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NCHRP Project 20-102
Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies

Announcement of New Tasks, August 2016

The **National Cooperative Highway Research Program** (NCHRP) is supported on a continuing basis by funds from participating member departments of the American Association of State Highway and Transportation Officials (AASHTO), with the cooperation and support of the Federal Highway Administration, U.S. Department of Transportation. The NCHRP is administered by the Transportation Research Board (TRB), a program unit of the National Academies of Sciences, Engineering, and Medicine. The NCHRP is an applied contract research program committed to providing timely solutions to problems facing highway and transportation practitioners and administrators.

The objectives of **NCHRP Project 20-102** are to (1) identify critical issues associated with connected vehicles and automated vehicles that state and local transportation agencies and AASHTO will face, (2) conduct research to address those issues, and (3) conduct related technology transfer and information exchange activities. This announcement contains preliminary descriptions of those tasks that will be undertaken next by NCHRP Project 20-102.

Nominations for panel members to oversee each of these tasks are currently being sought. A nomination form and résumé should be sent to Ms. Charlotte Thomas (cthomas@nas.edu) by September 7, 2016. You may nominate yourself or others. Panel members will be responsible for (1) developing the final scope of work, (2) selecting the best contractor, (3) overseeing the contractor's work, and (4) reviewing and recommending publication of interim and final deliverables.

The tasks included in this announcement are largely drawn from a research roadmap developed through **NCHRP Project 20-24(98)**. That roadmap is available on the project webpage and describes a five-year, $15M effort addressing the policy, planning, and implementation issues that will face state and local transportation agencies. This roadmap will be continually reviewed and modified based on events in the public and private sectors. The research described exceeds the resources that are expected to be available through the NCHRP and it is hoped that other organizations will choose to undertake some of the described efforts.

A competitive process was used to identify four task-order contractors for NCHRP Project 20-102. For each task, proposals will be requested from the selected task-order contractors. Unsolicited proposals from other organizations will not be considered (except as noted for Task 10).

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SUMMARY OF APPROVED RESEARCH PROJECTS

♦ Project 20-102(10)
Cybersecurity Implications of CV/AV Technologies on State and Local Transportation Agencies

Allocation: $250,000
Source: NCHRP 20-24(98) Research Roadmap, Task Statement 2.8

Connected vehicle technologies and applications have significant security requirements, not only for the applications themselves, but also as potential access points that could enable attackers to get inside an agency's broader network and operations. Safety-critical messaging between vehicles and infrastructure (and vice versa) needs to be trusted as being from a valid source and not spoofed by a hacker or malevolent agency. These cybersecurity requirements and technologies exceed the experience levels of most current DOT and local agency staff responsible for intelligent transportation equipment, as well as being more complex than most existing security schemes for commonly used services, such as online banking. Agencies need to understand the implications of these technologies on the design of their communications networks, networking equipment configuration, field device security, and operations best practices. AV technologies have similar vulnerabilities to hacking that could result in liability and public safety exposure to public agency owner/operators. While a proof of concept for the Security Credential Management System (SCMS) has been demonstrated in the Safety Pilot and will be further evaluated in the DOT CV pilot deployment programs, the ultimate scalability of the security approach(es) will still need to be determined as the market penetration levels increase dramatically. The role of AASHTO and state and local agencies in the development of security standards and certification for AV/CV operation in a locality needs to be clearly identified.

The objective of the research is to develop a primer on cybersecurity and related privacy issues in state DOT and local agency environments, based on experience gained in other domains where security and privacy issues are currently being managed (such as financial services). The report will focus initially on recommendations for best practices on a general level and then describe techniques that will support the agency in planning for the security environment and practices necessary for safety-critical CV applications, including the SCMS. The primer will provide recommendations for best practices and explore the development of standard requirements and testing and certification protocols for protecting the liability and burden of the protection of public safety for agencies when CV/AV technologies are in widespread deployment.

NOTE: This task will be combined with NCHRP Project 03-127, Cybersecurity of Traffic Signals and Related ITS, and an open request for proposals (that is, not limited to the NCHRP 20-102 task order contractors) will be issued under the NCHRP 03-127 project.

♦ Project 20-102(11)
Summary of Existing Studies on the Effects of CV/AV on Travel Demand

Allocation: $100,000
Source: NCHRP 20-102 Panel

As planning agencies begin to model different scenarios associated with the deployment of automated vehicles and connected vehicles, information on the likely impacts on trip making is a critical need. Many studies are currently underway internationally (including the proposals for the Smart City Challenge) and this task will bring their assumptions and any findings together into a concise format that will be useful to planners in scenario development.

♦ **Project 20-102(12)**
Business Models to Facilitate Deployment of CV Infrastructure to Support AV Operations

Allocation: $400,000
Source: NCHRP 20-24(98) Research Roadmap, Task Statement 1.2

Connected vehicle technology will be essential to support the operation of automated vehicles in ways that will generate societal benefits rather than disbenefits. Different jurisdictions will have varying levels of interest in deploying CV infrastructure, based on varying perceptions of the benefits that they will gain from CV systems. Limited availability of CV infrastructure will seriously impede the ability of AVs to operate everywhere and is likely to deter growth of the market for AVs. How should this problem be addressed, to provide policy frameworks and/or business models that can facilitate widespread deployment of the needed CV infrastructure?

The objective of the research is to provide guidance for agency decision-makers to use in evaluating possible business models for their CV investment and policy decisions. The project needs to start from a basis of solid analysis showing the importance of CV technology to enable AV systems to produce societal benefits, and then explore how to deploy the needed CV infrastructure. Tasks may include:

Task 1. Review and summarize existing authoritative research results to show the differences in traffic flow dynamics (and hence congestion, energy use, and pollutant emissions) associated with AV versus CV automation systems at various levels of automation. Based on these results, estimate the net difference in societal benefits of AV implementation with and without CV capabilities for a variety of representative deployment environments (large and small metropolitan regions, intercity corridors with different traffic volumes, etc.). Assess these separately for I2V and V2V cooperative automation (for which the infrastructure requirements are likely to be substantially different). For cases in which the existing literature does not provide sufficient information about the differences, perform additional modeling studies to produce refined estimates. *Note: The U.S. DOT is developing a benefits assessment tool that could be foundational to this effort.*

Task 2. Define how the requirements for CV systems to support AV operations could potentially be more stringent than they would be for other ITS applications, in ways such as: (a) limited tolerance of holes in communication coverage when driving from one jurisdiction to the next; (b) greater availability requirements based on safety and productivity implications of the loss of communications by the AV applications; (c) need for additional data elements beyond the minimum required BSM Part I data elements that will be required for cooperative collision warnings under NHTSA regulations; and (d) enhanced cyber security needs. Based on considerations such as these, identify the extent to which AV usage could impact the costs of deploying and/or operating the infrastructure elements of both I2V and V2V cooperative systems.

Task 3. Define potential business models for deployment of the CV infrastructure needed to support AV use of CV technology, accounting for public agencies sensitivity about providing others with access to their traffic signaling infrastructure. These could include: (a) combinations of designing, building, owning, operating, and maintaining the CV systems by the public agencies themselves; (b) franchising or contracting out to third parties; (c) offering right-of-way access to third parties in exchange for them providing the CV infrastructure; (d) other forms of public-private partnerships in which the AV industry or AV operators would finance the CV infrastructure costs based on their own direct benefits; (e) relying on cellular infrastructure as available rather than deploying dedicated short range communications (DSRC), considering the potential differences in communication capabilities and system performance as well as costs and responsibilities for the public agencies.

Task 4. Based on the findings from the previous tasks, develop recommendations for what actions states should take regarding implementation of both I2V and V2V connectivity infrastructure to support AV operations, addressing topics such as: (a) criteria states should use to prioritize locations for I2V and V2V CV infrastructure deployment and (b) how the CV deployments should be financed (what business models for what operating environments) based on

the levels of implementation costs and of societal benefits relative to direct private user benefits.

♦ Project 20-102(13)
Planning Data Needs and Collection Techniques for CV/AV Applications

Allocation: $250,000
Source: NCHRP 20-24(98) Research Roadmap, Task Statement 2.10 (partial)

Note: While similar to Task 14, this problem statement focuses on data for planning purposes.

As owners and operators of transportation infrastructure, state and local agencies maintain databases of relevant information. Currently, this includes travel survey records, traffic counts, crash records, design "as built" plan sets, construction schedules, and many more. CV/AV applications need certain information about the environment and infrastructure in a variety of time scales, and information about the potential impact of CV/AV on future transportation. Household travel surveys are administered on a regular basis in many MPOs, and in several states. However, no information about the potential impact that CV/AV would have on future travel is available from these surveys, and no consensus exists about standards to collect information in this area. Similarly, some AV developers are currently storing detailed digital 3-D maps for reference during automated driving. Perhaps such an asset of a public agency could be valuable to many applications, but this requires maintenance. Some agencies provide access to various sets of information electronically, others are available through records requests, and yet others are not available at all. Agencies vary widely in their ability to provide access to certain information now and in the future. There is a need to identify the information that is necessary for agencies to maintain to plan, enable, and enhance CV/AV applications; develop standard formats and standard systems where they would be helpful and do not already exist; and provide guidance for agencies on how to implement strategies for collecting, updating, maintaining, and disseminating the information.

Similarly, a variety of information about travel conditions can be collected by CV/AV enabled vehicles and can be shared with agencies to enhance their operations. Agencies currently struggle to collect good information about origin-destination flows, traffic volumes, travel delays, pavement surface quality, crash and anomaly location, and location of work zones, among others. There is a need to identify standards for collection of this information, how it is communicated to agencies, stored, maintained, updated, and eventually used to enhance transportation planning, operations, and maintenance.

The Safety Pilot Model Deployment and the upcoming additional CV pilot deployments will continue to contribute valuable information on the design and implementation of management systems for dissemination of agency-owned data and ingestion of CV/AV generated information for agency operations. The scalability of these systems needs to be estimated in this research as the penetration level of CV/AV technology advances from several thousand vehicles to several millions. Similarly, each CV pilot deployment will only deploy a small subset of the 50+ envisioned applications. Scalability of the back-end system to eventually accommodate up to 50 applications will also need to be explored in this research.

The objective of this research is to develop guidance on data collection and management strategies for the planning needs of typical agencies. This research will be coordinated with Task 14 that is looking at the operational realm.

The research team will define the data sensitive to the deployment of CVs and AVs that is needed by transportation planning organizations across the spectrum of planning applications. The team will describe promising approaches to forecasting that data and likely sources for the data underlying those forecasting approaches. Useful private sector sources of the underlying data will be described as well as obstacles to their use. A catalog of recommended stated preference questions and collection methods will be developed to allow market acceptance of these technologies to be charted over time and over different regions. Scenarios for typical agencies at state, regional, and local levels will be developed as examples for data management recommendations (including ingesting, storing, and using this data). The team will (a) review existing standards, formats, and commonly used

technologies and (b) develop recommendations for harmonizing standards, developing dissemination and data collection systems or approaches, and ways of maintaining the information that is disseminated and using the data that is collected over time. Maintenance of the information over time is the critical component of the research and the recommendations. These tasks also should identify data availability policies and methods to address privacy and security concerns while not compromising the value of the information collected from CV/AV enabled vehicles.

♦ Project 20-102(14)
Data Management Strategies for CV/AV Applications for Operations

Allocation: $250,000
Source: NCHRP 20-24(98) Research Roadmap, Task Statement 2.10 (partial)

Note: While similar to Task 13, this problem statement focuses on data for operations purposes.

As owners and operators of transportation infrastructure, state and local agencies maintain databases of relevant information. Currently, this includes crash records, design "as built" plan sets, traffic signal timing parameters, construction schedules, and many more. CV/AV applications need certain information about the environment and infrastructure in a variety of time scales. Signal timing status is obviously needed in real time, traffic sign placements might be updated daily, and the next month's construction projects might be updated weekly. Some AV developers are currently storing detailed digital 3-D maps for reference during automated driving. Perhaps such an asset of a public agency could be valuable to many applications, but this requires maintenance. Some agencies provide access to various sets of information electronically, others are available through records requests, and yet others are not available at all. Agencies vary widely in their ability to provide access to certain information now and in the future. There is a need to identify the information that is necessary for agencies to maintain to plan, enable, and enhance CV/AV applications; develop standard formats and standard systems where they would be helpful and do not already exist; and provide guidance for agencies on how to implement strategies for collecting, updating, maintaining, and disseminating the information.

Similarly, a variety of information about travel conditions can be collected by CV/AV enabled vehicles and can be shared with agencies to enhance their operations. Agencies currently struggle to collect good information about origin-destination flows, traffic volumes, travel delays, pavement surface quality, crash and anomaly location, and location of work zones, among others. There is a need to identify standards for collection of this information, how it is communicated to agencies, stored, maintained, updated, and eventually used to enhance transportation planning, operations, and maintenance.

The Safety Pilot Model Deployment and the upcoming additional CV pilot deployments will continue to contribute valuable information on the design and implementation of management systems for dissemination of agency-owned data and ingestion of CV/AV generated information for agency operations. The scalability of these systems needs to be estimated in this research as the penetration level of CV/AV technology advances from several thousand vehicles to several millions. Similarly, each CV pilot deployment will only deploy a small subset of the 50+ envisioned applications. Scalability of the back-end system to eventually accommodate up to 50 applications will also need to be explored in this research.

The objective of this research is to develop guidance on operational data management strategies for typical agencies. This research will be coordinated with Task 13 that is looking at the planning realm.

The research team will summarize CV and AV applications that require information from public agencies at various time scales and develop recommended strategies for agencies to update, maintain, and make this information available to CV/AV applications. The research team will review previous work such as the CV Pooled Fund Study report on impacts of CV data on TMCs. Similarly, the research team will summarize CV and AV applications that can provide important information to public agencies at various time scales and develop recommended strategies for agencies to ingest, store, and use this data.

Scenarios for typical agencies at state, regional, and local levels will be developed as examples for data management recommendations. A public sector task force will be established to provide feedback on project direction. The team will review existing standards, formats, and commonly used technologies and develop recommendations for harmonizing standards; developing dissemination and data collection systems or approaches; and approaches to maintaining the information that is disseminated and using the data that is collected over time. Maintenance of the information over time is the critical component of the research and the recommendations. These tasks should also identify data availability policies and methods to address privacy and security concerns while not compromising the value of the information collected from CV/AV enabled vehicles.