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Commercial Vehicle Fleet Management and Information Systems

Phase I Interim Report

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1.0 Introduction

The Federal Highway Administration (FHWA) commissioned this study to determine whether there are commercial vehicle fleet management needs that can be met through public sector involvement in the development of Intelligent Transportation Systems (ITS) technologies and standards. This Interim Report summarizes the research efforts and findings of Phase I of the research effort. This report also presents conclusions regarding the current state of ITS in the motor carrier industry, potential public sector services, and specific issues and areas that merit ongoing public sector attention.

Section 2.0 provides background information on the forces that are re-shaping the trucking industry and, in doing so, are making ITS increasingly useful for commercial vehicle fleet management. Section 3.0 discusses this study's methodology, including the development of a new typology for the motor carrier industry, selection of fleets for case study interviews, and development of interview guides. Section 4.0 presents the study findings, and Section 5.0 presents conclusions and recommendations drawn from the findings.

2.0 Background

2.1 The Changing Marketplace

Every business and industry in the United States relies to some degree on trucks. From stocking production facilities, to maintaining inventories of finished products, to distributing goods and services to customers, motor carriers are essential to the functioning of the economy.

Changes in the way companies do business – such as the introduction of just-in-time manufacturing and distribution systems, the use of overseas parts suppliers, and an increased emphasis on customer service -have had direct effects on motor carrier operations. For example, just-in-time production and retailing systems require carriers to make deliveries frequently, and within narrow "delivery windows." As companies shift production to overseas facilities or acquire parts from overseas suppliers, motor carriers are becoming involved in global intermodal supply chains. Furthermore, businesses are asking carriers to provide close monitoring of shipments. In many cases, carriers are being asked to track individual packages as well as individual vehicles.

To meet the demands of this dynamic and highly competitive marketplace, motor carriers have developed the capabilities to track trucks and shipments, predict pick-up and delivery times accurately, and communicate the progress of individual shipments to customers in "real time." These changing customer demands and carrier capabilities are relevant to ITS in two ways. First, many motor carriers have evolved into full-service transportation companies. Numerous carriers that formerly handled only truck freight now provide multimodal and intermodal services. In some cases, trucking companies now provide complete logistics services: transportation, warehousing, scheduling, final assembly, tagging, packaging, billing, and inventory management. These carriers (and their clients) are concerned not only with the benefits of ITS for motor carrier operations, but also with the impact of ITS on their total logistics supply chain and distribution network. This means that metropolitan areas and states must be willing to look well beyond their borders in determining the costs and benefits of ITS for the trucking industry.

The second effect of the changing marketplace is that the level of management and technological sophistication in the industry are increasing. The leading sectors of the industry have made the transition from "mom and pop" operations to national and international scale business operations, able to recruit and retain first-class technical, managerial, financial, and legal staff. This has given the industry a much greater capability to appreciate, develop, and apply new technologies. At the same time, it has given the industry a stronger and more knowledgeable voice in public policy debates about transportation. The motor carrier industry communicates its needs and concerns with regard to ITS, and is under pressure from its customers to demonstrate the cost-effectiveness of any ITS investments (private sector or public sector).

2.2 INCREASING COMPETITION

The economic deregulation of the motor carrier industry in 1980 and the imposition of uniform Federal size and weight standards for trucks operating on the interstate highways triggered a massive restructuring of the motor carrier industry and sharp competitive pressures to reduce costs. Freight rates dropped, business entry and failure rates increased sharply, and cost savings were identified in motor carrier management, engine and vehicle technology, and labor. Consequently, although the motor carrier industry as a whole has grown at about the same rate as the gross national product, profit margins in today's industry are relatively small, and profits generally are low compared to the margins realized prior to deregulation. The for-hire segment of the industry has undergone the most change, but deregulation has also forced significant changes in the management of private fleets.

2.3 INCREASING CONGESTION

In 1981, the FHWA estimated that 16 percent of urban interstate miles were severely congested; by 1988, over 30 percent of urban interstate miles were classified as severely congested. As congestion has increased, trucks increasingly have had to compete with cars for limited roadway space. Some public sector responses to congestion, such as the Los Angeles proposal to ban all large trucks from the freeways during peak commuter periods, could have serious economic consequences.

Major relief cannot be anticipated from expansion of the highway system. New highways will be built, but the pace of construction will be slow compared with that of the last 40 years. The Federal Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) explicitly recognized this. ISTEA shifts the focus of highway programs to better management and more efficient use of existing transportation systems, rather than expansion of highway capacity.

One type of industry response to congestion is to shift operations out of the peak commuting periods or to alternative routes whenever possible. However, this approach is not feasible for many motor carriers, including carriers in highly "demand responsive" industry segments such as overnight courier services (e.g., Federal Express), where on-time deliveries are expected throughout the day. Moreover, many carriers' operations are variable and do not always permit them to schedule deliveries in advance. For carriers that cannot avoid peak-period travel, the ability to avoid congestion and incidents by changing routes would be extremely valuable. Such re-routing requires real-time information on congestion and incidents. Other than demonstration projects, however, this kind of information is not available to carriers. Furthermore, studies of existing highway incident management programs indicate three problems that must be addressed before fleets can make effective use of congestion information in fleet management:

1. Current traffic monitoring and reporting systems do not provide information that is sufficient and timely enough to support routine routing and dispatching decisions.

2. Trucks have special routing constraints that are not being addressed in the development of urban ITS programs. The focus of urban ITS programs – Advanced Traffic Management Systems (ATMS) and Advanced Traveler Information Systems (ATIS) – is the private

automobile driver, who accounts for 95 percent of the traffic on most urban highways. However, information that suffices for commuters often is inadequate for trucks. For example, alternate routes around incidents must have adequate overhead clearance, bridge capacity, and turning radii to be safe for trucks, and must comply with local access, noise, and hazardous materials movement regulations.

3. Trucks need information about congestion conditions on a broader geographic scale than a single urban commuting area, which is the scope of most urban ITS programs. Most trucks operate within a 80.5 to 322 km (50 to 200 mile) radius of their terminal, a distance that often falls outside or between the coverage of individual urban ITS programs.

2.4 Regulatory Compliance

The regulatory framework governing commercial motor carrier operations has not kept pace with the changing nature of the trucking industry. Today, a great many businesses and trucking companies operate in multiple states, yet motor carriers remain subject to regulation and taxation by each individual state through which they pass. Because each state has its own unique needs, administrative structure, and regulations, the motor carrier regulatory system has become staggeringly complex. This complexity imposes a considerable burden on both the motor carriers, who must comply with the regulations, and the state agencies, who must administer them.

Base state reciprocal agreements, such as the International Registration Program (IRP) and the International Fuel Tax Agreement (IFTA), have helped streamline the process for obtaining interstate operating credentials. Under these programs, each interstate carrier obtains credentials (e.g., vehicle registration, fuel tax licenses, operating authority) from the state in which it is based. It is the responsibility of the base state to process and issue credentials to the motor carrier for travel in the states in which the carrier operates, and for apportioning fees among these jurisdictions.

Intelligent transportation systems have the potential to increase the efficiency and reduce the cost of regulatory transactions and vehicle movements by automating many of the procedures that are now performed manually. The technological building blocks for automated clearance at weigh stations and ports-of-entry are automated vehicle identification, weigh-in-motion, and automated vehicle classification systems. Under a fully-realized ITS/CVO program, carriers could obtain all credentials and permits in one electronic transaction and be able to cross state borders without stopping repeatedly for the purchase or verification of credentials, size and weight compliance, and safety status.

2.5 Information Technology

A revolution is occurring in today's transportation industry, brought about by the introduction of information and communications technologies. These technologies have enabled business and industry to organize and control regional, national, and international networks of suppliers and distributors for their products and services. The application of the same technologies to trucking has enabled motor carriers to monitor and manage the operation of their fleets more efficiently and effectively.

Today's sophisticated carriers are equipping their vehicles with onboard computers and communication systems that keep the drivers in constant contact with their dispatchers and clients. These systems make it possible for carriers to provide clients with information to assure the safety and security of their cargo, and to track the progress of shipments. Leading-edge carriers routinely provide large clients with direct dial-in access to their computers, and provide automated menus and reporting for smaller clients who call in to track the progress of their shipments. Some carriers are complementing this equipment with systems that monitor truck speed and vehicle spacing, warning the driver and, in emergencies, automatically applying the brakes when the truck follows another vehicle too closely. The cost of these systems, which maintain a record of the vehicle's movements, often are underwritten by the carrier's insurance company. Many carriers also equip their vehicles with onboard computers, which monitor and record engine performance, driving patterns, vehicle hours-of-service, and other data.

Electronic transponders constitute another layer of technology on trucks. Mounted behind the windshield or on the bumper of the tractor, on the trailer, or on the container and its chassis, electronic transponders can be interrogated by roadside readers while the truck is traveling at highway speeds. Transponders are in operation today to collect tolls while trucks are in motion; to identify trucks and permit legally compliant trucks to bypass state weigh stations and ports-of-entry; to verify credit at fuel stations; and to track the location of tractors, trailers, containers, and chassis in intermodal terminals and truck yards.

The next generation of information and communications technologies being deployed by carriers will move many business functions, such as order taking, route planning, and waybill processing. Today's Federal Express truck is a sophisticated mobile office, but even less time-sensitive operations routinely carry onboard fax machines to communicate with dispatchers and clients. The number of trucks and fleets currently equipped with such systems is limited. However, customer service expectations and competitive pressures will force the rapid adoption of these technologies among many segments of the motor carrier industry over the next decade. For ITS programs, this means that trucks will be among the most electronically sophisticated vehicles on the road. Many will be pre-wired by truck manufacturers and ready to accept ITS equipment.

3.0 Study Methodology

The methodology for Phase I of this study comprised four steps. First, the study team developed a taxonomy of the motor carrier industry based on the operational characteristics of commercial vehicles. Next, the study team used the taxonomy to identify major segments of the motor carrier industry. Next, twenty candidate fleets representing major industry segments were chosen for case study interviews. Following fleet selection, the study team prepared detailed interview questionnaires. The case study interviews were conducted using detailed interview guides prepared by the study team, and the findings were analyzed.

3.1 Development Motor Carrier Industry Typology

Although ITS offer a range of potential benefits to motor carriers, adoption of these technologies by the trucking industry has been uneven. Some carriers have embraced ITS, while others appear reluctant to adopt it. A major goal of this study has been to understand the factors that influence carriers' ITS investment decisions. In particular, this study has examined the ways in which carriers' operational characteristics and associated fleet management needs affect ITS adoption. To better understand these relationships, the study team developed a new typology of the motor carrier industry. This typology segmented the industry based on the following operating characteristics:

- ***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, both because of the nature of the products themselves, and because of the characteristics of the industries that produce and consume the products. Thus, different ITS technologies may be appropriate for different truck fleets, depending on the kinds of products they most often carry.

- ***Geographic Range of Operation.*** Fleet operations may vary depending on their geographic scale. Trucks operating locally within metropolitan areas [i.e., within 80.5 km (50 miles) of their base of operation] may face very different scheduling and routing conditions, and may operate on different classes of roadways, than trucks operating primarily at a regional scale [i.e., 80.5 to 322.0 km (50 to 200 miles) from base of operation] or national scale [i.e., over 322.0 km (200 miles) from base of operation]. These differences may influence the choices made by fleet managers and truck owners regarding investment in ITS systems.

- ***Fleet Size.*** The most obvious way in which fleet size may affect the adoption of ITS for fleet management is that companies with large fleets may have proportionately more resources available for maintaining and upgrading their fleets than will companies that operate only a few trucks. Even if budgets are proportional across fleet sizes, the absolute per-truck cost of installing certain ITS technologies may simply be out of range for small companies. Conversely, the total initial cost of implementing some ITS technologies may prove to be a significant burden for large fleets.

- ***Routing Variability.*** Generally, the greater the variability of a fleet's routes, the greater the incentive to use technology to track truck movements. Operators whose routes are subject to frequent or sudden changes may benefit from up-to-the-minute information concerning road closures, congestion and other factors. In addition, these operators also may benefit from the ability to track the locations of individual vehicles; such information would allow them to re-route vehicles rapidly, to choose the shortest or fastest alternate routes, and to minimize unladen mileage.

- ***Time Sensitivity of Deliveries.*** Time sensitivity refers to more than just the urgency of a shipment; it refers to the amount of time that is available in which to make a delivery (the delivery "window"), and also to the consequences for truck operators and the industries in which they work of missing specified delivery times. Time sensitivity is determined primarily by the product being carried and the industry being served. 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 fleet management systems might be justified.

3.2 SAMPLE SELECTION

Using this new typology, the study team analyzed a sample of industry data from the 1987 Truck Inventory and Use Survey (TIUS), a national database produced by the United States Bureau of Census. The TlUS database is based on a stratified probability sample of trucks in every state. The total sample includes approximately 135,000 trucks out of an estimated "universe" of 44.6 million trucks. The sample is stratified by truck body type, as follows:

- Pickup;
- Van;
- Single-unit light;
- Single-unit heavy; and
- Truck tractor.

Within each state, a predetermined number of trucks from each stratum was randomly sampled. (The average number of trucks sampled per state was 2,653.) A weighting factor based on the actual number of truck registrations within each state and body type stratum was applied to each truck in the sample to produce an estimate for the total truck "universe."

The TIUS database contains information on trucks' geographic ranges of operation and the sizes of the fleets in which they operate, but not on routing variability or the time-sensitivity of deliveries. Discussions were held with truck fleet operators from various segments of the trucking industry and with industry analysts to gather information about the nature of trucking operations for each of the commodities analyzed. The information was used to make assumptions regarding route variability and time sensitivity. These assumptions guided the assignment of trucks to the different categories of these variables.

The TIUS database contains information on numerous classes of trucks, including many trucks that are not appropriate for inclusion in this study. To limit the analysis to appropriate truck categories, the following selection criteria were used:

- Trucks with a gross weight of over 4,540 kg (10,000 lb.).
- Trucks operated by and for private businesses (i.e., private fleets), or for hire.
- Trucks operating on public roads and highways.

There are approximately 44.6 million trucks registered in the United States. However, about 41 million of these, or about 92 percent of the fleets, are pickup trucks, panel trucks, minivans, and similar light trucks, many of which are used for personal transportation. For traffic and congestion management purposes, these light trucks are indistinguishable from automobiles and are seldom counted as trucks. Light trucks were not included in this analysis because it was assumed that the ITS market for light trucks is very similar to the ITS markets for personal and commercial fleet automobiles.

The balance of the US fleet, approximately 3.6 million trucks or about eight percent of all trucks, are medium and heavy trucks, ranging from 4,540 kg (10,000 lb.) local delivery trucks with two axles and six tires, to large, 36,320 kg (80,000 lb.), over-the-road tractor semi-trailers with five axles and 18 tires. About 400,000 of these trucks are off-road construction vehicles, daily rental vehicles, and trucks used for personal transportation. If these vehicles are subtracted from the total fleet, there are about 3.2 million large trucks that constitute the primary potential motor carrier market for fleet management ITS, and are the primary focus of this analysis. These vehicles differ significantly from automobiles and light trucks because of their size, weight, and handling characteristics, the types of roads that they can use, and the business and safety regulations governing their use. More importantly, as a group they are thought to account for over three-quarters of all truck-miles of travel and most of the ton-miles and revenue-miles of travel in urban areas.

The majority of the trucks in the analysis (about 80 percent), are in private fleets; that is, fleets owned and operated by companies to move their own products. Included in this group are trucks employed in local distribution activities, such as delivering gasoline to service stations, stocking supermarket shelves, and delivering retail goods to local stores and shopping malls. Other private trucks are employed in long-haul transportation, which typically involves moving products such as processed foods and manufactured goods between company production facilities and warehouses, or distributing products to retail stores. The remaining 20 percent of the trucks in this study are operated by for-hire motor carriers, providing common or contract carriage of freight and goods for other firms, usually manufacturers and retailers.

3.3 Selection of Case Study Fleets

The study team produced detailed numerical taxonimies of nine industry segments: four based on principal product, and five based on major use. Figure 1 provides an example of the numerical taxonomies. Based on these taxonomies, and discussions with trucking industry experts, the research team developed more than twenty profiles of the types of fleets to include

Total	Operating Range	Fleet Size	Route Variability	Time Sensitivity
492,800* Total	19,700 (4%) National (> 200 Miles)	3,000 (15%) 500+ Trucks	Variable 200 (5%)	Time Sensitive 100 (5%)
				Non-Time Sensitive 200 (95%)
			Fixed 2,800 (95%)	Time Sensitive 100 (5%)
				Non-Time Sensitive 2,700 (95%)
		3,500 (18%) 100-499 Trucks	Variable 200 (5%)	Time Sensitive 100 (5%)
				Non-Time Sensitive 200 (95%)
			Fixed 3,300 (95%)	Time Sensitive 200 (5%)
				Non-Time Sensitive 3,100 (95%)
		3,700 (19%) 20-99 Trucks	Variable 900 (25%)	Time Sensitive 100 5%
				Non-Time Sensitive 900 (95%)
			Fixed 2,800 (75%)	Time Sensitive 100 (5%)
				Non-Time Sensitive 2,700 (95%)
		2,000 (10%) 6-19 Trucks	Variable 500 (25%)	Time Sensitive 400 (75%)
				Non-Time Sensitive 100 (25%)
			Fixed 1,500 (75%)	Time Sensitive 1,100 (75%)
				Non-Time Sensitive 400 (25%)
		7,500 (38%) 1-5 Trucks	Variable 3,700 (50%)	Time Sensitive 2,800 (75%)
				Non-Time Sensitive 900 (25%)
			Fixed 3,700 (50%)	Time Sensitive 2,800 (75%)
				Non-Time Sensitive 900 (25%)
	78,800 (16%) Regional (50-200 Miles)	1,600 (2%) 500+ Trucks	Variable 100 (5%)	Time Sensitive 100 (5%)
				Non-Time Sensitive 100 (95%)
			Fixed 1,500 (95%)	Time Sensitive 100 (5%)
				Non-Time Sensitive 1,400 (95%)
		5,500 (7%) 100-499 Trucks	Variable 300 (5%)	Time Sensitive 100 5%
				Non-Time Sensitive 300 95%.
			Fixed 5,200 (95%)	Time Sensitive 300 5%
				Non-Time Sensitive 4,900 (95%)
		18,100 (23%) 20-99 Trucks	Variable 4,500 (25%)	Time Sensitive 200 (5%)
				Non-Time Sensitive 4,300 (95%)
			Fixed 13,600 (75%)	Time Sensitive 700 (5%)
				Non-Time Sensitive 12,900 (95%)
		18,900 (24%) 6-19 Trucks	Variable 4,700 (25%)	Time Sensitive 3,500 (75%)
				Non-Time Sensitive 1,200 (25%)
			Fixed 14,200 (75%)	Time Sensitive 10,600 75%
				Non-Time Sensitive 3,500 (25%)
		33,900 (43%) 1-5 Trucks	Variable 17,000 (50%)	Time Sensitive 12,700 (75%)
				Non-Time Sensitive 4,200 (25%)
			Fixed 17,000 (50%)	Time Sensitive 12,700 75%
				Non-Time Sensitive 4,200 25%
	389,300 (79%) Local (< 50 Miles)	1,100 (< 1%) 500+ Trucks	Variable 800 (75%)	Time Sensitive 600 (75%)
				Non-Time Sensitive 200 (25%)
			Fixed 300 (25%)	Time Sensitive 200 75%
				Non-Time Sensitive 100 (25%)
		14,400 (4%) 100-499 Trucks	Variable 10,800 (75%)	Time Sensitive 8,100 75%
				Non-Time Sensitive 2,700 (25%)
			Fixed 3,600 (25%)	Time Sensitive 2,700 75%
				Non-Time Sensitive 900 (25%)
		70,100 (18%) 20-99 Trucks	Variable 66,600 (95%)	Time Sensitive 63,300 95%
				Non-Time Sensitive 3,300 (5%)
			Fixed 3,500 (5%)	Time Sensitive 3,300 (95%)
				Non-Time Sensitive 200 (5%)
		112,900 (29%) 6-19 Trucks	Variable 107,300 (95%)	Time Sensitive 101,900 95%
				Non-Time Sensitive 5,400 (5%)
			Fixed 5,600 (5%)	Time Sensitive 5 00 95%
				Non-Time Sensitive 300 (5%)
		190,800 (49%) 1-5 Trucks	Variable 181,300 (95%)	Time Sensitive 172,200 (95%)
				Non-Time Sensitive 9,100 (5%)
			Fixed 9,500 (5%)	Time Sensitive 9,000 (95%)
				Non-Time Sensitive 500 (5%)

* All figures rounded to nearest 100; percentages reflect actual (unrounded) figures.

Figure 1. Example of Trucking Industry Taxonomy,
Building Materials (Trucks greater than 10,000 pounds)

in the study. Guided by those profiles, the project team selected 20 motor carriers to represent the 16 major segments of the motor carrier industry. The case study fleets included private motor carriers, for-hire motor carriers, and motor coach operators. The case study fleets were selected based on the following criteria:

- Does the carrier represent a major segment of the motor carrier industry? Are all of the major industry segments adequately represented among the fleets selected as case studies?
- Is the carrier a bellwether for its segment of the industry? Has the carrier demonstrated a capability to implement new technologies in a way that is indicative of how the carrier's industry segment will behave over the next five to ten years?
- Is the carrier willing to participate in the study? Are the carrier's managers likely to be forthcoming about their firm's fleet management needs, and the costs and benefits of implementing ITS technology?

The case study carriers were the focus of extended interviews, which gathered detailed information on the carriers' operations, the factors driving their fleet management decisions, and their current and likely near-term use of ITS. For reasons of business confidentiality, the names of the case study companies cannot be disclosed. Instead, in the text and tables of this report, each fleet is assigned an identification number. Table 1 provides a brief description of each fleet.

3.4 ITS TECHNOLOGIES EVALUATED IN CASE STUDIES

The case study interviews collected information on the prevalence of four categories of ITS/fleet management technologies:

- ***Routing and Dispatching Systems.*** This category includes computer software and hardware used to plan, optimize, and monitor load consolidation, vehicle routing and dispatching, backhauling, and other functions. Routing and dispatching systems allow carriers to accomplish multiple objectives simultaneously, such as minimizing mileage while maximizing backhauling.

  The primary users of routing and dispatching systems have been carriers that are interested in maximizing equipment utilization and improving their overall fleet cost-effectiveness. These carriers include package delivery fleets and less-than-truckload operations.

- ***Onboard Computers*** (OBCs). This category includes devices used to monitor engine performance, driving patterns (e.g., acceleration, shifting), vehicle and/or driver hours-of-service, vehicle maintenance, arrivals and departures, loading and unloading times, and other functions. Onboard computers often are used in conjunction with routing and dispatching systems. The routing and dispatching programs use data on route distances and travel times collected by the onboard computers to select optimum routes.

Table 1. Descriptions of Case Study Fleets.

Name	Fleet Size	Private/ For-Hire	Principal Product or Major Use	Routing	Operating Range	Time Sensitivity
Fleet 1	Small	Private	Petroleum	Fixed	Local	Low
Fleet 2	Medium	For-Hire	Bulk Commodities (e.g., paper pulp, flour)	Fixed	Regional	High
Fleet 3	Small	Private	Electric Utility	Fixed	Regional	Low (except for emergencies)
Fleet 4	Very Large	For-Hire	General Freight	Fixed (pick up and delivery fleet) and Variable (line-haul fleet)	Regional (pick up and delivery fleet), National (line-haul fleet)	Moderate
Fleet 5	Very Large	For-Hire	Bulk Chemicals	Fixed	National	Low
Fleet 6	Large	Private	Processed Foods	Variable	National	Moderate
Fleet 7	Very Large	For-Hire	General Freight	Variable	National	Moderate
Fleet 8	Medium	Private	Grocery Products	Fixed	Regional	Moderate
Fleet 9	Medium	For-Hire	Motor Coach (Bus)	Fixed (daily service) and Variable (charters)	Regional	High (daily service) and moderate (charter)
Fleet 10	Very Large	For-Hire	Refrigerated Food	Variable	National	Moderate
Fleet 11	Medium	For-Hire	Intermodal (truck/rail)	Fixed	Regional	Moderate
Fleet 12	Large	Private	Pharmaceuticals	Fixed	Regional	Low

Table 1. Descriptions of Case Study Fleets. (continued)

Name	Fleet Size	Private/ For-Hire	Principal Product or Major Use	Routing	Operating Range	Time Sensitivity
Fleet 13	Medium	Private	Carpet Backing and Industrial Fibers	Variable	Regional	High
Fleet 14	Large	For-Hire	General Freight	Fixed	Regional	Moderate
Fleet 15	Large	For-Hire	General Freight	Variable	Regional	Moderate
Fleet 16	Very Large	Private	Electrical Utility	Variable	Regional	Low
Fleet 17	Medium	For-Hire	Munitions	Variable	National	Moderate
Fleet 18	Medium	For-Hire	Household Good Moving	Variable	National	High
Fleet 19	Large	Private	Grocery Products	Fixed	Regional	Low
Fleet 20	Large	Private	Furniture and Small Appliances	Variable	Regional	High

Long-haul truckload carriers, just-in-time delivery services, and couriers are most apt to use OBCs. Uses include improved data entry, optimization of routing, and shipment monitoring.

- ***Mobile Communications.*** This category includes radios, cellular telephones, and text transmission/reception devices that allow drivers to communicate with each other, with dispatchers, and with customers.

  Less-than-truckload carriers, long-haul companies, and just-in-time delivery operations have been the primary types of carriers using mobile communications systems.

- ***Automatic Vehicle Location/Global Positioning Systems.*** This category includes on-vehicle devices that use signals from satellites or from ground-based radio transmitters to obtain a vehicle's exact position, and then to transmit that information to the dispatcher. Vehicle location/GE systems allow dispatchers to monitor fleet activities, to predict vehicle arrival times, and to track shipments precisely.

  The largest market for automatic vehicle location systems and services among metropolitan fleets are transit (i.e., bus), and courier companies. In general, carriers most concerned with tracking shipments and making accurate estimates of delivery times will are most apt to employ AVL systems.

4.0 Findings

This section summarizes the findings of Phase I. Three categories of findings have emerged from the work to date. The first set of findings concerns the factors that influence the fleet management decisions of commercial motor carriers. The second set of findings relates to motor carriers' current use of ITS for fleet management, and to whether fleet operating characteristics and fleet management decision factors influence ITS adoption. The third set of findings addresses the availability of specific ITS technologies, and the degree to which ITS supply is meeting demand in the motor carrier industry.

4.1 Fleet Management Decision Factors

The case study interviews identified a number of factors that influence motor carrier fleet management decisions. Commercial vehicle fleet managers must rank these factors in terms of priorities, and gear their fleets' operations toward meeting the top priorities. The factors that are critical to the operation of one fleet may be less important to other carriers. The fleet management decision factors are shown in Table 2. These decision factors are not mutually exclusive. Indeed, certain objectives, such as maximizing revenue per mile, are realized by meeting others, such as obtaining backhauls and minimizing unladen mileage.

4.2 ITS Integration

Table 3 summarizes the use of ITS technology among the case study fleets. Mobile communications technologies were most prevalent ITS technology used by the case study fleets, followed by routing and dispatching systems, and on-board computers. Automatic vehicle location systems were the least prevalent ITS technology. One of the key questions in this study is whether fleet management decision factors influence motor carriers' adoption of ITS technologies. When the case study fleets are grouped according to their fleet management decision factors, relationships between the decision factors and the adoption of ITS become apparent. These relationships are not statistically significant due to the small sample size in the study (20 fleets) but are, nevertheless, illustrative (see Table 4), and strongly suggest that fleet management decision factors play a major role in determining carriers' ITS investment decisions.

Maximize Revenue per Mile

Routing and dispatching systems help carriers select the shortest routes and optimize load consolidation, thereby maximizing per-mile revenues. Of the four case study carriers for whom maximizing revenue per mile is an important fleet management decision factor, three currently use routing and dispatching systems.

Table 2. Commercial Vehicle Fleet Management Decision Factors.

- Maximizing Revenue per Mile
- Maximizing Revenue per Trip
- Minimizing Unladen Mileage
- Equipment Availability
- Maximizing Equipment Utilization
- Minimizing Fleet Operating Costs
- Driver Availability
- Backhaul Opportunities
- Drivers' Hours-of-Service Limits
- Driver Home Time
- Importance of Particular Accounts
- Shipment Origins and Destinations
- HAZMAT Routing Considerations
- Inventory Management
- Pick-up and Delivery Times/Dates
- Size of Shipments

Table 3. Adoption of ITS by Case Study Fleets.

Fleet	Routing/Dispatching Systems	Onboard Computers	Mobile Communications	Vehicle Location Systems
Fleet 1	X	X		
Fleet 2			X	
Fleet 3	X		X	
Fleet 4				
Line-haul Fleet	X		X	**X**
Local Fleet	X		X	
Fleet 5				
Fleet 6	X	**X**	X	
Fleet 7	X		X	**X**
Fleet 8	X		X	**Planned**
Fleet 9				
Regular Route				
Charter				
Fleet 10			**X**	
Fleet 11			**X**	**X**
Fleet 12	**X**			
Fleet 13	**X**		**X**	
Fleet 14				
Fleet 15				
Fleet 16				
Fleet 17	X		X	X
Fleet 18		X*	X*	X*
Fleet 19			X	
Fleet 20				
TOTAL	10	9	13	5
Percent of **all fleets**	45%	41%	59%	23%

* Installed on some trucks.

Table 4. Relationships between Fleet Management Decision Factors and Adoption of ITS.

	Total Number of Fleets	Number of Fleets Using Each ITS			
		Routing and Dispatching Systems	On-Board Computers	Automated Vehicle Location Systems	Mobile Communications
Fleet Management Decision Factors:					
Maximize Revenue/Mile	4	3	3	1	2
Maximize Revenue/Trip	3	1	1	0	0
Minimize Unladen Mileage	6	3	3	2	3
Equipment Availability	15	6	8	5	8
Maximize Equipment Utilization	6	4	5	2	3
Minimize Operating Costs	1	1	0	0	1
Driver Availability	13	7	7	4	6
Backhaul Oportunities	2	2	2	1	2
Driver's Hours-of-Service Limits	3	2	2	3	3
Driver Home Time	1	1	1	1	1
Importance of Account	6	3	4	1	3
Shipment Origin/Destination	13	6	7	4	7
HAZMAT Routing Considerations	4	1	3	1	1
Inventory Management	6	4	5	1	3
Delivery Times/Dates	4	3	2	1	3
Size of Shipments	1	0	0	0	1
Fuel Conservation	2	1	1	1	2

Equipment Utilization

Onboard computers allow carriers to track vehicle operation (including total mileage) and maintain accurate, up-to-date records of each truck's use. Of the six case study carriers for whom equipment utilization is an important fleet management decision factor, five currently use onboard computers. In contrast, only six of the 16 carriers for whom equipment utilization is not an important fleet management decision factor currently use onboard computers.

Routing and dispatching systems help carriers optimize the use of their vehicles so they can operate smaller fleets and use each vehicle as much as possible. Of the six case study fleets for whom maximizing equipment utilization is an important fleet management decision factor, four use routing and dispatching systems. By comparison, seven of the 16 carriers for whom equipment utilization is not an important fleet management decision factor use routing and dispatching systems.

Inventory Management

Routing and dispatching systems allow carriers to schedule deliveries to help insure that inventory stocks are maintained and special orders are filled quickly. Case study carriers that are concerned with inventory management show a higher rate of adoption of routing and dispatching systems (four out of six) than do fleets for whom inventory management is not a critical fleet management decision factor (seven out of 16).

Delivery Times/Dates

Routing and dispatching systems help carriers schedule shipments and plan routes to insure that deliveries are made on time. Of the four carriers for whom delivery times and dates play critical roles in fleet management decisions, three use routing and dispatching systems, compared with eight of the 18 carriers for whom delivery times and dates are not critical fleet management decision factors.

5.0 Conclusions and Recommendations

Many people view the trucking industry as monolithic, assuming that all trucks are 18-wheelers operating cross-country as part of large fleets. In reality, however, the trucking industry is highly fragmented, reflecting the complexity and diversity of the many businesses, industries, government agencies, and consumers it serves. The most effective way to gain insight into the fleet management needs of trucking companies is to speak directly with the people who operate those enterprises. The case study interviews completed in Phase I of this project collected information from a sample of fleets representing a cross-section of commercial motor carrier industry. Based on this information, conclusions were drawn.

5.1 CONCLUSIONS

The Market is Functioning Efficiently

The uneven adoption of ITS within the motor carrier industry is not necessarily an indication of market inefficiencies. Indeed, the market for ITS/CVO technology and services appears to be functioning efficiently, in several respects.

First, motor carriers appear to have a clear understanding of currently available ITS, including the limitations of particular systems, as well as of the improvements and innovations that are likely in the near future. Lack of ITS adoption by motor carriers does not appear to be due to lack of information or understanding. Rather, as the case study findings suggest, carriers' fleet management needs appear to drive their ITS investment decisions.

Second, carriers are investing in ITS cautiously and selectively. Those carriers that already have adopted one or more ITS have invested only up to the level of their current needs. Instead of purchasing more technology than they presently require, carriers appear to be buying systems that help them achieve their current fleet management objectives, while planning for upgrades of their current systems, or for the purchase of new equipment in the future, as their needs change.

Third, current ITS technologies and services appear to be meeting diverse fleet management needs successfully. The motor industry carrier is not monolithic, and different market segments (and even different carriers within segments) have different fleet management needs. Nevertheless, there appear to be few, if any, substantive fleet management needs for which no ITS services or technologies are available. This is not to say that existing ITS can meet every carrier's needs, but that all the fundamental fleet management requirements are addressed more than adequately by existing systems.

The question remains as to why certain carriers have not yet adopted ITS. This study's findings suggest three answers. First, some carriers, particularly some of the smaller companies, simply cannot afford to purchase ITS. Many ITS are still at the initial, high end of their cost cycles. However, as prices of the computer and electronic components on which ITS are based continue to drop, ITS will be within reach of an increasingly large group of motor carriers.

Second, some carriers that may be able to afford to buy ITS now have chosen to wait and watch the market. In most cases, these fence-sitting carriers are waiting for ITS technologies and services to emerge that match their particular fleet management needs more closely than those that currently are available.

Third, there are some carriers for whom investment in ITS does not make sense now, and will not make sense in the future. For example, small carriers, or carriers whose operations are simple and routine, may not face fleet management challenges that are complex enough to warrant investment in ITS.

The ITS/CVOMarket is Dynamic and Evolving

Just as motor carriers appear to be well informed with regard to available ITS systems and services, it also appears that ITS producers are well aware of trends in the motor carrier industry, and of the trucking industry's evolving fleet management needs. The ITS market is burgeoning, as both established companies and start-up ventures try to create profitable niches. This competition is a major reason why the diverse needs of motor carriers are being met successfully.

As is the case with all computer-based technologies, ITS are becoming increasingly powerful. For example, routing and dispatching systems that a few years ago could accommodate only a few vehicles at a time are now capable of coordinating the operations of large fleets. In addition, ITS capabilities are becoming more varied. For example, on-board computers originally were used to monitor drivers' hours of service, and to track shipments. Today, OBCs also are used to monitor the performance of individual vehicles (e.g., fuel consumption) and the driving patterns of individual drivers (e.g., shifting, braking, and acceleration).

Two likely growth areas for commercial vehicle ITS are Advanced Traveler Information Services and intermodal freight operations.

Advanced Traveler Information Services (ATIS)

Most ITS traffic management applications are oriented toward passengers cars. These applications include freeway surveillance and control systems, as well as incident management programs to reduce the congestion associated with accidents, vehicle breakdowns, and similar events. Although commercial vehicles share in the benefits of these systems, the systems cannot address the unique routing restrictions and service demands faced by motor carriers. Efforts are under way to adapt ATIS to meet the special needs of commercial motor carriers. A prominent example of these efforts is the *TruckDesk* project, being undertaken by a public/private partnership involving the I-95 Corridor Coalition (a coalition of the 12 states in the Northeast Corridor), the ATA Foundation (ATAF), and the Private Fleet Management Institute (PFMI).

The TruckDesk project, which is scheduled to enter its operational test phase in the summer of 1997, will test the feasibility of an information system designed to meet the needs of motor carriers for better routing and dispatching decision making. As currently envisioned, *TruckDesk* would receive information on highway conditions through the I-95 Corridor Coalition's Information Exchange Network (IEN); through existing traveler information services such as TRANSCOM; through state transportation agencies; and through private sector sources, including the motor carrier industry. It would collect this information, and then package and disseminate it to participating carriers. Different carriers would receive different packages of information, according to their needs.

Intermodal Freight

Intermodal applications of ITS represent another potential high-growth market segment. The number of intermodal containers coming into and out of the United States has been growing at an average annual rate of just over seven percent. Domestic containers, which are a new, small, and rapidly growing market, are expected to increase at an average annual rate of about 25 percent over the next decade. Roadrailers (truck trailers equipped with detachable railroad wheels and retractable highway wheels) and other new combination railcar/half-truck-trailer vehicles are expected to grow at about 10 percent per year. This will reduce the volumes of piggyback trailers (conventional truck trailers carried on railroad flatcars), which are projected to decline about 10 percent annually.

The major force driving the expansion of intermodal freight services has been pressure to reduce total transportation costs. The introduction of intermodal stack trains, especially double-stack trains, has cut the cost of moving a container long distance [over 1,932 km (1,200 miles)] approximately in half, making intermodal service competitive with long-haul truck service.

The application of ITS to intermodal freight operations will yield significant improvements in efficiency and cost effectiveness. ITS will help to optimize load building, routing, scheduling, dispatching, container management, and other aspects of intermodal operations. This will help ensure that all the links in intermodal "supply chains" are coordinated, and that the supply chains function as seamlessly as possible.

5.2 RECOMMENDATIONS

This section provides recommendations based on the findings from the Phase I research.

1. Public Sector involvement in development of ITS for CVO Fleet Management should be limited

There appears to be little, if any, need for public sector involvement in the development of ITS for CVO Fleet Management. The public sector often plays a significant role in expediting the transfer of information about nascent technology. In the case of ITS for CVO Fleet Management, however, there does not appear to be a need for this kind of public sector involvement. Lack of access to information about ITS for Fleet Management simply is not an issue for most motor carriers. To the contrary, the majority of carriers appear to be extremely well informed about the Fleet Management benefits and costs of ITS. In addition, current evidence suggests that the motor carrier industry needs diversification and flexibility in ITS. It appears that, when and if ITS standardization benefits motor carriers, the market will adjust accordingly.

2. Actively monitor the development of ATIS for CVO

The application of ATIS for commercial vehicles is clearly an important and growing area in the ITS market. Currently, however, it is unclear exactly how carriers will use the kinds of information that ATIS will be capable of providing. Therefore, it would be beneficial for the FHWA to monitor the development of ATIS for CVO development carefully, and to begin assessing the potential usefulness of these emerging technologies to the motor carrier industry. In particular, it would be useful to obtain the reactions and opinions of truck drivers regarding ATIS because, as the actual "consumers" of these technologies, drivers ultimately will decide the success of ATIS in the market.

The successful deployment of ATIS for CVO will require accurate, real-time information on congestion and incidents. Such information must be collected and disseminated on a regional level, given the travel patterns of large trucks. In addition, the technology used to collect and disseminate the information must be consistent from region to region, because many carriers operate in multiple areas. Although the private market may be able to meet the information and systems development requirements for successful ATIS for CVO deployment, public sector involvement may be beneficial as well. In particular, the FHWA may be able to assist in the development of standards for information collection and systems design, and in the collection of congestion and incident data.

3. The FHWA should consider conducting operational tests of ITS for intermodal freight movement

Intermodal freight transfers are critical links in the national supply and distribution network, and represent the fastest growing segment of the motor carrier industry. In addition, because intermodal transfers require high quality, timely information, intermodal motor carrier operations represent an excellent environment for the application of ITS. However, the successful application of ITS to intermodal operations will involve the cooperation of multiple industries (e.g., rail, truck, water, air), all of which may not agree on standards and procedures for deploying intermodal ITS. Consequently, the FHWA may be able to help by conducting operational tests of intermodal ITS to identify technical, logistical, and administrative issues, to help develop solutions, and to serve as a forum for different industries to resolve conflicts.