Budgetary Implications of ITS/CVO for State Agencies

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EXECUTIVE SUMMARY

Commercial vehicle regulation and enforcement is a necessary and important function of state governments. Through regulation, states promote highway safety, ensure that motor carriers have the proper licenses and operating permits, and collect taxes and fees for motor carriers' use of publicly funded roadways. Traditional methods of doing so, however, can be costly and time consuming to administer and enforce.

The application of intelligent transportation systems (ITS) to commercial vehicle operations (CVO) is expected to enable both states and motor carriers to realize significant operating efficiencies and other benefits. Several studies, for example, have projected significant operational benefits for the private sector from emerging ITS applications for CVO (ITS/CVO). To date, however, little has been done to quantify the budgetary impacts of these systems to agencies. *Budgetary Implications of ITS/CVO for State Agencies* was commissioned by the Federal Highway Administration (FHWA) and directed by the National Governors' Association to address this gap. Based on detailed case studies of eight states, each of which is at different stages of deployment and facing different challenges, this study presents a framework for estimating direct financial benefits and costs to state agencies of investing in ITS/CVO applications.

STUDY SCOPE

The institutional focus of this study is state agencies. The range of benefits catalogued for this analysis is thus restricted to changes in direct costs such as labor, supplies, and changes in revenues from sources such as citations and fuel tax payments. The costs shown in the study are restricted to the expenses necessary to install and operate ITS/CVO applications. These costs include hardware, installation, operating and maintenance, and additional labor. The intention of this effort is to assist states in evaluating ITS/CVO. By isolating the impacts on state budgets, planners and decision-makers will be better equipped to allocate resources between ITS/CVO and the other needs facing the state.

Although this study compares direct state agency benefits (cost savings and additional revenue) to agency costs, it is not a full benefit/cost analysis. Some of the most significant benefits of ITS/CVO—such as improved highway safety, time savings for motor carriers, and reduced air pollution—are not captured in this study because they are either not fiscal impacts, or do not affect state agencies.

For the purposes of this study, CVO functions and their corresponding ITS applications are divided into two broad categories: administrative processes and roadside activities.

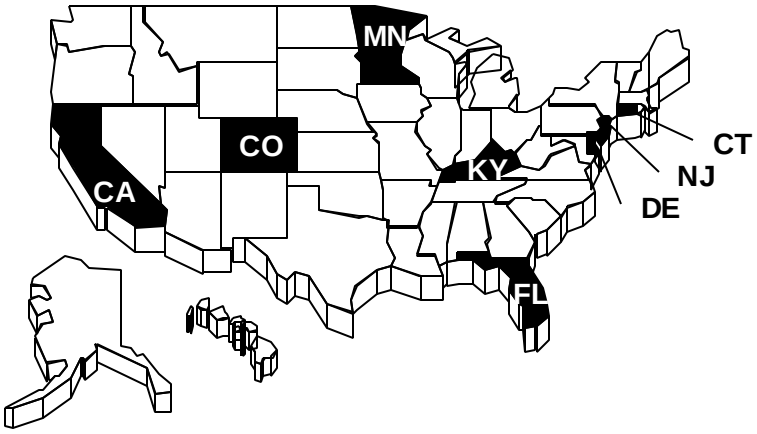
- **Administrative processes** refer to credentialing and permitting for commercial vehicles—the paperwork motor carriers are required to file to register their vehicles, pay fuel taxes, acquire special permits, etc. Through *electronic credentialing*, a carrier submits payments, credential and permit applications, and receives official documents via fax, modem or some other means of electronic data transfer.

- **Roadside activities** encompass vehicle safety and clearance efforts. These activities take place at a fixed weigh station, a remote (or mobile) weigh station, or remote inspection site. Through *electronic clearance and safety* state inspectors and troopers can weigh trucks without requiring them to stop, and verify a vehicle's credentials and evaluate vehicle safety records electronically before the vehicle arrives at the weigh station or checkpoint.

This study uses a 10-year timeframe for the analysis of state agency costs and cost savings and assumes that states will achieve full deployment of ITS/CVO by the end of that period. Since ITS/CVO products and services are offered with a variety of levels of quality, functionality, and cost, the study team analyzed a full range (low- and high-end) of equipment packages.

The case study states for this analysis are shown in Exhibit E1. These states were selected to represent a broad sample of characteristics such as level of trucking activity, state approach to CVO regulation, experience with ITS/CVO, and geography.

Exhibit E1. Case Study States



FINDINGS

This study finds a high level of variation in costs and cost savings among states for ITS/CVO. Therefore, while this report presents overall conclusions with regard to budgetary consequences, each state must evaluate investment decisions in the context of their own regulatory and enforcement framework. This report, and the accompanying Guidance manual, identifies the key issues to evaluate and a framework for doing so. Other specific conclusions include:

- Agency benefits of electronic credentialing generally exceed the costs of these systems, suggesting that these applications are financially self-supporting and can be justified within a state budgeting context alone.

- Direct agency cost savings of electronic clearance and safety, on the other hand, are generally less than the costs of these systems, suggesting that the rationale and means

of financing these investment should be evaluated jointly with an understanding of the operational benefits for each state and other public-policy implications.

- For all systems, motor carrier acceptance of ITS/CVO technologies and participation in state deployment initiatives will play a vital role in the realization of the full potential benefits for state agencies, motor carriers and society.

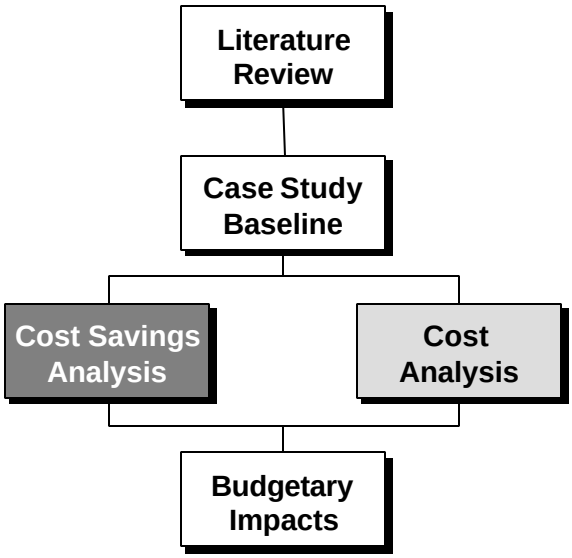
POLICY IMPLICATIONS

A long-standing role of the public sector has been to make critical investments in infrastructure that benefit society as a whole with less concern for the direct financial return to governmental treasuries. Thus, while the fiscal implications of ITS/CVO are very useful to making informed policy decisions regarding investments in the safety and efficiency of a state's transportation system, by themselves these impacts alone are not sufficient to make a decision. Policy issues are discussed in depth in the companion piece to this Executive Summary.

STUDY METHODOLOGY

The focal point of this study is a series of eight case studies that illustrate the range of impacts states may experience when investing in ITS/CVO. An overview of the study methodology is depicted in Exhibit E2. Chapter 1 of the study, *Introduction*, describes the methodology in greater detail.

Exhibit E2. Overview of Study Methodology



PRODUCTS OF THIS STUDY

There are three primary products of this study, each of which is designed for a separate audience:

- **Executive Briefing—**The Executive Summary from the Final Report and a white paper that expands upon the policy implications of the technical findings of this study. This product is targeted to the needs of high-level decision-makers.

- **Final Report—**The comprehensive findings of the study, including methodology and detailed analysis. This product is intended for state agency technical staff, transportation professionals, and academicians.

- **Guidance and Model—**An overview of the issues and procedures necessary to undertake a state level analysis relying on either state data or study findings. The Guidance is accompanied by a spreadsheet model designed to allow each state to develop a customized budgetary analysis of ITS/CVO using the methodology developed in this study. The Guidance and model are intended for a mix of technical and non-technical users.

I. INTRODUCTION

Intelligent Transportation Systems (ITS) applications for commercial vehicle operations (CVO) have the potential to streamline public agency commercial vehicle regulatory and enforcement activities and to result in substantial operational and enforcement benefits. Yet understanding how to capitalize on this potential is not simple. Each state must evaluate each of the ITS/CVO applications and options in the context of its own operational, regulatory, and budgetary framework.

This study, *Budgetary Implications of ITS/CVO for State Agencies*, seeks to address this need. Specifically, it presents the findings of an analysis of systems and state agency expenditures required to deploy and operate ITS/CVO applications and the fiscal benefits expected to result from this investment. The study, commissioned by the Federal Highway Administration (FHWA) and directed by the National Governors' Association, included four goals:

1) Evaluate and identify the functions and costs of traditional state administration of motor carrier regulatory requirements;

2) Identify current ITS/CVO alternatives that may substitute for and/or enhance the effectiveness of the traditional CVO regulatory practices and procedures;

3) Develop and apply a budgetary framework to inform state decision-makers about fiscal implications of deploying ITS/CVO; and

4) Provide guidance and an analytical framework to assist states in estimating the budgetary impacts of ITS/CVO investments taking into account the unique characteristics of each state.

This report is one product from that study. It provides an in-depth analysis of the direct budgetary impacts of full investment in ITS/CVO based on case studies of ITS/CVO implementation issues and costs for eight states selected from across the US to represent a wide range of regulatory and operational environments. The analysis itself quantifies how a fairly aggressive ITS/CVO deployment scenario—assuming full deployment of ITS/CVO in ten years or less—could change public-agency business practices. As such, it presents estimates of year-by-year costs to public agencies, as well as the potential direct cost savings and additional revenue that states may collect, for each of the major systems investments.

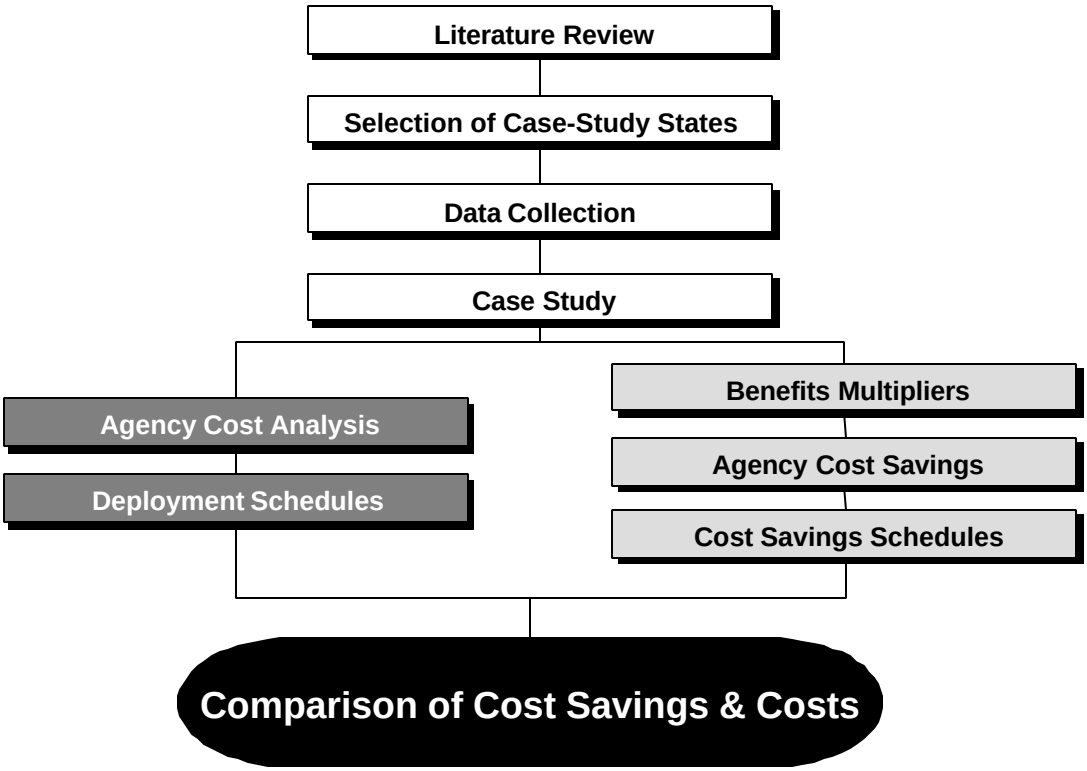
In addition, to ensure that the results of this study are useful to a broad audience, this report is accompanied by a step-by-step guide for assessing and implementing ITS/CVO alternatives for enhancing the effectiveness of regulatory compliance monitoring has been developed. This guidance will enable each state to undertake a "customized" budgetary analysis for ITS/CVO applications using the same method outlined in this report. This chapter describes:

- **Methodology** employed to accomplish the study goals; and
- **Parameters and Definitions** relied upon throughout the study process.

METHODOLOGY

The general approach to conducting this study is presented in Exhibit I-3.[1]

Exhibit I-3. Overview of Study Methodology



Literature Review

The literature review provided the study team with a firm understanding of related efforts that are completed or in progress across the US and identified gaps in the existing research that the current research effort could address.

The initial findings of the review of current state practices and ITS applications for CVO were presented to an expert panel to identify any additional sources of information and to determine how the finding can best be put to use in subsequent tasks of this study.

[1] An overview of the stratification methodology and the selection of the case-study states is presented in the Task I Technical Working Paper.

Selection of Case-Study States

Once the states were stratified, the study team selected a representative sample of eight states for case study analysis. States were selected to provide a range of observations with regard to number of trucking firms, annual truck vehicle miles traveled (VMT), regulatory activity, geography, and prior experience with ITS/CVO.

Data Collection

The next step in the case study analysis was to identify the data requirements and collect data from the eight case study states. This task was accomplished primarily through a combination of a survey of various state agencies involved in administrative processes and roadside activities and select, direct interviews with leaders in ITS/CVO. States provided information on the characteristics of their current (non-ITS) CVO practices (e.g., number of credential applications processed, and the number of staff required to process these applications). In a limited number of cases, states were also able to provide information on how much they had spent or expected to spend on ITS/CVO deployment. For the states with ongoing ITS/CVO activities, empirical data on benefits, in most cases, were unavailable. Where available, actual costs and benefits data from the states surveyed were used in the study. In the majority of cases, however, the study team estimated the likely costs and cost savings of deployment for a particular state. Throughout this report and the appendices, all estimates that are based on assumptions made by the research team are values that are clearly identified.

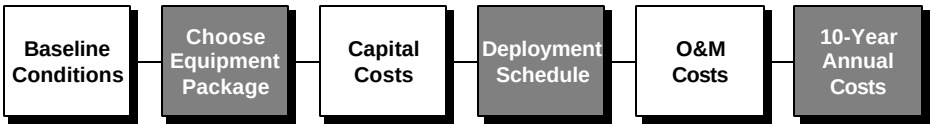
Develop Case Study Baseline

The data on the characteristics of current state CVO processes were assembled into a budgetary baseline in the second step of the case study analysis. As mentioned above, for all eight states it is assumed that the baseline represents no existing investment in ITS/CVO. Since this study focuses on state agencies, the anticipated benefits of ITS/CVO are assumed to take the form of either reduced agency costs or increased revenue. Thus both costs and cost savings for ITS/CVO are calculated as the change from the baseline.

Agency Cost Analysis

Once the baseline was established, the analyses of agency costs and cost savings proceeded in parallel, undertaken by separate research teams to ensure unbiased analysis.[2] The methodology for the cost analysis is shown in Exhibit 1-4.

Exhibit 1-4. Cost Analysis Methodology



From the wide variety of technological and operational options available, the study team selected a set deemed representative of the cost and function of the available systems. These equipment packages

[2] Castle Rock Consultants performed the cost analysis. Apogee Research performed the benefits analysis.

were assembled into a unit-cost template common to all case study states.[3] (These cost templates were presented to the study's Technical Advisory Group (TAG[4]) for review and comment.) Next, the study team scaled the unit costs for each state according to the number of facilities the state is currently operating. For example, the cost for a high-end weigh station under the Clearance and Safety scenario for roadside activities would be multiplied by the number of weigh stations currently operating in a particular state to estimate total weigh station costs for that state.[5]

Deployment Schedules

Once the total cost for each state was established, the study team developed alternative deployment schedules. These schedules illustrate the differences in costs under aggressive and conservative deployment initiatives and were used to calculate the year-by-year costs for each case study state. This was achieved by matching the total costs for a state with the marginal percentage of investment completed in a given year.

Benefits Multipliers

As mentioned above, the analysis of agency benefits, Exhibit I.5, was developed in parallel with the cost analysis. In this step, the study team estimated the potential agency cost savings and increased revenue as a percentage of typical baseline costs.[6] The general approach to the cost savings element of the study was to apply benefits multipliers to the baseline data. Where possible, these multipliers were derived from observational data and findings in published studies. In cases where no published source was available, the study team formulated estimates of the factor based on a combination of interviews with the relevant transportation professionals, input from the study's TAG, and the team's own judgment. In all cases, the study team attempted to use conservative multipliers to avoid any possible over-estimation of benefits. In addition, sensitivity analysis was used to capture the degree of uncertainty in any given estimate.

Exhibit I.5 Cost Savings Analysis Methodology

For the purposes of this study, "full" benefits represent the maximum savings or increase in revenue that a state can expect to achieve under a given scenario. In no case is it assumed that a category of costs (e.g., labor) could be entirely eliminated. Instead, if the benefits multiplier has a range of 33 percent to 40 percent, "full" benefits would mean that the state could realize between a 33–40 percent reduction in labor costs.

[3] As mentioned above, the decision-rule used by the study team was to use state-provided data where possible, and generate educated estimates where necessary. All estimates generated by the study team are identified with footnotes.

[4] A complete list of the Technical Advisory Group follows this report.

[5] In certain cases, the number of ITS/CVO units installed actually differs from the number currently operating in the state to produce a realistic cost estimate. This issue is explained in greater detail in Chapter V, Cost Analysis.

[6] For example, it might be assumed that electronic credentialing would result in 33-percent labor savings from the baseline, regardless of the state.

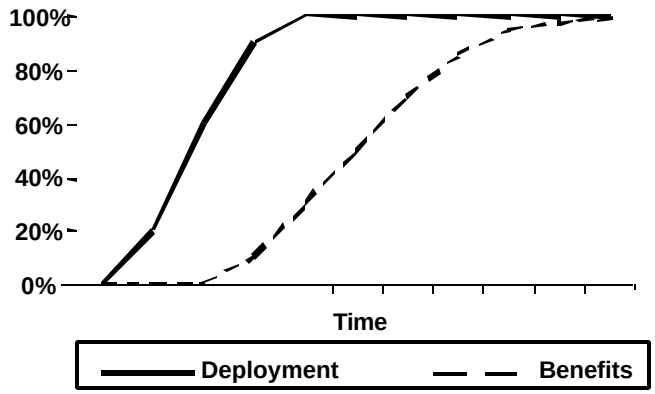
Agency Cost Savings

The range of benefits multipliers were applied to the baseline data to determine the total benefits that a state could achieve in a given year, assuming full carrier participation. Essentially this calculation is equivalent to the benefits expected in Year 11, after all systems are operating.

Benefits Realization Curves

The deployment schedules developed for the cost analysis are also the basis for determining the rate at which cost savings are realized. For each deployment alternative, the study team estimated the degree to which the statewide system of ITS/CVO applications would be functional. It is assumed that carriers will be reluctant to participate in ITS/CVO systems until they are confident that the ITS approach is becoming the normal business practice in a state, not the exception. Thus there is a lag between the deployment and the carrier acceptance/ participation. Once a critical mass of deployment takes place, however, carriers increase their participation and states begin to realize benefits in an accelerated manner. This general relationship between the system deployment and lagged savings is shown in Exhibit I-6.

Exhibit I-6. Generalized Relationship between Deployment & Realization of Benefits



Just as the deployment curves were used to apportion costs to a given year, the benefits curves were used to estimate the level of agency savings that could be realized in a given year.

Comparison of Agency Costs & Agency Cost Savings

Agency costs and cost savings were discounted these values to arrive at figures in constant (1997) dollars. A discount rate of seven percent was then applied to arrive at an estimated net present value (of agency cost savings and agency costs).[7]

In addition, a "fiscal benefit to cost ratio" was developed based on the ratio of cost savings to direct costs. As noted previously, this ratio does not account for all costs and all benefits; only the costs and costs savings relevant to public sector agencies are included in the estimates. For this analysis, separate ratios were developed for electronic credentialing, electronic clearance and safety and total ITS/CVO (electronic credentialing and electronic clearance and safety combined).

[7] A seven-percent discount rate is commonly used for evaluating public-sector projects.

STUDY PARAMETERS & DEFINITIONS

Major elements of the scope of this study are outlined below. This section identifies the types of CVO functions examined in this study and their corresponding ITS applications; the types of costs and cost savings included and excluded from this analysis; the range of case study states identified; the timeframe for the analysis; and assumptions relating to a state's level of effort for investments in ITS/CVO.

Definition of ITS/CVO Functions

For the purposes of this study, CVO functions and their corresponding ITS applications are divided into two broad categories: administrative processes and roadside activities. In general, the activities addressed in this study represent the full range of state involvement in state regulation of CVO.

ITS/CVO Functions—Administrative Processes

Administrative processes refer to credentialing and permitting for commercial vehicles—the paperwork motor carriers are required to file to register their vehicles, pay fuel taxes, and acquire special permits for oversize/overweight or hazardous cargo. These activities may be commonly referred to as credentialing, permitting or desk-side activities.

The ITS applications for administrative processing are termed *electronic credentialing*. As the name implies, these tools enable a carrier to submit credential and permit applications, submit payment, and receive official documents via, fax, modem, or some other electronic means of transfer. In addition, state agencies may be able to establish a single point of contact for motor carriers (One-Stop Shopping), reduce requirements for processing staff, and share data across various agencies more readily.

ITS/CVO Functions—Roadside Activities

Roadside activities encompass vehicle safety and clearance efforts. Roadside activities may take place at a fixed weigh station, a remote weigh station, remote inspection sight, or any place along the roadside when a trooper or inspector may have reason to pull a carrier over. Safety activities involve checking carrier and/or vehicle safety records, visual or physical inspection of vehicle condition, and verification that a driver is licensed and fit to operate a commercial vehicle. Clearance activities involve checking carrier and/or vehicle credentials and permits, counting vehicles, and weighing vehicles to ensure that they meet prescribed weight limits.

The ITS applications for roadside activities are commonly referred to as *electronic clearance and automated safety management*. These tools enable state inspectors and troopers to read and evaluate vehicle safety records, credentials, and other documentation electronically before the vehicle arrives at the weigh station or checkpoint. Some systems may be programmed to identify vehicles that are most likely to have safety or weight violations based on carrier/vehicle records. These "high-risk" vehicles will be called in for further review while vehicles with satisfactory records may be allowed to by-pass the station without stopping. Once a vehicle arrives at the weigh station or inspection site, ITS tools will enable a safety inspector to enter data records directly into networked databases rather than on a conventional paper form. In the case of electronic clearance, ITS applications facilitate automatic counting and classification of vehicles, as well as weighing a vehicle while in motion as opposed to requiring the vehicle to stop on a conventional scale. These tools enhance the effectiveness and efficiency of regulatory/safety enforcement, reduce delays to carriers, provide additional incentives for carriers to comply with regulations, and reduce costs to state agencies.

Definition of Costs & Cost Savings

This study focuses on the *incremental* budgetary costs and cost savings to state agencies of ITS/CVO deployment.[8, 9] This study is solely concerned with issues directly related to the impact of specific ITS/CVO applications and on state-agency operating budgets.

The costs estimated in this study include the infrastructure required to facilitate deployment of ITS/CVO, operating and maintenance costs, and in some cases replacement costs. Carriers may need to acquire special equipment to participate in ITS/CVO. In some early deployments, the cost of carrier equipment has been borne by the carrier. In other cases, the costs are assumed or subsidized by the state (or operating body).[10] To address this aspect of the costs, this study presents alternative cost scenarios to show the maximum and minimum likely range of costs to the public sector.

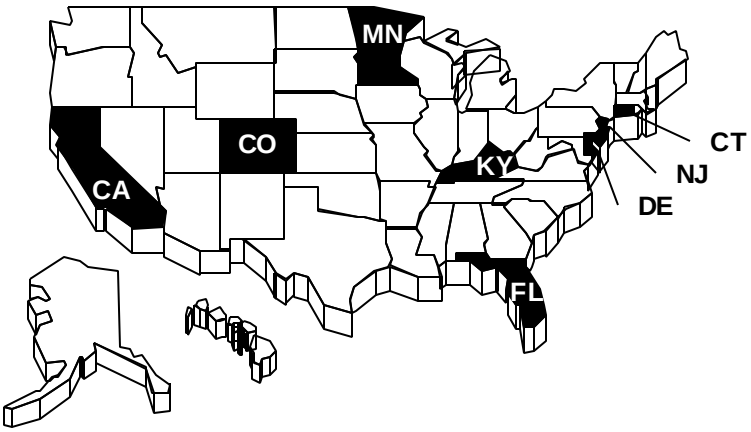
The cost savings (and "benefits") estimated in this study include only the direct budgetary savings that states and increased operating revenue are likely to realize. These benefits include labor savings, reduced paving costs (from reduced pavement damage), and increased revenue from voluntary compliance with taxes and regulations.

A long-standing role of the public sector has been to make critical investments in infrastructure that benefit society as a whole with less concern for the direct financial return to governmental treasuries. Because the focus of the study is on state agencies, several major societal benefits of ITS/CVO are not estimated. For example, societal benefits from reduced accidents and enhanced highway safety, and operational cost savings to motor carriers—perhaps the two largest benefits of ITS/CVO—are both outside the scope of this analysis. Further more, this study is not concerned with the costs and benefits of CVO regulations in general.

Case Study States

The case study states for this analysis are shown in Exhibit I-2. These states were chosen to represent a diverse sample using characteristics such as number of trucking firms, number of safety inspections performed, commercial vehicle miles traveled (VMT) and number of agencies responsible for regulating CVO.[11]

Exhibit I-2. Case Study Sates



[8] For the purposes of this study, "incremental" means *change from the baseline budget*. The study *does not* identify the incremental costs and cost savings of slight variations in ITS/CVO equipment packages.

[9] In some cases, cost savings may be referred to as "benefits."

[10] Direct equipment costs borne by the carriers are not included in the cost estimates for this study.

[11] For a detailed explanation of how the case study states were selected see the Task I Technical Working Paper.

In addition, states were selected to provide balance in terms of geography and level of experience with ITS/CVO. As such, some of the case study states have relatively little ITS/CVO infrastructure in place, and will face a substantial learning curve should they decide to invest in ITS/CVO. Other states, however, are already in the process of deploying ITS/CVO through the Commercial Vehicle Information Systems and Networks (CVISN) program, operational tests (Pre-Pass™, MAPS, Advantage I-75) or other initiatives.[12] Although some case study states may have some ITS/CVO infrastructure in place, the baseline for this analysis assumes that all eight case study states are starting at the same point: *no ITS/CVO deployment*. Consequently, it is also assumed that none of the case study states are currently realizing the benefits of ITS/CVO.[13]

Analysis Timeframe

This study uses a 10-year timeframe for the analysis of state agency costs and cost savings. It is assumed that states will achieve full deployment of ITS/CVO by the end of this period. Although some states may actually invest in these technologies in a more aggressive manner, it is likely that many states would spread their investments over a longer timeframe.

As a consequence of the 10-year timeframe, this analysis does not necessarily illustrate full life-cycle costs and cost savings for ITS/CVO infrastructure. Only that portion of equipment life-cycle costs that fall within the 10-year horizon are included in the estimated costs. Similarly, only the agency benefits that are realized during the analysis period are counted. For example, if a state retrofits a weigh station in year ten, this analysis will capture the capital cost for the weigh station, but not the operating and maintenance costs for the subsequent years. In addition, only a portion of the full cost savings at this weigh station would be counted, since the majority of the benefits would be realized in the period beyond the scope of this study.

Level of Investment

The nature of ITS/CVO investment varies according to the deployment plan and the breadth of the systems a state may elect to deploy. The study team developed a range of scenarios for the deployment of ITS/CVO infrastructure, ranging from "aggressive" to "conservative." Separate deployment schedules are used for administrative functions and roadside activities. In the case of electronic credentialing, deployment is assumed to be complete in either two or three years. For electronic clearance and safety, however, deployment requires between four and ten years.

Like most consumer markets, ITS/CVO products and services are offered with a variety of levels of quality, functionality, and cost. To address the range associated with these factors, the study team created low- and high-end equipment packages. For the purposes of this study, a low-end package includes the minimum investment a state would have to make in order to "get the job done." The high-end package typically includes additional features and increased durability—in other words, it is the *state-of-the-art* option. For electronic credentialing, this range represents the minimum cost to deploy a basic system and the cost to deploy an advanced system with greater flexibility and automation. In the case of electronic clearance and safety, the low-end option (referred to in the report as "Clearance Only") reflects a package that is primarily aimed at clearance functions and screening of vehicle safety

[12] For further discussion of the various deployment initiatives see Chapter II of this report.

[13] This assumption is discussed further in Chapter VI, Analysis of Benefits.

records. The high-end system (referred to in the report as "Clearance *and* Safety") includes additional applications for safety inspections. Within each of these electronic clearance and safety options are additional high- and low-end sets of equipment to perform the applicable functions.

STRUCTURE OF THE REPORT

Chapter II of this report presents an overview of state agency CVO activities, ITS applications for these activities, and the early field tests of these technologies. Chapter III provides a review of existing literature. The baseline conditions for the eight case study states are summarized in Chapter IV. Chapter V describes the approach to the agency cost analysis and the findings of this exercise.[14] The agency cost savings analysis is presented in Chapter VI of the report. This chapter explains the elements included and excluded from this analysis, the assumptions used and the key findings.[15] Agency costs and cost savings are compared in Chapter VII. Finally, Chapter VIII presents an initial discussion of the implications of the findings presented in Chapters V through VII.

[14] For detailed cost spreadsheets for each case study state see the Task II Technical Working Paper, Appendix 2.

[15] For detailed cost savings spreadsheets for each case study state see the Task II Technical Working Paper, Appendix 3.

II. CURRENT STATE PRACTICES & ITS/CVO ACTIVITIES

This chapter identifies current practices in state motor carrier regulation and the ITS/CVO applications that can support these practices as the first step toward quantification of ITS/CVO deployment impacts. Although based on a review of specific state practices, this section presents information regarding commercial vehicle regulatory administration and enforcement in general, while identifying key differences among states that may affect the value of ITS/CVO.

The information summarized in this document was obtained through a variety of sources including published research, professional journals, World Wide Web sites, interviews with Federal Highway Administration (FHWA) and state agency personnel, as well as the research experiences of the study team. It is presented in three sections:

1) Current state CVO administrative activities;

2) Current state CVO roadside activities; and

3) ITS/CVO activities.

CURRENT STATE CVO ADMINISTRATIVE ACTIVITIES

"State administrative regulation of motor carriers" encompasses all paperwork requirements that must be met to legally operate a commercial vehicle in a state or states. Regulatory administration consists largely of credentials and permits issued to motor carriers by jurisdictions where the vehicles will travel. In most cases, states require motor carriers to obtain vehicle registration, fuel-use tax licensing, authority to operate, and specialized over-dimensional permits for vehicles and cargoes of a size, shape, or weight that exceeds normal registration allowances.

These credentials, permits, and licenses are used (1) to identify motor-carrier businesses, commercial vehicles, and commercial-vehicle drivers and (2) to define the parameters under which and locations where they may operate. For instance, motor-carrier registration defines what types of vehicles a motor carrier can operate, specifies the gross vehicle weight limits for each vehicle, and identifies the jurisdictions in which each vehicle can operate.

Certain commercial vehicle credentials and permits are administered for all (member) jurisdictions under a base jurisdiction system. These credentials include:

- SSRS (Single State Registration System);
- IRP (International Registration Plan); and
- IFTA (International Fuel Tax Administration).

SSRS, IRP, and IFTA credentials are issued by the state in which a motor carrier is based. This base jurisdiction arrangement reduces the need for a state to interact with motor carriers outside their base state for registration, fuel tax, and authority credentials. Furthermore, the collection of the associated fees and taxes is simplified—the fees and taxes for all jurisdictions are paid only to the base jurisdiction. The funds are then transferred to the appropriate jurisdiction by the base state. The state is also responsible for auditing motor-carrier reporting, again made simpler through the base-state arrangement.

Other credentials are administered individually by each jurisdiction. The major credentials and permits in this category include:

- OS/OW (Oversize/Overweight) Permits;
- HAZMAT (Hazardous Material) Permits; and
- Weight-Distance Taxes.

In general, oversize/overweight permits and temporary permits are issued directly by each jurisdiction due to differences in size and weight regulations as well as routing considerations such as road construction, roadway design, and traffic.

While the SSRS, IRP, and IFTA programs have greatly simplified the credentialing and permitting process, states continue to receive paper forms and check payments for each type of credential. Much of the information that is required for each type of credential is redundant among the different forms, leading to redundant data entry for state agencies. Little or no information sharing takes place among state agencies even after the data is entered into an electronic format; information is kept in separate databases for each agency or even in separate databases within a single agency.

The splintering of commercial vehicle regulation among various agencies within each jurisdiction further compounds the effort required to administer these requirements. For example, in some jurisdictions the Department of Motor Vehicles is responsible for commercial vehicle registration credentials and permits, the Department of Revenue for fuel-use tax credentials and permits, the Department of Commerce for authority credentials and permits, and the Department of Transportation for oversize/overweight permits. This decentralization of authority can result in redundant staffing and infrastructure needs.

The following sections briefly describe the credentials and permits motor carriers are required to have, the programs used to administer these credentials, and other important details regarding these credentials.

Operating Authority (SSRS)

Operating authority designates the commodities hauled and geographic areas served by a motor carrier. Operating authority assures that state agencies have information about the motor carriers in their states, that the carriers have the appropriate insurance for their business and vehicles, and that the correct filing fee has been charged for the vehicles to be operated in the state. The base-state program for operating authority is the Single State Registration System (SSRS). Within the base state, operating authority is often issued by transportation commissions, public service commissions, utility commissions, state corporation commissions, or state DOTs. The SSRS system was intended as a temporary arrangement to provide administrative relief to motor carriers. However, SSRS continues in practice while federal agencies review comments on rulemaking from states and motor carriers on how to administer authority. Not all states are required to join the SSRS program.

Vehicle Registration (IRP)

All vehicles in a motor carrier's fleet must be registered in the carrier's base state. As with automobiles, this ensures the vehicle has a title and a legal and responsible owner, is covered by insurance, and that all taxes and registration fees have been paid. The registration fees are based on a weight-factor calculation. The vehicle's age, load capacity, and number of axles may also be considered. The International Registration Plan (IRP) was created to simplify the registration process for interstate carriers throughout the United States and Canada by allowing a vehicle to be registered in the base state only, regardless of where the carrier travels. The base state is responsible for auditing carriers' reports and transferring funds to other states.

Unlike SSRS, membership in IRP was mandated by the 1991 Intermodal Surface Transportation Efficiency Act (commonly know as ISTEA), which required states to join IRP by September 1996 in order to maintain eligibility for federal transportation funds.

Fuel Tax Payments (IFTA)

All but a few states have some form of a commercial vehicle fuel tax. Because large trucks can travel through entire states without refueling, and thus avoid paying fuel tax, states require that motor carriers report miles traveled within a state's borders and pay a fuel tax based on fuel usage calculated from fleet-fuel economy. Like SSRS and IRP, the International Fuel Tax Agreement (IFTA) was designed to simplify the administration of CVO regulatory requirements for both motor carriers and the states. With ITFA, fuel-tax licensing requirements for all member jurisdictions can be satisfied through the base state as well as quarterly fuel-use reporting. The base state provides the carrier with a fuel license, collects any additional monies owed, distributes payments to non-base states, collects refunds from other states, and performs the motor-carrier audits.

As with IRP, ISTEA mandated that all states join IFTA by September 1996 to maintain eligibility for certain federal highway funds.

Oversize/Overweight Vehicles (OS/OW)

State highway agencies issue permits allowing for the movement of oversize and overweight loads on state and interstate highways. In general, fees for these permits are intended to recover the administrative costs of permitting activities and are not directly related to the infrastructure costs that might be attributable to the oversize/overweight freight movement. Permitting regulations and fee structures vary greatly among the states due to differences in infrastructure design and management philosophies and the structural limitations of roadways and bridges.

Further complicating the administration of oversize and overweight permits is the need for highway-agency approval and vehicle routing for oversize/overweight movement. Highway and bridge design, current construction projects, and current roadway conditions affect vehicle-routing decisions. In most states, current data on infrastructure and construction restrictions is not available online but is kept on paper maps that are periodically updated.

Because of the differences in regulations and fee structures among jurisdictions, and the need for specific vehicle routing for many permits, oversize/overweight permitting does not lend itself to a base-state program. Thus, states currently issue oversize/overweight permits directly to each motor carrier for each applicable vehicle with little or no standardization or coordination among state agencies. While most agencies that issue oversize/overweight permits now accept application information over the telephone, oversize/overweight permitting remains a labor- and paper-intensive process.

Hazardous Materials (HAZMAT) Hauling

While a relatively small number of motor carriers hauls materials that are considered "hazardous," many states require some form of permit for these loads. The designation of a "hazardous material" is state-dependent but may include biohazards, radioactive material for use in a production process, radioactive waste, flammables, explosives, or chemicals (such as liquid nitrogen or hydrogen gas). Some states do not require permits for the movement of such materials if carriers are in compliance with federal guidelines.

Since regulations for HAZMAT vary by locale, permits for the movement of these goods are handled individually by each state. Most states that issue HAZMAT permits allow carriers to submit their application information via telephone or facsimile.

Weight-Distance Taxes

Twenty-three states have or have had weight-distance taxes. The weight-distance tax combines the weight of the vehicle with the distance traveled within a particular state in order to more closely relate highway-use fees to highway-use costs for a specific vehicle. Currently, four states—Idaho, New Mexico, New York, and Oregon—administer a weight-distance tax either instead of or in addition to a fuel tax. Traditionally, weight-distance taxes have been complicated and costly for both jurisdictions and motor carriers and have only been used by a few states. These taxes expend a great deal of resources, since they require accurate and detailed reporting on the carrier's part and thorough report auditing on the state's part.

Other Permits & Credentials

States also issue various permits and credentials as needed. These are usually for the movement of non-standard materials as designated by the state. Counties and cities may also charge fees or require permits.

Many states will issue temporary credentials/permits to motor carriers adding new vehicles to their fleets so that carriers may legally operate their vehicles without waiting for their paper credentials to arrive in the mail. Trip permits are issued to carriers making a "one-time only" movement. Some states require a permit to haul alcoholic beverages. Counties and cities may require special permits for their areas depending on what is being hauled, the route being taken, and how often the trips are made.

CURRENT STATE CVO ROADSIDE ACTIVITIES

States undertake a number of activities to ensure motor-carrier compliance with the credential, safety, and weight regulations described above. These activities generally consist of vehicle weighing and inspecting at roadside facilities. These activities require considerable resources in time, labor, and infrastructure.

Credential & Permit Compliance Activities

In addition to administrative auditing, states check permits and credentials at the roadside as part of Level I, II, and III inspections or other enforcement activities. These activities are based on paper documentation for the vehicle and driver carried on board each commercial vehicle. The inspections take a minimum of 15 minutes per vehicle and may only be performed by certified enforcement personnel.

Safety Compliance Activities

Drivers must hold a commercial drivers license, current medical certification, and must comply with the federal hours of service regulations, which set standards for the maximum number of hours per day a driver can be on active duty. Commercial vehicles must periodically pass inspections to ensure compliance with federal safety standards. Carriers, therefore, must maintain accurate and detailed safety-inspection reports and maintenance records. Where state law permits, fleets may self inspect.

Driver and vehicle safety requirements are enforced through two efforts: 1) inspection at the roadside, and 2) safety reviews performed at a motor carrier's place of business. Roadside inspections of vehicles and drivers are performed according to three standardized inspection procedures known as Level I, Level II, and Level III inspections.

- A Level III inspection is an inspection of the driver and a records check of credentials. The average Level III inspection takes 15 minutes.
- A Level II inspection adds a review of the credentials and permits for the vehicle and a walk-around inspection. The average Level II inspection takes 25 minutes.

- A Level I inspection, the most comprehensive, adds physical inspections of the mechanical and electrical systems of the vehicle. The average Level I inspection takes 45 minutes.

The driver and inspector must spend a minimum of 15 minutes completing paperwork and examining paper credentials and records. If the inspector finds violations with either the driver or the vehicle, the paperwork associated with issuing citations can add more than an hour to the inspection process.

Site reviews include examinations of safety and maintenance records and practices. These include accident records, logbooks, vehicle maintenance records, and drug-testing compliance. The site review can also include the inspection of vehicles at the facility. Inspectors require one to five days for a site review depending on the size of the carrier. Not all states perform site reviews.

Prior to the 1980s, safety standards and inspection processes varied widely among the individual states and between the states and the federal government. To help standardize safety standards and inspections, the states, the motor carrier industry, and the Federal Highway Administration (FHWA) formed the Commercial Vehicle Safety Alliance (CVSA) in 1980. As a result of the CVSA, the FHWA undertook the Motor Carrier Safety Assistance Program (MCSAP).

The CVSA exists to improve commercial vehicle safety by increasing the efficiency of the safety-inspection process and to minimize the costs associated with inspections through standardization. CVSA is a working agreement; it does not amend state laws and is not an interstate pact like IRP or IFTA. CVSA members recognize and affix common inspection decals to help target enforcement resources. For example, a vehicle bearing a current CVSA decal would indicate to enforcement personnel that the vehicle had passed a recent (within the last 90 days) CVSA Level I inspection. Enforcement personnel could then choose to either inspect the vehicle again or target vehicles that may not have been inspected recently. MCSAP was established to encourage the adoption of standardized enforcement processes and to expand enforcement activities. States receive federal MCSAP funds to implement safety enforcement programs compatible with federal regulations. MCSAP grants are used for roadside driver and vehicle inspections and site safety reviews.

The MCSAP has been instrumental in standardizing inspection procedures and increasing the number of vehicles and drivers inspected. Prior to the establishment of MCSAP, federal personnel conducted 36,000 inspections each year. During fiscal year 1990, MCSAP officials conducted 1.5 million inspections. Currently, all states are participating in the MCSAP program.[16]

Size & Weight Compliance Activities

All states have weight-enforcement programs to protect the highway infrastructure from premature failure due to overloading and to protect the public from vehicles made unsafe by overloading. States enforce weight compliance to federal size and weight limits on the National Highway System (NHS), which includes interstates and other significant highways but may have different standards for non-NHS roads. Size and weight requirements may vary significantly among states in terms of both the method and the level of enforcement pursued by a state. Some states rely primarily on static scales for weight enforcement, others rely on portable scales, while others use a combination of the two. A few states have no fixed weigh facilities to date

A motor carrier based in Michigan, for example would obtain operating authority from the state Public Service Commission, register its vehicles with the Department of State, license and pay fuel taxes with the Department of the Treasury, and purchase any oversize and overweight permits from the Department of Transportation. In contrast, a motor carrier based in Ohio would obtain operating authority from the Public Utilities Commission,

[16] Multi-state IVHS/CVO Institutional Issues Study. pp. 3-30.

register vehicles at the IRP Processing Center, pay fuel taxes to the Department of Taxation, and purchase oversize/overweight permits from the Department of Transportation. In Iowa, all credentials and permits are obtained through the Iowa Department of Transportation.

One-Stop Shopping & Electronic Credentialing

"One-Stop Shopping" is a single location or contact where motor carriers can obtain all permits and credentials. True one-stop shopping implies that the common credentials and permits (IRP, IFTA, SSRS, OS/OW, and HAZMAT) are administered by a single organization. Physical one-stop shopping is where two or more agencies issue CVO credentials and permits but are housed in the same physical location. This is convenient for those carriers who appear in person to register their vehicles or to seek problem resolution. One-stop shopping can also refer to a telephone system where motor carriers may phone a single number to conduct their administrative business.

"Electronic credentialing" is ITS/CVO for state administrative processes. Electronic credentialing allows carriers to apply for, pay for, and receive credentials through electronic data exchange via the internet, electronic mail, or facsimile. It also automates the filing of returns on fuel taxes, the payment of associated taxes and fees, the management of information about credentials/tax payment status, and the provision of information to various authorities.

Electronic credentialing requires computer systems and networking, advanced communications, electronic data interchange (EDI) capabilities, and specially-designed software. In addition to these equipment requirements, states may also need to reengineer the way they conduct business with motor carriers, "sell" the concept to other states and motor carriers in order to induce participation in electronic credentialing, and train new and existing staff to use the new systems effectively. Institutional and policy-related issues may be the most significant barriers to the successful implementation of ITS technologies in CVO.[17]

Electronic Clearance & Automated Safety Management

"Electronic clearance and automated safety management" is ITS that enhances and supplements state practices for roadside CVO. While clearance and safety functions are often performed in tandem and take place at the same roadside facilities. They are, in fact, two separate functions with very different objectives. These objectives will be important in determining costs and cost savings in this study.

Electronic Clearance refers to the automated activities that weigh and clear vehicles. These activities include:

- Weight and credential screening at fixed roadside facilities;
- Mainline (highway-speed) weight and credential screening at fixed roadside facilities; and
- Mobile weight and credential screening performed at remote locations rather than fixed sites.

These operations are intended to speed operations at weigh facilities and make CVO regulatory activities more convenient for both safety-enforcement officials and motor carriers. Electronic readers access information on transponders in the truck cabs to clear vehicles at mainline speeds; drivers no longer have to stop at every weigh facility along their routes, even after they have crossed a state border. Weigh-in Motion (WIM) and Automatic Vehicle Identification (AVI) are used to weigh trucks at highway speeds and identify trucks to weigh officials. Trucks with citation records can be targeted more easily for further inspections. Dangerous truck queues at fixed

[17] For a further discussion of policy issues, refer to the *Executive Briefing*, a companion piece to this report.

stations can be reduced, since trucks can be weighed and cleared more rapidly. Drivers that avoid fixed weigh stations can be cleared through roving operations that can function virtually anywhere. While ITS will not entirely replace current methods of weighing and clearing commercial vehicles, these technologies should significantly change CVO.

Automated Safety Management refers to activities that review the commercial driver and vehicle. These activities include:

- Electronic safety management;
- Remote safety enforcement; and
- Roving enforcement, with a van equipped with advanced technologies.

ITS/CVO safety applications are intended to target problematic carriers and make safety inspections faster and easier to perform. Safety information on either state or national databases can be accessed through computers at fixed stations or laptop computers in remote locations. These databases facilitate the sharing of safety information both within and among states. Currently, this information is not accessible at mainline speeds—an electronic transponder cannot relay safety-inspection history to weigh personnel as the vehicle passes the station on the highway—however, access to the online databases is almost instantaneous once a truck and driver are identified during the safety-inspection process. Enforcement officials can also use hand-held devices to inspect the undersides of trucks and make axle-counts without having to get under the truck. Mobile operations allow officials to target noncompliant carriers that may try to avoid fixed weigh facilities. Roving vans and equipment in state-trooper vehicles require fewer financial commitments than fixed weigh/inspection stations and may serve as good alternatives to station overhauls.

CURRENT ITS/CVO PROGRAMS

The technological advances of the last few decades have provided significant opportunities for industry to improve the efficiency and effectiveness of commercial vehicle operations. Since the early 1980s there have been significant efforts by the public and private sector to actively pursue the development, testing, and deployment of ITS/CVO. These initiatives have led to national, regional, and state operational tests that are demonstrating the potential impacts of ITS/CVO on public and private sector operations.

Electronic Credentialing

There have been few operational tests with electronic credentialing, perhaps because electronic credentialing uses communications and software that are proven technologies. However, many states offer some form of "one-stop shopping" to make CVO administration more convenient to carriers. Several states provide credential applications online, and electronic signatures, similar to PINs used with debit cards, also heighten carrier convenience. The crux of electronic credentialing remains paperless transactions. The success of ITS/CVO for administrative activities relies on carrier acceptance of these new technologies and state-agency provision of the technologies.

Electronic Clearance & Automated Safety Management

More operational tests have been performed at the roadside. These systems have relied on mainline clearance and the development of information databases.

HELP

The *Heavy Vehicle Electronic License Plate (HELP)* research initiative that began in the 1980s played a major role in defining and testing the functionality and applicability of Weigh-in-Motion, Automatic Vehicle Classification (AVC), and Automatic Vehicle Identification (AVI) technologies. The subsequent *HELP Crescent Demonstration Operational Test* examined the impact of these technologies in various deployments along the Interstate 10 and Interstate 5 corridors that extend from Texas to British Columbia. The HELP program led to the development of HELP, Inc., a not-for-profit organization that promotes and facilitates the deployment of ITS/CVO applications for both the public and private sector.

HELP PrePass™ is a non-profit, public-private partnership administered by the member states, each with a state government and motor-carrier representative on the board of directors. This program facilitates the database management elements of electronic clearance for participating states and passes many of the costs on to the participating carriers. Within the HELP PrePass™ program, each participating state enters into an agreement with HELP to develop software and manage the database that facilitates electronic screening in that state. Carriers sign up for HELP PrePass™ by submitting an application with their current credential and permit information to HELP. Once this information is verified a transponder bearing a unique identification number is issued to the carrier. The carrier pays a small fee for each time one of their vehicles is pre-cleared at a weigh station.[18] Participating states have the flexibility to deploy WIM, AVC, AVI, and vehicle-detection technology in the configuration that best meets their individual requirements.

ADVANTAGE I-75 & ADVANTAGE CVO

The *Advantage I-75 Mainline Automated Clearance System (MACS)* is a public/private partnership between six US states along the I-75 corridor (from Florida to Michigan), the Canadian Province of Ontario, and major system developers. Its purpose is to facilitate pre-clearance of safe and compliant vehicles at weigh stations. The ADVANTAGE Gateway Computer maintains a database of vehicles participating in MACS and holds WIM, AVC, AVI, and static-scale information. The weigh station computer determines if the vehicle is eligible for pre-clearance and communicates a "Go" or "No-Go" status to the vehicle's AVI transponder and communicates the transaction to the central database. The driver is notified of the clearance status by an in-vehicle display linked to the AVI transponder that displays a green or red light and an audible signal.

ADVANTAGE CVO is the continuing initiative to maintain and operate existing deployments and to further deploy and streamline the ADVANTAGE I-75 system. The immediate plan for expansion of the ADVANTAGE CVO program is to incorporate weigh stations that are not along the I-75 corridor and to increase enrollment in the program. Plans are in development to facilitate pre-clearance of non-registered vehicles equipped with compatible transponders.

Oregon Green Light

The *Oregon Green Light Operational Test* integrates ITS/CVO pre-clearance applications with safety information systems. The pre-clearance system provides mainline screening of registered vehicles based on registration information, date and time of last inspection, carrier compliance, and safety status. The system configuration is similar to the HELP and ADVANTAGE CVO systems and includes WIM, AVC, AVI, in-vehicle displays, vehicle detection, and compliance verification systems to facilitate vehicle screening.

The safety information systems include:

[18] The typical fee for a carrier to be pre-cleared is $0.99. User fees are required, since states can no longer afford to deploy this type of technology without them.

- Downhill speed information systems that measure the speed and weight of the truck and provide safe operating speed indications via variable message signs;
- Road weather information systems that detect visibility, wind, and ice problems that allow maintenance crews to more effectively mitigate snow and ice problems;
- Integrated communications networks among weigh stations to link safety inspection data on a real-time basis.

MAPS

Multi-jurisdictional Automated Pre-clearance System (MAPS) is a multi-state initiative that includes Washington, Oregon, Idaho, and Utah. This program offers coordinated and compatible pre-clearance systems that enable commercial vehicles to bypass all weigh stations in participating states. MAPS utilizes pre-clearance technology that is compatible with HELP PrePass™, Oregon Green Light, and ADVANTAGE CVO. This demonstration project will offer one-stop shopping, which allows a carrier to meet all regulatory requirements for one or more states from a single location. States will also be able to share information through an integrated database.

Automated Safety Management

SAFER

Safety and Fitness Electronic Records (SAFER) is an online system that provides standardized carrier, vehicle, and driver data sets ("snapshots" and "profiles") containing limited safety and credential information to authorized users. The data will be available to users over a nationwide data network of "mailboxes"—a central system that gathers and disseminates data electronically to and from multiple approved sources. The primary purpose of the SAFER mailbox is to support automated screening of vehicles at weigh stations and to provide out-of-service (OOS) orders and safety information to inspection and enforcement personnel once a vehicle has been stopped. However, information from the database is not transmitted in real-time or at mainline speeds and further data processing is required to automatically bypass vehicles at weigh stations.

MCSAP

The *Motor Carrier Safety Assistance Program* (MCSAP) program is a national initiative to improve motor carrier safety by instituting national inspection standards and implementing electronic data collection and communications systems into state inspection processes. The MCSAP program led to the development of the ASPEN software and AVALANCHE network. The ASPEN software facilitates electronic data collection of inspection data from the roadside. The AVALANCHE network is a national communications network that links state inspection data to the national and state repositories.

Integrated Programs

CVISN

Commercial Vehicle Information Systems and Networks (CVISN) is a nationally-developed system architecture that supports commercial vehicle operations. CVISN provides a framework for the development of public- and private-sector databases and data processing capabilities as well as the interconnection of their networks. The CVISN core infrastructure includes the following:

- *Electronic Credentialing*—includes the CAT system that enables carriers to transmit credential and fuel-tax information from their computers to state systems; a credentialing interface that facilitates

standardized communications links within state databases and to federal databases; and CVIEW that compiles data on intrastate carriers into snapshot data and includes a number of systems that support the electronic submission and issuance of credentials;

- *Safety Information Exchange*—includes remote communications links for safety data, in particular SAFER and CVIEW mailbox data, to state police, safety inspectors, and roadside clearance operators; and
- *Roadside Electronic Screening*—incorporates safety and credential data being developed in other aspects of CVISN into traditional pre-clearance operations.

CVIEW

Commercial Vehicle Information Exchange Window (CVIEW) will be a state-developed and managed database that will collect intrastate carrier, vehicle, and driver information from the state's safety, credentialing, and tax systems and will formulate snapshot data similar to the SAFER mailbox data. The CVIEW mailbox will exchange information with the SAFER system as well as provide data directly to the roadside to support automated screening and credential- and safety-status verifications.

PRISM (Formerly CVIS)

PRISM is a multi-state initiative that electronically integrates safety compliance with commercial vehicle registration privileges. Like CVISN, PRISM conforms to national architecture standards to develop databases and processing capabilities to perform electronic credentialing and to exchange safety information The PRISM project also consists of:

- Carrier eligibility monitoring, which incorporates previous registration information into current vehicle registration through information databases; and
- Motor Carrier Safety Improvement Process (MCSIP), in which a carrier with a poor safety status must improve or relinquish the authorization to operate commercial vehicles.

III. REVIEW OF THE LITERATURE

This chapter presents an overview of the on-going research related to ITS/CVO. While most deployments are in their infancy, a number of authors and research groups have attempted to quantify both direct and indirect conceptual costs and benefits to the public and private sectors. Since actual deployments are limited, few studies have been able to assess actual costs and benefits. Additionally, most projects do not produce benefits immediately; costs, typically, precede benefits by several years and may, therefore, be easier to quantify.

The purpose of this section is to highlight the important findings in the literature as well as identify gaps in this relatively small body of research. Three key studies will be summarized in this chapter. A short matrix of other relevant literature is also included. The studies reviewed in this chapter include:

1) *Commercial Vehicle Operations and Institutional Barriers* (more commonly known as the "COVE Study"), 1994. Booz-Allen and Hamilton, Inc.

2) *The Assessment of ITS/CVO User Services: Qualitative B/C Analysis*, 1996. American Trucking Association (ATA) Foundation.

3) *The Midwest Electronic One Stop Shopping System Study*, 1996. AAMVAnet, Inc.

Other studies are described at the end of the chapter.

THE COVE STUDY

The purpose of the COVE Study was to develop working relationships for ITS/CVO deployment among several southwestern states, identify the institutional barriers faced by each state, and plan the potential course of action required within each state. Western states have historically taken the lead in ITS/CVO and the seven COVE Study states (Colorado, Arizona, New Mexico, Texas, Oklahoma, Arkansas, and Louisiana) had begun addressing the institutional issues that made widespread diffusion of ITS/CVO difficult.

Ultimately, the COVE Study argued, ITS/CVO deployment would promote regulatory efficiency, improve productivity within the trucking industry, and enhance safety. The complexity of ITS/CVO and current commercial vehicle regulations coupled with resource constraints rendered these goals untenable. The COVE Study recommended a long-term plan to develop goals for each region, submit planning projects to the FHWA and state agencies, and simplify administrative processes within each state.

For the state of Colorado, the COVE Study anticipated that most actions would require less than $100,000 in funding. Additionally, the COVE Study found Colorado's state agency B/C ratio was 7.17 for Electronic Clearance technology, 7.89 for One-Stop/No-Stop Shopping programs, and 5.43 for Automated Safety Inspections. Given the scope of the study, researchers did not collect primary data for each of the seven states. Rather, they used cost data from state sources currently using some aspects of ITS/CVO, such as Iowa and California.

ASSESSMENT OF ITS/CVO USER SERVICES: QUALITATIVE B/C ANALYSIS

The American Trucking Association (ATA) Foundation's study, *Assessment of ITS/CVO User Services: Qualitative B/C Analysis*, assessed costs and benefits of ITS/CVO for motor carriers in a market of narrowing margins. The primary goal of this study was to measure the effects of the ITS/CVO User Services program on regulatory compliance costs for motor carriers. Surveying 700 motor carriers, ATA determined how the private

trucking industry would respond to ITS/CVO implementation. The ATA based their assessments on programs not yet in place. Reductions in the carrier's labor costs and no private funding of ITS/CVO served as the only benefits.

The ATA estimated average or median B/C ratios for six different ITS/CVO user services. The study found that B/C ratios will be greater for large (greater than 99 vehicles) firms than for small (1-10 vehicles) firms.

1) Commercial Vehicle Administrative Process—1.0:1–19.8:1;
2) Electronic Clearance—3.3:1–7.4:1;
3) Automated Roadside Safety Inspections—1.3:1–1.4:1;
4) On-Board Safety Monitoring—0.02:1–0.49:1;
5) Hazardous Materials Incident Response—0.3:1–2.5:1; and
6) Freight Mobility—1.5:1–5.0:1.[19]

The user services were assessed in two different ways: 1) a comparison of benefits and costs for motor carriers, and 2) consideration of the market potential among the motor carrier community. Only the potential benefits and costs to the motor carrier community are considered in this study.

THE MIDWEST ELECTRONIC ONE STOP SHOPPING SYSTEM STUDY

The Midwest Electronic One Stop Shopping System Study by American Association of Motor Vehicle Administrators presented a detailed report of the requirements for One-Stop Shopping systems in the Midwest (South Dakota, Minnesota, Wisconsin, Nebraska, Iowa, Illinois, Kansas, and Missouri). The report is one of several documents required for the Midwest Electronic One-Stop Shopping (MEOSS) System. The objective of the project is to enable motor carriers to apply for, pay for, and receive credentials and permits electronically.

While the study did not include rigorous benefit/cost analysis or recommendations for state implementation, the study provides a detailed overview of the requirements for One-Stop Shopping. The study includes a "how to" approach to One-Stop Shopping, along with a comprehensive review of general requirements.

INFORMATION GAPS

There were several key information gaps uncovered in the literature review. The most obvious gap in the ITS/CVO literature is the lack of a comprehensive state-by-state survey of potential deployments and their related costs and benefits. Notable exceptions include the COVE Study (described above) and a similar study by Maze et al. of the Midwest region (Iowa, Illinois, Minnesota, Missouri, Nebraska, South Dakota, and Wisconsin). Several studies focus on individual states, but do not address B/C in a comprehensive manner. For example, Kavalaris and Sinha focus on Indiana's direct benefits of CVO deployments, while Smadi and Rodriguez examine state institutional barriers in the Dakotas.

Several of the studies reviewed conclude that most benefits of ITS/CVO will accrue to the private sector (the commercial carriers) through cost savings, increases in productivity and efficiency, and eased compliance with regulatory agencies. Penn and Schoen Associates surveyed carrier drivers nationwide and found that most

[19] *Assessment of Intelligent Transportation Systems/Commercial Vehicle Operation (ITS/CVO) User Services Qualitative Benefit/Cost Analysis*, The ATA Foundation, August 1996, pp. i-xxi.

would favor ITS implementation; most wanted the time savings attributable to ITS technology and did not see that technology as a threat to their jobs. The ATA found the greatest benefits of User Service Systems would accrue to large trucking firms. The literature reviewed for this study does not address public-sector costs and benefits (agency or state-specific B/C), and generally focuses on direct costs and benefits.

Most studies of the public sector cited increased capabilities and efficiency for state agencies, including better identification of weight- and cargo-limit violations, safety improvements on roadways, revenue generation through fine collection, reduction in road construction, and increased market penetration. In most cases, however, these benefits were not quantified. Kavalaris and Sinha argue that most state benefits would be realized in terms of increased revenues rather than decreased costs.

A single study by Heavy Vehicle License Plate (HELP), Inc. attempted to quantify the indirect benefits of ITS/CVO, namely through decreased vehicle emissions and fuel consumption. Since indirect costs and benefits are difficult to identify and measure (due to time lags and difficulty identifying cause-and-effect relationships), few researchers concentrate on identifying and measuring indirect benefits. However, downward price effects, environmental preservation, improved forecast accuracy, employment effects, and an improved business climate may all prove to be potent political issues at the state level in the future. Furthermore, the magnitude of the indirect impacts resulting from ITS/CVO deployment may be significant.

Numerous studies, pamphlets, and brochures have postulated the general benefits to the public and private sectors. Absent from these studies is a comprehensive benefit/cost analysis or budgetary-impact analysis of the implementation, maintenance, and operation of ITS technology within the *public sector* across varying *geographic regions*. While many studies have estimated the private costs associated with ITS deployment, the study team found little in the literature, with the exception of the COVE Study and the Dakotas Study, that attempts to quantify the costs of personnel training, computer software modification, or technology installment. Additionally, the COVE Study was not based on an extensive primary data effort.

The NGA study attempts to fill some of these information gaps by providing a detailed, public-sector cost analysis and cost-savings analysis for three major ITS/CVO indicator groups for individual case study states.

1) Electronic Credentialing;

2) Electronic Clearance; and

3) Automated Safety Management.

Exhibit III-1 presents a summary of the ITS/CVO literature reviewed for this study.

Exhibit III-1. ITS/CVO Literature

Title	Date	Publishing Org./ Author	Geog. Region	Effects Addressed	Tech Studied	Summary	Relevance
An Evaluation of the Roadside Inspection Selection System (ISS) for Commercial Vehicles	1997	Lantz, Blevins, Hillegass (Upper Great Plains Transportation Institute)				abstract pending	
Midwest Electronic One Stop Shopping System	1996	AAMVAnet, Inc.	Midwest	Public and private costs	One Stop Shopping	This study presents the requirements for the one-stop shopping system in the Midwest	This study reports information on the exact requirements for one-stop shopping implementation based on current levels of automation.
Assessment of ITS/CVO User Services Qualitative Benefit/ Cost Analysis	1996	ATA Foundation	National	Private impacts of ITS/CVO deployment	User services	This study examines the market potential for small, medium, and large firms as well as the costs for the ITS/CVO technology.	This study breaks down private firms based on their size and provides cost data for the ITS technology.
Interstate Cooperation for Implementing ITS in Commercial Vehicle Operations: Institutional Opportunities and Barriers	1996	Maze, Hancock, Waggoner, McCall, Hunt (Iowa State University)	National	Barriers to efficiency	General ITS/CVO Technology	This study is an extensive discussion of institutional barriers to ITS/CVO implementation.	This study finds that benefits may not be as great if barriers to implementation are prohibitively high.
Assessment of Automated Administrative Functions and Electronic Clearance	1996	Pritchard, Stock (ATA Foundation)	National	ITS/CVO initiatives	Automated Admin. Functions (AAF), Electronic Clearance (EC)	This study assesses two proposed initiatives for AAF and EC based on motor carrier perceptions of labor requirements and their current use of technology.	This study describes the labor requirements for complying with regulation.

Exhibit III-1. (cont.) ITS/CVO Literature

Title	Date	Publishing Org./ Author	Geog. Region	Effects Addressed	Tech Studied	Summary	Relevance
TruckScan, Automating and Improving Roadside Checking	1996	Reid, Myers (Telstra Applied Technologies)	National	New technology	Weigh-in-Motion	This study describes a new technology that tracks vehicles in motion.	This study describes the business system and the role of the operator.
Dakotas' ITS/CVO Institutional Issues Study	1996	Smadi, Rodriguez (Upper Great Plains Transportation Institute, North Dakota State University)	Dakotas	Direct state benefits	General ITS/CVO Technology	This study finds that the costs of deployment of ITS/CVO will be greater than any other costs involved.	Description of costs involved, including labor and operating costs, training, and capital costs.
Benefits of Electronic Clearance for Enforcement of Motor Carrier Regulations	1996	Titus (North Dakota State University)	National	Direct private benefits	Electronic Clearance	This paper studies improving motor carrier compliance while reducing the costs of compliance.	This study describes the benefits to society of preclearance technology.
Automated Roadside Inspection Feasibility Study for Commercial Motor Vehicles	1996	Weppner, Rogova, Alexander (Calspan Corporation. Advanced Technology Center)	National	New technology	Roadside Inspections	This study reports the feasibility of roadside inspection technology and the development of a prototype.	
ITS Trends in Freight Management and CVO Applications	1995	Brown, Santeiu (Amtech Systems Corporation)	National	Direct Private Benefits	Vehicle Roadside Communications	This study describes new technology and recognizes widespread compatibility as the primary obstacle to cost-effective implementation.	This study describes technology that could be cost-effective for the trucking industry if there is compatibility among systems.
PrePass Project Overview for Automated Weigh Station Preclearance	1995	Heavy Vehicle License Plate, Inc.	National	Indirect benefits	Weigh Station Clearance	This study is a discussion of the indirect benefits of ITS/CVO deployment.	This study is an attempt to quantify indirect benefits.

Exhibit III-1. (cont.) ITS/CVO Literature

Title	Date	Publishing Org./ Author	Geog. Region	Effects Addressed	Tech Studied	Summary	Relevance
User Acceptance of Commercial Vehicle Operations Services	1995	Penn and Schoen Assoc.	National	Private barriers to ITS implementation	On-board Safety Monitoring, Incident Response, Inspections	This study found majority of carrier drivers would favor ITS implementation, arguing that it would save time without jeopardizing their jobs.	This study addresses private resistance to ITS/CVO.
Overcoming CVO Institutional Barriers: Recommended Actions	1994	Booz-Allen and Hamilton Inc.	Colorado	Institutional Barriers	General ITS/CVO Technology	This study identifies the institutional barriers to ITS/CVO implementation and develops a plan of implementation sensitive to those barriers.	This particular report is a case study of Colorado. Similar case studies have been done for several other Western states.
Institutional Issues Related to the Application of Intelligent Vehicle-Highway Systems Technologies to Commercial Vehicle Operations in Indiana	1994	Kavalaris, Sinha (Joint Highway Research Project)	Indiana	Direct state agency benefits	General ITS/CVO Technology	This is the most full discussion of direct agency benefits, increased enforcement revenues, and penetration rates.	This study finds that the most important benefit would be in terms of increased revenues rather than decreased costs.
Feasibility of a National Heavy Vehicle Monitoring System	1988	Grenzeback, Stowers, Boghani	National	Benefits to state agencies	General ITS/CVO Technology	This report summarizes the benefits accrued to the public sector, including the capability to identify overweight trucks, increase revenue through fines, and decrease pavement wear.	This study provides good qualitative data and statistics for direct cost savings increases in revenue.

IV. CASE-STUDY STATE BASELINES

DATA COLLECTION

This chapter provides an overview of the Commercial Vehicle Operations (CVO) characteristics of the eight case-study states. These characteristics are essential to quantifying the budgetary impacts of ITS/CVO for each state. The case-study states are:[20]

- California
- Colorado
- Connecticut
- Delaware
- Florida
- Kentucky
- Minnesota
- New Jersey

An extensive data-collection effort was undertaken for this study. The team distributed detailed list of questions and conducted telephone interviews with various state agencies to establish a baseline for current operations. State contacts also provided insight on the state's plans for ITS/CVO deployments. Various state permitting/credentialing agencies, such as State Departments of Transportation were asked questions relating to the number of permits/credentials (by type) the agency issued; percentage change in applications; and the number of application processed. The team also collected data on staffing, titles, and salary ranges for each state agency.

Commercial vehicle inspectors, state police, and patrol offices were asked questions regarding the number of vehicles cleared and processed; the number of fixed and portable weigh stations; staffing, titles, and salary ranges for the various weigh stations; the number of citations issued; and historical trends. While the questionnaire and phone interviews served as the primary source of this data, existing sources, such as FHWA's *Highway Statistics 1995* and the 1996 Rand McNally *Motor Carriers Atlas* served as secondary sources.

The data collected were organized into individual databases for each state.[21] State agencies then verified the information. The case study states provided assistance in verifying the data, noting incorrect interpretations of specific data, clarifying inconsistencies with specific data, and providing additional data in cases where data were incomplete. The study team then developed a final database on baseline conditions for each state.

DATA LIMITATIONS

Since much of the data for this study were collected via survey, the study team encountered several challenges in collecting data. Many state agencies do not keep official records regarding of the number of applications processed or the revenue generated from the permitting/credentialing process over time. Although all the case-study states were able to provide the study team with information about permitting/credentialing in the 1996

[20] For a detailed description of the selection of the case study states, see the Task I Technical Working Paper.

[21] The data collected for this study, as well as a listing of the state agencies contacted and related information may be found in the Task II Working Paper, Appendices.

fiscal year, some states do not archive data for past years. In several cases, directors and administrators were asked to provide their "best guess" estimates where data were incomplete or inconsistent. Since some of the states do not coordinate their data collection and reporting efforts among agencies (or among departments/divisions) the team sometimes received different estimates for the same data point.

Since IRP and IFTA have been implemented recently in several of the states over the past year, some states had no baseline information on these two permits. New Jersey, for example, joined IRP and IFTA during the 1996 calendar year. The figures the state reported for both these credentials, therefore, do not represent a full year of operation. According to the IRP/IFTA contact, however, the figures should provide an accurate representation of a full year's worth of applications for both credentials, since the vast majority of applicants filed with the state when the program was first implemented.

Furthermore, many states had difficulty separating CVO functions from other functions that were not CVO-related. In Colorado, for example, the Department of Revenue handles tax collection for all motor vehicles, not just commercial vehicles. Agency managers, therefore, had some difficulty estimating the percentage of time the office staff spent on the various CVO permitting/credentialing processes.

There is also uncertainty regarding mailing costs for state agencies. Since most mail is processed in a central mailroom servicing several state offices (departments/divisions), the mailroom manager is generally unaware of the costs attributed to a specific permitting/credentialing department. Additionally, the size and weight of the packages sent to motor carriers vary considerably. Very few office managers were able to provide an estimate of the average cost to mail a specific application to a carrier. In order to assure that mailing and delivery cost estimates were reliable, the study team compared the cost estimates for each application to the overall budget of the mailroom responsible for sending those applications.

Some of the safety-inspection data may not reflect the most current or accurate information. Several states experienced computer difficulties over the course of the year and were unable to enter data for days or weeks at a time. In addition, there is often a lag time between the time the data are collected and the time the information becomes accessible in a state's computer database. For example, Minnesota reported that the computer system used to store and compile clearance and safety data was malfunctioning for a substantial period of 1996. In order to correct for the potentially inaccurate information, the study relied on a five-year average to estimate the number of vehicles processed in 1996. New Jersey reported an unusually low number of vehicles weighed in 1996. Further discussions revealed that only one weigh facility out of five was functional in 1996 (the others were undergoing repair and renovation). Here again, a five-year average was used to estimate the number of trucks weighed in 1996.

In some cases different data sources (questionnaire responses, Motor Carrier's Atlas, FHWA publications) reported different information for the number of fixed weigh stations in certain states. For the purpose of this analysis, the team relied on the number of stations reported by the state police and verified this number with other state officials where possible.

While minor problems exist with the data, as discussed previously, the overall quality of the information is good. State contacts were generally confident in their estimates; when they were not, they allowed to not provide the requested information. In such instances, estimates by the study team were based on conversations with Technical Advisory Group, knowledgeable state contacts, and previous findings in the CVO literature. All study-team estimates were verified with state agents to ensure their accuracy and reliability. In all cases where empirical data were not available, the study team chose conservative estimates in order not to underestimate costs or overstate potential cost savings.

General Overview of Data

States vary greatly in how they organize their regulatory functions. No single agency in any of the case study states performs all five of the major permitting/credentialing functions. Responsibility for the various permits/credentials also lies with different departments and divisions within the states. In some cases the same department may be responsible for both IRP and IFTA, while in others, responsibility for administering the credentials lies with separate departments. Delaware, New Jersey, and Florida do not participate in SSRS. Connecticut, Delaware, Florida, Kentucky, and New Jersey do not issue HAZMAT permits. Also, while a single agency may perform several different functions, the functions may be performed by distinct divisions headed by different administrative directors and are spatially separated in different buildings.

In Kentucky for example, all major credentials and permits are issued through the Department of Motor Vehicle Regulations, though IRP and IFTA are not in the same division and are run by two different directors. Conversely, credentialing and permitting are combined in a single state agency in several case study states. Minnesota and Florida both have a single-agency office and staff for IRP and IFTA. For the most part state police do not issue credentials and permits, though California Highway Patrol issues HAZMAT permits, and the Connecticut State Fire Marshall issues explosive permits.

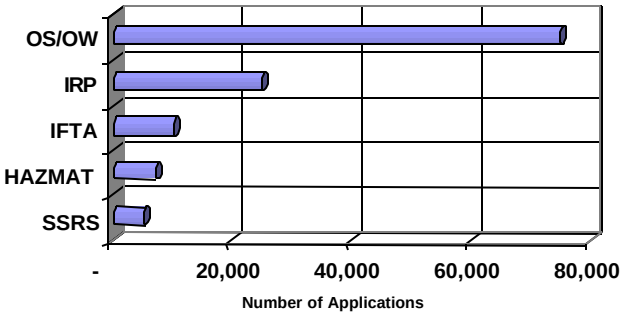
The clearance/safety process is very similar in all eight case study states. Enforcement personnel staffing weigh stations as well as state troopers can issue citations to motor carriers for a wide range of violations. The clearance function takes place at weigh stations, which may be fixed or mobile. There is some difference in the violation rate estimated for each of the case-study states.[22]

Description of Baseline Data—Administrative Processes

The number of credential applications processed was very different for each case-study state. The number of applications an agency processes is not necessarily equivalent to the number of trucks registered in a state. In most states, a fleet manager/owner can register more than one vehicle or even an entire fleet on a single application for certain types of credentials (IFTA and IRP, for example). On the other hand, permits such as OS/OW require a single carrier to register for a new permit for every single trip it makes.

OS/OW permits constitute the overwhelming bulk of administrative applications—from 40-90 percent of total applications—in every state.[23] IRP credentials make up a much smaller portion of total applications, ranging from five to 25 percent of the total. IFTA applications generally account for a slightly smaller percentage of total applications than IRP. HAZMAT and SSRS each typically account for only one to five percent of total applications. Exhibit IV-1 illustrates the application breakdown in a typical case-study state.

Exhibit IV-1. Typical Case-Study State, Application Volume by Type



[22] The violation rate is dependent upon the number of citations issued and the number of vehicles processed.

[23] This exhibit includes permits issued by state agencies, not the potentially numerous permits required by county and city governments.

For the eight case study states, the number of applications processed in 1996 ranged from 42,635 to 180,720. Staffing requirements for the various agencies ranged from approximately 15 personnel to 150 personnel. It is important to note that staffing requirements are not necessarily driven by trucking activity or number of credential/permit applications submitted, but by state budgets. Therefore, it may not be entirely accurate to compare staffing requirements in one state to another based on population, number of trucking firms, number of applications processed, or motor carrier VMT. The processing and application fees that are charged for various permits/credentials are also different for each state. Therefore reported revenue varies significantly from state to state—from $10 million to $243 million in 1996.

Description of Baseline Data—Roadside Activities

State police are generally responsible for clearance and safety activities. Weigh station operations are based on truck traffic, staff availability, state budgets, and seasonal production fluctuations in the state's economy (e.g., harvest cycles). The number of fixed weigh stations operating in the case study states ranged from one to 58. Although many of the weigh stations currently use Weigh-in-Motion (WIM) technology, static scales are still used in all weigh stations as a "back-up" weighing mechanism and are needed for citation information.

States provided limited information on the revenue generated from citations. States often had a total revenue figure, but were generally unable to provide estimates on the average amount of a fine, or whether more than one citation was typically issued to a non-compliant vehicle. The amount of an individual fine is typically determined through the court system, not by the enforcement personnel at the roadside. Information relating to the ultimate court fine issued to a particular driver or truck is not typically reported back to the state police. It is therefore difficult to estimate an "average" value for fines with any certainty. Most fines ranged from $200-$300 per citation. Citations and out-of-service orders issued in 1996 ranged from 575 to 142,000.

The number of vehicles cleared and processed ranged from 200,000 to 14.5 million. The number of vehicles inspected ranged from 3,000 to 400,000 across the case study states. The total weigh-station staffing requirements for the eight states ranged from nine to 500. Salary ranges for state troopers and patrol officers did not vary dramatically across the case study states. Exhibit IV-2, on the following page, summarizes several of the baseline conditions established through the data collection exercise.

Exhibit IV-2. Baseline Characteristics of the Case Study States

State	# Admin. Agencies	# App. Processed	Revenue Generated	Admin. Staff	# Vehicles Cleared	# Vehicles Inspected	# Weigh Facilities
California	5	176,000	$243 million	150	14.5 million	380,000	184
Colorado	3	43,000	$15 million	100	5 million	48,000	29
Connecticut	3	150,000	$24 million	40	.2 million	17,000	35
Delaware	1	48,000	$10 million	15	.2 million	3,000	5
Florida	2	150,000	$56 million	50	5 million	70,000	175
Kentucky	1	114,000	$55 million	50	.8 million	70,000	198
Minnesota	2	82,000	$47 million	50	1 million	28,000	39
New Jersey	1	181,000	$16 million	50	.2 million	50,000	111

V. ANALYSIS OF COSTS

For most states, intelligent transportation system (ITS) applications for commercial vehicle operations (CVO) are at best a partial reality. Many states have only a crude idea of what it will cost to deploy ITS/CVO for their state based on limited experiences elsewhere in the country. The cost analysis portion of this study was designed to provide states with a better understanding of the specific cost components of ITS/CVO, the drivers of these costs, and a methodology for developing cost estimates given each state's unique characteristics and policies.

In this chapter, the specific cost components of developing, deploying, and operating ITS/CVO applications for administrative processes and roadside activities are identified. The methodology and information sources used to estimate these costs are documented and applied to the eight case-study states. This data also forms the basis for the spreadsheet models developed to estimate investment requirements at the state level.

The cost estimates provided in this chapter support the analysis of agency cost savings and facilitate state assessments of the costs and cost savings for those states deploying ITS/CVO. The cost model facilitates customized cost estimates for states, reflecting each state's CVO, size, and plans for ITS/CVO deployment.

This chapter is organized around three sub-sections:

1) Discussion of cost concepts and definitions;

2) Methodology for collecting and reporting cost estimates; and

3) Presentation of cost findings.

COST CONCEPTS & DEFINITIONS

This section outlines the components that make up ITS-CVO, and provides background on the range of alternative configurations available on the market for each cost element. The items described in this section form the basis for the collection of cost data and the development of the cost model.

Electronic Credentialing

As mentioned in previous chapters of this report, electronic credentialing is the application of ITS technologies to state administrative processes for CVO. The costs of developing and implementing electronic credentialing are borne largely by state agencies, and these costs can be high. However, the prices of computers, electronic sensors, communications, software and other traditional drivers of ITS-CVO deployments are dropping. This puts ITS-CVO technologies within the reach of increasing numbers of public agencies. Furthermore, trends favoring interoperability and the establishment of electronic data interchange (EDI) standards are contributing toward the potential for widespread deployment of electronic credentialing. These crucial factors enable carriers to obtain credentials and file fuel tax returns, and enable states to process the applications and manage/share information electronically.

In order to offer electronic credentialing to carriers, states must modify existing systems and implement new functions. To enhance existing systems and implement new functions, states direct system and software-development work to in-house staff and contractors. Development costs can vary considerably

depending on the configuration of electronic credentialing in the state (that is, what the elements in the process are), the functionality that is developed in each system within the process, and the amount of contractor labor that is employed for development work.

Hardware can be a major cost when new processors and servers are required to support new functions. The character and age of existing administrative systems are an additional cost factor, affecting the magnitude of modification to be made to a Legacy System—a system to support standardized information exchange and electronic credentialing.

After the initial development of electronic credentialing, operating costs are primarily affected by communication costs and by the costs of maintenance and support services provided by state workers or contractors. Because many of the state systems are new, states may find that new staff is needed to maintain them. Alternatively, system maintenance can be provided by contracting outside for services.

The cost of electronic credentialing must also include the cost of doing business two ways: the traditional, paper-based way; and the electronic way. States that implement electronic credentialing will need to support dual systems for what may be a considerable length of time. It is possible that many carriers may not adopt electronic credentialing in the first few years. Furthermore, it is conceivable that some carriers will never choose to obtain their credentials electronically. Dual systems mean that the costs of electronic credentialing will be incurred *in addition to* the current costs of administrative processes. However, as increasing numbers of carriers obtain credentials electronically, the cost of supporting the traditional system will decline over time.

Types of Costs for Electronic Credentialing

The costs of electronic credentialing include start-up costs and annual costs. Start-up costs consist of development and capital costs. Development costs pertain to the new software, new systems, modifications to existing systems, and the creation of system interfaces. Capital costs include one-time investments in software and hardware, other system-related communications infrastructure, and training.

Annual costs include operating and maintenance costs. Operating costs include staff to support electronic credentialing, communication costs, and lease payments for certain systems or equipment. Maintenance costs include periodic or scheduled costs to keep systems operational and functional, including both software- and hardware-related expenditures.

Electronic Clearance & Automated Safety Management

Electronic clearance and safety applications supplement and enhance state practices for roadside CVO activities. The major cost factors driving these estimates are equipment and configuration options. In this analysis, cost estimates were developed for specific electronic clearance and safety applications. However, where possible, the equipment packages presented in the case studies reflect specific state deployments and plans.

The following categories of current and planned electronic clearance and safety applications were developed:

Clearance

- Weigh station weight and credential screening;
- Mainline weight and credential screening;

- Mainline credential screening; and
- Remote screening.

Safety Management

- Electronic safety management;
- Remote safety enforcement; and
- Roving operations.

Each of these ITS-CVO applications offer a number of deployment options that may affect the functionality of the system, the performance of ITS elements, and the administrative responsibility of operating the system.

Several templates for per-unit costs were developed for this study. These include the start-up costs and annual costs associated with the planning, installation, and deployment of each clearance and safety application. The templates allow for variation of both equipment as well as the level of functionality for each application. For the purpose of this study, high and low equipment/configuration options are considered in the cost estimates of each of the applications listed above. These cost estimates represent ranges of deployment costs but do not represent specific costs for individual deployments.

The case study cost estimates are based on current or planned state deployments. However, many states have not made definite ITS-CVO deployment plans for some applications. In these cases, representatives of the state were asked to provide insight on the state's future objectives and assess the potential utility of these applications in their state operations. Where no information was provided, the study team developed its own assumptions based on expert judgment and past experience.

Types of Costs for Electronic Clearance & Automated Safety Management

The costs of electronic clearance and safety include start-up costs and annual operating costs. As defined in this analysis, start-up costs include equipment and installation costs. Equipment costs include ITS equipment, supporting equipment and vendor software, installation and technical support. Additional installation costs include state or system integration, state oversight, and technical support.

Annual costs refer to operations and maintenance expenses. Operating costs include communications costs, additional staffing requirements, and operating supplies. Maintenance costs include maintenance contracts, routine maintenance and system calibrations, and equipment replacement (depreciation) for ten years.

Where applicable each cost component is considered independently for each equipment option. For installation costs, however, technical support and oversight cost estimates apply to overall deployments.

As noted in Chapter I, the scope of this study calls for cost estimates that reflect full deployment of ITS-CVO within ten years. Individual characteristics determine which ITS-CVO applications are appropriate, and the level of deployment required for each state. State characteristics that may influence selection of electronic clearance and safety equipment packages and their associated cost include the following:

- The percent of weight and safety operations performed at fixed weigh stations and remote sites;
- The number of weigh stations, inspection specialists and CVO field officers within a state;

- The type of remote weight checks and enforcement conducted by the state; and
- State plans to utilize real-time information exchange in safety operations.

It should be noted that the concept of "full deployment" for ITS-CVO is somewhat subjective. The study team determined full deployment according to the characteristics of the individual state's CVO. Each case study state was profiled to determine the number of operating weigh stations, the number of weigh station and remote safety inspectors and the number of state police assigned to CVO field operations. Where possible, state plans were used and/or extrapolated to represent full deployment. Thus, full deployment does not necessarily imply, for example, that every weigh station in a state is automated.

METHODOLOGY

ITS applications for electronic credentialing and electronic clearance and safety are evolving rapidly. The advance of communications capabilities and the development of national and state databases to incorporate the newly available information is a major contributor to this evolution. It is anticipated that electronic clearance operations will utilize technologies that upgrade credential administration and safety information exchange. These two functions can stand alone, but for optimum benefit, they should work as a unified system. They are closely linked by the timely exchange of critical motor carrier information made possible by advances in communication capabilities and enhancements to state administrative systems and functions.

Because of the overlap in safety and clearance applications, the study team combined the cost analyses of clearance and safety in order to account for shared operating costs and inclusive applications. Although administrative processes compliment these roadside activities, the study team separated-out electronic credentialing in the cost analysis because the direct funding and responsibilities for these applications are clearly distinct.

A major challenge was developing cost estimates for technologies and database administration functions that are still in the development stages. Little data exists on these costs. Thus, in many cases, the study team had to develop best estimates of the likely costs of these systems.

In some cases where data from operational tests was available, the format of the data (or the structure of the test) was somewhat incongruous with the systems being analyzed in this study. For example, many of the operational test clearance deployments were the result of cost sharing agreements with system integrators and vendors. This makes determining likely costs to be borne by states difficult.

The overall cost analysis was conducted in two stages. In the first stage a cost template of ITS/CVO applications was developed. Because there are a number of configurations and technology options available to provide similar functionality, it was necessary to establish a limited number of options that represent the range of available applications rather than identifying specific examples.

Electronic Credentialing

Essentially Electronic Credentialing consists of the following elements:

- CAT systems that enable carriers to transmit credential or fuel tax information from their computers to state systems;
- Communications networks that facilitate the exchange of information between the carriers and the state;

- Mailbox systems that route information from the carrier to the appropriate state credentialing system and responses from the state system back to the carrier, also called the credentialing interface (CI);
- Legacy systems that are the existing state credentialing systems; and
- Data mailboxes that handle the exchange of credentials and safety information within the state and between the state and multi-state and national systems—CVIEW.

Using a renewal application as an example, the sequence of events under electronic credentialing can be summarized as follows:

1) Renewal notice and data are sent from the state credentialing system to the mailbox/CI;
2) Mailbox routes the transaction to the specific CAT system;
3) Application data is sent by the carrier from the CAT system to the mailbox/CI;
4) Mailbox routes the transaction to the appropriate credentialing system, such as the International Registration Program (IRP) or Oversize/Overweight (OS/OW) permitting authority;
5) Query is sent from the credentialing system to CVIEW, the data mailbox, to retrieve status information from one or more other state systems that is needed to grant the credential;
6) Invoice is sent from the credentialing system to the mailbox/CI, which routes it to the CAT system;
7) Notice of the method of payment is sent from the CAT system to the mailbox/CI, which routes it to the credentialing system; and
8) Credential is issued from the credentialing system to the mailbox/CI, which routes it to the CAT system.

EDI standard transaction sets are used to carry the credentials and safety information among carriers and state agencies. These standardized data-flows provide a consistent basis for information exchange among multiple parties and they ensure interoperability among present and future CVO information systems.

Exchanges between CAT systems and mailboxes or credentialing interfaces are in the form of EDI transaction sets, but information exchanges involving the credentialing systems can be EDI standard transactions or non-EDI transactions depending on the capability of the systems. States may choose to make modifications to Legacy systems enabling them to support standardized information exchange with the mailbox/credentialing interface and the CVIEW. Alternatively, an interface can be developed for each legacy system and the interface translates information into the format required by the system.

Challenges in Cost Analysis for Electronic Credentialing

Cost analysis of electronic credentialing is challenging because no fully implemented electronic credentialing systems are currently in place. Empirical data on either start-up or operating and maintenance costs are scarce. Several field operational tests of electronic one-stop shopping have been implemented. The experience gained by the states while developing the capability for pilot carriers to apply for and receive some credentials electronically is useful for estimating resources needed for more

general implementation. The usefulness of operational test cost information, however, is limited by the very nature of operational tests—that is, operational tests demonstrate capability. The reengineering of procedures and systems across multiple agencies, the development of entirely new functions and systems, and the investment in expensive hardware—all generally needed to implement fully-functional electronic credentialing systems—are costs that go far beyond the scope of operational tests.

Data Collection & Sources

Many states are now planning for electronic credentialing. Their plans include estimates of labor costs to develop and modify systems, hardware and software purchases, training, and other direct costs. Presently, the states furthest along in planning for electronic credentialing have developed project plans that present resource estimates that will be refined significantly once development efforts begin. Operating and maintenance costs are not a part of these plans.

Some states were able to provide actual cost or labor effort information in telephone interviews and documentation. Documentation includes project plans, correspondence, and other written materials. Interviews provided the most pertinent and most detailed information for constructing cost spreadsheets. In the absence of empirical data, the following information was sought:

- The number of CVO regulatory and enforcement agencies;
- The existence of one-stop shopping;
- The interest of the carrier industry in electronic credentialing;
- Process reengineering of CVO administrative processes;
- The characteristics of the credentialing systems;
- Plans to modify or replace existing credentialing systems;
- The communications networks in place;
- Representative in-house and contractor labor rates; and
- Other details.

This information provided a good framework for developing reasonable cost estimates for the case study states when hard data were unavailable.

CVISN system architects and project managers were the primary contacts in California, Colorado, Connecticut, Kentucky and Minnesota. Delaware, Florida, and New Jersey are not CVISN pilot states but all three states have indicated interest in implementing electronic credentialing. At this time, Delaware and New Jersey are planning to operationally test electronic credentialing. The primary contacts in the two states were state personnel knowledgeable about electronic credentialing efforts and operational-test planning. Florida is not currently planning electronic credentialing. Credential specialists in the state were interviewed.

Key Assumptions

Several assumptions were made in the cost analysis, including:

- Costs directly associated with the development and implementation of electronic credentialing are captured or estimated for the case study states. When costs are associated with both electronic credentialing and other ITS/CVO applications, credentialing costs were partitioned

out to the degree possible. Additionally, electronic credentialing components currently in place or that would exist as cost items without development of electronic credentialing, are not included in the spreadsheets. Examples are an EDI translator owned by the state, an in-place VAN for external communications, and a newly-leased credentialing system that replaces a system leased from a different vendor (with the change being unrelated to acquiring electronic credentialing functionality).

- All state-borne costs of electronic credentialing, regardless of the source of funds to cover the costs, are included in the spreadsheets. This includes, therefore, Federal CVISN funds in addition to state-matching CVISN funds.
- Costs of vendors developing software or systems used in electronic credentialing are included only if the costs are directly paid by the state, as when the state pays for state-specific modifications to CAT software. Costs of developing the basic CAT software that is paid by other parties are not considered as applicable state costs.
- Costs generally are given as a range to reflect uncertainty in estimating the bases of the costs. In most cases, the larger the range of values the greater the uncertainty of predicting where the cost is within the range. Where no range is given, it is likely that the cost is "set" by budget allocation, by an off-the-shelf price, or by quotation or agreement.

Spreadsheet Structure

Cost spreadsheets for electronic credentialing are organized by types of costs as defined previously: development, capital, operating and maintenance costs. Development and capital costs are startup, or one-time, costs. Operating and maintenance costs are costs that occur annually.[24]

Data Limitations

Costs presented in the spreadsheets, even when developed from actual cost and/or labor information provided by the states, are temporary and evolving. States that have prepared project plans that include resource estimates have emphasized that solid cost estimates for development work must wait until further planning has been completed. Work plans that describe in detail tasks and schedules on a bi-weekly or monthly basis will provide considerable fine-tuning to current estimates. In the case of operating and maintenance costs, states may enter the early operational period before solid estimates can be made.

For states that did not provide cost or labor information, costs estimated by the consultant team are subject to even greater modification. In the absence of plans that identify how much time will be needed for specific tasks and how much these tasks will cost, resource needs must be estimated from details about the CVO regulatory structure in the state; the characteristics of the CVO credentialing systems and plans to change the systems; the presence or absence of CVO process reengineering, one-stop shopping, and participation in electronic one-stop shopping or other electronic-based tests or projects; the state's information management and technology structure; and other state-specific information, and from information provided by states having cost and labor details.

[24] For a detailed discussion of spreadsheet structure, see the Task II Technical Working Paper.

In the absence of a project plan, it was determined on the basis of available information, that a state will develop a certain configuration for carrying out electronic credentialing and certain functionality in its systems. However, if eventual plans show a different course, cost estimates presented here may change significantly because state configuration, functionality of systems, and attendant hardware needs are major driving costs.

The need for a state to add staff to support electronic credentialing is identified for most states. There is some uncertainty regarding this issue although it is evident that all states will need to operate dual systems for a period of time. At some point, current operating staff may be reduced as manual data entry and manual processing requirements decrease. However, new tasks such as inventory and contract management, procedural development, and help desk functions may be needed. This is in addition to program and software maintenance required for the functioning of electronic credentialing. Whether the same or similar skill sets are involved in old staff versus new staff and where the new staff will come from in states where multiple agencies are participating in electronic credentialing, are pivotal questions related to staffing requirements. These questions are not likely to be answered until operations beyond a pilot period commence.

In this study, additional staff was identified in two ways. First, state contacts stated they perceive a need for new staff. One-half, one, or more full-time equivalents (FTE) may be shown in the state spreadsheet on this basis. An approximate cost to the state is given. Second, calculation of annual system maintenance may show a need for dedicated staff time in terms of hours required for maintenance. The cost to the state may be shown in Annual System Costs, and there will be an indication in Additional Staff of this FTE. In the cases where this happened, generally the state contacts also stated the belief that new staff would be needed for program or software maintenance.

It is important to note that the number of new staff and the cost to the state are rough estimates and these figures should be interpreted cautiously.

Ongoing communication costs were often the most difficult costs for states to predict. This is a potentially costly area that states have not quantified. Communication costs will depend on who pays, the volume of transactions, and the motor carrier interface with the states. For this study, it was assumed that carriers pay for messages they send to state agencies and states pay for messages they send to the carriers. The medium of communication is a network such as a VAN or AAMVAnet. Because it is impossible to predict how many carriers will be participating in a state in a given year, communication costs were based on the electronic filing and issuance of all credentials and permits issued in a state in 1996.

The carrier-state interface may prove to be an important cost determinant in the future. Costs for all states assumed PC-based software in the carrier office (CAT system). Several states are considering a Web-based interface and credentialing via the Internet. This approach could significantly affect communications costs and costs of maintaining software.

Electronic Clearance

The functional components for electronic clearance costs are described below. For each functional component, the elements included in the low- and high-cost scenario are identified.

Weigh Station Screening

- **Weight sorting *(low cost)***—In this application WIM/AVC can be used to weigh and flag vehicles for potential violations, and a traffic signal system directs vehicles to a static scale or bypass lane.

- **Weight sorting and vehicle identifications *(high cost)***—WIM/AVC weigh and flag vehicles for potential violations. AVI and/or License Plate Readers (LPRs) identify vehicles and a traffic signal system directs vehicles to a static scale or bypass lane.

Mainline Screening

- **Mainline weight sorting and vehicle identification *(low cost)***—In this application, WIM/AVC weigh and flag vehicles on the highway for potential violations. AVI identifies vehicle status based on registration information in a central database or stored on the AVI transponder. An in-vehicle display directs vehicles to either bypass or enter the weigh stations. Compliance verification systems comprising vehicle detection and additional AVI systems verify vehicle path and initiate alarms when an unauthorized vehicle bypasses the weigh station.

- **Mainline weight sorting and vehicle identification with safety and credential database interface *(high cost)***—In this application, WIM/AVC weigh and flag vehicles on the highway for potential violations identified in systems like SAFER or CVIEW. An AVI and/or LPR is linked remotely to a state and/or national database and identifies vehicles against flag information. In-vehicle displays direct vehicles to either bypass or enter weigh stations. Compliance verification systems comprising vehicle detection and additional AVI systems verify the vehicle path and initiate alarms when an unauthorized vehicle illegally bypasses the weigh station.

Remote Weight Screening

- **Remote/portable weight sorting *(low cost)***—In this application, Variable Message Signs (VMS) alert drivers to remote weight facilities. WIM/AVC weigh and flag vehicles for potential violations. VMS or traffic signal systems direct vehicles to the static scale or alert the vehicle to bypass.

- **Remote/portable weight sorting and vehicle identification *(high cost)***—In this application, VMS alert drivers to remote weight facilities. WIM/AVC weigh and flag vehicles for potential violations. AVI or LPR identify vehicle status from information stored in a central database on an AVI transponder. An internal display, VMS, or traffic signal system directs vehicles to the static scale or to bypass.

Weigh Station Credential & Safety Screening

- **Credential screening through managed databases *(low cost)***—In this application, vehicles are screened in weigh-stations based on safety and credential data from a central database such as HELP PrePass™, ADVANTAGE CVO, or a state managed database.

- **Credential and safety screening through national and state snapshot databases *(high cost)***—In this application, vehicles are screened based upon information obtained from remote links to databases such as CVIEW and SAFER. It should be noted that this application is still in the developmental stage.

Automated Safety Management

The functional components for automated safety management (the safety portion of electronic clearance and safety) costs are described below. For each functional component, the elements included in the low- and high-cost scenario are identified.

Weigh Station Safety Management

- **Electronic inspection record management *(low cost)***—inspectors electronically download safety inspection data from ASPEN or similar software. Inspection data is uploaded daily to state SAFETYNET or comparable database, and national safety data records are updated quarterly.

- **Electronic inspection record management and real-time information exchange *(high cost)***—inspectors access real-time inspection and safety records for vehicles. Inspectors electronically input safety inspection data via ASPEN or similar software, and inspection data is uploaded daily to state SAFETYNET or comparable database in real-time.

Remote Safety Management

- **Remote safety and credential checks *(low cost)***—Laptop computers link to national and state safety and credential mailboxes and download information daily. Highway patrol or CVO inspectors input vehicle identification information. Safety and credential flags identify potential violators. Safety and credential violations are input electronically and up-loaded to national and state databases daily.

- **Remote real-time safety and credential checks *(high cost)***—Laptop computers link via CDPD or satellite communication systems to national and state safety and credential mailboxes such as SAFER and CVIEW and down-load information in real-time for identified vehicles and drivers. Safety and/or credential flags identify potential violators. Safety and credential violations are input electronically and up-loaded to national and state databases in real time.

Roving Weight/Safety/Credential Management

- **Portable weight/safety/credential screening *(low cost)***—roving vehicles equipped with PCs, portable WIM/AVC and LPR or AVI systems set-up in remote locations. The portable WIM/AVC weighs vehicles and identifies potential violators. The AVI or LPR identify vehicles and link to state and national safety data mailboxes; vehicles are flagged for potential safety and credential violations. VMS or highway patrol directs vehicles to pull over for further checks.

- **Portable weight/safety/credential screening and real-time information exchange *(high cost)***—roving vehicles equipped with PCs, portable WIM/AVC and LPR or AVI systems set-up in remote locations. The portable WIM/AVC weigh vehicles and identify potential violators. The AVI or LPR identify vehicles and link to state and national safety data mailboxes; vehicles are flagged for potential safety and credential violations. VMS or state police direct vehicles to pull over for further checks. Information is uploaded to national and state mailboxes in real-time.

These ITS/CVO applications were used to develop the unit-cost template. The template-cost estimates can be customized and applied to current and planned state deployments. The deployment configurations are based on the implementation of ITS/CVO technologies currently in place or planned deployments and upgrades. In instances where case study states did not have a defined ITS/CVO deployment plan, assumptions of technology deployments were made based on state operations and identified state CVO needs. Also, the scope of the study calls for a full deployment cost analysis. Therefore, the deployment cost estimates represent deployment to all operations unless states have made specific decisions not to deploy ITS/CVO at specific sites.

Cost Components & Data Sources

The keys cost components considered in the cost estimates are start-up costs and annual costs. Start-up costs include unit costs, which comprise the ITS equipment, supporting equipment, and vendor installation and technical support; and capital costs, which are the one-time costs of deployment, such as installation, planning and oversight, and technical support Annual costs include operating and maintenance costs. Operating costs are the ongoing costs to operate the system and are comprised of communications costs, additional staffing requirements, and operating supplies. Maintenance costs are the ongoing costs to keep the system operational and are comprised of equipment maintenance contracts, required maintenance and system calibrations, and equipment replacements for ten years.

Deployment cost estimates were derived from operational test cost estimates, state deployment costs, and vendor cost estimates. In cases where component technologies are not deployed, vendor and state employee cost estimates were used. Exhibit V-1 outlines the cost components, cost assumptions, and data sources for each cost component.

Exhibit V-1. Summary of Cost Estimates & Assumptions

ITS Equipment	Description	Cost Assumptions and Data Sources	Operating and Maintenance Cost Assumptions
WIM/AVC	Cost estimate ranges were from $60,000 to $80,000. These ranges are from estimates for bending plate and load cell installation WIM models. Costs include all subsystems, programming and vendor technical support.	These cost are based on estimates from states that have deployed systems and from vendors.	O&M cost are estimated at between $3000 and $10,000 and include general upkeep, calibration and surface upkeep. These cost are based on estimates provided by states.
AVI	Cost estimates range from $40,000 to $80,000 which account for between 2 and 4 readers to be installed per site at an average price of $20,000 per unit. Cost estimates also include vehicle detection systems.	These cost are derived from vendor cost estimates and from cost estimates provided by system integrators.	O7M cost estimates range from $2000 to $3000 per site and are based on the cost of a service technician providing general vendor maintenance recommendations. Operating supplies will range from 0 to approximately $35,000. The $35,000 cost assumes that the state will provide AVI transponders at an estimated cost of $35 each at a deployment and replacement rate of 1000 a year.
LPR	Cost estimates range from $27,000 to $50,000. The low cost estimate is for the basic system that provides image recognition and error indicators to a central computer and the high cost represent an advanced system that also provides image recording to support enforcement subsystems.	These cost are based on vendor cost estimates.	O&M costs are based on vendor estimates.
Traffic Signal System	Cost range from $12,000 to $15,000. These cost ranges are inclusive of overhead and ground installations.	These cost are based on vendor estimates and state estimates.	O&M cost are based on state estimates.
VMS	Cost range from $12,000 to $15,000 and based on fiber optic 32 character systems.	These cost are based on vendor and state estimates.	Vendors and states did not have 'broken out' O&M cost estimates. This cost is included in cost of product. (assumption)
Workstation	Cost ranges were from $3000 to $5000 and include PC, modem, printer and attachments.	These cost are based on vendor cost ranges for Pentium processors and laser printers.	O&M cost are based on system administrator cost estimates for technical support for system crashes and paper supplies.

Exhibit V-1. (cont.) Summary of Cost Estimates & Assumptions

ITS Equipment	Description	Cost Assumptions and Data Sources	Operating and Maintenance Cost Assumptions
Portable Workstation	Cost range from $3000 and $5000 and include cost ranges for pen-based systems and portable PCs with special casing for remote operations.	These cost are based on state cost estimates of pen-based computers used for inspection data collection and on SAFER mailbox cost estimates for portable workstation used in the operational tests.	Maintenance costs include estimates for technical support due to failure and replacement cost based on a life cycle of 4 years.
Central Workstation	Cost range from $40,000 to $80,000 and from $200,000 to $300,000. The low cost ranges are estimates for hardware for central PC servers and the higher cost ranges include software development cost that customize existing software to meet specific state needs. In applications in which a private administrator is contracted such as HELP Pre-pass, there is no cost to the state.	These cost are based on estimates provided by John Hopkins University Applied Physics Lab, one of the developers of the CVISN architecture. It should be noted the software developments for these applications are only conceptual at the time of this study.	O&M costs range from $5000 to $7000 for hardware maintenance, from $50,000 to $100,000 for additional staff to administer the central system and from $500 to $1000 for paper supplies.
Roving Vehicle	Cost of a customized bus to store and operate portable equipment and a remote workstation.	These cost are based on Virginia's cost for their "NOMAD" vehicle.	O&M costs were not included in cost estimates because it was assumed that the cost of this vehicle is not significantly more than the operating cost of the state police vehicle that it would replace.

State Profiles & Deployment Assumptions

The deployment estimates for this study are based on the current state planning for ITS/CVO and are derived from state CVO business plans or general estimates from state employees involved in current ITS/CVO initiatives. Each state has different options for deployment of ITS. States participating in CVISN pilot initiatives are further along in their overall ITS/CVO deployment plans than many of the non-CVISN states. Additionally, state deployment plans may change due to budget constraints or incentive funding that may be available.

California

California has 12 weigh stations equipped for mainline bypass and eight weigh stations equipped for weigh station bypass. California uses HELP PrePass™ to manage the central database for weigh station screening. Fourteen weigh stations are equipped to link the California Highway Patrol (CHP) 407 information network that links to the states CCVIS (CHP version of ASPEN), MIS (stores citation information), MISTER (stores citation and collision information), and SAFETYNET (stores inspection data) networks. Currently 70 percent of the CHP assigned to CVO inspections are equipped with computers and CCVIS software.

California's ITS/CVO plans call for an additional nine weigh stations to be equipped for mainline bypass using the HELP PrePass™ database management service and three additional weigh stations to be linked to the CHP 407 Network. Caltrans is currently developing a state CVIEW and there are plans to link the HELP PrePass™ database with the SAFER and CVIEW mailboxes to verify and update credential and safety information on HELP PrePass™ registered vehicles. Caltrans is also in the process of upgrading MIS and CCVIS systems to establish safety flags on data and to facilitate information inquiries.

Colorado

Weight and size enforcement is the responsibility of the Port of Entry (POE), which is a division of the Department of Revenue. The POE operates nine fixed weigh stations and conducts a limited number of safety inspections at these weigh stations. Currently, two weigh stations are equipped for mainline bypass using WIM/AVC and AVI. The state also developed and manages the central database that manages the AVI accounts. There are five POE safety inspectors equipped with pen-based computers and ASPEN software to record and manage safety inspection data. The Highway Patrol has seven state troopers that conduct roadside inspections and all are equipped with pen-based computers.

Colorado ITS/CVO plans will equip the remaining seven fixed weigh stations for mainline screening in the next four years. The state has recently come to an agreement with HELP PrePass™ to manage the central database operations. The state is also planning to link all fixed weigh stations to a single computer network that links to the Colorado Department of Revenue databases as well as the SAFER and CVIEW mailboxes. The POE also plans to equip five additional inspectors with pen-based computers.

The State Patrol does not have specific plans to link CVO officers remotely to CVIEW and SAFER databases; however, representatives thought that it may be worth investigating given the system development that is underway.

Connecticut

The Connecticut State Police are responsible for weight and safety enforcement. The state operates five fixed weigh stations, 16 portable scales and six remote scales. Connecticut safety inspectors are all

equipped with workstations that use ASPEN software to collect and download inspection data. Inspector workstations are equipped with CDPD communications capabilities; however, current operations only allow inspectors to upload data in real-time. State plans call for real-time data exchange with SAFER and CVIEW mailboxes when they are available.

Connecticut's ITS/CVO safety and roadside operations plans include equipping 30 additional CVO division state police with portable safety workstations.

Delaware

The Delaware State Police are primarily responsible for safety and weight monitoring and enforcement. Delaware currently operates one fixed weigh station, which is anticipated to be closed by the year 2000. Delaware has plans to deploy a portable remote weight screening system. Delaware currently has seven CVO state troopers and two inspection officers and is a participant in the SAFER Mailbox Operational Test.

Florida

The Florida DOT is the primary agency responsible for weight, clearance, and safety CVO monitoring and enforcement. Florida is a participant in the ADVANTAGE I-75 operational test, though their two equipped weigh stations do not facilitate mainline bypass; rather, screened vehicles are routed to an in-station bypass lane that allows vehicles to travel at near-highway speeds.

Safety inspections are primarily conducted remotely. Florida also conducts a large number of remote weigh checks. Florida has 153 officers equipped with portable scales and employs 129 CVO inspectors.

The state of Florida does not have specific plans for expanding ITS/CVO deployments or for implementing new applications.

Kentucky

Kentucky is a participant in the ADVANTAGE I-75 roadside electronic clearance operational test and currently has four ADVANTAGE I-75 weigh stations equipped for mainline screening and one other weigh station equipped for weigh station weight screening. The state currently checks non-AVI equipped vehicle credentials by manually entering the KYU identification number into a state database.

Kentucky's ITS/CVO safety and roadside operation plans call for the state to equip four additional weigh stations for mainline screening. Kentucky is also planning to develop two remote weight-screening sites along interstate alternative routes. These sites will be equipped with video technology and possibly WIM and will link information to nearby weigh stations for monitoring and enforcement. Kentucky is also developing a revised central database system that will link screening databases to SAFER and CVIEW snapshot data and utilize the KYU identification number as well as transponder identification numbers.

Minnesota

CVO safety inspectors currently use PCs with ASPEN software to record, maintain, and access inspection data. In this application, the inspection data is electronically transferred to the state's SAFETYNET system, which electronically links the data to the national MCMIS database. Currently, data is updated quarterly from MCMIS.

Minnesota's ITS/CVO plans include building a state-of-the-art weigh station, which will conduct weight, credential, and safety screening. The system will utilize WIM/AVC and associated ITS

technologies and link to the state CVIEW and the national SAFER mailboxes. The state will also retrofit four other weigh stations to offer a similar capability over the next ten years. State plans also include equipping state patrol officers with portable workstations to link state troopers with SAFER and CVIEW mailboxes.

New Jersey

Eighty percent of troopers performing CVO duties in New Jersey are equipped with pen-based computers with ASPEN software to record and maintain safety inspection records. New Jersey is also a participant in the SAFER mailbox demonstration and will equip five state troopers with portable safety workstations with CDPD links to the SAFER Mailbox for this demonstration.

Although New Jersey has no specific plans to deploy remote ITS/CVO weight screening applications, representatives did identify safety hazards derived from current remote weight operations and speculated that these applications may be worthwhile for the state.

Exhibit V-2 outlines the deployment scenarios used for each state and discusses the assumptions that were made to account for full deployment.

Exhibit V-2. Summary of Clearance & Safety Case Study ITS/CVO Deployments

State	List of ITS/CVO Deployments	Discussion of deployment assumptions
California	17 mainline weigh station screening 102 weigh station safety management units 136 remote credential/safety links	Only mainline installations were considered, although California did deploy in-station-screening systems prior to their enrollment in HELP PrePass™.
Colorado	9 mainline screening installation 20 weigh station safety management units 7 remote credential/safety links	20 weigh station safety management units were considered when current plans only call for a total of 10. It was assumed that the state police would implement these systems even though there are no definite plans.
Connecticut	5 mainline screening installation 22 weigh station safety management units 80 Remote credential/safety links	Full deployment of weigh station screening was assumed although current plans only call for 2 weigh stations to be ITS/CVO equipped
Delaware	1 remote weight screening installation 9 remote credential/safety links	Because of the anticipated closure of the existing weigh station, no fixed clearance deployments were considered.
Florida	24 weigh station screening installation 129 remote credential/safety links	It was assumed that all weigh stations would be equipped with deployments similar to the existing deployments and that all inspection officers would be linked safety mailboxes
Kentucky	16 mainline screening installation 2 remote screening installations 64 weigh station safety management units 6 remote credential/safety links	It was assumed that all weigh stations would be equipped with ITS/CVO although current plans do not call for a full deployment.
Minnesota	6 weigh station screening installations 84 weigh station safety management units 18 remote credential/safety links	Although Minnesota operates 8 weigh stations, full ITS/CVO deployment was considered for 6 sites because state planners explicitly stated that 1 weigh station would not be equipped.
New Jersey	2 mainline screening installations 4 remote weight screening deployments 50 remote credential/safety links	Although New Jersey has 5 fixed weigh stations and no remote weight screening operations, it was assumed that full deployment would comprise 2 mainline screening installations because currently 4 weigh stations are closed pending repair and according to representatives a large portion of weight monitoring is conducted remotely.

Source: Castle Rock Consultants

Data Limitations

The goal of this cost analysis was to establish general cost estimates to reflect cost ranges for ITS/CVO deployments. The cost estimates derived for the safety and clearance deployments are based on cost estimates from a number of sources and do not reflect the specific cost of one installation. It should be noted that the cost estimates derived from operational tests might reflect cost-sharing arrangements or volume-cost discounts that may not apply to a single state. Additionally, vendors were reluctant to provide specific cost estimates without detailed information on the deployment design. Costs may be weighted with system integrator fees.

The cost analysis was conducted in two parts. First a cost template was developed to represent general cost estimates for a range of ITS/CVO application options and configuration options. Because there is a large number of possible deployment options it was necessary to establish a finite number of options. These cost ranges combine costs of application options and configuration options. The cost estimates would be more precise if more applications and possible configurations were examined. Additionally, because ITS/CVO technologies and applications are rapidly advancing it was necessary to consider applications that are still in the developmental stages and the cost approximations for these estimates have significant cost variances. Specifically, the cost of developing and operating systems that screen vehicles based on real-time information exchange with safety and credential data are based on general cost estimates of an application that is not yet deployed in any state.

The total cost estimates for weigh station deployments were compared to cost estimates for site deployments of HELP PrePass™, Oregon Green Light, and ADVANTAGE CVO and were found to be consistent. The unit cost of safety systems is based on specific equipment costs; however, the central database and database operating and maintenance costs are based on general cost estimates of software applications that are not yet fully deployed in any state.

The case study state costs are based on full implementation of ITS/CVO and are customized to be consistent with the existing state deployments that are based on state ITS/CVO deployment plans. In the instances in which states have not made specific plans for ITS/CVO deployments, specifically Florida, New Jersey, and Delaware, there are more cost and deployment assumptions.

DEPLOYMENT SCHEDULES

The ITS/CVO project plans and the level of deployment information obtained from each state for clearance and safety, and electronic credentialing provided a sufficient basis for the identification of costs that would be incurred by each state. As previously noted, the detail and scope of these project plans varied significantly with each state, as did the level of system deployment completed. Some states, such as California, have already begun the implementation of electronic clearance and safety systems.

This variance in level of current deployment and total future deployment yielded several obstacles to overcome. As will be discussed in the cost savings analysis (Chapter VI), the level of deployment of an ITS/CVO application, the market penetration, and the realization of benefits are complementary in nature. Thus, in order to properly gauge the total costs for both electronic credentialing and clearance and safety, each state was assumed to have *no current ITS/CVO deployment*. This assumption provides the opportunity to determine benefit realization as a function of system deployment costs.

The rate of deployment also varied significantly by state. As a result, two deployment schedules were developed for electronic credentialing and another two schedules for electronic clearance and safety. These deployment schedules provided a set of curves that were representative of the known deployment plans of the eight case study states.[25]

Electronic Credentialing

The majority of states within the case study group have, or are currently developing, project plans for the institution of electronic credentialing within the state. Based on the information obtained from the states, a three-year deployment period for implementing various levels of electronic credentialing was selected as a representative period of time. The level of implementation may relate to the amount of functionality ready for use (such as electronic-funds-transfer capability) or number of credentials or permits obtainable (IRP, IFTA, HAZMAT, etc.). This time period was then used as the basis for the two deployment schedules shown in Exhibit V-3 below.

Exhibit V-3. Percentage Deployment Completed By End of Year

	Year 1	Year 2	Year 3	Year 4-10
Schedule 1 (Aggressive)	80 %	100 %	100 %	100 %
Schedule 2 (Conservative)	33 %	66 %	100 %	100 %

Source: Castle Rock Consultants

The percentages identified in Exhibit V-3 represent the percentage of software development completed for the implementation of electronic credentialing. Although some states may elect a longer time period to develop electronic credentialing capabilities, it was determined that deployment of the systems generally included in plans for electronic credentialing that was achievable under a three-year time frame.

Schedule 1 represents the development of software requirements by a state that wishes to pursue electronic credentialing at a very aggressive pace. Schedule 2 illustrates a state that is pursuing electronic credentialing, though due to the systems to be installed or modified, or budgetary reasons, it will not complete deployment as fast as a state under Schedule 1.

Electronic Clearance & Automated Safety Management

Most of the case study states have determined the number and type of electronic clearance and safety systems they wish to implement. Projections relating to when such systems will be implemented resulted in the development of two deployment schedules for electronic clearance and safety operations. The two scenarios provide a range of four to ten years for complete deployment. This time period was used as the basis for the two deployment schedules shown in Exhibit V-4 below.

[25] As stated above, this study assumes that no ITS/CVO deployment has taken place thus far, although in fact some states have already deployed some portion of ITS/CVO. In the forthcoming Guidance document, states will be able to use the deployment curves presented here to adjust their expected future costs and benefits to account for previous investment in ITS/CVO.

Exhibit V-4. Percentage of Deployment Completed By End of Year

	Year									
	1	2	3	4	5	6	7	8	9	10
Schedule 1 (Aggressive)	20%	60%	90%	100%	100%	100%	100%	100%	100%	100%
Schedule 2 (Conservative)	0%	2%	5%	15%	25%	35%	50%	65%	85%	100%

Source: Castle Rock Consultants

The percentages identified in the Exhibit V-4 represent the percentage of installations of roadside clearance and safety systems completed at the end of each year. For electronic clearance and safety it is assumed if a state had 10 installations, for each of the seven ITS/CVO applications identified earlier a state would not implement all of one application in a single year and all of another application in another year. Rather, a state would implement all applications at the same time, with the proportion of total deployment costs reflected in the Exhibit V-4. Although some states may elect to install electronic clearance and safety systems at a rate slightly different than that used for the deployment schedules in this study, the two schedules chosen are likely scenarios for all states.

Schedule 1 represents the implementation by a state at an aggressive pace. A state represented by this schedule may elect to institute ITS/CVO clearance and safety applications at very few installations or be able to complete the desired number of installations in a very short period of time. Schedule 2 illustrates a state that may wish to pursue roadside clearance and safety applications but has chosen to have other states determine the success and potential level of benefits from implementation prior to investing themselves.

FINDINGS

This section presents the findings from the cost analysis. It is important to note that the costs shown below are in current dollars—they have not been discounted into constant (1997) dollars. This step in the analysis is shown in the next chapter.

Electronic Credentialing

The total costs for each state to deploy electronic credentialing are summarized in Exhibit V-5.[26]

[26] Detailed cost tables for each state are presented in the Task II Technical Working Paper, Appendix 2.

Exhibit V-5. Summary of Electronic Credentialing Cost Estimates

	Startup Costs ($000s)		Annual Costs ($000s)	
	Low	High	Low	High
California	$739	$821	$243	$364
Colorado	$482	$656	$55	$89
Connecticut	$134	$178	$67	$120
Delaware	$213	$323	$50	$86
Florida	$201	$259	$101	$193
Kentucky	$309	$490	$142	$234
Minnesota	$753	$959	$120	$183
New Jersey	$341	$446	$119	$225

Source: Castle Rock Consultants

Among the states, the highest start-up costs are in Minnesota, California, and Colorado. (With the addition of costs expected for developing and modifying systems, Kentucky will also have relatively high startup costs.) These states provided the most detailed cost and labor information and relative to specific functions and needs. While it is not an axiom that fine-grained plans produce the highest startup costs, there is a greater probability in underestimating rather than overestimating the costs when specific information is lacking.

Among Minnesota, California, and Colorado, the commonality is that their plans for electronic credentialing include the five major credentials, IRP, IFTA, OS/OW, SSRS, and HAZMAT. Development costs can differ considerably based on the number of credentials. (Annual communication costs also depend, in part, on the number of credentials.) In Minnesota and California, the two highest-cost states, the percentage of development work to be carried out by contractors is very high, about 67 percent and 80 percent respectively. Because the rate for contractors is much higher than for state personnel, this produces greater development costs.

Overall, for startup costs, the factors contributing to variation among states include the following:

- Number of credentials included in electronic credentialing;
- Percentage of development work by contractors;
- Hourly labor rates, especially for contractors;
- Hardware needs; and
- Number of systems requiring modifications and the extent of these modifications.

Annual operating costs comprise additional staff, communication costs, leased costs, and system costs. Leased costs are not a factor among the study states. Communication costs are an important variable. They figure prominently in California and New Jersey especially, and also in Florida, Kentucky, and Minnesota, and result in higher operating costs. The volume of transactions in the past year essentially determine the cost because the basis for computing costs (rates and carrier-state cost responsibility) is the same for all states. The identification of additional staff needs in California and Kentucky (1.5 FTE) and Minnesota (1.0 FTE) and the concomitant annual cost to the state also contribute to these three states' higher operating costs compared to other states.

In sum, variation among the states in annual operating costs is explained by the following:

- Identified additional staff needs; and
- Communication costs.

Limitations of Findings

The cost analysis should be updated with current information when a state produces more finely detailed work plans or when a state develops initial resource estimates for implementing electronic credentialing. Some issues that were raised during this analysis will become better defined and also help produce more solid cost estimates. These issues include the character of the carrier-state interface and the way information technology is managed by states.

In all cases, it was assumed that carriers would use PC-based CAT software to submit applications and to communicate with states. However, several states are presently investigating electronic credentialing through the Internet, whereby carriers could browse the Web to find a CAT interface residing on a state's server. Maryland, which is not one of the case study states, is preparing to go on-line with Web-based credentialing. With this approach, the state controls the interface completely. Changes in the credentialing process, such as an administrative or a legislative change in requirements, can be made directly by the state instead of the CAT software vendor. A major cost to the state would be a Web server. Carriers derive a direct benefit; they would not need to purchase the software or maintenance packages.

Eventually, carriers may obtain their credentials using on-line CAT, using PC-based CAT systems, or using systems they develop themselves.

Connecticut's plans to privatize the state's data processing operations could have major impacts on the development and maintenance of systems such as electronic credentialing. It is too early to determine exactly what these impacts will be, but staffing levels, costs of reengineering systems, and costs of maintaining systems are likely to be affected.

Deployment Issues

States that are advanced in their planning for electronic credentialing typically have identified a project manager or a management team to direct and coordinate development activities. In general, implementing electronic credentialing is handled as a pilot project that brings together state (and often, Federal), academic, consultant, and motor-carrier participants. For the purposes of the project, roles and responsibilities are well defined and goals are held in common. To be sure, state project plans identify roles (tasks) and goals (products or deliverables).

Project plans do not identify how institutional (i.e., non-technical) issues will be solved. In most states, more than one agency or department is involved in CVO regulation and enforcement. The major challenges facing state agencies are working cooperatively after the pilot period is over and electronic credentialing is an operational program and deciding where responsibility for managing the program, not the project, will reside. It is easy enough to estimate the need for an FTE. The question is: what department will be responsible? States may find that this is not the best approach, and may develop other means to meet the challenge.

Electronic Clearance & Safety

The template cost estimates for the start-up and annual costs of clearance and safety ITS/CVO applications are summarized in Exhibit V-6. The total deployment costs for each deployment schedule are summarized in Exhibit V-7.[27]

[27] Detailed cost tables for each state are presented in the Task II Technical Working Paper, Appendix 2.

Exhibit V-6. Summary of ITS/CVO Safety & Clearance Template Costs

Electronic Clearance	"Clearance Only" ($000)				"Clearance & Safety" ($000)			
	Start-up Costs		Annual Costs		Start-up Costs		Annual Costs	
	Low	High	Low	High	Low	High	Low	High
Weigh Station Screening	$217	$643*	$11	$107	$257	$787*	$13	$142*
Mainline Screening	$295	$825*	$12	$72	$295	$922*	$13	$72
Credential Screening	$40	$95	$2	$4	$300	$550*	$57	$111
Remote Screening	$65	$259	$3	$5	$85	$289	$5	$11
Automated Safety	**"Clearance Only" ($000)**				**"Clearance & Safety" ($000)**			
	Start-up Costs		Annual Costs		Start-up Costs		Annual Costs	
	Low	High	Low	High	Low	High	Low	High
Weigh Station Safety Management	$240	$465	$3	$81	$240	$465	$5	$138
Remote Credential/Safety Checks	$233	$460	$.5	$22	$253	$480	$74	$132
Roving Weight/Credential/Safety	$190	$539	$120	$201	$480	$789	$165	$310

Source: Castle Rock Consultants

* It should be noted that this cost includes the cost of implementing a central system and the cost of subsequent installations would be significantly less. It should also be noted that a single central system might be used in a number of applications.

Exhibit V-7. Summary of Electronic Clearance & Safety Ten Year Total Cost

State	Aggressive Schedule ($M)		Conservative Schedule ($M)	
	Low Cost	High Cost	Low Cost	High Cost
California	$138.4	$270.8	$68.5	$135.5
Colorado	$20.9	$38.7	$11.0	$20.9
Connecticut	$44.1	$107.8	$22.6	$56.6
Delaware	$5.6	$12.9	$3.1	$6.7
Florida	$104.1	$202.4	$49.6	$101.1
Kentucky	$58.2	$108.6	$29.7	$55.9
Minnesota	$55.9	$109.7	$27.8	$56.2
New Jersey	$37.2	$70.1	$21.4	$40.7

Source: Castle Rock Consultants

The template cost findings depict wide variances in the cost estimates between high and low configuration cost estimates and much smaller variances between high and low system applications. The primary cost factor driving these differences is the cost of developing and operating central database management systems. In screening applications, both the high and low system application provides states with the option to develop and operate a central database management system or to have a third party administer these services and pass the cost onto the carriers. In the high-end screening application options it is assumed that the states will link to state and national databases to screen vehicles.

Exhibit V-7 shows a clear cost difference associated with the alternative deployment schedules. For the more aggressive schedule, systems are in place sooner. Thus operating and maintenance expenses are accrued earlier. Over the period of analysis, these accumulated costs can be significant. However, benefits begin to accrue more rapidly under the more aggressive scenario as well. This will likely mitigate at least some of the added costs of more aggressive ITS/CVO deployment.

It should also be noted that while these cost estimates represent the cost of a single deployment, the central system development and operating costs are also included in these costs. These one time costs

are shared for the total deployment of the application and may be shared for other applications. For example, a central database management system that is used for weigh station screening applications could also be used for remote screening applications and in the high application options may be used to support remote safety and credential checks.

In general, the states that weigh the most vehicles and conduct the largest number of inspections have the highest deployment cost estimates. The exceptions are Connecticut, Colorado and New Jersey. The primary reason that Connecticut's cost is higher than that of Colorado is the level of deployment planned for remote operations. Connecticut's ITS/CVO plan calls for large field deployment of remote safety and credential database access workstations and real-time information exchange. The cost of full deployment for New Jersey's system was based on a deployment plan derived from the study team assumptions because New Jersey has not yet developed specific plans. It was assumed that New Jersey would deploy the lower-end systems and lower-cost estimates were used. For example, it was assumed that New Jersey would deploy remote weight screening applications but would not establish real-time communication links to a central database.

The primary cost factor that differentiates costs is the level of deployment, which in credential and safety applications translates into the number of weigh stations, and the number of inspectors and CVO enforcement personnel. Another significant cost factor differentiating costs among states is the selection of deployment options. The high-end applications cost more to deploy and operate than the low-end applications. In addition, the configuration options being considered for each deployment also affect the total cost. This includes the configuration options to include LPR into the applications or the use of four AVI readers instead of three.

CONCLUSION

In summary, the cost estimates derived in this study will support general cost estimates for states considering ITS/CVO deployments and will support benefit/cost comparisons. The template model will allow states to select specific applications and deployment configurations, while the state case study estimates will allow other states to examine the potential cost of ITS/CVO based on similarities of CVO to one of the case study states. The cost estimates derived for both the template costs and the case study costs are only estimates and do not reflect the actual cost that any one state has incurred for ITS/CVO deployments.

There are a number of factors that influence the deployment of ITS/CVO. For example, although clearance applications of ITS are relatively well established, there are a number of factors that will influence costs. For example, the cost of WIM/AVC systems will vary depending on the type of equipment, the type of surface, and the level of programming required to establish state screening criteria. Also, the cost of AVI systems and transponders will vary with the type of equipment and the number of units used in the deployment configuration. The level of automation of credentialing and the inclusion of electronic fee transactions will also affect the costs of the ITS/CVO system deployed. Operating costs will vary based on the system configuration, general maintenance, calibration requirements, environmental impacts, state staff costs, and level of use of the system.

Finally, the cost of developing and operating a central database management system will depend on the functionality of the software and the staff requirements. Currently, software is being designed nationality to support real-time information exchange and the implementation of credential and safety information into screening operations. It is still necessary, however, for each state to customize these software packages to meet the credentialing, enforcement, and screening needs of the state.

VI. ANALYSIS OF BENEFITS

Public sector agencies will benefit from the deployment of ITS/CVO technologies. The automation of CVO administrative processes through electronic permitting/credentialing will enable state agencies to streamline their operations, effectively improving their operating efficiency and reducing labor costs. Likewise, the automation of administrative processes may reduce mail/delivery costs and reduce paper usage within state agencies. ITS/CVO will allow many public agencies to restructure their operations in order to respond to budget reductions while concurrently improving customer service. State agencies may also be able to reduce enforcement costs, reduce carrier tax evasion (fuel tax or weight-distance tax), and reduce pavement damage due to oversize/overweight carriers through the adoption of ITS/CVO technologies such as electronic clearance.

The focus of this study is on the costs and cost savings associated with state agency processes for commercial vehicle operations. The emphasis of this study is further narrowed to three distinct ITS/CVO functions (these functions do not necessarily correspond to the market packages on a one-to-one basis):[28]

1) Electronic Permitting/Credentialing;

2) Electronic Clearance; and

3) Automated Safety Management.

As a preliminary exercise, the study team identified and described all potential benefits associated with the three functions. A comprehensive list of the cost savings and benefits for each of the three functions is provided in Exhibits VI-1, VI-2, and VI-3.

These exhibits identify all of the potential benefits associated with three specific functions of ITS/CVO. The focus of this study, however, is only on the costs and cost savings accruing to state agencies included under those three functions. These cost savings or benefits can generally be narrowed down into three types:

1) New revenue generated;

2) Labor cost savings; and

3) Other direct cost-savings (paper, fax, postage, etc.).

In this study, the team examined only the benefits and cost savings associated with more efficient use of state agency labor resources through adoption of ITS/CVO and revenue gains (some of them only short-term) from improved regulatory enforcement and compliance. Potential benefits such as safety and industry-related timesavings are not quantified in this study. It is extremely important to consider the scope of the analysis when reviewing the quantified benefit estimates presented later in this chapter,

[28] The ITS/CVO functions identified in this study were selected by the Technical Advisory Group for the NGA study and are based on three ITS/CVO functions identified by the Volpe Institute.

as a substantial portion of the total potential benefits attributed to ITS/CVO are not included in the Benefit/Cost (B/C) analysis.[29] The benefits methodology is discussed in the following section.

[29] As stated in the first section of this chapter, most experts agree that the greatest benefits attributed to ITS/CVO will accrue to motor carrier owners/operators (industry-related benefits including time savings, reduced operating costs, and improved operator safety). Therefore, the benefits analysis may not account for a significant portion of total ITS/CVO benefits.

Exhibit VI-1. Overview of Potential Administrative Benefits Associated with ITS/CVO

Type	Direct/Indirect	Description	Accrue to:	How to Measure
Reduce manual data entry through automation and information sharing	Direct	Computerized, coordinated administrative processes will reduce the need for manual data entry and also reduce time spent reprocessing applications.	State	Cost savings. Improved operating efficiency.
Improve data consistency (reduce data-entry errors)	Direct	Through the process of automation, agencies can improve the consistency and quality of data. Error reduction and QA/QC measures can be targeted at one primary data entry point. Consolidation of existing databases into a single centralized database.	State	Cost Savings. The benefits associated with more accurate data are difficult to measure but could potentially be substantial in terms of budgeting and planning.
Reduce paper work and administrative labor	Direct	Automation will reduce the need for paper-based record keeping and administration.	State	Cost Savings.
Promote regulatory compliance	Direct	Automation may facilitate a more efficient process (the same number of registrations using less labor). Automation may also promote voluntary regulatory compliance.	State	Additional revenue from increased voluntary compliance.
Adoption of new technologies and the use of updated equipment	Direct	The administrative process will require the use of new/updated hardware and software. This upgrade can promote efficiency in other administrative areas.	State	Cost savings. Improved operating efficiency.
Improved access to data planning, long-term policy and procedure improvements	Indirect	Automation will make it easier for various agencies throughout the state to access and use transportation-related data. The sharing of this data can lead to improved planning and development.	State, General public, CV owner/operator	Improved forecast accuracy, improved pavement life, congestion forecasts, etc.
Simplified implementation of new/revised regulations	Direct	The coordination of CV administrators will make it much easier to disseminate information regarding new regulations.	State, CV owner/operator	Cost savings. Improved efficiency. Reduce misunderstanding and misinterpretation of regulations.
Simplified taxation/improved tax compliance and auditing	Direct	Automation will make it much easier to assess taxes and to bill CV operators. A centralized data collection facility will improve the speed and accuracy of billing.	State, CV owner/operator	Cost savings. Decreased tax evasion. More timely tax audits. Improved accuracy of tax audits.
Employment effects	Indirect	Automation may improve operating efficiency within each agency.	General public, State, National economy	New positions filled and title of position. Average salary and education level.
Time savings (carrier)	Direct	Automation will increase productivity for the individual motor carriers. Operators will no longer have to fill out paperwork for multiple agencies. All information processing at once via an integrated computer system.	CV owner/operator	Time savings.
Improve administrative efficiency (carrier)	Direct	An automated administrative process will reduce labor costs for carrier and fleet administration.	CV owner/operator	Cost savings.
Improved business climate	Indirect	An automated administrative process may promote the image of a well-organized, efficient state. This image may, in turn, promote economic development.	State	Opinion of manufacturing and service industry on the effects of centralized administration.
Price effects (lowering)	Indirect	Automation may improve labor efficiency and generate cost savings at the owner/operator level (increase productivity). It is possible these savings will be passed along to the consumer in the form of lower prices.	General public	Changed in product prices.

Exhibit VI-2. Overview of Potential Clearance Benefits Associated with ITS/CVO

Type	Direct/Indirect	Description	Accrue to:	How to Measure
Improved carrier productivity	Direct	Automation will reduce the amount of time CVs must spend at inspection stations and allow for targeting of specific carriers. Compliant carriers will be bypassed.	CV owner/operator	Time savings.
Improved enforcement	Direct	Through the use of information exchange, state officials will be able to target non-compliant vehicles. Carriers will have a definite incentive to comply with regulations.	State	Percentage of overall fleet in compliance. Percentage of non-compliant vehicles identified.
Increased revenue from fines (targeting of non-compliant carriers) Non safety-related violations	Direct	Non-compliant carriers will be more likely to be caught. Short-term revenue from fines will increase.	State	Increased revenue.
Reduced congestion	Direct	Domestic clearance should reduce congestion at and around weigh stations. More legal trucks will be able to bypass the weigh station reducing queuing.	General public, CV owner/operator	Time savings
Improved infrastructure	Indirect	A decrease in carrier weight and size violations will limit pavement and structural wear.	State	Construction and materials cost savings for roads and bridges.
Reduced vehicle emissions	Indirect	Electronic clearance applications will reduce CV emission as idle-time is reduced.	General public, State	Reduction in emissions. Increased average speed over certain road segments.
Reduced fuel consumption	Indirect	Electronic clearance may reduce fuel use.	CV owner/operator	Fuel cost savings.
Reduction of vehicle maintenance costs	Indirect	Improved compliance with weight and size restrictions should reduce wear and tear on the CV fleet. Reduction of idle time will reduce maintenance costs.	CV owner/operator	Maintenance cost savings.
Price effects (lowering)	Indirect	Electronic clearance may result in cost savings at the owner/operator level (increase productivity). It is possible these savings will be passed along to the general public in the form of lower prices.	General public	Changes in product prices.

Exhibit VI-3. Overview of Potential Safety Benefits Associated with ITS/CVO

Type	Direct/Indirect	Description	Accrue to:	How to Measure
Reduce the number and severity of incidents	Direct	Safety applications will allow the CV operator, state police, and inspectors to detect safety violations before an incident occurs.	State, CV owner/operator, General public	Number of incidents. Fatalities. Type and severity of injury.
Increased capacity to inspect vehicles	Direct	Through automated safety applications, inspectors may improve inspection efficiency. The greatest time savings may be from a reduction in the time spent entering data.	State	Cost savings.
Improved carrier productivity	Direct	Automation will reduce the amount of time CVs spend at inspection stations. Inspectors will be able to target non-compliant carriers and bypass compliant carriers.	CV owner/operator	Time savings.
Increased revenue from safety violations	Direct	Inspectors will be able to target non-compliant carriers and increase the number of citations issued in the short-run.	State	Increased revenue.
Improved voluntary compliance	Direct	Safety assurance will promote increased compliance with existing regulations. State agencies will be able to exchange information on traditionally non-compliant carriers and take appropriate action.	State, General public	Long-term reduction in the percentage of non-compliant vehicles inspected. Long-term increase in the percentage of overall fleet in compliance.
Reduced environmental damage	Indirect	Improved safety assurance should lead to additional benefits in terms of avoided environmental degradation due to HAZMAT spills.	State, General public	Reduction in environmental damage due to spills.

AGENCY COST SAVINGS METHODOLOGY

The potential benefits derived from ITS/CVO, and with ITS in general, are often vague and difficult to measure. Discussions of ITS-related benefits can be difficult to follow as many groups and organizations use different terminology and different units of measurement to describe benefits. This problem is compounded by the fact that deployment ITS technologies is a relatively recent occurrence, and therefore performance and evaluation data are sparse. Much of the existing information relating to the costs and benefits associated with ITS/CVO is qualitative in nature and provides general ranges of expected benefits based on speculation rather than empirical data. This study is different. The study team used state-specific data to estimate a unique current cost baseline for a "without ITS" scenario in each of the eight case study states. The team then drew on existing literature to estimate potential benefits for specific ITS/CVO technologies based on realistic deployment scenarios within the state.

The benefits analysis was developed to identify and quantify the potential benefits associated with the state processes for commercial vehicle operation in each of the eight case study states. This section describes the individual benefits categories identified in the study. The data inputs used to calculate both the baseline scenarios and the cost savings analysis are discussed as well as the overall methodology used for the cost savings analysis.

Baseline data was collected for individual states for the various benefits categories (see Chapter IV). State agencies responsible for administering the respective functions provided the data directly to the study team via telephone and/or fax. The data provided by the individual states served as the foundation for baseline cost estimates. A benefit multiplier was then applied to estimate potential benefits associated with each of the baseline cost (benefit) categories. The benefit multipliers used in the study are based on multipliers or estimates used in other ITS/CVO studies. In all cases, the study team selected what they considered to be a conservative estimate for the benefit multiplier. Sensitivity analysis was conducted for all of the benefit categories. Total benefits or cost savings were then estimated based on the selected multiplier.

The methodology used in the study is fairly straightforward. Exhibits VI-4, VI-5, and VI-6 provide a graphical overview of the methodology for each of the three functions.

Exhibit VI-4. Benefits and Cost Savings Methodology for Credentialing

Potential Benefits & Cost Savings

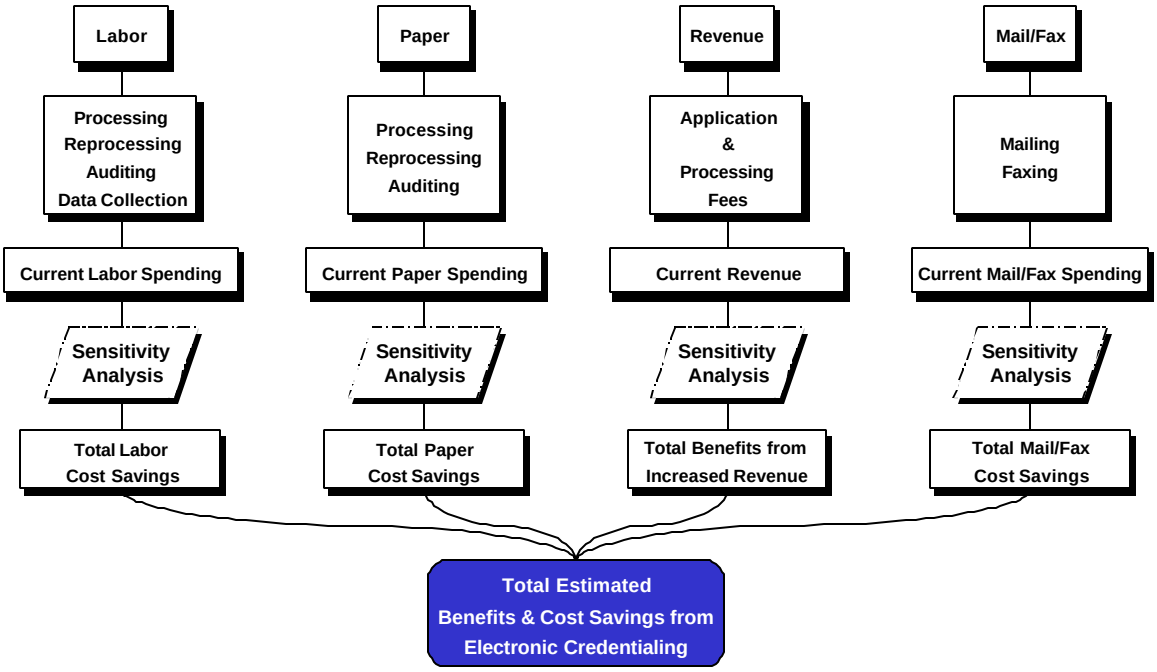


Exhibit VI-5. Benefits and Cost Savings Methodology for Clearance

Potential Benefits & Cost Savings

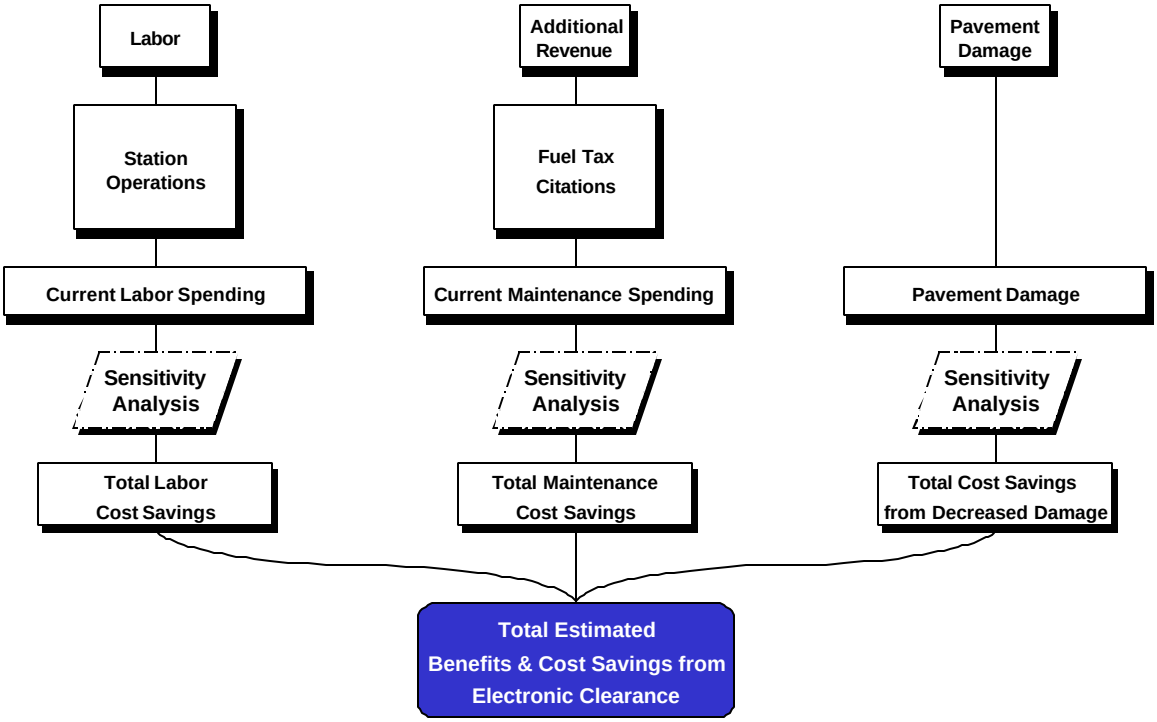
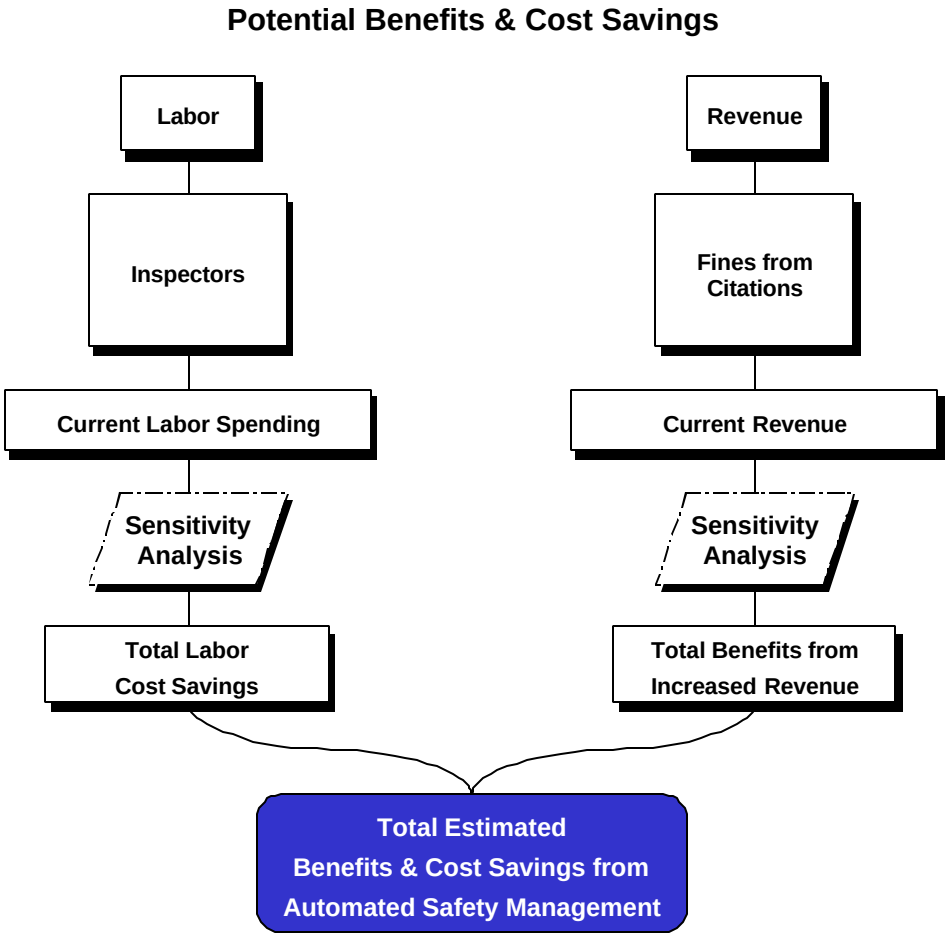


Exhibit VI-6. Benefits and Cost Savings Methodology for Safety Management



It is important to note that the electronic clearance and automated safety management functions are very similar, and it may be difficult for the reader to differentiate between the two.[30] The confusion regarding the difference between the two functions (or whether they should be viewed as a single function) centers around the fact that roadside clearance and safety systems do not operate in a mutually exclusive manner. In many states, clearance programs or systems also include safety screening. Since many of the same personnel who are responsible for weighing vehicles also perform safety inspections, it can be difficult to differentiate between the two. For the purpose of this analysis, clearance and safety will be considered as separate functions, but will be presented together in the analysis. Presenting the functions together will minimize problems associated with trying to separate the costs of systems that are currently deployed and operated in tandem.

[30] In fact, some experts believe there is no real distinction between the two functions, and they should really be presented as a single function.

For the purpose of the analysis, the baseline costs and benefits associated with the three functions/applications are grouped into two categories for both the traditional approach and the ITS/CVO approach.

Traditional Approach

1) Administrative Processes (Permitting/Credentialing); and

2) Roadside Activities (Safety Management and Clearance).

ITS/CVO Approach

1) Electronic Credentialing (Administrative Processes); and

2) Electronic Clearance and Automated Safety Management (Roadside Activities).

Exhibit VI-7 summarizes all the benefits the study team considered for the analysis. The exhibit also indicates where the majority of each of the cost savings or benefits is likely to accrue: public agency, private sector, or society. As mentioned earlier, only specific benefits accruing to public sector agencies are quantified in this study. The benefits categories highlighted in Exhibit IV-7 are the categories quantified in this study. A brief overview of reported industry-related benefits and/or cost savings and benefits accruing to the general public (societal benefits) will be presented at the end of this chapter.

Exhibit VI-7. Expected Benefits from ITS/CVO

	Public Agency	Private Sector	Society
Administrative Processes			
Application Processing Cost Savings	X		
Application Re-processing Cost Savings	X		
Permit/credential Audit Cost Savings	X		
Data Collection and Processing Cost Savings	X	X	X
Paper Reduction Cost Savings	X		
Mail/Delivery Cost Savings	X		
New Revenue Generated Through Increased Voluntary Permit/Credential Compliance	X		
Adoption of New Technologies (upgrade equipment)	X		
Simplified Implementation of Regulations		X	
Motor Carrier Timesaving		X	
Improved Business Climate			X
Price Effects (reduction of consumer prices)			X
	Public Agency	**Private Sector**	**Society**
Safety/Clearance Functions			
Safety Inspection Cost Savings	X		
New Revenue Generated Through Increased Voluntary Fuel Tax Compliance	X		
New Revenue from Increased Citations	X		
Cost Savings Realized by Reducing Roadway Damage due to Oversize/Overweight Carriers	X		
Reduced Accidents (lives saved, property damage)		X	X
Improved Carrier Productivity		X	
Reduced Congestion around Weigh Stations		X	X
Improved CVO Infrastructure	X	X	X
Reduced Vehicle Emissions			X
Reduced Fuel Consumption		X	X
Reduced Vehicle Maintenance Costs		X	
Price Effects			X

Source: Apogee Research

The specific benefits examined under Electronic Permitting/Credentialing will be discussed first. The individual benefit categories included under Electronic Credentialing and Automated Safety Management will follow. As mentioned earlier, for the purpose of this analysis, the safety and clearance functions will be presented together.

Electronic Permitting/Credentialing

There are six major benefits categories examined in administrative process. The baseline costs and benefits associated with each category will be discussed in detail.

1) Application processing and re-processing cost savings;

2) Permit/credential audit cost savings;

3) Data collection and processing cost savings (used for highway planning, pavement and bridge design, needs studies, highway research, etc.);

4) Paper reduction cost savings;

5) Mail/delivery cost savings; and

6) New revenue generated through increased voluntary permit/credential compliance.

1) Processing and Re-Processing Cost Savings

The baseline costs for processing and re-processing applications are driven by the number of applications, the percentage of time spent processing applications, salary ranges, and the number of staff required to process applications.[31]

The types of applications included in the analysis may differ by state. For example, some states require carriers to submit HAZMAT applications, while others do not. The analysis is tailored to reflect the actual credentialing process within each of the case study states. The analysis, however, is centered on five major permits/credentials:

1) International Registration Plan (IRP);

2) International Fuel Tax Agreement (IFTA);

3) Single State Registration System (SSRS);

4) Oversize/Overweight (OS/OW); and

5) Hazardous materials (HAZMAT).[32]

Where possible, additional information has been collected for other types of permits/credentials and added to the analysis on a state-by-state basis.

In order to estimate the baseline costs associated with processing and reprocessing, various applications of state-specific data were collected. Data include the number and type of applications processed, the percentage of applications re-processed (by type), the percentage of time spent processing and reprocessing applications (by type), and detailed staffing information (number of staff, salary range, title, percentage of time spent processing and re-processing applications).

In cases where information was not provided or was incomplete, the study team used various assumptions to complete the baseline data set. Since the assumptions differ by state and by application type, they are described in detail for individual states in each of the case study spreadsheets.

The analysis includes both low cost and high cost scenarios for each category. Labor costs are based on Full-Time-Equivalents (FTEs) for each staff member. Exhibit VI-9 provides an example of the FTE approach for calculating staffing costs. The number in the "staffing requirement" column is multiplied by the number in the "percentage of time spent" column for each position (contained in a separate row). The resulting number, 0.1 in the case of the Manager and 0.85 in the case of the Technician represent

[31] Application processing and re-processing baseline costs and estimated timesavings for each individual state are presented in the Task II Technical Working Paper, Appendix 3.

[32] For further discussion of permits/credentials see Chapter II of this report.

the FTE for each position. The FTE is multiplied by the low salary range parameter and the high salary range parameter to provide the respective low and high cost estimates for each position.

Exhibit VI-8. Example of Staffing Calculations

Type of Application	Position	Staffing Requirement	% of Time Spent	Salary Range (Annual)	Low Cost	High Cost
IRP	Manager	1	10%	$30-$40,000	$3,000	$4,000
IRP	Technician	10	85%	$22-$32,000	$187,000	$272,000
Total IRP					**$190,000**	**$276,000**

The number of applications processed represents baseline data provided by the individual states. The number of applications reprocessed is also based on data provided by the individual states in terms of the percentage of applications that need to be reprocessed. States also provided estimates for the percentage of time spent between processing and reprocessing. By definition, the percentage of time spent processing and the percentage of time spent reprocessing applications (for each type of application) must sum to 100 percent. Exhibit VI-9 provides an example of the application data received from the individual states.

Exhibit VI-9. Example of Application Data Received from Individual States

Type of Application	# of Applications Processed	# of Applications Reprocessed	% of Time Spent Processing	% of Time Spent Reprocessing
IRP	12,000	600	97%	3%

The baseline cost for processing the various applications was calculated by multiplying the total staffing cost parameters for each application type (See Exhibit VI-8.) by the percentage of time spent processing the respective applications (See Exhibit VI-9.). For example, using the IRP staffing scenario described above, the low cost scenario for processing IRP is $184,300 (low cost staffing parameter multiplied by percentage of time spent processing IRP). The calculations are provided in Exhibit VI-10. It should be noted that the total costs for both the low- and high-cost scenarios equal the low and high costs of the staffing costs.

Exhibit VI-10. Example of Processing/Reprocessing Cost Estimates

Type of Application	Processing Costs		Reprocessing Costs		Total Costs	
IRP	Low	High	Low	High	Low	High
	$184,300	$267,720	$5,700	$8,280	$190,000	$276,000

The methodology behind these estimates is based on an FTE approach. Estimates are not calculated by multiplying an average hourly wage rate by the average time spent processing/re-processing applications by the number of applications. The FTE approach was used to eliminate large variances in the time required to complete applications between the different agencies within a state (or between states). Furthermore, the FTE approach allows the study team to avoid complications or inconsistencies

in several important assumptions. It is assumed all applications are processed during the course of the year. Overtime and the use of temporary staff is not accounted for in this analysis.[33]

In order to conduct a "reality" check on our estimates, the team solicited some general feedback regarding the average amount of time required to complete various types of applications. These estimates were compared to rough estimates of the average time required to complete an application based on our analysis (deriving the average time per application through the FTE process).[34] The ranges were acceptable. It is important to note that states have different processes for processing applications. Furthermore, applications for the same permits/credentials may differ between states.

The benefit multiplier used to estimate agency cost savings for both the processing and re-processing applications is based on information contained in the COVE study.[35] According to the COVE study, agency cost savings resulting from one-stop/no-stop shopping is approximately 33 percent for intrastate applications and 40 percent for interstate applications.[36] The study team used the benefit multipliers of 33 percent for the low cost scenario and 40 percent for the high scenario. For the purpose of this analysis, there is no distinction drawn between cost savings attributed to intrastate carriers and cost savings attributed to interstate carriers. Potential benefits are estimated by multiplying the processing costs for each type of application by a fixed percentage cost saving (in this case 33 percent low and 40 percent high). Sensitivity analysis is performed for 20 percent, 40 percent, and 60 percent cost savings.

Exhibit VI-11 provides an illustration of the cost savings estimation methodology for the processing of IRP applications.

Exhibit VI-11. Example of Labor Time Savings for IRP

Type of Application	Labor Time Savings					
	40%		60%		COVE Study Estimates	
	Low	High	Low	High	Low	High
IRP	$73,720	$106,800	$110,580	$160,632	$60,819	$106,800

The benefits multipliers in this case are the COVE study estimates of 33 percent and 40 percent. The 40 percent and 60 percent low and high scenarios represent the sensitivity analysis. Labor timesavings are estimated by multiplying the processing costs for IRP (both low and high scenarios) by the respective benefit multiplier. The low scenario for IRP labor savings is calculated by multiplying $184,300 by 33 percent.

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[33] These assumptions may not be entirely accurate in the case of individual states, but they allow the study team to calculate a consistent baseline by not allowing variations in the assumptions among the individual states.

[34] An estimate of the average time required to complete a particular application can be derived through the FTE process. For example, for the purpose of this analysis, it was assumed that 1 FTE=2080 labor hours/year (8 hours a day, 260 days/year, 52 weeks/year). Using this approach, the average time spent per application can be derived.

[35] *Commercial Vehicle Operations and Institutional Barriers* (COVE Study). Booz Allen & Hamilton, Inc. July 1994.

[36] The ITS/CVO application one stop/no stop shopping allows carriers to physically or electronically purchase and pay all licensing fees, registration fees, and taxes through one centralized source. Although electronic permitting/credentialing is technically not the exact same thing as one stop/no stop shopping (it does not require the public agency to provide a physical single location for walk-in (or mail) applicants), for the purpose of this study, it is assumed one stop/no stop shopping is similar enough to electronic credentialing to be used as proxy.

2) Auditing Cost Savings

The baseline cost associated with compliance audits is driven by percentage of time spent auditing applications, salary range, and the number of staff required to audit applications.

The methodology behind the baseline cost associated with compliance audits and the respective benefits evaluation is exactly the same as the methodology used for processing and re-processing applications. Data was provided by the individual states concerning staffing requirements and salary ranges for auditors. A low cost scenario and high cost scenario value were calculated for each type of application. Cost savings were estimated using COVE study parameters for the low and high scenarios (33 percent and 40 percent respectively).

3) Data Collection & Processing Costs

The data collection and processing costs analysis is based on a similar analysis contained in the HELP/Crescent evaluation.[37] Both federal and state agencies require traffic volume, weight, and classification data to facilitate highway planning, needs studies, cost allocation studies, and general research and policy analysis. It is anticipated that ITS/CVO administrative processes will enable state agencies to improve the efficiency of their data collection efforts as well as improving data consistency and continuity. The baseline cost associated with data collection and processing is driven by the number of employees involved in data collection per session, the amount of time spent collecting data per session, the time spent processing data per session (as a function of time spent collecting), salary ranges, and the number of sessions required to collect and process data per year.

The baseline costs for data collection and processing were calculated using information contained in the HELP/Crescent evaluation. All the assumptions used in the baseline cost analysis are identical to, or consistent with the assumptions used in the Crescent evaluation. For example, information concerning data collection time per site, number of sessions, processing time per session, and hours spent collecting and processing data per year were obtained from the Crescent evaluation.

The salary-range parameters given in the HELP/Crescent evaluation were adjusted to reflect the salary ranges for commercial vehicle inspectors and/or troopers in each case study state. Exhibit VI-12 illustrates the baseline cost calculations for data collection/processing without Weigh-in-Motion (WIM) or Automated Vehicle Classification (AVC). Exhibit VI-13 illustrates the costs for data collection/processing with WIM/AVC.

Exhibit VI-12. Costs for Data Collection/Processing Without WIM or AVC

Hours Spent Collecting Data	Number of Session	Processing Time	Annual Time Spent Processing	Salary Range	Low Cost Estimate	High Cost Estimate
96 hours/session	10	192 hours/session	2,880	$20,000 - $30,000	$27,700	$41,550

[37] Appendix A: *On-Site Analysis of HELP Technologies and Operations*. Evaluation Report Draft. Castle Rock Consultants. October 1993.

Exhibit VI-13. Costs for Data Collection/Processing with WIM or AVC

Hours Spent Collecting Data	Number of Session	Processing Time	Annual Time Spent Processing	Salary Range	Low Cost Estimate	High Cost Estimate
48 hours/session	10	96 hours/session	1,440	$20,000 - $30,000	$13,840	$20,760

The annual time spent processing/collecting data is used to calculate the FTE. The number of hours in each of the two scenarios (without WIM/AVC, with WIM/AVC) is divided by 2,080 hours (1 FTE). The resulting calculation provides the FTE estimate for each of the two scenarios (1.38 in the without WIM/AVC scenario, and 0.69 in the with WIM/AVC scenario). The low cost was estimated by multiplying the FTE scalar (1.38 and 0.69 respectively) by the low salary parameter. In the without WIM/AVC scenario the low cost is $27,700. In the with WIM/AVC scenario the low cost is $13,840. The cost savings are estimated by subtracting $13,840 from $27,700. In this case the cost savings from ITS/CVO would be $13,860.

4) Paper Reduction Costs

The baseline cost associated with paper usage is driven by the number of applications used and cost per application.

Information was collected for individual states concerning the number of each type of application form used in 1996. In most cases the number of applications used was greater than the number of applications processed. Where information was not available concerning the number of applications used, the number of applications processed was used as a proxy.

The cost per application is based on an estimated cost per application page of five (5) cents. For the purpose of this analysis, it is assumed that there are five (5) pages per application form for IRP, IFTA, and SSRS. It was assumed there are three (3) pages per application form for all other applications including OS/OW and HAZMAT.[38] These assumptions are based on a general average number of pages per application across the eight case study states. In cases where the actual number of pages per application is known, the real number of pages was used. The cost of instructional booklets is not considered in the paper usage analysis. In some cases, instructional booklets may account for the majority of paper costs. It is unclear, however, how ITS/CVO may affect the use/manufacture of instructional booklets.

The cost saving associated with reduced paper usage was calculated by multiplying the baseline paper costs for each type of application by a benefit multiplier. In this case, the multiplier is a 50 percent reduction in paper usage (translates into a 50 percent reduction in paper application forms). A 50 percent reduction is assumed to represent a realistic estimate without being too conservative.

5) Mailing & Delivery Cost Savings

The baseline cost associated with mail and delivery is driven by the method of delivery, the delivery cost per application, and the number of applications sent.

[38] The number of pages per application will differ between states.

The number of applications used serves as the basis for this analysis. For the purpose of this analysis, it is assumed that permit/credential application packets are either sent by mail or fax. Applications that require official signatures are mailed (IRP, IFTA, and SSRS). Applications not requiring official signatures are faxed (OS/OW, others). It is assumed that HAZMAT applications are mailed because most of the case study states mailed their HAZMAT packets to the carriers. Again, it is important to note that the various states may deliver application packets in different ways. The assumptions used in this analysis are designed to provide some uniformity across the case study states.

This exercise required the use of some general assumptions by the study team. Baseline data regarding the cost of mailing/delivering applications was difficult to obtain. Most state agencies involved in processing CVO-related applications send their out-going mail to a mailroom, and generally have no idea what it costs to mail or deliver a specific type of application packet. At the same time, the various mailrooms receive out-going mail from numerous agencies or departments within agencies, and have no idea what percentage of mail they receive is attributed to specific types of applications (IRP, IFTA, etc.). For example, the mailroom supervisors contacted could not identify the average per unit cost of an out-going package from the department/agency that processes IFTA.

The unit cost for each type of application is based on the actual cost of two types of packages received from the state of Connecticut.[39] The study team received an IRP package and a hazardous materials package by mail from Connecticut. The unit costs were $2.19 and $2.39 respectively. According to the mailroom staff that handled IRP in Connecticut, the cost of a package does not change based on the distance the package is sent. Since IFTA and SSRS application were approximately the same size as IRP applications (based on applications received from other case study states), $2.19 was also used as a proxy for delivery costs for those application packets. The application packets are assumed to include any instructional booklets required to complete the application.

The cost associated with faxing information is based on the underlying assumption that it costs an average of 30 cents per page to send a fax. It is assumed only the actual application is faxed (no instructions). In the case of OS/OW (and other permits/credentials) the base cost per application is 90 cents (3 pages multiplied by 30 cents per page).[40]

In order to determine whether or not the baseline cost estimates for mail and delivery were realistic, the team performed a "reality" check exercise. The team obtained operating budgets from several different mailrooms in three different case study states. The baseline costs associated with delivery for the respective application packets were compared to the overall budget for the mailroom. In all cases, the total estimated mailing cost of the application(s) in question was between one percent and 10 percent of the total operating budget for the mailroom.[41] The reality check does not include fax costs, as mailrooms are not responsible for sending faxes.

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[39] The content and therefore the cost of similar application packets will vary between states. The cost of the packages from Connecticut was used as a best-guess approximation.

[40] Again, the cost per page of 30 cents is an average figure. This number may vary between states or even among different agencies within states.

[41] It is important to note that different agencies are responsible for different aspects of the CVO permitting/credentialing process. For example, in Connecticut the Department of Motor Vehicle mailroom services IRP, but the Department of Revenue mailroom services IFTA and CT Only permits. In Florida, the Department of Highway Safety and Motor Vehicles mailroom services both IRP and IFTA.

The cost savings associated with reduced mail and delivery costs were estimated to be 50 percent of the baseline costs.

6) New Revenue Collected Through Permitting & Credentialing

The baseline revenue generated through permitting/credentialing is driven by the revenue collected by type of application. The individual states provided the team with 1996 reported revenue figures for the various types of permits/credentials.

Electronic permitting/credentialing is expected to generate new revenue for the state by increasing voluntary regulatory compliance by motor carriers. New revenue collected through increased voluntary compliance was estimated using a benefit multiplier of 0.5 percent. In other words, ITS/CVO administrative processes are expected to result in an increase in regulatory compliance of half of one percent. Sensitivity analysis was performed at both the 0.75 percent and 1.00 percent levels. The 0.5 percent figure was selected by the team as a conservative estimate of expected voluntary compliance impacts resulting from state-wide implementation of various ITS/CVO technologies that may affect the administrative process for permitting/credentialing.

Benefits related to safety and clearance applications are discussed below.

Electronic Clearance & Automated Safety Management

There are four major benefits categories examined in this section:

1) Safety inspection cost savings;

2) New revenue generated through increased voluntary fuel tax compliance;

3) New revenue generated through increased citations; and

4) Cost savings realized by reducing road damage due to oversize/overweight carriers.

1) Safety Inspection Cost Savings

The baseline cost associated with safety inspections is driven by the number of inspections by level, average time spent performing inspections by level, staffing requirement for state, and the wage rate.

The baseline cost for conducting roadside safety inspections differs by state. For the purpose of this analysis, the difference in cost is reflected in staffing requirements and the number of vehicles inspected rather than the time spent conducting the various levels of inspections.[42] It is assumed that the average time spent conducting inspections is constant across the eight case study states.[43] Staffing requirements and salary ranges were provided by the individual case study states. The average salary range was estimated using the FTE method described in the previous section. Baseline inspection costs are calculated by multiplying the number of respective staff by the salary parameters. Total hours are calculated by multiplying the number of respective staff by 2,080 hours (1 FTE). The average hourly wage is calculated by dividing total cost by total hours.

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[42] For the purpose of this analysis, only Level I, II, and III inspections are considered.

[43] It is assumed Level III inspections require an average of 15 minutes per vehicle, Level II inspections an average 25 minutes, and Level I an average of 45 minutes.

Exhibits VI-14a, VI-14b, and VI-14c illustrate the methodology behind the wage estimation for roadside safety inspection personnel. A variation of the FTE approach used throughout the report is applied in this case. Low cost and high cost salary parameters are estimated for each of the labor categories by simply multiplying the number of staff by the salary range (as shown in Exhibit VI-11a).

Exhibit VI-14a. Staffing Requirements

Title	Staffing Requirement	Salary Range	Low Cost	High Cost
CV Inspector	50	$20,000 - $30,000	$1,000,000	$1,500,000
Patrol Officer	25	$25,000 - $40,000	$625,000	$1,000,000
Total Labor	**75**		**$1,625,000**	**$2,500,000**

Since the total cost of inspecting vehicles is a function of the average time spent performing the various types of inspections and the number of each type of inspection performed, average hourly wage rates were calculated. Exhibit VI-14b provides a typical example for how the team calculated wage rates. Total hours are calculated by multiplying the staffing requirement for each labor category by 2,080 hours (1 FTE).[44] The low and high cost salary parameters in Exhibit VI-14a are divided by the total hours (Exhibit VI-14b) to calculated average low and high wage rates for each labor category.

Exhibit VI-14b. Hourly Wage Rates

Title	Total Hours	Low Wage Rate	High Wage Rate
CV Inspector	104,000	$9.62	$14.42
Patrol Officer	52,000	$12.02	$19.23

A weighted average is then calculated for all labor categories. The weighted average is a function of the staffing requirements for each labor category divided by total labor (Exhibit VI-14a), multiplied by the wage rate. For example, the weighted average low was calculated by dividing the number of CV inspectors (50) by total labor (75). This value is then multiplied by the low average wage rate for CV inspectors. The process is then repeated for patrol officers. The two end results are added together to form a weighted average low rate. Exhibit VI-14c provides the weighted averages for this example.

Exhibit VI-14c. Weighted Averages for Hourly Wage Rates

Weighted Average Low	Weighted Average High
$10.42	$16.02

The baseline costs for safety inspections were calculated once the weighted averages were estimated. The number of inspections performed by level was provided by the respective case study states. The average cost per vehicle was calculated by multiplying the weighted average hourly wage by the average inspection time per vehicle. Low and high cost estimates were then calculated by multiplying the number of vehicles inspected by the average cost of inspection. Exhibit VI-15 provides an example of baseline cost for safety inspections.

[44] As is the case in other staffing calculations, it is assumed safety inspectors do not work overtime.

Exhibit VI-15. Baseline Cost for Roadside Safety Inspections

Type	Number	Average Inspection Time	Average Low Cost / Vehicle	Average High Cost / Vehicle	Low Cost	High Cost
Level I	10,000	0.75 hours	$7.815	$12.015	$78,150	$120,150
Level II	5,000	0.42 hours	$4.376	$6.728	$21,880	$33,640
Level III	1,000	0.25 hours	$2.605	$4.005	$2,605	$4,005
Total	**16,000**				**$102,635**	**$157,795**

The cost savings associated with vehicle safety inspections are estimated using a benefit multiplier obtained from the American Trucking Association (ATA) study.[45] According to the ATA study, fixed site and portable diagnostic equipment and electronic verification of driver service hours can reduce the time required to conduct a Level I inspection by 10 minutes per vehicle. For the purpose of this study, it is assumed that a Level I inspection takes an average of 45 minutes. Therefore, reducing the inspection by 10 minutes results in a timesaving of approximately 22 percent. A 22 percent timesaving was applied across all three safety-inspection categories.[46] Although this study does not attribute this timesaving to any particular aspect of the inspection process, it is assumed that much of the savings are achieved by reducing/eliminating the redundant step of having inspectors/data entry clerks type the information from inspection forms into a computer database.[47]

2) Fuel Tax Revenue

States currently collect revenue based on projected motor fuel use by motor carriers. The fuel tax is not calculated based on at the pump sales, rather through an analysis of estimated truck Vehicle Miles Traveled (VMT) per state. Fuel tax revenue is divided among states based on reported VMT within a particular state. This method of accounting eliminates potential revenue collection discrepancies associated with motor carriers buying all their fuel in states with low fuel prices, rather than buying fuel based on VMT within a particular state. Since fuel tax is based estimated VMT, carriers have some incentive to minimize their VMT estimates. Electronic clearance is expected to promote increased voluntary fuel tax compliance among motor carriers by essentially keeping more accurate records on carrier routes and operating hours.

The baseline cost associated with fuel tax revenue driven by special fuel used by motor carriers and diesel fuel tax (per gallon).

The case study states were not able to provide the study team with estimates on fuel tax revenue attributed to motor carriers.[48] In order to estimate a baseline for fuel tax revenue attributed to motor

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[45] *Assessment of Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) User Services Qualitative Benefit/Cost Analysis*. Final Report. Prepared for FHWA by the ATA Foundation. August 1996.

[46] The timesavings attributed to each inspection category may not be uniform across the three categories. However, the study team had no better information to work with, so it was assumed the 22 percent time savings would be applied equally to all three inspection levels.

[47] The study team does not attempt to differentiate between cost savings that are attributable to a reduction in the time spent entering data (through the use of portable computers and/or pen-based systems) and any savings that may be attributable to automated inspection equipment such as mobile cameras and diagnostic equipment.

[48] According to several of the case study states, they do not track the percentage of revenue attributed to motor carriers versus passenger vehicles (or other types of vehicles). Data relating to fuel tax revenue is focused on bottom line revenue rather than

carriers, the team estimated the baseline tax based on reported special fuel highway usage in each state.[49] It was assumed that 90 percent of total special fuel use (on highways) is attributed to motor carriers. The total number of gallons of fuel was then multiplied by the diesel fuel tax rate in the respective state. This number provided the team with an estimate of total baseline fuel-tax revenue based on 1995 fuel use.

New revenue from increased voluntary fuel tax compliance was calculated by applying a benefit multiplier to the baseline fuel-tax revenue number. In this case, the study team used a multiplier of 1.00 percent. It is assumed there will be a one-percent increase in revenue due to increased voluntary fuel tax compliance due to ITS/CVO clearance applications. The study does not define a percentage increase in compliant motor carriers for fuel tax, only an estimated percentage-increase in revenue.

3) New Revenue from Citations

Electronic clearance will enable enforcement personnel to target non-compliant carriers to be both weighed and inspected. In the short-term, the number of citations issued by state enforcement personnel is expected to increase due to improved targeting. With an increase in the number of citations issued, revenue from citations is also expected to increase in the short-term.

New revenue generated from increased citations is driven by the number of citations issued, the baseline revenue from citations, the average amount of fine, and the carrier violation rate.

Baseline revenue from citations was provided for most of the case study states for 1996. The states also provided the study team with information regarding the number of citations and out-of-service orders issued as well as the number of vehicle processed (weighed and/or inspected). Using this information, the study team calculated the average amount of each fine by dividing total revenue from citations by the number of citations issued. The violation rate was calculated by dividing the number of citations issued by the number of vehicles processed.[50] In cases where the total revenue from citations was not provided, an average fine of $180 was used.

Expected new short-term revenue collected due to improved targeting of non-compliant carriers was estimated by assuming a 1.5-percent increase in the number of citations issued and multiplying the new citation number by the average fine. Sensitivity analysis was performed for a 0.5 percent and 2.5 percent increase in the number of citations issued. Sensitivity analysis was also performed using an average fine of $250.[51] The baseline revenue was then subtracted from the new revenue calculation to capture expected additional revenue generated through a short-term increase in the number of citations issued. Only short-term revenue will be effected. It is assumed overall compliance will increase in the long-term as a result of ITS/CVO.

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the proportion of revenue attributed to any particular vehicle class. Likewise, according to FHWA's Motor Fuels Division, data is not available on a per state basis regarding the percentage of motor fuel receipts attributed to motor carriers.

[49] *Highway Statistics*. 1995. USDOT, FHWA.

[50] The violation rate is only a proxy. Since vehicles may be cited more than once and the same vehicle may be both weighed and inspected (possibly double counting the number of vehicles processed), the team does not have an exact measure of the violation rate.

[51] According to Kalavaris and Sinha, the average fine issued to non-compliant carriers is about $250. *Institutional Issues Related to the Application of Intelligent Vehicle Highway Systems Technologies to Commercial Vehicle Operations in Indiana*. Kalavaris and Sinha. Purdue University, 1994.

4) Reduced Roadway Damage from Overweight Carriers

The reduction in premature deterioration of highways has been identified as potentially one of the greatest benefits of electronic clearance.[52] With that in mind, the study team has evaluated the baseline costs associated with pavement damage attributed to motor carriers and has also performed a subsequent cost saving analysis. The analysis is based on a similar analysis performed in the HELP/Crescent study.

Baseline roadway damage costs attributed to motor carriers is driven by the distribution of annual VMT by combination trucks, the annual VMT by functional class, and the baseline estimate of roadway damage provided by Oregon Department of Transportation (OR DOT).

Baseline combination truck VMT is estimated by multiplying the distribution of annual VMT by combination trucks by functional class by annual VMT by functional class (as provided in 1995 Highway Statistics). The result is an estimate of VMT by combination trucks by functional class.

The annual cost of pavement damage is estimated by comparing the case study states to the baseline state used in the HELP/Crescent evaluation (Oregon). Total combination truck VMT for each of the case study states is compared to the Oregon baseline and scaled.[53] According to the HELP/Crescent evaluation, Oregon DOT estimated that combination trucks are responsible for around $20 million in roadway damage a year. The $20 million serves as the Oregon baseline and is adjusted by the overall truck VMT for each case study state.[54]

Cost savings are estimated by applying a 0.5 percent benefit multiplier to the baseline cost for each state. The multiplier represents a 0.5 percent reduction in pavement damage due overweight trucks. The multiplier does not represent a 0.5 percent decrease in oversize/overweight trucks; rather, a 0.5 percent decrease in the cost of pavement damage attributed to oversize/overweight carriers. Sensitivity analysis was also performed for a 0.25 percent reduction and a 0.75 percent reduction in overweight carriers.

FINDINGS

Summary cost savings/benefits figures are provided for the case study states in Exhibit VI-16. The numbers reported in the exhibit include only the new revenue and cost savings described in the previous section. The figures presented below represent study estimates for the maximum expected benefits attributed to each category. The cost savings presented in ExhibitVI-16 are presented in real dollars and are not based on the deployment schedules discussed in Chapters V and VII (i.e. there is no time lag for benefits realization). In reality, the magnitude of cost savings realized by each state will be directly affected by the deployment schedule for the various ITS/CVO applications and a time lag for realizing individual savings. The impact of the different deployment schedules and time lags for benefits realization are discussed in detail in Chapter VII.

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[52] *Appendix A: On-Site Analysis of HELP Technologies and Operations*. Evaluation Report Draft. Castle Rock Consultants. October 1993.

[53] For the purpose of this analysis, pavement damage is a function of combination truck VMT per state as compared to the Oregon baseline

[54] These steps are detailed in the Task II Technical Working Paper, Appendix 3.

Exhibit VI-16a. Public-Sector Administrative Cost Savings ($000)

Electronic Permitting/Credentialing (Annual Maximum Savings)							
	Processing Applications	Reprocessing Applications	Compliance Audits	Paper Costs	Mail and Delivery	Application Revenue	Total
California	$1,510-$2,007	$66-$84	$295-$525	$87	$391	$1,215	**$3,564-$4,309**
Colorado	$100-$173	$3-$6	$808-$1,312	$5	$40	$75	**$1,031-$1,610**
Connecticut	$266-$362	$5-$6	$93-$139	$11	$96	$117	**$587-$729**
Delaware	$57-$72	$3-$4	$59-$83	$4	$31	$48	**$202-$241**
Florida	$304-$485	$25-$37	$102-$143	$33	$269	$279	**$1,012-$1,247**
Kentucky	$204-$380	$8-$14	$66-$99	$16	$106	$276	**$676-$891**
Minnesota	$277-$449	$18-$28	$76-$120	$9	$72	$234	**$685-$912**
New Jersey	$277-$388	$13-$18	$83-$165	$14	$145	$79	**$611-$810**
Total	**$2,995-$4,316**	**$141-$197**	**$1,582-$2,586**	**$179**	**$1,150**	**$2,323**	**$8,370-$10,751**

Source: Apogee Research

Exhibit VI-16b. Public-Sector Roadside Cost Savings ($000)

Automated Roadside Management (Annual Maximum Savings)							
	Safety Inspections	Data Collection	Fuel Tax	Citations	Reduced Roadway Damage	Weight-Distance Tax	Total
California	$1,048	$63-$105	$3,418	$122	$750	NA	**$5,401-$5,443**
Colorado	$66-$68	$71-$98	$527	$38	$80	NA	**$782-$811**
Connecticut	$19-$43	$69-$79	$325	$72	$40	NA	**$525-$559**
Delaware	$4-$8	$44-$100	$63	$1	$18	NA	**$130-$190**
Florida	$83	$38-$69	$2,160	$158	$238	NA	**$2,677-$2,708**
Kentucky	$82-$177	$37-$79	$702	$12	$109	$120	**$1,062-$1,199**
Minnesota	$38-$50	$47-$67	$412	$21	$79	NA	**$597-$629**
New Jersey	$54-$86	$50-$79	$596	$74	$128	NA	**$902-$963**
Total	**$1,394-$1,563**	**$419-$676**	**$8,203**	**$498**	**$1,442**	**$120**	**$12,076-$12,502**

Source: Apogee Research

Cost Savings Attributed to Electronic Permitting/Credentialing

Summing across all eight case-study states, total cost savings attributed to electronic permitting/credentialing range from $8.4 million to $10.8 million annually. The largest cost savings attributed to electronic permitting/credentialing are realized in the form of labor savings for processing/reprocessing applications and labor savings for compliance auditing. Annual cost savings range from $3.1 to $4.5 million for processing and reprocessing applications, and from $1.6 to $2.6 million for compliance auditing. Paper cost savings are expected to generate the smallest benefits in terms of total dollar savings. This should be expected, as paper costs represent a relatively small portion of agency baseline costs in the individual case study states.

The expected cost savings from electronic permitting/credentialing vary greatly between case study states. State agency cost savings attributed to electronic permitting/credentialing range from around $200,000 per year in Delaware (low case) to around $4.3 million per year in California (high case). Median annual savings generally range from between $600,000 to $800,000 in the eight case study states. Total savings for Connecticut, Kentucky, Minnesota, and New Jersey all fall into this range.

Cost Savings Attributed to Automated Roadside Management

Total cost savings attributed to ITS-related roadside applications (electronic clearance and automated roadside safety inspection) range from $12.1 to $12.5 million annually. As shown in the tables, total cost savings for ITS-related roadside management applications are slightly higher than total benefits/cost savings for electronic permitting/credentialing for the case study states. The largest savings realized for automated roadside management are generated through increased annual fuel tax revenues. ITS/CVO is expected to promote increased voluntary fuel tax compliance in the case study states. Annual benefits attributed to increased fuel tax revenues are estimated to be around $8.2 million in the eight case study states. Increased short-term revenue from issuing new citations generates the smallest benefits in terms of dollar values—around $500,000 per year.[55]

Expected savings for automated roadside systems vary greatly between states. Annual state benefits range from $130,000 in Delaware (low case) to $5.4 million in California (high case). Median annual savings attributed to automated roadside management range from around $700,000 to slightly less than $1,000,000. Total roadside benefits for Colorado and New Jersey fall into this range.

Exhibit VI-17 presents total summary savings by state.

[55] New revenue from weight distance taxes is not used for comparison, because, of the eight case-study states, only Kentucky uses a third structure tax.

Exhibit VI-17. Summary of Annual Cost Savings by State ($000)

State	Low	High
California	$8,965	$9,751
Colorado	$1,814	$2,421
Connecticut	$1,112	$1,288
Delaware	$332	$431
Florida	$3,688	$3,956
Kentucky	$1,739	$2,091
Minnesota	$1,282	$1,540
New Jersey	$1,512	$1,773

As shown in Exhibit VI-17, the range of total expected cost savings varies considerably across the eight case study states. California realized the greatest benefits—$9.0 million to $9.8 million per year, while Delaware realized the smallest benefits—$332,000 to $431,000. The state of Florida is expected to receive the second largest total cost savings ($3.7 million to just under $4.0 million per year), followed by Colorado ($1.8 million to $2.4 million per year) and Kentucky ($1.7 million to $2.1 million per year). The benefits for the remaining three case study states range from $1.5 million to $1.8 million per year in New Jersey, from $1.3 million to $1.5 million in Minnesota, and from $1.1 million to $1.3 million in Connecticut.

OTHER BENEFITS

As mentioned in the preceding section, this study does not attempt to quantify benefits that accrue to the motor carrier industry or the general public (such as cost savings derived from fleet management practices or safety-related benefits). This section will present a summary of ITS/CVO benefits that appear in other sources. Industry-related and societal benefits that are not specifically addressed in this study will be briefly discussed here.

The study team relied on several key sources for quantified information on ITS/CVO benefits. These sources provided insight into possible state agency-related cost savings and benefits as well as providing information about other types of benefits that were not explicitly examined in the study. There are six primary sources for this information. They are presented in Exhibit IV-18 at the end of the chapter.[56]

These sources helped the study team conceptualize various potential cost savings or benefits associated with the three ITS/CVO functions. Several of the sources also provided information regarding potential benefit multipliers. Several of the benefits multipliers presented in the source literature were used as the foundation for the benefits analysis. The study team took great care to ensure our interpretation of the benefits described in these various studies was correct. It should be noted, however, that the team did not perform a critical review of the methodologies or underlying assumptions contained in any of the studies, and generally accepted the analysis results as given.

Exhibit VI-19 summarizes the findings presented in the six studies. These ratios are presented so the reader may glean some information about the expected benefits associated with ITS/CVO that were not specifically examined in the NGA study. It is not appropriate to add these ratios to the ratios presented

[56] There is a vast array of sources that address ITS/CVO in some way or another. For the most part, however, very few of these sources present quantified estimates for ITS/CVO costs and benefits.

in Chapter VII of this report. The results presented in Exhibit VI-19 should not be used to describe or elaborate upon any of the results presented in this report. Issues such as the compatibility of various ITS/CVO functions or user services, the potential double counting of both benefits and costs, and general inconsistencies relating to the underlying assumptions and study methodology prevent the use of the ratios presented in this exhibit in tandem with the results of this study.

Exhibit VI-18. Primary Sources of Benefits Information

Study	Services / Technologies Examined	Segment Examined
ATA	CV Administrative Process Electronic Clearance Automated Roadside Safety Inspection On-Board Safety Monitoring Hazardous Materials Incident Response Freight Mobility	Industry or private sector
COVE	Electronic Clearance One-stop/no stop shopping Automated Roadside Safety Inspection	Both public sector and private sector
Dakota's Provides a review of existing studies	CV Administrative Process Electronic Clearance Automated Roadside Safety Inspection On-Board Safety Monitoring Hazardous Materials Incident Response Freight Mobility	Industry or private sector (based on ATA study)
Purdue Provides a review of existing studies	Weigh-in-Motion Automatic Vehicle Identification Automatic Vehicle Classification	Public and private sector
HELP/Crescent	Weigh-in-Motion Automatic Vehicle Identification Automatic Vehicle Classification	Public and private sector
Advantage I-75	Weigh-in-Motion Automatic Vehicle Identification Automatic Vehicle Classification	Public and private sector (few benefits are quantified)

Exhibit VI-19. Reported Benefits

Study	Reported Benefits or Cost Savings
ATA	CV Administrative Process (2.0 : 1 to 19.8 : 1) Electronic Clearance (1.9 : 1 to 7.5 : 1) Automated Safety Inspections – Vehicle Inspections (positive benefits with no direct costs) Hours of Service Reporting and Verification (1.1 : 1 to 1.6 : 1) On-Board Safety Monitoring (<0.1 : 1 to 0.5 : 1) Collision Avoidance (undetermined) Hazardous Materials Incident Response (0.4 : 1 to 3.0 : 1) Freight Mobility (1.5 : 1 to 5.0 : 1)
COVE	**Public Sector (State Agencies)** Electronic Clearance (3.2 : 1 to 18.9 : 1) One-Stop/No Stop Shopping (3.3 : 1 to 14.9 : 1) Automated Roadside Safety Inspection (2.5 : 1 to 9.2 : 1) **Private Sector (Motor Carriers)** Electronic Clearance (3.5 : 1 to 16.0 : 1) One-Stop/No Stop Shopping (1.2 : 1 to 4.0 : 1)
Dakota's	**Administrative Process** Truckload (7.6 : 1 to 9.4 : 1) Less-Than-Truckload (6.9 : 1 to 7.9 : 1) Truckload/Less-Than-Truckload (3.2 : 1 to 3.8 : 1) Private Fleets (5.8 : 1 to 7.0 : 1) Other Carriers (5.1 : 1 to 6.1 : 1) Local Carriers (2.0 : 1 to 2.3 : 1) Regional Carriers (4.8 : 1 to 5.7 : 1) National Carriers (12.0 : 1 to 14.4 : 1) **Electronic Clearance** Truckload (3.8 : 1 to 7.5 : 1) Less-Than-Truckload (2.8 : 1 to 5.5 : 1) Truckload/Less-Than-Truckload (2.8 : 1 to 5.6 : 1) Private Fleets (2.9 : 1 to 5.8 : 1) Other Carriers (2.1 : 1 to 4.1 : 1) Local Carriers (2.4 : 1 to 4.6 : 1) Regional Carriers (3.2 : 1 to 6.4 : 1) National Carriers (3.6 : 1 to 7.2 : 1)

Exhibit VI-19. (cont.) Reported Benefits

Study	Reported Benefits or Cost Savings
Purdue	**For the state of Indiana** Weigh-In-Motion • 65 mph w/mainline bypass (annual cost savings of $268 million) • 40 mph w/off-line sorting (annual cost savings of $231 million) • 20 mph w/off-line sorting (annual cost savings of $137 million) Safety Enhancement ($3.8 million annually) Paperwork Reduction • State Benefits ($3.6 million for 10% participation to $5.5 million for 30% participation) • Motor Carrier Benefits ($18 million for 10% to $53 million for 30%) Increased Enforcement Revenues ($22 million each year from citations)
HELP/Crescent[57]	State Mainline Benefits • Highway-Related Data Collection and Processing (average cost savings of $55,373 per site) • Hazardous Materials Tracking (average annual cost savings per HELP site $14,072) • Improved Collection of Mileage-Based Taxes (average annual savings per HELP site $10,023) • Mainline Weight Enforcement (average annual savings per HELP site $24,192) State Weigh Station Benefits • Reduced Operating Costs (reduced operating costs per year per station $60,000) • Automated Credentials ($3.7 million per year per state) • Automated Safety Inspection Scheduling (average annual state savings $253,406) Carrier Benefits • Time Savings due to Mainline Bypass (average net savings per truck $1,329) • Time Savings from In-Station Bypass (average net savings per truck $991) • One-Stop Shopping ($40 annual net savings per truck) • Fleet Management (annual net benefits of $375 per truck)
Advantage I-75	Study was used to provide general guidance.

[57] The benefits and/or cost savings presented for the HELP/Crescent evaluation are based on the medium-case savings.

VII. BUDGETARY IMPACT ANALYSIS

The analysis presented in this chapter builds directly on earlier chapters included in this report—namely Chapter V *Analysis of Costs* and Chapter VI *Analysis of Benefits*. Chapter VII focuses on estimating incremental Budgetary Benefit/Cost Ratios (BBCRs) to evaluate the deployment of three specific ITS/CVO applications from the public agency perspective. Incremental analysis examines the marginal effects of adopting specific ITS/CVO applications or technologies as compared to the current baseline practices within each state.

The purpose of the analysis is to directly compare the expected cost savings of ITS/CVO deployment in each state to the costs of ITS/CVO deployment in each state. Due to differences in CV-related administrative processes/procedures and government structure within each state, results are not averaged across the case study states. A separate agency ratio is calculated for both electronic permitting/credentialing and automated roadside management in each of the eight case study states.

BENEFIT/COST ANALYSIS & THIS STUDY

Benefit/Cost Analysis (BCA) is an analytical approach commonly used to evaluate public investment decisions. It provides a framework for identifying various impacts associated with specific investment decisions and assigning values to those impacts. BCA involves assessing the resources invested in a project and comparing them to the benefits of the project over its lifetime.

In BCA, a stream of constant dollar benefits and costs is estimated for the lifetime of a project. Both future benefits and future costs are measured relative to the baseline scenario and discounted over time.[58] The various scenarios can then be compared to one another and/or to the baseline scenario in annualized terms. BCA should include all related benefits and costs for a particular project, including both direct and indirect costs.[59] This study does not, nor was it ever the intention of this study to do so.

Instead, the study examines the impacts on state budgets of investment in ITS/CVO and intentionally sets aside many direct and indirect investment benefits such as safety and operational benefits from streamlined operations. Therefore, the ratios and results presented in this study must be interpreted carefully. In traditional benefit/cost analysis, for example, a benefit/cost ratio greater than one means that the project's benefits exceed its costs. Likewise, ratios less than one imply an undesirable investment. This is not the case in the results presented in this report.

Therefore, the reader of this report must consider, in addition to the budgetary benefits presented herein, the specific circumstances associated with a given state's investment in order to understand the broader benefits associated with a given investment and judge the relative merits of the investment in consideration of those benefits.

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[58] Discounting captures the opportunity cost or value of resources over time.

[59] The difficulty of conducting BCA is not with the methodology, but in making sure that *all* relevant costs and benefits have been identified and quantified. This is not an easy task.

METHODOLOGY

The benefit/cost methodology utilized five distinct steps:

1) Calculation of life-cycle for benefits and costs for ITS/CVO in each of the case study states;

2) Selection of the time frame for the analysis;

3) Distribution of benefits and costs across the selected time frame;

4) Calculation of present value of ITS/CVO benefits and costs; and

5) Estimation of benefit/cost ratios.

Calculation of Life-Cycle Benefits & Costs

Time is a critical element in evaluating the costs and benefits of various investment scenarios. In the case of this analysis, there is a lag between the costs of ITS/CVO deployment for the various applications and the realization of benefits. The lag varies between the four deployment scenarios.[60] Because the time dimension is a critical aspect of BCA, the information describing the various scenarios must be time-specific. This means that both costs and benefits are calculated year-by-year for the baseline scenario and all four investment scenarios.

In theory, BCA should be conducted for the life cycle of the project. In reality, practitioners and planners sometimes have a limited understanding of the projected life cycle for various projects. Since the study team has limited information regarding deployment and expected life cycle of the specific ITS/CVO applications in the case study states, the calculations of life-cycle benefits were based on hypothetical deployment scenarios over a ten-year time period.

Certain types of benefits may not be realized until a system is fully deployed. In other cases, partial benefits may accrue as a system is in the process of being deployed. How soon benefits are realized and the magnitude of the benefits may also depend on carrier participation in some cases. For example, the physical deployment of a Weigh-In-Motion (WIM) system alone yields no benefits. Benefits begin to accrue when carriers purchase transponders and begin to participate in the WIM program. If carriers cannot communicate with the roadside enforcement officials, no benefits will accrue to either the carrier or the state. The life-cycle analysis considers both complete deployment and participation/penetration rates.

In addition to the four ITS/CVO deployment scenarios, the study team developed benefits realization functions, or benefits lag functions for each scenario. The functions account for the time lag between ITS/CVO deployment and the realization of the respective benefits associated with each application.

Exhibits VII-1, VII-2, VII-3, and VII-4 present the individual deployment scenarios along with their respective benefits realization functions.

[60] The four deployment scenarios are: 1) Electronic Credentialing (conservative), 2) Electronic Credentialing (aggressive), 3) Automated Roadside Management (conservative), and 4) Automated Roadside Management (aggressive).

Exhibit VII-1. Electronic Permitting/Credentialing (Conservative Scenario)

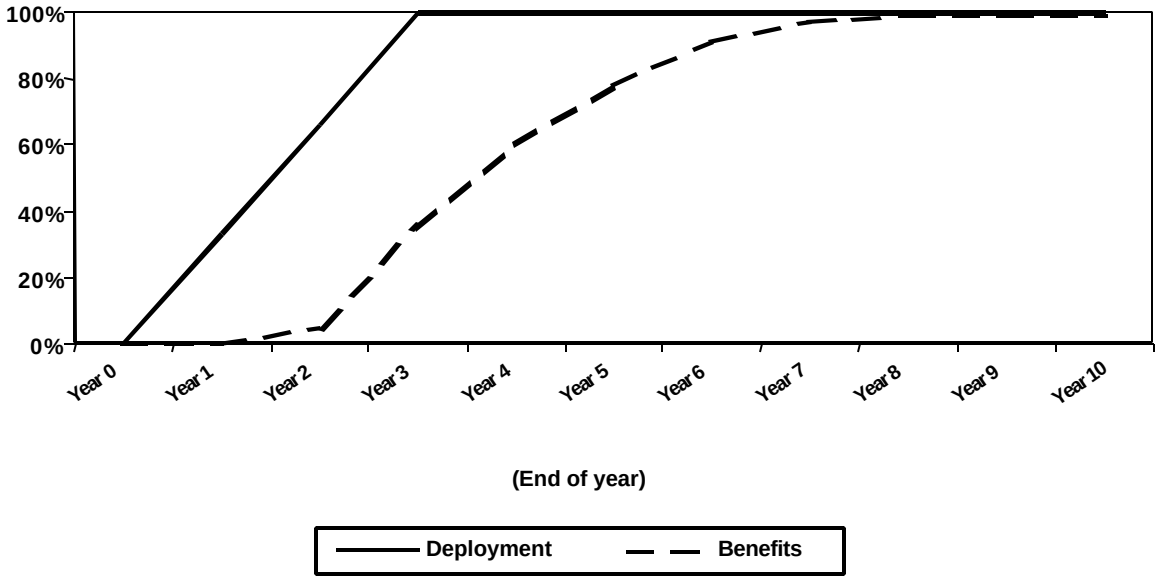


Exhibit VII-2. Electronic Permitting/Credentialing (Aggressive Scenario)

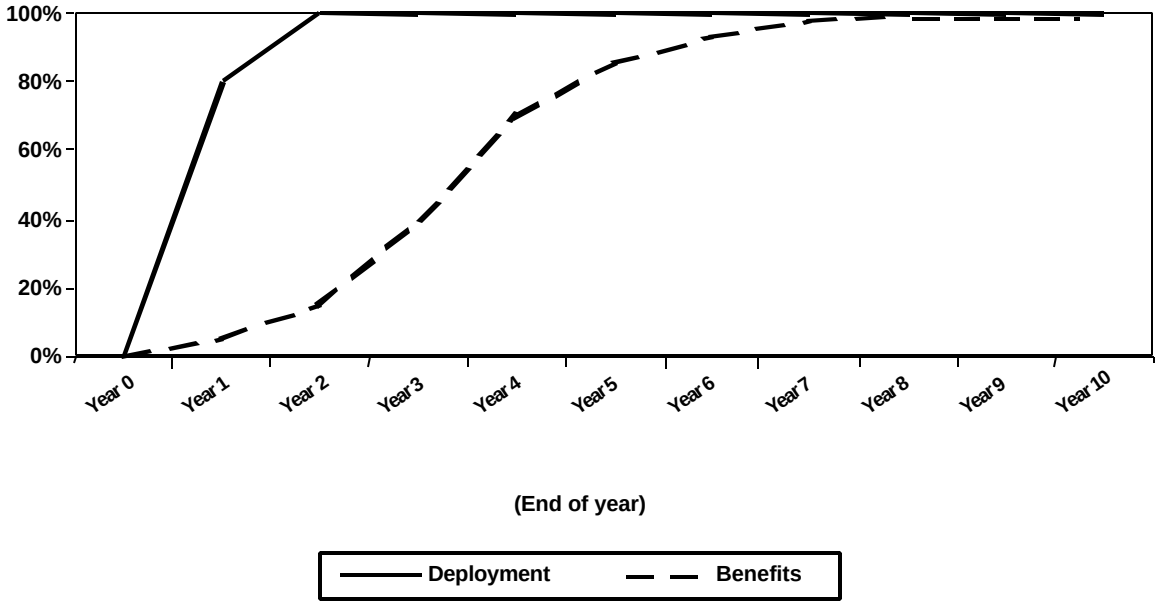


Exhibit VII-3. Automated Roadside Management (Conservative Scenario)

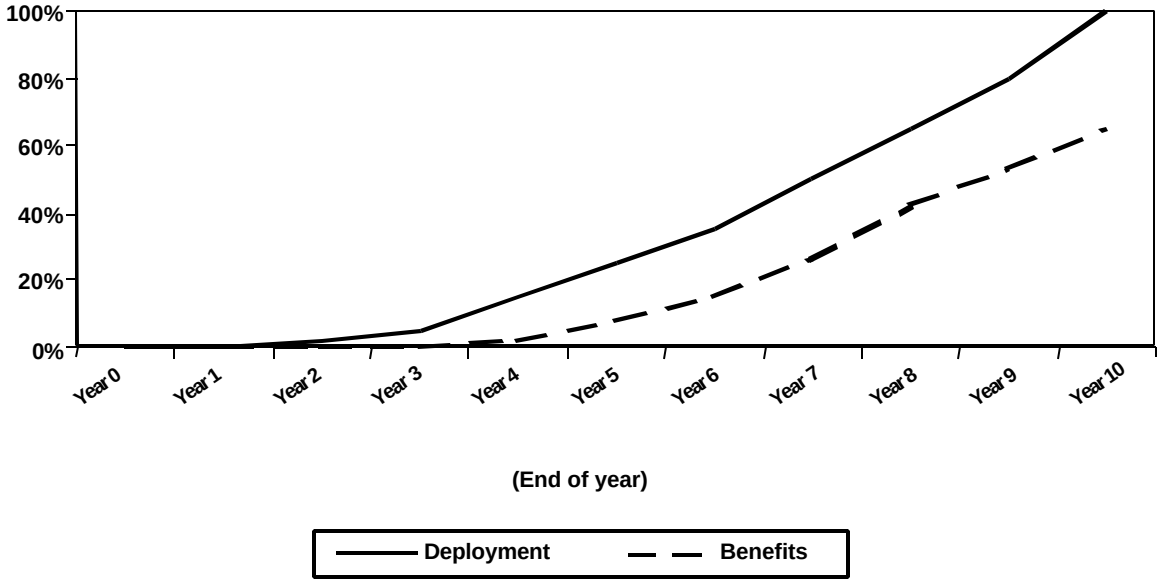
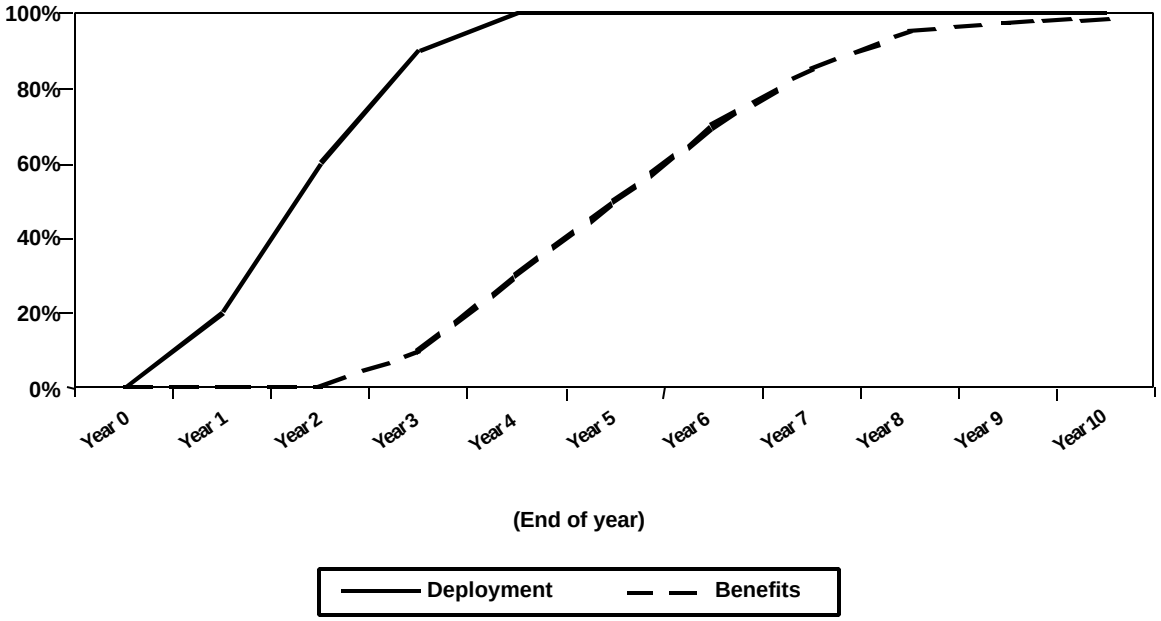


Exhibit VII-4. Automated Roadside Management (Aggressive Scenario)



Time Frame of the Analysis

The selected time frame for the analysis is ten years. For the purpose of this analysis, it is assumed all ITS/CVO applications will be fully deployed in a ten-year time frame. Although some states may actually invest in these technologies in a more aggressive manner, it is likely that many states will distribute their investments over a longer period of time. States may delay or stagger investment in ITS/CVO for numerous reasons including concerns about carrier participation, budget constraints, available technology, and issues regarding standardization of ITS/CVO technologies or practices.

Distribution of Benefits & Costs

As mentioned in the preceding paragraph, costs are distributed across the ten-year time frame based on the deployment schedule. Benefits are distributed based on the benefits realization function. The analysis does not necessarily illustrate full life-cycle costs and benefits for the various components of the ITS/CVO infrastructure. Only the portion of the equipment costs that fall within the ten-year time period is included in the cost analysis. For example, recurring capital costs such as equipment maintenance and replacement costs *outside* of the ten-year time frame are not included in the analysis. Similarly, only the agency benefits realized during the analysis period are counted. This caveat is particularly important in interpreting the BBCRs because the majority of potential benefits will be not even begin to be realized until around year six or seven for most scenarios in the analysis (See Exhibits VII-1, VII-2, VII-3, and VII-4.)

The choice of an appropriate discount rate can alter the value of streams of benefits and costs over time. Discount rates typically receive a fair amount of attention when conducting BCA for this reason. For the purpose of this study, a discount rate of seven (7) percent is used.[61] Other rates may be used for sensitivity testing.

Budgetary Benefit/Cost Ratios

The BBCR is simply calculated by dividing the discounted stream of benefits by the discounted stream of costs. BBCRs were calculated for each of the four scenarios described earlier. Exhibit VII-5 presents the BBCRs for the two electronic permitting/credentialing scenarios. Exhibit VII-6 presents BBCRs for the two automated roadside management scenarios.

[61] A seven (7) percent discount rate is recommended by the Congressional Budget Office for use in public investment analysis.

Exhibit VII-5. State Agency BBCRs for Electronic Permitting/Credentialing*

States	Conservative		Aggressive	
	Low Cost	High Cost	Low Cost	High Cost
California	7.45	6.57	7.55	6.64
Colorado	5.93	6.29	6.02	6.39
Connecticut	2.50	2.06	2.54	2.09
Delaware	0.99	0.52	1.00	0.53
Florida	4.32	3.02	4.37	3.06
Kentucky	3.79	2.25	3.84	2.28
Minnesota	2.16	2.06	2.19	2.08
New Jersey	2.74	2.09	2.78	2.12

* Not all costs and benefits attributed to electronic credentialing are included in this analysis

Exhibit VII-6. State Agency BBCRs for Automated Roadside Management*

States	Conservative		Aggressive	
	Low Cost	High Cost	Low Cost	High Cost
California	0.13	0.08	0.15	0.09
Colorado	0.13	0.08	0.16	0.10
Connecticut	0.04	0.02	0.05	0.02
Delaware	0.08	0.06	0.10	0.07
Florida	0.11	0.05	0.12	0.06
Kentucky	0.07	0.04	0.08	0.05
Minnesota	0.04	0.02	0.05	0.03
New Jersey	0.08	0.05	0.10	0.06

* Not all costs and benefits attributed to automated roadside management are included in this analysis

As shown in Exhibits VII-5 and VII-6, the BBCRs for the individual case study states associated with the electronic permitting/credentialing application are generally greater than one. On the other hand, the BBCRs for the individual case study states associated with automated roadside management are all significantly less than one.

In the case of electronic permitting/credentialing, the state of California is shown to have the highest BBCR—7.55 in the Aggressive Low scenario. Delaware is the only state found to have a BBCR of less than one for permitting/credentialing. Both the Conservative High and Aggressive High scenarios have BBCRs around 0.5. The BBCRs are generally the highest in the Aggressive Low scenario for all eight case study states.

In the case of automated roadside management, the BBCRs for all eight case study states are below 0.2. As in the case of electronic permitting/credentialing, the BBCRs are generally the highest in the Aggressive Low case.

Intuitively, one might expect the BBCRs to be highest in the aggressive scenarios. Since deployment is being aggressively pursued in these scenarios, benefits accrue much more quickly than in the conservative scenarios. However, it is also true that operating and maintenance (O&M) costs are significantly higher in the aggressive scenarios than in the conservative scenarios.

Interpretation of the Results

Care should be taken in interpreting the results presented in this study. There are several key issues to remember.

- **Budgetary benefit/cost ratios represent only direct financial costs and benefits accruing to state agencies**—While the vast majority of costs for these ITS/CVO applications accrue to the public sector, only a selected set of benefits are included in this analysis.[62]

- **The time frame of the study is ten years—**While the limited time frame of this study assumes complete deployment of the respective systems within ten years (i.e., all start up costs are realized), maximum benefits generally don't begin to accrue until between years six or eight of the analysis. That is, if the time frame of the analysis were extended, the full potential of expected benefits could be included.

The conclusion that investing in electronic permitting/credentialing is worthwhile, while investing in automated roadside management is not worthwhile, is *not* the correct interpretation of these results. Based on the results of this study, electronic permitting/credentialing yields net positive benefits in seven of the eight case study states from the state agency perspective alone. This finding is significant because even though the potential benefits accruing to motor carriers are excluded for the application, over 87 percent of the case study states have favorable BBCRs for electronic permitting/credentialing in all four scenarios.[63] Based on the benefits expected to accrue to state agencies *alone*, investment in electronic permitting/credentialing is justified.

Automated roadside management applications focus on safety-related issues and perhaps more importantly, on permanently changing the way motor carriers and state enforcement and regulatory personnel conduct their business. This study does not examine the possible safety implications of the roadside system. Nor does this study attempt to measure how improving long-term regulatory compliance among motor carriers will affect the individual states, motor carriers, or the nation as a whole.

Based on this study, it is reasonable to conclude that investment in automated roadside management applications cannot be justified based on the potential benefits accruing directly to state agencies *alone.* However, as identified in several instances in this report, not *all* benefits from automated roadside management applications are included in the scope of the BCA undertaken for this study. Clearly, there is potential for the BBCRs to change dramatically once many of the excluded benefits attributed to these applications (such as a reduction in the number and severity of incidents, industry-based time savings, and improved air quality) are included (see Exhibit VI-19 in Chapter VI for examples).

States may be better served by examining the individual costs and benefits associated with the ITS/CVO applications. Examination of the costs and benefits associated with each of the scenarios will give readers a clear idea of the magnitude of investment required in each scenario, along with the magnitude of potential benefits. The present value ten-year costs and benefits for electronic permitting/credentialing are presented in Exhibits VII-7 and VII-8 respectively.

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[62] For the purpose of this study, the study team looked only at cost savings accruing directly to state agencies as well as new revenue accruing to state agencies.

[63] The potential benefits accruing to motor carriers from electronic permitting/credentialing are expected to be significant, while the potential costs to motor carriers are expected to be relatively minor. The state agency will bear the cost of setting up the system network, collecting and compiling data. The state will simply need to connect to the system.

Exhibit VII-7. State Agency Costs for Electronic Permitting/Credentialing* (Ten-Year Totals, discounted—$ Millions)

States	Conservative		Aggressive	
	Low	High	Low	High
California	$2.0	$2.7	$2.1	$2.9
Colorado	$0.7	$1.1	$0.8	$1.1
Connecticut	$1.0	$1.5	$1.0	$1.6
Delaware	$0.9	$1.9	$0.9	$2.1
Florida	$1.0	$1.7	$1.0	$1.8
Kentucky	$0.7	$1.7	$0.8	$1.8
Minnesota	$1.3	$1.9	$1.4	$2.0
New Jersey	$0.9	$1.6	$1.0	$1.7

* Not all costs attributed to electronic credentialing are included in this analysis

Exhibit VII-8. State Agency Benefits for Electronic Permitting/Credentialing (Ten-Year Totals, discounted—$ Millions)

States	Conservative		Aggressive	
	Low	High	Low	High
California	$14.9	$18.0	$16.0	$19.4
Colorado	$4.3	$6.7	$4.6	$7.2
Connecticut	$2.5	$3.0	$2.6	$3.3
Delaware	$0.8	$1.0	$0.9	$1.1
Florida	$4.2	$5.2	$4.5	$5.6
Kentucky	$2.8	$3.7	$3.0	$4.0
Minnesota	$2.9	$3.8	$3.1	$4.1
New Jersey	$2.5	$3.4	$2.7	$3.6

* Not all benefits attributed to electronic credentialing are included in this analysis.

The net present value of ten-year costs and benefits for automated roadside management are presented in Exhibits VII-9 and VII-10 respectively.

Exhibits VII-9. State Agency Costs for Automated Roadside Management* (Ten-Year Totals, discounted—$ Millions)

States	Conservative		Aggressive	
	Low	High	Low	High
California	$40.9	$81.0	$95.7	$187.6
Colorado	$6.6	$12.5	$14.7	$27.3
Connecticut	$13.5	$34.0	$30.6	$75.4
Delaware	$1.8	$3.9	$4.1	$9.2
Florida	$29.5	$60.5	$71.4	$140.4
Kentucky	$17.6	$33.3	$40.6	$76.0
Minnesota	$16.7	$33.8	$38.7	$76.2
New Jersey	$12.9	$24.4	$26.5	$50.1

* Not all costs attributed to automated roadside management are included in this analysis.

Exhibit VII-10. State Agency Benefits for Automated Roadside Management* (Ten-Year Totals, discounted—$ Millions)

States	Conservative		Aggressive	
	Low	High	Low	High
California	$5.2	$6.5	$14.1	$17.6
Colorado	$0.9	$1.0	$2.3	$2.6
Connecticut	$0.6	$0.7	$1.6	$1.8
Delaware	$0.2	$0.2	$0.4	$0.6
Florida	$3.1	$3.2	$8.4	$8.8
Kentucky	$1.2	$1.4	$3.2	$3.9
Minnesota	$0.7	$0.8	$1.8	$2.0
New Jersey	$1.0	$1.2	$2.7	$3.1

* Not all benefits attributed to automated roadside management are included in this analysis.

VIII. CONTEXT & POLICY CONSIDERATIONS

Decision-makers face significant uncertainties when evaluating options and developing plans for ITS/CVO investments. This study addresses a significant gap in the informational resources available to decision-makers; however, it is crucial that these findings be utilized in the proper context.

ROLE OF THE PUBLIC SECTOR

In general, the public sector pursues policies and initiatives that maximize benefits to society as a whole (citizens and private enterprises both) rather than its own "profit." Achieving this objective is complicated by the competing needs of society (e.g., whether to invest in roads or education), the multitude of investment options within each need (what roads to build), and the reality of constrained budgets. Given this framework, the cost analysis portion of this study is of critical importance to the state because it provides information pertinent to all three aspects of this framework, especially the budget constraint. The cost savings analysis is also important because it demonstrates the degree to which costs are offset by direct financial and/or operational benefits. In this context, the primary use of the findings is to characterize the net public costs; the ratio indicates whether the project pays for itself from a public agency standpoint alone, or if, like many public sector initiatives, it requires additional funding from the sponsoring agency or another source. However, the budgetary benefit/cost ratio by itself *does not* indicate whether or not a project is an appropriate investment for the public sector.[64]

Benefit/cost analysis, as defined in this study, applies to the public sector in a very different way than it applies to the private sector or society as a whole. Many functions of the public sector that are of vital importance to all of society require considerably more funding than they may generate in direct revenue. In fact, many public sector functions do not generate direct revenue, which is often precisely why the public sector has assumed responsibility for that certain function. For example, there is no debate that fire and rescue squads are absolutely essential to any community, yet these services generate no direct revenue to pay the costs inherent in the service. National defense is another example of a function of the public sector (at significant expense to tax-payers) that is not fiscally self-supporting, nor are the benefits of this investment tangible on a daily basis.

The ratios presented in this study should be viewed in this same context. This study examines the implications of changing the business practices of ITS/CVO regulatory enforcement. Regulation of certain activities is widely accepted as a necessary function of the public sector (although the extent of this regulation is somewhat open to question.) Society benefits from regulation, but without the public sector to coordinate this activity, these benefits are unlikely to be realized. Thus, although this study finds that the public sector (budgetary) benefit/cost ratios for electronic clearance and safety are less than 1:1, it should not be inferred that ITS/CVO is not a viable and attractive investment for state agencies.

[64] As defined in this study, the benefit/cost ratio only considers direct financial agency benefits costs.

LIMITATIONS OF THE METHODOLOGY

As noted earlier in this report, this study adopted a consistently conservative approach to estimating agency costs and benefits. Where possible, costs reflect actual state deployment plans and actual costs for specific equipment packages. Similarly, benefits represent observed labor savings and operational efficiencies where possible. In cases where empirical data were not available, the study team was careful to avoid under-estimating costs and over-estimating benefits.

Similarly, the deployment rates and time frame selected for this analysis lend themselves to conservative benefits estimates. For example, the aggressive deployment scenario results in cost accumulation, while early benefits assume a lag between investment and realization of cost savings—another conservative assumption. Likewise, the ten-year analysis period results in some scenarios in which full benefits of ITS/CVO investment are either not realized, or some are counted for only a few years. In practice, states will continue to reap significant benefits of ITS/CVO well after the tenth year, while costs are generally diminished in the later years.[65]

UNCERTAINTIES IN PROJECTING COSTS & BENEFITS

In addition to the conservative assumptions employed in this study, is also important to understand the uncertainties inherent in projecting costs and benefits for high-technology systems that are not yet widespread. Costs are difficult to estimate simply because ITS/CVO is substantially different from current CVO practices and few systems are currently in place. Furthermore, the systems that have been deployed thus far are sufficiently unique such that there is no example of a typical or standard set-up for ITS/CVO. The existing deployments provide approximate estimates of the costs; however, estimates for benefits are not complete.

Cost savings are difficult to quantify because they are often intertwined with multiple cost decisions and trade-offs. For example, in the case of labor savings associated with automated safety, a state agency may choose not to reduce inspection staff even after the operating efficiencies of automated vehicle clearance and inspections are realized. Instead, staff may be re-assigned to tasks at the inspection site, they may perform more thorough checks, or other additional functions. Thus, although an agency could realize lower labor costs, this savings may be converted into a less tangible form of benefit.[66]

Benefits are also difficult to quantify because existing deployments are typically not designed with benefits estimation in mind. While operational tests of ITS/CVO may serve as a good source of data on costs, they are less useful for estimating benefits. This is primarily because these tests are designed to evaluate/demonstrate the capability of a technology rather than the cost savings associated with the system. As a result of the greater uncertainty in benefits estimates and the associated greater margin for error, this study incorporates an even more conservative approach to the benefits analysis.

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[65] It should also be noted that "full" benefits of ITS/CVO may never be reached so long as even a small number of truckers do not participate in electronic credentialing or electronic clearance and safety. Also, the costs of ITS/CVO after year ten are not simply operating and maintenance. It is assumed that many systems would need to be replaced every five to ten years.

[66] In this study, labor savings for clearance and weighing are not quantified specifically because it is assumed than staff will be re-assigned or will perform additional duties rather than be released.

KEY POLICY CONSIDERATIONS

The findings of this study point to several key policy considerations that may drive the success or failure of a state's deployment efforts. In brief, the critical policy issues are as follows:

- Deployment and operations may require either a net increase in agency funding or funding sources from outside the state treasury, such as motor carrier contributions, federal support, and/or privatization;
- States may need to pursue policies that support rapid penetration rates for ITS/CVO in the motor carrier community to ensure industry acceptance and maximize benefits;
- By coordinating deployment of electronic clearance and safety amongst states, participation by motor carriers may be maximized while state costs and risks may be minimized; and
- ITS/CVO may present states with an opportunity to change the commercial vehicle regulatory/business climate, not just transportation infrastructure.

CONCLUSIONS

This study is designed to assist states in evaluating and planning for ITS/CVO deployment. The results of the analyses of costs and agency cost savings must be viewed in the context of the public sector's role in CVO—states have broader goals than recouping their initial capital investment. However, states need to identify creative solutions to fulfill their responsibilities in an era of constrained budgets.

In this context, states may need to consider alternative sources of funding for certain aspects of ITS/CVO. These alternatives, however, must not jeopardize motor carrier participation in ITS/CVO since this participation is ultimately the key to realizing the benefits to all—states, motor carriers, and society—of ITS/CVO. To better achieve these complicated and inter-related objectives, states should consider coordinating their activities amongst neighboring states and including the private sector in the planning process.

Deployment of ITS/CVO is a rare opportunity for the transportation community. Sweeping changes in business practices are almost inevitable. It is largely up to state agencies to make sure that all groups—the public sector, motor carriers and society—realize the full potential benefits of these emerging technologies.