Innovations in Central Data Management for Truck Compliance and Mobility - Vehicle Information in Motion

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Abstract

Truck Compliance monitoring has matured in the US and elsewhere and is an important ITS application. To date, most data processing occurs at the local Station on the road. Centralized data access is used for offline statistical processing if at all. The value of the information collected at sites such as Weigh-In-Motion stations is currently underappreciated. This paper shows the benefits to use the information collected via current and upcoming technological solutions to not only improve the underlying operations (e.g. truck compliance checks), but also contribute to solving bigger challenges arising today in the area of freight transportation and mobility, such as lack of consistency of freight data, providing linkages across network segments, and integrating other data sources to obtain a more complete picture of truck and freight movements. Centralized data collection solutions can improve truck mobility and thereby freight mobility via a larger data sample, more complete data with enhanced data security and improved access for authorized parties to the data and the information being created through analysis. Utilizing these solutions will also improve safety on our road network, on the freeway network as well as in urban environments, playing a key role in future Smart City applications.

KEYWORDS

Truck Compliance Station, Weigh-In-Motion, Performance Measurement

Introduction

Truck Compliance Systems measure and identify trucks, commonly on highways, and check against a set of parameters, which typically include axle and gross vehicle weight, but also non-physical attributes that identify specific trucks such as License Plate, US DOT number etc. The parameters are checked against credentials obtained through FMCSA's ITD (Innovative Technology Deployment) program, formerly CVISN. Bypass credentials are also based on carrier opt-in services that allow trucks to bypass a compliance station depending on pre-established credentials. Nationwide electronic pre-screening and bypass services for carriers in the US are Prepass, NORPASS, and Drivewyze.

Given the multitude of possible scenarios at a Truck Compliance or Weigh Station, the details of information available as a result of the screening process are often different from Station to Station. Two typical station scenarios are shown in Figures 1 and 2 below that show the multitude and location of available sources of data.

Data and information obtained during the compliance checks and screening operations can be used for several main purposes;

- Real-time operations
- Online operation and performance monitoring
- Offline Analysis

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An important question is: where are the different sets of information used today in the process, and where will they be of benefit tomorrow? This question relates directly to availability of data and information at a central level – be it a State DOT headquarter, a regional operations centre, or another centralized locale.

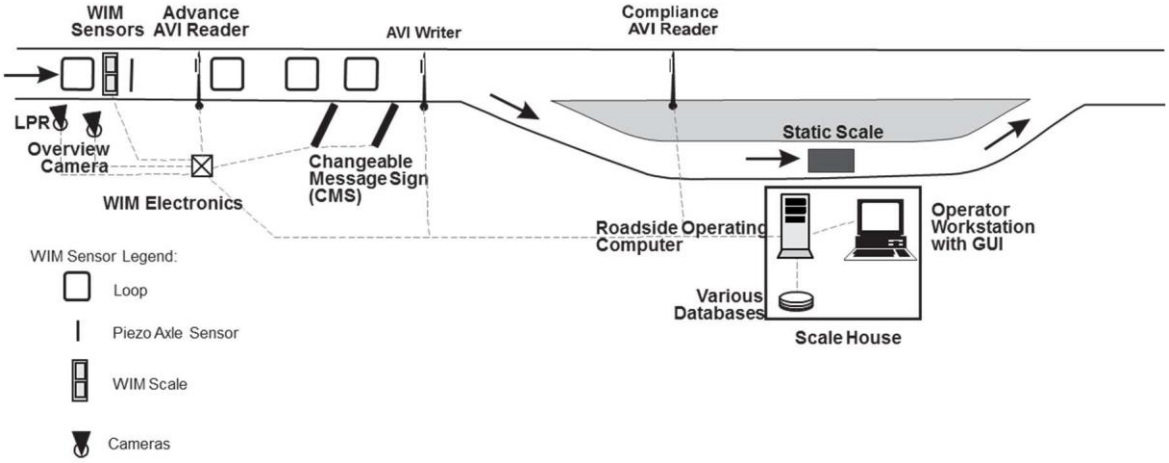

Figure 1 Mainline Pre-Screening Scenario

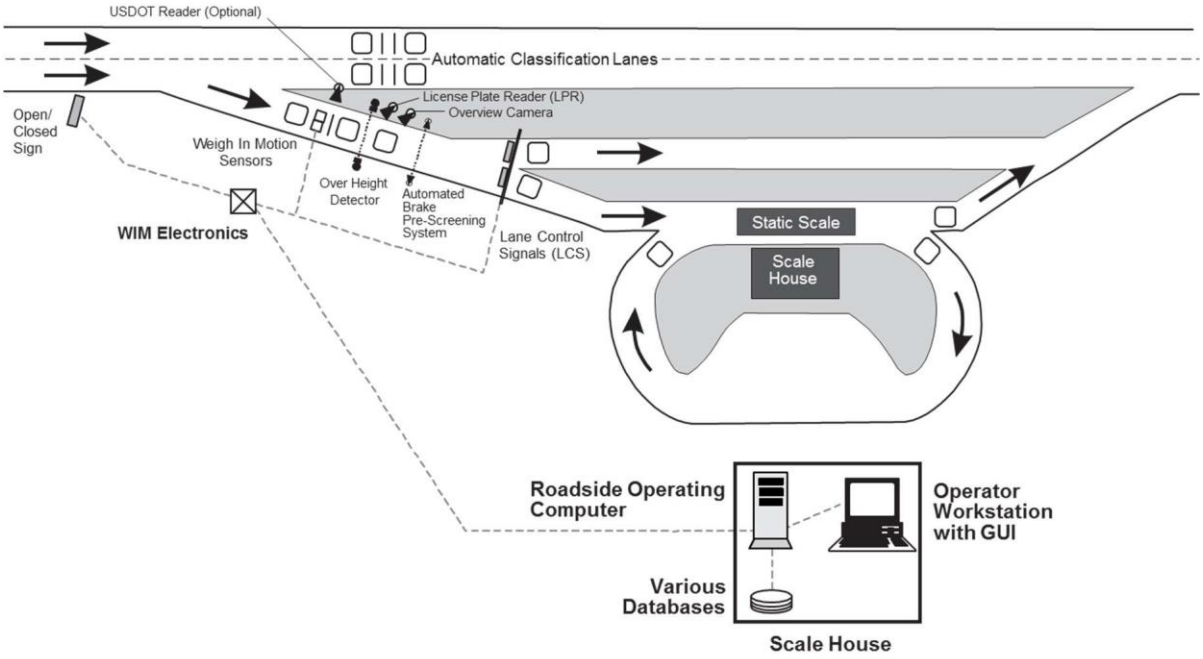

Figure 2 Ramp Screening Scenario

While in Scenario 1 trucks are screened on the main line, and any truck exiting the highway has to go on a static scale, in Scenario 2 trucks are screened on the ramp, and can still bypass the actual static scale based upon sorting criteria. In both cases a local roadside operating computer coordinates the operations, including informing the driver via Changeable Message Signs or Lane Use Signals on whether he or she is cleared to bypass, needs to be weighted or has to undergo other size and safety compliance inspections.

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Distribution of Control – Local Station and Central Office

Current Status

Typically, the main use of the data created locally during screening operations is to affect the real-time operations at the Compliance Station - i.e. to pass or not to pass. A truck needs to be informed within seconds of passing a WIM scale whether it must exit for further screening and possibly inspection. The operator at the Roadside Operating Computer monitors the screening operations using a local Operating Computer and can override system decisions.

The main communication to external systems is the offline download of credential information to the Roadside Operating Computer. As Compliance Stations are often located remotely, reliable communication to a central location cannot be always guaranteed. Therefore, to date, remote online monitoring of the operational status at a Compliance Station or even real-time operations making sorting decisions from afar are not common or often not even feasible.

Finally, offline analysis typically may be performed at a Central Location where statistical analysis is performed against a data set that is uploaded over night from the respective Stations as a file transfer.

Current Trends

While real-time operation will continue to be performed locally at a Truck Compliance Station, online monitoring may well be performed remotely if reliable communication to a central location is available. Such monitoring can monitor the technical performance and operation of the equipment, but it can also monitor the operational performance of the system – how well is the overall system achieving its goals. For a Truck Compliance System, operational performance may be measured in several areas. Potential questions of interest are:

- What is the percentage of screened trucks that are told to bypass (yesterday or in the previous 2 hours)
- What is the percentage of trucks flagged that ended up being inspected
- What is the percentage of trucks flagged that did not exit (violators)
- How long did the processing of a truck take on average (with the specifics of ‘processing’ to be defined on a scenario by scenario basis)

Questions such as these address Performance Measurement of Truck Compliance Stations. Performance Measurement solutions are increasingly being deployed in other ITS areas, measuring the performance of the transportation infrastructure against Key Performance Indicators (KPI’s such as average travel time, number of incidents etc. Providing performance measurement solutions to the truck compliance process can increase transparency and accountability, thereby setting the foundation for process improvements.

Providing an effective performance measurement solution requires reliable communication to a central location. At the least, overnight file transfer to a central office allows the establishment of a centralized view of operations at multiple sites for historical analysis. At this point, States mostly use the central data repository to run offline statistical reports, such as Classification by Hour. Those reports have been developed over the years and provide valuable information; they also satisfy Federal reporting requirements. Adding performance measurement analysis will provide additional valuable information for operators and decision makers; it may move the needle from having to create a report because it is required to actually wanting to do so, as it may result in actionable information.

While most current analysis and monitoring is done on a site by site basis, the next step is to look at information on a network level. As noted during this year’s TRB conference at the ABJ92T Task Force on Big Data in Freight Transportation meeting, there are several large data gaps, notably that of consistency of regional truck classification counts, and of overall data collection. Collecting data including classification counts consistently at a central location will help to alleviate these gaps.

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Future Enhancements

A network wide view of the truck compliance stations for monitoring and offline analysis of the operations will provide operational and planning benefits to DOT's and transportation agencies. Even more benefits can be expected once an additional focus on the physical truck movements is added. Another noted data gap during the 2016 TRB Annual Conference was the lack of origin-destination data by commodity of vehicle, as well as the lack of lower granularity information on the individual trucks. The more information that is available, the more centralized information can eventually support freight mobility.

DOT's also have an interest in the truck movements along the road network. Some DOT's are interested in collecting information on truck movements on secondary roads, as trucks bypass congested freeways. Those roads typically do not have truck compliance stations; travel time information collected through other means (Bluetooth data, travel time information obtained through 3rd parties that use GPS and cell phone probe information) does not adequately separate truck from passenger vehicle traffic. Having one network view of truck movements can benefit the carriers, the public transportation agencies as well as the driving public.

Having this information available at a central location allows the creation of powerful analytics solutions that eventually support what-if-scenarios, provide decision support for DOT's and allow integration with upcoming Vehicle-to-Infrastructure solutions towards an Automated Highway System. Figure 3 shows a high-level architecture of a Central Data Collection System that supports the above-mentioned scenarios – putting "vehicle information in motion".

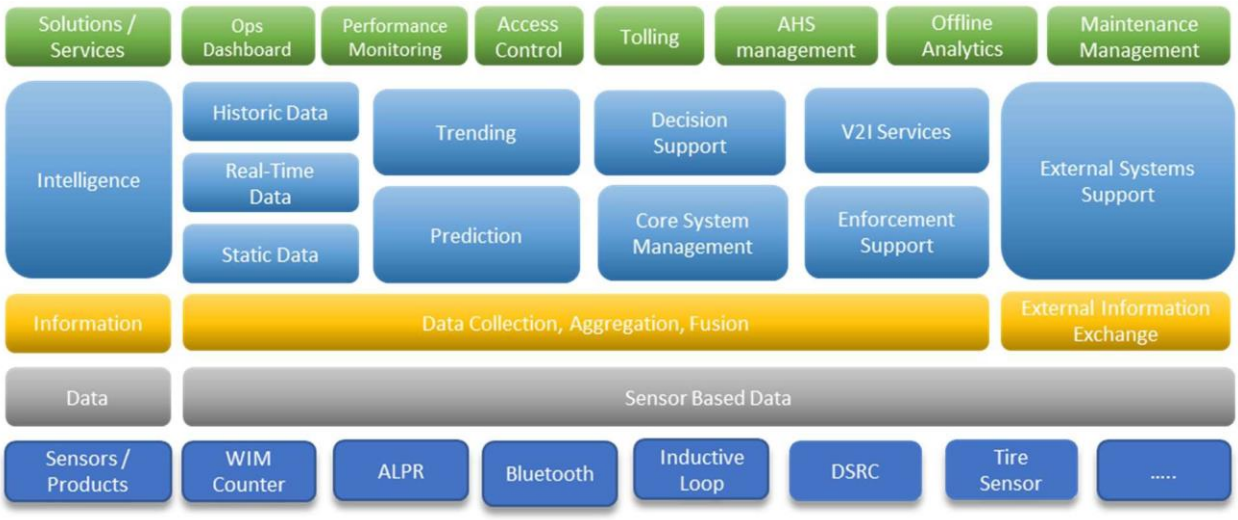

Figure 3 Central Data Collection System in the Context of Truck Mobility

Central Data Collection in the Context of Smart Urban Mobility

In addition to providing valuable information for DOT's for operational improvements and transportation planning, collecting data on truck compliance at specific locations (Stations) as well as on their mobility (tracking through the network) also provides benefits for Urban Mobility. FHWA's Smart City Initiative explicitly named Urban Delivery and Logistics as one of the High Priority Vision Elements. The Smart City Challenge Finalists did address this Vision Element through different approaches, realizing the benefits of improved urban freight logistics for urban mobility. Given the interconnection between the highway system and urban roads in our larger metropolitan areas, providing accurate information on truck movements (from weight compliance to classification) will improve integrated transportation management in those cities. This

can occur within the context of Smart City projects, Smart Regions or States, Integrated Corridor Management projects, and any scenario where truck movements affect overall urban mobility. Truck signal priority is one example of innovative solutions for identified freight priority corridors, e.g. near ports or logistics centres.

Safety – the Final Frontier

Collecting data on individual trucks and their compliance with State or local rules and laws directly improves safety. In addition to axle, gross vehicle weight measurements credential and operating authority checks, recent technological advances allow the measurement of additional truck specific attributes that will have an additional safety benefit. It is now possible to collect tire specific information while trucks are passing a dedicated tire pressure sensor at highway speeds. Such a sensor can detect whether a tire is missing, is overinflated or underinflated, and differentiate single, double and super single tires, thereby providing highly valuable safety information for the DOT's and transportation agencies. The following images show the visualization of tire pressure measurement and the use of that information in an anomaly detection system.

Figure 4 2D plot of Tire Pressure for a 4 Axle Truck

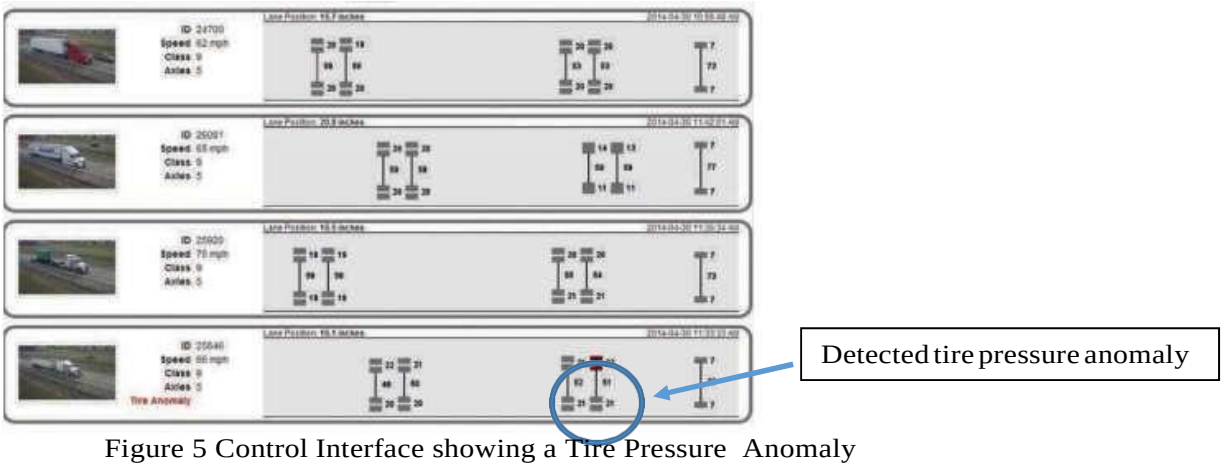

Figure 5 Control Interface showing a Tire Pressure Anomaly

This information can be added to a truck compliance check at a Truck Compliance Station as an additional screening criteria (see Figure 6), or it can be provided on a standalone basis (See figure 7).

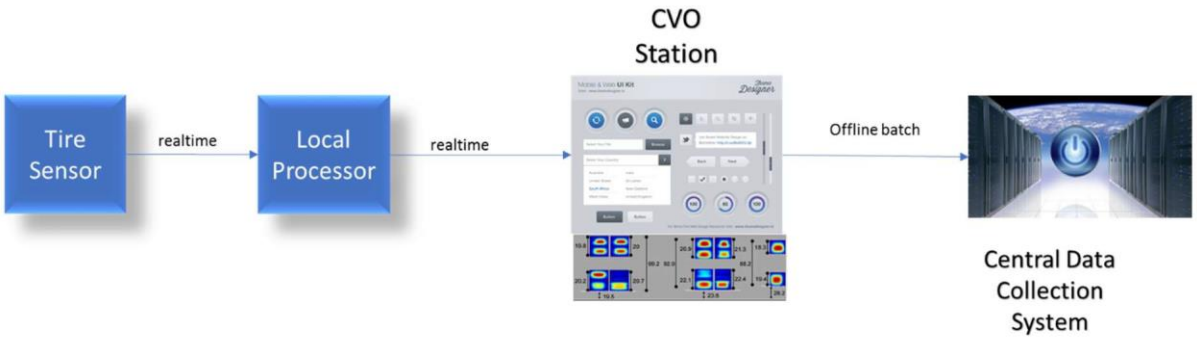

Figure 6 Tire Pressure Monitoring Integrated in Truck Compliance Check

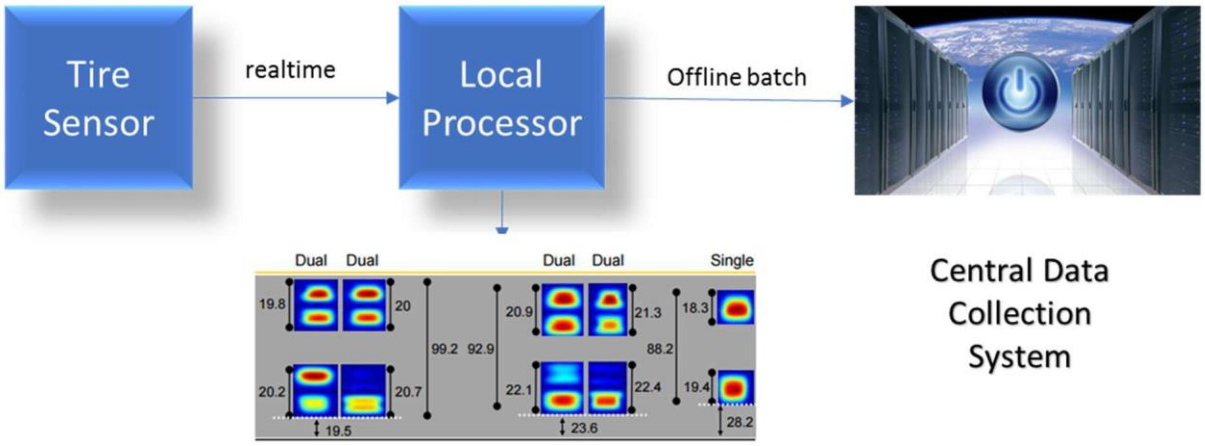

Figure 7 Standalone Tire Pressure Monitoring

This information will immediately provide safety benefits where it is used to prevent tire failures before they occur. Preventive checks also are expected to be of interest to private entities, from logistics companies looking for yard management efficiency improvements, to ports, boarders etc.

Conclusion

Truck compliance data is currently being collected locally and used at a central location for offline statistical analysis. Integrating several truck compliance stations into a network wide view allows for network wide reports and analysis. Adding network wide performance measurement will improve operational efficiency, and increase transparency and accountability. Additional data sources such as tire pressure sensors will add more valuable data points for monitoring, improving transportation safety. This applies to highway as well as urban environments – in the case of the latter, directly supporting the smart city vision. All of this requires a centralized data management – providing information and actionable intelligence. Current developments to create additional data, centrally collect these and combine them with other existing truck and freight related data set, and to provide enhanced analytics will contribute to improved Integrated Mobility.