ITS Technologies for Commercial Vehicle Compliance in the Maritimes

Randy Hanson, Executive VP and COO, IRD Inc.

Rod Klashinsky, VP Sales & Special Projects, IRD Inc.

Scott McGibney, Technical Specialist, IRD Inc.

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ABSTRACT

Commercial vehicles are the lifeline for many communities with respect to the transport of goods and services. Commercial vehicle weights and dimensions, credentials, and inspections are essential to ensure that the highways are made safer and the roadway infrastructure is protected from truck overload damage. ITS (Intelligent Transportation Systems) assists with these processes to improve safety, increase efficiency and productivity, reduce pavement damage, and decrease air pollution. This paper explains how ITS technologies are used in the Maritime Provinces to accomplish these objectives.

This paper reviews operational systems in New Brunswick, Nova Scotia and Newfoundland and Labrador. The ITS technologies include Weigh-In-Motion (WIM), License Plate Cameras (LPC), Side View Cameras (SVC), and tracking sensors. Mainline WIM Systems are examined in New Brunswick and Nova Scotia, and Virtual Weigh Stations (VWS) are discussed with respect to Newfoundland and Labrador.

The Mainline WIM Systems screen commercial vehicles on the main highway and vehicles which exceed weight limits are directed into the Vehicle Compliance Stations for further weighing and checks. Vehicles are tracked by sensors and cameras to ensure that the vehicle operators are following instructions.

In Newfoundland the VWS installation is used for long term monitoring and control of potential violators and to collect WIM data on commercial vehicles. The vehicles are weighed as they travel across WIM Sensors and images are captured by License Plate Cameras and Side View Cameras.

All of the foregoing systems fit into a strategic plan by each province to manage commercial vehicle traffic efficiently, decrease congestion and improve safety.

ITS (Intelligent Transportation Systems) assists with these processes to improve safety, increase efficiency and productivity, reduce pavement damage, and decrease air pollution.

INTRODUCTION

Weigh In Motion (WIM) systems can serve a wide variety of roles within the scope of Intelligent Transportation Systems: as a sorter to decide which vehicles report to an inspection station and which can bypass it, as Virtual Weigh Stations which can monitor traffic and display vehicle weights, images and compliance. over an Internet connection to a valid user anywhere in the world, as a WIM Data Collection system for gathering detailed weight and dimension data for long term analysis. Each of these functions can play a part in improving highway safety, increasing efficiency and productivity, reducing pavement damage, and decreasing air pollution.

Vehicles in violation of speed, weight and dimensional regulations pose a safety hazard. Speeding and overweight vehicles have an increase stopping distance, reduced maneuverability and are more prone to mechanical breakdown. By allowing compliant trucks to bypass inspection stations, a WIM sorting system reduces congestion by decreasing the number of heavy vehicles exiting to and merging from the inspection station.

The monitoring of commercial vehicle traffic weights is important because there is an exponential relationship between truck axle overloading and pavement damage [1].

Furthermore, as active enforcement of overloaded trucks increases, non-compliance with truck loading regulations decreases [2].

With conventional weigh stations, heavy trucks are directed to pull into an inspection station and stop for inspection. When heavy trucks can continue on the highway unimpeded, there is a significant reduction in vehicle emissions and fuel consumption, as compared with the acceleration and deceleration pattern which is typical of a conventional weigh station interaction [3].

In addition to the financial savings realized from longer pavement life and reduced maintenance, there is an additional, less obvious environmental gain due the saving in energy and emissions that would have been required to repair or reconstruct the roadway.

Unlike conventional weigh stations, WIM systems make uninterrupted highway travel possible for trucks that are compliant with weight and dimensional regulations. Studies have shown that WIM Systems reduce the percentage of overloaded trucks [4], thereby diminishing excessive vehicle emissions and damage to pavement infrastructure.

NEW BRUNSWICK AND NOVA SCOTIA

System Overview

The Mainline WIM Systems screen commercial vehicles on the main highway; vehicles which may exceed weight limits are directed into the Vehicle Compliance Stations for further weighing and checks and compliant vehicles are allowed to bypass the inspection station.

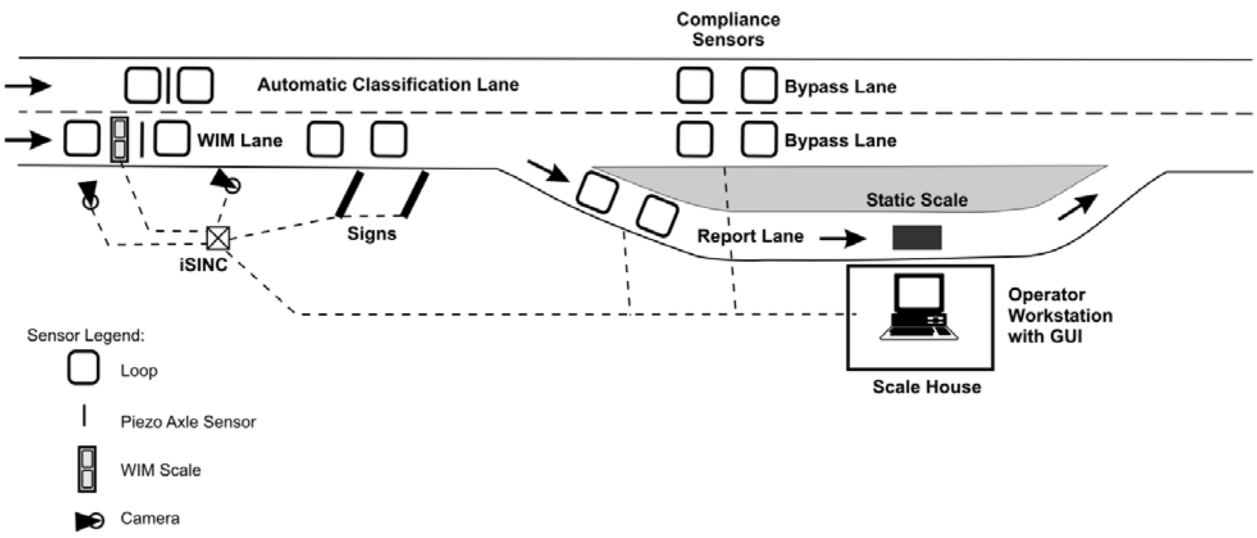

Figure 1 - Typical NB/NS Weigh Station Sorting System Layout

Vehicles are tracked by sensors and cameras to ensure that the vehicle operators are following instructions.

Figure 2 - WIM Sensors, Longs Creek, NB

Figure 3 – Camera, Overheight Sensor and Electronics Cabinet, Deerwood NB

The New Brunswick and Nova Scotia Weigh-In-Motion Systems weigh and classify commercial vehicles as they travel at highway speeds. All data collected is automatically evaluated and compared with legal load limits in real time. If the vehicle is found to be compliant, the driver is given a signal to bypass the weigh station without stopping. If the vehicle may be non-compliant, the driver receives a signal to exit the highway and report to the weigh station for further processing. The vehicle sort decision is communicated to the vehicle operator by means of message signs which automatically display the appropriate message, indicating when the vehicle must report to the weigh station or may remain on the mainline highway and bypass the inspection station.

Figure 4 - Controllable Message Sign, Salisbury, N.B.

Data collected from each commercial vehicle that passes over the Weigh-In-Motion (WIM) scale includes gross vehicle weight, axle weights, axle spacings, vehicle classification, speed, date and time of vehicle passage, overall length, number of axles, axle configuration, overheight and any errors that are detected during the WIM processing. This information is used to determine in real time vehicle compliance or non-compliance. The data record for each vehicle is stored for later analysis and used for planning and management of traffic systems.

To effectively track individual vehicles, License Plate Cameras (LPC) near the WIM scale location capture an image of the vehicle license plate for vehicles travelling in either lane. Side view cameras capture an image of the overall vehicle for vehicles travelling in either lane. Typically, one camera is located near the WIM scales and captures overview images of commercial vehicles travelling in the left lane (thus avoiding the WIM scales). The second camera is mounted near the first Changeable Message Sign (CMS) and captures overview images of vehicles as they pass over the inductive loop which triggers the message display.

The station operator interface is a computer workstation running a Microsoft Windows® operating system and provides information in both graphical or text format.

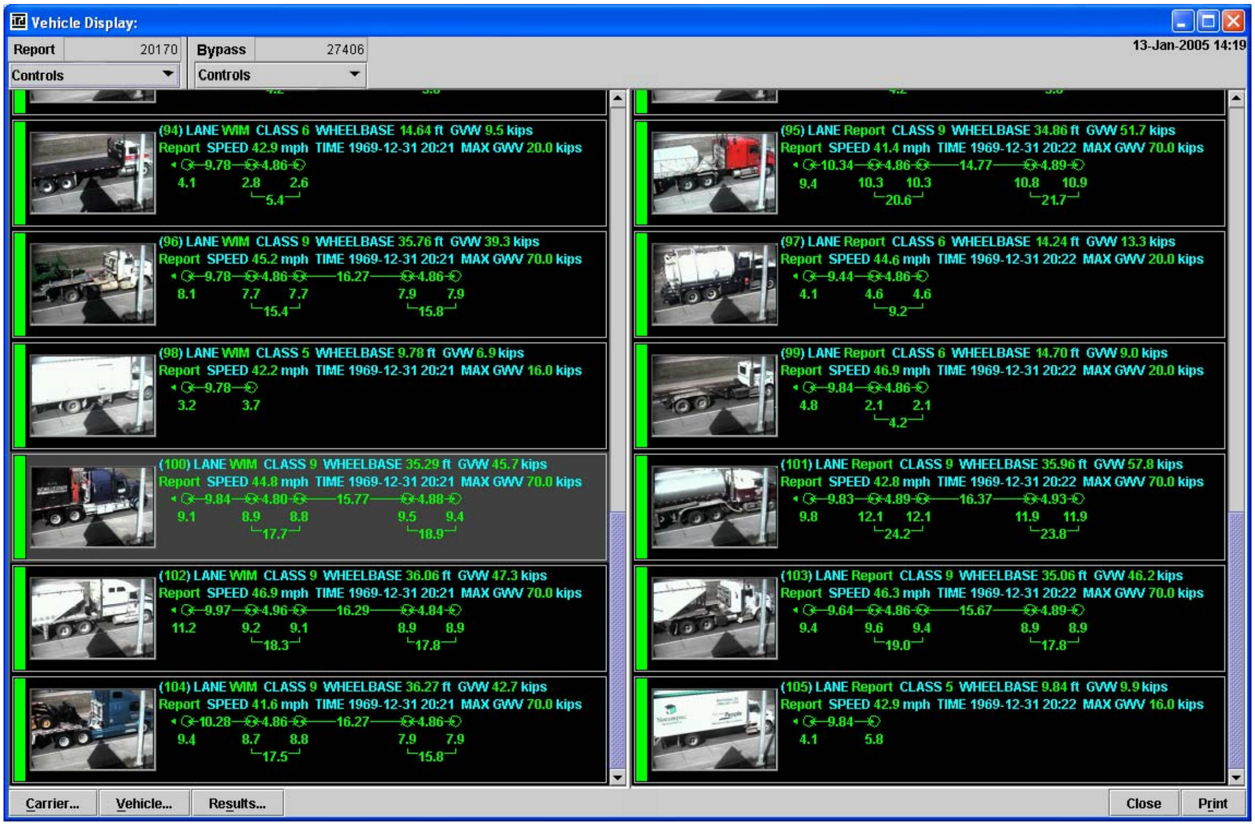

Figure 5 - Operator Workstation Display

The station inspector can call up a detailed record for any vehicle on the display, as shown in the example in Figure 6 - Operator Vehicle Record Display.

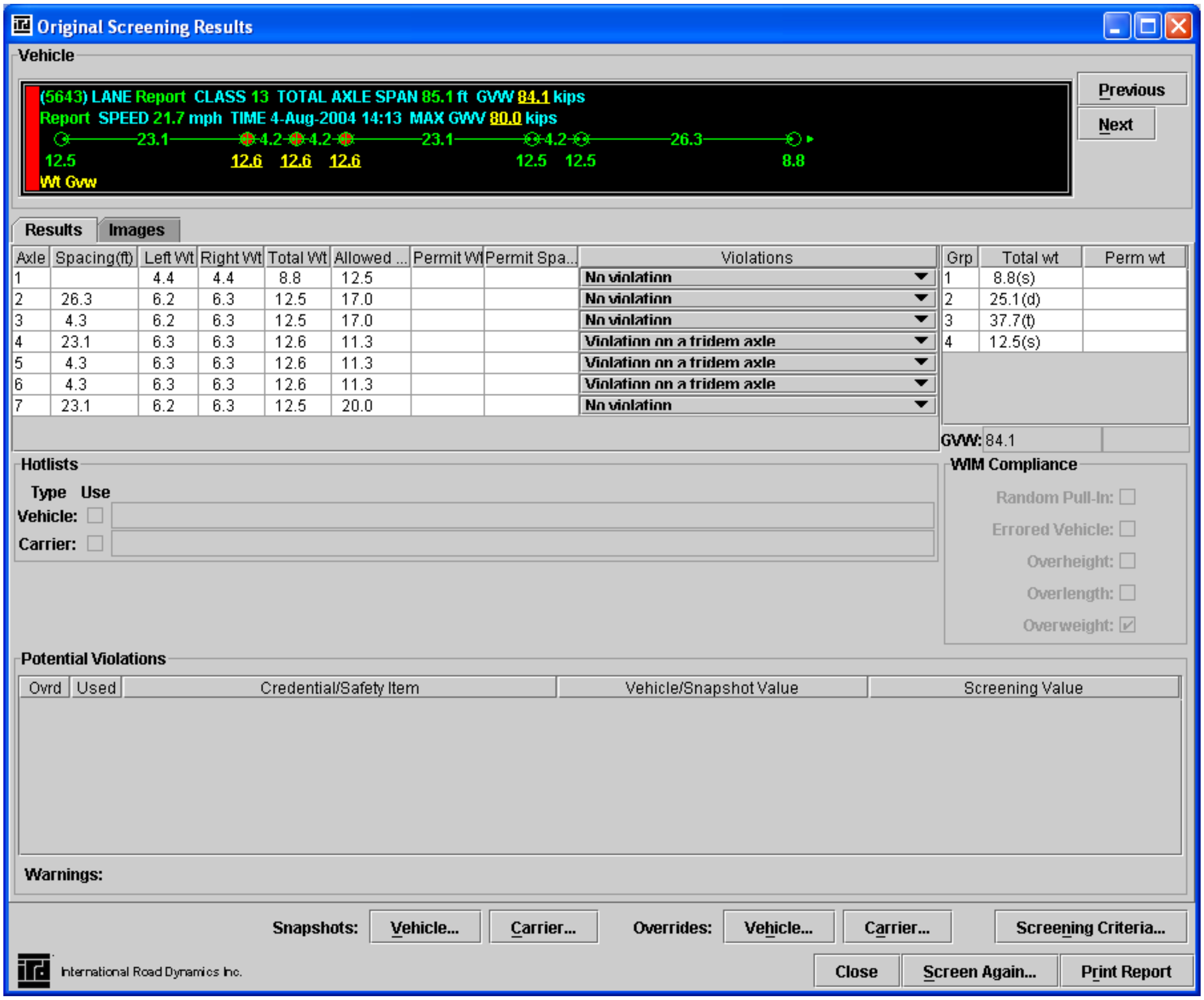

Figure 6 - Operator Vehicle Record Display

The system's compliance threshold, sign activation, random sorting percentage, calibration parameters etc. are all adjustable from the workstation. The system is accessible over a dial-up connection for downloading of vehicle data records that have been collected and for remote diagnostics and trouble shooting.

There are Mainline High Speed WIM sorting sites in New Brunswick located at Salisbury, Deerwood, Waweig, and Longs Creek, and in Nova Scotia at Enfield, Kelly Lake and Aulds Cove:

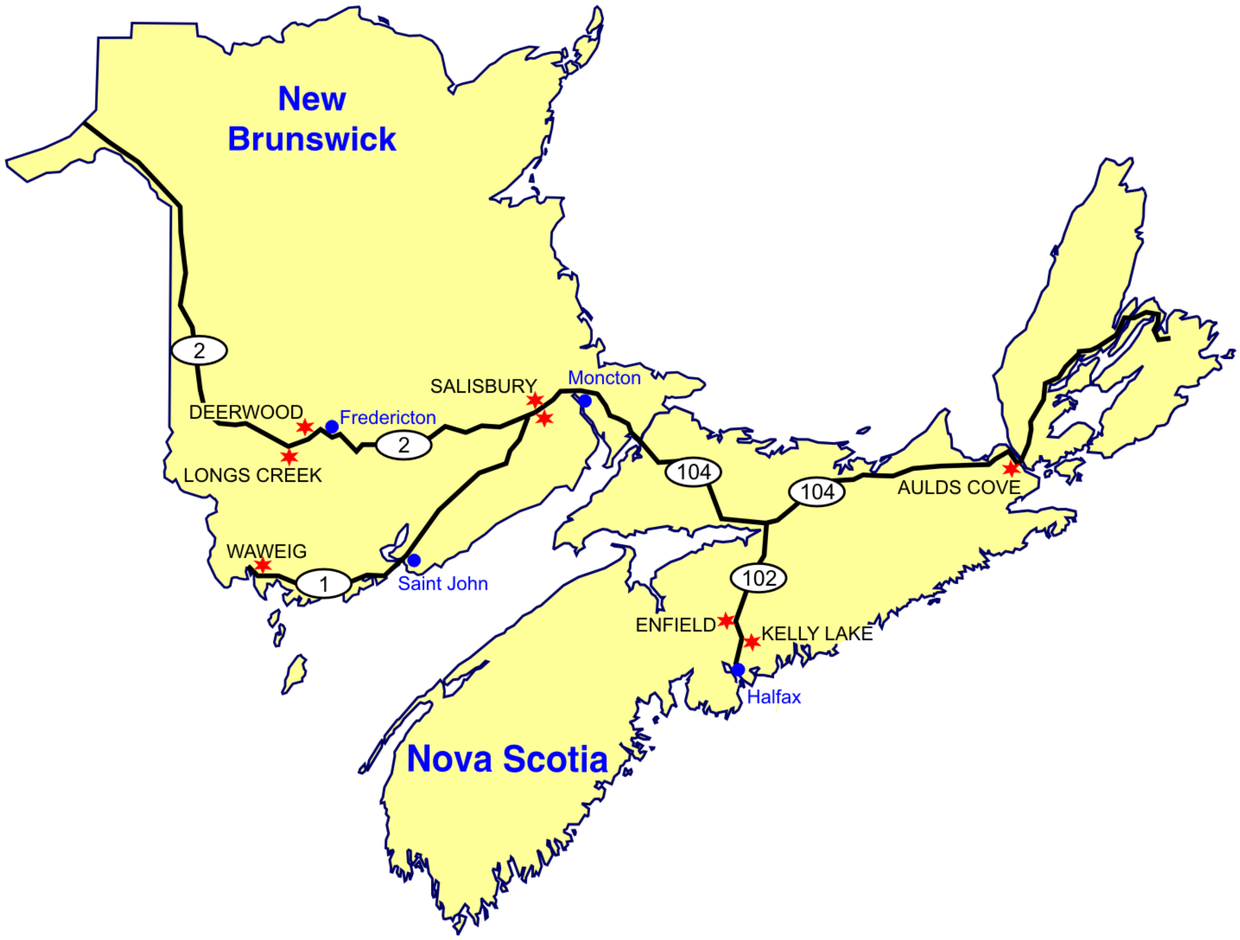

Figure 7 - WIM Sorter Locations in New Brunswick and Nova Scotia

A study at the Aulds Cove, Nova Scotia WIM site [5] indicates that prior to the installation of the WIM sorting system, in first 5 months of 2005, the station was open approximately 16 hours per day 5 days per week (1,779.5 hours over 158 day study period). During that period, all eastbound trucks were required to report when the station was open. This resulted in approximately 60 to 70 percent of eastbound truck traffic being weighed. After the WIM sorting system became operational in 2007, traffic was sampled over the same time period (January through June) with approximately 23 percent of eastbound commercial vehicles were required to report and 77 percent were allowed to bypass the station. Because vehicles under the weight limit were allowed to bypass the station, a more detailed inspection could be performed on each vehicle that was required to report. It should be noted that this reduction in the number of vehicles requiring inspection was achieved even though operations at the station were increased to an average of over 20 hours per day, 5 days per week (2293.6 hours over 158 day study period).

Improve Safety

The layout of the Aulds Cove inspection station requires that eastbound vehicles reporting to the station must make a left hand turn across the highway. Anything that reduces the number of trucks making this turn (while maintaining the objective of monitoring regulations) will produce a proportional reduction in the traffic hazard posed by large vehicles turning across the oncoming traffic.

Overweight vehicles have increased stopping distance, reduced handling and increased likelihood of mechanical failure, so by reducing the number of overweight vehicles on the highway, safety is increased.

Increase Efficiency and Productivity

By reducing the percentage of trucks that have to stop for inspection, the efficiency and productivity of commercial traffic flow past the station is increased.

In the survey conducted after the Aulds Cove WIM system was installed (5), approximately 86% of the carriers surveyed responded that the WIM system had decreased their time at the inspection station. With only 23 percent of commercial traffic that is now required to report, as opposed to the previous 60 to 70 percent, a larger number of vehicles are free to bypass the station with no delay. Of those vehicles that do have to report, because there is less traffic through the station, the delay while waiting in queue for inspection is reduced, resulting in a shorter average time at the station per vehicle.

So long as a carrier is within regulations, they can expect to be able to pass the station with no delay, this means that scheduling for departure and arrival can be done with greater accuracy, leading to increased efficiencies at the terminals.

The Aulds Cove study showed a reduction in the percentage of vehicles receiving citations for summary offences between the 2005 and the 2007 surveys, indicating an increase in the degree of compliance by commercial carriers using the highway. Citations declined from 15% of inspections (403 citations issued on 2,758 inspections) in 2005 to 11% (414 citations on 3682 inspections) in 2007 [5].

Reducing congestion at the inspection station allows inspectors the time to randomly check vehicles for three or four other operating regulations in addition to measuring vehicle weight, without incurring undue delay to the vehicle operators. The parameters that are checked include driving hours, vehicle and load safe operating condition, operator license and vehicle registration, dangerous goods and vehicle dimensions. Being able to verify that vehicles are meeting these regulations increases the safety of the commercial vehicles on the highway.

Braking to enter the inspection station and acceleration to return to the highway cause increased mechanical wear on vehicle components (tires, brakes, clutch, transmission and engine), so reducing the number of starts and stops at an inspection station can, over the life of the vehicle, results in reduced maintenance costs and down time.

Reduced Environmental Impact

Accelerating a vehicle back up to highway speed after it has stopped for inspection requires more fuel than maintaining a constant speed to travel the same distance. In addition, an engine operating at a constant highway speed produces fewer harmful emissions (CO_2, NOx, CO, unburned hydrocarbons) than an engine that is accelerating a vehicle.

A recent study in Oregon found the following reductions in emissions per million bypasses resulting from vehicles being weighed at highway speeds in normal traffic flow as compared to stopping at a conventional weigh station [3]:

- CO_2 – 583 tonnes (36.0%)

- NO_X – 5.33 tonnes (36.4%)
- CO – 1.6 tonnes (48.5 %)
- Hydrocarbons – .67 tonnes (46.3%)
- Particulate matter – .33 tonnes (67.1%)

Fuel saving was estimated at 336,000 liters per million bypasses. The travel time saving was estimated at 1.47 minutes per bypass or 24,500 hours per million vehicles.

The Oregon study was performed under ideal weighing conditions with no idling time and no starts or stops in a wait queue. In actual operating conditions, weigh stations frequently have queues of vehicles waiting to be inspected. Thus under real world conditions the time savings, decrease in fuel consumption and emissions reduction would likely be greater than indicated by the study.

The New Brunswick ITS plan (2008-2018) estimates a saving of $600,000 per year per site [6].

Reduction in Pavement Damage

Overweight vehicles are a major cause of pavement damage. As previously mentioned, the Aulds Cove study indicated a reduction of approximately 27% in the percentage of commercial traffic that received citations between the 2005 and the 2007 surveys. While the study did not differentiate between overweight vehicles and other types of violations, it may be a reasonable assumption that the proportion of citations for overweight violations for the two periods would be relatively constant. This would indicate a decline of approximately 27% in overweight vehicles, which would result in a significant reduction in pavement damage over the working life of the highway.

NEWFOUNDLAND AND LABRADOR

System Overview

The Virtual Weigh Station (VWS) systems installed on the island of Newfoundland are utilized for follow-up enforcement of commercial vehicle violations and also to continuously collect data on commercial vehicles.

The VWS sites in Newfoundland employ WIM Technology in conjunction with a camera system to obtain vehicle data. The system operates on a continuous basis, collecting vehicle images and WIM data for each vehicle that includes time and date, speed, vehicle length, axle weights, axle spacing, and vehicle classification (based on the number and spacing of axles). There are VWS sites at Port as Basques, Cormack, on the Outer Ring Road in St. John’s and on the #2 Bypass in St John’s (refer to the map in Figure 8)

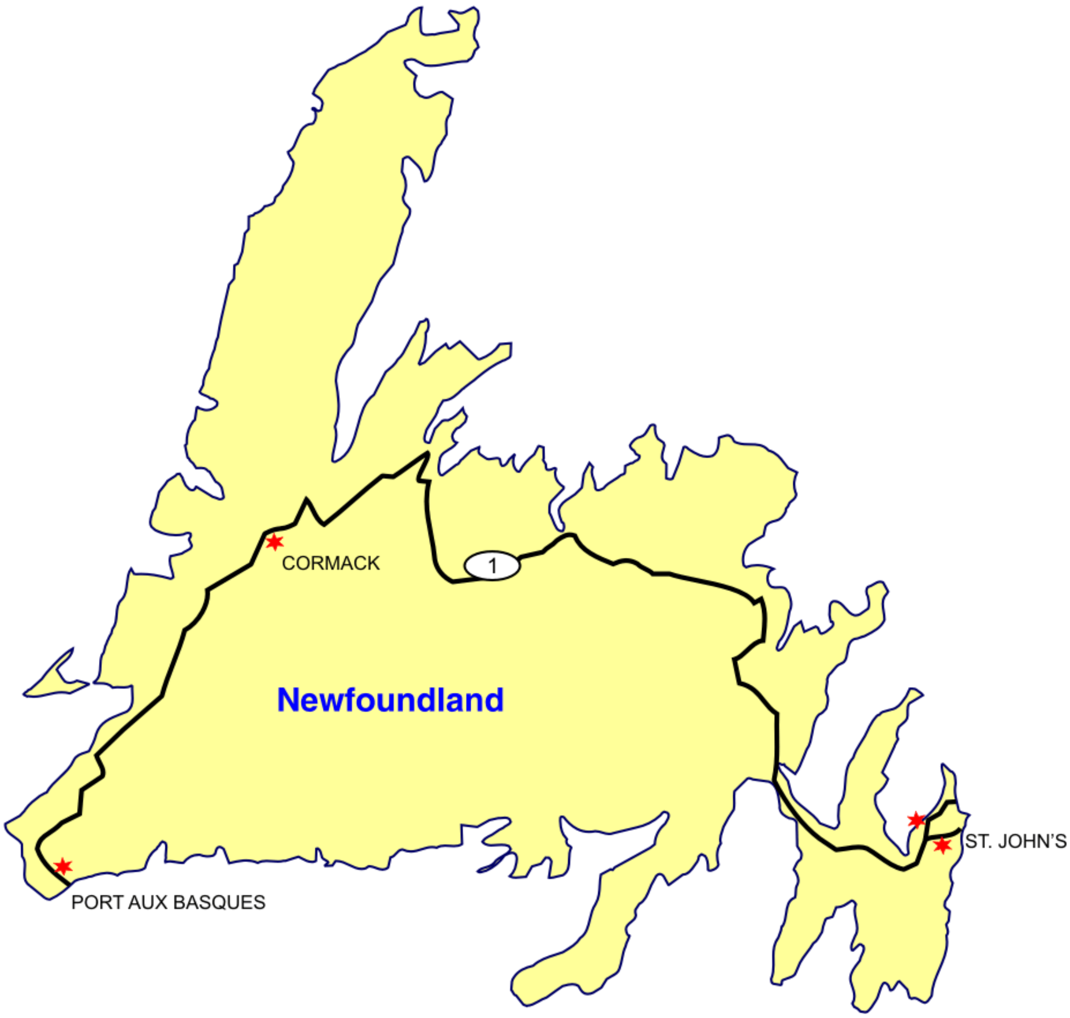

Figure 8 - VWS Locations in Newfoundland

As a vehicle travels along the roadway, it passes an array of sensors which includes Lineas® Quartz WIM sensors and inductive loops. All vehicles passing over the VWS sensors are weighed and classified (based on the number and spacing of axles).

The sensors trigger the camera sub-system to capture side view and license plate images of each vehicle as it passes over the WIM sensors and links each image with the data record for that vehicle. Based on the parameters set by the system administrator, images of commercial vehicles can be collected and stored for all vehicles, for just commercial vehicles or for only violating commercial vehicles; currently the Newfoundland system saves only pictures of violating vehicles.

The selected vehicle record data from each site is saved on site to system storage and downloaded once every 24 hours to a central database server.

From the server, the information can be viewed by any authorized personnel with secure network access. Information is displayed on a web browser. The main web page shows a listing of six vehicle images in each selected lane and site for the selected period. A detailed vehicle record of the most recent record in the selected lane is displayed at the top of the page (refer to Figure 9).

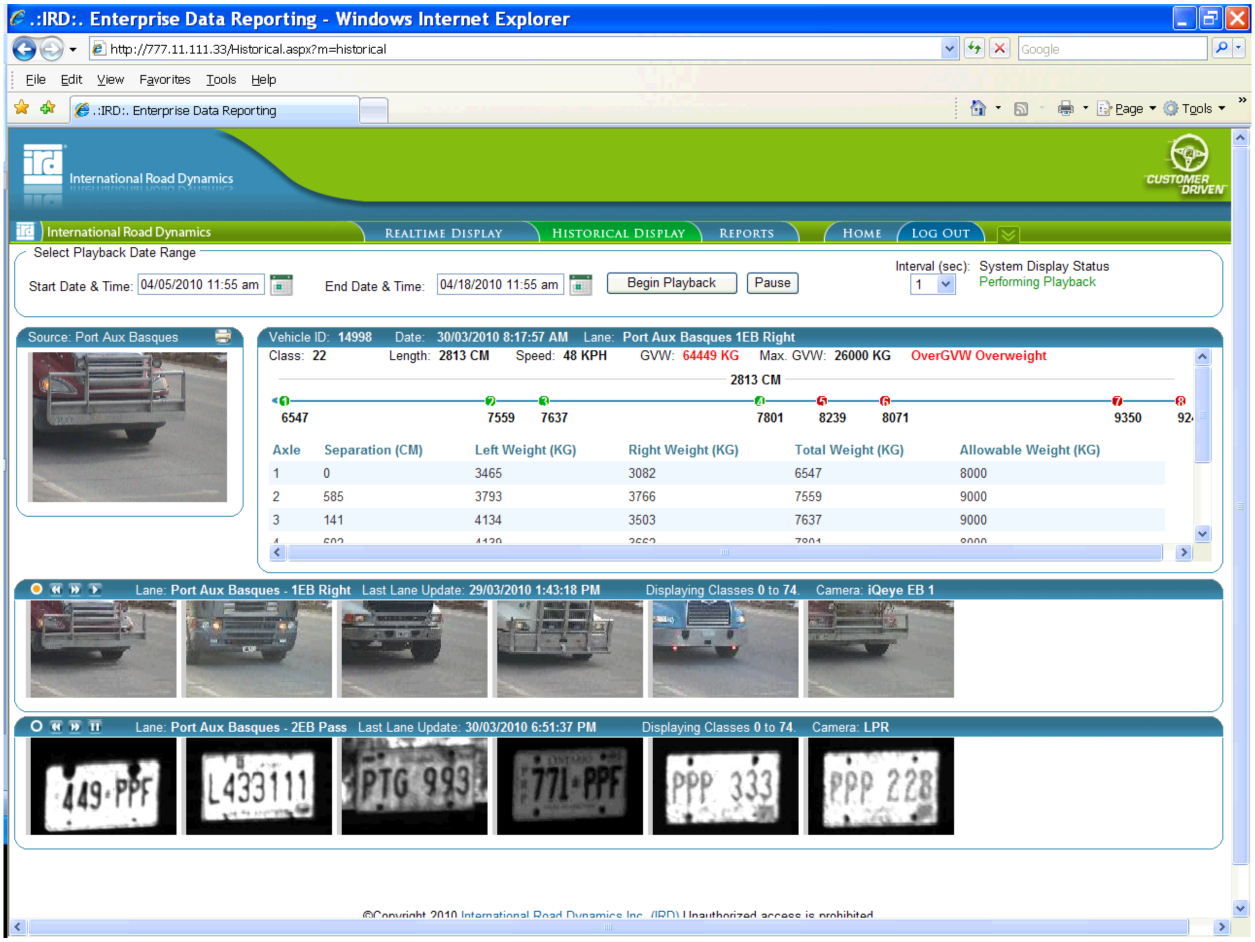

Figure 9 - Example Vehicle Record List Display

The display plays back the records for the selected period at a rate chosen by the viewer. The viewer can select any displayed record for detailed display, which will also pause the playback. Clicking the image in the detailed display opens a second web page with the detailed vehicle record information and full size images from all cameras in the lane (refer to Figure 10).

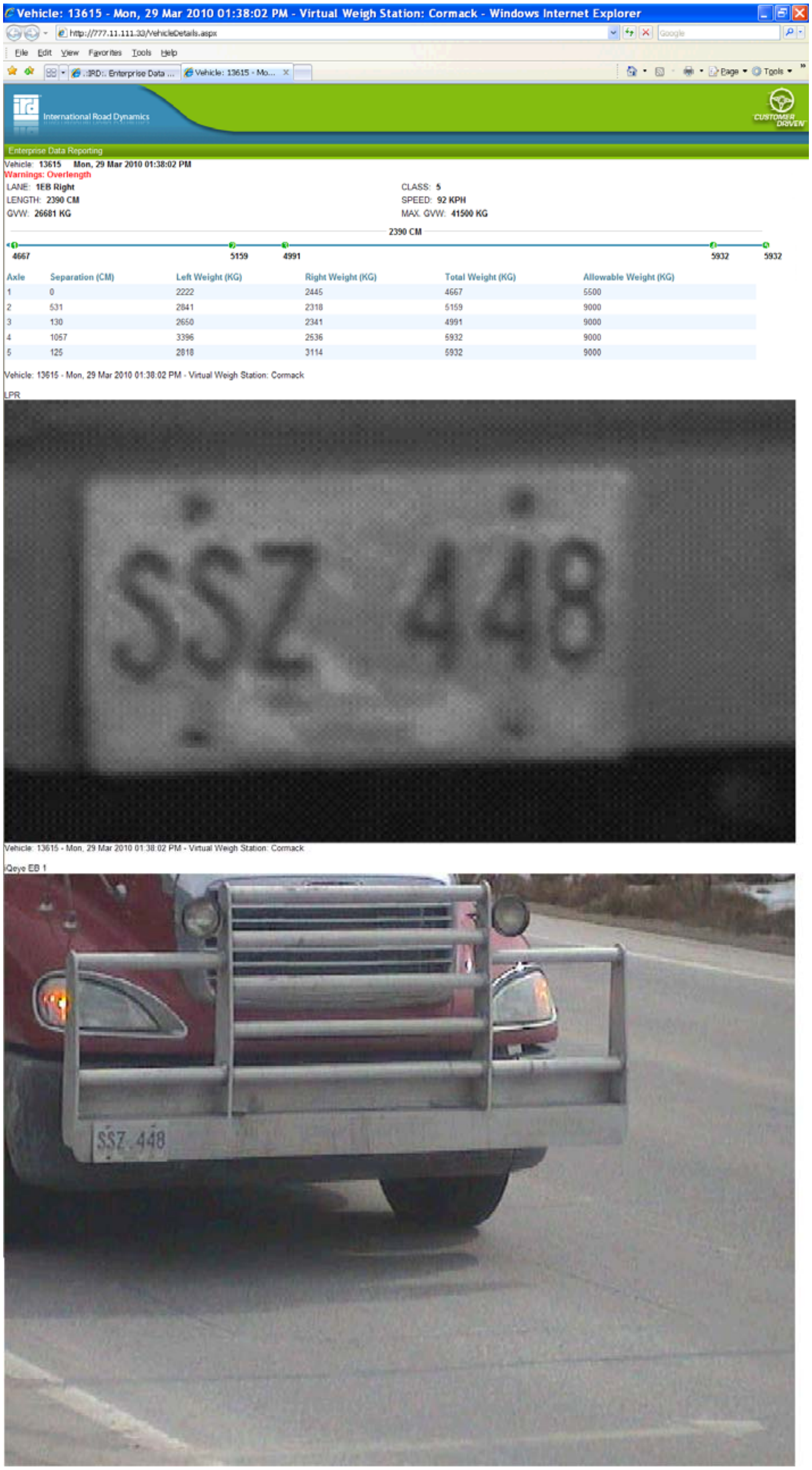

Figure 10 - Detailed Vehicle Record

The data can be filtered on a number of parameters such as site, time and date, vehicle class, or only vehicles with violations, to narrow the listing to as specific a set of vehicles as desired by the user.

The data can be used to identify carriers with “non-compliance tendencies” and follow-up actions taken for any carrier that is identified as a potential problem. Enforcement officials contact that carrier to inform them that they were observed to be in violation and may be subject to further enforcement procedures (including credential and record checks), and to encourage them to operate in compliance with regulations from this point forward.

Future plans include the addition of real time servers to the VWS. These make the vehicle records available for display within a few seconds of the vehicle passing over the VWS sensors. This will allow inspection officers to use the VWS to monitor traffic in real time and to screen traffic at a portable scale set up immediately downstream from the VWS.

In addition to the enforcement role, the stored data can be analyzed to produce reports of traffic statistics and usage patterns; the following are some potential uses of the long term data:

- Violation information can be used to determine requirements for enforcement in terms of location and time.
- Traffic volume and classification information can be used to analyze existing requirements and plan for future capacity requirements including number of lanes, type of access, and speed limits.
- Loading information can be used to evaluate pavement performance. Knowing the Equivalent Single Axle Load (ESAL) count allows for an accurate comparison of various designs.
- Loading information allows for future planning and budgeting for maintenance, rehabilitation, and reconstruction of the pavement.
- Loading information can be used to provide the design parameters for strength requirements for new construction or rehabilitation.
- Specific user defined topics of interest can be investigated by analyzing the data to produce custom reports that focus on those issues.

Conclusion

Weigh in Motion systems fit into a coordinated weight enforcement plan that includes:

- Traditional manned weigh stations
- Electronic screening (mainline and ramp sorters)
- Virtual Weigh Stations Portable spot enforcement
- Remote control weigh stations

The systems described in this paper utilize similar WIM equipment in different ways. The WIM Sorter Systems in New Brunswick and Nova Scotia and the VWS sites in Newfoundland and Labrador systems provide a method for continuous, non disruptive monitoring of commercial vehicle traffic, expanding the enforcement capabilities of the operating authorities while increasing the efficiency and productivity of both the inspectors and the carriers. In doing so, they increase traffic safety, reduce fuel consumption and harmful emissions and extend the life of the highway infrastructure.

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[3] Oregon Department of Transportation "Green Light" Emission Testing Project, 2008: http://www.oregon.gov/ODOT/MCT/docs/GreenLightEmissionTest.pdf

[4] Shaun Parkinson, John Finnie, Dennis Horn, and Robert Lottman; "A Procedure to Calculate the Economic Benefit of Increased Pavement Life That Results From Port of Entry Operations in Idaho"; paper presented to the Transportation Research Board 71st Annual Meeting, 1992

[5] Nova Scotia Department of Transportation and Infrastructure Renewal, Aulds Cove Weigh-In-Motion Evaluation Report, January 18, 2008

[6] Being A Leader With ITS - New Brunswick's Intelligent Transportation Systems (ITS) Strategic Plan 2008-2018

SPEAKER'S BIOGRAPHICAL NOTES

2010 TAC Annual Conference

September 26-29

Halifax, Nova Scotia

Name: **Randy Hanson**

Paper Title: **ITS Technologies for Commercial Vehicle Compliance in the Maritimes**

Session: **Innovative Ways to Increase Traffic Safety and Efficiency**

Biographical Notes:

Randy Hanson graduated with a Bachelor of Electrical Engineering from the University of Saskatchewan in 1977. Randy has been a consultant and project manager with IRD since 1998 and Executive Vice-President since 2000. He has managed IRD corporate operations during a period of substantial change and growth, identifying and implementing significant changes to internal processes to increase profits through improved effectiveness while reducing project and administrative costs. He has directed the expansion of engineering, manufacturing and the customer service network to satisfy corporate growth objectives. He served as an officer in the Canadian Navy and was assigned to leadership positions as a Combat Systems Engineer in both the Regular and Reserve Forces with numerous Commendations, Canada Decoration and promotion to Naval Commander.

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Name: **Randy Hanson**

Paper Title: **Real World Applications of Virtual Weigh Stations**

Session: **ITS Technologies for Commercial Vehicle Compliance in the Maritimes**