Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems:

National ITS/CVO Program Requirements

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Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems: National ITS/CVO Program Requirements

PUBLICATION NO. FHWA-RD-96-126 **JULY 1997**

U.S. Department of Transportation
Federal Highway Administration

Research and Development
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

FOREWORD

This report presents the results of a research study of the requirements of a national program to apply Intelligent Transportation Systems (ITS) to commercial vehicle operations (CVO). The report reviews the current ITS/CVO program and analyzes the market, organization, and resource requirements for a national ITS/CVO program.

The report provides a thorough discussion of the entire motor carrier regulatory environment, current initiatives for applying ITS technologies to improve that environment, and issues that must be addressed to achieve greater efficiency. The report is comprehensive in its content and is recommended for anyone seeking a greater understanding of the issues involved in improving motor carrier operations and regulatory processes.

A. George Ostensen
Director
Office of Safety and Traffic Operations
Research and Development

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-RD-96-126		

4. Title and Subtitle	5. Report Date
SYSTEMS PLANNING FOR AUTOMATED COMMERCIAL VEHICLE LICENSING AND PERMITTING SYSTEMS: NATIONAL ITS/CVO PROGRAM REQUIREMENTS	July 1997
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Lance R Grenzeback, Carol G. Colman, and John G. Kaliski	6039.01
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Cambridge Systematics, Inc. 150 Cambridge Park Drive Suite 4000 Cambridge, MA 02140	3B4a
	11. Contract or Grant No. DTFH61-92-C-00021
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Final Report 1994 - 1996
Federal Highway Administration Turner-Fairbank Highway Research Center 6300 Georgetown Pike, HSR-10 McLean, VA 22101-2296	14. Sponsoring Agency Code

15. Supplementary Notes

Contracting Officer's Technical Representative - Michael Freitas, HSR-10
Cambridge Systematics was supported in this contract by Sydec, Inc. and Science Applications International Corporation.

16. Abstract

This report describes the work of the study, "Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems." The objective of this study is to define the market, organization, and resource requirements for a national program for the application of Intelligent Transportation Systems (ITS) to commercial vehicle operations (CVO).

The report assesses the public and private sector markets for ITS/CVO products and services. The public sector analysis includes a review of the major CVO regulatory processes, the level and distribution of transactions, and the major regulatory issues relevant to the development of a national ITS/CVO program. The private sector analysis includes an examination of how major operating characteristics such as fleet size and geographic range shape the trucking industry's need for new technologies; the identification of major freight generation centers and freight corridors in the United States: and a description of the major regional markets in which the motor carrier industry operates. In addition, the report reviews more than 50 governmeni and public/private initiatives to develop, test, and deploy elements of the ITS/CVO program in four areas: credentials administration, enforcement, fleet and vehicle management, and highway traffic management. Finally, the report reviews the ITS/CVO program's current market, organization, and resource strategies, and recommends new directions and strategies to strengthen the program.

17. Key Words	18. Distribution Statement
intelligent transportation systems, commercial vehicle operations, motor carrier industry, commercial vehicle regulation, fleet management, safety inspections.	No restrictions. this document is available to the public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	363	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)

1 foot (ft) = 30 centimeters (cm)

1 yard (yd ❑ 0.9 meter (m)

1 mile (mi) =1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2 = 6.5 square centimeters (cm^2)

1 square foot (sq ft, ft^2 = 0.09 square meter (m^2)

1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)

1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)

1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)

1 pound (lb) = .45 kilogram (kg)

1 short ton = 2,000 pounds (Lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)

1 tablespoon (tbsp ❑ 15 milliliters (ml)

1 fluid ounce (fl oz) = 30 milliliters (ml)

1 cup (c) = 0.24 liter (l)

1 pint (pt) = 0.47 liter (l)

1 quart (qt) = 0.96 liter (l)

1 gallon (gal) = 3.8 liters (l)

1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)

1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] ^oF ❑ y ^oC

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)

1 centimeter (cm) = 0.4 inch (in)

1 meter (m) = 3.3 feet (ft)

1 meter (m) = 1.1 yards (yd)

1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)

1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)

1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)

1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)

1 kilogram (kg) = 2.2 pounds (lb)

1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliters (ml) ❑ 0.03 fluid ounce (fl oz)

1 liter (1) = 2.1 pints (pt)

1 liter (l) = 1.06 quarts (qt)

1 liter (l) = 0.26 gallon (gal)

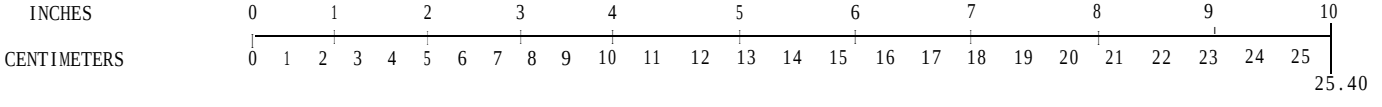
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)

1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

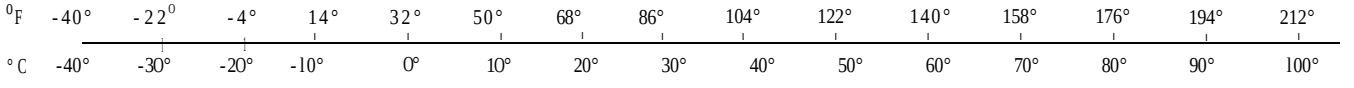
TEMPERATURE (EXACT)

[(9/5) y + 32] ^oC ❑ x ^oF

QUICK INCH-CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION



For more exact and or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

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List of Abbreviations

AADT	Annual Average Daily Trips
AAMVA	American Association of Motor Vehicle Administrators
AASHTO	American Association of State Highway and Transportation Officials
ABA	American Bus Association
AMASCOT	Automated Mileage and Stateline Crossing Operational Test
ATA	American Trucking Associations
ATIPE	Advanced Technologies for International and Intermodal Ports of Entry Operational Test
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVC	Automatic Vehicle Classification
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
BSWG	Base State Working Group on Uniform Motor Carrier Procedures
CBP	County Business Patterns
CDL	Commercial Driver's License
CDLIS	Commercial Drivers License Information System
CFR	Code of Federal Regulations
COHMED	Cooperative Hazardous Materials Enforcement Development program
CVIS	Commercial Vehicle Information System
CVISN	Commercial Vehicle Information Systems and Networks

List of Abbreviations
(continued)

CVO	Commercial Vehicle Operations
CVSA	Commercial Vehicle Safety Alliance
EDI	Electronic Data Interchange
EFT	Electronic Funds Transfer
EPIC	Expedited Processing and International Crossing Operational Test
ETC	Electronic Toll Collection
ETTM	Electronic Toll and Traffic Management
FHWA	Federal Highway Administration
FMMS	Hazardous Material Fleet Management and Data Monitoring System
FRA	Federal Railroad Administration
FTA	Federation of Tax Administrators
FIRS	Federal Information Processing Standards
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GPS	Global Positioning Systems
GVWR	Gross Vehicle Weight Rating
Hazmat	Hazardous Materials
HELP	Heavy-vehicle Electronic License Plate
HMTUSA	Hazardous Materials Transportation Uniform Safety Act of 1990
HPMS	Highway Performance Monitoring System

List of Abbreviations
(continued)

HVUT	Heavy Vehicle Use Tax
IBEX	International Border Electronic Crossing Operational Test
IBTTA	International Bridge, Tunnel, and Turnpike Association
ICC	Interstate Commerce Commission
IEN	Information Exchange Network
IFTA	International Fuel Tax Agreement
IOU	Idaho/Oregon/Utah Regional Mainstreaming Project
IRP	International Registration Plan
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
ITS America	Intelligent Transportation Society of America
IVHS	Intelligent Vehicle-Highway Systems
JHU/APL	Johns Hopkins University Applied Physics Laboratory
JPO	U.S. Department of Transportation Joint Program Office for Intelligent Transportation Systems
LCV	Longer-Combination Vehicle
LTL	Less-than-Truckload
MACS	Mainline Automated Clearance System
MCMIS	Motor Carrier Management Information System
MCSAP	Motor Carrier Safety Assistance Program
MOOO	Multi-Jurisdictional Oversize/Overweight Organization
MONY	Michigan/Oregon/New York Border Clearance Project

List of Abbreviations
(continued)

MPO	Metropolitan Planning Organization
NAFTA	North American Free Trade Agreement
NATA	National Automobile Transporters Association
NCHRP	National Cooperative Highway Research Program
NCSL	National Conference of State Legislatures
NETC	New England Transportation Consortium
NGA	National Governors' Association
NHPN	National Highway Planning Network
NHTSA	National Highway Traffic Safety Administration
NIER	National Institute for Environmental Research
NOOPA	Northeastern Oversize/Overweight Permitting Agreement
NPTC	National Private Truck Council
OBC	Onboard Computers
OMC	Office of Motor Carriers
OOIDA	Owner-Operators Independent Drivers Association
OOS	Out-of-Service
OS/OW	Oversize/Overweight
OST	Office of the Secretary of Transportation
RDTP	Roadside Data Technology Project
RFTA	Regional Fuel Tax Agreement
RSPA	Research and Special Projects Administration

List of Abbreviations
(continued)

SAE	Society of Automotive Engineers
SAFER	Safety and Fitness Electronic Records
SIC	Standard Industrial Classification
SSRS	Single State Registration System
TIUS	Truck Inventory and Use Survey
TL	Truckload
TRANSCOM	Transportation Operations Coordinating Committee
TRB	Transportation Research Board
TWC	Two-Way Communication
U.S. DOT	United States Department of Transportation
VISTA	Vehicle Information System for Tax Apportionment
VRC	Vehicle-to-Roadside Communication
WIM	Weigh-in-Motion
WRA	Western Regional Agreement

Executive Summary

This report describes the work of the project "Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems." The objective of the study is to define the market, organization, and resource requirements for a national program for the application of Intelligent Transportation Systems (ITS) to commercial vehicle operations (CVO).

INTELLIGENT TRANSPORTATION SYSTEMS FOR COMMERCIAL VEHICLE OPERATIONS

Commercial vehicle operations comprise three dozen areas of interaction involving public agencies and motor carriers. These include functions such as truck registration, size and weight enforcement, vehicle maintenance and inspection, and fleet routing and dispatching. These transactions are critical for highway safety, carrier productivity, and tax collections. For both agencies and carriers, the time and paperwork involved in these activities are substantial, as is the potential for streamlining current procedures.

ITS apply advanced and emerging technologies in such fields as information processing, communications, control, and electronics to surface transportation needs.[1] ITS technologies are being applied to CVO to streamline administrative procedures and improve the productivity and safety of trucking. ITS initiatives propose not to replace motor carrier regulations or established procedures, but to increase the efficiency and cost-effectiveness of these transactions through technology.

The vision statement for the national ITS/CVO program reads: "Assisted by advanced technology, trucks and buses will move safely and freely throughout North America."[2] The ITS/CVO program will address the following goals and objectives:

- Improved highway safety.
- Improved service level.
- Reduced energy and environmental impact.
- Enhanced productivity.
- Improved mobility.[3]

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[1]U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems and Intelligent Transportation Society of America, *National ITS Program Plan,* First Edition, Washington, DC, March 1995, p. 2.

[2]National ITS Program Plan, p. 182.

[3]National ITS Program Plan, p. 186-187.

The responsibility for CVO regulations and operations is distributed among public agencies at the Federal, State, and local levels; private motor carriers and industry associations; and third-party service providers. In many ways, the challenge to the development of ITS/CVO products and services begins with defining the markets among these diverse constituencies, as well as redefining existing roles, responsibilities, and relationships.

FRAMEWORK FOR ANALYSIS

The framework for analyzing the national ITS/CVO program is that of program "building blocks." Three components are necessary for successful programs:

- **Markets/Mandates: The existence of a commercial market or the legal or political justification for a program.** In the private sector, the "mandate" for a product or service takes the form of market demand; in the public sector, the source of a mandate can include popular demand, legislation, or executive leadership. Mandate/market issues that the ITS/CVO program must address include: How well has the ITS/CVO program met the markets and mandates for streamlining the administration of motor carrier credentials, improving the productivity and safety of enforcement activities, and enhancing fleet and traffic management capabilities?

- **Organization: The establishment of systems through which public or private entities are structured and administered, and how they respond to or implement change.** The organizational structure of a public sector program typically includes interagency, interjurisdictional, and public/private relationships. Organization issues that the ITS/CVO program must address include: How successful have the States, carriers, and vendors been in building the organizational and institutional arrangements necessary to deliver ITS/CVO services and products to public and private markets?

- **Resources: The availability of key inputs, including technology, funding, and staff expertise.** Resource issues that the ITS/CVO program must address include: How well have the public and private sectors been able to harness technology, investment funds, and skills to deliver ITS/CVO products and services?

This report attempts to answer these questions and to define the market, organization, and resource requirements for a national ITS/CVO program.

THE CURRENT ITS/CVO PROGRAM

Today's ITS/CVO "program" is an amalgam of dozens of initiatives covering multiple functions. These initiatives represent the efforts of individual States, consortia of States, the Federal Government, individual motor carriers, and industry associations. The program has expanded on a project-by-project basis, driven heavily by technological development, the particular needs of participating agencies and carriers, and individual personalities.

For the purposes of this analysis, ITS/CVO projects and services can be classified into four broad activity areas, corresponding to the major functions of CVO:

- **Enforcement: Programs and services designed to facilitate safety assurance and the verification of size, weight, and credentials information.** Enforcement projects are the most advanced element of the ITS/CVO program (see table 1). Two programs-the Heavy-Vehicle Electronic License Plate (HELP) in the West and Advantage CVO in the Great Lakes and Southeast-have developed and begun deployment of the technologies and procedures for the electronic clearance of vehicles past weigh stations and ports-of-entry. Another major effort involves a series of interrelated projects designed to enhance safety assurance activities by deploying an inspection selection algorithm, pen-based software, and an information system linking Federal and State data bases at 200 Motor Carrier Safety Assistance Program (MCSAP) sites by mid-1997. Other projects in this category are developing systems to verify compliance with out-of-service orders, and technologies for onboard monitoring of the safety status of the vehicle and the driver.

- **Credentials Administration: Programs and services designed to improve the deskside procedures and systems for managing motor carrier regulation.** These services would enable electronic application, purchasing, and issuance of credentials, as well as automated tax reporting and filing. The major projects in this category include the preparation for expanded membership in the International Fuel Tax Agreement (IFTA) and the International Registration Plan (IRE); the development of Base-State arrangements for the administration of other credentials such as oversize/overweight and hazardous materials permits; operational tests for regional electronic one-stop permit shopping systems; and the development of the Commercial Vehicle Information Systems and Networks (CVISN), an infrastructure to link the CVO information systems of States, the Federal Government, and carriers.

- **Fleet and Vehicle Management: Technologies and systems designed to improve the productivity of motor carriers through better utilization of fleets and vehicles.** Fleet management systems include electronic trip recorders, routing and dispatching software, communications technologies, and automatic vehicle location systems. The market penetration of these technologies is growing rapidly; a comparison of the responses to the 1987 and 1992 Truck Inventory and Use Survey shows a 50-fold increase in the number of trucks equipped with trip recorders, electronic engine controls, automatic vehicle identification transponders, or navigation systems. Most of these advances have occurred through market-driven research and investment, rather than through publicly-funded projects.

- **Highway Traffic Management: Programs and services designed to reduce congestion and manage the flow of commercial vehicle traffic.** These include incident management programs, travel advisory services, and hazardous materials incident response services. Highway traffic management is the least developed element of the ITS/CVO program. Most traffic management applications of ITS are oriented to passenger cars, although their benefits are available to commercial vehicles as well.

Lessons Learned

The experience of the more than 50 projects in these four categories has been uneven. The "lessons learned" have varied across the projects, but three cross-cutting lessons are apparent:

- **Deployment of most ITS/CVO services is technologically feasible; the challenges are developing standards and linkages among systems. The** key components of ITS/CVO

Table 1. Major ITS/CVO projects.

Objective	Representative Projects
Enforcement	
Automate clearance at weigh stations and ports of entry.	• HELP/Crescent/HELP, Inc. • Advantage CVO. • Oregon Greenlight.
Automate safety assurance activities (vehicle screening, data sharing).	• 100/200 MCSAP Site Project. . SAFER.
Evaluate automated systems to ensure compliance with out-of-service orders.	• MN/WI Out of Service Project. • ID Out of Service Project.
Develop technologies for onboard safety monitoring.	• Driver Workload Assessment. • Braking Analysis.
Administration	
Prepare for expanded IFTA/IRP membership.	• Base-State Working Group. • Interstate clearinghouses.
Link registration process to safety record.	• Commercial Vehicle Information System.
Automate fuel tax administration.	• Automated Mileage and Stateline Crossing Operational Test.
Develop base-state agreements for other credentials.	• Single-state Registration System. • OS/OW permit agreements. - Alliance for Uniform Hazmat Procedures.
Demonstrate electronic one-stop permit shopping.	• Southwest One-Stop Shopping. • HELP One-Stop Shopping. • Midwest One-Stop Shopping.
Identify institutional barriers to ITS/CVO deployment.	- Institutional issues studies.
Develop infrastructure linking CVO information systems.	- Commercial Vehicle Information Systems and Networks.
Highway Traffic Management	
Coordinate activities to enable more rapid detection, response, and clearance of incidents.	- General incident management programs.
Test advanced traveler information systems for commercial vehicles.	• I-95 Corridor Coalition CVO Project.
Develop systems for hazardous materials incident response.	- Operation Respond. • National Institute for Environmental Renewal.

enforcement and administration programs-such as weigh-in-motion, automatic vehicle identification, and information management technologies-are available and are being deployed by State agencies. Progress is being made on the enabling technologies for automated inspection and onboard monitoring systems, but widespread deployment of these products and services is not expected for another decade. The motor carrier industry has made great progress on the development of fleet and vehicle management systems. In both the public and the private sectors, the major technical needs are to develop standards and protocols for electronic data interchange (EDI) and vehicle-to-roadside communication (VRC), and to develop information systems to link existing and future CVO services. This is the fundamental resource challenge for the JTS/CVO program.

- **The institutional barriers to the deployment of ITS/CVO services are greater than the technical constraints.** Studies of the institutional barriers to ITS/CVO in 49 States demonstrated a striking commonality in their conclusions. Major barriers include inconsistent public sector support; limited private sector support; the lack of coordination across agencies; the lack of uniform regulations and policies across States; the lack of cooperation and trust between State agencies and the motor carrier industry; and the high anticipated public and private implementation costs. The core strategy to overcome these barriers is one of improving communication and redefining stakeholder roles and relationships. This is the fundamental organizational challenge for the ITS/CVO program.

- **The markets for ITS/CVO services differ among agencies, among carriers, and among regions and States.** With respect to commercial vehicle operations and regulations, there is neither a single motor carrier industry market nor a monolithic public sector mandate. The motor carrier industry encompasses multiple market segments, each of which has distinct operating characteristics. Public agencies involved in CVO vary in their priorities, capabilities, and objectives. Commercial vehicle regulation and operations differ among States and regions. Consequently, there is no single "market" or "mandate" for ITS/CVO, but rather several distinct market segments that must be differentiated to meet the needs of the private and public sectors. In general, these markets and mandates are not clearly defined, largely because data are scarce, technologies are evolving, and business opportunities are uncertain.

MARKET REQUIREMENTS

The central finding of this research is that the ITS/CVO program must differentiate among its markets. This differentiation must occur along three dimensions:

- Among public sector regulatory functions.
- Among motor carrier industry segments.
- Among regions and States.

Public Sector Markets

The administration and enforcement of motor carrier regulations is the focus of the public sector's role in CVO. Commercial vehicle regulation covers more than a dozen areas related to motor carrier business practices, vehicles, drivers, cargo, and trips. More than a decade after

the economic deregulation of the trucking industry **began,** the focus of motor carrier regulation today is on highway safety and revenue collection.

Figure 1 ranks the major areas of motor carrier regulation in terms of their importance to the ITS/CVO program. From the perspective of safety, the most significant regulations and processes include driver inspections, carrier reviews, commercial driver licensing, and vehicle inspections. With respect to revenue, the most significant functions are fuel use taxation, toll collections, and vehicle registration. In terms of the volume of transactions (as well as staff time), the most significant functions are toll collection (177 million commercial vehicle transactions in 1993), size and weight inspections (163 million), commercial driver licensing (more than 7 million), and vehicle registration (close to 6 million trucks, with multiple transactions per vehicle).

These regulatory areas vary widely with respect to their purpose, administrative procedures, use of automation, and level and distribution of transactions. Nevertheless, the State agencies responsible for the administration and enforcement of these regulatory programs face several common issues, as shown in figure 1:

- **Many regulatory programs are in a state of change.** Several States are preparing to join the IRP or the IFTA by the September 1996 deadline mandated by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The recent sunset of the Interstate Commerce Commission, the creation of the Single-State Registration System, and the deregulation of intrastate trucking are forcing many States to reconsider the roles of their public utility commissions in motor carrier regulation, as well as the purpose of operating authority requirements. Regional approaches to oversize/overweight permitting have emerged, and a multistate arrangement for hazardous materials permitting is under development. These concurrent changes present a challenge to the efficient administration of motor carrier regulations, but also present an opportunity to apply ITS/CVO technologies to streamline procedures and to rethink existing processes.

- **The administration and enforcement of motor carrier regulations are complex both within and among States. In the average** State, six different agencies are involved in motor carrier regulation. Carriers often are required to report similar information to multiple agencies. Across States, the legacy of regulatory programs tailored to the local economy and geography has left the administration of most regulatory programs highly "balkanized." The IFTA and the IRP have succeeded in establishing a national system for registration and fuel tax administration, but the administration of these programs varies widely among the States. For other credentials such as oversize/overweight or hazardous materials permits, procedures and requirements continue to vary widely among the States. The advent of electronic toll collection technology is creating an additional credential for many motor carriers, but these systems are being implemented on a project-by-project basis with little standardization. This piecemeal approach to motor carrier regulation presents a burden for carriers seeking to comply with regulations, as well as for agencies trying to communicate and exchange data or funds with other jurisdictions.

- **CVO administrative and enforcement activities vary more across than within regions.** The most striking regional difference is in enforcement strategies: States in the West and Midwest operate large numbers of fixed weigh stations, while Northeast States rely primarily on mobile enforcement (see figure 2). A second important difference is in the distribution of toll roads and bridges, which are heavily concentrated in the Northeast and

Midwest. Other regulatory areas with noteworthy regional differences include fuel use taxation, weight-distance taxation, size and weight permitting, and hazardous materials permitting. The distribution of IRP accounts, for example, is heavily concentrated in the Great Lakes and Southeast regions (see figure 3).

- **Most CVO regulatory programs operate in virtual isolation from each other.** The lack of coordination and interaction between CVO regulatory programs within most States is inefficient and undercuts the effectiveness of these programs. For example, the agency that administers vehicle registration programs rarely has access to information on a carrier's safety record, insurance status, or fuel tax account that would enable it to get unsafe, underinsured, or noncompliant vehicles off the road. Similarly, enforcement officials in most States lack on-line, real-time access to information on a driver's or carrier's safety record or compliance with credential requirements. Without this information, it is difficult for weight or safety inspectors to maximize highway safety and revenue collections. In other cases, the lack of coordination among agencies produces duplicative efforts. For example, IFTA and IRP accounts require similar types of information from carriers, yet fewer than half of the States administer the IFTA and IRP programs out of the same department, let alone the same division or agency.

- **Interstate data and funds exchanges are needlessly cumbersome and inefficient.** The exchange of data among IFTA and IRP jurisdictions generally occurs through hard copy, with less than one in five States reporting the use of EDI technologies. Data exchange is complicated by a lack of commonality among data bases. Funds exchange is less complicated, but tends to be inefficient because most States exchange offsetting payments where one check from the net debtor to the net creditor would suffice. Bilateral or multilateral transactions-as in the proposed IFTA and IRP clearinghouses-would reduce paperwork and administrative costs for many agencies.

- **Current enforcement activities are not completely effective.** States are committing vast financial and human resources to commercial vehicle enforcement, yet current enforcement activities generally do not maximize safety or revenue. Three elements of enforcement strategies are of particular concern:

  - *Safety versus weight*. The current allocation of resources is heavily oriented toward size and weight enforcement. More than 162 million vehicles are weighed each year, compared to less than 2 million safety inspections. However, the potential impact on motorists of an unsafe vehicle or driver is much more severe than that of an overweight vehicle.

  - *Mobile versus fixed.* Fewer than 1 percent of the weight inspections conducted by the States each year result in a citation. This rate suggests that weight inspections are effective at deterring overweight trucks from traveling on Interstate highways, but also that overloaded and unsafe carriers detour around fixed inspection sites. Similarly, the most effective safety enforcement strategies combine both fixed and mobile approaches.

  - *Performance versus paper.* There is concern that enforcement may not focus on high-risk carriers and drivers. Enforcement officials need more information and criteria for guidance in selecting vehicles for inspection, portable systems that enable mobile enforcement, and systems to monitor out-of-service vehicles to verify that repairs have occurred

as ordered. Similarly, driver safety inspections generally emphasize credentials such as the driver's license or hours-of-service log, and not actual driving ability. Credentials are difficult to enforce due to the lack of on-line verification capability; in most States, inspectors simply examine the appearance of the "paper"-the existence of a registration or a fuel tax decal-and not the status of a carrier's account.

Motor Carrier Industry Markets

The motor carrier industry includes many types of operations, equipment, and fleet sizes. The organization of the motor carrier industry is highly fragmented, reflecting the complexity and diversity of the many businesses, industries, government agencies, and consumers that it serves.

Five operating characteristics appear to be most relevant to the demand for ITS/CVO technologies within the industry. These characteristics influence a carrier's demand for fleet management systems such as routing and dispatching software, mobile communications, and onboard computers, as well as the need for information systems to facilitate compliance with public sector regulations. The characteristics are as follows:

- Principal product carried: The commodities that individual trucks haul most often, ranging from bulk goods such as gravel or lumber to perishable farm products to high value-added general freight. Each product has unique volume, weight, packaging, and temperature requirements that affect the operations of the fleets that are transporting them.

- **Fleet size**: The number of trucks in a fleet, ranging from the single digits to the hundreds. Fleet size is a major determinant of the complexity of a motor carrier's business operations. The market penetration of major ITS/CVO technologies increases with fleet size, according to the Truck Inventory and Use Survey as well as industry surveys.

- **Geographic range of operation**: The primary scope of the fleet's operation, ranging from local to national. The geographic range of operation affects the number of jurisdictions and highway systems through which a vehicle must pass, as well as the overall complexity of a carrier's operations. The use of ITS/CVO technologies appears to increase with the scope of a carrier's operations.

- **Routing variability:** The frequency with which a fleet changes routing patterns. Generally, as a fleet's routes become more variable, the incentive to use technology to track truck movements increases.

- **Time sensitivity of deliveries.** The urgency of a shipment, encompassing both the time value of the cargo and the amount of time that is available to make a delivery. Trucks that operate on highly time-sensitive schedules can benefit greatly from the ability to track individual vehicles and forecast delivery times precisely.

These operating characteristics loosely define segments of the motor carrier industry, as well as the market for ITS/CVO services (see figure 4). Many ITS/CVO products and services will meet the needs of more than one market segment, but it is evident that the motor carrier industry will not be a mass market for ITS/CVO. The small size of the potential market for many

technologies will increase the risk and reduce the rate of return. ITS/CVO technologies that can be tailored easily to specific market segments should be successful in the marketplace.

Regional Markets

Regional differences in trucking activity reflect variations in economic activity, industry mix, consumer markets, natural resources, highway infrastructure, and transportation costs. ITS/CVO services should be developed and deployed according to the distribution of trucking activity, and must be differentiated to reflect the regional variations in this activity.

Two measures of regional trucking activity were developed for this analysis: the distribution of freight-generating centers, as proxied by County Business Patterns data on the location of establishments in freight-intensive industries (see figure 5); and the location of major trucking corridors, as measured by the Highway Performance Monitoring System's information on annual average daily truck traffic along Interstate highways (see figure 6). The analysis of these two measures, not surprisingly, show parallel results. Truck traffic and freight intensity are concentrated in the eastern half of the Nation (particularly in the Northeast and Great Lakes regions), and along the Pacific Coast. These are the regions of highest population density and economic activity. In the central part of the Nation, scattered concentrations of truck traffic or freight intensity appear in the Denver, Dallas, and Houston metropolitan areas.

The results of these analyses were used to defined seven major trucking regions (see figure 7). Each of these regions, or "trucksheds," is characterized by a concentration of major freight-generating centers, highway linkages with high truck volumes, and similar industry mixes. Each truckshed has different ITS/CVO needs, reflecting its unique economic activity, types of trucking, and highway conditions (see figure 8).

Current Assessment

The most promising markets for ITS/CVO are in enforcement and fleet management. Figure 9 estimates the relative size and level of interest in lTS/CVO services for credentials administration and enforcement. The market share for State agency applications is measured relative to the number of States; the market share for motor carrier applications is measured relative to the number of carriers. The strongest markets include the following:

- **Driver and vehicle safety assurance:** Interest in better driver and vehicle safety enforcement is high and relatively uniform across the Nation, particularly in congested urban areas. The use of automated roadside inspection systems could enable States to inspect more vehicles each year, and also could provide significant time savings. Safe and compliant carriers would benefit if high-risk carriers can be identified with minimal disruption to motor carrier operations.

- **Interagency data exchange:** The market for interagency transactions within a single State is new. These applications would attempt to close existing loopholes in the effective administration and enforcement of motor carrier regulations by improving the flow of safety and credentials information. The market is of high interest and potentially is quite large, yet the ability of State agencies to form the required institutional relationships and reengineer their business practices to accommodate this information is still unclear.

- **Mobile communications:** One of the largest private sector markets is for mobile communications systems such as conventional two-way radio, digital text communications, wide area pagers, and satellite communications links. Surveys indicate that the demand for these systems is significant and growing. In addition, demand appears to be relatively independent of fleet size or operating range. The markets for other fleet management technologies are smaller, but interest in most applications is high.

- **Interstate data and funds exchange:** The initiatives to provide for interstate information exchange are the most advanced of the projects in the area of ITS/CVO administration. The CVISN will provide a critical platform for these services. The national Base State Working Group on Uniform Motor Carrier Procedures, which is overseeing the expansion of the IRP and the IFTA, is moving toward the development of clearinghouses for the electronic interchange of registration and fuel tax information among States. The Federally-sponsored Safety and Fitness Electronic Records (SAFER) project will link State and Federal motor carrier safety data bases, enabling the electronic interchange of information on safety ratings, inspections, citations, and accidents across States.

- **Basic information services:** The strongest market for administrative transactions between motor carriers and agencies is for basic information services that provide guidance through the thicket of **motor** carrier regulations and agencies: a single point of contact, a single telephone number for compliance information, or an on-line regulatory bulletin board. These services could apply to a wide range of carriers, regardless of fleet size or financial resources.

- **Automated weight and credential clearance:** The market for automated weight and credential clearance is strongest in the West and weakest in the Northeast, reflecting the distribution of fixed weigh stations. States could generate significant time savings and identify a larger number of noncompliant vehicles through the use of weigh-in-motion and automated clearance technologies. Carriers would benefit from reduced delays at weigh stations.

- **Electronic toll collection:** The market for electronic toll collection is strongest in the Northeast and Great Lakes regions, where the majority of toll roads are located. There are scattered markets along bridges and tunnels in California, Florida, Louisiana, and other areas. The States would benefit from improved speed and efficiency at toll plazas, as well as reduced operating and maintenance costs. Carriers would benefit from the ability to pay tolls without stopping, as well as improved recordkeeping.

Future Directions

The ITS/CVO program should emphasize several new directions in its markets and mandates. In most cases, the new directions represent a refinement of current strategies (see table 2):

- **The program should emphasize enforcement and safety.** The program to date has focused on the development of two major services: "transparent borders," the preclearance of vehicles past weigh stations and ports-of-entry; and "one-stop shopping," efforts to provide carriers with all necessary credentials and permits through a single point of contact. Preclearance programs are important and capable of generating large benefits, but are not applicable to the majority of truck movements. Similarly, the emphasis on one-stop shopping may be deflecting attention from more fundamental and productive changes that could

Table 2. New directions for the national ITS/CVO program: markets/mandates.

Old Strategy	New Strategy
"One size fits all."	Differentiate among markets.
Focus on markets for preclearance and one-stop shopping.	Focus on safety assurance, weight and credentials verification, and data linkages.
Focus on major Interstate corridors.	Organize around trade areas and traffic lanes.
Work with existing procedures and systems.	Encourage a broad rethinking of motor carrier regulatory practices.
Promote private sector investment and participation.	Enhance outreach effort to carriers and agencies.
Emphasize voluntary participation.	Continue to emphasize voluntary participation.

streamline or eliminate outdated procedures. In the future, public investment should focus primarily on safety assurance, and secondarily on the enforcement of weight and credentials regulations. A high priority should be the nationwide deployment of safety assurance and automated clearance programs. To realize the full benefits of these programs, the public sector should make a near-term investment in linking State safety and credential data bases.

- **The program should be organized around trade areas and traffic lanes.** The initial ITS/CVO projects were organized around major Interstate highway corridors to give the projects a strong marketing image and to provide a rationale for cooperative efforts among groups of States. In the long-run, a corridor orientation will limit motor carrier participation and reduce program effectiveness because corridors do not serve the majority of truck trips. The orientation of automated clearance and safety assurance programs should be broadened from highway corridors to geographic regions. Administrative programs should correspond to these regions, in part to reduce duplicative effort, but more fundamentally because the interstate exchange of data and funds follows a regional pattern similar to that of truck travel.

- **The program should encourage a broad rethinking of motor carrier regulatory practices.** In a broad sense, the ITS/CVO program should focus less on "ITS"-the specific deployment of technologies-and more on "CVO"-the general administration and enforcement of motor carrier regulations. The public sector in general, and the States in particular, should examine the effectiveness of and justification for motor carrier regulations and procedures. The ITS/CVO program should encourage operational tests that allow agencies and motor carriers to explore new ways of doing business.

- **The program should enhance its outreach efforts to agencies and carriers.** Because agency and carrier interest in ITS/CVO programs remains uneven, outreach and communication should be important elements of ITS/CVO efforts. In particular, participation by agencies should be broadened beyond State departments of transportation to include outreach to departments of revenue, State police, toll authorities, and other agencies; outreach to carriers should expand beyond the industry associations and largest national fleets. Outreach efforts may include disseminating information and conducting educational programs to increase the level of understanding of the structure, objectives, and functions of major CVO activities, and of the technologies and potential benefits associated with ITS. A major thrust should be to document of the successes of, and lessons learned from, early and ongoing ITS/CVO projects, including benefit/cost analysis.

- **Participation by States and carriers in ITS/CVO projects should remain voluntary.** The Federal Government generally has eschewed formal mandates for State or carrier participation in ITS/CVO initiatives. This lack of a formal mandate has provided flexibility for States to tailor programs to their specific needs, and has helped to alleviate some motor carrier concerns that ITS/CVO systems will be used to implement a national weight-distance tax or **to compromise** the confidentiality of business data. Participation should remain voluntary in the future. Over time, more carriers and agencies will participate as the benefits become more evident.

ORGANIZATION REQUIREMENTS

The ITS/CVO program's central organizational strategy deals with defining stakeholder roles and building agreement on the allocation of responsibilities. This strategy involves the complex web of interagency, interjurisdictional, and public/private relationships.

Current Assessment

The organization of the ITS/CVO program reflects the needs and interests of multiple stakeholders. Table 3 maps the current stakeholders in CVO policy and deployment by function and level of geography. Both dimensions of this matrix are important to the institutional architecture of the lTS/CVO program: first, whether existing organizations provide adequate coverage of each major function; and second, whether existing organizations provide adequate integration at each level of geography.

Although Federal leadership is critical to the development of the lTS/CVO program, State agencies control the day-to-day delivery of most CVO services and are the foundation of the CVO program. The States are responsible for building and maintaining highways and for taxing and regulating the motor carriers that use them. CVO responsibilities are fragmented among multiple agencies within each State. Too often, these agencies have conflicting goals and priorities, or overlapping responsibilities. In most States, the primary need is for the integration and coordination of the work of existing agencies to ensure smooth CVO planning and deployment.

To date, the model of State CVO planning has been the public/private working group, as required in the Federally-funded institutional issues studies. The groups that remained intact following the completion of these first-round studies have varied in their effectiveness, reflecting the lack of a mandate to continue from the States themselves or the national CVO program. Individual State CVO deployment organizations have not emerged yet, with the notable exception of Oregon's Greenlight program.

Organizational complexity is as much a problem across States as it is within States. The problem is more than just lack of coordination among States; it encompasses outright conflicts in regulations and policies. These interstate issues have been addressed, with varying degrees of success, by both national and regional forums.

The major CVO functions are well integrated at the national level through the work of the Federal Highway Administration (FHWA) and organizations such as the American Association of State Highway and Transportation Officials, the Commercial Vehicle Safety Alliance, the American Association of Motor Vehicle Administrators, the American Trucking Associations, and the National Private Truck Council. The CVO Committee of ITS America is emerging as the national forum for the development of CVO policy. Few national CVO deployment groups have emerged, except for permitting services and the organizations that administer the IRP, the IFTA, and the Commercial Driver's License lnformation System.

The major gap in the organizational infrastructure is at the regional level. At this level, only the regional FHWA offices and the regional units of AASHTO provide a voice in CVO planning for specific functions. The result is strong vertical integration of policies and programs between the State and national levels, and moderate horizontal integration of

Table 3. National, regional, and State CVO forums.

	Highway Maintenance & Operations	Law Enforcement	Revenue Collection	Motor Carriers	CVO Policy Forums	CVO Deployment Groups
National	. FHWA . AASHTO	. CVSA	- FTA . AAMVA	• ATA . NPTC . OOIDA	. ITS-A CVO Committee • BSWG	• Permit Services • IFTA, Inc. • IRP, Inc. • AAMVnet, **Inc.**
Regional	. FHWA Regional Offices • WASHTO, SASHTO, etc.				• ⍞✣□ Regional Consortia	• HELP, Inc. • Advantage c v o
State	• DOT's . **FHWA** Division Offices	• Police • **Patrols**	• DOR's • DMV's • PUCs	• **MTA's** • Carriers	• State Working Groups	

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State	• DOT's . **FHWA** Division Offices	• Police • **Patrols**	• DOR's • DMV's • PUCs	• **MTA's** • Carriers	• State Working Groups	

policies and programs at the State level and at the national level, but little integration at the regional level.

Future Directions

The organizational structure of the ITS/CVO should be strengthened (see table 4). The ITS/CVO program should develop policies, programs, and plans at three levels:

- The State level, because it is the States that have first-line responsibility for motor carrier regulation.
- The regional level, because many truck trips occur in multiple States.
- The national level, because of the need to ensure uniformity of services for carriers that operate in more than one region.

State Program

The foundation for the CVO institutional architecture must be the States. The key features of the State program should include the following:

- Support for public/private **forums with broad membership: The** State CVO program should emphasize the establishment and support of a public/private working group to oversee CVO planning and deployment. A core objective should be the continuing participation of all the major players involved in CVO: highway engineers, transportation planners, State police/highway patrol officers, motor vehicle registration officials, motor fuel tax administrators, motor carriers, shippers, and motor carrier service providers such as permitting services.
- **Development of State CVO business plans:** Each State should be encouraged to develop, and update on a regular basis, a CVO business plan with a strong policy commitment from State officials. The plan should define the ITS/CVO services to be deployed in each State. It should lay out the projects, objectives, roles, responsibilities, milestones, and funding, and estimate the costs and benefits of these activities for the State, motor carriers, and the public.
- **Staggered start dates:** Instead of attempting to make all States move along simultaneously, the program should be phased over a number of years. The initial effort should be limited to a dozen States that can show that they are prepared to operate an effective CVO forum and produce a practical business plan. Federal grants may be allocated among the CVO regions so that at least one "bellwether" program is created in each region. With proper encouragement and a better defined national CVO program, a second group of 10 to 15 States may be ready to develop a State CVO plan within a few years.
- **Joint Federal/State funding strategy:** Allowing for differences in the size and complexity of the States, initial Federal grants may be provided to cover the costs of developing a State CVO plan; creating and maintaining the CVO forum over 2-year periods; and updating the State CVO plan at the end of the period. The Federal Grants should be matched by State contributions. Thereafter, step-down Federal grants may be sufficient to sustain State forums and update plans. The initial funding match should make the CVO grants

Table 4. New directions for the national ITS/CVO program: organization.

Old Strategy	New Strategy
Introduce ITS technologies and define user needs.	Mainstream: move from concept to deployment.
Develop public/private forums.	Continue to support forums and seeks ways to make them permanent.
Include projects at the State, corridor, and national level.	Develop policies, projects, and plans at the State, regional, and national levels.

competitive with other transportation planning grants. The CVO funding strategy must attract and maintain the States' interest in CVO for a long enough time period to make these programs permanent.

- **Technical work including research, operational tests, and deployment planning:** Grants earmarked for State CVO forums should not be used to support regional activities, which must have their own dedicated funding source. Similarly, the Federal Government may wish to continue to provide separate funding for operational tests, technical studies, and mainstream deployment of ITS/CVO services.

Regional Program

Regional CVO programs should provide the context for the State programs. The regional programs would reflect the reality that most truck movements are regional and local rather than national; that most State-to-State interaction occurs within loosely defined regions or "trucksheds"; and that the needs and interests of State agencies and motor carriers differ more across regions than within them.

The key features of the regional programs should include the following:

- **Organization around economic regions:** The regional CVO programs should be based on the clusters of States that define the major truck markets. This structure will help to ensure that the development and deployment of ITS/CVO services match the markets. In general, programs should deploy CVO services, especially safety assurance programs, where the trucks are.

- **Support of multistate forums with broad membership:** The primary objective of the regional program should be to establish an ongoing, regional CVO forum that can provide policy and program direction. The development of stable regional consortia will require leadership by the FHWA and interested States because few existing regional forums deal with CVO issues.

- **Development of regional CVO business plans:** Each of the regional consortia should produce and regularly update an ITS/CVO program plan. The regional plan should reflect coordination with the constituent State CVO plans and show how the regional program will integrate its activities within the national ITS/CVO program.

- **Funding for forums and program support services:** The FHWA may wish to consider funding to support the forums and the preparation of the business plans. Possible use of funds may include travel by State officials and motor carrier managers to regional meetings, the rental of meeting space, communications, and other logistical functions. As the programs mature, funds could be made available to support a part-time or full-time program director.

- **Separate funding for technical studies, operational tests, and deployment.** The FHWA may wish to provide a second block of funds for technical studies that include staff or consultant support to develop the regional CVO plans; market research among State agencies, carriers, and service providers to determine user needs and priorities; preparation of public and private funding proposals for specific programs and projects; and evaluations and benefit/cost analyses.

- **Development of business entities for deployment of ITS/CVO** services. A secondary objective of the regional CVO program should be to set up regional entities able to deliver CVO services in a timely and cost-effective manner. In some cases, the consortia may choose to deliver ITS services directly. In many cases it is likely that third-party entities may be effective in managing and operating services. Greater third-party involvement will require the development of more explicit models for public/private partnerships.

National Program

The national CVO program provides an opportunity to coordinate the overall direction of the regional and State efforts, as well as to agree on standards and common policies in critical areas The key features of the national program should include the following:

- **Maintenance of a national CVO forum:** The role of the national program in the CVO institutional architecture is to provide commonality and uniformity so that "balkanized" CVO regions do not replace "balkanized" State motor carrier programs. The ITS America CVO Committee is the national CVO forum today, and its maintenance should be a top priority for the Federal ITS/CVO program.

- **Accelerated deployment of a national business plan:** The national CVO forum should develop and regularly update a national CVO program and business plan. The business plan should focus on coordinating and implementing policies and programs for deployment of the CVISN and development of regional safety assurance activities. An additional objective of the national forum should be to set up an entity or entities capable of delivering nationwide CVO services.

- **Funding for program support services and technical studies.** The Federal Government should continue to **provide** funding to support the national CVO program. Attached to this initiative should be supporting technical activities including benefit/cost analyses, project evaluations, and research and development.

Figure 10 summarizes the organizational priorities at the State, regional, and national levels.

RESOURCE REQUIREMENTS

Resources, broadly defined, are the supplies that enable a public or private enterprise to produce a good or service. These include staff, expertise, funding, and technologies. For the purposes of analyzing the ITS/CVO program, the critical elements are technology and staff expertise.

Current Assessment

The ITS/CVO program has achieved its initial technology goals. The States have developed and demonstrated the roadside technology for automated clearance and safety assurance, via weigh-in-motion (WIM), automatic vehicle identification (AVI), and similar technologies. The motor carrier industry is moving automation from the office to the truck, via two-way data communication, onboard computers, and automatic vehicle location. The remaining technical hurdles are as follows:

- **Lack of technical expertise among the current personnel of the agencies involved in CVO, as well as among some carriers.** Many CVO agencies are constrained in their ability to implement ITS/CVO programs because their personnel have had limited exposure to communications and information technologies. Transportation agencies historically have been oriented around skills such as highway engineering and planning. ITS/CVO program support requires a different set of skills, including expertise in electronics, computer programming, and information systems.

- **Lack of public sector data processing capabilities, and the incompatibility of existing systems across States.** Inventories of existing equipment and systems confirm that many public sector agencies currently lack data processing and information systems that are capable of handling the wide variety of data and tasks required by most ITS/CVO programs. In addition, many existing information systems are not compatible across agencies and across States. Some States have pushed for more rapid deployment of ITS/CVO **technologies, while** others have lagged.

- **Lack of national technical standards.** The lack of clear national technical standards for many of the ITS/CVO technologies contributes to the lack of understanding of and support for ITS/CVO, and makes agencies and carriers reluctant to invest in ITS systems for fear that their technology soon will become obsolete. Areas that need standards include transponder types, communication protocols, data definitions, and other key items.

- **High anticipated public and private implementation costs.** Funding needs include one-time capital costs for purchasing and installing equipment and for developing information systems, as well as ongoing costs for maintenance, operation, and personnel training. Cost concerns are real because of funding constraints at most CVO agencies, as well as the relatively low priority for given to CVO by most State Governments. The lack of demonstrated, quantifiable benefits to justify the new technologies and systems exacerbates this concern. However, the cost of ITS/CVO technologies, although high, is modest compared to that of a new highway or bridge.

Future Directions

The ITS/CVO program should refine its resource strategies as follows (see table 5):

- **The program should develop an open, modular, and adaptable architecture incorporating legacy systems. The** FHWA's CVISN project is developing a blueprint for a national CVO architecture, which will provide **the** framework necessary for cooperation and growth. The CVISN will enable the electronic interchange of data among public agencies, motor carriers, and third-party service providers. In many cases, it will provide the missing link between existing and planned administrative, preclearance, and safety assurance programs.

- **The program should continue to support private sector fleet management activities. Fleet** management technologies increasingly will be a tool for enhancing the productivity of motor carrier operations in the next decade. As in the past, most progress will come from market-driven private sector efforts. Although the public sector's role is limited, public sector CVO programs should support industry-driven efforts to define ED1 standards and protocols. In addition, public CVO programs can collect and disseminate information on fleet management technologies.

Table 5. New directions for the national ITS/CVO program: resources.

Old Strategy	New Strategy
Develop roadside technologies for preclearance.	Develop information system architecture incorporating legacy systems and focusing on data exchange.
Develop technologies for fleet and vehicle management.	Continue to support private sector fleet management initiatives.
Allow the marketplace to set de facto standards.	Develop standards for ED1 and VRC data and communications.
Live within the limits of the old system.	Upgrade equipment, improve staff expertise.

- **The program should establish national standards for VRC and ED1 data and communications.** In the past, the public sector has let the marketplace establish de facto technical standards. Today, the development of standards and protocols for ED1 and VRC is the major technical issue facing the national ITS/CVO program. The program should invest in the development of ED1 standards and translator software, and then demonstrate their performance in pilot programs with the States and motor carriers. The program must ensure the interoperability of AVI transponders across States, corridors, and regions, and coordinate CVO transponder standards with those in the toll industry.

- **The program should identify resources for upgrading agency computers, communications equipment, and software, as well as for improving the technical expertise of existing staff.** In the past, agencies have attempted to plan ITS/CVO services within the limits of the existing system. However, the experience with ITS/CVO projects has revealed the insufficiency of existing public sector data processing capabilities. To accelerate the process of deployment, the Federal Government and the States should identify funding sources for the upgrade or purchase of new computers, software, and communications equipment. These efforts should be accompanied by efforts to increase the technical expertise of public sector staff, either through training, new hires, or outside consultants.

1. Background

OBJECTIVE

This report describes the work of the study, "Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems." The purpose of the study is to assess the market for, and make recommendations on, the design of a national program for the application of Intelligent Transportation Systems (ITS) to commercial vehicle operations (CVO). This technical report is intended to define the requirements for a national lTS/CVO program.

The objectives of this report are to:

- Present a framework for analyzing the national program for ITS/CVO that considers the markets, organization, and resources of the program.
- Identify the major public sector motor carrier regulatory functions, and examine these functions with respect to their levels of transactions and distribution among the States.
- Examine how the motor carrier industry's geographic distribution and operating characteristics shape its demand for advanced technologies.
- Review the major operational tests and research projects currently underway, and summarize the lessons learned from these experiences that may be applied to the development of a national ITS/CVO program.
- Make recommendations for the future directions of the national ITS/CVO program.

COMMERCIAL VEHICLE OPERATIONS

Commercial vehicle operations comprise three dozen areas of interaction between, among, and within public agencies and motor carriers. These include functions such as the issuance of truck registrations, enforcement of size and weight limits, maintenance and inspection of vehicles, and routing and dispatching of fleets. These transactions are the focus of initiatives related to ITS because they are critical for tax collection, highway safety, and carrier productivity. For both agencies and carriers, the amount of time and paperwork involved in these activities is substantial, as is the potential for streamlining current procedures.

CVO activities address five broad areas: motor carrier business practices, vehicles, drivers, cargo, and trips. Many of these activities, such as the payment of fuel taxes and the issuance of special permits for overweight vehicles, represent interactions between public agencies and individual carriers. Other transactions, such as the exchange of apportioned registration fees among States, are exclusive to the public sector. Still other activities, such as the routing and dispatching of vehicles within a fleet, remain entirely within the domain of the private sector. What all of these activities have in common, however, is that they influence the productivity

and safety of trucking-the United States' dominant form of goods movement-as well as the efficiency of the public agencies that administer and enforce motor carrier regulations.

Responsibility for CVO regulations and operations is distributed among a complex web of public agencies and private companies. Major CVO stakeholders include the following:

- **State agencies** are the cornerstone for the public sector with respect to CVO. Commercial vehicle operations are administered and enforced primarily through State agencies. In a typical State, responsibility for commercial vehicle regulation is distributed among five or six departments and up to a dozen bureaus and offices. Nationally, over 300 State agencies administer and enforce motor carrier regulations. These agencies will be the major public sector beneficiaries of ITS/CVO programs.

- **Individual motor carriers** make virtually all private sector investment decisions, and have great latitude over their own operations, within the guidelines of government regulation. Individual motor carriers will be the major private sector beneficiaries of ITS/CVO programs.

- **Third-party service providers,** such as permitting and information management services, are emerging as critical vehicles for the deployment of ITS/CVO services.

- The **Federal Government** plays a critical role in shaping commercial vehicle and transportation policy. The Federal Highway Administration (FHWA), particularly through its Office of Motor Carriers (OMC), executes and enforces national commercial vehicle regulations. The U.S. Department of Transportation's Joint Program Office for Intelligent Transportation Systems (JPO) oversees the application of ITS to CVO and other transportation areas.

- **Motor carrier industry associations** attempt to represent the needs of the diverse motor carrier industry and provide a common voice in shaping policy. Major industry groups include the American Trucking Associations (ATA), the National Private Truck Council (NPTC), and the Owner-Operator Independent Drivers Association (OOIDA), as well as State motor truck associations.

- An assortment of **regional and national organizations** with varying levels of authority are becoming key players in policy development. These organizations include consortia of States such as the I-95 Corridor Coalition; representatives of State agencies such as the American Association of Motor Vehicle Administrators (AAMVA); and public/private coalitions such as the Intelligent Transportation Society of America (ITS America).

- **Quasi-public authorities** that own or operate toll roads, bridges, and tunnels may issue and enforce regulations for commercial vehicles using their facilities.

- **Shippers, receivers, and insurers have** an interest in ensuring the safe, timely, and efficient delivery of freight. Large shippers and receivers are becoming involved in ITS/CVO programs.

- **Metropolitan planning organizations** (MPO's), and city and county governments, are playing an increasing role in commercial vehicle administration and enforcement issues, especially in congested urban areas.

The administration and enforcement of motor carrier regulations are complex both within and across States. This complexity reflects that fact that truck movements were predominately local

until World War II, and only in the past 30 years have national trucking operations become commonplace. Historically, concerns about safety and taxation to pay for road repairs were local and State issues, and regulations governing motor carriers were tailored carefully to the needs of the local economy, geography, and politics. These patterns persist today, even as the forces that shaped them have faded. As the national economy and the motor carrier industry have grown, so too have conflicts over established roles, responsibilities, and procedures at the State level.

Motor carrier operations traditionally have been within the purview of the private sector-individual motor carriers, their industry associations, and vendors. Increasingly, the public sector is asserting its role in overseeing and influencing motor carrier operations, particularly with regard to safety and traffic management. These operational issues add yet another dimension to the already complex motor carrier regulatory environment-and increase the need for change.

INTELLIGENT TRANSPORTATION SYSTEMS FOR CVO

Commercial vehicle operations have become a major focus of Intelligent Transportation Systems (ITS, formerly known as Intelligent Vehicle-Highway Systems or (IVHS). ITS involve the application of advanced and emerging technologies in such fields as information processing, communications, control, and electronics to surface transportation needs.[1] ITS initiatives propose not to change or replace motor carrier regulations or established procedures, but to increase the efficiency and cost-effectiveness of these transactions through technology. ITS for CVO represents the intersection of ITS technologies with commercial vehicle regulations and operations (see figure 11).

The official statement of the current CVO program is the *National ITS Program Plan,* developed in early 1995 by the U.S. Department of Transportation and ITS America. The vision statement for the national lTS/CVO program reads, "Assisted by advanced technology, trucks and buses will move safely and freely throughout North America."[2] The ITS/CVO program is expected to meet the following objectives:

- Improved highway safety.
- Improved service level.
- Reduced energy and environmental impact.
- Enhanced productivity.
- Improved mobility.[3]

1 U.S. Department of Transportation, Joint Program Office for Intelligent Transportation Systems and Intelligent Transportation Society of America, *National ITS Program Plan,* First Edition, Washington, DC, March 1995, p. 2.

2 National ITS Program Plan, p. 182.

3 National lTS Program Plan, p. 186.

This vision is to be realized through the development and deployment of six lTS/CVO user services9

- **Commercial Vehicle Electronic Clearance-Services** to facilitate domestic and international border clearance and minimize stops and delays at weigh stations and ports-of-entry. These services would enable trucks and buses to have their safety status, credentials, and weight checked at mainline speeds. These services also would provide real-time, roadside access to the safety performance record of drivers, vehicles, and carriers. This service often is referred to as "transparent borders."

- **Automated Roadside Safety Inspection-**Services to automate and facilitate roadside inspections of vehicles **and** drivers.

- **Commercial Vehicle Administrative Processes**-Services to provide electronic application, purchasing, and issuance of credentials, as well as to automate tax reporting and auditing. These services would reduce the administrative burden of regulatory compliance on both State agencies and motor carriers. "One-stop shopping" refers to efforts to consolidate credentials issuance and reporting through a single agency or a single information network.

- **Onboard Safety Monitoring-Systems to** monitor the safety status of a commercial vehicle, cargo, and driver and warn the driver to take corrective action. Vehicle monitoring would include sensing and collecting data on the performance of critical components such as brakes, tires, and lights. Cargo monitoring would include sensing unsafe conditions such as shifts in cargo while the vehicle is in operation. Driver monitoring would include using nonintrusive technology to monitor driving time and alertness.

- **Freight Mobility-Systems** to facilitate communication between drivers, dispatchers, intermodal transportation providers, and highway traffic system managers. Such systems can enhance productivity by helping drivers to avoid congested areas.

- **Hazardous Materials Incident Response**-Services to provide a description of any hazardous materials involved in incidents and define appropriate countermeasures.

FORCES DRIVING INTEREST IN ITS/CVO

Three overlapping factors are driving State and motor carrier interest in using ITS to streamline and improve commercial vehicle operations: the geographic expansion of the motor carrier industry, cost competition, and service competition. Each of these factors reflects structural changes in the economy that are forcing businesses, the carriers that serve them, and the agencies that regulate the carriers to change the way they operate.

4 National ITS Program Plan, p. *30-33.*

Geographic Expansion

The geographic expansion of the motor carrier industry has occurred in three waves. The first expansion occurred after World War II when better truck technology and construction of the Interstate highway system enabled businesses and carriers to expand rapidly, establishing regional and national operations. By the mid-1960's, interstate motor carriers were well established, and the problems of administration and enforcement across States were widely acknowledged. These problems prompted a series of initiatives in the 1970's and early 1980's by the National Governors Association and other groups that took shape as the Motor Carrier Safety Assistance Program (MCSAP), the International Registration Plan (IRE), and similar programs. These initiatives succeeded in establishing national programs that matched the geographic scope of motor carrier operations. However, it was not until the mid 1990's that enough States participated to provide effective national coverage with these programs. A near-term objective of ITS/CVO today is to further streamline the administration of motor carrier regulations.

The industry's economic deregulation in 1980 triggered the second round of geographic expansion. Businesses took advantage of deregulation to consolidate warehousing and distribution operations into more cost-effective regional and national centers, which brought more carriers into long-haul interstate service. As the economy recovered from the recession of the early 1980's, the volume of trucks began to overwhelm the capacity of States that operate ports-of-entry, such as Arizona, Oregon, and California.[5] The congestion at these ports-of-entry was a catalyst for the creation of the Heavy-vehicle Electronic License Plate (HELP) program, the first organized attempt by the States to automate truck credential and weight clearance.6 The corresponding increase in administrative transactions prompted more States to join the IRP and fostered the creation of the International Fuel Tax Agreement (IFTA).

The administrative burden imposed by the growth in truck traffic has not diminished over the last decade, and the outlook is for a 20-percent increase in truck tonnage from 1993 to 2003.7 For many States, the problem of administering and enforcing motor carrier regulations is becoming more acute as budgets are cut. The need to do more with less is now a compelling argument for State participation in ITS/CVO initiatives.

A third wave of geographic expansion is underway, brought about by the North American Free Trade Agreement (NAFTA). Trade across the Canadian and Mexican borders is increasing, with much of it carried by trucks. Under the NAFTA, Canadian and Mexican carriers will be able to operate on an international basis by January 1,2000. The prospect of dealing with a growing volume of international administrative transactions in addition to the domestic transactions is reinforcing State and motor carrier interest in the IRE, the IFTA, and ITS/CVO applications for border clearance of trucks, drivers, and freight.

5 California operates combined agricultural inspection sites and truck weigh stations at its borders.

6 See Chapter 4 for a detailed discussion of the HELP program.

7 DRI/McGraw-Hill, U.S. *Freight Transportation Forecast to* 2003, Lexington, Massachusetts, April 1995, p. 10.

Cost Competition

The second driving force behind ITS/CVO is cost competition. Interstate deregulation triggered sharp competitive pressures within the motor carrier industry to reduce costs. Freight rates dropped, business entry and failure rates shot up sharply, and carriers scrambled to identify cost savings in management, engine and vehicle design, and labor. Intrastate deregulation, which took effect in January 1995, is having a similar, though less dramatic, impact.

Deregulation also triggered deep public anxiety about motor carrier safety as ever larger trucks shared the road with ever smaller passenger cars. The Federal and State motor carrier regulatory agencies responded by establishing a national commercial driver's license (CDL) and the commercial driver's license information system (CDLIS), introducing drug testing programs, and expanding MCSAP funding and training. ITS/CVO safety applications are an extension of these programs, all of which seek to improve the safety of motor carrier operations.

Cost competition within the motor carrier industry also had two other pervasive effects. It accelerated a generational and cultural change within the motor carrier industry, forcing motor carrier firms to adopt more sophisticated business management practices and technology. Prior to deregulation, the motor carrier industry lagged many other industries in the automation of business procedures. Today, almost all large carriers, many mid-sized carriers, and some small carriers have automated significant portions of their operations. Automation has fostered greater understanding of the electronics, communications, and information technologies underlying ITS/CVO applications, as well as a greater willingness to adapt these technologies to motor carrier operations.

Deregulation also was a catalyst for the restructuring of the freight transportation industry. One positive impact of this restructuring has been the development of integrated and intermodal transportation services. However, a side effect of this change has been an increase in highly complex freight movements performed by similarly complex business organizations. It is not uncommon for a shipper to consign freight to a motor carrier, who contracts with an owner-operator driver, who uses a truck leased to and registered by a third party, to deliver freight to a railroad, which will deliver it to another motor carrier, and ultimately to the receiver.

The carrier, driver, and truck in this example are not a "traditional" motor carrier firm; rather, they constitute a "virtual" transportation company whose components and services can be reconfigured daily or weekly to meet the needs of markets and clients. For State motor carrier regulators dealing with these changes, the task of tracking and assigning accountability for the vehicle, driver, and cargo has become a major challenge and a significant factor in driving State agencies toward integrated information management systems as a part of their ITS/CVO programs

Service Competition

The third element behind the current interest in ITS for CVO is service competition. Improvements in truck technology, combined with other transportation innovations such as intermodal containers, doublestack rail cars, and air cargo service, have reduced the cost of long-distance freight transportation. At the same time, computers and communication technologies have given businesses the capability to coordinate widely separated manufacturers, distributors, and

retailers. These changes have made it possible for businesses to buy more transportation and reach lower-cost labor markets and materials. Consequently, businesses have outsourced manufacturing and assembly work and developed long supply chains and distribution networks. At the same time, businesses have adopted just-in-time manufacturing and distribution systems as a strategy to reduce inventory carrying costs.

The result of these changes has been intense pressure on motor carriers to manage very precise and time-sensitive freight movements, tailored to needs of different shippers and receivers. To meet these demands, carriers are investing in ITS technology (such as routing and dispatching software, communications equipment, and automatic vehicle location systems) to improve the predictability of their freight service. Carriers also are pressuring State agencies to minimize delays from weigh stations, roadside inspections, highway construction, and traffic congestion. Carriers, businesses, and an increasing number of States are looking to lTS/CVO as a strategic tool to improve the quality of freight transportation services and gain competitive economic advantage.

FRAMEWORK FOR ANALYSIS

This report analyzes the national ITS/CVO program from two perspectives: broad categories of ITS/CVO activities-credentials administration, enforcement, fleet and vehicle management, and highway traffic management-and institutional building blocks-markets/mandates, organization, and resources.

CVO Areas and Functions

To understand the lTS/CVO program, two major functions are relevant: regulation and operation. Each of these functions may be subdivided, as follows:

- **Regulation-Administration:** Administration refers to deskside procedures and systems for managing motor carrier regulations. These systems include the processes for accepting and reviewing applications, issuing credentials, auditing, and reporting. Administration, or credentials, functions relate to the business (operating authority), vehicle (registration or fuel tax), driver (commercial driver's license), or cargo (hazardous material permits). Credentials are the focus of one ITS/CVO user service, Commercial Vehicle Administrative Processes.

- **Regulation-Enforcement:** Enforcement refers to roadside procedures designed to facilitate safely assurance and the verification of size, weight, and credentials information. Enforcement functions relate to the vehicle (weight and safety inspections), driver (hours-of-service restrictions), or cargo (hazardous materials inspections). **Two** ITS/CVO service bundles address enforcement issues: Commercial Vehicle Electronic Clearance and Automated Roadside Safety Inspection.

- **Operations-Fleet and Vehicle Management:** Fleet and vehicle management technologies and systems are designed to improve the productivity of motor carriers through better utilization of fleets and vehicles. These functions include routing and dispatching, communications between the driver and dispatcher, onboard safety monitoring, record keeping, and

regulatory compliance. These functions most often relate to the vehicle or the trip. Two ITS/CVO service bundles address fleet management issues: Onboard Safety Monitoring and Freight Mobility.

- **Operations- Traffic Management**: Traffic management programs and services are designed to reduce congestion and manage the flow of commercial vehicle traffic. These include travel advisory services, incident management plans, hazardous materials routing requirements and other routing restrictions, and other factors that influence the movement of commercial vehicles. These functions most often relate to the trip. Traffic management for commercial vehicles has not been a major focus of the ITS/CVO program to date; the only service bundle related to traffic management is Hazardous Materials Incident Response.

CVO activities also may be classified into five broad areas:

- **Business-Activities** that directly affect the business practices of motor carriers, such as operating authority and other regulatory requirements that qualify motor carriers to provide certain types of services.

- **Vehicle-Activities** that relate directly to the operation of a vehicle, such as registration, **fuel** taxes, size **and** weight restrictions, toll collections, and safety inspections.

- **Driver-Activities** that focus on the driver of a commercial vehicle, such as licensing, hours-of-service restrictions, and immigration controls at international border crossings.

- **Cargo-Activities** that relate to the materials transported on a commercial vehicle, such as hazardous materials permitting, as well as customs and agricultural clearance requirements at international border crossings.

- **Trip-Activities** and factors that directly affect the trip of a commercial vehicle, such as route restrictions, congestion, incidents, and construction.

Many ITS/CVO programs cut across more than one of these functions: for example, automated safety inspections involve both the vehicle and the driver, and electronic "one-stop" permit programs may involve credentials related to all functions.

Figure 12 describes the relationship between the two frameworks for understanding commercial vehicle operations-by area or by function. The figure also identifies the areas and functions that are addressed by ITS/CVO user services such as automated credentialing or automated clearance. For the purposes of this report, the functional classification of CVO activities is used to define four broad categories of ITS/CVO services: enforcement, administration, fleet and vehicle management, and highway traffic management.

Program Building Blocks

The second framework for analyzing the national ITS/CVO program is that of program "building blocks." Three building blocks are necessary for successful public sector programs (see figure 13):

- **Markets/Mandates -** The existence of a commercial market or the legal or political justification for a program. Most efforts that significantly affect the conduct of business operations require a clearly defined market or mandate. In the private sector, the "mandate" for a product or service takes the form of market demand; in the public sector, the source of a mandate may be popular demand, legislation, or executive leadership. Mandate/market issues that the ITS/CVO program must address include: How well has the ITS/CVO program met the markets and mandates for streamlining the administration of motor carrier credentials, improving the productivity and safety of enforcement activities, and enhancing fleet and traffic management capabilities? Which markets should be targeted for national implementation?

- **Organization -** The establishment of systems through which public or private entities are structured and administered, and how they respond to or implement change. The organizational structure of a public sector program typically includes intra-agency, interagency, interjurisdictional, and public/private relationships. Organization issues that the ITS/CVO program must address include: How successful have the States, carriers, and vendors been in building the organizational and institutional arrangements necessary to deliver ITS/CVO services and products to public and private markets? Are new organizational strategies necessary?

- Resources-The availability of key inputs, including technology, funding, and staff expertise. Resource issues that the ITS/CVO program must address include: How well have the public and private sectors been able to harness technology, investment funds, and skills to deliver ITS/CVO products and services? Where should new investment be targeted to realize the greatest return?

This simple framework applies to a wide range of public sector programs-from the national defense to public education, as well as motor carrier regulation and other transportation programs. In each instance, a program cannot be created and sustained without some form of market or political support, an organization to implement and maintain the activities, and supporting human, technological, and financial resources. In its broadest sense, the mandate is the "demand' for the program; the resources are the "supply" of inputs to produce the program; and the organization comprises the relationships and agreements among all parties involved in producing or consuming the good or service.

Each family of the ITS/CVO program must incorporate these three building blocks. The appropriate shape of each building block will differ for each ITS/CVO service, however, to reflect the unique needs, stakeholders, and resources involved in the production and consumption of each family of ITS/CVO services. For example, the private sector market for fleet management systems is different from the public agency market for interstate information clearinghouses. This report attempts to define the mix of markets, organization, and resources that will be optimal for each family of the ITS/CVO program.

ORGANIZATION OF THE REPORT

The remainder of this report is organized as follows:

- **Chapter 2** summarizes the major **public sector regulatory functions,** including registration, fuel tax administration, size and weight, safety, and tolls. The section discusses current regulatory procedures, the level and distribution of transactions, and major issues relevant to the development of a national ITS/CVO program. This section also reviews the major public sector stakeholders in CVO at the State, regional, and national levels.

- **Chapter 3 presents** an **overview of the motor carrier industry.** This overview includes an analysis of the operating characteristics that shape the industry's demand for new technologies. This section also identifies major freight generation centers and truck corridors in the United States. Finally, this section defines seven major "trucksheds," or operating regions, and assesses the market for ITS/CVO in each region.

- **Chapter 4** reviews the current **ITS/CVO program,** summarizing more than 50 existing public and private initiatives in the areas of enforcement, administration, fleet and vehicle management, and traffic management. This section highlights the objective, participants, schedule, and budget for each specific project, and identifies broad trends and lessons learned across projects.

- **Chapter 5** analyzes the **requirements for a national ITS/CVO program** in terms of the three building blocks: markets, organization, and resources. This section considers the current market, organization, and resources strategy for the ITS/CVO program, and draws conclusions about the program's ability to meet the needs of its public and private stakeholders.

- **Chapter 6** makes **recommendations** for the future direction of the national ITS/CVO program.

2. Public Sector Overview

Commercial vehicle operations represent partnership and interaction between two broad players: the public sector (represented primarily by regulatory agencies) and the motor carrier industry. The public sector is primarily responsible for the administration and enforcement of motor carrier regulations, takes leadership in most traffic management activities, and may play a supporting role to industry-driven fleet and vehicle management endeavors.

The objective of this chapter is to review the purpose, organization, and impact of public sector regulation of commercial vehicle operations. This analysis occurs in two major segments:

- Examination of the major public sector regulatory functions, including registration, fuel tax administration, size and weight, safety, and tolls. This summary includes discussion of the current regulatory procedures, the level and distribution of transactions, and the major issues relevant to the development of a national ITS/CVO program.
- Identification of the major public sector stakeholders in the CVO activities at the State, regional, and national levels.

REGULATORY FUNCTIONS

The administration and enforcement of motor carrier regulations is the focus of the public sector's role in commercial vehicle operations. The major tax and regulatory areas and procedures include:

- Operating authority and insurance requirements.
- Vehicle registration.
- Fuel use taxation.
- Weight-distance taxation.
- Toll collection.
- Vehicle size and weight restrictions and permitting.
- Vehicle safety regulations and inspections.
- Driver safety regulations and inspections.

These regulatory requirements apply in some manner to virtually all commercial vehicles and their operators. Other requirements apply to a narrow subset of the total commercial vehicle population; these include hazardous materials restrictions and permitting, air quality regulations, agricultural permit requirements, and customs and immigration requirements at international border crossings. Among this group of narrower functions, only one (hazardous materials) is addressed in this report.

These regulatory functions cover four major areas of the CVO world: the business, the vehicle, the driver, and the freight (see figure 14). In the fifth area, the trip, the public sector's emphasis is on management and operations, rather than regulation.

OPERATING AUTHORITY AND INSURANCE REGISTRATION

Operating authority regulations grant carriers the right to operate in one or more States. Until early 1996, carriers were required to receive interstate operating authority from the Interstate Commerce Commission (ICC) and are required to register that authority with most States. This process will be changed with the sunset of the ICC; it appears that the emphasis will shift to the verification of insurance requirements. Intrastate operating authority is required of carriers operating in 42 States. Regulatory procedures vary widely.

Current Regulatory Procedures

The ICC regulated the interstate motor carrier industry from 1935 to 1996. Eligible carriers were awarded operating rights, known as operating authority, by the ICC. Thirty-eight States required that a copy of the ICC authority be filed with their jurisdiction. In addition to the registration of operating authority, carriers generally were required to identify the vehicles operating under those rights, demonstrate evidence of insurance, and provide a list of the States in which the carrier operated.

The recent ICC sunset will reshape the objectives and administration of operating authority regulations. In November 1995, Congress enacted legislation to shut down the ICC and transfer its remaining powers to the U.S. DOT. The legislation replaced the ICC with a three-member panel within the U.S. DOT. The law abolished ICC operating authority, but requires for-hire carriers to register with the U.S. DOT during an 18-month transition period. At the end of the 18th month, the U.S. DOT will consolidate the ICC's carrier registration, its own registration program, and the new Single-State Registration System (SSRS).

The SSRS will be established in January 1997, as required by the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). The arrangement will obligate carriers to register proof of insurance with a base state. If the carrier is not based in a participating State, registration will be required in the State where the carrier operates the largest number of vehicles. The carrier will file its name, address, and insurance information, with the base State. The base State will collect and distribute fees for all the States in which the carrier plans to operate. Fees will be determined by the number of vehicles a carrier operates in each State, and the number of States in which the carrier operates. Base States will not be allowed to charge a fee greater than the amount they charged for operating authority as of November 15, 1991, and the fee will not exceed $10 per vehicle. The base State will issue a "receipt" that lists the States in which the carrier is authorized to operate. This receipt will be kept in the cab of each vehicle in the carrier's fleet.

Currently, operating authority may be administered by transportation commissions, public service commissions, utility commissions, State corporation commissions, or State departments

of transportation. In some States, multiple agencies may grant operating authority, depending on whether the carrier is an intrastate carrier or an interstate carrier.1 Many States exempt carriers providing certain services or transporting particular commodities from the requirement to file for operating authority; common exemptions include transportation of agricultural products and petroleum-related products (e.g., antifreeze or kerosene).

Certification as to the safe operating conditions of the motor carrier's vehicles is required by some States. Prior to issuing operating authority, few States, if any, have access to information about outstanding or repeat safety or traffic violations committed by a motor carrier in other States. In general, States do not collect data on operating authority infractions by motor carriers. In most cases, if appropriate proof of insurance and other certifications are provided, renewals are automatic for intrastate authority.

Level of Activity

In March 1995, nearly 70,000 carriers were registered with the ICC for operating authority.2 The distribution of ICC-regulated carriers by State of domicile aligned with demographic patterns and manufacturing areas (see figure 15). The number of carriers is highest among Middle Atlantic and Great Lakes States, as well as in California, Florida, Georgia, North Carolina, and Texas. It is assumed that the distribution of all interstate carriers follows a similar pattern.

Regarding intrastate carriers, there is no central source of data on the number of operating authorities granted in each State. The distribution of intrastate carriers throughout the country likely approximates the location of trucking warehouse, storage, and terminal facilities (see figure 16). The concentration of these facilities reflects demographic and international trade patterns.3 The number of trucking establishments follows demographic patterns except for the northern and southern borders of the United States, presumably because of warehouses and storage facilities used for trade with Canada and Mexico.

Issues

Many States are beginning to reconsider thefunction of *their public utility commissions in motor carrier regulation.* These changes come on the heels of the deregulation of intrastate trucking in 1995 and the ICC sunset in 1996. The impact of these changes is not yet clear, but it is likely that carriers will continue to be required to submit proof of insurance, either to a single State (for intrastate carriers) or a base-State program (for interstate carriers). The strategic use of information systems could facilitate this change.

In generaI, agencies that issue operating authority do so in isolation from other State agencies. Because of this isolation, issuing agencies have little or no ability to collect data on operating infractions or safety records. If appropriate proof of insurance and safety certifications are provided,

1 In this report, "Interstate trucking" refers to vehicles and carriers that operate in more than one State. "Intrastate trucking" refers to vehicles and carriers that operate in a single State.

2 Interstate Commerce Commission, March 1995.

3 U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1993.

renewals are issued fairly automatically. Issuing agencies should improve communication and coordination with the agencies that register vehicles and enforce safety regulations.

VEHICLE REGISTRATION

All States collect fees for the registration of trucks traveling in their territory. Registration fees (known as "first structure" or "first tier" taxes) have been in use for over 80 years, and are the oldest form of vehicle taxation.

Registration fees are second only to motor fuel taxes as a source of motor carrier revenue for the States. In fiscal year 1993, registration fees for commercial tractors, trailers, and buses totaled nearly $4.8 billion.4

Current Regulatory Procedures

A form of capital equipment tax, registration fees must be paid before a vehicle can be operated legally. Different registration procedures and requirements apply to intrastate and interstate vehicles.

Intrastate Registration

Procedures for registration of intrastate vehicles vary across States. In general, to register an intrastate vehicle, a carrier must fill out a registration form and pay the appropriate fee based on factors such as the vehicle's weight, number of axles, age, or load capacity. The operator may have to provide proof of insurance, title, and tax payments (including the Federal Heavy Vehicle Use Tax and any property taxes levied to the county in which the carrier is located). If the registration is accepted, the State issues a license plate and related paperwork for the vehicle.

Registration is required for all power units and trailers. In almost all cases, registration must be renewed annually, although some States offer permanent, one-time registration of trailers and special categories of vehicles such as government vehicles. Federal vehicles are exempt from State registration requirements.

Interstate Registration

In the past, most States maintained their own systems for registration of interstate vehicles. Motor carriers that wished to operate a vehicle in multiple States needed to register the vehicle in each State individually. As motor carriers expanded from local to regional and national operations, States began to develop bilateral and multilateral reciprocity agreements through which they agreed to accept registration credentials issued by other States. This process proved complex and cumbersome. Efforts by the American Association of Motor Vehicle Administrators (AAMVA) led to the formation in 1973 of the International Registration Plan

4 U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management, *Highway Statistics*, Washington, DC, 1994, Table MV-2.

(IRP), an agreement with nine original signatories. The IRP effectively superseded most of the older multistate and bilateral agreements.5

The ISTEA requires all States that collect interstate registration fees to join the IRP by September 30, 1996. As of March 1996, 46 States belong to the IRP.6 The U.S. non-member jurisdictions are Alaska, Hawaii, New Jersey, Rhode Island, and the District of Columbia. Plans are underway for New Jersey and Rhode Island to join the IRP by the ISTEA deadline.

Under the IRP, participating States agree that interstate commercial vehicle operators can satisfy vehicle registration and fee requirements for all States in which they operate through a single State (known as the "base State"). The IRP covers vehicles and combinations with over 11804 kg (26,000 lb) Gross Vehicle Weight Rating (GVWR), or with at least three axles. The goals of the IRP are to reduce administrative and reporting burdens on commercial vehicle operators, improve the efficiency of State registration programs, and make registration fees and procedures more uniform across States.

The IRP process includes five types of activities:

- The base State accepts and processes IRP applications from the carriers in its jurisdiction, and issues credentials (license plates and cab cards) to certify the right to operate in all IRP jurisdictions
- The base State collects application and registration fees on an annual basis from the carriers in its jurisdiction, and obtains operating mileage estimates by IRP jurisdiction for each carrier's fleet.
- The base State interacts with other IRP jurisdictions to document carrier operations, and to transfer shares of collected fees to other jurisdictions in proportion to each carrier's operating mileage.
- The base State conducts periodic audits of its carriers. Current IRP rules require that the base State audit 15 percent of the carriers in its jurisdiction every 5 years. The audits cover the authenticity of the mileage figures reported by the carrier.
- Each member State may issue temporary permits to vehicles that are not apportioned for travel in its jurisdiction. These permits are valid for travel during a limited amount of time (typically 2 to 10 days). Depending on the State, these temporary permits may be secured on the spot at weigh stations or ports-of-entry, or in advance by mail, phone, fax, or wire service.

The organization of registration activities varies significantly among States. Most often, a motor vehicle bureau, either independently or as part of a department of transportation or public safety, administers the IRP and corresponding intrastate registration programs. Within the lead department, separate units may handle account processing, billing, and auditing.

5 Some trucks will continue to be covered by bilateral and multi-State agreements for the foreseeable future. These include trucks under 11 804 kg, special mobile equipment, and other unique vehicles.

6 Two Canadian provinces (Alberta and Saskatchewan) belong the IRP.

The IRP agreement provides broad guidelines for member States, but each jurisdiction builds its own systems to support its internal operations and to exchange data with motor carriers or other States. Under the auspices of the National Governors' Association (NGA), a Congressionally-funded Base State Working Group on Uniform Motor Carrier Procedures (BSWG) is working to coordinate State approaches to IRP implementation. Developing common approaches and data exchange standards will take on a new urgency once the last few States have entered the agreement.

Most motor carriers rely on their base State to calculate their IRP fees and bill them for the appropriate amount. For new accounts, the registration fees due to the base State and declared jurisdictions reflect gross vehicle weights and the estimated mileage that will be traveled in the upcoming year within each jurisdiction. For renewals, registration fees are based on actual mileage traveled during the previous year.

Automation capabilities vary widely among States and among functions respondent. A survey of State regulatory agencies commissioned by the BSWG revealed that most regulatory agencies have automated a portion of the major IRP functions, including the issuance of cab cards, stickers, and plates; fee calculation and billing; vehicle registration and renewal processing; and new account processing. The major exceptions are the audit process and enforcement, which are currently automated by less than half of respondents (see figure 17).7 About half of the respondents have developed their own software to maintain mileage records and calculate fees, while 38 percent are using commercial off-the-shelf software. Twenty States use the Vehicle Information System for Tax Apportionment (VISTA), a software program developed by Lockheed Information Management Systems (Lockheed IMS). Four States are using a similar program developed by R.L. Polk.

Full implementation of the IRP agreement within the 48 contiguous States, which is expected by the September 30, 1996 deadline, will improve the efficiency of the agreement, and will eliminate the need for States to maintain expensive "dual track" registration systems-one track for carriers based in IRP jurisdictions, and one track for carriers based elsewhere.

Level of Activity

Because registration is required of nearly all commercial vehicles, it is one of the best indicators of the level and distribution of motor carrier administration across the States. The FHWA estimates that in 1993, a total of 1.3 million commercial tractors and 3.9 million commercial trailers were registered among the 50 States and the District of Columbia (see figures 18 and 19). In addition, the States registered 535,000 school and institutional buses, 120,000 commercial buses, and 1.8 million farm trucks.8 These totals include both interstate and intrastate vehicles. The States with the greatest number of registered tractors are Texas, California, and Ohio. The

7 Science Applications International Corporation, *ADP Survey Final* Results Report, prepared for the Base State Working Group on Uniform Motor Carrier Procedures, Oak Ridge, Tennessee, August 12, 1994, p. 35.

8 Federal Highway Administration, Office of Highway Statistics, 1993. The registration data base is based on State reports, supplemented by information from the Truck Inventory and Use Survey conducted by the U.S. Department of Commerce, Bureau of the Census in 5-year intervals. Some vehicles may be listed under more than one State, or counted as both commercial and farm vehicles.

average State registers three trailers for every tractor, but this ratio ranges from less than one to higher than nine.[9] Variations in the trailer-to-tractor ratio reflect State-specific registration fees, schedules, and structures.

Nationwide, the number of commercial tractors registered remained fairly flat over the past decade, increasing a total of just 4 percent between 1983 and 1993. The number of trailers registered increased 25 percent over the same period. Tractor registrations increased more than 40 percent in several States in the Rocky Mountains and the Southeast-including Montana, North Dakota, Nevada, Virginia, and Utah (see figure 20). These gains largely occurred at the expense of States in the Northeast (such as New York and New Jersey), as well as oil-producing States such as Oklahoma and Louisiana that were hit hard by the oil price collapse of the mid-to-late 1980's.

Data on IRP activity across States is somewhat limited. IRP, Inc., an independent body created by the AAMVA to administer the agreement, requests annual reports of account activity from member jurisdictions, but not all States comply with this request. The number of IRP accounts in each State is the most consistent available indicator of activity levels. However, the location of IRP accounts may be misleading. Physical domicile of a vehicle is not required for a carrier to secure IRP registration in a given base State. A carrier is only required to operate miles, maintain records, and run an office in the State it chooses as its IRP base.

As of June 1995, the total number of IRP accounts in the 46 member States is approximately 202,000 (see figure 21).[10] The States with large numbers of IRP accounts generally fall into two groups: traditional centers of heavy industry in the "Rust Belt" such as Ohio (the national leader with more than 14,000 accounts in 1994), Pennsylvania, and Illinois; and fast-growing Southeast States such as Georgia, North Carolina, and Alabama. Of the 38 States that reported this figure to IRP, Inc., about 17 percent of the accounts in force at the end of 1994 were created that year. The number of IRP accounts per State is a function of both actual establishment locations and base-State preferences among carriers; Ohio, for example, is a popular base State.

The average IRP account covers 6.4 power units, or truck tractors. The ratio of power units per account varies widely across States, however, reflecting differences in average fleet size as well as fee structures that influence how many vehicles a carrier may choose to register for the interstate market. For example, California, with high operating costs that have forced consolidation in the trucking industry, maintains 4,400 IRP accounts with 41,000 power units, for a ratio of 9.3 power units per account. Georgia, with a stronger presence of owner-operators and greater movement of goods across State boundaries than California, maintains 12,700 IRP accounts but only 37,900 power units, for a ratio of 3.0 power units per account.

In addition to the 1.3 million power units, IRP accounts cover 1.0 million truck trailers. The comparatively low number of trailers reflects the tendency for many carriers to register trailers only for intrastate use. Although not directly comparable to the FHWA estimates, these totals

9 Maine, for example, represents a unique situation, registering 5,100 tractors but more than 471,000 trailers in 1993. Maine is a popular site for trailer registration due to its low registration fees and 5-year registration system.

10 Data provided by IRP, Inc., June 1995 supplemented by telephone interviews with a small group of non-respondent States. Information could not be obtained for Massachusetts.

suggest that carriers register the vast majority of their power units for interstate use through the IRP, but register fewer than one-third of their trailers for this purpose.

Published data on the issuance of temporary or trip permits by individual States is limited. Of the 36 jurisdictions responding to the BSWG survey, 13 issue more than 15,000 trip permits annually; 10 issue between 5,000 and 15,000 permits; and 13 issue fewer than 5,000 permits.11

Audit frequency remains uneven across States. Cumulatively, the 40 States that provided this information to IRE, Inc. audited just over 9,200 accounts in 1994, or 5.0 percent of their aggregate number of accounts. Only 15 States, however, appear on target to meet the IRP requirement of auditing 15 percent of their accounts every 5 years. Three States-Illinois, Pennsylvania, and Texas-accounted for more than half of all audits performed in 1994. Four States-Idaho, Maine, Mississippi, and Vermont-reported no audits for the year. Close to 60 percent of the audits resulted in changes in the registration fees owed by carriers or apportioned to States.

Issues

The IRP program has resulted in a significant gain in efficiency compared to the old system, where carriers needed to obtain credentials and make payments to each State through which they traveled. However, the administration of registration programs could become more efficient if State regulatory agencies increase the application of information and communication technologies. Because technical expertise and financial capabilities vary among agencies and carriers, the registration process must embrace a variety of technological approaches.

The registration process operates in isolation from other programs such as safety and insurance. Because registration is a regulatory requirement that virtually all motor carriers must meet, registration agencies can share basic data with other programs (such as fuel tax) to keep unsafe noncompliant, or underinsured vehicles off the road.12 However, few States share this information across agencies on a routine basis. Among the 36 jurisdictions responding to the BSWG survey, only 9 possessed online access to other systems within the same State. A starting point toward improved interagency coordination in many States would be improved communication (and a common data base structure) between the IRP and corresponding intrastate registration programs.

Interstate data and funds exchange are complex and often efficient. Although almost all States now maintain computerized records of IRP information, nearly all the transactions are processed manually, either in person or by mail. Of the jurisdictions responding to the BSWG survey, 19 percent exchange data using EDI; 47 percent use other electronic means such as magnetic tapes, floppy disks, or modem; and 47 percent exchange data through hard copy.13 Data exchange is complicated by a lack of commonality across State registration data bases, aside from those States involved in the VISTA or Polk systems. Funds exchange is less complicated, but

[11] *ADP Survey Final Results Report*, p. **34.**

[12] The Commercial Vehicle Information System (CVIS) project is attempting to address this issue (see chapter 4 for details).

[13] The totals sum to more than 100 due to multiple responses by some agencies.

tends to be inefficient because most States exchange offsetting payments where one check from the net debtor to the net creditor would suffice. IRE, Inc. is developing a pilot program for a national clearinghouse to net remittances across States. This clearinghouse will not be fully operational for several years.

Audits remain a weak spot in many States. The IRP has reduced its audit requirements from 25 percent of accounts every 3 years to 15 percent every 5 years. Nevertheless, many States struggle to fulfill their audit requirements in the face of personnel cutbacks and budget restrictions for auditing purposes. IRP account audits receive limited resources because the potential gains are not as substantial when compared to corporate income, fuel, and sales tax audits. States often do not have the resources for conducting comprehensive audits of large carriers, even though such audits would cover a large number of vehicles. Without strong audits, the overall effectiveness of the IRP program depends on self-reporting by motor carriers. The declared mileage apportionment is subject to error, intentional or otherwise. For example, smaller carriers that operate in only a few States may be able to bias their declared apportionment toward the State with the lowest registration fees.

Roadside enforcement capabilities are limited in most States. Enforcement of registration requirements generally occurs only when a vehicle has been stopped for other purposes. The enforcement officer looks for the apportioned IRP plate that identifies the base State, and may examine the cab card, which provides detail on the apportioned States. Most States rely on State police or other enforcement agencies to enforce vehicle registration credentials. However, in most cases, IRP agencies are not able to provide enforcement personnel with automated, online credential verification capability.

InternationaI trucking will bring new issues to *the IRP.* The North American Free Trade Agreement (NAFTA) will bring full international trucking to the United States, Mexico, and Canada by January 2000. The IRP, as well as its member jurisdictions, must develop methods to incorporate Mexican carriers. In the near term, the outreach to Mexico may emphasize the use of trip permits and special arrangements between border States. In the long term, the IRP must help Mexican States develop the regulatory and institutional structure to support IRP membership. The BSWG has endorsed this priority.

FUEL USE TAXATION

All States collect some form of a tax on diesel fuel or a substitute fee or use tax that replaces the revenues that the diesel fuel tax would generate. Motor fuel taxes are sometimes called "second structure" or "second tier" taxes, because they were the second major source of highway revenue to be introduced. In most States, fuel taxes are now the largest single source of motor carrier-related tax revenue.

Motor fuel taxes usually are levied at the pump or point of delivery on a per-gallon basis. Intrastate motor carriers, by the nature of their operations, pay taxes on fuel that is both purchased and consumed in the State. On the other hand, large long-haul trucks and over-the-road buses can travel for many miles without refueling, so interstate motor carriers may cross entire States without paying for fuel taxes at the pump. Consequently, 47 States have instituted

motor carrier fuel use taxes, under which the interstate carriers report the mileage traveled and fuel purchased in each jurisdiction, as well as an average mileage per gallon for the fleet.14 Fuel use taxes are based on estimated fuel consumption in each State, less credits for fuel purchased in that jurisdiction

As with registration, motor carriers must file mileage reports and tax payments for each State through which they travel. The International Fuel Tax Agreement (IFTA) was established in 1982 by Arizona, Iowa, and Washington to encourage uniform administration of motor carrier fuel taxation laws, and to establish a base-State arrangement for collecting and administering fuel use taxes. As of March 1996, 42 States participate in the IFTA (see figure 22).[15] Three States (Maine, New Hampshire, and Vermont) that participate in a similar program, the Regional Fuel Tax Agreement (RFTA), recently agreed to join the IFTA by January 1997. Delaware, Kentucky, and Rhode Island have joined the IFTA and will implement the agreement by July 1996. New Jersey is expected to join the IFTA later this year. All remaining States that administer fuel use taxes are mandated to join the IFTA by September 30, 1996.[16]

Current Regulatory Procedures

The administration of motor fuel tax programs for intrastate vehicles varies widely across States. Some States simply collect taxes at the point of delivery; other States require all vehicles, regardless of whether they are operating in single or multiple States, to register for a fuel tax identification number and regularly report mileage and fuel consumption. Fees, reporting requirements, and minimum weight levels vary among jurisdictions.

The goal of the IFTA program is to facilitate common practices for the administration and enforcement of interstate fuel tax programs across all States. The IFTA is a reciprocity agreement through which interstate carriers can satisfy fuel tax registration and payment requirements for all jurisdictions in which they operate through a single State. The IFTA covers interstate commercial vehicles that exceed a gross vehicle weight of 11 804 kg (26,000 lb) or use three or more axles, either singly or in combination.

The IFTA process comprises five sets of activities:

- The base State accepts and processes IFTA applications from the carriers in its jurisdiction, and issues credentials (fuel tax licenses and vehicle decals) to certify the right to operate in all IFTA jurisdictions.
- The base State accepts and processes fuel tax returns on a quarterly basis from the carriers in its jurisdiction, and collects or refunds the net tax balance due for each carrier.

14 The jurisdictions without fuel use taxes or reporting requirements are Alaska, Hawaii, Oregon, and the District of Columbia.

15 Nine of the 10 Canadian provinces are members of the IFTA. Ontario is expected to join the IFTA in 1996.

16 Title IV, Section 4008 of the Intermodal Surface Transportation Efficiency Act of 1991 requires that any State that collects a fuel use tax must belong to the IFTA or a Base State agreement that is "not in conflict" with the IFTA by September 30, 1996.

- The base State interacts with other IFTA jurisdictions to document carrier operations and fuel tax collections, and to transfer tax funds due to other jurisdictions by carriers in the base State.
- The base State conducts periodic audits of its carriers. Current IFTA rules require that the base State audit 15 percent of the carriers in its jurisdiction every 5 years.
- Each State may issue temporary permits to vehicles that are not licensed for travel in its jurisdiction. Such permits are valid for travel during a limited amount of time (typically 2 to 10 days). Depending on the State, these temporary permits may be secured on the spot at weigh stations or ports-of-entry, or in advance by mail, phone, fax, or wire service.

The organization of these activities varies significantly across States. Usually, a State department of revenue or taxation administers IFTA and other fuel tax programs, although some States assign this responsibility to a department of transportation or motor vehicles. Within this lead department, however, separate units may handle account processing, billing, and auditing.

The IFTA agreement provides broad guidelines for member States, but each jurisdiction builds its own systems to support its internal fuel tax operations and to exchange data with motor carriers or other States. Under the auspices of the NGA, the BSWG is working to coordinate State approaches to IFTA implementation. Developing common approaches and data exchange standards will become a higher priority once the last group of States has entered the agreement.

Automation capabilities vary widely across States and functions. A survey commissioned by the BSWG revealed that the functions most commonly automated by agencies include new account processing, tax return processing, billing, and credential issuance. In contrast, bonding, enforcement, and insurance validation are automated by less than half of the respondents (see figure 23).[17] About two-thirds of the respondents developed their own software, while 24 percent are using commercial off-the-shelf software. VISTA is the most popular commercial software program.

The transition to IFTA membership affords an opportunity for many States to reengineer their operations. For the most part, the transition has been proceeding with few problems, according to interviews with fuel tax administrators in some of the newest member States. The major consequences of IFTA membership appear to include the following:

- The number of accounts each State must maintain falls dramatically, because the lFTA allows motor carriers to be licensed through just one base jurisdiction. Interviews with fuel tax administrators in the non-member States suggest that an So-to go-percent reduction in fuel tax accounts per State is likely (see table 6). The staff time devoted to processing applications and tax returns does not decrease at the same rate, however, because most account transactions become more complex. The number of IRP accounts may be a reasonable gauge for the likely number of IFTA accounts in each State following full implementation, except that some carriers currently use one jurisdiction as their base State for the IFTA and another for the IRP in order to minimize exposure to State-specific restrictions and fees.

17 ADP Survey Final Results Report, p. *14.*

Table 6. Projected impacts of IFTA participation for new members.

State	Implementation Date	Fuel Tax Accounts		Decals Issued		Anticipated Revenue Loss
		Prior to IFTA	Projected Under IFTA	Prior to IFTA	Projected Under IFTA	
Alabama	January 96	38,000	6,000	100,000	NA	Minor
California	January 96	90,000	6,000-7,000	NA	41,000	Minor
Connecticut	January 96	40,000	1,200-1,300	NA	NA	Significant
Delaware	July 96	30,000	1,200	650,000	l0,000-12,000	$2.7 Million
Georgia	January 96	46,000	8,000-12,000	750,000	40,000	$2.3 Million
Kentucky	July 96	36,000	2,500	NA	NA	NA
Maryland	January 96	45,000	8,000-10,000	710,000	30,000-45,000	$4.7 Million
Massachusetts	January 1996	45,000	3,500	614,000	20,000	NA
Michigan	January 96	36,000	6,000-8,000	600,000	NA	Minor
New Jersey	July 96	52,000	14,000	738,000	50,000	$14 Million
New York	January 96	80,000	6,800	NA	NA	$2 Million
Pennsylvania	January 96	80,000	11,000	950,000	60,000	$8 Million
Rhode Island	July 96	24,000	2,000	470,000	NA	$4 Million
South Carolina	January 96	33,000	2,000-3,000	600,000	NA	NA
Virginia	January 96	48,000	2,500	NA	NA	NA
West Virginia	January 96	38,000	4,800	NA	NA	NA

Note: NA=Not Available

Sources: Cambridge Systematics, Inc. interviews with State agencies; JHK & Associates, et al., *Eastern States Institutional Issues Study for Commercial Vehicle Operations,* Final Report, November 1995.

- States may suffer a significant revenue loss from the fees associated with the sale of decals and cab cards to carriers, which States now will issue only to their home-based carriers and vehicles. This revenue loss is a particular concern in the Northeast. In a small State like Rhode Island, decal fees represent a greater revenue stream than actual fuel use taxes. Other States such as California and Texas have not faced this issue because they do not charge decal fees.
- The issuance of trip permits, and associated fees, also may decrease in most States. Once all States participate in the IFTA, the primary need for a trip permit would be for a carrier that is registered only for intrastate use, but wishes to make one trip into a neighboring State.
- States with a minimum weight threshold lower than 11804 kg (26,000 lb) will experience a loss in revenue as they increase their thresholds to conform with IFTA requirements. Northeastern States such as Connecticut, Pennsylvania, and Rhode Island had maintained thresholds of 7,718 kg (17,000 lb) or lower. Vehicles with weights between these lower thresholds and 11,804 kg (26,000 lb) will be exempted from fuel use tax reporting.
- Fuel tax collections may increase modestly as a result of a more stringent audit program and decreased evasion rates.
- Staffing requirements may decrease slightly in account and tax return processing, but are likely to increase in the audit area.

Universal membership will eliminate the need for IFTA member States to maintain a costly "dual track" system-one for carriers based in IFTA States, and one for carriers based in other jurisdictions. Moreover, universal ETA membership may increase the incentive for vehicles to register for interstate use. A carrier that expects to make even one or two trips per year out of its base State may find that registering under the IFTA represents a similar cost (although some added paperwork) to purchasing trip permits each time it leaves the State. Consequently, smaller States like Delaware may be left with relatively few intrastate fuel tax accounts.

Overall, many States face declining revenues as a result of IFTA membership, at least in the near term. Few States have made plans to offset this revenue decrease. The Federal Government is assisting with one-time capital costs in many States, but States will need to finance their own increases in audit and enforcement staff as necessary.

Level of Activity

The current number of fuel tax accounts is quite large in many of the non-IFTA States. Once full implementation is achieved in early 1997, the number of interstate fuel tax accounts (including the RFTA member States) is likely to total 180,000.[18] The geographic distribution of accounts reflects the location of major truck routes and freight generation centers, as well as State-specific fee structures and tax policies. The States that expect the largest number of accounts primarily are located in the Industrial Belt in the Middle Atlantic and Great Lakes regions, although the South also will host a large number of IFTA accounts (see figure 24).

18 Cambridge Systematics, Inc., estimate based on data from IFTA, Inc. and interviews with administrators of State motor fuel use tax programs. No information is available for the State of Washington.

States that expect to maintain more than 7,000 IFTA accounts include New Jersey, Pennsylvania, Georgia, Maryland, Illinois, Ohio, California, and Michigan.

The majority of States currently issue decals that certify a vehicle's registration for the fuel use tax. The IFTA agreement requires that the base State issue decals to all vehicles in its jurisdiction. Projections by IFTA program administrators suggest that, upon full implementation of the IFTA, States will issue some 2.8 million vehicle decals. The current number of decals issued per account averages about 19 for the Nation, but its range is wide: States such as Minnesota, Oklahoma, and Tennessee issue more than 50 decals per account, while States such as South Carolina, Georgia, and Maryland issue fewer than five decals per account.

Many of the standard account transactions such as renewals, tax return processing, and billing are being automated and streamlined by States. Certain transactions, due to their nature, tend to be more complicated. These special transactions include new account processing and account cancellations, suspensions, or revocations. Few States appear to maintain current data on the number of new account applications. The frequency of account cancellations, suspensions, or revocations varies with State enforcement strategies or turnover in the local trucking industry; in States such as Utah, North Carolina, or Oklahoma, more than one in four IFTA accounts were canceled, suspended, or revoked in 1994.[19]

IFTA rules require member States to audit 15 percent of their base-State accounts every 5 years, but few States even reach this level. Of the 25 IFTA members in 1994, only 7-Arizona, Idaho, Missouri, Montana, South Dakota, Utah, and Wisconsin-audited more than 3 percent of their base-State accounts. Yet audits offer strong potential for increasing revenue to States: for the States that reported this statistic to IFTA, Inc., 67 percent of all audits resulted in a change (most often an increase) in the tax owed by a carrier. Fewer than 1,700 IFTA accounts were audited in 1994; the optimistic assumption that all new members will perform the minimum number of audits implies that just 5,300 fuel tax accounts-about 3.0 percent of the national total-will be audited each year under full implementation of the IFTA.

Issues

The IFTA program has resulted in a significant gain in efficiency compared to the old system, where carriers needed to obtain credentials and make payments to each State through which they traveled. However, a number of issues remain.

IFTA reporting remains burdensome for motor carriers. The IFTA covers the same class of vehicles as the IRP, but differs in that reporting is by fleet, rather than by individual vehicle. The IFTA also requires quarterly reports, rather than the annual reports required by the IRP. Further gains in productivity could be realized by developing ways for carriers to file applications and tax returns and make payments to States electronically using EDI and EFT technologies.

Interstate data and funds exchange are complex and often inefficient . The IFTA program has shifted a large portion of the record-keeping burden from motor carriers to State agencies. State agencies must handle the transactions with other States on behalf of carriers. Most transactions

19 International Fuel Tax Association, *Inc., International Fuel Tax Agreement Annual Report,* Tempe, Arizona, 1994.

between States currently occur through the exchange of paper invoices, receipts, and other documents. This system requires substantial effort by the States to handle, exchange, and store paper documents. Interactions between IFTA member States currently are handled on a unilateral basis; for example, Delaware pays its IFTA obligations to Maryland without regard to any moneys Maryland may owe Delaware. Bilateral or multilateral transactions would reduce paperwork and administrative costs for State agencies, as would the application of EFT to make payments between States. Progress is slowly being realized. New York State is developing a Regional Tax Processing Center that will serve as a funds-netting repository for IFTA payments. Instead of paying each State directly, participants would write one check to or collect one payment from the repository. Thirteen States have agreed to participate in the repository, including many of the largest trucking centers (California, New York, Texas, Georgia, Maryland, Pennsylvania, and Michigan. In the long term, an IFTA clearinghouse is expected to be developed.

Many States and carriers currently lack the technical, human, or financial resources to implement automated IFTA processing systems. Just 35 percent of those jurisdictions responding to the BSWG survey use EDI in the IFTA process; in contrast, 56 percent exchange data through other automated means such as magnetic tapes and floppy disks, and 71 percent exchange data through hardcopy.20 The ability of States to handle EDI is likely to develop unevenly. Similarly, motor carriers vary considerably in their ability to adopt or finance EDI and other information systems. Consequently, the IFTA process must embrace a variety of technological approaches. Education and training programs must occur in parallel with the expansion of the IFTA.

Auditing and credentials enforcement remain the weak spots in fuel tax administration in many States. As noted, only a handful of States currently meet the IFTA's standard of auditing 15 percent of their accounts every 5 years. Audits offer great potential to increase revenues and improve equity within the motor carrier industry. With the expansion of the IFTA, many States may need to add new audit staff and retrain existing staff. Enforcement of fuel use tax registration or payments, like that of operating authority or vehicle registration, generally occurs only when a vehicle has been stopped for other purposes. Moreover, roadside enforcement officials often do not have real-time access to information on the status of the carrier's fuel tax account. A more dynamic linkage of fuel tax credentialing and payment to weight or safety enforcement or to registration could help reduce evasion. Enforcement typically is the responsibility of the State police or some other agency separate from the fuel tax administrator. Communication and data-sharing between these two agencies is critical.

State IFTA programs often operate in isolation from IRP programs. Coordination of the IFTA and IRP programs in many States could achieve efficiencies in account processing and auditing. IFTA and IRP accounts require similar types of information; for example, both are based on mileage reports. Closer coordination could reduce reporting requirements for carriers and data storage and manipulation time for agencies. Unfortunately, fewer than half of all States administer the IFTA and the IRP programs from the same department, let alone the same division or agency. In many States, combining aspects of the IFTA and the IRP programs will require one agency to relinquish some of its authority in the data collection or recordkeeping process.

20 The total sums to more than 100 due to multiple responses by some agencies.

WEIGHT-DISTANCE TAXATION

A few States tax carriers on the basis of actual weight and distance traveled within the State. Such taxes are based on the presumption that the heavier the vehicle and the more miles it travels, the greater the wear-and-tear on the State's roadways. These weight-distance or weight-mile taxes sometimes are referred to as "third structure" or "third tier" taxes, as opposed to first structure taxes (i.e., registration fees) and second structure taxes (i.e., fuel taxes). Six States levy weight-distance taxes: Arizona, Idaho, Kentucky, New Mexico, New York, and Oregon.

Current Regulatory Procedures

Every State imposing a weight-distance or ton-mile tax requires motor carriers to register for a mileage tax identification number and to report each truck's in-State taxable miles and vehicle weight, usually on a quarterly basis. For example, Oregon requires that the carrier report the plate, marker or pass number, unit number, make of vehicle, declared weight, beginning and ending monthly odometer readings, total miles operated, Oregon taxable miles, type of fuel, number of axles, tax rates per mile, and Oregon highway use tax. Carriers operating infrequently in a particular weight-distance tax State must apply for a temporary permit in that State and pay the tax in advance, based on weight and mileage estimates, when they arrive at the State port-of-entry or obtain a trip permit.

In Kentucky, trucks subject to the weight-distance tax pay a flat rate tax of 2.85 cents per mile. In all of the other weight-distance tax jurisdictions, the taxes generally are levied based on a graduated schedule of rates according to the miles traveled and the vehicle's registered or declared gross weight. The tax rates are comparable in all of the weight-distance States except for Oregon, which charges substantially higher fees because it does not levy a fuel use tax (see table 7). The minimum threshold truck weight varies among the mileage-tax States: 8 172 kg (18,000 lb) GVWR for New York; 11804 kg (26,000 lb) for Arizona, New Mexico, and Oregon; and 27 240 kg (60,000 lb) for Idaho and Kentucky.

Level of Activity

Weight-distance tax activity among States can be compared using motor carrier accounts and revenue. The number of weight-distance accounts increases with population and decreases with weight thresholds. For example, New York has almost 500,000 accounts; the other, less populated States have between 22,000 and 40,000 accounts. The comparatively high number of accounts in New York also reflects its relatively low weight limit.

Revenues generated by weight-distance taxes reflect rate structures, the number of accounts, and in-State highway miles. Oregon accumulates the largest sum ($200 million in 1994) due to its high tax rate. New York received $121.8 million in fiscal year 1994 because of its large number of accounts. Arizona amassed $104.4 million in 1994 due to its extensive in-State trucking distances.

Table 7. Weight-distance tax rate comparisons, accounts and tax revenue.

	Weight-Distance Tax Rate, 1994 (cents/mile)			Weight-Distance Tax Accounts (Total)	Weight-Distance Tax Revenue ($ million)
	60,000 - 62,000 lb	70,000 - 72,000 lb	78,000 - 80,000 lb		
Arizona	2.74	4.48	4.78	22,000'	$104.42
Idaho	3.01	**3.64**	**4.49**	**40,000[2]**	**27.5[2]**
Kentucky	**2.85**	**2.85**	**2.85**	**28,800'**	**52.03**
New Mexico	2.26	2.74	3.17	32,950[1]	*34.63*
New York	2.30	3.00	3.50	476,917[1]	121.83
Oregon	8.80	12.00	14.55	27,460"	200.02

[1]1995
[2]1994
[3]**Fiscal Year 1994**
[4]1993

Note: 1 lb equals 0.454 kg
1 mi equals 1.61 km.

Source: Interviews with State agencies.

Issues

In theory, weight-distance taxes help to ensure that the vehicles placing the heaviest burdens on the highway system pay their fair share of the costs associated with highway use. Nonetheless, weight-distance taxes have been a source of controversy and have come under attack for being inequitable and overly complex.

Some motor carriers complain that the costs of compliance with mileage taxes are excessive. The mileage and registered weight data that the carriers report to the weight-distance tax States is the same as that which the carriers must keep for IRP purposes. Nevertheless, the reporting format, required data elements (e.g., mileage by fleet or by individual vehicle), reporting frequency, and basis for mileage calculations vary by State. This lack of uniformity imposes a procedural burden on carriers that operate in multiple mileage-tax States. From the States' perspective, the costs of compliance may be most significant for taxes applied at lower rates. Arizona, for example, spends 11 percent of its weight-distance tax revenues on operation and administrative costs, compared to the 5.5 percent of revenues spent by Oregon. The carriers' experience may mirror that of the States. Data exchange and standardized reporting requirements among the six mileage-tax States could facilitate transactions for carriers. Electronic funds transfer (EFT) could enable motor carriers to submit payments electronically to each State.

The mandate that States must join the IFTA will raise costs of administering weight-distance taxes. For non-IFTA member States, weight-distance tax accounts typically have been combined with fuel tax accounting so the administrative burden related to the weight-distance tax is minimal. However, because of the IFTA's fuel tax administration requirements, motor carriers will no longer be able to submit a combined report for weight-distance and fuel taxes, nor will agency staff administer these two taxes through one account. Kentucky and New York have reported that they expect an increase in their weight-distance tax administrative costs as a result of incorporating the IFTA processes. (Because Oregon does not have a fuel use tax, its administrative costs did not change significantly upon entering the IFTA.) In order to reduce administrative costs, agencies could develop deskside technologies to help improve communication with motor carriers. Carriers could input fleet information directly into a shared data base. Agencies could use this data base along with an EFT system to bill the carriers.

Significant evasion rates raise both equity and efficiency concerns. Evasion rates for existing weight-distance taxes have been estimated by one source to average about 10 percent.[21] Many believe that this is a conservative estimate and that the real rate may be 30 percent or more. These evasion rates are cause for concern regarding both equity-the widespread perception that it is easier for smaller carriers to evade the tax than it is for larger carriers who cannot afford to be caught "cheating" and so are forced to bear an unfair share of the tax burden-and efficiency-the amount of tax revenue raised may be less than would be generated by higher compliance with a tax more widely perceived as "fair." To improve equity and efficiency, data sharing and communication between tax administrators and State police or vehicle registration officials are crucial. An ED1 system would facilitate the exchange of fleet-related information. An ED1

21 U.S. Department of Transportation, *The Feasibility of a National Weight-Distance* Tax, National Cooperative Highway Research Program 20-24(7) Technical Memorandum 1, National Academy Press, Washington, DC, December 1988, p. 111-13.

system along with improved roadside technologies (i.e., weigh-in-motion and onboard computers) would make it easier for motor carriers to file weight-distance tax returns and more difficult for them to evade.

TOLL COLLECTION

Tolls are not aimed exclusively at motor carriers, but essentially function as another "tax" that carriers must pay and States must administer. The growing use of electronic toll collection technologies is improving the administration of toll authorities, but also is adding a new credential for many carriers and bringing new stakeholders into the CVO process.

Current Regulatory Procedures

Toll collection has been used for several decades to recoup capital and operating costs of selected bridges, tunnels, and highways. Toll charges generally apply to all vehicles using toll facilities. The rate at an individual toll plaza may be fixed, or it may vary according to the distance traveled. Commercial vehicles pay higher fees at most facilities, because their heavier weight and size cause greater stress to pavement. Most commercial vehicle toll charges vary according to the number of axles, or, less frequently, the gross weight of the vehicle.

Historically, vehicle operators have paid tolls at toll plazas, with either cash or prepaid tokens. Most toll plazas have converted some of their lanes to automatic, or exact change, collection. Many toll authorities also have allowed motor carriers to set up charge accounts, enabling them to pay tolls on a periodic basis.

Since the late 1980's, advances in information and communications technologies have fostered the emergence of electronic toll collection systems. In electronic toll collection (ETC), an electronic tag (or transponder) on a vehicle communicates with a roadside sensor at the toll plaza. This sensor feeds information to a computer at the toll station, which interprets data from the tag to identify the operator's account and bill the toll to the account. Alternatively, the transponder itself, or a "Smartcard" plugged into the transponder, carries the credit directly on the vehicle. In both cases, the key enabling technology is automatic vehicle identification (AVI), or vehicle-to-roadside communication (VRC). VRC refers to any system through which roadside sensors identify and communicate with electronic tags on vehicles. It is applicable to a range of functions, including electronic credentials verification, traffic monitoring, and incident detection. ETC systems that are designed to handle functions beyond toll collection generally are referred to as Electronic Toll and Traffic Management (ETTM) systems.[22]

The first ETTM system in the United States was installed in 1989 on the Crescent City Connection in New Orleans. As of early 1995, at least 10 of the approximately 55 toll agencies

[22] Pietrzyk, Michael C. and Edward A. Mierzejewski, *Electronic Toll and Traffic Management Systems,* National Cooperative Highway Research Program Synthesis 194, National Academy Press, Washington, DC, 1993, p. 1.

in the United States have installed ETTM systems. Another 20 agencies are in the process of studying, testing, or implementing electronic toll collection.[23]

The major benefit of ETTM is its ability to increase collection efficiency and vehicle speed at toll plazas. ETTM equipment can be installed in lanes that are used for automatic or manual collection, enabling properly equipped vehicles to pass through without coming to a complete stop. ETTM systems can read vehicle tags at up to mainline speeds, so vehicles can proceed through dedicated ETTM lanes with little reduction in speed. An express ETTM lane can handle 1,800 vehicles per hour, more than five times as many as a manually operated lane (see table 8).[24] This increased capacity enables toll facilities to handle increases in traffic without adding additional lanes. In addition, ETTM reduces staffing requirements, as well as other operating and maintenance costs per lane (see table 9). The Transportation Research Board estimates that the cost of operating and maintaining a manual toll lane is more than 33 times as high as the cost for a dedicated ETTM lane.25

Motor carriers are an important constituency for ETTM applications because they pay higher toll charges than passenger cars, particularly when fees are aggregated over an entire fleet. ETTM accounts can save time for commercial vehicles that drive along toll roads or bridges on a regular basis, and can eliminate the need for drivers to pay tolls in cash and later document their expenses. In addition, many toll authorities are offering toll discounts of up to 50 percent to encourage carriers to register for the service.

From the motor carrier's perspective, an ETTM account in many regions is fast becoming an additional credential to manage. Although it is optional (unlike a registration or fuel tax account), an ETTM account is becoming increasingly essential to efficient business operations. The process for setting up an account varies among the current systems. In most cases, the toll authority owns and operates the ETTM system, although a few facilities are being managed by third-party vendors such as Lockheed IMS.

Carriers must fill out applications and purchase tags, either through the mail or in-person at a toll plaza or a service center. Most ETTM systems charge between $10 and $30 for each vehicle tag; this fee may be waived if the carrier sets up a credit line. Additional fees may apply for monthly summary or account balance reports. In all cases, account holders are required to prepay either a flat minimum balance or some portion (often 2 months) of expected toll payments. The system operator will deduct toll charges from this balance, and require the carrier to replenish the balance at regular intervals. Electronic funds transfer (EFT) technologies typically are used to speed the payment process.

Compliance with ETTM regulations generally is enforced via video surveillance. A video camera often will record a vehicle's license plate to ensure that vehicles that have not purchased tags are not attempting to slip past the toll plaza in dedicated ETTM lanes. Video imaging also can provide documentation of the transaction to backup the AVI/VRC reading.

23 Schuster, Neil D., "ETTM Technology: Current Success and Future Potential," presented at ITS America Annual Meeting, Washington, DC, March 1995.

24 Pietrzyk, p. 12.

25 Pietrzyk, p. 23.

Table 8. Average capacity and speed of toll plaza lane types.

Lane Type	Capacity (vehicles per hour)	Speed (miles per hour)
Manual	350	2.5
Automatic	500	5.0
Mixed	700	7.0
Dedicated ETTM	1,200	15.0
Express ETTM	1,800	55.0

Source: Pietrzyk, Michael C. and Mierzejewski, Edward A., *Electronic Toll and Traffic Management Systems,* National Cooperative Highway Research Program Synthesis 194, 1993.

Note: 1 mi equals 1.61 km.

Table 9. Equipment, operating, and maintenance costs by lane type.

Lane Type	Equipment Costs per Lane	Annual Operating & Maintenance Costs per Lane
Manual	$58,500	**$141,900**
Automatic	$58,000	$43,300
Mixed Manual/Automatic	$107,500	$111,000
Mixed Manual/ETTM	$72,700	$146,100
Mixed Automatic/ETTM	$69,500	$47,500
Mixed Manual/Automatic/ETTM	$121300	$115,200
Dedicated ETTM	$15,400	$4,200
Express ETTM	$15,400	$4,200

Source: Pietrzyk, Michael C. and Mierzejewski, Edward A., *Electronic Toll and Traffic Management* Systems, National Cooperative Highway Research Program Synthesis 194, 1993.

Level of Activity

The majority of toll roads, bridges, and tunnels in the United States are concentrated in the Northeast and the Great Lakes regions (see figure 25). Membership in the International Bridge, Tunnel, and Turnpike Association (IBTTA) includes toll authorities representing 68 toll roads and 78 toll bridges and tunnels in the United States alone.26 In 1993, a total of 176.6 million commercial vehicles traveled along the IBTTA toll roads, representing 7.2 percent of the total traffic at these facilities.27 The toll road with the largest absolute volume of commercial vehicle traffic is the Tri-State Tollway (Interstates 94 and 294 near Chicago), which carried 31.5 million commercial vehicles in 1993 (see table 10). Absolute traffic volumes rank second and third, respectively, on the New Jersey Turnpike and the New York Thruway system. Among the 10 most traveled toll roads, the commercial vehicle share of total traffic is highest along the Ohio Turnpike (20 percent) and the Indiana Toll Road (18 percent). The commercial share ranges even higher among some of the smaller, less traveled toll roads; for instance, commercial vehicles account for 27 percent of the traffic along the Will Rogers Turnpike in Oklahoma.

IBTTA bridges and tunnels reported 43.4 million commercial vehicle crossings in 1993, representing 5.7 percent of the total traffic at these facilities.[28] Seven of the ten most heavily traveled toll bridges and tunnels are in the greater New York City area, including the George Washington Bridge between the Bronx and New Jersey; the Throgs Neck Bridge between the Bronx and Queens; and the Brooklyn-Battery Tunnel between Manhattan and Brooklyn (see table 11). The other heavily traveled toll bridges are along the Interstate 95 corridor, including the Fort McHenry Tunnel in Baltimore and the Delaware Memorial Bridge between New Jersey and Delaware. The Interstate 78 bridge near Easton, Pennsylvania carries the highest percentage of commercial vehicle traffic (26 percent). Other toll bridges with high proportions of commercial traffic are concentrated on the Delaware River and on international border crossings between New York and Ontario.

ETTM systems are now operational along portions or all of a few dozen toll roads, as well as several bridges and tunnels, according to surveys by the National Cooperative Highway Research Program (NCHRP) and the IBTTA. The IBTTA estimates that ETTM handles 6 percent of the average daily traffic on toll roads. The Interagency Group, representing toll roads with total average daily traffic of 2.6 million vehicles in New York, New Jersey, and Pennsylvania, began implementing an ETTM system known as EZ-PASS in early 1994. Other major ETTM projects include the 10 toll roads in the Oklahoma Turnpike system; the 4 Illinois toll roads; and private toll roads in California (see table 12). PIKEPASS, the Oklahoma ETTM system, has been operational since January 1991 and arguably is the most developed in the group. The Oklahoma turnpike has issued close to 64,000 truck tags, and handles nearly 12,000

26 The IBTTA does not include all toll facilities in the United States, but does capture nearly all facilities of significance.

27 Traffic statistics are derived from *Comparative Traffic Statistics* 1992-1993, published by the International Bridge, Tunnel, and Turnpike Association, (Washington, DC) 1993.

28 The IBTTA bridge and tunnel traffic data are incomplete. Most major bridges and tunnels in California, Florida, and Louisiana did not respond to the survey.

Table 10. Commercial vehicle traffic on major toll roads, 1993.

Toll Road	Total Commercial Vehicles (Millions)	Percent of Total Traffic	Miles Operated	Average Rate per Mile (cents, 1992)
Tri-State Tollway (Illinois)	31.5	11.0	83.0	9.0
New Jersey Turnpike	23.2	12.5	118.0	15.4
New York State Thruway	22.0	12.3	559.0	12.0
North-West Tollway (Illinois)	15.6	11.0	76.0	8.2
Pennsylvania Turnpike	13.3	12.1	470.0	varies with weight
Massachusetts Turnpike	9.2	6.8	135.0	13.1
Ohio Turnpike	7.7	20.1	241.2	varies with weight
Indiana Toll Road	6.5	17.6	156.9	9.3
Maine Turnpike	4.0	11.9	100.0	9.3
Kansas Turnpike	3.5	14.9	236.5	8.9

Source: International Bridge, Tunnel, and Turnpike Association, *Comparative Traffic Statistics, 1992-1993.*

Note: 1 rni equals 1.61 km.

Table 11. Commercial vehicle traffic on major toll bridges and tunnels, 1993.

Facility	Total Commercial Vehicles (Millions)	Percent of Total Traffic
George Washington Bridge (NY/NJ)	3.6	7.7
Fort McHenry Tunnel (Baltimore)	3.2	9.3
Throgs Neck Bridge (NY)	3.0	8.2
Brooklyn-Battery Tunnel (NY)	3.0	8.2
Verrazano-Narrows Bridge (NY)	2.9	4.7
Newburgh-Beacon Bridge (NY)	2.3	12.0
Triborough Bridge/Bronx Section (NY)	2.2	8.0
Delaware Memorial Bridge (NJ/DE)	1.8	13.3
Bronx-Whitestone Bridge (NY)	1.8	5.1
Interstate 78 Bridge (NJ/PA)	1.3	26.1

Source: International Bridge, Tunnel, and Turnpike Association, *Comparative Traffic Statistics, 1992-1993.* Most major bridges and tunnels in California, Florida, and Louisiana did not respond to the survey.

Table 12. Operational electronic toll and traffic management systems.

Facility	Average Daily Traffic (Thous.)	ETTM Percent of Average Daily Traffic
BZ-Pass Interagency Group (New York, New Jersey, Pennsylvania)	2,600.0	30
Illinois State Toll Authority (4 roads)	694.4	**25**
Private Toll Roads in California	697.1	30
Florida Turnpike	408.0	20
Dallas North Tollway	196.7	25
New Hampshire Turnpikes (3 roads)	195.7	40
Golden Gate Bridge (San Francisco, CA)	113.6	45
Oklahoma Turnpike system (10 roads)	100.0	35
Crescent City Connection (New Orleans, LA)	60.0	30
Lincoln Tunnel (New York City, NY)[1]	57.3	3
Lake Pontchartrain Causeway (New Orleans, LA)	22.5	60
Thomas Hatem Bridge (Havre de Grace, MD)	21.4	80
E-470 Public Highway (Denver, CO)	3.3	43

1Lincoln Tunnel system is operational for buses only.

Sources: International Bridge, Tunnel, and Turnpike Association, ETTM Systems Survey, March 1995; Pietrzyk, Michael C. and Mierzejewski, Edward A., *Electronic Toll and Traffic Management* Systems, National Cooperative Highway Research Program, Synthesis 194, 1993.

truck transactions per day through ETTM.[29] ETTM accounts for 35 percent of average daily traffic on its toll roads.

ETTM systems are expected to become more widespread during the late 1990's. The agencies responding to the IBTTA survey reported plans to implement ETTM systems along an additional 9 toll roads and 28 toll bridges and tunnels in the next few years. These include many of the most heavily traveled facilities in the Nation, including the New Jersey, Massachusetts, Ohio, and Indiana turnpikes; the major toll bridges and tunnels in California and Maryland; the toll bridges and tunnels across the Delaware River from New Jersey to Pennsylvania; and the toll bridges and tunnels across the Hudson River from New York to New Jersey. It is likely that ETTM will be incorporated into the design of all new toll roads.

Issues

The major issues facing the administration of toll collection and ETTM systems are not technological, but institutional. The technology for automatic toll collection is being developed and deployed. Institutional relationships should evolve to reflect this reality.

The growing use of ETTM technologies and systems is increasing interactions between toll authorities and motor *carriers.* In the past, toll authorities had relatively little contact with commercial vehicle operators other than at the toll booth or through the issuance of special permits for oversize or overweight loads. Other agencies within each State assumed responsibility for administering and enforcing most motor carrier credentials. Today, toll authorities that lease or operate ETTM systems are directly involved in setting up accounts and collecting payments from motor carriers. The positive implication of this involvement is the introduction of a new source of technological expertise. Indeed, the experience with EFT and AVI gives toll authorities technological expertise that many other State agencies lack. On the negative side, however, the enhanced role for toll authorities adds new stakeholders to the already complex institutional decision-making process.

The integration of ETTM systems with other motor carrier regulatory functions offers great potential. Toll roads with widespread deployment of ETTM systems (such as those in Oklahoma or Illinois) provide a ready platform for additional CVO services. For example, the roadside AVI readers can be used to check credentials, screen vehicles in advance of weigh stations and ports-of-entry, record mileage for the filing of fuel tax reports, and monitor traffic flow. More effective implementation of these functions can enhance the safety of highways as well as the efficiency of motor carrier administrative programs. In addition, toll authorities may find that much of the information they need to establish motor carrier accounts already exists in registration data bases. Data exchange protocols between the registration agency and the toll authority can eliminate duplicate data collection and storage. In the long term, it may be possible for carriers in some States to set up their toll accounts at the same time that they register their vehicles.

ETTM systems generally operate in isolation. Most ETTM and toll collection systems are run by individual toll authorities, with little integration once a vehicle leaves a particular facility or

29 ETTM System Survey, International Bridge, Tunnel, and Turnpike Association, Washington, DC, March 1995.

State. Carriers often must open accounts, purchase tags, and maintain balances from multiple toll authorities. For example, in New Orleans, the Crescent City Connection and Lake Pontchartrain Causeway ETTM systems are maintained by separate toll authorities. Carriers that use both facilities must open two separate accounts. As ETTM becomes more widespread, these standalone systems will produce a complex, balkanized arrangement similar to interstate vehicle registration prior to the introduction of the IRP. Toll authorities should work toward the development of AVI and EFT standards, and the establishment of regional or national clearinghouses through which motor carriers could pay tolls on multiple facilities through a single account and transponder. The EZ-PASS Interagency group in New York, New Jersey, and Pennsylvania is considering such a regional clearinghouse.

SIZE AND WEIGHT RESTRICTIONS AND PERMITTING

The Federal Government regulates the size and weight of commercial vehicles on the Interstate highway system. State governments regulate the size and weight of commercial vehicles on State routes and are responsible for enforcing the Federal size and weight statutes.

Vehicle size and weight restrictions are critical to the effective management of roadways and highway structures. Oversize vehicles may fail to clear highway structures such as bridges and other overpasses. Overweight vehicles may cause pavements and bridges to fail prematurely through overstress. A modern highway is designed to withstand a specific number of repeated loadings of a specified magnitude over its anticipated service life. A properly designed roadway will not be damaged by the traffic it is designed to support and will require only routine surface maintenance.30 Overweight vehicles also may present safety hazards and cause congestion due to their lack of acceleration, poor maneuvering and braking capabilities, and increased likelihood of mechanical or structural failure.31

Current Regulatory Procedures

The Surface Transportation Assistance Act of 1982 and the Tandem Truck Safety Act of 1984 established a national network of highways, primarily Interstates, as a designated large truck network. An "Interstate standard" truck (a truck measuring up to 2.59 m [102 in] wide and 4.11 m [13 ft 6 in] high) can travel unimpeded on the network and can petition for reasonable access over local roads to terminals and other freight facilities. The legal Federal weight limits are 9,080 kg (20,000 lb) on a single axle, 15,436 kg (34,000 lb) on tandem axles, and 36,320 kg (80,000 lb) gross vehicle weight. In addition, a Federal "bridge formula" was developed to assure that the allowable weight of heavy trucks correlates with axle spacing to prevent overstressing of highway bridges, the element of the highway infrastructure that is most sensitive to structural damage.

30 R.J. Hansen Associates, *State Laws and Regulation on Truck Size and Weight,* National Cooperative Highway Research Program 198, National Academy Press, Washington, DC, February 1979, p. 7.

31 *Use of Weigh-in-Motion Systems for Data Collection and Enforcement,* National Cooperative Highway Research Program Synthesis of Highway Practices 124, National Academy Press, Washington, DC, 1986, p. 7.

In practice, weight limits can vary substantially, due to the "grandfathering" of certain exemptions prior to the imposition of the Federal limits, as well as the variation in limits on State and local roads. The Federal Highway Administration has calculated that the States offer 41 different combinations of the 8 key weight limits-single axle, tandem axle, gross weight, and bridge formula, on both Interstate and non-Interstate highways.[32] These differences increase the complexity of administration and enforcement of weight regulations by agencies, as well as compliance by carriers.

Special Permits

Vehicles that exceed size limits, or are transporting nondivisible loads in excess of gross weight or axle weight regulations, may qualify for special hauling permits for each individual load. These permits, which are valid for a limited number of days, specify the route the vehicle must take. Some States issue permits for divisible loads as well, either on a single or multiple-load basis. Permits for some recurring loads within specified limits (generally less than 40 680 kg [90,000 lb]) may be self-issued by a carrier with the permission of the State. Some States issue books of permits for this purpose to properly credentialed carriers or issue annual permits to eligible carriers.33

A permit must be obtained for each State through which the vehicle will travel. In most cases, carriers must obtain an individual permit from each State, although some States have established reciprocity agreements to accept each other's permits. Special permitting regulations vary widely, and sometimes conflict, among the States. In many cases, local geography, weather, population, or highway and bridge construction methods impose particular size and weight limits or stipulations on vehicle operations. In other cases, the differences have developed over time in the absence of incentives to standardize these regulations.

Special permitting in most States falls under the purview of the State department of transportation. States have varying fee structures for special permits based on incremental vehicle weights. In most States, the fees for special permits are intended to cover solely the administrative cost of issuing the permit. In other States, such as those with weight-distance taxes, permit fees reflect the anticipated pavement damage caused by oversize/overweight vehicles on State roads.

States also must verify that the vehicle's Federal Heavy Vehicle Use Tax (HVUT) has been paid before a special permit can be issued. The HVUT is an annual tax on trucks with registered gross vehicle weight or gross combination weights over 24,970 kg (55,000 lb).

Most State permitting offices deal with third-party wire services that process carrier permit requests for a fee. The wire service companies deliver or fax permit applications to State permit offices, pick up and forward issued permits to locations specified by the carriers, and transmit payments to agencies.

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32 Federal Highway Administration, Office of Motor Carriers *Documentation of Existing Truck Size and Weight Regulations* Washington, DC, March 1995 p. 2.

33 *Eastern States Institutional Issues Study for Commercial Vehicle Operations, Final Report,* JHK & Associates with Parsons Brinckerhoff Quade & Douglas, Inc., ATA Foundation, Inc., and Daniel Consultants, Inc., November 1995, p. 3-34.

Special permits are issued only for approved routes. The particular route depends on the size (height and width) and weight of the truck. The larger and heavier the truck, the more its movement is restricted. Most special load routing is conducted manually using predefined routes. Many States are exploring routing software that uses Geographic Information Systems (GIS) technologies.

Enforcement

Enforcement of size and weight regulations is a State responsibility carried out at fixed weigh stations and by using portable roadside equipment for selective enforcement. In most States, the State police or highway patrol have primary responsibility for the enforcement of size and weight regulations, although in many cases the department of transportation or public service commission will operate weigh stations and ports-of-entry. States must make annual reports to the FHWA Office of Motor Carriers (OMC) certifying that Federal size and weight laws are being enforced.

States can choose among three basic strategies for weight enforcement: fixed sites, mobile equipment, or a combination of the fixed and mobile enforcement. Fixed sites include weigh stations along major highways and ports-of-entry at State borders. Most fixed weigh stations use static scales, which often include a single platform that requires multiple steps to process all axles. A basic check at an uncongested weigh station- which consists of a visual scan of license plates, fuel permit decals, and the truck, plus the weighing of each axle-may take only 3 to 5 min. However, waiting time can increase the time spent at a congested weigh station to as much as 20 min. Truck traffic at these stations often must be allowed to bypass the scales to prevent the queue from backing up onto the highway.

In the past decade, weigh-in-motion (WIM) technologies have emerged as an alternative to the static scales. WIM is a dynamic process for weighing vehicles at up to mainline speeds. WIM sensors are imbedded in the pavement and consist of an electronic looped wire, a load cell, and a capacitor pad. Either single or tandem axle weights are measured as the tires roll across the sensors. ITS operational tests are evaluating high-speed and mobile WIM applications for both weight enforcement and data collection. In combination with the same automatic vehicle identification technologies used in electronic toll collection, WIM can be used to facilitate mainline vehicle sorting. In such systems, a roadside reader and WIM sensors upstream of a weigh station identify the vehicle, check its weight, and relay this information to a computer at the weigh station. The weigh station enforcement officer can either flag the vehicle to stop for a manual inspection, or signal the vehicle to proceed without stopping. These types of systems have been tested in programs such as the Heavy-vehicle Electronic License Plate (HELP) program in the West and the Advantage CVO program in the Great Lakes and Southeast (see chapter 4 for more information).

Mobile enforcement patrols use manual axle and wheel weighers. Enforcement officials must process each axle, and then tally the sums to calculate the vehicle's tandem and gross weight. Mobile equipment may be portable or semiportable, depending on the flexibility and speed of moving the scales and other equipment. Because manual weighing is time-consuming and labor-intensive, it is used only to check trucks that enforcement officials suspect may be overweight. However, some States are beginning to use portable WIM devices to screen approaching trucks. Generally, States impose fines for passing or running weigh stations, violating the route and time specified in permits, and being overloaded.

Level of Activity

Special Permits

The oversize/overweight (OS/OW) permit process is creating an increasing administrative effort for State departments of transportation. In fiscal year 1993, permitting agencies issued nearly 1.8 million special OS/OW permits, a 54-percent increase since 1983 (see figure 26). This increase reflects underlying economic growth, as well as pressures to reduce costs by carrying greater loads on a single trip.

The distribution of OS/OW permits parallels trucking activity. Texas issued more OS/OW permits than any other State in 1993, totaling 137,000. New York finished a close second, with 133,000. California, Georgia, and Ohio each issued more than 75,000 permits (see figure 27). Sheer size alone does not guarantee a high volume of permits, however; New Jersey, for instance, issued relatively few permits.

OS/OW permits can be grouped into five categories:

- Nondivisible, single **trip permits** cover one-time movements of cargo that exceed weight limits and cannot be divided into smaller shipments. These permits accounted for nearly three-quarters of all OS/OW permits issued in 1993, and are issued in all States (see figure 28). Four States (Arkansas, Maine, New Jersey, and West Virginia) offer only nondivisible, single trip permits. Sixteen other States issue more than 90 percent of their permits in this category.
- **Nondivisible, multiple trip permits** enable carriers to make multiple movements of cargo that cannot be divided. Multiple permits save administrative effort for both agencies and carriers. The issuance of multiple permits more than tripled during the 1980's, but the use of these permits is not yet universal. Sixteen States, primarily in the Midwest and Northeast, do not issue nondivisible, multiple trip permits.
- **Divisible, single trip permits** cover one-time movements of cargo that could be divided into smaller shipments. The ability to use one truck rather than two or more saves both time and costs for motor carriers. A small group of States has embraced these types of permits-for example, more than half of the permits issued by Delaware, Georgia, Indiana, and Nebraska fall into this category. Thirty-three States do not issue divisible, single trip permits.
- **Divisible, multiple trip permits** enable multiple movements of cargo that could be divided. The issuance of such permits more than quadrupled between 1983 and 1993, reflecting the flexibility and cost-savings these permits provide to carriers. A small group of States are heavy issuers of these permits, including Idaho, Massachusetts, Montana, and Rhode Island. Twenty-one States do not issue nondivisible, multiple trip permits.
- **Divisible, overwidth permits** cover movement of divisible cargo that is wider than standard truck limits. Only nine States issue divisible, overwidth permits. Of this total, 95 percent come from 1 State: New York.

Growth in the number of OS/OW permits issued has been extremely uneven across the Nation (see figure 29). Many of the States that have witnessed the fastest growth are in the Northeast and industrial Midwest, including New York, New Hampshire, Maryland, Delaware, Indiana,

and Ohio. This trend reflects growth in heavy truck volumes in these industrialized States. The States with the lowest growth in permits issued are concentrated in the Southwest region.

Enforcement

State enforcement officials weighed nearly 163 million vehicles in fiscal year 1993, according to OMC data. This total represented an 81-percent increase since 1983 (see figure 30). The increase in enforcement weighings reflects several factors, including growth in truck volumes, the availability of Federal funding through the Motor Carrier Safety Assistance Program (MCSAP), and the application of new technologies to screen vehicles more effectively.

Of this total, 67 percent were weighed on fixed static scales (see figure 31). The share of enforcement weighings that used WIM increased from 2 percent in 1983 to 31 percent in 1993. Portable and semiportable scales each accounted for less than 1 percent of all enforcement weighings in 1993.

States vary tremendously in the intensity and mix of their weight enforcement strategies. The States with the largest number of weight inspections are concentrated in the Southeast, Great Lakes, and West regions. Georgia, Kentucky, California, and Virginia each weighed more than 10 million vehicles in 1993. The States that weighed the fewest vehicles are concentrated in the Northeast region (see figure 32).

This pattern reflects the distribution of fixed weigh stations and truck traffic across the Nation. As of January 1993,655 permanent scales were in operation at weigh stations and ports-of-entry. Nearly one-quarter of these scales are concentrated in the three Pacific Coast States: Oregon (64), Washington (50), and California (44).[34] Other States with large numbers of weigh stations are concentrated in the Northwest (particularly Wyoming, Montana, and Idaho), the Great Lakes (Illinois and Iowa), and the Southeast (Mississippi and Florida) (see figure 33). In contrast, six States (Alabama, Maine, Massachusetts, Nevada, New York, and Rhode Island) operate no fixed scales. These States rely on mobile enforcement.

Twenty-six States are using WIM for enforcement. These States are concentrated in the Eastern half of the Nation, with notable exceptions (see figure 34). Five States-including Alabama, Delaware, Florida, Kentucky, and Massachusetts-are now using either fixed or portable WIM for more than 80 percent of their enforcement weighings.

Growth in the number of enforcement weighings has spread across the Nation, reflecting both gains in truck traffic and investments in WIM, weigh station upgrades, and other technologies. The number of vehicles weighed more than quadrupled in six States between 1983 and 1993: Massachusetts, Kentucky, Indiana, Maryland, Wyoming, and South Carolina (see figure 35).

Enforcement weighings resulted in over 653,000 citations in fiscal year 1993. This level is just 11 percent higher than in 1983, suggesting that the dramatic increase in the number of weighings is not generating a proportional increase in the identification of oversize or overweight vehicles. About 0.4 percent of all weighings resulted in a citation in 1993, compared to 0.65 percent in 1983 (see figure 30). Of the citations, 43 percent involved axle weight violations, 23

34 *Motor Carrier's Road Atlas,* Rand McNally Corporation, Chicago, 1993.

percent gross weight violations, and 34 percent bridge formula violations. The number of citations per weighing is highest among Northeast States such as New Hampshire, Vermont and New York that rely heavily on selective mobile enforcement, as well as among South Central States such as Texas and Oklahoma (see figure 36).

Issues

The effectiveness of existing size and weight enforcement strategies is unclear. States weigh more than 162 million vehicles per year, but issue citations to fewer than 1 percent. This low citation rate suggests that weight inspections may be effective at deterring overweight trucks from traveling on Interstate highways past fixed inspection sites. However, it also is likely that overloaded and unsafe carriers detour around fixed inspection sites. Automating existing weigh stations benefits the majority of motor carriers that operate legally, but does little to deter these overloaded carriers. The introduction of relatively low-cost and portable WIM and AVI technology has encouraged State enforcement officials to think about unbundling enforcement operations: screening trucks well upstream of weigh stations and enforcement sites to collect data on evasion patterns, and equipping mobile patrols to screen and inspect trucks on bypass routes more productively.

Enforcement activities miss most urban trucking activity. Currently, most truck enforcement takes place along rural highways because of the space needed to build truck weigh stations and the congestion and safety risk caused by queuing trucks on urban highways. By giving enforcement officers the ability to screen and pinpoint illegally operating trucks, portable WIM, AVI, and wireless data communications technology is making possible better weight and safety enforcement of metropolitan truck movements.

Enforcement officials need more information and criteria for guidance in selecting vehicles for weighings. Except in the case of obvious gross violations, enforcement officials in the Northeast, who must rely on mobile scales, and thus are able to weigh only a small percentage of the trucks on their roadways.

Weigh station delays remain a major probIem. Congestion and a lack of automated equipment can push a weigh station stop to 20 min or more-a major burden for a driver who is carrying time-sensitive cargo and struggling with hours-of-service constraints. Each minute spent waiting in weigh stations directly impacts the carrier's costs and profitability. At the same time, weigh station congestion often impels enforcement officials to allow trucks to move ahead without stopping, preventing the States from screening all vehicles and maximizing their revenue streams. In addition, congestion at weigh stations can spill over into the shoulders and traveling lanes of roadways, provoking secondary accidents and endangering the safety of motorists.

The major problem facing special permitting is the lack of uniformity and consisten y among States. In the last few years, prompted by the FHWA and the motor carrier industry, States have begun to explore the potential for standardizing oversize/overweight permitting and enforcement. Under the aegis of the American Association of State Highway and Transportation Officials (AASHTO), uniform permitting procedures are being developed in four regions: New England, the Southeast, the Midwest, and the West (see chapter 4 for more information).

Too often, weight enforcement and permitting occur in virtual isolation from other CVO activities. This separation undercuts the effectiveness of these programs. For example, in most States, special permit officials lack the capability to compare vehicle registration and fuel tax information provided on a special permit application with information provided by other motor carrier regulatory offices, even within the same State. Few, if any, State permit offices are able to provide on-line credential verification to weight enforcement officers and weigh stations. Frequently, enforcement officials also lack the ability to check that a vehicle is carrying no outstanding citations before letting the driver leave the weigh station or inspection site.

The permitting process is nof closely linked to traffic management activities. In most cases, the imposition or removal of temporary travel restrictions for oversize or overweight vehicles (e.g., due to roadway construction) is transmitted to special permit offices by mail or telephone. Any delay in the transmission of this information may result in damage to vehicles or the roadway. Delay may also result in trucks being diverted to less attractive alternate routes.

VEHICLE SAFETY INSPECTIONS AND REVIEWS

Federal motor carrier safety regulations set standards for the safe operation of commercial vehicles by qualified drivers. Motor carriers are subject to over 200 individual safety regulations, which are published in Title 49 of the Code of Federal Regulations (49 CFR). The goal of these regulations is to improve the safety of commercial vehicle operations by reducing the incidence of mechanical defects and unqualified drivers, both of which contribute to the number and severity of accidents. The applicable requirements vary depending on the size of the vehicle and whether the driver operates in interstate or intrastate commerce. These regulations are enforced through inspections and audits, supported by a number of information systems.

The enforcement of safety regulations is assisted by Federal funding under the Motor Carrier Safety Assistance Program (MCSAP). The MCSAP was established by the Surface Transportation Assistance Act of 1982 and reauthorized in both the Commercial Motor Vehicle Safety Act of 1986 and the ISTEA of 1991. The Federal Government denies MCSAP funds to States that do not adopt and enforce regulations that are compatible with the Federal guidelines. The Motor Carrier Safety Act of 1984 preempted State safety requirements affecting interstate commerce that are not compatible with Federal regulations.

Current Regulatory Procedures

Current Federal and State motor carrier safety programs fall into two categories: inspections of vehicles at the roadside, and reviews of the carrier's operations at the office. These programs are supported by increasingly sophisticated information systems.

Safety Inspections

Commercial motor vehicles operating in interstate commerce must pass a periodic (at least annual) inspection to ensure compliance with Federal safety standards. Carriers must maintain inspection reports and maintenance records. They may meet the Federal requirement for annual inspection of commercial motor vehicles either by a self-inspection conducted by an employee qualified under the Federal motor carrier safety regulations, or through an inspection conducted by a similarly qualified individual at an outside shop. Proof of these inspections

must be carried in the vehicle cab, and a sticker may be affixed to the outside of the vehicle. Approximately 20 States have inspection programs that are recognized as the equivalent of the Federal program. Where these States' laws permit, carriers may self-inspect; otherwise, these inspections are conducted at appointed inspection stations.

Inspections performed under the MSCAP are conducted in accordance with standards developed by the Commercial Vehicle Safety Alliance (CVSA). The CVSA was formed in 1980, under the leadership of a group of western States, to improve commercial vehicle safety by increasing the efficiency of the inspection process while minimizing the costs associated with inspections. CVSA members include State and Canadian provincial agencies with responsibility for motor carrier safety enforcement, as well as representatives from private industry in the United States, Canada, and Mexico.[35] Agencies wishing to join must sign the CVSA Memorandum of Understanding by which they agree to implement uniform procedures and to grant reciprocity to other members. The CVSA is only a working agreement to use standardized procedures. It does not amend State laws and is not an interstate compact like the IFTA or the IRP.

Many State inspectors conducting CVSA inspections are paid under their jurisdiction's MSCAP grant.36 Members affix and recognize common inspection decals that indicate the quarter when the inspection occurred. These decals are valid for 3 months. Usually, vehicles with valid decals can travel without further inspection unless safety officials have a probable cause to suspect a violation or defect. Inspections may be conducted at weigh stations or other roadside sites, as well as at motor carrier terminals. Because not all vehicles will undergo a CVSA inspection, carriers may need to ensure that the Federal inspection requirements are met through self-inspection or visits to qualified shops.

The CVSA, in cooperation with the FHWA, developed five levels of inspection under the MSCAP. Only Level 1 and Level 5 inspections qualify for CVSA decals:

- **Level 1, the North American Standard,** is the most thorough inspection. Conducted at the roadside, it covers both the driver and the vehicle, and includes inspecting underneath the vehicle. The inspection covers the commercial driver's license (CDL), medical examiner's certificate, driver's hours of service, seat belt, vehicle inspection report, brake system, steering, wheels and rims, tires, coupling devices, suspension, frame, fuel and exhaust systems, windshield glazing and wipers, lighting devices, cargo securement, and applicable hazardous materials requirements. The full inspection typically takes 25 to 30 min.

- **Level 2, the Walk Around Driver/Vehicle Inspection,** covers both the driver and the vehicle but does not include inspecting underneath the vehicle.

- **Level 3, the Driver Only Inspection,** is an on-highway inspection of all driver-related aspects of the North American standard, such as the CDL, medical certificate, and hours of service.

[35] South Dakota is the only State that does not belong to the CVSA. Florida belongs to the CVSA, but does not participate in the MCSAP.

[36] Federal funding for the MCSAP program totaled $65 million in fiscal year 1993. States are required to provide a 20-percent matching contribution.

- **Level 4, the Special Inspection,** is a one-time examination of a particular item generally done in support of a study or to check a suspected trend (e.g., faulty brakes in a particular truck model).
- **Level 5, the Terminal Inspection,** is identical to the Level 1 inspection but is conducted at the carrier's terminal facility.

States use various strategies for selecting vehicles to undergo safety inspections. ln States where enforcement personnel are permanently assigned to a particular district, their experience and knowledge of the road system is often the primary guide to their inspection strategies. ln other States, the location of fixed inspection sites is reviewed against the road system's truck volumes, and integrated with portable field enforcement capabilities to develop inspection sampling strategies. In general, some element of the inspection process is based on probable cause, and some portion is random.

Two types of violations may be found during a MSCAP/CVSA safety inspection. "Out-of-service," or OOS, violations are those considered to pose an immediate danger to the public; "basic" violations represent minor infractions. Vehicles with OOS violations may not be operated until the violation has been corrected.

In practice, it is extremely difficult to enforce OOS violations. Because it usually is impractical to keep an enforcement official at the inspection site until a violation is corrected, it is almost impossible to prevent a truck from leaving while an OOS violation is in effect. A 1990 study concluded that 12 percent of OOS vehicles and drivers returned to the road without making the required corrections.[37] States with weigh stations operating on a 24-h basis are expected to have lower levels of OOS violations than States in which the weigh stations are only open for part of the day.

The time a vehicle or driver spends out of service can be substantial. A Northwestern University study estimated that the typical driver out-of-service violation (usually involving hours-of-service requirements) takes 4 h to correct. Brake adjustment and lighting problems typically take 30 to 90 min to correct, depending on their severity. More serious braking and mechanical problems can take 3 h to remedy.38

Defects found during CVSA inspections are the responsibility of the motor carrier, not the driver. Regardless of the type of violation, motor carriers must return the safety inspection form to the inspecting State within 15 days of the violation with certification that the appropriate repairs have been made. Nevertheless, no system is in place to ensure that the repairs have been made within the time allotted, or to take action against carriers that do not make the required repairs.

37 U.S. General Accounting Office, "Truck Safety: Need to Better Ensure Correction of Serious Inspection Violations," *Office of Motor Carriers Briefing Book*, Federal Highway Administration, Washington, DC, January 1992, p. 3-8.

38 Moses, Leon N. and Ian Savage, "A Cost-Benefit Analysis of the Federal Motor Carrier Safety Programs," Northwestern University, Evanston, IL, 1993, p. 15-16.

Carrier Reviews

The carrier review program is a key element of the FHWA's safety program. The Motor Carrier Safety Act of 1984 expanded the Federal safety audit program, which had been underway on a limited basis for several years. Full nationwide implementation of the carrier review program began in 1989. The current program rates carriers using a methodology adopted in 1993. The program includes two types of reviews: safety reviews and compliance reviews. Both are conducted onsite at company offices by FI-IWA Office of Motor Carriers field staff or State staff under MCSAP grants. Passenger and hazardous material carriers are given the highest priority for reviews.

The safety review, formally known as the Educational and Technical Assistance program, is an onsite assessment to determine whether a motor carrier has adequate safety management controls in place. Safety reviews involve examining company records to ensure that a carrier meets all safety regulations and has no unsafe operating practices. Each company receives a rating of satisfactory, conditional, or unsatisfactory based on the review. The entire review requires approximately 4 to 6 h of staff time, depending on the size of the carrier.39

The major thrust of the safety review is educational. Carriers with less than a satisfactory rating are told how to get into compliance. Although there is no enforcement power associated with safety reviews, carriers with less than satisfactory ratings probably will not be able to get insurance or any loads to carry. Thus, safety reviews may be effective at weeding out unsafe carriers. Companies receiving satisfactory ratings are unlikely to undergo another safety review unless their trucks begin to fail safety inspections, are involved in accidents, or are the subject of a complaint. The FHWA is phasing out the use of safety reviews in favor of the more rigorous compliance review, but plans to retain the educational portion of the program.

The compliance review, formally known as the Selective Compliance and Enforcement program, is an onsite investigation of motor carrier operations, such as driver's hours of service, vehicle maintenance and inspections, driver qualifications, financial responsibility, accidents, and other records. The compliance review is performed as a followup investigation of a carrier that was rated unsatisfactory or conditional in a previous review, to investigate a complaint, or to respond to a carrier's request to change a safety rating. The compliance review typically requires about 28 h of staff time.40

In contrast to the lack of formal sanctions associated with safety reviews, compliance reviews identify safety violations, levy fines, and require carriers to correct all problems within 45 days. If a carrier has not qualified for a conditional or satisfactory rating by the end of the 45-day period, the carrier will be prohibited from transporting hazardous materials or passengers.

Information Systems

The FHWA's OMC maintains the Motor Carrier Management Information System (MCMIS), a central repository of safety data on interstate motor carriers. The purpose of the MCMIS is to assist the OMC in maintaining a comprehensive record of the safety performance of motor

39 Federal Highway Administration, *Office of Motor Carrier Field Operations Annual Report, Fiscal Year* 1993, Washington, DC, 1993, p. 8.

40 Moses and Savage, p. 3.

carriers and hazardous materials shippers subject to Federal regulation. The FHWA uses MCMIS data to set priorities and targets for conducting safety and compliance reviews, to support State and Federal investigations, and to make safety fitness ratings available in response to public and private inquiries. The MCMIS also is the repository for data on the MCSAP inspections performed by the States. Information is kept on a central mainframe computer and is exchanged electronically with computers in all Federal field offices and State MCSAP offices.

The OMC also maintains the SAFETYNET, an information system for managing safety data on both interstate and intrastate motor carriers. The objective of the SAFETYNET is to provide a single system for both Federal and State offices to enter and exchange data electronically. States use the SAFETYNET software to maintain data locally and to transfer data to the MCMIS. In addition to inspections, the SAFETYNET includes systems for reporting accidents as well as safety and compliance reviews. National carrier profile reports and inspection facsimile reports may be downloaded from the MCMIS to the SAFETYNET's communications system.

Level of Activity

Safety Inspections

The number of safety inspections has increased dramatically since MCSAP funding became available. In 1984, just 159,000 commercial vehicles were inspected each year nationwide; in fiscal year 1993, nearly 1.95 million inspections were conducted (see figure 37).[41] Of this total, 1.76 million covered carriers of non-hazardous cargo; 155,000 carriers of hazardous materials; and 31,000 passenger carriers. Over 54 percent of the inspections were Level 1, the most thorough roadside inspection.

The frequency of inspections varies by State. California inspected close to 370,000 vehicles in fiscal year 1993, more than any other State. Tennessee, a moderately sized State, ranked second, followed by Kentucky, Illinois, and Missouri. The distribution of safety inspections shows a high concentration in the east central part of the Nation (see figure 38).

The safety inspections placed a total of 506,000 vehicles (26.0 percent) and 129,000 drivers (6.6 percent) out of service in 1993. The out-of-service rate, particularly for vehicles, has been trending downward in the past few years (see figure 39). Pennsylvania placed the greatest percentage of vehicles out of service, at 59 percent. Other States with high out-of-service rates are concentrated in the Northeast, including Maine and New York (see figure 40). The States with the lowest out-of-service rates include Maryland, Montana, and Wyoming.

About 45 percent of the vehicle violations cited during inspections in 1993 were related to the brakes (see figure 41). Other major sources of violations included lights, tires, and the suspension. The frequency with which these violations were cited varied substantially among the States. Of the 506,000 vehicles placed out of service in 1993, 22 percent were repaired at the scene and 4 percent were towed or escorted for repair.

41 Data for this section is derived primarily from the Federal Highway Administration, Office of Motor Carriers, 1993 *Annual Report on Field Operations Accomplishments and Effectiveness.*

Carrier Reviews

The FHWA is moving toward its goal of rating all interstate carriers for safety fitness. During fiscal year 1993, OMC or State personnel conducted reviews of 11,194 carriers. This total represents an enormous increase from just 114 carrier reviews in fiscal year 1984 (see figure 42).

Forty States conducted safety reviews in 1993 (see figure 43). The safety review program has taken root most deeply in the industrialized Midwest: Indiana, North Carolina, Missouri, Ohio, Arizona, Minnesota, and Wisconsin each conducted more than 500 carrier reviews in 1993. Most of the States that did not conduct safety reviews are concentrated in the West, including California, Hawaii, Nevada, New Mexico, Oregon, Washington, and Wyoming. In the East, only Delaware and the District of Columbia did not conduct safety reviews in 1993.

By the close of 1993, the safety review program had assigned ratings to 113,309 carriers, or 41 percent of the interstate carriers on record. Approximately 60 percent of the carriers have been rated Satisfactory; 32 percent Conditional; and 7 percent Unsatisfactory.

Compliance reviews are growing in frequency as the OMC attempts to shift its resources to this more thorough assessment. In fiscal year 1993, 7,961 compliance reviews were conducted by FHWA and State officials on interstate carriers. About 22 percent of the compliance reviews resulted in Conditional Ratings, and 10 percent in Unsatisfactory ratings.

About 27 percent of the Compliance Reviews in 1993 included a recommendation that enforcement actions be pursued against the carrier for the violation of safety or hazardous materials regulations. More than 87 percent of the violations cited in these cases dealt with hours of service or driver qualifications. Enforcement was pursued in 2,290 cases, compared with just 618 in fiscal year 1990.

Issues

The thoroughness and effectiveness of safety enforcement varies among States. Many States have a long history of commitment to safety enforcement and provide sufficient resources for a comprehensive enforcement program. A few States, which are under severe financial pressure, appear to focus on raising revenues- for example, if the number of violations decreases, these States may raise their fines and begin clamping down on less significant safety problems to avoid a decrease in revenues.

The *most effective safety inspection strategies appear to use a combination of fixed and mobile approaches.* Weigh stations and other fixed inspection sites can provide enforcement officers with the equipment that is needed to complete rigorous inspections. However, drivers may detour around these stations. Mobile enforcement introduces an element of surprise and may be able to catch a larger range of uncompliant vehicles, if inspection officers exercise good judgment in screening vehicles. In addition, mobile inspections tend to be briefer and result in fewer unnecessary delays.

Enforcement officials do not use a standardized process to screen vehicles for inspection. Most States leave enforcement officers in the field great discretion regarding the selection of vehicles for inspection. While roadside officials certainly need flexibility, the lack of established criteria and standards for screening vehicles may encourage officials to select a disproportionate number of

unfamiliar carriers or carriers known to have had problems in the past. Enforcement officials lack real-time access to data on the carrier's safety performance (e.g., the number of recorded violations in recent months), as well as information on the driver's record. This type of information could help them make decisions about screening vehicles and issuing violations and out-of-service orders more effectively.

Enforcement officers appear to exercise a great deal of discretion regarding the roadside citation of defects. When a fine is imposed for every single violation found during an inspection, no matter how frivolous, carriers see an attempt to generate revenue, rather than a genuine effort to improve operational safety. Carriers known to be safety conscious may not be written up for minor defects, while those thought to be frequent offenders, as well as those who are new to a State or unknown to the enforcement officer, are more likely to be cited.

The current system often requires double ent y of inspection results: once by hand at the roadside, and then electronically into MCMIS. Through its Roadside Data Technology Project, the FHWA is promoting the development of direct electronic roadside entry using laptop and hand-held computers. Because the programming required for this function is expensive, it is desirable to develop a standard national form for data entry. There also is some concern that inspection information is being entered into the MCMIS more efficiently than it is flowing to the States, and that MCMIS information is not available in real time to enforcement officials at the roadside.

States are constrained in their ability to monitor out-of-service vehicles and verify that repairs have occurred as ordered. It is difficult to prevent out-of-service vehicles from leaving inspection sites because it usually is impractical to keep an enforcement official at the site until the violation is corrected. This problem is particularly acute in States that lack 24-h weigh station operations. Moreover, because out-of-service vehicles can quickly exit a smaller State, States may need to develop regional approaches to tracking out-of-service vehicles and sharing information. The projects now underway in Idaho, Minnesota, and Wisconsin are expected to demonstrate technologies and information systems to address these problems.

DRIVER SAFETY

Safety regulations also apply to the drivers of commercial vehicles. The key elements of these regulations include requirements for a commercial driver's license and restrictions on hours of service. Driver credentials and safety regulations are enforced through carrier reviews and roadside inspections, often in conjunction with vehicle-related safety enforcement.

Current Regulatory Procedures

All drivers of intrastate and interstate commercial vehicles over 4 540 kg (10,000 lb) Gross Vehicle Weight Rating (GVWR), or vehicles that are used for hazardous materials transportation, must meet the requirements listed in 49 CFR Part 391. The requirements State that drivers must be in good physical health, be at least 21 years old, be able to operate a vehicle safely, and have a safe driving record. Part 391 also specifies that every commercial vehicle driver must pass the U.S. Department of Transportation physical examination. Drivers passing the

physical receive a Medical Examiner's Certificate that must be carried at all times when driving. The certificate must be renewed every 2 years.

Commercial Driver's License

Drivers of both interstate and intrastate vehicles over 11804 kg (26,000 lb) GVWR, or any vehicle carrying enough hazardous materials to warrant a warning placard on the outside of the truck, must be able to show that they hold a current commercial driver's license (CDL)[42]. The CDL program was created by the Commercial Vehicle Safety Act of 1986 to improve the quality of commercial drivers by ensuring that every commercial motor vehicle driver is qualified to operate the vehicle and has only one license. Each State is responsible for issuing CDL's to drivers in its jurisdiction. The CDL regulations are outlined in 49 CFR Part 383.

The Federal mandates and regulations have helped the CDL program to become one of the more consistent and uniform practices across States. Unlike most Federal safety requirements, the CDL program covers both interstate and intrastate drivers. Each State has its own licensing process, but must ensure that the driver meets common minimum requirements. The administration of the CDL program most often falls under the auspices of the department of public safety, motor vehicles, or transportation.

Typically, an applicant applies to an issuing agency in person or by mail. New drivers must pass an eye exam, a written knowledge test, and a driving skills test. Drivers seeking renewals must pass only a knowledge test. Drivers who operate special types of vehicles, such as those used for the transportation of hazardous materials, must pass an additional test and obtain an endorsement on their CDL. The term of a CDL varies by State; generally, they are valid for 4 years.

The CMVSA of 1986 mandated the establishment of the Commercial Driver's License Information System (CDLIS) to support the CDL process. The objectives of the CDLIS are to ensure that a driver has only one CDL, that all convictions are made part of the driver's history in the licensing State, and that conviction data are transferred between States. The CDLIS, which began operating in January 1989, serves as a "pointer" to the complete driver record kept by the State issuing the license. As States issue CDL's, they electronically notify the CDLIS of the driver's name, date of birth, social security number, and other identifying data items. The licensing State maintains all other data, such as information on the status of the license (valid, suspended, or revoked), endorsements (for example, to cover longer-combination vehicles or hazardous materials), restrictions, accidents, and convictions. If a driver moves to a State and applies for a CDL, an inquiry to the CDLIS allows the driver's record to be transferred to the new State. This single-license, single-record concept precludes drivers from escaping a poor driving record by obtaining a license from another State.

The CDLIS is a distributed system with a central data base and multiple users. It is connected to the 51 licensing jurisdictions by AAMVAnet, a national electronic communications network developed by IBM and managed by AAMVAnet, Inc., a not-for-profit subsidiary of the

42 Farmers, emergency vehicle operators, firefighters, drivers in isolated parts of Alaska, and military personnel are exempt from CDL requirements.

AAMVA. Both the CDLIS and the AAMVAnet are supported by user fees. Each State is assessed a fee of $1 per master pointer record per year.

Hours-of-Seruice Restrictions

Because driver fatigue has been linked to accidents, the hours that a driver may work are limited. Interstate drivers may not operate a vehicle after having driven for 10 h or been on duty for 15 h (after 8 consecutive hours off). They also may not drive after being on duty more than 60 h in 7 consecutive days or 70 h in 8 consecutive days. Intrastate drivers have slightly more liberal allowances in some States: they may drive up to 12 h, provided that the total amount of time spent driving and on duty while not driving does not exceed 16 h, and may drive up to 70 h in 7 days or 80 h in 8 days. Drivers must document their duty status for every 24-h period in a logbook that is subject to roadside inspections and audits. Under certain conditions, drivers may use automatic onboard recorders instead of handwritten logs.

Enforcement

Enforcement of driver regulations, including examination of the CDL, medical examiner's certificate, and hours-of-service logbook, generally occurs as a part of roadside safety inspections. In addition, driver credentials are inspected if the driver is pulled over for a traffic violation.

Two types of violations may be noted during a driver safety inspection: "out-of-service," or OOS, violations that pose an immediate danger to the public, and "basic" violations that do not preclude the driver from continuing on the road. Exceeding the hours-of-service limitations constitutes an OOS violation; minor recordkeeping deficiencies are a basic violation. A driver found to have an out-of-service violation during an inspection may not drive until the applicable violation has been corrected. As with vehicle out-of-service orders, however, it is difficult to keep a driver at the inspection site until the violation has been corrected.

A driver convicted of violating an out-of-service order for the first time is disqualified from operating a commercial vehicle for at least 90 days and is subject to a civil penalty of at least $1,000. A driver convicted of a second violation is disqualified from operating a commercial vehicle for between 1 and 5 years, and is subject to a civil penalty of at least $1,000. An employer who authorizes or requires a driver to operate a vehicle in violation of an out-of-service order is subject to a civil penalty of $10,000 or less.

Federal standards include mandatory disqualifications for drivers convicted of various traffic violations. These disqualifications may range from 60 days (for two serious traffic violations within a 3-year period) to a lifetime disqualification (for a second conviction involving driving under the influence of drugs or alcohol). A lifetime disqualification may be reduced by States to a minimum of 10 years if a driver completes an approved rehabilitation program.

Level of Activity

The best available indicator of activity levels in the CDL program is the number of master pointer records in the CDLIS system. A master pointer record is created each time a State adds

a new driver to the CDLIS.43 As of April 30, 1995, the CDLIS included nearly 7.4 million master pointer records. This represented an increase of more than 500,000 records over a 12-month period. The States with the largest number of master pointer records included California, Texas, New York, Florida, and Illinois (see figure 44).

States use the CDLIS most often to search a driver's record. AAMVAnet reported more than 500,000 search inquiries in April 1995 alone. Other major transactions include verifying data, creating a new driver, changing data, changing the State of residence, and reporting a conviction. Despite this heavy use, few States report major problems with the CDLIS. Use of the CDLIS system appears to vary across States. In April 1995, the most frequent users were California, Kentucky, Tennessee, Illinois, and North Carolina.

Enforcement of CDL regulations also appears to vary across States, with a heavy concentration of enforcement in the South. Relatively few drivers are disqualified for any length of time. However, data from AAMVAnet indicates that Alabama, Kentucky, and Tennessee consistently disqualify the largest number of drivers.

Data from the MSCAP inspection program indicate that the percentage of drivers placed out of service following roadside inspections has been trending downward, from a peak of 8.0 percent in 1991 to 6.6 percent in 1993. Hours-of-service violations account for nearly two out of three out-of-service orders. Nebraska recorded the largest driver out-of-service rate in 1993, at 13.9 percent; other States with high rates included Wisconsin, Wyoming, and Idaho (see figure 45).

Issues

There is concern that Federal and State safety enforcement programs do not focus consistently on high-risk drivers. Driver safety inspections should emphasize driving ability, not just credentials. Accidents strongly correlate with driving habits, yet most inspections focus on the driver's credentials, such as the CDL, medical certificate, and hours-of-service log. Additional attention could be paid to observing the driver's performance and tying commercial vehicle enforcement to traffic management activities.

The CDLZS will be effective only to the extent that it includes accurate, complete information. AAMVAnet is working to improve the completeness of the driver records within the CDLIS, particularly with regard to conviction history. To address this problem, the AAMVA has established a Uniform Identification Working Group to develop minimum uniform identification

43The number of master pointer records always will overstate the actual number of CDL's issued because it includes records for drivers who have been issued CDL permits but not yet a CDL, as well as for drivers who have been convicted for an offense while operating a commercial vehicle but never obtained a CDL. The number of MPR's also will overstate the number of active CDL holders because it includes records for drivers who are deceased, have surrendered a CDL, have an expired license, are disqualified, or accidentally have been added to the CDLIS twice.

standards for driver records. AAMVAnet is working with States and the private sector to develop methods for interstate exchange of digital driver's photographs and signatures.4

Access to the data residing in the *CDLIS can be improved.* Enforcement officials in the field desire real-time access to information on the driver's record, including data on both traffic violations (e.g., speeding or driving under the influence) and regulatory violations (e.g., logbook and hours of service). Generally, these officials must contact a police dispatcher to access this data. Some of this driver information is available through the CDLIS, but it can take up to 15 min to process-a long time when waiting at the roadside.

HAZARDOUS MATERIALS

Increasingly, hazardous materials are becoming a major focus of motor carrier regulation. The U.S. Department of Transportation has labeled more than 30,000 chemicals and products as hazardous due to their potential to harm people and property when improperly introduced into the environment. The U.S. DOT estimates that more than 3.63 billion metric tons of hazardous materials are transported annually, with over half of the 500,000 daily shipments occurring via commercial motor vehicles.

To ensure the protection of public health and safety, the transportation of hazardous materials is subject to Federal, State, and local government regulation, primarily in the form of registration and permitting requirements. Registration programs generally are intended to identify and provide information on the activities of the carriers involved in hazardous materials transportation, as well as to generate revenue for related safety activities. Permitting or licensing programs primarily are intended to establish criteria that certain carriers and shippers of hazardous materials must meet in order to operate.

Current Regulatory Procedures

The approach to hazardous materials regulation historically has been one of joint Federal-State cooperation. Federal regulation is preeminent, but recognizes the responsibility and interest of the States in protecting public health and environmental quality.

Federal Credentials

The Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA) amended the Hazardous Materials Transportation Act (HMTA) to require carriers and shippers engaged in the transportation of certain hazardous materials to register with the U.S. Secretary of Transportation.[45] Administrative responsibility for the Hazardous Materials Registration and Fee Assessment, which took effect in September 1992, resides with the Research and Special Programs Administration (RSPA) of the U.S. DOT.

44 "Overview and Status of the Commercial Driver's License Information System," AAMVAnet, Inc., Arlington, Virginia, August 29, 1994, p. 7.

45 Material in this section is drawn from the *Federal Register,* Vol. 57, No. 132, Rules and Regulations, Final Rule, July 9, 1992, pp. 30620-30633.

Under the program, Federal registration is required if a shipper offers or a carrier transports any of the following:

- Any large quantities of radioactive materials requiring highway routing control.
- More than 24.97 kg (55 lb) of explosives in a motor vehicle, rail car, or freight container.
- A single package containing more than a quart of any material that is extremely poisonous by inhalation.
- Any amount of a hazardous material in a bulk package having at least a 13 248 L (3,500 gal) capacity for liquids or gases or more than 13.1 m^3 (468 ft^3) capacity for solids.
- Shipment of a hazardous material in a number of smaller packages that together total 5,000 or more in a single shipment.

Both interstate and intrastate carriers are subject to registration. Federal and State agencies, employees of those agencies, political subdivisions of States, and hazardous materials employees (including owner-operators under a lease of at least 30 days to a registered motor carrier) are exempt from registration.

Requests for registration and renewals, along with the appropriate fees, must be submitted by June 30 for the upcoming registration year, which begins on July 1. Registrants must allow about 3 weeks for processing each request. The annual fee is $300.46 Expedited registration is available for an additional $50 to those paying by credit card.

The HMTUSA also requires motor carriers to obtain a safety permit if they carry certain hazardous materials. These materials include explosives, highway route-controlled quantities of radioactive materials, liquid natural gas, and extremely toxic-by-inhalation materials. Development of a Federal permitting program is in process. Unlike registration, which is available to all carriers willing to pay the fee, carriers will have to meet established criteria to qualify for a permit, including a satisfactory safety rating.

The RSPA, with the cooperation of other DOT agencies, has developed an enforcement policy to identify shippers and carriers failing to register and pay the fee. Persons who engage in any of the specified activities but fail to register for the registration year in which that activity occurred are subject to civil penalties for each day a covered function is performed.

In addition to these registration and permitting programs, the U.S. DOT has sole power to regulate the designation of materials, packaging, placarding, and shipping papers. The U.S. DOT also sets routing guidelines for the States.

State Credentials

Despite the common intent of enhancing public safety, States that currently regulate hazardous materials transportation have a wide variety of registration and permitting requirements that

46 Of this fee, $250 is applied toward a national emergency response training and planning grant program for State and local governments. The remaining $50 offsets the U.S. DOT's cost of processing each registration Statement.

often conflict and overlap. Within States, regulation of hazardous materials transportation is further complicated by issues of overlapping jurisdiction among the various transportation and environmental agencies involved. In a single State, hazardous materials transportation could fall under the jurisdiction of the departments of transportation, public safety, public health, or environmental protection, as well as the State police.

Forty-two States have some type of permitting or registration program for hazardous materials transportation, according to the National Conference of State Legislatures (see table 13). Because many States operate more than one regulatory program, a total of 81 State programs exist.47 Registration is required by 11 States for various placarded hazardous materials, by 9 States for hazardous waste, and by 5 States for radioactive materials. Registration programs cover the largest number of different commodities in Idaho, Michigan, Minnesota, Ohio, Oregon, and Pennsylvania.

Five States (California, Colorado, Kentucky, Nevada, and New Hampshire) require annual permits or licenses for the shipment of all placarded hazardous materials. Twelve other States (primarily along the East Coast and the Gulf Coast) require permits for the transport of selected hazardous commodities, most often liquid natural gas or explosives. Twenty-three States require a separate hazardous waste license, while 17 States require a license for the transport of radioactive materials. Nine States (Alaska, Hawaii, Indiana, New Mexico, North Dakota, South Dakota, Washington, and West Virginia) have no registration or permitting programs.

Under the current system, interstate carriers must obtain necessary registrations and permits, and remit fees, to every State through which they will be carrying hazardous materials. Like interstate registration or fuel tax administration, before the development of the base-State agreements, this process can be cumbersome and inefficient. In addition, States currently have no mechanism for sharing information about hazardous materials violations or incidents on a routine basis.

In response to these concerns, section 22 of the HMTUSA established a working group of State and local officials to recommend uniform procedures and forms for the registration, permitting, and fee collection requirements for carriers and shippers of hazardous materials. The group, known as the Alliance for Uniform Hazmat Procedures, issued its recommendations in May 1993 and proposed a 2-year, four-State pilot test. The Alliance proposes a base-State program similar to the IFTA or the IRP. The U.S. DOT expects to launch the base-State program in late 1996.

State participation in the Alliance program would be optional. Key features of the program include:[48]

- A motor carrier will apply for registration through a single base State, which will be responsible for collecting and distributing the registration fees for all member States.

47 National Governors' Association and National Conference of State Legislatures, *Report of the Alliance for Uniform Hazmat Transportation Procedures,* Washington, DC, November 17, 1993, pp. 2-7 to 2-9.

48 Alliance report, pp. l-l to 1.2.

Table 13. State hazardous materials registration and permitting programs.

	Hazardous Materials		Hazardous Waste		Radioactive Materials	
	Registration	Permitting	Registration	Permitting	Registration	Permitting
Alabama				●		
Alaska						
Arizona			●			
Arkansas			●			
California	●	●		●		
Colorado		●				
Connecticut				●		
Delaware				●		
District of **Columbia**		●				
Florida						●
Georgia		●				●
Hawaii						
Idaho	●			●		
Illinois			●			
Indiana						
Iowa						
Kansas				●		
Kentucky		●	●			
Louisiana		●		●		
Maine	●			●		
Maryland		●		●		●
Massachusetts		●		●		●
Michigan	●	●		●		●
Minnesota	●			●		
Mississippi						●
Missouri				●		
Montana				●		
Nebraska						
Nevada					●	
New Hampshire		●		●		
New Jersey		●		●		●
New Mexico						●
New York				●		●
North Carolina						
North Dakota						
Ohio	●					
Oklahoma				●		
Oregon	●					●
Pennsylvania	●	●		●		●
Rhode Island				●		●
South Carolina				●		●
South Dakota						
Tennessee			●			●
Texas		●				

Table 13. State hazardous materials registration and permitting programs (continued).

	Hazardous Materials		Hazardous Waste		Radioactive Materials	
	Registration	Permitting	Registration	Permitting	Registration	Permitting
Utah		•				
Vermont	•		•			•
Virginia		•		•	•	
Washington						•
West Virginia						
Wisconsin	•			•		
Wyoming	•				•	•
Total	**11**	**17**	**9**	**23**	**4**	**17**

Source: National Conference of State Legislatures.

- A motor carrier also will apply to its base State for a permit. The base State will conduct a review of the carrier's qualifications, and, if appropriate, will issue a single national permit that is valid in all participating jurisdictions.
- Member States may require additional disclosure of information from hazardous waste haulers, including information on the applicant's financial stability and integrity of ownership and management.
- Each participating jurisdiction will retain enforcement authority within its borders. Penalties and the procedures for assessing penalties will be those of the jurisdiction in which the violation takes place. Major violations will be reported to the base State.

The States are responsible for routing hazardous materials shipments, within Federal guidelines and considering input from local governments. These routing requirements may include restrictions on the use of certain bridges and tunnels, as well as time-of-day restrictions. Other areas of State regulation include shipment notification, incident reporting, liability and financial responsibility, emergency management and response, and recordkeeping.

Enforcement

In recent years, the Federal Government has helped the States strengthen their hazardous materials inspection and enforcement capabilities through MCSAP grants. The Surface Transportation Assistance Act of 1982, which authorized the MCSAP, specifically indicates that these grants may apply to enforcing rules pertaining to vehicles used to transport hazardous commodities. In order to participate in MCSAP, States first must pass legislation adopting Federal hazardous materials regulations pertaining to shipments on public highways (49 CFR Parts 171-171 and 177-178).[49]

Hazardous materials inspection procedures, including checking for documentation, are now part of CVSA inspection standards. As proof of registration, each motor carrier subject to the registration program must carry a copy of the current Certificate of Registration issued by the RSPA or another document bearing the registration number on board each truck and truck tractor.

The States employ a variety of enforcement methods, including desk audits, carrier reports, and spot inspections. States also use different methods to select carriers for various enforcement measures. In most States and localities, enforcement activities are prompted by spot inspections at weigh stations or as a result of vehicles being stopped for probable cause. The level of penalties assessed for hazardous materials violations ranges substantially among the States (from $25 to $l0,000), as does the level of training and resources dedicated to enforcement.%

49 U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities,* OTASET-301 Washington, DC, March 1986, pp. 16-20.

50 Nationa1 Governors' Association and National Conference of State Legislatures, Alliance Phase One *Subgroup Reports,* prepared for the Second Meeting of the Alliance for Uniform Hazardous Materials Transportation Procedures, Washington, DC, June 18-19, 1992, pp. 81-82.

Even when uniform base-State procedures are in place, enforcement levels will likely continue to vary. Nevertheless, the reciprocity system demands a very high level of confidence among the States with regard to each member State's enforcement activities. Under the proposed uniform system, enforcement activities will include periodic inspections, onsite reviews and audits, desk audits, roadside inspections and spot checks, consumer complaints, and data cross-matching. Any State will be able to suspend the authority of a carrier to conduct hazardous materials operations within its borders, but only the base State will have the authority to determine whether a carrier's registration and permit should be suspended or revoked.

To coordinate the efforts of the Federal Government and the States and to encourage uniform hazardous materials regulatory enforcement of all transportation modes, the RSPA established the Cooperative Hazardous Materials Enforcement Development (COHMED) program in 1986. The COHMED promotes the exchange of information among the States and the Federal agencies responsible for all aspects of hazardous materials transportation. Regional meetings of State and Federal officials focus on current and future enforcement activities and serve as a forum for the discussion of problems and needs. Innovative State programs can be highlighted through COHMED. The transfer of technological knowledge among the States can improve the effectiveness of enforcement systems and promote uniformity.

Level of Activity

Relatively little data is available from States on a consistent basis concerning the frequency and distribution of hazardous materials shipments, registrations, and permitting. This paucity of data reflects several factors: the fragmentation of regulatory responsibilities across different levels of government; differences in definitions and programs across States; and the lack of investment in modern information systems.

The OMC's census of motor carriers reports 30,616 active, interstate hazardous materials carriers of record in fiscal year 1993. These carriers were concentrated in the Great Lakes, Northeast, and Southeast regions. A central data source on intrastate hazardous materials carriers is not available. It would be difficult to compare the diverse registration programs in different States.

More substantial data is available on hazardous materials enforcement, reflecting its incorporation into the MCSAP and safety review programs. In fiscal year 1993, Federal and State officials conducted 558 safety reviews and 264 compliance reviews of hazardous materials carriers. The largest number of these reviews occurred in Midwest States such as Iowa, North Dakota, Missouri, and Minnesota. By the end of 1993, more than 22,000 hazardous materials carriers (72 percent of the carriers of record) had been assigned safety ratings. Of these safety ratings, 79 percent were satisfactory, 19 percent conditional, and less than 3 percent unsatisfactory.

Federal and State inspection officials conducted 155,258 roadside hazardous materials inspections under MCSAP in fiscal year 1993, a nearly l0-fold increase in a decade. Hazardous materials inspections accounted for more than 8 percent of all safety inspections. The frequency of hazardous materials inspections varies across States; in 1993, two States (Illinois and California) accounted for close to one-third of all hazardous materials inspections nationwide.

Inspectors placed 22 percent of vehicles and 4 percent of drivers out-of-service following hazardous materials inspections. These percentages were somewhat lower than that of non-

hazardous materials carriers. The major sources of vehicle out-of-service violations included improper placarding (32 percent), shipping papers (28 percent), and improper blocking or bracing (13 percent). The average hazardous material out-of-service violation also included three non-hazardous materials violations.

Issues

With the passage of the HMTUSA and the advent of the Alliance, work on expanding the scope and streamlining the administration of hazardous materials regulations is likely to be at an all-time high. However, several important issues remain.

Coordination between Federal and State programs remains unresolved. The HMTUSA envisions a dual system in which both Federal and State agencies regulate hazardous materials transportation. What is not clear is the manner in which Federal registration and permitting programs will interface with their State counterparts. Without this interface, carriers will continue to secure separate credentials from the RSPA and appropriate State agencies. As part of the Alliance pilot test, Ohio will demonstrate the potential for State administration of the Federal registration program. If successful, this test could pave the way for "one-stop shopping" for all necessary hazardous materials credentials.

Credentials programs face pressures to incorporate burgeoning interest from cities and towns. In addition to States, many cities and towns also collect licensing or similar fees. At least 27 localities require carriers to register or obtain a permit for carriage of hazardous materials.51 The interests of localities in restricting hazardous commodity movements needs to be protected without adding to the regulatory burden facing motor carriers. Under the proposed Alliance agreement, a locality would be allowed to operate a registration program only if the State in which it is located elects not to do so. However, any level of government would be allowed to operate a permit program and join the base-State agreement.

Data exchange, particularly regarding enforcement, is limited. Concerns about enforcement and data sharing have been the major stumbling block to State participation in the Alliance test. Many States hesitate to rely on another jurisdiction to get an unsafe carrier off the road, particularly because States do not always share data on carriers' safety records. Even within States, information systems can be fragmented and inaccurate; a 1993 study by the New York Legislative Commission on Critical Transportation Choices discovered that of 6,000 hazardous materials incidents in the Empire State between 1986 and 1990, only two appeared in all three of the separate record systems maintained by the U.S. DOT, the New York State Department of Motor Vehicles, and the New York State Department of Environmental Conservation. Regional or national clearinghouses and data bases should be developed in tandem with the Alliance base-State agreement. A major step in improving data exchange, as well as the efficiency of program administration, would be the increased automation of both the RSPA and State programs. The proposed Alliance agreement, for instance, relies on a paper form, although it may explore the use of ED1 in the future.

51 *Alliance* report, pp. **3.5.**

PUBLIC SECTOR ORGANIZATION

The development of a national lTS/CVO program must consider the diverse perspectives and interests of the many public sector stakeholders in motor carrier administration and enforcement. These stakeholders include State and Federal agencies with legislative responsibility for motor carrier regulation, as well as an assortment of national and regional organizations that influence policy.

State Roles and Responsibilities

Commercial vehicle operations are administered and enforced largely through State agencies. ln a typical State, responsibility for commercial vehicle regulation is distributed among four to five agencies and up to a dozen bureaus and offices. Nationally, over 300 State agencies are involved in the administration and enforcement of motor carrier regulations.

The organization of CVO activities varies widely among the States (see appendix B for a detailed listing of the administrative organization in each State). Typically, the agencies involved include the following:

- **A public service or public utility commission,** which grants intrastate operating authority, registers interstate operating authority, and confirms insurance coverage in 32 States. A department of transportation handles these functions in six States. Six States do not require intrastate operating authority. The role of the PSC or PUC is changing with intrastate trucking deregulation and the sunset of the ICC.
- **A motor vehicle bureau,** which administers the IRP program and corresponding intrastate vehicle registration plans. This motor vehicle bureau may exist as an independent agency (12 States) or as part of department of transportation (15 States) or department of public safety (7 States). Thirteen States have assigned this responsibility to the department of revenue, while other States rely upon a secretary of State, a department of licensing, or a public utility commission.
- **A department of revenue or taxation,** which administers fuel use tax programs, including the IFTA, in 34 States. A department of transportation administers fuel tax programs in 10 States, while other States assign this responsibility to departments of motor vehicles, public safety, State, or licensing.
- **A driver services bureau,** which administers the commercial driver's license and related program. This driver services bureau is housed in a variety of agencies, falling most often to a department of public safety (15 States), motor vehicles (14 States), or transportation (11 States). Other States assign this responsibility to the secretary of State, or departments of **revenue,** justice, licensing, or commerce.
- **A department of transportation, which** issues oversize/overweight permits and routings in 44 States. ln the remaining States, this responsibility falls to the department of motor vehicles, the highway patrol, or another agency. The department of transportation also operates weigh stations or ports-of-entry in 15 States, and plays a major role in safety enforcement in 11 States.

- **The State police or highway patrol,** which has primary responsibility for enforcement of safety regulations in 38 States and weight regulations in 34 States. Other agencies with significant enforcement responsibilities include public service commissions (primarily in the Southeast) and departments of public safety, motor vehicles, and revenue.
- **A department of environmental protection or quality,** which oversees hazardous materials transportation programs in 31 States. In most stages, multiple agencies have responsibility for hazardous materials programs. Other agencies that commonly are involved include the State police or highway patrol (17 States), departments of transportation (13 States), public utility commissions (11 States), and departments of public health (8 States).

Federal Roles and Responsibilities

In recent decades, the Federal Government has become a partner with the States in commercial vehicle regulation and enforcement. The Federal role primarily is the responsibility of the U.S. Department of Transportation (U.S. DOT), with supplemental involvement by other agencies.

U.S. Department of Transportation

The U.S. DOT was created in 1966 to consolidate Federal agencies with transportation responsibilities under one roof. The Department is organized into several offices and modal administrations (see figure 46). Current proposals call for a sweeping reorganization of the U.S. DOT in the next few years. The major units of the U.S. DOT relevant to the ITS/CVO program include:

- **Federal Highway Administration (FHWA):** The FHWA oversees Federal support for the Nation's highway system, focusing on the Interstate highways and other facilities of significance. The FHWA's mission statement indicates a concern with not only highway construction and maintenance, but also operations and safety. The FHWA's Office of Motor Carriers (OMC) has Federal regulatory authority over the safety performance of all commercial motor carriers engaged in interstate or foreign commerce. In this capacity, the OMC is responsible for oversight of the Motor Carrier Safety Assistance Program (MCSAP). It also manages information systems including the Motor Carrier Management Information System (MCMIS) and the Commercial Driver's License Information System (CDLIS). The OMC also sets the minimum levels of financial responsibility of motor carriers. A division of the OMC oversees the national ITS/CVO program.
- **Joint Program Office (JPO) for Intelligent Transportation Systems:** Although formally housed in the FHWA, the JPO coordinates ITS activities of all modal administrations in the U.S. DOT (see figure 47). Created in May 1994, the JPO's objectives are to provide strategic leadership for ITS research, development, testing, and deployment; guide policy coordination; and ensure resource accountability.[52] The JPO's specific responsibilities include budgeting, communications, market research, and development of architectures and standards.
- **Research and Special Programs Administration (RSPA):** The RSPA serves as a research, analytical, and technical development arm **of** the U.S. DOT. Hazardous materials

52 U.S. Department of Transportation, *Intelligent Transportation Systems Coordination,* Washington, DC, July 27, 1995, p. 3.

transportation is a particular focus of the RSPA's work. The Office of Hazardous Materials Transportation (OHMT) within the RSPA develops the national regulatory program for hazardous materials transportation by all modes. In addition, the RSPA coordinates hazardous materials enforcement by providing assistance to, and conducting joint inspections with, the U.S. DOT modal administrations, State agencies, and other Federal agencies.

- **The National Highway Traffic Safety Administration (NHTSA): The** NHSTA's mission is to improve highway safety by systematically identifying and eliminating motor vehicle and roadway safety problems. It carries out programs relating to the safety performance of motor vehicles and related equipment, drivers, occupants, and pedestrians.
- **Office of the Secretary of Transportation (OST):** The principal responsibility of the OST is to provide policy development and program oversight as well as coordination among the various U.S. DOT agencies. Within the OST, the Office of Intermodalism coordinates departmental efforts to develop an intermodal transportation system for both passengers and freight. With respect to ITS, the OST is responsible for ensuring that the various elements of the ITS program are consistent with the U.S. DOT's statutory responsibilities, including intermodal and international concerns.

Other Federal Agencies

Several other Federal agencies play a peripheral role in motor carrier policy and operations, including:

- Department of Agriculture (Agricultural Marketing Service).
- Department of Commerce (Bureau of the Census).
- Department of Defense (U.S. Transportation Command).
- Department of Energy (Transportation Management Division).
- Department of the Treasury (U.S. Customs Service).

U.S. Congress

The U.S. Congress also plays a major role in setting motor carrier policy and overseeing the work of the U.S. DOT and other Federal agencies. The following Congressional committees create commercial vehicle-related policy:[53]

- Senate Committee on Appropriations (Subcommittee on Transportation and Related Agencies).
- Senate Committee on Commerce, Science, and Transportation (Subcommittee on Surface Transportation),
- Senate Committee on Environment and Public Works (Subcommittee on Transportation).

53 Eno Transportation Foundation, *National Transportation Organizations: Their Roles in the Policy Development and Implementation* Process, Eno Transportation Foundation, Inc., Lansdowne, Virginia, 1994 with 1995 Update, pp. 44-46.

- Senate Committee on Finance (Subcommittee on Energy and Agricultural Taxation, and Subcommittee on Taxation).
- House Committee on Appropriations (Subcommittee on Transportation and Related Agencies).
- House Committee on Energy and Commerce (Subcommittee on Transportation and Hazardous Materials).
- House Committee on Public Works and Transportation (Subcommittee on Surface Transportation).
- House Committee on Ways and Means.

National Organizations

Increasingly, organizations at the national and regional (and sometimes international) levels are becoming important stakeholders in the determination of commercial vehicle policy. In the public sector, these organizations primarily are associations of public officials and agency representatives with specific areas of expertise and interest. These organizations coordinate the development of commercial vehicle policy across different levels of geography, and provide research and technical support to member agencies. Table 14 lists the organizations most relevant to development of a national ITS/CVO program.

Table 14. National and regional organizations with CVO interests.

Organization	Description
American Association of Motor Vehicle Administrators (AAMVA)	State and provincial agencies responsible for the administration and enforcement of motor vehicle and traffic laws.
American Association of State Highway and Transportation Officials (AASHTO)	Public **officials** in State agencies with responsibilities for highways and all other modes of transportation.
American Public Works Association (APWA)	State and local government officials, engineers, and administrators, and others engaged in some aspect of public works.
Commercial Vehicle Safety Alliance (CVSA)	Representatives of U.S. State, Canadian provincial, and Mexican vehicle safety enforcement agencies. Purpose is to ensure uniformity in vehicle safety regulations.
International Bridge, Tunnel, and Turnpike Association (IBTTA)	Public agencies and private companies operating toll facilities, as well as companies that provide support goods and services.
National Association of Counties (NACo)	Representatives of nearly 65 percent of all counties in the United States. Includes transportation as a specific area of interest and expertise.
National Association of Governor's Highway Safety Representatives	State officials who administer the Highway Safety Act.
National Association of Regional CounciIs (NARC)	Councils of government and planning and development commissions that promote regional solutions to urban and rural problems.
National Conference of State Legislatures (NCSL)	State legislators and legislative staff from all 50 States.
National Conference of State Transportation Specialists (NCSTS)	Employees of State public service commissions involved in transportation and private individuals.
National Governors' Association (NGA)	Governors of all 50 States and 5 territories. Includes transportation as a specific area of interest and expertise.
National League of Cities (NLC)	Government officials from about 1,400 municipalities. Includes transportation as a specific area of interest and expertise.
U.S. Conference of Mayors (USCM)	City government officials from cities with over 30,000 in population.

Source: Eno Transportation Foundation, *National Transportation Organizations,* 1995 Update,

3. Motor Carrier Industry Overview

Trucking, the dominant mode of goods movement in the United States, is critical to every city, State, and region. Intelligent transportation systems for commercial vehicle operations offer great potential to improve the safety, productivity, and competitiveness of the trucking industry.

The objective of this chapter is to provide an overview of the motor carrier industry and the role that ITS can play in the industry's operations. This analysis includes the following:

- An assessment of the economic role and impact of the motor carrier industry.
- An examination of how major operating characteristics such as fleet size, geographic range, and routing variability shape the trucking industry's need for new technologies.
- The identification of major freight generation centers and freight corridors in the continental United States.
- A description of the major regional markets, or "trucksheds," in which the motor carrier industry operates.

ECONOMIC ROLE OF THE MOTOR CARRIER INDUSTRY

The motor carrier industry is large, complex, and vitally important to the health of the U.S. economy. In many ways, trucking is more than just an industry like plastics or publishing; rather, it is a core part of the Nation's economic infrastructure, much like finance or health care.

Industry Size

About 48 million trucks were registered in the United States in 1992.[1] Approximately 92 percent of this fleet were pickup trucks, panel trucks, minivans, and similar light trucks, many of which are used for personal transportation. The balance of the fleet, some 3.3 million vehicles, was divided about equally between medium trucks (typically 2-axle, 6-tire local delivery trucks with Gross Vehicle Weight Rating [GVWR] of 4 540 kg [10,000 lb] to 11804 kg [26,000 lb]) and heavy trucks (ranging from 3-axle, lo-tire dump trucks with GVWR of 11804 kg to 5-axle, l&tire over-the-road tractor-semitrailers with GVWR of 36 320 kg [80,000 lb]).

Heavy trucks are the primary market for ITS/CVO programs because they account for a large proportion of ton-miles and truck-miles of travel. It has been estimated that Class 8, heavy

1 U.S. Department of Commerce, Bureau of the Census, Truck Inventory and Use Survey, 1992.

trucks with GVWR greater than 14 982 kg (33,000 lb) account for 61 percent of truck-miles of travel and 87 percent of ton-miles of travel for all trucks with more than 4 540 kg GVWR.[2]

These trucks are organized into fleets. As of October 1995, approximately 360,000 interstate motor carriers are operating.[3] About three quarters of these carriers are owner-operators. The number of interstate trucking companies increases by several hundred every week. The number of carriers engaged in intrastate commerce is more difficult to determine, but in total, it is widely believed that as many as one million fleets may exist in the United States.

Although it serves different markets, the bus industry is similar to the trucking industry with respect to regulation and the use of technologies. The intercity bus industry includes about 4,000 passenger carriers operating 25,000 buses and transporting more than 300 million passengers per year.[4] School buses and other local buses account for an additional 625,000 vehicles.

Industry Performance and Outlook

Efficient freight transportation is a critical to competing in a global economy. The United States moves 4.2 trillion ton-miles of freight per year, or more than 25 tons per person.[5] Freight ton-miles have risen steadily over the past four decades, as a result of increases in the average length of haul, rather than increases in the tonnage carried.

At some point, virtually all goods delivered in the United States travel by truck. The amount of freight transported by trucks has increased dramatically over the past decade. In 1982, intercity trucks hauled about 1.63 billion metric tons of freight. By 1992, that figure had grown nearly 60 percent, to approximately 2.54 billion metric tons (see figure 48).[6] In 1993, intercity and local trucks together transported 4.63 billion metric tons of freight, a figure that represents 55.7 percent of the total domestic tonnage hauled by all modes.7

In 1993, the trucking industry earned $345 billion in gross freight revenues.* This figure represents a 71 percent increase since 1982 (see figure 49). Truck revenues now account for over 78 percent of total U.S. freight revenues, representing slow but continuous gains in market share since 1950 (see figure 50). Trucking revenues represent nearly five percent of the U.S. Gross

2 Martin Labbe Associates, *Truck Vehicle Demand* 2993 *fo* 2003, Ormond Beach, Florida, April 1995, pp. 2-3.

3 Scientex Corporation, October 1995.

4U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics,* Washington, DC, 1995, p. 32.

5 U.S. Department of Transportation, Bureau of Transportation Statistics. A ton-mile is 0.907 metric tons (1 short ton) of cargo moved a distance of 1.61 km (1 mi).

6 The Eno Foundation for Transportation, *Transportation* in *America,* Landsdowne, Virginia, 1993.

7 The American Trucking Associations (ATA) Foundation, 1995.

8Transportation in America, 1993.

Domestic Product (GDP), and more than half of the Nation's total logistics bill, which has been estimated at close to $650 billion.[9]

Despite rapid growth in the small air freight and intermodal cargo markets, trucking is expected to remain the Nation's dominant form of freight movement and continue to enjoy moderate growth for the foreseeable future. DRI/McGraw-Hill forecasts that trucking industry revenues will increase a total of 21 percent from 1993 to 2003, compared to increases of 24 percent for total freight revenues and 29 percent for GDP. Although trucking's share of freight revenues is expected to decrease slightly as higher value products increasingly move by air, its share of freight tonnage is projected to increase from 55.7 percent in 1993 to 56.4 percent in 2003. This increased demand is expected to result in a 32 percent increase in ton-miles traveled by trucks, and a 14 percent increase in the number of trucks on the road.[10] The challenge for the Nation's transportation system and the ITS/CVO program is to accommodate this growth while meeting safety, economic, and environmental goals.

Industry Impact

Trucking is important not only as a competitor to other transportation modes such as rail, water, and air, but also as a partner for intermodal service. Trucks transport goods from their points of origin to railyards, airports, or ports, and deliver goods to their final destinations. Indeed, it is estimated that such intermodal or "secondary shipments" account for more than one-third of all trucking volume and about 11 percent of the industry's revenues.[11] These secondary shipments, which are primarily local in nature, will take on greater importance as the intermodal market expands.

Trucks are major users of the Nation's highway system, making them substantial contributors to the Nation's road maintenance and capacity problems. Trucks and buses account for-more than one-quarter of all vehicle-miles traveled in the United States.[12] Medium and heavy trucks account for about 7 percent of vehicle-miles. Large trucks with six or more axles average more than 96 600 km (60,000 mi) per year.

Approximately 2.8 million people were employed as drivers of heavy trucks in 1994.[13] The number of employed truck drivers increased 52 percent between 1984 and 1994. Other jobs related to trucking include the manufacturing, sales, and repair of trucks, as well as management functions within trucking companies. When all trucking-related occupations are considered, total industry employment reaches 7.8 million in 1994, up 18 percent since 1984 (see figure 51). This total represents more than 5 percent of all jobs in the United States.

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9 American Trucking Associations Foundation, 21st Century *Trucking: Profiles of the Future,* Alexandria, Virginia, 1994, p. VI-3. Logistics costs include actual transport costs as well as associated inventory or administrative costs incurred by shippers or receivers.

l0 DRI/McGraw-Hill, *U.S. Freight Transportation Forecast to 2003,* Lexington, Massachusetts, April 1995.

ll DRI/McGraw-Hill, p. 8.

12 NationaI Transporation Statistics, p.5

13 The ATA Foundation, 1995.

The average hourly wage for workers in trucking-related professions has increased approximately 16 percent over the last decade, from $10.44/h in 1982, to $12.10/h in 1992.[14] In 1992, workers in trucking-related occupations earned $227 billion in wages, accounting for over five percent of all personal income nationwide.

Because trucking dominates freight transportation, its productivity affects that of nearly every other industry. Moreover, the motor carrier industry is, by itself, a significant component of the national economy. Consequently, any increase in efficiency and cost effectiveness that motor carriers may achieve through the use of ITS/CVO technologies and services will have important ramifications for other industries, for employment, and for the entire economy.

INDUSTRY OPERATING CHARACTERISTICS

Many people view the trucking industry as monolithic, assuming that all trucks are 18-wheelers operating cross-country as part of large fleets. If this were true, it would be relatively easy to ascertain the industry's needs for ITS/CVO technologies and systems. However, in reality, the industry includes many types of operations, equipment, and fleet sizes. The organization of the motor carrier industry is highly fragmented, reflecting the complexity and diversity of the many businesses, industries, government agencies, and consumers that it serves. To identify the types of fleets that might benefit from the application of ITS/CVO technology, it is necessary to analyze the trucking industry based on the characteristics most relevant to determining ITS/CVO needs.

Traditional Segmentation

The standard approach to industry segmentation has been to divide the industry by regulatory status and type of operation. Figure 52 presents an industry segmentation based on regulatory status, carrier revenues, and commodity or contracting methods. The two major segments are Interstate Commerce Commission (ICC)-regulated carriers and non-ICC-regulated or private and exempt carriers. The ICC-regulated carriers are subdivided by revenue size class, and by type of commodity. The private carriers are subdivided by geographic range of operation (intercity or local).

Under this standard classification, five general types of carriers were differentiated:

- **For-Hire Truckload (TL) Carriers:** These carriers haul general freight and special commodities in truckload quantities, usually in a single move directly from the shipper to the receiver. Most for-hire truckload carriers are either regional or transcontinental carriers that operate on irregular schedules determined by the demands of shippers and receivers. In 1993, for-hire TL carriers accounted for an estimated 41 percent of truck tonnage and 37 percent of industry revenues.15

14 The ATA Foundation, 1995.

15 DRI/McGraw-Hill, p. 8.

- **For-Hire Less-Than-Truckload (LTL) Carriers:** These carriers haul general freight in less-than-truckload quantities, usually combining freight from many shippers to achieve cost-effective operations. Less-than-truckload carriers have two types of operations: local pick-up and delivery operations running urban trucks from a central terminal, and line-haul operations running over-the-road trucks in relays from terminal, to terminal across the country. For-hire LTL carriers account for an estimated 4 percent of trucking volume and 15 percent of industry revenues in 1993.16

- **Private Truckload Fleets:** Like their for-hire counterparts, private truckload carriers haul special commodities in truckload quantities, usually between manufacturing plants or from manufacturing plants to warehouses. These fleets make shorter moves and more scheduled moves than for-hire carriers. Private carriers are not in the business of trucking, but own trucks as a part of a related business such as manufacturing, wholesaling, or retailing. Private fleets account for 55 percent of trucking volume and 48 percent of industry revenues.17

- **Private Distribution Fleets:** These fleets haul general freight and special commodities, typically with short-haul scheduled moves between warehouses and retail outlets.

- **Service Fleets: These** fleets **include** utility company vehicles, Federal Government vehicles, State and local highway department trucks, fire apparatus, and similar vehicles. Generally, these fleets operate dedicated equipment from a local garage with irregular routes and schedules.

This approach to classifying motor carriers was used widely in the past to describe the trucking industry because these categories implicitly defined industry characteristics in a regulated environment. The ICC required for-hire fleets to report operating and financial statistics, such as fleet size and revenues, according to these regulatory categories. The deregulation of the interstate trucking industry in 1980 led to the elimination of many statistical and financial reporting requirements. Consequently, the amount of available information, particularly with respect to the for-hire segments, has declined. The impact of the ICC shutdown on data availability is unclear.

At the same time, deregulation has led to considerable restructuring of the trucking industry: for-hire LTL carriers have acquired TL operations; private fleets have applied for licenses to provide for-hire TL back-haul services; a movement toward outsourcing has increased the reliance of many manufacturers and retailers on for-hire carriers; and firms that once were exclusively truck lines have diversified into air freight and intermodal services. Therefore, segmentation of the trucking industry by regulatory status is no longer as meaningful as it once was.

In addition, segmentation by regulatory status and ownership does not incorporate all the characteristics that are most likely to affect a carrier's adoption of ITS/CVO technologies. The most relevant characteristics are not the carrier's regulatory status or ownership structure, but its operating characteristics.

16 DRI/McGraw-Hill, p. 8.

17 DRI/McGraw-Hill, p. 8.

Operating Characteristics

For the purposes of assessing the market for lTS/CVO technologies, operating characteristics are more significant than regulatory status. Five operational characteristics appear to be most relevant to the demand for ITS/CVO technologies within the industry:

- **Principal Product Carried:** The commodities that individual trucks haul most often, ranging from bulk goods such as gravel or lumber to perishable farm products to high value-added general freight.
- **Fleet Size:** The number of trucks in a fleet, ranging from the single-digits to the hundreds.
- **Geographic Range of Operation:** The primary scope of the fleet's operation, ranging from local to national.
- **Routing Variability:** The frequency with which a fleet changes routing patterns.
- **Time Sensitivity of Deliveries:** The urgency of a shipment, referring to both the time value of the cargo and the amount of time that is available to make a delivery.

These characteristics form the basis for an alternative segmentation of the motor carrier industry. Each of these characteristics affects a carrier's demand for and adoption of new technologies.

Principal Product Carried

Truck fleet operations are influenced, first and foremost, by the commodities they haul most often. Trucks carrying frozen vegetables, for example, will have different delivery schedules and production-to-distribution routes than will trucks hauling gravel or gasoline, due to the nature of the products as well as the characteristics of the industries that produce and consume the products. The principal product carried is a major determinant of a fleet's size, geographic range of operations, routing variability, and time sensitivity of deliveries.

Analysis of the 1992 Truck Inventory and Use Survey (TIUS) indicates that building materials and fresh farm products are the largest principal product categories for commercial vehicles with more than 4 540 kg (10,000 lb) GVWR. Combined, these two products account for 29 percent of all commercial fleets nationwide (see figure 53).[18] Other major principal product categories include processed foods, mixed cargo/general freight, liquid petroleum, transportation equipment, machinery, and refuse.

Each of these products has unique characteristics such as volume, weight, packaging, and temperature that affect the operations of fleets that are transporting them. In addition, each of these products is produced and consumed by a unique set of industries, which in turn have

18 The TIUS is produced every 5 years by the United States Department of Commerce, Bureau of the Census, as part of the Census of Transportation. The TIUS is based on a stratified probability sample of private and commercial trucks registered in each State, and provides data on the physical and operational characteristics of the Nation's truck population.

different geographic locations, delivery schedules, and customer service needs. Consequently, the technological needs of each truck fleet will depend on the products that it carries. Figure 54 depicts the market penetration of three ITS technologies among medium and heavy trucks in six different principal product categories. The market penetration of trip recorders and navigation systems is highest for trucks delivering processed foods; for transponders, it is highest among general freight deliveries.19

Fleet Size

Most trucks operate in small fleets. More than 40 percent of trucks weighing more than 4 540 kg (10,000 lb) GVWR operate in fleets of fewer than 5 trucks, tractors, and trailers, according to the 1992 TIUS; more than 65 percent operate in fleets of fewer than 25 vehicles (see figure 55). Among heavy trucks with over 11804 kg (26,000 lb) GVWR, 32 percent operate in fleets of fewer than 5 vehicles, and 56 percent in fleets of fewer than 25 vehicles.

Fleet size is a major determinant of the complexity of a motor carrier's business operations. An owner-operator with one vehicle faces a vastly different business challenge than a large fleet such as United Parcel Service. Fleet size may shape a carrier's demand for fleet and vehicle management technologies, as well as for systems that simplify or facilitate credentials applications and associated reporting requirements.

Large fleets have proportionately more resources available for maintaining and upgrading their fleets than do companies with only a few trucks. Even if budgets are proportional across fleets, the absolute cost-per-truck of installing certain ITS technologies may be prohibitive for smaller fleets. However, the total cost of implementing certain ITS technologies may be a significant burden even for large fleets.

The market penetration of leading ITS/CVO technologies appears to increase with fleet size. Analysis of the 1992 TIUS data shows that the market penetration of trip recorders, transponders, and navigation systems increases with the size of the fleet (see figure 56). A 1995 ATA Foundation survey of approximately 500 motor carriers found that adoption rates for four ITS/CVO technologies-electronic data interchange (EDI), routing and dispatching software, automatic vehicle location (AVL), and onboard computers (OBC)-were markedly higher among respondents with large fleets (more than 99 power units) than those with medium or small fleets (see table 15).[20] More than two-thirds of the large fleets responding to the survey reported using EDI or computer-aided dispatch. These technologies help large carriers to manage their fleets more effectively, and often are not necessary or cost-effective for a small fleet. The exception to this pattern was the use of mobile communications systems, where market penetration according to the ATA survey is roughly constant across fleet sizes. This trend suggests that carriers of all sizes desire to improve their driver-to-driver and driver-to-dispatcher communications.

19 Trip recorders are onboard devices that monitor and record information on the performance of the engine, vehicle, and ancillary equipment. See chapter 4 for more information.

20 The ATA Foundation, Inc., *ITS/CVO User Services Benefit/Cost Analysis,* prepared for the Federal Highway Administration, Pawtucket, Rhode Island, June 1995. The ATA Foundation surveyed the membership of the ATA and the National Private Truck Council. The survey was not based on a statistically random sample, and therefore may not accurately represent the larger population of motor carriers.

Table 15. Market penetration of ITS/CVO technologies by fleet size.

Percent of Respondent Fleets

Industry Segment	Use Electronic Data Interchange (EDI)	Willing to Use ED1 to Obtain Operating Credentials	Willing to Use ED1 to File Fuel Tax Reports or Payments	Use Routing & Dispatch Software	Use Mobile Commun-ications Systems	Use Automatic Vehicle Location	Use Onboard Computers
All Fleets	34	**62**	**61**	**49**	**53**	**9**	**31**
Small (fewer than 11 power units)	**9**	**28**	**26**	**20**	**64**	**4**	**12**
Medium (11 to 99 power units)	28	**65**	64	**48**	**45**	**6**	**26**
Large (more than 99 power units)	**69**	80	**78**	**74**	**63**	**19**	**55**

Source: The American Trucking Associations Foundation, Inc., *ITS/CVO User Services Benefit/Cost Analysis,* June 1995.

Geographic Range of Operation

Fleet operations vary with respect to their geographic scope. Approximately 60 percent of trucks with more than 4 540 kg (10,000 lb) GVWR operate within 80.5 km (50 mi) of their home base, according to the 1992 TIUS (see figure 57). About 24 percent of these trucks operate in a regional market of 80.5 to 322 km (50 to 200 mi) from their home base, while 16 percent operated on a long-haul, national market of more than 322 km (200 mi). Since 1987, the share of trucks operating in local markets has decreased by 4 percentage points.

The geographic range of operation affects the number of jurisdictions and highway systems through which a vehicle must pass, as well as the overall complexity of the carrier's operations. Trucks operating locally within a single metropolitan area face very different scheduling and routing conditions, and operate on different classes of roadways, than trucks operating primarily at a regional or national scale. These differences influence the choices made by fleet managers and truck owners regarding investment in ITS/CVO systems.

As is the case with fleet size, the use of ITS/CVO technologies appears to increase with the geographic scope of a carrier's operations. The 1992 TlUS data show a clear correlation between geographic scope and use of trip recorders, transponders, and navigation systems (see figure 58). The ATA Foundation survey found that the market penetration of ITS/CVO technologies was higher among national or regional carriers than among local carriers. This trend was most evident in the use of routing and dispatching software, which was reported by 16 percent of local fleets, 42 percent of regional fleets, and 70 percent of national fleets (see table 16).

The TIUS data suggest that reaching a 805-km (500-mi) operating range may trigger more widespread use of transponders and navigation systems in particular. With most other technologies, market penetration rates in the ATA survey were fairly similar among the-regional and national fleets, suggesting that the movement from a local to a regional scope is the threshold for adoption of ITS by large carriers. Again, an exception was the use of mobile communications systems, which was fairly constant across all levels of geography.

Routing Variability

Routing variability refers to the frequency with which a fleet changes its routes. Some carriers operate primarily on fixed routes, covering the same stops on a routine basis. Other carriers operate on different routes each trip.

Detailed information on the routing variability of shipments generally is not available, but may be gleaned from analysis of the logistics patterns of specific producing or consuming industries. For example, the movement of building materials is an example of a truck market segment whose routing is usually variable (see table 17). In contrast, refuse trucks operate predominantly on fixed routes.

Generally, the greater the variability of a fleet's routes, the greater the incentive to use technology to track truck movements. Carriers whose routes are subject to frequent or sudden changes benefit from up-to-the-minute information concerning road closures, congestion, and other trip-specific factors. In addition, these operators benefit from the ability to track the locations of individual vehicles. This information allows dispatchers to reroute vehicles rapidly, to choose the shortest or fastest alternate routes, and to minimize unladen mileage.

Table *16.* Market penetration of ITS/CVO technologies by geographic range of operations.

Percent of Respondent Fleets

Industry Segment	Use Electronic Data Interchange (EDI)	Willing to Use ED1 to Obtain Operating Credentials	Willing to Use ED1 to File Fuel Tax Reports or Payments	Use Routing & Dispatch Software	Use Mobile Commun-ications Systems	Use Automatic Vehicle Location	Use Onboard Computers
All Fleets	34	62	61	49	53	9	37
Local carriers	17	27	32	16	56	3	11
Regional carriers	35	64	61	42	49	6	31
National carriers	36	66	65	70	58	15	36

Source: The American Trucking Associations Foundation, Inc., *ITS/CVO User Services Benfit/Cost Analysis, June 1995.*

Table 17. Motor carrier operating characteristics by principal product category.

	Principal Product					
	Building Materials	Fresh Farm Materials	Processed Foods	General Freight	Liquid Petroleum	Refuse
Total Number of Trucks (with greater than 4 450 kg [10,000 lb] GVWR)	466,650	433,626	301,071	161,780	111,103	99,133
Percent of Trucks						
Operating Range						
National (500+ mi)	1	5	16	17	2	<1
Regional (200300 mi)	7	8	25	22	14	5
Sub-Regional (50-200 mi)	14	10	22	18	18	13
Local (< 50 mi)	78	77	37	42	66	82
Fleet Size (power units and trailers)						
l-5	44	69	17	11	31	34
6-24	30	22	21	9	36	29
25-99	16	4	24	8	16	25
100-499	7	2	22	10	12	10
500-999	2	1	5	8	2	<l
l,000-5,000	1	<l	7	16	2	1
5,000+	< l	< l	4	39	1	1
Routing Variability (estimated)						
Variable Routes	75	25	25	50	25	10
Fixed Routes	25	75	75	50	75	90
Time Sensitivity **(estimated)**						
Time Sensitive	75	75	25	50	25	10
Non-Time Sensitive	25	25	75	50	75	90

Note: Table excludes trucks with gross vehicle weight rating (GVWR) less than or equal to 4,540 kg (10,000 lb); trucks that operate primarily off road; rental trucks; and trucks used primarily for personal transportation. Totals may not sum to 100 due to rounding. One mile equals 1.61 km.

Source: 1992 Truck Inventory and User Survey; Cambridge Systematics estimates.

Time Sensitivity of Deliveries

Time sensitivity refers to the urgency of a shipment, the amount of time that is available to make a delivery (the delivery "window"), and the consequences of missing specified delivery times for truck operators and their customers. Time sensitivity is determined primarily by the product being carried and the industry being served.

As with routing variability, detailed information on the time sensitivity of shipments generally is not available, but may be gleaned from analysis of the logistics patterns of specific industries. Examples of time-sensitive shipments include perishable cargo such as farm products, as well as materials destined for immediate use at a construction site or a factory with just-in-time inventory control (see table 17). Non-time-sensitive shipments include bulk goods such as petroleum or gravel, as well as scrap and refuse.

Trucking companies that operate on highly time-sensitive schedules can benefit greatly from the ability to track individual vehicles and forecast delivery times precisely. For these companies, the added cost of implementing ITS/CVO systems may be justifiable.

A New Typology

These operating characteristics form the basis for a new typology of the motor carrier industry. This segmentation takes the form of a branching tree, as depicted in figure 59. Individual segments of the trucking industry can be described by single paths through the branches. Figure 60 describes how this typology could be applied to the trucks that deliver building materials; figure 61 includes, as an example, the full data set for the building materials segment.

In theory, each branch has unique operating and technology needs. In practice, large groups of carriers share similar operating and technology needs and will form a market for ITS/CVO products and services. However, the distinctions made in the typology will be useful in sizing and pricing ITS/CVO submarkets.

This new typology suggests two important conclusions about the private sector market for each ITS/CVO:

- *The market is fragmented into many small segments.* The full typology includes more than 100 branches for each principal product category. Even if the number of operating characteristics was reduced to three or four, the number of market segments would remain high. Many ITS/CVO products and services will meet the needs of more than one market segment. However, it is evident that the motor carrier industry will not be a mass market for ITS/CVO. The small size of the potential market for many technologies will increase the risk and reduce the rate of return. In addition, the timetable of the adoption of new technologies will vary by market segment, forcing vendors to maintain close contact with carriers.

ITS/CVO products and services must be adaptable. ITS/CVO technologies that can easily be tailored to specific motor carrier markets should be successful in the marketplace. Just as the development of public sector products such as information systems and weigh-in-motion equipment must reflect the diversity of administration and enforcement practices

across States, so too the development of fleet management systems and other private sector technologies must account for the variation in operating characteristics across motor carrier industry segments.

DISTRIBUTION OF TRUCKING ACTIVITY

Trucking is an important industry nationwide, but is organized to serve a variety of markets at the national, regional, and local levels. Some regions and States generate more trucking activity than others. These regional differences in trucking activity reflect variations in economic activity, industry mix, consumer markets, natural resources, highway infrastructure, and transportation costs.

The distribution of trucking activity across the Nation is relevant to the development of ITS/CVO programs in two ways. First, ITS/CVO services should be developed and deployed according to the distribution of trucking activity-"put the services where the trucks are." Second, ITS/CVO services should be differentiated to reflect regional variations in trucking and highway conditions. This distribution can be analyzed from two perspectives:

- Trucking activity centers: the location of major factories, warehouses, airports, ports, and other facilities that generate freight for movement by truck.
- **Truck routes:** the distribution of truck traffic along major Interstate highways.

Essentially, the trucking activity or freight-generation centers represent the major origins and destinations of freight carried by truck-the "dots" on a map. The major truck routes or freight lanes represent how these "dots" are connected.

Trucking Activity Centers

The development of a comprehensive national data base on the generation of freight tonnage by location is beyond the scope of this project. However, a "bird's eye" view of the distribution of trucking activity can be obtained by examining the approximate location of establishments likely to generate or receive significant amounts of freight.

Information on the location of establishments by industry can be obtained for every county from the County Business Patterns (CBP) data base, produced annually by the U.S. Department of Commerce, Bureau of the Census. The CBP data base contains detailed data by industry on the number of establishments, employment, and payroll in each county.21 From the full data base, counts of establishments for the following freight-intensive industry groups were selected for further analysis:

21An establishment is a single physical location at which business is conducted or where services or industrial operations are performed. It is not necessarily identical with a company or enterprise, which may consist of one establishment or more. All activities carried out at one location generally are grouped together and classified on the basis of the major reported activity, and all the data for the establishment are **included** in that classification.

- Construction (Standard Industrial Classification [SIC] Codes 15 to 17).
- Manufacturing (SIC Codes 20 to 39).
- Trucking and Warehousing (SIC Code 42).
- Public Utilities (SIC Code 48).
- Wholesale Trade (SIC Codes 50 and 51).
- Retail Trade (SIC Codes 52 to 59).

These establishment counts were combined at the county level to create a national data base of freight-intensive establishments, or trucking activity centers.[22] To control for differences in county size, county totals were scaled by the area of each county. Using geographic information system (GIS) software, a series of maps showing the concentration of trucking activity centers were generated. Figure 62 shows the results of this analysis.

Commercial Vehicle Volumes

Information on commercial vehicle traffic along major highways was developed using two data bases maintained by the Federal Highway Administration:

- The National Highway Planning Network (NHPN) data base, which contains geographically coded information on the location of Interstate highways, State routes, and local roads.
- The Highway Performance Monitoring System (I-IPMS) data base, which provides detailed information on highway conditions and performance for approximately 110,000 sample sections of the Nation's highway systems. This information includes peak and off-peak commercial vehicle volumes, expressed in Annual Average Daily Trips (AADT).

The HPMS covers the Interstate highway system, principal arterials, and major State highways. The level of detail and completeness varies by State. Because the State highway data were incomplete, the analysis for this study was limited to truck volumes on Interstate routes. However, for the purpose of obtaining a broad national view of truck trip distribution, the use of Interstates only should be sufficient. Combined, the NHPN and HPMS data provide a

[22] The use of the CBP data base underestimates the amount of freight activity associated with farming due to the paucity of regional data on the agricultural sector. However, a large portion of farm-related freight is captured in the warehousing industry.

powerful tool for analyzing commercial vehicle traffic along major highways.23 Figure 63 shows the results of this analysis.24

The national distribution of freight-intensive industries by county and the national concentration of truck traffic volumes on Interstate highways, as expected, show parallel results. Truck traffic and freight intensity are concentrated in the eastern half of the Nation (particularly in the Northeast and Great Lakes regions), and along the Pacific Coast. These are the regions of highest population density and economic activity. In the central part of the Nation, scattered concentrations of truck traffic or freight intensity appear in the Denver, Dallas, and Houston metropolitan areas.

The results of this analysis were used to define seven major trucking regions (see figure 64). Each of these regions, or "trucksheds," is characterized by a concentration of major freight-generation centers, highway linkages with high truck volumes, and similar industrial mixes. The trucksheds are not mutually exclusive; indeed, States such as Illinois or Arizona belong to more than one region.

"Trucksheds" provide another means of organizing and defining the markets for ITS/CVO services. Each truckshed will have different needs, reflecting its unique economic activity, types of trucking, and highway conditions. The national ITS/CVO program must plan for and accommodate this diversity (see table 18).

NORTHEAST REGION

Definition

The Northeast truckshed includes 13 States: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia. The District of Columbia also falls into this region.

23 The peak and off-peak commercial AADT values associated with each sample segment in each county were averaged, using a formula that weighted each average based on the duration of the peak and off-peak periods. This procedure yielded a single commercial AADT value for each sample segment in each county. Because some counties contain more than one HPMS sample segment, the commercial vehicle AADT values associated with each segment in each county were averaged to produce a single traffic volume for each route in each county. This was accomplished using a formula that weighted each average based on the different lengths of the sample segments. After the commercial AADT values were produced, they were matched to their corresponding NHPN route segments using Federal Information Processing Standards (FIPS) codes, so that the different truck volumes could be displayed on a geographic information systems (GIS) map. For a small number of road segments, truck volumes were estimated by interpolation from the nearest route segments for which data were available. This interpolation method was used for road segments that are not included in the HPMS, as well as for segments where the NHPN and HPMS data could not be matched because of missing county or route data. This method produces an approximation of the truck volumes on Interstate highways. The FHWA is developing software that will match exactly HPMS traffic counts to the NHPN. This software will be available in 1996.

24 The truck traffic map is missing data for Indiana, which has not submitted reports to the Highway Performance Monitoring System in recent years.

Table 18. Key characteristics of the regional "trucksheds."

	North East	south East	Great Lakes	Mid West	South West	North West	West	United States Total
Member States	CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT,WV	AL, FL, GA, MS, NC, SC, TN	IL, IN, KY, MI, OH, TN, WV, WI	IA, IL, KS, MN, MO, ND, NE, SD, WI	AR, AZ, CO, LA, NM,OK, TX	ID, MT, OR, WA, WY	AZ CA, NV, UT	
Employment								
Total employment, 1993 (millions)	35.8	23.2	29.2	20.4	20.0	6.0	20.1	140.6
Percent change, 1983 to 1993	13.4	31.3	21.9	19.5	20.7	32.1	27.5	21.5
Number of Trucks								
Number of trucks over 10,000 lb GVWR, 1992 (thous.)	714.7	514.3	829.7	822.7	386.7	161.3	363.6	3,311.7
Percent change, 1987 to 1992	-2.3	-0.4	1.3	6.2	-3.6	2.4	21.9	4.2
Percent with over 26,000 lb GVWR	52.1	54.9	59.8	59.0	55.0	60.6	53.3	55.7
Largest Principal Products Carried	• Building materials • Processed food • Farm products • General freight . Petroleum	• Building materials • Processed food • Farm products • General freight • Logs/forest products	• Building materials • Farm products . Processed food - General freight • Transportation equipment	• Farm products - Building materials • Processed food • General freight • Live animals	• Building materials • Farm products • Processed food • Petroleum • General freight	• Farm products • Building materials • Processed foods • Logs/forest products • Live animals	• Building materials • Processed food • General freight • Farm products • Refuse	• Building materials • Farm products • Processed food • General freight • Petroleum

Table 18. Key characteristics of the regional "trucksheds" (continued).

	North East	South East	Great Lakes	Mid West	south West	North West	West	United States Total
Geographic Range of Operations (percent of vehicles)								
Local (<50 miles from base)	64.9	54.7	58.9	63.2	55.7	60.9	55.0	60.1
Regional (50 to 200 miles from base)	26.1	26.8	20.3	17.4	26.9	24.8	31.7	24.1
National (>200 miles from base)	9.1	18.5	20.8	19.4	17.4	14.3	13.3	15.8
Fleet Size (percent of vehicles)								
1 to 5 vehicles	39.4	41.2	38.3	45.1	36.7	40.8	33.9	40.6
6 to 24 vehicles	27.4	21.6	22.7	22.3	25.8	30.6	23.8	24.5
25 to 99 vehicles	14.5	13.4	13.6	11.3	16.1	13.6	18.2	14.0
More than 100 vehicles	18.6	23.9	25.4	21.3	21.4	15.1	24.0	21.8
Market Penetration (percent of vehicles)								
Electronic Vehicle Management Systems	2.5	4.8	6.3	5.9	4.2	3.6	4.4	4.4
Transponders	0.6	1.2	2.3	2.2	0.8	1.0	0.8	1.2
Trip Recorders	3.8	5.9	6.1	5.4	3.8	5.7	7.8	5.1
Navigation Systems	0.4	0.8	1.7	1.5	0.6	0.3	0.3	0.8
Credentials Administration								
ICC-regulated carriers, March 1995	16,739	12,624	15,626	15,660	8,509	4,990	6,791	69,828
IRP accounts, June 1995	39,752	47,647	56,672	37,749	24,288	12,481	10,411	202,010
Projected IFTA accounts	61,868	30,538	38,863	33,154	16,178	8,246	10,941	180,326
OS/OW permits issued, 1993 (thous.)	470.1	274.1	324.2	242.7	294.0	184.1	143.3	1791.4
Percent change in OS/OW permits, 1983-93	224.7	121.2	85.7	10.0	-23.2	57.9	30.4	53.9

Table 18. Key characteristics of the regional "trucksheds." (continued).

	North East	south East	Great Lakes	Mid West	south West	North West	West	United States Total
Weight and Safety Enforcement								
Fixed weigh stations	50	88	100	146	80	186	65	655
Enforcement weighings, 1993 (millions)	20.4	44.2	45.4	19.3	26.3	10.8	18.2	162.6
Percent of weighings using WIM, 1993	41.8	35.9	41.7	6.5	8.6	24.9	7.6	31.2
Percent change in weighings, 1983 to 1993	111.7	56.5	87.0	41.6	57.1	137.5	150.3	80.8
Percent of weighings with citation issued, 1993	0.58	0.58	0.19	0.35	0.29	0.38	**0.30**	0.40
MSCAP safety inspections, 1993 (thous.)	280.0	264.6	521.5	328.7	254.3	136.0	419.5	1,752.2
Percent of inspections with Level One standard, 1993	49.9	57.2	51.9	33.3	40.2	44.4	82.1	55
Percent of vehicles placed out of service, 1993	28.7	27.1	26.3	22.4	22.7	23.9	28.5	26
Percent of drivers placed out of service, 1993	7.0	7.8	7.9	9.1	9.7	7.2	1.2	7
Safety reviews, 1993	994	1,628	2,696	3,270	1,604	256	604	9,679
Compliance reviews, 1993	210	32	104	534	87	76	514	1,515

Note: One pound is equal to 0.454 kg; 1 mi is equal to 1.61 km.

Sources: 1992 and 1987 Truck Inventory and Use Survey, produced by U.S. Department of Commerce, Bureau of the Census; U.S. Department of Commerce, Bureau of Economic Analysis; Interstate Commerce Commission; IRP, Inc.; IFTA, Inc.; Federal Highway Administration, Office of Motor Carriers; interviews with State agencies; Cambridge Systematics estimates.

Employment in the region totaled 35.8 million in 1993, representing more than one quarter of the national total. The region experienced a severe recession in the late 1980's and early 1990's. Employment increased just 13 percent during the 1983 to 1993 period, the slowest pace among the seven regions.

Motor Carrier Industry Characteristics

In 1992, 715,000 trucks were operating in the region, according to the TIUS. This represents a 2-percent decrease from 1987, the second weakest performance among the seven regions. About 52 percent of these trucks weighed more than 11804 kg (26,000 lb) GVWR, the smallest share of large trucks in the Nation. The distribution of trucks by fleet size is comparable to the national average, except for the relatively small number of large fleets in the region.

Building materials are the largest principal product category for trucks based in the Northeast, accounting for nearly 19 percent of all vehicles. In part, the high proportion of trucks delivering building materials reflects the comparatively small roles that manufacturing and agriculture play in the regional economy. Other leading products delivered by truck in the region include processed foods, farm products, general freight, and petroleum.

Nearly 65 percent of the trucks in the Northeast operate fewer than 80.5 km (50 mi) from their base, making it the most local-oriented trucking industry in the Nation. The high proportion of local traffic reflects the concentration of population along a narrow corridor in the region. Just 9 percent of the trucks in the region operate more than 322 km (200 mi) from their base, the smallest share in the Nation.

Trucking Activity Centers

The Boston-to-Washington corridor dominates freight activity in the Northeast (see figure 65). This corridor includes part of 11 States, and major metropolitan areas such as Boston, New York City, Newark, Philadelphia, Baltimore, and Washington, DC. Most of the other major freight centers in the region are located in upstate New York (including Albany, Syracuse, Rochester, and Buffalo) and western Pennsylvania (including Pittsburgh and Erie). Other parts of the region, such as the northernmost area of New England and most of Virginia and West Virginia, generate comparatively little freight.

Truck Routes

Interstate 95 dominates goods movement in the Northeast, carrying high volumes of trucks from Boston into southern Virginia (see figure 66). The major alternative for north-south travel is Interstate 81, which carries heavy traffic from Binghamton, New York to southwestern Virginia. Among east-west routes, truck traffic is heavy along Interstate 84 in Connecticut and southeastern New York; Interstate 80 in New Jersey and Pennsylvania; Interstate 78 from New York City to Harrisburg, Pennsylvania; Interstate 76 from Philadelphia to Pittsburgh; and portions of Interstate 90 in upstate New York.

Many of the major freight centers and corridors in the Northeast suffer from heavy congestion. The New York metropolitan area ranks second only to Los Angeles for congestion, with more

than 1.5 million vehicle-hours of delay in 1990. Washington, Boston, and Philadelphia also rank among the 10 most congested urban areas.

Regulatory Environment

The administration and enforcement of CVO regulations in the Northeast is distinctive for several reasons. The 14 jurisdictions in the region rely heavily on mobile enforcement, operating just 50 fixed weigh stations. Weigh-in-motion (WIM), which is used widely to screen vehicles, accounts for nearly 42 percent of weighings, more than in any other region. The use of selective enforcement results in citations being issued for 0.58 percent of all weighings, the highest share in the Nation.

The sheer number of jurisdictions in the region creates an organizational challenge. CVO administration is further complicated by the variation in registration and fuel tax programs. The Northeast States have been slow to join the IFTA and the IRE, in large part due to concerns about the loss of decal fees charged to out-of-State carriers. Delaware and New Jersey are expected to implement the IFTA in July 1996. Maine, New Hampshire, and Vermont are expected to join the IFTA in January 1997.

As the Northeastern States sort out these issues, they also must deal with the rapid growth in special permitting. The number of oversize and overweight permits issued to trucks in the region more than tripled between 1983 and 1993, representing a substantial administrative effort for the States. The region's aging infrastructure and rising congestion ensures that special permitting will remain an important issue in CVO policy.

Finally, CVO administration and operation in the Northeast is unique due to the region's preponderance of toll roads. The Northeast region includes dozens of toll roads, bridges, and tunnels. The toll authorities in the region reported combined revenue traffic of more than 1.3 billion vehicles to the IBTTA in 1993-more than every other region combined. Commercial vehicles represent about 7 percent of the toll road revenue traffic in the region.

ITS/CVO Markets

An ITS/CVO program for the Northeast region should consider the following markets:

- Enforcement: The dominance of mobile enforcement and the lack of fixed weigh stations and inspection sites creates a market for advanced, portable WIM systems, as well as for information systems to track out-of-service violations. The preponderance of toll authorities in the region creates a market for electronic toll collection systems, as well as a platform to leverage automatic **vehicle** identification (AVI) transponders for other applications.

- **Administration:** The large number of jurisdictions in the region, and their varying status with respect to membership in the IRP and the IFTA suggests a need **to** automate and streamline registration and fuel tax administration, as well as to establish electronic one-

25 Texas Transportation Institute, *Estimates of Urban Roadway Congestion,* Research Report 1131-5, Texas A&M University, College Station, Texas, March 1993.

stop permit shopping. The rapid growth in OS/OW permits creates a market for a regional, electronic permitting system.

- **Fleet and Vehicle Management**: The region's trucking industry faces a mature regional economy and high business costs. In this environment, fleet management applications such as routing and dispatching software and mobile communications can be powerful tools for increasing carrier productivity. However, the current market penetration of technologies such as electronic vehicle management systems, transponders, trip recorders, and navigation systems in the region is among the lowest in the Nation.

- **Traffic Management**: Heavy congestion along Interstate 95 and other routes in the region's major metropolitan areas creates a market for advanced traffic management and traveler information systems specifically oriented to commercial vehicles. This need is particularly acute in view of the limited number of alternate truck routes in the region.

SOUTHEAST REGION

Definition

The Southeast region includes seven States: North Carolina, South Carolina, Tennessee, Georgia, Alabama, Mississippi, and Florida. Employment in the region totaled 23.2 million in 1993, representing 17 percent of the national total. The region has been one of the fastest growing parts of the Nation, buoyed by a low-cost structure, ample labor force, and favorable industry mix. Total employment increased 31 percent from 1983 to 1993.

Motor Carrier Industry Characteristics

The number of trucks operating in the region was fairly flat from 1987 to 1992, totaling just over 514,000. Compared to the national average, the Southeast includes a disproportionate number of both small fleets (one to five vehicles) and large fleets (more than 100 vehicles).

The largest principal product category for trucks operating in the Southeast is building materials (with 15 percent), followed by processed foods, farm products, general freight, and machinery. The trucking industry in the Southeast is increasingly regional and national in scope; just 55 percent of trucks operate within 80.5 km (50 mi) of their home base, the smallest share in the Nation.

Trucking Activity Centers

Freight centers are scattered throughout the Southeast, following the pattern of the region's extensive Interstate highway network (see figure 67). Atlanta is the hub for truck traffic in the region, although it does not dominate the Southeast the way New York City does the Northeast. Other major freight centers include distribution centers such as Memphis, Tennessee; industrial cities such as Charlotte, North Carolina and Greenville, South Carolina; and deep-water ports such as Charleston, South Carolina, Jacksonville, Florida, and Mobile, Alabama. Freight-intensive industries also are concentrated in central and southern Florida, reflecting the strong consumer market in this region known for tourists and retirees.

Congestion is significant in Atlanta and Miami, but is moderate in most other parts of the region.

Truck Routes

North-south connections are generally superior to east-west routes in the region (see figure 68). Major north-south routes include Interstate 95, particularly in North Carolina and coastal Georgia and Florida; Interstate 85 from Raleigh, North Carolina to Atlanta; Interstate 75 from Knoxville, Tennessee to Tampa, Florida; and Interstate 65 from Nashville, Tennessee to Birmingham, Alabama. Major east-west routes include Interstate 40 from Knoxville to Memphis, and Interstate 20 from Atlanta to Birmingham.

Regulatory Environment

The region operates 88 fixed weigh stations. The Southeast States weighed more than 44 million vehicles in 1993, second only to the Great Lakes region. Georgia led the Nation with more than 15 million weighings. WIM accounts for close to 36 percent of the weighings, but is not used in North Carolina or Tennessee. The number of weighings using fixed scales increased less than 1 percent during the 1983 to 1993 period, suggesting congestion or staffing shortages at some facilities. The number of size and weight citations in the region more than doubled during the last decade. Led by Georgia, the Southeast issued more than 40 percent of the Nation's size and weight violations in 1993.

The frequency of safety inspections and violations also varies among the States in the region. The involvement of the public service commission in several Southeast States further complicates safety enforcement issues. Only one State (North Carolina) conducted carrier compliance reviews in 1993. Florida does not participate in the Motor Carrier Safety Assistance Program (MCSAP).

Because of the large number of small fleets and the growth of the regional economy, the number of administrative transactions in the region is large and growing. The number of oversize/overweight permits issued, for example, more than doubled during the last decade.

ITS/CVO Markets

An lTS/CVO program for the Southeast region must consider the following markets:

- **Enforcement: The** heavy use of, and rising congestion at, fixed weigh stations supports the need to invest in WIM, weigh station upgrades, and preclearance technologies. The large number of small fleets and uneven safety programs suggests a market for compliance reviews and safety training programs oriented toward smaller carriers.

- **Administration: The** fast-growing economy and rising freight demand is attracting new entrants to the industry, who may need assistance obtaining registration, operating authority and other credentials. The rapid growth in special permitting creates demand for a regional, electronic permitting system.

- **Fleet and Vehicle Management:** The smaller carriers in the region offer a potential market for communications systems. Medium-sized carriers can use routing and dispatching software and onboard computers to assist with expansion plans. The market penetration of electronic vehicle management systems, trip recorders, and transponders matches or exceeds the national average.

- **Traffic Management:** The Atlanta and Miami areas may support investment in commercial vehicle traveler information systems.

GREAT LAKES REGION

Definition

The Great Lakes region includes eight States: Ohio, Indiana, Michigan, Illinois, Wisconsin, West Virginia, Kentucky, and Tennessee. Although the latter three States are not part of most traditional definitions of the region, they are included because of their strong industrial and transportation ties to the other States, which are especially evident in their growing importance to the automotive industry. (Illinois and Wisconsin also are included in the Midwest region due to their ties to that region's agricultural economy.)

Employment in the region totaled 29.2 million in 1993, representing 21 percent of the national total. The region experienced a deep recession in the early 1980's, but its economy has improved due to a resurgence in export activity and productivity improvements in the manufacturing sector. Total employment increased 22 percent between 1983 and 1993.

Motor Carrier Industry Characteristics

Nearly 830,000 trucks operated in the region in 1992, the largest total among the seven "trucksheds." Nearly.60 percent of these trucks weighed more than 11804 kg (26,000 lb) GVWR, the largest share in the Nation. Trucks in the Great Lakes region carry a variety of agricultural and manufacturing products, reflecting the diversity of the region's economy. The largest principal product category is building materials, followed by fresh farm products, processed food, general freight, and transportation equipment.

The region's trucking industry is mature and consolidating. Nearly 21 percent of the trucks based in the region serve a national market, the highest share among the major trucksheds. More than 25 percent of the trucks in the region operate in fleets of more than 99 power units, again the highest percentage in the Nation.

Trucking Activity Centers

The southern and eastern shores of Lake Erie and Lake Michigan are the major freight-generation centers in these States (see figure 69). Metropolitan areas along these lakes include Cleveland; Detroit; and the arc of Gary (Indiana), Chicago, and Milwaukee. In the southern part of the region, Indianapolis, Columbus, and Cincinnati are important distribution centers. Many outlying areas, particularly in upper Wisconsin and Michigan, generate relatively little

freight beyond local agriculture and forest product movements. Traffic congestion is fairly heavy in Chicago and Detroit, but mild in the region's other major cities.

Truck Routes

Truck traffic is heavy on many of the major Interstates in the Great Lakes region (see figure 70). North-south Interstates with heavy truck volumes include Interstate 75 from Detroit to Chattanooga, Tennessee; Interstate 71 from Cleveland to Louisville; Interstate 65 from Gary to Nashville; and Interstate 55 from Chicago to St. Louis. East-west Interstates with large truck volumes include Interstate 94 from Detroit to Minneapolis; Interstates 90 and 80 from Cleveland to Chicago; Interstate 70 from Pittsburgh to Indianapolis; and Interstate 40 from Knoxville to Memphis.

Regulatory Environment

The large number of trucks based in the region create a substantial administrative burden for the States. The Great Lakes States maintain nearly 57,000 IRP accounts, or 28 percent of the national total. The region ranks second among the trucksheds number of IFTA accounts and number of oversize/overweight permits.

In 1993, the Great Lakes States combined weighed more than 45 million vehicles and conducted 521,000 safety inspections under the MCSAP, more than any other region in both cases. The States operate 100 fixed weigh stations. The eastern part of the region actively participates in the Advantage CVO program (formerly known as Advantage I-75). WIM is used in nearly 42 percent of all weighings, but this average masks sharp variations: Kentucky weighed more than 12 million vehicles using WIM in 1993, while Illinois and Tennessee used only static scales.

ITS/CVO Markets

An ITS/CVO program for the Great Lakes region should consider the following markets:

- **Enforcement:** Due to the sheer number of weight and safety inspections conducted in the region each year, efforts to increase the use of WIM and automate roadside safety inspections could generate substantial benefits for both agencies and carriers. Illinois, Indiana, Ohio, and Kentucky all operate extensive turnpike systems that are in varying stages of deployment of electronic toll collection systems.

- **Administration:** The number of fleets and vehicles based in the Great Lakes region creates a large and growing number of administrative transactions. The State agencies in the region would benefit from continued efforts to automate the credentials administration process, particularly with respect to interstate transactions and data exchange. Because of their large fleet size, many carriers operating in the region would benefit from electronic one-stop shopping programs, and expansion of the existing regional oversize/overweight permitting system.

- **Fleet and Vehicle Management:** The mature regional economy and high proportion of large and national fleets make the Great Lakes a strong market for fleet management

applications such as onboard computers, routing and dispatching software, and communications systems. The market penetration for vehicle transponders and navigation systems already is more than twice the national average.

- **Traffic Management**: The Chicago and Detroit areas are potential markets for traffic management and traveler information systems geared to motor carriers. Elsewhere in the region, carriers may benefit from **some** rural applications of advanced traveler information systems (ATIS). Hazardous materials incident response is a potential application in view of the large number of hazardous materials shipments moving through the area.

MIDWEST REGION

Definition

The Midwest region includes nine States: Illinois, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. (Illinois and Wisconsin also are included in the Great Lakes region due to their ties to that economy.)

Employment in the Midwest region totaled 20.4 million in 1993, representing 14 percent of the national total. The region experienced a deep recession in the early and mid-1980's because of instability in its large agricultural sector. Its economy has improved over the last decade due to a low cost structure and gains in labor-intensive service industries. Total employment increased 20 percent from 1983 to 1993.

Motor Carrier Industry Characteristics

More than 822,000 trucks operated in the region in 1992, ranking second only to the Great Lakes. Their average fleet size tends **to** be small; more than 45 percent of these trucks operate in fleets of fewer than six vehicles. Reflecting the region's role as the Nation's breadbasket, more than 25 percent of the trucks based in the region carry fresh farm products as their principal commodity. Other major products shipped in the region include building materials, processed foods, general freight, and live animals. Compared to the national average, the trucking industry in the Midwest region has a larger local segment and a larger national segment; the regional segment is smaller than average.

Trucking Activity Centers

Freight activity is dispersed among the sparsely populated Midwest States (see figure 71).[26] The Chicago area, which distributes many of the region's manufactured and agricultural products, is the hub for truck traffic in the Midwest. Secondary freight centers include Milwaukee, St. Louis, Kansas City, Minneapolis/St. Paul, Omaha (Nebraska), and Des Moines (Iowa). Duluth, Minnesota is the major port at the western end of Lake Superior. Many parts of the

26 This analysis will understate trucking activity associated with agriculture due to the limited data provided to CBP on farming.

region (such as North and South Dakota) generate relatively little freight other than farm products and consumer goods imports. Congestion tends to be heavy in Chicago, moderate in Minneapolis/St. Paul and St. Louis, and light elsewhere in the region.

Truck Routes

Traffic volumes are heavy on many of the expressways in the Chicago metropolitan area, as well as on the Interstates that radiate out from the city (see figure 72). These "spokes" include Interstate 90 to Madison, Wisconsin; Interstate 94 through Milwaukee to Minneapolis; and Interstate 55 to St. Louis. The other major truck corridor in the region is Interstate 70 from St. Louis to Kansas City.

Regulatory Environment

Due to the large number of trucks and carriers based in the region, the Midwest truckshed conducts a large number of administrative transactions, particularly in the areas of operating authority and vehicle registration. The Midwest States operate a total of 146 permanent weigh stations, yet weighed only 19 million vehicles in 1993, less than half as many as the Great Lakes or the Southeast. Within the region, only Minnesota and Wisconsin report using WIM for enforcement weighings. Fixed static scales accounted for 92 percent of weighings, the highest share in the Nation. The States conducted nearly 329,000 MCSAP inspections, but only one-third of these inspections qualified as Level One, the North American standard.27 However, the States conducted more than 3,900 carrier safety and compliance reviews in 1993, by far the highest total among the seven trucksheds.

ITS/CVO Markets

An ITS/CVO program for the Midwest region should consider the following markets:

- **Enforcement:** The Midwest region should explore more widespread use of WIM technologies, as well as ways to automate the safety inspection process and encourage more comprehensive roadside inspections.
- **Administration:** The smaller fleets in the region would benefit from efforts to disseminate information and guide carriers through the credential processes, but may not represent a strong market for EDI.
- **Fleet and Vehicle Management:** Nearly one-third of the trucks in the region carry fresh farm products or livestock. Although their time-sensitive delivery schedules suggest that these trucks are strong candidates for fleet management systems, their economic status and physical condition are likely to forestall early adoption of these technologies. The large number of small fleets in the region offers a less attractive market for fleet management technologies, except in particular segments. Nevertheless, market penetration of the four technologies included in the TIUS is above average.

27 South Dakota is not a member of the Commercial Vehicle Safety Alliance (CVSA), and does not participate in the MCSAP program.

- **Traffic Management: The** Chicago area, **due** to **both** its congestion and its role as the transportation hub of the Midwest, should examine motor carrier applications of advanced traffic management systems. In much of the region, rural traveler information systems offer strong market potential.

SOUTHWEST REGION

Definition

The Southwest region includes seven States: Arkansas, Louisiana, Oklahoma, Texas, Colorado, New Mexico, and Arizona. (Arizona also is included in the West region due to its ties to that economy.) Employment in the region totaled 19.9 million in 1993, representing 14 percent of the national total. The region experienced a deep recession in the mid-1980's as a result of the collapse in oil prices. In the 1990's, however, this region has been among the fastest growing in the Nation, reflecting favorable costs and expanding trade with Mexico. Total employment increased 21 percent from 1983 to 1993.

Motor Carrier Industry Characteristics

Approximately 387,000 trucks operated in the region in 1992, a 3.6-percent decrease from 1987. The principal products carried by trucks in the region follow the national pattern: building materials, fresh farm products, processed foods, petroleum, general freight, and processed foods. However, the Southwest region is noteworthy for the relatively high proportion of trucks carrying machinery, petroleum, and industrial water. Trade with Mexico and industrial activity along the border account for a large share of the shipments of manufactured goods in the region. Compared to the Nation, fleets in the Southwest region tend to be medium-sized, and to serve a regional or national market.

Trucking Activity Centers

Freight centers are scattered throughout the Southwest region (see figure 73). The centers coincide with the major population centers in the region, including Dallas/Fort Worth, Houston, San Antonio, Denver, and Phoenix. These urban areas host large manufacturing industries and serve as distribution centers for outlying agricultural and mining communities. Other major freight centers in the region are border crossings with Mexico, including Nogales, Arizona; and El Paso, Laredo, and Brownsville, Texas. Traffic congestion is moderately high in Dallas/Fort Worth, Houston, and Phoenix.

Truck Routes

Interstate 10 is the major east-west truck route in the Southwest region (see figure 74). Traffic volumes on this Interstate are heavy near New Orleans, Houston, and San Antonio, and through much of southern Arizona (including Phoenix and Tucson). The Denver and Dallas/Fort Worth metropolitan areas have substantial truck traffic in their boundaries, but traffic falls off quickly in outlying areas. Traffic also is heavy along Interstates 40 and 30 in Arkansas.

Regulatory Environment

The States in the region operate 80 fixed weigh stations, which account for more than 90 percent of the enforcement weighings in the region. Enforcement strategies vary widely among the States, with the number of weighings in 1993 ranging from more than 9 million in Louisiana to less than 10,000 in Oklahoma. The number of weighings in both Texas and Oklahoma has decreased over the past decade. The number of safety inspections and carrier reviews in the region also varies sharply across States. For example, only Texas and Oklahoma conducted carrier compliance reviews in 1993.

ITS/CVO Markets

An ITS/CVO program for the Southwest region should consider the following markets:

- **Enforcement:** The major border crossings should apply ITS to speed the border clearance process. The uneven frequency and growth of inspections and carrier reviews suggests a need for automated inspections and agency training.

- **Administration:** The expected strong performance of the regional economy and trucking industry will produce a growing volume of transactions for State agencies, creating a market for ED1 and other information systems. Growing commerce with Mexico supports ongoing efforts to expand the IFTA, the IRP, and similar programs to the Mexican border States.

- **Fleet and Vehicle Management:** Market penetration of major ITS technologies is below average in the Southwest region. Medium-sized carriers can use routing and dispatching software and onboard computers to assist with expansion plans.

- **Traffic Management:** Congestion in metropolitan areas such as Houston, Dallas, and Phoenix suggests a need for commercial vehicle traffic management and traveler information systems. Rural ATIS could be deployed in the mountain regions. The large volume of hazardous material shipments creates a market for hazmat incident response.

NORTHWEST REGION

Definition

The Northwest region includes five States: Washington, Oregon, Idaho, Montana, and Wyoming. Employment in the region totaled 6.0 million in 1993, representing just 4 percent of the national total. The region has been one of the fastest growing in the Nation during the past decade. Total employment increased 32 percent from 1983 to 1993.

Motor Carrier Industry Characteristics

The number of trucks is small but growing. About 161,000 commercial vehicles operated in the region in 1992. Nearly 61 percent of trucks in the region weigh more than 11804 kg (26,000 lb)

GVWR, the highest share in the Nation. The average fleet size is small-to-medium: more than 30 percent of trucks operate in fleets of between 6 and 24 vehicles, the largest share in the Nation. Only 15 percent operate in fleets of more than 99 vehicles, the smallest share in the Nation. The distribution of fleets by geographic range of operation closely tracks the national average.

About 22 percent of the trucks in the region carry either farm products or live animals as their principal product. An additional 12 percent carry logs **or** lumber, by far the highest share in the Nation. Other major products carried on trucks include building materials, processed foods, and general freight.

Trucking Activity Centers

The major freight generating centers in the Northwest are located along the Pacific Coast, including Seattle, Portland, and their satellite metropolitan areas (see figure 75). Only two other centers of note-Spokane, Washington and Boise, Idaho-are located in the interior of the region. Relatively little freight activity takes place in Montana, Wyoming, and most of Idaho and eastern Oregon. Traffic congestion is moderately heavy in Seattle, but not a major issue in the rest of the region.

Truck Routes

The only Interstate with significant truck volumes in the Northwest is Interstate 5 from Seattle through Portland to the California border (see figure 76). Other Interstates with moderate truck traffic include Interstate 84 from southern Idaho to Portland, portions of Interstates 82 and 90 in Washington, and Interstate 80 in southern Wyoming.

Regulatory Environment

The Northwest States maintain an active weight enforcement program. They operate 186 fixed weigh stations, close to one-third of the national total. The Northwest States weighed 10.8 million vehicles in 1993, nearly twice as many as their share of the national population would suggest. The number of enforcement weighings more than doubled between 1983 and 1993. However, WIM is not yet in wide use, and is not used at all for enforcement in Washington or Montana. Size and weight enforcement in the region is further complicated in that some States permit the use of longer-combination vehicles and have grandfathered exemptions from Federal weight limits.

ITS/CVO Markets

An ITS/CVO program for the Northwest region should consider the following markets:

- **Enforcement:** The large number of weigh stations and high frequency of inspections in the Northwest creates a market for preclearance systems, particularly in view of the low penetration of WIM at this time.

- **Administration:** Compared to other regions, the number of transactions in the Northwest is small but growing. State agencies in the region can **get** ahead of the curve today through careful investments in information systems.

- **Fleet and Vehicle Management:** The high proportion of small and local carriers, often carrying time-sensitive farm products and livestock, creates a market for communications systems and shipment tracking technologies.

- **Traffic Management:** Traffic management systems can be deployed in Seattle, but most of the region would benefit from rural ATIS applications.

WEST REGION

Definition

The West region includes four States: California, Arizona, Nevada, and Utah. (Arizona also is included in the Southwest region due to its ties to that economy.) Employment in the region totaled 20.1 million in 1993, representing 14 percent of the national total. In recent years, the economies of the States within the region have diverged: California has experienced a deep recession due to its high business costs **and** shrinking defense industry, while the interior States have been thriving. Regional employment increased 28 percent from 1983 to 1993, with gains of more than 40 percent in Nevada, Arizona, and Utah.

Motor Carrier Industry Characteristics

The number of trucks in the region is small but growing rapidly. About 363,000 trucks operated in the region in 1992, up 22 percent from 1987. About 34 percent of trucks operate in fleets of fewer than five vehicles, the smallest share in the Nation. The share of trucks based in the region that serve a regional market is the highest in the Nation, at 32 percent. The average fleet size is large; 42 percent of the trucks in the region operate in fleets of more than 25 vehicles, compared to just 36 percent nationally.

Building materials is the largest principal product category (17 percent). Processed foods (12 percent) and general freight (7 percent) follow, in both cases with the largest share among the seven regions. The share of trucks carrying several other products (including machinery, refuse, glass, and hazardous waste) also ranks highest in the Nation.

Trucking Activity Centers

California accounts for most of the West's population and industry, and consequently dominates freight activity in the region (see figure 77). Freight-intensive industries are concentrated in most of California, including San Francisco, Oakland, San Jose, Los Angeles, and San Diego. Los Angeles **is** the most congested urban area in the Nation, with more than 1.8 million

vehicle-hours of delay in 1990.[28] Congestion also is heavy in the San Francisco Bay area and San Diego.

Phoenix and Tucson also have emerged as freight centers, reflecting Arizona's large consumer market, trade with Mexico, and ability to serve as a low-cost distribution center for Southern California. Las Vegas and Reno are major tourist centers in the region. Salt Lake City is emerging in importance as a regional distribution center.

Truck Routes

Relatively few Interstates have been constructed in the West (see figure 78). The major north-south truck route in the Southwest is Interstate 5, which runs through central California from the Oregon border to San Diego. Truck volumes also are heavy on many of the beltways and connector roads in the San Francisco Bay and Los Angeles areas. The portion of Interstate 15 from Las Vegas to San Diego carries high truck volumes, but traffic is moderate on the rest of this route except near Salt Lake City. Among the East-West routes, the highest truck volumes are found on Interstate 10 from Los Angeles to Tucson, and on Interstate 80 from San Francisco to Reno.

Regulatory Environment

The number of administrative transactions is huge in California, but only moderate elsewhere in the region. Growth in trucking activity is increasing the administrative burden. The number of tractors and trailers registered in the region, for example, increased more than 30 percent from 1983 to 1993, largest increase in the Nation.

The 4 States operate 65 fixed weigh stations and weighed more than 18 million vehicles in 1993. The number of vehicles weighed increased more than 150 percent from 1983 to 1993, placing severe pressure on fixed sites. California and Arizona did not use WIM for enforcement weighing in 1993, but are upgrading their weigh stations. The States conducted 419,000 safety inspections in 1993, with 88 percent of these in California alone. More than 82 percent of the region's inspections conformed with the Level One standards. The inspections placed 29 percent of vehicles out of service, ranking second to the Northeast.

ITS/CVO Markets

An lTS/CVO program for the West region should consider the following markets:

- Enforcement: The large and growing weight and safety inspection burden can be addressed through weigh station upgrades and automated safety inspections. With relatively few vehicles repaired onsite, the region offers a market for out-of-service repair verification systems. International border clearance with Mexico also represents an important application.

28 Estimates of Urban Roadway Congestion.

- **Administration:** The growing number of trucks, along with pressure from carriers to reduce costs, suggests a need to further automate systems for registration, fuel tax administration, and other credentials. These improvements may begin in California and then expand to the rest of the region.

- **Fleet and Vehicle Management:** The West includes a large number of large and regional carriers, which offer strong market potential for fleet management systems such as onboard computers and routing and dispatching software. In California, the productivity gains associated with fleet management can offset the weak local economy and high business costs. In the fast-growing interior States, fleet management can be a tool to assist with carrier expansion.

- **Traffic Management:** Southern California and the San Francisco Bay area include some of the Nation's worst traffic congestion. Commercial vehicle operators in these regions could benefit from carrier-oriented information and traffic management systems. Carriers in the interior States may benefit from rural applications.

4. ITS/CVO Program

More than 50 government and public/private initiatives are underway to develop, test, and deploy elements of the ITS/CVO program, as defined by the four CVO functions described in chapter 1. This chapter reviews the leading projects and summarizes the lessons learned from the work to date that may be applied to the development of the national ITS/CVO program.

The projects are described by their purpose and participants, approach, results to date, deployment plans, and costs and benefits. ITS/CVO enforcement applications are discussed first, followed by administration, fleet and vehicle management, and highway traffic management.

ENFORCEMENT

ITS/CVO enforcement projects have had four major thrusts:

- Efforts to automate commercial vehicle clearance at weigh stations and ports-of-entry. The most prominent projects in this area are the Heavy-vehicle Electronic License Plate (HELP) and Advantage CVO projects.
- Projects to improve the clearance of trucks at international borders with Canada and Mexico.
- Projects focusing on automating aspects of safety assurance. The major projects in this area include the 100/200 MCSAP Site, Safety and Fitness Electronic Records (SAFER), and Out-of-Service Verification projects.
- Projects examining onboard monitoring of the safety status of the driver and vehicle.

Although the specific objectives of these projects have varied, they have tended to share common goals of increasing the efficiency of safety and weight inspection programs; reducing the time spent by commercial vehicles at inspection sites; and increasing highway safety for both carriers and the motoring public. Table 19 summarizes the major enforcement projects to date.

Projects

Heavy-Vehicle Electronic License Plate (HELP) Program/Crescent Demonstration/HELP, Inc.

The HELP (Heavy-vehicle Electronic License Plate) program began in the early 1980's as an effort by Arizona and Oregon to automate the process of weighing trucks and checking credentials at ports-of-entry. The work focused on the development and testing of weigh-in-motion (WIM), vehicle-to-roadside communication (VRC), and automatic vehicle classification (AVC) technologies, linked by communications networks to centralized computer data bases of motor carrier credentials. The program grew to include 10 U.S. States, the FHWA, 1 Canadian

Table 19. ITS/CVO enforcement projects.

Title	Objective	Participants	status	Budget
Heavy Vehicle Electronic License Plate (HELP)/Crescent/HELP, Inc.	Automate weight inspection and credentials verification at weigh stations and ports-of-entry	11 States, FHWA, British Columbia, Transport Canada, Port Authority of New York & New Jersey, industry representatives	Beginning deployment; expect to enroll 15,000 vehicles and 28 weigh stations by December 1996	$22 million for demonstration project
Greenlight	Provide automated clearance of commercial vehicles at all major weigh stations in region	Oregon	Beginning deployment; 15 sites planned by January 1997	$16.8 million
Regional Automated Permit Processing (RAPP)/IOU Project	Demonstrate preclearance of longer-combination vehicles past weigh stations on the I-84 corridor	Idaho, Oregon, Utah	Expected to be operational by September 1996	$0.2 million
Advantage CVO	Provide mainline automated clearance past weigh stations along I-75 from Ontario to Florida	6 States, Ontario, FHWA, Transport Canada, ATA, NPTC, NATA, provincial and State motor truck associations, individual carriers	l&month operational test began December 1995	$12 million
International Electronic Border Clearance Operational Tests	Develop, test, and evaluate technologies to communicate clearance information at Mexican and Canadian borders	Four operational tests in Nogales, Arizona; Otay Mesa, California; Santa Teresa, Mexico; and a joint Michigan/Ontario/New York project	Varies, generally occurring in 1996 and 1997	$16 million
100/200 MCSAP Site Project	Develop and test software for use in roadside safety inspections	FHWA, 32 States, and AAMVAnet	Deployment underway to meet deadline of 200 sites by 1997	$4.5 million
Safety and Fitness Electronic Records (SAFER)	Provide access from roadside to data in motor carrier safety information systems	FHWA, Johns Hopkins University, AAMVAnet	Initial testing in April 1996, operational by late 1997	$5.9 million

Table 19. ITS/CVO enforcement projects (continued).

Title	Objective	Participants	Status	Budget
Minnesota/Wisconsin Out-of-Service Verification	Evaluate multistate system for verifying compliance with out-of-service orders	Minnesota Dept. of Public Safety, Minnesota DOT, Wisconsin DOT, FHWA; possible expansion to Illinois and Michigan	Operational test began July 1995	$0.3 million
Idaho Out-of-Service Verification	Evaluate various automated approaches to assure compliance with out-of-service orders	Idaho State Patrol, Idaho Transportation Dept., Univ. of Idaho; Idaho National Engineering Laboratory	System development by July 1996; deployment by June 1997	$1.2 million
Braking Analysis for Heavy Commercial Vehicle Collision Avoidance	Study feasibility of adding automated braking equipment to commercial vehicles	NHTSA, Eaton Corporation	Concluded December 1995	$0.6 million
Brake Testing Project	Develop automated systems to inspect brake systems without crawling underneath a vehicle	12 states, FHWA, Nitze Vehicle Research Testing Center, Battelle Memorial institute	Completion scheduled by September 1996	$2.4 million
Driver Fatigue and Alertness Study	Study and develop in-vehicle systems to monitor driver fatigue and provide appropriate counter measures	FHWA, Essex Corporation, ATA Foundation, Transport Canada	Completion scheduled by July 1996	$0.8 million
Onboard Driver Monitoring/ Fitness for Duty Testing	Test systems to monitor a driver's ability to keep a vehicle in its lane	FHWA, ATA Foundation, Schneider National, Evaluation Systems, Inc.	Completion scheduled by November 1996	$0.6 million
Heavy Vehicle Driver Workload Assessment	Develop capability to evaluate effects of high-tech systems on driver safety performance	NHTSA, Battelle Memorial Institute	Completed in 1995	$1.0 million
Dynamic Downhill Truck Speed Warning System	Provide commercial vehicles with advance information on safe operating speeds prior to a steep downgrade	Colorado DOT, Colorado Motor Carriers Association, International Road Dynamics	Final evaluation began December 1995	$0.2 million

Note: NA = Not Available

province, Transport Canada, the Port Authority of New York and New Jersey, and representatives of the motor carrier industry.

Through the mid and late 1980's, the HELP program was the national forum for CVO technical research and debate on the benefits of ITS/CVO applications. The HELP technical studies succeeded in establishing the potential of WIM and AVI for automated clearance, but the debate about the merits of the program was contentious. The States maintained that the sole purpose of the program was to reduce delays and improve productivity at weigh stations. However, motor carriers argued that the program was intended to establish the infrastructure for a national weight-distance tax program.

The program stabilized in the late 1980's with an agreement to initiate a large-scale technology test along the Crescent Corridor, formed by the arc of Interstates 5 and 10 from British Columbia to Texas. Thirty-two sites were instrumented with various combinations of WIM, AVI, and AVC, and linked to a regional computer. Approximately 2,000 trucks from 75 fleets were recruited and monitored in 1992 and 1993 to demonstrate various levels of automated clearance. To allay concerns about the possible misuse of data by State agencies to enhance tax enforcement or by motor carriers to gain unfair competitive advantage, the project steering committee contracted with a third party, Lockheed Information Management Systems (IMS), to develop and operate the information system for the demonstration.

The HELP/Crescent approach to clearance is diagrammed in figure 79. After registering with the State and receiving its credentials (steps 1 and 2), the motor carrier applies to HELP/Crescent (steps 3 and 4) and submits copies of its credentials (step 5), which are entered into the Crescent regional data base and verified with the State agency.1 The program provides an AVI transponder with a unique identification number to the carrier, which the carrier mounts on the truck (step 7). Concurrently, the HELP/Crescent Program downloads the truck's transponder number, registered weight, and a set of credential flags (for example, registration valid/not valid) to computers at each weigh station (step 6). As the truck approaches the weigh station, its weight is screened by a WIM scale and its identification number is read (steps 8 and 9). The station computer matches the number and weight readings to the truck's records (step 10). If the truck's weight and credentials are in order, it is signaled to bypass the station; if not, it is signaled to the station for inspection (step 11).

In practice, few of the Crescent demonstration sites were equipped to provide fully automated mainline bypass service. However, even with partial equipment, the demonstration was able to show that the technology and procedures were practical and effective at screening trucks. "HELP system technologies are adequate and not a barrier to the implementation of HELP applications," concluded an onsite evaluation of the demonstration. However, "actual use of the HELP system was limited due to lack of training in operating the systems, limited sense of the

[1]The long-term vision for the program called for electronic links between the carrier, HELP, and the State to eliminate redundant registration procedures.

system's importance, and lack of confidence in the system reliability and data accuracy by weigh station personnel"2

The program evaluation documented the technical and institutional issues involved, but failed to produce a definitive cost-benefit assessment because of the difficulties of collecting consistent data across a constantly evolving set of sites and technologies. The general findings were that agencies expected more benefits and desired more applications than motor carriers, but that carriers believed the automated bypass functions provided significant benefits.3 In the end, the project was judged a success, largely because the participating carriers and agencies concluded that their benefits, however measured, were sufficient to warrant continued participation. The total cost of the project through the Crescent demonstration was $22 million, including $5.9 million in Federal funds.

In late 1993, a joint public/private, not-for-profit corporation, called HELP, Inc., was formed to finance and implement an operational system. HELP, Inc. proposed a menu of pay-per-use services to carriers and States. For the carriers, HELP, Inc. proposed PrePass, an automated clearance service modeled after the Crescent system. HELP, Inc. would maintain and provide the necessary credentials and weight data, charging carriers $1 each time one of their trucks was automatically cleared through a weigh station or port-of-entry. For the States, HELP, Inc. proposed to serve as an electronic, one-stop, retail shopping window, serving as an agent for motor carrier agencies and providing carriers with streamlined application and permitting services. To maintain industry confidence in the effort, the board of directors was balanced with one State representative and one motor carrier representative from each participating State. The board awarded Lockheed IMS with a franchise to operate the system, with revenues committed to defraying operating costs, recovering Lockheed's prior investment, and expanding services. Carriers must meet safety conditions to participate in the program and are subject to random inspections.

As of April 1996, seven weigh stations in California and one in New Mexico have been reengineered to operate the PrePass system. Weigh station redesign is underway at nine other sites in California, four other sites in New Mexico, and five new sites in Arizona. HELP, Inc. is negotiating a memorandum of understanding with Colorado to provide services at three sites by December 1996. HELP, Inc. has set a target of offering PrePass services through at least 35 weigh stations in its 11 member States in 1997.4 About 4,500 vehicles have been recruited by HELP, Inc. for PrePass as of April 1996. HELP, Inc's goal is to recruit 15,000 vehicles by December 1996.5

2 Castle Rock Consultants, *Heavy Vehicle Electronic License PIate (HELP) Program Final Report,* September 1993, p. 41-42.

3 HELP Final Report, p. 42-43.

4 Current member States include Arizona, California, Colorado, Minnesota, Montana, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming. HELP, Inc. hopes to recruit participation from Idaho and Nevada and then pursue States in the Eastern half of the Nation.

5 Interview with HELP, Inc. program officials, March 1996.

Oregon Projects

The HELP program prompted further work in Oregon. Oregon automated the Woodburn port-of-entry on southbound Interstate 5 in 1987, and began testing of automated mainline clearance at the Ashland port-of-entry on northbound Interstate 5 in 1992. Oregon's experience with weigh station modernization has been quite successful. An analysis of the Woodburn port-of-entry, for example, estimated that the modernization program resulted in average annual savings of $237,000 to the State and $286,000 to the trucking industry over a 5-year period. The major public sector benefits included a reduction in crew size and the postponement of future expansion plans. The major private sector benefits were time savings to motor carriers.6

In light of this experience, Oregon developed the Greenlight Electronic Pre-Clearance Operational Test program to automate clearance at all major weigh stations across the State. The program will provide mainline automated clearance at 16 sites, and automated screening at 35 enforcement sites. The total program budget is estimated at $16.8 million. The Greenlight program plans to automate 15 sites by January 1997.

In addition, Idaho, Oregon, and Utah obtained funding for a demonstration of automated clearance on the I-84 corridor from Portland to Salt Lake City. Dubbed the IOU program (and more formally, the Regional Automated Permit Processing program), the demonstration is aimed at preclearing longer-combination vehicles, or trucks hauling two or three trailers. Initial plans are to install AVI transponders on 2,000 trucks, using the transponder as an annual trip permit. The information on truck movements collected at weigh stations along the corridor also will be used to develop exposure data for longer-combination vehicles as part of an ongoing safety study. The total project funding is $208,000, split equally between the Federal Government and the participating States. The system is expected to be operational by September 1996.

Advantage CVO

Advantage CVO (formerly known as Advantage I-75) was established in 1990 to provide mainline automated clearance at weigh stations along the Interstate 75 Corridor from Ontario to Florida. Government participants include the States of Kentucky (the lead State), Florida, Georgia, Tennessee, Ohio, and Michigan; the province of Ontario, Canada; the FHWA; and Transport Canada. Industry partners include the American Trucking Associations (ATA), the National Private Truck Council (NPTC), the National Automobile Transporters Association (NATA), the provincial and State motor truck associations along the corridor, and individual for-hire carriers and private fleets. The Kentucky Transportation Center at the University of Kentucky serves as the program's research and operational center. Science Applications International Corporation (SAIC) serves as the system integrator and operator.

The primary objective of Advantage CVO is to provide automated clearance at the 30 weigh stations along the 3 500-km corridor.7 Vehicles approaching a weigh station equipped with the

6Krukar, Milan and Evert, Ken, "Findings from Five Years of Operating Oregon's Automated Woodburn Port-of-Entry," Oregon Department of Transportation, Salem, Oregon, p. 21.

7This includes a portion of Canadian Highway 401 in Ontario.

program's Mainline Automated Clearance System (MACS) are identified and weighed using AVI and WIM technology. The station computer then verifies the vehicle's credentials and signals the vehicle to either proceed or pull into the station.

Unlike the HELP system, the Advantage CVO system is designed to be decentralized and distributed. When the truck clears the first weigh station on its trip, the MACS system at that station writes the date, time, location, total weight, and axle weight data to the truck's transponder. As the truck approaches a subsequent station, this packet of information is read by the MACS system at that station, processed, and used to decide whether to bypass or inspect the truck. Although a State may accept the weight data written to the transponder by an upstream State, each State is responsible for verifying that the truck meets its unique weight and credential requirements. Advantage CVO plans no permanent centralized regional data base, other than a central registry.* Enrollment in the program requires that carriers meet certain safety requirements and be subject to random safety inspections.

The program began a l&month operational test in October 1995. Thirty weigh stations between Ontario and Florida will be equipped for the test, and 4,500 trucks will be recruited and outfitted with an m-cab transponder. As of February 1996, 29 weigh stations are in operation and 2,000 trucks from over 30 carriers are equipped with transponders.9

The program is directed by a policy committee representing the participating States and the motor carrier industry. A formal evaluation program is underway, but no systemwide quantification of costs and benefits is available. The MACS systems and transponders are financed with State and Federal funds. The total budget for the program is estimated at $12 million, including $8.4 million in Federal funding. The program has no plans at this time to charge carriers for the bypass service. Carrier participation in the operational tests has been growing steadily, and anecdotal evidence suggests that both carriers and State agencies are willing to advance toward full-scale deployment. Georgia is considering deployment of MACS systems at all major weigh stations within the State.

International Border Clearance Projects

The North American Free Trade Agreement (NAFTA) will bring full international trucking to the United States, Canada, and Mexico by January 2000. In response, the ITS/CVO program at this time is attempting to achieve "transparent borders" among the three nations by using automated technologies to communicate clearance information. These systems will address customs, immigration, administrative, and safety requirements. The capability for international electronic border clearance is being developed through four operational tests:

- **The Michigan/Ontario/New York** (MONY) operational test involves selected sites on the U.S./Canadian border such as Detroit and Buffalo. The goal of the project is to enhance cross-border safety and efficiency by developing an automated system. The operational test will involve both customs and immigration functions. The system includes electronic toll

8A temporary registry will be maintained during the development and testing phases to evaluate the system.

9 Interviews with Advantage CVO program staff, March 1996.

collection, in-vehicle communication, weigh-in-motion, and dedicated lanes for equipped vehicles.

- **The Expedited Processing and International Crossing** (EPIC) operational test involves the Nogales, Arizona international port. The prototype system will include electronic filing, licensing plate registration, expedited safety information, vehicle emissions monitoring, and electronic data transfer using VRC. The prototype system is scheduled for full implementation in July 1997.

- **The International Border Electronic Crossing** (IBEX) operational test involves the Otay Mesa, California international port. The prototype system will include VRC for identification of the carrier and its cargo, voice recognition for driver identification, and environmental monitoring. The pilot test is scheduled to run from June 1996 to January 1997.

- **The Advanced Technologies for International and Intermodal Ports of Entry** (ATIPE) operational test involves the Santa Theresa, New Mexico international port. This project will develop an information system, using global tracking, to improve the efficiency of the border clearance process. The project is in its preliminary phase.

Participants in the tests include various State DOT's; Lockheed Martin IMS; HELP, Inc.; Hughes TMS; Perceptics; the Western Highway Institute; Sandia National Laboratory; and JHK & Associates. The estimated cost of the four projects is $16 million.

100/200 MCSAP Site Project

The 100/200 MCSAP Site Project provides electronic access to carrier safety and driver license data from Motor Carrier Safety Assistance Program (MCSAP) roadside inspection sites. The 1994 Department of Transportation Appropriations Bill mandated that the electronic access be available at 100 sites by December 1995, and at 200 sites by mid-1997. The project is surpassing these milestones: 124 sites were operational by December 1995, and 192 by April 1996.

The objective of the project is to use information systems to target inspection resources to carriers with unknown or poor safety records, to improve driver license status checks, and to record inspection results electronically at the roadside. The l00-site requirement was met primarily through the deployment of pen-based inspection systems as part of the Roadside Data Technology Project (RDTP). These 200-site requirement will be met in conjunction with the development of the Safety and Fitness Electronic Records (SAFER) system.

The RDTP project is developing and testing generic software for use by safety inspectors in performing roadside safety inspections of commercial vehicles. This project has developed a custom software known as "Aspen", as well as an Inspection Selection System (ISS) to provide enforcement officials with recent data on a motor carrier's safety record, along with a recommendation regarding whether an inspection is appropriate. The inspection algorithm, developed by North Dakota State University, considers the prior frequency and results of inspections and safety reviews for the carrier. Historical information will be downloaded into the pen-based system on a periodic basis so that the system can be used in the field without a connection to an external network. In the future, the SAFER system, once developed, will make current carrier safety data available "on-line" within seconds to all equipped inspection sites, as well as to other State, Federal, and industry users (see discussion below).

Participating sites in the original RDTP tests included Alabama, Connecticut, Idaho, Kansas, Michigan, Nebraska, Ohio, Virginia, and Wyoming. Ontario also is participating in the tests. In 1995, 23 additional States were awarded grants to participate in the deployment of the systems at the first 100 sites. A number of additional States are purchasing the computers and software with their own funds. The total cost of the project is estimated at $1.1 million for the software and algorithm development, and $3.4 million for equipment deployment.

In a related effort, the FHWA has contracted with AAMVAnet to develop the capability for MCSAP personnel to access the Commercial Driver's License Information System (CDLIS) using microcomputer systems and the AAMVAnet communications system. The system will require the computer to be connected to a commercial telephone line, which will not be feasible at many inspection sites. Experimentation with local wireless and data cellular connections will begin in the future.

Safety and Fitness Electronic Records (SAFER)

The objective of the Safety and Fitness Electronic Records (SAFER) system is to provide a much-needed link between existing and planned motor carrier safety information systems, including SAFETYNET, the Motor Carrier Management Information System (MCMIS) and the CDLIS. The U.S. Congress authorized the SAFER system in the 1994 Department of Transportation Appropriation Bill, and mandated that SAFER be deployed at 200 MCSAP sites by 1997. The FHWA Office of Motor Carriers (OMC) is developing the system, with the support of the Johns Hopkins University Applied Physics Laboratory (JHU/APL); AAMVAnet, Inc.; and SAIC.

Once operational, SAFER will provide access from fixed and mobile commercial vehicle inspection sites to the data residing within Federal and State motor carrier safety information systems. SAFER will replace the periodic physical download of information needed for the pen-based software at MCSAP sites with a more frequent electronic transmittal. JHU/APL expects that within seconds, the SAFER system will provide information pertaining to a motor carrier's safety fitness rating, roadside inspection history, and accident record. Under this system, roadside enforcement officers will have access to the most recent information available when screening vehicles for inspection. In addition, the system will provide insurance companies and shippers with electronic access to safety information on motor carriers with whom they do business.

The system design eventually will support other ITS applications, such as electronic clearance, verification of safety credentials at the time of vehicle registration, and other commercial vehicle administrative processes. Once fully deployed, SAFER will incorporate information on both interstate and intrastate vehicles, and "may become the authoritative source for motor carrier identification information."[10]

[10] Johns Hopkins University Applied Physics Laboratory, *Safety and Fitness Electronic Records (SAFER) System* Description, Laurel, Maryland, October 18, 1994, p. 3.

The project began in June 1994, and is currently in the system design stage. JHU/APL plans to build the system in phases. Iowa and Oregon are scheduled to began testing portions of SAFER in April 1996. The system is expected to be operational by late 1997.

JHU/APL is coordinating development of SAFER with the broader Commercial Vehicle Information Systems and Networks (CVISN). It is envisioned that SAFER will form the foundation for the CVISN Information Exchange System. The technical steering committee includes representatives of the OMC; the Commercial Vehicle Safety Alliance (CVSA); HELP, Inc.; Advantage CVO; enforcement agencies in three States; industry associations including the ATA, the NPTC, and the American Bus Association (ABA); an insurer; and a shipper. The Federal Government is funding the estimated total project cost of $5.9 million.

Out-of-Seruice Verification Projects

Two separate projects are developing methods for verifying compliance with out-of-service orders issued following driver or vehicle safety inspections. One project is a joint effort of Minnesota and Wisconsin, and the other is being undertaken by Idaho.

The Minnesota/Wisconsin project will design a system for automatic, real-time out-of-service verification among several commercial vehicle inspection sites along a 252-mile section of westbound Interstates 90 and 94. Video identification equipment will record license plates and create a data base containing key data on specific out-of-service vehicles. Subsequent identification of the vehicles will help to determine if a particular vehicle is in violation of the out-of-service orders. Real-time information systems will connect the weigh stations and inspection sites. Once deployed, the systems will share information on out-of-service vehicles among States, enabling a coordinated effort to prevent violations.

This project is a joint venture of the Minnesota Department of Public Safety/State Patrol, the Minnesota Department of Transportation, the Wisconsin Department of Transportation, the FHWA. The project may be extended to Illinois and Michigan. The operational test began in July 1995. The total cost is estimated at $270,000, including $216,000 in Federal funding.

The Idaho project will evaluate several approaches to assuring compliance with out-of-service orders. The project will use various types of vehicle transponders and automated license plate identification through video image analysis. The project also will investigate systems currently used by the U.S. Departments of Energy and Defense. Roadside inspection sites will be equipped with an alarm system that is activated when an out-of-service vehicle attempts to leave. Use of these tracking and identification techniques would increase efficiency by freeing inspectors from surveillance duties.

Project partners include the Idaho State Police, the Idaho Transportation Department, the University of Idaho's National Center for Advanced Transportation Technology, and the Idaho National Engineering Laboratory. The project began in September 1994. The system is expected to be developed by July 1996 and to be installed at the East Boise port-of-entry by June 1997. The total project cost is estimated at $1.2 million, including $800,000 in Federal funding.

Onboard Monitoring Projects

A number of projects are exploring methods for onboard monitoring of the condition of the vehicle and driver.

On behalf of the National Highway Traffic Safety Administration (NHTSA), the Eaton Corporation studied Braking Analysis for Heavy Commercial Vehicle Collision Avoidance. The project investigated the feasibility of adding automatic braking equipment to heavy commercial vehicles. The project modeled brake performance, developed design requirements, and tested prototype hardware. The program concluded in December 1995 with extensive test track work and a demonstration of the prototype system. The total project cost was about $560,000, including $450,000 in Federal funding.

The FHWA is sponsoring a Brake Testing project to develop, evaluate, and implement brake testing devices. This project will develop and test automated systems to inspect the braking systems of a commercial vehicle without requiring the inspector to crawl underneath the vehicle. Devices being tested include roller dynamometers, flat plate/friction testers, breakaway torque testers, and infrared devices. All devices will include an interface to the collection of roadside inspection data. The project also will establish an out-of-service criteria based on the automated readings. Participating States in the field tests include Colorado, Connecticut, Indiana, Kentucky, Maryland, Minnesota, Nevada, New York, Ohio, Oregon, West Virginia, and Wisconsin. The NHTSA's Nitze Vehicle Research Testing Center is conducting the field tests. The Battelle Memorial Institute is collecting and analyzing the data. The project is scheduled to be completed by September 1996. The total project funding is $2.4 million.

The Driver Fatigue and Alertness study is evaluating in-vehicle systems to detect and offset driver fatigue. These systems would monitor the driver's status, detect degrades in performance due to drowsiness or fatigue, and provide a warning signal or other countermeasures. The project began in 1989, and is scheduled for completion in the Spring 1996. A total of 85 drivers from three motor carriers-were recruited and monitored in late 1993 to construct a sizable data base of performance, physiological, and psychological data. The findings from this study will be used to develop educational materials and to recommend changes in hours-of-service regulations. The Essex Corporation and the ATA Foundation/Trucking Research Institute are the project contractors. The total project cost is $835,000.

In addition, the FHWA is sponsoring the Onboard Driver Monitoring/Fitness for Duty Testing study to monitor driver performance. The project is installing lane tracking devices on 30 trucks owned by Schneider National Corporation and operated in San Diego, California. The devices monitor the driver's ability to keep the vehicle in its lane, which is considered to be a proxy for the driver's overall fitness for duty. Early results suggest that driver fatigue is a primary contributor to poor lane-following performance. The study is being conducted by the ATA Foundation/Trucking Research Institute and Evaluation Systems, Inc. The project began in July 1995, and a final report is due by November 1996. The Federal share of the project cost is estimated at $630,000.

Also on behalf of the NHTSA, the Battelle Memorial Institute conducted the Heavy Vehicle Driver Workload Assessment. The study developed a capability to evaluate the effects of high-technology systems such as crash avoidance and navigation systems on driver safety performance. The project also developed standardized driver workload measurement protocols,

obtained baseline workload data, and evaluated high-technology systems. The project identified aspects of system design and operation that can compromise safety. The project ran from **1991** to 1995. **The Federal Government funded** the entire estimated project cost of $1.0 million.

The Dynamic Downhill Truck Speed Warning System provides commercial vehicles with advance information on safe operating speeds on a steep downgrade in the Colorado mountains. The system uses weigh-in-motion equipment to measure truck weight and automatic loop detectors to monitor vehicle speed. A roadside computer uses weight and vehicle configuration data, along with an FHWA-approved algorithm, to calculate a safe descent speed for the truck. A variable message sign notifies drivers of this safe operating speed. The system became operational in June 1995. The final evaluation began in December 1995. Project participants include the Colorado Department of Transportation, the Colorado Motor Carriers Association, and International Road Dynamics. The total project cost is estimated at $243,000.

Lessons Learned

The general lessons learned from the enforcement projects to date are as follows:

1. Deployment of ITS/CVO enforcement applications is technologically feasible.
2. The markets for ITS/CVO enforcement programs differ across regions.
3. **The institutional barriers** involved in building ITS/CVO enforcement applications are greater than the technological problems.
4. States will realize benefits from investment in roadside automated clearance programs because current clearance procedures in most States are labor intensive and inefficient.
5. The motor carrier industry will realize significant benefits from ITS/CVO enforcement applications, but the benefits will be distributed unevenly.
6. Roadside enforcement applications require timely access to safety and credential data.
7. Shippers may realize significant benefits from easier access to safety data.

1. Deployment of ITS/CVO enforcement applications is technologically feasible.

The key components of ITS/CVO enforcement programs-WIM, AVI, AVC, communications systems, and information management technologies-are available and being deployed by State motor carrier regulatory agencies. Consequently, automated roadside clearance programs such as HELP and Advantage CVO are making great progress. In contrast, the enabling technologies for automated inspection and onboard driver monitoring systems are still under development. Work in these areas is promising, but products and systems are not **expected** to mature for widespread deployment for another decade.

2. The markets for ITS/CVO enforcement programs differ across regions.

States in the West, Southeast, and Great Lakes regions have made great progress toward implementing the automated clearance concept through the HELP and Advantage CVO programs. The I-95 Corridor Coalition and Eastern States consortium, however, have

emphasized driver and vehicle safety assurance in their CVO work. The relative lack of interest in preclearance in the Northeast is striking but not surprising, given the differences in enforcement strategies across regions. The West and Southeast regions include large numbers of weigh stations and ports-of-entry. The Northeast States rely primarily on mobile enforcement, and are concerned with congestion along Interstate 95 and other major routes. These different enforcement strategies and focuses yield different markets for CVO services.

3. The institutional barriers involved in building ITS/CVO enforcement applications are greater than the technological problems.

Three issues have dominated the institutional and organizational evolution of the ITS/CVO enforcement program. The first has been the lack of State and regional forums to bring together all of the parties involved in commercial vehicle operations. The HELP and Advantage CVO programs created the first regional, multistate forums to reengineer commercial vehicle operations. These initial efforts involved only State departments of transportation and the motor carrier industry. State police and highway patrols began participating after the projects were well underway, and both programs are struggling today to involve revenue and tax agencies. The process of building "public/public" partnerships to support ITS/CVO applications has proven nearly as trying as building public/private partnerships between the States and the motor carrier industry. Nevertheless, the programs have been successful in creating forums, and the experience has been critical to the development of the national ITS/CVO program.

The second issue affecting the institutional evolution of the ITS/CVO programs has been the motor carrier industry's opposition to weight-distance taxes. Many motor carriers oppose weight-distance taxes because they would add to the existing tax burden, would redistribute the tax burden within the motor carrier industry, and may increase the complexity of tax administration and enforcement. Critics argue that the cost of added paperwork and the potential for evasion, especially by intrastate carriers, would outweigh the benefits of greater tax equity. The motor carrier industry delayed the early HELP program because of concerns that automated clearance programs were a precursor to the introduction of weight-distance taxes. This problem was resolved in the Crescent and Advantage CVO demonstrations by ensuring equal representation of carriers and State agencies on the program policy committees, and publishing explicit policy statements noting that participation in the programs was voluntary for both carriers and States. The resistance to weight-distance taxes continues to affect the ITS/CVO program. United Parcel Service announced its decision not to contract for the HELP, Inc. PrePass service, which would cost the carrier $1 each time one of its trucks is cleared automatically through a weigh station. Among the issues underlying UPS' decision were concerns that the pay-for-pass service represented double taxation and could form a precedent for a national weight-distance tax program.11

The third issue shaping the institutional approach to ITS/CVO enforcement applications has been the need to protect the confidentiality of motor carrier business transactions. In addition to their concern about weight-distance taxes, carriers were anxious that data on their truck

11 Saccomano, Ann, "UPS Quits Key Program to Develop System for Nationwide Electronic Clearance," *Traffic World*, April 10, 1995, p.8.

movements might be released or sold to business competitors, or used by State tax auditors for purposes other than the enforcement of credential, size, and weight regulations. The solution in the HELP program was to contract with a third-party private sector corporation (Lockheed IMS) to collect and manage the information. Under the current agreement, only the motor carrier has access to all records of its truck movements. Each State has access only to summary data that are stripped of individual firm and truck identifiers for the transactions within its borders. A State cannot obtain data on a firm's truck movements across a multistate region without the carrier's permission. The Advantage CVO approach sidesteps this problem by not having a centralized computer that could collate observations on interstate truck movements.

4. States will realize benefits from investment in roadside automated clearance programs because current clearance procedures in most States are labor intensive and inefficient.

A 1988 study for the Transportation Research Board (TRB) found that retrofitting weigh stations for mainline automated clearance would be cost effective.12 For a State operating 25 or more weigh stations, the 20-year net present (discounted) value was positive if 10 percent of the trucks operating through the weigh stations were equipped with transponders. For a State with 15 to 20 weigh stations, the investment was positive if 20 percent of trucks were equipped with transponders. Benefit/cost ratios for an average State were estimated in the range of 1.1 to 1.5 to 1. A similar analysis for the Oregon Greenlight project calculated a benefit/cost ratio of 2.1 to 1. The Oregon analysis included estimates of the benefits from reducing pavement damage associated with overloaded trucks, as well as estimates of the additional revenues from reducing tax evasion.

The return on investment for the States comes from the ability to identify and fine carriers that have not paid registration and fuel taxes. By removing transponder-equipped trucks from queues, the States gain the capacity **to** screen trucks that now are waved off without a weighing or credentials check at congested stations. In addition, States are able to inspect more vehicles without a proportional increase in enforcement staffs. The TRB study calculated that once a State invests in the equipment for automated clearance, its benefits will rise with increasing motor carrier participation. However, the marginal benefits were expected to decrease once motor carrier participation rates exceeded 30 percent in an average State. At that level, queuing at most weigh stations would be significantly reduced, and the pool of unweighed and noncompliant trucks would shrink. Safety would improve because trucks would not back up entering weigh stations and would merge into traffic less frequently.

The automation of safety inspections-such as the software systems proposed by the 100/200 MCSAP Site project--should bring further benefits to State agencies in terms of increased productivity and an ability to screen a larger number of vehicles. In addition to the direct benefits, the States anticipate longer-term, indirect benefits from improved safety and reduced wear-and-tear on pavement. However, these benefits will be achieved only if automated clearance is combined with a broader restructuring of enforcement programs, including greater use of compliance reviews, mobile patrols, relevant evidence **laws, and** carrier training.

12 Lance R. Grenzeback, et al., *Feasibility of a National Heavy-vehicle Monitoring System,* National Cooperative Highway Research Program Report 303, National Academy Press, Washington, DC, December 1988, pp. 48-58.

5. The motor carrier industry will realize significant benefits from ITS/CVO enforcement applications, but the benefits will be distributed unevenly.

In the TRB study, the benefit/cost ratio for participating carriers was estimated at about 10 to 1. Oregon's analysis found a 7.2 to 1 benefit cost ratio for participating carriers; however, the Oregon analysis assumes that by the end of the 20-year period, about 60 percent of trucks will be equipped with transponders.[13] The time savings and benefits for individual trucks in the TRB study were modest, since on average, each large truck is weighed only about 100 times a year. However, the aggregate savings to participating carriers were substantial because the average State weighs more than 3.1 million trucks per year.[14]

The benefits for individual motor carriers vary depending on their type of operation and routes. Carriers operating just-in-time delivery systems, long-haul carriers, contract drivers paid by the hour, and carriers who repeatedly pass the same weigh station were very positive about the HELP and Advantage CVO demonstration programs. Carriers with less demanding schedules, and carriers operating in areas with few and uncongested weigh stations, found the demonstrated services convenient, but less compelling. HELP, Inc's pay-for-pass program will more clearly define the motor carrier markets for automated clearance, especially within California.

It is expected that automated weigh stations will reduce the risk of queued accidents at congested weigh stations, but no studies have documented this impact yet. Automated clearance and safety screening, coupled with mobile enforcement, also can improve the equity of enforcement. Equity is important to the industry because it maintains a "level playing field" in an industry that has become very cost and service competitive. Finally, the standardization of transponders will create opportunities for the motor carrier industry to piggyback other applications on automated clearance. In addition to toll collection, commonly discussed applications are mileage reporting (using AVI readers at weigh stations and State borders to place time, date, and location stamps on onboard mileage recorders); fuel control (ensuring that fuel billed to a carrier is delivered to the company's truck at the contracted price and station); and maintenance (writing and reading maintenance orders and actions).

6. Roadside ITS/CVO applications require timely access to current safety and credential data.

Both the HELP and Advantage CVO systems require that State agencies process and post credential transactions quickly and accurately, and that they disseminate this information rapidly to the weigh stations (in the Advantage CVO system) or the system operator (in the HELP, Inc. system). If the State agencies fail to do so, then truck credentials cannot be verified electronically, and both the States and the carriers lose the benefits of automated

13 Oregon's "Greenlight" Project. This assumption is reasonable for Oregon because its weight-distance tax and extensive enforcement program will provide an incentive for carriers to participate. However, States without weight-distance taxes, or those with less intensive enforcement programs, may not realize as high a participation rate.

14 Federal Highway Administration, Office of Motor Carriers data for 1993. The national average masks considerable variation among States (see section 2.7 and appendix A).

clearance and screening. The SAFER project is an important step in providing real-time access from the roadside to motor carrier safety information systems, and could be extended to credentials data as well.

7. Shippers may realize significant benefits from easier access to safety data.

Deregulation expanded shippers' choice of carriers and competition forced down the price of freight services, but it also eliminated many motor carrier reporting requirements that once gave shippers information on the quality and safety of a motor carrier's operations. Today, it is difficult for a shipper to obtain information on a carrier's safety record. When accidents occur, the shipper can be held liable for damages, especially if it can be shown that the shipper was employing a carrier with an unsatisfactory safety record. Systems such as SAFER that permit States and carriers to obtain an accurate profile of a carrier's safety record will be valuable to shippers seeking to minimize risk, and to carriers trying to market themselves based on the quality of their management and operations.

ADMINISTRATION

ITS/CVO credential administration projects have had six major thrusts:

- Preparation for universal participation in the International Fuel Tax Agreement (IFTA) and the International Registration Plan (IRE);
- Efforts to automate additional portions of the registration and fuel tax administration processes;
- Efforts to develop base-State agreements for administration of other credentials, including oversize/overweight permitting and hazardous materials permitting systems;
- "One-stop shopping" programs where carriers can obtain all necessary permits through a single point of contact;
- Commercial vehicle information systems and credentials clearinghouses; and
- Studies of the institutional barriers to deployment of ITS/CVO services in each State.

The driving goal of the credentials projects has been to increase the efficiency of motor carrier regulatory administration, bringing cost savings to both agencies and motor carriers. Table 20 highlights the major ITS/CVO administration projects to date.

Projects

Base State Working Group on Uniform Motor Carrier Programs (BSWG)

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 established the Base State Working Group on Uniform Motor Carrier Programs (BSWG) to provide technical assistance to States entering the International Fuel Tax Agreement (IFTA) and the International

Table 20. ITS/CVO administration projects.

Title	Objective	Participants	Status	Budget
Base State Working Group on Uniform Motor Carrier Programs (BSWG)	Provide technical assistance and funding to States entering the IFTA and the IRP	Representatives of 16 State agencies; HELP, Inc.; FHWA; AAMVA; FTA; NGA; NCSL	Ongoing group	$500,000 per year ceiling authorized in the ISTEA
Automated Mileage and Stateline Crossing Operational Test (AMASCOT)	Demonstrate and evaluate technology to automate data collection and mileage and fuel reports	Iowa DOT, Rockwell International, Rand McNally-TDM, Iowa State University, Wisconsin DOT, Western Highway Institute, FHWA, State trucking associations	Final report issued early 1996	$1.6 million
New York Fuel Tax System	Develop software for multijurisdictional fuel tax processing	New York State Department of Taxation and Finance, 11 other IFTA jurisdictions	Under development	NA
Commercial Vehicle Information System (CVIS)	Feasibility study to link motor carrier safety fitness data to State commercial vehicle registration	Iowa, Indiana, Minnesota, Oregon, and Colorado; Warren Dunham & Associates; Volpe National Transportation Systems Center; AAMVAnet, Inc.	System design underway; pilot system to be completed by December 1996	$9.5 million
Northeast Oversize/ Overweight Permitting Agreement (NOOPA)	Issue regional OS/OW permit	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont	Under development	NA
Multi-Jurisdictional Oversize/Overweight Organization (MOOO)	Issue regional OS/OW permit	Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, Wisconsin	Trial program ended in early 1990's	NA
Western Regional Agreement (WRA)	Issue regional OS/OW permit	Arizona, Idaho, Montana, Oregon, Utah, Washington	Operating	NA
Multistate Permitting Agreement	Issue regional OS/OW permit	Alabama, Florida, Georgia, Kentucky, Louisiana, Michigan Mississippi, North Carolina, Ohio, South Carolina, Tennessee, Virginia, West Virginia	Operating since 1994	NA

Table 20. ITS/CVO Administration Projects (continued).

Title	Objective	Participants	Status	Budget
Alliance for Uniform Hazmat Transportation Procedures Pilot Test	Develop base-State procedures for registering and permitting carriers of hazardous materials	Minnesota, Nevada, Ohio, West Virginia	Pilot program under development	NA
Southwest States Electronic One-Stop Shopping	Demonstrate an electronic one-stop credential purchasing process	Colorado, Arkansas,Texas, and possibly New Mexico; Western Highway Institute; Ballofet & Associates; AAMVAnet; NeuronData; Arkansas State University	Operational test to be completed December 1996	$0.7 million
HELP One-Stop Electronic Purchase	Evaluate the increase in State and motor carrier productivity from automating and integrating common motor carrier administrative functions	California, Arizona, and New Mexico; HELP, Inc.; Western Highway Institute; Private Fleet Management Institute; Lockheed IMS; AAMVA	Operational test to be completed by January 1997	$4.3 million
Midwest States One-Stop Electronic Purchase	Evaluate the increase in State and motor carrier productivity from automating and integrating common motor carrier administrative functions	Minnesota, Illinois, Indiana, Iowa, Kansas, Missouri, Nebraska, and Wisconsin; AAMVAnet; Western Highway Institute; Lockheed IMS; Rockwell International; FHWA; Iowa State University	Operational test to be completed by July 1997	$2.4 million
Commercial Vehicle Information Systems and Networks (CVISN)	Provide technical framework for implementing CVO information systems and electronic data interchange	FHWA, Johns Hopkins University	Prototype test to begin in spring 1996; pilot test to follow in 2 to 8 States	$12 million
CVO Institutional Issues Studies	Identify the institutional barriers to the implementation of ITS CVO programs, and recommend strategies to overcome them	49 States, primarily in large consortia; FHWA	First-round studies are nearly complete; second round underway	$7.5 million

Note: NA = Not Available

Registration Plan (IRE). The purpose of the BSWG is to facilitate the transition process, and to resolve disputes that may occur following universal participation.

The BSWG includes representatives of 16 State agencies responsible for commercial vehicle registration and fuel tax administration; HELP, Inc.; the FHWA; the American Association of American Motor Vehicle Administrators (AAMVA); and the Federation of Tax Administrators (FTA). The National Governors Association (NGA) is providing staff support for the BSWG, in cooperation with the FTA and the National Conference of State Legislatures (NCSL). The ISTEA authorized an annual budget of about $500,000 for the group, and provided funding to assist States with some of the costs of converting to or upgrading their IRP and IFTA programs.

The BSWG's initial work emphasized developing a strategy to encourage States to join the IFTA and the IRP, and helping the non-members to identify "best practices" in use by member jurisdictions. Nationwide surveys commissioned by the BSWG concluded that although most jurisdictions demonstrate the ability to comply with the ISTEA mandates, several jurisdictions may have difficulty meeting the deadline without the use of advanced technologies.15 The surveys concluded that no single path of technological development is likely to meet the needs of all jurisdictions, and that many States may need to pursue multiple paths simultaneously.

Recent BSWG efforts have emphasized the development of electronic data interchange capabilities among members of the IFTA and the IRP. The BSWG is conducting a pilot test of fuel tax data sharing via EDI among six States: Colorado, Iowa, New Mexico, North Carolina, South Carolina and Utah.

The BSWG established a Technology and Information Committee to assist States with data processing and exchange needs. In addition, the BSWG is providing support to States in enhancing their audit capabilities. The passage of the North American Free Trade Agreement has required the BSWG to expand its work with Mexican-based carriers.

Automated Mileage and Stateline Crossing Operational Test (AMASCOT)

The Automated Mileage and Stateline Crossing Operational Test (AMASCOT) project demonstrated and evaluated technology to automate the collection of data and filing of motor carrier mileage and fuel reports for commercial vehicles. This project focused on improving the collection and reporting of data to IFTA and IRP base jurisdictions.

The objectives for the project were to reduce compliance costs for carriers, reduce IFTA/IRP administrative costs for State agencies, and improve carrier compliance rates. The project developed procedures and software to submit the fuel use and apportioned mileage reports to the base jurisdictions electronically. It also developed State auditing guidelines to support the automated data.

The operational test involved an onboard computer (OBC) system; a mobile communications system; and a global positioning system (GPS) receiver to track truck movements, locate State

15 Science Applications International Corporation, ADP Survey: *Final Results Report,* August 1994; and Lockheed Information Management Services, *Final Technology and Information Report,* November 1994.

line crossings, and track mileage. Data from the onboard systems was uploaded to a central computer for processing and comparison with manually entered fuel and tax information. A proposed commercial system will not include the capability to upload data from trucks via satellite.

Thirty trucks from six motor carriers were equipped for the test. Project partners included the Iowa Department of Transportation; Rockwell International; Rand McNally; the Iowa Transportation Center at Iowa State University; the Wisconsin Department of Transportation; the Western Highway Institute/ATA Foundation; the FHWA; and trucking associations in Iowa, Minnesota, and Wisconsin. The project budget was $1.6 million. The operational test was completed in August 1995. The final report was issued in early 1996.

New York Fuel Tax System

The New York State Department of Taxation and Finance is developing a set of software for a multijurisdictional tax processing system. The system will support all IFTA transactions among the States and between the States and motor carriers. The system will deposit return remittances and capture return data; compute returns, identify liabilities, and provide for corrections; capture data from incoming fee transmittals; identify liabilities between participants and provide for funds transfer; and print and mail returns and notices. A management committee representing all participating jurisdictions guides the development of the system. Participating jurisdictions include Alabama, California, Connecticut, Delaware, Georgia, Maryland, Massachusetts, Michigan, New York, Pennsylvania, Rhode Island, and Texas.

Commercial Vehicle Information System (CVIS)

The objective of the Commercial Vehicle Information System (CVIS) is to link nationwide motor carrier safety fitness data to State commercial vehicle registration. This information system aims to improve the safety of commercial vehicle operations nationwide by denying registration to unsafe carriers. Although the overall goal of the CVIS is to improve highway safety, it also represents an effort to improve commercial vehicle registration processes beyond full implementation of the IRP and a major initiative toward improving interagency data exchange.

The ISTEA required the FHWA to determine the feasibility of linking commercial vehicle registration with safety fitness information. Once developed, the CVIS will provide State agencies responsible for commercial vehicle registration with automated and timely access to information on the safety fitness of a carrier.[16] The CVIS also will determine the types of sanctions or operating restrictions that should be imposed on the registrant to ensure safety fitness.

Development of the CVIS is a cooperative effort between the States, the FHWA, motor carriers, and third-party service providers. The Iowa Department of Transportation is leading the project. A pilot program covering five States--Colorado, Indiana, Iowa, Minnesota, and Oregon-is under development. AAMVAnet, Inc. is working with the Iowa DOT as the system developer. The Volpe National Transportation Systems Center is developing the carrier safety fitness module of the project. Warren Dunham Associates, Inc. is serving as the project facilitator.

16 Presentation by Mr. Mike Keohn, Iowa Department of Transportation, June 23, 1994.

The project team is in the system design phase. Automation of the pilot system is scheduled for completion by December 1996. The total funding for the project is estimated at $9.5 million.

Oversize/Overweight Permitting Systems

In contrast to the national systems for registration and fuel tax administration, efforts to standardize for oversize/overweight (OS/OW) vehicle permitting are still in their nascent form. Over the past decade, prompted by the FHWA and the motor carrier industry, the States have begun to make progress in this area. Much of this work has occurred at the regional level, reflecting the tendency for most OS/OW truck trips to be less than 322 km (200 mi) in length. Under the aegis of the American Association of State Highway and Transportation Officials (AASHTO), uniform permitting procedures are being developed in four regions:

- **The Northeast Oversize/Overweight Permitting Agreement (NOOPA)** is under development. Participating States include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. The NOOPA has been under discussion since 1992, and a rough draft of the agreement was developed in 1996. Under the system currently envisioned, a motor carrier would apply for an OS/OW permit from the first NOOPA State that it enters. The issuing State would provide a permit that is valid in all NOOPA jurisdictions, and distribute the fee among the States in which the vehicle will travel. The permits would be valid for a single trip, would be restricted to travel along Interstate highways, and would apply only to vehicles within predetermined size and weight limits.17

- **The Multistate Permit Agreement** covers 11 States in the Southeast: Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. Among AASHTO's Southeast members, only Arkansas is not participating in the agreement at this time. Ohio and Michigan also participate in the agreement, and other border States such as Indiana, Maryland, Missouri, and Texas are considering participation.18 The agreement has been operational since 1994, and the participating States typically issue 20 to 30 permits per month. Under the system, a motor carrier must apply for a multistate permit through an authorized permit agent (typically a third-party service provider). The permit agent petitions each State in which the vehicle will travel, remits all fees on behalf of the carrier, and issues a single permit that is valid in all jurisdictions. Each State determines routing restrictions for OS/OW vehicles in its jurisdiction.

- The **Multi-Jurisdictional Oversize/Overweight Organization** (MOOO) was proposed in 1991 in the Midwest. Participating states include Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. A four-State pilot test demonstrated

17 The New England Transportation Consortium (NETC), comprising the States of Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, created the first regional OS/OW permitting program in 1985. It is possible that the emerging NOOPA agreement may absorb the NETC permit program, although the two programs still face major differences. In particular, the NOOPA permits would be restricted to travel along Interstate highways, while the NETC permits cover travel along a predetermined network of Interstate and State routes. The potential to resolve these differences is not clear. Interview with Maryland State Highway Administration representative, April 1996.

18 Interview with Louisiana Department of Transportation official, April 1996.

the feasibility of the system, but a lack of consensus on the mechanics prevented full implementation. Although interest remains high in a regional program, it is not clear whether the States will reconvene.

- **The Western Regional Agreement** covers Arizona, Idaho, Montana, Oregon, Utah, and Washington. Through this agreement, regional permits allowing travel in all member jurisdictions can be issued for OS/OW vehicles. The participating States can issue permits and collect fees for all member jurisdictions. Each jurisdiction has developed its own fee schedule and collection process. When regional permits are issued, the motor carrier pays the total fees for all States in which the truck will travel. The member jurisdictions participated in designating a regional highway system on which multistate permit holders are allowed to travel.

Alliance for Uniform Hazmat Transportation Procedures Pilot Test

The Alliance for Uniform Hazmat Transportation Procedures is developing uniform procedures and forms for States that register and issue permits to motor carriers for the transportation of hazardous materials (hazmat). The work of this group was authorized by section 22 of the Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA).19

The Alliance recommends that uniform State programs incorporate a base-State system similar to the IFTA or the IRP. Under this program, a motor carrier will apply to a single base State. The base State will conduct a review of the motor carrier's qualifications, and, if appropriate, will issue a permit that is valid in all participating jurisdictions. The motor carrier will pay a single registration fee to the base State, which will be responsible for distributing the fee to all States in which the carrier operates. Participating States may require additional disclosure from hazardous waste haulers, and will retain enforcement authority for hazardous materials transportation within their borders.20 The Alliance will develop an interstate clearinghouse of registered hazmat carriers.

The Alliance is conducting a four-State pilot test of its program. Participating States include Minnesota, Nevada, Ohio, and West Virginia. The National Governors Association (NGA) and the National Conference of State Legislators (NCSL) are providing staff support to the Alliance. Members of the Alliance include representatives of the NGA, the NCSL, the National Association of Counties, the National Association of Towns and Townships, the National League of Cities, the U.S. Conference of Mayors, and the AAMVA, as well as 10 at-large members representing individual States and municipalities. RS Information Systems is providing technical support to the Alliance. The system is scheduled to be operational in April 1996.

One-Stop Electronic Shopping Programs

The IFTA, IRP, OS/AU, and hazmat projects have addressed the issuance of specific types of credentials. A growing number of States, either independently or cooperatively, are examining methods to streamline the process for issuing multiple types of permits, registrations, and other credentials to motor carriers. Effectively, these "one-stop shopping" systems would en-

19 See Chapter 2 for more information.

20 *Report of the Alliance for Uniform Hazmat Transportation Procedures*, November 17, 1993, p l-l.

able carriers to obtain all necessary credentials for a single State or group of States through a single point of contact. These systems also would facilitate electronic data interchange among States, and between carriers and State agencies. Operational tests of the one-stop shopping concept are underway in three regions:

- **The Southwest States Electronic One-Stop Shopping** project will demonstrate a computer-based credential purchasing process. The system is expected to analyze credential applications to ensure that all State requirements are met, and generate all necessary credentials at one time. The system will allow motor carriers to file credential applications electronically with State agencies. In addition, the system will provide a common credential data structure and an electronic data transfer function. Colorado, Arkansas, and Texas began the operational test in early 1996. Other project participants include the Western Highway Institute/ATA Foundation; Ballofet and Associates, Inc.; In-Motion, Inc.; AAMVAnet; NeuronData; and Arkansas State University. The project team is scheduled to complete the operational test by December 1996. The total project cost is estimated at $734,000, including $537,000 in Federal funding.

- The **HELP One-Stop Electronic Purchase** project is an extension of the HELP system involving the issuance of both annual and temporary credentials. The system will enable motor carriers to obtain credentials and permits from multiple States, as well as to calculate fees and make payments, via electronic means. Credentials will be received, verified, and transferred electronically to weigh stations and port-of-entry facilities. Project partners include the California, Arizona, and New Mexico departments of transportation; HELP, Inc.; the Western Highway Institute/ATA Foundation; the Private Fleet Management Institute; Lockheed IMS; and AAMVA. The operational test began in March 1996, and is scheduled for completion by January 1997. The total project cost is estimated at $4.3 million, including $2.1 million in Federal funding.

- **The Midwest States One-Stop Electronic Purchase** project will design and test a system for one-stop, multistate electronic purchase of credentials. Carriers will be able to purchase credentials from eight States at locations such as motor carrier offices, permitting services, truck stops, and State agencies. Credentials will be delivered electronically to the requesting location or a location specified by the carrier. A carrier will request and pay for credentials electronically through its base State of registration. Project partners include the departments of transportation in Minnesota, Illinois, Indiana, Iowa, Kansas, Missouri, Nebraska, and Wisconsin; the Minnesota Department of Public Safety; AAMVAnet; the Western Highway Institute/ATA Foundation; Lockheed IMS; Rockwell International; the FI-IWA; and the Iowa Transportation Center. The operational test is scheduled to run from July 1996 to July 1997. The total project cost is estimated at $2.4 million, including $1.3 million in Federal funding.

Commercial Vehicle Information Systems and Networks (CVISN)

The Commercial Vehicle Information Systems and Networks (CVISN) project is intended to provide a technical framework for implementing future CVO information systems. The FHWA has contracted with a team led by the Applied Physics Laboratory at Johns Hopkins University (JHU/APL) to facilitate the development of the CVISN.

The CVISN would provide a fully integrated collection of commercial vehicle information systems operated by the States, the FHWA, carriers, and other stakeholders. These systems would include existing data bases such as the CDLIS, planned data bases such as the National Motor Vehicle Title Information System, and planned clearinghouses for the IFTA, the IRP, and other credentials.

The central vision of the CVISN architecture is that by the year 2005, the vast majority of CVO business transactions will be handled electronically. The CVISN project emphasizes the areas of interaction between the public and private sectors. In conjunction with the ITS America CVO Program Subcommittee, the CVISN project identified a number of guiding principles:21

- A balanced approach involving ITS/CVO technology as well as institutional changes will be used to achieve measurable improvements in efficiency and effectiveness for carriers, governments, and other CVO stakeholders. Specific technology and process choices will be largely market-driven.

- The CVISN architecture will enable electronic information exchange among authorized shareholders via open standards.

- The architecture development will evolve incrementally, starting with legacy systems where practical and proceeding in manageable steps with heavy end-user involvement.

- Safety assurance activities will focus resources on high-risks and be structured so as to reduce the compliance costs of low-risk carriers and drivers.

- Information technology will support improved practices and procedures to enhance CVO credential and tax administration efficiency for carriers and government.

- Roadside operations will focus on eliminating unsafe and illegal carriers, drivers, and vehicles from service without undue hindrance to the productivity and efficiency of safe and legal carriers and drivers.

JHU/APL is working with appropriate public and private organizations to consolidate and refine the requirements for a national CVISN architecture. To date, JHU/APL has produced a preliminary architecture and an *Operational* Concept Document that provides an overview of the CVISN concept, along with supporting project summaries and statistical documents. The CVISN project is being coordinated with the development of a national ITS architecture. It is expected that the SAFER system will provide the platform for more advanced elements of the CVISN. These would include an information exchange network to connect all participants and an information exchange system to contain information on all carriers, vehicles, and drivers.

A prototype test involving one to two States (most likely Maryland and Virginia) is scheduled to begin in 1996. The prototype will demonstrate the technology and refine the operational concept. A pilot test involving two to eight States will follow. The FI-IWA will issue a request

21 Johns Hopkins University Applied Physics Laboratory, *CommerciaI Vehicle Information Systems Network Statement of Direction,* prepared for the Federal Highway Administration, March 18,1996.

for information to solicit State interest in the pilot program in early 1996. The pilot program will deploy elements of the CVISN before moving to widespread deployment. The pilot program will focus on the core infrastructure, including IRP and IFTA clearinghouses and safety information systems. Complete national deployment is expected to occur by 2005. The estimated project cost is $12 million.

CVO Institutional Issues Studies/Mainstreaming Projects

In 1991, the FHWA offered $50,000 to each State department of transportation to study the institutional, or non-technical, barriers to the implementation of ITS/CVO programs. The objective of these studies was to provide a "bottoms up" perspective on the institutional barriers, as well as the strategies to overcome them.

Through early 1995, 49 States and the District of Columbia have participated in institutional issues studies. Seven multistate projects have encompassed 37 States and the District (see figure 80). Major consortia came together in the Southeast, the Middle Atlantic (Eastern States study), the Southwest (COVE study), and the Northwest (Western States study). Other teams included Maine, New Hampshire, and Vermont; Kansas and Missouri; and North Dakota and South Dakota. Twelve other States-primarily in the Midwest and Southern New England, but also including California-undertook individual studies. Hawaii, which has no interstate truck traffic due to its geographic isolation, is the only State that has not participated in the program. The final studies from the first round are scheduled for completion in late 1996.

The cooperative agreements negotiated between the FHWA and the State DOT's required that the studies document the current procedures for the administration and enforcement of motor carrier regulation; describe how ITS/CVO concepts could be applied to current motor carrier regulatory programs; identify the institutional issues that would impede or prevent the application of ITS/CVO services and the strategies likely to overcome these barriers; and create an interagency working group to provide oversight for the study as well a forum for discussion of CVO issues. The FHWA did not specify a particular technical approach to the studies, leaving that for the States to determine. In an important decision that increased participation in the program, the FHWA did not require a matching contribution by the States for these exploratory studies.

In mid-1994, the FHWA released guidelines for Phase II of the institutional issues studies. The focus of the second round of studies will be on developing and deploying ITS/CVO services. The second-round studies will serve as the launching pad for FHWA's "mainstreaming" initiative, which will build the institutional architecture to support ITS/CVO deployment. This time, the FHWA is encouraging States to participate in multistate consortia, and is requiring 50 percent matching contributions from each State. As of April 1996, teams expected to participate in this round include (see figure 81):

- The Inter-Regional consortium, including 12 States (Alabama, Florida, Georgia, Indiana, Kentucky, Michigan, Mississippi, North Carolina, Ohio, South Carolina, Tennessee, and Virginia). Georgia is the lead State. The group is focusing on uniform weight enforcement and electronic one-stop shopping.

- The Eastern States coalition, comprising seven States (Delaware, Maryland, New Jersey, New York, Pennsylvania, Virginia, and West Virginia). Pennsylvania is the lead State. The group is focusing on safety assurance activities.

- The scaled-down COVE project, comprising five States (Arizona, Arkansas, Colorado, Louisiana and Oklahoma). Colorado is the lead State. The group is focusing on electronic data sharing of safety and credentials information. The scaled-down Northwest team of Idaho, Oregon, and Utah. Oregon is the lead State. The group is focusing on permitting for longer-combination vehicles.

- The Northern New England team of Maine, New Hampshire, and Vermont.

- The Midwest team of Minnesota and Missouri.

California will conduct a second independent study. The plans of the remaining States are still unclear. The total cost of both phases of the institutional issues studies will be $7.5 million, including $5 million in Federal funding.

Lessons Learned

The general lessons learned from the administration projects to date are as follows:

1. **ITS/CVO** administrative applications **should** be supported by interagency, public/private working groups with an objective of resolving institutional barriers.
2. ITS/CVO administrative applications will benefit from linking existing CVO information systems.
3. The key challenges are developing ED1 standards and protocols, and establishing uniform identifiers for motor carriers, vehicles, and drivers.
4. **State** agencies will be the primary beneficiaries of ITS/CVO administrative applications.
5. One-stop shopping applications will generate benefits for large carriers, as well as carriers that conduct frequent transactions with State agencies.

1. ITS/CVO administrative applications should be supported by interagency, public/private working groups with an objective of resolving institutional barriers.

Participants in a wide range of the CVO institutional studies agree that the major achievement of the projects was improved communication among the many agencies involved in CVO activities, among the States, and between the public sector and the private sector. In many States, too, the studies heightened awareness about the role of CVO and the challenges to efficient administration of CVO activities. Efforts of the working groups have played a major role in developing this awareness.

The studies demonstrated a striking degree of commonality in the identification of major barriers. Major institutional barriers to ITS/CVO include the lack of support from top leadership of many affected agencies and the motor carrier industry; the lack of coordination among agencies; the lack of uniform regulations and policies across States; the lack of coop-

eration and trust between **State agencies and motor carriers; and the high anticipated public** and private implementation costs. Continuing support of the working groups was identified frequently as a critical strategy to overcome many of these barriers.

2. ITS/CVO administrative applications will benefit from linking existing CVO information systems.

The States have invested heavily in their existing computer systems and software for registration, fuel tax accounting, and accident reporting. Moreover, motor carrier registration and fuel tax accounting typically are a small part of a State's motor vehicle registration and tax accounting systems. Relatively few opportunities exist to build new, integrated CVO data bases because States are reluctant to overhaul their vehicle registration systems just to meet the need of their CVO programs. This means that most ITS/CVO information needs, whether for automated filing of fuel tax mileage reports or providing information on credential status for automated clearance services, must be met by linking existing computers **and** data bases, as is being attempted by the CVISN project.

The major exception is in the area of oversize/overweight permitting. State departments of transportation are willing to invest in the development of new oversize/overweight permitting **information** systems because the investment is small, relatively few transactions are involved compared to registration systems, and new technology (such as geographic information system software) can be applied to improve the accuracy and productivity of these transactions.

3. The key challenges are developing EDI standards and protocols, and establishing uniform identifiers for motor carriers, vehicles, and drivers.

Models and procedures for setting up EDI standards and protocols are readily available in the private and public sectors.. The basic CVO deskside transactions, such as registering a truck, are well defined. The data sets needed to support roadside transactions, such as automated clearance or safety screening, must be refined, but they are based on existing deskside transactions. The challenge is in bringing together the considerable number of parties who have a critical stake in these transactions and building a consensus on the technical details of the standards.

4. State agencies will be the primary beneficiaries of ITS/CVO administrative applications.

Linking existing State data bases is the first step toward rethinking and reengineering State motor carrier regulation. The current approach, with its standalone functions and separate data bases, worked well when carrier operations were local and enforcement needs were less complex. Today, that approach is costly, redundant, and increasingly ineffective. **By** integrating information and procedures, States can achieve greater productivity within fixed budgets and can support better safety enforcement.

5. One-stop shopping applications will generate benefits for large carriers, as well as carriers that conduct frequent transactions with State agencies (such as specialized riggers and haulers who move oversize/overweight loads).

The experience with the regional oversize/overweight permitting programs suggests that carriers will realize the benefits in the form of better quality service to their clients. The automation of registration and permitting will reduce labor costs for carriers, but the savings will be marginal unless the transaction volume is large. More valuable to carriers will be the improved reliability and predictability provided by electronic one-stop shopping. The ability to obtain permits or reregister a truck without delay means more reliable pick-up and delivery scheduling for clients.

FLEET AND VEHICLE MANAGEMENT

Fleet management systems include electronic trip recorders (also known as onboard computers), routing and dispatching systems, communications technologies, and automatic vehicle location systems. These technologies provide fleet managers with information about the use and deployment of their trucks, and facilitate timely and cost-effective trucking services.

The market for fleet management systems is relatively new. Three factors are driving demand in this market. The first is microprocessor technology, which has fostered the development of small, reliable, low-cost computers **that** can be installed on trucks and in dispatch offices. These computers capture, process, and communicate information quickly and efficiently, making existing fleet management tasks, such as dispatching, more cost effective. In addition, these computers can be used to monitor engine performance, determine truck location, control communications, maintain manifests and logs, and dispatch loads.

The second factor driving the market is the impact of the U.S. trucking industry deregulation, which spawned greater competition within the industry and provided incentives to motor carriers to operate with greater efficiency and lower costs. Since the deregulation of interstate trucking in 1980 and intrastate deregulation in 1995, competition among motor carriers has increased sharply, forcing fleet managers to improve their productivity or risk bankruptcy. In this competitive environment, fleet management has become a key tool for motor carrier managers to reduce costs and improve productivity.

The final factor driving the market for fleet management systems is global competition. The pressures and opportunities of the global marketplace are forcing companies to change the way they do business. Many of the changes, such as the use of overseas parts suppliers, the introduction of just-in-time manufacturing and distribution systems, and the increased emphasis on quality and consumer service, are having a direct impact on motor carriers. Motor carriers are being asked to provide nationwide coverage, intermodal services, schedules tailored to the needs of shippers and receivers, and close monitoring of the location and condition of shipments. Again, fleet management has emerged as one of the key tools that motor carrier managers can use to serve these new demands. Table 21 describes the major categories of fleet management technologies.

Table 21. Fleet and vehicle management systems.

System	Applications	Major Users	Estimated Cost
Electronic Trip Recorders/ Onboard Computers	Automatically monitors and records information on performance of the vehicle or the driver	Large or private fleets; carriers with national or regional operations	Capital costs range from $800 to $5,000 per vehicle.
Static Routing and Dispatching Software	Computes most direct route between an origin and a destination, enabling carriers to maximize fleet efficiency	Carriers operating on fixed routes with the same customers	Off-the-shelf software costs range between $1,000 and $3,000. Requires a desktop PC to run.
Dynamic Routing and Dispatching Software	Uses real-time congestion and shipment volume information to determine the most efficient route for a vehicle	Carriers operating large numbers of vehicles over variable routes; national fleets	Software ranges in cost based on functionality; average costs may exceed $5,000.
Communications Systems	Provides driver-to-driver communication and a link between the carrier's terminal, dispatch office, and vehicles	Large fleets, especially those with time-sensitive cargo and variable routes	Capital costs range from $200 to $2,000. Monthly service charges may be significant.
Automatic Vehicle Location	Enables real-time identification of a vehicle's location relative to a map; assists with package tracking and real-time routing	Truckload carriers operating over long distances	Onboard technology costs range from $2,000 to $5,000 per vehicle. Also requires software.

Technology Descriptions

Electronic Trip Recorders

Trip recorders originated as mechanical tachographs that recorded engine and vehicle speed over a period of time on paper charts. Although some simple tachographs are still on the market, the current generation of trip recorders is actually an onboard computer. These computers automatically monitor and record information on the performance of the engine and the truck, as well as ancillary equipment such as a refrigeration unit.

The more sophisticated units provide a keyboard and display screen, which allow the driver to log information, such as fuel purchases and hours of service, into the computer. A removable memory cartridge usually is used to transfer the recorded data onto a microcomputer for analysis. Sophisticated systems can relay real-time information while in transit to motor carrier terminals via wireless communications.

Large. fleets and private fleets tend to be the major markets for electronic logs. A recent ATA Foundation survey of approximately 500 motor carriers found that one-third of the respondents reported using onboard computers, primarily to monitor fuel and engine use.22 About 9 percent of respondents reported the use of electronic driver logs and trip recorders. Carriers reported annual fuel savings of 5 to 10 percent, or about $2,000 per truck, per year.

Routing and Dispatching Systems

Motor carriers use routing and dispatching systems to maximize fleet efficiency and reduce operating costs. Vehicle routing software uses digital mapping and optimization algorithms to determine the most direct route between an origin and a destination, or for a series of stops.

The two major categories of routing and dispatching software are:

- **Static Routing/Dispatching Software-This** software provides motor carriers with a routing plan for a fleet of vehicles. This software does not have the capacity to analyze the routing impacts of real-time information such as congestion or incidents. This software typically is used **by** carriers that operate on relatively fixed routes, serving the same customers on a routine basis.

- **Dynamic Routing/Dispatching Software-This** technology **uses** real-time information for routing and dispatching vehicles. The software can organize and analyze equipment availability, traffic congestion, incident information, changes in shipment volumes, and other information that may affect the progress of a particular shipment. Dynamic routing and dispatching software typically is used by carriers operating a large number of vehicles over variable routes. In addition, it is useful when shipment volumes are likely to change once trucks are already en-route.

22 The ATA Foundation, Inc., *ITS/CVO* User Services Benefit/Cost *Analysis,* prepared for the Federal Highway Administration, Pawtucket, Rhode Island, June 1995.

About half of the carriers responding to the ATA Foundation survey reported using routing and dispatching software. Carriers using routing and dispatching software reported operating cost savings-in mileage, fuel, time, labor, and paperwork-of 3 to 10 percent per year. However, the benefits varied considerably with the size and complexity of the carrier's fleet and operations.

Communication Systems

Communications systems provide a link between a carrier's terminal, dispatch sites, and vehicles. The systems available on the market today vary in terms of their sophistication, cost, and functionality. The principal technological approaches to deskside-to-vehicle communications, in ascending order of sophistication, are as follows:

- Telephone and facsimile, which use standard telephone lines but require that vehicles stop for the transmission of information.
- Advisory radio and radio digital broadcast systems.
- Mobile phones, citizen band radios, and land mobile communication.
- Onboard facsimiles, satellite transceivers, and two-way data text communicators.

Motor carriers adopt these communication systems to meet the specific needs of their operation. Carriers that operate a large number of vehicles or carry time-sensitive or highly valuable freight tend to invest in more sophisticated technology. Carriers that have less of a need to be in constant contact with their drivers may opt for less sophisticated forms of communications, such as the telephone.

Over half of the carriers responding to the ATA Foundation survey reported using mobile communications systems. These systems included conventional two-way radio, digital text communications, wide area pagers, and satellite communication links.

Automatic Vehicle Location

Automatic vehicle location (AVL) combines automatic vehicle identification with the location of a vehicle relative to a map. AVL and two-way communications between a vehicle and dispatcher allow a driver to receive real-time routing and navigation advice in response to route changes, traffic conditions, and unforeseen circumstances. One preferred AVL technology that is being used by a number of major motor carriers involves global positioning systems (GPS), which locate vehicles using trilateration from multiple satellite-based transmitters.

Truckload carriers operating vehicles over long distances (typically over 805 km [500 mi] from the base of operations) widely have adopted AVL technology. Carriers use the information that they collect through AVL to provide package tracking information to customers, to estimate time of arrival, and to support route planning decision making.

In the industry as a whole, however, AVL is still an emerging technology. About 10 percent of the carriers responding to the ATA Foundation survey reported using AVL systems.

Lessons Learned

The general lessons from carriers' experience with fleet management systems to date are as follows:

1. Motor carriers are aware of ITS in general and fleet management technology in particular, and the number of carriers and trucks using ITS systems is increasing rapidly.
2. The early adopters of ITS technology have been large, for-hire truckload carriers with national operations.
3. Motor carriers are encouraging equipment suppliers to integrate ITS systems with motor carrier administrative systems and business logistics management systems.

1. Motor carriers are aware of ITS in general and fleet management technology in particular, and the number of carriers and trucks using ITS systems is increasing rapidly.

Data on the market penetration of specific products is sketchy, but general trends can be discerned from Truck Inventory and Use Survey (TlUS) data and the advertising content of motor carrier industry journals. A comparison of 1987 and 1992 TIUS survey results shows a 50-fold increase in the number of trucks equipped with trip recorders, electronic engine controls, automatic vehicle identification transponders, or AVL systems.23

2. **The early adopters of ITS technology have been large, for-hire truckload carriers with national operations.**

The ATA Foundation survey identified a fairly widespread use of communication systems, routing and dispatching software, and onboard computers within the trucking industry. In most cases, large, for-hire truckload carriers with national operations were the first fleets to adopt and deploy these technologies. Sales of ITS equipment to regional carriers and local pick-up-and-delivery operators are growing now. This pattern now appears to be repeating with AVL systems and other emerging technologies.

3. Motor carriers are encouraging equipment suppliers to integrate ITS systems with motor carrier administrative systems and business logistics management systems.

Early ITS products were designed as standalone products, but carriers are moving to integrate the systems. Integration may include, for example, electronically linking customer order systems to routing and dispatching software, or combining data from satellite vehicle location systems into route planning software. To accomplish integration, many equipment and service vendors are considering, and some are moving toward, an open architecture for ITS fleet and vehicle management systems. The introduction of electronic engine controls is

23U.S. Department of Commerce, Bureau of the Census, Truck Inventory and Use Survey for 1987 and 1992. In 1987, TIUS statistics show that less than 0.01 percent of the Nation's 4.5 million medium and heavy trucks were equipped with trip recorders, electronic engine controls, automatic vehicle identification transponders, or automatic vehicle location systems. In 1992, TIUS statistics show that just under 4.0 percent of trucks were equipped with one or more of these technologies.

accelerating this process. Beginning in 1996, manufacturers will equip all new heavy-duty truck engines with electronic controls built around the Society of Automotive Engineer's standards for in-vehicle communication. This "data bus" will provide a communications infrastructure within the truck-a vehicle-level Internet-that will support integration of data from engine controls, communication systems, onboard monitors, and other instruments.

HIGHWAY TRAFFIC MANAGEMENT

Highway traffic management has been one of the least developed areas of the ITS/CVO program. Most traffic management applications are oriented to passenger cars, although their benefits are available to commercial vehicles as well. The major ITS/CVO projects relating to traffic management fall into three categories:

- Advanced traveler information systems oriented to commercial vehicles.
- Incident management programs.
- Hazardous materials incident notification projects.

Table 22 highlights the major ITS/CVO highway traffic management projects to date.

Projects

I-95 Corridor Coalition CVO Project

The objectives of the I-95 Corridor Coalition Commercial Vehicle Operations Project are to identify and develop an operational test of advanced traveler information systems for commercial vehicles along the I-95 Corridor, and to examine opportunities to make the truck regulatory process more cost effective for both motor carriers and the States.

The first phase of this study is defining trucking patterns in the I-95 Corridor from Maine to Virginia, and developing an operational test of ITS technologies that provide motor carriers with the information on congestion, incidents, weather, and optimum routing that they need for safe and efficient operations. The second phase is developing a corridor-wide program to streamline State motor carrier administrative, regulatory, and enforcement procedures.

The study is being conducted by Cambridge Systematics, Inc. for the I-95 Corridor Coalition, a consortium of 33 public and private sector agencies. States represented in the Coalition include Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia.[24] As of April 1996, the consultant has defined the motor carrier markets, identified major truck activity centers, assessed motor carrier routing and dispatching procedures, summarized the results of ITS/CVO institutional issues

[24] "West Virginia is not a member of the Coalition, but is being included in the study due to its interest in the Coalition's activities.

Table 22. ITS/CVO highway traffic management projects.

Title	Objective	Participants	Status	Budget
I-95 Corridor Coalition CVO Project	Identify and develop an operational test of advanced traveler information systems for commercial vehicles along the I-95 corridor	Consortium of 33 public and private sector agencies in Northeast	Research underway	$0.7 million
Incident Management projects	Identify and coordinate activities to enable more rapid detection, response, and clearance of incidents from highways	Individual programs in at least 15 States and 30 major metropolitan areas	Various stages of operation	Various
Operation Respond	Provide rapid, accurate information on freight cargo following accidents or spills	Federal Railroad Administration, FHWA, RSPA	Completion scheduled for June 1997	$0.4 million
Hazardous Materials Fleet Management and Data Monitoring System	Demonstrate information systems to identify the contents of hazardous materials transported by motor carriers	National Institute for Environmental Renewal, Pennsylvania DOT, FHWA, PAR Government Systems Corp.	Completion scheduled for December 1996	$4.0 million

Note: NA = Not Available

studies, and developed a draft CVO program plan. The project is scheduled for completion in 1996. The total project cost is estimated at $700,000.

Incident Management

A growing number of cities and States are establishing and expanding programs to reduce the impact of incidents on traffic. Incidents range from simple breakdowns to major accidents that can tie up highway traffic for hours. Incident management includes activities to enable more rapid detection, response, and clearance of incidents from highways, as well as efforts to spread information about the incident to encourage drivers to seek alternate routes and reduce the traffic queue. Incident management programs are not geared specifically to the needs of commercial vehicles, but motor carriers are frequent beneficiaries of such activities.25 In many areas, incident management presents an opportunity to test the technologies and create the institutional structures needed to support more advanced ITS services.

The earliest incident management programs began in the 1960's and 1970's in major cities such as Chicago and Los Angeles. These efforts often consisted of ad hoc responses to specific crises or rising traffic congestion. More recent incident management programs, such as those in Minneapolis and Dallas/Fort Worth, have been the product of cooperation between several agencies and jurisdictions that are impacted by incident-related congestion. Today, at least 15 States and 30 metropolitan areas have deployed, or begun development of, formal incident management programs.

Incident management programs have three stages. The general state-of-practice is as follows:

- Detection and Verification-Most major incidents are detected within 5 to 15 min. About one half of all incidents are reported to police or highway departments from cellular phones or roadside callboxes. Routine police patrols or special service patrols detect between one third and one half of all reported incidents. The remaining incidents are detected or verified through automatic sensors or closed-circuit television cameras.

- Response and Clearance-Communications about an incident commonly are handled directly by police dispatchers, but an increasing number of cities and States are building special purpose traffic management centers to coordinate traffic and incident information. Almost all urban areas have emergency response plans for catastrophic incidents, especially those involving hazardous materials; some have formal procedures for major incidents; and a few have procedures for minor incidents. Private tow-truck operators clear the vast majority of incidents, although some highway departments and toll authorities purchase their own equipment.

- Recovery and Information-Most cities and States have prepared traffic diversion plans for major incidents, and can use highway advisory radio, variable message signs, and other communication venues to reroute traffic out of the queue and reduce travel demand in the area. Many cities are finding that partnerships with commercial radio stations are an at-

25The ATA Foundation, for example, has been a key promoter of incident management activities and is providing staff support for the National Incident Management Coalition.

tractive method of disseminating traffic information to motorists. Overall, however, traffic management is the least developed element of incident management programs.

The benefits of reduced incident-related congestion accrue to the entire motoring public. Motor carriers are particular beneficiaries along major freight corridors or near freight generation centers. Left unchecked, incident congestion can create bottlenecks on the national highway system and impede efficient goods movement.

State and local agency operations budgets bear most of the costs of incident management programs. The Federal Government increasingly is financing planning and startup costs, and, since passage of the ISTEA, is able to fund operating costs as well. Many metropolitan areas are using ITS early deployment grants to support the development of incident management programs. Cities and States increasingly are looking to the private sector for assistance with the operation of service patrols and the dissemination of traffic information.

Funding for incident management programs tends to be limited due to stiff competition from competing transportation needs such as highway construction and maintenance. Yet the experience of many cities has shown that incident management can be a cost-effective solution: the Chicago program, for instance, is estimated to have a benefit/cost ratio of 17 to 1.[26]

Hazardous Materials Incident Response

Incidents involving hazardous materials are a special concern because of the risk they pose to respondents, motorists, and the environment. A nurnber of projects are examining ways to track and exchange information about hazardous materials shipments that are involved in accidents and other incidents.

The Houston Cooperative Emergency Planning Project-also known as "Operation Respond"-began as a partnership between the Federal Railroad Administration (FRA) and Houston-area railroads. Its purpose was to provide rapid, accurate information on the contents of railcars to response personnel following accidents or spills. The project included electronic placards on both rail cars and cargo containers inside the cars with information on their contents. The second phase of the project, which began in August 1994, incorporates motor carriers that carry hazardous materials as well. The project is developing a format for information exchange and computer linkages between railroads, intermodal motor carriers, and first responders to speed the flow of information and notification about hazardous materials incidents. Operational tests are being conducted in Atlanta, Georgia; Buffalo, New York; Houston and Laredo, Texas; and New Orleans and Baton Rouge, Louisiana. The FHWA and the U.S. DOT's Research and Special Programs Administration (RSPA) are participating in this phase of the project. The project is expected to conclude in June 1997, with a total cost of $350,000.

The National Institute for Environmental Renewal (NIER) is developing a pilot program for a Hazardous Materials Fleet Management and Data Monitoring System (FMMS). The project

26 Cambridge Systematics, Inc. in association with JHK & Associates, Transmode Consultants, Inc., and Sydec, Inc., *Incident Management Executive Summary*, prepared for the Trucking Research Institute, Cambridge, Massachusetts, October 1990, p. 14.

will establish and operate information systems to identify the contents of hazardous materials transported by motor carriers. It will provide information to facilitate response to incidents involving hazardous materials shipments by motor carriers, either directly or through linkages to other systems. Other project participants include the Pennsylvania Department of Transportation, the FHWA, and PAR Government Systems Corporation. A pilot program along the Interstate 81 corridor between Binghamton, New York, and Harrisburg, Pennsylvania is scheduled for completion in December 1996. The estimated total project cost is **$4.0** million.

Lessons Learned

The major lessons learned from the highway traffic management projects to date are as follows:

1. The national freight system in general, and motor carriers in particular, are largely invisible to State and metropolitan traffic engineers, whose attention is focused primarily on lTS applications for private automobiles and the management of peak-period urban congestion.
2. Motor carriers need information on regional traffic conditions as well as metropolitan traffic conditions.

1. The national freight **system in general, and motor carriers in particular, are largely invisible to State and metropolitan traffic engineers, whose attention is focused primarily on ITS applications for private automobiles and the management of peak-period urban congestion.**

   Because large trucks typically account for less than 5 percent of peak-period traffic on urban freeways, traffic engineers have tended to overlook them in traffic analysis and planning. Compared to the data available on automobiles, relatively little information has been collected on truck movements in urban areas. Most State and metropolitan planning agencies do not model truck trips separately from automobiles when forecasting and analyzing traffic patterns. This tendency has carried over into the planning and development of advanced traffic management systems (ATMS) and advanced traveler information systems (ATIS). Few of the systems under development today take into account the special routing needs of trucks, or provide information tailored to the needs of motor carrier dispatchers and drivers.

2. Motor carriers need information on regional traffic conditions as well as metropolitan traffic conditions.

   Three-quarters of all truck trips are under 322 km (200 mi), and most are clustered around the major population and distribution centers (such as Boston, New York, Atlanta, Chicago, Dallas, Denver, Los Angeles, and Seattle). However, over half of these truck trips extend outside the core metropolitan areas that currently planned ATMS and ATIS will cover. Because trucks (particularly large trucks) generally are restricted to a limited network of highways, dispatchers and drivers need information on highway incidents, congestion, and construction closures well in advance of their arrival into a congested area if they are to divert to alternative routes. The Transportation Operations Coordinating Committee (TRANSCOM) program, which collates and disseminates information on highway incidents,

congestion, and construction closures to transportation agencies in the New York-New Jersey metropolitan region, ran a pilot program with a handful of carriers to test the motor carrier market for traffic information. The pilot was successful, and will be expanded by the I-95 Corridor Coalition into a corridor-wide test.

THE NATIONAL CVO PROGRAM

Plans for the future stages of the ITS/CVO program continue to evolve, reflecting technological developments as well as the shifting political climate. One of the most detailed outlines of the current thinking for the future of the ITS/CVO program has been developed by the Applied Physics Laboratory at Johns Hopkins University, in consultation with the FHWA Office of Motor Carriers, ITS America, and Cambridge Systematics, Inc.

Figure 82 summarizes State participation in the major ITS/CVO projects. Figure 83 presents a "roadmap" to the ITS/CVO program. It details the major tasks planned for the ITS/CVO program, their expected start and end dates, and the linkages between tasks. The information included in this roadmap is accurate as of November 1995.

The major paths in the ITS/CVO roadmap include:

- **Safety Information-**Tasks focusing on the development of the information systems and network to provide enforcement officials and other personnel with information relevant to safety assurance activities. These tasks include deployment of pen-based software and an inspection selection system at 100 MCSAP sites in December 1995; development of the SAFER system; and the deployment of SAFER at 200 MCSAP sites by 1997.

- **Administrative** Processes-Tasks focusing on the development of electronic methods for the application, issuance, and reporting of credentials. These tasks initially focus on the one-stop shopping and AMASCOT operational tests, as well as the development of interstate clearinghouses for IFTA and IRP data and transactions. In the late 1990's, planned credentials activities include the expansion of clearinghouses to include special permitting functions such as oversize/overweight vehicles and hazardous materials.

- **Electronic** Clearance-Tasks focusing on the enhancement of safety, weight, and credentials verification technologies and programs. These tasks are a major focus of near-term CVO activities, and include the completion of many ongoing projects, including the Commercial Vehicle Information System, the Out-of-Service Verification projects, and the Roadside Data Technology Project. These tasks also will emphasize research on such topics as the State experience with weigh-in-motion (WIM) and State enforcement strategies, along with the development of guidelines for the use and maintenance of WIM. In the late 1990's, planned activities include the development of advanced portable scales and a pilot test of new weighing systems and strategies.

- **International Electronic Border** Clearance-Tasks focusing on improving border clearance procedures with both Canada and Mexico. In the near-term, the FHWA is conducting four operational test programs at specific crossings. In forthcoming years, tasks will include the

development of international compatibility agreements and standard forms and the reengineering of the border process.

- **Automated Inspection-Tasks** focusing on automating portions of the vehicle inspection or carrier review processes. These include automated tests of brake conditions and fuel emissions, and the development of onboard diagnostic systems.

- **Onboard Safety-Tasks** focusing on the development of onboard systems to monitor the condition of the vehicle and the driver. A major emphasis will be monitoring brake performance. In addition, the program will develop non-intrusive technologies to monitor driver alertness and performance. These tasks will be linked to the Society of Automotive Engineers' development of the J1939 vehicle "data bus" standard.

- **Freight Mobility-Tasks** related to fleet and vehicle management activities. The future path for the Federal role in this area is under review.

- **Hazmat Incident Response-Tasks** focusing on **the development** of systems and procedures to respond to incidents and accidents involving hazardous materials. In the near-term, these include the ongoing Operation Respond and FMMS projects. The results of these projects may lead to the development of a prototype hazmat response system and a pilot test.

- **Architecture and Standards** (CVISN)-Tasks focusing on the deployment of the ITS/CVO system architecture and standards. The initial emphasis will be on the CVISN prototype and pilot test. In the late 1990's, the program will develop standards for ED1 and AVI, and prepare for nationwide deployment of CVISN.

- FHWA Coordination-Tasks focusing on the management of the ITS/CVO program, including development of a program plan, benefit/cost analyses, institutional assessments, and similar programs.

5. New Directions for the National ITS/CVO Program

The national ITS/CVO program must have a strategy for dealing with each of the three program building blocks: markets, organization, and resources. This chapter reviews the current ITS/CVO program strategies for each building block, and recommends new directions and strategies to strengthen the program. In developing new directions, the chapter considers the following factors:

- The procedures currently used by State agencies to administer and enforce commercial vehicle regulations.
- The level and distribution of public sector CVO administrative and enforcement activity among the States.
- The operating characteristics such as fleet size and geographic range of operations that shape the motor carrier industry's demand for new technologies.
- The geographic distribution of trucking activity among regions and highway corridors.
- The current needs of stakeholders in the CVO community.
- The institutional barriers to further progress on ITS/CVO planning and development.
- The lessons learned from more than 50 existing public and private ITS/CVO initiatives.

MARKETS/MANDATES

The ITS/CVO program needs clearly defined markets and mandates. In the private sector, the "mandate" for a product or service comes in the form of market demand; in the public sector, a mandate may arise from popular demand, legislation, or executive leadership.

With respect to commercial vehicle operations and regulation, there is neither a single motor carrier industry market nor a monolithic public sector mandate. The motor carrier industry encompasses multiple market segments, each of which has distinct operating characteristics. Public agencies involved in CVO policy and deployment vary in their priorities, capabilities, and objectives. Consequently, there is no single "market" or "mandate" for ITS/CVO, but rather several distinct market segments and mandates that must be differentiated to meet the needs of the private and public sectors. Despite notable progress in some areas such as preclearance and fleet management, these markets and mandates are not clearly defined, in large part because data are scarce, technologies are evolving, and business opportunities are uncertain,

Current Strategies

Today's ITS/CVO "program" is an amalgam of dozens of initiatives covering multiple functions. These initiatives represent the efforts of individual States, consortia of States, the Federal Government, individual motor carriers, and industry associations. The program has expanded on a project-by-project basis, driven heavily by technological development, the particular needs of participating agencies and carriers, and individual personalities.

The market strategies implied by the current ITS/CVO program include the following:

1. Focus on markets for weigh station clearance and one-stop shopping services.
2. Focus on major Interstate highway corridors.
3. Work with existing procedures and systems.
4. Promote motor carrier **and** private sector participation and investment to develop private sector markets,
5. Emphasize voluntary participation by States and carriers.

1. Focus on markets for weigh station clearance and one-stop shopping services.

The ITS/CVO program to date has focused on the development of two major services: "transparent borders," the preclearance of vehicles past weigh stations and ports-of-entry; and "one-stop shopping," efforts to provide carriers with all necessary credentials and permits through a single point of contact. These services have appealed to States and carriers because of their potential to increase productivity, and because they involve refinements of existing procedures rather than the development of new regulatory approaches. The technologies and procedures necessary for preclearance have been developed through the HELP and Advantage CVO projects, along with work by individual States such as Oregon. Although not as advanced as preclearance, progress has been made on one-stop shopping through multistate operational tests and the development of multistate oversize/overweight permitting systems.

The focus on these two user services has shaped the overall development of ITS/CVO activities. Preclearance programs are important and capable of generating large benefits, but are not applicable to the majority of truck movements. Other services, such as automated roadside safety inspection, would apply to a larger number of vehicles. Similarly, the emphasis on one-stop shopping may be deflecting attention from more fundamental and productive changes, such as the reengineering of credentials administration procedures. Moreover, operational issues such as commercial vehicle fleet and traffic management have received only limited public sector attention to date.

2. Focus on major Interstate highway corridors.

The initial ITS/CVO projects were organized around major Interstate highway corridors to give the projects a strong marketing image and to provide a rationale for cooperative efforts among groups of States. The HELP project began as a demonstration of preclearance technologies along Interstates 5 and 10 in the Western United States. In the Eastern United States, the major CVO project has been Advantage CVO, focusing on Interstate 75 from Michigan to

Florida. These programs have made progress in demonstrating the viability of automatic vehicle identification (AVI), weigh-in-motion (WIM), and similar technologies. Moreover, these programs drew together diverse groups of agencies and States to work cooperatively, with some private sector participation.

Despite these successes, the heavy emphasis on these corridor programs may have limited the direction of ITS/CVO activity. The HELP and Advantage CVO programs were conceived to provide benefits for long-haul truck movements along single highway corridors. Trucks that travel for long distances over these corridors certainly stand to gain from the ability to preclear weigh stations. However, these trucks represent a small share of truck movements nationwide. The vast majority of truck trips use a network of highways rather than a single corridor. Most trucks will use an Interstate corridor for a portion of their trip and may cross a State line, but most will encounter only a few weigh stations, if any, during any given trip. Most fleets operate at a local or regional level, rather than at a transcontinental scope. These fleets will have greater interest in ITS/CVO projects that improve highway safety, reduce congestion, and ease the administrative burden associated with motor carrier regulation.

An additional difficulty with the corridor approach to the ITS/CVO program is that it has not encompassed all major truck lanes in the Nation. Attempts to create ITS/CVO corridors along other major Interstates-most notably, along Interstate 80 from New York to San Francisco-collapsed amidst disagreements about the objectives and scope of these initiatives. Progress has been realized on a CVO program for the I-95 corridor-the most congested highway corridor in the Nation and a critical artery in the national freight system-only because the I-95 Corridor Coalition is looking beyond the Interstate to CVO issues regionwide.

3. Work with existing procedures and systems.

Most ITS/CVO projects to date have involved efforts to automate existing procedures rather than attempt to use technology to change the way carriers and Government agencies do business. For example, weigh station clearance-the service in which the States have made the most progress--essentially is the use of modern sensor and communication technologies to improve efficiency of existing procedures for size, weight, and credentials verification. Similarly, motor carriers have been applying fleet management systems to automate their existing recordkeeping, internal communications, and routing.

In view of institutional resistance to change, this conservative approach has appealed to many States **and** carriers. Certainly, the automation of business practices can have a large, immediate impact on productivity, and is much needed in many agencies. However, an emphasis on automating existing procedures may prevent a fundamental restructuring of motor carrier regulations, and preclude these technologies from reaching their full potential.

4. Promote motor carrier and private sector participation and investment to develop private sector markets.

Most aspects of the CVO program have recognized the importance of motor carrier and private sector participation and investment, although the private sector's level of involvement has been uneven. Individual motor carriers have assumed the lead in the deployment of fleet management technologies. Industry associations such as the American Trucking Associations (ATA) and the National Private Truck Council (NPTC) have been involved in most of the major public sector initiatives; some of these projects have attracted participation **by** individual

motor carriers as well. Motor carriers have been willing to participate in planning exercises or operational tests, but generally have been reluctant to commit investment capital as a condition of their participation.

Participation by vendors and third-party service providers has been scarce and indirect in many cases. Consequently, they are not involved in shaping the overall program. Certain service providers, such as Lockheed IMS, have become intimately involved in particular CVO projects, such as HELP. This involvement has included a heavy commitment of financial resources. Overall, however, the participation of the vendors and service providers has been limited to activities considered to be in their own economic interest, and not to general program planning and support.

5. Emphasize voluntary participation by States and carriers.

Although the FHWA actively is promoting the development of ITS/CVO user services, the Federal Government generally has eschewed formal mandates for participation in ITS/CVO initiatives. This lack of a formal mandate has provided flexibility for States to tailor programs to their specific needs, and has helped to alleviate some motor carrier concerns with respect to the Government's intentions. However, the lack of a mandate has slowed the development of ITS/CVO programs.

Assessment

ITS/CVO products and services are emerging in four areas: enforcement, credentials administration, fleet and vehicle management, and highway traffic management. The most promising markets are in enforcement and fleet management. The needs and priorities of these four areas vary, and the ITS/CVO program must embrace these differences.

Enforcement

The relative size and level of interest in lTS/CVO enforcement markets are illustrated in figure 84. These applications include automated weight and credential clearance, driver and vehicle safety assurance, electronic toll collection, driver fatigue monitoring, and automated brake testing. The market share for State agency applications, such as automated weigh station clearance, is measured relative to the number of States; the market for carrier applications, such as driver fatigue monitoring, is measured relative to the number of trucks. The diagram represents the current outlook for the applications given today's technologies. The relative positions of the applications are likely to change as more cost-effective approaches are developed.

Automated weight and credential clearance: The market for automated weight and credential clearance is strongest in the West and weakest in the Northeast. These extreme positions reflect the distribution of fixed weigh stations across the Nation. Other factors driving this market include variations in the collection and enforcement of motor fuel taxes, as well as differences in pavement conditions.

The States conducted more than 162 million enforcement weighings in 1993, so the potential market for automated clearance is large (see table 23). Less than one-third of these weighings used WIM technologies. Citations were issued to just 0.4 percent of the weighed vehicles, suggesting that States could identify more noncompliant vehicles from the use of portable WIM

Table 23. ITS/CVO enforcement transactions, 1993.

	Number. 1993	Percent (%)
Weight Inspections	165596,432	
Fixed	109347,468	67.3
Portable/Semiportable	5523,326	1.6
Weigh-in-Motion	50,725,638	31.2
Size/Weight Citations	653,483	
As percent of weight inspections		0.4
Safety Inspections	1,935,344	90.5
Non-hazmat	1,752,153	8.0
Hazmat	154,487	1.5
Passenger bus	28,704	
Out-of-Service Violations		
Vehicles	503,094	
Drivers	128,569	
As percent of Safety Inspections		
Vehicle		26.0
Driver		6.6
Carrier Reviews	11,194	
Commercial Vehicle Traffic on Toll Roads	176,564,000	

Sources: Federal Highway Administration, Office of Motor Carriers; International Bridge, Tunnel, and Turnpike Association

systems to screen vehicles, at least on high-volume truck routes. Carriers would benefit from a reduction in the delay associated with weight inspections, which can last up to 20 rnin depending on the amount of congestion at the inspection site.

Driver and vehicle safety assurance: In contrast, interest in better driver and vehicle safety enforcement is high and relatively uniform across the Nation. Interest in better enforcement of driver safety is particularly strong in heavily congested areas such as the Northeast, southern California, and metropolitan Chicago, because of the potential of truck and hazardous material accidents to cause massive delays and injury.

The number of safety inspections conducted each year is substantially smaller than the number of weighings, totaling 1.9 million vehicles in 1993. However, the potential impact on motorists of an unsafe vehicle or driver is much more severe than that of a overweight vehicle. Moreover, safety citations are issued at a much greater frequency than size and weight violations. In 1993, safety inspectors placed 26 percent of vehicles and 7 percent of drivers out of service following roadside inspections.

The use of safety assurance systems could enable States to inspect more vehicles each year, and also could provide significant time savings. A typical roadside inspection can last up to 30 min. Carrier reviews, which are relatively few in number, represent a large expense for both agencies and carriers because they may require more than 3 days of staff time.

Onboard safety monitoring: Because driver fatigue and brake problems are among the primary causes of truck accidents, interest also is high for Onboard safety monitoring systems such as driver alertness monitoring and automated brake testing. However, the market for these applications is small because the high cost of these systems is likely to be prohibitive for many carriers. In addition, many drivers view these systems as an invasion of their privacy.

Electronic toll collection: The market for electronic toll collection is strongest in the Northeast and Great Lakes regions, where the majority of the major toll roads are located. There are scattered markets for electronic toll collection along bridges and tunnels in Florida, Louisiana, California, and other areas. Electronic toll collection will be incorporated into in most future toll road or bridge projects. Commercial vehicle revenue traffic along major toll roads totaled more than 176 million vehicles in 1993, so the potential market for electronic toll collection is substantial.

Administration

Table 24 describes the volume of transactions for the major commercial vehicle regulatory functions, including registration, fuel tax administration, oversize/ overweight permitting, and commercial driver licensing. The most frequent transactions are those that apply to every commercial vehicle (e.g., registration), or driver (e.g., commercial driver's license). The number of International Fuel Tax Administration (IFTA) or International Registration Plan (IRE) accounts is substantially smaller because these agreements apply only to interstate carriers; however, the number of transactions represented by a single IFTA or IRP account can be quite high.

The market for ITS/CVO administrative services includes three types of transactions: those between States; those between agencies within a single State; and those between motor carriers and regulatory agencies.

Table 24. ITS/CVO administrative transactions.

	Number
ICC-Registered Carriers (March 1995)	69,828
Vehicle Registrations (1993)	
Truck Tractors	1,288,828
Truck Trailers	3,906,832
Buses	654,432
IRP (1994)	
Accounts	202,010
Power Units	1,268,109
Trailers	1,031,292
IFTA/RFTA Accounts (projected at full implementation, 1996)	196,630
Oversize/Overweight Permits (1993)	1,791,432
CDL Master Pointer Records (April 1995)	7,370,981

Sources: Interstate Commerce Commission; Federal Highway Administration; IRP, Inc.; IFTA, Inc.; AAMVAnet, Inc.; interviews with State agencies; Cambridge Systematics estimates.

Interstate Transactions: Figure 85 describes the current market for ITS/CVO administrative services that apply to interactions within and among States. The size of the market is measured relative to the number of agencies.

The initiatives to provide for interstate information exchange are the most advanced of the projects in the area of lTS/CVO administration. The FHWA is developing the Commercial Vehicle Information Systems and Networks (CVISN) to serve as a high-level infrastructure for data exchange among States, agencies, and carriers. The national Base State Working Group, which is overseeing the expansion of the IRP and the IFTA, is moving toward the development of national clearinghouses for the electronic interchange of registration and fuel tax permit information among States. The Federally-sponsored Safety and Fitness Electronic Records (SAFER) project will link State and Federal motor carrier safety data bases, enabling the electronic interchange of information on safety ratings, inspections, citations, and accidents across States. The regional oversize/overweight permitting consortia provide a platform for the interchange of permit information. The Alliance for Uniform Hazmat Procedures is developing a pilot program to streamline the complex realm of hazardous materials regulations.

Intrastate Transactions: The market for interagency transactions within a single State is new. Most motor carrier agencies do not routinely exchange or correlate data on individual motor carriers. For example, State departments of transportation seldom know when a motor carrier is delinquent on fuel tax payments to the State revenue department. In addition, carriers generally are able to reregister trucks without being held accountable for clearing outstanding weight or safety citations. This lack of interagency communication represents a major loophole in the effective administration and enforcement of motor carrier regulations.

The findings of the CVO institutional issues studies indicate that the need for ITS/CVO applications addressing this problem is more immediate than the need for improving motor carrier/agency transactions, although both are recommended. The market for interagency applications is being driven by State budget constraints that are forcing States to explore every possible source of revenue, by staff shortages that are prompting States to eliminate redundant data entry procedures, and public pressure for more enforcement of truck safety regulations.

The major initiative to provide for the intrastate exchange of information among agencies is the Commercial Vehicle Information Systems (CVlS) project. This project will develop electronic links between carrier safety performance records and vehicle registration records so that carriers with unsatisfactory safety records can be denied registration of their trucks. This project is of critical importance to the ITS/CVO program in particular, and to the motor carrier safety program in general. If the project is successful, then it will become a model for this market, and the demand for interagency electronic data interchange will expand rapidly.

Motor Carrier/Agency Transactions: The markets for ITS/CVO administrative services that handle transactions between motor carriers and agencies are described in figure 86. Market size is measured relative to the number of **motor carrier** firms. The largest market is for basic information services that provide guidance through the thicket of motor carrier regulations and agencies: a single point of contact, a single telephone number for compliance information, or an **on-line regulatory** bulletin board. These services could apply to a wide range of carriers, regardless of fleet size or financial resources.

The markets for electronic tax filing and payment applications, electronic oversize/overweight permitting, and electronic registration are smaller, but still sizable. All three of these motor

carrier/agency markets involve the automation of well-established procedures: tax filing, permitting, and registration. Large fleets with established capabilities for electronic data interchange (EDI) and electronic funds transfer (EFT) will make use of automated credentialing applications. However, most truck fleets are relatively small, and the potential savings accruing to most fleets from automated credentialing is uncertain. Penetration of these markets is likely to be slow unless the applications are offered as part of a package of services. The HELP, Southwest, and Midwest one-stop shopping demonstrations, now getting underway, propose to do this. The experiences of these demonstrations will help to better define the markets for motor carrier/agency applications.

Fleet and Vehicle Management

Figure 87 describes the current markets for fleet and vehicle management systems. These systems include mobile communications, EDI for business transactions, automated routing and dispatching, onboard computers, and automatic vehicle location. The market size is measured in terms of the potential number of motor carrier customers for these technologies.

The largest market is for mobile communications systems such as conventional two-way radio, digital text communications, wide area pagers, and satellite communications links. Surveys indicate that the market penetration for these systems is significant and growing. In addition, demand appears to be relatively independent of fleet size or operating range.

The markets for other fleet management technologies are smaller, but interest in most applications is high. This is particularly true for the use of ED1 for business transactions, as well as automated routing and dispatching and automatic vehicle location

Highway Traffic Management

Figure 88 describes the current market for ITS/CVO highway traffic management applications. The market for general incident management programs is large and of increasing interest to both States and motor carriers. The potential market for incident and congestion notification systems also is large, but interest in this service, particularly among motor carriers, has not yet reached critical mass. Hazardous materials incident notification and response systems represent a smaller market in which there is growing interest from States and cities.

Barriers

There are three primary market barriers to the development of the ITS/CVO program: inconsistent public sector support; limited private sector support; and the lack of data to support decision making and market planning.

Inconsistent Public Sector Support

Efforts to implement ITS/CVO services cannot succeed without support from the top management of the public agencies involved in CVO. Without this mandate, it is difficult to make the organizational changes or commit the resources necessary to support ITS/CVO implementation. The agencies that must be part of ITS/CVO programs include not only State departments of transportation, but also the full spectrum of agencies whose activities affect CVO, including departments of motor vehicles, revenue, public safety, environmental protection, and economic development; commerce and public utility commissions; toll authorities; and

State police. Each of these agencies faces a multitude of demands and responsibilities, yet each must make the implementation of ITS/CVO a priority for any major innovation to succeed. Unfortunately, the experience to date of many ITS/CVO projects, as documented in the CVO institutional issues studies, is that this support is tenuous and inconsistent.

Four factors contribute to the lack of agency support for ITS/CVO initiatives:

- *A lack of understanding and appreciation of the scope and complexity of CVO regulations and operations.* Many of the key players simply do not grasp the "big picture" of CVO operations and regulations. Each agency sees only its own small piece of the CVO world, without regard for the role it plays in the larger regulatory scheme. Without this understanding, agencies may not realize fully the burden of regulation on motor carriers, or perceive the need to streamline administrative processes to achieve greater efficiencies. A major achievement of the CVO institutional issues studies was the promotion of a broader view of CVO through the working groups and the documentation of the current business practices in each State.

- *An inadequate understanding and appreciation of ITS/CVO technologies and services and their potential* benefits. Because many agency representatives are not exposed to the full spectrum of commercial vehicle operations, they do not have the opportunity to develop a detailed understanding of ITS technologies and their potential benefits. This lack of understanding also reflects limited technical expertise among current agency staff, as well as the difficulty of keeping current with the full range of ITS applications, from mature existing technologies to untested research and development products.

- *A lack of customer service orientation among* agencies *involved in CVO.* Motor carriers value timeliness, accessibility, fairness, and customer service attitudes among State employees, but some agencies may be limited in their ability to satisfy these demands. Many aspects of ITS/CVO require agencies to rethink their operations and procedures, yet agencies may not place a high priority on the need to pursue administrative efficiencies that would benefit the motor carrier industry.

- *A need for statutory, administrative, and regulatory change.* In many States, the current language of statutes and regulations does not reflect the advent of modern communications systems and information technologies. References to "written communication" or "paper" credentials that are "carried" in vehicles, if strictly enforced, would impede the widespread use of EDI, EFT, and AVI.

Limited Private Sector Support

Uneven and inconsistent support for ITS/CVO programs also is evident among motor carriers and third-party service providers. This lack of support stems from four sources:

- *The lack of well-defined ITS/CVO products, services, and benefits for motor carriers.* As is the case for public sector managers, a fundamental source of the lack of support by motor carriers for ITS/CVO is a lack of understanding about what "ITS" means. To many, ITS is synonymous with futuristic conceptions of "smart highways" and systems to provide automatic vehicle control. Relatively few motor carriers appreciate that many ITS technologies, such as computers and information systems, already are commonplace within the industry and among transportation agencies.

- *Fears about the use of technology for enforcement and revenue enhancement.* Many motor carriers fear not the technology itself, but how it will be used. Carriers may be concerned that AVI systems will enable States to enhance their enforcement capabilities, and that the real purpose of lTS/CVO is to raise additional revenues for States through strengthened enforcement or new taxes. ln particular, the potential for the development of a national weight-distance tax is a concern of many carriers.

- *Concerns about equity and the impact on small carriers.* Because the motor carrier industry is diverse and fragmented, there is some concern about the equity of lTS/CVO programs. ln particular, there is fear that ITS will be designed to meet the needs only of the larger carriers, and that smaller carriers will be effectively denied access due to the high costs of equipment and information systems.

- *Concerns about data privacy, security, and use.* Carriers want to ensure that the data collected by lTS/CVO systems, such as AVI and automated inspections, are accurate and confidential. The information systems need quality control measures to guard against data errors. More importantly, much of the data collected will be of a sensitive and proprietary nature. Carriers fear that without adequate security, these data could enable their competitors to learn privileged information about customers, routings, and cargo.

Lack of Data to Support Market Planning

In addition to uneven support from both the public and the private sector, the market for lTS/CVO suffers from a paucity of data to support the market planning and decision-making processes. Data that would be useful to CVO planners include market segmentation, market size, market penetration, costs, benefits, pricing, and equity impacts. Unfortunately, as documented elsewhere this report, the data currently available in most of these areas are weak. For example:

- Relatively little information is available on intrastate commercial vehicle operations, which account for a large share of trucking activity. There is no reliable, central source of data on even such basic statistics as the number of carriers with intrastate operating authority or the number of vehicles registered for intrastate use in each State.

- Data on interstate administrative transactions are limited. In terms of the IRP or the IFTA, for example, most States maintain up-to-date summary information only on the number of accounts and vehicles. Data on the frequency of transactions per account, or the number and size of transactions between States-both of which would be critical to defining the market for automated credentialing and interstate data exchange-are available in a useful form from only a few States.

- Most of the data on the size of the motor carrier industry are organized by the regulatory status of carriers (e.g., for-hire, private, etc.), and do not reflect the blurring of these regulatory boundaries since deregulation. Carrier operating characteristics such as fleet size, geographic range of operations, and routing variability appear to correlate with the size of the market for lTS/CVO technologies, but little information is available to support this conclusion.

- Data on freight flows are limited. lnformation from the Highway Performance Monitoring System (HPMS) can describe commercial vehicle traffic on major highways, but no

information is available on the origin and destination of these trips, or how many vehicles pass specific weigh stations or inspection sites. Without more specific survey data, it is difficult to determine the share of commercial vehicles in a given State that undergo weight or safety inspections, as well as the share that avoid inspections by taking alternate routes, are not selected by enforcement officials, or are waived by due to weigh station congestion-all of which are important measures of the overall effectiveness of a State's enforcement strategy.

- Data on the market penetration of ITS/CVO technologies in the motor carrier industry are limited. The Truck Inventory and Use Survey (TIUS) includes summary data on a handful of technologies, but is conducted only once every 5 years. The 1992 TIUS, which became available in the fall of 1995, already is out-of-date given the pace of technological development. More recent information is available only from the limited surveys by the ATA, the NPTC, and other groups.

- Data on the costs to both carriers and States of compliance with commercial vehicle regulations are extremely limited. Little information is available on the staff and financial resources that States or carriers must devote to processing and issuing credentials. This type of information is critical to performing benefit/cost analysis.

Future Directions

The assessment of the current market for lTS/CVO, as well as an examination of the barriers to the development of this market, suggests several future directions for the national ITS/CVO program.

1. The ITS/CVO program should differentiate among its markets.
2. The ITS/CVO program should emphasize enforcement and safety.
3. The ITS/CVO program should be organized around trade areas and traffic lanes.
4. The ITS/CVO program should encourage a broad rethinking of motor carrier regulatory practices.
5. The lTS/CVO program should enhance its outreach efforts.
6. The ITS/CVO program should continue to emphasize voluntary participation by States and carriers.

1. The ITS/CVO program should differentiate among its markets.

The ITS/CVO program should recognize that the needs for enforcement and administrative applications will vary among States and regions. These differences are particularly evident in their safety and weight enforcement strategies, as well as in their reliance on toll collection. States also vary widely with respect to their use and understanding of new technologies, as well as their organizational structures.

The private sector's appetite for ITS/CVO services varies as well. Carrier needs for and interests in new technologies are influenced by product, fleet size, geographic range of operations,

routing variability, and time sensitivity. These characteristics define a carrier's operations and shape its need for communications systems, routing and dispatching software, and other fleet management systems. For example, a carrier making time-sensitive deliveries of building materials along variable routes in a metropolitan area will have very different needs than a carrier transporting canned food along a fixed, transcontinental route from a factory to a warehouse. Additional work is necessary to define the precise size and user needs of market segments.

2. The ITS/CVO program should emphasize enforcement and safety.

The public sector ITS/CVO program should focus on the development of three types of services:

- Safety assurance services.

- Roadside clearance services (especially size, weight, and credentials screening).

- Data exchange links between administrative and enforcement agencies within a single State.

The results of early operational tests, benefit/cost studies, CVO institutional studies, and Congressional mandates have identified these as the services offering the highest potential payoffs for the States, carriers, the FHWA, and the general public.

Public investment should focus primarily on safety assurance, and secondarily on the enforcement of weight and credentials regulations. A high priority should be the nationwide deployment of safety assurance and automated clearance programs. In these markets, technology is available, and the HELP and Advantage CVO programs have demonstrated the potential benefits. Investment in these services offers the greatest return on investment to businesses and the public because motor carriers account for 1 out of every 2 dollars spent on domestic logistics. Automated clearance and safety assurance programs can directly improve the productivity and safety of motor carrier operations. This improvement will have a direct, positive impact on the economic well-being of the States and the Nation

To realize the benefits of automated clearance and safety assurance programs, the public sector should make a near-term investment in linking State safety and credential data bases. These data bases are the engines that will power roadside clearance and safety assurance programs. Without these linkages, the return on investment to States and carriers will be limited.

Private sector deployment of ITS fleet management products and services is well underway. The public sector should encourage and support the current trend toward integrated fleet management and logistics management systems. However, fleet management should not be a major focus of public sector ITS/CVO efforts.

3. The ITS/CVO program should be organized around trade areas and traffic lanes.

The ITS/CVO program should focus its energies where the trucks are, concentrating on the major trucking activity centers and truck traffic lanes. These centers are the major national population and distribution centers, such as the Boston-to-Washington corridor; metropolitan Chicago, Atlanta, and Dallas; and southern California. The traffic lanes are the major Interstates that connect these centers. Combined, the activity centers and traffic lanes loosely define major "trucksheds" where the industry's activity is concentrated. For the public sector,

these trucksheds can help guide investment decisions and define multistate consortia. For the private sector, these trucksheds can shape marketing opportunities. The markets for ITS/CVO services vary across these regions (see table 25, and chapter 3 for more detailed discussion).

Enforcement: The orientation of automated clearance and safety assurance programs should be broadened from highway corridors to geographical regions. In the long run, corridor-oriented programs will limit motor carrier participation and reduce the effectiveness of the programs to improve safety and regulatory compliance because they do not serve the majority of truck trips. The ITS/CVO program should expand to cover regional, as well as transcontinental, truck movements, and should tailor automated clearance and safety assurance programs to the needs of the different regions.

Administration: ITS/CVO administrative programs also should correspond to these regions, in part to reduce duplicative effort, but more fundamentally because interstate exchange of data and funds follows a regional pattern similar to truck travel. The major interstate transactions include IRP and IFTA account information and payments. Currently, most pairs of States exchange IFTA and IRP fees through two offsetting checks, where a single payment from the net debtor to the net creditor would suffice. The available data on the distribution of these transactions among the States confirms that most IRP transactions occur between a State and other nearby States in its natural truckshed (see figures 89 to 92). Regional programs could facilitate the exchange of these data and funds. Other credentials that would benefit from regional programs include oversize/overweight permitting (for which several initiatives already are established), toll collection, and hazardous materials permitting.

Fleet and Vehicle Management: The regional variation in the market for fleet management technologies needs further exploration. Results of the 1992 TIUS, as well as anecdotal evidence, indicates that the market penetration of technologies such as navigation systems, transponders, and trip recorders is highest in the Great Lakes and North Central regions, and lowest in the Northeast, Northwest, and South Central. This pattern may reflect the distribution of fleets by size or geographic scope; for example, the Great Lakes and North Central regions include larger shares of trucks operating in large fleets or in regional or national markets than do the Northeast or Northwest regions. Other regional factors such as educational attainment or technology costs also may contribute to this variation, but additional analysis would be required to make such a determination.

Traffic Management: Highway traffic **management applications** should **correspond to** traffic congestion, which is concentrated in the Northeast, California, and major metropolitan areas **elsewhere in the Nation.**

4. The ITS/CVO program should encourage a broad rethinking of motor carrier regulatory practices.

The ITS/CVO program should focus less on "ITS"-the specific deployment of AVI, WIM, and other technologies- **and more on** "CVO"-the general administration and enforcement of motor carrier regulations. The public sector in general, and the States in particular, must examine the effectiveness of and justification for motor carrier administrative and enforcement procedures. Many of these procedures are rooted in decades-old practices that are no longer cost effective, having been overtaken by changes in the economy and the transportation system. The ITS/CVO program should encourage operational tests that allow State agencies and motor carriers to explore new ways of doing business.

Table 25. Regional markets for ITS/CVO services.

	Enforcement	Administration	Fleet Management	Traffic Management
Northeast	Advanced portable WIM; automated roadside inspections; electronic toll collection	Automated fuel tax administration and OS/OW permitting; one-stop shopping	Automated routing and dispatching; systems to enhance productivity	Commercial vehicle ATIS and incident management along I-95 corridor
Southeast	WIM and preclearance technologies; safety reviews for smaller carriers	Basic information services; electronic OS/OW permitting	Communications systems; fleet management oriented toward expanding carriers	Limited to large cities
Great Lakes	WIM and preclearance technologies; automated roadside inspections; electronic toll collection	Interstate data exchange; one-stop shopping programs	Onboard computers, routing and dispatching software; AVL	Commercial vehicle ATIS and ATMS in Chicago and Detroit; hazardous materials incident response
Midwest	WIM; automated safety inspections	Basic information services	Communication systems, AVL; systems for small fleets	Limited to large cities
South Central	Border clearance technologies; automated inspections and agency training	ED1 and information systems to handle growing transactions; outreach to Mexican carriers	Routing and dispatching software; onboard computers; systems for expanding carriers	Limited to large cities; hazardous materials incident response
Northwest	Weigh station preclearance and WIM	Information systems to handle growing transactions	Communications and shipment-tracking systems	Limited to large cities
West	Weigh station preclearance; automated safety inspections	Automated registration and fuel tax administration	Onboard computers; routing and dispatching software; systems to increase productivity and aid with expansion	Commercial vehicle ATIS and ATMS in southern California and the Bay Area

States should be encouraged to view ITS technologies as an opportunity to change the way they tax motor carriers and assure highway safety. Information systems can be used not only to improve the efficiency of existing credentialing procedures, but also to reengineer the credential process so that carriers can obtain all necessary registrations and permits through a single source. Data linkages between agencies can enhance the effectiveness of revenue collection and safety programs: for example, providing vehicle registration officials with access to information on a carrier's safety record and fuel tax account would enable them to deny registration to carriers with poor safety performance or unpaid tax liabilities.

On the roadside, the use of WIM, AVI, and automated safety inspection systems can enable States to unbundle their enforcement operations. By deploying resources away from fixed inspection sites and conducting more frequent mobile enforcement, States should catch vehicles that otherwise would detour around fixed sites. Increased use of mobile enforcement also would facilitate inspections of trucks in urban areas, where congestion and high land prices impede weigh station operation.

5. The ITS/CVO program should enhance its outreach effort.

Because agency and carrier interest in and support of ITS/CVO programs remains uneven, outreach and communication must be important elements in ITS/CVO efforts. Outreach efforts may include disseminating information and conducting educational programs to increase the level of understanding of the structure, objectives, and functions of major CVO activities, and of the technologies and potential benefits associated with ITS. A second major thrust must be documentation of the successes and lessons learned from early and ongoing ITS/CVO projects. This documentation must include more rigorous benefit/cost analysis.

On the agency side, the involvement of senior leadership in ITS/CVO planning and deployment can foster a sense of "ownership" and secure the commitment of the entire agency. Day-to-day involvement by agency leadership in operational details is neither practical nor desirable, but the leadership can and should participate in defining the broad ITS/CVO goals in each State. The majority of the progress on ITS/CVO deployment will come from the efforts of middle and line managers who have the time and expertise to handle these details.

The ITS/CVO program should continue to encourage communication between agencies and carriers. Better lines of communication will help agencies understand how they can best structure their activities to serve the motor carrier industry. Carriers can share with the States their expertise with ED1 and information systems.

6. The ITS/CVO program should continue to emphasize voluntary participation by States and carriers.

Participation by motor carriers in ITS/CVO programs should remain voluntary. The motor carrier industry is concerned that automated clearance programs will become a vehicle for a national weight-distance tax program. Only an explicit policy supporting voluntary participation and continuing industry involvement in the design and oversight of the programs will allay these concerns. Voluntary participation also channels the early benefits to those carriers who are the most willing to support deployment and invest in the necessary equipment. Over time, more carriers will participate as the benefits become more evident.

Similarly, State involvement in new information systems and regulatory agreements such as the CVISN or the clearinghouses for the IFTA, the IRP, and other credentials should remain voluntary in the near-term. In this way, the States with the greatest interest and expertise in ITS/CVO services will be able to reap early benefits, without being held back by States that are not ready. As envisioned in the CVISN deployment plan, these lead States should be encouraged to share their expertise with others in their regions. Once enough States are participating in these programs, the momentum toward full participation may develop. The IFTA and IRP examples are instructive: both agreements began with a handful of jurisdictions, moved to majority participation once the benefits were evident, but will reach full participation only because a Federal mandate was issued to "close the loop."

ORGANIZATION

New programs often require the reallocation of roles and responsibilities. TheITS/CVO program's organizational strategy should define these new roles and build agreement on the allocation of responsibilities. The organizational structure of the ITS/CVO program includes interagency, inter-jurisdictional, and public/private relationships.

Current Strategies

The ITS/CVO program today reflects a variety of organizational approaches. It is being advanced at the State level, by departments of transportation and other agencies; at the regional level, most often by groups of States along a common highway corridor; and at the national level, by the FHWA, ITS America, and other organizations. In the private sector, most of the progress has come from the efforts of individual carriers, particularly those operating at a regional or national scale. Private sector participation in public sector ITS/CVO projects varies widely.

The organization strategies implied by the current ITS/CVO program include the following:

1. Introduce ITS technology and concepts, and define user needs and priorities, through operational tests and institutional issues studies.
2. Develop public/private forums.
3. Include projects at the State, corridor, and national levels.

1. Introduce ITS technology and concepts, and define user needs and priorities, through operational tests and institutional issues studies.

A primary organizational initiative of the ITS/CVO program to date has been the introduction of ITS technology and concepts and the definition of user needs and priorities. This has occurred through a series of demonstration projects and operational tests, primarily in the area of weigh station preclearance. The CVO institutional studies have played an important role not only in identifying the needs of each State and the barriers to ITS/CVO deployment, but also in drawing agencies together and raising the level of awareness about ITS/CVO in each State. Moreover, many projects have been conducted between several States, addressing issues such

as regulatory differences and data exchange. This effort has been much needed, and has created considerable momentum for the ITS/CVO program.

2. Develop public/private forums.

As part of the ITS/CVO program, public/private forums for the planning and discussion of CVO issues have been developed. This has been accomplished largely through the CVO institutional studies, as well as through the major operational tests such as HELP and Advantage CVO. Two national organizations-the ITS America CVO Committee and the Base State Working Group on Uniform Motor Carrier Programs-have played an integral role in focusing national discussion of CVO issues. The support of the FHWA has been instrumental in this effort. However, the current experience with the public/private forums has been uneven. With the exception of HELP, Inc. and Advantage CVO, most of these forums have focused on planning rather than deployment.

3. Include projects at the State, corridor, and national levels.

The geographic orientation of the ITS/CVO program to date has been at three levels: State, corridor, and national. The State level is where most day-to-day control of CVO programs lies, but the organization of the State programs has varied widely. Groups of States have joined together to conduct institutional issues studies, but in most cases the focus has remained on individual needs and projects. The corridor programs such as HELP and Advantage CVO provided a marketing focus and an additional rationale for State collaboration, but, as discussed earlier, their services have applied to a limited number of truck-trips. The national program has emphasized research on technologies as well as non-technical issues such as institutional or legal concerns.

Assessment

The organization of the ITS/CVO program reflects the needs and interests of multiple stakeholders. Table 26 maps the current stakeholders in CVO policy and deployment, by function (highway engineering, law enforcement, revenue collection, and motor carrier operations) and geographic level (national, regional, or State). Both dimensions of the table are important to the institutional architecture of the CVO program: first, whether existing organizations provide adequate coverage of each major function; and second, whether existing organizations provide adequate integration at each level of geography.

Although Federal leadership is critical to the development of the ITS/CVO program, State agencies control the day-to-day delivery of most CVO services and are the building blocks of the CVO program. The States are responsible for building and maintaining highways and for taxing and regulating the motor carriers that use them. In most States, the primary need is for the integration and coordination of the work of existing agencies to ensure smooth CVO planning and deployment.

To date, the model for State CVO planning has been the public/private working group, as required in the first round institutional issues studies. However, many of these forums dissolved upon completion of the studies. The groups that have continued vary in effectiveness, reflecting the lack of a mandate to continue, either from the States themselves or the national CVO

Table 26. National, regional, and State CVO forums.

	Highway Maintenance & Operations	Law Enforcement	Revenue Collection	Motor Carriers	CVO Policy Forums	c v o Deployment Groups
National	• FHWA . AASHTO	• CVSA	- FTA - AAMVA	• ATA . NPTC . OOIDAA	. ITS-A c v o Committee	- Permit Services • IFTA, Inc. • IRP, Inc. • AAMVAnet, Inc.
Regional	. FHWA Regional Offices . WASHTO, SASHTO, etc.				• CVO Regional Consortia	• HELP, Inc. • Advantage C V O
State	. DOT's . FHWA Division Offices	- Police • Patrols	. DOR's . DMV's • PUC's	• MTA's • Carriers	• State Working Groups	

program. Individual State CVO deployment organizations have not emerged yet, with the notable exception of Oregon's Greenlight program.

The major CVO functions are well integrated at the national level, with organizations representing various interests as follows:

- State highway engineers-the American Association of State Highway and Transportation Officials.
- Law officers -the Commercial Vehicle Safety Alliance.
- Revenue collectors-the Federation of Tax Administrators and the American Association of Motor Vehicle Administrators.
- Motor carriers-the ATA, NPTC, and other associations.

These organizations are designed to influence Federal polices, and to provide an institutional framework for coordinating CVO activities at the national level. In addition, Federal agencies such as the FHWA provide national leadership on motor carrier issues. The CVO Committee of ITS America is emerging as the national forum for the development of CVO policy.

Few national CVO deployment groups have emerged, with the exception of the permitting services that assist carriers with obtaining credentials, and the organizations that administer the IRP, the IFTA, and the Commercial Driver's License Information System (AAMVAnet, Inc.).

The major gap in the organizational infrastructure is at the regional level. The regional FHWA offices and the regional units of AASHTO are the only organizations that provide a regional voice in CVO planning for specific functions. The AAMVA regional organizations have not yet been drawn into the ITS/CVO program, although there is strong interest from AAMVA representatives in particular CVO projects such as the CVIS pilot. The result is strong vertical integration of policies and programs between the State and national levels, and moderate horizontal integration of policies and programs at the State level and at the national level, but little integration at the regional level.

Despite this lack of integration, the regional level is where many of the advancements in ITS/CVO have occurred. The two major CVO deployment groups to date-HELP, Inc., and Advantage CVO-are regional programs organized around highway corridors. Some of the regional consortia that developed in the CVO institutional studies have emerged as important policy forums, including the Southeast/Inter-Regional consortium and the Eastern States consortium. In addition, the I-95 Corridor Coalition is becoming an important CVO planning forum due to its efforts in the Northeast region.

Barriers

There are three primary organizational barriers to the implementation of ITS/CVO. These barriers encompass three dimensions of organizational relationships that are involved in motor carrier regulation: agency-to-agency, State-to-State, and agency-to-carrier.

Interagency Relationships

Lack of interagency communication, cooperation, and coordination within individual States is a fundamental obstacle to meaningful improvements in current CVO administrative and enforcement activities. This problem stems from three related factors:

- *Fragmentation of CVO responsibilities among multiple agencies within each State.* In a typical State, responsibility for the administration and enforcement of CVO regulations is divided among a half-dozen agencies. In a few States, CVO activities may fall under the purview of as many as 10 agencies. Moreover, local Governments, particularly in congested metropolitan areas, increasingly are asserting their own interests with respect to truck routing and hazardous materials. Even if all of the organizational responsibilities and priorities are defined clearly and consistently, the sheer number of agencies that are involved in CVO creates a communication and management challenge.

- *Conflicting goals and priorities among agencies involved in CVO.* Not only are a large number of agencies involved in CVO, but all too often their goals and priorities are in conflict. Each agency has a legitimate purpose for its CVO activities, but its goals may conflict with those of other agencies. For example, the revenue department's desire to check compliance with every credential during a weigh station stop may conflict with a State DOT's desire to reduce delays and the resultant traffic queues backing onto the highways. These conflicts can lead to disagreements about the objectives and configurations of ITS/CVO programs.

- *Overlapping responsibilities among agencies involved in CVO.* Redundancies and overlapping responsibilities create the potential for "turf wars" among agencies involved in the CVO process. For example, the information used to process the IFTA and IRP accounts is virtually identical, yet in many States carriers must submit this information to two separate departments (revenue and motor vehicles) responsible for handling these functions. Streamlining this process may require convincing one of the agencies to surrender its role in the data collection process.

Interstate Relationships

Organizational complexity is as much a problem across States as it is within States. The problem is more than just lack of coordination among States; it encompasses outright conflicts in regulations and policies. The roots of this barrier closely parallel the sources of interagency miscoordination:

- *Large number of States.* Many truck movements today are regional or national in scope. Issues relating to intrastate organizational structure multiply quickly as more than one State becomes involved in a single truck trip. Achievement of the most far-reaching goals of ITS/CVO-including "transparent borders" and multistate electronic permitting-will require agreement from a large number of States.

- *Conflicting goals and priorities among States.* States often pursue different priorities in their CVO programs. Some States with large numbers of weigh stations and ports-of-entry are concerned about preclearance; other States with mostly mobile enforcement are more interested in automated safety assurance. The Northeast and California must deal with major congestion problems; States in the Rocky Mountains and the Upper Midwest generally do not share this problem.

- *Redundant responsibilities among* States. Overlapping and redundant responsibilities create waste and "turf wars" among States as well as among agencies. For instance, interstate carriers often must provide the same types of information to many different States to obtain all necessary permits and registrations, and must stop at ports-of-entry in many adjacent States. Eliminating these redundancies could require States to relinquish some of their territorial sovereignty.

Public Private Relationships

Historically, State agencies and motor carriers have had difficulty developing cooperative, nonadversarial relationships. For the most part, carriers have seen the State only as a regulator and a collector of fees and taxes. Motor carriers have a limited perception of being a "client" of State services. Many State agencies are not fully oriented toward providing customer service to the motor carrier industry. As a result, carriers and agencies often have had difficulty communicating and working together.

Consequently, it is not surprising that participation to date by motor carriers and third-party service providers in ITS/CVO program planning and deployment has been limited. This limited involvement, as discussed earlier, reflects the lack of well-defined ITS/CVO products, services, and benefits from the private sector perspective; fears about the use of technology for enforcement and revenue enhancement; and concerns about equity and data privacy. However, the limited involvement also reflects more tactical issues, such as time constraints on motor carrier managers and State regulations governing public/private partnerships.

Future Directions

The organization structure of the ITS/CVO program should be strengthened.

1. The ITS/CVO program should develop policies, programs, and plans at the State level because it is the States that have the first-line responsibility for motor carrier regulations.
2. The ITS/CVO program should develop policies, programs, and plans at the regional level because many truck trips occur in more than one State.
3. The ITS/CVO program should develop policies, programs, and plans at the national level because of the need to ensure uniformity of services for carriers operating in more than one region.

1. State Program

The basic building block for the CVO institutional infrastructure must be the States. The key features of the State programs should include the following:

- Public/private forums with broad membership.

- Development of State CVO business plans.

- Staggered start dates.

- A joint Federal/State funding strategy.
- Technical work including research, operational tests, and deployment planning.

The initial round of CVO institutional issues studies recognized the primary role of the States by funding the States to review their operations and identify barriers to the deployment of CVO services. The lTS/CVO program should build on this experience by encouraging the States to establish ongoing State CVO forums and produce State CVO business plans that are updated on a regular basis.

Public/Private Forums: For many States, the CVO institutional issues studies provided the first opportunity for agencies to meet and review common business interests. However, without additional encouragement and funding, these nascent State CVO working groups are not likely to meet often enough to provide strong platforms for the realization of a national CVO program. State agencies operate under tight budgets, and CVO issues are not yet a top priority for State administrators and legislators preoccupied with other pressing issues. The State program should fill this gap by strengthening State CVO activities and ensuring a foundation for the regional and national CVO efforts

A core objective of the State ITS/CVO business programs should be the continuing participation of all the major players involved in CVO: highway engineers, transportation planners, State police/highway patrol officers, motor vehicle registration officials, motor fuel tax administrators, motor carriers, shippers, and motor carrier service providers such as permitting services. The most successful ITS/CVO projects to date have involved a broad cross-section of agencies, associations, and private sector service providers. Only with this type of representation can the States develop a good understanding of problems and opportunities, and build a political consensus for specific policy and project initiatives.

A major task of the forums should be to increase the level of understanding about agency roles in CVO, **and** identify where agency responsibilities or objectives overlap or conflict. The working groups should clarify agency roles, and should designate a lead agency to develop and implement particular ITS/CVO services. The CVO institutional studies demonstrated that multiple agencies can work together under the direction of a lead agency; now, this process must be extended to actual operations.

State CVO Business Plans: The State CVO business plan should secure a strong policy commitment to the CVO program by State officials and motor carrier managers. It should define the ITS/CVO services to be deployed in each State, giving particular attention to motor carrier safety and deployment of the CVISN. It should lay out a business plan specifying projects, objectives, roles, responsibilities, milestones, and funding, and estimate the costs and benefits of these activities for the State, motor carriers, and the public. As of April 1996, only two States-Minnesota and Oregon-have completed this effort. Maryland is beginning to develop a State CVO plan.

Until States make these forums and plans a regular part of their doing business, there will be no constituency to continue these activities except for the individual agencies. Given the number of agencies, the complexity of CVO regulation, and competing demands, it may take 5 to 8 years to establish formal State CVO programs in most States. For the longer term, the FHWA may wish to consider incorporating a requirement to maintain a State CVO plan into the

statewide transportation planning regulations or into a specific CVO program, such as the Motor Carrier Safety Assistance Program (MCSAP).

Start Dates: The State CVO program should use a phasing strategy that differs from that used in the institutional studies. Instead of attempting to move all States along simultaneously, the program should be phased over a number of years. The initial effort should be limited to a dozen States that can show that they are prepared-whether through prior work or the first phase institutional study-to operate an effective CVO forum and produce a practical business plan. Federal grants may be allocated among the dozen States so that there are at least one or two participating States in each CVO region. The intent in distributing the grants in this manner would be to create bellwether programs in each region that could serve as models for the States participating in subsequent cycles. With encouragement and a better defined national CVO program, a second group of 10 to 15 States may be ready to develop a State CVO plan within a few years. The remaining States would follow about 2 or 3 years after the second group.

Funding Strategy: The State program funding strategy should combine Federal and State resources. In one scenario, initial Federal grants could be provided to cover the costs of developing a State CVO plan; creating and maintaining the CVO forum over 2-year periods; and updating the State CVO plan at the end of the period. The magnitude of these grants may vary according to the size and organizational complexity of each State. The Federal grants should be matched by State contributions. States that have completed the first 2-year cycle and successfully updated their State CVO plan at the end of year 2 would be eligible for an additional grant to support their CVO forums for the next two years. The State match could step up over time, perhaps from a 20-percent share in the initial 2 years to 50 percent or higher for the fifth and sixth years. Whatever the sequence, the initial funding match should make the CVO grants competitive with other transportation planning grants. The CVO funding strategy should attract and maintain the States' interest in CVO for a time period that is long enough to make these programs become permanent.

Technical Work: The program should result in State-specific CVO plans and projects. Therefore, grants earmarked for State CVO forums should not be used to support regional activities, which should have their own dedicated funding source. The Federal Government may wish to continue to provide separate funding for operational tests, technical studies, and mainstream deployment of ITS/CVO services.

2. Regional Program

Regional CVO programs should provide the context for the State programs. The regional programs should reflect the reality that most truck movements are regional and local rather than national; that most State-to-State interaction occurs within loosely defined regions or "trucksheds"; and that the needs and interests of State agencies and motor carriers differ more across regions than within them.

The key features of the regional programs should include the following:

- Organization around economic regions.
- Support of multistate forums with broad membership.

- Development of regional CVO business plans.
- Funding for forums and program support services.
- Separate funding for technical studies, operational tests, and deployment.
- Development of business entities for deployment of ITS/CVO services.

Organization around Economic Regions: The regional CVO programs should be based on the clusters of States that cover the major truck markets. In the first phase of the CVO institutional studies, States were allowed, and even encouraged, to join regional consortia. These consortia generally coincided with the major national population and distribution regions. With some reshuffling and refinement, these consortia are being maintained for the second phase of work. The ITS/CVO program could collapse these consortia into seven forums, as suggested in chapter 3 (see figure 93). This structure would help to ensure that the development and deployment of ITS/CVO services matches the markets. In general, the programs should deploy CVO services, especially safety assurance programs, where the trucks are.

Building regional CVO programs can help to tailor the services and the rate of deployment to the needs and markets of each region. Regions with heavy investment in weigh stations could deploy automated clearance systems; regions with heavy congestion could give priority to mobile safety screening and traffic and congestion management. When the States and carrier focus on services with an immediate payoff for their region, they are more likely to push for deployment and defend these services when budgets are limited.

This strategy is consistent with the current Federal organization of its regional offices. The regional CVO forums illustrated in the exhibits do not correspond one-to-one with the Federal administrative regions, a distinction that may create an administrative headache for the **FHWA.** However, the definition of the regions should be driven first and foremost by the market. The FHWA should provide the flexibility for States to participate in two or more regional CVO forums where appropriate. (For example, the States of Kentucky, Tennessee, West Virginia, Illinois, Wisconsin, and Arizona are classified in these exhibits as belonging to multiple regions.)

Regional Forums: The primary objective of the regional program should be to establish an ongoing, regional CVO forum that can provide policy and program direction. The HELP program, Advantage CVO, I-95 Corridor Coalition, and four institutional issues studies (Inter-Regional/ Southeast, Eastern States, COVE, and Northern New England) have all succeeded, to some degree, in establishing regional CVO forums. These groups should be stabilized and made permanent. Where regional groups are still coalescing, such as in the Great Lakes, the Midwest, and the Northwest, an early priority should be the establishment and support of these forums.

The development of stable regional consortia will require support from and leadership by the FHWA and interested States because few existing regional forums deal with CVO issues. State Government provides a framework for coordinating CVO activities at the local level, and the Federal Government and trade associations provide a framework at the national level. However, little integration occurs at the regional level. A key objective of the regional ITS/CVO program should be to fill this gap.

Regional Business Plans: As with the State programs, each of the regional consortia should produce and regularly update an ITS/CVO program plan. The regional plan should reflect coordination with the constituent State CVO plans and show how the regional program will integrate its activities with the national ITS/CVO program. Continuing Federal support of the programs should be contingent upon continuing participation by State transportation, public safety, and revenue agencies, and upon the involvement of motor carriers, associations, shippers, and private sector service providers.

Funding for Forums and Support Services: The FHWA may wish to consider funding to support the forums and regional CVO business plans. These grants could be matched by contributions from the forum members. These regional forums should be made a part of the "mainstreaming" effort, which seeks to move ITS/CVO technology from concept to deployment. Possible uses of the regional funds include partial or complete subsidies for travel by State officials and motor carriers to regional meetings, the rental of meeting space, communications, and other logistical functions. It is important that travel funds be available to representatives of all agencies, and not just the State DOTs who are administering these grants. As the programs mature, an additional use of funds could be used to support a part-time or full-time program director. The program director would "champion" the regional and State CVO programs, presenting and explaining the services and their benefits and costs to administrators, legislators, agencies, motor carriers, and the public.

The work of the regional consortia should be critical to the development of the national ITS/CVO program. For this reason, the FHWA should push to keep all of the regional programs moving ahead at roughly the same pace. This may require modification of the current funding approach for the second-phase institutional issues studies, which requires a full 50:50 match of the FHWA grants.

Funding for Technical Studies: The Federal Government may wish to provide a second block of funds for technical studies that include staff or consultant support to develop the regional CVO plans; market research among State agencies, carriers, and service providers to determine user needs and priorities; preparation of public and private funding proposals for specific programs and projects; and evaluations and benefit/cost analyses. Again, the participating States should provide matching contributions. In general, these funds should be restricted to activities that further the progress of regional CVO programs and cannot be covered under existing programs such as MCSAP, or under research and development grants.

Because few of the regional forums today are prepared to manage large technical studies, the existing funding under the second-phase institutional issues studies should be sufficient to cover immediate technical work. By the late 1990's, the better organized regional forums should be able to double their rate of work on technical activities, creating a need for additional funding. As the regional programs are stabilized, the need for technical funds should taper off, with more of the monies directed to the States for deployment and operation of ITS/CVO

regional consortia should be encouraged to develop and test alternative methods for contracting for multistate ITS/CVO services.

In some cases, the consortia may choose to deliver ITS/CVO services directly. However, in many cases, third-party entities-private sector service providers under contract to a consortium or individual member States, or public/private partnerships such as HELP, Inc.-may be effective in managing and operating services. The desire for third-party control is especially strong where States and motor carriers are concerned about the confidentially of business and tax records. Greater third-party involvement will require the development of more explicit models for public/private partnerships.

3. National Program

The national CVO program provides an opportunity to coordinate the overall direction of the regional and State efforts, as well as to agree on standards and common policies in critical areas. The key features of the national program should include the following:

- Maintenance of a national CVO forum.
- Accelerated development of a national CVO plan.
- Funding for the forum, program support services, and technical projects.

Maintenance of a National CVO Forum: The role of the national program in the CVO institutional architecture is to provide commonality and uniformity so that "balkanized" CVO regions do not replace "balkanized" State motor carrier programs. The critical elements that must be addressed are safety, weight and credentials enforcement thresholds; vehicle-to-roadside communications standards; and a national architecture that facilitates ED1 and EFT transactions among States, carriers, and shippers.

The States, the motor carrier industry, and the FHWA have made good progress on these issues through the Program Subcommittee and the Standards and Protocols Subcommittee of the ITS America CVO Committee. The ITS America CVO Committee is the national CVO forum today, and its maintenance should be a top priority for the Federal ITS/CVO program. The committee has moved beyond immediate tactical issues and prompted the CVO community to rethink its overall approach to safety and regulatory enforcement. Regional consortia participation in these discussions-directly through participation on the national committee and indirectly through participation of committee members in regional forums and individual projects-will be critical for integrating the State and regional programs into a national program that provides uniform services to motor carriers and agencies.

Accelerated Deployment of a National CVO Plan: The national CVO forum should develop

AAMVAnet, Inc. The FHWA could provide direction to support this type of operation during the prototype and early pilot programs, but concerns about data privacy and confidentiality may create a consensus that any data base service be managed by a third-party provider.

It is likely that the regional CVO programs, if broadly constituted and connected by a national CVISN, will provide the national coverage and uniformity that the national motor carriers and the FHWA seek. The telecommunications industry operates under a similar model. Nevertheless, there may be a need for service along national corridors (such as Interstate 80) that cannot be provided by coordinating regional programs or having a common service provider spanning two or more regions. In these cases, a "National CVO, Inc." could serve as a vehicle for service deployment and delivery. An important first step in this process would be the development of clearinghouses for the IFTA, the IRP, and SAFER.

Funding for the Forum, Program Support Services, and Technical Studies: The Federal Government could continue to provide funding to support both the national CVO forum and the national CVO plan. In addition, consideration should be given to supporting a set of technical activities that would assist in the evolution of the national CVO forum and business plan. These activities would include benefit/cost analyses; project evaluations; research and development on new technologies; and technical studies on issues most appropriately handled at a national level, such as the use of ITS/CVO at international border crossings.

Figure 94 summarizes the organizational priorities at the State, regional, and national levels. As shown, the State CVO working groups should focus on State-level policy and planning support for State CVO projects. The States also should provide portions of capital, operations, and maintenance funding. The regional CVO forums should focus their energies on policy and planning support at the regional level, as well on providing outreach to State agencies and motor carriers. The regional forums eventually should develop deployment entities that would focus on research and development, outreach, and program evaluation. The national CVO forum should focus on policy and planning support from a national perspective. It eventually should develop a deployment entity that would provide technical expertise, outreach, and research and development.

RESOURCES

Resources, broadly defined, are the supplies that enable a public or private enterprise to produce a good or service. These include staff, expertise, funding, and technologies. For the purposes of analyzing the national ITS/CVO program, the critical elements are technology and staff expertise.

This section provides a brief overview of the resource requirements for the national ITS/CVO program. A detailed discussion of technologies or funding for the ITS/CVO program is beyond the scope of this project. Technological issues have been addressed in great detail

through the CVISN project.1 This study concurs with the CVISN work, and emphasizes the market and organizational strategies.

Current Strategies

The technical strategies implied by the current ITS/CVO program include the following:

1 Develop roadside technology for weigh station clearance.

2. Deploy onboard technology for fleet and vehicle management.

3. Allow the marketplace to set de facto technical standards.

4 Live within the limits of the old system.

1. Develop roadside clearance technology for weigh station clearance.

The public sector ITS/CVO activities to date have focused on the development of the roadside technology for automatic clearance of vehicles past weigh stations and ports of entry. The enabling technologies include weigh-in-motion (WIM), automatic vehicle classification (AVC), and automatic vehicle identification (AVI). Preclearance has been advanced through projects such as HELP and Advantage CVO. The public sector also has made great progress on electronic toll collection, and has commenced the laborious process of developing information systems to support its safety assurance and credential activities.

2. Develop onboard technology for fleet and vehicle management.

Private sector activity has focused on the deployment of fleet management systems, particularly mobile communications, Onboard computers, and automated routing and dispatching software. This deployment has been driven by market forces, and has occurred with limited public sector involvement.

3. Allow the marketplace to set de facto technical standards.

Neither the public or the private sector as yet has made a concerted effort to develop standards for the use of technologies or information systems. Instead, the general attitude has been to let the market forces establish de facto standards, particularly for AVI.

4. Live within the limits of the old system.

To reduce the burden on staff and financial resources, many States have planned or begun deployment of ITS from the perspective of what is possible with the constraints of existing computers, communications equipment, and staff expertise. This perspective is important to

1 The Johns Hopkins University Applied Physics Laboratory, *Commercial Vehicle Information Systems (CVISN) Sfafemenf of Direction and Program Overview, Laurel, Maryland,* November 6, 1995, and related documents.

develop a practical plan, but may be preventing States from considering the full range of ITS applications.

Assessment

The ITS/CVO program has achieved its initial technology goals. The States have developed and demonstrated the roadside technology for automated clearance and safety assurance, via WIM, AVI, and AVC. The motor carrier industry is moving automation from the office to the truck, via two-way data communication, onboard computers, and automatic vehicle location.

Table 27 identifies some of the key enabling technologies that have been developed and deployed. The next challenge is to enable data exchange among these systems.

Barriers

The primary technical barriers to the deployment of ITS/CVO services include the following:

- *Lack of technical expertise among the current personnel of the agencies involved in CVO, as well as among* some *carriers.* Many CVO agencies are hindered in their ability to implement ITS/CVO services because their personnel have had limited exposure to communications and information technologies. Transportation agencies historically have been oriented around skills such as highway engineering and planning. ITS/CVO program support requires a different set of skills, including expertise in electronics, computer programming, and information systems.

- *Lack of public sector data processing capabilities, and the incompatibility of existing systems across States.* Inventories of existing equipment and systems confirm that many public sector agencies currently lack data processing and information systems that are capable of handling the wide variety of data and tasks required by most ITS/CVO services. In addition, many existing systems are not compatible across agencies and across States. Some States have pushed for more rapid deployment of ITS/CVO technologies, while others have lagged. This technical deficiency also is evident in the motor carrier industry, although it appears less severe. The sharp cost and service competition triggered by the deregulation of the interstate trucking industry in the early 1980's has transformed trucking into one of the more technically-proficient industries in the Nation. Still, technical expertise varies widely among the fleets in the industry.

- *Lack of national technical standards.* The lack of clear national technical standards for many of the ITS/CVO technologies (such as EDI and VRC) contributes to the lack of understanding of and support for ITS/CVO, and makes agencies and carriers reluctant to invest in ITS systems for fear that they will select and implement a technology destined for obsolescence. As one of the CVO institutional studies noted, many agencies and carriers fear purchasing the equivalent of a Betamax system and then watching VHS become the national standard. Areas that need standards include transponder types, communication protocols, data definitions, and other key items.

- *High anticipated public and private implementation costs.* The cost of ITS/CVO technologies and services can be prohibitive, although it can be argued that a well-defined market and

Table 27. Major ITS technologies applied to CVO

Roadside Technologies
Automatic Vehicle Identification (AVI)/Vehicle-to-Roadside Communication (VRC)
Automatic Vehicle Classification (AVC)
Weigh-in-Motion (WIM)
Highway Safety Warning Systems
Onboard Computers (OBC)
Automatic Vehicle Location (AVL)
In-Vehicle Route Guidance and Safety Monitoring Systems
Deskside Technologies
Information Systems
Communication Systems
Electronic Data Interchange (EDI)
Electronic Funds Transfer (EFT)
Routing and Dispatching Software

smooth organization would mollify this concern. Funding needs include one-time capital costs for purchasing and installing equipment and for developing information systems, as well as ongoing costs for maintenance, operation, and personnel training. Cost concerns are real because of funding constraints at most CVO agencies, as well as the relatively low priority for given to CVO by most State governments. The lack of demonstrated, quantifiable benefits to justify the new technologies and systems exacerbates this concern.

Future Directions

The technical resources in support of the national lTS/CVO program exist, but must be enhanced and linked.

1. The ITS/CVO program should develop an open, modular, and adaptable architecture incorporating legacy system. The architecture should focus on data exchange among government agencies, motor carriers, and service providers.
2. The ITS/CVO program should continue to support private sector **fleet management** activities.
3. The ITS/CVO program should establish national standards for AVI/VRC and ED1 data and communications.
4. The ITS/CVO program should identify appropriate resources for upgrading agency computers, communications equipment, and software, as well as for improving the technical expertise of existing staff.

1. The ITS/CVO program **should develop an open, modular, and adaptable architecture incorporating legacy systems.**

To accommodate its many users in both the public and private sectors, the information system architecture for linking CVO information systems should be open, modular, and adaptable. Registration and fuel tax systems are provided today by two private sector vendors, individual States, and a consortium of regulatory agencies (under development). Permitting services are provided by several large, national private sector service bureaus, dozens of smaller companies, many individual States, and four State consortia. Automated clearance services are being provided by a public/private not-for-profit corporation and a multistate consortium. As the range of services and business entities grows, so will the need for integration across these services and providers. Because all of these providers maintain separate systems today, the systems architecture would be most efficient if it built upon these legacy systems.

The FHWA's CVISN project is developing a blueprint for a national CVO architecture, which will provide the framework necessary for cooperation and growth. The CVISN will enable the interchange of data among public agencies, motor carriers, and third-party service providers. The elements of the network have been defined; technical work is underway to define ED1 standards and demonstrate the capabilities of the CVISN through prototype applications. The CVISN pilot program will be a critical step in the nationwide deployment of ITS/CVO capabilities. Successful deployment of the CVISN will provide the infrastructure for expanded ITS/CVO services (see figure 95).

The CVISN framework is shown in figure 96. This framework defines the high-level elements of the architecture (a State credentials administration center, weigh station, truck); lists the functions assigned to each of these segments (a State administration centers would include functions such as vehicle registration and fuel tax administration); and the existing or desired linkages among these functions (such as dial-up telephone lines, radio data links, and satellite communication links). In addition, the architecture will define a dictionary of data elements (such as a vehicle identification number), and the EDI format that specifies the structure and meaning of messages passed from one computer to another.

Because the CVO architecture does not require special purpose or proprietary communications technologies or computer systems, the types of systems and services necessary to meet CVO requirements are readily available from multiple vendors. Most of the data elements, such as a vehicle identification number, already are well defined. The missing elements are EDI standards and translator software that can extract data from a proprietary data base and map them to EDI standards.

2. The ITS/CVO program should continue to support private sector fleet management activities.

Fleet management technologies increasingly will be an important tool for enhancing the productivity of motor carrier operations in the next decade. The productivity and health of the motor carrier industry is of great importance to the national freight system, as well as the economy, because trucking is the Nation's dominant form of goods movement. The public sector should support fleet management initiatives, but, as in the past, most progress will occur through market-driven private sector efforts. The ITS/CVO program should encourage and support industry efforts to define EDI standards and protocols, and to integrate fleet management systems with existing motor carrier administrative systems and business logistics management systems.

The appropriate Federal role in developing these technologies is under review, but is limited. The Federal role may include the following:

- The collection and dissemination of information on the current market penetration and potential applications of fleet management technologies.
- The examination of ways to stimulate private investment in this area.
- The provision of technical expertise.

3. The ITS/CVO program should establish national standards for AVI/VRC and EDI data and communications.

The ITS/CVO program should develop EDI standards and translator software, and then demonstrate their performance in pilot programs with the States and motor carriers. The techniques and procedures for developing EDI protocol and software are well established. The ITS/CVO program can build upon many protocols that are already in use in the public and private sectors. Nevertheless, the development of standards will be a major undertaking because of the complexity of commercial vehicle transactions and the number of players involved.

The major technical issue facing ITS/CVO enforcement programs today is the development of AVI/VRC standards. The motor carrier industry has been emphatic about the need to ensure interoperability of AVI transponders across States, corridors, and regions. Interoperability requires agreement on transponder communications frequencies, data formats and interchange protocols, and the positioning of the transponder and roadside reader. In their early phases, the HELP and Advantage CVO transponders were not compatible. These technologies are converging, but a consensus on a future path has yet to form. The ITS America CVO Technical Committee recently established a Standards Subcommittee and charged it with making recommendations on AVI user requirements and a standards-setting process. The development of standards, which has been debated for a dozen years, will strongly influence the rate of market penetration of ITS/CVO clearance applications.

A secondary need is to coordinate CVO transponder standards with those in the toll industry. In its early stages, the HELP program was the defining highway market for AVI technology and could steer the development of AVI to the special needs of the States and motor carrier industry. Today, the development of AVI technology is being driven largely by the needs of the toll road industry. States and motor carriers will benefit from economies of scale in production and operation if they can foster development of a transponder that accommodates both CVO and toll applications.

The task of establishing uniform identifiers for motor carriers, vehicles, and drivers presents both technical and organizational challenges. To reduce costs, many fleets are leasing trucks and contracting for drivers. This means that a truck may be owned by one party (such as a credit corporation), registered by another (the motor carrier), and operated by a third party (the driver). The commercial driver's license (CDL) serves as a unique identifier for drivers; now, State agencies must agree on unique identifiers for motor carriers and vehicles, and add these to their information systems so that data may be linked and collated across agencies and States. The CVIS project is tackling this issue.

The Federal Government also has an interest in establishing uniform standards for the electronic mapping of truck routes and hazardous materials transport routes. Routing and dispatching software, advanced traffic management systems, and advanced traveler information systems share a common need for accurate route maps. The private sector is developing and marketing good digitized map data bases. However, few of these data bases incorporate information critical to large truck routing, such as data on weight limits, bridge clearances, and hazardous materials route restrictions. Although this information is available from States and local Governments, it is expensive to assemble and maintain. Moreover, most private sector companies do not want to bear the liability risks of accidentally incorporating inaccurate information into their map data bases. The FHWA has work underway to investigate and recommend approaches for standardizing the information format, content, and accuracy of a nationwide map data base for traveler information systems.2 The work should examine the

2 The FHWA has a Link Identification Format and Map Data Base Requirements study underway with the Oak Ridge National Laboratory. The purpose of the study is to "work closely with national interests to examine various methods for identifying segments of transportation links and develop recommendations for standardizing the information format, content, and accuracy of a nationwide map data base that can be associated with multimodal traveler information systems." See Federal Highway Administration, *Intelligent Transportation Systems (ITS) Projects,* Washington, DC, January 1995, page 261.

costs and benefits-with respect to both motor carrier productivity and hazardous materials safety-of incorporating CVO-specific information into this data base.

4. The ITS/CVO program should identify appropriate resources for upgrading agency computers, software, and communications equipment as well as for improving the technical expertise of existing staff.

In view of the insufficiency of existing public sector data processing capabilities, the deployment of ITS/CVO systems and the development of technical standards may be difficult without upgrades to basic computer and communications equipment. These efforts must be accompanied by efforts to increase the technical expertise of public and private staffs, particularly among the State agencies that are the cornerstone of CVO regulation. Some States have identified a need to hire additional labor, while others expect that the administrative streamlining associated with ITS/CVO programs will free up some personnel for reassignment to new areas. It is clear, however, that the mix of skills will change. As appropriate, most States will find that they require a combination of retraining existing staff; recruiting new staff with specialized expertise in engineering, electronics, information systems, and other areas; and retain outside consultants.

6. Strategies for the National ITS/CVO Program

The objective of this chapter is to make recommendations regarding the market, organization, and resource requirements for the categories of the national ITS/CVO program: enforcement, administration, fleet and vehicle management, and highway traffic management.

ENFORCEMENT

The recommended strategies for the national ITS/CVO program with respect to the enforcement of safety, weight, and credentials regulations are as follows:

Markets

1. The ITS/CVO program should emphasize driver and vehicle safety assurance through the development of better systems for the screening of high-risk carriers, the development of automated roadside safety inspections, the expansion of onsite carrier safety fitness reviews, and the establishment of electronic linkages between safety and credentials data bases.

2. The ITS/CVO program should continue to emphasize the verification of weight and credentials information. The program should expand the deployment of technologies for the automated clearance of vehicles past weigh stations and ports of entry. The program also should develop methods for States relying on mobile enforcement to enhance their enforcement capabilities.

3. The ITS/CVO program should develop policies and agreements to enable the regional coordination of safety assurance activities

4. The ITS/CVO program should continue to support the development and deployment of electronic toll collection systems. Deployment should include outreach efforts to encourage motor carrier participation in these programs.

Organization

1. Enforcement services should be developed and deployed by a series of regional consortia. Membership in these consortia should correspond to the natural "trucksheds" defined by the distribution of freight-generating centers and truck traffic along major highways.

2. Each regional consortium should have the flexibility to offer the "bundle of services" that will meet the needs of its agencies and carriers-for example, the West may emphasize weigh station preclearance, while mobile enforcement may be the focus in the Northeast.

Resources

1. The ITS/CVO program should develop electronic linkages between safety and credentials data bases to provide a broader range of information to enforcement officers in the field on a real-time basis.

2. The Federal Government should take a proactive role in the development of vehicle-to-roadside communication standards, which would permit interoperability of preclearance and electronic toll collection systems.

3. The Federal Government should consider funding for research, operational tests, and deployment of enforcement services, including both capital and operating costs.

ADMINISTRATION

The recommended strategies for the national ITS/CVO program with respect to the administration of motor carrier regulations are as follows:

Markets

1. The ITS/CVO program should focus on the regulations involving the largest number of transactions, the largest flow of funds, and the largest commitment of staff time. These include vehicle registration, fuel tax administration, and oversize/overweight permitting.

2. The deployment of ITS/CVO administrative services will be spread across the Nation, but should focus on the States and regions with the largest number of trucks and regulatory transactions.

3. An important part of the ITS/CVO program in each State should be the development of single points of contact for credentials information, such as telephone information numbers, customer service desks, and on-line bulletin boards.

4. The ITS/CVO program should continue to improve the systems and infrastructures for the exchange of credentials and safety information and funds along two dimensions: among States, and among different agencies in individual States.

5. The ITS/CVO program should develop agreements and systems to make vehicle registration contingent upon a carrier's satisfactory compliance with all credential requirements and its safety performance record. In this manner, the registration process can be used to screen unsafe or noncompliant carriers.

6. The ITS/CVO program should continue to encourage the development of regional, electronic one-stop shopping programs, but with the recognition that these programs will not appeal to all carriers.

Organization

1. The primary focus of ITS/CVO administrative services should be at the State level, which is where most day-to-day control of regulatory functions lies. Where appropriate, States should be encouraged to streamline regulatory processes by taking advantage of lTS/CVO services.

2. Regional ITS/CVO forums should pay attention to administrative issues as well as enforcement concerns, because of common regulatory structures and organizations, as well as the tendency for most interstate transactions to occur between States in the same trade area.

3. The national ITS/CVO program should play a role in developing standards and protocols for motor carrier regulation.

Resources

1. At the State, regional, and national levels, the ITS/CVO program should develop electronic data interchange capabilities and information systems to link together agencies within and among States.

2. The FHWA should maintain its commitment to the national deployment of the Commercial Vehicle Information Systems and Networks (CVISN).

3. The Federal Government should consider funding to support State, regional, and national CVO forums; the development of State, regional, and national CVO plans; and technical studies, particularly benefit/cost analyses.

FLEET AND VEHICLE MANAGEMENT

The recommended strategies for the national CVO program with respect to fleet and vehicle management are as follows:

Markets

1. The public sector should support industry-driven efforts to use fleet and vehicle management technologies to improve the productivity and safety of the trucking industry, because of the trucking industry's importance to the national freight system and economy. However, the public sector's formal role in this area should be limited,

2. The Federal Government should gather and disseminate information on the current market penetration and potential applications of fleet management technologies, focusing on priority markets including large fleets and fleets operating at a national or regional scale.

Organization

1. The market for fleet management systems is most efficiently left to private sector forces. However, the public sector should keep abreast of developments in this evolving market to ensure the integration of fleet management systems with public sector information systems where appropriate, and to provide technical expertise to the motor carrier industry as needed.

Resources

1. The ITS/CVO program should encourage and support industry efforts to define electronic data interchange standards and protocols for fleet and vehicle applications, and to integrate fleet management systems with existing motor carrier administrative systems and business logistics management systems.

2. Private investment will be the key to the expansion of the fleet management market. The Federal Government should examine ways to stimulate private investment in this area.

3. The Federal Government should consider providing funding for technical research on fleet and vehicle management technologies, as well as providing expertise to the industry or the States on new technologies.

HIGHWAY TRAFFIC MANAGEMENT

The recommended strategies for the national ITS/CVO program with respect to highway traffic management are as follows:

Markets

1. ITS/CVO highway traffic management applications should focus on congested urban areas. The Boston-to-Washington corridor, the Gary Chicago-Milwaukee corridor, and southern California should be early priorities.

2. In the near term, ITS/CVO programs should emphasize links to incident management activities. In the long term, ITS/CVO programs should consider the development of advanced traveler information systems oriented to trucks.

3. The ITS/CVO program should continue to develop hazardous materials incident response services.

Organization

1. The development of ITS/CVO traffic management services should be led by regional or State programs.

2. The development of ITS/CVO traffic management services should be tied to ongoing traffic management and information programs for passenger cars.

3. The ITS/CVO program should ensure compatibility among State and metropolitan traffic management services. This compatibility is critical for carriers with regional or national operations.

Resources

1. ITS/CVO traffic management programs should leverage passenger car technologies and funding sources where possible.