



Traffic Management Centers

In a Connected Vehicle Environment

Project Summary

Feb. 2014

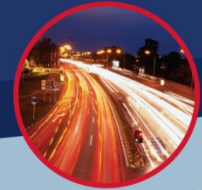
Prepared for the Cooperative Transportation
Systems Pooled Fund Study

Prepared by: Kimley-Horn and Noblis



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Cooperative Transportation Systems Pooled Fund Study Overview

- *“Program to support the development and deployment of Cooperative Transportation Systems Applications”*
- Goals
 - To facilitate the development and evaluation of Connected Vehicle applications
 - To prepare state and local transportation agencies for the deployment of Connected Vehicle technologies
- Program Status (http://cts.virginia.edu/CTSPFS_1.html)
 - Phase I (July 2009 – August 2012)
 - Phase II (September 2012 – December 2014)
 - Phase III will begin from January 2015
 - PFS Dynamic Mobility Application Project: Multi-Modal Intelligent Traffic Signal Systems Phase I and II (October 2011 – June 2015)

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Current PFS Membership

■ Core/Voting Members

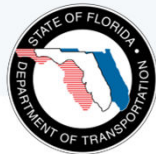
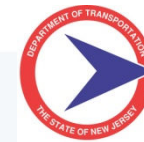
- Virginia, California, Florida, Michigan, Minnesota, New Jersey, New York, Pennsylvania, Texas, Utah, Washington, Wisconsin, Maricopa County and FHWA
- VDOT is lead agency with technical/administrative support from UVA

■ Associate Members

- Palm Beach Co, FL; Oakland Co, MI; MTC (Bay Area), Transport Canada, Rijkswaterstaat and North Texas Toll Authority

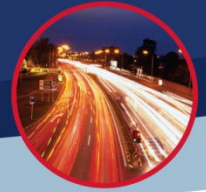
■ Liaisons

- NCHRP/SHRP 2; AASHTO (strategic and deployment plans)



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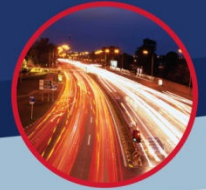


Project Team

- Cooperative Transportation Systems Pooled Fund Study
 - Melissa Lance (Virginia Department of Transportation)
 - Hyungjun Park and Brian Smith (University of Virginia)
- Project Team
 - Kimley-Horn and Associates, Inc.
 - Noblis
 - DGD Enterprises

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Future TMCs....

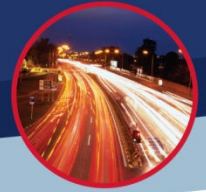
- What are the potential impacts of CV on transportation management centers?
 - New operational capabilities
 - New data sources
 - Key considerations
 - Staffing and required skills
 - How will operations change?
 - Policy and institutional issues
- How can TMCs ready for a future CV environment?



Source: USDOT/NHTSA

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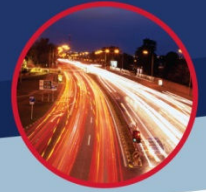


Project Overview

- February 2013 – December 2013
- Outreach to a variety of TMCs throughout country
- Wide net approach to input; focused interviews with candidate states
- Ongoing coordination with Panel and PFS
- Other related efforts
 - Overall Connected Vehicle Research Program
 - Footprint Analysis
 - Connected Vehicle Reference Implementation Architecture
 - Multiple test beds

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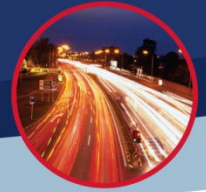
Key Tasks and Deliverables

Task	Deliverable
Task 1	Connected Vehicle Program Activities in Relation to TMC Operations (Technical Working Paper)
Task 2	Expected Changes in TMCs – Concept Paper and Summary
Task 3	Operational Concept for Future TMCs in a Connected Vehicle Environment
Task 4	Final Recommendations

All deliverables are located at: http://cts.virginia.edu/CTSPFS_2.html

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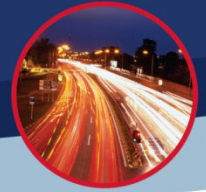


Task 1 – Review CV Program Activities in Relation to TMC Operations

- Current data capabilities (real-time) and TMC operating environments
- TMC perspective on priority CV apps
- Potential benefits and impacts of CV on TMCs
- Survey and interviews

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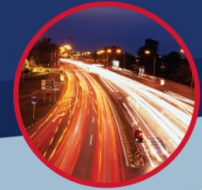


Survey

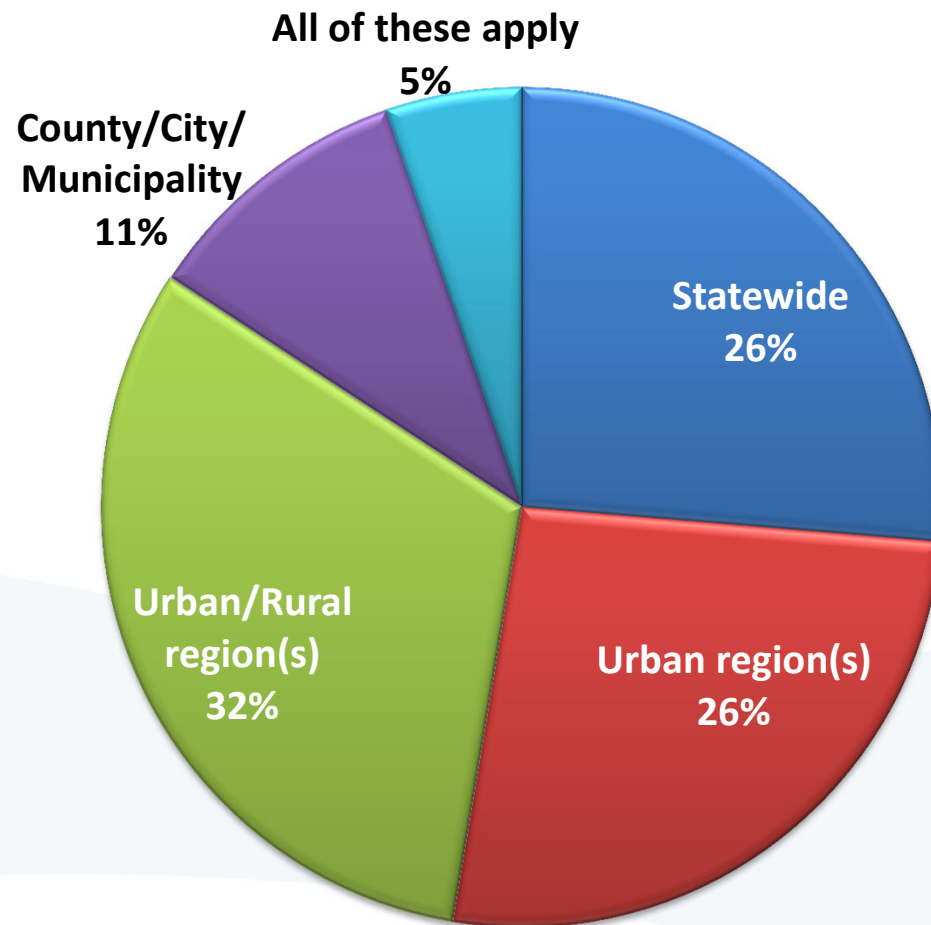
- Total of 16 completed
- Awareness of connected vehicle research
- Multi-source data
- How connected vehicles would enhance, expand or impact TMC operations
 - Staffing/skill set needs
 - Policy and legal considerations
 - Systems and networks
- Basis for more detailed interviews

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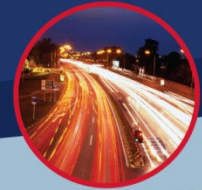


TMC Coverage Areas

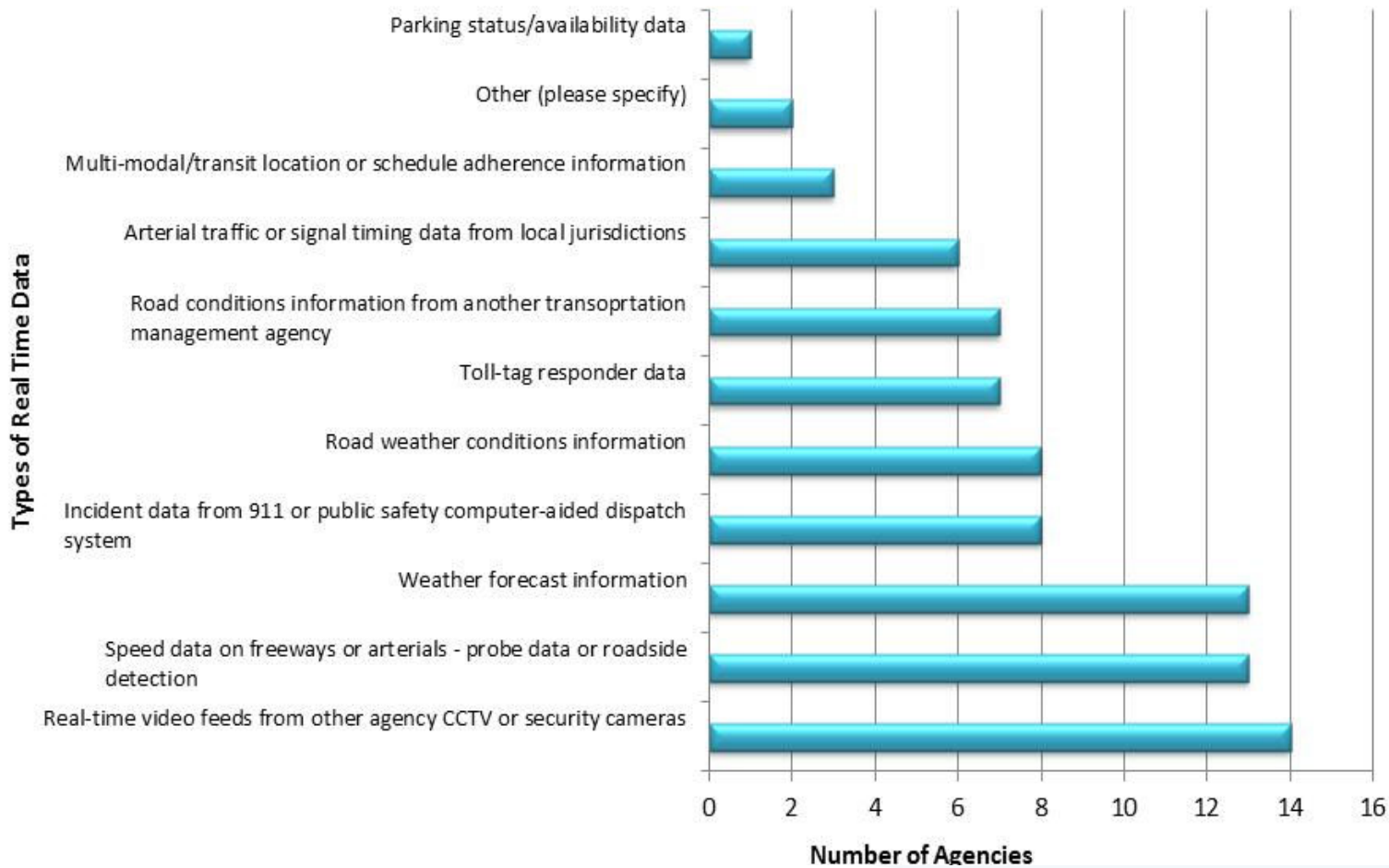


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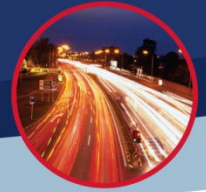


Real-Time Data from Other Sources



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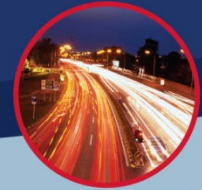
Priority CV Application Areas

Primary focus: Enhance Core Functions, Expand Situational Awareness (arterials)

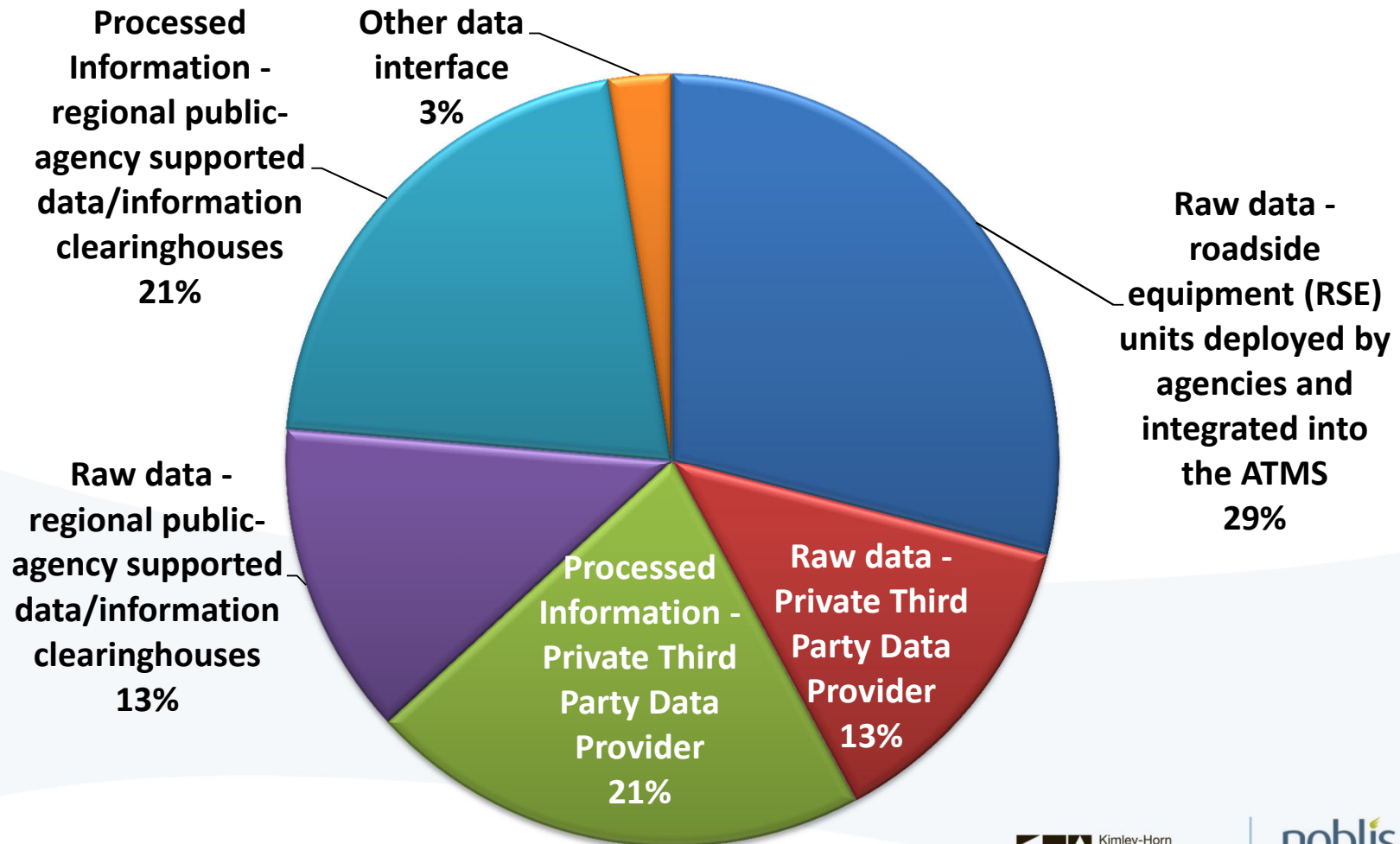
- Incident Detection (11)
- Probe Data Collection - Vehicle position, speed, and heading (10)
- Arterial Management - Advanced Traffic Signal Systems (e.g. leveraging connected vehicle data to support traffic signal operations including adaptive traffic signal systems) (8)
- Traveler Information - Traffic Conditions (7)
- Traveler Information – Travel Times and Incidents (4)
- Safety Applications (CICAS) – Signal/Stop Sign Violation (3)

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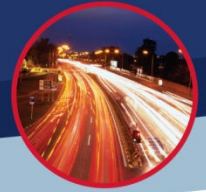


How TMCs Prefer to Acquire Data



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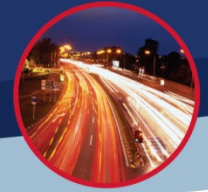


TMC Interviews

- In person – Detroit and Arizona
- Telephone – Florida and Virginia
- Common Themes:
 - Incident information, verification, system recovery
 - Situational awareness, decision making
 - Would complement agency data, not replace
 - Better information to travelers
 - Support for dynamic strategies (ICM and ATM)
 - Excited about data potential – addressing today's data gaps

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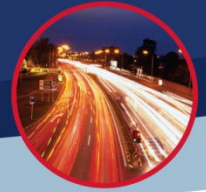


Challenges

- CV activity and testing has not reached the TMCs
- What can be demonstrated (cost/benefit) for TMC with limited number of vehicles?
- First focus is on issues with field infrastructure
- Mixed response regarding staffing impacts
- Unknowns on data management issues, communications capability
- Agency IT environment and relationships

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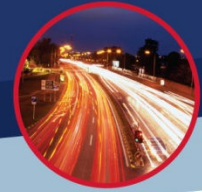


Potential Impacts

- Avoiding TMC operator 'data overload'
- Will CV be viewed as 'verified' data?
- Rapid technology lifecycle turnover
- Managing data
- Ability for legacy equipment to support new technologies
- Ability to transition to new field and TMC equipment
- Software and operating system capabilities to support multi-source data environment

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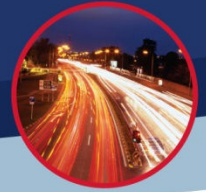


Task 2 – Investigation of Expected Changes in TMCs

- Current status and functions of TMCs
- Trends Impacting TMCs
 - Proactive and integrated operations programs
 - Mobile communications and multi-source data
 - Advances in wireless network capabilities
 - Traveler information and social media
 - Performance management
 - TMC staffing and skill sets
- Description of the Connected Vehicle Environment

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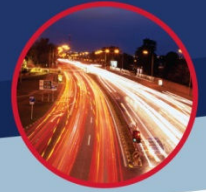


Aligning with Service Packages

- Incident Management
- Roadway Hazard Warnings
- Speed Monitoring and Warning
- Cooperative Intersection Collision Avoidance Systems (CICAS)
- Traffic Signal Control
- Probe Data Collection
- Traffic Metering
- Lane Management
- Electronic Payments / Fee Collection
- Traffic Information Dissemination
- Emissions Monitoring and Management
- Road Weather Monitoring and Management
- Asset Management
- Parking Management
- Performance Measures*

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Service Package Assessment

Service Package
Description

Potential
Connected Vehicle
Applications

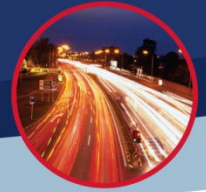
Potential Changes to
TMC Operations

- Incident Detection
- Incident Warnings
- Advanced Automatic Crash Notification Relay
- Emergency Communications and Evacuation
- Incident Scene Pre-Arrival Staging for Emergency Responders
- Incident Scene Work Zone Alerts for Drivers and Workers
- Emergency Vehicle Alerts

- Available data
- Decision support
- Incident response from TMC
- Disseminate information
- Ongoing automated updates

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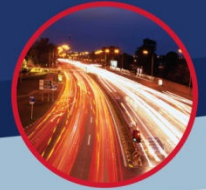


Expected Changes

- Change to the TMC data environment – “Big Data”
 - Enhancements needed to store, process, retrieve, and present data
 - New opportunities for working with third party data providers and clearinghouses
- Development of software modules and algorithms to support CV applications
 - Automating processes and information processing for TMC operators
- Customer expectations in a CV environment will change
- Deployment, maintenance and operations of roadside equipment (RSE) units
 - A transition period will exist in the near and mid-term
- Integration of CV infrastructure and data into existing ATMS
- Connecting to the Core System
- Training for TMC operations and maintenance staff

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Task 3 – Future of TMCs in a Connected Vehicle Environment

- Develop some operational concepts
- No single path for all TMCs
- Data environment – single biggest change



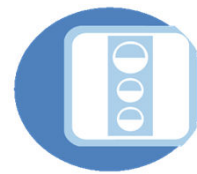
Incidents



Weather



Speed
(Detection
and
Probe)



Field
Devices



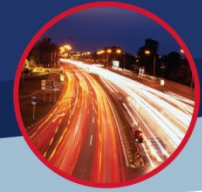
Work
Zones




Special
Events

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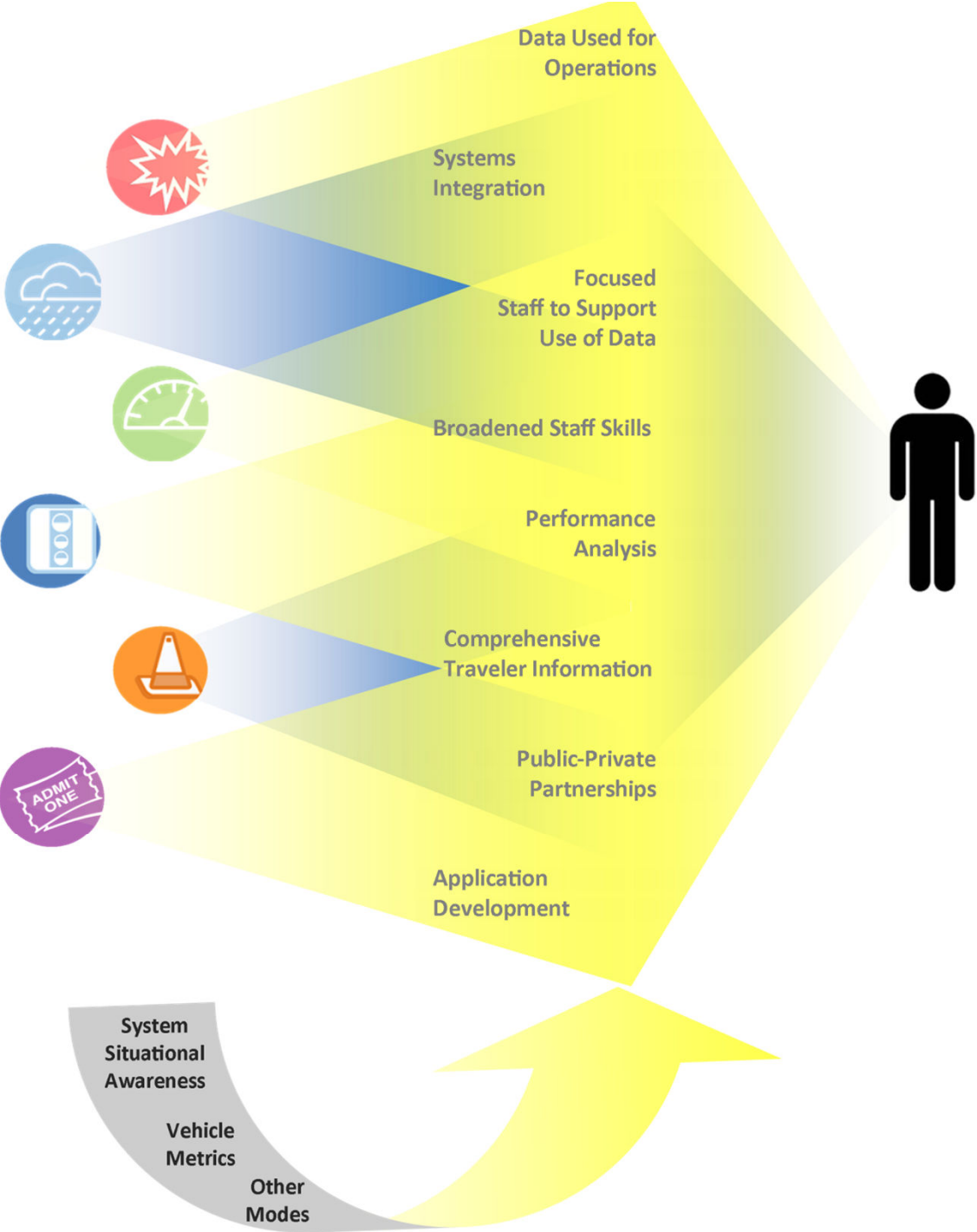
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New Data Types and Processes

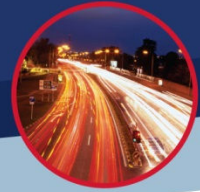
Data/Information Category	Typical Data/Information Currently Available	Data Environment enabled by Connected Vehicles	Potential Changes to TMC Operations and Processes
<p>Incident</p> 	<ul style="list-style-type: none"> • Location • Start time/end time • Duration • Severity 	<ul style="list-style-type: none"> • Geo-locating capability for precise incident location • Real-time and specific impacts to network • Lanes restricted • Types of vehicles involved • Response status • Condition of potential detour routes 	<ul style="list-style-type: none"> • Respond better to scene with the right resources and the right equipment • Network management to support incident impact mitigation • Real-time information on incident clearance • Improved traveler notifications on nearby corridors • Before-and-after analysis to determine cause/improvements • Improved predictive modeling

Growth in Data and Responsibility in a CV Environment



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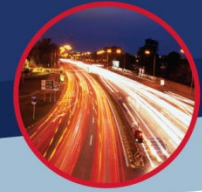


TMC Functions and Potential Changes

Functions	Current Processes	CV Data Introduced	Changes to TMC Ops Processes
Traffic Management	<ul style="list-style-type: none"> Updating signal timing periodically or as-warranted Monitor / use camera images Provide notification (in some form) 	<ul style="list-style-type: none"> Traffic violations Hazard alerts Continuous lane by lane detection of volumes and congestion Density context Back of queue and flush rate Pavement conditions Network impacts Vehicle metrics Forecasting Prediction of impacts 	<ul style="list-style-type: none"> Greater accuracy in signal control analysis Signal timing updates responsive to traffic patterns System-wide vehicle priority Responsive traffic metering Lane management Lighting control systems Parking availability information Safe speed warnings Intersection control and warnings Continuous dynamic roadway warnings

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New/Expanded Functions at TMCs

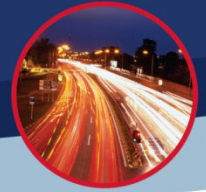
- Asset Management
- IT Network Management
- Non-Typical Infrastructure Monitoring (bridges, tunnels)
- Real-time performance analysis



Source: Arizona DOT

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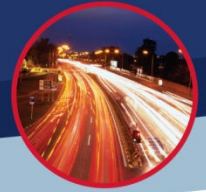


Data Management/Big Data

- New tools needed, old tools retired...
 - Acquisition and storage
 - Marshaling (raw data to usable information)
 - Analysis and analytics
 - Action tools – enhancements to current systems
- Systems and Data Management Issues
 - Big Data Tools
 - Communications and Computing
 - Regional Organization and Partnerships
- Task 3 Deliverable – Table 4

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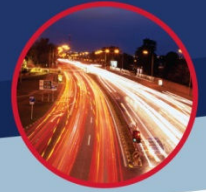
Staffing Skill Set Needs

- Information Technology and Data Management
- System Analytics and Processing
- Network and Device Maintenance
- Operations Engineering Decision Making



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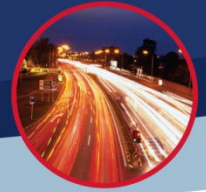


Summary of Recommendations

- “Day 1” not certain
 - NHTSA decision finalized going forward
 - Footprint looking at ~2020
 - Near-term apps
 - What will emerge in the meantime??
- All things are pointing to a more robust data environment (CV, AV, other)

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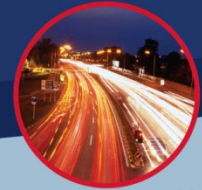
TMC Operational Readiness

- Geographic Scale of the Transportation Network (managed by the TMC)
- Device and Communications Infrastructure
- Staffing Levels and Skill Sets
- Data Storage Support
- Data Analysis
- System Functionality
- Operational Processes
- System Performance Reporting
- Institutional Support



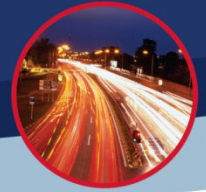
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Data Analysis

Robust	Data analysis done by dedicated staff knowledgeable of traffic operations and engineering principles, analysis applied to enhance TMC operations and traffic management	<ul style="list-style-type: none"> Invest in data mining applications or software packages that could automate data analysis for better efficient use of staff time Regular review of data analysis performed to encourage creativity and innovation in data mining and story-telling through data comparisons
Adequate	Data analysis by studies or planning group, not necessarily with traffic operations and engineering principles, not typically applied to real-time operations strategies	<ul style="list-style-type: none"> Consider investing in data mining applications or software packages that could automate data analysis for better efficient use of staff time Training or education on types of analysis that would be beneficial to justify before-and-after investments in TMC operations, devices and communications, or system enhancements
Limited	No data analysis capabilities or resources to support this effort	<ul style="list-style-type: none"> Identify resource to perform data analysis based on types of reporting required to justify current investments or support future investments Training or education on types of analysis that would be beneficial to justify before-and-after investments in TMC operations, devices and communications, or system enhancements

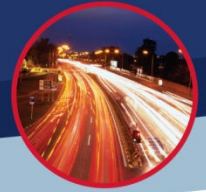


TMC Role in Test Beds

- How can the myriad test beds be leveraged:
 - Impacts on operating systems
 - Impacts on processes
 - Data storage, acquisition, marshaling
- Opportunities to broaden the test bed focus to include TMCs
 - Partner with TMC PFS
 - Define requirements
 - Get software and system developers engaged

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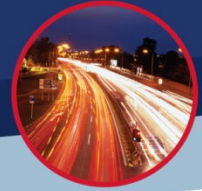


Advancing the Dialogue

- Status of national forum or Coalition (AASHTO/FHWA)
 - Other private industry – IT and system developers (beyond auto OEMs)
- TMC Staffing and Resource Needs
 - Partner with TMC PFS
- Input to upcoming USDOT Guidance (2015)
- Inreach within agency
 - What other agency dept/division needs could CV data support?
 - Who are the internal and regional partners?

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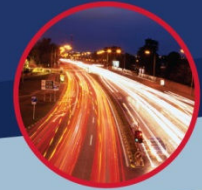
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QUESTIONS

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For More Information

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