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ITS/Commercial Vehicle Operations

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1) Introduction

Intelligent Transportation Systems (ITS) utilize information, communication, sensor, and control technologies to achieve improved levels of performance. The U.S. DOT has developed a National ITS Program Plan that includes seven major elements. One of them addresses the ITS technologies which uniquely support Commercial Vehicle Operations (CVO).

ITS/CVO is broadly scoped. It includes the operations associated with moving freight and passengers in commercial vehicles and the activities necessary to regulate these operations as well as activities related to safety assurance, commercial vehicle credentials and tax administration, roadside operations, freight management, fleet management, and vehicle operation.

Commercial Vehicle Information Systems and Networks (CVISN, pronounced see' vision) is the term used to refer to the ITS information system elements that support commercial vehicle operations. The information systems may be owned and operated by governments, carriers, or other parties.

A common framework for planning, defining and integrating intelligent transportation systems is being established and is called the National ITS Architecture. It defines:

- 1) Functions (e.g. gather traffic information) that are required for ITS.
- 2) The physical entities or subsystems where these functions reside (e.g. the roadside or the vehicle)
- 3) The information flows that connect these functions and subsystems into an integrated system.

The National ITS Architecture also defines user services, that is, what ITS should do from the user's perspective. A broad range of users is considered, including the traveling public as well as many different types of system operators. In addition, the National ITS Architecture sets forth User Service Requirements, statements of what needs to be done to implement these user services.

Figure 1 shows the relationships between some of the terms that are used:

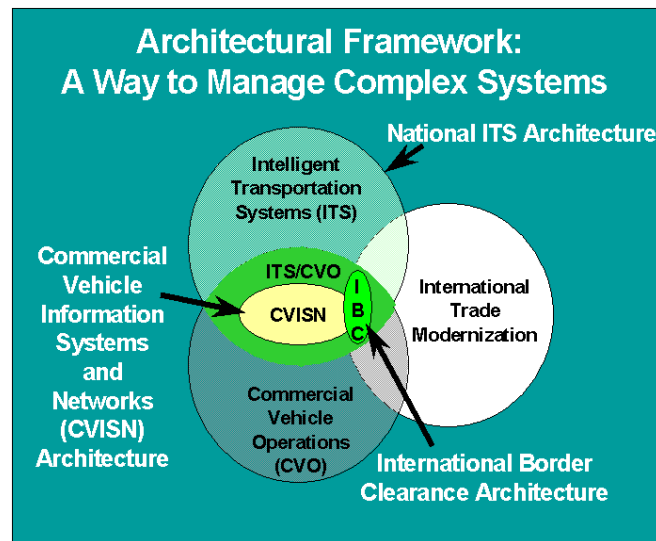


Figure 1: CVISN Terminology

Source: <http://www.jhuapl.edu/cvisn/Architecture/Architecture.html>

2) Functions

Commercial vehicle clearance, automated roadside safety inspection, on-board safety monitoring, hazardous materials incident response, automated administrative processing, and commercial fleet management are some of the key functions that intelligent transportation systems can provide for commercial vehicles.

Commercial Vehicle Electronic Clearance

The National ITS Architecture mandates, "ITS shall include a Commercial Vehicle Electronic Clearance (CVEC) capability." Commercial Vehicle Electronic Clearance capability is defined as a fixed facility consisting of structures and equipment such as Ports Of Entry, Inspection Stations, Weigh Stations and Toll Booths.

Commercial vehicle electronic clearance consists of two parts:

- 1) Domestic electronic clearance- This allows commercial vehicles under intrastate and interstate registration to continue past checkpoints without having to stop.
- 2) International electronic clearance- This allows vehicles at the international borders with Mexico and Canada to pass checkpoints without stopping.

When a commercial vehicle is detected, a request is transmitted electronically for its on-board tag data. If the vehicle is equipped with an on-board tag, identification of the vehicle takes place electronically and its credentials are made available to authorities, including such items as vehicle weight, safety status and cargo. The credentials of the vehicle are checked against a list of vehicles known to have safety problems, held in a databank (“store”) at the roadside station facility. Sensors also are used to determine the number of axles, gross vehicle weight and weight per axle for use by inspectors at the roadside checkstation facilities., which is passed on to the roadside facility. . Pull-in or pass messages are issued to the driver, using roadside equipment such as dynamic message signs or simple red -green lights or flashing orange lights. If no tag data is received, the data cannot be interpreted correctly, or a problem is detected, a request is sent out for the vehicle to pull in.

A sample of equipped vehicles also could be requested to pull in for checks, with those with good records checked less often than those that have had problems.

Automated Roadside Safety Inspection

With automated roadside safety inspection, sensors are used to differentiate between different kinds of vehicles and to determine the number of axles, gross vehicle weight and weight per axle data for use by inspectors at the roadside check station facilities. On-board electronic tags store information about vehicle credentials, which can be read electronically from the vehicle as it passes the safety inspection station. If violations are detected, details of commercial vehicle carriers and drivers that require prosecution could be sent electronically to the appropriate law enforcement agency.

It is also possible for commercial vehicle owners to enroll the electronic credentials for their vehicles. This enrollment is achieved by loading the credentials data into a central database or data “store”, from which such data are then downloaded to commercial vehicle roadside check stations and border crossing facilities.

Also, a central safety inspection facility could review electronic data from border crossings and other check stations. The inspector could override the pull-in or pass decisions made at a border crossing, for example, issuing a pull-in request that overrides a green light issued by the border crossing equipment. A safety inspector also could issue a general request for all commercial vehicles to pull into the roadside check station.

On-Board Safety Monitoring

On-board safety monitoring provides warnings of safety problems. The main objective is to inform the driver, as soon as possible, of any problem that has been detected. On-board safety monitoring could cover such things as load balance or shifts in the load, load temperature, open doors or loose latches or tie-downs, etc., as well as vehicle component information such as tire pressure. The capability to alert the commercial vehicle driver whenever there is a critical safety problem or potential emergency is thus provided. These capabilities require equipment on the

commercial vehicle, including the sensors and processors to monitor the vehicle and alert the driver, and possibly to also store the information on the vehicle.

Hazardous Material Incident Response

Hazardous material incidence response includes the capability to provide enforcement and response teams with timely and accurate information about cargo contents when the vehicle is involved in an incident. The data on what materials are being transported would be stored on board and downloaded at various checkpoints.

Automated Commercial Vehicle Administrative Processes

ITS technologies could speed up and better manage a variety of administrative processes, especially those associated with government taxation and regulation. Applications include electronic purchase of credentials, automated mileage reporting, automated fuel reporting, tax calculation, and auditing functions, as well as safety inspections described earlier. The data would be exchanged between the vehicle and the data at each roadside check station, and would be loaded into a data store in the commercial vehicle administration facility. Electronic funds transfers would be made to cover purchases, taxes, etc.

Commercial Fleet Management-

Commercial fleet management applications of intelligent transportation systems enable drivers and dispatchers to receive real-time routing information and access databases containing vehicle, driver, carrier and cargo information. The process should be able to supply routing information in audio and visual form.

3) Technologies

Intelligent transportation systems for commercial vehicle operations depend on a number of technologies. A variety of roadside and on-board technologies are used in the various applications.

Key roadside technologies involve Automated Vehicle Identification (AVI), which in turn refers to a variety of specific technologies and functions that are performed. For the commercial vehicle operations applications discussed earlier, key technologies and functions are as follows:

- Vehicle-to-Roadside Communication (VRC)
- Automatic Vehicle Classification (AVC)
- Weigh-in-motion (WIM)

Additional roadside technologies often provide added safety and efficiency benefits. In particular, Highway Safety Warning Systems provide road condition information (ranging from ice on the road to pavement defects to construction zone ahead) and Automatic Toll Collection provides no-stop payment on toll facilities.

Vehicle technologies for ITS/ commercial vehicle operations include:

- Advanced communication systems
- On-board electronic data systems
- In-vehicle route guidance and navigation systems
- On-board safety monitoring systems

Many of these applications also utilize or are complemented by automatic vehicle location (AVL) and real-time routing and dispatching systems. These latter systems are already in widespread use in commercial vehicles; many long-haul commercial trucking companies, for example, routinely monitor their trucks using wireless technologies and Global Positioning Satellites (GPS). These systems make delivery schedules more predictable and relieve drivers of some arbitrary work rules. They also increase the level of surveillance to which the drivers are subjected, however, which has raised issues of privacy [6].

4) Applications

To date, there have been over 100 operational tests or demonstration projects of ITS/CVO. With government, industry, and academia participating. A few key examples are summarized here.

Advantage I-75 Automated Truck Weight and Credential Checking

Partners included enforcement and regulatory agencies in Florida, Georgia, Tennessee, Kentucky, Ohio, Michigan, and Ontario; the Federal Highway Administration; motor carrier groups; individual trucking companies; the University of Kentucky's Transportation Center; Iowa State University's Transportation Center; Science Applications International Corporation (SAIC); Hughes Transportation Management Systems (HTMS); and Delco Electronics. The Kentucky Transportation Cabinet was the lead agency for the project.

The goal of the operational test was to develop a commercial vehicle electronic screening system called the Mainline Automated Clearance System or MACS, deploy it at 29 weigh stations along Interstate 75 and Canadian Route 401, operate the system for two years, and evaluate the results. The official, two-year test period ran from October 1995 to September 1997. The objective of MACS was to allow transponder-equipped and properly documented trucks to travel any segment along the entire length of Interstate 75 at mainline with no more than one stop at weigh stations to verify weight compliance and credential status.

Each truck enrolled to participate in the MACS Operational Test was equipped with a transponder, a two-way communication device that mounts on the windshield in the truck's cab. The transponder communicates with roadside readers to allow the system to identify the truck and check the truck's credentials. Weight data can be stored in the truck's transponder from an earlier weighing (on the same trip), or it can be obtained from weigh-in-motion equipment. If the system determines that the truck's weight and credentials are valid, it sends a preclearance signal

to the transponder. The driver then sees a green light and hears a distinctive audible signal, and can bypass the station.

Near the end of the Advantage I-75 project, the University of Kentucky Transportation Center was enlisted to design and develop a "next generation" electronic screening system using lessons learned from the Advantage I-75 project. This new version of the Mainline Automated Clearance System (MACS) came to be known as "Model MACS." The system is designed to be simple, flexible, and inexpensive to implement. It is now being used at multiple sites in Kentucky and three other states.

Commercial Vehicle Intelligent Systems and Networks (CVISN) Applications

As noted earlier, CVISN (Commercial Vehicle Information Systems and Networks) refers to the collection of information systems and communications networks that support commercial vehicle operations (CVO). The CVISN Program has been working to develop and deploy new capabilities that will enable government agencies, the motor carrier industry, and other parties engaged in CVO safety assurance and regulation to exchange information and conduct business transactions electronically. Three areas have been emphasized:

- Safety Information Exchange
- Credentials Administration
- Electronic Screening

Safety Information Interchange:

In the past, the FHWA funded states through the Motor Carrier Safety Assessment Program (MCSAP) to perform safety inspections of selected commercial vehicles at the roadside and to perform audits of the safety processes of selected motor carriers at their terminals. A central Motor Carrier Management Information System (MCMIS) was maintained to support these tasks. The information was entered into the system from paper forms and outputs were available as printed reports. The CVISN Safety Information Exchange area aims to provide improved electronic exchange of MCMIS and other safety information among roadside and deskside, state and federal systems.

The collection of results of driver and vehicle inspections is now being automated through a system called ASPEN. ASPEN is a laptop-based system that allows safety inspectors to enter Inspection Reports at the roadside and forwards them to the Commercial Vehicle Information Exchange Window (CVIEW). The inspection reports are relayed from ASPEN via a Commercial Vehicle Information Exchange Window (CVIEW) system at the state level to the Safety and Fitness Electronic Records System (SAFER) at the national level. SAFER relays them to the central system, MCMIS, and makes them available back to the CVIEWs and roadside systems in the various states. These relays are conducted in near real-time and the states can usually have the results of inspection reports in less than an hour.

Credentials Administration

The main objective is to enable motor carriers to apply for, pay for and to receive credentials electronically. Thus, the goal is to provide electronic application, processing, fee collection, issuance, and distribution of CVO credentials, tax filing and auditing, and support of multistate information exchange and processing agreements. The carrier would use some type of credentialing system software on their computer to prepare applications electronically. A significant feature of CVISN is the use of a standard Electronic Data Interchange interface by each state. Electronic data interchange is the electronic exchange of information from one computer to another. It has been in use for many years by shippers and carriers and examples of transactions include shipping orders and invoices.

Electronic Screening:

Weigh in motion, credential checking, and other exchanges of information are used in electronic screening. Weigh in motion refers to the use of in-road sensors to check truck weights without the vehicle having to stop. Commercial vehicles that participate in electronic credential checking programs have on-board tags and other communications devices that can be queried by roadside readers, that allow credentials to be monitored either by connecting vehicle information to data previously entered in a data store or by allowing direct readings.

Example: Washington State CVISN Demonstration

Washington State is a Commercial Vehicle Information Systems and Networks (CVISN) demonstration state. The first CVISN Weigh-in-Motion (WIM) site went into operation at the south I-5 Ridgefield Port of Entry. Five more weigh stations are being converted to CVISN sites in 2001. This technology will allow truck weights and credentials to be checked without requiring the trucks to stop. This program is a joint effort of WSDOT, the Washington State Patrol and the Department of Licensing.

WSDOT is installing a system to facilitate the movement of containers across the USA/Canada border. Working with the Ports of Seattle and Tacoma, as well as US Customs and the Washington State Patrol, WSDOT has installed a system of tag readers at the ports and at the border. These will provide US Customs with information on port-to-border travel times as well as ID numbers of containers approaching the border. These IDs can be matched with the manifests of the containers so US Customs can decide whether to inspect the container or allow it to pass into Canada. A project to install the same system for southbound container traffic also has received federal funding. A concept of operations has been developed and was under review as of spring 2001 [9]

Federal funding for this operational test is \$ 3,000,000 and the total cost is \$23,000,000. The expected date of completion is June 2005.

Example: Green Light

Oregon DOT is using ITS/CVO technologies to electronically verify safety and weight information on drivers, vehicles, and carriers, using fixed and mobile roadside sites. ODOT also is providing commercial vehicle operators with road condition, weather, and downhill speed information. In 2000, a total of 641,302 trucks received a green light to bypass Oregon Green Light weigh stations. If bypassing a weigh station at highway speed saves five minutes, the 641,302 green lights represent a total savings of 53,442 hours of travel time. [8]



Figure 2. Oregon Weigh-in-Motion System

Figure 2 shows a 26 – wheeler being weighed in motion , identified by its transponder, and pre-cleared to continue west past the Wyeth Weigh Station on Interstate 84 in the Columbia River Gorge.[8]

International Border Crossing Study [9]

The Northern US border with Canada includes 76 land border crossings that handle commercial vehicle traffic. Trade with Canada includes manufactured goods, raw materials and agriculture products, and in particular includes automotive manufacturing trade (products assembled in Canadian factories from parts originating in the US or overseas). The southern US border with Mexico includes 22 land border crossings, with the westernmost at Otay Mesa, CA. Trade with Mexico includes exchanges of manufactured goods and agricultural products as well as the mequiladora trade – products assembled in Mexican factories with parts originating in the U.S. and overseas. While Canadian and US trucks operate interchangeably, most commercial vehicles moving goods across the border with Mexico are of Mexican origin, and most of these vehicles perform a drayage function, wherein loaded trailers are transferred from one side of the border to the other, over short distances. Laws have prevented U.S. owned fleets from operating in Mexico, and Mexico owned fleets from operating outside “commercial zones” in the U.S. which extend from 5 to 25 miles from the point of crossing. However, the Mexican truck restrictions are being lifted, and soon Mexican trucks are expected to be operating in the US on a far wider

basis. Furthermore, as trade among the three countries grows as a result of the North American Free Trade Agreement (NAFTA), managing international border crossings will be an increasing challenge. Large increases in traffic are expected, and unless new management approaches are implemented could result in serious delays

International electronic clearance is one way to improve border crossing management. It allows vehicles that are “in the system” at the international borders with Mexico and Canada to pass checkpoints without stopping. A recent study [9] has been done to identify how international border crossings have made progress towards facilitating trade through the use of this ITS/CVO technology. The study lists findings obtained from field operational test evaluation reports and from interview with federal, state and industry officials at 6 border crossing sites:

- Blaine, WA
- Buffalo, NY
- Detroit, MI
- Laredo, TX
- Nogales, AR
- Otay Mesa, CA

The study indicate that institutional issues are among the biggest challenges. In particular:

- State and federal agencies have different roles and different focus areas.
- Differences among U.S. states also present a challenge.
- Partnerships with private sector companies or non-US government agencies are not easily accommodated by state planning processes.
- Obtaining funding for and conducting coordination of property and infrastructure improvements related to transportation in non-transportation compounds is complex.
- There is uncertainty regarding strategies for cofunding bi-national projects.

5) Issues Involved in Implementation

The National ITS Architecture states that each individual vehicle's or carrier's participation in CVO applications is to be on a voluntary basis. Factors determining ITS/CVO applications include the following (Grenzeback, et al, 1997):

1. principal product carried;
2. fleet size;
3. geographic range of operation;
4. routing variability and
5. time sensitivity of deliveries

The Introductory Guide to CVISN (Richeson, 1999) highlights the role that stakeholders (vehicle owners, managers, operators; regulators, facility providers and managers) play in the process. Stakeholders need to understand the problems with current operations and the benefits of

improved processes. Efforts to implement new technologies may fail due to a lack of understanding of the impacts of the technology on operations by the users of the technology.

A particular concern is whether the various stakeholders see and value the benefits of ITS/CVO. Benefits that have been suggested in the literature include the following:

1) Safety-

- Reduced congestion at weigh stations will reduce accident risk.
- Law enforcement will be able to concentrate its efforts on high-risk and uninspected carriers and operators.
- Fewer trucks pulling in and out of weigh stations reduces accident risk for motor carriers and passenger vehicles.

2) Simplicity-

- Simplified, automated screening and targeting of high-risk operators improves enforcement efficiency.
- Standardized data exchange results in a simpler workday for motor carriers, drivers, and regulators alike.
- Low risk carriers, vehicles and drivers face fewer and simpler roadside inspections.
- Applications can be easily filed from the motor carrier's administrative offices.
- Motor carriers can get better information quicker from regulatory and enforcement agencies

3) Savings-

- Electronic screening will eliminate the need for truckers to stop for unnecessary weight and safety inspection, saving time and money.
- Automated reporting and record keeping technology will reduce costly paperwork for government and motor carriers.
- Motor carriers no longer have to go in person to file applications at each of the agencies that regulate the company's business.
- Government agencies will be able to process license and certificate applications more quickly and accurately.
- Electronic screening will reduce the number of stops and starts commercial vehicles must make, thus reducing fuel consumption and time idling in lines at weigh stations.
- The flow of goods from manufacturer to distributor to consumer is streamlined and on-time deliveries will improve.
- The new technologies are cheaper to install and use than constructing new weigh stations.
- Electronic screening technologies allow government agencies to shift personnel and resources from processing paperwork to other tasks.
- States will be able to more effectively collect taxes and other revenues.

The *Introductory Guide to CVISN* provides a good summary of specific benefits documented to date:

Benefits of Safety Exchange Information

- In a study of 40,000 commercial motor vehicle inspections, safety inspectors removed an additional 4,000 (increasing from 8,000 to 12,000) unsafe drivers and vehicles using advanced safety information systems instead of traditional methods.[USDOT, 1998]
- Improvement in safety data quality and transfer time through Electronic Data Interchange (EDI) vastly improves safety monitoring. Roadside inspectors receive more current, timely information.[USDOT, FHWA-JPO-97-013]
- The ability to identify hazardous cargo on vehicles involved in crashes can reduce the risk to those involved in the crash, the emergency response team, and the people living and working near the crash scene by reducing the time needed to properly handle the material. [Report to Congress, 1996]
- Electronic screening automated roadside safety inspections, and onboard safety systems could reduce fatalities by 14 to 32 percent. [Report to Congress, 1996]

Credentialing Benefits

- A case study involving eight states estimated that the deployment of Intelligent Transportation Systems/Commercial Vehicle Operations (ITS/CVO) technologies for electronic credentialing would have up to a 6:1 benefit/cost ratio. [Rubel, 1998]
- Electronic credential administration enables state agencies to share and exchange accurate, current, and protected motor carrier information both inside and outside the state. [Report to Congress, 1996]
- ITS/CVO technologies are predicted to deter tax evasion, which could save an estimated \$500,000 to \$1.8 million per State. [Report to Congress, 1996]
- Labor costs for administrative compliance are reduced significantly for medium and large-sized carriers using EDI, showing a benefit/cost ratio of 4:1 and 20:1, respectively. [American Trucking Association Foundation, June 1996]

Electronic screening benefits

- Washington State Department of Transportation (WSDOT) officials expect to reduce road and bridge damage from oversize/overweight loads through implementing multiple ITS technologies including roadway weigh-in-motion scales at electronic clearance stations, improved mobile enforcement systems, and an automated permit system. Within 10 years, WSDOT estimates the value of infrastructure costs avoided to reach a nominal 0.7 percent of overall infrastructure rehabilitation and preservation expenditures [“Draft Guidelines for Participation in the Commercial Vehicle Information Systems and Networks (CVISN) Deployment Program,” 1998]

- Carriers that pay their drivers by the hour can save time and money through reduced labor costs from electronic screening at weigh stations. Savings ratios are 3:1 to 7:1 for small carriers; 4:1 to 7:1 for medium-sized carriers; and 2:1 to 4:1 for large carriers. [American Trucking Association Foundation, 1996]

These benefits suggest that most ITS/CVO applications would pay off in benefits in a matter of a few years.

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