International Journal of Computer and Communication Technology

Volume 1 | Issue 1 Article 5

January 2010

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Abstract: Intelligent Transportation Systems (ITS) is the application of computers, communications and sensor technology to improve the efficiency or safety of surface transportation systems. The ITS initiative has been taken up by most developed countries including US, Canada, Australia and the European Union. This paper introduces ITS and its vision to save time, money and human lives. ITS can be applied to the entire spectrum of the transportation industry. This includes Freeway, Incident & Emergency Management, Electronic Toll Collection, Arterial Management, Travelers Information Systems, Advanced Public Transportation Systems, Commercial Vehicle Operations, etc. However the primary focus in this paper is on introducing the application of ITS technologies in the realm of Commercial Vehicle Operations (CVO). The paper covers the three major capability areas namely safety information exchange, electronic screening and electronic credentialing, giving details on the ongoing initiatives and the different technologies applied in the respective areas as well as the benefits offered by the same. The ITS initiative has caught up in a big way in the United States. The U.S. Department of Transportation (U.S. DOT) has sponsored and undertaken a program called Commercial Vehicle Information Systems and Networks (CVISN) Model Deployment Initiative (MDI). The goal of the CVISN initiative has been to assist each state in US to achieve "ambitious but achievable" level of deployment of ITS technology in all the three areas of commercial vehicle operations by establishing an organizational framework among state agencies and motor carriers for cooperative system development and creating a CVISN design architecture which can evolve and accommodate new technologies.

Keywords: ITS; CVO; CVISN; Safety Information Exchange; SAFER; CVIEW; Electronic Screening; Electronic Credentialing.

Reference to this paper should be as follows: Agrawala, S. and Kallianpur, H.(2009) 'Intelligent Transport Systems in Commercial Vehicle Operations ', *Int. J.CCT*, Vol.1 , No.1, pp. 27-35.

Biographical notes: Sunil Agrawala is a certified Project Management Professional (PMP) from PMI. He received a Master of Science degree in Computer Science from Florida Institute of Technology, USA with a CGPA of 4.000/4.000. He also has earned a Bachelor of Science degree in Electronics & Telecommunications from University College of Engineering, Burla, India. He has worked with giants like Cap Gemini USA, Keane, Satyam and HCL Technologies in the capacities of software engineer to Senior Program Manager. Sunil is also a visiting faculty at Xavier Institute of Management, Bhubaneswar Orissa. He has worked extensively in E-Commerce and HIPAA compliance solution development on J2EE platforms. This paper was written during his tenure at Satyam Computer Services Limited for presentation in intra company conference. Sunil is Director at Bharti Consulting.

Harish Kallianpur is currently working as an independent IT consultant in USA. He received a Bachelor of Engineering in Computer Science from The University of Mumbai in 2000. He has worked extensively on enterprise application development using J2EE platforms for fortune 100 clients. He has worked for more than 5

years with Satyam Computer Services Limited before becoming independent consultant. This paper was written for internal conference, while he was working with Satyam Computer Services Limited. While not coding Harish loves travelling places and gazing through his telescope.

1 Introduction

The growing demand to expand transportation capacity has put intense pressure on existing transportation infrastructure; moreover there are a lot of hurdles - social, political and economic in achieving the same. There is an ever-increasing need to deliver goods and passengers quickly and safely. All this has motivated the evolvement of newer concepts in transportation.

Intelligent Transportation Systems (ITS) apply well-established technologies in communications, control, electronics, and computer hardware & software to improve surface transportation system performance. ITS aims to transform surface transportation into an effectively managed, well integrated, universally available, customer-oriented and affordable system that ensures quick and safe movement of people and goods.

2 ITS in Commercial Vehicle Operations

The commercial motor carrier industry is a complex mix of businesses ranging from small owner-operators to huge fleets with thousands of vehicles transporting both goods and passengers. Trucking is more than $300 billion per year industry in US alone. The lifeblood of the economy depends on the ability of the transportation system to safely and efficiently bring products to market - everything from groceries, furniture and computers to hazardous chemicals.

ITS is used in commercial vehicle operations to help improve the commercial vehicle safety and regulatory processes and enhance the efficiency by continuously reassessing and adjusting the operations, both of the motor carrier industry and the state run motor carrier agencies. In this pursuit, ITS is significantly changing the way Federal and state agencies conduct business with the motor carrier industry.

ITS applied to commercial vehicle operations include the following:

1. *Safety Information Exchange Systems,* to facilitate the collection, distribution and retrieval of motor carrier safety information at the roadside.
2. *Electronic Screening Systems*, which allow commercial vehicles with good safety and legal status to bypass roadside inspection and weigh stations.
3. *Electronic Credentialing Systems* for electronic submission, processing, approval, invoicing, payment and issuance of credentials; electronic tax filing and auditing; and participation in clearing houses for electronic accounting and distribution of registration fee payments, fuel taxes etc. among states.

The infrastructure, framework and guidelines that links these information systems is known as Commercial Vehicle Information Systems and Networks, or CVISN (pronounced "see vision"). The various ITS systems for commercial vehicle operations can be logically conceived as systems for motor carrier industry users, systems used by the state agencies and core systems to be used at the national or regional level.

3 Safety Information Exchange

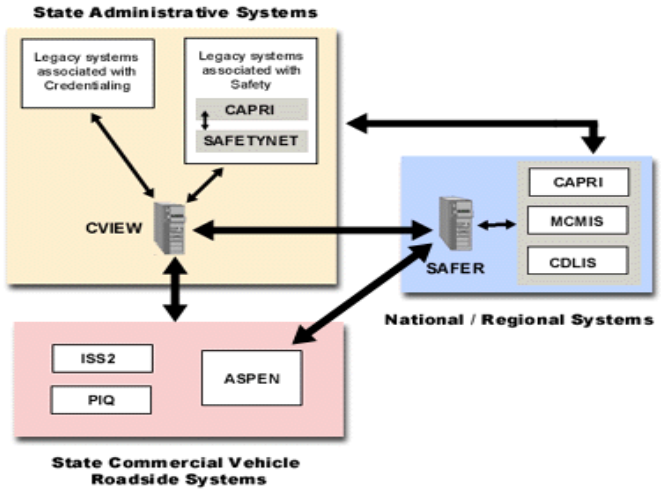
Safety information Exchange is the electronic exchange of safety data and supporting credentials information regarding motor carriers, vehicles, and drivers involved in commercial vehicle operations. This information is used by the enforcement community and the related agencies and organizations to take better-informed decisions based on historical safety performance information. Safety information

Exchange Systems facilitates the following:

- Automated collection of information about safety performance
- Augmentation of safety information with the automated collection of supporting credentials information
- Improved access to carrier, vehicle & driver safety and credentials information.
- Proactive updates of carrier, vehicle & driver safety and credentials information
- Support for programs that identify and encourage unsafe operators to improve their performance

In the US, safety information exchange systems have found widespread acceptance due to the numerous initiatives taken by the U.S. DOT and other federal and state agencies. As part of the CVISN initiative, the biggest breakthrough has been the development of two systems, namely SAFER and CVIEW, containing all the safety and credential information and providing them on demand to other systems. Figure 1 describes the overall connectivity between the various commercial vehicle information systems for safety information exchange.

Figure 1 Safety Information Exchange Systems



3.1 State Infrastructure Systems

- *Commercial Vehicle Information Exchange (CVIEW):* It is a system which provides a state with a single point access to its intrastate safety and credential information and acts as an interface between state legacy systems and SAFER (CVIEW equivalent at National or Regional level), integrating interstate & intrastate carrier safety data, driver and vehicle information, and a variety of carrier credentials and insurance data.
- *SAFETYNET:* It is a cooperative effort to share motor carrier information among states and FHWA - Federal Highway Administration (now FMCSA - Federal Motor Carrier Safety Administration). It comprises of information management software called SAFETYNET for entering/editing inspection reports and compliance reviews.

3.2 Core CVISN Infrastructure Systems

- *Motor Carrier Management Information System (MCMIS):* It is a central repository of motor carrier information maintained by the FMCSA. The system contains operational information filed by the motor carriers on the MC-150 form and safety /violations data. Based on the safety data received from SAFETYNET and the roadside, MCMIS generates safety-snapshot data,

[1] **Vehicle Tracking Loops -** Inductance loops used to track vehicle positions as they proceed through the site.

interstate carrier census and summary safety information, which it sends to SAFER on a weekly basis.

- *Safety and Fitness Electronic Records (SAFER):* SAFER is a federal system that provides standardized carrier & vehicle safety and credentials information to authorized users. The users are provided with either snapshots or detailed reports such as carrier profile and vehicle/driver inspection report as required. The SAFER Data Mailbox (SDM) facilitates the exchange of information between roadside sites and administrative canters by acting as a temporary repository for data files and messages.
- *Commercial Driver License Information System (CDLIS):* It is a database established by FMCSA, which permits states to share information regarding commercial driver's license. Individual State Department of Motor Vehicles (DMV) maintain their own CDLIS. Whenever information is requested, a pointer system maps the requests to the appropriate State DMV. The information can be either accessed via ASPEN (Roadside system) or through SAFER
- *Carrier Automated Performance Review Information (CAPRI):* CAPRI is an application that is used by federal and state investigators that captures and transmits Compliance Review (CR) information recorded during compliance reviews of carriers and hazardous material shippers to SAFETYNET. These onsite-reviews are carried out to ensure conformity of carriers to the Federal Motor Carrier Safety Regulations.

3.3 Roadside Systems

- *ASPEN:* It is data management software for electronic collection and dissemination of inspection data to state data management systems like SAFETYNET and national systems like MCMIS. This is used for conducting roadside/driver vehicle inspections and executes on palm-computers and police cruiser mounted laptops known as Mobile Data Terminals (MDT).
- *Inspection Selection System (ISS2):* It is an application, which helps safety inspectors target on high-risk carriers and avoid performing repetitive inspections on carriers with good safety performance records. It accesses identification and safety statistics on motor carriers based on the USDOT number issued by FMCSA
- *Past Inspection Query (PIQ):* It is an information retrieval application that allows federal and state law enforcement personnel to obtain past vehicle safety inspections on any vehicle regardless of where the inspection was performed. These 'past' inspections are saved in SAFER for a 60 day period and can be queried by PIQ via the SAFER Data Mailbox (SDM).

Figure 2 Roadside Safety Inspection

Safety assurance programs allow states to have electronic access to national safety data at the roadside. By having up-to-the-minute information, inspectors can identify safe carriers and focus limited resources on unsafe trucks and drivers.

The expected benefits from safety information exchange are:

- Improved safety performance
- Focusing government resources on high risk operators
- Providing carriers with better information to manage their safety programs.

4 Electronic Screening

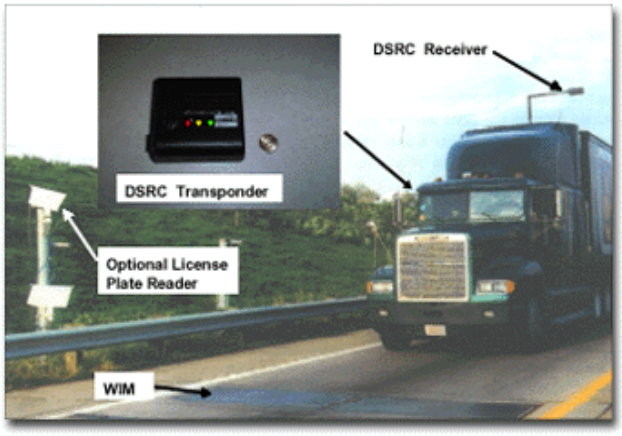
'Screening', in the context of Commercial Vehicle Operations, is a selection mechanism to target high-risk operators and make efficient use of weigh station and inspection resources. Electronic Screening, popularly known as e-screening is the application of different technologies to make more informed screening decisions resulting in improved traffic flow, increased safety and reduced operating costs. It allows certain commercial vehicles (i.e. with good safety and legal status) to by pass roadside inspection and weigh stations.

Different technologies used for Electronic Screening Systems are as follows:

1. *Dedicated Short Range Communications (DSRC):* DSRC provides data communications between a moving vehicle having a transponder
2. (electronic tag) mounted on them and the roadside reader equipment to support the screening process.
3. *Weigh in Motion (WIM):* WIM technology enables vehicle weights to be determined without the need for it to stop on a scale. High-Speed WIM enables trucks to be weighed at highway speed.
4. *Automatic Vehicle Classification (AVC):* AVC uses axle detectors to classify the various vehicle types at the WIM-equipped sites. This classification information is used to actually calculate the weight of the vehicle.
5. *Automatic Signing:* Lane signals and variable message signs are automatically controlled by roadside operations and are coordinated with the detected location of the vehicle. The vehicle locations are detected using Vehicle Tracking Loops[1].

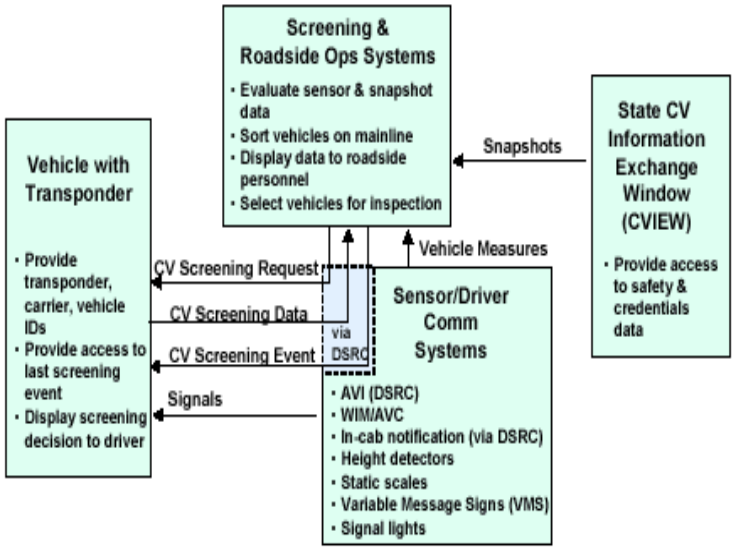
The various Electronic Screening systems are deployed at the roadside inspection sites as well as at the ends of the carriers and vehicles opting to participate in e-screening. All the different systems are deployed as per the CVISN framework. Figure 4 depicts the data exchange and communication between the different systems involved in Electronic Screening.

Figure 3 Electronic Screening Equipment



[1] **Vehicle Tracking Loops -** Inductance loops used to track vehicle positions as they proceed through the site.

Figure 4 Electronic Screening Overview



There are two aspects to effective implementation of Electronic Screening. Firstly, the states will have to make their roadside inspection infrastructure equipped with necessary screening systems. Secondly, the carriers desirous to opt for electronic screening of their moving vehicles will need to enrol themselves into different Electronic Screening programs of the states. This is facilitated to the carriers via a process called Electronic Screening Enrolment (ESE). Different programs namely HELP (Heavy Vehicle Electronic License Plate), NORPASS (North American Preclearance and Safety System), EZ PASS, and Oregon's Green light etc. already have many states as well as many motor carrier fleets participating in these screening programs.

Electronic Screening will offer tangible and time saving benefits both to the carriers as well as to the state agencies. The benefits vary by carrier type and operating practice. Test statistics show that it provides time saving to the participating carriers between 1.5 and 4.5 minutes per bypass. Smooth traffic and reduced inspection queues save the states the need and costs of building bigger weigh stations. Electronic Screening will also facilitate the vehicles to operate with the same equipment and similar rules as they travel from one state to the other.

Figure 5 Roadside Safety Inspections

Electronic screening enables states to identify, weigh and check safety and credentials for trucks at highway speeds. Drivers of safe and legal trucks are electronically notified of their status and directed past the station.

5 Electronic Credentialing

A credential is some form of evidence of meeting specified qualifications. It is issued by an authorized source and it entitles the holder to specified rights, privileges or authority. Operating a commercial vehicle requires many "credentials"; these credentials vary depending on the area of operations namely intrastate (single state) or interstate (multiple states).
Different credentials are required for carriers, vehicles and drivers, such as: Motor carrier registration, purchase of liability insurance, registration and title of vehicles, fuel taxes payments, oversize/overweight (OS/OW) permits, hazardous materials hauling permits (HAZMAT), Federal heavy vehicle use tax payments and compliance with other state-specific regulations.

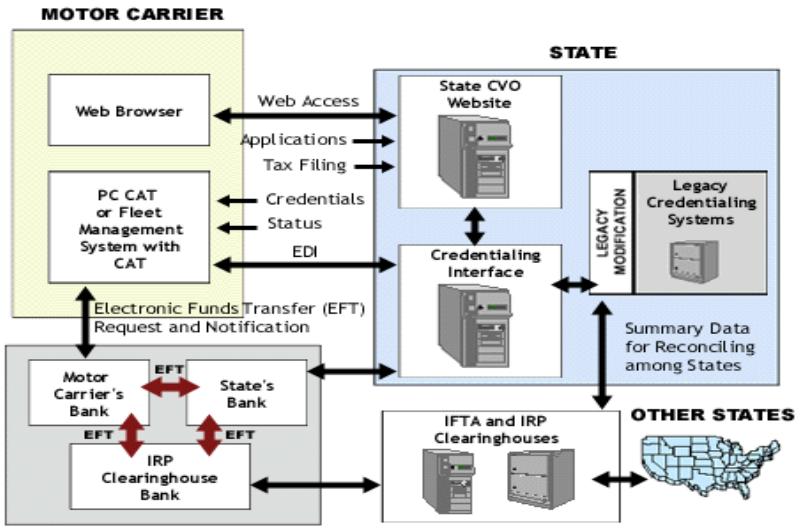
The state agencies need to administer and manage these credential requirements efficiently in order for commercial vehicles to legally operate on the roadways. The credential administration process includes managing:

- All aspects of applying for, reviewing, and granting commercial vehicle credentials; paying the associated fees
- Filing returns on fuel taxes, paying the associated taxes and fees
- Managing information about credentials and tax payment status, providing information to users
- Supporting base state agreements (International Registration Plan - IRP & International Fuel Tax Agreement - IFTA) and associated fee payment reconciliation amongst states for interstate carriers.

Earlier, most credentials were issued in paper form, with supporting records on file in the issuing jurisdiction's system. However an electronic credential is an electronic record of the credential and through electronic credentialing systems carriers can send credential applications and fuel tax returns to the state as well as receive electronic notification of their credentials status. Through the use of these systems electronic payment from carrier to state agencies and distribution of apportioned registration fee and fuel taxes to other states can also be undertaken.

Figure 6 describes how the different credentialing systems are connected to provide electronic credentialing.

Figure 6 Electronic Credentialing Overview



[1] **Vehicle Tracking Loops -** Inductance loops used to track vehicle positions as they proceed through the site.

Motor carriers can use the following options for electronic credentialing:

1. *Personal Computer Carrier Automated Transaction (PC CAT):* In this case the motor carrier or independent service provider uses stand-alone software that provides a user interface to enter application information and transmit/receive state responses via a personal computer using EDI standards.
2. *World Wide Web:* Here an applicant (motor carrier or independent service provider) uses commercial web browser software for access to a state or service provider's web site that accepts application information and forwards information to state systems.
3. *Fleet Management Systems:* Motor carriers can use their Fleet Management Systems to send messages to a Credentialing Interface (CI), which passes on the information to state legacy systems which in turn process the information and send back the response via Credentialing Interface.

Electronic credentials administration shall result in more efficient and responsive administrative processes for carriers and government agencies. Since data interchange among states, carriers, and other stakeholders will be electronic, it will be more timely, accurate, and less expensive. Credentials issuance, tax filing, interstate reconciliation, and audits will be automated to proceed more effectively and efficiently. Both administrators and enforcement personnel will have rapid, electronic access to required data. All this will result in better enforcement of registration, licensing, and tax regulations and better customer service to motor carriers and drivers.

6 Data Exchange Standards

Effective implementation of ITS in commercial vehicle operations calls for seamless integration of various user systems, state agency systems and the national level systems. This has already led to the development of various EDI based data communication standards for data exchange among these systems. With the growing use of internet, XML has also been used for information exchange.

7 Future Technologies

Vehicles will alert their drivers to potentially dangerous driving situations using in-vehicle technologies. Freight Mobility Systems shall improve how fleets are managed by providing links between drivers and dispatchers, thereby supplying up-to-the-minute information for planning, scheduling and vehicle routing.

Other technologies will identify impaired drivers and address reckless driving. A national network of transportation information will allow people to choose the best service to meet their travel needs, and fleet operators - truck or transit - to manage their systems better.

8 Conclusion

To achieve the overall efficiency in the area of commercial vehicle operations, both at the ends of the motor carrier industry users and the various state/federal motor administration agencies, it will become essential that all the different systems exchange information among them in a seamless manner by communicating in a standard way. This ever increasing need for saving time, money and human lives by improved efficiency in CVO has opened tremendous opportunities for the IT industry. It may not come as a surprise, if the federal US government comes up with some regulations for Commercial Vehicle Industry to make all their systems and communication between them compliant according to some standards similar to that of HIPAA regulations, which is for the healthcare industry. Presently, some targets have already been defined for all the states in the US to achieve certain level of ITS implementation in the CVO area.

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Some useful websites

Johns Hopkins University Applied Physics Laboratory: www.jhuapl.edu/cvisn
US Department of Transport: IT'S Initiative: www.its.dot.gov
Intelligent Transportation Society of America: www.itsa.org

[1] **Vehicle Tracking Loops -** Inductance loops used to track vehicle positions as they proceed through the site.