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Commercial Vehicle Operations in

Intermodal Transportation Management Centers

October, 1996

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ABSTRACT

The report documents findings from a series of studies investigating the role of commercial vehicle operations within inter-modal transportation management centers. The study concludes that there exists no strong market push to better integrate motor carrier operations with governmental agencies in California today. **As** companies adopt ITS technologies for vehicle tracking and wireless communication, they are clearly not pushing for electronic transfer of information to and from governmental agencies. Likewise, none of the companies in the vehicle tracking industry has given priority to improving governmental interfaces. Despite these cautions, the motor carrier industry is not opposed to ITS and it certainly is not opposed to moving toward a paperless system. Trucking companies are willing and perhaps eager to invest and participate in projects that possess four basic characteristics:

- Modest investment
- No new taxes or user fees
- Promotes operating efficiency, customer service, or safety
- Voluntary

On top of these characteristics, the industry is much more inclined to favor CHP led efforts over those initiated by Caltrans, DMV or other state agencies.

Keywords: Commercial Vehicle Operations, Motor Carriers, Intelligent Transportation Systems.

ACKNOWLEDGMENTS

EXECUTIVE SUMMARY

California's Department of Transportation operates a network of Transportation Management Centers (TMCs) that are used in incident response and clearance, control of traffic meters and changeable message signs, and dissemination of information to travelers. Through the Southern California Priority Corridor program, Caltrans is considering expanding the functionality of its TMCs to provide inter-modal services, including direct services for public transit and commercial vehicles. The purpose of this report is to examine how Commercial Vehicle Operations (CVO) might be integrated within TMC operations. This report is an outgrowth of earlier work investigating the concept of "Computer Integrated Transportation" (CTT).

The report presents findings from a series of studies on CVO in California:

(1)   Surveys with trucking terminal managers.
(2)   Review of trucking regulations and technologies.
(3)   Case study site visits at terminals operated by nationwide trucking companies.
 (4)   Telephone interviews with product managers at leading truck-tracking technology developers.
(5)   Focus groups with 70 individuals representing trucking companies, Caltrans, California Trucking Association and various governmental agencies.

The findings from the fourth and fifth studies are documented in full in this report. Other findings are provided in abbreviated form, with complete findings available in a prior working paper.

Based on our most recent results, there exists no strong market push to better integrate motor carrier operations with governmental agencies in California today. As companies adopt ITS technologies for vehicle tracking and wireless communication, they are clearly not pushing for electronic transfer of information to and from governmental agencies. Likewise, none of the companies in the vehicle tracking industry has given priority to improving governmental interfaces. This is due in part to a perceived absence of market demand, and in part due to the daunting obstacle of satisfying the requirements of 50 separate states.

Despite these cautions, the motor carrier industry is not opposed to ITS and it certainly is not opposed to improved technologies and moving toward a paperless system. Trucking companies are willing and perhaps eager to invest and participate in projects that possess four basic characteristics:

- Modest investment
- No new taxes or user fees
- Promotes operating efficiency, customer service, or safety

- Voluntary

On top of these characteristics, the industry is much more inclined to favor CHP led efforts over those initiated by Caltrans, DMV or other state agencies.

There also seems to be no strong desire (and perhaps opposition) in the industry to including CVO within intermodal TMCs. While the industry certainly desires better information on roadway conditions (especially closures and weather conditions), CVO has few special requirements beyond that of the general motoring public. From the standpoint of traffic operations, the biggest benefit from the intermodal TMC concept comes from improved access to information on hazardous materials.

Finally, it would be worthwhile for the state to develop task forces to address several key issues. For each issue, the focus should be on assessing whether the current system of regulation and operation is the most effective way to achieve the desired objectives, and to identify new technologies that better serve the purpose.

The three key areas are:

(1)   Safety assurance, focused on the issues of driver safety, vehicle safety and cargo safety.

(2)   Protection of the roadway from damage by oversize or overweight vehicles.

(3)   Reducing congestion experienced by trucks and produced by trucks.

A fourth ITS related function, taxation, is better addressed at a national level, but is also a priority.

1. INTRODUCTION

The State of California's Department of Transportation currently operates a network of Transportation Management Centers (TMCs) that are used in incident response and clearance, control of traffic meters and changeable message signs, and dissemination of information to travelers. Through the Southern California Priority Corridor program, Caltrans is considering expanding the functionality of its TMCs to provide inter-modal services, including direct services to public transit and commercial vehicles.

The purpose of this report is to examine how Commercial Vehicle Operations (CVO) might be integrated within TMC operations. This report is an outgrowth of earlier work investigating the concept of "Computer Integrated Transportation" (CIT). CIT is envisioned as an integrated network of public and private transportation organizations, each with unique responsibilities, but working toward a common mission of facilitating travel across all modes of transportation, CIT is designed to achieve effective coordination of the transportation system, while at the same time respecting the individual responsibilities of participating organizations. This is accomplished through defining channels and protocols for communicating and responding to information, and defining leaders within functional and geographic areas.

In an earlier report [9], CIT was introduced, and investigated from the perspective of arterial and highway TMCs. Site visits and interviews were conducted at California TMCs, followed by focus group meetings with TMC managers. Institutional impediments and opportunities were identified as part of this study, particularly as they pertain to cooperation among governmental agencies. The report only touched on the issues of how transportation agencies interact with non-transportation agencies, and how they interact with the private sector. In later reports, follow-up surveys and interviews were conducted with emergency service providers and transit agencies, in addition to commercial vehicles [8].

This paper represents both the continuation and conclusion of the earlier commercial vehicle work. Prior results are summarized, and new results are provided based on: (1) interviews with product managers at technology development companies, (2) focus groups with industry leaders, and *(3)* review of ongoing CVO projects and technology advances. **As** is revealed in the research, trucking companies must interact with numerous local, state and national agencies in the normal course of their business. The nature of this interaction is anything but uniform, presenting carriers with a myriad of confusing and sometimes poorly documented requirements. Furthermore, CVO (and often transportation) is not the primary focus of most of these agencies. **As** a result, it is not at all surprising when trucking companies view government as "regulators" instead of "service providers," presenting a serious obstacle to implementing ITS within the CVO industry. Nevertheless, there does not appear to be a strong desire among either technology companies or trucking companies to use ITS as a tool for system integration between government and industry.

1.1 Industry Overview

Commercial vehicle operations (CVO) encompasses a range of industries, including service and repair vehicles, private buses and taxis, and trucks. The focus of this research is on the most prominent segment of CVO: motor carriers (i.e., trucking companies).

Trucking is a huge industry in the United States. Nationwide, trucking companies had total revenues of $295 billion in 1992, meaning that an average person spends more than $1,000 per year (directly or indirectly) on trucking. *Inter*state trucking accounts for $82 billion in revenue, intrastate/intercity accounts for $96 billion and intrastate/local accounts for $117 billion. Despite the overall size of the trucking industry, the vast majority of trucking companies are small. The largest carrier, United Parcel Service (UPS), had revenues of $12.7 billion in 1992, just **4.3%** of the total.

Motor carriers fall into three general classifications: "common", "contract" and "private." **A** common carrier is a business that carries goods for-hire, serving the general public or other businesses at established rates. **A** contract carrier also carries goods for-hire, but on a contract basis, for specific customers. **A** private carrier is a unit that serves the internal transportation needs of an organization (e.g., the truck fleet for a supermarket chain).

The motor carrier industry can be further segmented by shipment size. UPS, for instance, is dominant in the *package* business, serving shipments under 150 pounds. Its biggest competitor in package shipments is the U.S. Postal Service (not inclcded in the revenue total). However, UPS also competes with overnight package carriers, such as Federal Express and Emery Overnight, which are classified as air carriers, even though much of their business is by truck.

Less-than-truckload (LTL) is another major segment. These carriers serve medium size shipments (100-5000 pounds) through networks of consolidation terminals. LTL can be further segmented by longhaul and regional. The major longhaul, nationwide, carriers are Consolidated Freightways (CF), Roadway Express (operating independently of Roadway Package System), and Yellow Freight System. In California, the largest regional LTL carrier is Viking Freight System. The nationwide carriers also own, as separate operating units, a number of non-union regional carriers, which compete with companies like Viking

Truckload (TL) is a third major segment. These serve full truckload shipments, which are not consolidated in terminals. Small truck fleets, ranging from the owner-operator on up, carry the majority of TL shipments. J.B. Hunt and Schneider National are the largest in the industry, but by no means dominate it.

Trucking can also be segmented by commodity. The most prominent companies carry boxed, palletized or otherwise packaged shipments. Bulk cargo such as fuels, agricultural products, and gravel, as well as some hazardous materials, are carried by specialized carriers, often by private fleets. Major petroleum companies, for instance, operate their

own fleets of tanker trucks. Agricultural trucking (a major California industry), *on* the other hand, is typically served by common or contract carriers.

The motor carrier industry as a whole has undergone major changes since the passage of the Motor Carrier Act of 1980, which deregulated interstate trucking. According to Corsi [4], LTL costs and profits have both declined since deregulation (costs declined 38% in real dollars between 1977 and 1987). The most successful companies pursued "a strategy of differentiation" that was characterized by "supporting a high level of service quality with high prices and high rewards for employees." In the TL industry, Corsi states "major TL operators recognize that the economics of long-haul shipping dictate intennodal partnerships" and "railroads will probably gain significantly from the increasing reliance placed on their services by the TL carriers."

1.2 Prior Research on CVO

Corsi [4], Dunn et al [6], Hall and Chatterjee [8], Muller [12] and Zogby [13] all provide background on the state of the CVO industry. Corsi focuses on the regulatory and economic state of the industry, including the effects of the Motor Carrier Act of 1990, which deregulated interstate trucking. Dunn examines the effects of the North American Free Trade Agreement on trucking to and from Mexico. Muller discusses standards for Electronic Data Interchange (EDI), which is widely used for billing and accounting purposes in place of paper. Zogby discusses licensing and registration requirements and opportunities for coordination across states. Hall and Chatterjee include a general review of governmental roles and technologies used in **CVO.**

Research on Intelligent Transportation Systems in CVO includes the evaluation of the Crescent Project [5], which provides a range of technologies to facilitate inspection and clearance of trucks on interstate highways in western states. **A** more comprehensive multi-state study of ITS was conducted by Cambridge Systematics [3], focusing on governmental roles in issuance of carrier operating authority, vehicle registration, fuel taxation, oversize vehicle permitting and safety/weight enforcement. They provide a number of recommendations for streamlining state/carrier interactions, including providing "one-stop shopping" services for issuing credentials.

The use of ITS technologies in the operation of commercial carriers is documented in a survey conducted by the ATA Foundation [1], which concluded that computer-aided dispatching is the most widely used. Kavalaris and Sinha [11] also surveyed trucking companies as to their awareness and attitudes toward ITS technologies, focusing on regulatory related functions. About half of the respondents rated weigh station pre-clearance and one-stop shopping for trucking administration as very helpful. Recently, the Federal Highway Administration commissioned the Applied Physics Laboratory at John Hopkins University to develop a system architecture for commercial vehicles [10]. The "CVISN" document, as it is called, concentrates on developing data interchange standards

for administrative processing of CVO documents and for on-the-road inspections. More generally, ITS user services are defined in [7].

Most recently, the ATA Foundation has completed a cost/benefit and market assessment of ITS technologies in CVO [2]. They concluded "from the perspective of motor carriers, regulatory efficiency is best realized through the elimination of regulation" and "It is also recommended that institutional renovation be analyzed to accompany ITS/CVO deployment for motor carrier/government applications." The authors concluded that many ITS technologies do not have favorable cost/benefit ratios, even though carriers spend $2000-$3000 per year per vehicle on regulatory compliance.

The remainder of the paper is divided into four sections. Section 2 summarizes prior results. Section *3* provides new results on ITS technologies in trucking. Section **4** documents focus groups, and Section *5* provides conclusions and recommendations.

2. SUMMARY OF PRIOR PROJECT RESEARCH

Prior project research is documented full in [8]. This section summarizes results in the areas of government roles, interviews with terminal managers and case studies.

2.1 Government Roles in Commercial Vehicle Operations

This section reviews four principle areas of government/industry interaction: (1) Cargo and common carrier regulations, (2) Driver regulations, *(3)* Vehicle regulations, (4) Governmental services, and (5) Overview.

2.1.1 Cargo and Common Carrier Regulations

Motor carrier (i.e., trucking) regulation has occurred at both the state and national level. Rooted in its constitutional power to regulate commerce among the states, Congress established the Interstate Commerce Commission (ICC) in 1887 to regulate interstate transportation. Over time, the ICC has been used to control rates, services and routes for trucking companies, as well as railroads. However, interstate trucking was deregulated under the Motor Carrier Act of 1980 and subsequent legislation.

Within California, *intrastate* motor carriers were regulated until recently by the state Public Utilities Commission. However, Section 601 of the Airport Improvement Program Reauthorization Act of 1994 prohibited states from regulating "prices, routes or services" of motor carriers, excepting household goods carriers [12]. In January of 1995, Governor Wilson established a task force to study to improve and streamline oversight of motor carriers, which recommended that PUC's remaining regulatory authority be transferred to the California Highway Patrol *(CHP)*. This recommendation was modified in recent legislation, which divided regulatory authority between the CHP and Department of

Motor Vehicles (DMV). Other task force recommendations included "reform of the Biennial Inspection of Terminal (BIT) program to make it more performance based", to "apply automated administrative and inspection processes to the terminal inspection program" and "maximize the utilization of Intelligent Transportation System (ITS) technology to make governmental programs less intrusive."

Following the Motor Carrier Act of 1991, the ICC adopted a "Single State Registration System" in 1993, which requires motor carriers to carry, in their vehicles: a registration from a single base state, proof of satisfactcry insurance coverage, and a copy of ICC operating authority (if operating interstate). Carriers must also comply with the state regulations of every state in which it operates, and that it designate a process agent in each state in which it operates. As of this writing, ICC's remaining regulatory powers have been transferred to the US DOT.

In addition to common carrier regulations, hazardous material and medical waste transportation are regulated by the California Department of Health Services and the California and Federal Environmental Protection Agencies, both of which require operating permits. The motor carrier must also obtain a Hazardous Materials Transportation License; the driver must obtain a HAZMAT endorsement; and the vehicle must display federally mandated placards.

Freight is subject to additional regulation when crossing borders. Agricultural shipments entering California are governed by the State Department of Agriculture, which operates inspection stations at border crossings with Arizona, Nevada and Oregon. Freight entering California from Mexico is subject to inspection from **U.S.** Customs, which also inspects for **U.S.** Department of Agriculture violations. However, under terms of the North American Free Trade Act, as well as Custom's ongoing programs to speed **up** inspections for reputable carriers, the scope of cargo inspections is likely to diminish (on the other hand, the importance of *vehicle* inspections will likely increase [6]).

2.1.2 Driver Regulations

Commercial driver licenses are governed by the Commercial Motor Vehicle Safety Act, passed by Congress in 1986 [13]. This act requires each state to meet the same minimum standards for testing and licensing commercial drivers, and prohibits drivers from holding licenses from more than one state. It also established a national database to track driver records. Additional testing is required for drivers who transport hazardous materials, operate tank trucks, or pull double or triple trailers. In California, the Department of Motor Vehicles (DMV) is responsible for testing and licensing.

Drivers are subject to a great range of vehicle code regulations, which are enforced in California by the Highway Patrol, as well as by local police departments. Many of the regulations are more stringent for commercial drivers than for the general public. For instance, commercial drivers are not allowed to operate a vehicle with any level of alcohol in their system. Drivers are also subject to "hours of service" regulations, which govern

the number of hours that may be worked without taking a break. These rules are quite complicated, and require tracking hours over a rolling period of eight days. The regulations are different for intrastate and interstate movements (most importantly, California allows no more than 12 hours per day, while federal rules limit workdays to no more than 10 hours). In either case, drivers are required to maintain a log, which must be presented for inspection immediately upon request by any law enforcement officer (exceptions are granted to trucks that operate within 100 miles of their terminal).

Employers are also required to register their drivers with the DMV's "pull notice" program. The program notifies employers when: "a driver has been convicted of a violation of the California Vehicle Code, has an accident posted to his or her driving record, is classified as a negligent operator, or has his or her driver license suspended or revoked." The notices are mailed automatically at 6 or 12 month intervals (with employers held accountable for keeping records).

2.1.3   Vehicle Regulations

Vehicle regulations affect licensing, safety, emissions and tax collection. Under provisions of the Motor Carrier Act of 1991, motor carriers are required to register their vehicles with their base state, which is the state of their principal place of business [13]. Motor carriers are also responsible for obtaining a "fuel user's tax permit" from the State Board of Equalization, and keeping records to ensure that proper fuel taxes are paid in each state (diesel taxes, unlike gas tax, are not uniformly paid at the pump). Special permits are required from the State Department of Transportation for oversize or overweight vehicles. The Environmental Protection Agency, and the California Air Resources Board, also regulate vehicle emissions, and the Highway Patrol plays a role in enforcing "opacity" requirements on emissions.

Record keeping requirements for vehicle maintenance are extensive. Drivers must write a report each day on their vehicle's condition, which must be retained by the carrier for a minimum of one month. The carrier must also document its adherence to a preventive maintenance program, including safety inspections at 90 day, or shorter, intervals. The carrier must retain records of vehicle inspection, maintenance, lubrication and repair for a minimum of one to two years.

Within California, safety regulations are primarily enforced by the California Highway Patrol *(CHP)*. The CHP is also responsible for operation of truck inspection stations and for performing the *Biennial Inspection of Terminals* (BIT; see CHP, 1992). Inspection stations are positioned on highways throughout the State. When open, all commercial vehicles passing the inspection station are required to stop. The inspection may include any or all of the following checks: (1) vehicle weight, (2) vehicle and driver licenses, (3) hours of service logs, (4) safety inspection, *(5)* maintenance operations records (for vehicles assigned away from their normal base of operations). In addition, CHP officers set up spot inspections on a random basis.

2.1.4   Governmental Services

Fewer governmental agencies provide services to trucking than regulate trucking.
Certainly the most important service is construction and operation of streets, highways,
signals and rest areas, which in California falls under the jurisdiction of Caltrans, as well as
county and city public works departments. Caltrans also operates a free statewide
roadway condition phone line, and highway advisory radio and changeable message signs
are available in some locations.

The state, under the direction of CHP, also plays the primary role in clearing incidents
under the direction of CHP. The CHP is supported by Caltrans maintenance (road repairs
and debris clearance), fire departments, ambulance companies, tow operators, and
hazardous material teams (some of which charge a fee for service). In addition, the
Federal Government operates the National Response Center, which provides a toll-free
number for reporting chemical hazards, as well as the Chemical Transportation Emergency
Center, which advises emergency personnel. Drivers are required to phone the National
Response Center under certain conditions, such as when hazardous materials are released.
Drivers are also required to carry emergency response information for the shipments they
carry. Smaller incidents are sometimes handled by the Freeway Service Patrol, but these
tow trucks are not well equipped for serving trucks, who rely more on private contractors.
Finally, emergency call-boxes, now installed on many of the state's roads, is another
important service for disabled trucks.

2.1.5 Overview of Government Interaction

To summarize earlier findings, the trucking industry interacts with a great many
governmental agencies, largely for regulatory reasons. In addition to agencies involved in
general business regulation (e.g., IRS and worker's compensation), trucking companies
encounter a long list of agencies that are somewhat unique to their business. Table 1,
which is directed at California, categorizes agencies according to whether their primary
interaction with CVO is in vehicles, cargo or drivers.

The list reveals two things. First, most of the interaction between trucking companies and
government is regulatory in nature, and second, trucking companies must interact with a
great many agencies. Hence, even though government provides an enormous service to
the industry through the construction and operation of roadways, it is explainable when
trucking companies perceive government in a negative light. This creates an atmosphere
of suspicion that impedes governmental efforts to improve trucking services.

2.2 Interviews with Terminal Managers

Trucking terminal managers were interviewed to assess current and planned use of
technologies and attitudes toward governmental regulations and services. The survey
group was managers of trucking terminals located in the State of California, identified
through two sources: phone directories (for-hire carriers only) and California Trucking

Table 1. Summary of Governmental Interfaces

Agency	Functions	Category
California Air Resources Board	Emission Standards	Vehicle
California Highway Patrol	Vehicle Code Enforcement Biennial Inspection of Terminals Weigh Station Operations Incident Clearance	Driver. Vehicle
Caltrans	Oversize Vehicle Permit Roadway Services Incident Clearance Road Condition Information	Vehicle
Department of Agriculture	Agriculture Inspections at State Borders	Cargo
Department of Health Services	Hazardous Materials Permit Medical Wastes	Cargo
Department of Motor Vehicles	Driver Licensing Vehicle Licensing	Driver, Vehicle
Environmental Protection Agency	Hazardous Materials Permit Emission standards	Cargo Vehicle
Interstate Commerce Commission (responsibilities to US DOT)	Interstate Operating Authority Proof of Insurance	Cargo
National Response Center Chemical Transportation Emergency Center	Hazardous Materials Clearance	Cargo
Public Utilities Commission (responsibilities moved to DMV/CHP)	Highway Carrier Permit Financial Responsibility. Proof of Insurance Safety Requirements	Cargo
State Board of Equalization	Fuel Taxation	Vehicle
U.S. Customs	Inspections at U.S. Borders	Cargo
U.S. Department of Transportation	Registration and Safety Rating	Vehicle

Association's list of terminal managers (private and for-hire carriers). The company profile reflected the diversity of the trucking industry, including intra-state and interstate carriers, small fleet and large fleet carriers, and a variety of commodity types carried.

2.2.1 Information Acquisition

Information on roadway conditions is obtained by dispatchers through various means, the two most important are radio traffic reports and the information that is relayed back by drivers. Only a few of the respondents cited on-line services as an information source. Dispatchers use information for a variety of purposes, the most common of which is advising drivers about routes and conditions (58%).

Drivers, like dispatchers, also rely on radio traffic reports and other drivers (via CB radio), with no other source cited by more than 13% of respondents. By far the most important use of this information was to change routes (60%). Combining the dispatcher and driver questions, it appears that trucking companies are rigid in how they assign shipments to drivers, and in altering pick-up and delivery times.

The preferred means of accessing information from Caltrans was telephone information lines (45%), on-line information by modem (40%) and radio broadcasts (30%). It should be noted that the preference for modem-based information was far stronger than its actual usage, indicating an area for future growth.

Generally, managers were dissatisfied with the quality and accuracy of information that is currently available from the state. Most importantly, terminal managers desire better information on roadway conditions (e.g., snow, flooding, etc.), roadway closures and roadway construction.

2.2.2 Use of Technologies

A wide range of technologies were used for communicating to/from drivers. CB Radio (42%), pagers (39%) and cellular phones (22%) were frequently used. A small number of companies (4%) had wireless data transmission capabilities. A significant percentage only communicated by conventional telephone (33%). Most companies only communicate with their drivers on an infrequent basis.

Just 35% of the large companies, 20% of the medium companies and 10% of the small companies utilized computer modems, and even smaller numbers were Internet accessible. Vehicle tracking devices achieved moderate market penetration: none of the small companies, 25% of the medium companies and 29% of the large companies had tracking. Computers were widely used by large companies in regulatory compliance (close to 80%), but infrequently used by medium (25%) and small (38%) companies.

2.2.3   Regulations

Virtually all companies stated that regulations are necessary, especially in the area of vehicle maintenance and licensing. Companies recognize the need for safe operation, and they recognize that many of the regulations add to their protection. Some companies felt that regulations could be more stringent, including greater vigilance in preventing drivers from obtaining multiple licenses.

On the other hand, many of the regulations are viewed as confusing and burdensome. The strongest complaints were directed at the paperwork and complexity of hours-of-service rules, and the delays imposed by inspection stations. Managers were concerned that even when companies make good faith efforts to follow the rules, violations inevitably occur. Some companies also felt that hours-of-service rules added to their cost of doing business by reducing their flexibility in scheduling drivers. Several mentioned that the hours-of-service rules should be changed, to allow more hours, or to implement the "24-hour-restart" program (which re-sets the driver's "clock" after a 24-hour rest period).

2.2.4   Attitudes Toward ITS Technologies

The survey group proved to be unfamiliar with ITS or its objectives. Attitudes toward ITS were one of ambivalence mixed with skepticism. However, none of the US **FHWA** ITS user services elicited negative comments and mangers generally supported any service that simplifies paperwork and speeds up processes.

2.3   Case Studies with Major Carriers

Case studies were conducted with major trucking companies to explore issues in depth. The case studies were based on site visits to trucking terminals, including tours of their dispatching operations and in-vehicle technologies. The case studies may be indicative of the industry's direction, and possibly the leading edge of technological innovation. Three important trends were observed:

(1) The primary motivator of technology implementations has been enhancement of customer service. This is reflected in technologies for tracking shipments and electronic data interchange.

(2) Pick-up and delivery routing (especially pick-up) is usually a manual process, at the discretion of the driver. This partially reflects the complexity of routing these vehicles, and partially reflects the desire to empower employees.

(3) Companies have not invested heavily in technologies to simplify regulatory compliance, which is not viewed as a value added investment.

From the standpoint of intermodal TMCs, the emphasis of the trucking industry is much more on integration with *customers* than on integration with *government*, presenting a serious obstacle to implementing many of the ITS user services.

3. REVIEW OF ITS/CVO TECHNOLOGIES

The last ten years have seen the development of a wide range of information technologies (IT) to serve the trucking industry. In many respects, the need for IT is greater in trucking than almost any other industry. The dispersed nature of the workforce, assets, and customers, as well as the need to comply with regulations from multiple regulatory agencies, makes trucking especially difficult to manage in their absence.

In addition, the fragmented nature of the industry, low margins, and relatively low wages for drivers, have all been obstacles to adoption. More recently, the teamsters strike of 1994 jeopardized the cash-flow position of some of the larger LTL carriers, making it difficult to make any sort of investment. In this environment, IT could only be justified when it provided immediate payback.

3.1 Technology Examples

Like most industries today, information technologies have influenced the motor carrier industry in many different ways. The following provides examples of the types of technologies that are currently being marketed.

Maintenance Management Systems A variety of software products are available for tracking and reporting on vehicle repairs, component replacement, and preventive maintenance (e.g., Bender Engineering's "Maint Star"). Truck manufacturers have also developed diagnostic equipment that monitors and records detailed vehicle operating information before, during and after a fault occurs (e.g., Freightliner's "ServiceLink").

Internet Services Several companies have developed internet services to post and search for loads (e.g., "NetTrans" and "The Internet Truckstop"). General trucking information is also available from the web pages of trucking oriented magazines.

Accounting Software Various companies market personal computer software to assist carriers in regulatory compliance, tax filing, accounting and invoicing. Examples include "Fleet Analyst", "Truckin Buddy", "Quick Truck", "Trucker" and "California Toolbox." These products are directed at small carriers and usually require manual data entry.

Transponders Common specifications have been developed for in-vehicle transponders as part of the Advantage 75 and PrePass projects. Lockheed Martin serves as the system integrator and operator for HELP/Crescent, using transponders built by Delco Electronics.

Safety Equipment Several companies are marketing side-detection warning system for collision avoidance (including Delco Electronics' "Forewarn" and the "Blind-Sight" system. Other products include driver alertness warning systems (e.g., "TravAlert") and rear mounted video systems.

Electronic Data Interchange (EDI) is used by some carriers to transmit and receive shipment data from their customers, primarily for billing and accounting purposes. The American National Standards Institute and the United Nations have both issued EDI standards for transportation, which are not completely compatible [12]. EDI is also being expanded to exchange of customs and trade documents, to facilitate international cargo movements, through such organizations as ENCOMPASS (a joint venture between AMR and CSX). Larger trucking companies have also established centralized computing centers, which receive and transmit data on loads and drivers traveling between terminals.

Mobile Data Terminals are hand-held devices, including a keyboard and bar-code scanner, that allow truck operators to electronically record information that would ordinarily appear on shipment documents (i.e., a bill-of-lading). They have two primary advantages: (1) eliminating paper-work and the cost of re-entering information into databases, and (2) providing immediate entry of shipment information into tracking systems. Mobile data terminals are especially effective when coupled with wireless data communication, as they allow shipment status to be tracked from the moment of pick-up to the moment of delivery.   Some mobile data terminals even allow signatures to be recorded electronically, completely eliminating the need for drivers to carry paper records.

Route Planning and Scheduling Systems are used to plan vehicle routes and assign drivers to routes. These are most often proprietary or otherwise customized. They are also frequently coupled with Geographic Information Systems (GIS) for the purpose of displaying routes and for constructing route instructions.

Tracking Systems By far the most prominent ITS product, several companies market products that both track vehicle locations and provide wireless data communication to and from vehicles. These are described in detail in following sections.

3.2   Tracking Based Technologies

Vehicle tracking entails calculating the precise location of vehicles in real time, usually through the use of Global Positioning Systems (GPS). Tracking can be used to accomplish different functions, usually falling in one or the other of the following broad categories:

- **Truck Tracking Systems:** Global Positioning System (GPS), cellular and pager based technologies have been developed to track truck location and direction. These systems offer a wide range of other functionalities, including communication and sensor interfaces. These systems usually do not provide road directions.

- General GPS & Direction Finding: An emerging marketplace is developing to provide road directions to drivers. These companies are targeting truck drivers, delivery services, traveling salespeople, and even the general public. These direction finding systems vary tremendously in cost and the technology required to run the applications. These systems usually do not relay vehicle locations back to a base station and usually do not support communication and regulatory compliance.

Developers of tracking technologies were interviewed to accomplish the following objectives:

- Gain an overview of emerging technologies in the trucking industry.

- Define opportunities for companies to utilize the new technologies to automate their compliance report filing with government regulatory bodies.

- Determine whether the development of software that enables a direct interface to governmental systems is a strategic initiative.

- Determine whether the technology manufacturers believe that their customers are interested in products that electronically interface with government systems.

The study focused on GPS based technologies, within each of the broad categories mentioned previously. The survey group was product managers (or equivalent) at GPS companies. Interviews were conducted by telephone following a set interview guide. For the trucking group, the guide covered background on the product, current regulatory compliance initiatives and assessment of strategic opportunities with respect to integrating with government systems. For the general group, the guide covered background on the product and initiatives directed at trucking (without emphasis on regulation).

3.3 Truck Tracking Systems

Global Positioning Systems utilize Department of Defense (DOD) satellites to track individual trucks across the continental Untied States. Each truck is equipped with a small antenna that can receive data from the DOD satellite. This signal enables the on-board computer to identify the truck's latitude and longitude. A signal is then sent from the truck to a commercial satellite, which is either owned or leased by the tracking system company. This second satellite transmits data to the tracking system manufacturer's base station for all of the manufacturer's customers. These data are then transmitted over a landline from the base station to the appropriate trucking company.

The GPS system allows the trucking companies to keep in constant communication with their vehicles throughout the country. They can track the trucks against the scheduled route to determine whether the estimated time of arrival will be met. They also have the ability to communicate with any driver at any time. Additionally, the GPS system can

transmit data captured by the truck's on-board computer, transparent to the driver. For example, the system can be interfaced to the on-board engine computer which monitors the truck's speed, RPMs, braking, etc. Also, the GPS system can be interfaced with trailer sensors, and adjustments can be made from the central dispatch station. For example, a warning light might flash if a trailer's milk tank temperature is increasing. The dispatcher would be able to adjust the temperature remotely to avoid spoilage.

In contrast to the "General GPS and Direction Finding", all truck tracking companies have similar base products, providing tracking and communication to and from base stations. Table 2 details the additional features offered by each company.

The product specific features are described below:

- **Display Map** A video monitor inside the cab that can display truck location. The map is customized to the truck's geographic location with zoom-in and zoom-out.

- **Voice Communication** Ability to communicate to and from the base using either a cellular or satellite phone.

- **Cab/engine** Monitoring of engine vital signs, such as oil pressure and RPMs at the base station. Additionally, companies have developed algorithms that flash warning signals when threshold values are exceeded. For example, a warning signal may be activated when the engine temperature reaches a certain level.

- **Trailer** Similar to the cab/engine interfaces, but for the trailer. This requires additional interfacing. For example, monitoring the tank temperature of milk.

- **Smart Card** A credit card sized device that records driver information. Each driver would utilize his/her smart card while driving to associate the driving records to the person. This capability is important when multiple drivers share trucks.

- **Shipment Status Information** Determining which packages are on which trucks using bar coding technology, and then calculating when the packages will be delivered to the customer based on an expected time of arrival (ETA).

- **Driver Navigation System** A system that enables a driver to obtain directions using an on-board system. This does not include using the communications equipment to request directions from the base station.

- **Base Station Map** A map of the entire fleet's location at the base station.

- **Fuel Tax Reports** Utilizing the GPS technology to quantify the number of miles driven in each state and then calculating the fuel tax for each state. This includes automatically writing the government report for the companies, rather than directly

Table 2. Additional Features of Truck Tracking Companies

	ATC	AMSC	Eaton	HwyMstr	Ppl Net	Qualcomm	Rockwell
Communication							
Display Map	♦	♦					
Fax		♦		♦			
Voice Comm.	4	♦	♦	♦	♦		♦
Paging					♦		
Sensory Interfaces							
Cab/engine	4	♦	4	♦		♦	♦
Trailer	4	♦	4	4	♦		
Other. Technologies							
"Smart Card"	♦	♦	♦			♦	♦
Bar Coding	♦						♦
Shipment Status	♦	♦		4		♦	♦
Navigation System							♦
Base Station Map	♦	♦	♦	♦	♦	4	♦
Interfaces							
Fuel Tax Reports	●		♦	♦		?	♦
Driver Hours of Service	♦	♦	♦			?	

interfacing with the government systems. None of the GPS manufacturers have developed the capability to routinely interface directly with government systems.

- **Driver Hours of Service** Calculate the driver hours of service and verify that the drivers are in compliance with all regulations.

Although products are similar, especially with respect to tracking and communication, each company has attempted to develop its own niche market. The general feeling among product managers is that the market is both large and untapped, and that there are roles for many competitors. The following remarks reflect product manager views on how their products are differentiated in the marketplace.

Advanced Technology Corporation
- Bar coding and smart card technologies to customize systems
- Mayday transmission
- Estimated time of arrival calculation
- Niche buyers, including bus lines and local/regional carriers.

American Mobile Satellite Corporation
- Outsourcing electronics components to proven vendors (e.g., Mitsubishi, Westinghouse)
- Both mobile messaging services (textual) and voice products.
- Open architecture system coupled with customization
- Targeting longhaul carriers with fleets of 25 trucks and greater.

Eaton Corporation
- Modular design which allows customers to pick and choose features and easily upgrade
- Smart card to back up the data contained in the on-board microprocessor.
- Wide customer range, with longhaul and shorthaul customers.

Highway Master
- "Rolling ETA" to continuously calculate a truck's expected time of arrival coupled with exception report to alert dispatch of late deliveries.
- Cellular network for all communication, with more complete coverage than satellites
- Longhaul customer focus.

People Net Communications, Inc.
- Ability to track trailers independent of tractors.
- Flexible platform and modular design to facilitate upgrades
- Longhaul market

Qualcomm
- Industry leader -- identified by all as the major competitor

- Early mover into the marketplace.
- Enhanced display unit allows the driver to view 15 lines of character display for mobile messages.

Rockwell
- Smart card allowing each driver to record driving data separately when sharing trucks.
- Smart card microprocessor also records engine statistics for a minimum of 90 seconds, which can be used in accident investigation.
- Longhaul carriers, food service and other delivery companies, and tour bus Companies.

Few product managers cited integration with regulatory agencies as a differentiator, and none has made this a major strategic factor in product development. To date, the biggest effort has been in the area of fuel tax reporting.

Rockwell stated that the government reporting system must first be simplified. However, they have developed reporting capability for fuel taxes. They would like the routine processes to be automated so that the government can focus on investigating questionable companies.

Advanced Technology believes that "government backing" is important, but do not think that it is required for profitability. They are not working with government agencies to develop integrated systems - rather they have focused their resources on other areas (e.g. bar coding).

People Net has discussed fuel tax reporting, and indicated that governmental agencies would accept a direct interface (data integrity would not be an issue). However, they have not pursued government interfacing as a strategic edge.

AMSC has worked with the Federal Interagency Communications Center to develop a customized GPS application, but has not worked to automate any of the required reporting. They feel that the government reporting process is too disjointed to automate, and changes must first be made to ease the reporting requirements.

Highway Master is actively persuading state governments to accept their system's fuel tax data to fulfill their customers' reporting requirements. To date, the state of Missouri has accepted Highway Master's data. Additionally, IFTA (The International Fuel Tax Agreement) has supported their system. Highway Master is concerned that governments may require companies with automated data collection tools to keep more records than those companies who record data manually. This uneven playing field would discourage companies from investing in their technology and set the industry back.

Eaton talks with government agencies to ensure that their products are in compliance, and they do believe that interfacing with government systems will provide a strategic edge in the future, particularly when direct interfaces are required. However, they have not developed any interfaces to date.

3.4 General GPS & Direction Finding

A wide range of ideas and new products are being developed to provide routing directions to truckers. The systems vary tremendously in the methods used to communicate with the drivers and the input required of the drivers. Communication to the driver is completed via either graphical displays or voice commands. The truck's location is determined by a variety of methods. Some companies utilize GPS technologies to track locations; some require the driver to input the location into the system; and another uses microwave beacons to communicate to the truck. The products are described below.

Amerigon Voiced based routing system. The driver hears one command at a time from synthesized voice, and after executing it, the next command is given. The system determines the optimal route based upon known beginning and endpoints, which are input by the driver. Additionally, the system is self-contained within the vehicle, and all routing data resides on CD-ROM.

Bitronics Their "Win AVL" product contains all U.S. roads at street level on CD-ROM, with a **GPS** system to track the vehicles. Ground based communication systems (e.g. radio, cellular phone) are used to communicate to and from the ground base systems. Base station determines the optimal route, tracks the truck's progress, and transmits directions via voice synthesis to the driver. Bitronics customizes its products with respect to region, display, etc. Additionally, the system requires a log-on, and it remembers each user's preferences. Therefore, multiple users can utilize the system to their liking.

Clarion Combines a dead reckoning system with a map to determine the vehicle's position on a certain road. The driver is prompted before each turning point by bells or a voice message. In the future, the "Adaptive Pathfinding" system will alert drivers to traffic incidents on a real time basis. The system will determine a new route, and estimate the amount of time that the congestion will add to the trip.

Liikkuva The "Retki" system uses GPS technologies to track vehicles and wireless communication to transmit messages to and from vehicles. The system provides routing information using a visual display or via voice synthesis. Retki was designed to utilize a laptop **486** computer. Therefore, customers are not required to purchase a separate system for in-vehicle use if they already own a computer. Likkuva is developing multilingual communication for their system.

Motorola "Autolink" will provide a variety of features. It will utilize paging technology to enable messages to be sent between the vehicle and the base. In addition to sending textual messages (e.g. directions), the system will also have access to the vehicle's computer. Therefore, it can open locked doors if the keys are inside the car and disable the starter if the car is stolen. The Motorola system was designed to provide added safety to the driver, and road directions are only one minor product feature. Autolink will

provide access to EMS services or a tow truck in any location. High-end luxury cars will be the initial target market.

Roadwise Roadwise has developed a beacon based/microwave system to transmit messages to trucks. These beacons can be placed on street signs and cost roughly $50 each. The driver inputs the destination. Once the vehicle hits a beacon, the onboard system calculates the shortest route to the destination. The beacons track the truck's progress and transmit directions to the driver via voice or an optional map display. The on-board databases have only 26 kilobytes or memory. Therefore, only local street data are contained on-board. If the vehicle leaves its home area, the roadside beacons upload new road data to the truck. This system allows changes to the road information to be made at the beacons, and users do not need to obtain new CD's periodically.

3.5 Government Initiatives

Government agencies are attempting to simplify and expedite regulatory compliance requirements through the use of new technologies. This section provides a few examples of prominent projects affecting California.

PrePass/Weigh in Motion HELP Inc. (Heavy vehicle Electronic License Plate) has developed and implemented "PrePass" technology, with weigh-in-motion and electronic credential verification while traveling on an interstate highway. This enables pre-registered vehicles to bypass the weigh station and avoid delays. HELP Inc. is a private/public partnership governed by a board of state transportation and industry representatives. HELP Inc. contracted with Lockheed Martin to develop and implement the PrePass system.

Trucking companies who have historically been in compliance with weigh station regulations may register with HELP Inc. and install transponders in their cabs. These transponders communicate with the weigh station as the truck passes over the scale, which is imbedded in the road. The transponder transmits the truck's registration data to the weigh station, which is coupled with the truck's total weight and weight of each axle data measured by the in-road scale. If the truck is in compliance, a signal is automatically sent to the in-vehicle transponder, which allows the truck to bypass the station.

Approximately 10,000 trucks have installed transponders and nine western weigh stations have implemented PrePass, with 27 more planning to become operational later in **1996.** The transponder is provided to the trucking companies free of charge, but they are billed $0.99 for each station bypass.

The Interstate 5 Grapevine station was visited to observe PrePass in operations. Inspectors there were concerned that the trucks bypassing the station would no longer be checked visually. They identify loose lug nuts, tire problems, and other maintenance issues when the trucks pull through the station. Secondly, at night it is difficult to determine whether a pre-cleared truck bypassed the station or if someone failed to stop

when multiple trucks bypass the station. The inspectors cannot read the truck logos at night, so it has become an honor system. This problem will intensify as more companies use the system and many trucks bypass the stations.

Electronic Clearance for International Borders The federal government has supported a border clearance project at the Port of Long Beach. Calstart, a private/public consortium, is the primary contractor for the project, and much of the technology is being supplied by Scientific Atlantica. A strategic plan is being developed for border crossing, which will serve as a model for the entire country. The Long Beach border clearance project is one of four pilot projects being completed in the country. These pilots will be assessed to develop an improved border clearance system.

The focus of the project is to improve the consistency of the time for goods to be cleared. The companies will know with greater precision when the goods will arrive, and can therefore reduce inventory carrying charges. Additionally, they will be able to promise goods to customers with greater accuracy.

The trucks will be equipped with "Electronic Vehicle to Roadside" technology, which will enable them to transfer trip information regarding the truck and driver to the border station while en route. The trip information will be contained on a PC card, and transferred to the border station when the truck reaches the border. The cargo and driver information will be displayed on-line for the customs inspector. The inspector will verify the truck's contents based on information contained in additional databases. This process will allow customs inspector to collect the cargo's data before the truck reaches the border, and smooth the border clearing process.

Operation Respond is designed to help emergency response crews access information on hazardous materials in the event of truck or rail accidents. Software has been developed and implemented that allows officers to connect to the carrier's database and access the hazardous cargo data. The system's developer stressed that officers will only have access to hazardous cargo data of participating carriers, and that the program will not be used for enforcement purposes.

Operation Respond is intended to reduce incident clearance time. Currently, truckers are required to store hazardous material manifests and clearance procedures in their glove compartments. This information is sometimes dated *or* difficult to reach after an accident. Using Operation Respond, an officer can contact their dispatcher, who will have direct access to manifests from his or her computer. Companies implementing this technology are required to establish the communication link to Operation Respond. This typically requires 85 to 100 person-hours. Once the systems are linked, the police and fire departments are able to access the company servers without assistance.

Two prominent trucking companies are currently using Operation Respond: Yellow Freight and Chemical Lehman, the largest hauler of hazardous cargo in the country. Operation Respond is attempting to gain participation from the top twelve to fifteen

hazardous cargo companies. These companies haul approximately 75% of the hazardous freight in the country. Unfortunately, it will be difficult to sign up the smaller companies. Many do not have computer systems which contain the hazardous cargo data.

State Border Crossing (One Stop Shopping) HELP Inc. and Lockheed are developing a system that will enable trucking companies in California to easily obtain permits in Arizona and vice-versa. For example, a carrier may be fully registered in California, but require a special trip permit for an oversized load in Arizona. The company would electronically contact HELP Inc. and define the permits that are required. HELP Inc. would complete the filing and the company would be charged the permitting fees plus a service charge. HELP Inc. would become a middle-man for permitting in Arizona and California. The private companies will leverage HELP Inc.'s relationships with government officials and knowledge of the permitting process.

HELP Inc. and Lockheed had planned to complete the project by the end of July, 1996, but it is behind schedule. The service will be operable 24 hours per day, seven days per week. Additionally, all operations will be completed electronically. The trucking companies will have an account with HELP Inc., and their accounts will be electronically debited after each permit request is fulfilled. If the project is successful, it will be rolled out at other state borders.

3.6 Integration Issues

This section discusses opportunities for companies to leverage existing and emerging technologies to more easily fulfill government regulatory requirements. The manufacturers of truck tracking products have begun to develop systems that allow for integration in some areas.

- **A** number of GPS manufacturers have automated the state fuel tax accounting and driver hours of service reporting processes. To determine the appropriate fuel tax by state, the GPS tracking is utilized. Additional algorithms have been developed to determine when a truck crosses a state line. The miles traveled by state are then used to pro-rate the fuel tax by state. The **GPS** manufacturers then generate reports for their clients that meet government specifications.

- The automated driver hours of service record keeping works in a similar manner. If a single person is the sole driver in the truck, the driver hours are captured using the GPS system. If multiple drivers use multiple trucks, then either a password must be entered or a "smart card" must be swiped to start the truck. Either method allows the system to know who is driving the truck and for how long. The GPS manufacturer

then uses the driver hours data to generate driver hours of service records for their clients.

Neither of these two compliance issues is fully integrated with government systems. All reports are generated and filed manually. GPS manufactures cited two reasons for this. First, they did not feel that government integration would provide a competitive edge. The marketplace is wide-open, and other services could be provided that are more valuable to the customer. Secondly, the trucking companies are leery of allowing the government to access their data. They indicated that the government inspectors are interested in citing minor violations, as opposed to searching for the major offenders. These major offenders would never allow the government to directly access their systems, and would have a better chance of not being caught.

The general GPS companies have not begun to develop any products targeted at regulatory compliance. Additionally, many were not aware of the work being done by other organizations, such as PrePass, Operation Respond, and Border Clearance. Again, the GPS manufacturers do not feel that the money invested in providing government integration services will provide them with a competitive edge. They are focusing their limited resources in other areas. These companies do provide general road information to drivers, but this is not linked to government systems. In some cases, road closure information, traffic conditions, and weather conditions will be relayed to the drivers using the GPS technology. The information comes primarily from other drivers that are on the road or news sources. As of now, government is not integral to this service.

To date, the major trucking companies have been interested in investing in these new technologies, while the smaller firms have been unable to justify the expense. Additionally, many shorthaul companies do not need GPS equipment and do not cross state borders. They find it simpler to manually track driver location and driver hours of service. Furthermore, government has not provided an incentive for them to purchase the technology.

In general, these technologies benefit major longhaul carriers. First, they need systems to track and record all truck and driver information. Second, they utilize the communication capabilities of the GPS systems. For example, their long range delivery schedules can be optimized constantly as fleet and environment data (i.e. weather situations) are taken into account. Finally, major carriers have more capital to make this investment.

4. FOCUS GROUPS WITH INDUSTRY LEADERS

As a final step in the project, a series of focus groups was conducted over the Summer of 1996 to discuss opportunities for ITS within the motor carrier industry. Four of these meetings were held under the auspices of metropolitan planning organizations:

- Fresno Council of Governments

- Merced, San Joaquin and Stanislaus Councils of Government (combined meeting in Merced)
- Metropolitan Transportation Commission (Oakland)
- Southern California Association of Governments (Los Angeles)

Each organization has established a Freight or Goods Movement advisory committee, and these are the only active MPO freight/goods movement advisory committees in the state. The focus group was conducted within regularly scheduled meetings of these groups. In total, these meetings were attended by 60 individuals, representing a cross-section of private industry (trucking, rail, shipping and consultants), government (MPOs, CHP, Caltrans and port and airport authorities), and regions of California. *An* additional focus group was conducted within the California Trucking Association's Intelligent Transportation System sub-committee, with no government representatives at this meeting (attended by eight people).

4.1 Format

The focus group format was identical in all cases. The session began with a brief description of the study's purpose and a summary of accomplishments to date. Then three topics were presented for discussion: (1) use of in-vehicle transponders to support regulatory processes, (2) specific needs to satisfy hours-of-service requirements, and (3) opportunities for improved interaction with governmental agencies. To put the discussion in context, the Pre-Pass and Qualcomm systems were presented, and participants were invited to discuss a variety of regulatory issues, such as fuel taxes, licensing, permits, border crossings and incident response.

Participants were allowed both to respond freely and to interact with each other. Sessions lasted between 30 minutes and 1 hour in total (5 minutes of which was devoted to presentation). The flow of discussion did not differ appreciably from location to location, and there was no appreciable difference between the CTA sponsored meeting (no government present) and the *MPO* sponsored meetings. In all cases, discussion was dominated by the private industry truckers. Nevertheless, positions were similar at *MPO* meetings and the CTA meeting. It should be noted that the CTA has taken no official position on ITS, though the American Trucking Association has taken the position of opposing fees for inspection station bypass.

4.2 Results

As should be expected, the trucking industry does not speak with a single voice. Different individuals hold different opinions, based on their specific market segment (e.g., common carrier, private carrier, commodities) and their size. Opinions also reflect the relative sophistication of companies, in terms of technology and managerial practices. Nevertheless, several themes emerged. These are divided into two sections, first covering attitudes toward ITS specific issues and second covering attitudes toward government in general.

Technology Mandates: Unanimously, participants felt that the industry should not be forced to purchase or acquire new technologies to fulfill regulatory requirements. Participation should be strictly voluntary.

Use and Participation Fees: The industry is divided as to whether user fees are an appropriate way to finance inspection station bypass or related technologies. Companies participating in Pre-Pass generally took a pragmatic view, stating that the benefits justify modest charges. Nevertheless, some companies are not participating in Pre-Pass out of principle and deeply resent the concept of paying charges on top of existing taxes.

Effects on Taxation: Perhaps the biggest fear of ITS comes from the potential for imposing additional taxes, especially weight-distance taxes. In this regard, the State of Oregon was cited in several meetings as a model to avoid.

"Big Brother": In some cases, individuals expressed a fear that ITS may lead to overly zealous regulation of the industry. This is somewhat based on a suspicion that databases will be merged in ways that make it easier to detect violations and perhaps to impose new rules. However, this wasn't the most prevalent view, and in fact "big brother" is much less of a worry than new taxes and cost. More commonly, the industry recognizes the need for prudent regulation and believes that government officials aim to do their work honestly and fairly (if not efficiently). Some felt that the "big brother" worry was a question of "good carriers" versus "bad carriers". Clearly, most carriers work hard to obey the rules and do not mind when the rules are fairly enforced. Yet these same companies also expressed skepticism that new technologies would have any effect on compliance from "bad" companies.

Data Privacy: The industry clearly wants to protect the privacy of as much data as possible. Any change that resulted in sharing more data with government would be viewed negatively and with suspicion by many. The industry is especially suspicious of sharing data in real-time, such as tracking data.

Paperwork: Reducing paperwork associated with government reporting is seen as an important benefit of ITS. Nevertheless, the industry is largely taking care of this problem on its own through proprietary software and automated report generation. The industry sees little additional benefit from submitting electronic reports to government over submitting computer generated paper reports.

Liability: The industry is extremely sensitive to safety issues, and a major motivation for adopting new technologies will be to reduce accidents. Carriers felt that whether or not regulations were in place, they would carefully monitor driver-hours-of-service, driver records and vehicle maintenance. In fact, insurance and liability concerns are motivating many carriers to be stricter than required under the law.

Bottomline: Adoption of new technologies is driven by bottomline costbenefit considerations and different companies follow different directions largely because of their circumstances. This, more than anything, will set the direction for **ITS** in CVO. With few exceptions, direct costs and benefits will drive implementation decisions.

In addition to the attitudes toward ITS, the following attitudes were expressed toward government:

California Highway Patrol: The industry has high regard for the CHP. **As** stated by one participant, "the CHP officer is your best friend." The agency is viewed as an efficient and business-like agency, with competent employees. Nevertheless, each meeting contained its share of "horror stories," usually centered on a CHP employee writing a ticket for violating a rule that does not exist. Though these stories were always described as exceptions, they clearly stick in people's minds and are a significant irritant.

Department of Motor Vehicles: The DMV is viewed as the classic bureaucracy, with indifferent employees, inefficient technologies and lack of basic customer service. The industry is clearly frustrated with the speed at which the agency processes licenses and registrations and their ability to serve the industry.

California Department of Transportation: Caltrans is not highly regarded, but it does not engender the same level of frustration as DMV. Truckers place considerable blame on Caltrans for traffic congestion problems, especially with respect to accident clearance and road maintenace. Right or wrong, many in the industry hold Caltrans acconntable. Truckers also hold some resentment for the way in which Caltrans bills for incident clearance, especially in cases where Caltrans charged for hazardous materials clearance of *non*-hazardous substances. Participants did not complain about processing over-size and over-weight permits, but few had ever needed one.

Regulations: Participants would prefer regulations to be based more on the safety performance of carriers, and less on the specifics of how they carry out their job. This applies in particular to hours-of-service rules and the biennial-inspection-of-terminals (BIT). Carriers clearly want greater flexibility and less intrusion in their business, while retaining regulation on the basis of overall safety performance.

Services: Unlike motorists, who benefit from "Freeway Service Patrols", truckers are not provided with free roadside assistance. To the contrary, many complained about Caltrans' practice of billing for incident cleanup. Generally, participants were skeptical that government could provide useful services and that if they did, whether the services would be worth the cost.

5. CONCLUSIONS AND RECOMMENDATIONS

Implementation of inter-modal TMCs entails coordinating transportation activities through the sharing and exchange of information, and the execution of control strategies. This section summarizes conclusions from the prior phase of the CVO work, and provides recommendations based on the project as a whole.

5.1 Prior Conclusions

Hall and Chatterjee [8] came to the following conclusions:

- Opportunities exist to greatly simplify regulations within a paperless system. Some companies are already doing this for their vehicle maintenance. Through development of standard record formats, and data interchange standards, inspections could be greatly simplified, while at the same time providing trucking companies with improved data for planning and dispatching.

- From a technological standpoint, opportunities exist to develop in-vehicle devices, with standard interfaces, that can store records on: (1) driver hours-of-service, (2) daily inspection reports, (3) vehicle maintenance, **(4)** cargo manifest and hazardous materials, *(5)* licenses and permits, and **(6)** fuel accounting. Many regulatory functions could be automated within such an in-vehicle device. In the process, drivers and terminal managers could be alerted in advance, so that it is easier for motor carriers to operate within regulations.

- Development of in-vehicle devices might also be viewed as a step toward eliminating or drastically changing the current inspection station system. While on-the-road inspection will undoubtedly be needed in the future, the value of performing these inspections at fixed locations with limited hours of operation is questionable. Furthermore, much of the information that is collected at inspection stations could just as easily be collected "off-line" through down-loading information from automated recorders. Thus, in addition to following the strategy of automating existing stations, the alternative of replacing inspections stations with something radically different should be explored.

- ITS faces important obstacles in CVO, including: (1) Mistrust of government due to confusing and inconsistent regulation across too many agencies. (2) The financial state of the industry, and the limited capital available for investment in technology. (3) Shortage of technically trained employees within the industry. **(4)**Decentralized structure of companies, giving considerable power to individual drivers and terminals. *(5)* Priority given to automating customer services over automating governmental functions.

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- These objectives may entail a re-organization of governmental functions along four lines: (1) licensing and permitting, (2) enforcement, *(3)* roadway information, and (4) incident clearance (Figure 1). While multiple agencies exist within each category, designating a single leader for each should improve coordination, and simplify interactions between government and industry.

5.2 Recommendations

Based on our subsequent research, through focus groups and interviews with technology developers, the earlier conclusions must be tempered and put in perspective. In California today, there exists no strong market push to better integrate motor carrier operations with governmental agencies. **As** companies adopt ITS technologies for vehicle tracking and wireless communication, they are clearly not pushing for electronic transfer of information to and from governmental agencies. Rather, they are using these technologies first to improve their own operations, and second to automate filing of paper reports. **As** of the present, the industry does not see an economic incentive for electronic data transfer with government, and in fact has some fear this prospect.

Likewise, none of the companies in the vehicle tracking industry has given priority to improving governmental interfaces. This is due in part to a perceived absence of market demand, and in part due to the daunting obstacle of satisfying the requirements of 50 separate states. Technologies that fully integrate and automate regulatory processes are not on the immediate horizon.

Despite thcse cautions, the motor carrier industry is not opposed to ITS and it certainly is not opposed to improved technologies and moving toward a paperless system. Trucking companies are willing and perhaps eager to invest and participate in projects that possess four basic characteristics:

- Modest investment
- No new taxes or user fees
- Promotes operating efficiency, customer service, or safety
- Voluntary

On top of these characteristics, the industry is much more inclined to favor CHP led efforts over those initiated by Caltrans, DMV or other state agencies.

Contrary to prior conclusions, expanded functionality of transponders is likely to meet opposition, unless there is a simultaneous and significant reduction in regulatory requirements. Electronic data transfer to regulatory agencies provides no incentive to participation and perhaps a disincentive. The industry views a change such as this as being more beneficial to government than to industry. On the other hand, a strategy aimed at *completely paperless and non-intrusive* regulation, with voluntary and free participation, should be considered. In addition to providing inspection station bypass, such a system would forego the biennial inspection and eliminate other reporting requirements.
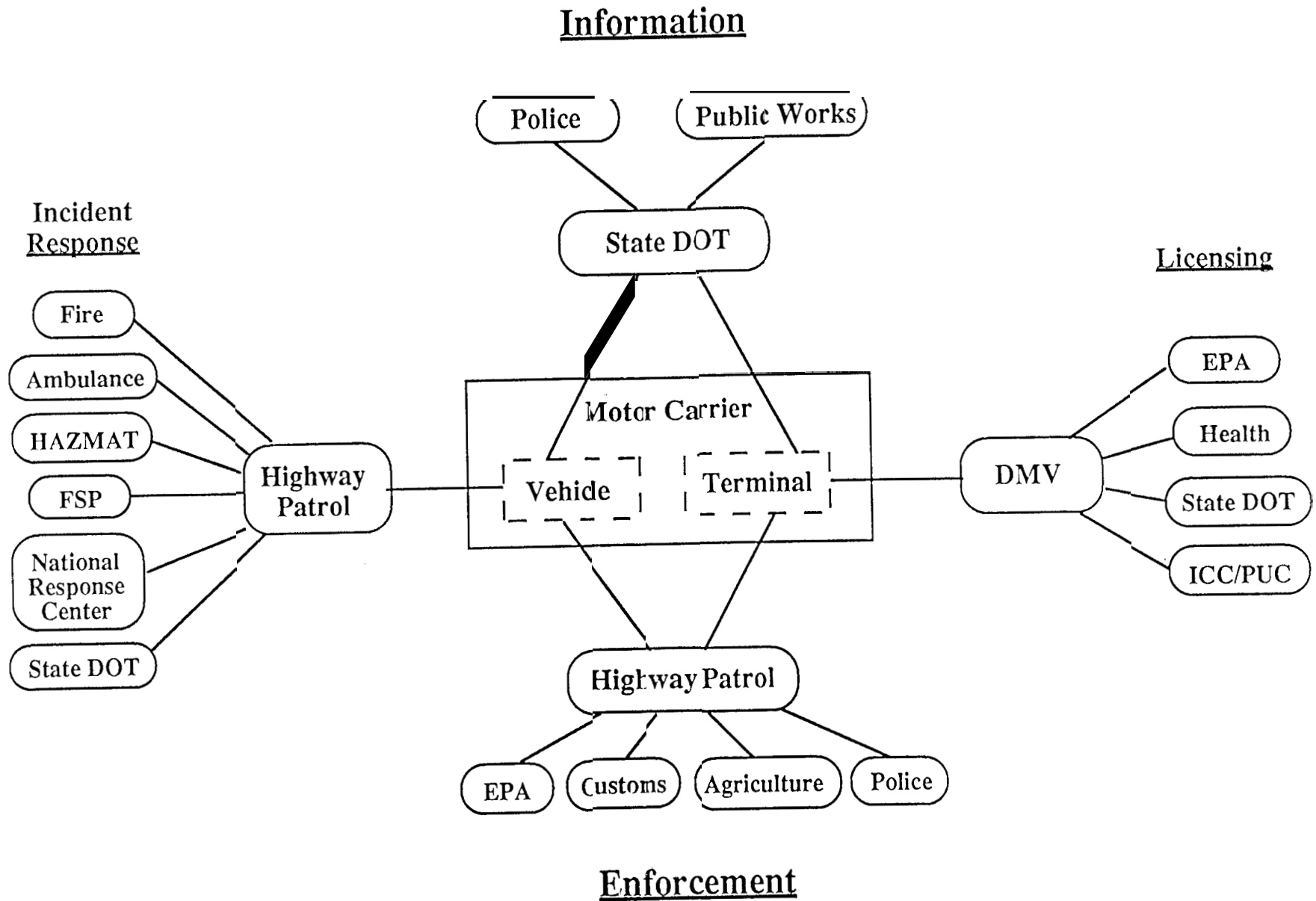
Information

Police   Public Works

State DOT

Incident Response

Fire

Ambulance

HAZMAT

FSP

National Response Center

State DOT

Highway Patrol

Motor Carrier

Vehicle   Terminal

DMV

Licensing

EPA

Health

State DOT

ICC/PUC

Highway Patrol

EPA   Customs   Agriculture   Police

Enforcement

Figure 1. CIT Organizational Structure

Likewise, there seems to be no strong desire (and perhaps opposition) in the industry to including CVO within intermodal TMCs. While the industry certainly desires better information on roadway conditions (especially closures and weather conditions), CVO has few special requirements beyond that of the general motoring public. From the standpoint of traffic operations, the biggest benefit from the intermodal TMC concept comes from improved access to information on hazardous materials information. "Operation Respond" provides one approach to this problem. The state should seriously explore expanding the scope of this program, or substituting more decentralized technologies in which HAZMAT information can be downloaded directly from the vehicle.

Finally, an earlier conclusion was that transportation functions should be coordinated along four lines, (1) incident clearance, (2) licensing/permitting, (3) enforcement and (4) information. While this approach may be beneficial, a functionally based effort (rather than a process focused effort), may prove more beneficial. As a first step, it would be worthwhile for the state to develop task forces to address key issues. For each issue, the focus should be on assessing whether the current system of regulation and operation is the most effective way to achieve the stated objective, and to identify new technologies that better serve the purpose.

The three key areas are:

(1)   Safety assurance, focused on the issues of driver safety, vehicle safety and cargo safety, along with carrier financial responsibility.

(2)   Protection of the roadway from damage by oversize or overweight vehicles.

(3)   Reducing congestion experienced by trucks and produced by trucks.

A fourth ITS related function, fuel taxation, is better addressed at a national level, but is also a priority.

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