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
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)
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
Future TMCs....

What are the potential impacts of CV on transportation management centers?

• New operational capabilities
• New data sources
• Key considerations
  o Staffing and required skills
  o How will operations change?
  o Policy and institutional issues

How can TMCs ready for a future CV environment?

Source: USDOT/NHTSA
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
## Key Tasks and Deliverables

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<th>Deliverable</th>
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<td>Task 1</td>
<td>Connected Vehicle Program Activities in Relation to TMC Operations (Technical Working Paper)</td>
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<td>Task 2</td>
<td>Expected Changes in TMCs – Concept Paper and Summary</td>
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<td>Task 3</td>
<td>Operational Concept for Future TMCs in a Connected Vehicle Environment</td>
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<td>Task 4</td>
<td>Final Recommendations</td>
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All deliverables are located at: [http://cts.virginia.edu/CTSPFS_2.html](http://cts.virginia.edu/CTSPFS_2.html)
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
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
TMC Coverage Areas

- Statewide: 26%
- Urban/Rural region(s): 32%
- Urban region(s): 26%
- County/City/ Municipality: 11%
- All of these apply: 5%
Real-Time Data from Other Sources

Types of Real-Time Data:
- Parking status/availability data
- Multi-modal/transit location or schedule adherence information
- Arterial traffic or signal timing data from local jurisdictions
- Road conditions information from another transportation management agency
- Toll-tag responder data
- Road weather conditions information
- Incident data from 911 or public safety computer-aided dispatch system
- Weather forecast information
- Speed data on freeways or arterials - probe data or roadside detection
- Real-time video feeds from other agency CCTV or security cameras

Number of Agencies (0 to 16)
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)
How TMCs Prefer to Acquire Data

- **Processed Information - regional public-agency supported data/information clearinghouses**: 21%
- **Raw data - roadside equipment (RSE) units deployed by agencies and integrated into the ATMS**: 29%
- **Raw data - regional public-agency supported data/information clearinghouses**: 21%
- **Processed Information - Private Third Party Data Provider**: 13%
- **Other data interface**: 3%
- **Other data interface**: 3%

- **Other data interface**: 3%
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
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
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
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
### 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*
Service Package Assessment

Service Package Description

Potential Connected Vehicle Applications

• 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

Potential Changes to TMC Operations

• Available data
• Decision support
• Incident response from TMC
• Disseminate information
• Ongoing automated updates
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
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
## New Data Types and Processes

<table>
<thead>
<tr>
<th>Data/Information Category</th>
<th>Typical Data/Information Currently Available</th>
<th>Data Environment enabled by Connected Vehicles</th>
<th>Potential Changes to TMC Operations and Processes</th>
</tr>
</thead>
</table>
| Incident                  | • Location  
  • Start time/end time  
  • Duration  
  • Severity | • 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 | • 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
<table>
<thead>
<tr>
<th>Functions</th>
<th>Current Processes</th>
<th>CV Data Introduced</th>
<th>Changes to TMC Ops Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Management</td>
<td>• Updating signal timing periodically or as-warranted</td>
<td>• Traffic violations</td>
<td>• Greater accuracy in signal control analysis</td>
</tr>
<tr>
<td></td>
<td>• Monitor / use camera images</td>
<td>• Hazard alerts</td>
<td>• Signal timing updates responsive to traffic patterns</td>
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<td>• Provide notification (in some form)</td>
<td>• Continuous lane by lane detection of volumes and congestion</td>
<td>• System-wide vehicle priority</td>
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<tr>
<td></td>
<td></td>
<td>• Density context</td>
<td>• Responsive traffic metering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Back of queue and flush rate</td>
<td>• Lane management</td>
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<tr>
<td></td>
<td></td>
<td>• Pavement conditions</td>
<td>• Lighting control systems</td>
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<tr>
<td></td>
<td></td>
<td>• Network impacts</td>
<td>• Parking availability information</td>
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<tr>
<td></td>
<td></td>
<td>• Vehicle metrics</td>
<td>• Safe speed warnings</td>
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<td></td>
<td></td>
<td>• Forecasting</td>
<td>• Intersection control and warnings</td>
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<td>• Prediction of impacts</td>
<td>• Continuous dynamic roadway warnings</td>
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</tbody>
</table>
New/Expanded Functions at TMCs

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

Source: Arizona DOT
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
Staffing Skill Set Needs

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

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Recommendations</th>
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</thead>
</table>
| Robust   | Data analysis done by dedicated staff knowledgeable of traffic operations and engineering principles, analysis applied to enhance TMC operations and traffic management | • 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 | • 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            | • 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
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?
QUESTIONS
For More Information

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

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