# Baltimore-Washington
# Integrated Corridor Management Pilot Project

Presentation to Baltimore Regional Transportation Board

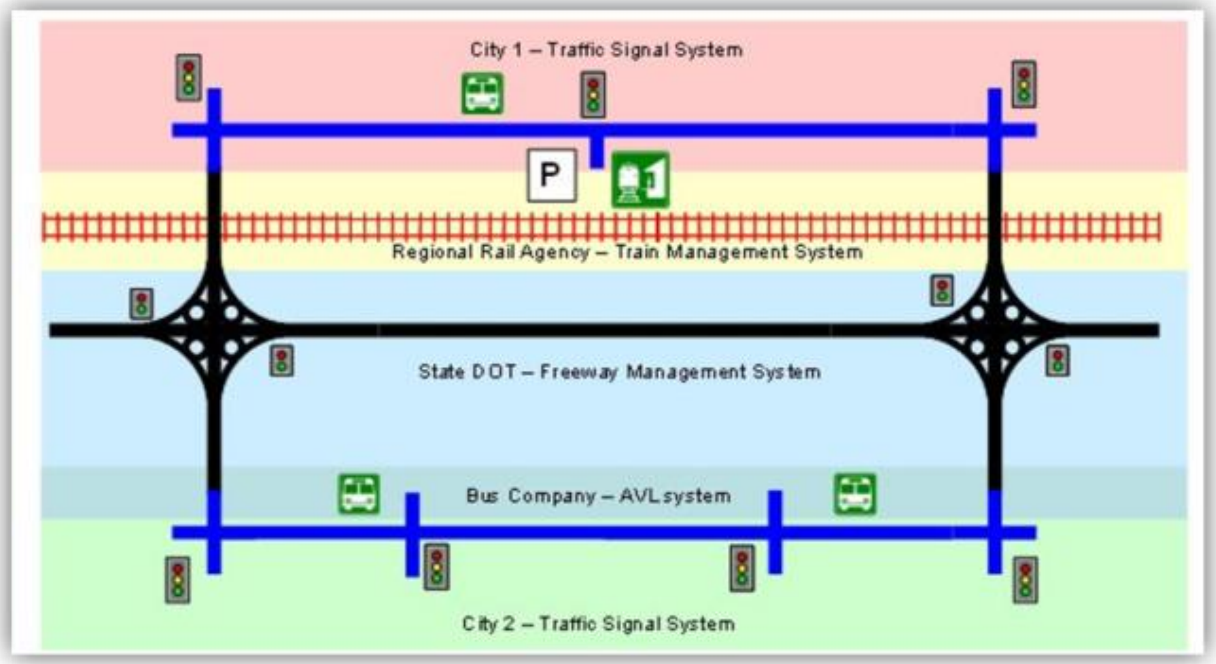
3/28/2018

# Agenda

- What is Integrated Corridor Management
- Summary of the Baltimore-Washington ICM pilot project
  - Project scope
  - Project activities and accomplishments
- Reviewing Concept of Operations
- Next steps

# Integrated Corridor Management

- The **joint management of a transportation corridor as a complete system**
- Address recurring congestion, improve incident management operations, leverage alternate routes and modes





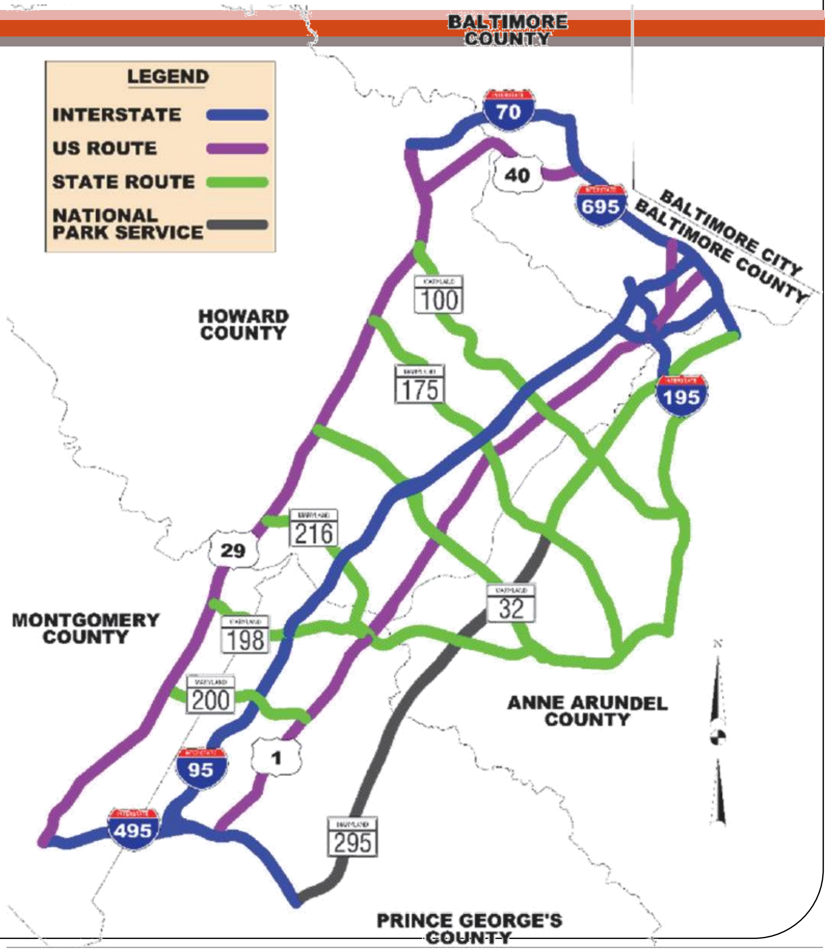

Source: USDOT

# ICM can target 'non-recurring' *and* 'recurring' congestion

- There is no doubt that ICM can mitigate ***non-recurring*** events as they are *very* visible, incident-specific, sudden, and can be hugely impacting (e.g., crashes, lane blockages, weather events)
- However, ICM can also mitigate ***atypical recurring*** congestion by:
  - Repeatedly reminding people that alternate modes exist
  - Making those modes user friendly through complementary transit information, parking availability, "how to" instruction, cost-benefit comparisons (e.g., carpooling to take advantage of HOV)
  - Emphasizing commuter programs, bus, rail, modal connections, and local transit trips to avoid 'highway headaches'

# Baltimore-Washington ICM Pilot Project

- In 2013, US DOT announced $2.6 million in Grants to Expand Real-Time Travel Information in 13 Cities
- 33 Proposals received
- Joint MDOT SHA/BMC proposal supported by UMD was a winner
- Proposed site was a portion of Baltimore-Washington corridor, later expanded to entire corridor



# Stakeholders and Partners

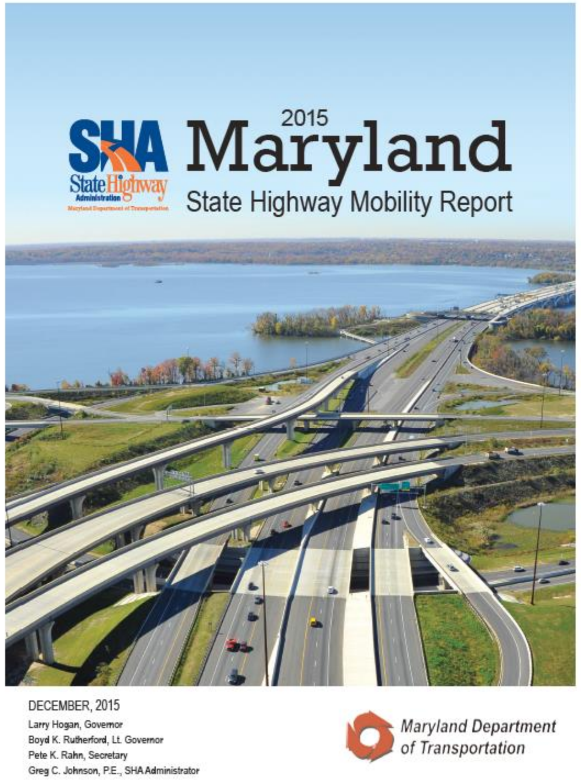
- Address institutional, operational, and technical barriers to successful Integrated Corridor Management

- Mobility, safety and productivity can be increased in Baltimore-Washington Corridor by:
  - Efficient, effective, proactive use of ITS technology
  - Improved use of real-time data sharing
  - Implementing demand management strategies

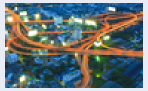
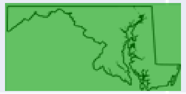
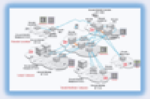
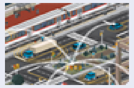
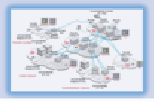
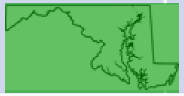
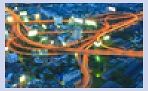
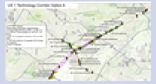
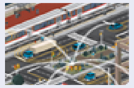
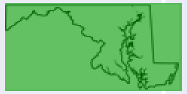
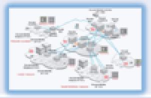
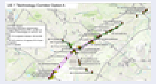
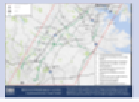
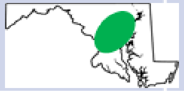
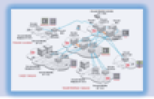
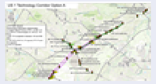
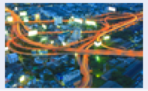
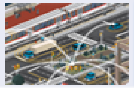
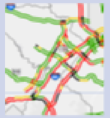
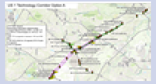
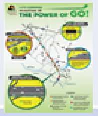
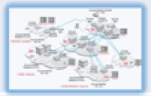
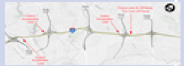
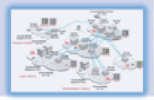
| Role<br>Stakeholder | Trans. Planner | Freeway Oper | Roadway Oper | Rail Oper | Bus Oper | Paratrans Oper | Parking Oper | Emerg Resp | System Dev | Info Prov | Info Consumer |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MDOT-SHA | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ | ✓ |
| MDOT-MTA | | | | ✓ | ✓ | ✓ | | | | ✓ | |
| MDOT-MDTA | ✓ | ✓ | | | | | | | | ✓ | ✓ |
| MSP | | ✓ | ✓ | | | | | ✓ | | | |
| BMC | ✓ | | | | | | | | | | ✓ |
| MWCOG | ✓ | | | | | | | | | | ✓ |
| WMATA | | | | ✓ | ✓ | | | | | ✓ | ✓ |
| CMRT | | | | | ✓ | | | | | | |
| Ride On | | | | | ✓ | | | | | ✓ | ✓ |
| Local gov | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| NPS | | ✓ | | | | | | ✓ | | | ✓ |
| USDOT | ✓ | | | | | | | | | | |
| Fleet oper | | | | | | | | | | ✓ | ✓ |
| UMCP | ✓ | | | | | | | | ✓ | | ✓ |
| Travelers | | | | | | | | | | ✓ | ✓ |
| Private sec | | | | | | | | | ✓ | ✓ | ✓ |
| Jacobs | ✓ | | | | | | | | ✓ | | |

# Motivation/Drivers for ICM in the Corridor

- Innovative Solutions needed for congested corridor
- Maryland Mobility Initiatives
- MD TSM&O Strategic Implementation Plan
- Practical Transportation
- Performance Management – regional and state




# MDOT-SHA TSM&O Planning/Project Context

| | Title | Purpose | Scope | Dependence |
|---|---|---|---|---|
|  | TSM&O Strategic Plan | Overall TSM&O Direction [Signed August 2016] |  | |
|  | Freeway / Arterial TSM&O Master Plan | Identify Specific TSM&O Implementation Considerations |  |    |
|  | Communications Infrastructure Study | Concurrent Analysis of Network Needs to Support TSM&O |  |    |
|  | Connected and Automated Vehicle Strategic Action Plan | Focus on Strategic Direction for CAV Development |  |   |
|  | B/W Integrated Corridor Management (ICM) Plan | Assessment / Plan for Intermodal Coordination |  |   |
|  | US 1 Arterial / Connected and Automated Vehicle (CAV) Pilot | Develop a Test Bed for TSM&O and CAV Technologies |  |    |
|  | Advanced Transportation and Congestion Management Technologies Deployment | Funding Grant Application for the US 1 Corridor |  |  |
|  | I-270 Innovative Congestion Management Project | Specific Project Incorporating TSM&O Technologies on I-270 |  |  |
|  | I-95 Active Traffic Management Project | Specific Project Incorporating TSM&O Technologies on I-95 |  |    |

# Project Objective

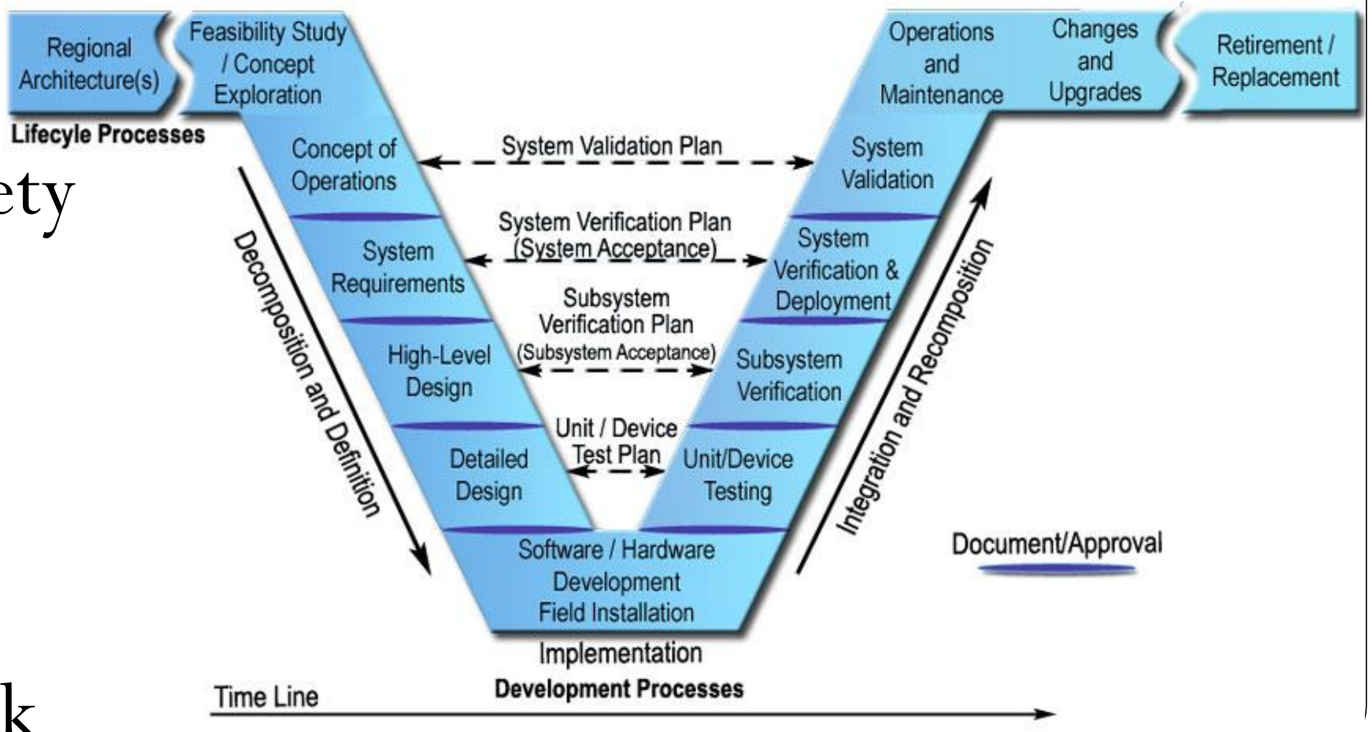
- Develop Concept of Operations (ConOps), ICM Analysis, Modeling and Simulation Plan, and ICM Deployment Approach Plan.
- Build a foundation for systematic ICM expansion throughout the Baltimore-Washington region and state

key questions:

- Why it is needed?
- How it will help solve current problems?
- How it will benefit each of the stakeholder groups?

# ICM Concept of Operations

- Part of Systems Engineering Process
  - High-level description of major ICM system capabilities
- Provide User-Oriented Vision of ICM System
  - Understood by wide variety of stakeholders (different operational & technical experience)
  - Engage stakeholders; soliciting input & feedback



# ICM Project Goals

- Improve safety and incident response
- Promote economic vitality
- Improve mobility, throughput, and travel reliability
- Promote multi-modalism, and capacity and demand management
- Disseminate reliable, real-time information to customers
- Promote transportation sustainability

*Objectives and performance measures have been identified for each goal.*

| Goals | Objectives | Performance measures |
|---|---|---|
| **Improve mobility, throughput and travel reliability** | • Reduce overall trip and person travel-time.<br>• Improve travel predictability and reliability.<br>• Maximize inter-modal activity.<br>• Empower customers to make intelligent travel choices.<br>• Measure, monitor, and assess performance. | • Methods used in the Maryland Mobility report to quantify TTI, PTI and bottlenecks |
| **Improve safety and incident response** | • Lessen the probability of secondary crashes by responding expeditiously to incidents.<br>• Implement connected vehicle technologies for enhancing incident detection and response | • Number of crashes, severity of the crashes, emergency response time distribution |
| **Promote multi-modalism, capacity management and demand management** | • Promote park-and-ride and carpooling<br>• Simplify inter-modal transfers<br>• Manage capacity through Dynamic Lane Assignment and Hard Shoulder Running<br>• Manage demand by converting existing lanes/shoulders to HOV/HOT<br>• Reduce delay caused by schedules workzone activities through temporarily increase in transit capacity, changing parking fees and promoting use of transit during such periods | • Train and bus ridership<br>• HOV/HOT throughput and time savings<br>• Transit ridership<br>• Total delay |
| **Disseminate reliable, real-time information to customers** | • Expand and standardize the types of information available to travelers.<br>• Emphasize dissemination of real-time conditions and status data across modes.<br>• Furnish adequate information to travelers so they can make informed decisions on routing, modal shifts, etc. | • Number of visits to the 511 website<br>• Smartphone application usage |
| **Promote transportation sustainability and economic** | • Reduce delays associated with non-recurrent congestion by improving the incident response, and informing travelers on the traffic conditions and alternative routes<br>• Reduce GHG emissions and fuel consumption by promoting transit, walking and bicycling<br>• Develop performance metrics reflecting environmental goals | • Gallons of fuels saved<br>• Level of pollutants in the corridor CO, $CO_2$, NOx |
| **Promote economic vitality** | • Increase access to employment opportunities<br>• Attract potential workers and employers by providing safe access to mobility | • Number of jobs |

# Performance measures and targets

Performance measures, calculation methods and targets must be determined for the following categories:

- Mobility
  - Methods used in the Maryland Mobility Report
- Reliability
  - Methods used in the Maryland Mobility Report
- Fuel Savings
  - Generated by the ICM AMS
- Emissions
  - Methods used in the Maryland Mobility Report / AMS output
- B/C ratio: the bottom line monetized benefits over costs
  - USDOT has the numbers for San Diego (10:1), Dallas (20:1), and Minneapolis (22:1)

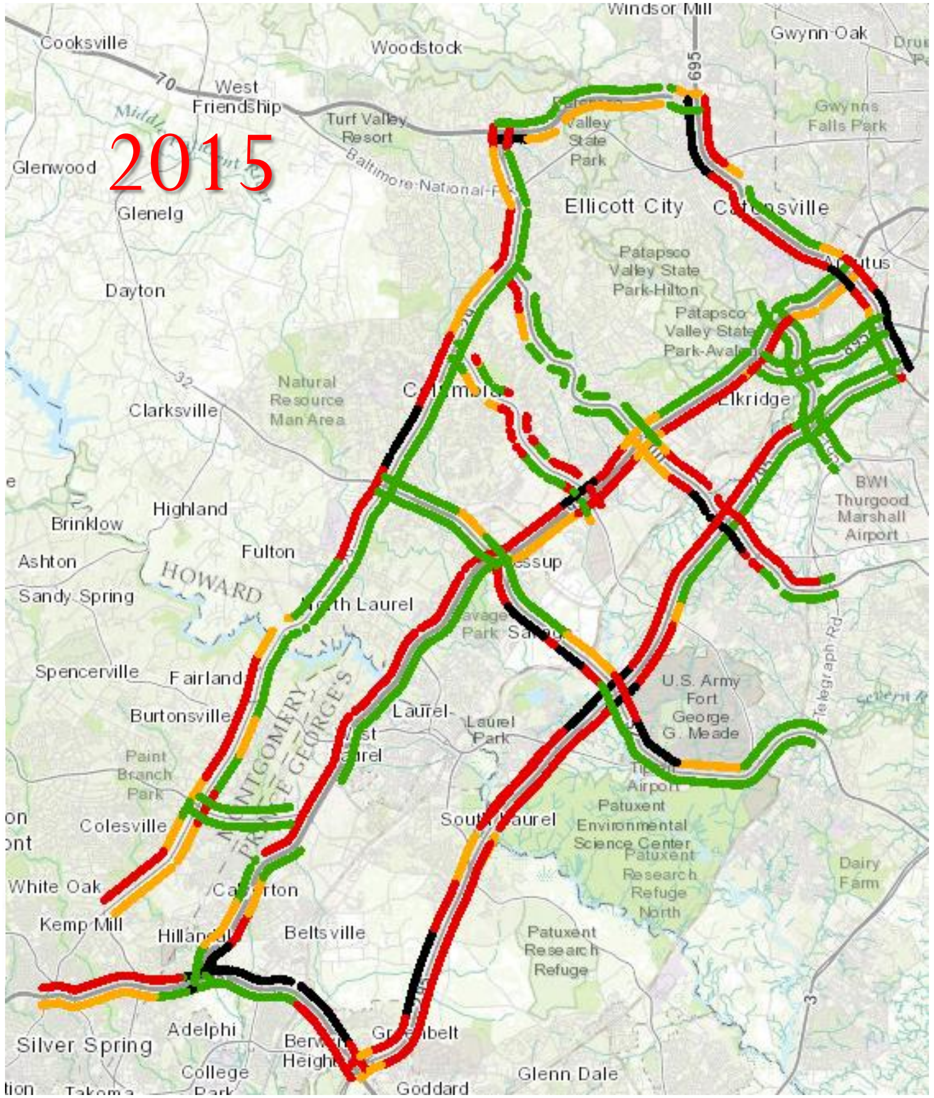
# Institutional Partnership Examples Motivated by Stakeholder Meetings

- NPS and DOD are signing MOU to allow DOD officers to participate in enforcement of banning commercial vehicles on Baltimore-Washington Parkway
- NPS is cooperating with DOD to allow enhancement on bike lanes between their east and west campus
- Park Police has discussed possibility of using DOD's pullover areas for law enforcement
- NPS is discussing the potential use of SHA facilities for shared road maintenance activities (i.e. snow removal, striping, etc.)

# ICM Project Network

## Mobility:

- Congestion in the Baltimore/Washington region costs motorists $1.185 Billion annually




**Legend**

- Uncongested (TTI < 1.15)
- Light (TTI 1.15-1.3)
- Moderate (TTI 1.3-2.0)
- Severe (TTI > 2.0)

## Safety:

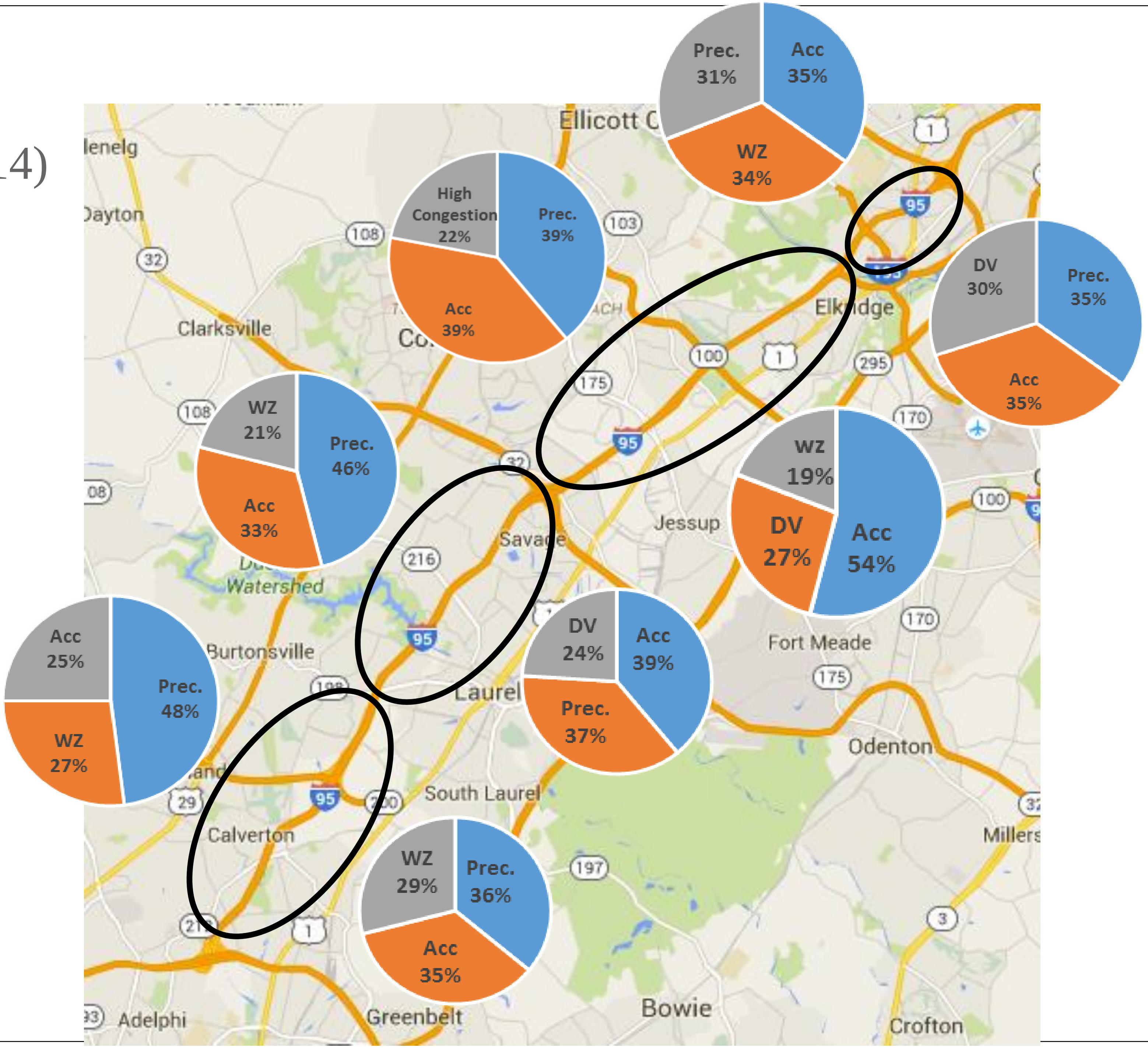
- Major roads in study area experience frequent incidents, averaging 1 - 2 per day. Besides safety concerns, they also result in additional delays and potential for secondary incidents.



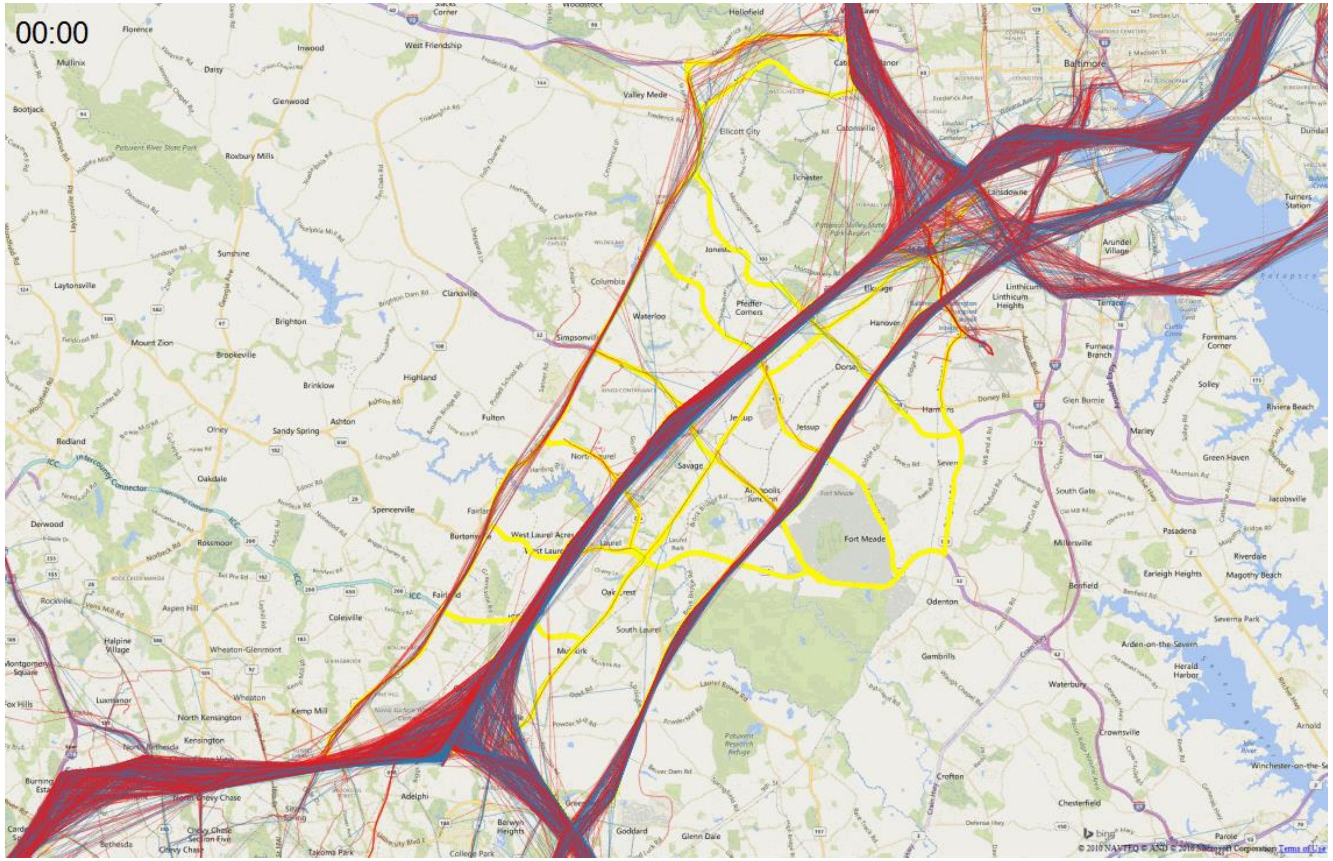
Source: Mahapatra et al., 2013

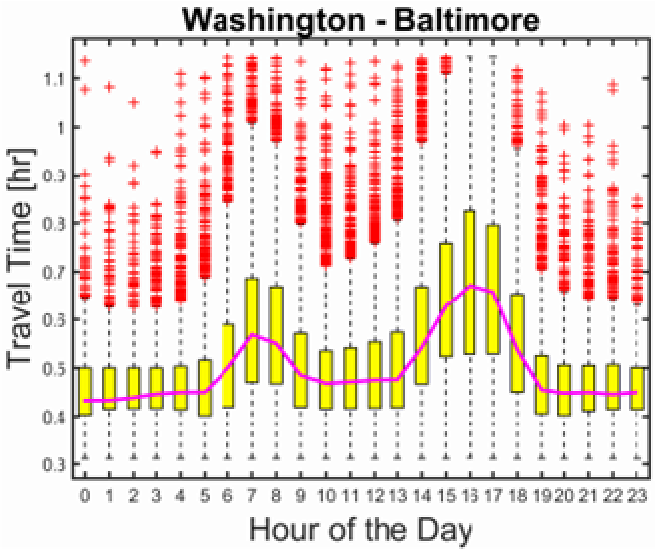
# SHRP-2 Project L-02
# Summary of Results – I95 (2014)

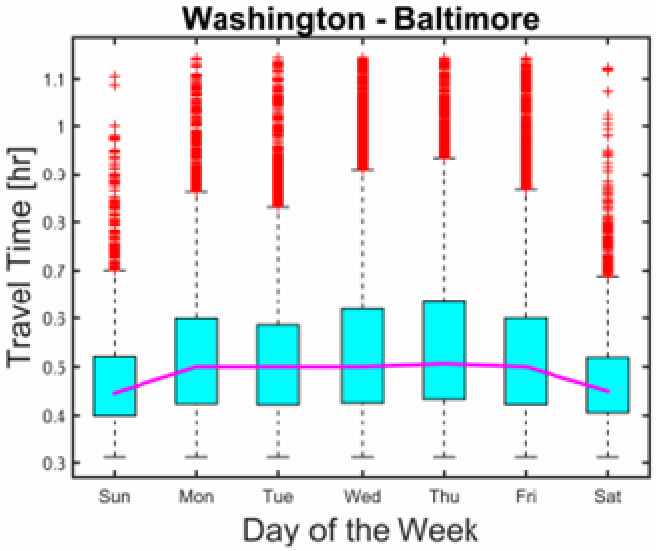
- I-95
  - Sub-corridor 1:
    - Capital Beltway (I-495) to MD-198
    - ~5 miles
  - Sub-corridor 2:
    - MD-198 to MD-32
    - ~5 miles
  - Sub-corridor 3:
    - MD-32 to I-895
    - ~6 miles
  - Sub-corridor 4:
    - I-895 to I-695
    - ~2.6 miles



# Trip analysis using high-resolution INRIX OD data




Blue/Red trajectories are result of 70K trajectories on Northbound/Southbound directions from the trips made in July 2016 between Baltimore and Washington

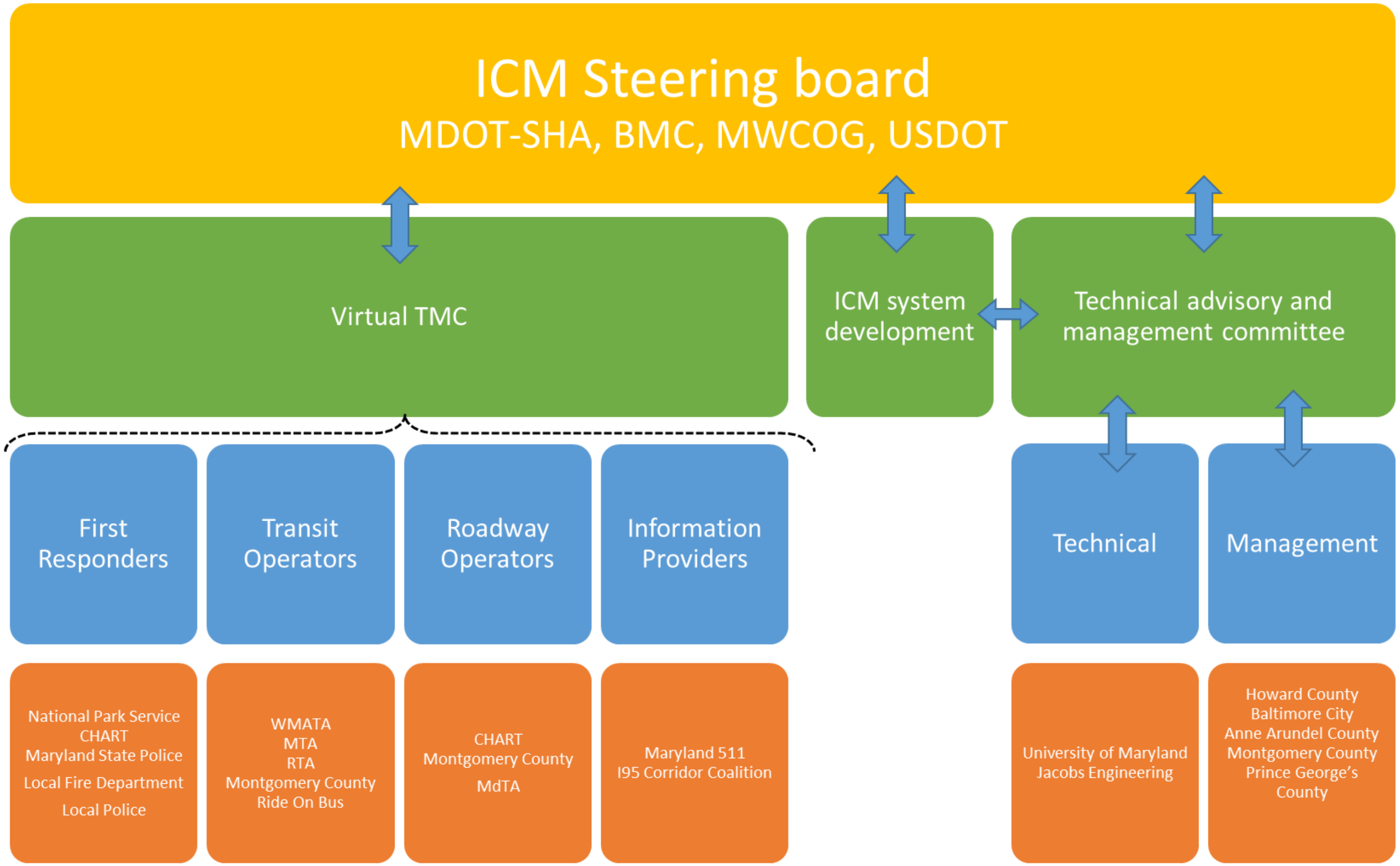
# Digital Repository

**UMD has created an online GIS-based repository to gather ITS and data assets on the corridor in one location, represented as different layers**

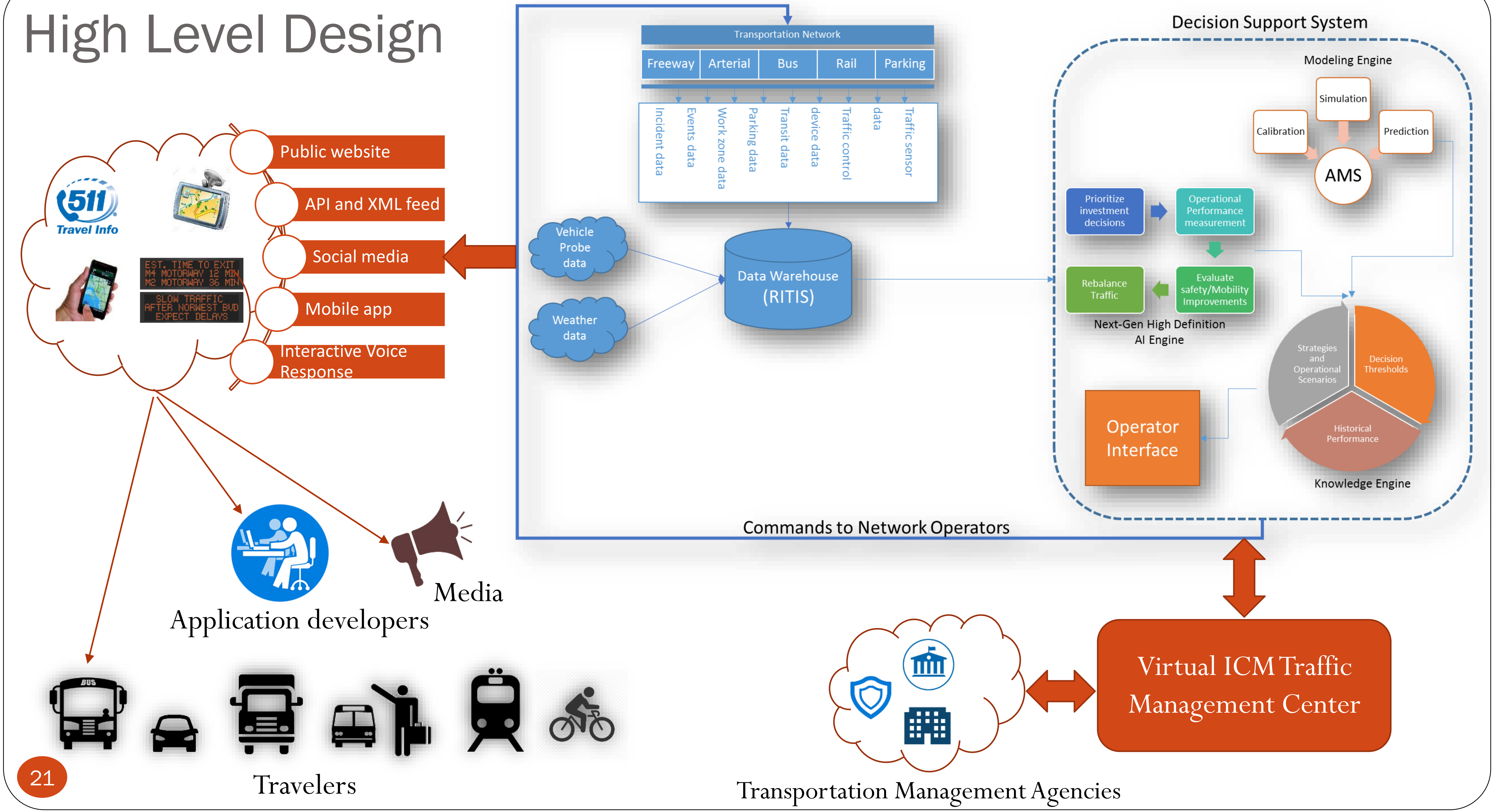
- Stationary traffic detectors
- CCTV
- DMS
- Traffic signals
- Bluetooth/WiFi sensors (existing and proposed)
- Park and Ride facilities
- ICM Boundary and links
- Transit routes and stops
- AADT (links and points)
- TMC Segmentation (INRIX, HERE and TomTom)
- Bottleneck Analysis (AM and PM PTI and TTI for 2013, 2014 and 2015)
- Incident Analysis
- OD trajectory analysis
- Evacuation routes
- Alternative routes
- MARC

Hyperlink to the online ICM Digital Repository

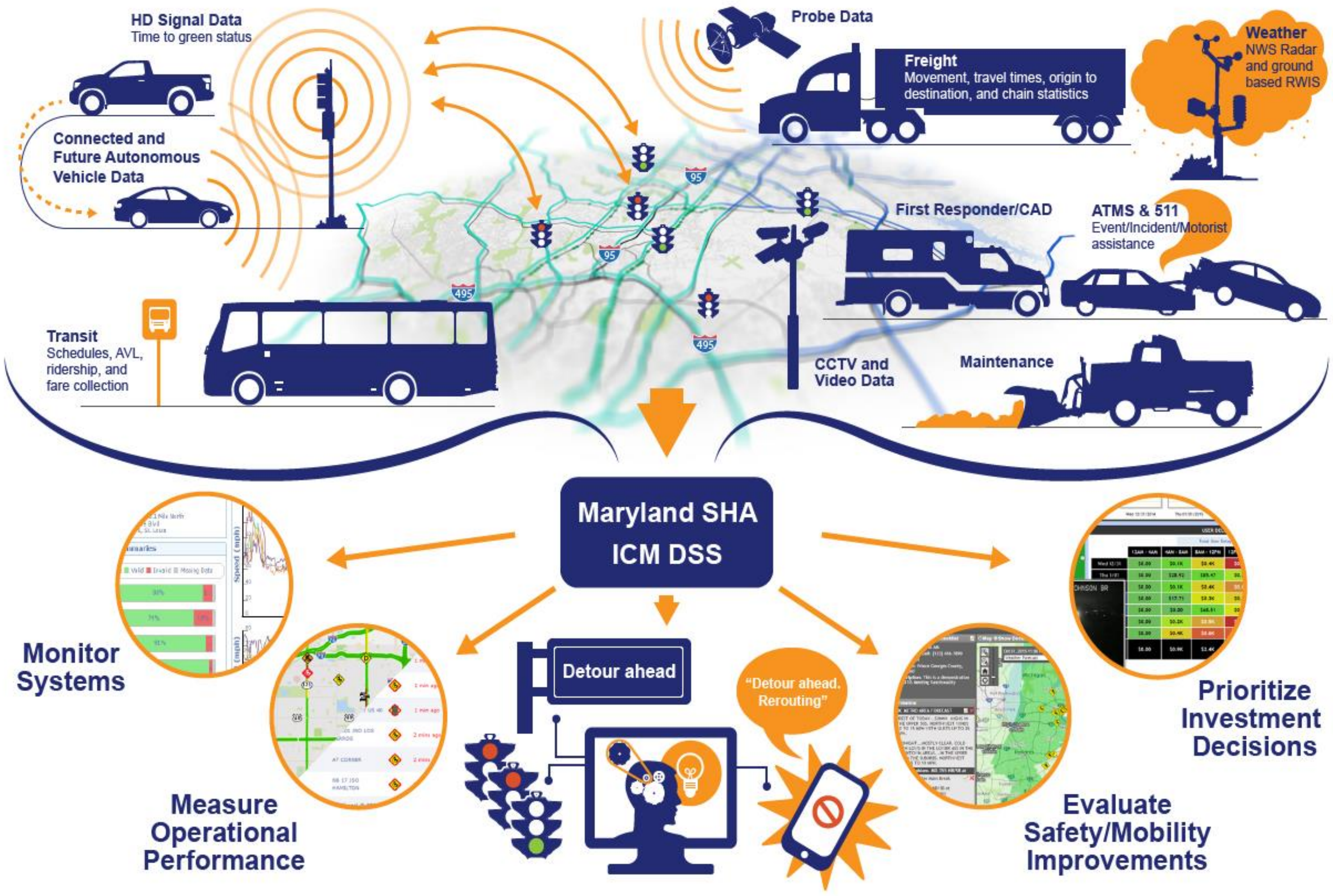
# ICM Institutional Framework



# High Level Design

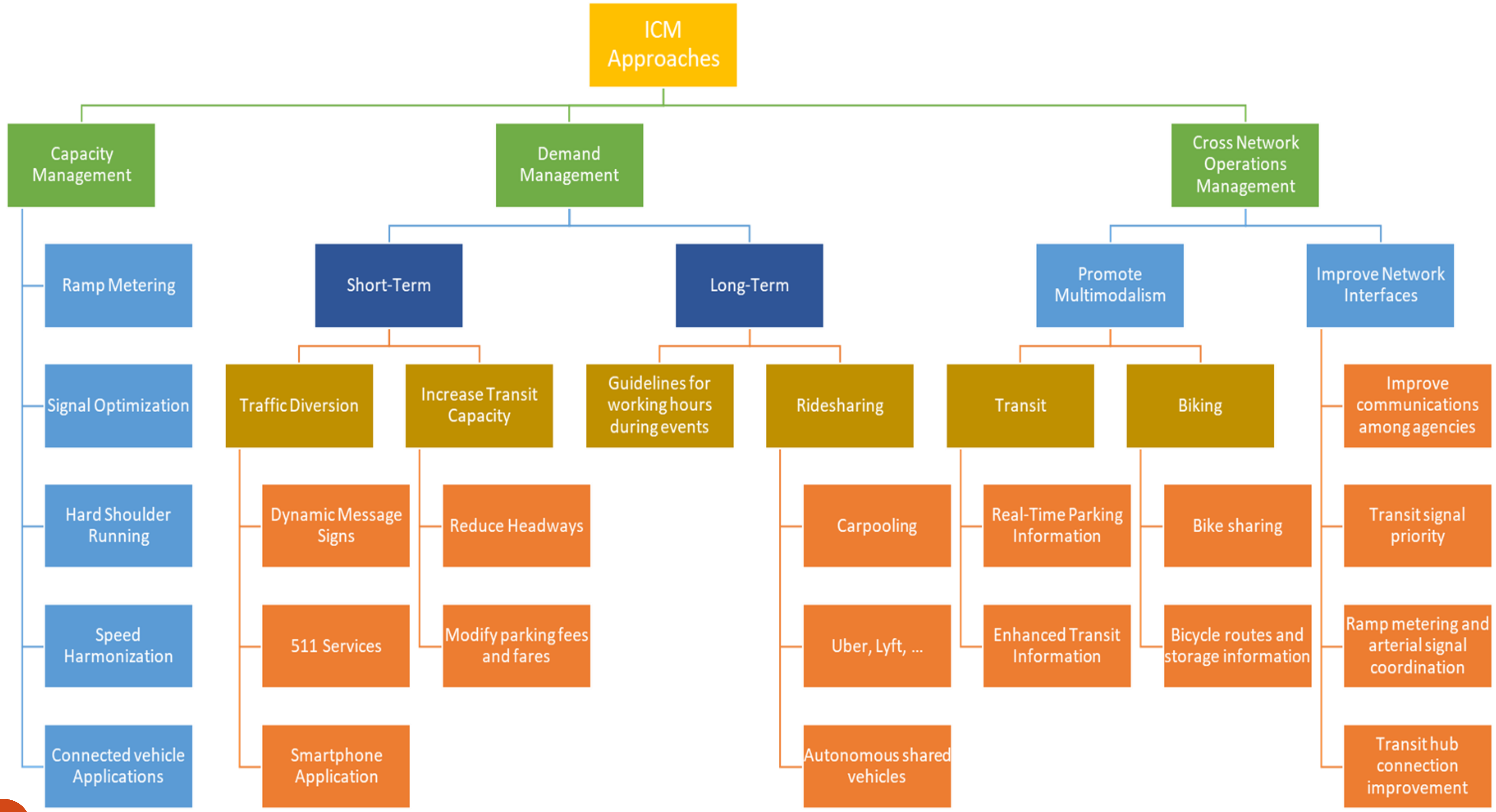


# NEXT GEN High-resolution ICM



# Potential ICM improvement strategies

- Data collection and system monitoring
- Travel demand monitoring
- Information sharing
- Promoting transit and car sharing
- Smart parking systems
- Improve traffic operations and incident response
- Capacity enhancement


ICM Approaches
Capacity Management
Demand Management
Cross Network Operations Management
Ramp Metering
Signal Optimization
Hard Shoulder Running
Speed Harmonization
Connected vehicle Applications
Short-Term
Long-Term
Traffic Diversion
Increase Transit Capacity
Guidelines for working hours during events
Ridesharing
Dynamic Message Signs
511 Services
Smartphone Application
Reduce Headways
Modify parking fees and fares
Carpooling
Uber, Lyft, ...
Autonomous shared vehicles
Promote Multimodalism
Improve Network Interfaces
Transit
Biking
Real-Time Parking Information
Enhanced Transit Information
Bike sharing
Bicycle routes and storage information
Improve communications among agencies
Transit signal priority
Ramp metering and arterial signal coordination
Transit hub connection improvement

# Operational Scenarios

The objective of operational scenarios is to allow all stakeholders to clearly identify their expected role.

Operational Scenarios:

- describe a sequence of events and activities carried out by the user, the system, and the environment,
- specify what triggers the sequence, who or what performs each step, when communications occur and to whom or what [e.g., a log file], and what information is being communicated.

The scenarios cover all:

- Normal conditions
- Failure events
- Anomalies
- Stress conditions
- Maintenance
- Exceptions

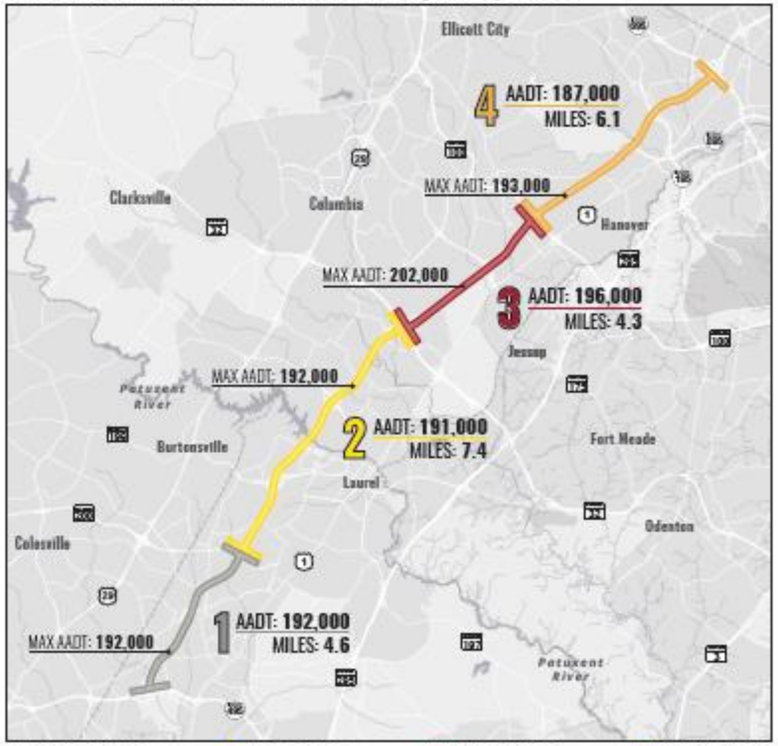
# Deployment Approach

- **FREEWAY**
  - Upgrades to the freeway surveillance capabilities including more detectors and CCTV coverage
  - Real-time processing of CCTV feeds to extract volume, headway and queue length to complement conventional data sources
  - **Dynamic Message Signs (DMS)** at additional locations along the freeway.
  - **Implementation of Dynamic Lane Control** to allow **Hard Shoulder Running** on I-95, MD-32, Md-100, US-29 and US-1. More specifically, the following TSM&O strategies are recommended:
    - I-95 NB left shoulder: MD 32 to MD 100 (PM)
    - I-95 SB/I-495 WB right shoulder: MD 212 (I-95) to MD 650 (I-495) (AM/PM)
    - I-95 NB left shoulder: MD 198 to MD 32 (PM)
  - Variable Speed Limit system on I-95 to adjust speed limits based on real-time traffic, roadway, and/or weather conditions.
  - Identification and implementation of adaptive ramp metering sites to regulate the flow into freeway links

**I-95 HARD SHOULDER RUNNING (HSR) CONCEPTS**
SEPTEMBER 2017

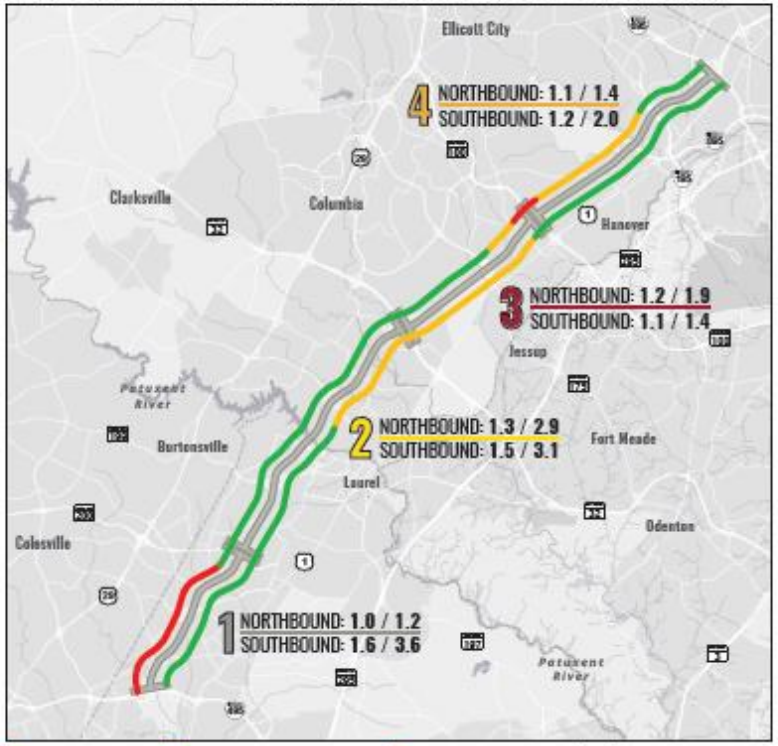
**Purpose:** To provide an overview of I-95 operations and to present potential HSR concepts along I-95

## ANNUAL AVERAGE DAILY TRAFFIC (AADT) 2014



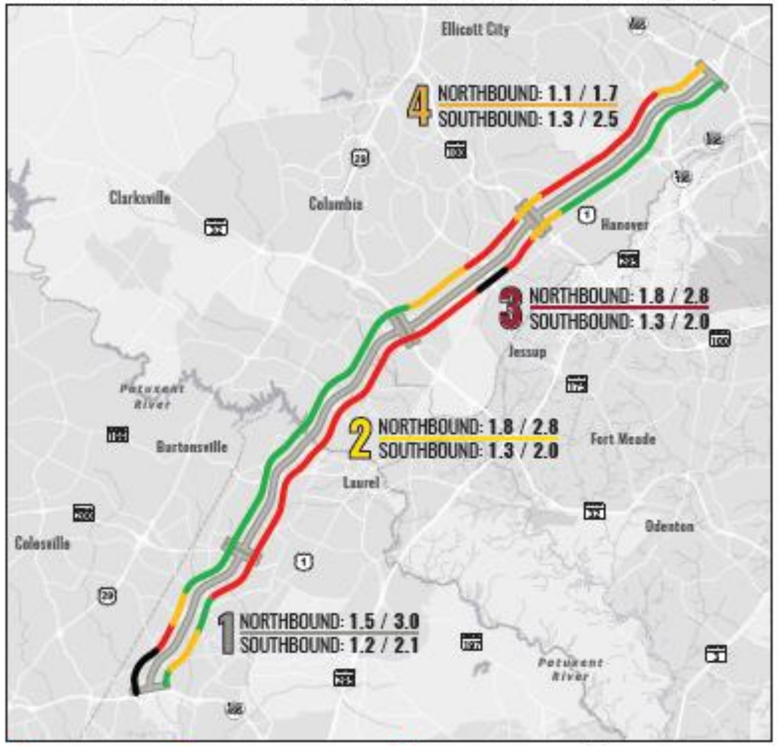

SEGMENT 1 SEGMENT 2 SEGMENT 3 SEGMENT 4

## AM TRAVEL TIME INDEX (TTI) / PLANNING TIME INDEX (PTI)




UNCONGESTED MODERATE CONGESTION HEAVY CONGESTION SEVERE CONGESTION

## PM TRAVEL TIME INDEX (TTI) / PLANNING TIME INDEX (PTI)




UNCONGESTED MODERATE CONGESTION HEAVY CONGESTION SEVERE CONGESTION

**Source:** *AADT, Travel Time Index, Planning Time Index from MDOT SHA Mobility Report/DSED GIS Data Services (shown as weighted average by length)*

**TTI VALUES:** UNCONGESTED (TTI < 1.15) MODERATE CONGESTION (TTI 1.15 - 1.3) HEAVY CONGESTION (TTI 1.3 -2.0) SEVERE CONGESTION (TTI > 2.0)

**PTI VALUES:** RELIABLE (PTI < 1.5) MODERATELY RELIABLE (1.5 < PTI < 2.5) UNRELIABLE (PTI > 2.5)

**Overview:**
Segment 1 has moderate to severe congestion in the AM and PM
Segment 2 has heavy congestion in the northbound direction in the AM and PM
Segment 3 has moderate to severe congestion in the AM and PM, primarily in the northbound direction
Segment 4 has moderate to severe congestion in the AM and PM, primarily in the southbound direction

*I-95 is not ranked as top congested / unreliable corridor in the 2016 Mobility Report

# Deployment Approach

- **ARTERIAL**
  - Increasing traffic detection stations along US-1 including:
    - Arterial Closed-circuit Television (CCTV) Cameras to support traffic/incident
    - Speed/volume Traffic Detectors to support mid-block vehicle detection and arterial travel times
    - Arterial Dynamic Message Signs (DMS) for travelers' information and the deployment of a Highway Access Alert System
    - Localized Roadway Weather Information Systems (RWIS)
  - Implementation of adaptive signal system operations along US-1 allowing timing to be adjusted to conditions.
- **MULTI-MODALISM**
  - Implementing real-time parking information system at Park-and-Ride facilities and transit stations
  - Enhancing bike routes to/from NSA campus to transit stations

# Deployment Approach

- **CONNECTED AND AUTOMATED VEHICLES**

  Designating a portion of US-1 as a corridor for testing and operating CV/AV technology and installing necessary V2V and V2I equipment including Dedicated Short Range Communication (DSRC) radios to support the following applications:

  - Safety:
    - Red Light Violation Warning (RLVW)
    - Spot Weather Impact Warning (SWIW)
    - Reduced Speed/Work Zone Warning (RSWZ)
  - Mobility:
    - Advanced Traveler Information Systems (ATIS)
    - Intelligent Traffic Signal System (I-SIG)
    - Emergency Signal Priority (PREEMPT)
    - Transit Signal Priority (TSP) and Freight Signal Priority (FSP)
    - Mobile Accessible Pedestrian Signal Systems (PED-SIG)
  - Environment:
    - Connected Eco-Driving
    - Eco-Approach and Departure

# ConOps Outline

- Executive Summary
- Chapter 1. Purpose of Document and Summary
- Chapter 2. Corridor Overview
- Chapter 3. Existing Transportation Management Assets
- Chapter 4. Existing Operational Status
- Chapter 5. Issues, Needs and Desired Changes
- Chapter 6. Proposed ICM System Concept
- Chapter 7. User Oriented Operational Descriptions
- Chapter 8. Operational Scenarios
- Chapter 9. Summary of Impacts on Stakeholders
- Chapter 10. ICM Analysis, Modeling and Simulation Plan
- Chapter 11. Deployment Approach


CONCEPT OF OPERATIONS FOR THE
BALTIMORE-WASHINGTON INTEGRATED
CORRIDOR MANAGEMENT PROJECT



PREPARED BY: CENTER FOR ADVANCED TRANSPORTATION TECHNOLOGY
UNIVERSITY OF MARYLAND, COLLEGE PARK

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# Next Steps

- Link ICM to TSMO Strategic Implementation Plan Action Items
- Align the B-W ICM project with the Integrated Freeway/Arterial Master Plan
- Determine how B-W ICM supports
  - Automated and Connected Vehicle Strategic Plan
    - ICM as a platform to promote/adapt/support Connected and Autonomous Vehicle related projects
  - Smart Cities & ICM
- Conduct Analysis Modeling Simulation to identify most promising ICM strategies
  - Work has started on this

# Next Steps (cont.)

- Define ICM system and develop system requirements
  - What are requirements of B-W ICM system
  - How will it link to existing (i.e., CHART) and planned (I-270) systems
- Important to align B-W ICM with other projects:
  - Projects in the B-W corridor
  - Projects around the state, i.e., Freeway/Arterial Master Plan; I-270 Congestion Mitigation project
- Make sure we do not miss opportunities; projects are moving fast
- Engage major employers in the corridor
- Communications/messaging to elected officials/public
  - Tell the story of how ICM can improve traffic

# Final Thoughts

- Institutional cooperation is critical for a successful ICM
- Important for local jurisdictions to participate to ensure they have a voice in the planning and operations
- There are some no-cost next steps that can start now
- SHA is realigning to be able to fully harness the benefits of ICM and other new approaches to traffic management
- Next steps discussion will continue through: TSMO Strategic Implementation Plan, CHART Board, Data Repository, MPOs, incenTrip, incident/event after action reports,

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