Executive Summary

MOTOR CARRIER TECHNOLOGIES

— Fleet Operational Impacts and Implications for Intelligent Transportation Systems/Commercial Vehicle Operations

Prepared by
The ATA Foundation

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U.S. Department of Transportation
Office of Motor Carrier Safety

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Trucking companies are increasingly in the business of information management to stay competitive. Their use of information technologies (IT) in fleet operations is increasing dramatically both in terms of number of users and in intensity of use. The reasons for this include:

- For many segments of the industry, the carriers’ customers are rapidly becoming technologically highly integrated organizations requiring seamless information exchange between all parties involved with the business (including transportation services, whether in-house or hired). To successfully compete for freight, trucking companies make significant investments in information technologies to meet the information demands of their customers.

- Motor carrier operating ratios are very low, generally two percent or less for for-hire carriers. Subtle productivity improvements across a carrier’s operation can make the difference between profit and loss. Timely collection, processing, and use of information can enhance the management of all areas of fleet operations.

- Overall technology trends—increasing power and storage capabilities of computing platforms, development of increasingly robust and scalable software applications, increasing bandwidth availability, a general decline in technology costs, and increasing user acceptance of technology solutions.

The diversity of the trucking industry and its customers results in a wide range of technologies used in myriad combinations. This has implications for government-sponsored, technology-based motor carrier services. To solicit motor carrier participation and function effectively, the services must meet the same criteria that carriers apply to their selection of fleet technologies—1) is it cost-effective; and, 2) will it integrate seamlessly with existing or planned information technology infrastructure?

INTELLIGENT TRANSPORTATION SYSTEMS/COMMERCIAL VEHICLE OPERATIONS

The Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) Program is a cooperative effort between the U.S. Department of Transportation Office of Motor Carrier Safety, motor carriers, state government agencies, technology vendors, and other transportation stakeholders to define, pilot test, and deploy IT solutions to enhance roadway safety, and improve operational and regulatory efficiencies. Participation in the ITS/CVO program is voluntary for both states and motor carriers.
ITS/CVO Services focus on developing the technical infrastructure and institutional relationships that enable seamless information exchange between motor carriers, regulators, enforcement, and other authorized stakeholders. This information exchange could enable electronic regulatory transactions (i.e., electronic credentialing), focusing of enforcement resources on unsafe motor carriers, and providing motor carriers real-time access to fleet safety and operations enhancing information.

The National ITS/CVO Program is comprised of four program areas: Safety Assurance, Credentials Administration, Electronic Screening, and Carrier Operations. The functions of the four program areas are described in the following:

**Safety Assurance**—improve targeting of high-risk operators for inspection rather than the entire motor carrier population through roadside access to real-time safety information; automate safety inspection activities to reduce inspection time and improve consistency; and, support in-vehicle safety monitoring.

**Credential Administration**—automate regulatory functions and enhance data communications capabilities of state agencies to enable paperless transactions between motor carriers and agencies.

**Electronic Screening**—screen commercial vehicles for size/weight, safety, and credential compliance at mainline speeds.

**Carrier Operations**—enhance motor carrier safety and efficiencies through technical/programmatic support for: delivery of timely and accurate information to fleet managers; outreach regarding benefits of technology-enhanced fleet operations; bringing emerging technologies to market; and, providing responders to hazardous materials incidents rapid access to information concerning the shipment.

Critical to the success of the ITS/CVO Program is motor carrier acceptance and participation in deployed services. That participation will be driven by the same criteria carriers use in deciding whether to adopt specific technologies to support their fleet operations.

In other words, the ITS/CVO services need to be an effective extension of carriers’ IT solutions to successfully solicit motor carrier participation (i.e., the technologies enabling participation are widespread in use with strong adoption rates by motor carriers; the technologies provide strong benefit/cost ratios for motor carriers; and, they can be used in multiple applications in ITS/CVO services).

To assess the potential motor carrier participation in the ITS/CVO services, this effort examined how motor carriers use technology, which segments of the industry are using specific technologies, the benefits and costs of the technologies in fleet operations, and how the technologies could be used to support participation in the services.
CURRENT USE AND POTENTIAL ITS/CVO APPLICATIONS OF FLEET TECHNOLOGIES

Computer Aided Routing & Dispatch

Routing and Dispatch software, also known as Computer Aided Dispatch (CAD), generates pickup and delivery schedules and determines optimal routing based on the company’s routing criteria (i.e. fastest route, toll averse, predominately interstate highway, etc.).

Many firms have integrated their order entry systems with CAD software to automatically match available loads with driver and equipment availability, improve asset utilization, decrease turn-around time on load acceptance, and enhance on-time performance. CAD is often integrated with a firm’s other decision support software modules to track vehicle and driver utilization (hours-of-service), vehicle maintenance, calculate driver settlements, track loads, or automate the capture of mileage data for fleet credentialing and tax administration information.

CAD is used extensively in the trucking industry—53% of surveyed carriers. This is due, in part, to broad ranges in pricing and functionality making CAD a cost effective management tool for many sizes and types of trucking operations. The adoption of CAD has been strong between 1996 and 1998, an 8.5 percent annual increase.

The use of CAD can yield significant benefits to many types of motor carriers. These benefits are derived through improved coordination and utilization of personnel and assets. Benefit/cost ratios for CAD were estimated to range from 3.1:1 to 9.4:1.

Applications of CAD supporting participation in ITS/CVO services could include:

- Automated carrier collection of mileage data from dispatches for apportionment calculations or documentation for audits.
- Integration of exception-based travel information to trigger re-routing, scheduling, and load assignments.

Mobile Communication Technologies

Mobile communications provide voice and/or data communications between the drivers, dispatchers, and authorized third parties. Mobile communications technologies are used to notify drivers of new loads or changes in scheduling and routing. Additionally, dispatchers can be notified of on-route conditions such as vehicle location, traffic and weather delays, and vehicle breakdowns. Mobile Communications can also
allow drivers to stay in-touch with their families while on the road, thus supporting driver retention.

Mobile communications technologies are the most widely used technologies in the trucking industry—72 percent of the surveyed motor carriers. Cellular phones and pagers are the most used mobile communications technologies, 62 and 55 percent, respectively. These technologies are highly complimentary and are often used together. Strong annual growth is observed in the use of cellular phones (seven percent) and pagers (five percent) between 1996 and 1998. In 1998, approximately 30 percent of surveyed motor carriers used mobile radio, up modestly from 27 percent in 1996. Cellular phones, pagers, and mobile radio are used primarily by motor carriers whose average haul length is less than 500 miles. The level of use of these technologies is about the same across fleet sizes.

Satellite communication was used by 28 percent of survey respondents, up from 17 percent in 1996. The primary users are larger truckload fleets with haul lengths of greater than 500 miles. This technology is very often used with automatic vehicle location tracking and on-board computers. The greatest growth in satellite communications adoption came from firms that felt on time performance was their most important operating objective.

Many segments of the motor carrier industry realize benefits of mobile communications. These benefits accrue through rapid relay of new load information, travel conditions, or vehicle or driver availability thus improving personnel and asset utilization and potentially customer service. Benefit/cost ratios calculated for mobile communications range from 4.4:1 to 6.3:1.

Supporting participation in ITS/CVO services, mobile communications could be used to:

- Enable drivers access to real-time traffic/travel information via cellular phone.
- Enable dispatchers to communicate incident/ and re-routing information to drivers following exception alert from real-time traffic/travel information system.
- Remote monitoring of driver available hour-of-service or of vehicle systems.

Electronic Data Interchange and Internet/World Wide Web

Electronic Data Interchange (EDI) allows for inter-company computer-to-computer communication of data using standardized electronic message formats or “transaction sets.” EDI enables companies to exchange information fast and efficiently, reducing the amount of paperwork and manual input, thereby improving data accuracy and processing speed.
Strongly driven by customer requirements for conducting business electronically, EDI has become an integral part of many segments of the trucking industry.

Increasingly, motor carriers are using the Internet and web-based solutions to improve market reach, identify available loads and bidding, invoice, and communicate via e-mail. A basic application is a simple web page providing company information, such as contact names, phone numbers, area of operation, and hours of operation. More advanced systems can include on-line access to load postings, bidding, load acceptance, shipping document generation, etc. In a fully integrated system, the on-line information can be integrated with an order entry module to start internal planning, routing, and distribution processes.

In 1998, EDI was used by 41 percent of surveyed carriers. Approximately 33 percent of small to mid-sized firms and 60 percent of large fleets were EDI capable in 1998. The number of surveyed companies using EDI increased 6.5 percent per year between 1996 and 1998, with the strongest adoption rates among large and short haul carriers (9.2 and 8.1 percent, respectively).

In 1998, 48 percent of surveyed firms reported using the Internet, up from ten percent in 1996. Adoption rates among firms using the Internet is very strong (19 percent per year) and generally consistent across haul types. Reflecting expected continued strong growth in overall Internet use, strong adoption rates for motor carriers can also be expected to continue for several years.

The benefit of EDI/Internet Access estimated in this analysis is limited to reductions in overall clerical labor costs. These reductions are assumed to be derived through improved administrative efficiencies. Estimated Benefit/cost ratios ranged from 2.7:1 to 11.7:1.

ITS/CVO uses of EDI/Internet could include:

- Electronic transmittal of carrier data, forms, supporting documentation to agencies.
- Electronic reception of credentials and payment of fees/taxes.
- Provide carriers electronic access to fleet safety inspection reports to enhance safety monitoring functions.
- Provide carriers electronic access to regulatory safety rules and regulations.
- Provide carriers access to real-time traffic/travel information.
- Posting of load information for access by emergency responders to incidents involving hazardous materials.
**Automatic Vehicle Location**

Automatic Vehicle Location systems (AVL) make it possible to pinpoint the location of a vehicle using satellite or ground-based technologies. When combined with on-board computers and routing and dispatching software, these systems can track and document detailed truck or load information from pickup to delivery.

AVL systems can be integrated with other carrier systems such as CAD, accounting software, and maintenance and safety support systems to provide customers with current shipment status information, enable dynamic re-routing, automate settlements and mileage and tax calculations, enhance driver log auditing, and track vehicle use for preventative maintenance purposes.

In 1998, 21 percent of survey respondents reported using AVL, up from 12 percent in 1996. AVL is primarily used by larger, time-sensitive, variable-route fleets requiring increased asset coordination. Long-haul users are primarily truckload fleets using satellite communications. The short haul users are generally larger pickup and delivery fleets using radio-based AVL.

Too few survey respondents reported using AVL to quantify benefits in this analysis.

Applications of AVL in ITS/CVO services could include:

- Carriers monitor vehicle speeds/location in real-time supporting driver monitoring or scheduling/routing based on available hours-of-service.
- Automated carrier data collection for apportionment calculations.
- Vehicle position reports supporting CAD response to roadway incident reports.
- Vehicle position reports support identification of loads by hazardous materials incident responders

**On-Board or Hand-Held Computers**

On-Board or Hand-Held Computers (OBCs) are data processing units that take information from sensors and other devices, process and present it to the truck driver or carrier in a convenient and easily accessible manner. These units can also keep records of sensor readings (such as engine and refrigeration unit data) for vehicle diagnostic and preventative maintenance purposes. Many fleet managers also use this data to analyze fleet performance statistics such as driver performance and fuel consumption.
OBCs can also control additional communication devices and interface with transponders installed on the tractor/trailer. They might also be connected to a hand-held device for data collection outside the vehicle, such as bar code reading, sensors, electronic signature readings, or keypads for direct driver data entry. An emerging application of OBCs is their use as electronic logbooks.

Ten percent of surveyed carriers reported using OBCs in 1998, up from six percent in 1996. Mostly larger fleets; firms with time-sensitive hauls, less-than-truckload and private carriers, and firms with safety performance as their prime objective use OBCs.

Six percent of surveyed carriers used electronic logbooks in 1998, compared to three percent in 1996. Approximately three to four percent of for-hire carriers reported using electronic logbooks, while 18 percent of the surveyed private carriers used the devices.

Benefit/cost ratios for OBCs are estimated to range from 0.3:1 to 6.6:1.

Within the context of ITS/CVO services, OBC/electronic logbooks can enable the following functions:

- Monitor driver/vehicle performance either in real-time or historically.
- Automate the recording/demonstration of drivers’ hours-of-service.
- Enable presentation of vehicle systems performance data to inspectors.

**Diagnostic and Maintenance Support Systems**

Diagnostic and Maintenance Support systems (MSS) are used to collect information and track a variety of operational statistics and asset performance/wear data to allow timely maintenance activities. These systems can be used to analyze error codes from electronic engines and on-board computers, track the total number of hours and miles logged on the vehicle, service intervals, and flag a vehicle due for preventive maintenance work.

MSS were used by 30 percent of the surveyed carriers in 1998, an increase of six percent per year from 1996. The strong rate of adoption is due to the vendor community offering a range of MSS to meet the functional and price needs of many diverse fleet types. The benefits to firms using maintenance support systems examined in this analysis include reductions in maintenance and insurance costs derived through enhanced preventative maintenance programs. Benefit/cost ratios calculated for maintenance support systems range from 0.7:1 to 1.8:1.

Supporting ITS/CVO Safety Assurance functions, MSS can be used to enable automated maintenance records/reports possibly stored via on-board/handheld computers or RF-tags for electronic access by enforcement.
Automatic Vehicle/Equipment Identification

Automatic Vehicle/Equipment Identification (AVI/AEI) systems are generally based on dedicated short-range radio communication between a transponder or RF tag on the equipment and a stationary reader system. The transponders are typically programmed with identification, authorization and any other types of information unique to the user, equipment or the application.

AVI/AEI can be utilized to identify: equipment entering or exiting a yard (yard access control); equipment within a yard (equipment availability); trucks passing through toll collection lanes (electronic toll collection); or, fuel use and authorization.

Three percent of surveyed carriers reported using RF tags in 1998, compared to two percent in 1996—primarily by larger fleets to track assets and to coordinate load consolidation; smaller fleets operating in metropolitan areas supporting electronic toll collection; and fleets participating in electronic clearance programs. Too few survey respondents reported using AVI/AE to quantify benefits in this analysis.

Regulatory uses of AVI/AEI include electronic identification and screening of vehicles for bypassing roadside inspections at mainline speeds and enable transmittal of information between roadside enforcement and vehicle. For the purpose of identifying vehicles, optical recognition technologies (license plate readers) are currently being tested as a “passive” alternative to RF tags.

Collision Warning Systems/Driver Impairment Detectors

Collision warning systems (CWS) alert the driver of possible collisions based on proximity to, and rates of closure, on obstacles. Obstacle detection can use closed-circuit television, infrared, or low frequency radar detection. Alerting signals can be audible or visual. These data can be downloaded or relayed via mobile communications and used for driver performance evaluation or accident reconstruction.

CWS was used by only three percent of the surveyed carriers in 1998. Annual growth between 1996 and 1998 was about one percent per year. Too few survey respondents reported using CWS to quantify benefits for the technology.

Emerging technologies include drowsy driver detection/warning systems to monitor a driver’s physical state and performance behind the wheel and alert the driver and/or the carrier if a serious fatigue condition is detected. Systems under development could monitor driver posture changes, eye blinking and degree of eyelid closure, erratic steering, etc. to assess alertness. These sophisticated, non-intrusive detection/warning systems are not expected to reach the marketplace for several years.
There are near-market-ready devices that monitor the tractor’s placement within the driving lane. If the placement/location changes, such as if a commercial vehicle begins to drift out of the lane, the driver receives an audible or tactile warning signal.

Supporting ITS/CVO safety assurance functions, CWS provide warnings to drivers of closure rates on obstacles (especially useful in limited visibility conditions). Other CWS features include the capture and storage of alert documentation for driver performance monitoring/review.

**Motor Carrier Value Perceptions and Potential Participation in ITS/CVO Services**

How motor carriers perceive value for ITS/CVO services/functions can provide a benchmark from which potential participation levels can be estimated. To this end, the surveyed motor carriers were asked to rank their perceived value for ITS/CVO services.

The results show that the highest values are placed on services in which requirements for participation involve the use of technologies currently widespread in use (proven, cost-effective, and interoperable technologies requiring little or no modifications for participation). It is also seen that the perceived value for ITS/CVO services is sensitive to fleet operating characteristics such as fleet size, range of operations, time sensitivity of hauls, and route variability.

Based on current and projected use of fleet technologies and the surveyed motor carriers’ value perceptions by fleet characteristics, estimates of potential motor carrier participation in ITS/CVO services were developed. Participation estimates assume a sufficient time frame following implementation of ITS/CVO services to allow carriers to realistically assess service functionality, costs and possible benefits, and resolution to the many intricate barriers identified in states’ ITS/CVO Institutional Issues studies and other related literature. These estimates are presented in Figure 1 and summarized in the following:

- The ITS/CVO services/functions estimated to have the highest initial and potential participation are those that are informational in function: electronic access to information about travel conditions, fleet safety performance, and motor carrier rules and regulations. It is expected that motor carriers would adopt these services rapidly due to the relatively low cost and expected adoption rates of enabling technologies, and potential medium to high benefits in terms of enhanced fleet operations and safety management.

- Participation in the electronic credentialing services for fleet registration, fuel tax administration, and oversize/overweight permitting can be expected to be modest at first, then developing rapidly towards strong participation levels. Similar to informational ITS/CVO services/functions, technology costs are expected to be relatively low. Low to medium benefits in terms of reduced administrative costs can be expected.
• Participation in electronic screening and automated safety inspection activities is expected to be low at first and slowly developing towards modest participation levels. Participation is expected to be constrained due to uncertain benefits, exposure levels, and institutional and technical issues.

• As a reasonably well-developed service in the more metropolitan areas, moderate growth is expected in the number of motor carriers participating in electronic toll collection programs. This growth would be driven primarily by the benefits of toll discounts and administrative cost savings.

### Figure 1

*Estimated Motor Carrier Participation in ITS/CVO Services (Commercial Vehicles and Percent Participation)*

<table>
<thead>
<tr>
<th>ITS/CVO Service</th>
<th>Conservative Participation Estimate (Commercial Vehicles &amp; Percent)</th>
<th>Optimistic Participation Estimate (Commercial Vehicles &amp; Percent)</th>
</tr>
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<tbody>
<tr>
<td>Electronic Registration Credentialing</td>
<td>1.2 Million 39%</td>
<td>2.5 Million 63%</td>
</tr>
<tr>
<td>Electronic Fuel Tax Credentialing</td>
<td>0.7 Million 33%</td>
<td>1.4 Million 62%</td>
</tr>
<tr>
<td>Electronic Fuel Tax Filings/Payments</td>
<td>0.7 Million 33%</td>
<td>1.4 Million 62%</td>
</tr>
<tr>
<td>Electronic Oversize/Overweight Permitting</td>
<td>1.0 Million 26%</td>
<td>1.4 Million 39%</td>
</tr>
<tr>
<td>Demonstration of Hours-of-Service Compliance via Electronic Logs</td>
<td>0.2 Million 5%</td>
<td>0.3 Million 8%</td>
</tr>
<tr>
<td>Real-Time Access to Reel Safety Inspection Reports</td>
<td>1.3 Million 33%</td>
<td>2.8 Million 71%</td>
</tr>
<tr>
<td>Electronic Access to Motor Carrier Rules and Regulations</td>
<td>1.2 Million 29%</td>
<td>2.7 Million 67%</td>
</tr>
<tr>
<td>Electronic Safety/Weight Screening</td>
<td>0.3 Million 7%</td>
<td>0.5 Million 9%</td>
</tr>
<tr>
<td>Access to Real-Time Traffic and Travel Information</td>
<td>1.7 Million 44%</td>
<td>2.9 Million 72%</td>
</tr>
<tr>
<td>Electronic Toll Collection</td>
<td>0.3 Million 7%</td>
<td>0.8 Million 20%</td>
</tr>
<tr>
<td>Hazardous Materials Incident Response</td>
<td>0.6 Million 16%</td>
<td>1.4 Million 35%</td>
</tr>
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