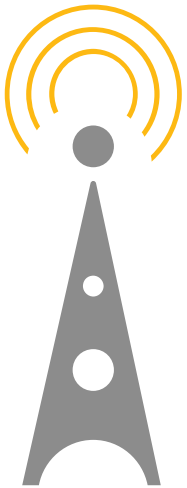
WHY TSMO IN MD? – SUPPLY SIDE

- **System operating at/over capacity**
- Over-saturated conditions lead to higher unreliability
- **Multiple priorities** (SOGR, Safety, Mobility, Capacity, Economy)
- **Technology playing a key role** – efficiency, reliability and system of systems

Focus on "Door to Door" Customer Experience



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MDOT SHA

TSMO PROGRAM

Integrated approach to planning, engineering, operations, and maintenance.

Effectively manage and operate existing facilities and systems to maximize their full service potential.

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WHAT IS TSMO?

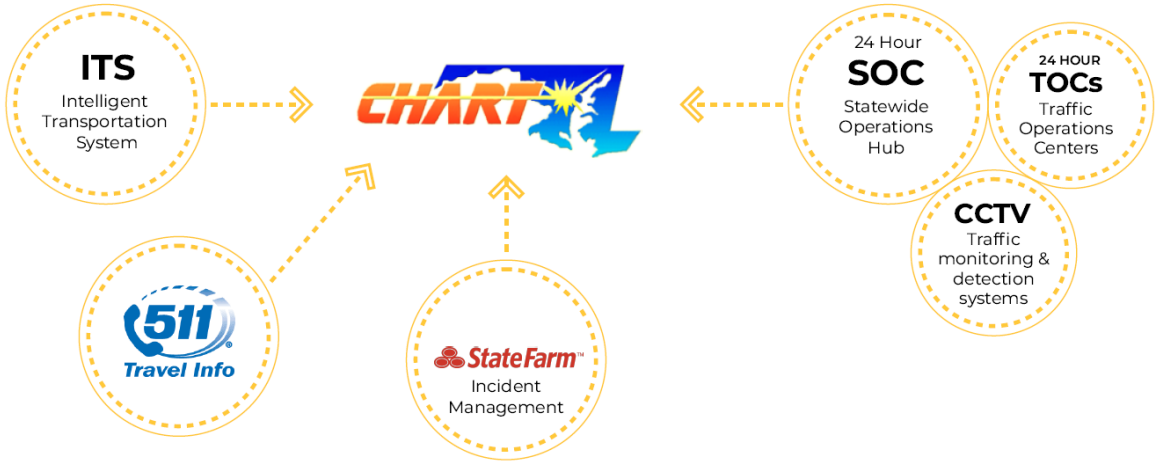
Integrated approach to planning, engineering, operations, and maintenance. Effectively manage and operate existing facilities and systems to maximize their full-service potential.

ABOUT CHART

Coordinated Highways Action Response Team (CHART)

Coordinated Highways Action Response Team (CHART) began in the mid-1980s as the "Reach the Beach" initiative, focused on improving travel to and from Maryland's eastern shore.

CHART is now a statewide, multidisciplinary program providing traveler information, traffic monitoring, traffic management, and incident response and management services through our long-standing partnership with State Farm.



Maryland's real-world application of TSMO

- Traffic & Roadway Monitoring
- Incident Management
- Travelers Information
- Traffic Management
- Emergency & Weather Management
- Statewide Radio Communications

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STATE HIGHWAY ADMINISTRATION

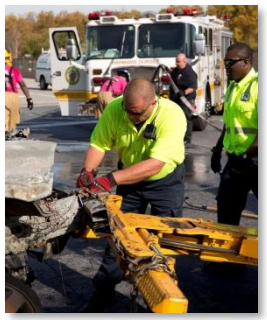
MDOT SHA TSMO STRATEGIES

TSMO Strategy: Traffic Incident Management

Office of CHART and ITS Development/Districts and Shops

- "Clear the Road Policy"
- Close coordination with Maryland State Police (MSP)
- Emergency Response Technicians (ERTs)
  - Emergency Traffic Patrols (ETPs)
  - Emergency Response Units (ERUs)
  - Approximately **42** units on the road
- CHART Operations Centers

24 HOURS/DAY | **7** DAYS/WEEK



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MDOT SHA AND TSMO STRATEGIES

TSMO Strategy: Planned Special Event Management

Office of CHART & ITS Development, Districts, Shops

Effective event management requires intra and inter agency collaboration and coordination

- Planning and protocols - coordination with districts, shops and outside agencies on the development of operational plans when required
- Day-of-event activities – coordination with districts/shops on operation plan
- Post-event activities – after action review with all stakeholders

MDOT SHA AND TSMO STRATEGIES

TSMO Strategy: Emergency Management

Office of CHART & ITS Development/
Office of Maintenance/District Offices and Shops

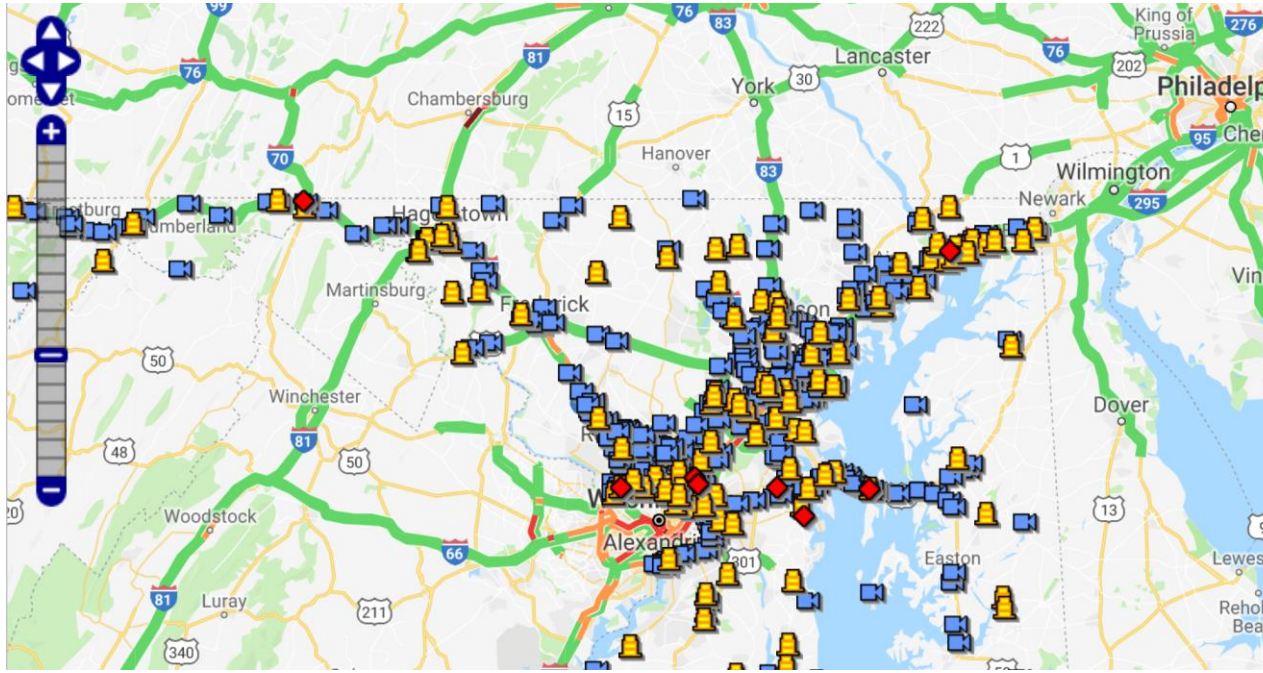
- Large-scale impacts
- Severe weather
- Homeland security
- Can happen anytime, often without warning
- Transportation operations are critical to effective response
- Impacts to transportation infrastructure?
- Coordination prior, during, & following an event
- Multi-agency planning and coordination a must
- Debris management
- Truck parking app during winter operations

MDOT SHA AND TSMO STRATEGIES

TSMO Strategy: Traveler Information

Office of CHART and ITS Development

- 511 Web, CHART Web, Regional Integrated Transportation Information System (RITIS), Metropolitan Area Transportation Operations Coordination (MATOC)
- I-95 Corridor Coalition
- Dynamic message signs (DMS)
- Highway Advisory Radio
- Radio and television traffic reports
- Smart Phone app
- Social media tools
- Commercial traffic conditions and prediction services

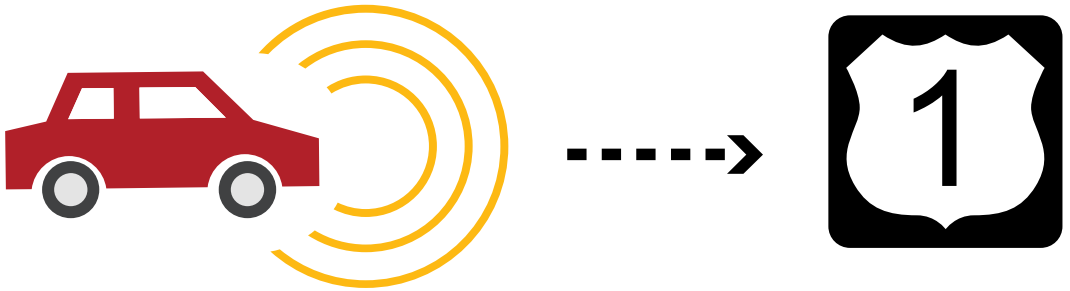


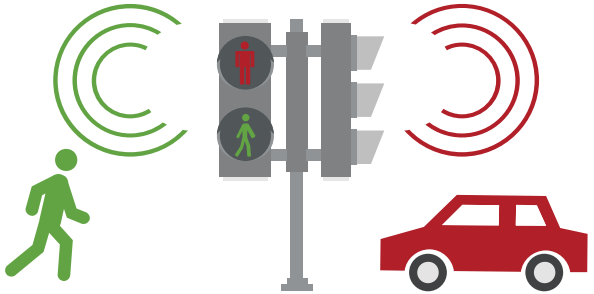
MDOT SHA AND TSMO STRATEGIES

TSMO Strategy: Traffic Signal Synchronization and Operations

Office of Traffic & Safety/District Offices

- Regular signal retiming
- Coordination of signal inter connect projects
- Installation of real-time traffic adaptive signal software and equipment
  - 14 Smart Signal Corridors
- Part of Freeway and Arterial Master Plan
- Part of CAV pilot on US-1 and AASHTO SPaT challenge





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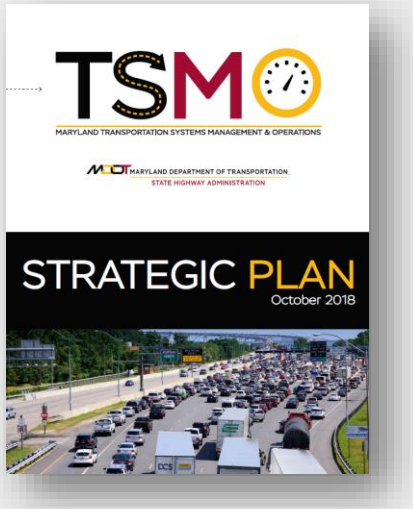
MDOT SHA TSMO STRATEGIC PLAN

MDOT SHA TSMO PROGRAM



- **Plan provides:**
  Vision, Purpose, Goals, Objectives & Strategies
- **Focus on Integration:**
  Institutional, Operational & Technical
- **Governance Structure:**
  Executive Committee, Working Group & Task Forces

GOAL 1

BUSINESS PROCESSES & COLLABORATION

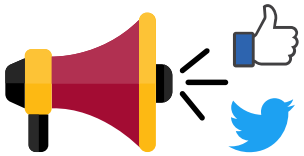
GOAL 2

SYSTEMS & TECHNOLOGY

GOAL 3

DATA, ANALYSIS & PERFORMANCE MANAGEMENT

GOAL 4



CUSTOMER EXPERIENCE & ENGAGEMENT

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STATE HIGHWAY ADMINISTRATION

RETHINKING OUR TRANSPORTATION SOLUTIONS & SERVICES

ROADWAY WEATHER MANAGEMENT

HOMELAND SECURITY PREPAREDNESS

EMERGENCY RESPONSE

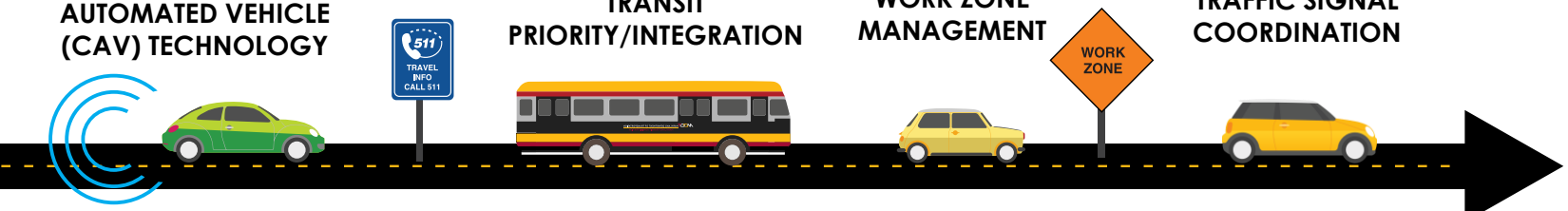
TRAFFIC INCIDENT MANAGEMENT

CONNECTED AUTOMATED VEHICLE (CAV) TECHNOLOGY

TRANSIT PRIORITY/INTEGRATION

WORK ZONE MANAGEMENT

TRAFFIC SIGNAL COORDINATION

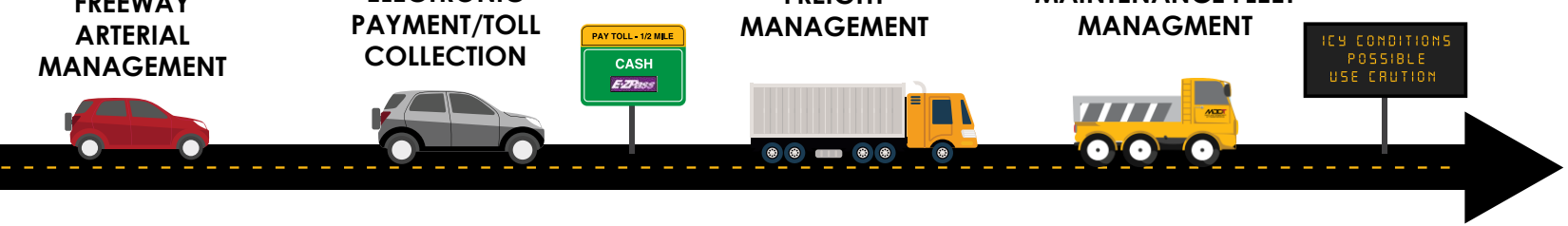


FREEWAY ARTERIAL MANAGEMENT

ELECTRONIC PAYMENT/TOLL COLLECTION

FREIGHT MANAGEMENT

MAINTENANCE FLEET MANAGMENT



TSMO

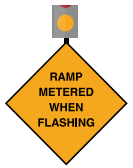
MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS

- OPERATIONS
- PLANNING
- PERFORMANCE MEASURES
- COMMUNICATIONS

INTEGRATED CORRIDOR MANAGEMENT

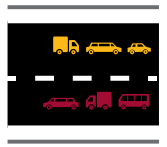
HARD SHOULDER RUNNING

RAMP METERING

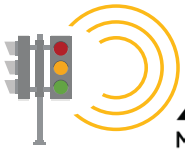


REVERSIBLE LANES

MANAGED LANES



SMART TRAFFIC SIGNALS



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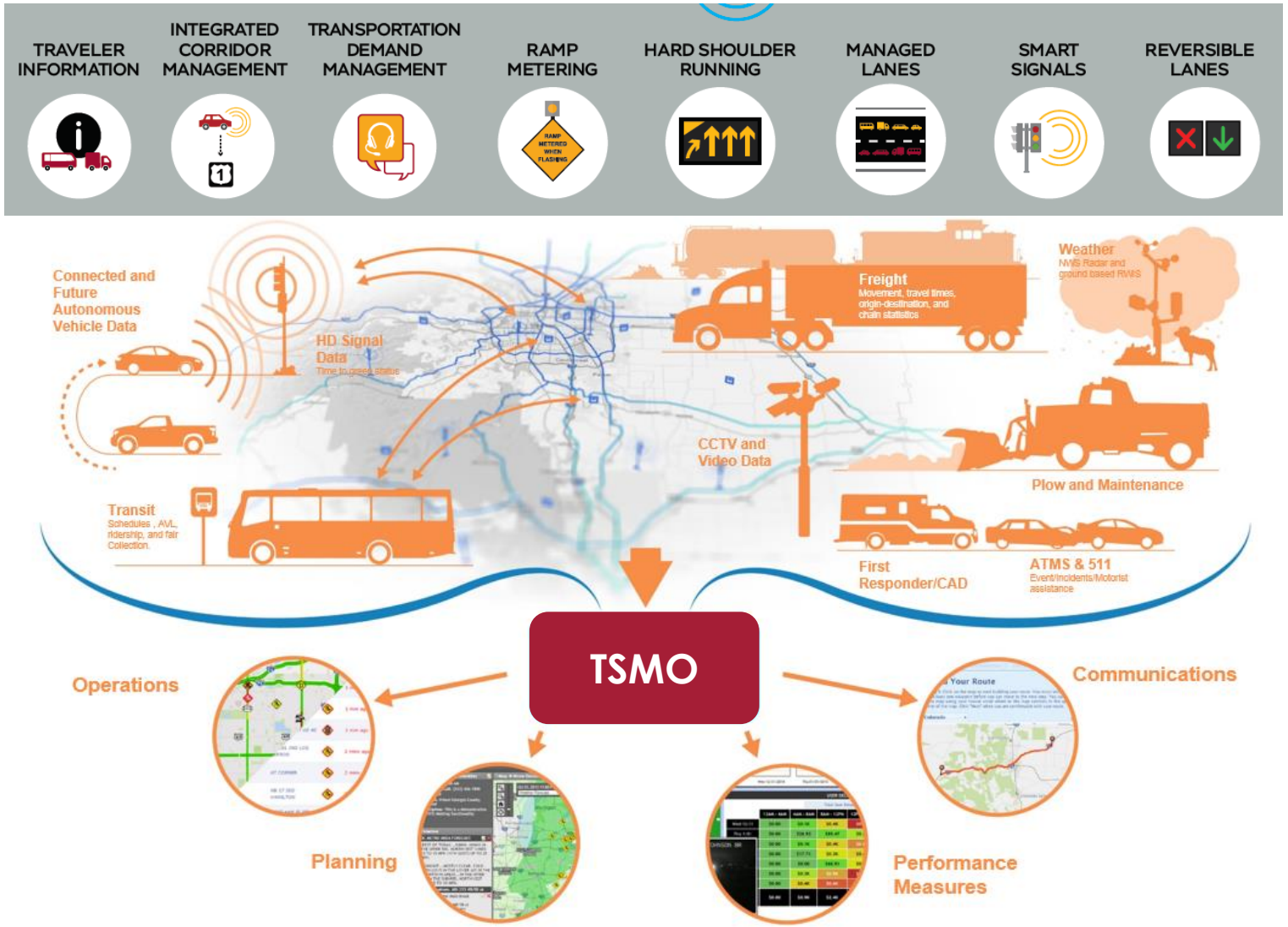
RETHINKING OUR TRANSPORTATION SOLUTIONS & SERVICES



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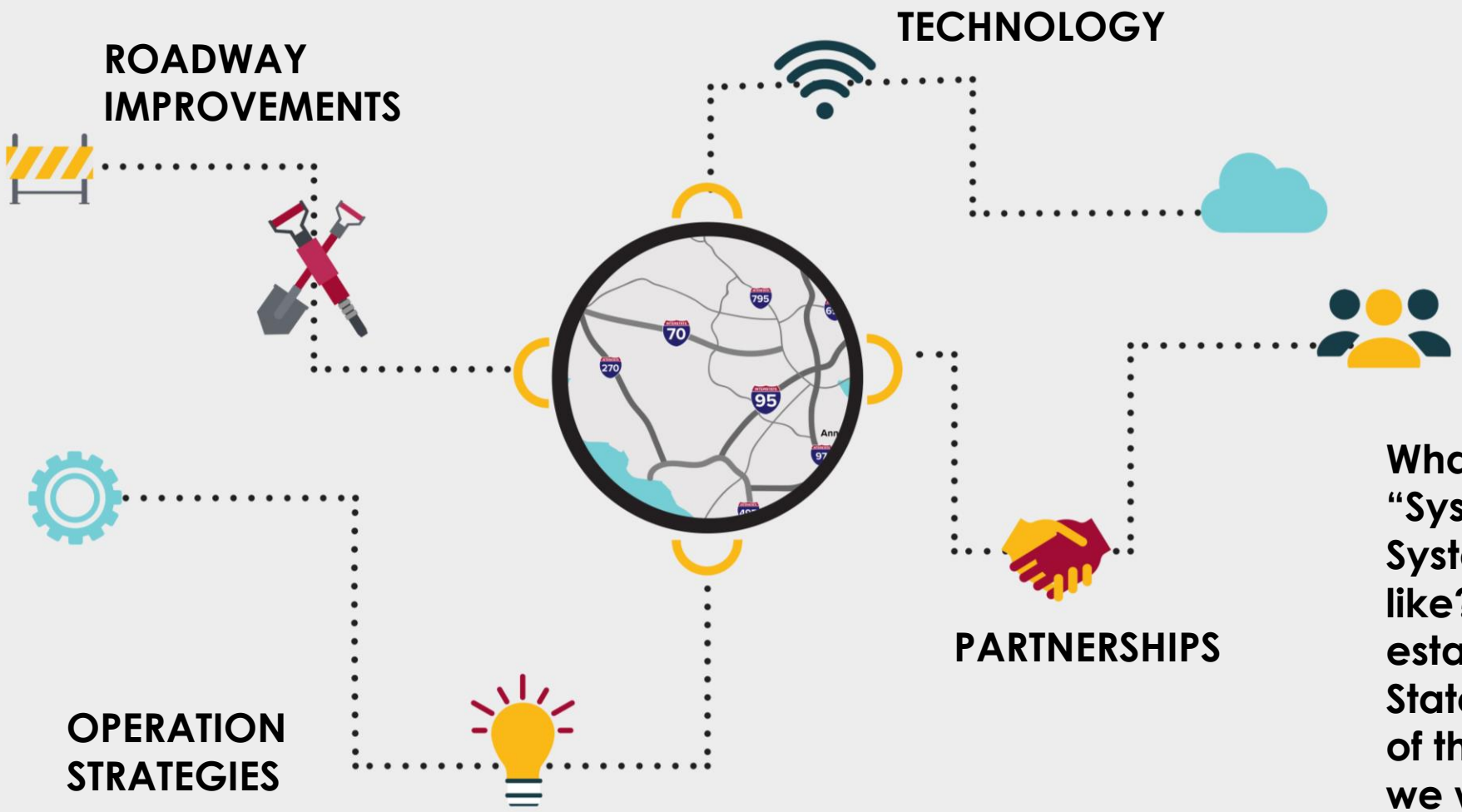
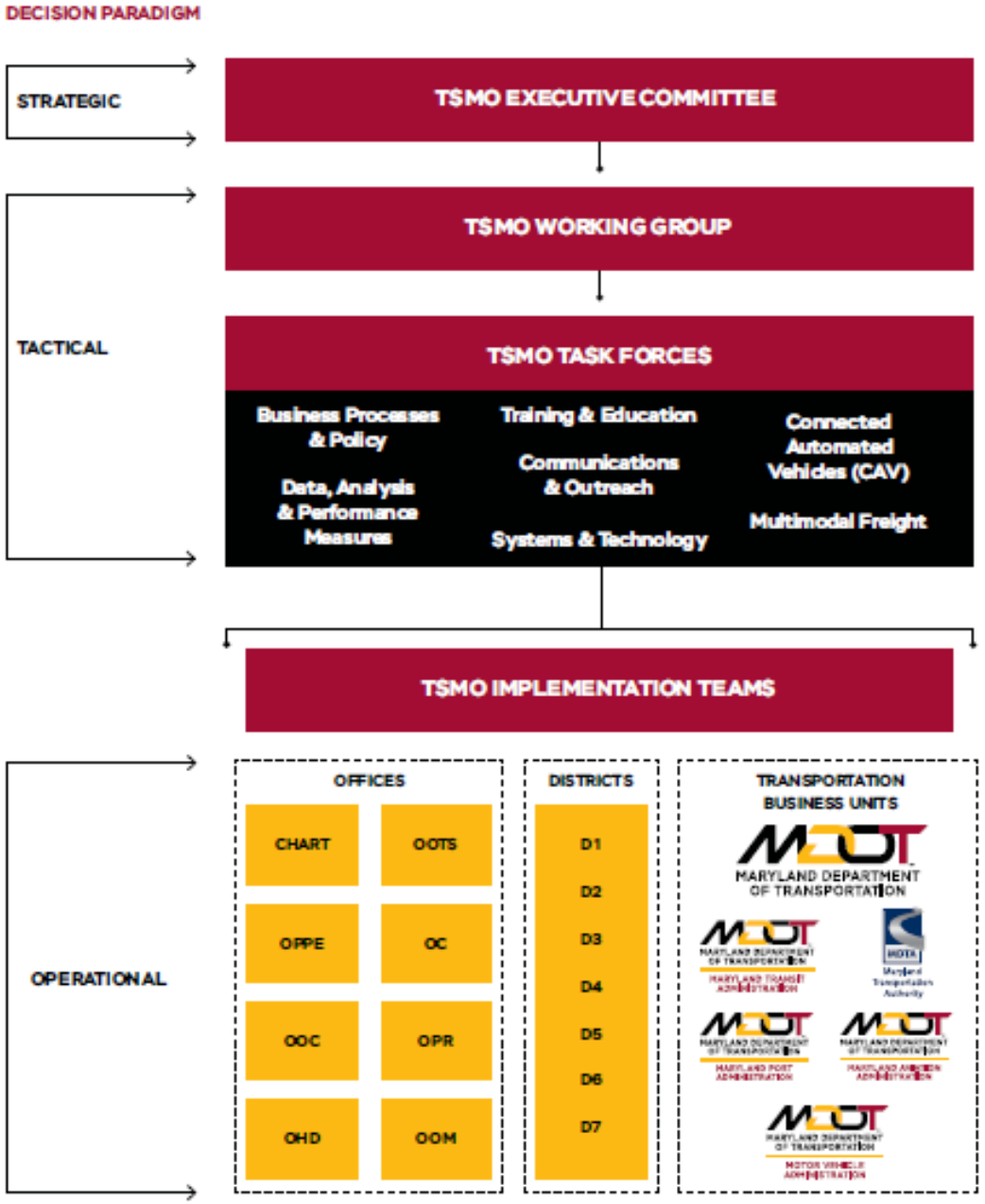
BUILDING A SYSTEM OF SYSTEMS



What does the "System of Systems" look like? Need to establish a Statewide vision of the services we want to offer to our customers.

TSMO ORGANIZATIONAL STRUCTURE

- TSMO Executive Committee provides Strategic Direction and governance
- TSMO Working group develops the Action Plan in coordination with various Offices and Districts
- TSMO & CAV Deputy Director in the Office of CHART and ITS Development oversees the TSMO Program Implementation



BUSINESS PROCESSES AND FUNDING

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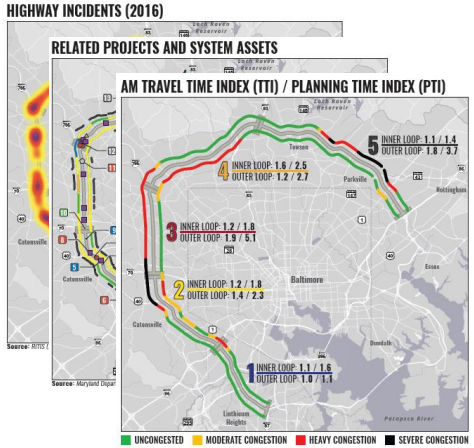
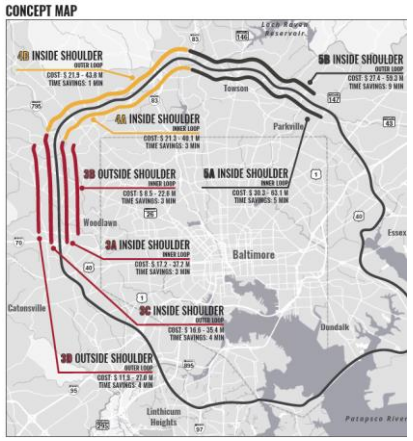
FORMALIZING A TSMO MASTER PLAN





Identify Statewide Priority

- Safety
- Mobility
- Reliability
- Asset Management

TSMO Corridor Screening

- Traffic Conditions
- Safety/ Incidents
- Asset Conditions
- Programmed Activities
- Environmental

TSMO Corridor Analysis

- Potential Strategies
- Traffic Analysis
- User Benefits
- Risks/ Opportunities
- Recommendation

Recommendation

Design | Planning | Construction | No Action

TSMO

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LEVERAGING SIGNIFICANT TSMO PROJECTS

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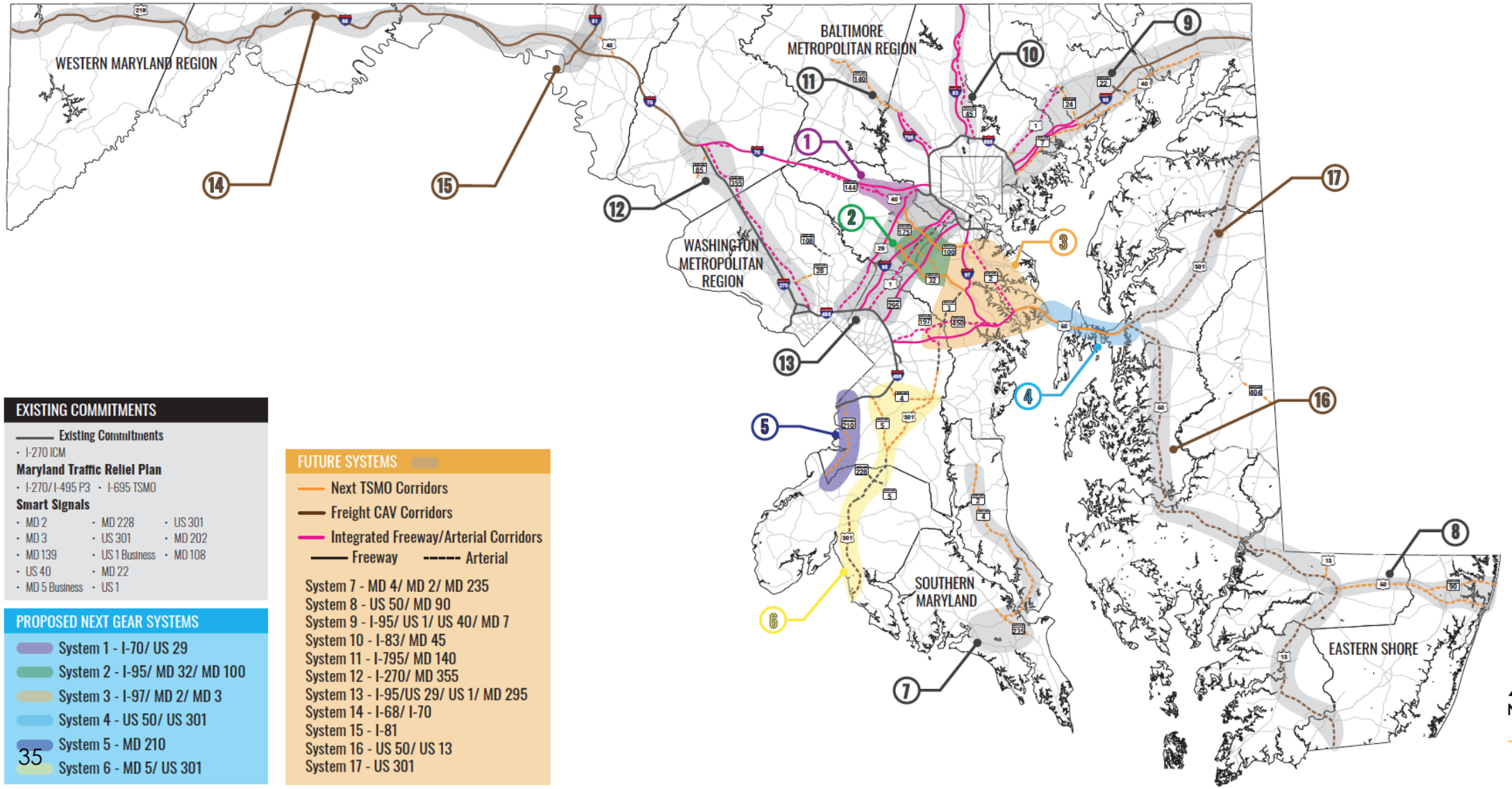
NEXT GEAR - SYSTEM OF SYSTEMS



EXISTING COMMITMENTS

Existing Commitments
- I-270 ICM

Maryland Traffic Relief Plan
- I-270/I-495 P3
- I-695 TSMO

Smart Signals
- MD 2
- MD 3
- MD 139
- US 40
- MD 5 Business
- MD 228
- US 301
- MD 22
- US 1
- US 301
- US 1 Business
- MD 202
- MD 108

PROPOSED NEXT GEAR SYSTEMS
- System 1 - I-70/ US 29
- System 2 - I-95/ MD 32/ MD 100
- System 3 - I-97/ MD 2/ MD 3
- System 4 - US 50/ US 301
- System 5 - MD 210
- System 6 - MD 5/ US 301

FUTURE SYSTEMS
- Next TSMO Corridors
- Freight CAV Corridors
- Integrated Freeway/Arterial Corridors
- Freeway ----- Arterial

System 7 - MD 4/ MD 2/ MD 235
System 8 - US 50/ MD 90
System 9 - I-95/ US 1/ US 40/ MD 7
System 10 - I-83/ MD 45
System 11 - I-795/ MD 140
System 12 - I-270/ MD 355
System 13 - I-95/US 29/ US 1/ MD 295
System 14 - I-68/ I-70
System 15 - I-81
System 16 - US 50/ US 13
System 17 - US 301

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RETHINKING PROJECT DEVELOPMENT

Incorporate Communications & Operational Technology in Projects

- Infrastructure for TSMO and ATM/ICM/CAV Needs

- Ways to procure/deliver effectively – mainstreaming TSMO projects:
  - Major Projects (TSMO Strategies, ITS Infrastructure in scope)
  - **Rethink System Preservation Projects**
  - Operational projects (ITS/Software/ Communications)

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TSMO PROJECTS

Rethinking

- Projects as Systems
- Performance Measures
- Programming Models

- Changes to scoping/project development process
- Consider TSMO strategies in whole or in part
- Use Annual Mobility Report and other data/metrics
- Incorporate Communications & Operational Technology in Project Scope
  - Major Projects
  - System Preservation Projects
- Operational projects (ITS/Software/ Communications)

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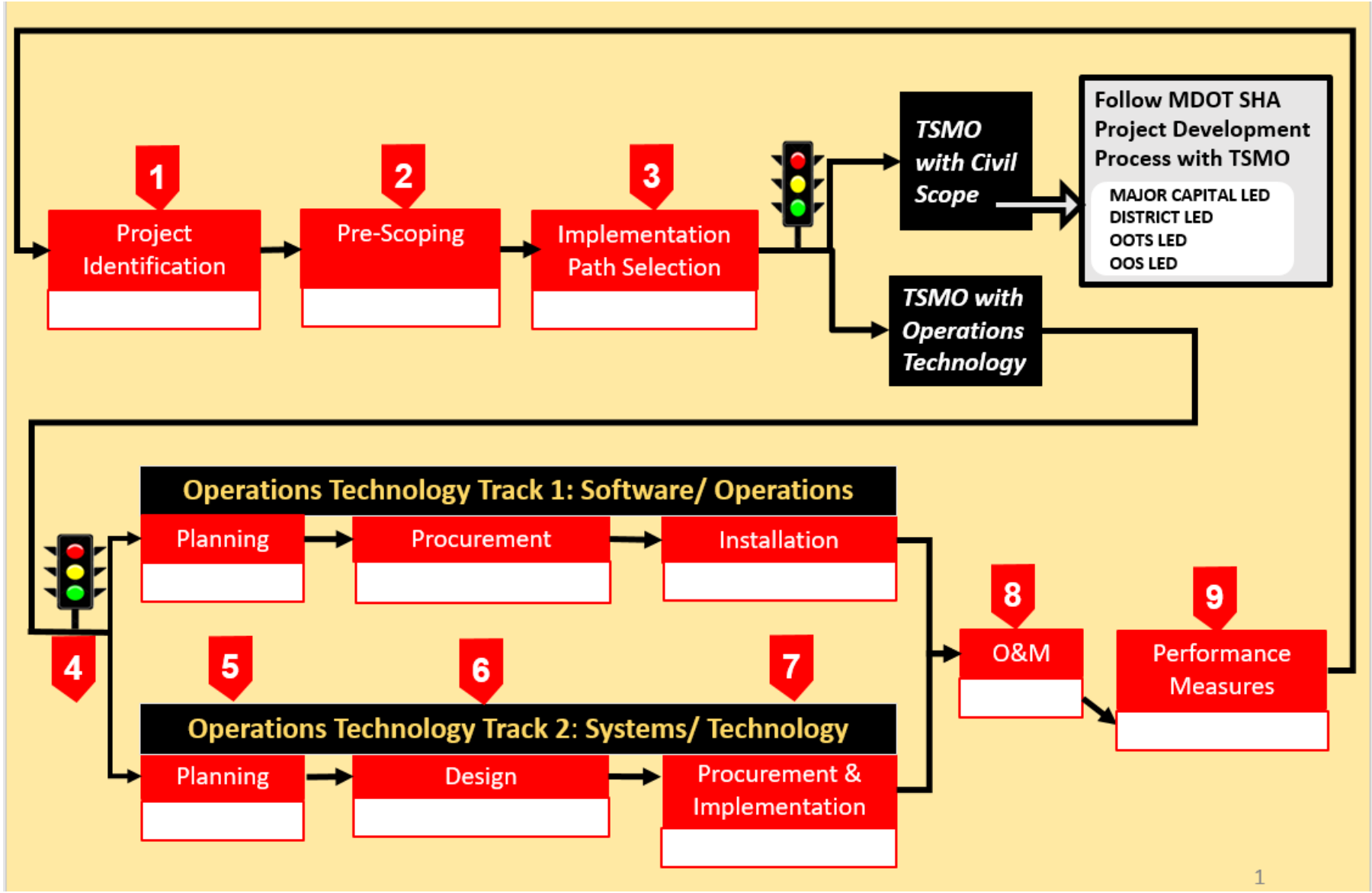
DELIVERING TSMO PROJECTS



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DELIVERING SYSTEMS

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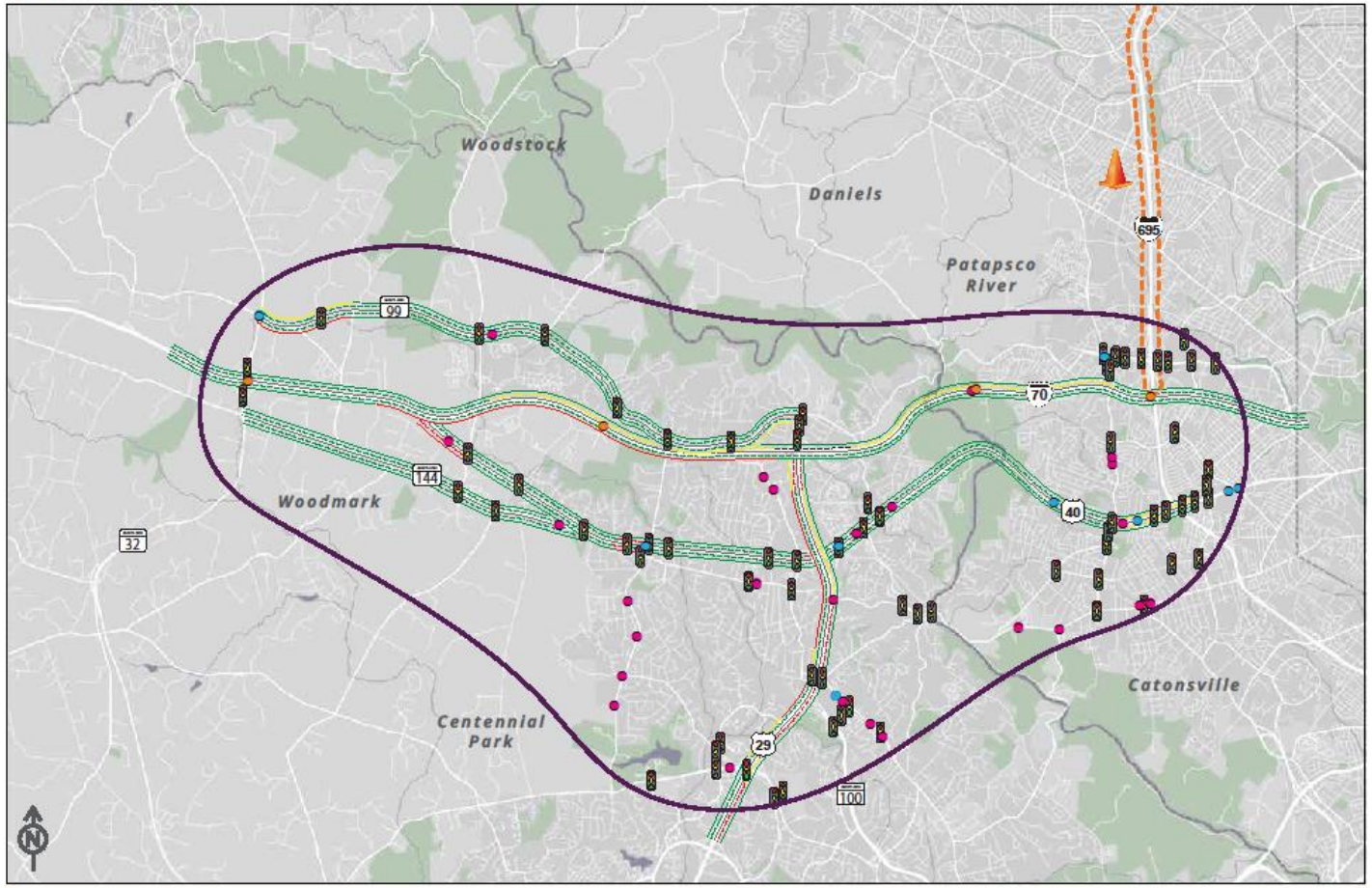
TSM

40 29 70

TSMO SYSTEM # 1



- Signal System Component
- Changeable Message Sign, SHAZAM Sign, Roadway Info Tower, Camera, CHART In-road Detector
- Intersection Control Beacon, Hazard Identification Beacon, School Flasher
- Traffic Signal
- AM TTI
- PM TTI
- Uncongested (TTI < 1.15)
- Moderate Congestion (1.15 < TTI < 1.3)
- Heavy Congestion (1.3 < TTI < 2.0)
- Severe Congestion (TTI > 2.0)

TSMO STRATEGIES:

- Hard Shoulder Running along I-70 from US 40 to US 29
- Hard Shoulder Running along US 29 from MD 100 to I-70
- Traffic Signal Upgrades along US 40
- Freeway Arterial Integrated Corridor Management

Prelim. Engineering ($M)	XX
Construction ($M)	XX
User Benefit ($M)	XX
Benefit/ Cost	XX

Larry Hogan | Governor · Boyd K. Rutherford | Lt. Governor · Pete K. Rahn | Secretary · Gregory Slater | Administrator

DRAFT 4/15/19

707 North Calvert St., Baltimore, MD 21202 | 410.545.0300 | TTY 800.735.2258 | roads.maryland.gov

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

DELIVERING SYSTEMS

PERE TRACK

- System level Needs & Opportunities Assessment
- Performance & Conditions
  - MOBILITY & RELIABILITY
  - SAFETY
  - ASSET CONDITIONS
  - FREIGHT
  - ACCESS, LAND USE & ECONOMIC DEVELOPMENT
- Deliverables:
  - High-level transportation solutions/ project concepts
  - Break-out Projects with Phasing recommendations
- Next Steps: Project Purpose & Need

OPERATIONS TRACK

- Concept of Operations
  - Transportation Network & Users
  - ITS & Traffic Signal Systems
  - Operational Scenarios
  - User based Operational Descriptions
- High-level Strategy Identification & Feasibility
- Deliverables:
  - Operational technology solution concepts
- Next Steps:
  - High-level Design Requirements
  - Systems Software Development

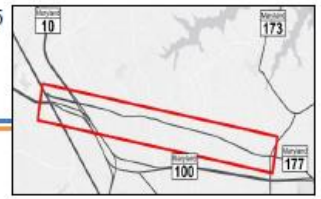
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

LEVERAGING SYSTEM PRESERVATION

8: MD 177 CORRIDOR (MD 2 to MD 607)

Intersection Improvements at Solley Road, Catherine Avenue, Edwin Raynor Boulevard and MD 607

District 5



Safety Savings (millions)	Operational Savings (millions)	Benefit /Cost	Cost Estimate (millions)	ROW Impacts (acres)
$0.5	$38.8	16.8	$2.1	0.7

*ROW costs not included

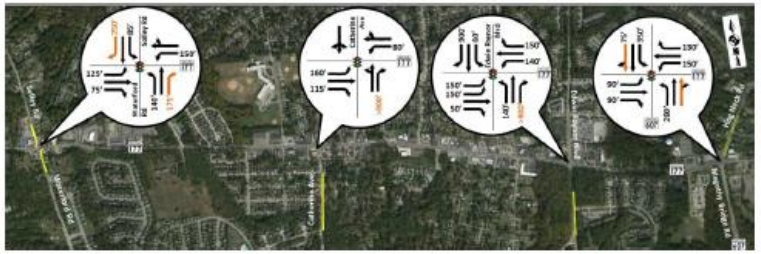
PROJECT

Intersection improvements at Solley Road, Catherine Avenue, Edwin Raynor Boulevard, and MD 607 on side streets

- Add 3rd southbound lane providing exclusive through and left turn lanes from Solley Road.
- Add 3rd northbound lane providing exclusive through and right turn lanes from Solley Road/Waterford Road
- Extend 2nd northbound lane on Catherine Avenue to Schramms Crossing
- Stripe 2nd northbound lane on Edwin Raynor Boulevard to just north of MD 100 bridge
- Convert exclusive northbound right turn lane on Magothy Bridge Road to a shared through-right lane and provide 2nd northbound receiving lane on Hog Neck Road
- Convert exclusive southbound right turn lane on Hog Neck Road to a shared through-right lane and extend storage length

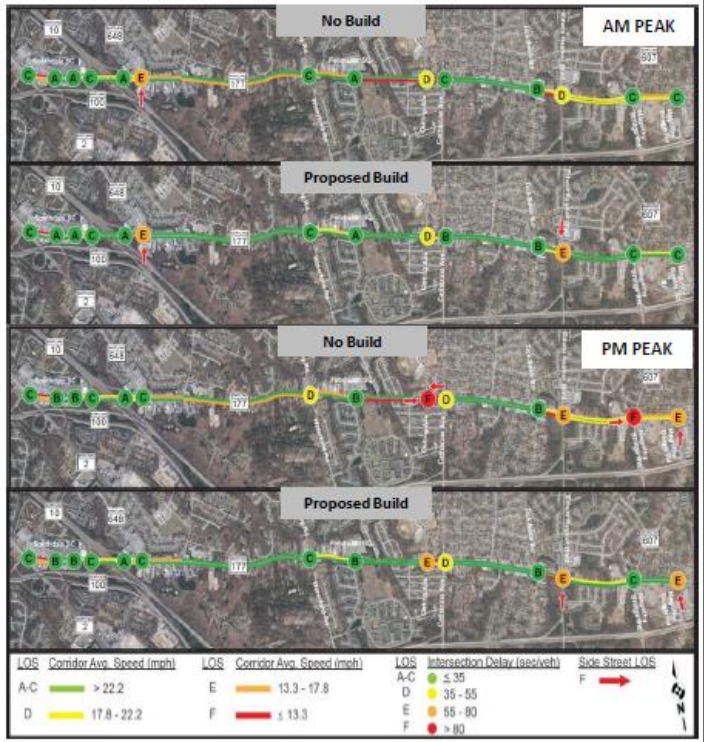
CORRIDOR

- 4.5 miles, 14 signals
- PM Speeds up to 23 MPH below posted
- Some failing intersections and multiple failing movements
- Eastbound queuing during PM peak hour at Solley Road, Catherine Ave/Outing Ave, Magothy Bridge Road, and Edwin Raynor Boulevard
- 306 crashes, crash rate - 394.5 per 100 MVM (192.7 statewide average)



BENEFITS

- No failing signalized intersections
- PM peak average speeds improve by about 5 mph
- PM network delay reduced by over 25%
- PM travel time reduced by over 15%



THREE BUCKETS OF FUNDING

- SAFETY
- ASSET MANAGEMENT
- MOBILITY

TSMO CORRIDOR PROJECTS CAN BE DEVELOPED THAT LEVERAGES SAFETY AND ASSET MANAGEMENT NEEDS.

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STATE HIGHWAY ADMINISTRATION

TSMO FUNDING AND PROCUREMENT

- Delivery/Procurement Strategies
  - Areawide/corridor specific operations
  - Performance based service contracts
  - P3/Resource-sharing opportunities

SHRP2 LO5

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MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

SYSTEMS AND TECHNOLOGIES

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

MOBILITY & OPS FUNCTIONAL AREAS

To optimize operations and improve mobility and safety on Maryland's major highways through the use of intelligent transportation systems, technology, and 21st century strategies and interagency teamwork.

CHART Operations

24/7 Traffic monitoring, traffic management, incident response and management, emergency operations and traveler information (Maryland 511)

CHART Systems

Development, integration, deployment and maintenance of Maryland's ATMS, EORS, ITS devices and other communications infrastructure

TSMO

Integrated coordination of planning, engineering, operations and maintenance activities to help manage congestion, reduce delays and improve safety and efficiency on existing facilities

CAV

Developing, implementing and managing strategies, technologies and initiatives related to connected and automated vehicles

CHART OPERATIONS

Traffic Management

The CHART system strives to manage freeway and arterial traffic flows with the goal of greater efficiency and safety.

Statewide arterial signal systems provide:

- Remote and adaptive traffic signal control
- Coordinated signal timing

Incident Response and Management

CHART Emergency Traffic Patrols (ETPs) have been helping broken-down motorists and assisting police at incidents since the 1980s.

40+ Emergency Responder Technicians **WORKING** **24/7** **COVERING** **2000 MILES**

Operating in parnternship with Maryland Agencies

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION

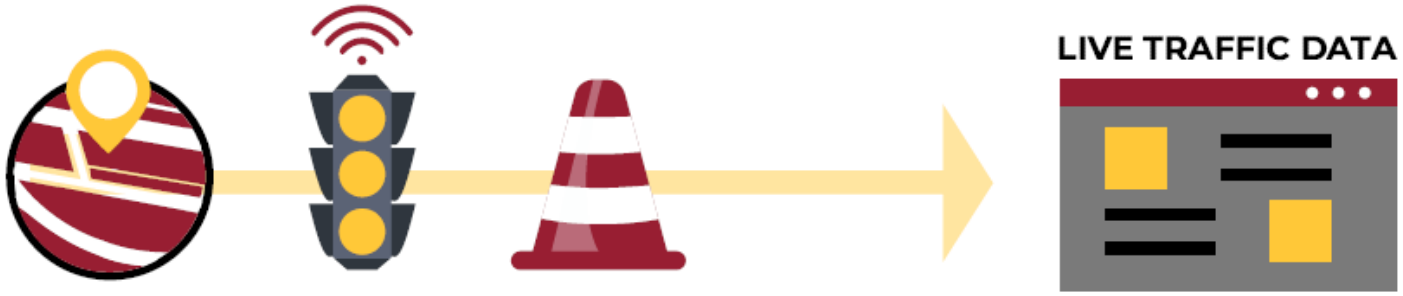
Maryland Transportation Authority

MARYLAND STATE POLICE

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

CHART OPERATIONS

Traveler Information



Traffic Monitoring

CHART uses a combination of monitoring tools including traffic speed detectors, traffic counting devices, CCTV cameras, pavement weather sensors, and field unit reports to assess and report real-time traffic flow.

SPEED DETECTORS

TRAFFIC COUNTING

CCTV CAMERAS

WEATHER SENSORS

FIELD REPORTS

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

CHART SYSTEMS FOCUS AREAS

Advanced Traffic Management System (ATMS)

- Identify and track traffic flow disruptions using CCTV, Traffic Sensor Systems & remote weather stations
- Send responders to correct the disruption
- Notify the public using DMS & HAR
- Send notifications to the media
  Feeding data to a live traffic web site & MD 511

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STATE HIGHWAY ADMINISTRATION

CHART SYSTEM FOCUS AREAS

Emergency Operations Reporting System (EORS)

- Storm Event Reporting –utilization of personnel, equipment, materials and conditions
- Snow Emergency Plans – Declared and managed for counties
- Event Mapping – specify conditions of predefined road segments.
- Route Restrictions – manage vehicle restriction information
- Post Storm Review & Archive
- Situational Awareness Reporting (SARS)/ Archive – add event data at the district, EOC, CHART and PIO level

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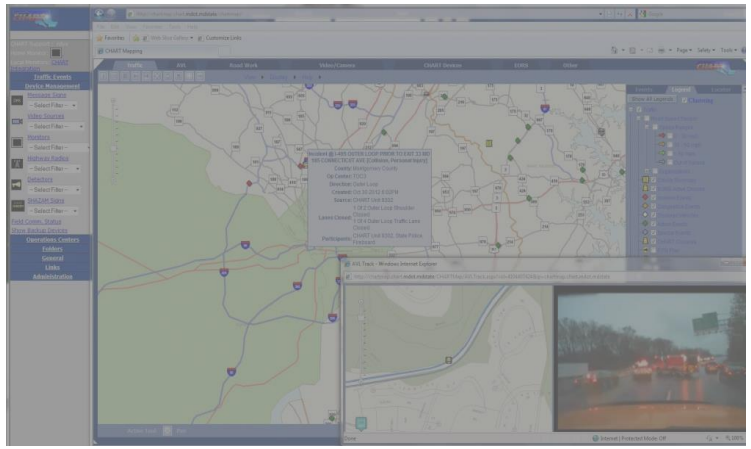
STATE HIGHWAY ADMINISTRATION

CHART SYSTEM FOCUS AREAS



Lane Closure Permitting System (LCP)

- Permit Management – add, edit, update, approve & delete
- List Permits – list, activate and print permits
- Permit Workflow –manage workflow rules for permit states
- Permit Reports – generate PDF reports for active and approved permits
- Permit Mapping – geo-locate a lane closure permit.
- LCP Data Exporter services – Provides an interface for external applications to get LCP permit data

World Wide Web Presence / Integrated GIS Mapping

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STATE HIGHWAY ADMINISTRATION

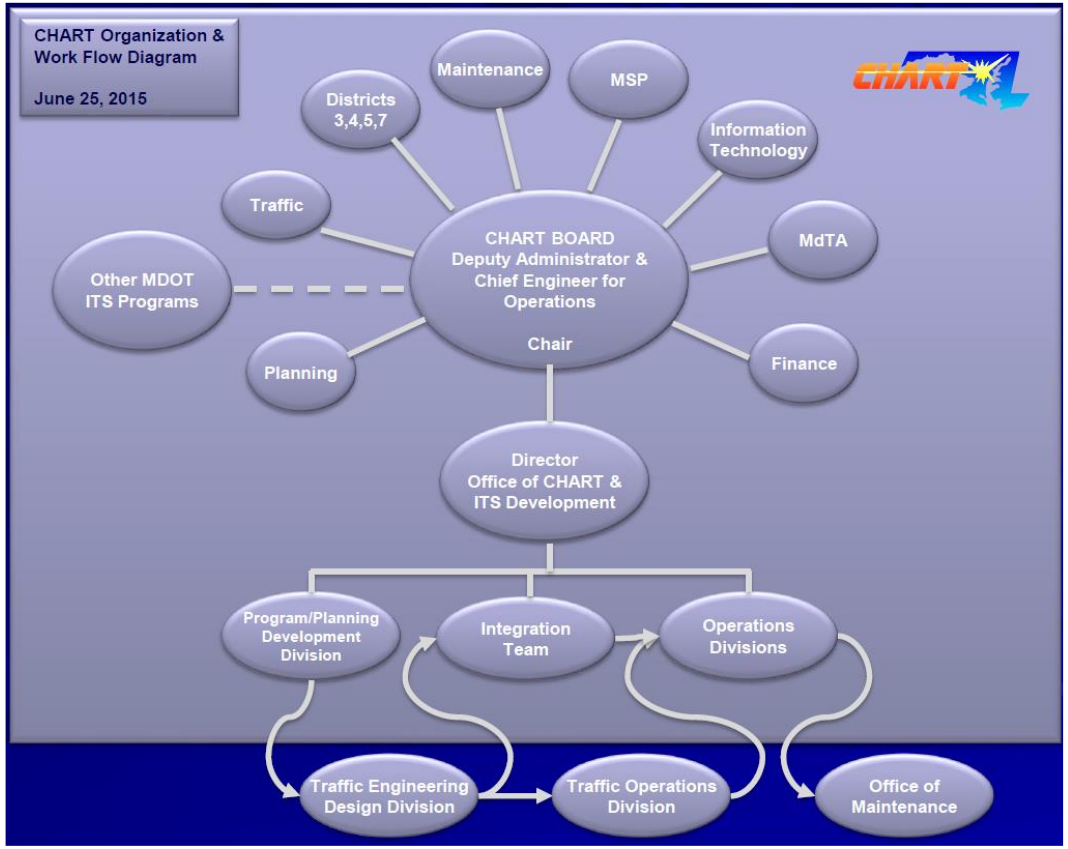
CHART SYSTEM/ ATMS USERS

Current Users of CHART Video and Data:

Over 36 agencies in over 91 operations centers

PARTNERS INCLUDE:

- Transportation Management
- Law Enforcement
- Highway Maintenance
- Emergency Operations
- Information Sharing
- Device Maintenance



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STATE HIGHWAY ADMINISTRATION

CHART ATMS REQUIREMENTS

Federal Mandate

(Sec 5206(e) of TEA–21)

- Conformance with the National Intelligent Transportation Systems Architecture and Standards
- All ITS projects funded with highway trust funds shall be based on a systems engineering analysis.

State Requirements
(Finance and Procurement Title 3 § 3-403, Chap 467 & 468)

- CHART Systems Development is a Major Information Technology Development Project
- Rigorous Systems Development Life Cycle (SDLC) Methodology are mandated

WATERFALL MODEL/ LINEAR APPROACH

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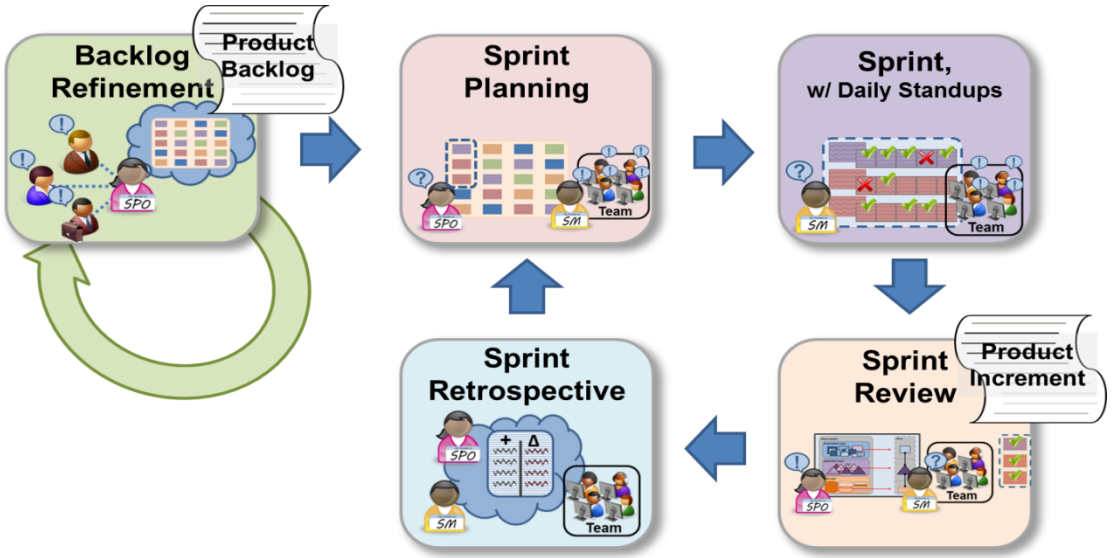
STATE HIGHWAY ADMINISTRATION

THE MOVE TO AGILE

- Helps teams respond to unpredictability through incremental, iterative work cadences, known as sprints
- Each major activity occurs concurrently, organized into cycles
- Work is continuous, with frequent small deliveries that add up to releases
- Customers have frequent opportunities to interact with slices of product
- Changes in customer need, team adaptations, and process improvements are immediately integrated into the next iteration



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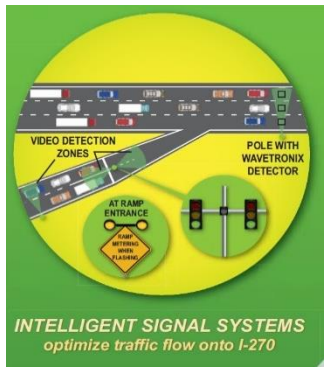
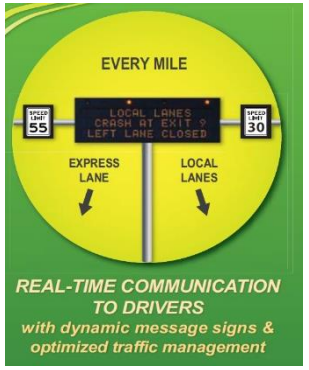
STATE HIGHWAY ADMINISTRATION

LEVERAGE MAJOR TSMO PROJECT IMPLEMENTATIONS

- I-270 ICM Project mainstreams **Coordinated Adaptive Ramp Metering, Dynamic Speed Limits**
- I-695 TSMO Project will implement **Dynamic HSR**
- TSMO System-1 will develop **integrated freeway/ arterial operation** strategies
- Statewide Freight Program will develop **Smart Truck Parking and Advisory Systems**





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THE NEXT 4 YEARS FOR ATMS

- Use of Artificial Intelligence
- Cybersecurity
- Getting Ready for CAV Future

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STATE HIGHWAY ADMINISTRATION

SMART TRAFFIC SIGNALS PROJECT

- MDOT SHA owns :
  - 3,647 traffic control signals.
  - ***MDOT SHA's Office of Traffic and Safety*** maintains all but 750 +/-of these signals.
- Controllers - Econolite ASC/3 or Econolite Cobalt
- Detection – Video camera, non-invasive micro loop probes, inductive loop, radar based detection, thermal detection
- Communication – Telephone Service with Dial-Up Modems and Ethernet Based High Speed Data Communications with Cellular Modems
  - 2,624 traffic control signals have some form of communication.
- Old ATMS (Aries) over 20 years old
- Timing Plans – Time of Day/Day of Week. Retimed every 3 years or so

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MDOT SHA SIGNAL SYSTEMS

Traffic Relief Plan dedicated funding of $50.3 million for upgrading signal infrastructure

SMART SIGNALS

- Adaptive Signal Control Technology
- Upgraded Communication
- Signal Performance Measures
- SPaT Challenge

Opportunities for Traffic Responsive ATM and ICM strategies.

WBAL NEWSRADIO 1090

NOW STREAMING
WBAL News Now with Bryan Nehman

Home Shows News Weather Traffic Sports Ravens Orioles

Hogan Announces $50M To Deploy Smart Traffic Signals

Print

Wednesday, October 25 2017
Associated Press

Maryland is getting smarter traffic signals.

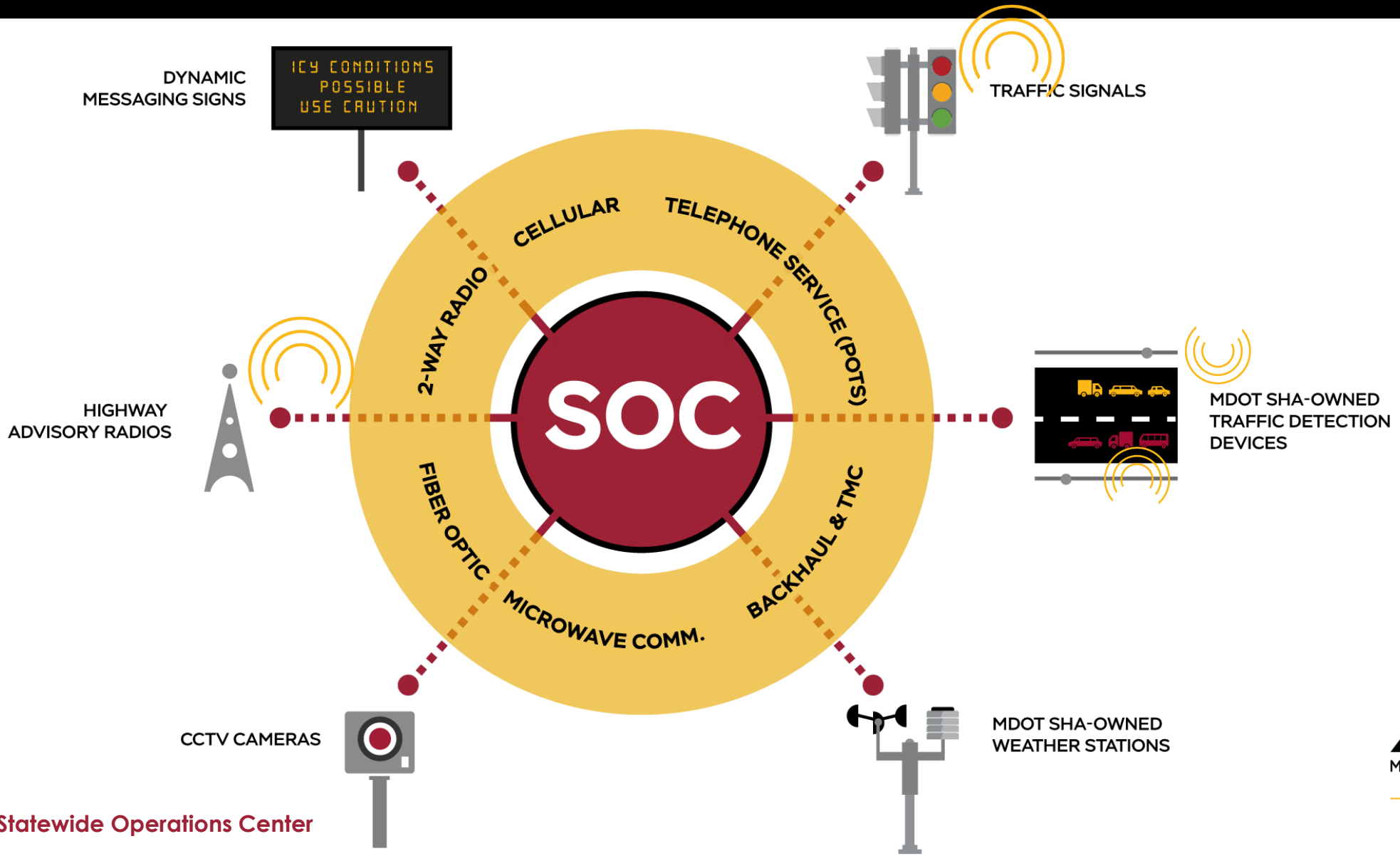
Gov. Larry Hogan announced Wednesday a $50 million plan to deploy a system that uses real-time traffic conditions and computer software to adjust the timing of traffic signals.

The Hogan administration says it will ease congestion for about 700,000 drivers a day on 14 major corridors. Three of them are in Anne Arundel County, two are in Baltimore County and three are in Charles County. Harford and Prince George's counties will each get smart signals in two corridors. Howard and Montgomery counties will get signals in one corridor each.

The governor says it's the second phase of his traffic-relief plan. Last month, he announced a $9 billion plan to add four lanes to I-270, I-495 and the Baltimore-Washington Parkway.

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

MDOT COMMUNICATION NETWORK



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STATE HIGHWAY ADMINISTRATION

SOC: Statewide Operations Center

FIBER JUSTIFICATION

- Reduces cost of cellular and T1 connections that are ineffective/outdated
- Needed for current transportation and public safety communication
- Future need for Smart Cities and Connected & Automated Vehicles (CAV)
- Economic growth, Mobility & Rural Broadband
- Provides a redundant path for mission critical communications in times of crisis and large scale Statewide emergencies
- Reduces contractual obligations / reliance on private networks
- Potential revenue (to cover maintenance cost) with Resource Sharing

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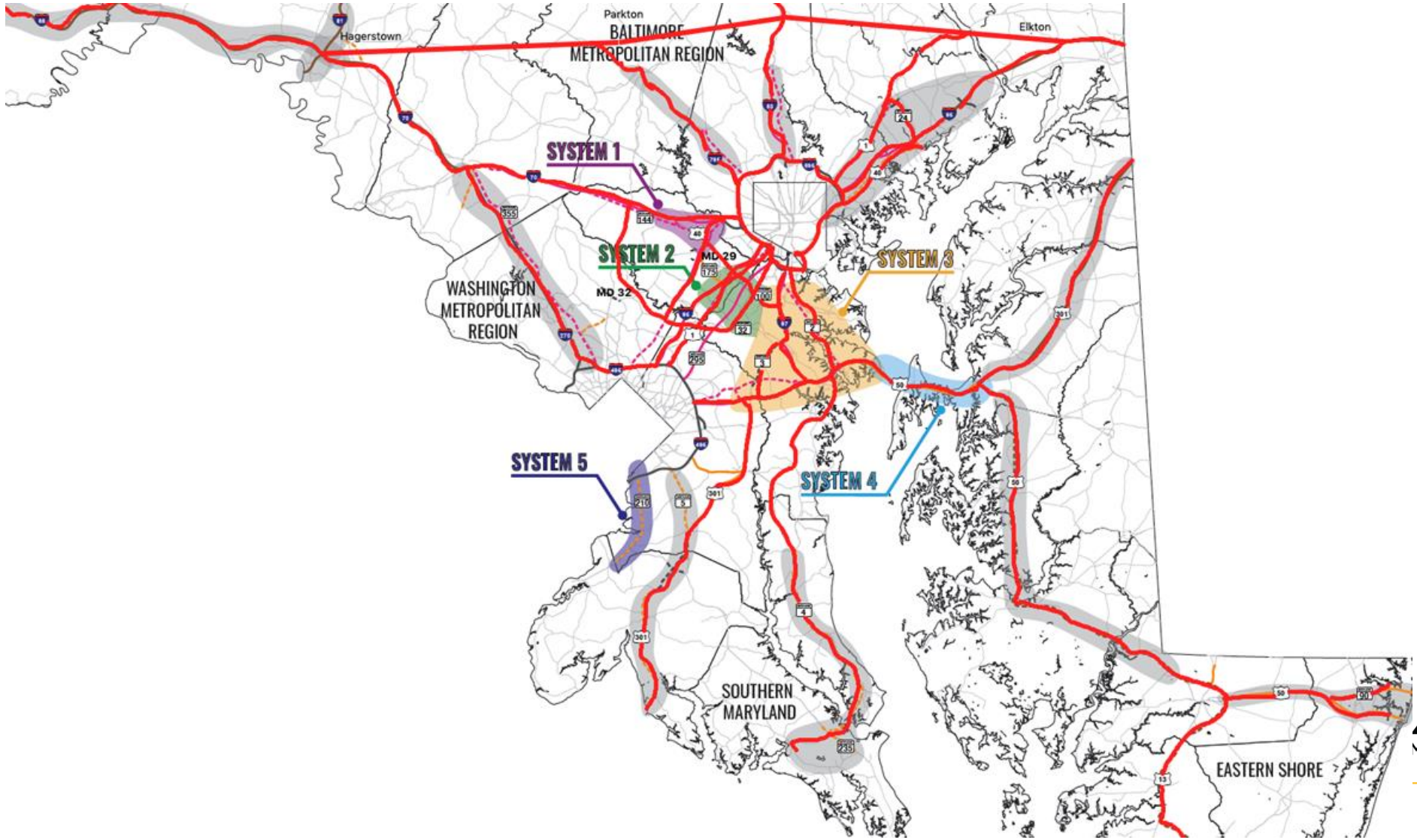
STATE HIGHWAY ADMINISTRATION

MAPPING FIBER NEEDS



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STATE HIGHWAY ADMINISTRATION

FIBER FUNDING

Potential ways to fund Maryland's Fiber Network

- Project-based "dig once" initiative
  - (Add 15% for conduit/fiber installation)
- Statewide Project in Phases
- Areawide Projects managed by District Offices
- Public Safety Justification through Operations Funds
  - Grant Programs
    - Homeland Security - $1 Billion annually
    - Maryland's Rural Broadband Initiative

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DATA, ANALYSIS & PERFORMANCE MEASURES

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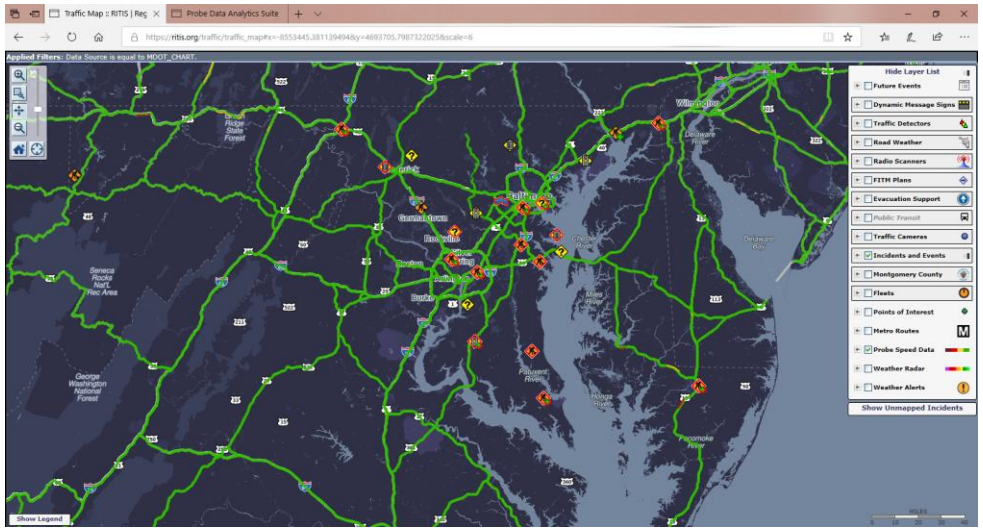
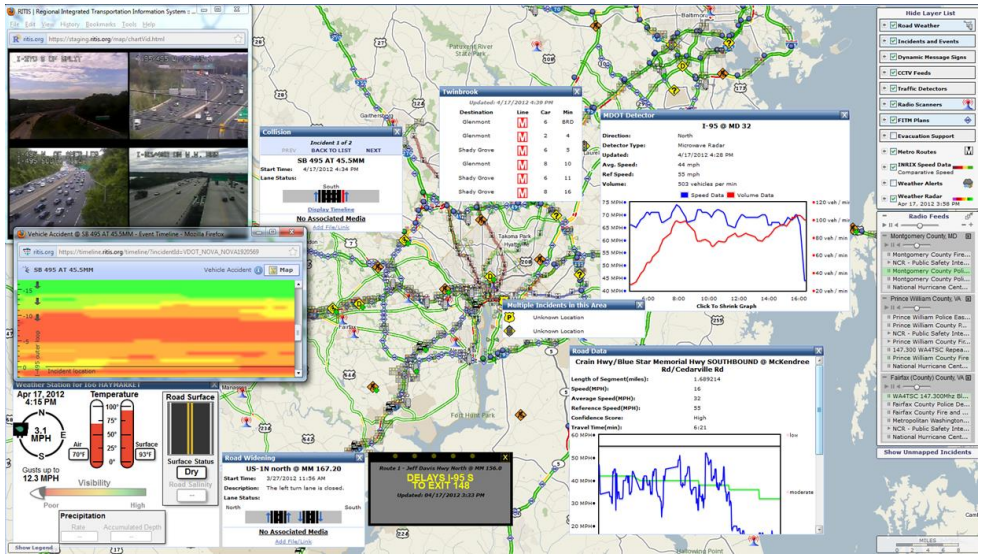
DATA TECHNOLOGY SUPPORTING TSMO

- Real time applications
- Archived data applications
- Combination of in-house tools and UMD CATT Lab RITIS
- MDOT Common Operating Picture
- **Big Data and Crowd Sourced Data Applications**





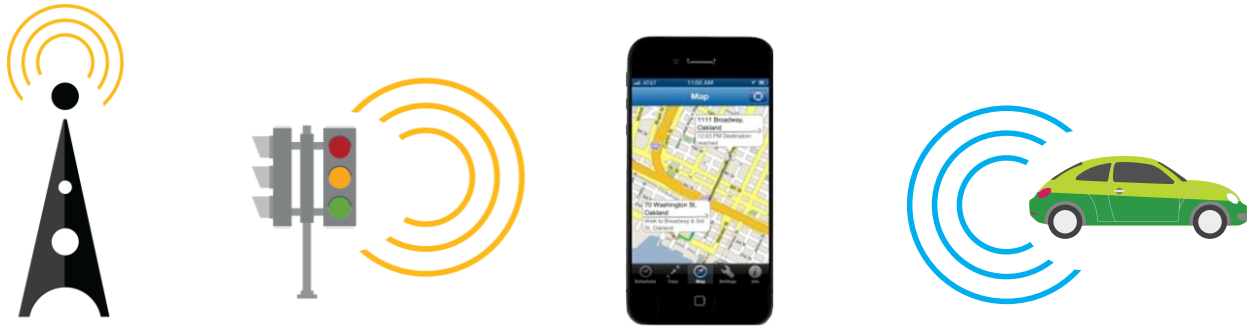
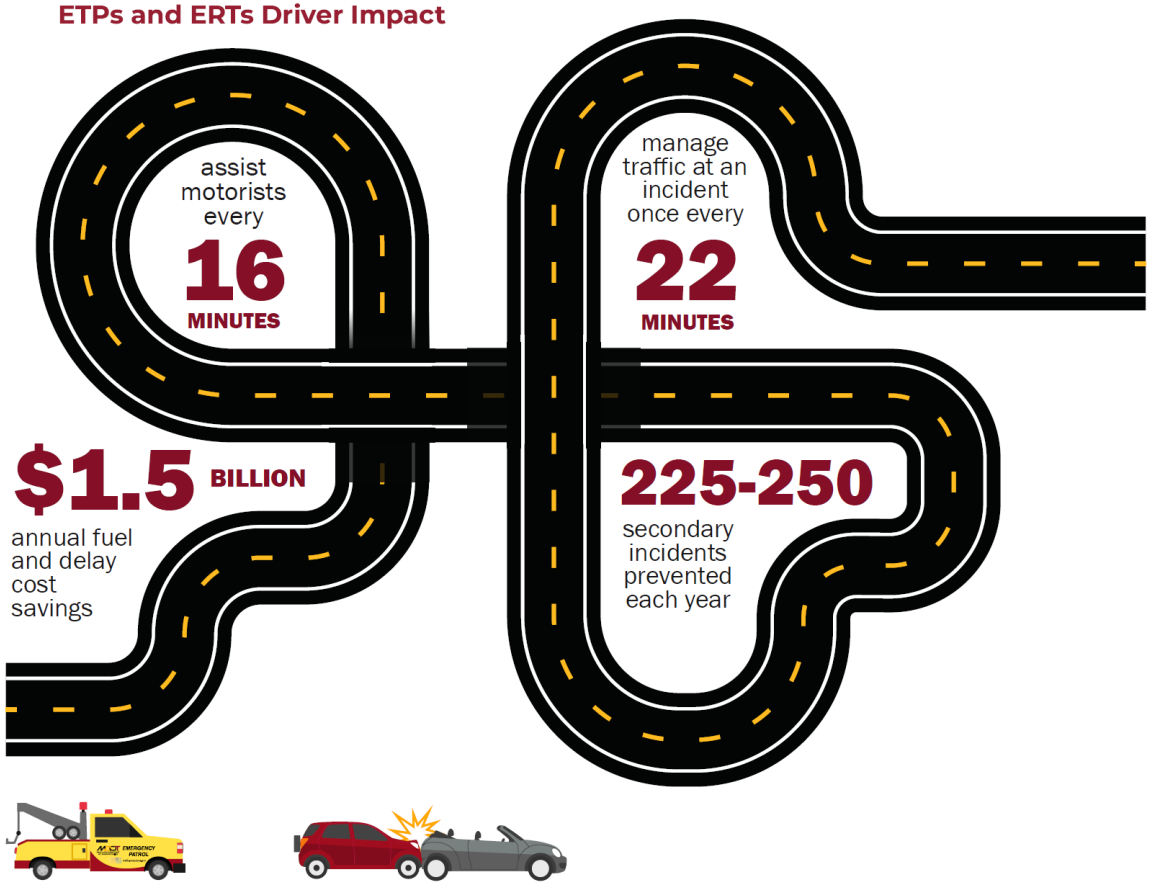


CHART PERFORMANCE MEASURES

Since 1990, CHART has provided more than **574,000** assists

In the same period, CHART has responded to more than **287,000** incidents



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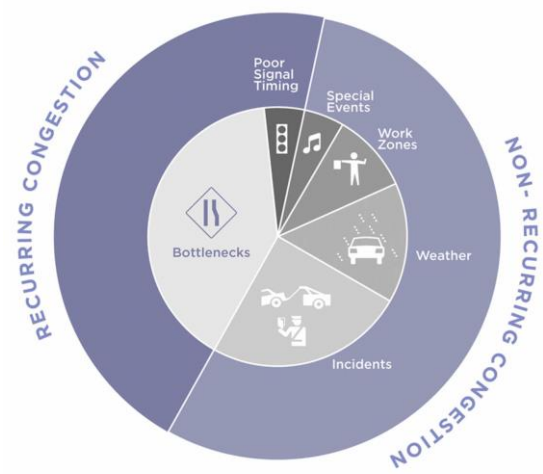
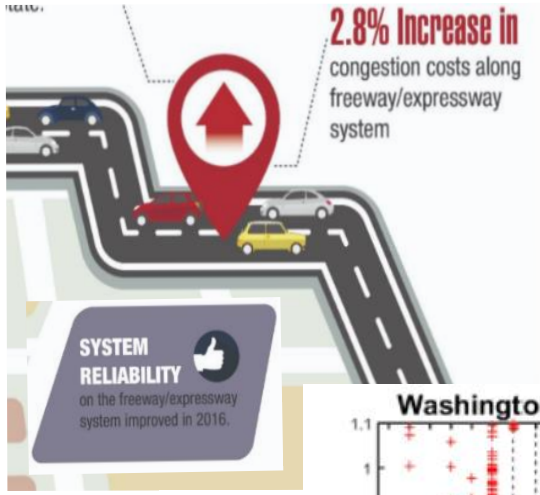
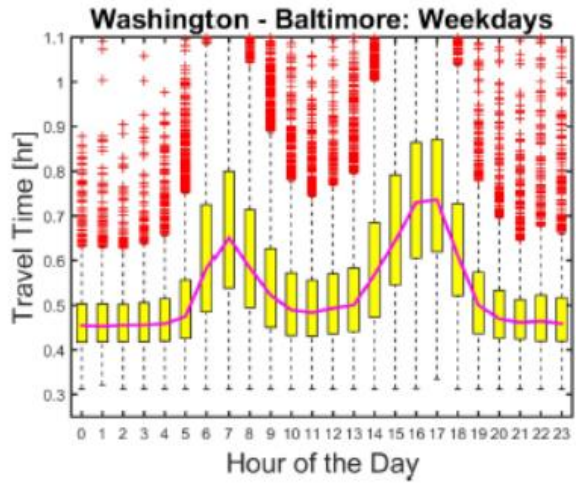
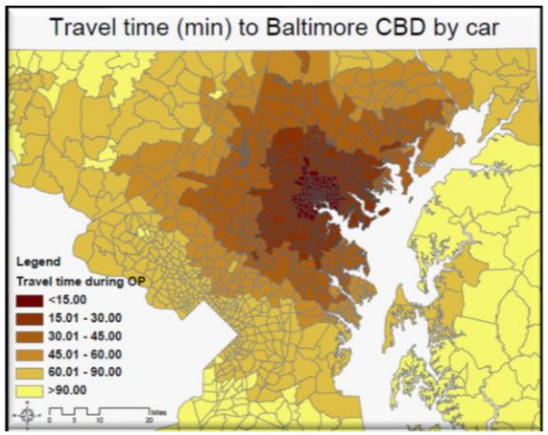
TSMO PERFORMANCE MEASURES

- Congestion & Reliability (Segment Level/Trip Level)
- Accessibility/Connectivity
- Market Segments (businesses, commodity flows)
- Freight Fluidity (supply chains)
- Economic Metrics









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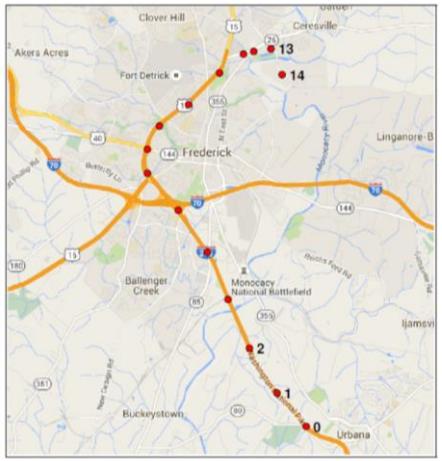
O/D TRAJECTORY DATA UTILIZATION EXPERIENCE



- MDOT SHA has partnered with UMD CATT to mainstream big data use for planning, TSMO and performance management
- Beta testing/ Prototyping in 2016-17 with 4 months of GPS trajectory data from INRIX
- **UMD CATT Lab currently under task for application development using 2018 INRIX O/D Trajectory Data**

MARYLAND DEPARTMENT OF TRANSPORTATION
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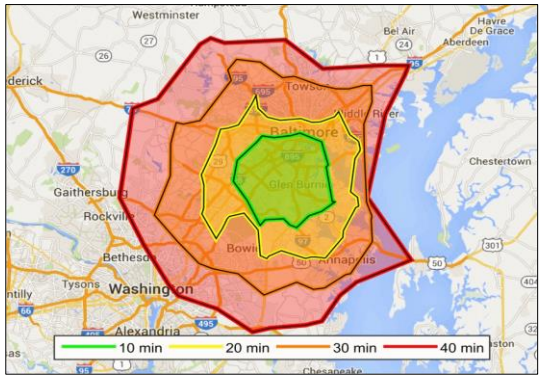
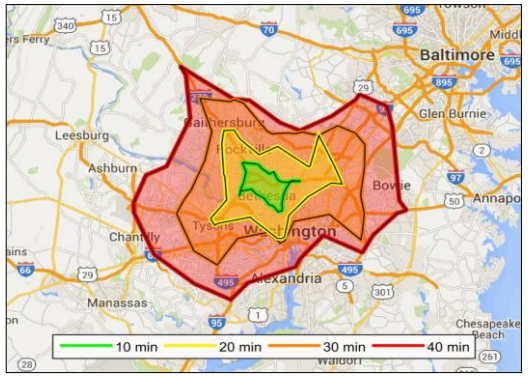
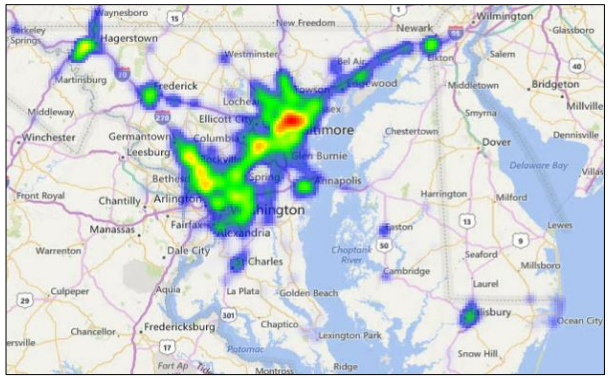
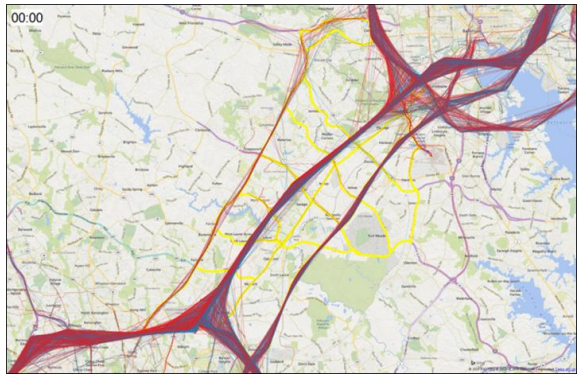
O/D TRAJECTORY DATA UTILIZATION EXPERIENCE

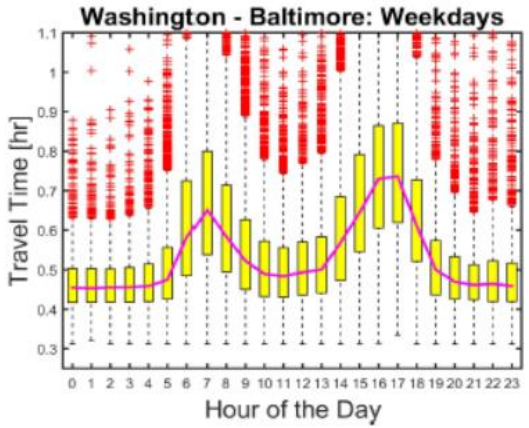
ACTIVITY ZONES, TRAVEL TIME CONTOURS, ACCESSIBILITY MAPS











- Heat map of trip origins reveals main trip generators
- Trips from activity zones are used to derive isochrones
- Compute trip-based performance measures
- Determine distribution of traffic along major routes
- Estimate turning movements at major intersections

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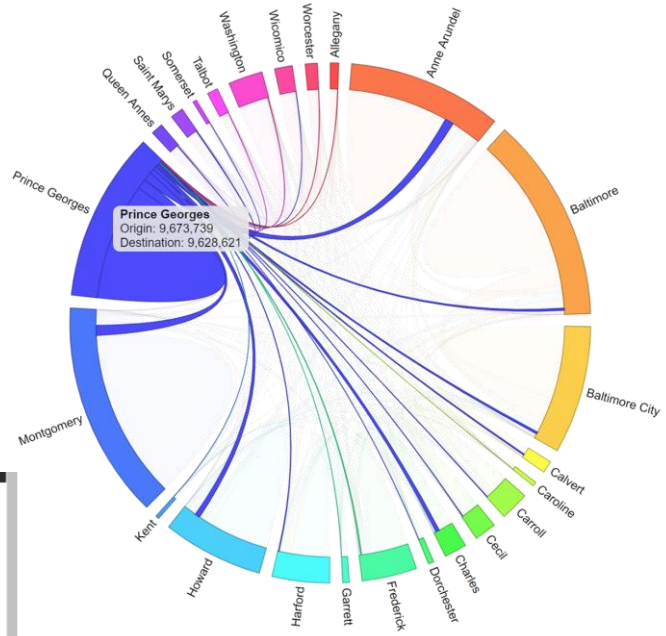
OD MATRIX

Set up an Origin-Destination matrix by choosing geographies and dates available

START



- Estimate O-D matrices (state, county, zip code, TAZ) for planning purposes
- Validate statewide travel demand models

Origin and Destination Matrix

Currently using the MD data set | Switch Data Set | Switch to Chord Diagram

Time Range: February, June, July, October 2015 and Jan… All Days of W… 12 AM - 12 AM | Trip Filters | Matrix Controls

Legend: 0% – 14.44%; 0.22%

Destinations

Origins	Allegany	Anne Arundel	Baltimore	Baltimore City	Calvert	Caroline	Carroll	Cecil	Charles	Dorchester	Frederick	Garrett	Harford	Howard	Kent	Montgomery	Prince Georges	Queen Annes	Saint Marys	Somerset	Talbot	Washington	Wicomico	Worcester	Total
Allegany	0.51%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.01%	0.04%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.05%	0%	0%	0.63%
Anne Arundel	0%	8.5%	0.64%	0.59%	0.08%	0.01%	0.06%	0.02%	0.03%	0.01%	0.05%	0%	0.08%	0.63%	0%	0.21%	0.72%	0.1%	0.01%	0%	0.03%	0.02%	0.01%	0%	11.82%
Baltimore	0%	0.63%	11.24%	1.98%	0.01%	0%	0.28%	0.08%	0.01%	0%	0.07%	0%	0.53%	0.58%	0%	0.12%	0.18%	0.01%	0%	0%	0%	0.04%	0%	0%	15.77%
Baltimore City	0%	0.59%	1.98%	6.17%	0.01%	0%	0.08%	0.05%	0.01%	0%	0.05%	0%	0.2%	0.33%	0%	0.1%	0.17%	0.01%	0%	0%	0.01%	0.04%	0%	0%	9.83%
Calvert	0%	0.08%	0.01%	0.01%	0.63%	0%	0%	0%	0.03%	0%	0%	0%	0%	0.01%	0%	0.01%	0.1%	0%	0.06%	0%	0%	0%	0%	0%	0.93%
Caroline	0%	0.01%	0.01%	0%	0%	0.19%	0%	0%	0%	0.02%	0%	0%	0%	0%	0%	0%	0%	0.03%	0%	0%	0.03%	0%	0.01%	0%	0.32%
Carroll	0%	0.06%	0.27%	0.08%	0%	0%	1.42%	0%	0%	0%	0.12%	0%	0.02%	0.13%	0%	0.06%	0.03%	0%	0%	0%	0%	0.02%	0%	0%	2.23%
Cecil	0%	0.02%	0.08%	0.05%	0%	0%	0%	1.23%	0%	0%	0.01%	0%	0.18%	0.03%	0.01%	0.01%	0.02%	0.01%	0%	0%	0%	0.01%	0%	0%	1.68%
Charles	0%	0.03%	0.01%	0.01%	0.03%	0%	0%	0%	1.22%	0%	0%	0%	0%	0.01%	0%	0.02%	0.3%	0%	0.08%	0%	0%	0%	0%	0%	1.72%
Dorchester	0%	0.01%	0%	0%	0%	0.02%	0%	0%	0%	0.26%	0%	0%	0%	0%	0%	0%	0%	0.01%	0%	0%	0.04%	0%	0.04%	0.01%	0.42%
Frederick	0.01%	0.05%	0.07%	0.05%	0%	0%	0.12%	0.01%	0%	0%	3.11%	0%	0.02%	0.12%	0%	0.35%	0.07%	0%	0%	0%	0%	0.21%	0%	0%	4.2%
Garrett	0.05%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.41%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.02%	0%	0%	0.5%
Harford	0%	0.08%	0.52%	0.2%	0%	0%	0.02%	0.2%	0%	0%	0.01%	0%	3.24%	0.06%	0%	0.02%	0.04%	0%	0%	0%	0%	0.01%	0%	0%	4.4%
Howard	0%	0.63%	0.58%	0.34%	0.01%	0%	0.13%	0.03%	0.01%	0%	0.12%	0%	0.06%	5.01%	0%	0.35%	0.41%	0.01%	0%	0%	0%	0.03%	0%	0%	7.75%
Kent	0%	0%	0%	0%	0%	0%	0%	0.01%	0%	0%	0%	0%	0%	0%	0.19%	0%	0%	0.04%	0%	0%	0%	0%	0%	0%	0.26%
Montgomery	0%	0.21%	0.12%	0.1%	0.01%	0%	0.06%	0.01%	0.02%	0%	0.36%	0%	0.03%	0.36%	0%	14.44%	0.85%	0.01%	0.01%	0%	0%	0.05%	0%	0%	16.63%
Prince Georges	0%	0.74%	0.18%	0.17%	0.1%	0%	0.03%	0.02%	0.32%	0%	0.06%	0%	0.04%	0.43%	0%	0.85%	9.96%	0.03%	0.05%	0%	0.01%	0.02%	0%	0%	13.02%
Queen Annes	0%	0.09%	0.01%	0.02%	0%	0.03%	0%	0.01%	0%	0.01%	0%	0%	0%	0.01%	0.04%	0.01%	0.03%	0.57%	0%	0%	0.05%	0%	0.01%	0%	0.9%
Saint Marys	0%	0.01%	0%	0%	0.06%	0%	0%	0%	0.07%	0%	0%	0%	0%	0%	0%	0.01%	0.04%	0%	0.78%	0%	0%	0%	0%	0%	0.98%
Somerset	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.18%	0.01%	0%	0.05%	0.03%	0.29%
Talbot	0%	0.02%	0%	0.01%	0%	0.03%	0%	0%	0%	0.04%	0%	0%	0%	0%	0%	0%	0%	0.01%	0.05%	0%	0.81%	0%	0.02%	0%	0.82%
Washington	0.05%	0.02%	0.03%	0.03%	0%	0%	0.02%	0.01%	0%	0%	0.2%	0.01%	0.01%	0.03%	0%	0.05%	0.02%	0%	0%	0%	0%	2.14%	0%	0%	2.63%
Wicomico	0%	0.01%	0%	0%	0%	0.01%	0%	0%	0%	0.04%	0%	0%	0%	0%	0%	0%	0%	0.01%	0%	0.05%	0.02%	0%	1.11%	0.09%	1.36%
Worcester	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.01%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.03%	0%	0%	0.09%	0.77%	0.92%
Total	0.64%	11.82%	15.77%	9.84%	0.93%	0.32%	2.23%	1.7%	1.72%	0.41%	4.19%	0.48%	4.43%	7.76%	0.26%	16.61%	12.96%	0.9%	0.99%	0.29%	0.82%	2.66%	1.36%	0.92%	100%

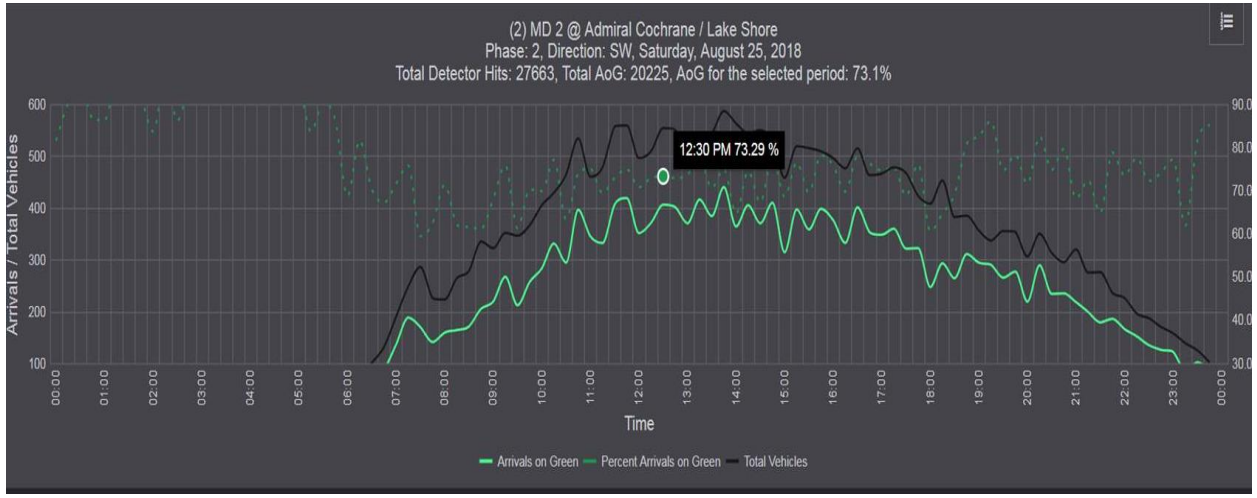
Top Ten OD Pairs

Montgomery →	Montgomery	10,730,597
Baltimore →	Baltimore	8,354,598
Prince Georges →	Prince Georges	7,402,334
Anne Arundel →	Anne Arundel	6,320,207
Baltimore City →	Baltimore City	4,586,722
Howard →	Howard	3,721,508
Harford →	Harford	2,405,948
Frederick →	Frederick	2,310,010
Washington →	Washington	1,587,751
Baltimore →	Baltimore City	1,474,783

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

SIGNAL PERFORMANCE MEASURES

- Operating at 4 signals along MD 2 at Annapolis Harbor



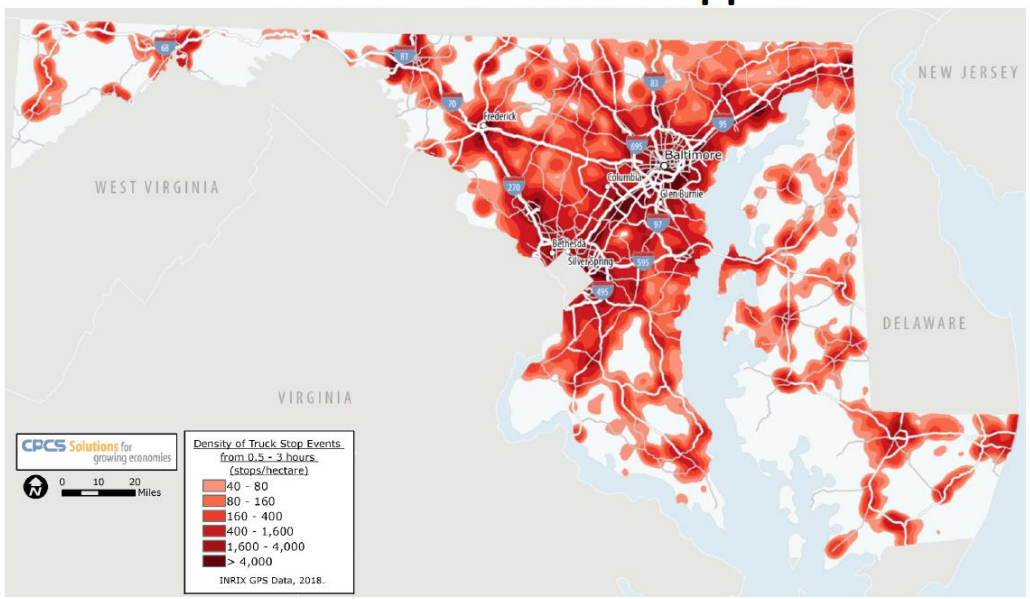
- Arrival on green
- Pedestrian delay
- Preemption events
- Split failures
- Purdue Coordination diagrams
- Vehicle delay, v/c ratios

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

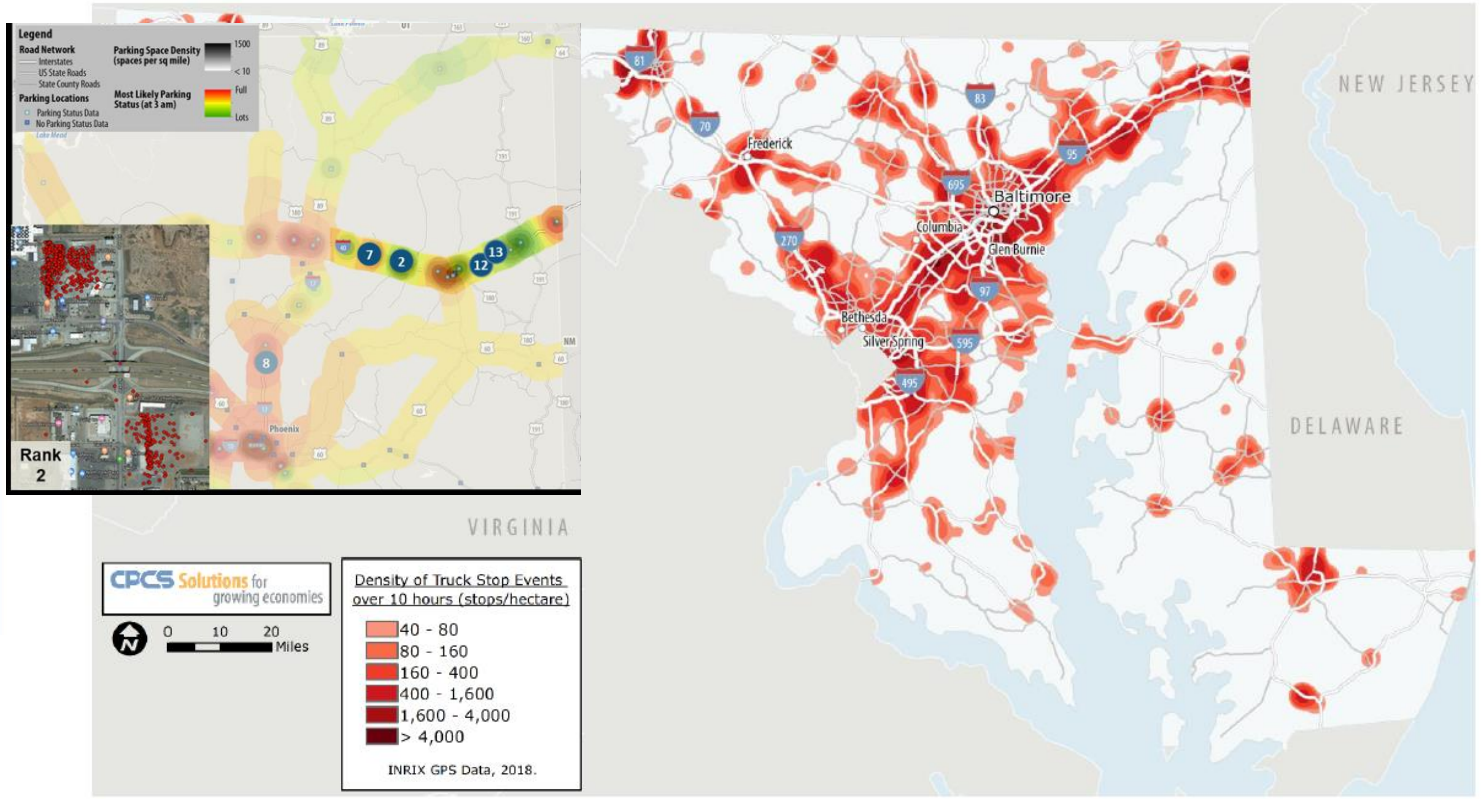
TRUCK PARKING IN MARYLAND

Undesignated Truck Parking

½ Hour – 3 Hours Stopped



10+ Hours Stopped



MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

TRANSFORMATIONAL TECHNOLOGIES

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

A TIMELINE OF MARYLAND'S CAV ACTIVITIES

2015

+ MARYLAND SECRETARY PETE RAHN ESTABLISHED THE CONNECTED AND AUTOMATED VEHICLES (CAV) WORKING GROUP

2016

+ MDOT SHA RELEASES ITS TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO) STRATEGIC ACTION PLAN, WHICH INCLUDES CAV.

2017

+ MDOT SHA RELEASES A CAV STRATEGIC ACTION PLAN.
+ MDOT COMMITS TO A US 1 TECHNOLOGY DEPLOYMENT CORRIDOR
+ GOVERNOR LARRY HOGAN ANNOUNCES $50M TO DEPLOY ADAPTIVE SIGNAL TECHNOLOGY ON 14 MARYLAND HIGHWAYS
+ MARYLAND CREATES THE CAV "EXPRESSION OF INTEREST FORM
+ MDOT PERMITS PRIVATE FIRM TO PERFORM AUTONOMOUS PARKING IN A CONTROLLED ENVIRONMENT.

2018

+ MDOT "LOCATIONS to ENABLE TESTING SITES" (LETS) APPLICATION IS RELEASED TO PUBLIC
+ MDOT APPLIES FOR THE "ADVANCED TRANSPORTATION AND CONGESTION MANAGEMENT TECHNOLOGIES DEPLOYMENT (ATCMTD) GRANT
+ MARYLAND CAV STRATEGIC VISION IS FINALIZED
+ MDTA RELEASES ITS CAV STRATEGIC ACTION PLAN
+ MDOT SHA UPDATES ITS TSMO STRATEGIC ACTION PLAN WITH NEW CAV INITIATIVES
+ MDOT PERMITS OLLI AUTONOMOUS SHUTTLE DEPLOYMENT IN NATIONAL HARBOR, MD

2019

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

MARYLAND CAV VISION & WORKING GROUP

*"Uphold and enhance a **Safe, Efficient**, and **Equitable** transportation future by delivering collaborative and leading-edge CAV solutions.*

Maryland is open for business and eager to realize the life-saving and economic benefits of CAV technology, while ensuring safety for all.

We are embracing CAV technology and innovation through continuing collaboration with partners interested in researching testing, and implementing CAVs in MD."

CAV Actions in Maryland

CONNECTED & AUTOMATED VEHICLES (CAV)

- Prepare MDOT SHA for a CAV future by implementing the MDOT SHA CAV Strategic Action Plan
- US 1 Innovative Technology Deployment Corridor – pilot project combining ITS solutions and CAV technology to support incident and traffic management
- Established CAV "Champions" within MDOT SHA
- Mapping location of fiber to support CAV planning efforts
- Encourage submission of CAV-related project ideas

2018 CAV ACCOMPLISHMENTS

SUPPORTING CAV TESTING WITHIN THE STATE

Office of Planning and Preliminary Engineering developed and maintains the **Maryland Locations for Enabling Testing Sites (LETS)** web mapping application.

Facilitated CAV testing on MDOT SHA facilities including:

STEER Tech autonomous vehicle parking

olli Self Driving Shuttle

PLANNING TOOLS AND MATERIALS RELATED TO CAVS

Developed interactive **CAV Public Policy in the US Story Map** to track monthly legislative actions related to CAV across the country.

Developed Rough Order of Magnitude **(ROM) estimates for CAV technology and fiber deployment** to be incorporated in each of MDOT SHA's CTP Projects.

Developed **Call for Projects Template** to solicit ideas for CAV projects across the agency.

TRAINING INITIATIVES

MDOT SHA co-hosted the FHWA **Connected Vehicle 201 training**.

MDOT SHA co-hosted the FHWA **Introduction to ARC-IT Architecture workshop**.

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

2018 CAV ACCOMPLISHMENTS

ORGANIZATIONAL MANAGEMENT OF CAV

TSMO
MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS

New Deputy Director for TSMO & CAV and New Communications Division within the Office of CHART.

MDOT SHA CAV Working Group co-chaired by CHART and OPPE with representatives from various Offices and Districts.

Developed **Draft CAV Data Governance Chapter** for data that supports future CAV related applications.

CAV STRATEGIC ACTION PLAN

RELEASED
DEC 2017

WITH **35** RECOMMENDED ACTIONS

Progress made on **26** of those recommended actions in 2018!

US-1 INNOVATIVE TECHNOLOGY DEPLOYMENT CORRIDOR

Completed a **comprehensive requirements document** for a proposed connected vehicle pilot project along US-1 with recommended ITS solutions to support incident and traffic management.

CURRENT STRUCTURE

Connected and Automated Vehicles (CAV) Working Group

Created by Maryland Department of Transportation Secretary Pete Rahn in December 2015

CAV Technical SubGroup
(MDOT, MSP, other agencies as necessary)

- **Triage Team for CAV Applications**
  (MDOT, MSP, other agencies as necessary)
- **Technical/Project Coordination**
  (MDOT)

CAV Policy SubGroup
(includes external partners)

- **Develop / Modify CAV Permit Process**
  (includes external partners)
- **Policy/Planning Coordination**
  (MDOT)

CAV Freight SubGroup
(includes external partners)

Emergency Responder SubGroup
(includes external partners)

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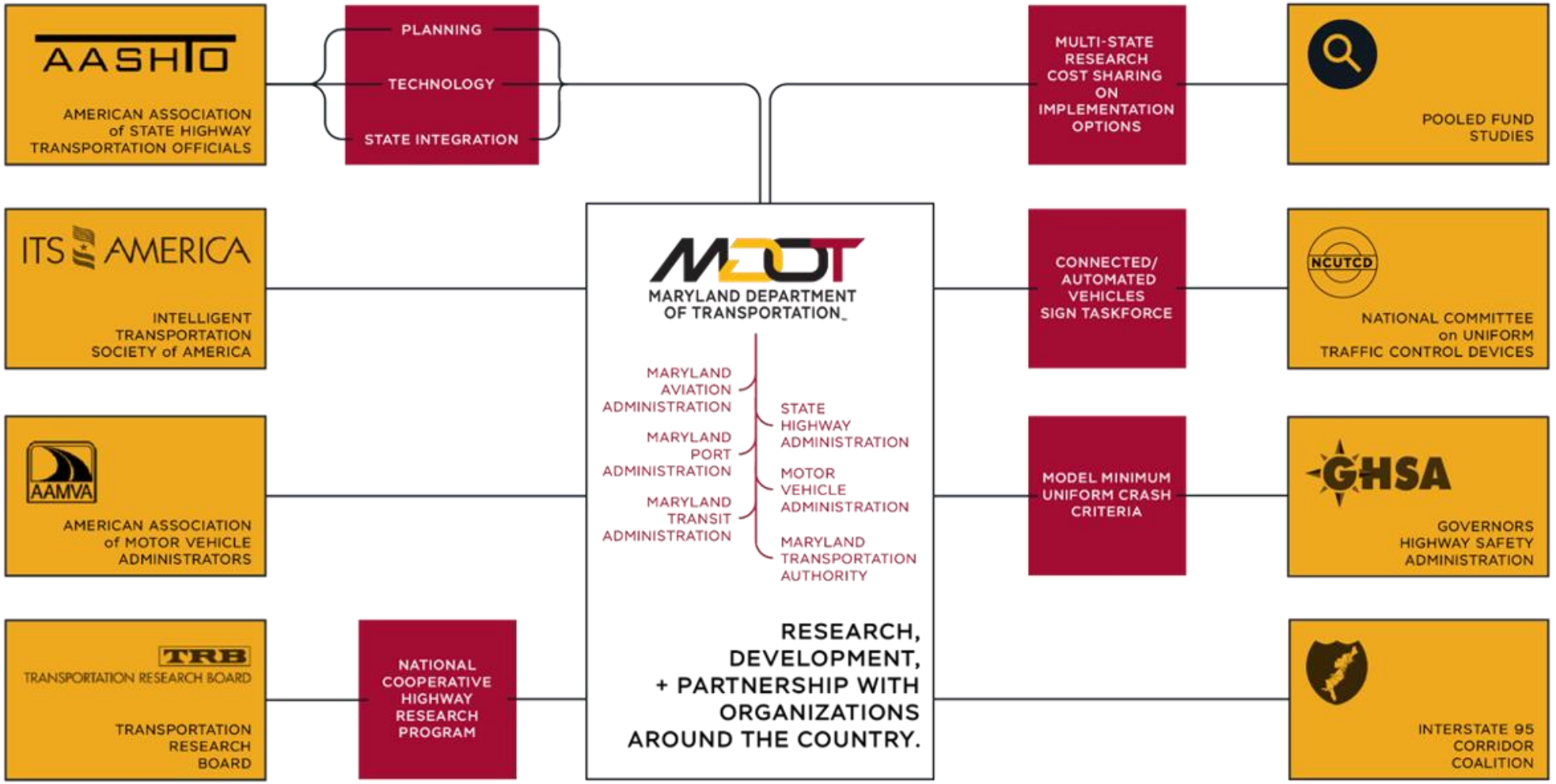
NATIONAL TIE IN



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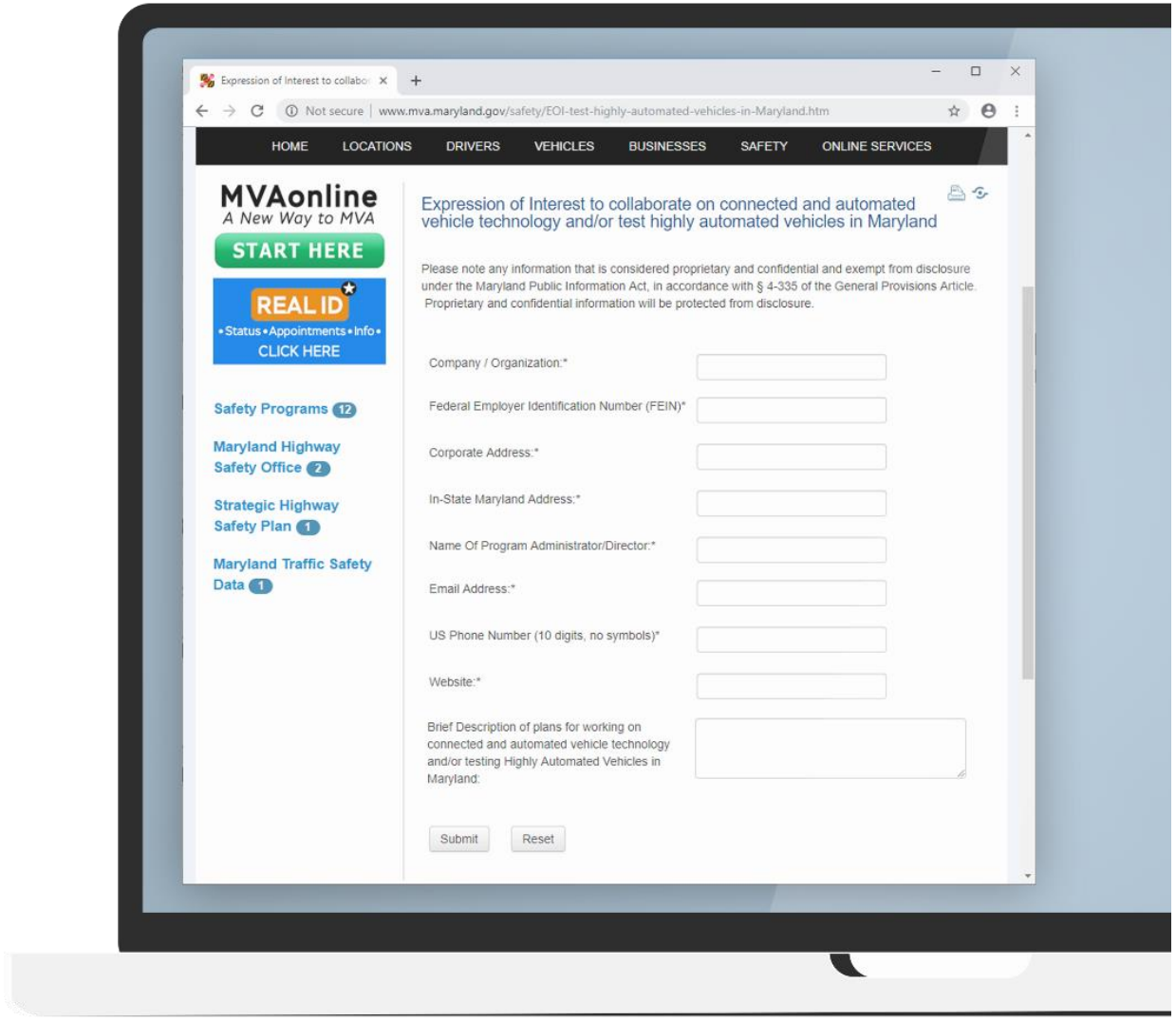
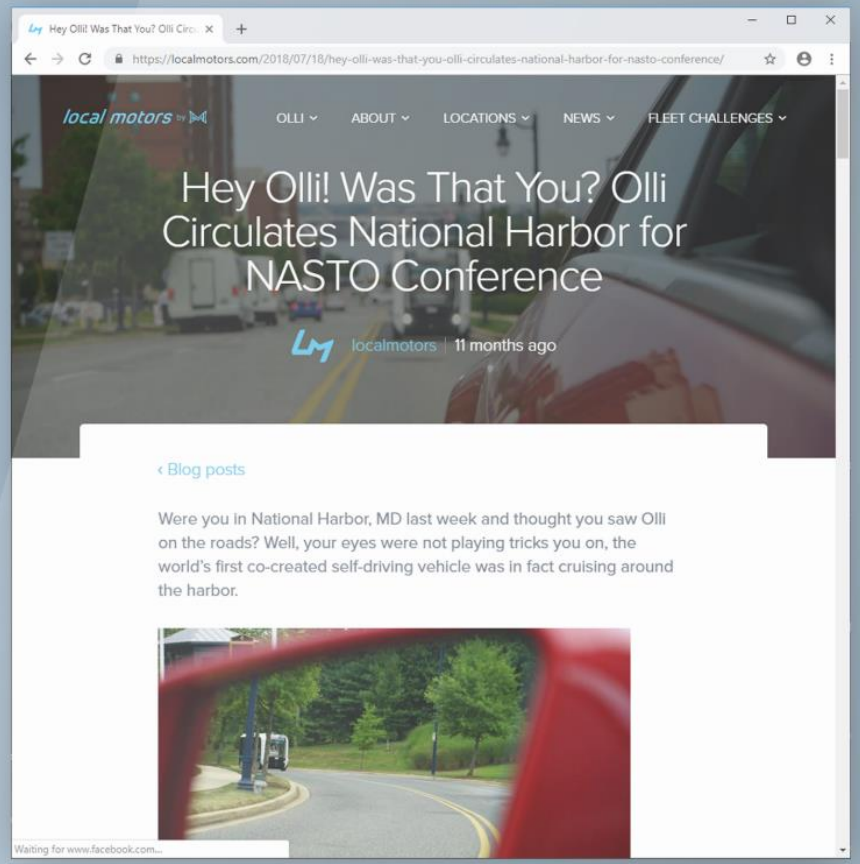
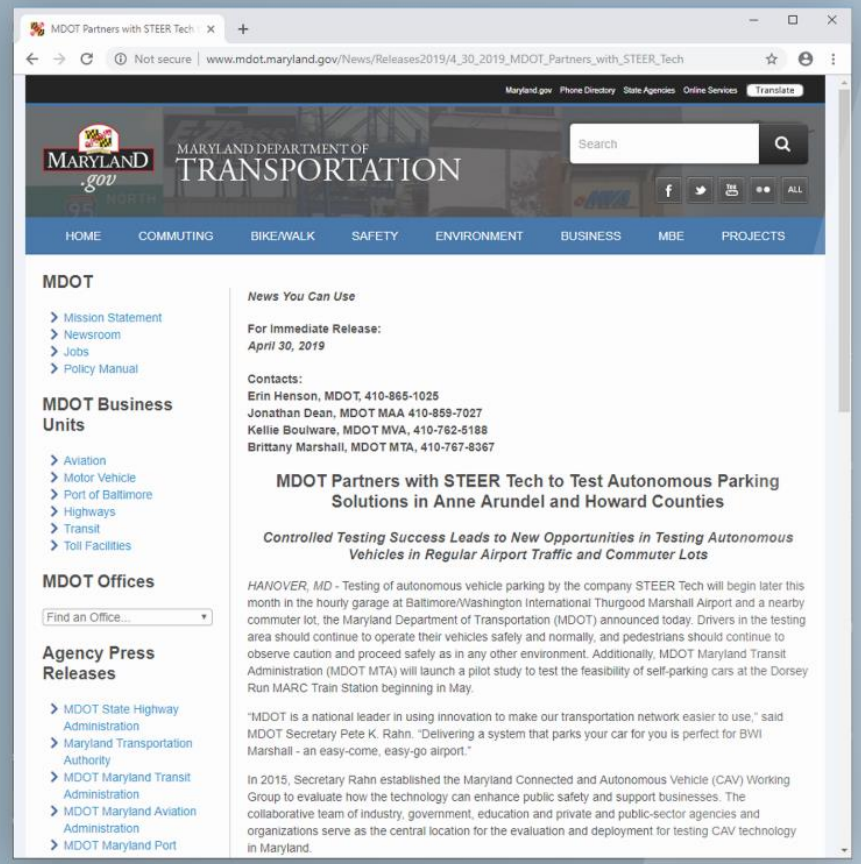
MARYLAND'S EXPRESSION OF INTEREST PROCESS

MDOT provides an opportunity to collaborate with companies that are interested in **researching**, **testing**, and **supporting** CAVs in Maryland.



MARYLAND'S CURRENT DEPLOYMENTS





INDUSTRY INTEREST

- **High** interest in:
  - SPaT information (#1 request from companies nationally)
  - Solutions relating to autonomous anything (e.g. truck platooning, mowers, etc.)
  - Privacy concerns (e.g. SPY bill at federal level and StL issue at BPW)
  - Spectrum talks (5.9 GhZ)
- **Low** interest in:
  - Having government own and operate technology supporting CAV (too cumbersome)
  - Restrictive standards that don't allow for innovative solutions

FOUNDATIONAL STEPS

- Educate staff and bring them up to speed on what to expect
- Development of strategic telecommunications infrastructure (regardless of technology)
- Implementation of a needs-based prioritization list of projects
- Review of long-term planning to determine range of impacts to State infrastructure
  - Supports a more efficient funding strategy if projects can be scaled back given smarter mobility technology deployments (i.e. optimize system through CAV)

EDUCATION AND OUTREACH

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

TSMO AWARENESS, EDUCATION, TRAINING/ COMMUNICATIONS & OUTREACH

- MDOT SHA Internet Website
- MDOT TSMO SharePoint (Internal)
- TSMO University

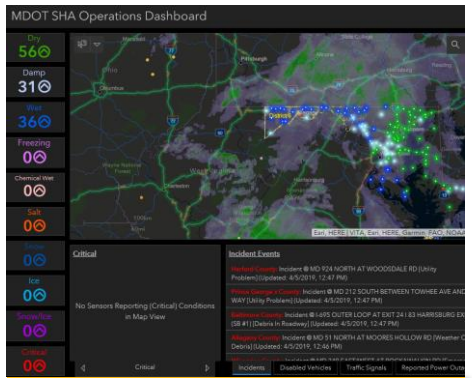
- GIS Story Maps
- Newsletters, Brochures, TSMO Articles, etc.

MDOT SHA TSMO Story Map

CAV Strategic Action Plan Story Map

MDOT Freight Story Map

MDOT SHA Mobility Performance



MDOT SHA Winter Operations

MARYLAND DEPARTMENT OF TRANSPORTATION
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NEXT STEPS – TRAINING & OUTREACH

- Identify District Teams/Champions
- Develop/customize training programs - broader and functional area specific (2 hour/4 hour/full day versions) – Fall/Winter 2019
- Develop TSMO & CAV websites, newsletters, fact sheets, TSMO videos – Summer/Fall 2019
- Develop education and outreach materials for partners, stakeholders and customers – Fall 2019
- Start working towards a Regional Operations Forum - Spring 2020

WORKFORCE, RE-ORG & PROCUREMENT

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STATE HIGHWAY ADMINISTRATION

TSMO WORKFORCE CHALLENGES

- Recruitment
- Compensation
- Classification
- Staffing Levels
- PINs
- Retention

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FUTURE TSMO WORKFORCE

- Succession Planning
- Bench Strength/ Pipeline
- Humans Capital Development
- Internal Promotions / External Hires
- Comp Time/ Uneven workload

FUTURE TSMO WORKFORCE

- Integrating Systems Engineering & Traffic Engineering Functions
- Role of Big Data & Crowd Sourcing Opportunities – Data Scientists
- GIS enabled Data Portals – Data Analysts
- Business Intelligence Experts
- Network Engineers and System Integrators
- Procurement Specialists for TSMO/ Technology Projects

IMPROVE MOBILITY THRU' TSMO

- TSMO CONNECTS THE DOTS OF OUR ORGANIZATION
- NEED TO LOOK AT PLANNING, ENGINEERING, OPERATIONS & MAINTENANCE AS A WHOLE
- BUILDING A SYSTEMS OF SYSTEMS THRU' TECHNOLOGY, INNOVATIONS AND PARTNERSHIPS
- MAXIMIZING THE FULL SERVICE POTENTIAL OF OUR INFRASTRUCTURE FOR ***CONNECTING OUR CUSTOMERS TO LIFE'S OPPORTUNITIES***

MARYLAND DEPARTMENT OF TRANSPORTATION
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QUESTIONS?
THANK YOU!

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