Opportunities for the Application of Intelligent Transportation Systems to Commercial Vehicle Operations (ITS-CVO) in the Prairie Region for Truck Safety Improvement

Jeannette Montufar, Ph. D., P.Eng., University of Manitoba
Robyn McGregor, P.Eng., EBA Engineering Consultants Ltd.

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ABSTRACT

Improving motor carrier and highway safety is a primary focus of many transportation agencies in Canada and the U.S. With the decreased building of new infrastructure, and the rapid growth of trucking activity in the two countries, it is important to develop innovative ways to improve highway safety as it relates to commercial vehicles. Due to the nature of trucking in the Canadian Prairie region, its safety performance may be impacted to a large extent by the application of intelligent transportation systems (ITS). Based on current knowledge about truck operations and safety in the region, it has been determined that there may be great opportunities for safety improvements, particularly regarding weather-related issues, seasonal weight regulations, and special permit operations in the region. This paper investigates the potential for the application of ITS to commercial vehicle operations in the Prairie region for improved truck safety. More specifically, the paper: (1) describes the trucking activity in the region; (2) presents the results of previous research about truck accidents on provincial highways in the prairies, including urban and rural areas; (3) discusses the Canadian ITS architecture, particularly its commercial vehicle operation component; and (4) identifies potential ways to improve truck safety by applying ITS to CVO in the region.

INTRODUCTION

According to the World Health Organization (WHO), road collisions are the 9th leading cause of death worldwide, with over 1.2 million people killed due to road traffic incidents in the year 2000 *(1)*. Fatalities due to road collisions are expected to rank third by the year 2020, surpassed only by heart disease and major depression (1).

In the U.S., road collisions are the leading cause of death for people between the ages of 5 and 29 (2). With over 75 percent of value-related trade between Canada and the U.S. being moved by truck, freight transportation is a large contributor to traffic on the roads where these fatalities and injuries are taking place.

Both Canada and the U.S. have specific goals geared towards the reduction in the number of fatalities and serious injuries involving commercial vehicles. In the U.S., for example, the Federal Motor Carrier Safety Administration (FMCSA) has a goal to reduce truck-related fatalities by 50 percent by 2010, and truck-related injuries by 20 percent by 2008 (3). In Canada, as part of Road Safety Vision 2010, the target is a 20 percent reduction in fatalities or serious injuries in accidents involving commercial vehicles by the year 2010 (4).

Applying this Vision 2010 initiative to heavy truck safety on provincial highways in the Prairie region, and assuming this outcome is directly linked to the frequency of heavy truck accidents (HTAs), the target means the following:

- That the number of heavy truck accidents on provincial highways will have to decrease by 20 percent, or about 250 HTAs per year by 2010; and

- That the HTA rate per million truck-kilometers traveled (TKT) on provincial highways will have to decrease by about 50 percent assuming continuing growth in truck traffic of four percent per year over the next 10 years, and the 20 percent reduction in HTAs in the region (as intended by this initiative).

This poses a challenging problem, particularly because not much new infrastructure is being built and there are limited resources to maintain the existing infrastructure in the Prairie region. This, coupled with the fact that trucking is very complex (the trucking industry is subject to strong economic pressures, is specifically regulated from the safety perspective, uses professional drivers, moves a wide range of commodities using different types of equipment, and in many cases, is multi-jurisdictional) may provide unique opportunities for the application of Intelligent Transportation Systems (ITS) to improve truck safety in the region.

This paper discusses trucking in the Prairie region, including truck safety issues in urban and rural areas, as well as regulatory issues. The paper also provides some potential applications of these technologies to improve truck safety performance.

TRUCK TRANSPORTATION IN THE PRAIRIE REGION

The Prairie region is comprised of a vast road network with over 65,000 km of provincial highways in the three provinces. Most of these highways have very low truck traffic volumes, meaning that most truck traffic moves on a few selected corridors (e.g., the Trans-Canada Highway, Highway 16—the Yellowhead Highway, Highway 2 between Calgary and Edmonton, and others). Highways with less than 400 trucks/day account for 80 percent of the road network and highways with more than 400 trucks/day account for 20 percent of the road network. Only 5 percent of the road network moves over1,000 trucks/day. In 1998 the total truck-kilometers traveled on provincial highways in the region was 3.5 billion (5). Figure 1 illustrates truck traffic volumes in the Prairie region and the U.S. The figure clearly shows the low-volume nature of the region, which is important to understand to be able to apply the most appropriate ITS technologies to improve truck safety.

This section provides an overview of truck transportation in the Prairie region, including commodity movements, weight regulations governing truck operations, and roadside safety inspection practices.

Commodity Movements

From its origins to today, the region's economy has been and will continue to be dependent on the efficiency of the freight transportation system. Trucking activity in the region accounts for almost 85 percent of value-related land trade to and from the U.S.

Manitoba-related trucking operates mainly to and from North Dakota, South Dakota, Minnesota, Illinois, and the north-eastern states. Saskatchewan-related trucking operates mainly to and from North Dakota, Minnesota, Wisconsin, Illinois, Texas, California, and the north-eastern states. Alberta deals mainly with western Canada-U.S. border states, California, and Texas (6).

According to the U.S. Transborder Surface Freight database, the following was observed in 2000 regarding freight movements to and from each of the Prairie provinces, by value:

- Major origins for northbound movements to Manitoba as measured by value were Pennsylvania (17 percent), Illinois (12 percent) and Minnesota (10 percent). Major destinations for southbound movements from Manitoba as measured by value were Minnesota (16 percent), Pennsylvania (11 percent), North Dakota (10 percent) and Colorado (10 percent).

- Major origins for northbound movements to Saskatchewan as measured by value were Illinois (16 percent), Texas (9 percent) and North Carolina (8 percent). Major destinations for southbound movements from Saskatchewan as measured by value were California (11 percent), North Dakota (10 percent) and Illinois (8 percent).

- Major origins for northbound movements to Alberta as measured by value were Texas (27 percent), California (18 percent) and Oklahoma (6 percent). Major destinations for southbound movements from Alberta as measured by value were New York (16 percent), California (12 percent) and Texas (11 percent).

The 10 most common commodities identified in the Transborder Surface Freight database moving to and from the Prairie provinces are: machinery and mechanical products, copper and products, vehicles, electrical machinery, jewelry, instruments and apparatus, paper and products, meat, aircraft and parts, and live animals.

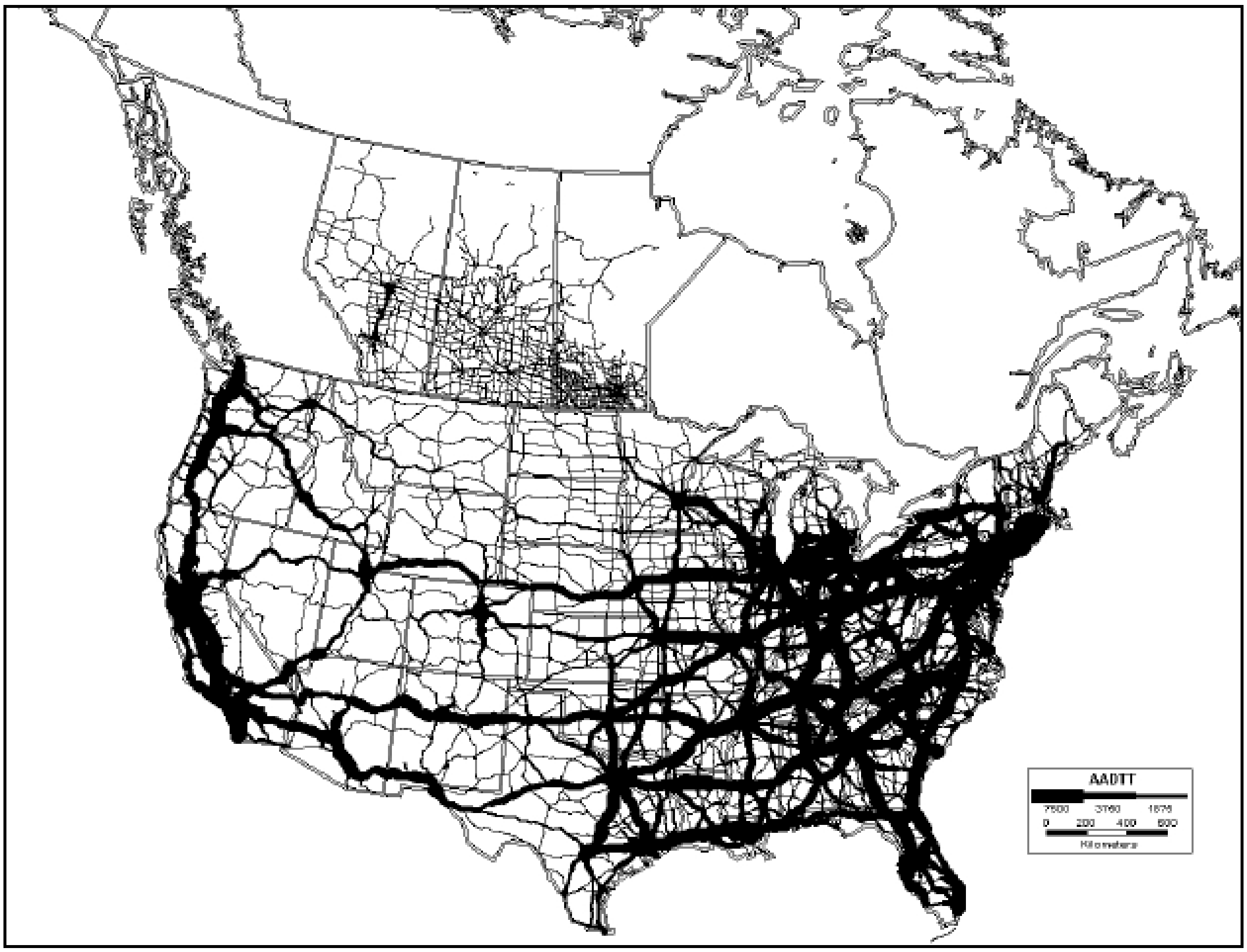

Figure 1. Commercial vehicle traffic in the Prairie region and the U.S.
Source: University of Manitoba Transport Information Group (UMTIG) based on state and provincial data

According to the international portion of the Canadian Council of Motor Transport Administrators (CCMTA) roadside survey, the following was observed in 1999 regarding freight movements to and from each of the Prairie provinces by tonnage *(6)*:

- For tonnage moving to Manitoba, major origins were South Dakota (57 percent), Minnesota (12 percent) and North Dakota (6 percent). Major destinations for southbound movements from Manitoba were North Dakota (25 percent), Minnesota (19 percent), Illinois and Texas (7 percent each).

- Major origins of tonnage moving into Saskatchewan were California (23 percent), Oregon (15 percent) and South Dakota (13 percent). Major destinations out of Saskatchewan were Montana (22 percent), North Dakota (16 percent) and California (9 percent).

- For tonnage moving into Alberta, major origins were California (24 percent), Washington (15 percent) and Oregon (12 percent). Major destinations for movements out of Alberta were Washington (21 percent), California (17 percent), Montana and Idaho (10 percent each).

The 10 most common commodities identified in the CCMTA roadside survey moving to and from each of the Prairie provinces are: cereal grains; agricultural products (not live animals); wood products; petroleum refining and coal products; vehicles; fuel oils; prepared foods; pulp, newsprint, and paperboard; fertilizers and fertilizer materials; and coal.

Size and Weight Regulations Governing Truck Operations

Over the last two decades there have been many changes in truck transportation in the region, including increases in truck size and weight limits, introduction of special permitting for the operation of long combination vehicles (LCVs), and changes in seasonal weight limits and the way they are applied. These changes have had an impact on both truck productivity and safety.

Long combination vehicles

The operation of long combination vehicles (LCVs) is allowed under special permit in the three provinces. These vehicles, which exceed the maximum allowable length, have been introduced by the industry to more efficiently transport bulky and low density freight over long distances. Some of the benefits associated with these vehicles are: lower transportation costs, savings in fuel consumption, reduced pavement wear, and lower truck exposure rates (fewer vehicles are required to move the same amount of freight). There are three types of LCVs: Turnpike doubles, Rocky Mountain doubles, and triple trailer combinations.

These vehicles operate under a set of very strict requirements to maintain a good level of safety. These requirements are similar in the three provinces, and they include: routing specifications, driver training and qualifications, equipment type and condition, weather conditions and time of day restrictions, speed control, and safety monitoring and evaluation.

From a safety perspective, it is important to continuously monitor the performance of these vehicles on the highways. There are many opportunities for the application of ITS to do this, particularly when it comes to operating speed, hours of work regulations, routing, and safety issues associated with weather conditions. These are discussed later in the paper.

Seasonal weight limits

Seasonal weight limits are an important aspect of truck transportation regulation in the region. Taking the region as a whole, seasonal weight limits are in effect at one place or another for a seven-month period, with winter weight premiums (WWPs) starting as early as December 1 and spring weight restrictions (SWRs) ending as late as June 30. Hence, for a significant period of time each year, SWRs and WWPs play a part in determining the region's trucking characteristics, volumes, and routing.

Winter weight premiums are weight limits which are applied during frozen periods in some systematic manner allowing truck operations at higher than basic weight limits without the use of permits. WWPs apply in the three Prairie provinces and bordering states of Minnesota and North Dakota.

A variety of WWP systems are used, varying both among and within jurisdictions. They include: (1) a constant percent increase system, sometimes capped by the basic GVW limit and sometimes uncapped; (2) a flat axle weight increase system (e.g., 1,000 kg per axle group in Alberta); and (3) the up-class system used in Manitoba, where a low basic weight class road (e.g., B1) is increased to a higher basic weight class road in winter (e.g., "seasonal" RTAC).

Spring weight restrictions are weight limits applied during spring thaw periods in some systematic manner restricting truck operations to lower than basic weight limits.

As with WWPs, a variety of SWR systems are used throughout the region: (1) percentage of the basic axle load; (2) specified axle load; (3) reduced tire loading per unit width (Saskatchewan); (4) a down-class system in Saskatchewan (the reverse of the WWP up-class method); and (5) commodity and time of day effects (Manitoba) *(7)*.

Manitoba is the only jurisdiction that uses a totally fixed-time system for controlling seasonal weight limits. In Manitoba, WWPs are in effect from December 1 to the last day of February of the following year and SWRs are in effect from March 23 to May 31 of each year. The other jurisdictions use mixtures of fixed and variable timing. The intensity of SWR levels varies widely from jurisdiction to jurisdiction, and from road to road. However, there are three basic categories: c 90 percent of basic, c 75 percent of basic, and c 65 percent of the basic weight regulations *(7)*.

Premium weight allowances in winter provide opportunities to increase truck productivity and lower shipping costs for dense commodities. In doing so, they can attract certain freight movements to periods of higher strength frozen pavement conditions from lower strength (thawing or normal) periods. This can be beneficial to reducing the rate at which infrastructure deteriorates in serving its function of handling required freight movements. By the same token, reduced loading on certain roads during spring thaw helps reduce inordinate deterioration often associated with weak pavement and/or subgrade conditions *(5)*. Some of the safety implications of this are the following:

In the winter, WWPs result in many lower-grade secondary roads handling larger, heavier trucks, and with fixed-time implementation systems like the one in Manitoba, these heavy truck operations may take place when the pavement structure is not yet frozen, resulting in potentially unsafe situations. In the spring, restrictions could result in more extensive travel distances, particularly in jurisdictions that use fixed-time implementation systems. This would increase exposure due to longer travel distances, resulting in potentially undesirable situations from the safety perspective.

Roadside Safety Inspections

Roadside safety inspections are conducted in the Prairie region as part of the National Safety Code (NSC). These inspections consist of a uniform inspection process developed by the Commercial Vehicle Safety Alliance (CVSA) using the North American Uniform out-of-service (OOS) Criteria. There are 14 critical items (one of which applies only to buses) used as the OOS criteria during the safety inspection of a commercial vehicle. An OOS defect is a mechanical condition or loading so imminently hazardous as to likely cause an accident or breakdown. The 13 truck-related items included in the OOS criteria are: (1) brake systems; (2) coupling devices; (3) exhaust system; (4) frame; (5) lighting equipment; (6) load securement; (7) steering mechanism; (8) suspension; (9) tires; (10) trailer bodies; (11) wheels and rims; (12) windshield wipers; and (13) fuel system.

There are five different levels of CVSA inspections:

- Level I is a complete inspection of the vehicle and driver, including an inspection of the items underneath the vehicle.
- Level II is a complete inspection of the vehicle and driver that does not include inspecting the items underneath the vehicle.
- Level III is the inspection of the driver only.
- Level IV is an inspection of specific item(s) on the vehicle or driver.
- Level V is an inspection of the vehicle at the motor carrier's terminal.

One of the challenges associated with conducting these inspections is the climatic conditions of the Prairie region. Previous research has shown that in Manitoba and Saskatchewan, less than one in 20 of all level I inspections (the most intensive inspection type, and the only type of inspection capable of identifying the most common vehicle defect—brakes out of adjustment) take place in the winter (December to February) *(5)*. These inspections are mainly conducted in June, July, and August (about 60 percent). Knowing that the NSC "forms the basis of a national safety regime", it is important to implement innovative ways to conduct these inspections throughout the year, in a more efficient and effective manner.

HEAVY TRUCK ACCIDENTS IN THE REGION

A comprehensive analysis was conducted about heavy truck accidents in the Prairie region between 1993 and 1998 *(5)*. The research considered 14,838 heavy truck accidents over a period of 6 years in the three provinces (including their major urban centers). A heavy truck was defined as any articulated combination using a truck-tractor for propulsion. Such combinations include two and three-axle tractors with a single, tandem or tridem-axle semitrailer; a double trailer combination; or triple-trailer combination. This also includes truck-tractors with no units attached.

The following points present the highlights from the research.

- Of the 14,838 HTAs considered in the research, one half occurred on provincial highways, and one half occurred in urban areas.

- Heavy trucks were involved in a disproportionately high number of fatal accidents. Although they only accounted for 10 percent of all vehicle-miles traveled in the Prairie region, heavy trucks were involved in 18 percent of all fatal accidents on provincial highways. Comparatively, in the U.S., large trucks account for seven percent of all vehicle-miles traveled, and were involved in 13 percent of the fatalities in 1998 *(8)*. In urban areas, HTAs accounted for six percent of all fatal accidents. Comparative travel data is not readily-available for these areas.

- Four percent of all heavy truck collisions that occurred on provincial highways in the Prairie region resulted in a fatality, compared to less than one percent of HTAs in urban areas. More than one-quarter (28 percent) of all HTAs that occurred on provincial highways resulted in injury, compared to 15 percent in urban areas.

- There were more multiple-vehicle HTAs in urban areas than on provincial highways in the prairies. Nearly nine of every 10 HTAs in urban areas were multiple-vehicle accidents, compared to about six of every 10 on provincial highways.

- The most commonly-reported contributing factor for HTAs on provincial highways was environmental conditions (reported in 42 percent of all HTAs), whereas in urban areas it was human action (reported in 45 percent of HTAs).

- Both for HTAs occurring in urban areas and for HTAs occurring on provincial highways, adverse road surface conditions (wet, snow, ice, slush) accounted for approximately 40 percent of all heavy truck accidents in the region. On provincial highways, the four months of November to February accounted for approximately one-half of HTAs in the region.

- HTAs on provincial highways and in urban areas are concentrated on selected road sections and at selected intersections. Such concentrations suggest that there may be opportunities to improve the HTA situation in these areas by implementing intelligent transportation systems.

- Regarding HTA rates, the research found that when all HTAs are considered, the heavy truck accident rate is lower on divided highways than on undivided highways in the region (0.31 HTAs per million TKT on divided highways, and 0.35 HTAs per million TKT on undivided highways). However, when intersection HTAs are removed from the analysis, the HTA rate is about the same for divided and undivided non-urban highways in the region (0.24 HTAs per million TKT for divided and 0.25 HTA per million TKT for undivided highways).

- The temporal distribution of HTA rates based on traffic exposure is interesting. In Manitoba, the HTA rate is 2.24 times the summer rate and 1.77 times the spring/fall rate. Similarly, there are large differences in the time of day HTA traffic-based exposure rate, with the average evening/nighttime rate being about 60 percent higher than the average morning/daytime rate.

WHAT IS ITS-CVO AND HOW CAN IT HELP IMPROVE TRUCK SAFETY?

Infrastructure development for surface modes of transport will not be able to keep pace with the increasing demand. In developing new infrastructure or in the continued use of the existing infrastructure, there must be ways to maximize the capacity, make operations more efficient and above all, provide improved safety for all road users. Intelligent Transportation Systems (ITS) provide the opportunity to integrate travelers, vehicles, and infrastructure into a comprehensive system through a range of technologies that supports these functional requirements for a system that is increasingly under demand.

Compliance and enforcement are of significant importance in safe commercial vehicle operations. When truckers are able to avoid regulation and enforcement, the potential exists for unsafe drivers and trucks to remain in operation compromising the safety of all road users *(9)*. Systems that can enhance the coverage of potentially maximized inspection and enforcement services, as well as make inspection and reporting processes more efficient for commercial operators are likely to support an increase in overall compliance to local regulations and therefore result in an increase in road safety for all users.

ITS cannot be pursued as a collection of independent applications. Interoperability of CVO systems is preferred so each commercial vehicle does not need to carry more than one system and data can be utilized in each region of travel *(10)*. Public-private partnerships and interagency coordination (across jurisdictional borders) will be very important in the successful deployment of ITS for commercial vehicle operations. Pursuing ITS within an overall framework or architecture that is developed within the ITS Architecture for Canada can assure integration and interoperability of systems.

The ITS Architecture for Canada was launched by the Federal Government in September 2000 and is a product of the ITS Plan for Canada entitled “En Route to *(11)*. Intended as a guideline or a tool for use by transportation professionals in the development of unique regional ITS architectures and integrated deployment of ITS initiatives, the ITS Architecture for Canada is:

- A framework to identify components and interconnections between functions, for standardization and to ensure products and services are compatible.

- A common language or vocabulary to better communicate the required activities or functions.

- A guideline to facilitate deployment by Canadian transportation providers and to identify opportunities for integration *(12)*.

Largely based on the National ITS Architecture in the United States, the ITS Architecture for Canada reflects the needs for conformity and integration across our common trade and transportation corridors but it also reflects the unique features of Canada. These would include enhanced roadway and fleet maintenance features for winter operations, as well as intermodal container and intermodal terminal operations given the sea/air/surface modal transfers in our commercial shipping operations. Many of these new aspects are currently being adopted into the U.S. National ITS Architecture.

System architectures are primarily based on services required to fulfill the needs of stakeholders or users of the system. In the ITS Architecture for Canada, there are eight user service bundles or categories of like services that are required by the system users. These user service bundles reflect the major areas for applying ITS services and describe the functions and objectives rather than the specific system technology applications. To categorize functions in further detail, within the eight user service bundles, there are 35 user services, and 90 user subservices. One of the eight user service bundles is Commercial Vehicle Operations, which is concerned with the application of technology to better manage and service the freight industry while maintaining a high level of safety and cost efficiency. This bundle is specifically described by the user services and subservices shown in Table 1.

Each user service and user subservice describes the functions or services that are required to fulfill a specific stakeholder need, and references are made to other components of the architecture (processes, dataflows, market packages, etc.) that reflect components or activities in the actual Intelligent Transportation System that should be integrated.

The application of ITS-CVO in a coordinated and integrated manner will provide opportunities for enhanced truck operations, and will also help improve truck safety through more efficient enforcement, fleet management, permitting and other functions.

Table 1. User services and subservices included under ITS-CVO

User Service	User Subservice
Commercial Vehicle Electronic Clearance	Electronic Clearance
	International Border Crossing Clearance
	Weigh-In-Motion (WIM)
Automated Roadside Safety Inspection	Inspection Support Systems
	Automated Vehicle Safety Read Out
On-Board Safety Monitoring	On-Board Safety Monitoring
Commercial Vehicle Administrative Processes	Commercial Vehicle Administrative Processes
Intermodal Freight Management	Freight In-Transit Monitoring
	Intermodal Interface Management
Commercial Fleet Management	Fleet Administration
	Freight Administration
	CVO Fleet Maintenance

POTENTIAL ITS-CVO APPLICATIONS FOR IMPROVED TRUCK SAFETY

ITS-CVO applications are already in place throughout North America and other parts of the world. Significant study and documentation is underway to quantify the benefits of these applications in terms of safety and infrastructure preservation.

Many Canadian jurisdictions, including the Prairie provinces, are either in the process, or have already developed ITS strategic plans for their transportation system operations. Many of these plans have large CVO components, mainly because trucking forms an integral part of the economy of these jurisdictions.

In terms of the Prairie region, there are many unique characteristics that warrant special ITS-CVO applications to improve truck safety. These applications can address the issues discussed in the previous sections. For example, there is a need for action in the urban truck safety area. There are also opportunities for improved truck safety through the implementation of technologies that address winter time problems. This section presents some potential ITS applications, specific to the needs of the Prairie region, which could help improve truck safety in the region.

Seasonal Weight Limits

Regarding seasonal weight limits, advanced technologies can be used to develop a condition-based approach to implementing seasonal weight limits in the region. A network of technologies such as frost probes, and soil moisture sensors can be implemented to monitor and forecast pavement and subgrade conditions for the management of seasonal weight limit restrictions. This network can also use information resulting from road weather information systems regarding air temperature, humidity, wind speed and direction, precipitation, and road surface temperature. In addition to safety benefits due to reduced unnecessary travel due to spring weight restrictions, and reduced operation of heavier vehicles on lower-grade secondary roads, the implementation of these technologies will also help reduce pavement maintenance costs due to reduced damage to the highway infrastructure, and increase motor carrier productivity.

Special Permitting of LCVs

Special permitting offers much potential for the application of ITS, particularly to monitor compliance with permit requirements. Equipping LCVs with computerized on-board route management and recording systems for continuous tracking, and vehicle and driver safety monitoring can help highway agencies and motor carriers evaluate the safety performance of each vehicle (on each trip) and the operation in general, hence improving the safety of these operations. The use of on-board computers to record engine operations and time for each trip can also be used to audit hours of operation and operating speed for these vehicles after the trip.

With special permitting, it is important to have ready access to the location of each vehicle at any point in time. Most trucking companies are now using satellite systems for fleet management. This technology can very well be used as a way to improve safety by providing timely information about the location of vehicles involved in incidents.

One technology from which LCVs can benefit is on-board roadway environmental sensing and road/weather information systems. This technology will enable drivers to operate in a reasonable and prudent manner, having regard for road and weather conditions. This is particularly important given the special conditions included in these permits regarding operations under adverse weather conditions.

Winter Driving

In the Prairie region, there is a need for ITS applications to address the winter/summer and day/night safety issue. The use of road and weather information systems (RWIS) can help improve truck safety as it relates to winter driving, particularly at night. Real-time information about weather and road surface conditions is critical in the prairies, particularly due to the rural nature of the region (with sparsely populated land and long travel distances), and the special climatic conditions. ITS could be used for monitoring and forecasting weather and road surface conditions, and can help with the implementation of an intelligent road maintenance strategy to reduce truck accidents. RWIS can also be used in urban areas for improved truck safety.

Roadside Inspections and Truck Enforcement

There are many potential applications for improved truck safety through more efficient and effective enforcement practices.

The first application involves using a network of weigh-in-motion (WIM) devices and automatic vehicle classifiers (AVCs) for improved enforcement of weight and safety regulations. Telephone lines or wireless communication technology can be used to link these data collection sites with a central enforcement office (or weigh station). Deployment of enforcement resources will take place based on the screening of the information.

Another potential application is the installation of remote monitoring systems that capture images of the vehicles and their identification number. These images can then be transmitted to a nearby weigh/inspection station where the information can be assessed. If and when it is determined that the operator does not have the appropriate registration or a history of non-compliance, an officer can be dispatched. The state of Kentucky has already installed this technology to improve the effectiveness of commercial vehicle regulation and enforcement on roadways that are not monitored by existing weigh/inspection facilities. The state found that the low cost and high capabilities of this application extended Kentucky's enforcement presence to a greater proportion of the state roadways *(9)*. This application functions on the assumption that all motor carrier records are readily-available, electronically, at weigh/inspection stations, and possibly on laptops in patrol vehicles. This is not necessarily the current situation in the Prairie region. Work has been done in the three provinces to fully automate the enforcement process, including roadside inspections, but there is still more to be done. This is then another potential application of ITS to CVO for safety improvement.

The use of special cameras or sensors to conduct roadside inspections in the winter could be beneficial. Of course, the most reliable way to check brake adjustment is by going underneath the vehicle. However, there may be technology that can be used to check brake adjustment without having to go underneath the truck. This technology could be used in the winter, and the conventional method could be applied during other times of the year.

Highway Operations and Truck Safety

The accident analysis showed that there are strong concentrations of accidents on particular road sections and at particular intersections. Many of these accidents are due to adverse road surface conditions. However, some are due to a combination of driver behavior and road design deficiencies. Curves with small radii, particularly at exit ramps present a significant problem for large trucks. Also, steep grades, as is the case in Alberta, present a problem for inexperienced drivers.

There are technologies that could be implemented to warn drivers about hazardous situations involving the operation of their vehicles at these particular locations. Two of the most common technologies have been developed by a Saskatchewan-based company. The first technology uses WIM devices and sensors to determine potential rollover conditions based on vehicle weight, type, speed, deceleration, and road geometry. A targeted warning is given to drivers in critical situations. The second warning system targets truck drivers that are operating at a speed higher than the desirable for the specific road conditions and truck characteristics when entering a steep and long downgrade. The system determines a safe speed for a heavy truck on steep downward slopes. The safe speed varies considerably depending on the truck's weight and configuration, and the length and grade of the slope. This warning system also uses weigh-in-motion devices to detect vehicle speed, weight and configuration. When the controller determines that the truck speed is too high for the given slope, the system illuminates a warning message for the driver.

Urban Truck Safety

There are a number of ITS applications or technologies that could be utilized in urban areas to improve safety with respect to commercial truck traffic on these roadways. Dynamic message signs that warn of rollover potential for trucks traveling at excessive speeds on curved ramps (as discussed in the previous section), or similar message signs that warn of high load collision potential for specific vehicles in the vicinity of urban overpasses. All these provide the opportunity for commercial vehicle operators to change their behavior as needed and avoid an incident.

Real time traffic and traveler information reporting on incidents, work zones, or congested arterials combined with computer aided dispatch or re-routing through urban and commercial areas can reduce the increased exposure of light vehicles to truck traffic.

In addition to these applications, some of the other applications discussed in this section can also be applied in urban areas for improved truck safety.

Hazardous Materials Incident Response

The Prairie provinces could benefit from the implementation of a hazardous materials incident management system to provide immediate emergency response when needed. This would help reduce the severity of collisions involving hazardous materials, particularly in rural areas.

Currently, there are technologies that allow for more efficient incident management response by providing timely and accurate information about cargo contents and location due to the tracking capabilities of the technology. These technologies can be applied to operations in both rural and urban areas.

CONCLUDING REMARKS

Governments throughout North America are committed to achieving large reductions in the absolute frequency of heavy truck collisions. That goal, combined with expectations of large growths in truck traffic, implies significant attendant decreases in truck collision rates. Applying ITS to commercial vehicle operations offers many benefits to engineers and others charged with improving motor carrier safety. However, just as there are benefits to using ITS, there are also constraints, many of which are easily overcome.

One reality that must be considered when thinking about applying ITS-CVO is that many trucking firms are small to medium sized in operation and therefore technology must be affordable. There are also data confidentiality issues, as well as data ownership issues. Another constraint involving the application of ITS-CVO is the standardization of available technology. There is much work already being done in all of these areas.

This paper discussed trucking in the Prairie region, including truck safety issues in urban and rural areas, as well as regulatory issues. The paper also provided some potential applications of these technologies to improve truck safety performance. It is important to remember that interoperability of ITS-CVO across jurisdictional boundaries is essential and must satisfy both the technical and institutional conditions. Public-private partnerships and cooperation among many agencies will be required.

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